IAR Embedded Workbench® IDE

User Guide

UEW-9

IAR SYSTEMS

EDITION NOTICE

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Brief contents

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Preface

Welcome to the *IAR Embedded Workbench IDE User Guide*. The purpose of this guide is to help you fully use the features in IAR Embedded Workbench with its integrated Windows development tools. The IAR Embedded Workbench IDE is a very powerful Integrated Development Environment that allows you to develop and manage a complete embedded application project.

This guide describes the processes of editing, project managing, building, and debugging. The guide also includes reference information, as well as tutorials that will help you get started.

Who should read this guide

Read this guide if you want to get the most out of the features and tools available in the IDE. In addition, you should have working knowledge of:

- The C or C++ programming language
- Application development for embedded systems
- The architecture and instruction set of the processor (refer to the chip manufacturer's documentation)
- The operating system of your host computer.

For more information about the other development tools incorporated in the IDE, refer to their respective documentation, see *Other documentation*, page xxxvii.

How to use this guide

If you are new to using this product, we suggest that you first read the guide *Getting Started with IAR Embedded Workbench®* for an overview of the tools and the features that the IDE offers.

If you already have had some experience using IAR Embedded Workbench, but need refreshing on how to work with the IAR Systems development tools, *Part 1. Tutorials*, page 1 is a good place to begin. The process of managing projects and building, as well as editing, is described in *Part 2. Project management and building*, page 51, whereas information about how to use C-SPY for debugging is described in *Part 3. Debugging*, page 89.

If you are an experienced user and need this guide only for reference information, see the reference chapters in *Part 5. Reference information* and the online help system available from the IAR Embedded Workbench IDE **Help** menu.

Finally, we recommend the *Glossary* if you should encounter any unfamiliar terms in the IAR Systems user and reference guides.

SOME DESCRIPTIONS DO NOT APPLY TO YOUR PRODUCT

This guide describes the IDE and the C-SPY debugger, which are generic components.

However, some functionality and some tools described do not apply to all IAR Embedded Workbench product packages, for example:

- Not all product packages support C++
- IAR Embedded Workbench includes either the IAR ILINK Linker or the IAR XLINK Linker
- IAR Embedded Workbench includes either the IAR DLIB Library, the IAR CLIB Library, or both
- Not all product packages support invoking flash loaders based on the IAR flash loader mechanism.

Descriptions that do not apply to all product packages have a brief disclaimer.

For a list of components used in your product package, see the Information Center.

Filename extensions

Depending on whether your IAR Embedded Workbench comes with the IAR XLINK Linker or the IAR ILINK Linker, different sets of filename extensions will be used. In this guide, all filename extensions in examples and in screenshots reflect the XLINK linker. This table maps the different sets of filename extensions:

Type of file	Filename extension for products with XLINK*	Filename extension for products with ILINK
Target application	`a`*`xx`*	`out`
Target application with debug information	`d`*`xx`*	`out`
Object module	`r`*`xx`*	`o`
Library module	`r`*`xx`*	`a`
Assembler source code	`s`*`xx`* or `s`	`s`

Table 1: Filename extensions in XLINK versus ILINK

***** *`xx`* **is a numeric part that represents your product package.**

For a complete list of filename extensions, see *File types*, page xliv.

The terms segment versus section

An object such as a variable or a function is in the UBROF object format—used by the XLINK linker—represented by a *segment*. In the ELF object format—used by the ILINK linker—such an object is represented by a *section*. Whenever these two terms are used in this guide, they relate to XLINK and ILINK, respectively.

What this guide contains

This is a brief outline and summary of the chapters in this guide. Some chapters only apply to certain versions of the IAR Embedded Workbench IDE, partly or in their entirety.

Part 1. Tutorials

The tutorials give you hands-on training to help you get started with using the tools:

- *Creating an application project* guides you through setting up a new project, compiling your application, examining the list file, and linking your application. The tutorial demonstrates a typical development cycle, which is continued with debugging in the next chapter.
- *Debugging using the IAR C-SPY Debugger* explores the basic facilities of the debugger.
- *Mixing C and assembler modules* demonstrates how you can easily combine source modules written in C with assembler modules. The chapter also demonstrates how to use the compiler for examining the calling convention.
- *Using C++* shows how to create a C++ class, which creates two independent objects. The application is then built and debugged. This chapter only applies to product packages with C++ support.
- *Simulating an interrupt* shows how to add an interrupt handler to the project and how to simulate this interrupt, using C-SPY facilities for simulated interrupts, breakpoints, and macros.
- *Creating and using libraries* demonstrates how to create library modules.

Part 2. Project management and building

This section describes the process of editing and building your application:

- *The development environment* introduces you to the IAR Embedded Workbench development environment. The chapter also demonstrates the facilities available for customizing the environment to meet your requirements.

- *Managing projects* describes how you can create workspaces with multiple projects, build configurations, groups, source files, and options that helps you handle different versions of your applications.
- *Building* discusses the process of building your application.
- *Editing* contains detailed descriptions about the IAR Embedded Workbench editor, how to use it, and the facilities related to its usage. The final section also contains information about how to integrate an external editor of your choice.

Part 3. Debugging

This section gives conceptual information about C-SPY functionality and how to use it:

- *The IAR C-SPY Debugger* introduces some of the concepts that are related to debugging in general and to the IAR C-SPY Debugger in particular. It also introduces you to the C-SPY environment and how to setup, start, and configure the debugger to reflect the target hardware.
- *Executing your application* describes how you initialize C-SPY, the conceptual differences between source and disassembly mode debugging, the facilities for executing your application, and finally, how you can handle terminal input and output.
- *Working with variables and expressions* defines the syntax of the expressions and variables used in C-SPY, as well as the limitations on variable information. The chapter also demonstrates the various methods for monitoring variables and expressions.
- *Using breakpoints* describes the breakpoint system and the various ways to define breakpoints.
- *Monitoring memory and registers* shows how you can examine memory and registers.
- *Using the C-SPY® macro system* describes the C-SPY macro system, its features, the purposes of these features, and how to use them.
- *Analyzing your application* presents facilities for analyzing your application.

Part 4. The C-SPY® Simulator

- *Simulator-specific debugging* describes the functionality specific to the simulator.
- *Simulating interrupts* contains detailed information about the C-SPY interrupt simulation system and how to configure the simulated interrupts to make them reflect the interrupts of your target hardware.

Part 5. Reference information

- *IAR Embedded Workbench IDE reference* contains detailed reference information about the development environment, such as details about the graphical user interface.
- *C-SPY reference* provides detailed reference information about the graphical user interface of the IAR C-SPY Debugger.
- *General options* specifies the target, output, library, and MISRA C options.
- *Compiler options* specifies compiler options for language, optimizations, output, list file, preprocessor, diagnostics, and MISRA C.
- *Assembler options* describes the assembler options for language, output, list, preprocessor, and diagnostics.
- *Converter options* describes the options available for converting linker output files from the ELF format. These options are only available if your product package includes the IAR ILINK Linker.
- *Custom build options* describes the options available for custom tool configuration.
- *Build actions options* describes the options available for pre-build and post-build actions.
- *XLINK linker options* describes the options for setting up for linking using the XLINK linker.
- *ILINK linker options* describes the options for setting up for linking using the ILINK linker.
- *Library builder options* describes the options for building a library.
- *Debugger options* gives reference information about generic C-SPY options.
- *The C-SPY Command Line Utility—cspybat* describes how to use the debugger in batch mode.
- *C-SPY® macros reference* gives reference information about C-SPY macros, such as a syntax description of the macro language, summaries of the available setup macro functions, and pre-defined system macros. Finally, a description of each system macro is provided.

Other documentation

User documentation is available as hypertext PDFs and as a context-sensitive online help system in HTML format. You can access the documentation from the Information Center or from the **Help** menu in the IAR Embedded Workbench IDE. The online help system is also available via the F1 key.

The context-sensitive online help contains reference information about the menus and dialog boxes in the IDE. It also contains keyword reference information for the DLIB library functions. To obtain reference information for a function, select the function name in the editor window and press F1. Note that if you select a function name in the editor window and press F1 while using the CLIB library, you will get reference information for the DLIB library.

USER AND REFERENCE GUIDES

The complete set of IAR Systems development tools are described in a series of guides. For information about:

- Getting started using IAR Embedded Workbench and the tools it provides, refer to the guide *Getting Started with IAR Embedded Workbench®* .
- System requirements and information about how to install and register the IAR Systems products, refer to the booklet *Quick Reference* (available in the product box) and the *Installation and Licensing Guide*.
- Programming for the IAR C/C++ Compiler, refer to the *IAR C/C++ Compiler Reference guide* if your product package includes the IAR XLINK Linker, and the *IAR C/C++ Development Guide, compiling and linking* if your product package includes the IAR ILINK Linker.
- Using the IAR XLINK Linker, the IAR XAR Library Builder, and the IAR XLIB Librarian, refer to the *IAR Linker and Library Tools Reference Guide.* This guide is only available if your product package includes the IAR XLINK Linker.
- Programming for the IAR Assembler, refer to the *IAR Assembler Reference Guide.*
- Using the IAR DLIB Library, refer to the *DLIB Library Reference information*, available in the IDE online help system. This documentation is only available if your product package includes the DLIB library.
- Using the IAR CLIB Library, refer to the *IAR C Library Functions Reference Guide*, available in the IDE online help system. This guide is only available if your product package includes the CLIB library.
- Developing safety-critical applications using the MISRA C guidelines, refer to the *IAR Embedded Workbench® MISRA C:2004 Reference Guide* or the *IAR Embedded Workbench® MISRA C:1998 Reference Guide*.

Note: Additional documentation might be available depending on your product installation.

WEB SITES

Recommended web sites:

- The chip manufacturer's web site, contains information and news about the microcontroller.

- The IAR Systems web site, **www.iar.com**, holds application notes and other product information.
- Finally, the Embedded C++ Technical Committee web site, **www.caravan.net/ec2plus**, contains information about the Embedded C++ standard.

Document conventions

When, in this text, we refer to the programming language C, the text also applies to C++, unless otherwise stated.

When referring to a directory in your product installation, for example `*cpuname*\doc`, the full path to the location is assumed, for example `c:\Program Files\IAR Systems\Embedded Workbench 5.*n*\*cpuname*\doc`.

TYPOGRAPHIC CONVENTIONS

This guide uses the following typographic conventions:

Style	Used for
`computer`	• Source code examples and file paths. • Text on the command line. • Binary, hexadecimal, and octal numbers.
`parameter`	A placeholder for an actual value used as a parameter, for example *`filename`*`.h` where *`filename`* represents the name of the file. Note that this style is also used for *`cpuname`*, *`configfile`*, *`libraryfile`*, and other labels representing your product, as well as for the numeric part of filename extensions—*`xx`*.
`[option]`	An optional part of a command.
`a|b|c`	Alternatives in a command.
`{a|b|c}`	A mandatory part of a command with alternatives.
bold	Names of menus, menu commands, buttons, and dialog boxes that appear on the screen.
italic	• A cross-reference within this guide or to another guide. • Emphasis.
…	An ellipsis indicates that the previous item can be repeated an arbitrary number of times.
🛠	Identifies instructions specific to the IAR Embedded Workbench® IDE interface.
🖥	Identifies instructions specific to the command line interface.

Table 2: Typographic conventions used in this guide

Style	Used for
💡	Identifies helpful tips and programming hints.
⚠	Identifies warnings.

Table 2: Typographic conventions used in this guide (Continued)

NAMING CONVENTIONS

The following naming conventions are used for the products and tools from IAR Systems® referred to in this guide:

Brand name	Generic term
IAR Embedded Workbench® for *CPUNAME*	IAR Embedded Workbench®
IAR Embedded Workbench® IDE for *CPUNAME*	the IDE
IAR C-SPY® Debugger for *CPUNAME*	C-SPY, the debugger
IAR C-SPY® Simulator	the simulator
IAR C/C++ Compiler™ for *CPUNAME*	the compiler
IAR Assembler™ for *CPUNAME*	the assembler
IAR XLINK Linker™	XLINK, the linker
IAR ILINK Linker™	ILINK, the linker
IAR XAR Library Builder™	the library builder
IAR XLIB Librarian™	the librarian
IAR DLIB Library™	the DLIB library
IAR CLIB Library™	the CLIB library

Table 3: Naming conventions used in this guide

Note that all of these products and tools might not be available in the product package you are using.

Installed files

This chapter describes which directories are created during installation and what file types are used.

Directory structure

The installation procedure creates several directories to contain the various types of files used with the IAR Systems development tools. The following sections give a description of the files contained by default in each directory.

ROOT DIRECTORY

The root directory created by the default installation procedure is the `x:\Program Files\IAR Systems\Embedded Workbench 6.n\` directory where *x* is the drive where Microsoft Windows is installed and `6.n` is the version number of the IDE.

In the root directory, there are two subdirectories—`common` and one named after the processor you are using. The latter directory will hereafter be referred to as *cpuname*.

THE *CPUNAME* DIRECTORY

The *cpuname* directory contains all product-specific subdirectories.

Directory	Description
cpuname`\bin`	The *cpuname*`\bin` subdirectory contains executable files for target-specific components, such as the compiler, the assembler, the linker and the library tools, and the C-SPY® drivers.
cpuname`\config`	The *cpuname*`\config` subdirectory contains files used for configuring the development environment and projects, for example: • Linker configuration files (`*.xcl` for XLINK)(`*.icf` for ILINK) • Special function register description files (`*.sfr`) • C-SPY device description files (`*.ddf`) • Device selection files (`*.ixx`, `*.menu`) • Flash loader applications for various devices (`*.dxx`), depends on your product version • Syntax coloring configuration files (`*.cfg`) • Project templates for both application and library projects (`*.ewp`), and for the library projects, the corresponding library configuration files.

Table 4: The CPUNAME directory

Directory	**Description**
cpuname\doc	The *cpuname*\doc subdirectory contains release notes with recent additional information about the tools. We recommend that you read all of these files. The directory also contains online versions in hypertext PDF format of this user guide, and of the reference guides, as well as online help files (*.chm). The directory also contains an online version in PDF format of the *IAR Linker and Library Tools Reference Guide* (only for the XLINK linker).
cpuname\drivers	The *cpuname*\drivers subdirectory contains low-level device drivers, typically USB drivers required by the C-SPY drivers.
cpuname\examples	The *cpuname*\examples subdirectory contains files related to example projects, which can be opened from the Information Center.
cpuname\inc	The *cpuname*\inc subdirectory holds include files, such as the header files for the standard C or C++ library. There are also specific header files that define special function registers (SFRs); these files are used by both the compiler and the assembler.
cpuname\lib	The *cpuname*\lib subdirectory holds prebuilt libraries and the corresponding library configuration files, used by the compiler.
cpuname\plugins	The *cpuname*\plugins subdirectory contains executable files and description files for components that can be loaded as plugin modules.
cpuname\powerpac	The *cpuname*\powerpac subdirectory contains files related to the add-on product IAR PowerPac. This directory is only available if you have installed IAR PowerPac.
cpuname\src	The *cpuname*\src subdirectory holds source files for some configurable library functions. This directory also holds the library source code and the source code for ELF utilities (the latter only for the ILINK linker). If your product package includes the XLINK linker, the directory also contains source files for components common to all IAR Embedded Workbench products, such as a sample reader of the IAR XLINK Linker output format SIMPLE.
cpuname\tutor	The *cpuname*\tutor subdirectory contains the files used for the tutorials in this guide.

Table 4: The CPUNAME directory (Continued)

THE COMMON DIRECTORY

The `common` directory contains subdirectories for components shared by all IAR Embedded Workbench products.

Directory	Description
`common\bin`	The `common\bin` subdirectory contains executable files for components common to all IAR Embedded Workbench products, such as the editor and the graphical user interface components. The executable file for the IDE is also located here.
`common\config`	The `common\config` subdirectory contains files used by the IDE for settings in the development environment.
`common\doc`	The `common\doc` subdirectory contains release notes with recent additional information about the components common to all IAR Embedded Workbench products, such as the linker and library tools. We recommend that you read these files.
`common\plugins`	The `common\plugins` subdirectory contains executable files and description files for components that can be loaded as plugin modules, for example modules for Code coverage and Profiling.

Table 5: The common directory

THE INSTALL-INFO DIRECTORY

The `install-info` directory contains metadata (version number, name, etc.) about the installed product components. Do not modify these files.

File types

The versions of the IAR Systems development tools use the following default filename extensions to identify the produced files and other recognized file types:

Ext.	Type of file	Output from	Input to
`a`*`xx`* / `out`	Target application	XLINK/ILINK	EPROM, C-SPY, etc.
`asm`	Assembler source code	Text editor	Assembler
`bat`	Windows command batch file	C-SPY	Windows
`c`	C source code	Text editor	Compiler
`cfg`	Syntax coloring configuration	Text editor	IDE
`chm`	Online help system	--	IDE
`cpp`	C++ source code	Text editor	Compiler
`d`*`xx`* / `out`	Target application with debug information	XLINK/ILINK	C-SPY and other symbolic debuggers
`dat`	Macros for formatting of STL containers	IDE	IDE
`dbg`	Target application with debug information	XLINK	C-SPY and other symbolic debuggers
`dbgt`	Debugger desktop settings	C-SPY	C-SPY
`ddf`	Device description file	Text editor	C-SPY
`dep`	Dependency information	IDE	IDE
`dni`	Debugger initialization file	C-SPY	C-SPY
`ewd`	Project settings for C-SPY	IDE	IDE
`ewp`	IAR Embedded Workbench project (current version)	DE	IDE
`ewplugin`	IDE description file for plugin modules	--	IDE
`eww`	Workspace file	IDE	IDE
`fmt`	Formatting information for the Locals and Watch windows	IDE	IDE
`h`	C/C++ or assembler header source	Text editor	Compiler or assembler `#include`
`helpfiles`	Help menu configuration file	Text editor	IDE
`html`, `htm`	HTML document	Text editor	IDE
`i`	Preprocessed source	Compiler	Compiler
`i`*`xx`*	Device selection file	Text editor	IDE

Table 6: File types

Ext.	Type of file	Output from	Input to
icf	Linker configuration file	Text editor	ILINK linker
inc	Assembler header source	Text editor	Assembler #include
ini	Project configuration	IDE	–
log	Log information	IDE	–
lst	List output	Compiler and assembler	–
mac	C-SPY macro definition	Text editor	C-SPY
map	List output	XLINK	–
menu	Device selection file	Text editor	IDE
pbd	Source browse information	IDE	IDE
pbi	Source browse information	IDE	IDE
pew	IAR Embedded Workbench project (old project format)	IDE	IDE
prj	IAR Embedded Workbench project (old project format)	IDE	IDE
r*xx* / o	Object module	Compiler and assembler	XLINK, XAR, XLIB, or ILINK
r*xx* / a	Library	XAR, XLIB	XLINK, XAR, XLIB, or ILINK
s*xx* / s	Assembler source code	Text editor	Assembler
sfr	Special function register definitions	Text editor	C-SPY
vsp	visualSTATE project files	IAR visualSTATE Designer	IAR visualSTATE Designer and IAR Embedded Workbench IDE
wsdt	Workspace desktop settings	IDE	IDE
xcl	Extended command line	Text editor	Assembler, compiler, linker
xlb	Extended librarian batch command	Text editor	XLIB

Table 6: File types (Continued)

Note: The notation *xx* denotes two digits, which form an identifier for the processor you are using.

When you run the IDE, some files are created and located in dedicated directories under your project directory, by default `$PROJ_DIR$\Debug`, `$PROJ_DIR$\Release`,

`$PROJ_DIR$\settings`, and the file `*.dep` under the installation directory. None of these directories or files affect the execution of the IDE, which means you can safely remove them if required.

FILES WITH NON-DEFAULT FILENAME EXTENSIONS

In the IDE you can increase the number of recognized filename extensions using the **Filename Extensions** dialog box, available from the **Tools** menu. You can also connect your filename extension to a specific tool in the toolchain. See *Filename Extensions dialog box*, page 259.

To override the default filename extension from the command line, include an explicit extension when you specify a filename.

Note: If you run the tools from the command line, the XLINK listings (map files) will, by default, have the extension `lst`, which might overwrite the list file generated by the compiler. Therefore, we recommend that you name XLINK map files explicitly, for example `project1.map`.

Part 1. Tutorials

This part of the IAR Embedded Workbench IDE User Guide contains the following chapters:

- Welcome to the tutorials
- Creating an application project
- Debugging using the IAR C-SPY Debugger
- Mixing C and assembler modules
- Using C++
- Simulating an interrupt
- Creating and using libraries.

Welcome to the tutorials

The tutorials give you hands-on training to help you get started using the IAR Embedded Workbench IDE and its tools.

Below you will get an overview of the tutorials.

Tutorials overview

The tutorials are divided into different parts. You can work through all tutorials as a suite or you can choose to go through the tutorials individually.

Note: The tutorials call the `printf` library function, which calls the low-level `write` function part of the DLIB library or the `putchar` function part of the CLIB library. This works in the C-SPY simulator, but if you want to run the tutorials in a release configuration on real hardware, you must provide your own version of these functions (depending on the library that you are using), adapted to your hardware.

CREATING AN APPLICATION PROJECT

This tutorial guides you through how to set up a new project, compiling your application, examining the list file, and linking your application. These are the related files:

Workspace:	`tutorials.eww`
Project files:	`project1.ewp`
Source files:	`Tutor.c`, `Tutor.h`, `Utilities.c`, and `Utilities.h`

DEBUGGING USING THE IAR C-SPY DEBUGGER

This tutorial explores the basic facilities of the debugger while debugging the application used in project1. These are the related files:

Workspace:	`tutorials.eww`
Project files:	`project1.ewp`
Source files:	`Tutor.c`, `Tutor.h`, `Utilities.c`, and `Utilities.h`

MIXING C AND ASSEMBLER MODULES

This tutorial demonstrates how you can easily combine source modules written in C with assembler modules. The chapter also demonstrates how to use the compiler for examining the compiler calling convention. These are the related files:

Workspace:	`tutorials.eww`
Project files:	`project2.ewp`
Source files:	`Tutor.c`, `Tutor.h`, `Utilities.c`, `Utilities.h`, and `Utilities.s`

USING C++

This tutorial demonstrates how to create a C++ class, which creates two independent objects. The application is then built and debugged. This chapter only applies to product versions with C++ support. These are the related files:

Workspace:	`tutorials.eww`
Project files:	`project3.ewp`
Source files:	`CppTutor.cpp`, `Fibonacci.cpp`, and `Fibonacci.h`

SIMULATING AN INTERRUPT

This tutorial demonstrates how you add an interrupt handler to the project and how you simulate this interrupt, using C-SPY facilities for simulated interrupts, breakpoints, and macros. These are the related files:

Workspace:	`tutorials.eww`
Project files:	`project4.ewp`
Source files:	`Interrupt.c`, `Utilities.c`, and `Utilities.h`

CREATING AND USING LIBRARIES

This tutorial demonstrates how to create library modules. These are the related files:

Workspace:	`tutorials.eww`
Project files:	`project5.ewp` and `tutor_library.ewp`
Source files:	`Main.s`, `MaxMin.s`, and `Utilities.h`

GETTING STARTED

You can access the tutorials from the Information Center available from the **Help** menu in the IDE. Click **TUTORIALS** and then click the **Open the tutorial project** hyperlink. This will create a copy of the workspace and its associated project files.

You can find all the files needed for the tutorials in the `cpuname\tutor` directory. Make a copy of the `tutor` directory in your `projects` directory.

Note: You can customize the amount of information to be displayed in the Build messages window. In the tutorial projects, the default setting is not used. Thus, the contents of the Build messages window on your screen might differ from the screen shots in the text.

Now you can start with the first tutorial project: *Creating an application project*, page 7.

Creating an application project

This chapter introduces you to the IAR Embedded Workbench® integrated development environment (IDE). The tutorial demonstrates a typical development cycle and shows how you use the compiler and the linker to create a small application for your device. For instance, creating a workspace, setting up a project with C source files, and compiling and linking your application.

For a short overview of all tutorials and their related files, see *Tutorials overview*, page 3.

Setting up a new project

Using the IDE, you can design advanced project models. You create a *workspace* to which you add one or several *projects*. There are ready-made *project templates* for both application and library projects. Each project can contain a hierarchy of *groups* in which you collect your *source files*. For each project you can define one or several *build configurations*. For more details about designing project models, see the chapter *Managing projects* in this guide.

Because the application in this tutorial is a simple application with very few files, the tutorial does not need an advanced project model.

Before you can create your project you must first create a workspace.

CREATING A WORKSPACE

The first step is to create a new workspace for the tutorial application. When you start the IDE for the first time, there is already a ready-made workspace, which you can use for the tutorial projects. If you are using that workspace, you can ignore the first step.

Choose **File>New>Workspace**. Now you are ready to create a project and add it to the workspace.

CREATING THE NEW PROJECT

1 To create a new project, choose **Project>Create New Project**. The **Create New Project** dialog box appears, which lets you base your new project on a project template.

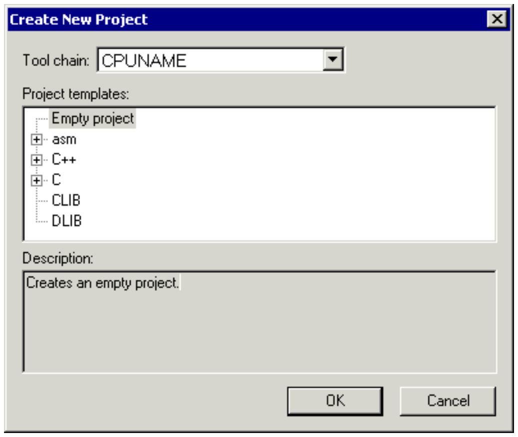


Figure 1: Create New Project dialog box

2 From the **Tool chain** drop-down list, choose the toolchain you are using and click **OK**.

3 For this tutorial, select the project template **Empty project**, which simply creates an empty project that uses default project settings.

4 In the standard **Save As** dialog box that appears, specify where you want to place your project file, that is, in your newly created `projects` directory. Type `project1` in the **File name** box, and click **Save** to create the new project.

Note: If you copied all the files from the *`cpuname`*`\tutor` directory before you started with the tutorials, a project file will already be available in your `projects` directory. You can use that ready-made file, or create your own file.

The project will appear in the Workspace window.

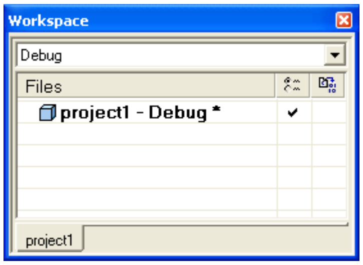
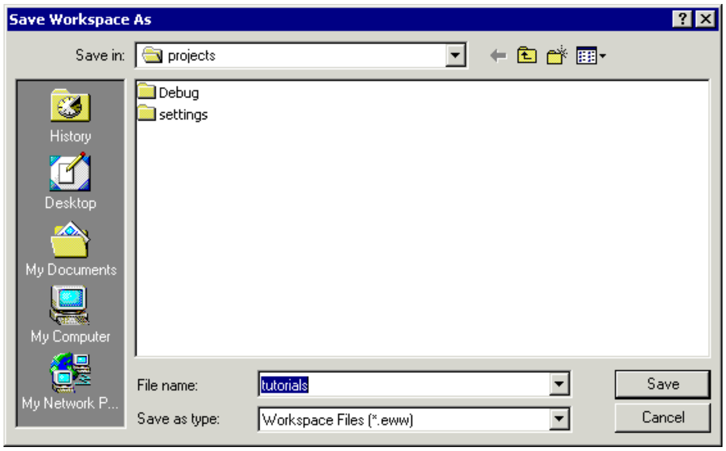


Figure 2: Workspace window

By default, two build configurations are created: Debug and Release. In this tutorial only Debug will be used. You choose the build configuration from the drop-down menu at the top of the window. The asterisk in the project name indicates that there are changes that have not been saved.

A project file—with the filename extension `ewp`—will be created in the `projects` directory, not immediately, but later on when you save the workspace. This file contains information about your project-specific settings, such as build options.

5 Before you add any files to your project, you should save the workspace. Choose **File>Save Workspace** and specify where you want to place your workspace file. In this tutorial, you should place it in your newly created `projects` directory. Type `tutorials` in the **File name** box, and click **Save** to create the new workspace.



File name: tutorials

Save as type: Workspace Files (*.eww)

Figure 3: Save workspace

A workspace file—with the filename extension `eww`—has now been created in the `projects` directory. This file lists all projects that you will add to the workspace. Information related to the current session, such as the placement of windows and breakpoints is located in the files created in the `projects\settings` directory.

ADDING FILES TO THE PROJECT

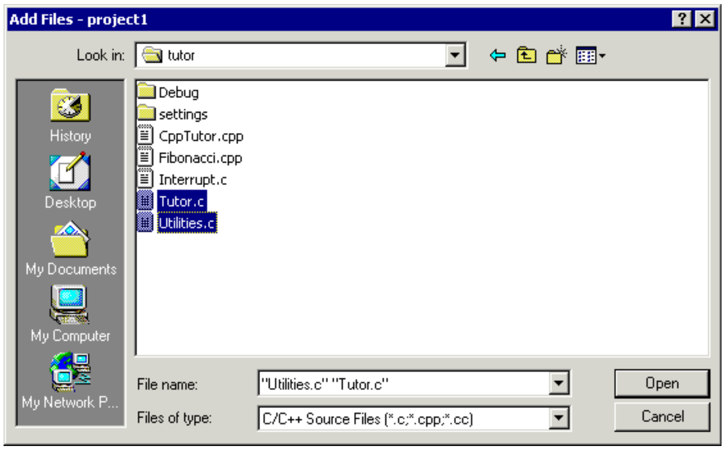
This tutorial uses the source files `Tutor.c` and `Utilities.c`.

- The `Tutor.c` application is a simple program using only standard features of the C language. It initializes an array with the ten first Fibonacci numbers and prints the result to `stdout`.
- The `Utilities.c` application contains utility routines for the Fibonacci calculations.

Creating several *groups* is a possibility for you to organize your source files logically according to your project needs. However, because this project only contains two files, you do not need to create a group. For more information about how to create complex project structures, see the chapter *Managing projects*.

1 In the Workspace window, select the destination to which you want to add a source file; a group or, as in this case, directly to the project.

2 Choose **Project>Add Files** to open a standard browse dialog box. Locate the files `Tutor.c` and `Utilities.c`, select them in the file selection list, and click **Open** to add them to the `project1` project.



File name: "Utilities.c" "Tutor.c"
Files of type: C/C++ Source Files (*.c;*.cpp;*.cc)

Figure 4: Adding files to project1

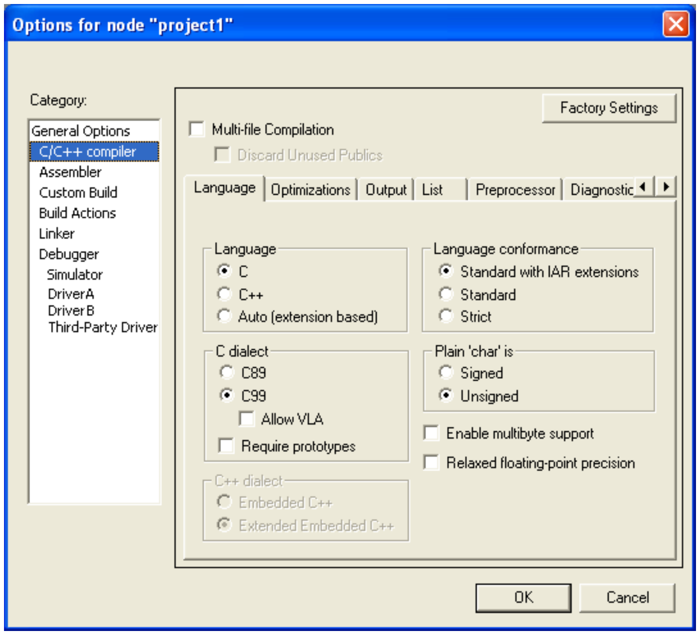
SETTING PROJECT OPTIONS

Now you will set the project options. For application projects, options can be set on all levels of nodes. First you will set the general options to suit the processor configuration in this tutorial. Because these options must be the same for the whole build configuration, they must be set on the project node.

1 Select the project folder icon **project1 - Debug** in the Workspace window and choose **Project>Options**. In this tutorial you should use the default settings.

Then set the compiler options for the project.

2 Select **C/C++ Compiler** in the **Category** list to display the compiler option pages.



☐ Multi-file Compilation
☐ Discard Unused Publics

Language: [✓ C] C++ Auto (extension based)

Language conformance: [✓ Standard with IAR extensions] Standard Strict

C dialect: C89 [✓ C99]
☐ Allow VLA
☐ Require prototypes

Plain 'char' is: Signed [✓ Unsigned]

☐ Enable multibyte support
☐ Relaxed floating-point precision

C++ dialect: Embedded C++ [✓ Extended Embedded C++]

Figure 5: Setting compiler options

3 Verify that the default settings are used. In addition to the default settings, click the **List** tab, and select the options **Output list file** and **Assembler mnemonics**. Click **OK** to set the options you have specified.

The project is now ready to be built.

Compiling and linking the application

You can now compile and link the application. You will also view the compiler list file and the linker map file.

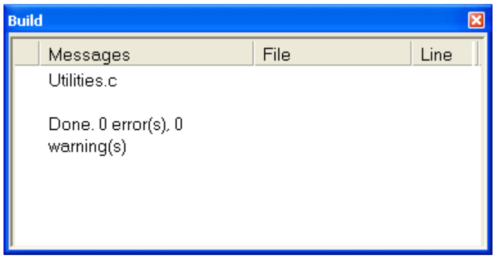
COMPILING THE SOURCE FILES

1 To compile the file `Utilities.c`, select it in the Workspace window.

2 Choose **Project>Compile**.

Alternatively, click the **Compile** button in the toolbar or choose the **Compile** command from the context menu that appears when you right-click on the selected file in the Workspace window.

The progress is displayed in the Build messages window.



```
Utilities.c

Done. 0 error(s), 0
warning(s)
```

Figure 6: Compilation message

3 Compile the file `Tutor.c` in the same manner.

The IDE has now created new directories in your project directory. Because you are using the build configuration **Debug**, a `Debug` directory has been created containing the directories `List`, `Obj`, and `Exe`:

- The `List` directory is the destination directory for the list files. The list files have the extension `lst`.
- The `Obj` directory is the destination directory for the object files from the compiler and the assembler. These files have the extension `rxx` and are used as input to the XLINK linker. For the ILINK linker, the corresponding filename extension is `o`.
- The `Exe` directory is the destination directory for the executable file. It has the extension `dxx` (for XLINK) and `out` (for ILINK), and is used as input to the IAR C-SPY® Debugger. Note that this directory is empty until you have linked the object files.

Click on the plus signs in the Workspace window to expand the view. As you can see, the IDE has also created an output folder icon in the Workspace window containing any generated output files. All included header files are displayed as well, showing the dependencies between the files.

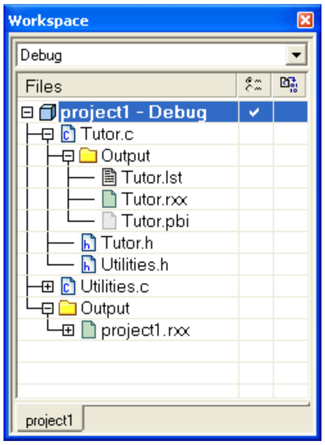


Figure 7: Workspace window after compilation

VIEWING THE LIST FILE

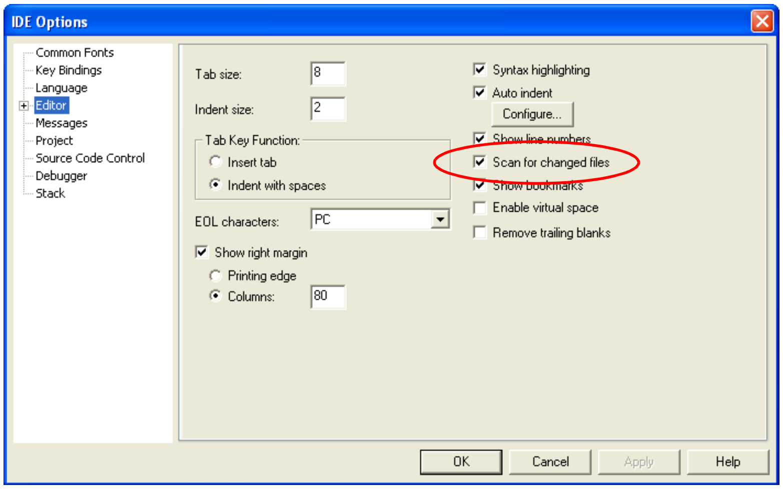
Now examine the compiler list file and notice how it is automatically updated when you, as in this case, will investigate how different optimization levels affect the generated code size.

1 Open the list file `Utilities.lst` by double-clicking it in the Workspace window. Examine the list file, which contains the following information:

- The *header* shows the product version, information about when the file was created, and the command line version of the compiler options that were used
- The *body* of the list file shows the assembler code and binary code generated for each statement. It also shows how the variables are placed in segments/sections
- The *end* of the list file shows the amount of stack, code, and data memory required, and contains information about error and warning messages that might have been generated.

Notice the amount of generated code at the end of the file and keep the file open.

2 Choose **Tools>Options** to open the **IDE Options** dialog box and click the **Editor** tab. Select the option **Scan for Changed Files**. This option turns on the automatic update of any file open in an editor window, such as a list file.



Tab size: 8
Indent size: 2
Tab Key Function:
( ) Insert tab
(●) Indent with spaces
EOL characters: PC
☑ Show right margin
( ) Printing edge
(●) Columns: 80

☑ Syntax highlighting
☑ Auto indent
☑ Show line numbers
☑ Scan for changed files
☑ Show bookmarks
☐ Enable virtual space
☐ Remove trailing blanks

Figure 8: Setting the option Scan for Changed Files

Click the **OK** button.

3 Select the file `Utilities.c` in the Workspace window, right-click and choose **Options** from the context menu to open the **C/C++ Compiler** options dialog box. Select the **Override inherited settings** option. Click the **Optimizations** tab and choose **High** level of optimization. Click **OK**.

Notice that the options override on the file node is indicated with a red dot in the Workspace window.

4 Compile the file `Utilities.c`. Now you will notice two things. First, note the automatic updating of the open list file due to the selected option **Scan for Changed Files**. Second, look at the end of the list file and notice the effect on the code size due to the increased optimization.

5 For this tutorial, the optimization level **None** should be used, so before linking the application, restore the default optimization level. Open the **C/C++ Compiler** options dialog box by right-clicking on the selected file in the Workspace window. Deselect the **Override inherited settings** option and click **OK**. Recompile the file `Utilities.c`.

LINKING THE APPLICATION

Now you should set the options for the linker.

1 Select the project folder icon **project1 - Debug** in the Workspace window and choose **Project>Options**, or right click and choose **Options** from the context menu. Then select **Linker** in the **Category** list to display the linker option pages.

For this tutorial, the default factory settings are used. However, pay attention to the choice of output format (XLINK linker only) and the linker configuration file.

Output format using the XLINK linker

It is important to choose the output format that suits your purpose. You might want to load it to a debugger—which means that you need output with debug information. In this tutorial you will use the default output options suitable for C-SPY—**Debug information for C-SPY**, **With runtime control modules**, and **With I/O emulation modules**—which means that some low-level routines will be linked that direct `stdin` and `stdout` to the Terminal I/O window in the C-SPY Debugger. You find these options on the **Output** page.

Alternatively, in your real application project, you might want to load the output to a PROM programmer—in which case you need an output format without debug information, such as Intel-hex or Motorola S-records.

Output format using the ILINK linker

The linker produces an output file in the ELF format, including DWARF for debug information. If you need to have a file in the Motorola or Intel-standard formats instead, for example to load the file to a PROM memory, you must convert the file. You can use the converter provided with IAR Embedded Workbench, see *Converter options*, page 333.

Linker configuration file

In the XLINK linker configuration file (filename extension `xcl`), the XLINK command line options for segment control are used for placing segments. It is important to be familiar with the linker configuration file and the placement of segments.

For the ILINK linker, program code and data are placed in memory according to the configuration specified in the linker configuration file (filename extension `icf`). It is important to be familiar with its syntax for how sections are placed in memory.

Read more about this in the compiler documentation.

Note: In the simulator, you can use the linker configuration file templates supplied with the product as they are, but when you use them for your target system you might have to adapt them to your actual hardware memory layout. You can find supplied linker configuration files in the `config` directory.

In this tutorial you will use the default linker configuration file, which you can see on the **Config** page.

If you want to examine the linker configuration file, use a suitable text editor, such as the IAR Embedded Workbench editor, or print a copy of the file, and verify that the definitions match your requirements.

Linker map file

By default, no linker map file is generated. To generate a linker map file, click the **List** tab and for the XLINK linker, select the options **Generate linker listing**, **Segment map**, and **Module map.** If you have the ILINK linker, select the option **Generate linker map file**.

2 Click **OK** to save the linker options.

Now you should link the object file, to generate code that can be debugged.

3 Choose **Project>Make**. The progress will as usual be displayed in the Build messages window. The result of the linking is the code file `project1.d`*`xx`* with debug information located in the `Debug\Exe` directory and a map file `project1.map` located in the `Debug\List` directory.

VIEWING THE MAP AND LOG FILES

Both XLINK and ILINK can generate extensive listings:

- XLINK can generate a map file which optionally contains a segment map, symbol listing, module summary, etc
- ILINK can generate a map file, which typically contains a placement summary. ILINK can also generate a log file, which logs decisions made by the linker regarding initializations, module sections, section select, etc.

Typically, this information can be useful if you want to examine:

- How the segments/sections and code were placed in memory
- Which source files actually contributed to the final image
- Which symbols that were actually included and their values
- Where individual functions were placed in memory.

The `project1.d`*`xx`* application is now ready to be run in C-SPY.

Debugging using the IAR C-SPY Debugger

This chapter continues the development cycle started in the previous chapter and explores the basic features of C-SPY®.

Note that, depending on what IAR Systems product package you have installed, C-SPY might or might not be included. The tutorials assume that you are using the C-SPY Simulator.

For a short overview of all tutorials and their related files, see *Tutorials overview*, page 3.

Debugging the application

The `project1.dxx` application, created in the previous chapter, is now ready to be run in C-SPY where you can watch variables, set breakpoints, view code in disassembly mode, monitor registers and memory, and print the program output in the Terminal I/O window, etc.

STARTING THE DEBUGGER

Before starting C-SPY, you must set a few options.

1 Choose **Project>Options** and then the **Debugger** category. On the **Setup** page, make sure that you have chosen **Simulator** from the **Driver** drop-down list and that **Run to main** is selected. Click **OK**.

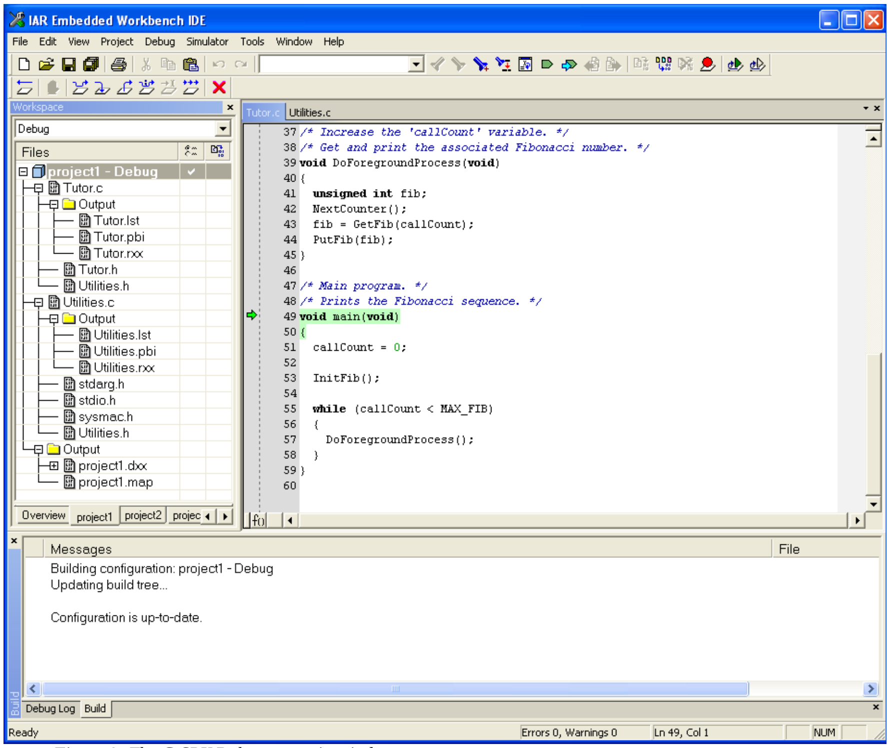
2 Choose **Project>Download and Debug**. Alternatively, click the **Download and Debug** button in the toolbar. C-SPY starts with the `project1.dxx` application loaded. In addition to the windows already opened in the IDE, a set of C-SPY-specific windows are now available.

ORGANIZING THE WINDOWS

In the IDE, you can *dock* windows at specific places, and organize them in tab groups. You can also make a window *floating,* which means it is always on top of other windows. If you change the size or position of a floating window, other currently open windows are not affected.

The status bar, located at the bottom of the Embedded Workbench main window, contains useful help about how to arrange windows. For further details, see *Organizing the windows on the screen*, page 55.

Make sure the following windows and window contents are open and visible on the screen: the Workspace window with the active build configuration **tutorials – project1**, the editor window with the source files `Tutor.c` and `Utilities.c`, and the Debug Log window.



```
/* Increase the 'callCount' variable. */
/* Get and print the associated Fibonacci number. */
void DoForegroundProcess(void)
{
  unsigned int fib;
  NextCounter();
  fib = GetFib(callCount);
  PutFib(fib);
}

/* Main program. */
/* Prints the Fibonacci sequence. */
void main(void)
{
  callCount = 0;

  InitFib();

  while (callCount < MAX_FIB)
  {
    DoForegroundProcess();
  }
}
```

```
Building configuration: project1 - Debug
Updating build tree...

Configuration is up-to-date.
```

Figure 9: The C-SPY Debugger main window

Note: Depending on the toolchain you are using, the current position—indicated by a green arrow—might now be `main` or `callCount`.

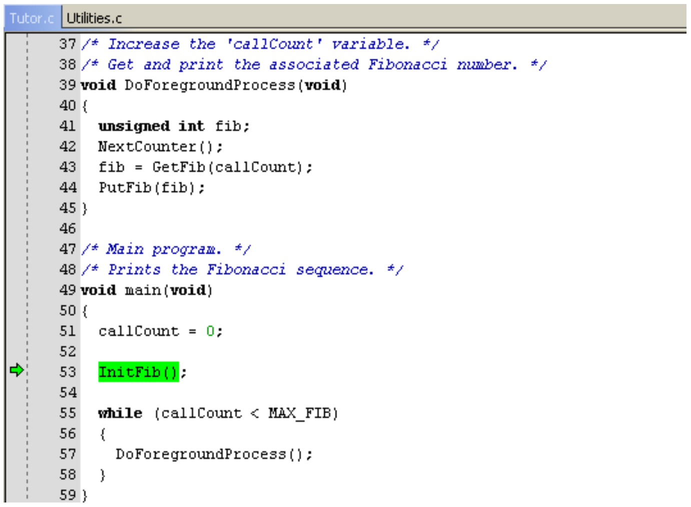
INSPECTING SOURCE STATEMENTS

1 To inspect the source statements, double-click the file `Tutor.c` in the Workspace window.

2 With the file `Tutor.c` displayed in the editor window, first step over with the **Debug>Step Over** command.

Alternatively, click the **Step Over** button on the toolbar.

Step until the call to the `InitFib` function.



```
/* Increase the 'callCount' variable. */
/* Get and print the associated Fibonacci number. */
void DoForegroundProcess(void)
{
  unsigned int fib;
  NextCounter();
  fib = GetFib(callCount);
  PutFib(fib);
}

/* Main program. */
/* Prints the Fibonacci sequence. */
void main(void)
{
  callCount = 0;

  InitFib();

  while (callCount < MAX_FIB)
  {
    DoForegroundProcess();
  }
}
```

Figure 10: Stepping in C-SPY

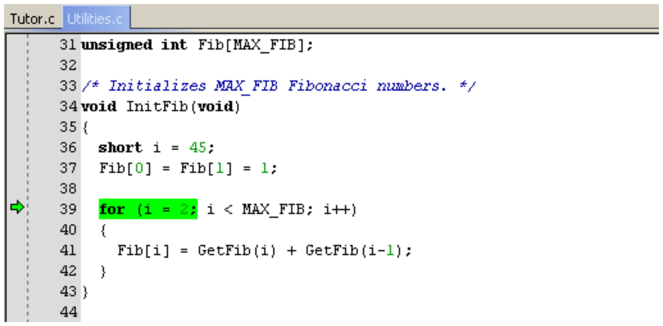
3 Choose **Debug>Step Into** to step into the function `InitFib`.

Alternatively, click the **Step Into** button on the toolbar.

At source level, the **Step Over** and **Step Into** commands allow you to execute your application a statement at a time. **Step Into** continues stepping inside function or subroutine calls, whereas **Step Over** executes each function call in a single step. For further details, see *Step*, page 104.

When **Step Into** is executed you will notice that the active window changes to `Utilities.c` as the function `InitFib` is located in this file.

4 Use the **Step Into** command until you reach the `for` loop.



```
unsigned int Fib[MAX_FIB];

/* Initializes MAX_FIB Fibonacci numbers. */
void InitFib(void)
{
  short i = 45;
  Fib[0] = Fib[1] = 1;

  for (i = 2; i < MAX_FIB; i++)
  {
    Fib[i] = GetFib(i) + GetFib(i-1);
  }
}

```

Figure 11: Using Step Into in C-SPY

5 Use **Step Over** until you are back in the header of the `for` loop. Notice that the step points are on a function call level, not on a statement level.

You can also step on a statement level. Choose **Debug>Next statement** to execute one statement at a time. Alternatively, click the **Next statement** button on the toolbar.

Notice how this command differs from the **Step Over** and the **Step Into** commands.

6 Debugging with C-SPY is usually quicker and more straightforward in C/C++ source mode. However, if you want to have full control over low-level routines, you can debug in disassembly mode where each step corresponds to one assembler instruction. C-SPY lets you switch freely between the two modes.

Choose **View>Disassembly** to open the Disassembly window, if it is not already open.You will see the assembler code corresponding to the current C statement.

Try the step commands also in the Disassembly window.

INSPECTING VARIABLES

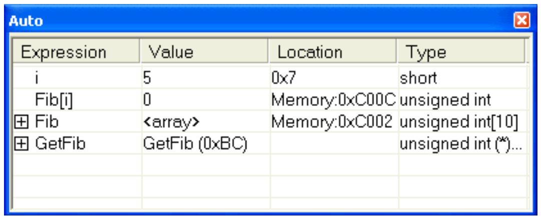
C-SPY allows you to watch variables or expressions in the source code, so that you can keep track of their values as you execute your application. You can look at a variable in several ways. For example, point at it in the source window with the mouse pointer, or open one of the Auto, Locals, Live Watch, Statics, or Watch windows. In this tutorial, we will look into some of these methods. For more information about inspecting variables, see the chapter *Working with variables and expressions*.

Note: When optimization level **None** is used, all non-static variables will live during their entire scope and thus, the variables are fully debuggable. When higher levels of optimizations are used, variables might not be fully debuggable.

Using the Auto window

1 Choose **View>Auto** to open the Auto window.

The Auto window will show the current value of recently modified expressions.



Auto

Expression	Value	Location	Type
i	5	0x7	short
Fib[i]	0	Memory:0xC00C	unsigned int
⊞ Fib	<array>	Memory:0xC002	unsigned int[10]
⊞ GetFib	GetFib (0xBC)		unsigned int (*)...

Figure 12: Inspecting variables in the Auto window

2 Keep stepping to see how the values change.

Setting a watchpoint

Next you will use the Watch window to inspect variables.

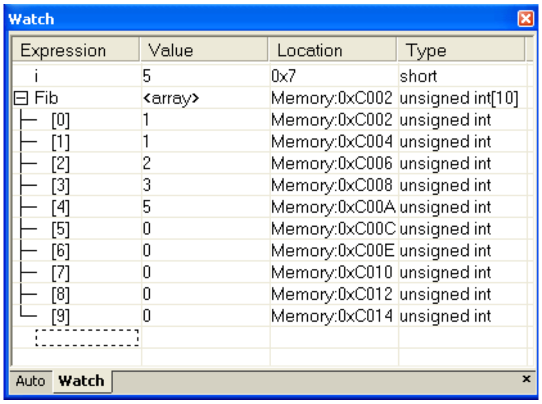
3 Choose **View>Watch** to open the Watch window. Notice that it is, by default, grouped together with the currently open Auto window; the windows are located as a *tab group*.

4 Set a watchpoint on the variable `i` using this procedure: Click the dotted rectangle in the Watch window. In the entry field that appears, type `i` and press the Enter key.

You can also drag a variable from the editor window to the Watch window.

5 Select the `Fib` array in the `InitFib` function, then drag it to the Watch window.

The Watch window will show the current value of `i` and `Fib`. You can expand the `Fib` array to watch it in more detail.



Expression	Value	Location	Type
i	5	0x7	short
⊟ Fib	<array>	Memory:0xC002	unsigned int[10]
[0]	1	Memory:0xC002	unsigned int
[1]	1	Memory:0xC004	unsigned int
[2]	2	Memory:0xC006	unsigned int
[3]	3	Memory:0xC008	unsigned int
[4]	5	Memory:0xC00A	unsigned int
[5]	0	Memory:0xC00C	unsigned int
[6]	0	Memory:0xC00E	unsigned int
[7]	0	Memory:0xC010	unsigned int
[8]	0	Memory:0xC012	unsigned int
[9]	0	Memory:0xC014	unsigned int

Figure 13: Watching variables in the Watch window

6 Execute some more steps to see how the values of `i` and `Fib` change.

7 To remove a variable from the Watch window, select it and press **Delete**.

SETTING AND MONITORING BREAKPOINTS

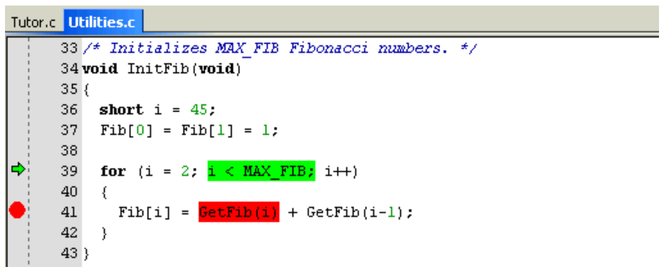
C-SPY contains a powerful breakpoint system with many features. For detailed information about the breakpoints, see *The breakpoint system*, page 117.

The most convenient way is usually to set breakpoints interactively, simply by positioning the insertion point in or near a statement and then choosing the **Toggle Breakpoint** command.

1 Set a breakpoint on the function call `GetFib(i)` using this procedure: First, click the `Utilities.c` tab in the editor window and click in the statement to position the insertion point. Then choose **Edit>Toggle Breakpoint**.

Alternatively, click the **Toggle Breakpoint** button on the toolbar.

A breakpoint will be set at this function call. The function call will be highlighted and there will be a **red dot** in the margin to show that there is a breakpoint there.


Tutor.c Utilities.c

```
/* Initializes MAX_FIB Fibonacci numbers. */
void InitFib(void)
{
  short i = 45;
  Fib[0] = Fib[1] = 1;

  for (i = 2; i < MAX_FIB; i++)
  {
    Fib[i] = GetFib(i) + GetFib(i-1);
  }
}
```

Figure 14: Setting breakpoints

To view all defined breakpoints, choose **View>Breakpoints** to open the Breakpoints window. You can find information about the breakpoint execution in the Debug Log window.

Executing up to a breakpoint

2 To execute your application until it reaches the breakpoint, choose **Debug>Go**.

Alternatively, click the **Go** button on the toolbar.

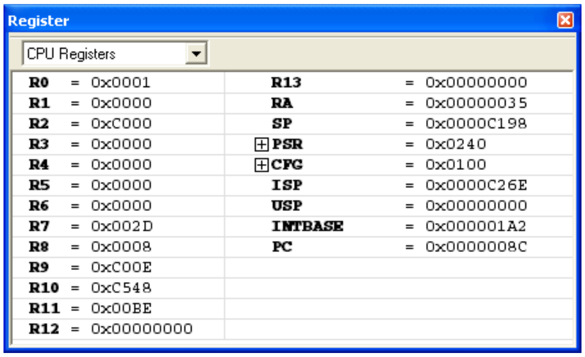
The application will execute up to the breakpoint you set. The Watch window will display the value of the `Fib` expression and the Debug Log window will contain information about the breakpoint.

3 Select the breakpoint, right click and choose **Toggle Breakpoint (Code)** from the context menu, alternatively choose **Toggle Breakpoint** from the **Edit** menu to remove the breakpoint.

MONITORING REGISTERS

The Register window lets you monitor and modify the contents of the processor registers.

1 Choose **View>Register** to open the Register window.



R0	=	0x0001	R13	=	0x00000000
R1	=	0x0000	RA	=	0x00000035
R2	=	0xC000	SP	=	0x0000C198
R3	=	0x0000	⊞PSR	=	0x0240
R4	=	0x0000	⊞CFG	=	0x0100
R5	=	0x0000	ISP	=	0x0000C26E
R6	=	0x0000	USP	=	0x00000000
R7	=	0x002D	INTBASE	=	0x000001A2
R8	=	0x0008	PC	=	0x0000008C
R9	=	0xC00E			
R10	=	0xC548			
R11	=	0x00BE			
R12	=	0x00000000			

Figure 15: Register window

2 **Step Over** to execute the next instructions, and watch how the values change in the Register window.

3 Close the Register window.

MONITORING MEMORY

The Memory window lets you monitor selected areas of memory. In the following example, the memory corresponding to the array `Fib` will be monitored.

1 Choose **View>Memory** to open the Memory window.

2 Make the Utilities.c window active and select `Fib`. Then drag it from the C source window to the Memory window.

The memory contents in the Memory window corresponding to `Fib` will be selected.

If not all of the memory units have been initialized by the `InitFib` function of the C application yet, continue to step over and you will notice how the memory contents are updated.

To change the memory contents, edit the values in the Memory window. Just place the insertion point at the memory content that you want to edit and type the desired value.

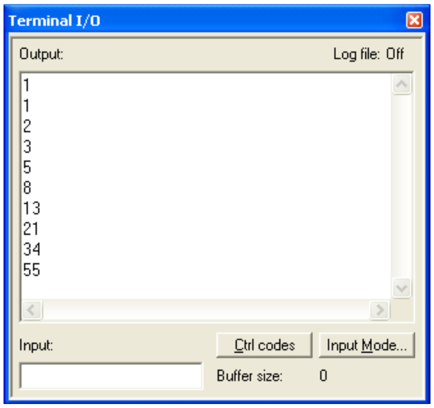
Close the Memory window.

VIEWING TERMINAL I/O

Sometimes you might have to debug constructions in your application that make use of `stdin` and `stdout` without the possibility of having hardware support. C-SPY lets you simulate `stdin` and `stdout` by using the Terminal I/O window.

Note: The Terminal I/O window is only available in C-SPY if you have linked your project using the output option **With I/O emulation modules**. This means that some low-level routines are linked that direct `stdin` and `stdout` to the Terminal I/O window, see *Linking the application*, page 15.

- Choose **View>Terminal I/O** to display the output from the I/O operations.



```
1
1
2
3
5
8
13
21
34
55
```

Figure 16: Output from the I/O operations

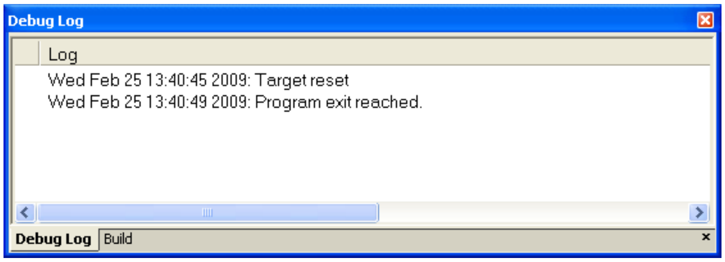
The contents of the window depends on how far you have executed the application.

REACHING PROGRAM EXIT

- To complete the execution of your application, choose **Debug>Go**.

Alternatively, click the **Go** button on the toolbar.

As no more breakpoints are encountered, C-SPY reaches the end of the application and a `Program exit reached` message is printed in the Debug Log window.



```
Wed Feb 25 13:40:45 2009: Target reset
Wed Feb 25 13:40:49 2009: Program exit reached.
```

Figure 17: Reaching program exit in C-SPY

All output from the application has now been displayed in the Terminal I/O window.

If you want to start again with the existing application, choose **Debug>Reset**, or click the **Reset** button on the toolbar.

2 To exit from C-SPY, choose **Debug>Stop Debugging**. Alternatively, click the **Stop Debugging** button on the toolbar. The Embedded Workbench workspace is displayed.

C-SPY also provides many other debugging facilities. Some of these—for example macros and interrupt simulation—are described in the following tutorial chapters.

For further details about how to use C-SPY, see *Part 3. Debugging*. For reference information about the features of C-SPY, see *Part 5. Reference information* and the online help system.

Mixing C and assembler modules

In some projects it might be necessary to write certain pieces of source code in assembler language. The chapter first demonstrates how the compiler can be helpful in examining the calling convention, which you must be familiar with when calling assembler modules from C/C++ modules or vice versa. Furthermore, this chapter demonstrates how you can easily combine source modules written in C with assembler modules, but the procedure is applicable to projects containing source modules written in C++, too, if your product package supports C++.

This tutorial assumes that you are familiar with the basics of the IAR Embedded Workbench® IDE described in the previous tutorial chapters.

For a short overview of all tutorials and their related files, see *Tutorials overview*, page 3.

Examining the calling convention

When you write an assembler routine that is called from a C routine, you must be aware of the calling convention that the compiler uses. If you create skeleton code in C and let the compiler produce an assembler output file from it, you can study the produced assembler output file and find the details of the calling convention.

In this example you will make the compiler create an assembler output file from the file `Utilities.c`.

1 Create a new project in the same workspace `tutorials` as used in the previous tutorial project, and name the project `project2`.

2 Add the files `Tutor.c` and `Utilities.c` to the project.

To display an overview of the workspace, click the **Overview** tab available at the bottom of the Workspace window. To view only the newly created project, click the **project2** tab. For now, the **project2** view should be visible.

3 To set options, choose **Project>Options**, and select the **General Options** category. On project level, the default factory settings should be used in this tutorial. Click **OK**.

4 To set options on file level node, in the Workspace window, select the file `Utilities.c`.

Choose **Project>Options**. You will notice that only the **C/C++ Compiler** and **Custom Build** categories are available.

5 In the **C/C++ Compiler** category, select **Override inherited settings** and verify these settings:

Page	Option
Optimizations	Level: None (Best debug support)
List	Output assembler file Include source Include call frame information (must be deselected).

Table 7: Compiler options for project2

Note: In this example you must use a low optimization level when you compile the code, to show local and global variable accesses. If you use a higher level of optimization, the required references to local variables might be removed. However, the actual function declaration is not changed by the optimization level.

6 Click **OK** and return to the Workspace window.

7 Compile the file `Utilities.c`. You can find the output file `Utilities.s`*`xx`* in the subdirectory `projects\debug\list`.

8 To examine the calling convention and to see how the C or C++ code is represented in assembler language, open the file `Utilities.s`*`xx`*.

You can now study where and how parameters are passed, how to return to the program location from where a function was called, and how to return a resulting value. You can also see which registers an assembler-level routine must preserve.

Note: The generated assembler source file might contain compiler internal information, for example `CFI` directives. These directives are available for debugging purpose and you should ignore these details.

To obtain the correct interface for your own application functions, you should create skeleton code for each function that you need.

For more information about the calling convention used in the compiler, see the compiler documentation.

Adding an assembler module to the project

This tutorial demonstrates how you can easily create a project containing both assembler modules and C modules. You will also compile the project and view the assembler output list file.

SETTING UP THE PROJECT

1 Modify `project2` by adding the `Utilities.s`*`xx`* (`Utilities.s` for ILINK) file that you just created and removing the `Utilities.c` file.

Note: To view assembler files in the **Add files** dialog box, choose **Project>Add Files** and choose **Assembler Files** from the **Files of type** drop-down list.

2 Select the project level node in the Workspace window, choose **Project>Options**. Use the default settings in the **General Options**, **C/C++ Compiler**, and **Linker** categories. Select the **Assembler** category, click the **List** tab, and select the option **Output list file**.

Click **OK**.

3 Select the file `Utilities.s`*`xx`* in the Workspace window and choose **Project>Compile** to assemble it.

Assuming that the source file was assembled successfully, the file `Utilities.r`*`xx`* (`Utilities.o` for ILINK) is created, containing the linkable object code.

Viewing the assembler list file

4 Open the list file by double-clicking the file `Utilities.lst` available in the `Output` folder icon in the Workspace window.

The *end* of the file contains a summary of errors and warnings that were generated.

For further details of the list file format, see the *IAR Assembler Reference Guide*.

5 Choose **Project>Make** to relink `project2`.

6 Start C-SPY to run the `project2.d`*`xx`* (`Utilities.out` for ILINK) application and see that it behaves like the application in the previous tutorial.

Exit the debugger when you are done.

Using C++

In this chapter, C++ is used to create a C++ class. The class is then used for creating two independent objects, and the application is built and debugged. We also show an example of how to set a conditional breakpoint.

This tutorial assumes that you are familiar with the basics of the IAR Embedded Workbench® IDE described in the previous tutorial chapters.

Note that, depending on what IAR Systems product package you have installed, support for C++ might or might not be included. This tutorial assumes that the product supports C++.

For a short overview of all tutorials and their related files, see *Tutorials overview*, page 3.

Creating a C++ application

This tutorial demonstrates how to use the C++ features. The tutorial consists of two files:

- `Fibonacci.h` and `Fibonacci.cpp` define a class `Fibonacci` that can be used to extract a series of Fibonacci numbers
- `CppTutor.cpp` creates two objects, `fib1` and `fib2`, from the class `Fibonacci` and extracts two sequences of Fibonacci numbers using the `Fibonacci` class.

To demonstrate that the two objects are independent of each other, the numbers are extracted at different speeds. A number is extracted from `fib1` each turn in the loop while a number is extracted from `fib2` only every second turn.

The object `fib1` is created using the default constructor while the definition of `fib2` uses the constructor that takes an integer as its argument.

COMPILING AND LINKING THE C++ APPLICATION

1. In the workspace `tutorials` used in the previous chapters, create a new project, `project3`.
2. Add the files `Fibonacci.cpp` and `CppTutor.cpp` to `project3`.
3. Choose **Project>Options** and make sure the default factory settings are used.

Note: For this application, the default stack size might be too small. For further information about the required settings, see the `CppTutor.cpp` file.

In addition to the default settings, you must switch to the C++ programming language, which is supported by the IAR DLIB Library. To use a DLIB library, choose the **General Options** category and click the **Library Configuration** tab. From the **Library** drop-down list, choose **Normal DLIB** (for some product packages **DLIB**).

To switch to the C++ programming language, choose the **C/C++ Compiler** category and click the **Language** tab. Choose **Language>C++, C++ dialect>Embedded C++** and press **Ok**.

To read more about the IAR DLIB Library and the C++ support, see the compiler documentation.

4 Choose **Project>Make** to compile and link your application.

Alternatively, click the **Make** button on the toolbar. The **Make** command compiles and links those files that have been modified.

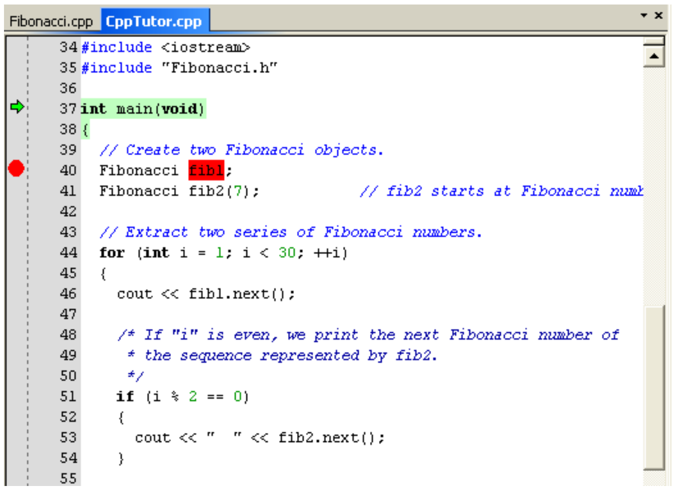
5 Choose **Project>Debug** to start C-SPY.

SETTING A BREAKPOINT AND EXECUTING TO IT

1 Open the CppTutor.cpp window if it is not already open.

2 To see how the object is constructed, set a breakpoint on the C++ object `fib1` on this line:

```
Fibonacci fib1;
```



```
#include <iostream>
#include "Fibonacci.h"

int main(void)
{
  // Create two Fibonacci objects.
  Fibonacci fib1;
  Fibonacci fib2(7);            // fib2 starts at Fibonacci numb

  // Extract two series of Fibonacci numbers.
  for (int i = 1; i < 30; ++i)
  {
    cout << fib1.next();

    /* If "i" is even, we print the next Fibonacci number of
     * the sequence represented by fib2.
     */
    if (i % 2 == 0)
    {
      cout << "  " << fib2.next();
    }

```

Figure 18: Setting a breakpoint in CPPTutor.cpp

3 Choose **Debug>Go**, or click the **Go** button on the toolbar.

The cursor should now be placed at the breakpoint.

4 To step into the constructor, choose **Debug>Step Into** or click the **Step Into** button in the toolbar. Then click **Step Out** again.

5 **Step Over** until the line:

```
cout << fib1.next();
```

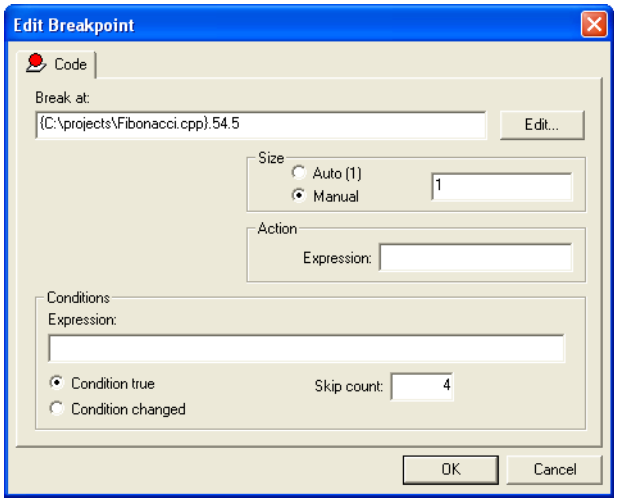
Step Into until you are in the function `next` in the file `Fibonacci.cpp`.

6 Use the **Go to function** button in the lower left corner of the editor window and double-click the function name `nth` to find and go to the function. Set a breakpoint on the function call `nth(n-1)` at the line

```
value = nth(n-1) + nth(n-2);
```

7 It can be interesting to backtrace the function calls a few levels down and to examine the value of the parameter for each function call. If you add a condition to the breakpoint, the break will not be triggered until the condition is true, and you will be able to see each function call in the Call Stack window.

To open the Breakpoints window, choose **View>Breakpoints**. Select the breakpoint in the Breakpoints window, right-click to open the context menu, and choose **Edit** to open the **Edit Breakpoint** dialog box.



Break at: {C:\projects\Fibonacci.cpp}.54.5

Size: Auto (1) [✓ Manual] 1

Action — Expression:

Conditions — Expression:

[✓ Condition true] Condition changed

Skip count: 4

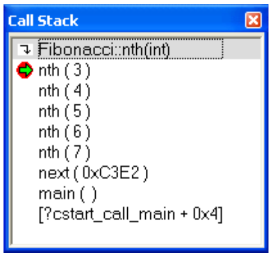
Figure 19: Setting a breakpoint with skip count

Set the value in the **Skip count** text box to `4` and click **OK**.

Looking at the function calls

8 Choose **Debug>Go** to execute the application until the breakpoint condition is fulfilled.

9 When C-SPY stops at the breakpoint, choose **View>Call Stack** to open the Call Stack window.



```
Fibonacci::nth(int)
nth ( 3 )
nth ( 4 )
nth ( 5 )
nth ( 6 )
nth ( 7 )
next ( 0xC3E2 )
main ( )
[?cstart_call_main + 0x4]
```

Figure 20: Inspecting the function calls

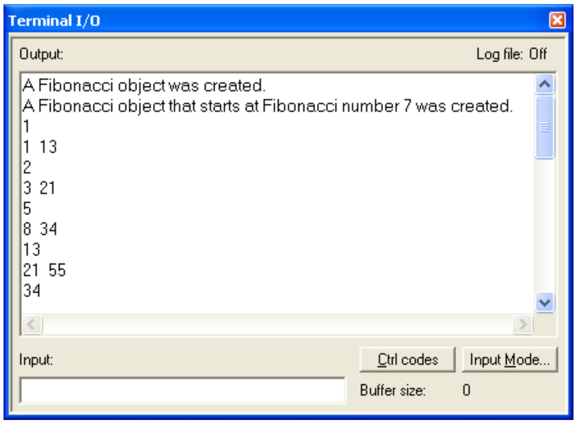
Five instances of the function `nth` are displayed on the call stack. Because the Call Stack window displays the values of the function parameters, you can see the different values of `n` in the different function instances.

You can also open the Register window to see how it is updated as you trace the function calls by double-clicking on the function instances.

PRINTING THE FIBONACCI NUMBERS

1 Open the Terminal I/O window from the **View** menu.

2 Remove the breakpoints and run the application to the end and verify the Fibonacci sequences being printed.



```
A Fibonacci object was created.
A Fibonacci object that starts at Fibonacci number 7 was created.
1
1  13
2
3  21
5
8  34
13
21  55
34
```

Figure 21: Printing Fibonacci sequences

Simulating an interrupt

In this tutorial an interrupt handler for a serial port is added to the project. The Fibonacci numbers are read from an on-chip communication peripheral device (UART).

This tutorial will show how the compiler interrupt keyword and the #pragma vector directive can be used. The tutorial will also show how to simulate an interrupt, using the features that support interrupts, breakpoints, and macros. Notice that this example does not describe an exact simulation; the purpose is to illustrate a situation where C-SPY® macros, breakpoints, and the interrupt system can be useful to simulate hardware.

This tutorial assumes that you are familiar with the basics of the IAR Embedded Workbench® IDE described in the previous tutorial chapters.

Note that interrupt simulation is possible only when you are using the IAR C-SPY Simulator.

For a short overview of all tutorials and their related files, see *Tutorials overview*, page 3.

Adding an interrupt handler

This section will demonstrate how to write an interrupt in an easy way. It starts with a brief description of the application used in this project, followed by a description of how to set up the project.

THE APPLICATION—A BRIEF DESCRIPTION

The interrupt handler will read values from the serial communication port receive register (UART), `RBUF`. It will then print the value. The main program enables interrupts and starts printing periods (.) in the foreground process while waiting for interrupts.

Note: In this tutorial, the serial communication port UART and the receive buffer register `RBUF` are symbolic names. To follow this tutorial and simulate the interrupt in the C-SPY Simulator, you should instead use names that are suitable for your target system. See the `Interrupt.c` file in the `*cpuname*\tutor` directory.

WRITING AN INTERRUPT HANDLER

The following lines define the interrupt handler used in this tutorial (the complete source code can be found in the file `Interrupt.c` in `project4` supplied in the *`cpuname`*`\tutor` directory):

```
/* Defines an interrupt handler. */
#pragma vector=UARTR_VECTOR
__interrupt __root void UartReceiveHandler( void )
```

The `#pragma vector` directive is used for specifying the interrupt vector address—in this case the interrupt vector for the UART receive interrupt—and the keyword `__interrupt` is used for directing the compiler to use the calling convention needed for an interrupt function.

Note: In this tutorial, the name of the vector is symbolic. To follow this tutorial and simulate the interrupt in the C-SPY Simulator, you should instead use a name that is suitable for your target system. See the `Interrupt.c` file in the *`cpuname`*`\tutor` directory.

For detailed information about the extended keywords and pragma directives used in this tutorial, see the compiler documentation.

SETTING UP THE PROJECT

1. Add a new project—`project4`—to the workspace `tutorials` used in previous tutorials.
2. Add the files `Utilities.c` and `Interrupt.c` to it.
3. In the Workspace window, select the project level node and choose **Project>Options**.

   Make sure default factory settings are used in the **General Options**, **C/C++ Compiler**, and **Linker** categories.

   Note: Look in the file `Interrupt.c` to find information about any target-specific settings that might be required.

   Next you will set up the simulation environment.

Setting up the simulation environment

The C-SPY interrupt system is based on the cycle counter. You can specify the amount of cycles to pass before C-SPY generates an interrupt.

To simulate the input to UART, values are read from the file `InputData.txt`, which contains the Fibonacci series. You will set an *immediate read breakpoint* on the UART receive register, `RBUF`, and connect a user-defined macro function to it (in this example the `Access` macro function). The macro reads the Fibonacci values from the text file.

Whenever an interrupt is generated, the interrupt routine reads `RBUF` and the breakpoint is triggered, the `Access` macro function is executed and the Fibonacci values are fed into the UART receive register.

The immediate read breakpoint will trigger the break *before* the processor reads the `RBUF` register, allowing the macro to store a new value in the register that is immediately read by the instruction.

This section will demonstrate the steps involved in setting up the simulator for simulating a serial port interrupt. The steps involved are:

- Defining a C-SPY setup file which will open the file `InputData.txt` and define the `Access` macro function
- Specifying debugger options
- Building the project
- Starting the simulator
- Specifying the interrupt request
- Setting the breakpoint and associating the `Access` macro function to it.

Note: For a simple example of a system timer interrupt simulation, see *Simulating a simple interrupt*, page 175.

DEFINING A C-SPY SETUP MACRO FILE

In C-SPY, you can define setup macros that will be registered during the C-SPY startup sequence. In this tutorial you will use the C-SPY macro file `SetupSimple.mac`, available in the *`cpuname`*`\tutor` directory. It is structured as follows:

First the setup macro function `execUserSetup` is defined, which is automatically executed during C-SPY setup. Thus, it can be used to set up the simulation environment automatically. A message is printed in the Log window to confirm that this macro has been executed:

```
execUserSetup()
{
  __message "execUserSetup() called\n";
```

Then the file `InputData.txt`, which contains the Fibonacci series to be fed into UART, is opened:

```
  _fileHandle = __openFile(
"$TOOLKIT_DIR$\\tutor\\InputData.txt", "r" );
```

After that, the macro function `Access` is defined. It will read the Fibonacci values from the file `InputData.txt`, and assign them to the receive register address:

```
Access()
{
  __message "Access() called\n";
  __var _fibValue;
  if( 0 == __readFile( _fileHandle, &_fibValue ) )
  {
    RBUF = _fibValue;
  }
}
```

You must connect the `Access` macro to an immediate read breakpoint. However, this will be done at a later stage in this tutorial.

Finally, the file contains two macro functions for managing correct file handling at reset and exit.

For detailed information about macros, see the chapters *Using the C-SPY® macro system* and *C-SPY® macros reference*.

Next you will specify the macro file and set the other debugger options needed.

SETTING C-SPY OPTIONS

1 To set debugger options, choose **Project>Options**. In the **Debugger** category, click the **Setup** tab.

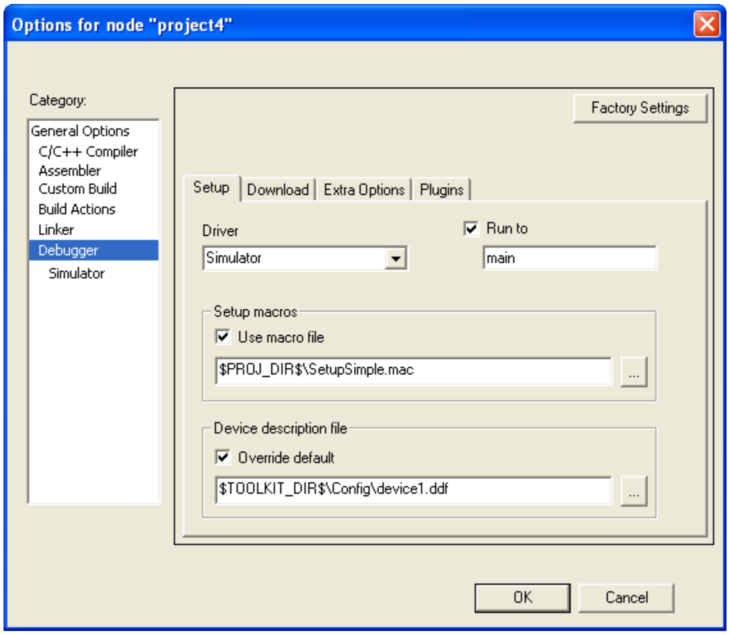
2 Use the **Use macro file** browse button to specify the macro file to be used:

```
SetupSimple.mac
```

Alternatively, use an argument variable to specify the path:

```
$TOOLKIT_DIR$\tutor\SetupSimple.mac
```

See *Argument variables summary*, page 228, for details.


Options for node "project4"

Category:

- General Options
  - C/C++ Compiler
  - Assembler
  - Custom Build
  - Build Actions
  - Linker
  - Debugger
    - Simulator

Factory Settings

Setup | Download | Extra Options | Plugins

Driver: Simulator

☑ Run to: main

Setup macros

☑ Use macro file

$PROJ_DIR$\SetupSimple.mac

Device description file

☑ Override default

$TOOLKIT_DIR$\Config\device1.ddf

OK Cancel

Figure 22: Specifying the setup macro file

3 The C-SPY interrupt system requires some interrupt definitions, provided by the device description files. With the **Device description file** option you can specify the appropriate file. See the `Interrupt.c` file in the *`cpuname`*`\tutor` directory for information about which device description file to be used in this tutorial.

4 Select **Run to main** and click **OK**. This will ensure that the debug session will start by running to the `main` function.

The project is now ready to be built.

BUILDING THE PROJECT

1 Compile and link the project by choosing **Project>Make**.

Alternatively, click the **Make** button on the toolbar. The **Make** command compiles and links those files that have been modified.

STARTING THE SIMULATOR

1 Start C-SPY to run the `project4` project.

The Interrupt.c window is displayed (among other windows). Click in it to make it the active window.

2 Examine the Log window. Note that the macro file has been loaded and that the `execUserSetup` function has been called.

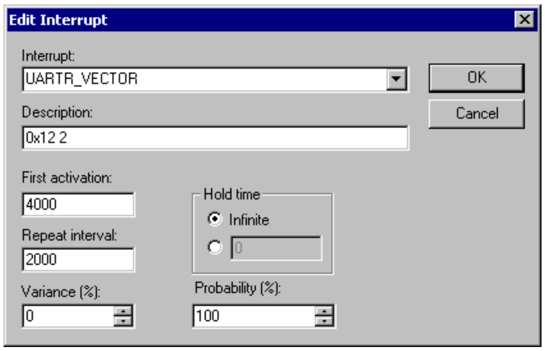
SPECIFYING A SIMULATED INTERRUPT

Now you will specify your interrupt to make it simulate an interrupt every 2000 cycles.

1 Choose **Simulator**>**Interrupt Setup** to display the **Interrupt Setup** dialog box. Click **New** to display the **Edit Interrupt** dialog box and make these settings for your interrupt:

Setting	Value	Description
Interrupt	`UARTR_VECTOR`	Specifies which interrupt to use.
Description	As is	The interrupt definition that the simulator uses to be able to simulate the interrupt correctly.
First activation	`4000`	Specifies the first activation moment for the interrupt. The interrupt is activated when the cycle counter has passed this value.
Repeat interval	`2000`	Specifies the repeat interval for the interrupt, measured in clock cycles.
Hold time	`Infinite`	Hold time, not used here.
Probability (%)	`100`	Specifies probability. 100% specifies that the interrupt will occur at the given frequency. Another percentage might be used for simulating a more random interrupt behavior.
Variance (%)	`0`	Time variance, not used here.

Table 8: Interrupts dialog box



Interrupt: UARTR_VECTOR
Description: 0x12 2
First activation: 4000
Repeat interval: 2000
Variance (%): 0
Hold time: [✓ Infinite] 0
Probability (%): 100

Figure 23: Inspecting the interrupt settings

During execution, C-SPY will wait until the cycle counter has passed the activation time. When the current assembler instruction is executed, C-SPY will generate an interrupt which is repeated approximately every 2000 cycles.

2 When you have specified the settings, click **OK** to close the **Edit Interrupt** dialog box, and then click **OK** to close the **Interrupt Setup** dialog box.

For information about how you can use the system macro `__orderInterrupt` in a C-SPY setup file to automate the procedure of defining the interrupt, see *Using macros for interrupts and breakpoints*, page 45.

SETTING AN IMMEDIATE BREAKPOINT

By defining a macro and connecting it to an immediate breakpoint, you can make the macro simulate the behavior of a hardware device, for instance an I/O port, as in this tutorial. The immediate breakpoint will not halt the execution, only temporarily suspend it to check the conditions and execute any connected macro.

In this example, the input to the UART is simulated by setting an immediate read breakpoint on the `RBUF` address and connecting the defined `Access` macro to it. The macro will simulate the input to the UART. These are the steps involved:

1 Choose **View>Breakpoints** to open the Breakpoints window, right-click to open the context menu, choose **New Breakpoint>Immediate** to open the **Immediate** tab.

2 Add these parameters for your breakpoint.

Setting	Value	Description
Break at	`RBUF`	Receive buffer address.
Access Type	`Read`	The breakpoint type (Read or Write)

Table 9: Breakpoints dialog box

Setting	Value	Description
Action	`Access()`	The macro connected to the breakpoint.

Table 9: Breakpoints dialog box (Continued)

During execution, when C-SPY detects a read access from the `RBUF` address, C-SPY will temporarily suspend the simulation and execute the `Access` macro. The macro will read a value from the file `InputData.txt` and write it to `RBUF`. C-SPY will then resume the simulation by reading the receive buffer value in `RBUF`.

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

For information about how you can use the system macro `__setSimBreak` in a C-SPY setup file to automate the breakpoint setting, see *Using macros for interrupts and breakpoints*, page 45.

Simulating the interrupt

In this section you will execute your application and simulate the serial port interrupt.

EXECUTING THE APPLICATION

1 In the Interrupt.c source window, step through the application and stop when it reaches the `while` loop, where the application waits for input.

2 In the Interrupt.c source window, locate the function `UartReceiveHandler`.

3 Place the insertion point on the `++callCount;` statement in this function and set a breakpoint by choosing **Edit>Toggle Breakpoint**, or click the **Toggle Breakpoint** button on the toolbar. Alternatively, use the context menu.

If you want to inspect the details of the breakpoint, choose **View>Breakpoints**.

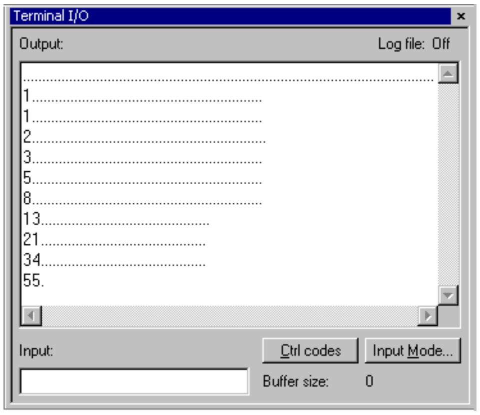
4 Open the Terminal I/O window and run your application by choosing **Debug>Go** or clicking the **Go** button on the toolbar.

The application should stop in the interrupt function.

5 Click **Go** again to see the next number being printed in the Terminal I/O window.

Because the main program has an upper limit on the Fibonacci value counter, the tutorial application will soon reach the `exit` label and stop.

The Terminal I/O window will display the Fibonacci series.



```
1
1
2
3
5
8
13
21
34
55.
```

Figure 24: Printing the Fibonacci values in the Terminal I/O window

Using macros for interrupts and breakpoints

To automate the setting of breakpoints and the procedure of defining interrupts, the system macros `__setSimBreak` and `__orderInterrupt`, respectively, can be executed by the setup macro `execUserSetup`.

The file `SetupAdvanced.mac` is extended with system macro calls for setting the breakpoint and specifying the interrupt:

```
simulationSetup()
{...
  _interruptID = __orderInterrupt( "UARTR_VECTOR", 4000,
                                    2000, 0, 1, 0, 100 );

  if( -1 == _interruptID )
  {
    __message "ERROR: failed to order interrupt";
  }

  _breakID = __setSimBreak( "RBUF", "R", "Access()" );

}
```

If you replace the file `SetupSimple.mac`, used in the previous tutorial, with the file `SetupAdvanced.mac`, C-SPY will automatically set the breakpoint and define the interrupt at startup. Thus, you do not need to start the simulation by manually filling in the values in the **Interrupts** and **Breakpoints** dialog boxes.

Note: Before you load the file `SetupAdvanced.mac` you should remove the previously defined breakpoint and interrupt.

Creating and using libraries

This tutorial demonstrates how to create a library project and how you can combine it with an application project.

This tutorial assumes that you are familiar with the basics of the IAR Embedded Workbench® IDE described in the previous tutorial chapters.

For a short overview of all tutorials and their related files, see *Tutorials overview*, page 3.

Using libraries

If you are working on a large project, you will soon accumulate a collection of useful modules that contain one or more routines to be used by several of your applications. To avoid having to assemble or compile a module each time it is needed, you can store such modules as object files, that is, assembled or compiled but not linked.

You can collect many modules in a single object file which then is referred to as a *library*. It is recommended that you use library files to create collections of related routines, such as a device driver.

If your product package includes the XLINK linker, use the IAR XAR Library Builder to build libraries, and if your product package includes the ILINK linker, use the IAR Archive Tool `iarchive` to build libraries.

The Main program

The `Main.sxx` (`Main.s` for ILINK) program uses a routine called `max` to set the contents of one register to the maximum value of two other registers. The `EXTERN` directive declares `max` as an external symbol, to be resolved at link time.

A copy of the program is provided in the `cpuname\tutor` directory.

The library routines

The two library routines will form a separately assembled library. It consists of the `max` routine called by `main`, and a corresponding `min` routine, both of which operate on the contents of the registers used in the `Main.sxx` program. The `Maxmin.sxx` file contains these library routines and a copy is provided in the `cpuname\tutor` directory.

The routines are defined as library modules by the `MODULE` directive (XLINK only), which instructs the IAR XLINK Linker to include the modules only if they are referenced by another module.

The `PUBLIC` directive makes the `max` and `min` symbols public to other modules.

For detailed information about the `MODULE` and `PUBLIC` directives, see the *IAR Assembler Reference Guide*.

CREATING A NEW PROJECT

1 In the workspace `tutorials` used in previous chapters, add a new project called `project5`.

2 Add the file `Main.sxx` to the new project.

3 To set options, choose **Project>Options.** Select the **General Options** category and click the **Library Configuration** tab. Choose **None** from the **Library** drop-down list, which means that a standard C/C++ library will not be linked.

The default options are used for the other option categories.

4 To assemble the file `Main.sxx`, choose **Project>Compile**.

You can also click the **Compile** button on the toolbar.

CREATING A LIBRARY PROJECT

Now you are ready to create a library project.

1 In the same workspace `tutorials`, add a new project called `tutor_library`.

2 Add the file `Maxmin.sxx` to the project.

3 To set options, choose **Project>Options.** In the **General Options** category, verify these settings:

Page	Option
Output	Output file: Library
Library Configuration	Library: None

Table 10: General options for a library project

Note that **Library Builder** appears in the list of categories, which means that the IAR XAR Library Builder (for XLINK) but IAR Archive Tool `iarchive` (for ILINK) is added to the build toolchain. You do not have to set any specific options specific for library building for this tutorial.

Click **OK.**

4 Choose **Project>Make**.

The library output file `tutor_library.rxx` has now been created in the `projects\Debug\Exe` directory.

USING THE LIBRARY IN YOUR APPLICATION PROJECT

Now add your library containing the maxmin routine to `project5`.

1 In the Workspace window, click the **project5** tab. Choose **Project>Add Files** and add the file `tutor_library.rxx` (`tutor_library.a` for ILINK) located in the `projects\Debug\Exe` directory. Click **Open**.

2 Click **Make** to build your project.

3 You have now combined a library with an executable project, and the application is ready to be executed. For information about how to manipulate the library, see the *IAR Linker and Library Tools Reference Guide* if you built the library using XAR and IAR Archive Tool documentation available in the compiler documentation if you built the library using `iarchive`.

Part 2. Project management and building

This part of the IAR Embedded Workbench IDE User Guide contains the following chapters:

- The development environment
- Managing projects
- Building
- Editing.

The development environment

This chapter introduces you to the IAR Embedded Workbench® integrated development environment (IDE). The chapter also demonstrates how you can customize the environment to suit your requirements.

The IAR Embedded Workbench IDE—an overview

THE TOOLCHAIN

The IDE is the environment where all necessary tools—the *toolchain*—are integrated: a C/C++ compiler, an assembler, a linker, an editor, a project manager with Make utility, and the IAR C-SPY® Debugger. The tools used specifically for building your source code are referred to as the *build tools*.

The compiler, assembler, and linker can also be run from a command line environment, if you want to use them as external tools in an already established project environment.

CONTINUOUS WORKFLOW

You have the same user interface regardless of which microcontroller you have chosen to work with—coupled with general and target-specific support for each device.

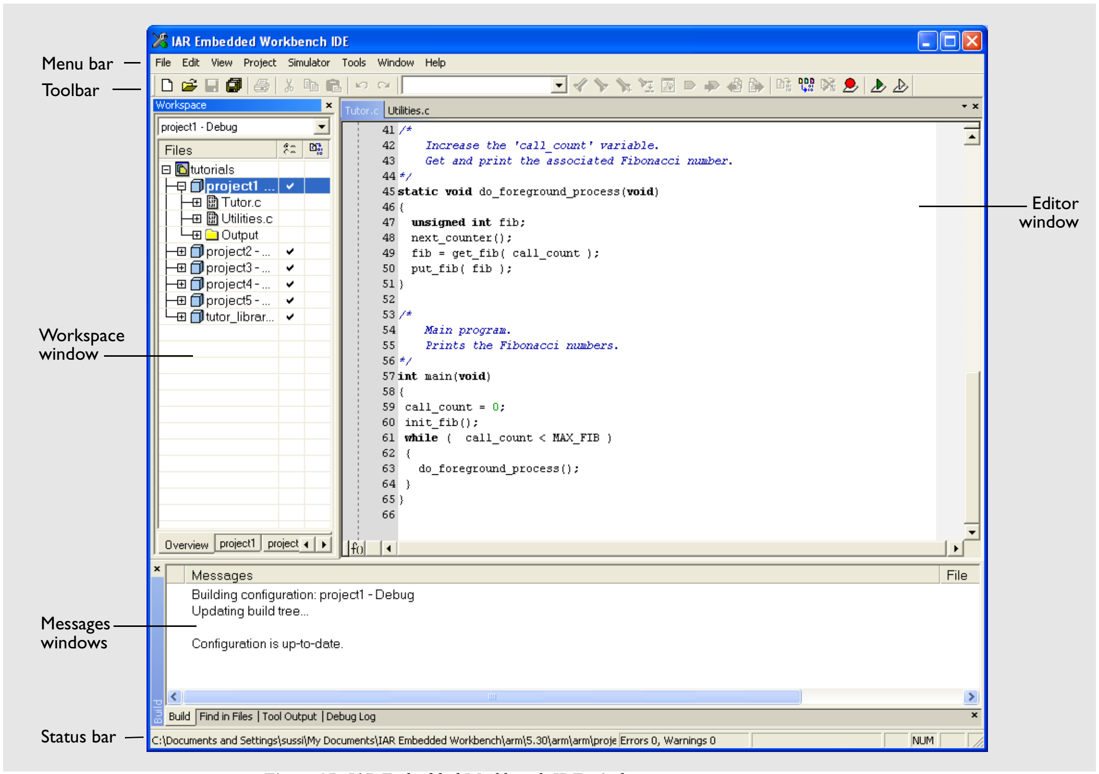
AN EXTENSIBLE AND MODULAR ENVIRONMENT

Although the IDE provides all the features required for your project, you can also integrate with other tools. For example, you can add IAR visualSTATE to the toolchain, which means that you can add state machine diagrams directly to your project in the IDE. Source code control (SCC)—or revision control—is useful for keeping track of different versions of your source code. IAR Embedded Workbench can identify and access any third-party source code control system that conforms to the SCC interface published by Microsoft. You can use the Custom Build mechanism to incorporate also other tools to the toolchain, see *Extending the toolchain*, page 75.

WINDOW MANAGEMENT

To give you full and convenient control of the placement of the windows, each window is *dockable* and you can optionally organize the windows in *tab groups*.

This illustration shows the IAR Embedded Workbench IDE window with various components.



```
/*
    Increase the 'call_count' variable.
    Get and print the associated Fibonacci number.
*/
static void do_foreground_process(void)
{
  unsigned int fib;
  next_counter();
  fib = get_fib( call_count );
  put_fib( fib );
}

/*
    Main program.
    Prints the Fibonacci numbers.
*/
int main(void)
{
 call_count = 0;
 init_fib();
 while (  call_count < MAX_FIB )
 {
   do_foreground_process();
 }
}
```

```
Building configuration: project1 - Debug
Updating build tree...

Configuration is up-to-date.
```

```
C:\Documents and Settings\sussi\My Documents\IAR Embedded Workbench\arm\5.30\arm\arm\proje Errors 0, Warnings 0      NUM
```

Figure 25: IAR Embedded Workbench IDE window

The window might look different depending on what additional tools you are using.

RUNNING THE IDE

Click the **Start** button on the taskbar and choose **All Programs>IAR Systems>IAR Embedded Workbench for *chip manufacturer CPUNAME*>IAR Embedded Workbench**.

The file `IarIdePm.exe` is located in the `common\bin` directory under your IAR Systems installation, in case you want to start the program from the command line or from within Windows Explorer.

Double-clicking the workspace filename

The workspace file has the filename extension eww. If you double-click a workspace filename, the IDE starts. If you have several versions of IAR Embedded Workbench installed, the workspace file is opened by the most recently used version of your IAR Embedded Workbench that uses that file type.

EXITING

To exit the IDE, choose **File>Exit**. You will be asked whether you want to save any changes to editor windows, the projects, and the workspace before closing them.

Customizing the environment

The IDE is a highly customizable environment. This section demonstrates how you can work with and organize the windows on the screen, the possibilities for customizing the IDE, and how you can set up the environment to communicate with external tools.

ORGANIZING THE WINDOWS ON THE SCREEN

In the IDE, you can position the windows and arrange a layout according to your preferences. You can *dock* windows at specific places, and organize them in tab groups. You can also make a window *floating,* which means it is always on top of other windows. If you change the size or position of a floating window, other currently open windows are not affected.

Each time you open a previously saved workspace, the same windows are open, and they have the same sizes and positions.

For every project that is executed in the C-SPY environment, a separate layout is saved. In addition to the information saved for the workspace, information about all open debugger-specific windows is also saved.

Using docked versus floating windows

Each window that you open has a default location, which depends on other currently open windows. To give you full and convenient control of window placement, each window can either be docked or floating.

A docked window is locked to a specific area in the Embedded Workbench main window, which you can decide. To keep many windows open at the same time, you can organize the windows in tab groups. This means one area of the screen is used for several concurrently open windows. The system also makes it easy to rearrange the size of the windows. If you rearrange the size of one docked window, the sizes of any other docked windows are adjusted accordingly.

A floating window is always on top of other windows. Its location and size does not affect other currently open windows. You can move a floating window to any place on your screen, also outside of the IAR Embedded Workbench IDE main window.

Note: The editor window is always docked. When you open the editor window, its placement is decided automatically depending on other currently open windows. For more information about how to work with the editor window, see *Using the IAR Embedded Workbench editor*, page 79.

Organizing windows

To place a window as a *separate* window, drag it next to another open window.

To place a window in the same tab group as another open window, drag the window you want to locate to the middle of the area and drop the window.

To make a window floating, double-click on the window's title bar.

The status bar, located at the bottom of the IAR Embedded Workbench IDE main window, contains useful help about how to arrange windows.

CUSTOMIZING THE IDE

To customize the IDE, choose **Tools>Options** to get access to a wide variety of commands for:

- Configuring the editor
- Configuring the editor colors and fonts
- Configuring the project build command
- Organizing the windows in C-SPY
- Using an external editor
- Changing common fonts
- Changing key bindings
- Configuring the amount of output to the Messages window.

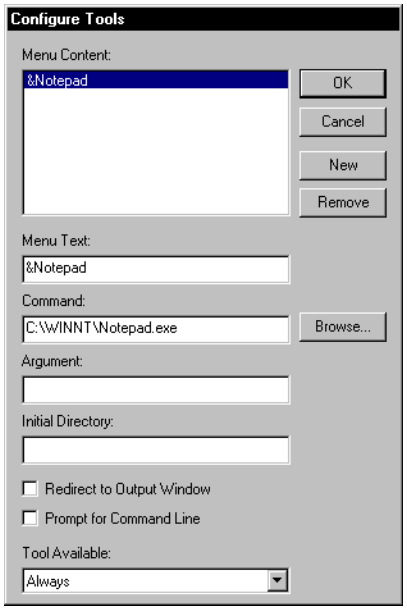
In addition, you can increase the number of recognized filename extensions. By default, each tool in the build toolchain accepts a set of standard filename extensions. If you have source files with a different filename extension, you can modify the set of accepted filename extensions. Choose **Tools>Filename Extensions** to get access to the necessary commands.

For reference information about the commands for customizing the IDE, see *Tools menu*, page 235. You can also find further information related to customizing the editor in the section *Customizing the editor environment*, page 86. For further information about customizations related to C-SPY, see *Part 4. The C-SPY® Simulator*.

INVOKING EXTERNAL TOOLS

The **Tools** menu is a configurable menu to which you can add external tools for convenient access to these tools from within the IDE. For this reason, the menu might look different depending on which tools you have preconfigured to appear as menu commands.

To add an external tool to the menu, choose **Tools>Configure Tools** to open the **Configure Tools** dialog box.



Menu Content: &Notepad

Menu Text: &Notepad

Command: C:\WINNT\Notepad.exe

Argument:

Initial Directory:

☐ Redirect to Output Window

☐ Prompt for Command Line

Tool Available: Always

Figure 26: Configure Tools dialog box

For reference information about this dialog box, see *Configure Tools dialog box*, page 257.

Note: You cannot use the **Configure Tools** dialog box to extend the toolchain in the IDE, see *The toolchain*, page 53.

After you have entered the appropriate information and clicked **OK**, the menu command you have specified is displayed on the **Tools** menu.

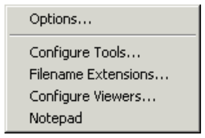


Figure 27: Customized Tools menu

Note: If you intend to add an external tool to the standard build toolchain, see *Extending the toolchain*, page 75.

Adding command line commands

Command line commands and calls to batch files must be run from a command shell. You can add command line commands to the **Tools** menu and execute them from there.

1 To add commands to the **Tools** menu, you must specify an appropriate command shell.

Type one of these command shells in the **Command** text box:

Command shell	System
`cmd.exe`	Windows XP/Vista/7

Table 11: Command shells

2 Specify the command line command or batch file name in the **Argument** text box.

The **Argument** text should be specified as:

```
/C name
```

where *`name`* is the name of the command or batch file you want to run.

The `/C` option terminates the shell after execution, to allow the IDE to detect when the tool has finished.

Example

To add the command **Backup** to the **Tools** menu to make a copy of the entire `project` directory to a network drive, you would specify **Command** either as `command.cmd` or as `cmd.exe` depending on your host environment, and **Argument** as:

```
/C copy c:\project\*.* F:
```

Alternatively, to use a variable for the argument to allow relocatable paths:

```
/C copy $PROJ_DIR$\*.* F:
```

Managing projects

This chapter discusses the project model used by the IAR Embedded Workbench IDE. It covers how projects are organized and how you can specify workspaces with multiple projects, build configurations, groups, source files, and options that help you handle different versions of your applications. The chapter also describes the steps involved in interacting with an external third-party source code control system.

The project model

In a large-scale development project, with hundreds of files, you must be able to organize the files in a structure that is easily navigated and maintained by perhaps several engineers involved.

MANAGING PROJECTS—AN OVERVIEW

The IDE comes with functions that will help you to stay in control of all project modules, for example, C or C++ source code files, assembler files, include files, and other related modules. You create workspaces and let them contain one or several projects. Files can be grouped, and options can be set on all levels—project, group, or file. Changes are tracked so that a request for rebuild will retranslate all required modules, making sure that no executable files contain out-of-date modules. This list shows some additional features:

- Project templates to create a project that can be built and executed for a smooth development startup
- Hierarchical project representation
- Source browser with an hierarchical symbol presentation
- Options can be set globally, on groups of source files, or on individual source files
- The Make command automatically detects changes and performs only the required operations
- Text-based project files
- Custom Build utility to expand the standard toolchain in an easy way
- Command line build with the project file as input.

HOW PROJECTS ARE ORGANIZED

The IDE has been designed to suit the way that software development projects are typically organized. For example, perhaps you need to develop related versions of an application for different versions of the target hardware, and you might also want to include debugging routines into the early versions, but not in the final application.

Versions of your applications for different target hardware will often have source files in common, and you might want to be able to maintain only one unique copy of these files, so that improvements are automatically carried through to each version of the application. Perhaps you also have source files that differ between different versions of the application, such as those dealing with hardware-dependent aspects of the application.

The IDE allows you to organize projects in an hierarchical tree structure showing the logical structure at a glance. In the following sections the various levels of the hierarchy are described.

Projects and workspaces

Typically you create a *project* which contains the source files needed for your embedded systems application. If you have several related projects, you can access and work with them simultaneously. To achieve this, you can organize related projects in *workspaces*.

Each workspace you define can contain one or more projects, and each project must be part of at least one workspace.

Consider this example: two related applications—for instance A and B—are developed, requiring one development team each (team A and B). Because the two applications are related, they can share parts of the source code between them. The following project model can be applied:

- Three projects—one for each application, and one for the common source code
- Two workspaces—one for team A and one for team B.

Collecting the common sources in a library project (compiled but not linked object code) is both convenient and efficient, to avoid having to compile it unnecessarily.

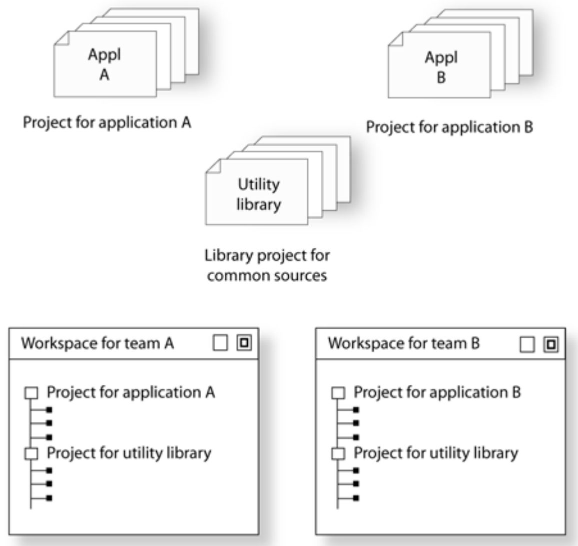

Appl
A
Project for application A
Appl
B
Project for application B
Utility
library
Library project for
common sources
Workspace for team A
Project for application A
Project for utility library
Workspace for team B
Project for application B
Project for utility library

Figure 28: Examples of workspaces and projects

For an example where a library project has been combined with an application project, see the chapter *Creating and using libraries* in *Part 1. Tutorials*.

Projects and build configurations

Often, you need to build several versions of your project. The Embedded Workbench lets you define multiple build configurations for each project. In a simple case, you might need just two, called **Debug** and **Release**, where the only differences are the options used for optimization, debug information, and output format. In the Release configuration, the preprocessor symbol `NDEBUG` is defined, which means the application will not contain any asserts.

Additional build configurations might be useful, for instance, if you intend to use the application on different target devices. The application is the same, but hardware-related parts of the code differ. Thus, depending on which target device you intend to build for, you can exclude some source files from the build configuration. These build configurations might fulfil these requirements for Project A:

- Project A - Device 1:Release
- Project A - Device 1:Debug

- Project A - Device 2:Release
- Project A - Device 2:Debug

Groups

Normally, projects contain hundreds of files that are logically related. You can define each project to contain one or more groups, in which you can collect related source files. You can also define multiple levels of subgroups to achieve a logical hierarchy. By default, each group is present in all build configurations of the project, but you can also specify a group to be excluded from a particular build configuration.

Source files

Source files can be located directly under the project node or in a hierarchy of groups. The latter is convenient if the amount of files makes the project difficult to survey. By default, each file is present in all build configurations of the project, but you can also specify a file to be excluded from a particular build configuration.

Only the files that are part of a build configuration will actually be built and linked into the output code.

Once a project has been successfully built, all include files and output files are displayed in the structure below the source file that included or generated them.

Note: The settings for a build configuration can affect which include files that are used during the compilation of a source file. This means that the set of include files associated with the source file after compilation can differ between the build configurations.

CREATING AND MANAGING WORKSPACES

This section describes the overall procedure for creating the workspace, projects, groups, files, and build configurations. The **File** menu provides the commands for creating workspaces. The **Project** menu provides commands for creating projects, adding files to a project, creating groups, specifying project options, and running the IAR Systems development tools on the current projects.

For reference information about these menus, menu commands, and dialog boxes, see the chapter *IAR Embedded Workbench IDE reference*.

The steps involved for creating and managing a workspace and its contents are:

- Creating a workspace.

  An empty Workspace window appears, which is the place where you can view your projects, groups, and files.
- Adding new or existing projects to the workspace.

When creating a new project, you can base it on a *template project* with preconfigured project settings. Template projects are available for C applications, C++ applications, assembler applications, and library projects.

- Creating groups.

  A group can be added either to the project's top node or to another group within the project.
- Adding files to the project.

  A file can be added either to the project's top node or to a group within the project.
- Creating new build configurations.

  By default, each project you add to a workspace will have two build configurations called **Debug** and **Release**.

  You can base a *new* configuration on an already existing configuration. Alternatively, you can choose to create a default build configuration.

  Note that you do not have to use the same toolchain for the new build configuration as for other build configurations in the same project.
- Excluding groups and files from a build configuration.

  Note that the icon indicating the excluded group or file will change to white in the Workspace window.
- Removing items from a project.

For a detailed example, see *Creating an application project*, page 7.

Note: It might not be necessary for you to perform all of these steps.

Drag and drop

You can easily drag individual source files and project files from the Windows file explorer to the Workspace window. Source files dropped on a *group* are added to that group. Source files dropped outside the project tree—on the Workspace window background—are added to the active project.

Source file paths

The IDE supports relative source file paths to a certain degree, for:

- Project file

  Paths to files part of the project file is relative if they are located on the same drive. The path is relative either to `$PROJ_DIR$` or `$EW_DIR$`. The argument variable `$EW_DIR$` is only used if the path refers to a file located in subdirectory to `$EW_DIR$` and the distance from `$EW_DIR$` is shorter than the distance from `$PROJ_DIR$`.

  Paths to files that are part of the project file are absolute if the files are located on different drives.

- Workspace file

  For files located on the same drive as the workspace file, the path is relative to `$PROJ_DIR$`.

  For files located on another drive as the workspace file, the path is absolute.
- Debug files

  The path is absolute if the file is built with IAR Systems compilation tools.

Navigating project files

There are two main different ways to navigate your project files: using the Workspace window or the Source Browser window. The Workspace window displays an hierarchical view of the source files, dependency files, and output files and how they are logically grouped. The Source Browser window, on the other hand, displays information about the build configuration that is currently active in the Workspace window. For that configuration, the Source Browser window displays a hierarchical view of all globally defined symbols, such as variables, functions, and type definitions. For classes, information about any base classes is also displayed.

VIEWING THE WORKSPACE

The Workspace window is where you access your projects and files during the application development.

1 To choose which project you want to view, click its tab at the bottom of the Workspace window.

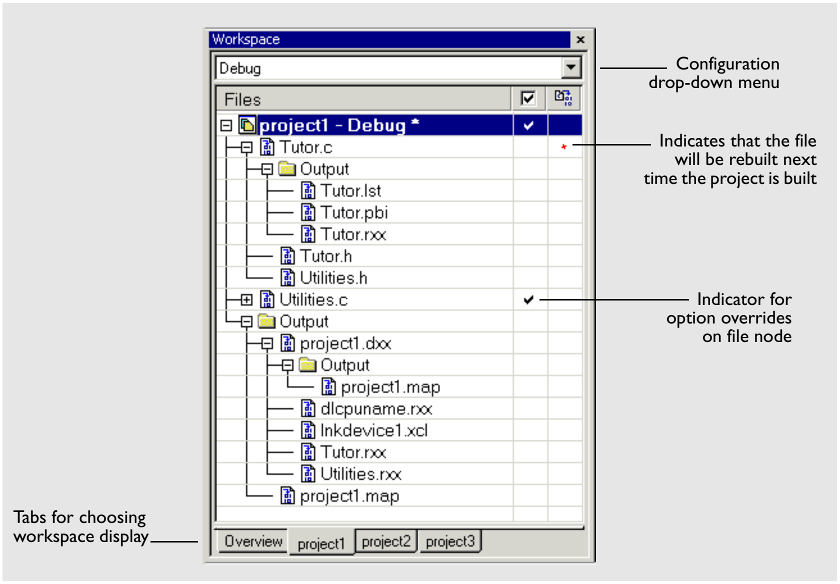


Figure 29: Displaying a project in the Workspace window

For each file that has been built, an `Output` folder icon appears, containing generated files, such as object files and list files. The latter is generated only if the list file option is enabled. There is also an `Output` folder related to the project node that contains generated files related to the whole project, such as the executable file and the linker map file (if the list file option is enabled).

Also, any included header files will appear, showing dependencies at a glance.

2 To display the project with a different build configuration, choose that build configuration from the drop-down list at the top of the Workspace window**.**

The project and build configuration you have selected are displayed highlighted in the Workspace window. It is the project and build configuration that you select from the drop-down list that is built when you build your application.

3 To display an overview of all projects in the workspace, click the **Overview** tab at the bottom of the Workspace window.

An overview of all project members is displayed.

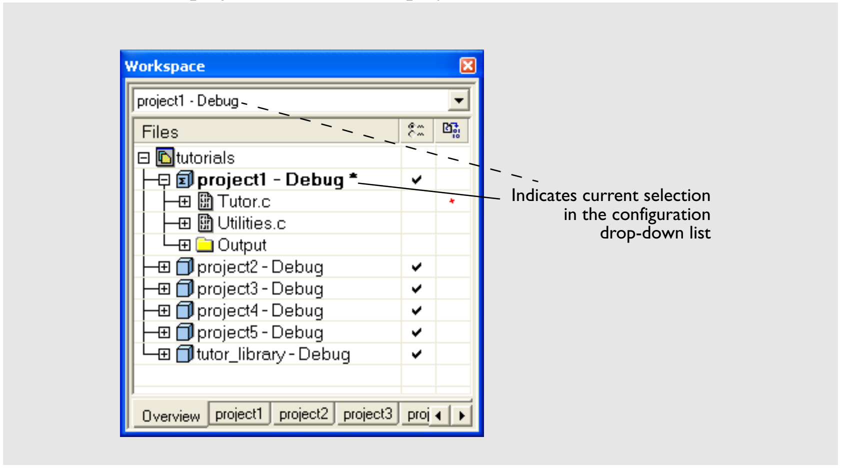


Figure 30: Workspace window—an overview

The current selection in the **Build Configuration** drop-down list is also highlighted when an overview of the workspace is displayed.

DISPLAYING BROWSE INFORMATION

To display browse information in the Source Browser window, choose **Tools>Options>Project** and select the option **Generate browse information**.

To open the Source Browser window, choose **View>Source Browser**. The Source Browser window is, by default, docked with the Workspace window. Source browse information is displayed for the active build configuration. For reference information, see *Source Browser window*, page 198.

Note that you can choose a file filter and a type filter from the context menu that appears when you right-click in the top pane of the window.

To see the definition of a global symbol or a function, you can use three alternative methods:

- In the Source Browser window, right-click on a symbol, or function, and choose the **Go to definition** command from the context menu that appears
- In the Source Browser window, double-click on a row
- In the editor window, right-click on a symbol, or function, and choose the **Go to definition** command from the context menu that appears.

The definition of the symbol or function is displayed in the editor window.

The source browse information is continuously updated in the background. While you are editing source files, or when you open a new project, there will be a short delay before the information is up-to-date.

Source code control

IAR Embedded Workbench can identify and access any installed third-party source code control (SCC) system that conforms to the SCC interface published by Microsoft corporation. From within the IDE you can connect an IAR Embedded Workbench project to an external SCC project, and perform some of the most commonly used operations.

To connect your IAR Embedded Workbench project to a source code control system you should be familiar with the source code control *client application* you are using. Note that some of the windows and dialog boxes that appear when you work with source code control in the IAR Embedded Workbench IDE originate from the SCC system and are not described in the documentation from IAR Systems. For information about details in the client application, refer to the documentation supplied with that application.

Note: Different SCC systems use very different terminology even for some of the most basic concepts involved. You must keep this in mind when you read the following description.

INTERACTING WITH SOURCE CODE CONTROL SYSTEMS

In any SCC system, you use a client application to maintain a central archive. In this archive you keep the working copies of the files of your project. The SCC integration in IAR Embedded Workbench allows you to conveniently perform a few of the most common SCC operations directly from within the IDE. However, several tasks must still be performed in the client application.

To connect an IAR Embedded Workbench project to a source code control system, you should:

- In the SCC client application, set up an SCC project
- In IAR Embedded Workbench, connect your project to the SCC project.

Setting up an SCC project in the SCC client application

Use your SCC client tools to set up a working directory for the files in your IAR Embedded Workbench project that you want to control using your SCC system. The files can be placed in one or more nested subdirectories, all located under a common root. Specifically, all the source files must reside in the same directory as the `ewp` project file, or nested in subdirectories of this directory.

For information about the steps involved, refer to the documentation supplied with the SCC client application.

Connecting projects in IAR Embedded Workbench

In IAR Embedded Workbench, connect your application project to the SCC project.

1. In the Workspace window, select the project for which you have created an SCC project. From the **Project** menu, choose **Source Code Control>Add Project To Source Control**. This command is also available from the context menu that appears when you right-click in the Workspace window.

   Note: The commands on the **Source Code Control** submenu are available when at least one SCC client application is available.

2. If you have source code control systems from different vendors installed, a dialog box will appear to let you choose which system you want to connect to.

3. An SCC-specific dialog box will appear where you can navigate to the proper SCC project that you have set up.

Viewing the SCC states

When your IAR Embedded Workbench project has been connected to the SCC project, a column that contains status information for source code control will appear in the Workspace window. Different icons are displayed depending on whether:

- a file is checked out to you
- a file is checked out to someone else
- a file is checked in
- a file has been modified
- a new version of a file is in the archive.

There are also icons for some combinations of these states. Note that the interpretation of these states depends on the SCC client application you are using. For reference information about the icons and the different states they represent, see *Source code control states*, page 188.

For reference information about the commands available for accessing the SCC system, see *Source Code Control menu*, page 186.

Configuring the source code control system

To customize the source code control system, choose **Tools>Options** and click the **Source Code Control** tab. For reference information about the available commands, see *Terminal I/O options*, page 255.

Building

This chapter briefly discusses the process of building your application, and describes how you can extend the chain of build tools with tools from third-party suppliers.

Building your application

The build process consists of these steps:

- Setting project options
- Building the project
- Correcting any errors detected during the build procedure.

To make the build process more efficient, you can use the **Batch Build** command. This gives you the possibility to perform several builds in one operation. If necessary, you can also specify pre-build and post-build actions.

In addition to using the IAR Embedded Workbench IDE to build projects, you can also use the command line utility `iarbuild.exe`.

For examples of building application and library projects, see *Part 1. Tutorials* in this guide. For further information about building library projects, see the compiler documentation.

SETTING OPTIONS

To specify how your application should be built, you must define one or several build configurations. Every build configuration has its own settings, which are independent of the other configurations. All settings are indicated in a separate column in the Workspace window.

For example, a configuration that is used for debugging would not be highly optimized, and would produce output that suits the debugging. Conversely, a configuration for building the final application would be highly optimized, and produce output that suits a flash or PROM programmer.

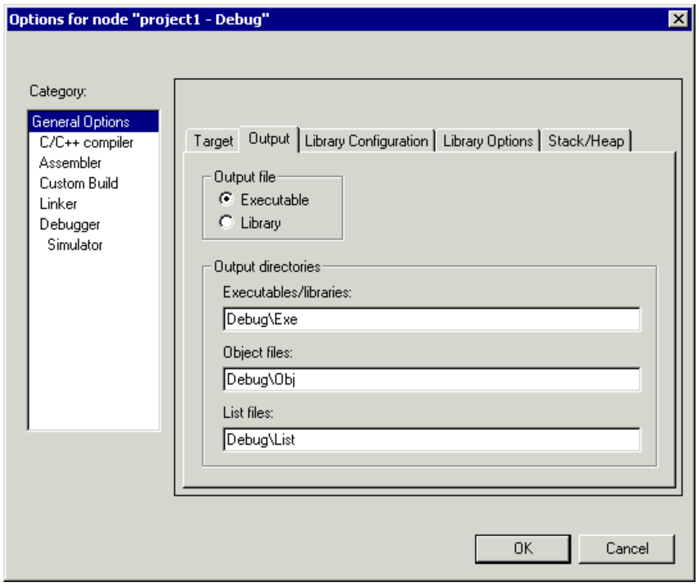
For each build configuration, you can set options on the project level, group level, and file level. Many options can only be set on the project level because they affect the entire build configuration. Examples of such options are **General Options**, linker settings, and debug settings. Other options, such as compiler and assembler options, that you set on project level are default for the entire build configuration.

To override project level settings, select the required item—for instance a specific group of files—and then select the option **Override inherited settings**. The new settings will affect all members of that group, that is, files and any groups of files. To restore all settings to the default factory settings, click the **Factory Settings** button.

Note: There is one important restriction on setting options. If you set an option on group or file level (group or file level override), no options on higher levels that operate on files will affect that group or file.

Using the Options dialog box

The **Options** dialog box—available by choosing **Project>Options**—provides options for the building tools. You set these options for the selected item in the Workspace window. Options in the **General Options**, **Linker**, and **Debugger** categories can only be set for the entire build configuration, and not for individual groups and files. However, the options in the other categories can be set for the entire build configuration, a group of files, or an individual file.



Output file: [✓ Executable] Library

Output directories

Executables/libraries: Debug\Exe

Object files: Debug\Obj

List files: Debug\List

Figure 31: General options

The **Category** list allows you to select which building tool to set options for. The tools available in the **Category** list depends on which tools are included in your product. If you select **Library** as output file on the **Output** page, **Linker** is replaced by **Library**

Builder in the category list. When you select a category, one or more pages containing options for that component are displayed.

Click the tab corresponding to the type of options you want to view or change. To restore all settings to the default factory settings, click the **Factory Settings** button, which is available for all categories except **General Options** and **Custom Build**. Note that two sets of factory settings are available: Debug and Release. Which one that is used depends on your build configuration; see *New Configuration dialog box*, page 230.

For information about each option and how to set options, see the chapters *General options*, *Compiler options*, *Assembler options*, *XLINK linker options*, *ILINK linker options*, *Library builder options*, *Custom build options*, and *Debugger options*. For information about options specific to the C-SPY driver you are using, see the part of this book that corresponds to your driver.

Note: If you add to your project a source file with a non-recognized filename extension, you cannot set options on that source file. However, you can add support for additional filename extensions. For reference information, see *Filename Extensions dialog box*, page 259.

BUILDING A PROJECT

You have access to the build commands both from the **Project** menu and from the context menu that appears if you right-click an item in the Workspace window.

The three build commands **Make**, **Compile**, and **Rebuild All** run in the background, so you can continue editing or working with the IDE while your project is being built.

For further reference information, see *Project menu*, page 225.

BUILDING MULTIPLE CONFIGURATIONS IN A BATCH

Use the batch build feature when you want to build more than one configuration at once. A batch is an ordered list of build configurations. The **Batch Build** dialog box—available from the **Project** menu—lets you create, modify, and build batches of configurations.

For workspaces that contain several configurations, it is convenient to define one or more different batches. Instead of building the entire workspace, you can build only the appropriate build configurations, for instance Release or Debug configurations.

For detailed information about the **Batch Build** dialog box, see *Batch Build dialog box*, page 233.

USING PRE- AND POST-BUILD ACTIONS

If necessary, you can specify pre-build and post-build actions that you want to occur before or after the build. The **Build Actions** dialog box—available from the **Project** menu—lets you specify the actions required.

For detailed information about the **Build Actions** dialog box, see *Build actions options*, page 337.

Using pre-build actions for time stamping

You can use pre-build actions to embed a time stamp for the build in the resulting binary file. Follow these steps:

1 Create a dedicated time stamp file, for example, `timestamp.c` and add it to your project.

2 In this source file, use the preprocessor macros `__TIME__` and `__DATE__` to initialize a string variable.

3 Choose **Project>Options>Build Actions** to open the **Build Actions** dialog box.

4 In the **Pre-build command line** text field, specify for example this pre-build action:

```
"touch $PROJ_DIR$\timestamp.c"
```

You can use the open source command line utility `touch` for this purpose or any other suitable utility which updates the modification time of the source file.

5 If the project is not entirely up-to-date, the next time you use the **Make** command, the pre-build action will be invoked before the regular build process. The regular build process then always must recompile `timestamp.c` and the correct timestamp will end up in the binary file.

If the project already is up-to-date, the pre-build action will not be invoked. This means that nothing is built, and the binary file still contains the timestamp for when it was last built.

CORRECTING ERRORS FOUND DURING BUILD

The compiler, assembler, and debugger are fully integrated with the development environment. If your source code contains errors, you can jump directly to the correct position in the appropriate source file by double-clicking the error message in the error listing in the Build message window, or selecting the error and pressing Enter.

After you have resolved any problems reported during the build process and rebuilt the project, you can directly start debugging the resulting code at the source level.

To specify the level of output to the Build message window, choose **Tools>Options** to open the **IDE Options** dialog box. Click the **Messages** tab and select the level of output in the **Show build messages** drop-down list. Alternatively, you can right-click in the **Build Messages** window and select **Options** from the context menu.

For reference information about the Build messages window, see *Build window*, page 208.

BUILDING FROM THE COMMAND LINE

To build the project from the command line, use the IAR Command Line Build Utility (`iarbuild.exe`) located in the `common\bin` directory. As input you use the project file, and the invocation syntax is:

```
iarbuild project.ewp [-clean|-build|-make] <configuration>
[-log errors|warnings|info|all]
```

Parameter	Description
project`.ewp`	Your IAR Embedded Workbench project file.
`-clean`	Removes any intermediate and output files.
`-build`	Rebuilds and relinks all files in the current build configuration.
`-make`	Brings the current build configuration up to date by compiling, assembling, and linking only the files that have changed since the last build.
configuration	The name of the configuration you want to build, which can either be one of the predefined configurations Debug or Release, or a name that you define yourself. For more information about build configurations, see *Projects and build configurations*, page 61.
`-log errors`	Displays build error messages.
`-log warnings`	Displays build warning and error messages.
`-log info`	Displays build warning and error messages, and messages issued by the `#pragma message` preprocessor directive.
`-log all`	Displays all messages generated from the build, for example compiler sign-on information and the full command line.

Table 12: iarbuild.exe command line options

If you run the application from a command shell without specifying a project file, you will get a sign-on message describing available parameters and their syntax.

Extending the toolchain

IAR Embedded Workbench provides a feature—Custom Build—which lets you extend the standard toolchain. This feature is used for executing external tools (not provided by

IAR Systems). You can make these tools execute each time specific files in your project have changed.

If you specify custom build options on the **Custom tool configuration** page, the build commands treat the external tool and its associated files in the same way as the standard tools within the IAR Embedded Workbench IDE and their associated files. The relation between the external tool and its input files and generated output files is similar to the relation between the C/C++ Compiler, `c` files, `h` files, and `rxx` files. See *Custom build options*, page 335, for details about available custom build options.

You specify filename extensions of the files used as input to the external tool. If the input file has changed since you last built your project, the external tool is executed; just as the compiler executes if a `c` file has changed. In the same way, any changes in additional input files (for instance include files) are detected.

You must specify the name of the external tool. You can also specify any necessary command line options needed by the external tool, and the name of the output files generated by the external tool. Note that you can use argument variables for substituting file paths.

For some of the file information, you can use argument variables.

You can specify custom build options to any level in the project tree. The options you specify are inherited by any sublevel in the project tree.

TOOLS THAT CAN BE ADDED TO THE TOOLCHAIN

Some examples of external tools, or types of tools, that you can add to the IAR Embedded Workbench toolchain are:

- Tools that generate files from a specification, such as Lex and YACC
- Tools that convert binary files—for example files that contain bitmap images or audio data—to a table of data in an assembler or C source file. This data can then be compiled and linked together with the rest of your application.

ADDING AN EXTERNAL TOOL

The following example demonstrates how to add the tool *Flex* to the toolchain. The same procedure can be used also for other tools.

In the example, Flex takes the file `myFile.lex` as input. The two files `myFile.c` and `myFile.h` are generated as output.

1 Add the file you want to work with to your project, for example `myFile.lex`.

2 Select this file in the Workspace window and choose **Project>Options**. Select **Custom Build** from the list of categories.

3 In the **Filename extensions** field, type the filename extension `.lex`. Remember to specify the leading period (`.`).

4 In the **Command line** field, type the command line for executing the external tool, for example

```
flex $FILE_PATH$ -o$FILE_BPATH$.c
```

During the build process, this command line is expanded to:

```
flex myFile.lex -omyFile.c
```

Note the usage of *argument variables*. For further details of these variables, see *Argument variables summary*, page 228.

Take special note of the use of `$FILE_BNAME$` which gives the base name of the input file, in this example appended with the `c` extension to provide a C source file in the same directory as the input file `foo.lex`.

5 In the **Output files** field, describe the output files that are relevant for the build. In this example, the tool Flex would generate two files—one source file and one header file. The text in the **Output files** text box for these two files would look like this:

```
$FILE_BPATH$.c
$FILE_BPATH$.h
```

6 If the external tool uses any additional files during the build, these should be added in the **Additional input files** field: for instance:

```
$TOOLKIT_DIR$\inc\stdio.h
```

This is important, because if the dependency files change, the conditions will no longer be the same and the need for a rebuild is detected.

7 Click **OK**.

8 To build your application, choose **Project>Make**.

Editing

This chapter describes in detail how to use the IAR Embedded Workbench editor. The final section describes how to customize the editor and how to use an external editor of your choice.

Using the IAR Embedded Workbench editor

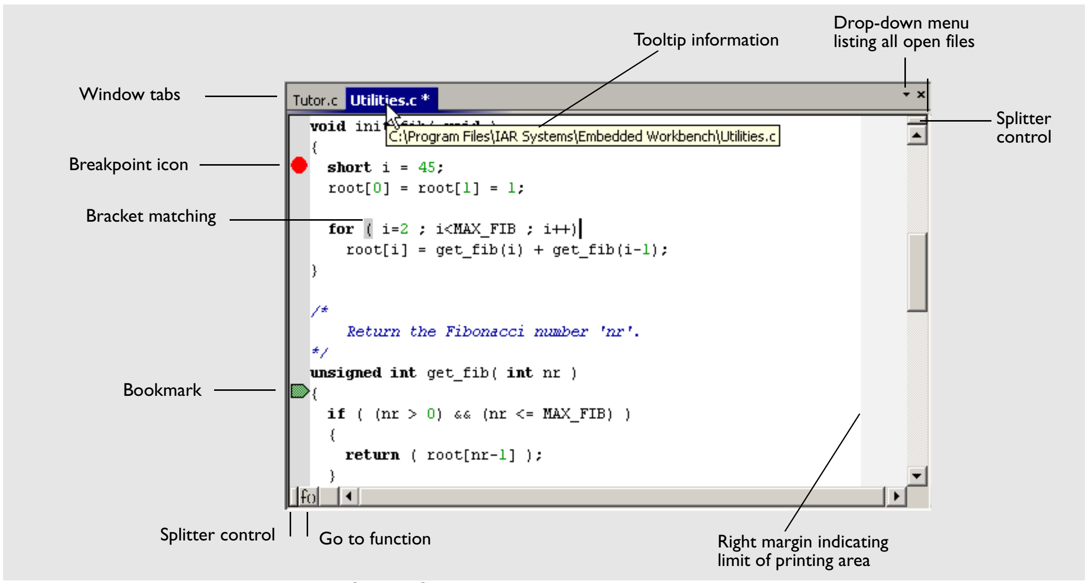
The integrated text editor allows editing of multiple files in parallel, and provides all basic editing features expected from a modern editor. In addition, it provides functions specific to software development, like coloring of keywords (C/C++, assembler, and user-defined), block indent, and function navigation within source files. It also recognizes C language elements like matching brackets. This list shows some additional features:

- Context-sensitive help system that can display reference information for DLIB library functions
- Syntax of C or C++ programs and assembler directives shown using text styles and colors
- Powerful search and replace commands, including multi-file search
- Direct jump to context from error listing
- Multibyte character support
- Parenthesis matching
- Automatic completion and indentation
- Bookmarks
- Unlimited undo and redo for each window.

EDITING A FILE

The editor window is where you write, view, and modify your source code. You can open one or several text files, either from the **File** menu, or by double-clicking a file in the Workspace window. If you open several files, they are organized in a *tab group*. Several editor windows can be open at the same time.

Click the tab for the file that you want to display. All open files are also available from the drop-down menu at the upper right corner of the editor window.


Tooltip information
Drop-down menu listing all open files
Window tabs
Splitter control
Breakpoint icon
Bracket matching
Bookmark
Splitter control
Go to function
Right margin indicating limit of printing area
Tutor.c
Utilities.c *
C:\Program Files\IAR Systems\Embedded Workbench\Utilities.c

```
void init_fib( void )
{
  short i = 45;
  root[0] = root[1] = 1;

  for ( i=2 ; i<MAX_FIB ; i++)
    root[i] = get_fib(i) + get_fib(i-1);
}

/*
    Return the Fibonacci number 'nr'.
*/
unsigned int get_fib( int nr )
{
  if ( (nr > 0) && (nr <= MAX_FIB) )
  {
    return ( root[nr-1] );
  }
```

Figure 32: Editor window

The name of the open source file is displayed on the tab. If a file is read-only, a padlock is visible at the bottom left corner of the editor window. If a file has been modified after it was last saved, an asterisk appears on the tab after the filename, for example `Utilities.c *`.

The commands on the **Window** menu allow you to split the editor window into panes. On the **Window** menu you also find commands for opening multiple editor windows, and commands for moving files between editor windows. For reference information about each command on the menu, see *Window menu*, page 262. For reference information about the editor window, see *Editor window*, page 192.

Note: When you want to print a source file, it can be useful to enable the option **Show line numbers**—available by choosing **Tools>Options>Editor**.

Accessing reference information for DLIB library functions

When you need to know the syntax for any C or Embedded C++ library function, select the function name in the editor window and press F1. The library documentation for the selected function appears in a help window.

Using and customizing editor commands and shortcut keys

The **Edit** menu provides commands for editing and searching in editor windows, for instance, unlimited undo/redo (the **Edit>Undo** and **Edit>Redo** commands, respectively). You can also find some of these commands on the context menu that appears when you right-click in the editor window. For reference information about each command, see *Edit menu*, page 214.

There are also editor shortcut keys for:

- moving the insertion point
- scrolling text
- selecting text.

For detailed information about these shortcut keys, see *Editor key summary*, page 196.

To change the default shortcut key bindings, choose **Tools>Options**, and click the **Key Bindings** tab. For further details, see *Key Bindings options*, page 237.

Splitting the editor window into panes

You can split the editor window horizontally or vertically into multiple panes, to look at different parts of the same source file at once, or to move text between two different panes.

To split the window, double-click the appropriate splitter bar, or drag it to the middle of the window. Alternatively, you can split a window into panes using the **Window>Split** command.

To revert to a single pane, double-click the splitter control or drag it back to the end of the scroll bar.

Dragging and dropping of text

You can easily move text within an editor window or between editor windows. Select the text and drag it to the new location.

Syntax coloring

If the **Tools>Options>Editor>Syntax highlighting** option is enabled, the IAR Embedded Workbench editor automatically recognizes the syntax of:

- C and C++ keywords
- C and C++ comments
- Assembler directives and comments
- Preprocessor directives
- Strings.

The different parts of source code are displayed in different text styles.

To change these styles, choose **Tools>Options**, and use the **Editor>Colors and Fonts** options. For additional information, see *Editor Colors and Fonts options*, page 245.

In addition, you can define your own set of keywords that should be syntax-colored automatically:

1. In a text file, list all the keywords that you want to be automatically syntax-colored. Separate each keyword with either a space or a new line.
2. Choose **Tools>Options** and select **Editor>Setup Files**.
3. Select the **Use Custom Keyword File** option and specify your newly created text file. A browse button is available for your convenience.
4. Select **Editor>Colors and Fonts** and choose **User Keyword** from the **Syntax Coloring** list. Specify the font, color, and type style of your choice. For additional information, see *Editor Colors and Fonts options*, page 245.
5. In the editor window, type any of the keywords you listed in your keyword file; see how the keyword is syntax-colored according to your specification.

Automatic text indentation

The text editor can perform various kinds of indentation. For assembler source files and normal text files, the editor automatically indents a line to match the previous line. If you want to indent several lines, select the lines and press the Tab key. Press Shift-Tab to move a whole block of lines to the left.

For C/C++ source files, the editor indents lines according to the syntax of the C/C++ source code. This is performed whenever you:

- Press the Return key
- Type any of the special characters `{`, `}`, `:`, and `#`
- Have selected one or several lines, and choose the **Edit>Auto Indent** command.

To enable or disable the indentation:

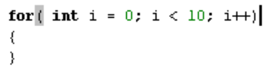
1. Choose **Tools>Options** and select **Editor**.
2. Select or deselect the **Auto indent** option.

To customize the C/C++ automatic indentation, click the **Configure** button.

For additional information, see *Configure Auto Indent dialog box*, page 241.

Matching brackets and parentheses

When the insertion point is located next to a parenthesis, the matching parenthesis is highlighted with a light gray color:



```
for( int i = 0; i < 10; i++)
{
}
```

Figure 33: Parentheses matching in editor window

The highlight remains in place as long as the insertion point is located next to the parenthesis.

To select all text between the brackets surrounding the insertion point, choose **Edit>Match Brackets**. Every time you choose **Match Brackets** after that, the selection will increase to the next hierarchic pair of brackets.

Note: Both of these functions—automatic matching of corresponding parentheses and selection of text between brackets—apply to `()`, `[]`, and `{}`.

Displaying status information

As you are editing, the status bar—available by choosing **View>Status Bar**— shows the current line and column number containing the insertion point, and the Caps Lock, Num Lock, and Overwrite status:

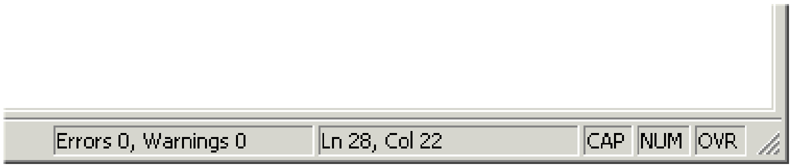


Figure 34: Editor window status bar

USING AND ADDING CODE TEMPLATES

Code templates is a method for conveniently inserting frequently used source code sequences, for example `for` loops and `if` statements. The code templates are defined in a normal text file. By default, a few example templates are provided. In addition, you can easily add your own code templates.

Enabling code templates

By default, code templates are enabled. To enable and disable the use of code templates:

1 Choose **Tools>Options**.

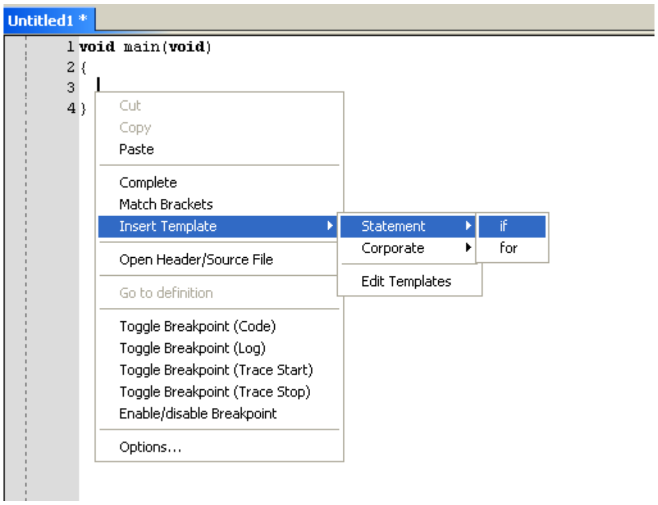
2 Go to the **Editor Setup Files** page.

3 Select or deselect the **Use Code Templates** option.

4 In the text field, specify which template file you want to use; either the default file or one of your own template files. A browse button is available for your convenience.

Inserting a code template into your source code

To insert a code template into your source code, place the insertion point at the location where you want the template to be inserted, right-click, and choose **Insert Template** and the appropriate code template from the menu that appears.



```
void main(void)
{

}
```

Figure 35: Editor window code template menu

If the code template you choose requires any type of field input, as in the `for` loop example which needs an end value and a count variable, an input dialog box appears.

Adding your own code templates

The source code templates are defined in a normal text file. The original template file `CodeTemplates.txt` is located in the `common\config` installation directory. The first time you use IAR Embedded Workbench, the original template file is copied to a directory for local settings, and this is the file that is used by default if code templates are enabled. To use your own template file, follow the procedure described in *Enabling code templates*, page 83.

To open the template file and define your own code templates, choose **Edit>Code Templates>Edit Templates**.

The syntax for defining templates is described in the default template file.

Selecting the correct language version of the code template file

When you start the IAR Embedded Workbench IDE for the very first time, you are asked to select a language version. This only applies if you are using an IDE that is available in other languages than English.

Selecting a language creates a corresponding language version of the default code template file in the `Application Data\IAR Embedded Workbench` subdirectory of the current Windows user (for example `CodeTemplates.ENU.txt` for English and `CodeTemplates.JPN.txt` for Japanese). The default code template file does not change automatically if you change the language version of the IDE afterwards.

To change the code template:

1. Choose **Tools>Options>IDE Options>Editor>Setup Files**.
2. Click the browse button of the **Use Code Templates** option and select a different template file.

   If the code template file you want to select is not in the browsed directory, you must:
3. Delete the file name in the **Use Code Templates** text box.
4. Deselect the **Use Code Templates** option and click OK.
5. Restart the IAR Embedded Workbench IDE.
6. Then choose **Tools>Options>IDE Options>Editor>Setup Files** again.

   The default code template file for the selected language version of the IDE should now be displayed in the **Use Code Templates** text box. Select the check box to enable the template.

NAVIGATING IN AND BETWEEN FILES

The editor provides several functions for easy navigation within the files and between files:

- Switching between source and header files

  If the insertion point is located on an `#include` line, you can choose the **Open "`header.h`"** command from the context menu, which opens the header file in an editor window. You can also choose the command **Open Header/Source File**, which opens the header or source file that corresponds to the current file, or activates it if it is already open. This command is available if the insertion point is located on any line except an `#include` line.

- Function navigation

  Click the **Go to function** button in the bottom left corner in an editor window to list all functions defined in the source file displayed in the window. You can then choose to go directly to one of the functions by double-clicking it in the list.

- Adding bookmarks

  Use the **Edit>Navigate>Toggle Bookmark** command to add and remove bookmarks. To switch between the marked locations, choose **Edit>Navigate>Go to Bookmark**.

SEARCHING

There are several standard search functions available in the editor:

- **Quick search** text box
- **Find** dialog box
- **Replace** dialog box
- **Find in files** dialog box
- **Incremental Search** dialog box.

To use the **Quick search** text box on the toolbar, type the text you want to search for and press Enter. Press Esc to cancel the search. This is a quick method for searching for text in the active editor window.

To use the **Find**, **Replace**, **Find in Files**, and **Incremental Search** functions, choose the corresponding command from the **Edit** menu. For reference information about each search function, see *Edit menu*, page 214.

Customizing the editor environment

The IDE editor can be configured on the **IDE Options** pages **Editor** and **Editor Colors and Fonts**. Choose **Tools>Options** to access the pages.

For details about these pages, see *Tools menu*, page 235.

USING AN EXTERNAL EDITOR

The **External Editor** options—available by choosing **Tools>Options>Editor**—let you specify an external editor of your choice.

Note: While debugging using C-SPY, C-SPY will not use the external editor for displaying the current debug state. Instead, the built-in editor will be used.

To specify an external editor of your choice, follow this procedure:

1 Select the option **Use External Editor**.

2 An external editor can be called in one of two ways, using the **Type** drop-down menu.

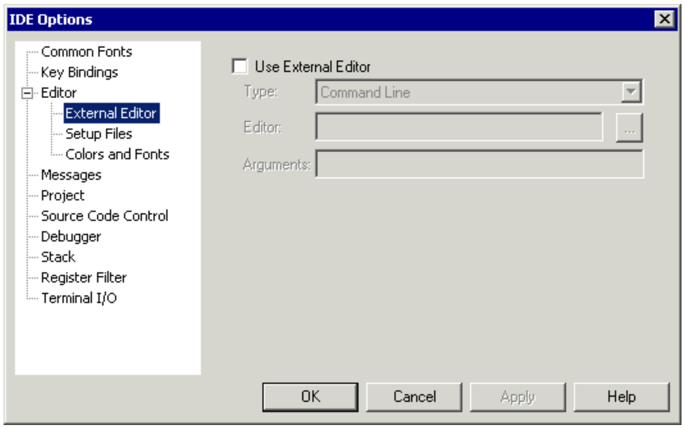
Command Line calls the external editor by passing command line parameters.

DDE calls the external editor by using DDE (Windows Dynamic Data Exchange).

3 If you use the command line, specify the command line to pass to the editor, that is, the name of the editor and its path, for instance:

```
C:\WINDOWS\NOTEPAD.EXE.
```

To send an argument to the external editor, type the argument in the **Arguments** field. For example, type `$FILE_PATH$` to start the editor with the active file (in editor, project, or Messages window).



Use External Editor [ ]
Type: Command Line
Editor:
Arguments:

Figure 36: Specifying an external command line editor

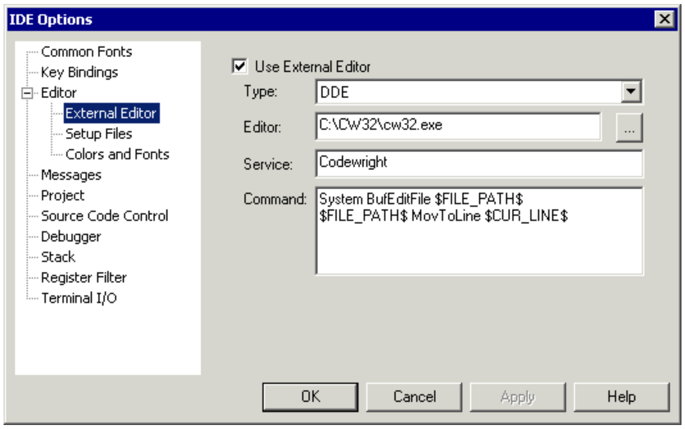
4 If you use DDE, specify the editor's DDE service name in the **Service** field. In the **Command** field, specify a sequence of command strings to send to the editor.

The service name and command strings depend on the external editor that you are using. Refer to the user documentation of your external editor to find the appropriate settings.

The command strings should be entered as:

```
DDE-Topic CommandString1
DDE-Topic CommandString2
```

as in this example, which applies to Codewright®:



[✓] Use External Editor

Type: DDE

Editor: C:\CW32\cw32.exe

Service: Codewright

Command: System BufEditFile $FILE_PATH$ $FILE_PATH$ MovToLine CUR_LINE

Figure 37: External editor DDE settings

The command strings used in this example will open the external editor with a dedicated file activated. The cursor will be located on the current line as defined in the context from where the file is open, for instance when searching for a string in a file, or when double-clicking an error message in the Message window.

5 Click **OK**.

When you double-click a file in the Workspace window, the file is opened by the external editor.

Variables can be used in the arguments. For more information about the argument variables that are available, see *Argument variables summary*, page 228.

Part 3. Debugging

This part of the IAR Embedded Workbench IDE User Guide contains the following chapters:

- The IAR C-SPY Debugger
- Executing your application
- Working with variables and expressions
- Using breakpoints
- Monitoring memory and registers
- Using the C-SPY® macro system
- Analyzing your application.

The IAR C-SPY Debugger

This chapter introduces you to the IAR C-SPY® Debugger and to the concepts that are related to debugging in general and to C-SPY in particular. Then, you get a description of how to set up, start, and finally adapt C-SPY to target hardware.

C-SPY—an overview

AN INTEGRATED ENVIRONMENT

C-SPY is a high-level-language debugger for embedded applications. It is designed for use with the IAR Systems compilers and assemblers, and is completely integrated in the IDE, providing development and debugging within the same application. This will give you possibilities such as:

- Editing while debugging. During a debug session, you can make corrections directly into the same source code window that is used to control the debugging. Changes will be included in the next project rebuild.
- Setting breakpoints at any point during the development cycle. You can inspect and modify breakpoint definitions also when the debugger is not running, and breakpoint definitions flow with the text as you edit. Your debug settings, such as watch properties, window layouts, and register groups will remain between your debug sessions.

All windows that are open in the Embedded Workbench workspace will stay open when you start the C-SPY Debugger. In addition, a set of C-SPY-specific windows are opened.

In addition to the features available in the IDE, the C-SPY environment consists of a set of C-SPY-specific items, such as a debugging toolbar, menus, windows, and dialog boxes.

GENERAL C-SPY DEBUGGER FEATURES

Because IAR Systems provides an entire toolchain, the output from the compiler and linker can include extensive debug information for the debugger, resulting in good debugging possibilities for you.

C-SPY offers these general features:

- Source and disassembly level debugging

  C-SPY allows you to switch between source and disassembly debugging as required, for both C or C++ and assembler source code.

- Single-stepping on a function call level

  Compared to traditional debuggers, where the finest granularity for source level stepping is line by line, C-SPY provides a finer level of control by identifying every statement and function call as a step point. This means that each function call—inside expressions, and function calls that are part of parameter lists to other functions—can be single-stepped. The latter is especially useful when debugging C++ code, where numerous extra function calls are made, for example to object constructors.

- Code and data breakpoints

  The C-SPY breakpoint system lets you set breakpoints of various kinds in the application being debugged, allowing you to stop at locations of particular interest. For example, you set breakpoints to investigate whether your program logic is correct or to investigate how and when the data changes.

- Monitoring variables and expressions

  For variables and expressions there are a wide choice of facilities. Any variable and expression can be evaluated in one-shot views. You can easily both monitor and log values of a defined set of expressions during a longer period of time. You have instant control over local variables, and real-time data is displayed non-intrusively. Finally, the last referred variables are displayed automatically.

- Container awareness

  When you run your application in C-SPY, you can view the elements of library data types such as STL lists and vectors. This gives you a very good overview and debugging opportunities when you work with C++ STL containers.

- Call stack information

  The compiler generates extensive call stack information. This allows the debugger to show, without any runtime penalty, the complete stack of function calls wherever the program counter is. You can select any function in the call stack, and for each function you get valid information for local variables and registers available.

- Powerful macro system

  C-SPY includes a powerful internal macro system, to allow you to define complex sets of actions to be performed. C-SPY macros can be used solely or in conjunction with complex breakpoints and—if you are using the simulator—the interrupt simulation system to perform a wide variety of tasks.

Additional general C-SPY debugger features

This list shows some additional features:

- Threaded execution keeps the IDE responsive while running the target application
- Automatic stepping
- The source browser provides easy navigation to functions, types and variables
- Extensive type recognition of variables
- Configurable registers (CPU and peripherals) and memory windows
- Dedicated Stack window
- Support for code coverage and function level profiling
- The target application can access files on the host PC using file I/O (requires the DLIB library)
- Optional terminal I/O emulation.

RTOS AWARENESS

C-SPY supports real-time OS awareness debugging.

RTOS plugin modules can be provided by IAR Systems, and by third-party suppliers. Contact your software distributor or IAR Systems representative, alternatively visit the IAR Systems web site, for information about supported RTOS modules.

Debugger concepts

This section introduces some of the concepts that are related to debugging in general and to C-SPY in particular. This section does not contain specific conceptual information related to the functionality of C-SPY. Instead, you will find such information in each chapter of this part of the guide. The IAR Systems user documentation uses the following terms when referring to these concepts.

C-SPY AND TARGET SYSTEMS

You can use C-SPY to debug either a software target system or a hardware target system.

This figure shows an overview of C-SPY and possible target systems.

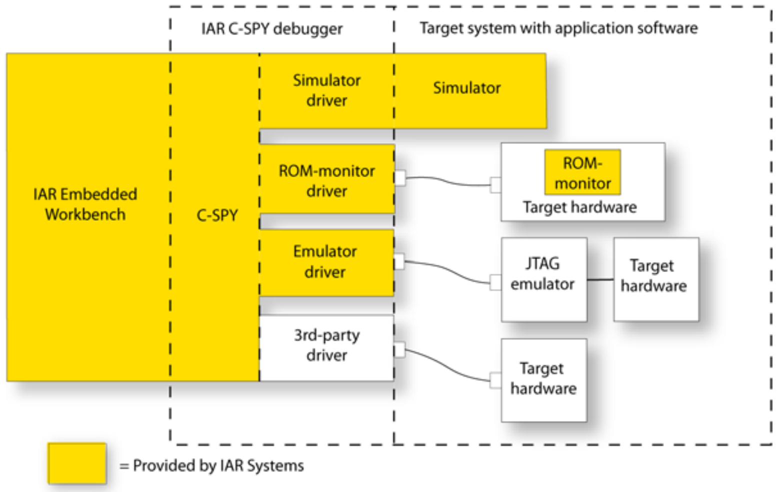


Figure 38: C-SPY and target systems

DEBUGGER

The debugger, for instance C-SPY, is the program that you use for debugging your applications on a target system.

TARGET SYSTEM

The target system is the system on which you execute your application when you are debugging it. The target system can consist of hardware, either an evaluation board or your own hardware design. It can also be completely or partially simulated by software. Each type of target system needs a dedicated C-SPY driver.

USER APPLICATION

A user application is the software you have developed and which you want to debug using C-SPY.

C-SPY DEBUGGER SYSTEMS

C-SPY drivers:types ofC-SPY consists of both a general part which provides a basic set of debugger features, and a target-specific back end. The back end consists of two components: a processor module—one for every microcontroller, which defines the properties of the microcontroller, and a C-SPY driver. The C-SPY driver is the part that provides communication with and control of the target system. The driver also provides the user interface—menus, windows, and dialog boxes—to the functions provided by the target system, for instance, special breakpoints. There are three main types of C-SPY drivers:

- Simulator driver
- ROM-monitor driver
- Emulator driver

Depending on your product installation, C-SPY is available with a simulator driver and optional drivers for hardware debugger systems. For an overview of of the available C-SPY drivers and the functionality provided by each driver, see the driver documentation available in the online help system available from the **Help** menu or the guide in hypertext PDF format available in the `doc` directory.

ROM-MONITOR PROGRAM

The ROM-monitor program is a piece of firmware that is loaded to non-volatile memory on your target hardware; it runs in parallel with your application. The ROM-monitor communicates with the debugger and provides services needed for debugging the application, for instance stepping and breakpoints.

THIRD-PARTY DEBUGGERS

You can use a third-party debugger together with the IAR Systems toolchain as long as the third-party debugger can read any of the output formats provided by XLINK, such as UBROF, ELF/DWARF, COFF, Intel-extended, Motorola, or any other available format, and for ILINK any of the output formats ELF/DWARF, Intel-extended, or Motorola. For information about which format to use with third-party debuggers, see the user documentation supplied with that tool.

C-SPY PLUGIN MODULES

C-SPY is designed as a modular architecture with an open SDK that can be used for implementing additional functionality to the debugger in the form of plugin modules. These modules can be integrated in the IDE.

Plugin modules are provided by IAR Systems, and can be supplied by third-party vendors. Examples of such modules are:

- Code Coverage, Profiling, and the Stack window, all integrated in the IDE.
- The various C-SPY drivers for debugging using certain debug systems.
- RTOS plugin modules for support for real-time OS awareness debugging.
- C-SPYLink that bridges IAR visualSTATE and IAR Embedded Workbench to make true high-level state machine debugging possible directly in C-SPY, in addition to

the normal C level symbolic debugging. For more information, refer to the documentation provided with IAR visualSTATE.

For more information about the C-SPY SDK, contact IAR Systems.

Setting up C-SPY

Before you start C-SPY, you should set options for the debugger system. These options are available on the **Setup** page of the **Debugger** category, available with the **Project>Options** command. On the **Plugins** page you can find options for loading plug-in modules.

In addition to the options for setting up the debugger system, you can also set debugger-specific IDE options. These options are available with the **Tools>Options** command. For further information about these options, see *Debugger options*, page 251.

CHOOSING A DEBUG DRIVER

Before starting C-SPY, you must choose a driver for the debugger system from the **Driver** drop-down list on the **Setup** page. The contents of the drop-down list depend on your product installation; drivers for hardware debugger systems might, or might not be available. If you choose a driver for a hardware debugger system, you must also set hardware-specific options. For information about these options, see the online help system available from the **Help** menu.

Note: You can only choose a driver you have installed on your computer.

EXECUTING FROM RESET

Using the **Run to** option, you can specify a location you want C-SPY to run to when you start the debugger as well as after each reset. C-SPY will place a breakpoint at this location and all code up to this point is executed before stopping at the location.

The default location to run to is the `main` function. Type the name of the location if you want C-SPY to run to a different location. You can specify assembler labels or whatever can be evaluated to such, for instance function names.

If you leave the check box empty, the program counter will then contain the regular hardware reset address at each reset.

If no breakpoints are available when C-SPY starts, a warning message notifies you that single stepping will be required and that this is time consuming. You can then continue execution in single step mode or stop at the first instruction. If you choose to stop at the first instruction, the debugger starts executing with the `PC` (program counter) at the default reset location instead of the location you typed in the **Run to** box.

Note: This message will never be displayed in the C-SPY Simulator, where breakpoints are not limited.

For driver-specific information about breakpoints, see the online help system available from the **Help** menu.

USING A SETUP MACRO FILE

A setup macro file is a standard macro file that you choose to load automatically when C-SPY starts. You can define the setup macro file to perform actions according to your needs, using setup macro functions and system macros. Thus, if you load a setup macro file you can initialize C-SPY to perform actions automatically.

To register a setup macro file, select **Use macro file** and type the path and name of your setup macro file, for example `Setup.mac`. If you do not type a filename extension, the extension `mac` is assumed. A browse button is available for your convenience.

For detailed information about setup macro files and functions, see *The macro file, page 130*. For an example about how to use a setup macro file, see the chapter *Simulating an interrupt* in *Part 1. Tutorials*.

SELECTING A DEVICE DESCRIPTION FILE

C-SPY uses device description files to handle several of the target-specific adaptations. They contain device-specific information about for example, definitions of peripheral units and CPU registers, and groups of these.

If you want to use the device-specific information provided in the device description file during your debug session, you must select the appropriate device description file. Device description files are provided in the `*cpuname*\config` directory and they have the filename extension `ddf`.

To load a device description file that suits your device, you must, before you start C-SPY, choose **Project>Options** and select the **Debugger** category. On the **Setup** page, enable the use of a description file and select a file using the **Device description file** browse button.

For an example about how to use a setup macro file, see *Simulating an interrupt* in *Part 1. Tutorials*.

LOADING PLUGIN MODULES

On the **Plugins** page you can specify C-SPY plugin modules that are to be loaded and made available during debug sessions. Plugin modules can be provided by IAR Systems, and by third-party suppliers. Contact your software distributor or IAR Systems representative, or visit the IAR Systems web site, for information about available modules.

For information about how to load plugin modules, see *Plugins*, page 370.

The C-SPY RTOS awareness plugin modules

Provided that one or more real-time operating systems plugin modules is supported for the IAR Embedded Workbench version you are using, you can load one for use with C-SPY. C-SPY RTOS awareness plugin modules give you a high level of control and visibility over an application built on top of a real-time operating system. It displays RTOS-specific items like task lists, queues, semaphores, mailboxes and various RTOS system variables. Task-specific breakpoints and task-specific stepping make it easier to debug tasks.

A loaded plugin will add its own set of windows and buttons when a debug session is started (provided that the RTOS is linked with the application). For information about other RTOS awareness plugin modules, refer to the manufacturer of the plugin module.

Starting C-SPY

When you have set up the debugger, you are ready to start a debug session.

To start C-SPY and load the current project, click the **Download and Debug** button. Alternatively, choose **Project>Download and Debug**.

To start C-SPY without reloading the current project, click the **Debug without Downloading** button. Alternatively, choose **Project>Debug without Downloading**.

For information about how to execute your application and how to use the C-SPY features, see the remaining chapters in *Part 4. The C-SPY® Simulator*.

EXECUTABLE FILES BUILT OUTSIDE OF THE IDE

You can also load C-SPY with an application that was built outside the IDE, for example applications built on the command line. To be able to set debugger options for the externally built application, you must create a project within the IDE.

To load an externally built executable file, you must first create a project for it in your workspace. Choose **Project>Create New Project**, and specify a project name. To add the executable file to the project, choose **Project>Add Files** and make sure to choose **All Files** in the **Files of type** drop-down list. Locate the executable file (filename extension `d`*`xx`*). To start the executable file, click the **Debug** button. The project can be reused whenever you rebuild your executable file.

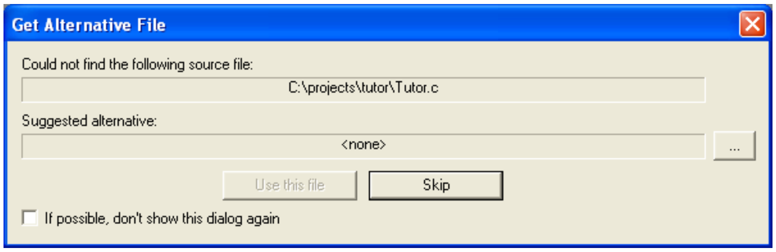
The only project options that are meaningful to set for this kind of project are options in the **General Options** and **Debugger** categories. Make sure to set up the general project options in the same way as when the executable file was built.

To flash an externally generated application using an IAR flash loader, a corresponding `sim` file must be available in the same directory as the `dxx` file. The `sim` file is automatically generated by C-SPY if you have the IAR ILINK Linker.

STARTING A DEBUG SESSION WITH SOURCE FILES MISSING

Normally, when you use the IAR Embedded Workbench IDE to edit source files, build your project, and start the debug session, all required files are available and the process works as expected.

However, if C-SPY cannot automatically find the source files, for example if the application was built on another computer, the **Get Alternative File** dialog box is displayed:



Could not find the following source file:
C:\projects\tutor\Tutor.c
Suggested alternative:
<none>
If possible, don't show this dialog again

Figure 39: Get Alternative File dialog box

At this point you can choose from these actions:

Skip	C-SPY will assume that the source file is not available for this debug session.
Suggested alternative	Use the browse button to specify an alternative file.
Use this file	After you have specified an alternative file, **Use this file** establishes that file as the alias for the requested file. Note that after you have chosen this action, C-SPY will automatically locate other source files if these files reside in a directory structure similar to the first selected alternative file. The next time you start a debug session, the selected alternative file will be preloaded automatically.
If possible, don't show this dialog again	Instead of displaying the dialog box again for a missing source file, C-SPY will use the previously supplied response.

Typically, you can use the dialog box like this:

- The source files are not available—Click **If possible, don't show this dialog again** and then click **Skip**. C-SPY will assume that there simply is no source code available. The dialog box will not appear again, and the debug session will not try to display the source code.
- Alternative source files are available at another location—Specify an alternative source code file, click **If possible, don't show this dialog again**, and then click **Use this file**. C-SPY will assume that the alternative file should be used. The dialog box will not appear again, unless a file is needed for which there is no alternative file specified and which cannot be located automatically.

If you restart the IAR Embedded Workbench IDE, the **Get Alternative File** dialog box will be displayed again once even if you have clicked **If possible, don't show this dialog again**. This gives you an opportunity to modify your previous settings.

LOADING MULTIPLE IMAGES

Normally, a debuggable application consists of exactly one file that you debug. However, you can also load additional debug files (images) after a debug session has started. This means that the complete program consists of several images.

Typically, this is useful if you want to debug your application in combination with a prebuilt ROM image that contains an additional library for some platform-provided features. The ROM image and the application are built using separate projects in the IAR Embedded Workbench IDE and generate separate output files.

Follow these steps:

1 To load an additional debug file in the IDE, choose **Project>Options>Debugger>Images**. For more information, see *Images*, page 369.

To load an additional debug file from the command line, use the `__loadImage` system macro. For more information, see *__loadImage*, page 391.

2 To display a list of loaded debug files, choose **Images** from the **View** menu. The Images window is displayed, see *Images window*, page 294.

If more than one image has been loaded, you will have access to the combined debug information for all the loaded images. In the Images window you can choose whether you want to have access to debug information for one image or for all images.

REDIRECTING DEBUGGER OUTPUT TO A FILE

The Debug Log window—available from the **View** menu—displays debugger output, such as diagnostic messages and trace information. It can sometimes be convenient to log the information to a file where you can easily inspect it. The **Log Files** dialog box—available from the **Debug** menu—allows you to log output from C-SPY to a file. The two main advantages are:

- The file can be opened in another tool, for instance an editor, so you can navigate and search within the file for particularly interesting parts
- The file provides history about how you have controlled the execution, for instance, what breakpoints have been triggered etc.

By default, the information printed in the file is the same as the information listed in the Log window. However, you can choose what you want to log in the file: errors, warnings, system information, user messages, or all of these. For reference information about the Log File options, see *Log File dialog box*, page 304.

Executing your application

The IAR C-SPY® Debugger provides a flexible range of facilities for executing your application during debugging. This chapter contains information about:

- The conceptual differences between source mode and disassembly mode debugging
- Executing your application
- The call stack
- Handling terminal input and output.

Source and disassembly mode debugging

C-SPY allows you to switch seamlessly between source mode and disassembly mode debugging as required.

Source debugging provides the fastest and easiest way of developing your application, without having to worry about how the compiler or assembler has implemented the code. In the editor windows you can execute the application one statement at a time while monitoring the values of variables and data structures.

Disassembly mode debugging lets you focus on the critical sections of your application, and provides you with precise control over the hardware. You can open a disassembly window which displays a mnemonic assembler listing of your application based on actual memory contents rather than source code, and lets you execute the application exactly one instruction at a time. In Mixed-Mode display, the debugger also displays the corresponding C/C++ source code interleaved with the disassembly listing.

Regardless of which mode you are debugging in, you can display registers and memory, and change their contents.

For an example of a debug session both in C source mode and disassembly mode, see *Debugging the application*, page 17.

Executing

C-SPY provides a flexible range of features for executing your application. You can find commands for executing on the **Debug** menu and on the toolbar.

STEP

C-SPY allows more stepping precision than most other debuggers because it is not line-oriented but statement-oriented. The compiler generates detailed stepping information in the form of *step points* at each statement, and at each function call. That is, source code locations where you might consider whether to execute a step into or a step over command. Because the step points are located not only at each statement but also at each function call, the step functionality allows a finer granularity than just stepping on statements. There are four step commands:

- Step Into
- Step Over
- Next Statement
- Step Out

Consider this example and assume that the previous step has taken you to the `f(i)` function call (highlighted):

```
int f(int n)
{
 value = f(n-1) + f(n-2) + f(n-3);
 return value;
}
...
f(i);
value ++;
```

While stepping, you typically consider whether to step into a function and continue stepping inside the function or subroutine. The **Step Into** command takes you to the first step point within the subroutine, `f(n-1)`:

```
int f(int n)
{
 value = f(n-1) + f(n-2) + f(n-3);
 return value;
}
...
f(i);
value ++;
```

The **Step Into** command executes to the next step point in the normal flow of control, regardless of whether it is in the same or another function.

The **Step Over** command executes to the next step point in the same function, without stopping inside called functions. The command would take you to the `f(n-2)` function call, which is not a statement on its own but part of the same statement as `f(n-1)`. Thus, you can skip uninteresting calls which are parts of statements and instead focus on critical parts:

```
int f(int n)
{
 value = f(n-1) + f(n-2) + f(n-3);
 return value;
}
...
f(i);
value ++;
```

The **Next Statement** command executes directly to the next statement `return value`, allowing faster stepping:

```
int f(int n)
{
 value = f(n-1) + f(n-2) + f(n-3);
 return value;
}
...
f(i);
value ++;
```

When inside the function, you can—if you wish—use the **Step Out** command to step out of it before it reaches the exit. This will take you directly to the statement immediately after the function call:

```
int f(int n)
{
 value = f(n-1) + f(n-2) f(n-3);
 return value;
 ...
}
...
f(i);
value ++;
```

The possibility of stepping into an individual function that is part of a more complex statement is particularly useful when you use C code containing many nested function calls. It is also very useful for Embedded C++, which tends to have many implicit function calls, such as constructors, destructors, assignment operators, and other user-defined operators.

This detailed stepping can in some circumstances be either invaluable or unnecessarily slow. For this reason, you can also step only on statements, which means faster stepping.

GO

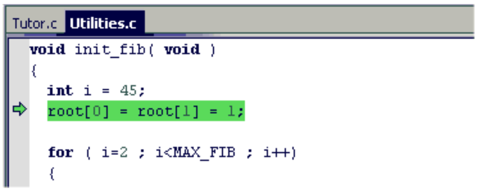
The **Go** command continues execution from the current position until a breakpoint or program exit is reached.

RUN TO CURSOR

The **Run to Cursor** command executes to the position in the source code where you have placed the cursor. The **Run to Cursor** command also works in the Disassembly window and in the Call Stack window.

HIGHLIGHTING

At each stop, C-SPY highlights the corresponding C or C++ source or instruction with a green color, in the editor and the Disassembly window respectively. In addition, a green arrow appears in the editor window when you step on C or C++ source level, and in the Disassembly window when you step on disassembly level. This is determined by which of the windows is the active window. If none of the windows are active, it is determined by which of the window is currently placed over the other window.



```
void init_fib( void )
{
  int i = 45;
  root[0] = root[1] = 1;

  for ( i=2 ; i<MAX_FIB ; i++)
  {
```

Figure 40: C-SPY highlighting source location

For simple statements without function calls, the whole statement is typically highlighted. When stopping at a statement with function calls, C-SPY highlights the first call because this illustrates more clearly what **Step Into** and **Step Over** would mean at that time.

Occasionally, you will notice that a statement in the source window is highlighted using a pale variant of the normal highlight color. This happens when the program counter is at an assembler instruction which is part of a source statement but not exactly at a step point. This is often the case when stepping in the Disassembly window. Only when the program counter is at the first instruction of the source statement, the ordinary highlight color is used.

USING BREAKPOINTS TO STOP

You can set breakpoints in the application to stop at locations of particular interest. These locations can be either at code sections where you want to investigate whether your program logic is correct, or at data accesses to investigate when and how the data is changed. Depending on which debugger system you are using you might also have access to additional types of breakpoints. For instance, if you are using the C-SPY Simulator, a special kind of breakpoint facilitates simulation of simple hardware devices. See the chapter *Simulator-specific debugging* for further details.

For a more advanced simulation, you can stop under certain conditions, which you specify. You can also connect a C-SPY macro to the breakpoint. The macro can be defined to perform actions, which for instance can simulate specific hardware behavior.

All these possibilities provide you with a flexible tool for investigating the status of, for example, variables and registers at different stages during the application execution.

For detailed information about the breakpoint system and how to use the breakpoint types, see the chapter *Using breakpoints*.

USING THE BREAK BUTTON TO STOP

While your application is executing, the **Break** button on the debug toolbar is highlighted in red. To stop the execution, click the **Break** button or choose the **Debug>Break** command.

STOP AT PROGRAM EXIT

Typically, the execution of an embedded application is not intended to end, which means that the application will not make use of a traditional exit. However, in some situations a controlled exit is necessary, such as during debug sessions. You can link your application with a special library that contains an exit label. A breakpoint will be automatically set on that label to stop execution when it gets there. Before you start C-SPY, choose **Project>Options**, and select the **Linker** category. For the XLINK linker, choose **Output>With runtime control modules** and for the ILINK linker, choose **Library>Include C-SPY debugging support**.

Call stack information

The compiler generates extensive backtrace information. This allows C-SPY to show, without any runtime penalty, the complete call chain at any time.

Typically, this is useful for two purposes:

- Determining in what context the current function has been called
- Tracing the origin of incorrect values in variables and incorrect values in parameters, thus locating the function in the call chain where the problem occurred.

The Call Stack window—available from the **View** menu—shows a list of function calls, with the current function at the top. When you inspect a function in the call chain, by double-clicking on any function call frame, the contents of all affected windows are updated to display the state of that particular call frame. This includes the editor, Locals, Register, Watch and Disassembly windows. A function would normally not make use of all registers, so these registers might have undefined states and be displayed as dashes (---). For reference information about the Call Stack window, see *Call Stack window*, page 287.

In the editor and Disassembly windows, a green highlight indicates the topmost, or current, call frame; a yellow highlight is used when inspecting other frames.

For your convenience, it is possible to select a function in the call stack and click the **Run to Cursor** command—available on the **Debug** menu, or alternatively on the context menu—to execute to that function.

Assembler source code does not automatically contain any backtrace information. To be able to see the call chain also for your assembler modules, you can add the appropriate `CFI` assembler directives to the source code. For further information, see the *IAR Assembler Reference Guide*.

Terminal input and output

Sometimes you might have to debug constructions in your application that use `stdin` and `stdout` without an actual hardware device for input and output. The Terminal I/O window—available on the **View** menu—lets you enter input to your application, and display output from it.

This facility is useful in two different contexts:

- If your application uses `stdin` and `stdout`
- For producing debug trace printouts.

To use this window, you must link your application with a library that contains C-SPY debugging support, for XLINK this means that you must select the option **With I/O emulation modules**, and for ILINK the option **Include C-SPY debugging support**. C-SPY will then direct `stdin`, `stdout`, and `stderr` to this window.

For reference information, see *Terminal I/O window*, page 288.

Directing stdin and stdout to a file

You can also direct `stdin` and `stdout` directly to a file. You can then open the file in another tool, for instance an editor, to navigate and search within the file for particularly interesting parts. The **Terminal I/O Log Files** dialog box—available by choosing **Debug>Logging**—allows you to select a destination log file, and to log terminal I/O input and output from C-SPY to this file.

For reference information, see *Terminal I/O Log File dialog box*, page 305.

Working with variables and expressions

This chapter defines the variables and expressions used in C-SPY®. It also demonstrates the methods for examining variables and expressions.

C-SPY expressions

C-SPY lets you examine the C variables, C expressions, and assembler symbols that you have defined in your application code. In addition, C-SPY allows you to define C-SPY macro variables and macro functions and use them when evaluating expressions. Expressions that are built with these components are called C-SPY expressions and there are several methods for monitoring these in C-SPY.

C-SPY expressions can include any type of C expression, except function calls. The following types of symbols can be used in expressions:

- C/C++ symbols
- Assembler symbols (register names and assembler labels)
- C-SPY macro functions
- C-SPY macro variables

Examples of valid C-SPY expressions are:

```
i + j
i = 42
#asm_label
#R2
#PC
my_macro_func(19)
```

C SYMBOLS

C symbols are symbols that you have defined in the C source code of your application, for instance variables, constants, and functions. C symbols can be referenced by their names.

Using sizeof

According to the C standard, there are two syntactical forms of `sizeof`:

```
sizeof(type)
sizeof expr
```

The former is for types and the latter for expressions.

In C-SPY, do not use parentheses around an expression when you use the `sizeof` operator. For example, use `sizeof x+2` instead of `sizeof (x+2)`.

ASSEMBLER SYMBOLS

Assembler symbols can be assembler labels or register names. That is, general purpose registers, and special purpose registers, such as the program counter and the status register. If a device description file is used, all memory-mapped peripheral units, such as I/O ports, can also be used as assembler symbols in the same way as the CPU registers. See *Selecting a device description file*, page 97.

Assembler symbols can be used in C-SPY expressions if they are prefixed by `#`.

Example	What it does
`#pc++`	Increments the value of the program counter.
`myptr = #label7`	Sets `myptr` to the integral address of `label7` within its zone.

Table 13: C-SPY assembler symbols expressions

In case of a name conflict between a hardware register and an assembler label, hardware registers have a higher precedence. To refer to an assembler label in such a case, you must enclose the label in back quotes ` (ASCII character 0x60). For example:

Example	What it does
`#pc`	Refers to the program counter.
``#`pc` ``	Refers to the assembler label `pc`.

Table 14: Handling name conflicts between hardware registers and assembler labels

Which processor-specific symbols are available by default can be seen in the **Register** window, using the `CPU Registers` register group. See *Register groups*, page 127.

MACRO FUNCTIONS

Macro functions consist of C-SPY variable definitions and macro statements which are executed when the macro is called.

For details of C-SPY macro functions and how to use them, see *The macro language*, page 130.

MACRO VARIABLES

Macro variables are defined and allocated outside your application, and can be used in a C-SPY expression. In case of a name conflict between a C symbol and a C-SPY macro variable, the C-SPY macro variable will have a higher precedence than the C variable. Assignments to a macro variable assigns both its value and type.

For details of C-SPY macro variables and how to use them, see *The macro language*, page 379.

Limitations on variable information

The value of a C variable is valid only on step points, that is, the first instruction of a statement and on function calls. This is indicated in the editor window with a bright green highlight color. In practice the value of the variable is accessible and correct more often than that.

When the program counter is inside a statement, but not at a step point, the statement or part of the statement is highlighted with a pale variant of the ordinary highlight color.

EFFECTS OF OPTIMIZATIONS

The compiler is free to optimize the application software as much as possible, as long as the expected behavior remains. Depending on your project settings, a high level of optimization results in smaller or faster code, but also in increased compile time. Debugging might be more difficult because it will be less clear how the generated code relates to the source code. Typically, using a high optimization level can affect the code in a way that will not allow you to view a value of a variable as expected.

Consider this example:

```
myFunction()
{
 int i = 42;
 ...
 x = compute(i); /* Here, the value of i is known to C-SPY */
 ...
}
```

From the point where the variable `i` is declared until it is actually used, the compiler does not need to waste stack or register space on it. The compiler can optimize the code, which means C-SPY will not be able to display the value until it is actually used. If you try to view a value of a variable that is temporarily unavailable, C-SPY will display the text:

```
Unavailable
```

If you need full information about values of variables during your debugging session, you should make sure to use the lowest optimization level during compilation, that is, **None**.

Viewing variables and expressions

There are several methods for looking at variables and calculating their values:

- Tooltip watch—in the editor window—provides the simplest way of viewing the value of a variable or more complex expressions. Just point at the variable with the pointer. The value is displayed next to the variable.
- The Auto window—available from the **View** menu—automatically displays a useful selection of variables and expressions in, or near, the current statement.
- The Locals window—available from the **View** menu—automatically displays the local variables, that is, auto variables and function parameters for the active function.
- The Watch window—available from the **View** menu—allows you to monitor the values of C-SPY expressions and variables.
- The Live Watch window—available from the **View** menu—repeatedly samples and displays the value of expressions while your application is executing. Variables in the expressions must be statically located, such as global variables.
- The Statics window—available from the **View** menu—automatically displays the values of variables with static storage duration.
- The Quick Watch window, see *Using the Quick Watch window*, page 113.
- The Trace system, see *Using the trace system*, page 113.

For text that is too wide to fit in a column—in any of the these windows, except the Trace window—and thus is truncated, just point at the text with the mouse pointer and tooltip information is displayed.

For reference information about the windows, see *C-SPY windows*, page 265.

WORKING WITH THE WINDOWS

All the windows are easy to use. You can add, modify, and remove expressions, and change the display format.

A context menu containing useful commands is available in all windows if you right-click in each window. Convenient drag-and-drop between windows is supported, except for in the Locals window and the Quick Watch window where it is not applicable.

To add a value you can also click in the dotted rectangle and type the expression you want to examine. To modify the value of an expression, click in the **Value** field and modify its content. To remove an expression, select it and press the Delete key.

Using the Quick Watch window

The Quick Watch window—available from the **View** menu—lets you watch the value of a variable or expression and evaluate expressions.

The Quick Watch window is different from the Watch window in the following ways:

- The Quick Watch window offers a fast method for inspecting and evaluating expressions. Right-click on the expression you want to examine and choose **Quick Watch** from the context menu that appears. The expression will automatically appear in the Quick Watch window.
- In contrast to the Watch window, the Quick Watch window gives you precise control over when to evaluate the expression. For single variables this might not be necessary, but for expressions with side effects, such as assignments and C-SPY macro functions, it allows you to perform evaluations under controlled conditions.

USING THE TRACE SYSTEM

A *trace* is a recorded sequence of events in the target system, typically executed machine instructions. Depending on what C-SPY driver you are using, additional types of trace data can be recorded. For example, read and write accesses to memory, and the values of C-SPY expressions.

By using the trace system, you can trace the program flow up to a specific state, for instance an application crash, and use the trace information to locate the origin of the problem. Trace information can be useful for locating programming errors that have irregular symptoms and occur sporadically. Trace information can also be useful as test documentation.

The trace system is not supported by all C-SPY drivers. For detailed information about the trace system and the components provided by the C-SPY driver you are using, see the corresponding driver documentation.

Which trace system functionality that is provided depends on the C-SPY driver you are using. However, for all C-SPY drivers that support the trace system, the Trace window, the Find in Trace window, and the **Find in Trace** dialog box are always available. You can save the trace information to a file to be analyzed later.

The Trace window and its browse mode

The type of information that is displayed in the Trace window depends on the C-SPY driver you are using. The various types of trace data are displayed in separate columns, but the **Trace** column is always available if the driver you are using supports the trace system. The corresponding source code can also be shown.

To follow the execution history, simply look and scroll in the Trace window. Alternatively, you can enter *browse mode*. To enter browse mode, double-click an item in the Trace window, or click the **Browse** toolbar button. The selected item turns yellow and the source and disassembly windows will highlight the corresponding location. You can now move around in the Trace window using the up and down arrow keys, or by scrolling and clicking; the source and Disassembly windows will be updated to show the corresponding location. Double-click again to leave browse mode.

Searching in the trace data

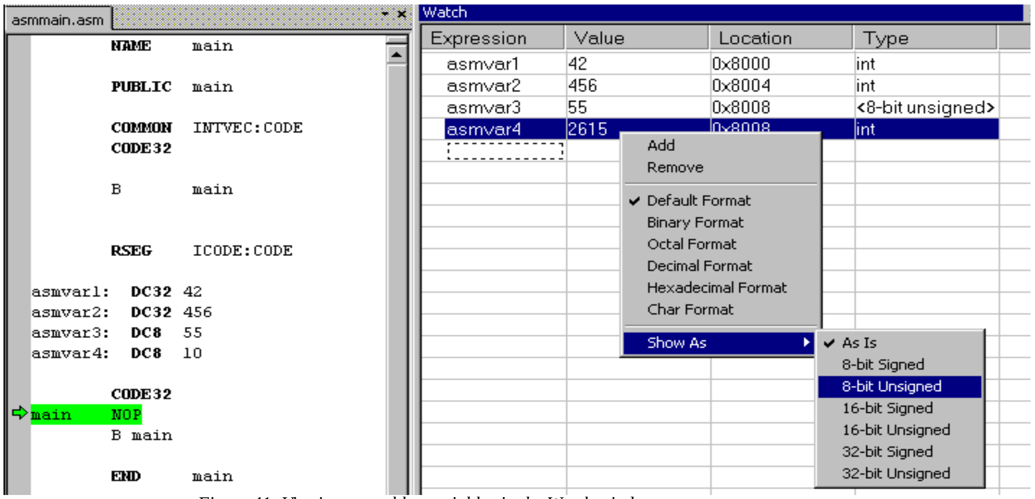
You can perform advanced searches in the recorded trace data. You specify the search criteria in the **Find in Trace** dialog box and view the result in the Find in Trace window.

The Find in Trace window is very similar to the Trace window, showing the same columns and data, but *only* those rows that match the specified search criteria. Double-clicking an item in the Find in Trace window brings up the same item in the Trace window.

VIEWING ASSEMBLER VARIABLES

An assembler label does not convey any type information at all, which means C-SPY cannot easily display data located at that label without getting extra information. To view data conveniently, C-SPY treats, by default, all data located at assembler labels as variables of type `int`. However, in the Watch, Quick Watch, and Live Watch windows, you can select a different interpretation to better suit the declaration of the variables.

In this figure, you can see four variables in the Watch window and their corresponding declarations in the assembler source file to the left:



```
asmmain.asm
            NAME      main

            PUBLIC    main

            COMMON    INTVEC:CODE
            CODE32

            B         main


            RSEG      ICODE:CODE

asmvar1:     DC32  42
asmvar2:     DC32  456
asmvar3:     DC8   55
asmvar4:     DC8   10

            CODE32
main        NOP
            B main

            END       main
```

Watch

Expression	Value	Location	Type
asmvar1	42	0x8000	int
asmvar2	456	0x8004	int
asmvar3	55	0x8008	<8-bit unsigned>
asmvar4	2615	0x8008	int

Figure 41: Viewing assembler variables in the Watch window

Note that `asmvar4` is displayed as an `int`, although the original assembler declaration probably intended for it to be a single byte quantity. From the context menu you can make C-SPY display the variable as, for example, an 8-bit unsigned variable. This has already been specified for the `asmvar3` variable.

Using breakpoints

This chapter describes the breakpoint system and various ways to create and monitor breakpoints. The chapter also gives some useful breakpoint tips and information about breakpoint consumers.

The breakpoint system

The C-SPY® breakpoint system lets you set various kinds of breakpoints in the application you are debugging, allowing you to stop at locations of particular interest. You can set a breakpoint at a *code* location to investigate whether your program logic is correct, or to get trace printouts. In addition to code breakpoints, and depending on what C-SPY driver you are using, additional breakpoint types might be available. For example, you might be able to set a *data* breakpoint, to investigate how and when the data changes. If you are using the simulator driver you can also set *immediate* breakpoints. C-SPY also provides several ways of defining the breakpoints.

All your breakpoints are listed in the *Breakpoints window* where you can conveniently monitor, enable, and disable them.

You can let the execution stop only under certain *conditions*, which you specify. You can also let the breakpoint trigger a *side effect*, for instance executing a C-SPY macro function, without stopping the execution. The macro function can be defined to perform a wide variety of actions, for instance, simulating hardware behavior.

You can set breakpoints while you edit your code even if no debug session is active. The breakpoints will then be validated when the debug session starts. Breakpoints are preserved between debug sessions.

All these possibilities provide you with a flexible tool for investigating the status of your application.

Defining breakpoints

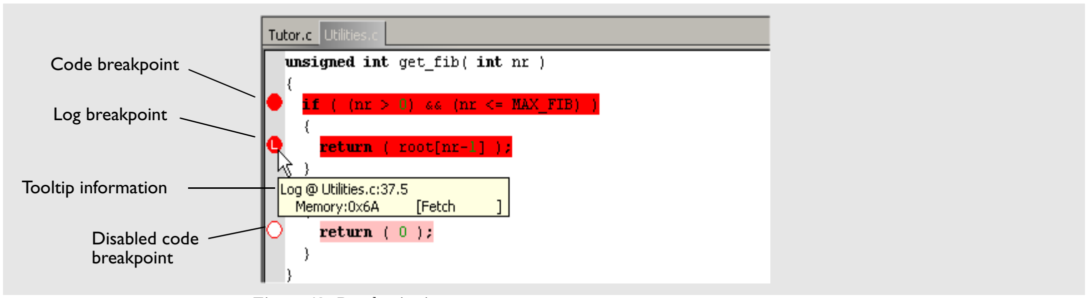
You can set breakpoints in many various ways and the breakpoints you define will appear in the Breakpoints window. From this window you can conveniently view all breakpoints, enable and disable breakpoints, and open a dialog box for defining new breakpoints.

Breakpoints are set with a higher precision than single lines, using the same mechanism as when stepping; for more details about the precision, see *Step*, page 104.

For reference information about code and log breakpoints, see *Code breakpoints dialog box*, page 202 and *Log breakpoints dialog box*, page 204, respectively. For details about any additional breakpoint types, see the driver-specific documentation.

BREAKPOINT ICONS

A breakpoint is marked with an icon in the left margin of the editor window, and the icon is different for code and for log breakpoints:



```
unsigned int get_fib( int nr )
{
  if ( (nr > 0) && (nr <= MAX_FIB) )
  {
    return ( root[nr-1] );
  }
Log @ Utilities.c:37.5
  Memory:0x6A       [Fetch      ]
    return ( 0 );
  }
}
```

Figure 42: Breakpoint icons

If the breakpoint icon does not appear, make sure the option **Show bookmarks** is selected, see *Editor options*, page 239.

Just point at the breakpoint icon with the mouse pointer to get detailed tooltip information about all breakpoints set on the same location. The first row gives user breakpoint information, the following rows describe the physical breakpoints used for implementing the user breakpoint. The latter information can also be seen in the **Breakpoint Usage** dialog box.

Note: The breakpoint icons might look different for the C-SPY driver you are using. For more information about breakpoint icons, see the driver-specific documentation.

DIFFERENT WAYS TO SET A BREAKPOINT

You can set a breakpoint in various ways:

- Using the **Toggle Breakpoint** command toggles a code breakpoint. This command is available both from the **Tools** menu and from the context menus in the editor window and in the Disassembly window
- Right-clicking in the left side margin of the editor window or the Disassembly window toggles a code breakpoint.
- Using the **New Breakpoints** dialog box and the **Edit Breakpoints** dialog box available from the context menus in the editor window, Breakpoints window, and in

the Disassembly window. The dialog boxes give you access to all breakpoint options.

- Setting a data breakpoint on a memory area directly in the Memory window.
- Using predefined system macros for setting breakpoints, which allows automation.

The different methods allow different levels of simplicity, complexity, and automation.

TOGGLING A SIMPLE CODE BREAKPOINT

Toggling a code breakpoint is a quick method of setting a breakpoint. The following methods are available both in the editor window and in the Disassembly window:

- Double-click in the gray left-side margin of the window
- Place the insertion point in the C source statement or assembler instruction where you want the breakpoint, and click the **Toggle Breakpoint** button in the toolbar
- Choose **Edit>Toggle Breakpoint**
- Right-click and choose **Toggle Breakpoint** from the context menu.

DEFINING BREAKPOINTS USING THE DIALOG BOX

The advantage of using a breakpoint dialog box is that it provides you with a graphical interface where you can interactively fine-tune the characteristics of the breakpoints. You can set the options and quickly test whether the breakpoint works according to your intentions.

All breakpoints you define using a breakpoint dialog box are preserved between debug sessions.

You can open the dialog box from the context menu available in the editor window, Breakpoints window, and in the Disassembly window.

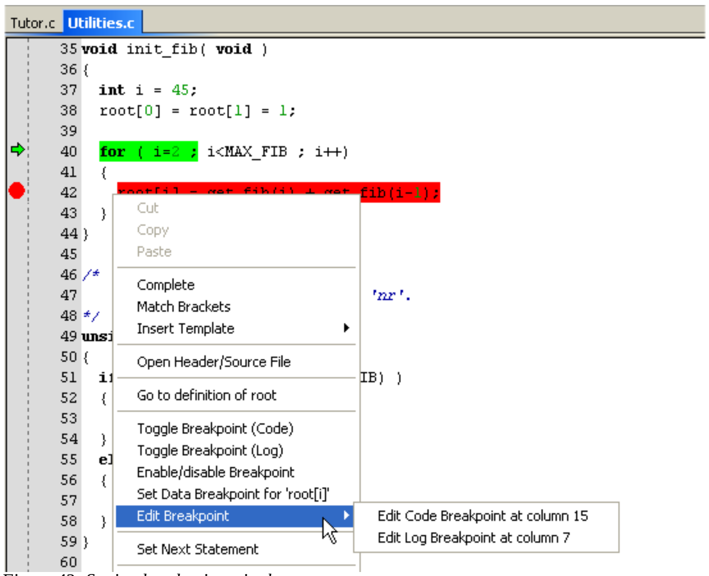
To define a new breakpoint

1. Choose **View>Breakpoints** to open the Breakpoints window.
2. In the Breakpoints window, right-click to open the context menu.
3. On the context menu, choose **New Breakpoint**.
4. On the submenu, choose the breakpoint type you want to set. Depending on the C-SPY driver you are using, different breakpoint types might be available.

A breakpoint dialog box appears. Specify the breakpoint settings and click **OK**. The breakpoint is displayed in the Breakpoints window, see *Viewing all breakpoints*, page 122.

To modify an existing breakpoint

1 In the Breakpoints window, editor window, or in the Disassembly window, select the breakpoint you want to modify and right-click to open the context menu.



```
void init_fib( void )
{
  int i = 45;
  root[0] = root[1] = 1;

  for ( i=2 ; i<MAX_FIB ; i++)
  {
    root[i] = get_fib(i) + get_fib(i-1);
  }
}

/*
                                  'nr'.
*/
unsi
{
  i                               IB) )
  {

  }
  el
  {

  }
}
```

Figure 43: Setting breakpoints via the context menu

If there are several breakpoints on the same line, they will be listed on a submenu.

2 On the context menu, choose the appropriate command.

A breakpoint dialog box appears. Specify the breakpoint settings and click **OK**. The breakpoint is displayed in the Breakpoints window, see *Viewing all breakpoints*, page 122.

SETTING A DATA BREAKPOINT IN THE MEMORY WINDOW

You can set breakpoints directly on a memory location in the Memory window. Right-click in the window and choose the breakpoint command from the context menu that appears. To set the breakpoint on a range, select a portion of the memory contents.

The breakpoint is not highlighted; you can see, edit, and remove it in the Breakpoints window, which is available from the **View** menu. The breakpoints you set in this window will be triggered for both read and write accesses. All breakpoints defined in the Memory window are preserved between debug sessions.

Setting different types of breakpoints in the Memory window is only supported if the driver you use supports these types of breakpoints.

DEFINING BREAKPOINTS USING SYSTEM MACROS

You can define breakpoints not only in the breakpoint dialog box but also by using built-in C-SPY system macros. When you use macros for defining breakpoints, the breakpoint characteristics are specified as function parameters.

Macros are useful when you have already specified your breakpoints so that they fully meet your requirements. You can define your breakpoints in a macro file, using built-in system macros, and execute the file at C-SPY startup. The breakpoints will then be set automatically each time you start C-SPY. Another advantage is that the debug session will be documented, and that several engineers involved in the development project can share the macro files.

If you use system macros for setting breakpoints, you can still view and modify them in the Breakpoints window. In contrast to using the dialog box for defining breakpoints, all breakpoints that are defined using system macros are removed when you exit the debug session.

Depending on the C-SPY driver you are using, these breakpoint macros are available:

```
__setCodeBreak
__setDataBreak
__setLogBreak
__setSimBreak
__setTraceStartBreak
__setTraceStopBreak
__clearBreak
```

For details of each breakpoint macro, see the chapter *C-SPY® macros reference*.

Defining breakpoints at C-SPY startup using a setup macro file

You can use a setup macro file to define breakpoints at C-SPY startup. Follow the procedure described in *Registering and executing using setup macros and setup files*, page 133.

USEFUL BREAKPOINT TIPS

Below comes some useful tips related to setting breakpoints.

Tracing incorrect function arguments

If a function with a pointer argument is sometimes incorrectly called with a `NULL` argument, it is useful to put a breakpoint on the first line of the function with a condition that is true only when the parameter is 0. The breakpoint will then not be triggered until the problematic situation actually occurs.

Performing a task with or without stopping execution

You can perform a task when a breakpoint is triggered *with* or *without* stopping the execution.

You can use the **Action** text box to associate an action with the breakpoint, for instance a C-SPY macro function. When the breakpoint is triggered and the execution of your application has stopped, the macro function will be executed.

If you instead want to perform a task without stopping the execution, you can set a condition which returns `0` (false). When the breakpoint is triggered, the condition is evaluated and because it is not true, execution continues.

Consider this example where the C-SPY macro function performs a simple task:

```
__var my_counter;

count()
{
  my_counter += 1;
  return 0;
}
```

To use this function as a condition for the breakpoint, type `count()` in the **Expression** text box under **Conditions**. The task will then be performed when the breakpoint is triggered. Because the macro function `count` returns `0`, the condition is false and the execution of the program will resume automatically, without any stop.

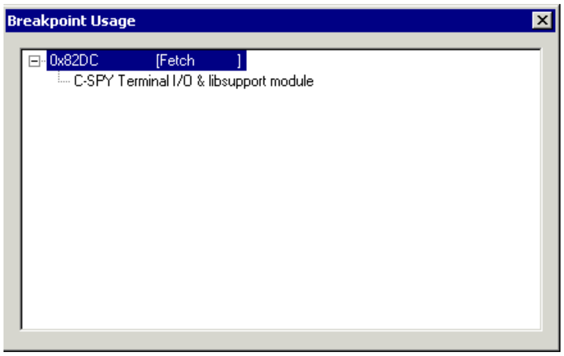
Viewing all breakpoints

To view breakpoints, you can use the Breakpoints window and the **Breakpoints Usage** dialog box.

For information about the Breakpoints window, see *Breakpoints window*, page 201.

USING THE BREAKPOINT USAGE DIALOG BOX

The **Breakpoint Usage** dialog box—available from C-SPY driver-specific menus, for example the **Simulator** menu—lists all active breakpoints.



0x82DC [Fetch]
C-SPY Terminal I/O & libsupport module

Figure 44: Breakpoint Usage dialog box

The **Breakpoint Usage** dialog box lists all breakpoints currently set in the target system, both the ones you have defined and the ones used internally by C-SPY. For each breakpoint in the list, the address and access type are shown. Each breakpoint can also be expanded to show its originator. The format of the items in this dialog box depends on which C-SPY driver you are using.

The dialog box gives a low-level view of all breakpoints, related but not identical to the list of breakpoints shown in the breakpoint dialog box.

Exceeding the number of available low-level breakpoints will cause the debugger to single step. This will significantly reduce the execution speed. Therefore, in a debugger system with a limited amount of breakpoints, you can use the **Breakpoint Usage** dialog box for:

- Identifying all consumers of breakpoints
- Checking that the number of active breakpoints is supported by the target system
- Configuring the debugger to use the available breakpoints in a better way, if possible.

For information about the available number of breakpoints in the debugger system you are using and how to use the available breakpoints in a better way, see the section about breakpoints in the part of this book that corresponds to the debugger system you are using.

BREAKPOINT CONSUMERS

A debugger system includes several consumers of breakpoints.

User breakpoints—the breakpoints you define in the breakpoint dialog box or by toggling breakpoints in the editor window—often consume one low-level breakpoint each, but this can vary greatly. Some user breakpoints consume several low-level breakpoints and conversely, several user breakpoints can share one low-level breakpoint. User breakpoints are displayed in the same way both in the **Breakpoint Usage** dialog box and in the Breakpoints window, for example `Data @[R] callCount`.

C-SPY itself also consumes breakpoints. C-SPY will set a breakpoint if:

- the debugger option **Run to** has been selected, and any step command is used. These are temporary breakpoints which are only set when the debugger system is running. This means that they are not visible in the Breakpoint Usage window.
- the linker option **With I/O emulation modules** for XLINK and **Include C-SPY debugging support** for ILINK has been selected.

These types of breakpoint consumers are displayed in the **Breakpoint Usage** dialog box, for example, `C-SPY Terminal I/O & libsupport module`.

C-SPY plugin modules, for example modules for real-time operating systems, can consume additional breakpoints. Specifically, by default, the Stack window consumes a breakpoint. To disable the breakpoint used by the Stack window:

- Choose **Tools>Options>Stack**.
- Deselect the **Stack pointer(s) not valid until program reaches:** ***label*** option.

Monitoring memory and registers

This chapter describes how to use the features available in the IAR C-SPY® Debugger for examining memory and registers.

Memory addressing

In C-SPY, the term *zone* is used for a named memory area. A memory address, or *location*, is a combination of a zone and a numerical offset into that zone.

Memory zones are used in several contexts, most importantly in the Memory and Disassembly windows. Use the **Zone** box in these windows to choose which memory zone to display.

Memory zones are defined in the device description files. For further information, see *Selecting a device description file*, page 97.

Windows for monitoring memory and registers

C-SPY provides many windows for monitoring memory and registers, each of them available from the **View** menu:

- The Memory window

  Gives an up-to-date display of a specified area of memory—a memory zone—and allows you to edit it. Different colors are used for indicating data coverage along with execution of your application. You can fill specified areas with specific values and you can set breakpoints directly on a memory location or range. You can open several instances of this window, to monitor different memory areas. For more information, see *Memory window*, page 272. See also *Setting a data breakpoint in the Memory window*, page 120.
- The Symbolic memory window

  Displays how variables with static storage duration are laid out in memory. This can be useful for better understanding memory usage or for investigating problems caused by variables being overwritten, for example by buffer overruns.
- The Stack window

  Displays the contents of the stack, including how stack variables are laid out in memory. In addition, some integrity checks of the stack can be performed to detect and warn about problems with stack overflow. For example, the Stack window is useful for determining the optimal size of the stack.

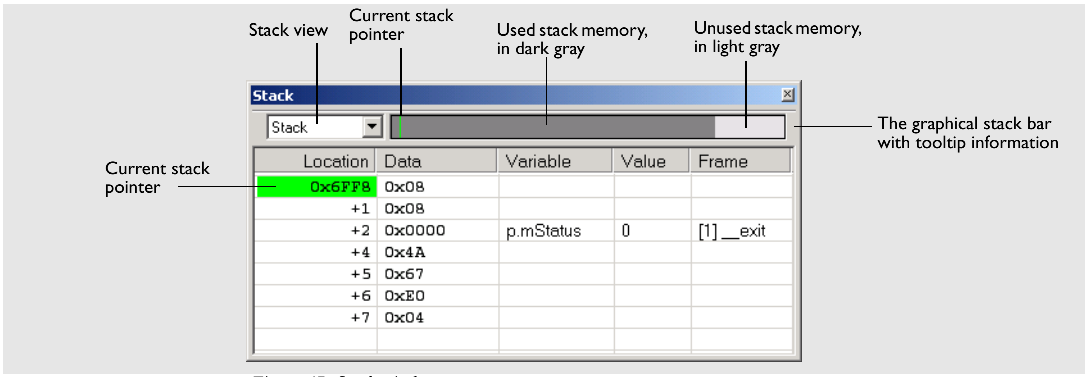
- The Register window

  Gives an up-to-date display of the contents of the processor registers and SFRs, and allows you to edit them.

To view the memory contents for a specific variable, simply drag the variable to the Memory window or the Symbolic memory window. The memory area where the variable is located will appear.

USING THE STACK WINDOW

Before you can open the Stack window you must make sure it is enabled; Choose **Project>Options>Debugger>Plugins** and select **Stack** from the list of plugins. In C-SPY, you can then open a Stack window by choosing **View>Stack**. You can open several instances of the Stack window, each showing a different stack—if several stacks are available—or the same stack with different display settings.


Stack view
Current stack pointer
Used stack memory, in dark gray
Unused stack memory, in light gray
The graphical stack bar with tooltip information
Current stack pointer
Stack
Stack

Location	Data	Variable	Value	Frame
0x6FF8	0x08			
+1	0x08			
+2	0x0000	p.mStatus	0	[1] __exit
+4	0x4A			
+5	0x67			
+6	0xE0			
+7	0x04			

Figure 45: Stack window

For detailed reference information about the Stack window, and the method used for computing the stack usage and its limitations, see *Stack window*, page 296. For reference information about the options specific to the window, see *Stack options*, page 252.

Place the mouse pointer over the stack bar to get tool tip information about stack usage.

Detecting stack overflows

If you have selected the option **Enable stack checks**, available by choosing **Tools>Options>Stack**, you have also enabled the functionality needed to detect stack overflows. This means that C-SPY can issue warnings for stack overflow when the application stops executing. Warnings are issued either when the stack usage exceeds a threshold that you can specify, or when the stack pointer is outside the stack memory range.

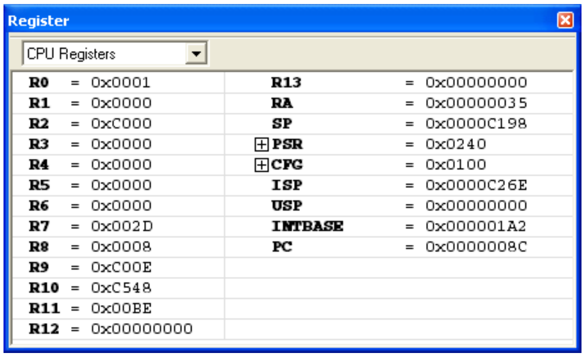
Viewing the stack contents

The display area of the Stack window shows the contents of the stack, which can be useful in many contexts. Some examples are:

- Investigating the stack usage when assembler modules are called from C modules and vice versa
- Investigating whether the correct elements are located on the stack
- Investigating whether the stack is restored properly.

WORKING WITH REGISTERS

The Register window gives an up-to-date display of the contents of the processor registers and special function registers, and allows you to edit them.



```
R0  = 0x0001        R13      = 0x00000000
R1  = 0x0000        RA       = 0x00000035
R2  = 0xC000        SP       = 0x0000C198
R3  = 0x0000       ⊞PSR      = 0x0240
R4  = 0x0000       ⊞CFG      = 0x0100
R5  = 0x0000        ISP      = 0x0000C26E
R6  = 0x0000        USP      = 0x00000000
R7  = 0x002D        INTBASE  = 0x000001A2
R8  = 0x0008        PC       = 0x0000008C
R9  = 0xC00E
R10 = 0xC548
R11 = 0x00BE
R12 = 0x00000000
```

Figure 46: Register window

Every time C-SPY stops, a value that has changed since the last stop is highlighted. To edit the contents of a register, click it, and modify the value. You can expand some registers to show individual bits or subgroups of bits.

To change the display format, change the **Base** setting on the **Register Filter** page—available by choosing **Tools>Options**.

Register groups

Due to the large amount of registers—memory-mapped peripheral unit registers and CPU registers—it is inconvenient to show all registers concurrently in the Register window. Instead you can divide registers into *register groups*. By default, there is only one register group in the debugger: **CPU Registers**.

In addition to the **CPU Registers**, additional register groups are predefined in the device description files—available in the `cpuname\config` directory—that make all SFR registers available in the register window. The device description file contains a section that defines the special function registers and their groups.

You can select which register group to display in the Register window using the drop-down list. You can conveniently keep track of different register groups simultaneously, as you can open several instances of the Register window.

Enabling predefined register groups

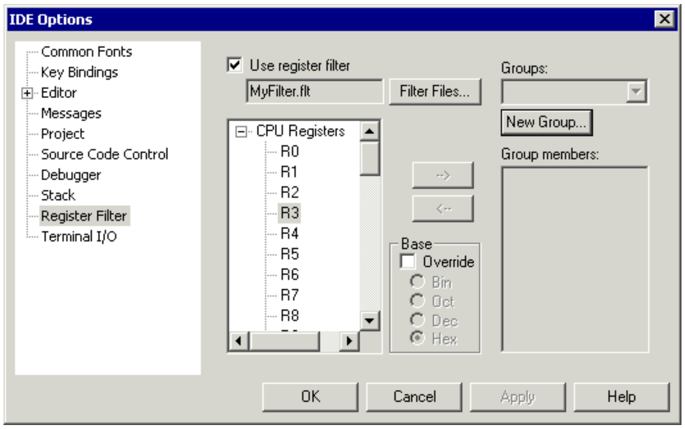
To use any of the predefined register groups, select a device description file that suits your device, see *Selecting a device description file*, page 97.

The available register groups are listed on the **Register Filter** page, available if you choose the **Tools>Options** command when C-SPY is running.

Defining application-specific groups

In addition to the predefined register groups, you can create your own register groups that better suit the use of registers in your application.

To define new register groups, choose **Tools>Options** and click the **Register Filter** tab. This page is only available when the debugger is running.



Use register filter: [✓]
MyFilter.flt
Override: [ ]
Hex [✓]

Figure 47: Register Filter page

For reference information about this dialog box, see *Register Filter options*, page 254.

Using the C-SPY macro system

C-SPY includes a comprehensive macro system which allows you to automate the debugging process and to simulate peripheral devices. Macros can be used in conjunction with complex breakpoints and interrupt simulation to perform a wide variety of tasks.

This chapter describes the macro system, its features, for what purpose these features can be used, and how to use them.

The macro system

You can use C-SPY macros either by themselves or in conjunction with complex breakpoints and interrupt simulation to perform a wide variety of tasks. Some examples where macros can be useful:

- Automating the debug session, for instance with trace printouts, printing values of variables, and setting breakpoints.
- Hardware configuring, such as initializing hardware registers.
- Developing small debug utility functions, for instance calculating the stack depth.
- Simulating peripheral devices, see the chapter *Simulating interrupts*. This only applies if you are using the simulator driver.

The macro system has several features:

- The similarity between the *macro language* and the C language, which lets you write your own macro functions.
- Predefined *system macros* which perform useful tasks such as opening and closing files, setting breakpoints and defining simulated interrupts.
- Reserved *setup macro functions* which can be used for defining at which stage the macro function should be executed. You define the function yourself, in a *setup macro file*.
- The option of collecting your macro functions in one or several *macro files.*
- A *dialog box* where you can view, register, and edit your macro functions and files. Alternatively, you can register and execute your macro files and functions using either the setup functionality or system macros.

Many C-SPY tasks can be performed either in a dialog box or by using macro functions. The advantage of using a dialog box is that it provides you with a graphical interface where you can interactively fine-tune the characteristics of the task you want to perform, for instance setting a breakpoint. You can add parameters and quickly test whether the breakpoint works according to your intentions.

Macros, on the other hand, are useful when you already have specified your breakpoints so that they fully meet your requirements. To set up your simulator environment automatically, write a macro file and execute it, for instance, when you start C-SPY. Another advantage is that the debug session will be documented, and if several engineers are involved in the development project, you can share the macro files within the group.

THE MACRO LANGUAGE

The syntax of the macro language is very similar to the C language. There are *macro statements*, which are similar to C statements. You can define *macro functions*, with or without parameters and return values. You can use built-in system macros, similar to C library functions. Finally, you can define global and local *macro variables*. For a detailed description of the macro language components, see *The macro language*, page 379.

Example

Consider this example of a macro function which illustrates the various components of the macro language:

```
CheckLatest(value)
{
 oldvalue;
 if (oldvalue != value)
 {
  __message "Message: Changed from ", oldvalue, " to ", value;
  oldvalue = value;
 }
}
```

Note: Reserved macro words begin with double underscores to prevent name conflicts.

THE MACRO FILE

You collect your macro variables and functions in one or several macro files. To define a macro variable or macro function, first create a text file containing the definition. You can use any suitable text editor, such as the editor supplied with the IDE. Save the file with a suitable name using the filename extension `mac`.

Setup macro file

You can load a macro file at C-SPY startup; such a file is called a *setup macro file*. This is especially convenient if you want to make C-SPY perform actions before you load your application software, for instance to initialize some CPU registers or memory-mapped peripheral units. Other reasons might be if you want to automate the initialization of C-SPY, or if you want to register multiple setup macro files. You will find an example of a C-SPY setup macro file, `SetupSimple.mac`, in the `cpuname\tutor` directory.

For information about how to load a setup macro file, see *Registering and executing using setup macros and setup files*, page 133. For an example of how to use setup macro files, see the chapter *Simulating an interrupt* in *Part 1. Tutorials*.

SETUP MACRO FUNCTIONS

The *setup macro functions* are reserved macro function names that are called by C-SPY at specific stages during execution. The stages to choose between are:

- After communication with the target system has been established but before downloading the application software
- Once after your application software has been downloaded
- Each time the reset command is issued
- Once when the debug session ends.

To define a macro function to be called at a specific stage, you should define and register a macro function with the name of a setup macro function. For instance, if you want to clear a specific memory area before you load your application software, the macro setup function `execUserPreload` is suitable. This function is also suitable if you want to initialize some CPU registers or memory mapped peripheral units before you load your application software. For detailed information about each setup macro function, see *Setup macro functions summary*, page 384.

As with any macro function, you collect your setup macro functions in a macro file. Because many of the setup macro functions execute before `main` is reached, you should define these functions in a *setup macro file*.

Using C-SPY macros

If you decide to use C-SPY macros, you must first create a macro file in which you define your macro functions. C-SPY must know that you intend to use your defined macro functions, and thus you must *register* (load) your macro file. During the debug session, you might have to list all available macro functions and execute them.

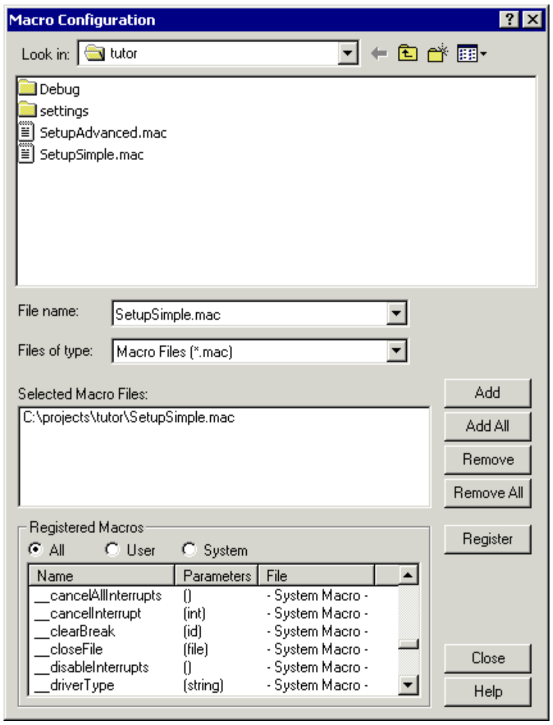
To list the registered macro functions, you can use the **Macro Configuration** dialog box. There are various ways to both register and execute macro functions:

- You can register a macro interactively in the **Macro Configuration** dialog box.
- You can register and execute macro functions at the C-SPY startup sequence by defining setup macro functions in a setup macro file.
- You can register a file containing macro function definitions, using the system macro `__registerMacroFile`. This means that you can dynamically select which macro files to register, depending on the runtime conditions. Using the system macro also lets you register multiple files at the same moment. For details about the system macro, see *__registerMacroFile*, page 397.
- The Quick Watch window lets you evaluate expressions, and can thus be used for executing macro functions.
- A macro can be connected to a breakpoint; when the breakpoint is triggered the macro is executed.

USING THE MACRO CONFIGURATION DIALOG BOX

The **Macro Configuration** dialog box—available by choosing **Debug>Macros**—lets you list, register, and edit your macro files and functions. The dialog box offers you an interactive interface for registering your macro functions which is convenient when you develop macro functions and continuously want to load and test them.

Macro functions that have been registered using the dialog box are deactivated when you exit the debug session, and will not automatically be registered at the next debug session.



Look in: tutor

Debug
settings
SetupAdvanced.mac
SetupSimple.mac

File name: SetupSimple.mac

Files of type: Macro Files (*.mac)

Selected Macro Files:
C:\projects\tutor\SetupSimple.mac

Registered Macros
[✓ All] User System

Name	Parameters	File
__cancelAllInterrupts	()	- System Macro -
__cancelInterrupt	(int)	- System Macro -
__clearBreak	(id)	- System Macro -
__closeFile	(file)	- System Macro -
__disableInterrupts	()	- System Macro -
__driverType	(string)	- System Macro -

Figure 48: Macro Configuration dialog box

For reference information about this dialog box, see *Macro Configuration dialog box*, page 302.

REGISTERING AND EXECUTING USING SETUP MACROS AND SETUP FILES

It can be convenient to register a macro file during the C-SPY startup sequence, especially if you have several ready-made macro functions. C-SPY can then execute the macros before `main` is reached. To do this, specify a macro file which you load before starting the debugger. Your macro functions will be automatically registered each time you start C-SPY.

If you use the setup macro function names to define the macro functions, you can define exactly at which stage you want the macro function to be executed.

Follow these steps:

1 Create a new text file where you can define your macro function.

For example:

```
execUserSetup()
{
 ...
 __registerMacroFile("MyMacroUtils.mac");
 __registerMacroFile("MyDeviceSimulation.mac");

}
```

This macro function registers the macro files `MyMacroUtils.mac` and `MyDeviceSimulation.mac`. Because the macro function is defined with the `execUserSetup` function name, it will be executed directly after your application has been downloaded.

2 Save the file using the filename extension `mac`.

3 Before you start C-SPY, choose **Project>Options** and click the **Setup** tab in the **Debugger** category. Select the check box **Use Setup file** and choose the macro file you just created.

The interrupt macro will now be loaded during the C-SPY startup sequence.

EXECUTING MACROS USING QUICK WATCH

The Quick Watch window—available from the **View** menu—lets you watch the value of any variables or expressions and evaluate them. For macros, the Quick Watch window is especially useful because it is a method which lets you dynamically choose when to execute a macro function.

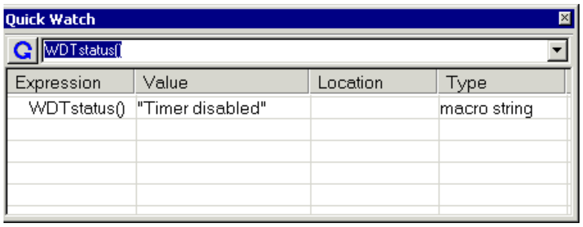
Consider this simple macro function that checks the status of a watchdog timer interrupt enable bit:

```
WDTstatus()
{
  if (#WDreg & 0x01 != 0) /* Checks the status of WDTIE */
    return "Timer enabled"; /* C-SPY macro string used */
  else
    return "Timer disabled"; /* C-SPY macro string used */
}
```

1 Save the macro function using the filename extension `mac`. Keep the file open.

2 To register the macro file, choose **Debug>Macros**. The **Macro Configuration** dialog box appears. Locate the file, click **Add** and then **Register**. The macro function appears in the list of registered macros.

3 In the macro file editor window, select the macro function name `WDTstatus`. Right-click, and choose **Quick Watch** from the context menu that appears.



Expression	Value	Location	Type
WDTstatus()	"Timer disabled"		macro string

Figure 49: Quick Watch window

The macro will automatically be displayed in the Quick Watch window.

Click **Close** to close the window.

EXECUTING A MACRO BY CONNECTING IT TO A BREAKPOINT

You can connect a macro to a breakpoint. The macro will then be executed at the time when the breakpoint is triggered. The advantage is that you can stop the execution at locations of particular interest and perform specific actions there.

For instance, you can easily produce log reports containing information such as how the values of variables, symbols, or registers changes. To do this you might set a breakpoint on a suspicious location and connect a log macro to the breakpoint. After the execution you can study how the values of the registers have changed.

For an example of how to create a log macro and connect it to a breakpoint, follow these steps:

1 Assume this skeleton of a C function in your application source code:

```
int fact(int x)
{
 ...
}
```

2 Create a simple log macro function like this example:

```
logfact()
{
 __message "fact(" ,x, ")";
}
```

The `__message` statement will log messages to the Log window.

Save the macro function in a macro file, with the filename extension `mac`.

3 Before you can execute the macro it must be registered. Open the **Macro Configuration** dialog box—available by choosing **Debug>Macros**—and add your macro file to the list **Selected Macro Files**. Click **Register** and your macro function will appear in the list **Registered Macros**. Close the dialog box.

4 Next, you should toggle a code breakpoint—using the **Toggle Breakpoint** button—on the first statement within the function `fact` in your application source code. Open the **Breakpoint** dialog box—available by choosing **Edit>Breakpoints**—your breakpoint will appear in the list of breakpoints at the bottom of the dialog box. Select the breakpoint.

5 Connect the log macro function to the breakpoint by typing the name of the macro function, `logfact()`, in the **Action** field and clicking **Apply**. Close the dialog box.

6 Now you can execute your application source code. When the breakpoint has been triggered, the macro function will be executed. You can see the result in the Log window.

You can easily enhance the log macro function by, for instance, using the `__fmessage` statement instead, which will print the log information to a file. For information about the `__fmessage` statement, see *Formatted output*, page 382.

For a complete example where a serial port input buffer is simulated using the method of connecting a macro to a breakpoint, see the chapter *Simulating an interrupt* in *Part 1. Tutorials*.

Analyzing your application

It is important to locate an application's bottle-necks and to verify that all parts of an application have been tested. This chapter presents facilities available in the IAR C-SPY® Debugger for analyzing your application so that you can efficiently spend time and effort on optimizations.

Function-level profiling

The profiler will help you find the functions where most time is spent during execution, for a given stimulus. Those functions are the parts you should focus on when spending time and effort on optimizing your code. A simple method of optimizing a function is to compile it using speed optimization. Alternatively, you can move the function into the memory which uses the most efficient addressing mode. For detailed information about efficient memory usage, see the compiler documentation.

The Profiling window displays profiling information, that is, timing information for the functions in an application. Profiling must be turned on explicitly using a button on the window's toolbar, and will stay active until it is turned off.

The profiler measures the time between the entry and return of a function. This means that time consumed in a function is not added until the function returns or another function is called. You will only notice this if you are stepping into a function.

For reference information about the Profiling window, see *Profiling window*, page 292.

USING THE PROFILER

Before you can use the Profiling window, you must build your application using these options:

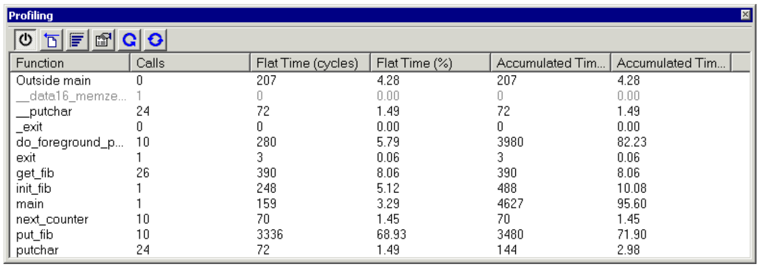
Category	Setting
C/C++ Compiler	Output>Generate debug information
Linker (XLINK)	Format>Debug information for C-SPY
Linker (ILINK)	Output>Include debug information in output
Debugger	Plugins>Profiling

Table 15: Project options for enabling profiling

1 After you have built your application and started C-SPY, choose **View>Profiling** to open the window, and click the **Activate** button to turn on the profiler.

2 Click the **Clear** button, alternatively use the context menu available when you right-click in the window, when you want to start a new sampling.

3 Start the execution. When the execution stops, for instance because the program exit is reached or a breakpoint is triggered, click the **Refresh** button.



Function	Calls	Flat Time (cycles)	Flat Time (%)	Accumulated Tim...	Accumulated Tim...
Outside main	0	207	4.28	207	4.28
__data16_memze...	1	0	0.00	0	0.00
__putchar	24	72	1.49	72	1.49
_exit	0	0	0.00	0	0.00
do_foreground_p...	10	280	5.79	3980	82.23
exit	1	3	0.06	3	0.06
get_fib	26	390	8.06	390	8.06
init_fib	1	248	5.12	488	10.08
main	1	159	3.29	4627	95.60
next_counter	10	70	1.45	70	1.45
put_fib	10	3336	68.93	3480	71.90
putchar	24	72	1.49	144	2.98

Figure 50: Profiling window

Profiling information is displayed in the window.

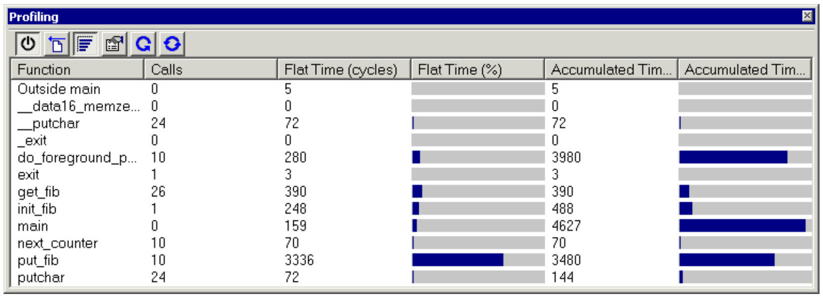
Viewing the figures

Clicking on a column header sorts the entire list according to that column.

A dimmed item in the list indicates that the function has been called by a function which does not contain source code (compiled without debug information). When a function is called by functions that do not have their source code available, such as library functions, no measurement in time is made.

There is always an item in the list called Outside main. This is time that cannot be placed in any of the functions in the list. That is, code compiled without debug information, for instance, all startup and exit code, and C/C++ library code.

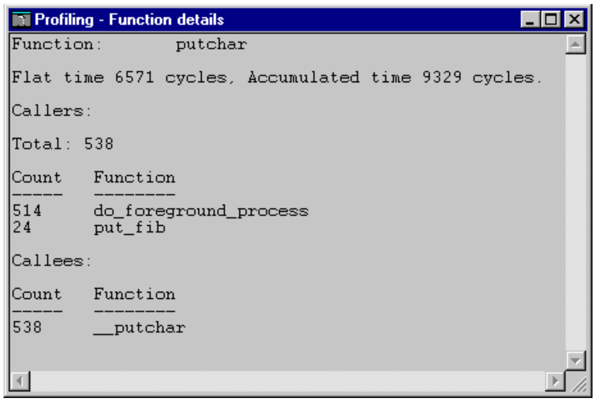
Clicking the **Graph** button toggles the percentage columns to be displayed either as numbers or as bar charts.


Profiling

Function	Calls	Flat Time (cycles)	Flat Time (%)	Accumulated Tim...	Accumulated Tim...
Outside main	0	5		5	
__data16_memze...	0	0		0	
__putchar	24	72		72	
_exit	0	0		0	
do_foreground_p...	10	280		3980	
exit	1	3		3	
get_fib	26	390		390	
init_fib	1	248		488	
main	0	159		4627	
next_counter	10	70		70	
put_fib	10	3336		3480	
putchar	24	72		144	

Figure 51: Graphs in Profiling window

Clicking the **Show details** button displays more detailed information about the function selected in the list. A window is opened showing information about callers and callees for the selected function:


Profiling - Function details

```
Function:        putchar

Flat time 6571 cycles, Accumulated time 9329 cycles.

Callers:

Total: 538

Count    Function
-----    --------
514      do_foreground_process
24       put_fib

Callees:

Count    Function
-----    --------
538      __putchar
```

Figure 52: Function details window

Producing reports

To produce a report, right-click in the window and choose the **Save As** command on the context menu. The contents of the Profiling window are saved to a file.

Code coverage

The code coverage functionality helps you verify whether all parts of your code have been executed. This is useful when you design your test procedure to make sure that all parts of the code have been executed. It also helps you identify parts of your code that are not reachable.

USING CODE COVERAGE

The Code Coverage window—available from the **View** menu—reports the status of the current code coverage analysis, that is, what parts of the code have been executed at least once since the start of the analysis. The compiler generates detailed stepping information in the form of *step points* at each statement, and at each function call. The report includes information about all modules and functions. It reports the amount of all step points, in percentage, that have been executed and lists all step points that have not been executed up to the point where the application has been stopped. The coverage will continue until turned off.

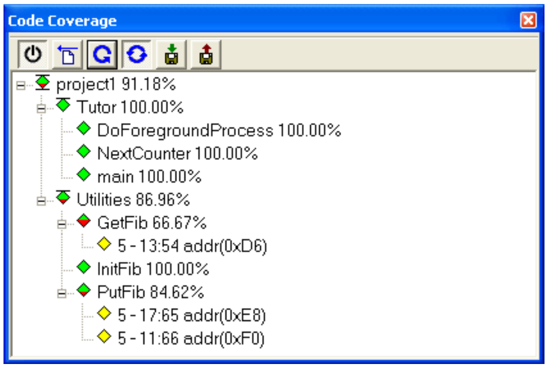
For reference information about the Code Coverage window, see *Code Coverage window*, page 290.

Before using the Code Coverage window you must build your application using these options:

Category	Setting
C/C++ Compiler	Output>Generate debug information
Linker (XLINK)	Format>Debug information for C-SPY
Linker (ILINK)	Output>Include debug information in output
Debugger	Plugins>Code Coverage

Table 16: Project options for enabling code coverage

1 After you have built your application and started C-SPY, choose **View>Code Coverage** to open the Code Coverage window. This window is displayed:



```
project1 91.18%
  Tutor 100.00%
    DoForegroundProcess 100.00%
    NextCounter 100.00%
    main 100.00%
  Utilities 86.96%
    GetFib 66.67%
      5 - 13:54 addr(0xD6)
    InitFib 100.00%
    PutFib 84.62%
      5 - 17:65 addr(0xE8)
      5 - 11:66 addr(0xF0)
```

Figure 53: Code Coverage window

2 Click the **Activate** button, alternatively choose **Activate** from the context menu, to switch on the code coverage analyzer.

3 Start the execution. When the execution stops, for instance because the program exit is reached or a breakpoint is triggered, click the **Refresh** button to view the code coverage information.

Viewing the figures

The code coverage information is displayed in a tree structure, showing the program, module, function and step point levels. The plus sign and minus sign icons allow you to expand and collapse the structure.

These icons are used to give you an overview of the current status on all levels:

- A red diamond signifies that 0% of the code has been executed
- A green diamond signifies that 100% of the code has been executed
- A red and green diamond signifies that some of the code has been executed
- A yellow diamond signifies a step point that has not been executed.

The percentage displayed at the end of every program, module and function line shows the amount of code that has been covered so far, that is, the number of executed step points divided with the total number of step points.

For step point lines, the information displayed is the column number range and the row number of the step point in the source window, followed by the address of the step point.

```
<column start>-<column end>:row.
```

A step point is considered to be executed when one of its instructions has been executed. When a step point has been executed, it is removed from the window.

Double-clicking a step point or a function in the Code Coverage window displays that step point or function as the current position in the source window, which becomes the active window. Double-clicking a module on the program level expands or collapses the tree structure.

An asterisk (*) in the title bar indicates that C-SPY has continued to execute, and that the Code Coverage window must be refreshed because the displayed information is no longer up to date. To update the information, use the **Refresh** command.

What parts of the code are displayed?

The window displays only statements that were compiled with debug information. Thus, startup code, exit code and library code are not displayed in the window. Furthermore, coverage information for statements in inlined functions is not displayed. Only the statement containing the inlined function call is marked as executed.

Producing reports

To produce a report, right-click in the window and choose the **Save As** command on the context menu. The contents of the Code Coverage window are saved to a file.

Part 4. IAR C-SPY Simulator

This part of the IAR Embedded Workbench IDE User Guide contains the following chapters:

- Simulator-specific debugging
- Simulating interrupts.

Simulator-specific debugging

In addition to the general C-SPY® features, the C-SPY Simulator provides some simulator-specific features, which are described in this chapter.

You will get reference information, and information about driver-specific characteristics, such as memory access checking and breakpoints.

The C-SPY Simulator introduction

The C-SPY Simulator simulates the functions of the target processor entirely in software, which means that you can debug the program logic long before any hardware is available. Because no hardware is required, it is also the most cost-effective solution for many applications.

FEATURES

In addition to the general features in C-SPY, the simulator also provides:

- Instruction-level simulation
- Memory configuration and validation
- Interrupt simulation
- Peripheral simulation (using the C-SPY macro system in conjunction with immediate breakpoints).

SELECTING THE SIMULATOR DRIVER

Before starting C-SPY, you must choose the simulator driver. In the IDE, choose **Project>Options** and click the **Setup** tab in the **Debugger** category. Choose **Simulator** from the **Driver** drop-down list.

Note that you can only choose a C-SPY driver that is installed on your computer.

Simulator-specific menus

When you use the simulator driver, the **Simulator** menu is added to the menu bar.

SIMULATOR MENU

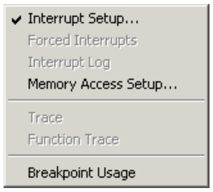


Figure 54: Simulator menu

The **Simulator** menu contains these commands:

Menu command	Description
Interrupt Setup	Displays a dialog box to allow you to configure C-SPY interrupt simulation; see *Interrupt Setup dialog box*, page 169.
Forced Interrupts	Displays a window from which you can trigger an interrupt; see *Forced Interrupt window*, page 171.
Interrupt Log	Displays a window which shows the status of all defined interrupts; see *Interrupt Log window*, page 173.
Memory Access Setup	Displays a dialog box to simulate memory access checking by specifying memory areas with different access types; see *Memory Access setup dialog box*, page 147.
Trace	Opens the Trace window which displays the recorded trace data; see *Trace window*, page 153.
Function Trace	Opens the Function Trace window which displays the trace data for function calls and function returns; see *Function Trace window*, page 155.
Breakpoint Usage	Displays the Breakpoint Usage dialog box which lists all active breakpoints; see *Breakpoint Usage dialog box*, page 163.

Table 17: Description of Simulator menu commands

Memory access checking

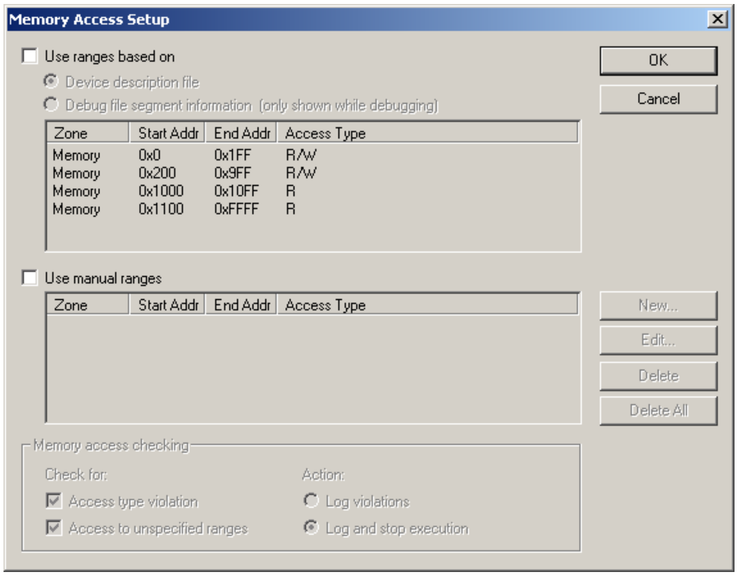
C-SPY can simulate various memory access types of the target hardware and detect illegal accesses, for example a read access to write-only memory. If a memory access occurs that does not agree with the access type specified for the specific memory area, C-SPY will regard this as an illegal access. The purpose of memory access checking is to help you to identify any memory access violations.

The memory areas can either be the zones predefined in the device description file, or memory areas based on the segment/section information available in the debug file. In addition to these, you can define your own memory areas. The access type can be read and write, read only, or write only. You cannot map two different access types to the same memory area. You can check for access type violation and accesses to unspecified ranges. Any violations are logged in the Debug Log window. You can also choose to have the execution halted.

Choose **Simulator>Memory Access Setup** to open the **Memory Access Setup** dialog box.

MEMORY ACCESS SETUP DIALOG BOX

The **Memory Access Setup** dialog box—available from the **Simulator** menu—lists all defined memory areas, where each column in the list specifies the properties of the area. In other words, the dialog box displays the memory access setup that will be used during the simulation.



Zone	Start Addr	End Addr	Access Type
Memory	0x0	0x1FF	R/W
Memory	0x200	0x9FF	R/W
Memory	0x1000	0x10FF	R
Memory	0x1100	0xFFFF	R

Figure 55: Memory Access Setup dialog box

Note: If you enable both the **Use ranges based on** and the **Use manual ranges** option, memory accesses are checked for all defined ranges.

For information about the columns and the properties displayed, see *Edit Memory Access dialog box*, page 149.

Use ranges based on

Use the **Use ranges based on** option to choose any of the predefined alternatives for the memory access setup. You can choose between:

- **Device description file**, which means the properties are loaded from the device description file
- **Debug file segment information**, which means the properties are based on the segment/section information available in the debug file. This information is only available while debugging. The advantage of using this option, is that the simulator can catch memory accesses outside the linked application.

Use manual ranges

Use the **Use manual ranges** option to specify your own ranges manually via the **Edit Memory Access** dialog box. To open this dialog box, choose **New** to specify a new memory range, or select a memory zone and choose **Edit** to modify it. For more details, see *Edit Memory Access dialog box*, page 149.

The ranges you define manually are saved between debug sessions.

Memory access checking

Use the **Check for** options to specify what to check for:

- Access type violation
- Access to unspecified ranges.

Use the **Action** options to specify the action to be performed if an access violation occurs. Choose between:

- Log violations
- Log and stop execution.

Any violations are logged in the Debug Log window.

Buttons

The **Memory Access Setup** dialog box contains these buttons:

Button	Description
OK	Standard OK.

Table 18: Function buttons in the Memory Access Setup dialog box

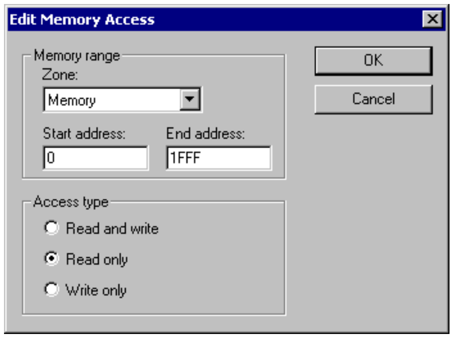
Button	Description
Cancel	Standard Cancel.
New	Opens the **Edit Memory Access** dialog box, where you can specify a new memory range and attach an access type to it; see *Edit Memory Access dialog box*, page 149.
Edit	Opens the **Edit Memory Access** dialog box, where you can edit the selected memory area. See *Edit Memory Access dialog box*, page 149.
Delete	Deletes the selected memory area definition.
Delete All	Deletes all defined memory area definitions.

Table 18: Function buttons in the Memory Access Setup dialog box (Continued)

Note: Except for the OK and Cancel buttons, buttons are only available when the option **Use manual ranges** is selected.

EDIT MEMORY ACCESS DIALOG BOX

In the **Edit Memory Access** dialog box—available from the **Memory Access Setup** dialog box—you can specify the memory ranges, and assign an access type to each memory range, for which you want to detect illegal accesses during the simulation.


Edit Memory Access

Memory range
Zone: Memory
Start address: 0
End address: 1FFF

Access type
Read and write [✓ Read only] Write only

Figure 56: Edit Memory Access dialog box

For each memory range you can define the following properties:

Memory range

Use these settings to define the memory area for which you want to check the memory accesses:

Zone	The memory zone; see *Memory addressing*, page 125.
Start address	The start address for the address range, in hexadecimal notation.
End address	The end address for the address range, in hexadecimal notation.

Access type

Use one of these options to assign an access type to the memory range; the access type can be one of **Read and write**, **Read only**, or **Write only**. You cannot assign two different access types to the same memory area.

Using the trace system in the simulator

This section gives you information about using the trace system. More specifically, these topics are covered:

- *Requirements for using the trace system*, page 150
- *Reasons for using the trace system*, page 150
- *Briefly about the trace system*, page 151
- *How to use the trace system*, page 151
- *Related reference information*, page 151.

REQUIREMENTS FOR USING THE TRACE SYSTEM

In the simulator there are no specific requirements for using the trace system.

REASONS FOR USING THE TRACE SYSTEM

By using the trace system, you can trace the program flow up to a specific state, for instance an application crash, and use the trace information to locate the origin of the problem. Trace information can be useful for locating programming errors that have irregular symptoms and occur sporadically. Trace information can also be useful as test documentation.

BRIEFLY ABOUT THE TRACE SYSTEM

In C-SPY, a *trace* is a recorded sequence of executed machine instructions. In addition, you can record the values of C-SPY expressions by selecting the expressions in the Trace Expressions window. The Function Trace window only shows trace data corresponding to calls to and returns from functions, whereas the Trace window displays all instructions.

HOW TO USE THE TRACE SYSTEM

Before you can use the trace system in the simulator, no specific build settings are required.

1 After you have built your application and started C-SPY, choose **View>Trace** to open the Trace window, and click the **Activate** button to enable trace logging.

2 Start the execution. When the execution stops, for instance because the program exit is reached or a breakpoint is triggered, trace data is displayed in the Trace window. For more information about the window, see *Trace window*, page 153.

For more information about using the generic features in the trace system, see *Using the trace system*, page 113.

Starting the trace system using breakpoints

A convenient way to trace instructions between two execution points is to start and stop the trace system using dedicated breakpoints. To set these breakpoints, you can either use the **Trace Start** and **Trace Stop** dialog boxes, or the system macros `__setTraceStartBreak` and `__setTraceStopBreak`.

RELATED REFERENCE INFORMATION

To use the trace system, you might need reference information about these windows and dialog boxes:

- *Trace Start breakpoints dialog box*, page 152
- *Trace Stop breakpoints dialog box*, page 152
- *Trace window*, page 153
- *Function Trace window*, page 155
- *Trace Expressions window*, page 156
- *Find In Trace window*, page 157
- *Find in Trace dialog box*, page 157.

TRACE START BREAKPOINTS DIALOG BOX

The options for setting trace start breakpoints are available from the context menu that appears when you right-click in the Breakpoints window. On the context menu, choose **New Breakpoint>Trace Start** to set a new breakpoint. Alternatively, to modify an existing breakpoint, select a breakpoint in the Breakpoints window and choose **Edit** on the context menu.

The **Trace Start** breakpoint dialog box appears.

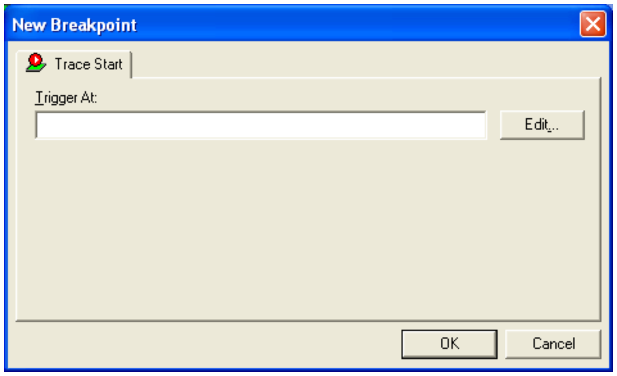


Figure 57: Trace Start breakpoints dialog box

When the breakpoint is triggered the trace system is started.

Trigger At

Specify the location for the breakpoint in the **Trigger At** text box. Alternatively, click the **Edit** browse button to open the **Enter Location** dialog box; see *Enter Location dialog box*, page 206.

TRACE STOP BREAKPOINTS DIALOG BOX

The options for setting trace stop breakpoints are available from the context menu that appears when you right-click in the Breakpoints window. On the context menu, choose **New Breakpoint>Trace Stop** to set a new breakpoint. Alternatively, to modify an existing breakpoint, select a breakpoint in the Breakpoints window and choose **Edit** on the context menu.

The **Trace Stop** breakpoint dialog box appears.

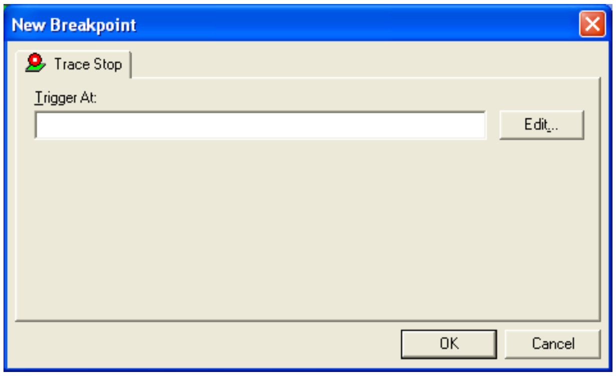


Figure 58: Trace Stop breakpoints dialog box

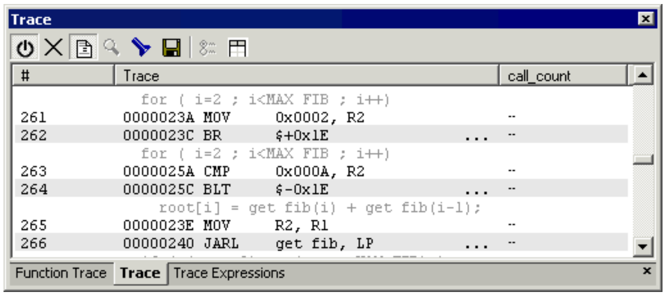
When the breakpoint is triggered the trace system is stopped.

Trigger At

Specify the location for the breakpoint in the **Trigger At** text box. Alternatively, click the **Edit** browse button to open the **Enter Location** dialog box; see *Enter Location dialog box*, page 206.

TRACE WINDOW

The Trace window—available from the **Simulator** menu—displays a recorded sequence of executed machine instructions. In addition, the window can display trace data for expressions.



```
#            Trace                                         call_count
               for ( i=2 ; i<MAX FIB ; i++)
261          0000023A MOV      0x0002, R2                  --
262          0000023C BR       $+0x1E                ...   --
               for ( i=2 ; i<MAX FIB ; i++)
263          0000025A CMP      0x000A, R2                  --
264          0000025C BLT      $-0x1E                ...   --
                 root[i] = get fib(i) + get fib(i-1);
265          0000023E MOV      R2, R1                      --
266          00000240 JARL     get fib, LP           ...   --
```

Figure 59: Trace window

C-SPY generates trace information based on the location of the program counter.

Trace toolbar

The Trace toolbar at the top of the Trace window and in the Function trace window provides these toolbar buttons:

Toolbar button	Description
Enable/Disable	Enables and disables tracing. This button is not available in the Function trace window.
Clear trace data	Clears the trace buffer. Both the Trace window and the Function trace window are cleared.
Toggle Source	Toggles the Trace column between showing only disassembly or disassembly together with corresponding source code.
Browse	Toggles browse mode on and off for a selected item in the Trace window. For more information about browse mode, see *The Trace window and its browse mode*, page 113.
Find	Opens the **Find In Trace** dialog box where you can perform a search; see *Find in Trace dialog box*, page 157.
Save	Opens a standard **Save As** dialog box where you can save the recorded trace information to a text file, with tab-separated columns.
Edit Settings	This button is not enabled in the C-SPY Simulator.
Edit Expressions	Opens the Trace Expressions window; see *Trace Expressions window*, page 156.

Table 19: Trace toolbar buttons

Trace display area

The display area displays trace information in these columns:

Trace window column	Description
#	A serial number for each row in the trace buffer. Simplifies the navigation within the buffer.
Trace	The recorded sequence of executed machine instructions. Optionally, the corresponding source code can also be displayed.

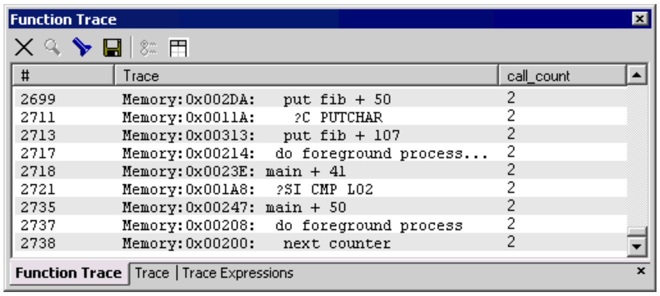
Table 20: Trace window columns

Trace window column	Description
Expression	Each expression you have defined to be displayed appears in a separate column. Each entry in the expression column displays the value *after* executing the instruction on the same row. You specify the expressions for which you want to record trace information in the Trace Expressions window; see *Trace Expressions window*, page 156.

Table 20: Trace window columns (Continued)

FUNCTION TRACE WINDOW

The Function Trace window—available from the **Simulator** menu—displays a subset of the trace data displayed in the Trace window. Instead of displaying all rows, the Function Trace window only shows trace data corresponding to calls to and returns from functions.



#	Trace	call_count
2699	Memory:0x002DA: put fib + 50	2
2711	Memory:0x0011A: ?C PUTCHAR	2
2713	Memory:0x00313: put fib + 107	2
2717	Memory:0x00214: do foreground process...	2
2718	Memory:0x0023E: main + 41	2
2721	Memory:0x001A8: ?SI CMP L02	2
2735	Memory:0x00247: main + 50	2
2737	Memory:0x00208: do foreground process	2
2738	Memory:0x00200: next counter	2

Figure 60: Function Trace window

Toolbar

For information about the toolbar, see *Trace toolbar*, page 154.

The display area

For information about the columns in the display area, see *Trace display area*, page 154.

TRACE EXPRESSIONS WINDOW

In the Trace Expressions window—available from the Trace window toolbar—you can specify specific expressions for which you want to record trace information.

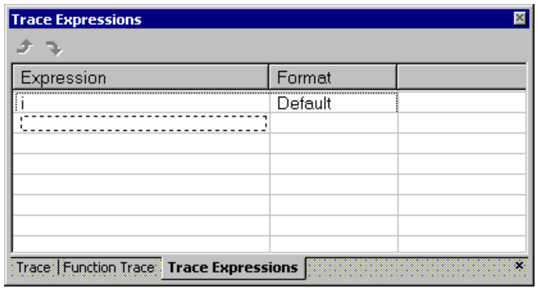


Figure 61: Trace Expressions window

Toolbar

Use the toolbar buttons to change the order between the expressions:

Toolbar button	**Description**
Arrow up	Moves the selected row up.
Arrow down	Moves the selected row down.

Table 21: Toolbar buttons in the Trace Expressions window

Display area

In the display area you can specify expressions for which you want to record trace information:

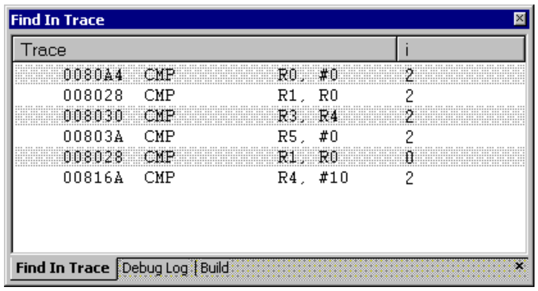
Column	**Description**
Expression	Specify any expression that you want to be recorded. You can specify any expression that can be evaluated, such as variables and registers.
Format	Shows which display format that is used for each expression.

Table 22: Trace Expressions window columns

Each row in this window will appear as an extra column in the Trace window.

FIND IN TRACE WINDOW

The Find In Trace window—available from the **View>Messages** menu—displays the result of searches in the trace data.



```
Trace                                        i
    0080A4  CMP          R0, #0      2
    008028  CMP          R1, R0      2
    008030  CMP          R3, R4      2
    00803A  CMP          R5, #0      2
    008028  CMP          R1, R0      0
    00816A  CMP          R4, #10     2
```

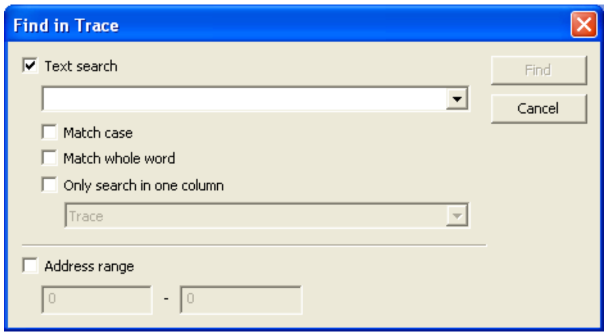
Figure 62: Find In Trace window

The Find in Trace window looks like the Trace window and shows the same columns and data, but *only* those rows that match the specified search criteria. Double-click an item in the Find in Trace window to bring up the same item in the Trace window.

You specify the search criteria in the **Find In Trace** dialog box. For information about how to open this dialog box, see *Find in Trace dialog box*, page 157.

FIND IN TRACE DIALOG BOX

Use the **Find in Trace** dialog box—available by choosing **Edit>Find and Replace>Find** or from the Trace window toolbar—to specify the search criteria for advanced searches in the trace data. Note that the **Edit>Find and Replace>Find** command is context-dependent. It displays the **Find in Trace** dialog box if the Trace window is the current window or the **Find** dialog box if the editor window is the current window.



☑ Text search

☐ Match case

☐ Match whole word

☐ Only search in one column

Trace

☐ Address range

0 - 0

Figure 63: Find in Trace dialog box

The search results are displayed in the Find In Trace window—available by choosing the **View>Messages** command, see *Find In Trace window*, page 157.

In the **Find in Trace** dialog box, you specify the search criteria with the following settings.

Text search

A text field where you type the string you want to search for. Use these options to fine-tune the search:

Match Case	Searches only for occurrences that exactly match the case of the specified text. Otherwise specifying `int` will also find `INT` and `Int`.
Match whole word	Searches only for the string when it occurs as a separate word. Otherwise `int` will also find `print`, `sprintf` and so on.
Only search in one column	Searches only in the column you selected from the drop-down list.

Address Range

Use the text fields to specify an address range. The trace data within the address range is displayed. If you also have specified a text string in the **Text search** field, the text string is searched for within the address range.

Using breakpoints in the simulator

Using the C-SPY Simulator, you can set an unlimited amount of breakpoints. For code and data breakpoints you can define a size attribute, that is, you can set the breakpoint on a range. You can also set immediate breakpoints.

For information about the breakpoint system, see the chapter *Using breakpoints*. For detailed information about code breakpoints, see *Code breakpoints dialog box*, page 202.

DATA BREAKPOINTS

Data breakpoints are triggered when data is accessed at the specified location. Data breakpoints are primarily useful for variables that have a fixed address in memory. If you set a breakpoint on an accessible local variable, the breakpoint is set on the corresponding memory location. The validity of this location is only guaranteed for small parts of the code. The execution will usually stop directly after the instruction that accessed the data has been executed.

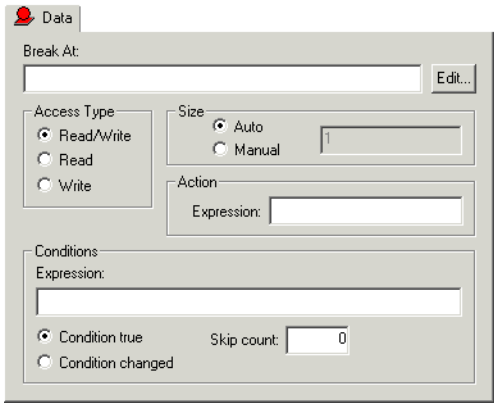
You can set a data breakpoint in various ways, using:

- A dialog box, see *Data breakpoints dialog box*, page 159
- A system macro, see *__setDataBreak*, page 399
- The Memory window, see *Setting a data breakpoint in the Memory window*, page 120
- The editor window, see *Editor window*, page 192.

DATA BREAKPOINTS DIALOG BOX

The options for setting data breakpoints are available from the context menu that appears when you right-click in the Breakpoints window. On the context menu, choose **New Breakpoint>Data** to set a new breakpoint. Alternatively, to modify an existing breakpoint, select a breakpoint in the Breakpoint window and choose **Edit** on the context menu.

The **Data** breakpoints dialog box appears.



Access Type: [✓ Read/Write] Read Write

Size: [✓ Auto] Manual 1

Conditions: [✓ Condition true] Condition changed

Skip count: 0

Figure 64: Data breakpoints dialog box

Break At

Specify the location for the breakpoint in the **Break At** text box. Alternatively, click the **Edit** browse button to open the **Enter Location** dialog box; see *Enter Location dialog box*, page 206.

Access Type

Use the options in the **Access Type** area to specify the type of memory access that triggers data or immediate breakpoints.

Memory Access type	Description
Read/Write	Read or write from location.
Read	Read from location.
Write	Write to location.

Table 23: Memory Access types for data breakpoints

Note: Data breakpoints never stop execution within a single instruction. They are recorded and reported after the instruction is executed. (Immediate breakpoints do not stop execution at all, they only suspend it temporarily. See *Immediate breakpoints*, page 161.)

Size

Optionally, you can specify a size—in practice, a *range* of locations. Each read and write access to the specified memory range will trigger the breakpoint. For data breakpoints, this can be useful if you want the breakpoint to be triggered on accesses to data structures, such as arrays, structs, and unions.

There are two different ways to specify the size:

- **Auto**, the size will automatically be based on the type of expression the breakpoint is set on. For example, if you set the breakpoint on a 12-byte structure, the size of the breakpoint will be 12 bytes
- **Manual**, you specify the size of the breakpoint manually in the **Size** text box.

Action

You can optionally connect an action to a breakpoint. You specify an expression, for instance a C-SPY macro function, which is evaluated when the breakpoint is triggered and the condition is true.

Conditions

You can specify simple and complex conditions.

Conditions	Description
Expression	A valid expression conforming to the C-SPY expression syntax.
Condition true	The breakpoint is triggered if the value of the expression is true.
Condition changed	The breakpoint is triggered if the value of the expression has changed since it was last evaluated.
Skip count	The number of times that the breakpoint must be fulfilled before a break occurs (integer).

Table 24: Data breakpoint conditions

IMMEDIATE BREAKPOINTS

In addition to generic breakpoints, the C-SPY Simulator lets you set *immediate* breakpoints, which will halt instruction execution only temporarily. This allows a C-SPY macro function to be called when the processor is about to read data from a location or immediately after it has written data. Instruction execution will resume after the action.

This type of breakpoint is useful for simulating memory-mapped devices of various kinds (for instance serial ports and timers). When the processor reads at a memory-mapped location, a C-SPY macro function can intervene and supply appropriate data. Conversely, when the processor writes to a memory-mapped location, a C-SPY macro function can act on the value that was written.

The two different methods of setting an immediate breakpoint are by using:

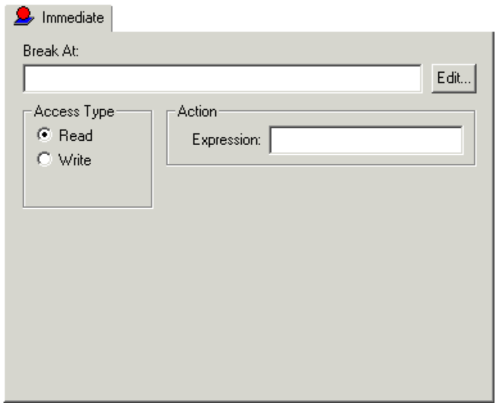
- A dialog box, see *Immediate breakpoints dialog box*, page 162

- A system macro, see *__setSimBreak*, page 401.

IMMEDIATE BREAKPOINTS DIALOG BOX

The options for setting immediate breakpoints are available from the context menu that appears when you right-click in the Breakpoints window. On the context menu, choose **New Breakpoint>Immediate** to set a new breakpoint. Alternatively, to modify an existing breakpoint, select a breakpoint in the Breakpoint window and choose **Edit** on the context menu.

The **Immediate** breakpoints dialog box appears.



Access Type: Read [✓]

Figure 65: Immediate breakpoints page

Break At

Specify the location for the breakpoint in the **Break At** text box. Alternatively, click the **Edit** browse button to open the **Enter Location** dialog box; see *Enter Location dialog box*, page 206.

Access Type

Use the options in the **Access Type** area to specify the type of memory access that triggers data or immediate breakpoints.

Memory Access type	Description
Read	Read from location.
Write	Write to location.

Table 25: Memory Access types for immediate breakpoints

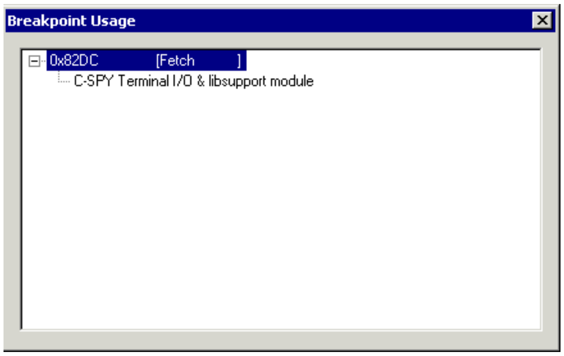
Note: Immediate breakpoints do not stop execution at all; they only suspend it temporarily. See *Using breakpoints in the simulator*, page 159.

Action

You should connect an action to the breakpoint. Specify an expression, for instance a C-SPY macro function, which is evaluated when the breakpoint is triggered and the condition is true.

BREAKPOINT USAGE DIALOG BOX

The **Breakpoint Usage** dialog box—available from the **Simulator** menu—lists all active breakpoints.



```
0x82DC        [Fetch      ]
  C-SPY Terminal I/O & libsupport module
```

Figure 66: Breakpoint Usage dialog box

In addition to listing all breakpoints that you have defined, this dialog box also lists the internal breakpoints that the debugger is using.

For each breakpoint in the list the address and access type are shown. Each breakpoint in the list can also be expanded to show its originator.

For more information, see *Viewing all breakpoints*, page 122.

Simulating interrupts

By being able to simulate interrupts, you can debug the program logic long before any hardware is available. This chapter contains detailed information about the C-SPY® interrupt simulation system and how to configure the simulated interrupts to make them reflect the interrupts of your target hardware. Finally, reference information about each interrupt system macro is provided.

For information about the interrupt-specific facilities useful when writing interrupt service routines, see the compiler documentation.

The C-SPY interrupt simulation system

The C-SPY Simulator includes an interrupt simulation system that allows you to simulate the execution of interrupts during debugging. You can configure the interrupt simulation system so that it resembles your hardware interrupt system. If you use simulated interrupts in conjunction with C-SPY macros and breakpoints, you can compose a complex simulation of, for instance, interrupt-driven peripheral devices. Simulated interrupts also let you test the logic of your interrupt service routines.

The interrupt system has the following features:

- Simulated interrupt support for the microcontroller
- Single-occasion or periodical interrupts based on the cycle counter
- Predefined interrupts for various devices
- Configuration of hold time, probability, and timing variation
- State information for locating timing problems
- Two interfaces for configuring the simulated interrupts—a dialog box and a C-SPY system macro—that is, one interactive and one automating interface
- Activation of interrupts either instantly or based on parameters you define
- A log window which continuously displays the status for each defined interrupt.

The interrupt system is activated, by default, but if it is not required you can turn it off to speed up the simulation. You can turn the interrupt system on or off as required either in the **Interrupt Setup** dialog box, or using a system macro. Defined interrupts will be preserved until you remove them. All interrupts you define using the **Interrupt Setup** dialog box are preserved between debug sessions.

INTERRUPT CHARACTERISTICS

The simulated interrupts consist of a set of characteristics which lets you fine-tune each interrupt to make it resemble the real interrupt on your target hardware. You can specify a *first activation time*, a *repeat interval*, a *hold time*, and a *variance*.

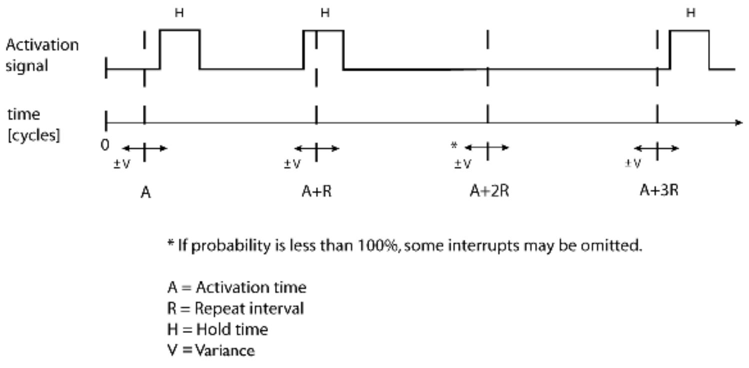


Figure 67: Simulated interrupt configuration

The interrupt simulation system uses the cycle counter as a clock to determine when an interrupt should be raised in the simulator. You specify the *first activation time*, which is based on the cycle counter. C-SPY will generate an interrupt when the cycle counter has passed the specified activation time. However, interrupts can only be raised between instructions, which means that a full assembler instruction must have been executed before the interrupt is generated, regardless of how many cycles an instruction takes.

To define the periodicity of the interrupt generation you can specify the *repeat interval* which defines the amount of cycles after which a new interrupt should be generated. In addition to the repeat interval, the periodicity depends on the two options *probability*—the probability, in percent, that the interrupt will actually appear in a period—and *variance*—a time variation range as a percentage of the repeat interval. These options make it possible to randomize the interrupt simulation. You can also specify a *hold time* which describes how long the interrupt remains pending until removed if it has not been processed. If the hold time is set to *infinite*, the corresponding pending bit will be set until the interrupt is acknowledged or removed.

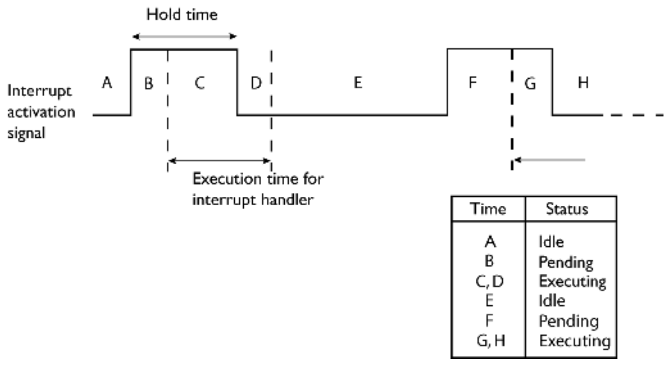
INTERRUPT SIMULATION STATES

The interrupt simulation system contains status information that you can use for locating timing problems in your application. The **Interrupt Setup** dialog box displays the available status information. For an interrupt, these statuses can be displayed: *Idle*, *Pending*, *Executing*, *Executed*, *Removed*, or *Expired*.

Status	Description
Idle	Interrupt activation signal is low (deactivated).
Pending	Interrupt activation signal is active, but the interrupt has not been acknowledged yet by the interrupt handler.
Executing	The interrupt is currently being serviced, that is the interrupt handler function is executing.
Executed	This is a single-occasion interrupt and it has been serviced.
Removed	The interrupt has been removed by the user, but because the interrupt is currently executing it is visible in the **Interrupt Setup** dialog box until it is finished.
Expired	This is a single-occasion interrupt which was not serviced while the interrupt activation signal was active.

Table 26: Interrupt statuses

For a repeatable interrupt that has a specified repeat interval which is longer than the execution time, the status information at different times can look like this:

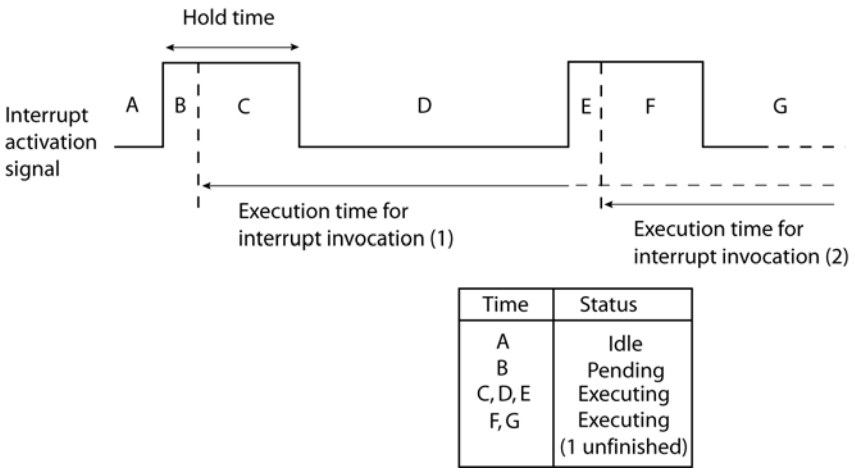

Hold time
Interrupt activation signal
A
B
C
D
E
F
G
H
Execution time for interrupt handler

Time	Status
A	Idle
B	Pending
C, D	Executing
E	Idle
F	Pending
G, H	Executing

Figure 68: Simulation states - example 1

Note: The interrupt activation signal—also known as the pending bit—is automatically deactivated the moment the interrupt is acknowledged by the interrupt handler.

If the interrupt repeat interval is shorter than the execution time, and the interrupt is re-entrant (or non-maskable), the status information at different times can look like this:


Hold time
Interrupt activation signal
A
B
C
D
E
F
G
Execution time for interrupt invocation (1)
Execution time for interrupt invocation (2)

Time	Status
A	Idle
B	Pending
C, D, E	Executing
F, G	Executing (1 unfinished)

Figure 69: Simulation states - example 2

In this case, the execution time of the interrupt handler is too long compared to the repeat interval, which might indicate that you should rewrite your interrupt handler and make it faster, or that you should specify a longer repeat interval for the interrupt simulation system.

Using the interrupt simulation system

The interrupt simulation system is easy to use. However, to take full advantage of the interrupt simulation system you should be familiar with how to adapt it for the processor you are using, and know how to use:

- The Forced Interrupt window
- The **Interrupts** and **Interrupt Setup** dialog boxes
- The C-SPY system macros for interrupts
- The Interrupt Log window.

TARGET-ADAPTING THE INTERRUPT SIMULATION SYSTEM

The interrupt simulation has the same behavior as the hardware. This means that the execution of an interrupt is dependent on the status of the global interrupt enable bit. The execution of maskable interrupts is also dependent on the status of the individual interrupt enable bits.

To be able to perform these actions for various derivatives, the interrupt system must have detailed information about each available interrupt. Except for default settings, this information is provided in the device description files. You can find preconfigured `ddf` files in the *`cpuname`*`\config` directory. The default settings are used if no device description file has been specified.

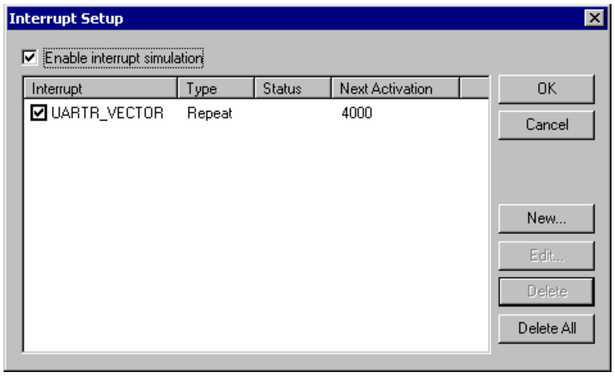
1 To load a device description file before you start C-SPY, choose **Project>Options** and click the **Setup** tab of the **Debugger** category.

2 Choose a device description file that suits your target.

Note: In case you do not find a preconfigured device description file that resembles your device, you can define one according to your needs. For details of device description files, see *Selecting a device description file*, page 97.

INTERRUPT SETUP DIALOG BOX

The **Interrupt Setup** dialog box—available by choosing **Simulator>Interrupt Setup**—lists all defined interrupts.



Interrupt	Type	Status	Next Activation
☑ UARTR_VECTOR	Repeat		4000

Figure 70: Interrupt Setup dialog box

The option **Enable interrupt simulation** enables or disables interrupt simulation. If the interrupt simulation is disabled, the definitions remain but no interrupts are generated. You can also enable and disable installed interrupts individually by using the check box to the left of the interrupt name in the list of installed interrupts.

The columns contain this information:

Interrupt	Lists all interrupts.
Type	Shows the type of the interrupt. The type can be **Forced**, **Single**, or **Repeat**.

Status	Shows the status of the interrupt. The status can be **Idle**, **Removed**, **Pending**, **Executing**, or **Expired**.
Next Activation	Shows the next activation time in cycles.

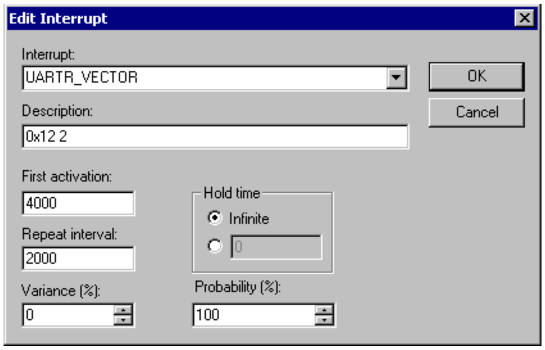
Note: For repeatable interrupts there might be additional information in the **Type** column about how many interrupts of the same type that is simultaneously executing (`n executing`). If *n* is larger than one, there is a reentrant interrupt in your interrupt simulation system that never finishes executing, which might indicate that there is a problem in your application.

You can only edit or remove non-forced interrupts.

Click **New** or **Edit** to open the **Edit Interrupt** dialog box.

EDIT INTERRUPT DIALOG BOX

Use the **Edit Interrupt** dialog box—available from the **Interrupt Setup** dialog box—to add and modify interrupts. This dialog box provides you with a graphical interface where you can interactively fine-tune the interrupt simulation parameters. You can add the parameters and quickly test that the interrupt is generated according to your needs.



Interrupt: UARTR_VECTOR
Description: 0x12 2
First activation: 4000
Repeat interval: 2000
Variance (%): 0
Hold time: [✓ Infinite] 0
Probability (%): 100

Figure 71: Edit Interrupt dialog box

For each interrupt you can set these options:

Interrupt	A drop-down list containing all available interrupts. Your selection will automatically update the **Description** box. The list is populated with entries from the device description file that you have selected.

Description	Contains the description of the selected interrupt, if available. The description is retrieved from the selected device description file. For interrupts specified using the system macro `__orderInterrupt`, the **Description** box is empty.
First activation	The value of the cycle counter after which the specified type of interrupt will be generated.
Repeat interval	The periodicity of the interrupt in cycles.
Variance %	A timing variation range, as a percentage of the repeat interval, in which the interrupt might occur for a period. For example, if the repeat interval is 100 and the variance 5%, the interrupt might occur anywhere between T=95 and T=105, to simulate a variation in the timing.
Hold time	Describes how long, in cycles, the interrupt remains pending until removed if it has not been processed. If you select **Infinite**, the corresponding pending bit will be set until the interrupt is acknowledged or removed.
Probability %	The probability, in percent, that the interrupt will actually occur within the specified period.

FORCED INTERRUPT WINDOW

From the **Forced Interrupt** window—available from the **Simulator** menu—you can force an interrupt instantly. This is useful when you want to check your interrupt logistics and interrupt routines.

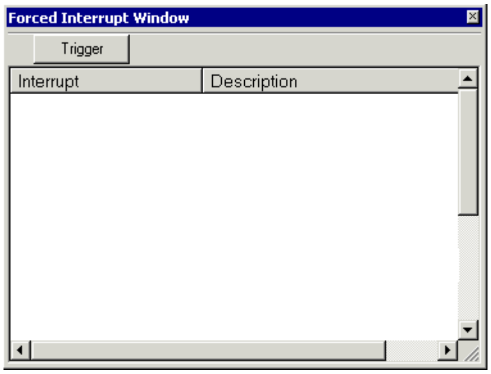


Figure 72: Forced Interrupt window

To force an interrupt, the interrupt simulation system must be enabled. To enable the interrupt simulation system, see *Interrupt Setup dialog box*, page 169.

The Forced Interrupt window lists all available interrupts and their definitions. The description field is editable and the information is retrieved from the selected device description file. See this file for a detailed description.

If you select an interrupt and click the **Trigger** button, an interrupt of the selected type is generated.

A triggered interrupt will have these characteristics:

Characteristics	Settings
First Activation	As soon as possible (0)
Repeat interval	0
Hold time	Infinite
Variance	0%
Probability	100%

Table 27: Characteristics of a forced interrupt

C-SPY SYSTEM MACROS FOR INTERRUPTS

Macros are useful when you already have sorted out the details of the simulated interrupt so that it fully meets your requirements. If you write a macro function containing definitions for the simulated interrupts, you can execute the functions automatically when C-SPY starts. Another advantage is that your simulated interrupt definitions will be documented if you use macro files, and if you are several engineers involved in the development project you can share the macro files within the group.

The C-SPY Simulator provides a set of predefined system macros for the interrupt simulation system. The advantage of using the system macros for specifying the simulated interrupts is that it lets you automate the procedure.

These are the available system macros related to interrupts:

`__enableInterrupts`

`__disableInterrupts`

`__orderInterrupt`

`__cancelInterrupt`

`__cancelAllInterrupts`

`__popSimulatorInterruptExecutingStack`

The parameters of the first five macros correspond to the equivalent entries of the **Interrupts** dialog box. To read more about how to use the `__popSimulatorInterruptExecutingStack` macro, see *Interrupt simulation in a multi-task system*, page 173.

For detailed reference information about each macro, see *Description of C-SPY system macros*, page 387.

Defining simulated interrupts at C-SPY startup using a setup file

If you want to use a setup file to define simulated interrupts at C-SPY startup, follow the procedure described in *Registering and executing using setup macros and setup files*, page 133.

Interrupt simulation in a multi-task system

If you are using interrupts in such a way that the normal instruction used for returning from an interrupt handler is not used, for example in an operating system with task-switching, the simulator cannot automatically detect that the interrupt has finished executing. The interrupt simulation system will work correctly, but the status information in the **Interrupt Setup** dialog box might not look as you expect. If too many interrupts are executing simultaneously, a warning might be issued.

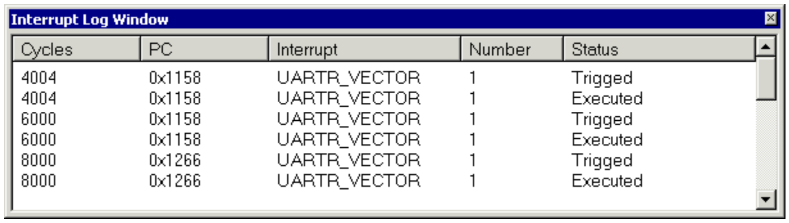
To avoid these problems, you can use the `__popSimulatorInterruptExecutingStack` macro to inform the interrupt simulation system that the interrupt handler has finished executing, as if the normal instruction used for returning from an interrupt handler was executed. You can use this procedure:

1. Set a code breakpoint on the instruction that returns from the interrupt function.
2. Specify the `__popSimulatorInterruptExecutingStack` macro as a condition to the breakpoint.

When the breakpoint is triggered, the macro is executed and then the application continues to execute automatically.

INTERRUPT LOG WINDOW

The **Interrupt Log** window—available from the **Simulator** menu—displays runtime information about the interrupts that you have activated in the **Interrupts** dialog box or forced via the **Forced Interrupt** window. The information is useful for debugging the interrupt handling in the target system.



Cycles	PC	Interrupt	Number	Status
4004	0x1158	UARTR_VECTOR	1	Trigged
4004	0x1158	UARTR_VECTOR	1	Executed
6000	0x1158	UARTR_VECTOR	1	Trigged
6000	0x1158	UARTR_VECTOR	1	Executed
8000	0x1266	UARTR_VECTOR	1	Trigged
8000	0x1266	UARTR_VECTOR	1	Executed

Figure 73: Interrupt Log window

The columns contain this information:

Column	Description
Cycles	The point in time, measured in cycles, when the event occurred.
PC	The value of the program counter when the event occurred.
Interrupt	The interrupt as defined in the device description file.
Number	A unique number assigned to the interrupt. The number is used for distinguishing between different interrupts of the same type.
Status	Shows the status of the interrupt: Triggered, Forced, Executing, Finished, or Expired. • Triggered: The interrupt has passed its activation time. • Forced: The same as Triggered, but the interrupt has been forced from the Forced Interrupt window. • Executing: The interrupt is currently executing. • Finished: The interrupt has been executed. • Expired: The interrupt hold time has expired without the interrupt being executed.

Table 28: Description of the Interrupt Log window

When the Interrupt Log window is open it is updated continuously during runtime.

Note: If the window becomes full of entries, the first entries are erased.

Simulating a simple interrupt

This example demonstrates the method for simulating a timer interrupt. However, the procedure can also be used for other types of interrupts.

This simple application contains an interrupt service routine for a timer, which increments a tick variable. The main function sets the necessary status registers. The application exits when 100 interrupts have been generated.

```
#include "iocpuname.h"
#include <intrinsics.h>

volatile int ticks = 0;
void main (void)
{
 /* Add your timer setup code here */

 __enable_interrupt();        /* Enable interrupts */

 while (ticks < 100);         /* Endless loop */
 printf("Done\n");
}

/* Timer interrupt service routine */
#pragma vector = TIMER_VECTOR
__interrupt void basic_timer(void)
{
 ticks += 1;
}
```

To simulate and debug an interrupt, follow these steps:

1. Add your interrupt service routine to your application source code and add the file to your project.
2. C-SPY needs information about the interrupt to be able to simulate it. This information is provided in the device description files. To select a device description file, choose **Project>Options**, and click the **Setup** tab in the **Debugger** category. Use the **Use device description file** browse button to locate the file `ddf` file.
3. Build your project and start the simulator.

4 Choose **Simulator>Interrupt Setup** to open the **Interrupts Setup** dialog box. Select the **Enable interrupt simulation** option to enable interrupt simulation. Click **New** to open the **Edit Interrupt** dialog box. The following table lists the options and suggests some settings. For your interrupt, verify the options according to your requirements:

Option	Settings
Interrupt	TIMER_VECTOR
First Activation	4000
Repeat interval	2000
Hold time	0
Probability (%)	100
Variance (%)	0

Table 29: Timer interrupt settings

Click **OK**.

5 Execute your application. If you have enabled the interrupt properly in your application source code, C-SPY will:

- Generate an interrupt when the cycle counter has passed 4000
- Continuously repeat the interrupt after approximately 2000 cycles.

To watch the interrupt in action, open the Interrupt Log window by choosing **Simulator>Interrupt Log**.

Part 5. Reference information

This part of the IAR Embedded Workbench IDE User Guide contains the following chapters:

IAR Embedded Workbench IDE reference

This chapter contains reference information about the windows, menus, menu commands, and the corresponding components that are found in the IDE. For information about how to best use the IDE for your purposes, see parts 2 to 4 in this guide. This chapter contains the following sections:

- *Windows*, page 179
- *Menus*, page 211.

The IDE is a modular application. Which menus are available depends on which components are installed.

Windows

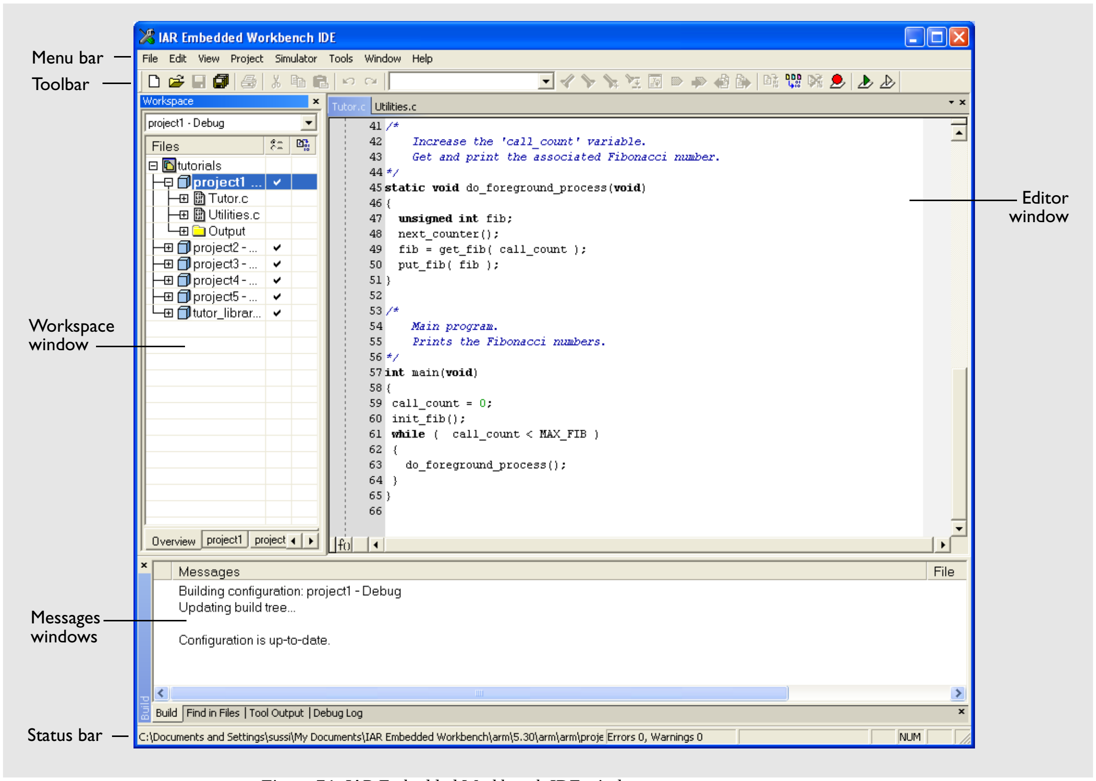
The available windows are:

- IAR Embedded Workbench IDE window
- Workspace window
- Editor window
- Source Browser window
- Breakpoints window
- Message windows.

In addition, a set of C-SPY®-specific windows becomes available when you start the debugger. For reference information about these windows, see the chapter *C-SPY reference* in this guide.

IAR EMBEDDED WORKBENCH IDE WINDOW

The figure shows the main window of the IDE and its various components. The window might look different depending on which plugin modules you are using.



```
/*
   Increase the 'call_count' variable.
   Get and print the associated Fibonacci number.
*/
static void do_foreground_process(void)
{
  unsigned int fib;
  next_counter();
  fib = get_fib( call_count );
  put_fib( fib );
}

/*
   Main program.
   Prints the Fibonacci numbers.
*/
int main(void)
{
 call_count = 0;
 init_fib();
 while (  call_count < MAX_FIB )
 {
   do_foreground_process();
 }
}
```

```
Building configuration: project1 - Debug
Updating build tree...

Configuration is up-to-date.
```

```
C:\Documents and Settings\sussi\My Documents\IAR Embedded Workbench\arm\5.30\arm\arm\proje Errors 0, Warnings 0 NUM
```

Figure 74: IAR Embedded Workbench IDE window

Each window item is explained in greater detail in the following sections.

Menu bar

Gives access to the IDE menus.

Menu	Description
File	The File menu provides commands for opening source and project files, saving and printing, and exiting from the IDE.
Edit	The Edit menu provides commands for editing and searching in editor windows and for enabling and disabling breakpoints in C-SPY.

Table 30: IDE menu bar

Menu	Description
View	Use the commands on the View menu to open windows and decide which toolbars to display.
Project	The Project menu provides commands for adding files to a project, creating groups, and running the IAR Systems tools on the current project.
Tools	The Tools menu is a user-configurable menu to which you can add tools for use with the IDE.
Window	With the commands on the Window menu you can manipulate the IDE windows and change their arrangement on the screen.
Help	The commands on the Help menu provide help about the IDE.

Table 30: IDE menu bar (Continued)

For reference information for each menu, see *Menus*, page 211.

Toolbar

The IDE toolbar—available from the **View** menu—provides buttons for the most useful commands on the IDE menus, and a text box for typing a string to do a quick search.

For a description of any button, point to it with the mouse button. When a command is not available, the corresponding toolbar button is dimmed, and you will not be able to click it.

This figure shows the menu commands corresponding to each of the toolbar buttons:

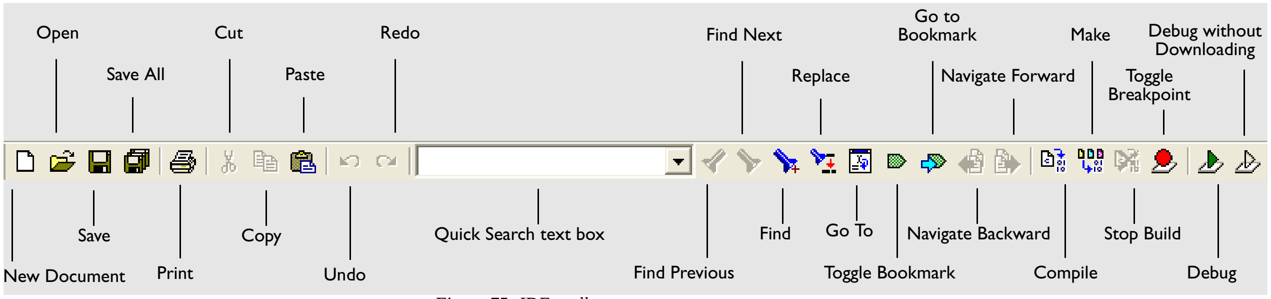


Figure 75: IDE toolbar

Note: When you start C-SPY, the **Download and Debug** button will change to a **Make and Debug** button and the **Debug without Downloading** will change to a **Restart Debugger** button.

Status bar

The Status bar at the bottom of the window displays the number of errors and warnings generated during a build, the position of the insertion point in the editor window, and the state of the modifier keys. The Status bar is available from the **View** menu.

As you are editing, the status bar shows the current line and column number containing the insertion point, and the Caps Lock, Num Lock, and Overwrite status.

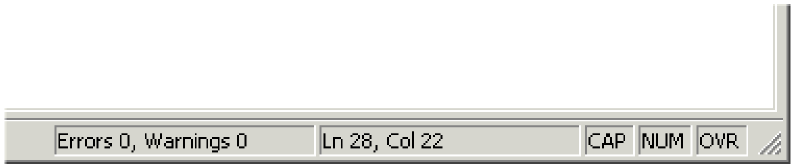


Figure 76: IAR Embedded Workbench IDE window status bar

WORKSPACE WINDOW

The Workspace window, available from the **View** menu, is where you can access your projects and files during the application development.

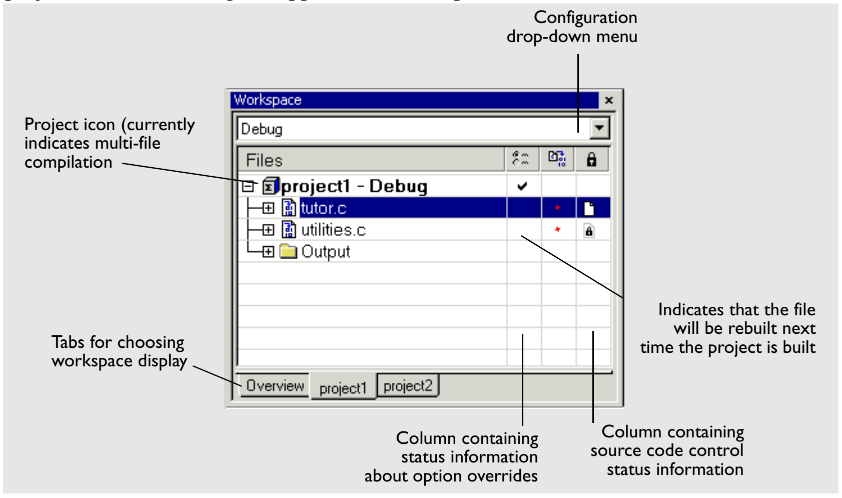

Configuration drop-down menu
Workspace
Debug
Files
project1 - Debug
tutor.c
utilities.c
Output
Project icon (currently indicates multi-file compilation
Tabs for choosing workspace display
Overview
project1
project2
Indicates that the file will be rebuilt next time the project is built
Column containing status information about option overrides
Column containing source code control status information

Figure 77: Workspace window

Toolbar

At the top of the window there is a drop-down list where you can choose a build configuration to display in the window for a specific project.

The display area

The display area is divided into different columns.

The **Files** column displays the name of the current workspace and a tree representation of the projects, groups and files included in the workspace. One or more of these icons are displayed:

Workspace

Project

Project with multi-file compilation

Group of files

Group excluded from the build

Group of files, part of multi-file compilation

Group of files, part of multi-file compilation, but excluded from the build

Object file or library

Assembler source file

C source file

C++ source file

Source file excluded from the build

Header file

Text file

HTML text file

Control file, for example the linker configuration file

IDE internal file

Other file

The column that contains status information about option overrides can have one of three icons for each level in the project:

Blank	There are no settings/overrides for this file/group
Black check mark	There are local settings/overrides for this file/group

Red check mark	There are local settings/overrides for this file/group, but they are either identical to the inherited settings or they are ignored because you use of multi-file compilation, which means that the overrides are not needed.

The column that contains build status information can have one of three icons for each file in the project:

Blank	The file will not be rebuilt next time the project is built
Red star	The file will be rebuilt next time the project is built
Gearwheel	The file is being rebuilt.

For details about the various source code control icons, see *Source code control states*, page 188.

At the bottom of the window you can choose which project to display. Alternatively, you can choose to display an overview of the entire workspace.

For more information about project management and using the Workspace window, see the chapter *Managing projects* in *Part 3. Debugging* in this guide.

Workspace window context menu

Clicking the right mouse button in the Workspace window displays a context menu which gives you convenient access to several commands.

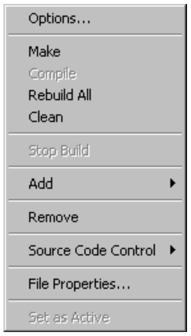


Figure 78: Workspace window context menu

These commands are available on the context menu:

Menu command	Description
Options	Displays a dialog box where you can set options for each build tool on the selected item in the Workspace window. You can set options on the entire project, on a group of files, or on an individual file.
Make	Brings the current target up to date by compiling, assembling, and linking only the files that have changed since the last build.
Compile	Compiles or assembles the currently active file as appropriate. You can choose the file either by selecting it in the Workspace window, or by selecting the editor window containing the file you want to compile.
Rebuild All	Recompiles and relinks all files in the selected build configuration.
Clean	Deletes intermediate files.
Stop Build	Stops the current build operation.
Add>Add Files	Opens a dialog box where you can add files to the project.
Add>Add "*filename*"	Adds the indicated file to the project. This command is only available if there is an open file in the editor.
Add>Add Group	Opens a dialog box where you can add new groups to the project.
Remove	Removes selected items from the Workspace window.
Rename	Opens the **Rename Group** dialog box where you can rename a group. For more information about groups, see *Groups*, page 62.
Source Code Control	Opens a submenu with commands for source code control, see *Source Code Control menu*, page 186.
File Properties	Opens a standard **File Properties** dialog box for the selected file.
Set as Active	Sets the selected project in the overview display to be the active project. It is the active project that will be built when the **Make** command is executed.

Table 31: Workspace window context menu commands

Rename Group dialog box

The **Select Source Code Control Provider** dialog box is displayed if several SCC systems from different vendors are available. Use this dialog box to choose the SCC system you want to use.

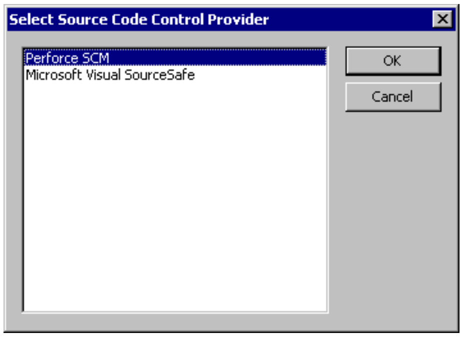

Select Source Code Control Provider
Perforce SCM
Microsoft Visual SourceSafe
OK
Cancel

Figure 79: Select Source Code Control Provider dialog box

Source Code Control menu

The **Source Code Control** menu is available from the **Project** menu and from the context menu in the Workspace window. This menu contains some of the most commonly used commands of external, third-party source code control systems.

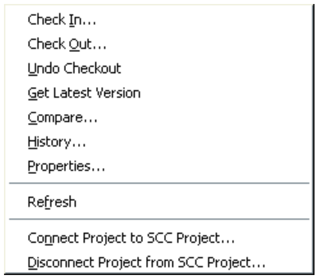


Figure 80: Source Code Control menu

For more information about interacting with an external source code control system, see *Source code control*, page 67.

These commands are available on the submenu:

Menu command	Description
Check In	Opens the **Check In Files** dialog box where you can check in the selected files; see *Check In Files dialog box*, page 189. Any changes you have made in the files will be stored in the archive. This command is enabled when currently checked-out files are selected in the Workspace window.
Check Out	Checks out the selected file or files. Depending on the SCC system you are using, a dialog box might appear; see *Check Out Files dialog box*, page 190. This means you get a local copy of the file(s), which you can edit. This command is enabled when currently checked-in files are selected in the Workspace window.
Undo Check out	The selected files revert to the latest archived version; the files are no longer checked-out. Any changes you have made to the files will be lost. This command is enabled when currently checked-out files are selected in the Workspace window.
Get Latest Version	Replaces the selected files with the latest archived version.
Compare	Displays—in a SCC-specific window—the differences between the local version and the most recent archived version.
History	Displays SCC-specific information about the revision history of the selected file.
Properties	Displays information available in the SCC system for the selected file.
Refresh	Updates the SCC display status for all the files that are part of the project. This command is always enabled for all projects under SCC.
Connect Project to SCC Project	Opens a dialog box, which originates from the SCC client application, to let you create a connection between the selected IAR Embedded Workbench project and an SCC project; the IAR Embedded Workbench project will then be an SCC-controlled project. After creating this connection, a special column that contains status information will appear in the Workspace window.
Disconnect Project From SCC Project	Removes the connection between the selected IAR Embedded Workbench project and an SCC project; your project will no longer be a SCC-controlled project. The column in the Workspace window that contains SCC status information will no longer be visible for that project.

Table 32: Description of source code control commands

Source code control states

Each source code-controlled file can be in one of several states.

SCC state	Description
📄	Checked out to you. The file is editable.
📄✓	Checked out to you. The file is editable and you have modified the file.
🔒 (grey padlock)	Checked in. In many SCC systems this means that the file is write-protected.
🔒🟩 (grey padlock)	Checked in. A new version is available in the archive.
🔒 (red padlock)	Checked out exclusively to another user. In many SCC systems this means that you cannot check out the file.
🔒🟩 (red padlock)	Checked out exclusively to another user. A new version is available in the archive. In many SCC systems this means that you cannot check out the file.

Table 33: Description of source code control states

Note: The source code control in IAR Embedded Workbench depends on the information provided by the SCC system. If the SCC system provides incorrect or incomplete information about the states, IAR Embedded Workbench might display incorrect symbols.

Select Source Code Control Provider dialog box

The **Select Source Code Control Provider** dialog box is displayed if several SCC systems from different vendors are available. Use this dialog box to choose the SCC system you want to use.

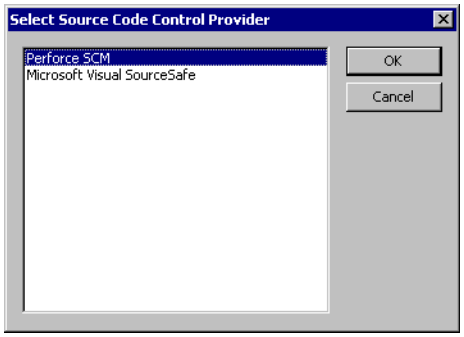

Select Source Code Control Provider
Perforce SCM
Microsoft Visual SourceSafe
OK
Cancel

Figure 81: Select Source Code Control Provider dialog box

Check In Files dialog box

The **Check In Files** dialog box is available by choosing the **Project>Source Code Control>Check In** command, alternatively available from the Workspace window context menu.

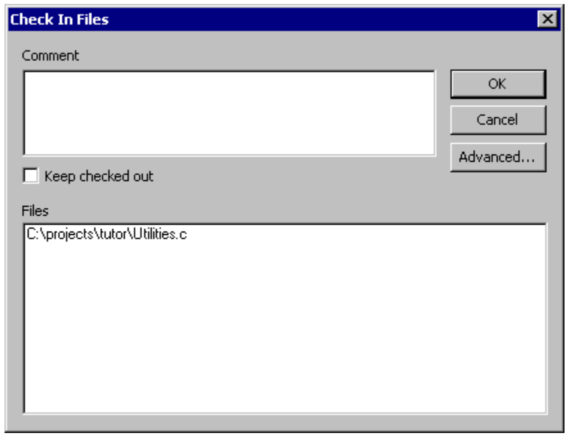


Figure 82: Check In Files dialog box

Comment

A text box in which you can write a comment—typically a description of your changes—that will be stored in the archive together with the file revision. This text box is only enabled if the SCC system supports the adding of comments at check-in.

Keep checked out

The file(s) will continue to be checked out after they have been checked in. Typically, this is useful if you want to make your modifications available to other members in your project team, without stopping your own work with the file.

Advanced

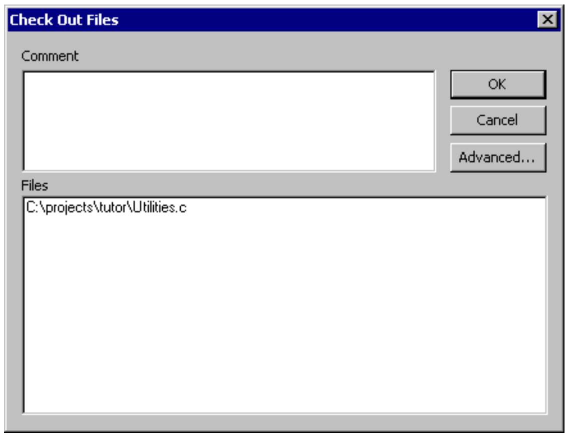
Opens a dialog box, originating from the SCC client application, that contains advanced options. This button is only available if the SCC system supports setting advanced options at check in.

Files

A list of the files that will be checked in. The list will contain all files that were selected in the Workspace window when this dialog box was opened.

Check Out Files dialog box

The **Check Out File** dialog box is available by choosing the **Project>Source Code Control>Check Out** command, alternatively available from the Workspace window context menu. However, this dialog box is only available if the SCC system supports adding comments at check-out or advanced options.



C:\projects\tutor\Utilities.c

Figure 83: Check Out Files dialog box

Comment

A text field in which you can write a comment—typically the reason why the file is checked out—that will be placed in the archive together with the file revision. This text box is only enabled if the SCC system supports the adding of comments at check-out.

Advanced

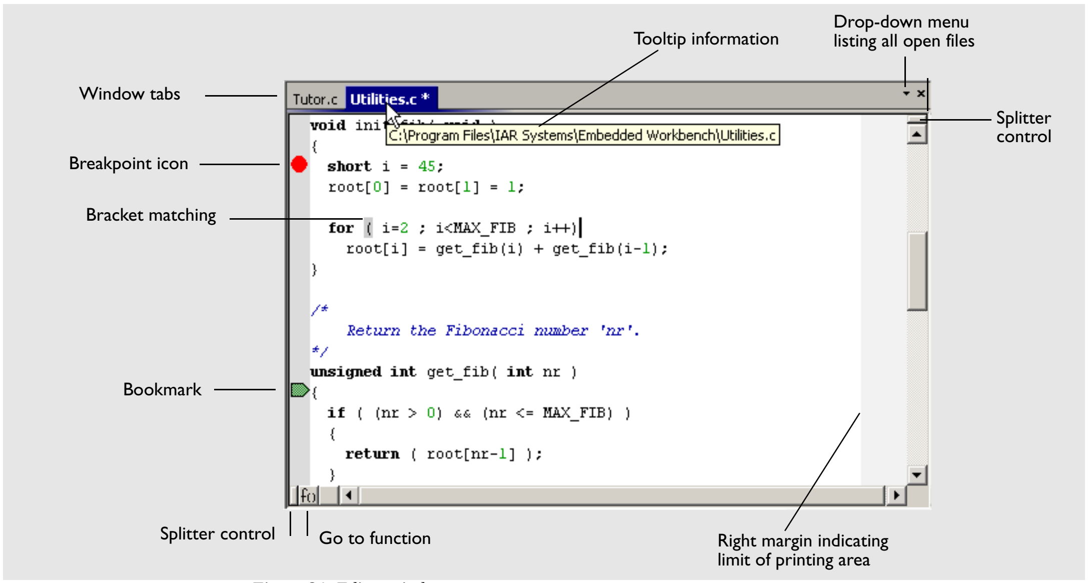
Opens a dialog box, originating from the SCC client application, that contains advanced options. This button is only available if the SCC system supports setting advanced options at check out.

Files

A list of files that will be checked out. The list will contain all files that were selected in the Workspace window when this dialog box was opened.

EDITOR WINDOW

Source code files and HTML files are displayed in editor windows. You can have one or several editor windows open at the same time. The editor window is always docked, and its size and position depends on other currently open windows.


Tooltip information
Drop-down menu listing all open files
Window tabs
Splitter control
Breakpoint icon
Bracket matching
Bookmark
Splitter control
Go to function
Right margin indicating limit of printing area
Tutor.c
Utilities.c *
C:\Program Files\IAR Systems\Embedded Workbench\Utilities.c

```
void ini
{
  short i = 45;
  root[0] = root[1] = 1;

  for ( i=2 ; i<MAX_FIB ; i++)
    root[i] = get_fib(i) + get_fib(i-1);
}

/*
    Return the Fibonacci number 'nr'.
*/
unsigned int get_fib( int nr )
{
  if ( (nr > 0) && (nr <= MAX_FIB) )
  {
    return ( root[nr-1] );
  }
```

Figure 84: Editor window

The name of the open file is displayed on the tab. If a file is read-only, a padlock icon is visible at the bottom left corner of the editor window. If a file has been modified after it was last saved, an asterisk appears after the filename on the tab, for example `Utilities.c *`. All open files are available from the drop-down menu in the upper right corner of the editor window.

For information about using the editor, see the chapter *Editing*, page 79.

HTML files

Use the **File>Open** command to open HTML documents in the editor window. From an open HTML document you can navigate to other documents using hyperlinks:

- A link to an `html` or `htm` file works like in normal web browsing
- A link to an `eww` workspace file opens the workspace in the IDE, and closes any currently open workspace and the open HTML document.

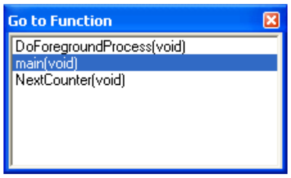
Split commands

Use the **Window>Split** command—or the Splitter controls—to split the editor window horizontally or vertically into multiple panes.

On the **Window** menu you also find commands for opening multiple editor windows, and commands for moving files between the editor windows.

Go to function

Click the **Go to function** button in the bottom left-hand corner of the editor window to make all C or C++ functions in that window appear as a list in the Go to Function window.


Go to Function

DoForegroundProcess(void)
main(void)
NextCounter(void)

Figure 85: Go to Function window

Double-click a function to jump to its location in the source code.

Editor window tab context menu

This is the context menu that appears if you right-click on a tab in the editor window:

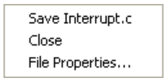


Figure 86: Editor window tab context menu

The context menu provides these commands:

Menu command	Description
Save *file*	Saves the file.
Close	Closes the file.
File Properties	Displays a standard file properties dialog box.

Table 34: Description of commands on the editor window tab context menu

Editor window context menu

The context menu available in the editor window provides convenient access to several commands.

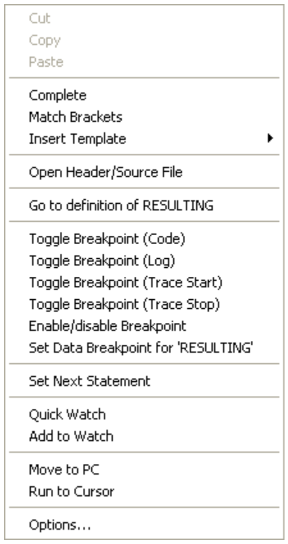


Figure 87: Editor window context menu

Note: The contents of this menu are dynamic, which means it might contain other commands than in this figure. All available commands are described in Table 35, *Description of commands on the editor window context menu*.

These commands are available on the editor window context menu:

Menu command	Description
Cut, Copy, Paste	Standard window commands.
Complete	Attempts to complete the word you have begun to type, basing the guess on the contents of the rest of the editor document.
Match Brackets	Selects all text between the brackets immediately surrounding the insertion point, increases the selection to the next hierarchic pair of brackets, or beeps if there is no higher bracket hierarchy.

Table 35: Description of commands on the editor window context menu

Menu command	Description
Insert Template	Displays a list in the editor window from which you can choose a code template to be inserted at the location of the insertion point. If the code template you choose requires any field input, the **Template** dialog box appears; for information about this dialog box, see *Template dialog box*, page 222. For information about using code templates, see *Using and adding code templates*, page 83.
Open "`*header*.h`"	Opens the header file "`*header*.h`" in an editor window. This menu command is only available if the insertion point is located on an `#include` line when you open the context menu.
Open Header/Source File	Jumps from the current file to the corresponding header or source file. If the destination file is not open when performing the command, the file will first be opened. This menu command is only available if the insertion point is located on any line except an `#include` line when you open the context menu. This command is also available from the **File>Open** menu.
Go to definition of *symbol*	Shows the declaration of the symbol where the insertion point is placed.
Check In Check Out Undo Checkout	Commands for source code control; for more details, see *Source Code Control menu*, page 186. These menu commands are only available if the current source file in the editor window is SCC-controlled. The file must also be a member of the current project.
Toggle Breakpoint (Code)	Toggles a code breakpoint at the statement or instruction containing or close to the cursor in the source window. For information about code breakpoints, see *Code breakpoints dialog box*, page 202.
Toggle Breakpoint (Log)	Toggles a log breakpoint at the statement or instruction containing or close to the cursor in the source window. For information about log breakpoints, see *Log breakpoints dialog box*, page 204.
Toggle Breakpoint (Trace Start)	Toggles a Trace Start breakpoint. When the breakpoint is triggered, the trace system is started. For information about Trace Start breakpoints, see *Trace Start breakpoints dialog box*, page 152. Note that this menu command is only available if the C-SPY driver you are using supports the trace system.
Toggle Breakpoint (Trace Stop)	Toggles a Trace Stop breakpoint. When the breakpoint is triggered, the trace system is stopped. For information about Trace Stop breakpoints, see *Trace Stop breakpoints dialog box*, page 152. Note that this menu command is only available if the C-SPY driver you are using supports the trace system.

Table 35: Description of commands on the editor window context menu (Continued)

Menu command	Description
Enable/disable Breakpoint	Toggles a breakpoint between being disabled, but not actually removed—making it available for future use—and being enabled again.
Set Data Breakpoint for *variable*	Toggles a data breakpoint on variables with static storage duration. Requires support in the C-SPY driver you are using.
Edit Breakpoint	Displays the **Edit Breakpoint** dialog box to let you edit the currently selected breakpoint. If there are more than one breakpoint on the selected line, a submenu is displayed that lists all available breakpoints on that line.
Set Next Statement	Sets the PC directly to the selected statement or instruction without executing any code. Use this menu command with care. This menu command is only available when you are using the debugger.
Quick Watch	Opens the Quick Watch window, see *Quick Watch window*, page 285. This menu command is only available when you are using the debugger.
Add to Watch	Adds the selected symbol to the Watch window. This menu command is only available when you are using the debugger.
Move to PC	Moves the insertion point to the current PC position in the editor window. This menu command is only available when you are using the debugger.
Run to Cursor	Executes from the current statement or instruction up to a selected statement or instruction. This menu command is only available when you are using the debugger.
Options	Displays the **IDE Options** dialog box, see *Tools menu*, page 235.

Table 35: Description of commands on the editor window context menu (Continued)

Source file paths

The IDE supports relative source file paths to a certain degree.

If a source file is located in the project file directory or in any subdirectory of the project file directory, the IDE will use a path relative to the project file when accessing the source file.

Editor key summary

The following tables summarize the editor's keyboard commands.

Use these keys and key combinations for moving the insertion point:

To move the insertion point	Press
One character left	Arrow left
One character right	Arrow right
One word left	Ctrl+Arrow left
One word right	Ctrl+Arrow right
One line up	Arrow up
One line down	Arrow down
To the start of the line	Home
To the end of the line	End
To the first line in the file	Ctrl+Home
To the last line in the file	Ctrl+End

Table 36: Editor keyboard commands for insertion point navigation

Use these keys and key combinations for scrolling text:

To scroll	Press
Up one line	Ctrl+Arrow up
Down one line	Ctrl+Arrow down
Up one page	Page Up
Down one page	Page Down

Table 37: Editor keyboard commands for scrolling

Use these key combinations for selecting text:

To select	Press
The character to the left	Shift+Arrow left
The character to the right	Shift+Arrow right
One word to the left	Shift+Ctrl+Arrow left
One word to the right	Shift+Ctrl+Arrow right
To the same position on the previous line	Shift+Arrow up
To the same position on the next line	Shift+Arrow down
To the start of the line	Shift+Home
To the end of the line	Shift+End
One screen up	Shift+Page Up
One screen down	Shift+Page Down

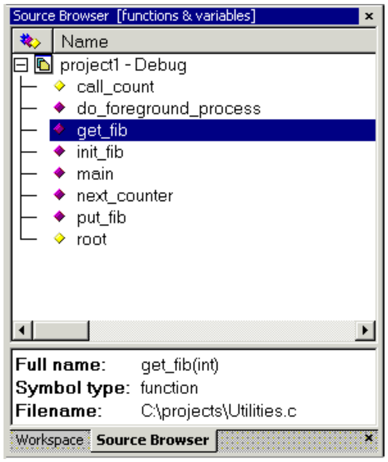
Table 38: Editor keyboard commands for selecting text

To select	Press
To the beginning of the file	Shift+Ctrl+Home
To the end of the file	Shift+Ctrl+End

Table 38: Editor keyboard commands for selecting text (Continued)

SOURCE BROWSER WINDOW

The Source Browser window—available from the **View** menu—displays an hierarchical view in alphabetical order of all symbols defined in the active build configuration.



Full name: get_fib(int)
Symbol type: function
Filename: C:\projects\Utilities.c

Figure 88: Source Browser window

The window consists of two separate display areas.

The upper display area

The upper display area contains two columns:

Column	Description
Icons	An icon that corresponds to the Symbol type classification, see *Icons used for the symbol types*, page 199.
Name	The names of global symbols and functions defined in the project.

Table 39: Columns in Source Browser window

If you click in the window header, you can sort the symbols either by name or by symbol type.

In the upper display area you can also access a context menu; see *Source Browser window context menu*, page 200.

The lower display area

For a symbol selected in the upper display area, the lower area displays its properties:

Property	Description
Full name	Displays the unique name of each element, for instance `classname::membername`.
Symbol type	Displays the symbol type for each element, see *Icons used for the symbol types*, page 199.
Filename	Specifies the path to the file in which the element is defined.

Table 40: Information in Source Browser window

Icons used for the symbol types

These are the icons used:

▨		Base class
▨		Class
▣		Configuration
●		Enumeration
⊟		Enumeration constant
◆	(Yellow rhomb)	Field of a struct
◆	(Purple rhomb)	Function
#		Macro
{ }		Namespace
●		Template class
◆		Template function
▫		Type definition
◆		Union
◆	(Yellow rhomb)	Variable

Usage

For further details about how to use the Source Browser window, see *Displaying browse information*, page 66.

Source Browser window context menu

This is the context menu available in the upper display area:

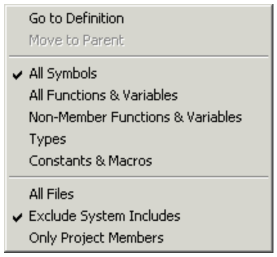


Figure 89: Source Browser window context menu

These commands are available on the context menu:

Menu command	Description
Go to Definition	The editor window will display the definition of the selected item.
Move to Parent	If the selected element is a member of a class, struct, union, enumeration, or namespace, this menu command can be used for moving to its enclosing element.
All Symbols	Type filter; all global symbols and functions defined in the project will be displayed.
All Functions & Variables	Type filter; all functions and variables defined in the project will be displayed.
Non-Member Functions & Variables	Type filter; all functions and variables that are not members of a class will be displayed
Types	Type filter; all types such as structures and classes defined in the project will be displayed.
Constants & Macros	Type filter; all constants and macros defined in the project will be displayed.
All Files	File filter; symbols from all files that you have explicitly added to your project and all files included by them will be displayed.
Exclude System Includes	File filter; symbols from all files that you have explicitly added to your project and all files included by them will be displayed, except the include files in the IAR Embedded Workbench installation directory.
Only Project Members	File filter; symbols from all files that you have explicitly added to your project will be displayed, but no include files.

Table 41: Source Browser window context menu commands

BREAKPOINTS WINDOW

The Breakpoints window—available from the **View** menu—lists all breakpoints. From the window you can conveniently monitor, enable, and disable breakpoints; you can also define new breakpoints and modify existing breakpoints.

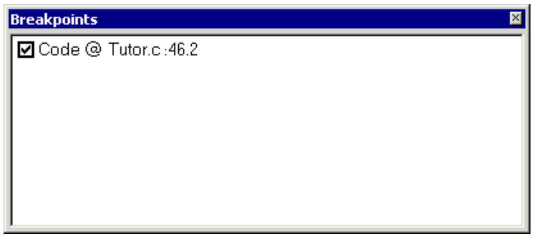


Figure 90: Breakpoints window

All breakpoints you define are displayed in the Breakpoints window.

For more information about the breakpoint system and how to set breakpoints, see the chapter *Using breakpoints* in *Part 4. The C-SPY® Simulator*.

Breakpoints window context menu

Right-clicking in the Breakpoints window displays a context menu with several commands.

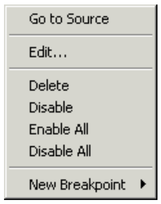


Figure 91: Breakpoints window context menu

These commands are available on the context menu:

Menu command	Description
Go to Source	Moves the insertion point to the location of the breakpoint, if the breakpoint has a source location. Double-click a breakpoint in the Breakpoints window to perform the same command.
Edit	Opens the **Edit Breakpoint** dialog box for the selected breakpoint.

Table 42: Breakpoints window context menu commands

Menu command	Description
Delete	Deletes the selected breakpoint. Press the Delete key to perform the same command.
Enable	Enables the selected breakpoint. The check box at the beginning of the line will be selected. You can also perform the command by manually selecting the check box. This command is only available if the selected breakpoint is disabled.
Disable	Disables the selected breakpoint. The check box at the beginning of the line will be cleared. You can also perform this command by manually deselecting the check box.This command is only available if the selected breakpoint is enabled.
Enable All	Enables all defined breakpoints.
Disable All	Disables all defined breakpoints.
New Breakpoint	Displays a submenu where you can open the **New Breakpoint** dialog box for the available breakpoint types. All breakpoints you define using the **New Breakpoint** dialog box are preserved between debug sessions. In addition to code and log breakpoints—see *Code breakpoints dialog box*, page 202 and —other types of breakpoints might be available depending on the C-SPY driver you are using. For information about driver-specific breakpoint types, see the driver-specific debugger documentation.

Table 42: Breakpoints window context menu commands (Continued)

Code breakpoints dialog box

Code breakpoints are triggered when an instruction is fetched from the specified location. If you have set the breakpoint on a specific machine instruction, the breakpoint will be triggered and the execution will stop, before the instruction is executed.

To set a code breakpoint, right-click in the Breakpoints window and choose **New Breakpoint>Code** on the context menu. To modify an existing breakpoint, select it in the Breakpoints window and choose **Edit** on the context menu.

The **Code** breakpoints dialog box appears.

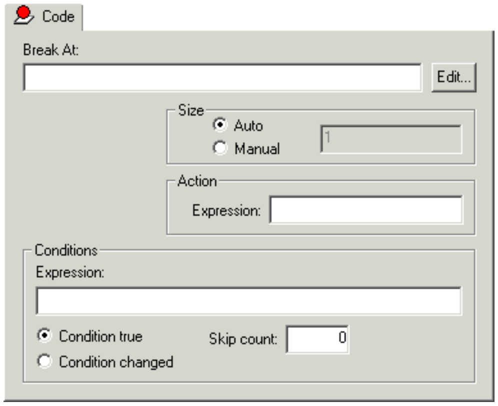


Figure 92: Code breakpoints page

Break At

Specify the location of the breakpoint in the **Break At** text box. Alternatively, click the **Edit** browse button to open the **Enter Location** dialog box; see *Enter Location dialog box*, page 206.

Size

Optionally, you can specify a size—in practice, a *range*—of locations. Each fetch access to the specified memory range will trigger the breakpoint. There are two different ways to specify the size:

- **Auto**, the size will be set automatically, typically to 1
- **Manual**, you specify the size of the breakpoint range manually in the **Size** text box.

Action

You can optionally connect an action to a breakpoint. Specify an expression, for instance a C-SPY macro function, which is evaluated when the breakpoint is triggered and the condition is true.

Conditions

You can specify simple and complex conditions.

Conditions	Description
Expression	A valid expression conforming to the C-SPY expression syntax.
Condition true	The breakpoint is triggered if the value of the expression is true.
Condition changed	The breakpoint is triggered if the value of the expression has changed since it was last evaluated.
Skip count	The number of times that the breakpoint must be fulfilled before a break occurs (integer).

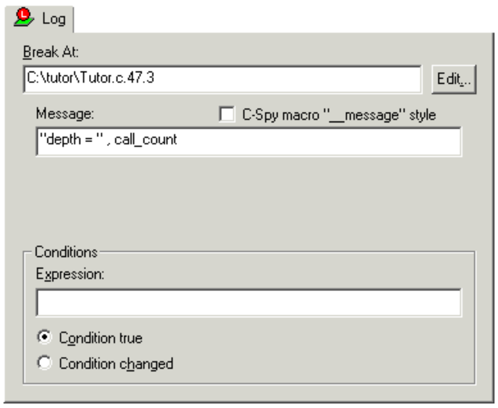
Table 43: Breakpoint conditions

Log breakpoints dialog box

Log breakpoints are triggered when an instruction is fetched from the specified location. If you have set the breakpoint on a specific machine instruction, the breakpoint will be triggered and the execution will temporarily halt and print the specified message in the C-SPY Debug Log window. This is a convenient way to add trace printouts during the execution of your application, without having to add any code to the application source code.

To set a log breakpoint, right-click in the Breakpoints window and choose **New Breakpoint>Log** on the context menu. To modify an existing breakpoint, select it in the Breakpoints window and choose **Edit** on the context menu.

The **Log** breakpoints dialog box appears.



Break At: C:\tutor\Tutor.c.47.3

Message: "depth = " , call_count

[ ] C-Spy macro "__message" style

Expression:

(●) Condition true
( ) Condition changed

Figure 93: Log breakpoints page

The quickest—and typical—way to set a log breakpoint is by choosing **Toggle Breakpoint (Log)** from the context menu available when you right-click in either the editor or the Disassembly window. For more information about how to set breakpoints, see *Defining breakpoints*, page 117.

Break At

Specify the location of the breakpoint in the **Break At** text box. Alternatively, click the **Edit** button to open the **Enter Location** dialog box; see *Enter Location dialog box*, page 206.

Message

Specify the message you want to be displayed in the C-SPY Debug Log window. The message can either be plain text, or—if you also select the option **C-SPY macro "__message" style**—a comma-separated list of arguments.

C-SPY macro "__message" style

Select this option to make a comma-separated list of arguments specified in the Message text box be treated exactly as the arguments to the C-SPY macro language statement `__message`, see *Formatted output*, page 382.

Conditions

You can specify simple and complex conditions.

Conditions	Description
Expression	A valid expression conforming to the C-SPY expression syntax.
Condition true	The breakpoint is triggered if the value of the expression is true.
Condition changed	The breakpoint is triggered if the value of the expression has changed since it was last evaluated.

Table 44: Log breakpoint conditions

Enter Location dialog box

Use the **Enter Location** dialog box—available from a breakpoints dialog box—to specify the location of the breakpoint.

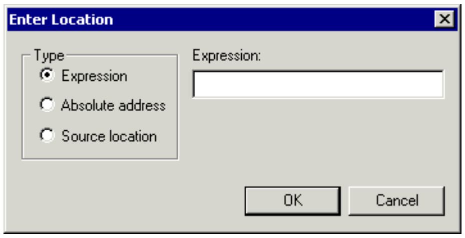


Figure 94: Enter Location dialog box

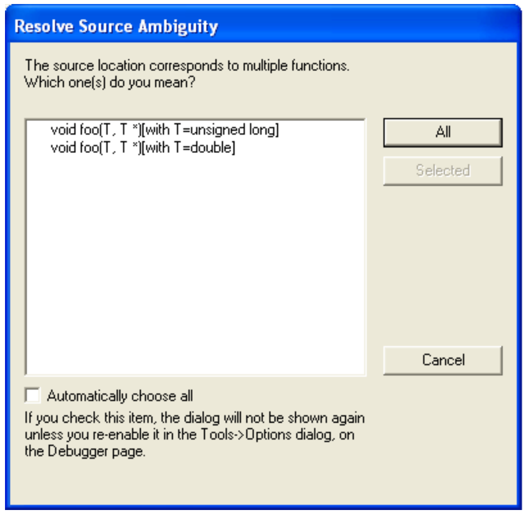
You can choose between these locations and their possible settings:

Location type	**Description/Examples**
Expression	Any expression that evaluates to a valid address, such as a function or variable name. Code breakpoints are set on functions and data breakpoints are set on variable names. For example, `my_var` refers to the location of the variable `my_var`, and `arr[3]` refers to the third element of the array `arr`.
Absolute Address	An absolute location on the form *`zone`*`:`*`hexaddress`* or simply *`hexaddress`*. Zone specifies in which memory the address belongs. For example `Memory:0x42`. If you enter a combination of a zone and address that is not valid, C-SPY will indicate the mismatch.
Source Location	A location in the C source code using the syntax: `{`*`file path`*`}.`*`row`*`.`*`column`*`.` *File* specifies the filename and full path. *Row* specifies the row in which you want the breakpoint. *Column* specifies the column in which you want the breakpoint. Note that the Source Location type is usually meaningful only for code breakpoints. For example, `{C:\`*`my_projects`*`\Utilities.c}.22.3` sets a breakpoint on the third character position on line 22 in the source file `Utilities.c`.

Table 45: Location types

RESOLVE SOURCE AMBIGUITY DIALOG BOX

The **Resolve Source Ambiguity** dialog box appears, for example, when you try to set a breakpoint on inline functions or templates, and the source location corresponds to more than one function.



The source location corresponds to multiple functions.
Which one(s) do you mean?

```
void foo(T, T *)[with T=unsigned long]
void foo(T, T *)[with T=double]
```

☐ Automatically choose all

If you check this item, the dialog will not be shown again unless you re-enable it in the Tools->Options dialog, on the Debugger page.

Figure 95: Resolve Source Ambiguity dialog box

All

All listed locations will be used.

Selected

Select one or more of the locations in the list. Only the selected locations will be used.

Cancel

No location will be used.

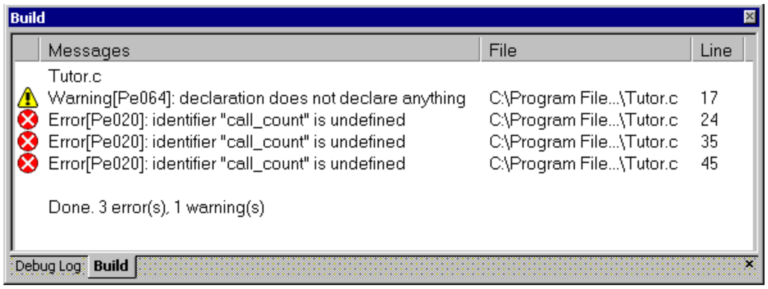
Automatically choose all

Whenever a specified source location corresponds to more than one function, all locations will be used.

Note that this option can also be specified in the **IDE Options** dialog box, see *Debugger options*, page 251.

BUILD WINDOW

The Build window—available by choosing **View>Messages**—displays the messages generated when building a build configuration. When opened, this window is, by default, grouped together with the other message windows, see *Windows*, page 179.



```
Messages                                            File                      Line
Tutor.c
Warning[Pe064]: declaration does not declare anything  C:\Program File...\Tutor.c  17
Error[Pe020]: identifier "call_count" is undefined     C:\Program File...\Tutor.c  24
Error[Pe020]: identifier "call_count" is undefined     C:\Program File...\Tutor.c  35
Error[Pe020]: identifier "call_count" is undefined     C:\Program File...\Tutor.c  45

Done. 3 error(s), 1 warning(s)
```

Figure 96: Build window (message window)

Double-clicking a message in the Build window opens the appropriate file for editing, with the insertion point at the correct position.

Right-clicking in the Build window displays a context menu which allows you to copy, select, and clear the contents of the window.

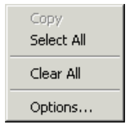
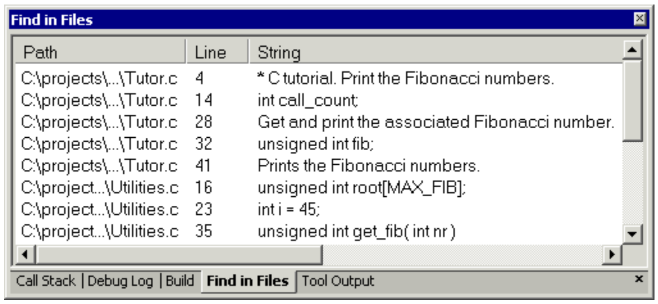


Figure 97: Build window context menu

The **Options** command opens the **Messages** page of the **IDE options** dialog box. On this page you can set options related to messages; see *Messages options*, page 247.

FIND IN FILES WINDOW

The Find in Files window—available by choosing **View>Messages**—displays the output from the **Edit>Find and Replace>Find in Files** command. When opened, this window is, by default, grouped together with the other message windows, see *Windows*, page 179.



Path	Line	String
C:\projects\...\Tutor.c	4	* C tutorial. Print the Fibonacci numbers.
C:\projects\...\Tutor.c	14	int call_count;
C:\projects\...\Tutor.c	28	Get and print the associated Fibonacci number.
C:\projects\...\Tutor.c	32	unsigned int fib;
C:\projects\...\Tutor.c	41	Prints the Fibonacci numbers.
C:\project...\Utilities.c	16	unsigned int root[MAX_FIB];
C:\project...\Utilities.c	23	int i = 45;
C:\project...\Utilities.c	35	unsigned int get_fib(int nr)

Figure 98: Find in Files window (message window)

Double-clicking an entry in the window opens the appropriate file with the insertion point positioned at the correct location.

Right-clicking in the Find in Files window displays a context menu which allows you to copy, select, and clear the contents of the window.

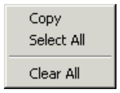


Figure 99: Find in Files window context menu

TOOL OUTPUT WINDOW

The Tool Output window—available by choosing **View>Messages**—displays any messages output by user-defined tools in the Tools menu, provided that you have selected the option **Redirect to Output Window** in the **Configure Tools** dialog box;

see *Configure Tools dialog box*, page 257. When opened, this window is, by default, grouped together with the other message windows, see *Windows*, page 179.

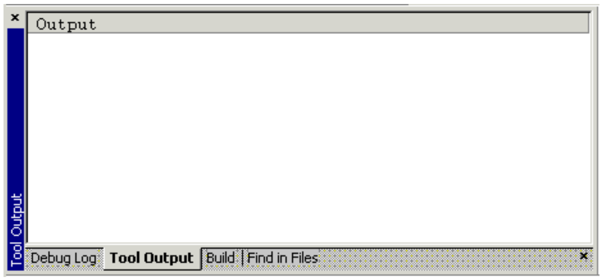


Figure 100: Tool Output window (message window)

Right-clicking in the Tool Output window displays a context menu which allows you to copy, select, and clear the contents of the window.

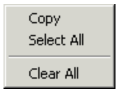
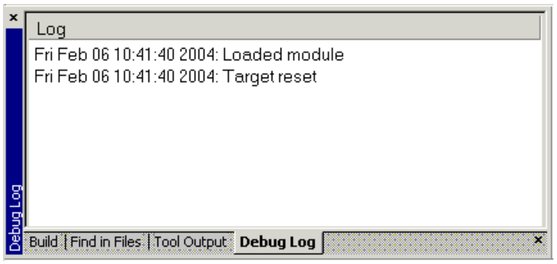


Figure 101: Tool Output window context menu

DEBUG LOG WINDOW

The Debug Log window—available by choosing **View>Messages**—displays debugger output, such as diagnostic messages and trace information. This output is only available when C-SPY is running. When opened, this window is, by default, grouped together with the other message windows, see *Windows*, page 179.



```
Fri Feb 06 10:41:40 2004: Loaded module
Fri Feb 06 10:41:40 2004: Target reset
```

Figure 102: Debug Log window (message window)

Double-click any rows in one of the following formats to display the corresponding source code in the editor window:

```
<path> (<row>):<message>
<path> (<row>,<column>):<message>
```

Right-clicking in the Debug Log window displays a context menu which allows you to copy or clear the contents of the window.

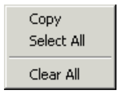


Figure 103: Debug Log window context menu

Menus

These menus are available in the IDE:

- File menu
- Edit menu
- View menu
- Project menu
- Tools menu
- Window menu
- Help menu.

In addition, a set of C-SPY-specific menus become available when you start the debugger. For reference information about these menus, see the chapter *C-SPY reference*, page 265.

FILE MENU

The **File** menu provides commands for opening workspaces and source files, saving and printing, and exiting from the IDE.

The menu also includes a numbered list of the most recently opened files and workspaces. To open one of them, choose it from the menu.

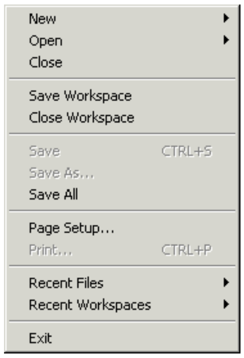


Figure 104: File menu

These commands are available on the **File** menu:

Menu command	Shortcut	Description
New	CTRL+N	Displays a submenu with commands for creating a new workspace, or a new text file.
Open>File	CTRL+O	Displays a submenu from which you can select a text file or an HTML document to open.
Open> Workspace		Displays a dialog box where you can open a workspace file. You will be given the opportunity to save and close any currently open workspace file that has been modified before opening a new workspace.
Open> Header/Source File	CTRL+ SHIFT+H	Opens the header file or source file that corresponds to the current file, and jumps from the current file to the newly opened file. This command is also available from the context menu available from the editor window.
Close		Closes the active window. You will be given the opportunity to save any files that have been modified before closing.
Save Workspace		Saves the current workspace file.
Close Workspace		Closes the current workspace file.
Save	CTRL+S	Saves the current text file or workspace file.
Save As		Displays a dialog box where you can save the current file with a new name.

Table 46: File menu commands

Menu command	Shortcut	Description
Save All		Saves all open text documents and workspace files.
Page Setup		Displays a dialog box where you can set printer options.
Print	CTRL+P	Displays a dialog box where you can print a text document.
Recent Files		Displays a submenu where you can quickly open the most recently opened text documents.
Recent Workspaces		Displays a submenu where you can quickly open the most recently opened workspace files.
Exit		Exits from the IDE. You will be asked whether to save any changes to text windows before closing them. Changes to the project are saved automatically.

Table 46: File menu commands (Continued)

EDIT MENU

The **Edit** menu provides several commands for editing and searching.

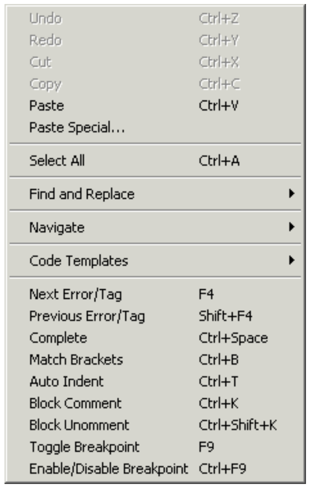


Figure 105: Edit menu

Menu command	Shortcut	Description
Undo	CTRL+Z	Undoes the last edit made to the current editor window.
Redo	CTRL+Y	Redoes the last **Undo** in the current editor window. You can undo and redo an unlimited number of edits independently in each editor window.
Cut	CTRL+X	The standard Windows command for cutting text in editor windows and text boxes.
Copy	CTRL+C	The standard Windows command for copying text in editor windows and text boxes.
Paste	CTRL+V	The standard Windows command for pasting text in editor windows and text boxes.
Paste Special		Provides you with a choice of the most recent contents of the clipboard to choose from when pasting in editor documents.
Select All	CTRL+A	Selects all text in the active editor window.

Table 47: Edit menu commands

Menu command	Shortcut	Description
Find and Replace>Find	CTRL+F	Displays the **Find** dialog box where you can search for text within the current editor window. Note that if the insertion point is located in the Memory window when you choose the **Find** command, the dialog box will contain a different set of options than it would otherwise do. If the insertion point is located in the Trace window when you choose the **Find** command, the **Find in Trace** dialog box is opened; the contents of this dialog box depend on the C-SPY driver you are using, see the driver documentation for more information.
Find and Replace> Find Next	F3	Finds the next occurrence of the specified string.
Find and Replace> Find Previous	SHIFT+F3	Finds the previous occurrence of the specified string.
Find and Replace> Find Next (Selected)	CTRL+F3	Searches for the next occurrence of the currently selected text or the word currently surrounding the insertion point.
Find and Replace> Find Previous (Selected)	CTRL+ SHIFT+F3	Searches for the previous occurrence of the currently selected text or the word currently surrounding the insertion point.
Find and Replace> Replace	CTRL+H	Displays a dialog box where you can search for a specified string and replace each occurrence with another string. Note that if the insertion point is located in the Memory window when you choose the **Replace** command, the dialog box will contain a different set of options than it would otherwise do.
Find and Replace> Find in Files		Displays a dialog box where you can search for a specified string in multiple text files; see *Find in Files dialog box*, page 219.
Find and Replace> Incremental Search	CTRL+I	Displays a dialog box where you can gradually fine-tune or expand the search by continuously changing the search string.
Navigate>Go To	CTRL+G	Displays the **Go to Line** dialog box where you can move the insertion point to a specified line and column in the current editor window.
Navigate> Toggle Bookmark	CTRL+F2	Toggles a bookmark at the line where the insertion point is located in the active editor window.
Navigate> Go to Bookmark	F2	Moves the insertion point to the next bookmark that has been defined with the Toggle Bookmark command.

Table 47: Edit menu commands (Continued)

Menu command	Shortcut	Description
Navigate> Navigate Backward	ALT+Left arrow	Navigates backward in the insertion point history. The current position of the insertion point is added to the history by actions like **Go to definition** and clicking on a result from the **Find in Files** command.
Navigate> Navigate Forward	ALT+Right arrow	Navigates forward in the insertion point history. The current position of the insertion point is added to the history by actions like **Go to definition** and clicking on a result from the **Find in Files** command.
Navigate> Go to Definition	F12	Shows the declaration of the selected symbol or the symbol where the insertion point is placed. This menu command is available when browse information has been enabled, see *Project options*, page 248.
Code Templates> Insert Template	CTRL+ SHIFT+ SPACE	Displays a list in the editor window from which you can choose a code template to be inserted at the location of the insertion point. If the code template you choose requires any field input, the **Template** dialog box appears; for information about this dialog box, see *Template dialog box*, page 222. For information about using code templates, see *Using and adding code templates*, page 83.
Code Templates> Edit Templates		Opens the current code template file, where you can modify existing code templates and add your own code templates. For information about using code templates, see *Using and adding code templates*, page 83.
Next Error/Tag	F4	If the Messages window contains a list of error messages or the results from a **Find in Files** search, this command will display the next item from that list in the editor window.
Previous Error/Tag	SHIFT+F4	If the Messages window contains a list of error messages or the results from a **Find in Files** search, this command will display the previous item from that list in the editor window.
Complete	CTRL+ SPACE	Attempts to complete the word you have begun to type, basing the guess on the contents of the rest of the editor document.
Match Brackets		Selects all text between the brackets immediately surrounding the insertion point, increases the selection to the next hierarchic pair of brackets, or beeps if there is no higher bracket hierarchy.

Table 47: Edit menu commands (Continued)

Menu command	Shortcut	Description
Auto Indent	CTRL+T	Indents one or several lines you have selected in a C/C++ source file. To configure the indentation, see *Configure Auto Indent dialog box*, page 241.
Block Comment	CTRL+K	Places the C++ comment character sequence `//` at the beginning of the selected lines.
Block Uncomment	CTRL+K	Removes the C++ comment character sequence `//` from the beginning of the selected lines.
Toggle Breakpoint	F9	Toggles a breakpoint at the statement or instruction that contains or is located near the cursor in the source window. This command is also available as an icon button in the debug bar.
Enable/Disable Breakpoint	CTRL+F9	Toggles a breakpoint between being disabled, but not actually removed—making it available for future use—and being enabled again.

Table 47: Edit menu commands (Continued)

Find dialog box

The **Find** dialog box is available from the **Edit** menu. Note that the contents of this dialog box look different if you search in an editor window compared to if you search in the Memory window.

Option	Description
Find what	Selects the text to search for.
Match case	Searches only occurrences that exactly match the case of the specified text. Otherwise specifying `int` will also find `INT` and `Int`. This option is only available when you search in an editor window.
Match whole word	Searches the specified text only if it occurs as a separate word. Otherwise specifying `int` will also find `print`, `sprintf` etc. This option is only available when you search in an editor window.
Search as hex	Searches for the specified hexadecimal value. This option is only available when you search in the Memory window.
Find next	Finds the next occurrence of the selected text.
Find previous	Finds the previous occurrence of the selected text.
Stop	Stops an ongoing search. This button is only available during a search in the Memory window.

Table 48: Find dialog box options

Replace dialog box

The **Replace** dialog box is available from the **Edit** menu.

Option	Description
Find what	Selects the text to search for and to be replaced.
Replace with	Your replacement text.
Match case	Searches only for occurrences that exactly match the case of the specified text. Otherwise specifying `int` will also find `INT` and `Int`.
Match whole word	Searches the specified text only if it occurs as a separate word. Otherwise `int` will also find `print`, `sprintf` etc. This checkbox is not available when you perform the search in the Memory window.
Search as hex	Searches for the specified hexadecimal value. This checkbox is only available when you perform the search in the Memory window.
Find next	Searches the next occurrence of the text you have specified.
Replace	Replaces the searched text with the specified text.
Replace all	Replaces all occurrences of the searched text in the current editor window.

Table 49: Replace dialog box options

Find in Files dialog box

Use the **Find in Files** dialog box—available from the **Edit** menu—to search for a string in files.

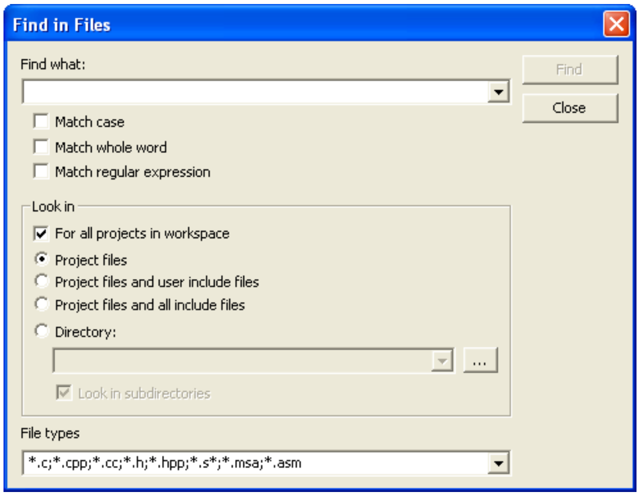


Figure 106: Find in Files dialog box

The result of the search appears in the Find in Files messages window—available from the **View** menu. You can then go to each occurrence by choosing the **Edit>Next Error/Tag** command, alternatively by double-clicking the messages in the Find in Files messages window. This opens the corresponding file in an editor window with the insertion point positioned at the start of the specified text. A blue flag in the left-most margin indicates the line.

In the **Find in Files** dialog box, you specify the search criteria with the following settings.

Find what:

A text field in which you type the string you want to search for or a regular expression. Choose between these commands:

Match case	Searches only for occurrences that exactly match the case of the specified text. Otherwise specifying `int` will also find `INT` and `Int`.
Match whole word	Searches only for the string when it occurs as a separate word (short cut `&w`). Otherwise `int` will also find `print`, `sprintf` and so on.

Match regular expression	Searches only for the regular expression, which must follow the standard for the Perl programming language.

Look in

The options in the **Look in** area let you specify which files you want to search in for a specified string. Choose between:

For all projects in workspace	The search traverses all projects in the workspace, not just the active project.
Project files	The search is performed in all files that you have explicitly added to your project.
Project files and user include files	The search is performed in all files that you have explicitly added to your project and all files that they include, except the include files in the IAR Embedded Workbench installation directory.
Project files and all include files	The search is performed in all project files that you have explicitly added to your project and all files that they include.
Directory	The search is performed in the directory that you specify. Recent search locations are saved in the drop-down list. Locate the directory using the browse button.
Look in subdirectories	The search is performed in the directory that you have specified and all its subdirectories.

File types

This is a filter for choosing which type of files to search; the filter applies to all options in the **Look in** area. Choose the appropriate filter from the drop-down list. Note that the **File types** text field is editable, which means that you can add your own filters. Use the `*` character to indicate zero or more unknown characters of the filters, and the `?` character to indicate one unknown character.

Stop

Stops an ongoing search. This function button is only available during an ongoing search.

Incremental Search dialog box

The **Incremental Search** dialog box—available from the **Edit** menu—lets you gradually fine-tune or expand the search string.

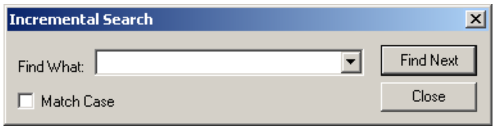


Figure 107: Incremental Search dialog box

Find What

Type the string to search for. The search is performed from the location of the insertion point—the *start point*. Gradually incrementing the search string will gradually expand the search criteria. Backspace will remove a character from the search string; the search is performed on the remaining string and will start from the start point.

If a word in the editor window is selected when you open the **Incremental Search** dialog box, this word will be displayed in the **Find What** text box.

Match Case

Use this option to find only occurrences that exactly match the case of the specified text. Otherwise searching for `int` will also find `INT` and `Int`.

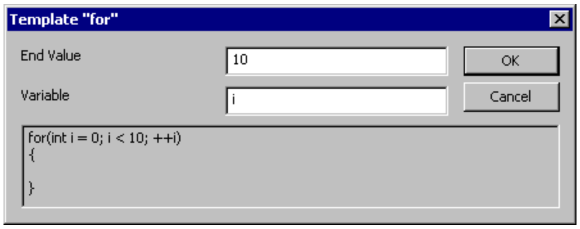
Function buttons

Function button	Description
Find Next	Searches for the next occurrence of the current search string. If the **Find What** text box is empty when you click the **Find Next** button, a string to search for will automatically be selected from the drop-down list. To search for this string, click **Find Next**.
Close	Closes this dialog box.

Table 50: Incremental Search function buttons

Template dialog box

Use the **Template** dialog box to specify any field input that is required by the source code template you insert. This dialog box appears when you insert a code template that requires any field input.



End Value: 10
Variable: i

```
for(int i = 0; i < 10; ++i)
{

}
```

Figure 108: Template dialog box

Note: This figure reflects the default code template that can be used for automatically inserting code for a `for` loop.

The contents of this dialog box match the code template. In other words, which fields that appear depends on how the code template is defined.

At the bottom of the dialog box, the code that would result from the code template is displayed.

For more information about using code templates, see *Using and adding code templates*, page 83.

VIEW MENU

With the commands on the **View** menu you can choose what to display in the IAR Embedded Workbench IDE. During a debug session you can also open debugger-specific windows from the **View** menu.

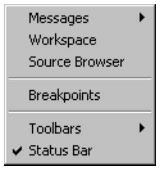


Figure 109: View menu

Menu command	Description
Messages	Opens a submenu which gives access to the message windows—Build, Find in Files, Tool Output, Debug Log—that display messages and text output from the IAR Embedded Workbench commands. If the window you choose from the menu is already open, it becomes the active window.
Workspace	Opens the current Workspace window.
Source Browser	Opens the Source Browser window.
Breakpoints	Opens the Breakpoints window.
Toolbars	The options **Main** and **Debug** toggle the two toolbars on and off.
Status bar	Toggles the status bar on and off.

Table 51: View menu commands

Menu command	Description
Debugger windows	During a debugging session, the various debugging windows are also available from the **View** menu: Disassembly window Memory window Symbolic Memory window Register window Watch window Locals window Statics window Auto window Live Watch window Quick Watch window Call Stack window Terminal I/O window Code Coverage window Profiling window Stack window For descriptions of these windows, see *C-SPY windows*, page 265.

Table 51: View menu commands (Continued)

PROJECT MENU

The **Project** menu provides commands for working with workspaces, projects, groups, and files, and for specifying options for the build tools, and running the tools on the current project.

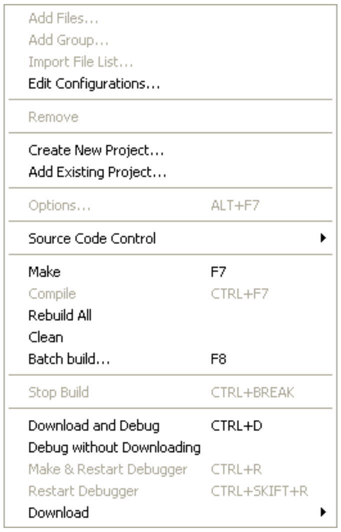


Figure 110: Project menu

Menu Command	Description
Add Files	Displays a dialog box that where you can select which files to include to the current project.
Add Group	Displays a dialog box where you can create a new group. In the **Group Name** text box, specify the name of the new group. For more information about groups, see *Groups*, page 62.
Import File List	Displays a standard **Open** dialog box where you can import information about files and groups from projects created using another IAR Systems toolchain. To import information from project files which have one of the older filename extensions `pew` or `prj` you must first have exported the information using the context menu command **Export File List** available in your own IAR Embedded Workbench.
Edit Configurations	Displays the **Configurations for project** dialog box, where you can define new or remove existing build configurations.

Table 52: Project menu commands

Menu Command	Description
Remove	In the Workspace window, removes the selected item from the workspace.
Create New Project	Displays a dialog box where you can create a new project and add it to the workspace.
Add Existing Project	Displays a dialog box where you can add an existing project to the workspace.
Options (Alt+F7)	Displays the **Options for node** dialog box, where you can set options for the build tools on the selected item in the Workspace window. You can set options on the entire project, on a group of files, or on an individual file.
Source Code Control	Opens a submenu with commands for source code control, see *Source Code Control menu*, page 186.
Make (F7)	Brings the current build configuration up to date by compiling, assembling, and linking only the files that have changed since the last build.
Compile (Ctrl+F7)	Compiles or assembles the currently selected file, files, or group. One or more files can be selected in the Workspace window—all files in the same project, but not necessarily in the same group. You can also select the editor window containing the file you want to compile. The **Compile** command is only enabled if *every* file in the selection is individually suitable for the command. You can also select a *group*, in which case the command is applied to each file in the group (including inside nested groups) that can be compiled, even if the group contains files that cannot be compiled, such as header files. If the selected file is part of a multi-file compilation group, the command will still only affect the selected file.
Rebuild All	Rebuilds and relinks all files in the current target.
Clean	Removes any intermediate files.
Batch Build (F8)	Displays a dialog box where you can configure named batch build configurations, and build a named batch.
Stop Build (Ctrl+Break)	Stops the current build operation.
Download and Debug (Ctrl+D)	Downloads the application and starts C-SPY so that you can debug the project object file. If necessary, a make will be performed before running C-SPY to ensure the project is up to date. This command is not available during debugging.

Table 52: Project menu commands (Continued)

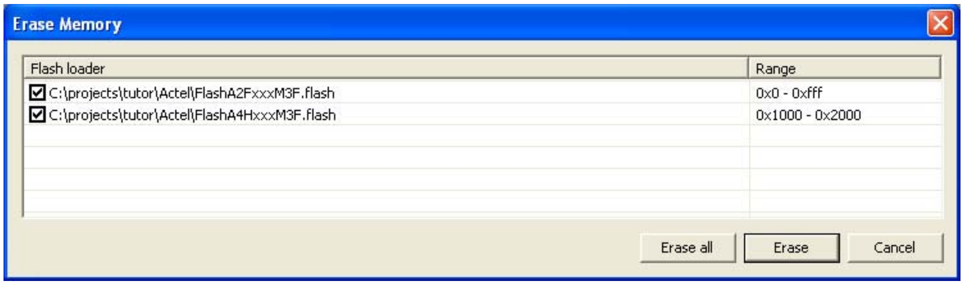
Menu Command	Description
Debug without Downloading	Starts C-SPY so that you can debug the project object file. This menu command is a short cut for the **Suppress Download** option available on the **Download** page. This command is not available during debugging.
Make & Restart Debugger	Stops C-SPY, makes the active build configuration, and starts the debugger again; all in a single command. This command is only available during debugging.
Restart Debugger	Stops C-SPY and starts the debugger again; all in a single command. This command is only available during debugging.
Download	Commands for flash download using the flash loader mechanism provided with IAR Embedded Workbench. Note that this mechanism might not be applicable to the product package you are using, in which case these commands will not appear on the **Project** menu. Choose between these commands: **Download the active application** downloads the active application to the target without launching a full debug session. The result is roughly equivalent to launching a debug session but exiting it again before the execution starts. **Download file** opens a standard **Open** dialog box where you can specify a file to be downloaded to the target system without launching a full debug session. **Erase memory** erases all parts of the flash memory. If your `.board` file specifies only one flash memory, a simple confirmation dialog box is displayed where you confirm the erasure. However, if your `.board` file specifies two or more flash memories, the **Erase Memory** dialog box is displayed. See *Erase Memory dialog box*, page 227.

Table 52: Project menu commands (Continued)

Erase Memory dialog box

Note that the **Erase Memory** dialog box is only available if your product package supports the IAR Embedded Workbench flash loader mechanism.

In the **Erase Memory** dialog box—displayed when you have chosen the **Project>Erase Memory** command and your flash memory system configuration file (filename extension `.board`) specifies two or more flash memories—you can to erase one or more of the flash memories.



Flash loader	Range
☑ C:\projects\tutor\Actel\FlashA2FxxxM3F.flash	0x0 - 0xfff
☑ C:\projects\tutor\Actel\FlashA4HxxxM3F.flash	0x1000 - 0x2000

Figure 111: Erase Memory dialog box

Each line lists the path to the flash memory device configuration file (filename extension `.flash`) and the associated memory range. Select the memory you want to erase.

These buttons are available:

Erase all	All memories listed in the dialog box are erased, regardless of individually selected lines.
Erase	Erases the selected memories.
Cancel	Cancels the dialog box.

Argument variables summary

You can use these argument variables for paths and arguments:

Variable	Description
`$CONFIG_NAME$`	The name of the current build configuration, for example Debug or Release.
`$CUR_DIR$`	Current directory
`$CUR_LINE$`	Current line
`$DATE$`	Todays date
`$EW_DIR$`	Top directory of IAR Embedded Workbench, for example `c:\program files\iar systems\embedded workbench 6.`*`n`*
`$EXE_DIR$`	Directory for executable output
`$FILE_BNAME$`	Filename without extension

Table 53: Argument variables

Variable	Description
`$FILE_BPATH$`	Full path without extension
`$FILE_DIR$`	Directory of active file, no filename
`$FILE_FNAME$`	Filename of active file without path
`$FILE_PATH$`	Full path of active file (in Editor, Project, or Message window)
`$LIST_DIR$`	Directory for list output
`$OBJ_DIR$`	Directory for object output
`$PROJ_DIR$`	Project directory
`$PROJ_FNAME$`	Project file name without path
`$PROJ_PATH$`	Full path of project file
`$TARGET_DIR$`	Directory of primary output file
`$TARGET_BNAME$`	Filename without path of primary output file and without extension
`$TARGET_BPATH$`	Full path of primary output file without extension
`$TARGET_FNAME$`	Filename without path of primary output file
`$TARGET_PATH$`	Full path of primary output file
`$TOOLKIT_DIR$`	Directory of the active product, for example `c:\program files\iar systems\embedded workbench 6.`*`n`*`\`*`cpuname`*
`$USER_NAME$`	Your host login name
`$_`*`ENVVAR`*`_$`	The environment variable *ENVVAR*. Any name within `$_` and `_$` will be expanded to that system environment variable.

Table 53: Argument variables (Continued)

Configurations for project dialog box

In the **Configuration for project** dialog box—available by choosing **Project>Edit Configurations**—you can define new build configurations for the selected project; either entirely new, or based on a previous project.

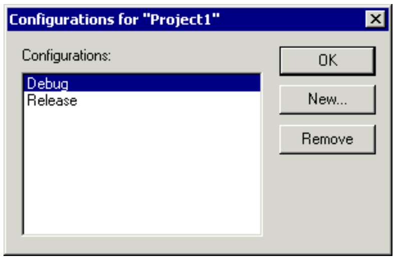


Figure 112: Configurations for project dialog box

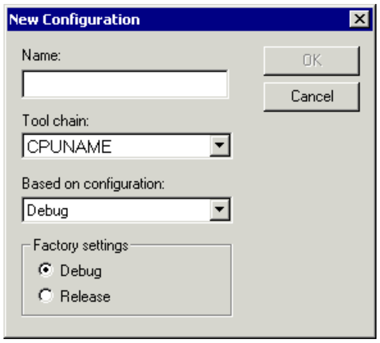
The dialog box contains the following:

Operation	Description
Configurations	Lists existing configurations, which can be used as templates for new configurations.
New	Opens a dialog box where you can define new build configurations.
Remove	Removes the configuration that is selected in the **Configurations** list.

Table 54: Configurations for project dialog box options

New Configuration dialog box

In the **New Configuration** dialog box—available by clicking **New** in the **Configurations for project** dialog box—you can define new build configurations; either entirely new, or based on any currently defined configuration.



Name:
Tool chain: CPUNAME
Based on configuration: Debug
Factory settings
[✓ Debug]
Release

Figure 113: New Configuration dialog box

The dialog box contains the following:

Item	Description
Name	The name of the build configuration.
Tool chain	The target to build for. If you have several versions of IAR Embedded Workbench for different targets installed on your host computer, the drop-down list can contain these targets.
Based on configuration	A currently defined build configuration that you want the new configuration to be based on. The new configuration will inherit the project settings and information about the factory settings from the old configuration. If you select None, the new configuration will have default factory settings and not be based on an already defined configuration.

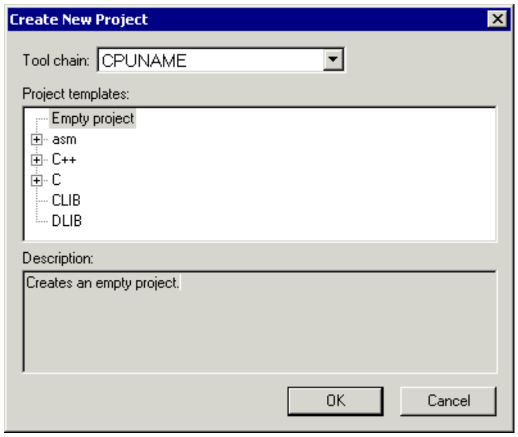
Table 55: New Configuration dialog box options

Item	Description
Factory settings	Specifies the default factory settings—either Debug or Release—that you want to apply to your new build configuration. These factory settings will be used by your project if you press the **Factory Settings** button in the **Options** dialog box.

Table 55: New Configuration dialog box options (Continued)

Create New Project dialog box

The **Create New Project** dialog box is available from the **Project** menu, and lets you create a new project based on a template project. Template projects are available for C/C++ applications, assembler applications, and library projects. You can also create your own template projects.



Creates an empty project.

Figure 114: Create New Project dialog box

The dialog box contains the following:

Item	Description
Tool chain	The target to build for. If you have several versions of IAR Embedded Workbench for different targets installed on your host computer, the drop-down list can contain these targets.
Project templates	Lists all available template projects that you can base a new project on.

Table 56: Description of Create New Project dialog box

Options dialog box

The **Options** dialog box is available from the **Project** menu.

In the **Category** list you can select the build tool for which you want to set options. The options available in the **Category** list will depend on the tools installed in your IAR Embedded Workbench IDE, and will typically include these options:

Category	Description
General Options	General options
C/C++ Compiler	IAR C/C++ Compiler options
Assembler	IAR Assembler options
Output Converter	Options for converting ELF output to Motorola or Intel-standard. These options are only available if your product package includes the ILINK linker.
Custom Build	Options for extending the toolchain
Build Actions	Options for pre-build and post-build actions
Linker	Linker options. This category is available for application projects.
Library Builder	Library builder options. This category is available for library projects.
Debugger	IAR C-SPY Debugger options
Simulator	Simulator-specific options

Table 57: Project option categories

Note: Additional debugger categories might be available depending on the debugger drivers installed.

Selecting a category displays one or more pages of options for that component of the IDE.

For detailed information about each option, see the option reference chapters:

- *General options*
- *Compiler options*
- *Assembler options*
- *Converter options*
- *Custom build options*
- *Build actions options*
- *XLINK linker options*
- *ILINK linker options*

- *Library builder options*
- *Debugger options*.

For information about the options related to available hardware debugger systems, see the online help system.

Batch Build dialog box

The **Batch Build** dialog box—available by choosing **Project>Batch build**—lists all defined batches of build configurations.

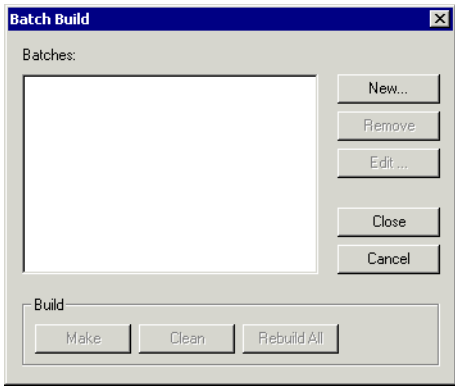


Figure 115: Batch Build dialog box

The dialog box contains the following:

Item	Description
Batches	Lists all currently defined batches of build configurations.
New	Displays the **Edit Batch Build** dialog box, where you can define new batches of build configurations.
Remove	Removes the selected batch.
Edit	Displays the **Edit Batch Build** dialog box, where you can modify already defined batches.
Build	Consists of the three build commands **Make**, **Clean**, and **Rebuild All**.

Table 58: Description of the Batch Build dialog box

Edit Batch Build dialog box

In the **Edit Batch Build** dialog box—available from the **Batch Build** dialog box—you can create new batches of build configurations, and edit already existing batches.

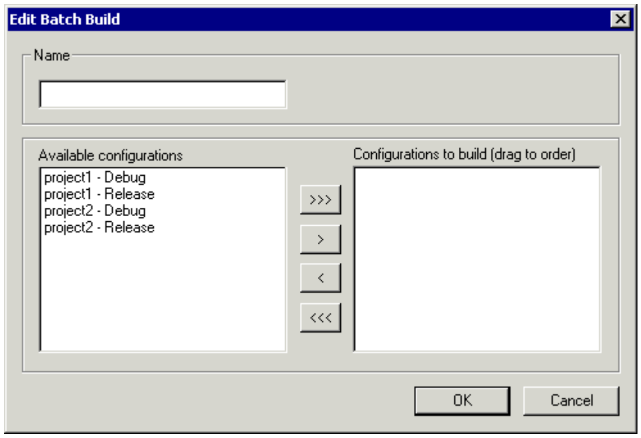


Figure 116: Edit Batch Build dialog box

The dialog box contains the following:

Item	Description
Name	The name of the batch.
Available configurations	Lists all build configurations that are part of the workspace.
Configurations to build	Lists all the build configurations you select to be part of a named batch.

Table 59: Description of the Edit Batch Build dialog box

To move appropriate build configurations from the **Available configurations** list to the **Configurations to build** list, use the arrow buttons. Note also that you can drag the build configurations in the **Configurations to build** field to specify the order between the build configurations.

TOOLS MENU

The **Tools** menu provides commands for customizing the environment, such as changing common fonts and shortcut keys.

It is a user-configurable menu to which you can add tools for use with IAR Embedded Workbench. Thus, it might look different depending on which tools have been preconfigured to appear as menu items. See *Configure Tools dialog box*, page 257.

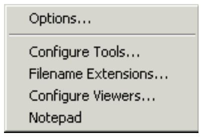


Figure 117: Tools menu

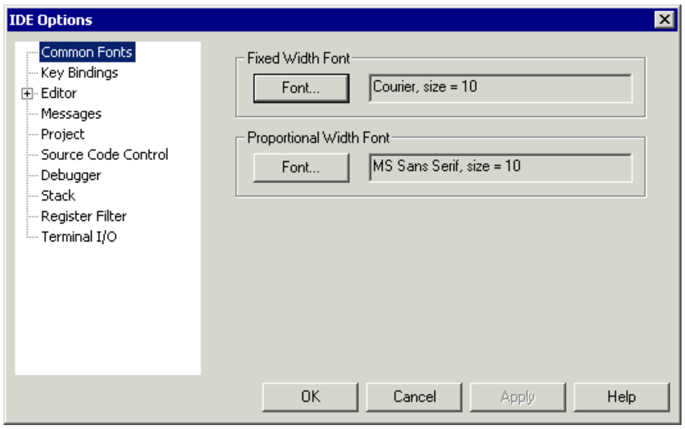
Tools menu commands

Menu command	Description
Options	Displays the **IDE Options** dialog box where you can customize the IDE. In the left side of the dialog box, select a category and the corresponding options are displayed in the right side of the dialog box. Which categories that are available in this dialog box depends on your IDE configuration, and whether the IDE is in a debugging session or not.
Configure Tools	Displays a dialog box where you can set up the interface to use external tools.
Filename Extensions	Displays a set of dialog boxes where you can define the filename extensions to be accepted by the build tools.
Configure Viewers	Displays a dialog box where you can configure viewer applications to open documents with.
Notepad	User-configured. This is an example of a user-configured addition to the Tools menu.

Table 60: Tools menu commands

COMMON FONTS OPTIONS

Use the **Common Fonts** options—available by choosing **Tools>Options**—for configuring the fonts used for all project windows except the editor windows.



Fixed Width Font

Font... Courier, size = 10

Proportional Width Font

Font... MS Sans Serif, size = 10

Figure 118: Common Fonts options

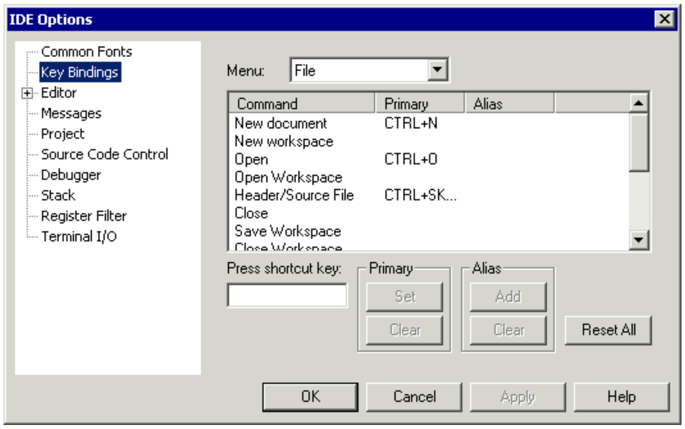
With the **Font** buttons you can change the fixed and proportional width fonts, respectively.

Any changes to the **Fixed Width Font** options will apply to the Disassembly, Register, and Memory windows. Any changes to the **Proportional Width Font** options will apply to all other windows.

None of the settings made on this page apply to the editor windows. For information about how to change the font in the editor windows, see *Editor Colors and Fonts options*, page 245.

KEY BINDINGS OPTIONS

Use the **Key Bindings** options—available by choosing **Tools>Options**—to customize the shortcut keys used for the IDE menu commands.



Menu: File

Command	Primary	Alias
New document	CTRL+N	
New workspace		
Open	CTRL+O	
Open Workspace		
Header/Source File	CTRL+SK...	
Close		
Save Workspace		

Figure 119: Key Bindings options

Menu

Use the drop-down list to choose the menu you want to edit. Any currently defined shortcut keys are shown in the scroll list under the drop-down list.

Command

All commands available on the selected menu are listed in the **Commands** column. Select the menu command for which you want to configure your own shortcut keys.

Press shortcut key

Use the text field to type the key combination you want to use as shortcut key. You cannot set or add a shortcut if it is already used by another command.

Primary

The shortcut key will be displayed next to the command on the menu. Click the **Set** button to set the combination for the selected command, or the **Clear** button to delete the shortcut.

Alias

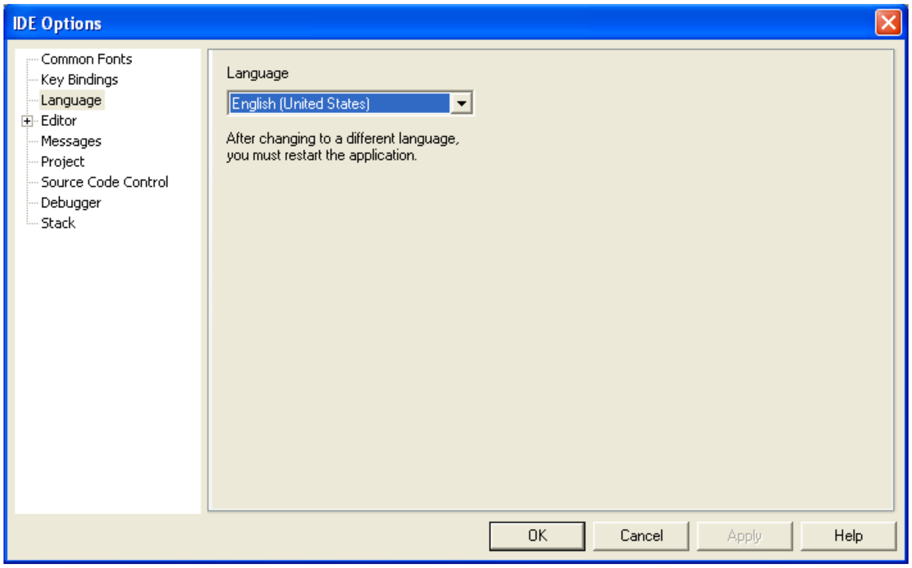
The shortcut key will work but not be displayed on the menu. Click either the **Add** button to make the key take effect for the selected command, or the **Clear** button to delete the shortcut.

Reset All

Reverts all command shortcut keys to the factory settings.

LANGUAGE OPTIONS

Use the **Language** options—available by choosing **Tools>Options**—to specify the language to be used in windows, menus, dialog boxes, etc.



Language

English (United States)

After changing to a different language, you must restart the application.

Figure 120: Language options

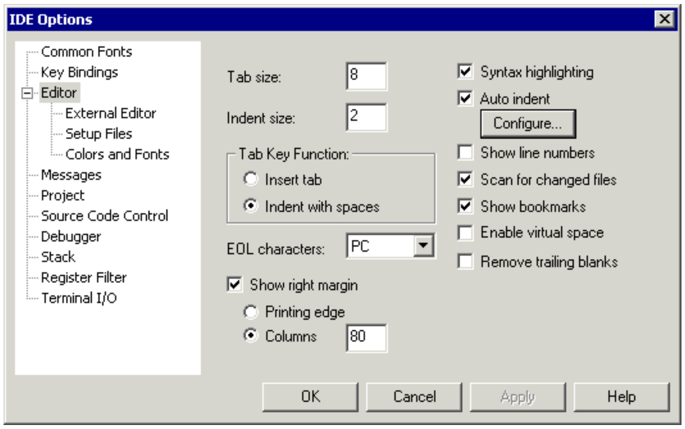
Language

Use the drop-down list to choose the language to be used. The available languages depend on your product package.

Note: If you have IAR Embedded Workbench IDE installed for several different toolchains in the same directory, the IDE might be in mixed languages if the toolchains are available in different languages.

EDITOR OPTIONS

Use the **Editor** options—available by choosing **Tools>Options**—to configure the editor.



Tab size: 8
Indent size: 2
Tab Key Function: [ ] Insert tab [✓ Indent with spaces]
EOL characters: PC
[✓] Show right margin
[ ] Printing edge [✓ Columns] 80
[✓] Syntax highlighting
[✓] Auto indent
[ ] Show line numbers
[✓] Scan for changed files
[✓] Show bookmarks
[ ] Enable virtual space
[ ] Remove trailing blanks

Figure 121: Editor options

For more information about the IAR Embedded Workbench IDE Editor and how to use it, see *Editing*, page 79.

Tab size

Use this option to specify the number of character spaces corresponding to each tab.

Indent size

Use this option to specify the number of character spaces to be used for indentation.

Tab Key Function

Use this option to specify how the Tab key is used. Choose between:

- **Insert tab**
- **Indent with spaces**.

EOL character

Use this option to select the line break character to be used when editor documents are saved. Choose between:

PC (default)	Windows and DOS end of line characters. The PC format is used by default.
Unix	UNIX end of line characters.
Preserve	The same end of line character as the file had when it was opened, either PC or UNIX. If both types or neither type are present in the opened file, PC end of line characters are used.

Show right margin

The area of the editor window outside the right-side margin is displayed as a light gray field. You can choose to set the size of the text field between the left-side margin and the right-side margin. Choose to set the size based on:

Printing edge	Size based on the printable area which is based on general printer settings.
Columns	Size based on number of columns.

Syntax highlighting

Use this option to make the editor display the syntax of C or C++ applications in different text styles.

To read more about syntax highlighting, see *Editor Colors and Fonts options*, page 245, and *Syntax coloring*, page 81.

Auto indent

Use this option to ensure that when you press Return, the new line is indented automatically. For C/C++ source files, indentation is performed as configured in the **Configure Auto Indent** dialog box. Click the **Configure** button to open the dialog box where you can configure the automatic indentation; see *Configure Auto Indent dialog box*, page 241. For all other text files, the new line will have the same indentation as the previous line.

Show line numbers

Use this option to display line numbers in the editor window.

Scan for changed files

Use this option to reload files that have been modified by another tool.

If a file is open in the IDE, and the same file has concurrently been modified by another tool, the file will be automatically reloaded in the IDE. However, if you already started to edit the file, you will be prompted before the file is reloaded.

Show bookmarks

Use this option to display a column on the left side in the editor window, with icons for compiler errors and warnings, **Find in Files** results, user bookmarks and breakpoints.

Enable virtual space

Use this option to allow the insertion point to move outside the text area.

Remove trailing blanks

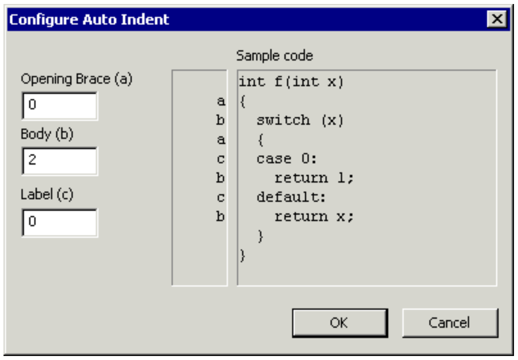
Use this option to remove trailing blanks from files when they are saved to disk. Trailing blanks are blank spaces between the last non-blank character and the end of line character.

CONFIGURE AUTO INDENT DIALOG BOX

Use the **Configure Auto Indent** dialog box to configure the automatic indentation performed by the editor for C/C++ source code. To open the dialog box:

1. Choose **Tools>Options**.
2. Click the **Editor** tab.
3. Select the **Auto indent** option.

4 Click the **Configure** button.



```
a  int f(int x)
b  {
a    switch (x)
c    {
b    case 0:
c      return 1;
b    default:
       return x;
     }
   }
```

Figure 122: Configure Auto Indent dialog box

To read more about indentation, see *Automatic text indentation*, page 82.

Opening Brace (a)

Use the text box to type the number of spaces used for indenting an opening brace.

Body (b)

Use the text box to type the number of additional spaces used for indenting code after an opening brace, or a statement that continues onto a second line.

Label (c)

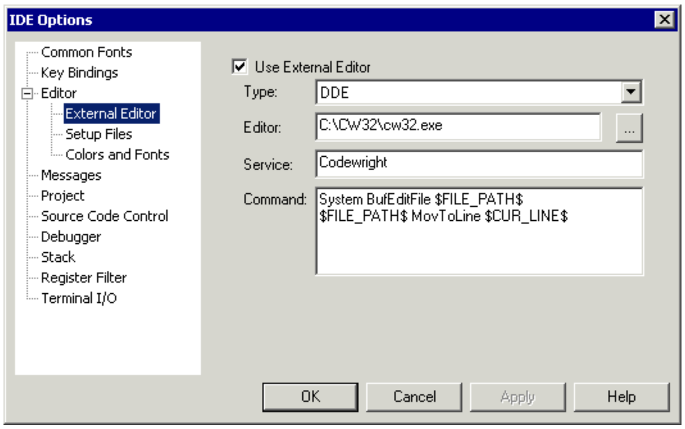
Use the text box to type the number of additional spaces used for indenting a label, including case labels.

Sample code

This area reflects the settings made in the text boxes for indentation. All indentations are relative to the preceding line, statement, or other syntactic structures.

EXTERNAL EDITOR OPTIONS

Use the **External Editor** options—available by choosing **Tools>Options**—to specify an external editor of your choice.



Use External Editor [✓]

Type: DDE

Editor: C:\CW32\cw32.exe

Service: Codewright

Command:
```
System BufEditFile $FILE_PATH$
$FILE_PATH$ MovToLine $CUR_LINE$
```

Figure 123: External Editor options

Note: The appearance of this dialog box depends on the setting of the **Type** option.

See also *Using an external editor*, page 86.

Use External Editor

Use this option to enable the use of an external editor.

Type

Use the drop-down list to select the type of interface. Choose between:

- **Command Line**
- **DDE** (Windows Dynamic Data Exchange).

Editor

Use the text field to specify the filename and path of your external editor. A browse button is available for your convenience.

Arguments

Use the text field to specify any arguments to pass to the editor. Only applicable if you have selected **Command Line** as the interface type, see *Type*, page 243.

Service

Use the text field to specify the DDE service name used by the editor. Only applicable if you have selected **DDE** as the interface type, see *Type*, page 243.

The service name depends on the external editor that you are using. Refer to the user documentation of your external editor to find the appropriate settings.

Command

Use the text field to specify a sequence of command strings to send to the editor. The command strings should be typed as:

```
DDE-Topic CommandString
DDE-Topic CommandString
```

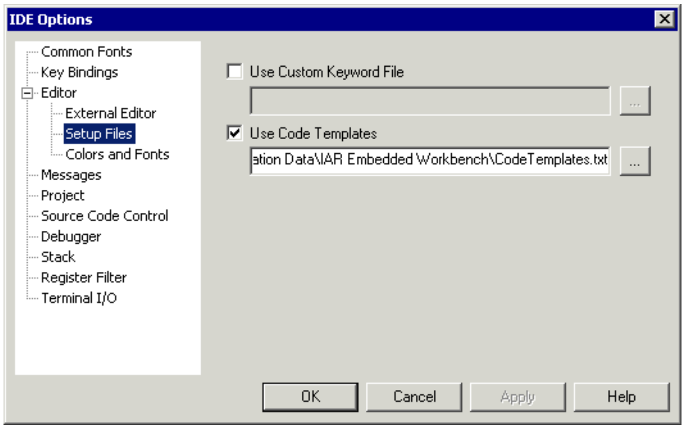
Only applicable if you have selected **DDE** as the interface type, see *Type*, page 243.

The command strings depend on the external editor that you are using. Refer to the user documentation of your external editor to find the appropriate settings.

Note: You can use variables in arguments. See *Argument variables summary*, page 228, for information about available argument variables.

EDITOR SETUP FILES OPTIONS

Use the **Editor Setup Files** options—available by choosing **Tools>Options**—to specify setup files for the editor.



IDE Options

- Common Fonts
- Key Bindings
- Editor
  - External Editor
  - Setup Files
  - Colors and Fonts
- Messages
- Project
- Source Code Control
- Debugger
- Stack
- Register Filter
- Terminal I/O

☐ Use Custom Keyword File

☑ Use Code Templates

ation Data\IAR Embedded Workbench\CodeTemplates.txt

Figure 124: Editor Setup Files options

Use Custom Keyword File

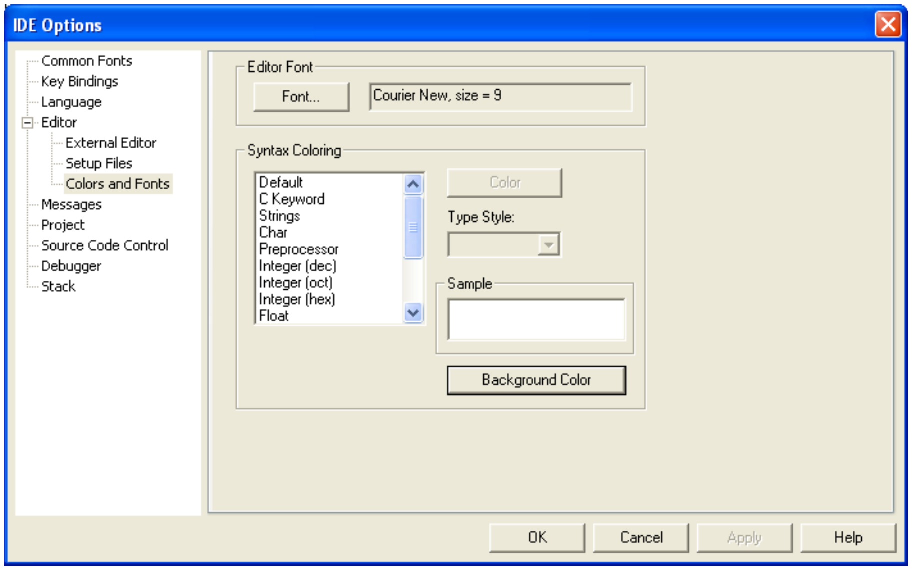
Use this option to specify a text file containing keywords that you want the editor to highlight. For information about syntax coloring, see *Syntax coloring*, page 81.

Use Code Templates

Use this option to specify a text file with code templates that you can use for inserting frequently used code in your source file. For information about using code templates, see *Using and adding code templates*, page 83.

EDITOR COLORS AND FONTS OPTIONS

Use the **Editor Colors and Fonts** options—available by choosing **Tools>Options**—to specify the colors and fonts used for text in the editor windows.



Courier New, size = 9

Figure 125: Editor Colors and Fonts options

Editor Font

Press the **Font** button to open the standard **Font** dialog box where you can choose the font and its size to be used in editor windows.

Syntax Coloring

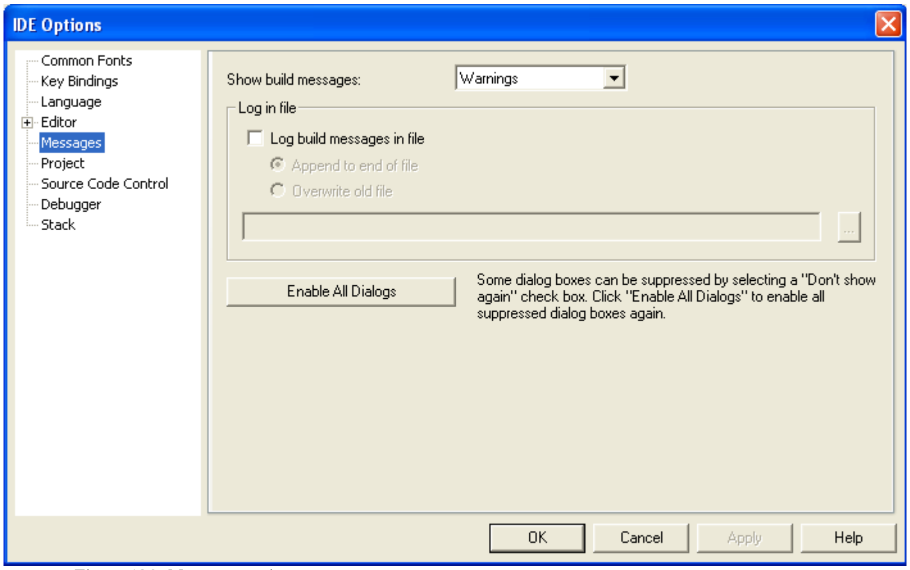
Use the **Syntax Coloring** options to choose the color and type style for selected item. Use these options:

Scroll-bar list	Lists the possible items for which you can specify color and type style. Select an item in the list and choose the color and type style for it. Note that the **User keyword** list entry refers to the keywords that you have listed in the custom keyword file, see *Use Custom Keyword File*, page 245.
Color	Provides a list of colors to choose from for the selected element. Choose **Custom** from the list to define your own color. The standard Windows **Color** dialog box appears.
Type Style	Provides a list of type styles to choose from.
Sample	Displays the current setting for the selected item.
Background Color	Provides a list of background colors to choose from for the editor window.

The keywords controlling syntax highlighting for assembler and C or C++ source code are specified in the files `syntax_icc.cfg` and `syntax_asm.cfg`, respectively. These files are located in the `config` directory.

MESSAGES OPTIONS

Use the **Messages** options—available by choosing **Tools>Options**—to choose the amount of output in the Build messages window.



Some dialog boxes can be suppressed by selecting a "Don't show again" check box. Click "Enable All Dialogs" to enable all suppressed dialog boxes again.

Figure 126: Messages option

Show build messages

Use this drop-down menu to specify the amount of output in the Build messages window. Choose between:

All	Shows all messages, including compiler and linker information.
Messages	Shows messages, warnings, and errors.
Warnings	Shows warnings and errors.
Errors	Shows errors only.

Log File

Use these options to write build messages to a log file. To enable the options, select the **Enable build log file** option. Choose between:

Append to end of file	Appends the messages at the end of the specified file.

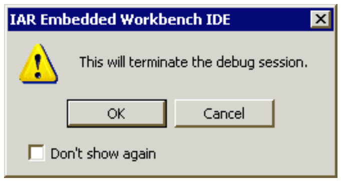
Overwrite old file	Replaces the contents in the file you specify.

Type the filename you want to use in the text box. A browse button is available for your convenience.

Enable All Dialogs

The **Enable All Dialogs** button enables all suppressed dialog boxes.

You can suppress some dialog boxes by selecting a **Don't show again** check box, for example:



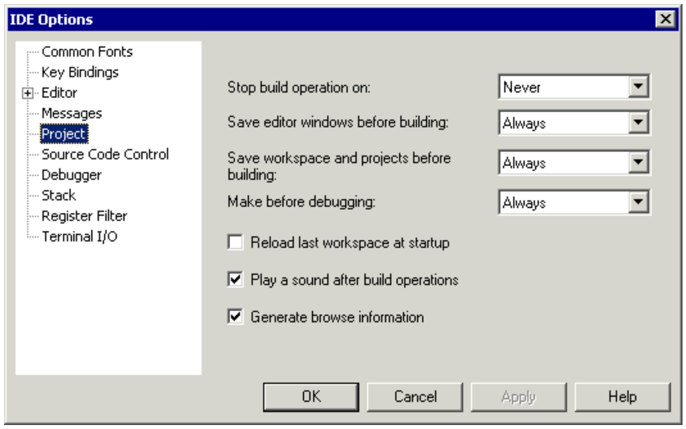
This will terminate the debug session.

☐ Don't show again

Figure 127: Message dialog box containing a Don't show again option

PROJECT OPTIONS

Use the **Project** options—available by choosing **Tools>Options**—to set options for the **Make** and **Build** commands.



Stop build operation on: Never

Save editor windows before building: Always

Save workspace and projects before building: Always

Make before debugging: Always

☐ Reload last workspace at startup

☑ Play a sound after build operations

☑ Generate browse information

Figure 128: Project options

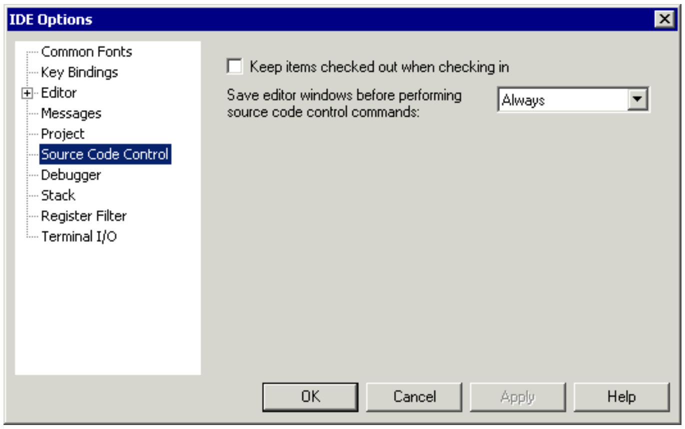
These options are available:

Option	Description
Stop build operation on	Specifies when the build operation should stop. **Never**: Do not stop. **Warnings**: Stop on warnings and errors. **Errors**: Stop on errors.
Save editor windows before building	**Always**: Always save before Make or Build. **Ask**: Prompt before saving. **Never**: Do not save.
Save workspace and projects before building	**Always**: Always save before Make or Build. **Ask**: Prompt before saving. **Never**: Do not save.
Make before debugging	**Always**: Always perform the **Make** command before debugging. **Ask**: Always prompt before performing the **Make** command. **Never**: Do not perform the **Make** command before debugging.
Reload last workspace at startup	Select this option if you want the last active workspace to load automatically the next time you start IAR Embedded Workbench.
Play a sound after build operations	Plays a sound when the build operations are finished.
Generate browse information	Enables the use of the Source Browser window, see *Source Browser window*, page 198.

Table 61: Project IDE options

SOURCE CODE CONTROL OPTIONS

Use the **Source Code Control** options—available by choosing **Tools>Options**—to configure the interaction between an IAR Embedded Workbench project and an SCC project.



☐ Keep items checked out when checking in

Save editor windows before performing source code control commands: Always

Figure 129: Source Code Control options

Keep items checked out when checking in

Determines the default setting for the option **Keep Checked Out** in the **Check In Files** dialog box; see *Check In Files dialog box*, page 189.

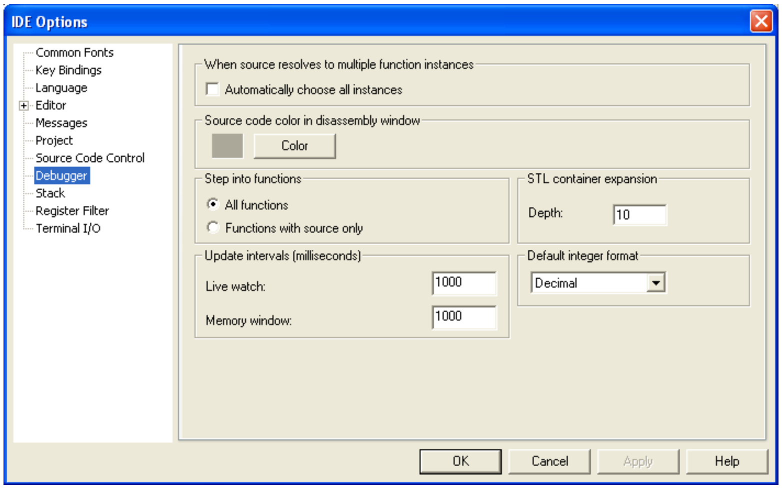
Save editor windows before performing source code control commands

Specifies whether editor windows should be saved before you perform any source code control commands. Choose between:

Ask	When you perform any source code control commands, you will be asked about saving editor windows first.
Never	Editor windows will *never* be saved first when you perform any source code control commands.
Always	Editor windows will *always* be saved first when you perform any source code control commands.

DEBUGGER OPTIONS

Use the **Debugger** options—available by choosing **Tools>Options**—for configuring the debugger environment.



IDE Options

- Common Fonts
- Key Bindings
- Language
- Editor
- Messages
- Project
- Source Code Control
- Debugger
- Stack
- Register Filter
- Terminal I/O

When source resolves to multiple function instances
☐ Automatically choose all instances

Source code color in disassembly window
Color

Step into functions
(●) All functions
( ) Functions with source only

STL container expansion
Depth: 10

Update intervals (milliseconds)
Live watch: 1000
Memory window: 1000

Default integer format
Decimal

Figure 130: Debugger options

When source resolves to multiple function instances

Some source code corresponds to multiple code instances, for example template code. When specifying a source location in such code, for example when setting a source breakpoint, you can make C-SPY act on all instances or a subset of instances. Use the **Automatically choose all instances** option to let C-SPY act on all instances without asking first.

Source code color in disassembly window

Use the **Color** button to select the color of the source code in the Disassembly window. To define your own color, choose **Custom** from the list of colors. The standard Windows **Color** dialog box appears.

Step into functions

Use this option to control the behavior of the **Step Into** command. Choose between:

All functions	The debugger will step into all functions.

Functions with source only	The debugger will only step into functions for which the source code is known. This helps you avoid stepping into library functions or entering disassembly mode debugging.

STL container expansion

The **Depth** value decides how many elements that are shown initially when a container value is expanded in, for example, the Watch window. To show additional elements, click the expansion arrow.

Update intervals

The **Update intervals** options specify how often the contents of the Live Watch window and the Memory window are updated.

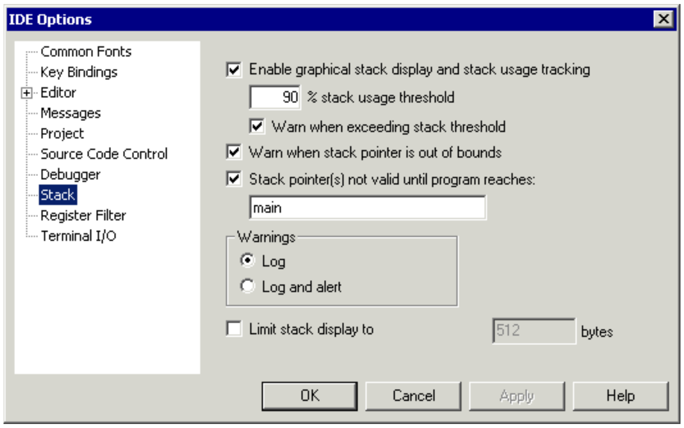
These options are available if the C-SPY driver you are using has access to the target system memory while executing your application.

Default integer format

Use the drop-down list to set the default integer format in the Watch, Locals, and related windows.

STACK OPTIONS

Use the **Stack** options—available by choosing **Tools>Options** or from the context menu in the Memory window—to set options specific to the Stack window.



[✓] Enable graphical stack display and stack usage tracking
90 % stack usage threshold
[✓] Warn when exceeding stack threshold
[✓] Warn when stack pointer is out of bounds
[✓] Stack pointer(s) not valid until program reaches:
main
Warnings
[✓ Log]
Log and alert
[ ] Limit stack display to 512 bytes

Figure 131: Stack options

Enable graphical stack display and stack usage tracking

Use this option to enable the graphical stack bar available at the top of the Stack window. At the same time, it enables the functionality needed to detect stack overflows. To read more about the stack bar and the information it provides, see *The graphical stack bar*, page 296.

% stack usage threshold

Use this text field to specify the percentage of stack usage above which C-SPY should issue a warning for stack overflow.

Warn when exceeding stack threshold

Use this option to make C-SPY issue a warning when the stack usage exceeds the threshold specified in the **% stack usage threshold** option.

Warn when stack pointer is out of bounds

Use this option to make C-SPY issue a warning when the stack pointer is outside the stack memory range.

Stack pointer(s) not valid until reaching

Use this option to specify a *location* in your application code from where you want the stack display and verification to occur. The Stack window will not display any information about stack usage until execution has reached this location. By default, C-SPY will not track the stack usage before the `main` function. If your application does not have a `main` function, for example, if it is an assembler-only project, you should specify your own start label. If this option is used, after each reset C-SPY keeps a breakpoint on the given location until it is reached.

Typically, the stack pointer is set up in the system initialization code `cstartup`, but not necessarily from the very first instruction. If you use this option, you can avoid incorrect warnings or misleading stack display for this part of the application.

Warnings

You can choose to issue warnings using one of these options:

Log	Warnings are issued in the Debug Log window
Log and alert	Warnings are issued in the Debug Log window and as alert dialog boxes.

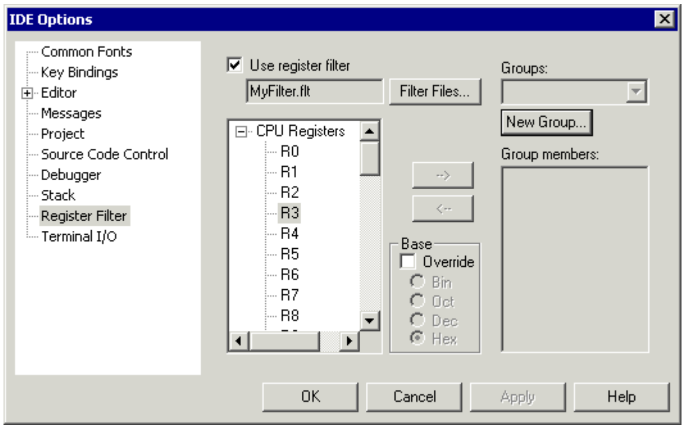
Limit stack display to

Use this option to limit the amount of memory displayed in the Stack window by specifying a number, counting from the stack pointer. This can be useful if you have a big stack or if you are only interested in the topmost part of the stack. Using this option can improve the Stack window performance, especially if reading memory from the target system is slow. By default, the Stack window shows the whole stack, or in other words, from the stack pointer to the bottom of the stack. If the debugger cannot determine the memory range for the stack, the byte limit is used even if the option is not selected.

Note: The Stack window does not affect the execution performance of your application, but it might read a large amount of data to update the displayed information when the execution stops.

REGISTER FILTER OPTIONS

Use the **Register Filter** options—available by choosing **Tools>Options** when the debugger is running—to display registers in the Register window in groups you have created yourself. For more information about register groups, see *Register groups*, page 127.



[✓] Use register filter: MyFilter.flt
Base: [ ] Override; Hex selected

Figure 132: Register Filter options

These options are available:

Option	Description
Use register filter	Enables the usage of register filters.

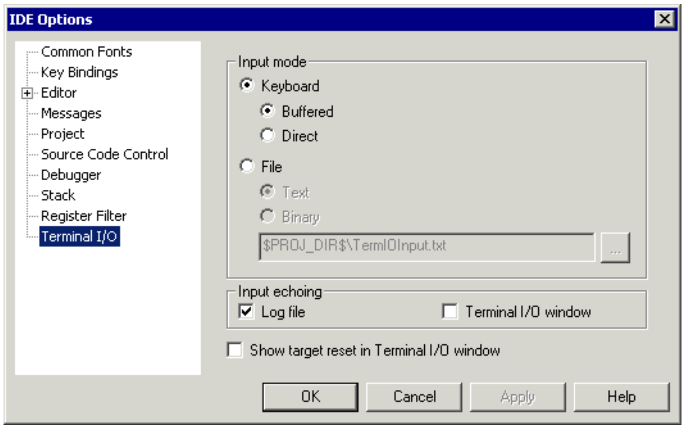
Table 62: Register Filter options

Option	Description
Filter Files	Displays a dialog box where you can select or create a new filter file.
Groups	Lists available groups in the register filter file, alternatively displays the new register group.
New Group	The name for the new register group.
Group members	Lists the registers selected from the register scroll bar window.
Base	Changes the default integer base.

Table 62: Register Filter options (Continued)

TERMINAL I/O OPTIONS

Use the **Terminal I/O** options—available by choosing **Tools>Options** when the debugger is running—to configure the C-SPY terminal I/O functionality.



Input mode
- (●) Keyboard
  - (●) Buffered
  - ( ) Direct
- ( ) File
  - (●) Text
  - ( ) Binary
  - $PROJ_DIR$\TermIOInput.txt

Input echoing
- [✓] Log file
- [ ] Terminal I/O window

[ ] Show target reset in Terminal I/O window

Figure 133: Terminal I/O options

Keyboard

Use the **Keyboard** option to make the input characters be read from the keyboard. Choose between:

Buffered	Input characters are buffered.
Direct	Input characters are not buffered.

File

Use the **File** option to make the input characters be read from a file. A browse button is available for locating the file. Choose between:

Text	Input characters are read from a text file.
Binary	Input characters are read from a binary file.

Input Echoing

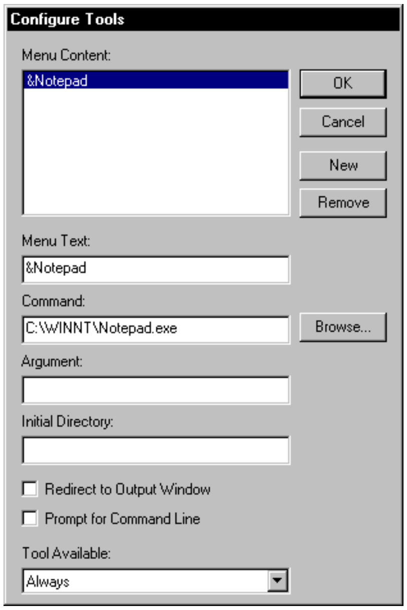
Input characters can be echoed either in a log file, or in the C-SPY Terminal I/O window. To echo input in a file requires that you have enabled the option **Debug>Logging>Enable log file**.

Show target reset in Terminal I/O window

When the target resets, a message is displayed in the C-SPY Terminal I/O window.

CONFIGURE TOOLS DIALOG BOX

In the **Configure Tools** dialog box—available from the **Tools** menu—you can specify a user-defined tool to add to the Tools menu.


Configure Tools

Menu Content: &Notepad

Menu Text: &Notepad

Command: C:\WINNT\Notepad.exe

Argument:

Initial Directory:

Redirect to Output Window [ ]

Prompt for Command Line [ ]

Tool Available: Always

Figure 134: Configure Tools dialog box

Note: If you intend to add an external tool to the standard build toolchain, see *Extending the toolchain*, page 75.

These options are available:

Option	Description
Menu Content	Lists all available user defined menu commands.
Menu Text	Specifies the text for the menu command. If you add the sign `&`, the following letter, `N` in this example, will appear as the mnemonic key for this command. The text you type in this field will be reflected in the **Menu Content** field.
Command	Specifies the command, and its path, to be run when you choose the command from the menu. A browse button is available for your convenience.

Table 63: Configure Tools dialog box options

Option	Description
Argument	Optionally type an argument for the command.
Initial Directory	Specifies an initial working directory for the tool.
Redirect to Output window	Specifies any console output from the tool to the **Tool Output** page in the Messages window. Tools that are launched with this option cannot receive any user input, for instance input from the keyboard. Tools that *require* user input or make special assumptions regarding the console that they execute in, will *not* work at all if launched with this option.
Prompt for Command Line	Displays a prompt for the command line argument when the command is chosen from the **Tools** menu.
Tool Available	Specifies in which context the tool should be available, only when debugging or only when not debugging.

Table 63: Configure Tools dialog box options (Continued)

Note: You can use variables in the arguments, which allows you to set up useful tools such as interfacing to a command line revision control system, or running an external tool on the selected file.

To remove a command from the **Tools** menu, select it in this list and click **Remove**.

Click **OK** to confirm the changes you have made to the **Tools** menu.

The menu items you have specified will then be displayed on the **Tools** menu.

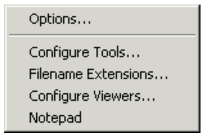


Figure 135: Customized Tools menu

Specifying command line commands or batch files

Command line commands or batch files must be run from a command shell, so to add these to the **Tools** menu you can specify an appropriate command shell in the **Command** text box. These are the command shells that you can enter as commands:

Command shell	System
`cmd.exe`	Windows XP/Vista/7

Table 64: Command shells

For an example, see *Adding command line commands*, page 58.

FILENAME EXTENSIONS DIALOG BOX

In the **Filename Extensions** dialog box—available from the **Tools** menu—you can customize the filename extensions recognized by the build tools. This is useful if you have many source files that have a different filename extension.

If you have an IAR Embedded Workbench for a different microprocessor installed on your host computer, it can appear in the **Tool Chain** box. In that case you should select the toolchain you want to customize.

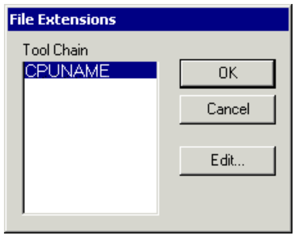


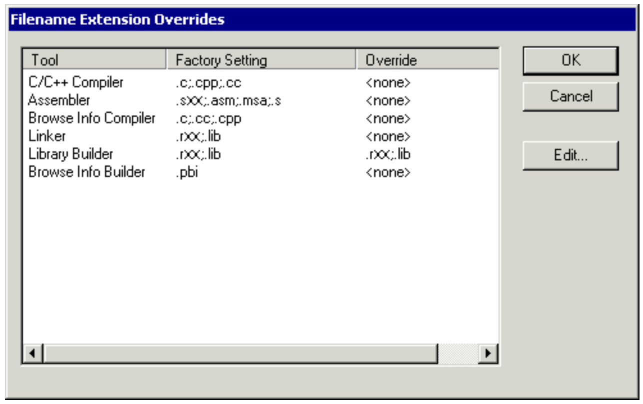
Figure 136: Filename Extensions dialog box

Note the `*` sign which indicates user-defined overrides. If there is no `*` sign, factory settings are used.

Click **Edit** to open the **Filename Extension Overrides** dialog box.

FILENAME EXTENSION OVERRIDES DIALOG BOX

The **Filename Extension Overrides** dialog box—available by clicking **Edit** in the **Filename Extensions** dialog box—lists the available tools in the build chain, their factory settings for filename extensions, and any defined overrides.


Filename Extension Overrides

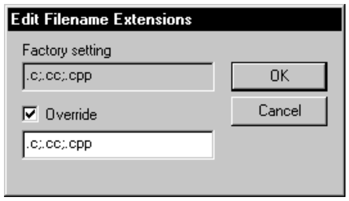
Tool	Factory Setting	Override
C/C++ Compiler	.c;.cpp;.cc	<none>
Assembler	.sxx;.asm;.msa;.s	<none>
Browse Info Compiler	.c;.cc;.cpp	<none>
Linker	.rxx;.lib	<none>
Library Builder	.rxx;.lib	.rxx;.lib
Browse Info Builder	.pbi	<none>

Figure 137: Filename Extension Overrides dialog box

Select the tool for which you want to define more recognized filename extensions, and click **Edit** to open the **Edit Filename Extensions** dialog box.

EDIT FILENAME EXTENSIONS DIALOG BOX

The **Edit File Extensions** dialog box—available by clicking **Edit** in the **Filename Extension Overrides** dialog box—lists the filename extensions accepted by default, and you can also define new filename extensions.


Edit Filename Extensions

Factory setting: .c;.cc;.cpp

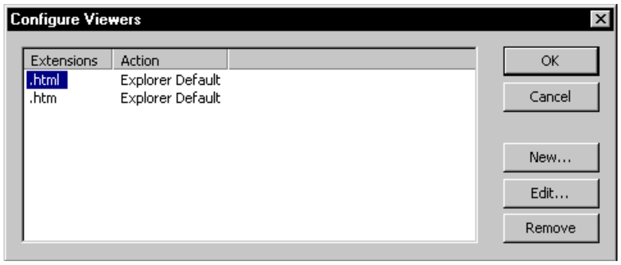
☑ Override: .c;.cc;.cpp

Figure 138: Edit Filename Extensions dialog box

Click **Override** and type the new filename extension you want to be recognized. Extensions can be separated by commas or semicolons, and should include the leading period.

CONFIGURE VIEWERS DIALOG BOX

The **Configure Viewers** dialog box—available from the **Tools** menu—lists the filename extensions of document formats that IAR Embedded Workbench can handle, and which viewer application that are used for opening the document type. **Explorer Default** in the **Action** column means that the default application associated with the specified type in Windows Explorer is used for opening the document type.



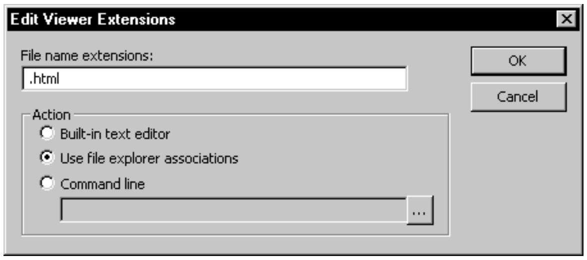
Extensions	Action
.html	Explorer Default
.htm	Explorer Default

Figure 139: Configure Viewers dialog box

To specify how to open a new document type or editing the setting for an existing document type, click **New** or **Edit** to open the **Edit Viewer Extensions** dialog box.

EDIT VIEWER EXTENSIONS DIALOG BOX

Type the filename extension for the document type—including the separating period (.)—in the **Filename extensions** box.



File name extensions: .html

Action
- ( ) Built-in text editor
- (✓) Use file explorer associations
- ( ) Command line

Figure 140: Edit Viewer Extensions dialog box

Then choose one of the **Action** options:

- **Built-in text editor**—select this option to open all documents of the specified type with the IAR Embedded Workbench text editor.
- **Use file explorer associations**—select this option to open all documents with the default application associated with the specified type in Windows Explorer.

- **Command line**—select this option and type or browse your way to the viewer application, and give any command line options you would like to the tool.

WINDOW MENU

Use the commands on the **Window** menu to manipulate the IDE windows and change their arrangement on the screen.

The last section of the **Window** menu lists the windows currently open on the screen. Choose the window you want to switch to.

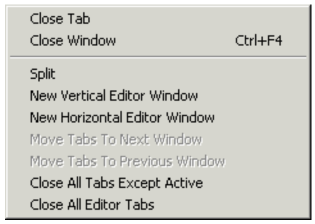

Close Tab
Close Window Ctrl+F4
Split
New Vertical Editor Window
New Horizontal Editor Window
Move Tabs To Next Window
Move Tabs To Previous Window
Close All Tabs Except Active
Close All Editor Tabs

Figure 141: Window menu

These commands are available on the Window menu:

Menu command		Description
Close Tab		Closes the active tab.
Close Window	CTRL+F4	Closes the active editor window.
Split		Splits an editor window horizontally or vertically into two, or four panes, to allow you to see more parts of a file simultaneously.
New Vertical Editor Window		Opens a new empty window next to current editor window.
New Horizontal Editor Window		Opens a new empty window under current editor window.
Move Tabs To Next Window		Moves all tabs in current window to next window.
Move Tabs To Previous Window		Moves all tabs in current window to previous window.
Close All Tabs Except Active		Closes all the tabs except the active tab.
Close All Editor Tabs		Closes all tabs currently available in editor windows.

Table 65: Window menu commands

HELP MENU

The **Help** menu provides help about IAR Embedded Workbench and displays the version numbers of the user interface and of the IDE.

You can also access the Information Center from the **Help** menu. The Information Center is an integrated navigation system that gives easy access to the information resources you need to get started and during your project development: tutorials, example projects, user guides, support information, and release notes. It also provides shortcuts to useful sections on the IAR Systems web site.

C-SPY reference

This chapter contains reference information about the windows, menus, menu commands, and the corresponding components that are specific for the IAR C-SPY® Debugger. This chapter contains the following sections:

- *C-SPY windows*, page 265
- *C-SPY menus*, page 300.

C-SPY windows

The following windows specific to C-SPY are available:

- C-SPY Debugger main window
- Disassembly window
- Memory window
- Symbolic Memory window
- Register window
- Watch window
- Locals window
- Statics window
- Auto window
- Live Watch window
- Quick Watch window
- Call Stack window
- Terminal I/O window
- Code Coverage window
- Profiling window
- Images window
- Stack window
- Symbols window.

Additional windows are available depending on which C-SPY driver you are using. For information about driver-specific windows, see the driver-specific documentation.

EDITING IN C-SPY WINDOWS

You can edit the contents of the Memory, Symbolic Memory, Register, Auto, Watch, Locals, Statics, Live Watch, and Quick Watch windows.

Use these keyboard keys to edit the contents of these windows:

Key	Description
Enter	Makes an item editable and saves the new value.
Esc	Cancels a new value.

Table 66: Editing in C-SPY windows

In windows where you can edit the **Expression** field, you can specify the number of elements to be displayed in the field by adding a semicolon followed by an integer. For example, to display only the three first elements of an array named `myArray`, or three elements in sequence starting with the element pointed to by a pointer, write:

```
myArray;3
```

Optionally, add a comma and another integer that specifies which element to start with. For example, to display elements 10–14, write:

```
myArray;5,10
```

C-SPY DEBUGGER MAIN WINDOW

When you start the debugger, these debugger-specific items appear in the main IAR Embedded Workbench IDE window:

- A dedicated debug menu with commands for executing and debugging your application
- Depending on the C-SPY driver you are using, a driver-specific menu. Typically, this menu contains menu commands for opening driver-specific windows and dialog boxes. See the driver-specific documentation for more information
- A special debug toolbar
- Several windows and dialog boxes specific to C-SPY.

The window might look different depending on which components you are using.

Each window item is explained in greater detail in the following sections.

Menu bar

In addition to the menus available in the development environment, the **Debug** menu is available when C-SPY is running. The **Debug** menu provides commands for executing and debugging the source application. Most of the commands are also available as icon buttons on the debug toolbar.

Additional menus might be available, depending on which debugger drivers have been installed; for information, see the driver-specific documentation.

Debug toolbar

The debug toolbar provides buttons for the most frequently-used commands on the **Debug** menu.

For a description of any button, point to it with the mouse pointer. When a command is not available the corresponding button is dimmed and you will not be able to select it.

This diagram shows the command corresponding to each button:

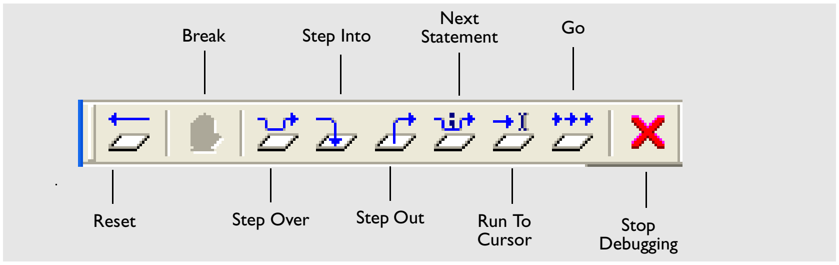
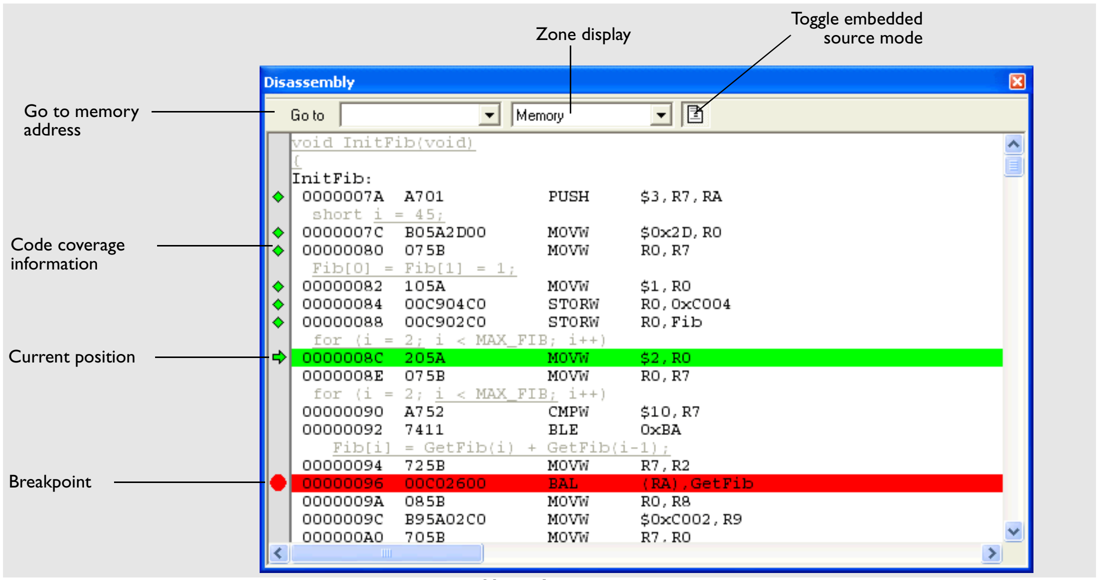


Figure 142: C-SPY debug toolbar

DISASSEMBLY WINDOW

The C-SPY Disassembly window—available from the **View** menu—shows the application being debugged as disassembled application code.



```
void InitFib(void)
{
InitFib:
 0000007A   A701          PUSH     $3,R7,RA
  short i = 45;
 0000007C   B05A2D00      MOVW     $0x2D,R0
 00000080   075B          MOVW     R0,R7
  Fib[0] = Fib[1] = 1;
 00000082   105A          MOVW     $1,R0
 00000084   00C904C0      STORW    R0,0xC004
 00000088   00C902C0      STORW    R0,Fib
  for (i = 2; i < MAX_FIB; i++)
 0000008C   205A          MOVW     $2,R0
 0000008E   075B          MOVW     R0,R7
  for (i = 2; i < MAX_FIB; i++)
 00000090   A752          CMPW     $10,R7
 00000092   7411          BLE      0xBA
    Fib[i] = GetFib(i) + GetFib(i-1);
 00000094   725B          MOVW     R7,R2
 00000096   00C02600      BAL      (RA),GetFib
 0000009A   085B          MOVW     R0,R8
 0000009C   B95A02C0      MOVW     $0xC002,R9
 000000A0   705B          MOVW     R7,R0
```

Figure 143: C-SPY Disassembly window

Toolbar

At toolbar at the top of the window provides these toolbar buttons:

Toolbar button	Description
Go to	The location you want to view. This can be a memory address, or the name of a variable, function, or label.
Zone display	Lists the available memory zones to display. Read more about Zones in the section *Memory addressing*, page 125.
Toggle Mixed-Mode	Toggles between showing only disassembled code or disassembled code together with the corresponding source code. Source code requires that the corresponding source file has been compiled with debug information.

Table 67: Disassembly window toolbar

The display area

The current position—highlighted in green—indicates the next assembler instruction to be executed. To move the cursor to any line in the Disassembly window, click on the line. Alternatively, move the cursor using the navigation keys. Double-click in the gray left-side margin of the window to set a breakpoint, which is indicated in red. Code that has been executed—code coverage—is indicated with a green diamond.

If instruction profiling has been enabled from the context menu, an extra column in the left-side margin appears with information about how many times each instruction has been executed.

To change the default color of the source code in the Disassembly window, choose **Tools>Options>Debugger**. Set the default color using the **Set source code coloring in Disassembly window** option.

To view the corresponding assembler code for a function, you can select it in the editor window and drag it to the Disassembly window.

Disassembly context menu

This is the context menu available in the Disassembly window:

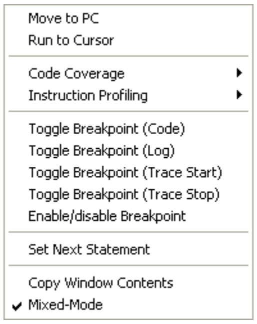


Figure 144: Disassembly window context menu

Note: The contents of this menu are dynamic, which means it might contain other commands than in this figure. All available commands are described in Table 68, *Disassembly context menu commands*.

These commands are available on the menu:

Menu command	Description
Move to PC	Displays code at the current program counter location.

Table 68: Disassembly context menu commands

Menu command	Description
Run to Cursor	Executes the application from the current position up to the line containing the cursor.
Code Coverage	Opens a submenu that provides commands for controlling code coverage. This command is only enabled if the driver you are using supports it. **Enable**, toggles code coverage on and off. **Show**, toggles the display of code coverage. Executed code is indicated by a green diamond. **Clear**, clears all code coverage information.
Instruction Profiling	Opens a submenu that provides commands for controlling instruction profiling. This command is only enabled if the driver you are using supports it. **Enable**, toggles instruction profiling on and off. **Show**, toggles the display of instruction profiling. For each instruction, the left-side margin displays how many times the instruction has been executed. **Clear**, clears all instruction profiling information.
Toggle Breakpoint (Code)	Toggles a code breakpoint. Assembler instructions at which code breakpoints have been set are highlighted in red. For information about code breakpoints, see *Code breakpoints dialog box*, page 202.
Toggle Breakpoint (Log)	Toggles a log breakpoint for trace printouts. Assembler instructions at which log breakpoints have been set are highlighted in red. For information about log breakpoints, see *Log breakpoints dialog box*, page 204.
Toggle Breakpoint (Trace Start)	Toggles a Trace Start breakpoint. When the breakpoint is triggered, the trace system is started. For information about Trace Start breakpoints, see *Trace Start breakpoints dialog box*, page 152. Note that this menu command is only available if the C-SPY driver you are using supports the trace system.
Toggle Breakpoint (Trace Stop)	Toggles a Trace Stop breakpoint. When the breakpoint is triggered, the trace system is stopped. For information about Trace Stop breakpoints, see *Trace Stop breakpoints dialog box*, page 152. Note that this menu command is only available if the C-SPY driver you are using supports the trace system.
Enable/Disable Breakpoint	Enables and Disables a breakpoint.

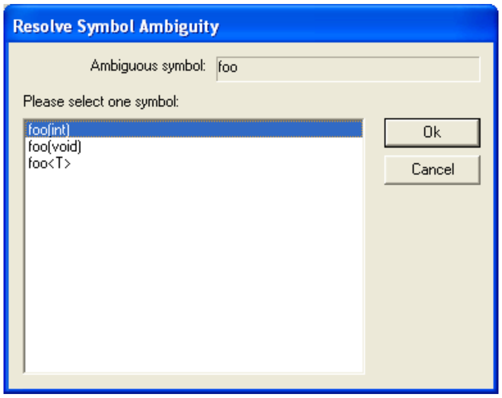
Table 68: Disassembly context menu commands (Continued)

Menu command	Description
Edit Breakpoint	Displays the **Edit Breakpoint** dialog box to let you edit the currently selected breakpoint. If there are more than one breakpoint on the selected line, a submenu is displayed that lists all available breakpoints on that line.
Set Next Statement	Sets program counter to the location of the insertion point.
Copy Window Contents	Copies the selected contents of the Disassembly window to the clipboard.
Mixed-Mode	Toggles between showing only disassembled code or disassembled code together with the corresponding source code. Source code requires that the corresponding source file has been compiled with debug information.

Table 68: Disassembly context menu commands (Continued)

RESOLVE SYMBOL AMBIGUITY DIALOG BOX

The **Resolve Symbol Ambiguity** dialog box appears, for example, when you specify a symbol in the Disassembly window to go to, and there are several instances of the same symbol due to templates or function overloading.



Ambiguous symbol: foo

Please select one symbol:

foo(int)
foo(void)
foo<T>

Figure 145: Resolve Symbol Ambiguity dialog box

Ambiguous symbol

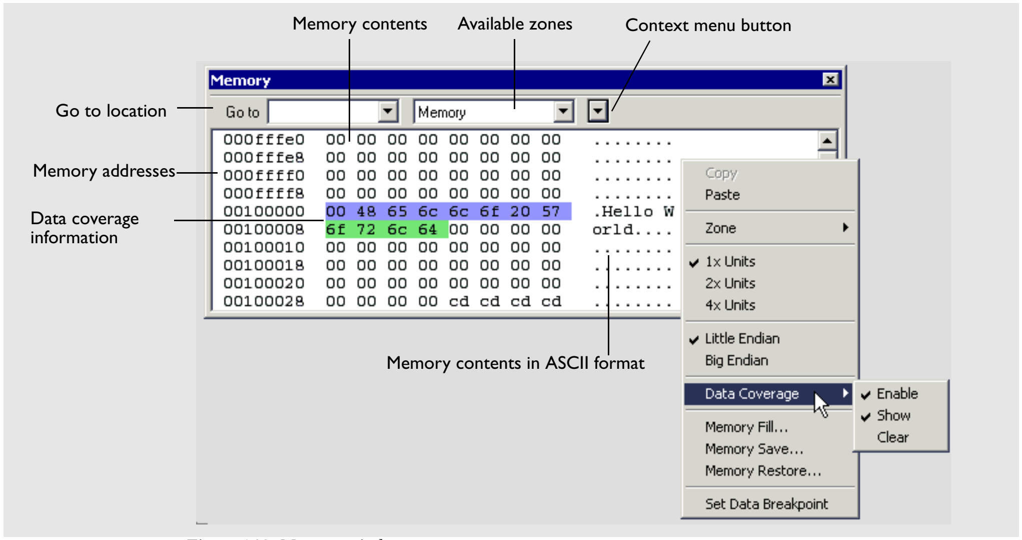
Indicates which symbol that is ambiguous.

Please select one symbol

A list of possible matches for the ambiguous symbol. Select the one you want to be used.

MEMORY WINDOW

The Memory window—available from the **View** menu—gives an up-to-date display of a specified area of memory and allows you to edit it. You can open several instances of this window, which is very convenient if you want to keep track of several memory or register zones, or monitor different parts of the memory.



```
000fffe0  00 00 00 00 00 00 00 00   ........
000fffe8  00 00 00 00 00 00 00 00   ........
000ffff0  00 00 00 00 00 00 00 00   ........
000ffff8  00 00 00 00 00 00 00 00   ........
00100000  00 48 65 6c 6c 6f 20 57   .Hello W
00100008  6f 72 6c 64 00 00 00 00   orld....
00100010  00 00 00 00 00 00 00 00   ........
00100018  00 00 00 00 00 00 00 00   ........
00100020  00 00 00 00 00 00 00 00   ........
00100028  00 00 00 00 cd cd cd cd   ........
```

Figure 146: Memory window

Toolbar

The toolbar at the top of the window provides these commands:

Operation	Description
Go to	The location you want to view. This can be a memory address, or the name of a variable, function, or label.
Zone display	Lists the available memory zones to display. Read more about Zones in *Memory addressing*, page 125.
Context menu button	Displays the context menu, see *Memory window context menu*, page 274.
Update Now	Updates the content of the Memory window while your application is executing. This button is only enabled if the C-SPY driver you are using has access to the target system memory while your application is executing.

Table 69: Memory window operations

Operation	Description
Live Update	Updates the contents of the Memory window regularly while your application is executing. This button is only enabled if the C-SPY driver you are using has access to the target system memory while your application is executing. To set the update frequency, specify an appropriate frequency in the **IDE Options>Debugger** dialog box.

Table 69: Memory window operations (Continued)

The display area

The display area shows the addresses currently being viewed, the memory contents in the format you have chosen, and the memory contents in ASCII format. You can edit the contents of the Memory window, both in the hexadecimal part and the ASCII part of the window.

Data coverage is displayed with these colors:

- Yellow indicates data that has been read
- Blue indicates data that has been written
- Green indicates data that has been both read and written.

Note: Data coverage is not supported by all C-SPY drivers. Data coverage is supported by the C-SPY Simulator.

To view the memory corresponding to a variable, you can select it in the editor window and drag it to the Memory window.

Memory window context menu

This context menu is available in the Memory window:

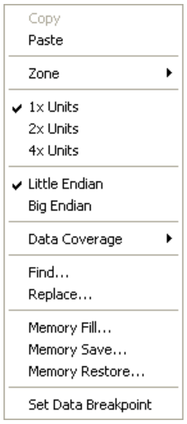


Figure 147: Memory window context menu

These commands are available on the menu:

Menu command	Description
Copy, Paste	Standard editing commands.
Zone	Lists the available memory zones to display. Read more about Zones in *Memory addressing*, page 125.
x1, x2, x4 Units	Switches between displaying the memory contents in units of 8, 16, or 32 bits
Little Endian Big Endian	Switches between displaying the contents in big-endian or little-endian order.
Data Coverage	Choose between: **Enable** toggles data coverage on and off. **Show** toggles between showing and hiding data coverage. **Clear** clears all data coverage information.
Find	Displays the **Find** dialog box where you can search for text within the Memory window, see *Find dialog box*, page 217.
Replace	Displays a dialog box where you can search for a specified string and replace each occurrence with another string, see *Replace dialog box*, page 218.

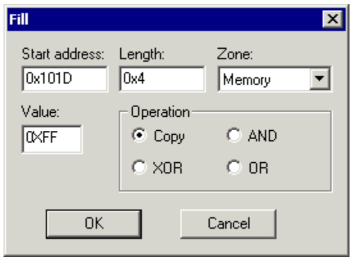
Table 70: Commands on the memory window context menu

Menu command	Description
Memory Fill	Displays the **Fill** dialog box, where you can fill a specified area with a value, see *Fill dialog box*, page 275.
Memory Save	Displays the **Memory Save** dialog box, where you can save the contents of a specified memory area to a file, see *Memory Save dialog box*, page 276.
Memory Restore	Displays the **Memory Restore** dialog box, where you can load the contents of a file in Intel-hex or Motorola s-record format to a specified memory zone, see *Memory Restore dialog box*, page 277.
Set Data Breakpoint	Sets breakpoints directly in the Memory window. The breakpoint is not highlighted; you can see, edit, and remove it in the Breakpoints dialog box. The breakpoints you set in this window will be triggered for both read and write access.

Table 70: Commands on the memory window context menu (Continued)

FILL DIALOG BOX

In the **Fill** dialog box—available from the context menu in the Memory window—you can fill a specified area of memory with a value.


Fill

Start address: 0x101D
Length: 0x4
Zone: Memory
Value: 0XFF
Operation: [✓ Copy] AND XOR OR

Figure 148: Fill dialog box

Options

Option	Description
Start Address	Type the start address—in binary, octal, decimal, or hexadecimal notation.
Length	Type the length—in binary, octal, decimal, or hexadecimal notation.
Zone	Select memory zone.
Value	Type the 8-bit value to be used for filling each memory location.

Table 71: Fill dialog box options

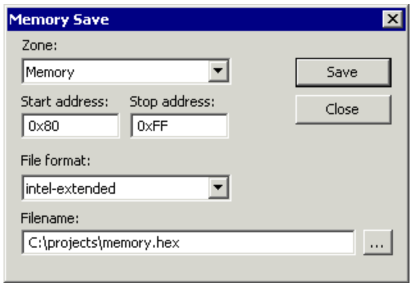
These are the available memory fill operations:

Operation	Description
Copy	The **Value** will be copied to the specified memory area.
AND	An `AND` operation will be performed between the **Value** and the existing contents of memory before writing the result to memory.
XOR	An `XOR` operation will be performed between the **Value** and the existing contents of memory before writing the result to memory.
OR	An `OR` operation will be performed between the **Value** and the existing contents of memory before writing the result to memory.

Table 72: Memory fill operations

MEMORY SAVE DIALOG BOX

Use the **Memory Save** dialog box—available by choosing **Debug>Memory>Save** or from the context menu in the Memory window—to save the contents of a specified memory area to a file.



Zone: Memory
Start address: 0x80
Stop address: 0xFF
File format: intel-extended
Filename: C:\projects\memory.hex

Figure 149: Memory Save dialog box

Zone

The available memory zones.

Start address

The start address of the memory range to be saved.

Stop address

The stop address of the memory range to be saved.

File format

The file format to be used, which is Intel-extended by default.

Filename

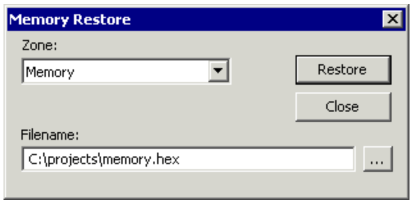
The destination file to be used; a browse button is available for your convenience.

Save

Saves the selected range of the memory zone to the specified file.

MEMORY RESTORE DIALOG BOX

Use the **Memory Restore** dialog box—available by choosing **Debug>Memory>Save** or from the context menu in the Memory window—to load the contents of a file in Intel-extended or Motorola S-record format to a specified memory zone.



Zone: Memory

Filename: C:\projects\memory.hex

Figure 150: Memory Restore dialog box

Zone

The available memory zones.

Filename

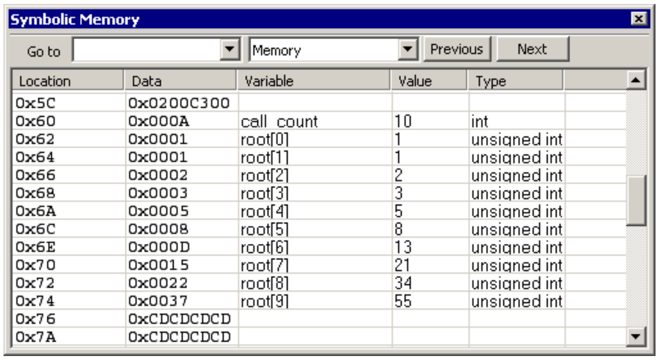
The file to be read; a browse button is available for your convenience.

Restore

Loads the contents of the specified file to the selected memory zone.

SYMBOLIC MEMORY WINDOW

The Symbolic Memory window—available from the **View** menu when the debugger is running—displays how variables with static storage duration, typically variables with file scope but also static variables in functions and classes, are laid out in memory. This can be useful for spotting alignment holes or for understanding problems caused by buffers being overwritten.



Location	Data	Variable	Value	Type
0x5C	0x0200C300			
0x60	0x000A	call_count	10	int
0x62	0x0001	root[0]	1	unsigned int
0x64	0x0001	root[1]	1	unsigned int
0x66	0x0002	root[2]	2	unsigned int
0x68	0x0003	root[3]	3	unsigned int
0x6A	0x0005	root[4]	5	unsigned int
0x6C	0x0008	root[5]	8	unsigned int
0x6E	0x000D	root[6]	13	unsigned int
0x70	0x0015	root[7]	21	unsigned int
0x72	0x0022	root[8]	34	unsigned int
0x74	0x0037	root[9]	55	unsigned int
0x76	0xCDCDCDCD			
0x7A	0xCDCDCDCD			

Figure 151: Symbolic Memory window

Toolbar

The toolbar at the top of the window provides these toolbar buttons:

Operation	Description
Go to	The memory location or symbol you want to view.
Zone display	Lists the available memory zones to display. To read more about zones, see *Memory addressing*, page 125.
Previous	Jumps to the previous symbol.
Next	Jumps to the next symbol.

Table 73: Symbolic Memory window toolbar

The display area

The display area displays the memory space, where information is provided in these columns:

Column	Description
Location	The memory address.
Data	The memory contents in hexadecimal format. The data is grouped according to the size of the symbol. This column is editable.
Variable	The variable name; requires that the variable has a fixed memory location. Local variables are not displayed.

Table 74: Symbolic memory window columns

Column	Description
Value	The value of the variable. This column is editable.
Type	The type of the variable.

Table 74: Symbolic memory window columns (Continued)

There are several different ways to navigate within the memory space:

- Text that is dropped in the window is interpreted as symbols
- The scroll bar at the right-side of the window
- The toolbar buttons **Next** and **Previous**
- The toolbar list box **Go to** can be used for locating specific locations or symbols.

Note: Rows are marked in red when the corresponding value has changed.

Symbolic Memory window context menu

This context menu is available in the Symbolic Memory window:

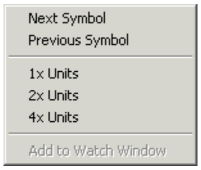


Figure 152: Symbolic Memory window context menu

These commands are available on the context menu:

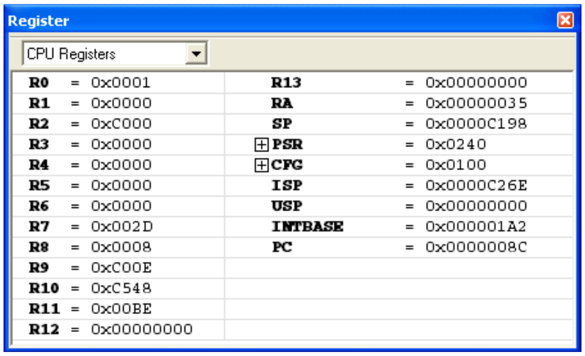
Menu command	Description
Next Symbol	Jumps to the next symbol.
Previous Symbol	Jumps to the previous symbol.
x1, x2, x4 Units	Switches between displaying the memory contents in units of 8, 16, or 32 bits. This applies only to rows which do not contain a variable.
Add to Watch Window	Adds the selected symbol to the Watch window.

Table 75: Commands on the Symbolic Memory window context menu

REGISTER WINDOW

The Register window—available from the **View** menu—gives an up-to-date display of the contents of the processor registers, and allows you to edit them. When a value changes it becomes highlighted. Some registers are expandable, which means that the register contains interesting bits or sub-groups of bits.

You can open several instances of this window, which is very convenient if you want to keep track of different register groups.



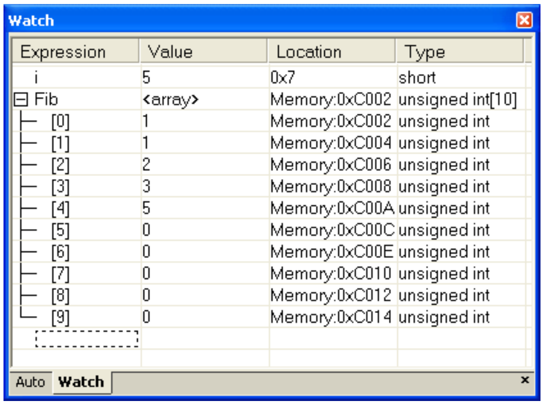
R0	= 0x0001	R13	=	0x00000000
R1	= 0x0000	RA	=	0x00000035
R2	= 0xC000	SP	=	0x0000C198
R3	= 0x0000	⊞PSR	=	0x0240
R4	= 0x0000	⊞CFG	=	0x0100
R5	= 0x0000	ISP	=	0x0000C26E
R6	= 0x0000	USP	=	0x00000000
R7	= 0x002D	INTBASE	=	0x000001A2
R8	= 0x0008	PC	=	0x0000008C
R9	= 0xC00E			
R10	= 0xC548			
R11	= 0x00BE			
R12	= 0x00000000			

Figure 153: Register window

Use the drop-down list to select which register group to display in the Register window. To define application-specific register groups, see *Defining application-specific groups*, page 128.

WATCH WINDOW

The Watch window—available from the **View** menu—allows you to monitor the values of C-SPY expressions or variables. You can view, add, modify, and remove expressions in the Watch window. Tree structures of arrays, structs, and unions are expandable, which means that you can study each item of these.



Expression	Value	Location	Type
i	5	0x7	short
⊟ Fib	<array>	Memory:0xC002	unsigned int[10]
[0]	1	Memory:0xC002	unsigned int
[1]	1	Memory:0xC004	unsigned int
[2]	2	Memory:0xC006	unsigned int
[3]	3	Memory:0xC008	unsigned int
[4]	5	Memory:0xC00A	unsigned int
[5]	0	Memory:0xC00C	unsigned int
[6]	0	Memory:0xC00E	unsigned int
[7]	0	Memory:0xC010	unsigned int
[8]	0	Memory:0xC012	unsigned int
[9]	0	Memory:0xC014	unsigned int

Figure 154: Watch window

Every time execution in C-SPY stops, a value that has changed since the last stop is highlighted. In fact, every time memory changes, the values in the Watch window are recomputed, including updating the red highlights.

Watch window context menu

This context menu is available in the Watch window:

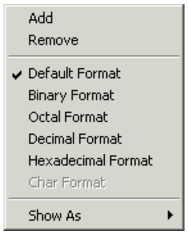


Figure 155: Watch window context menu

The menu contains these commands:

Menu command	Description
Add, Remove	Adds or removes the selected expression.
Default Format, Binary Format, Octal Format, Decimal Format, Hexadecimal Format, Char Format	Changes the display format of expressions. The display format setting affects different types of expressions in different ways, see Table 77, *Effects of display format setting on different types of expressions*. Your selection of display format is saved between debug sessions.
Show As	Provides a submenu with commands for changing the default type interpretation of variables. The commands on this submenu are mainly useful for assembler variables—data at assembler labels—because these are, by default, displayed as integers. For more information, see *Viewing assembler variables*, page 114.

Table 76: Watch window context menu commands

The display format setting affects different types of expressions in different ways:

Type of expressions	Effects of display format setting
Variable	The display setting affects only the selected variable, not other variables.
Array element	The display setting affects the complete array, that is, same display format is used for each array element.

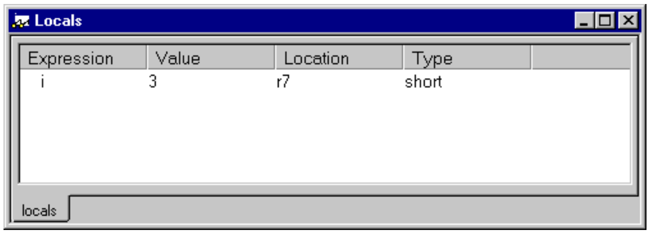
Table 77: Effects of display format setting on different types of expressions

Type of expressions	Effects of display format setting
Structure field	All elements with the same definition—the same field name and C declaration type—are affected by the display setting.

Table 77: Effects of display format setting on different types of expressions (Continued)

LOCALS WINDOW

The Locals window—available from the **View** menu—automatically displays the local variables and function parameters.



Expression	Value	Location	Type
i	3	r7	short

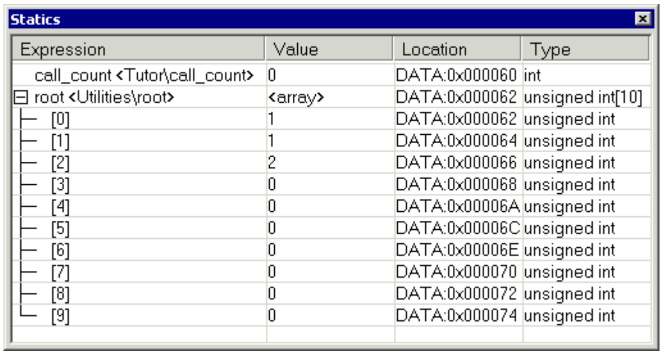
Figure 156: Locals window

Locals window context menu

The context menu available in the Locals window provides commands for changing the display format of expressions; for information about these commands, see *Watch window context menu*, page 281.

STATICS WINDOW

The Statics window—available from the **View** menu—displays the values of variables with static storage duration, typically that is variables with file scope but also static variables in functions and classes. Note that `volatile` declared variables with static storage duration will not be displayed.



Statics

Expression	Value	Location	Type
call_count <Tutor\call_count>	0	DATA:0x000060	int
⊟ root <Utilities\root>	<array>	DATA:0x000062	unsigned int[10]
[0]	1	DATA:0x000062	unsigned int
[1]	1	DATA:0x000064	unsigned int
[2]	2	DATA:0x000066	unsigned int
[3]	0	DATA:0x000068	unsigned int
[4]	0	DATA:0x00006A	unsigned int
[5]	0	DATA:0x00006C	unsigned int
[6]	0	DATA:0x00006E	unsigned int
[7]	0	DATA:0x000070	unsigned int
[8]	0	DATA:0x000072	unsigned int
[9]	0	DATA:0x000074	unsigned int

Figure 157: Statics window

The display area

The display area shows the values of variables with static storage duration, where information is provided in these columns:

Column	Description
Expression	The name of the variable. The base name of the variable is followed by the full name, which includes module, class, or function scope. This column is not editable.
Value	The value of the variable. Values that have changed are highlighted in red. This column is editable.
Location	The location in memory where this variable is stored.
Type	The data type of the variable.

Table 78: Symbolic memory window columns

Statics window context menu

This context menu is available in the Statics window:

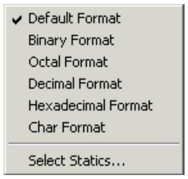


Figure 158: Statics window context menu

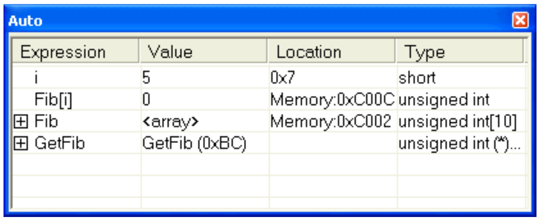
The menu contains these commands:

Menu command	Description
Default Format, Binary Format, Octal Format, Decimal Format, Hexadecimal Format, Char Format	Changes the display format of expressions. The display format setting affects different types of expressions in different ways, see Table 77, *Effects of display format setting on different types of expressions*. Your selection of display format is saved between debug sessions.
Select Statics	Displays a dialog box where you can select a subset of variables to be displayed in the Statics window, see *Select Statics dialog box*, page 286.

Table 79: Statics window context menu commands

AUTO WINDOW

The Auto window—available from the **View** menu—automatically displays a useful selection of variables and expressions in, or near, the current statement.



Expression	Value	Location	Type
i	5	0x7	short
Fib[i]	0	Memory:0xC00C	unsigned int
⊞ Fib	<array>	Memory:0xC002	unsigned int[10]
⊞ GetFib	GetFib (0xBC)		unsigned int (*)...

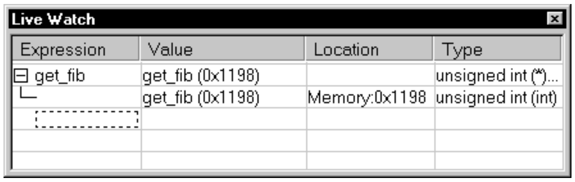
Figure 159: Auto window

Auto window context menu

The context menu available in the Auto window provides commands for changing the display format of expressions; for information about these commands, see *Watch window context menu*, page 281.

LIVE WATCH WINDOW

The Live Watch window—available from the **View** menu—repeatedly samples and displays the value of expressions while your application is executing. Variables in the expressions must be statically located, such as global variables.



Expression	Value	Location	Type
⊟ get_fib	get_fib (0x1198)		unsigned int (*)...
└	get_fib (0x1198)	Memory:0x1198	unsigned int (int)

Figure 160: Live Watch window

Typically, this window is useful for hardware target systems supporting this feature.

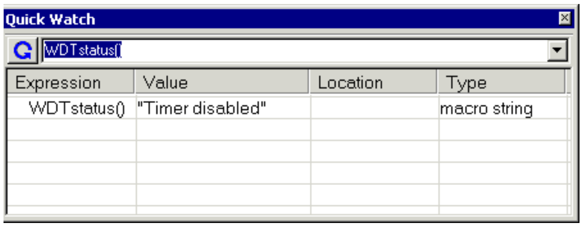
Live Watch window context menu

The context menu available in the Live Watch window provides commands for adding and removing expressions, changing the display format of expressions, and commands for changing the default type interpretation of variables. For information about these commands, see *Watch window context menu*, page 281.

In addition, the menu contains the **Options** command, which opens the **Debugger** dialog box where you can set the **Update interval** option. The default value of this option is 1000 milliseconds, which means the **Live Watch** window will be updated once every second during program execution.

QUICK WATCH WINDOW

In the Quick Watch window—available from the **View** menu—you can watch the value of a variable or expression and evaluate expressions.



WDTstatus()

Expression	Value	Location	Type
WDTstatus()	"Timer disabled"		macro string

Figure 161: Quick Watch window

Type the expression you want to examine in the **Expressions** text box. Click the **Recalculate** button to calculate the value of the expression. For examples about how to use the Quick Watch window, see *Using the Quick Watch window*, page 113 and *Executing macros using Quick Watch*, page 134.

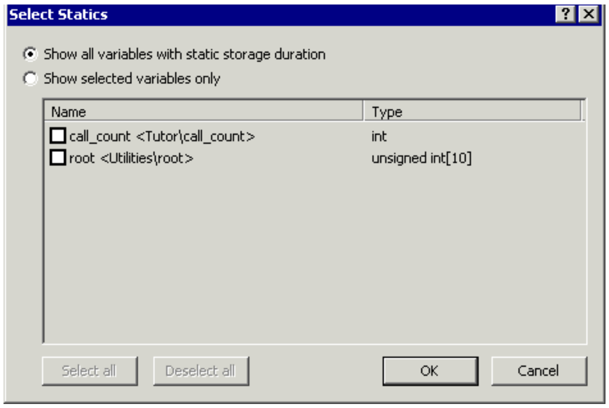
Quick Watch window context menu

The context menu available in the Quick Watch window provides commands for changing the display format of expressions, and commands for changing the default type interpretation of variables. For information about these commands, see *Watch window context menu*, page 281.

In addition, the menu contains the **Add to Watch window** command, which adds the selected expression to the Watch window.

SELECT STATICS DIALOG BOX

Use the **Select Statics** dialog box—available from the context menu in the Statics window—to select which variables should be displayed in the Statics window.


Select Statics

[✓ Show all variables with static storage duration]
Show selected variables only

Name	Type
☐ call_count <Tutor\call_count>	int
☐ root <Utilities\root>	unsigned int[10]

Figure 162: Select Statics dialog box

Show all variables with static storage duration

Use this option to make all variables be displayed in the Statics window, including new variables that are added to your application between debug sessions.

Show selected variables only

Use this option to select which variables you want to be displayed in the Statics window. Note that in this case if you add a new variable to your application between two debug sessions, this variable will not automatically be displayed in the Statics window. If the checkbox next to a variable is selected, the variable will be displayed.

CALL STACK WINDOW

The Call stack window—available from the **View** menu—displays the C function call stack with the current function at the top. To inspect a function call, double-click it. C-SPY now focuses on that call frame instead.

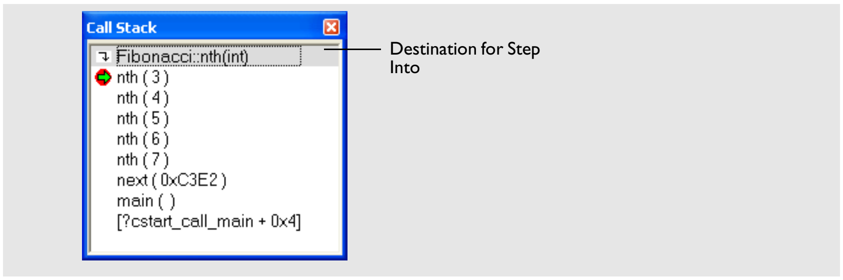


Figure 163: Call Stack window

Each entry has the format:

`function``(`*`values`*`)`

where *`(values)`* is a list of the current value of the parameters, or empty if the function does not take any parameters.

If the **Step Into** command steps into a function call, the name of the function is displayed in the grey bar at the top of the window. This is especially useful for implicit function calls, such as C++ constructors, destructors, and operators.

Call Stack window context menu

The context menu available when you right-click in the Call Stack window provides these commands:

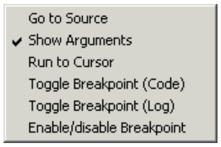


Figure 164: Call Stack window context menu

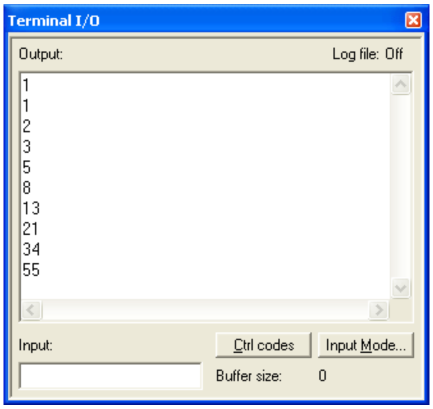
Commands

Go to Source	Displays the selected functions in the Disassembly or editor windows.
Show Arguments	Shows function arguments.

Run to Cursor	Executes to the function selected in the call stack.
Toggle Breakpoint (Code)	Toggles a code breakpoint.
Toggle Breakpoint (Log)	Toggles a log breakpoint.
Enable/Disable Breakpoint	Enables or disables the selected breakpoint.

TERMINAL I/O WINDOW

In the Terminal I/O window—available from the **View** menu—you can enter input to the application, and display output from it. To use this window, you must link your application with a library that contains C-SPY debugging support, for XLINK this means that you must select the option **With I/O emulation modules**, and for ILINK the option **Include C-SPY debugging support**. C-SPY will then direct `stdin`, `stdout` and `stderr` to this window. If the Terminal I/O window is closed, C-SPY will open it automatically when input is required, but not for output.



```
1
1
2
3
5
8
13
21
34
55
```

Figure 165: Terminal I/O window

Clicking the **Ctrl codes** button opens a menu with submenus for input of special characters, such as `EOF` (end of file) and `NUL`.

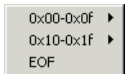


Figure 166: Ctrl codes menu

Clicking the **Input Mode** button opens the **Input Mode** dialog box where you choose whether to input data from the keyboard or from a file.

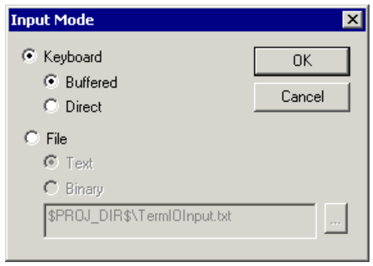
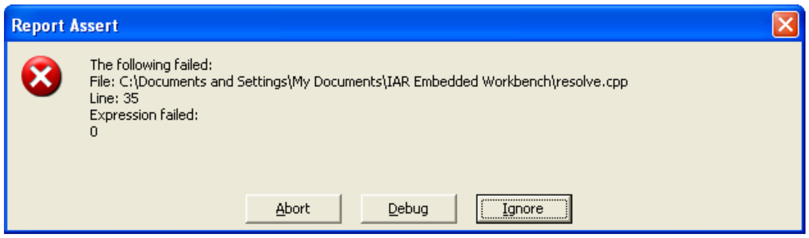


Figure 167: Input Mode dialog box

For reference information about the options available in the dialog box, see *Terminal I/O options*, page 255.

REPORT ASSERT DIALOG BOX

The **Report Assert dialog box** appears if you have a call to the `assert` function in your application source code, and the assert condition is false. In this dialog box you can choose how to proceed.



```
The following failed:
File: C:\Documents and Settings\My Documents\IAR Embedded Workbench\resolve.cpp
Line: 35
Expression failed:
0
```

Figure 168: Report Assert dialog box

Abort

The application stops executing and the runtime library function `abort`, which is part of your application on the target system, will be called. This means that the application itself terminates its execution.

Debug

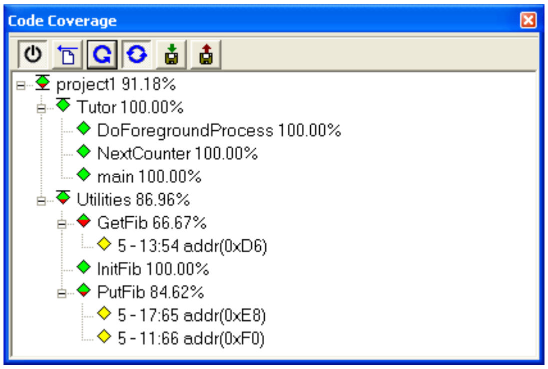
C-SPY stops the execution of the application and returns control to you.

Ignore

The assertion is ignored and application continues to execute.

CODE COVERAGE WINDOW

The Code Coverage window—available from the **View** menu—reports the status of the current code coverage analysis, that is, what parts of the code that have been executed at least once since the start of the analysis. The compiler generates detailed stepping information in the form of *step points* at each statement, and at each function call. The report includes information about all modules and functions. It reports the amount of all step points, in percentage, that have been executed and lists all step points that have not been executed up to the point where the application has been stopped. The coverage will continue until turned off.



```
project1 91.18%
  Tutor 100.00%
    DoForegroundProcess 100.00%
    NextCounter 100.00%
    main 100.00%
  Utilities 86.96%
    GetFib 66.67%
      5 - 13:54 addr(0xD6)
    InitFib 100.00%
    PutFib 84.62%
      5 - 17:65 addr(0xE8)
      5 - 11:66 addr(0xF0)
```

Figure 169: Code Coverage window

Note: You can enable the Code Coverage plugin module on the **Debugger>Plugins** page available in the **Options** dialog box.

Code coverage is not supported by all C-SPY drivers. For information about whether the C-SPY driver you are using supports code coverage, see the driver-specific documentation in the online help system available from the **Help** menu. Code coverage is supported by the C-SPY Simulator.

Toolbar

The toolbar at the top of the window provides these buttons:

Toolbar button	Description
Activate	Switches code coverage on and off during execution.
Clear	Clears the code coverage information. All step points are marked as not executed.
Refresh	Updates the code coverage information and refreshes the window. All step points that have been executed since the last refresh are removed from the tree.
Auto-refresh	Toggles the automatic reload of code coverage information on and off. When turned on, the code coverage information is reloaded automatically when C-SPY stops at a breakpoint, at a step point, and at program exit.
Save As	Saves the current code coverage result in a text file.
Save session	Saves your code coverage session data to a `*.dat` file.
Restore session	Restores previously saved code coverage session data.

Table 80: Code Coverage window toolbar

The display area

These icons are used to give you an overview of the current status on all levels:

- A red diamond signifies that 0% of the code has been executed
- A green diamond signifies that 100% of the code has been executed
- A red and green diamond signifies that some of the code has been executed
- A yellow diamond signifies a step point that has not been executed.

For step point lines, the information displayed is the column number range and the row number of the step point in the source window, followed by the address of the step point.

```
<column start>-<column end>:<row>.
```

Code Coverage window context menu

This context menu is available in the Code Coverage window:

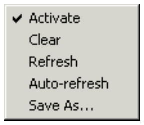


Figure 170: Code coverage context menu

These commands are available on the menu:

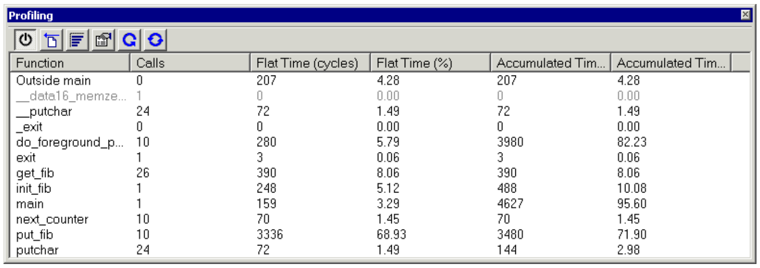
Menu command	Description
Activate	Switches code coverage on and off during execution.
Clear	Clears the code coverage information. All step points are marked as not executed.
Refresh	Updates the code coverage information and refreshes the window. All step points that has been executed since the last refresh are removed from the tree.
Auto-refresh	Toggles the automatic reload of code coverage information on and off. When turned on, the code coverage information is reloaded automatically when C-SPY stops at a breakpoint, at a step point, and at program exit.
Save As	Saves the current code coverage result in a text file.

Table 81: Code Coverage window context menu commands

PROFILING WINDOW

The Profiling window—available from the **View** menu—displays profiling information, that is, timing information for the functions in an application. Profiling must be turned on explicitly using a button in the window's toolbar, and will stay active until it is turned off.

The profiler measures time at the entry and return of a function. This means that time consumed in a function is not added until the function returns or another function is called. You will only notice this if you are stepping into a function.



Function	Calls	Flat Time (cycles)	Flat Time (%)	Accumulated Tim...	Accumulated Tim...
Outside main	0	207	4.28	207	4.28
__data16_memze...	1	0	0.00	0	0.00
__putchar	24	72	1.49	72	1.49
_exit	0	0	0.00	0	0.00
do_foreground_p...	10	280	5.79	3980	82.23
exit	1	3	0.06	3	0.06
get_fib	26	390	8.06	390	8.06
init_fib	1	248	5.12	488	10.08
main	1	159	3.29	4627	95.60
next_counter	10	70	1.45	70	1.45
put_fib	10	3336	68.93	3480	71.90
putchar	24	72	1.49	144	2.98

Figure 171: Profiling window

Note: You can enable the Profiling plugin module on the **Debugger>Plugins** page available in the **Options** dialog box.

Profiling is not supported by all C-SPY drivers. For information about whether the C-SPY driver you are using supports profiling, see the driver-specific documentation in the online help system available from the **Help** menu. Profiling is supported by the C-SPY Simulator.

Profiling commands

In addition to the toolbar buttons, the context menu available in the Profiling window gives you access to these and some extra commands:

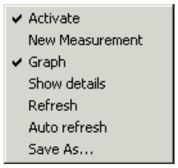


Figure 172: Profiling context menu

You can find these commands on the menu:

Activate	Toggles profiling on and off during execution.
New measurement	Starts a new measurement. To reset the displayed values to zero, click the button.
Graph	Displays the percentage information for Flat Time and Accumulated Time as graphs (bar charts) or numbers.

	Show details	Shows more detailed information about the function selected in the list. A window is opened showing information about callers and callees for the selected function.
	Refresh	Updates the profiling information and refreshes the window.
	Auto refresh	Toggles the automatic update of profiling information on and off. When turned on, the profiling information is updated automatically when C-SPY stops at a breakpoint, at a step point, and at program exit.
	Save As	Saves the current profiling information in a text file.

Profiling columns

The Profiling window contains these columns:

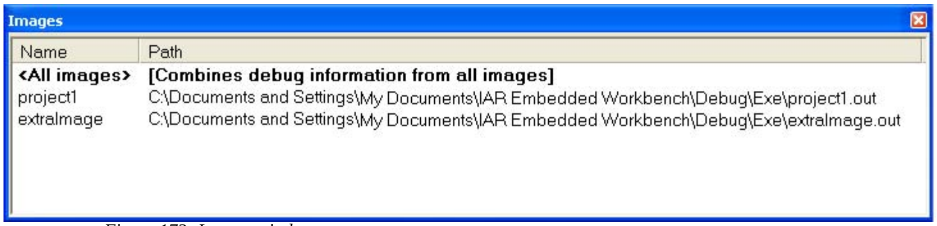
Column	Description
Function	The name of each function.
Calls	The number of times each function has been called.
Flat Time	The total time spent in each function in cycles or as a percentage of the total number of cycles, excluding all function calls made from that function.
Accumulated Time	Time spent in each function in cycles or as a percentage of the total number of cycles, including all function calls made from that function.

Table 82: Profiling window columns

There is always an item in the list called **Outside main**. This is time that cannot be placed in any of the functions in the list. That is, code compiled without debug information, for instance, all startup and exit code, and C/C++ library code.

IMAGES WINDOW

The Images window—available from the **View** menu—lists all currently loaded images (debug files).



Name	Path
<All images>	**[Combines debug information from all images]**
project1	C:\Documents and Settings\My Documents\IAR Embedded Workbench\Debug\Exe\project1.out
extraImage	C:\Documents and Settings\My Documents\IAR Embedded Workbench\Debug\Exe\extraImage.out

Figure 173: Images window

Normally, a debuggable application consists of exactly one image that you debug. However, you can also load additional images after a debug session has started. This means that the complete debuggable unit consists of several images.

Typically, this is useful if you want to debug your application in combination with a prebuilt ROM image that contains an additional library for some platform-provided features. The ROM image and the application are built using separate projects in the IAR Embedded Workbench IDE and generate separate output files.

The display area

The display area lists the loaded images:

Column	Description
Name	The name of the loaded image.
Path	The path to the loaded image.

Table 83: Images window columns

C-SPY can either use debug information from all of the loaded images simultaneously, or from one image at a time. Double-click on a row to show information only for that image. The current choice is highlighted.

Images window context menu

This context menu is available in the Images window:

Figure 174: Images window context menu

These commands are available on the menu:

Menu command	Description
Show all images	Shows debug information for all loaded debug images.
Show only *image*	Shows debug information for the selected debug image.

Table 84: Images window context menu commands

Related information

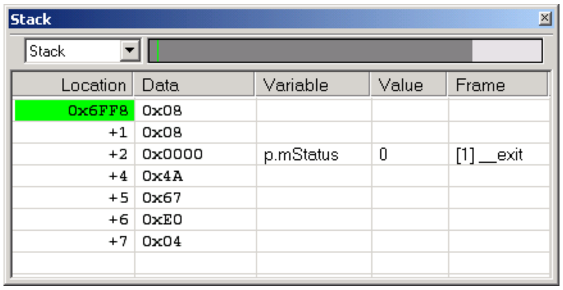
For related information, see:

- *Loading multiple images*, page 100
- *__loadImage*, page 391
- *Images*, page 369.

STACK WINDOW

The Stack window is a memory window that displays the contents of the stack. In addition, some integrity checks of the stack can be performed to detect and warn about problems with stack overflow. For example, the Stack window is useful for determining the optimal size of the stack.

Before you can open the Stack window you must make sure it is enabled: choose **Project>Options>Debugger>Plugins** and select **Stack** from the list of plugins. In C-SPY, you can then open a Stack window by choosing **View>Stack**. You can open several Stack windows, each showing a different stack—if several stacks are available—or the same stack with different display settings.



Location	Data	Variable	Value	Frame
0x6FF8	0x08			
+1	0x08			
+2	0x0000	p.mStatus	0	[1] __exit
+4	0x4A			
+5	0x67			
+6	0xE0			
+7	0x04			

Figure 175: Stack window

The stack drop-down menu

If the microcontroller you are using has multiple stacks, you can use the stack drop-down menu at the top of the window to select which stack to view.

The graphical stack bar

At the top of the window, a stack bar displays the state of the stack graphically. To view the stack bar you must make sure it is enabled: choose **Tools>Options>Stack** and select the option **Enable graphical stack display and stack usage tracking**.

The left end of the stack bar represents the bottom of the stack, in other words, the position of the stack pointer when the stack is empty. The right end represents the end of the memory space reserved for the stack. A green line represents the current value of the stack pointer. The part of the stack memory that has been used during execution is displayed in a dark gray color, and the unused part in a light gray color. The graphical stack bar turns red when the stack usage exceeds a threshold that you can specify.

When your application is first loaded, and upon each reset, the memory for the stack area is filled with the dedicated byte value `0xCD` before the application starts executing. Whenever execution stops, the stack memory is searched from the end of the stack until a byte with a value different from `0xCD` is found, which is assumed to be how far the stack has been used. Although this is a reasonably reliable way to track stack usage, there is no guarantee that a stack overflow is detected. For example, a stack *can* incorrectly grow outside its bounds, and even modify memory outside the stack range, without actually modifying any of the bytes near the stack range. Likewise, your application might modify memory within the stack range by mistake. Furthermore, the Stack window cannot detect a stack overflow when it happens, but can only detect the signs it leaves behind.

Note: The size and location of the stack is retrieved from the definition of the segment/section holding the stack, typically `CSTACK`, made in the linker configuration file. If you, for some reason, modify the stack initialization made in the system startup code, `cstartup`, you should also change the segment definition in the linker configuration file accordingly; otherwise the Stack window cannot track the stack usage. To read more about this, see the compiler documentation.

When the stack bar is enabled, the functionality needed to detect and warn about stack overflows is also enabled, see *Stack options*, page 252.

The Stack window columns

The main part of the window displays the contents of stack memory in these columns:

Column	Description
Location	Displays the location in memory. The addresses are displayed in increasing order. If your target system has a stack that grows toward high addresses, the top of the stack will consequently be located at the bottom of the window. The address referenced by the stack pointer, in other words the top of the stack, is highlighted in a green color.
Data	Displays the contents of the memory unit at the given location. From the Stack window context menu, you can select how the data should be displayed; as a 1-, 2-, or 4-byte group of data.
Variable	Displays the name of a variable, if there is a local variable at the given location. Variables are only displayed if they are declared locally in a function, and located on the stack and not in registers.
Value	Displays the value of the variable that is displayed in the **Variable** column.
Frame	Displays the name of the function the call frame corresponds to.

Table 85: Stack window columns

The Stack window context menu

This context menu is available if you right-click in the Stack window:

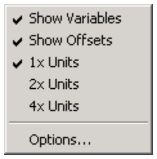


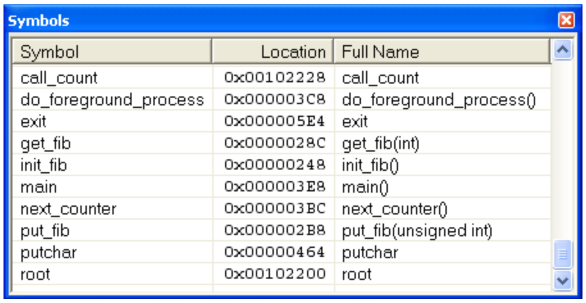
Figure 176: Stack window context menu

These commands are available on the context menu:

Show Variables	Separate columns named **Variables**, **Value**, and **Frame** are displayed in the Stack window. Variables located at memory addresses listed in the Stack window are displayed in these columns.
Show Offsets	When this option is selected, locations in the **Location** column are displayed as offsets from the stack pointer. When deselected, locations are displayed as absolute addresses.
1x Units	The data in the **Data** column is displayed as single bytes.
2x Units	The data in the **Data** column is displayed as 2-byte groups.
4x Units	The data in the **Data** column is displayed as 4-byte groups.
Options	Opens the **IDE Options** dialog box where you can set options specific to the Stack window, see *Stack options*, page 252.

SYMBOLS WINDOW

The Symbols window—available from the **View** menu—displays all symbols with a static location, that is, C/C++ functions, assembler labels, and variables with static storage duration, including symbols from the runtime library.



Symbol	Location	Full Name
call_count	0x00102228	call_count
do_foreground_process	0x000003C8	do_foreground_process()
exit	0x000005E4	exit
get_fib	0x0000028C	get_fib(int)
init_fib	0x00000248	init_fib()
main	0x000003E8	main()
next_counter	0x000003BC	next_counter()
put_fib	0x000002B8	put_fib(unsigned int)
putchar	0x00000464	putchar
root	0x00102200	root

Figure 177: Symbols window

The display area

The display area lists the symbols, where information is provided in these columns:

Column	Description
Symbol	The symbol name.
Location	The memory address.
Full Name	The symbol name; often the same as the contents of the Symbol column but differs for example for C++ member functions.

Table 86: Symbols window columns

Click on the column headers to sort the list by name, location, or full name.

Symbols window context menu

This context menu is available in the Symbols window:

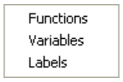


Figure 178: Symbols window context menu

These commands are available on the menu:

Menu command	Description
Function	Toggles the display of function symbols in the list.
Variables	Toggles the display of variables in the list.
Labels	Toggles the display of labels in the list.

Table 87: Commands on the Symbols window context menu

C-SPY menus

In addition to the menus available in the development environment, the **Debug** menu is available when C-SPY is running.

Additional menus are available depending on which C-SPY driver you are using. For information about driver-specific menus, see the online help system available from the **Help** menu for information about driver-specific documentation.

DEBUG MENU

The **Debug** menu provides commands for executing and debugging your application. Most of the commands are also available as toolbar buttons.

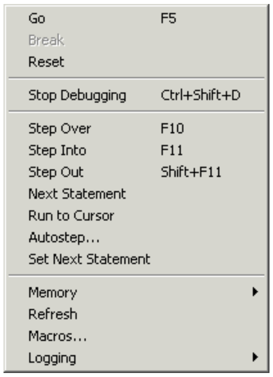


Figure 179: Debug menu

Menu Command		Description
Go	F5	Executes from the current statement or instruction until a breakpoint or program exit is reached.

Table 88: Debug menu commands

Menu Command		Description
Break		Stops the application execution.
Reset		Resets the target processor.
Stop Debugging	Ctrl+Shift+D	Stops the debugging session and returns you to the project manager.
Step Over	F10	Executes the next statement, function call, or instruction, without entering C or C++ functions or assembler subroutines.
Step Into	F11	Executes the next statement or instruction, entering C or C++ functions or assembler subroutines.
Step Out	Shift+F11	Executes from the current statement up to the statement after the call to the current function.
Next Statement		Executes directly to the next statement without stopping at individual function calls.
Run to Cursor		Executes from the current statement or instruction up to a selected statement or instruction.
Autostep		Displays the **Autostep settings** dialog box which lets you customize and perform autostepping.
Set Next Statement		Moves the program counter directly to where the cursor is, without executing any source code. Note, however, that this creates an anomaly in the program flow and might have unexpected effects.
Memory>Save		Displays the **Memory Save** dialog box, where you can save the contents of a specified memory area to a file, see *Memory Save dialog box*, page 276.
Memory>Restore		Displays the **Memory Restore** dialog box, where you can load the contents of a file in Intel-extended or Motorola s-record format to a specified memory zone, see *Memory Restore dialog box*, page 277.
Refresh		Refreshes the contents of all debugger windows. Because window updates are automatic, this is needed only in unusual situations, such as when target memory is modified in ways C-SPY cannot detect. It is also useful if code that is displayed in the Disassembly window is changed.
Macros		Displays the **Macro Configuration** dialog box to allow you to list, register, and edit your macro files and functions.

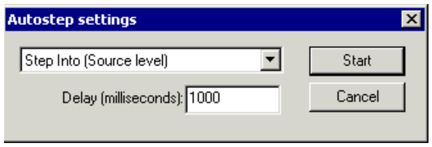
Table 88: Debug menu commands (Continued)

Menu Command	Description
Logging>Set Log file	Displays a dialog box to allow you to log input and output from C-SPY to a file. You can select the type and the location of the log file. You can choose what you want to log: errors, warnings, system information, user messages, or all of these.
Logging> Set Terminal I/O Log file	Displays a dialog box to allow you to log terminal input and output from C-SPY to a file. You can select the destination of the log file.

Table 88: Debug menu commands (Continued)

Autostep settings dialog box

In the **Autostep settings** dialog box—available from the **Debug** menu—you can customize autostepping.



Step Into (Source level)
Delay (milliseconds): 1000

Figure 180: Autostep settings dialog box

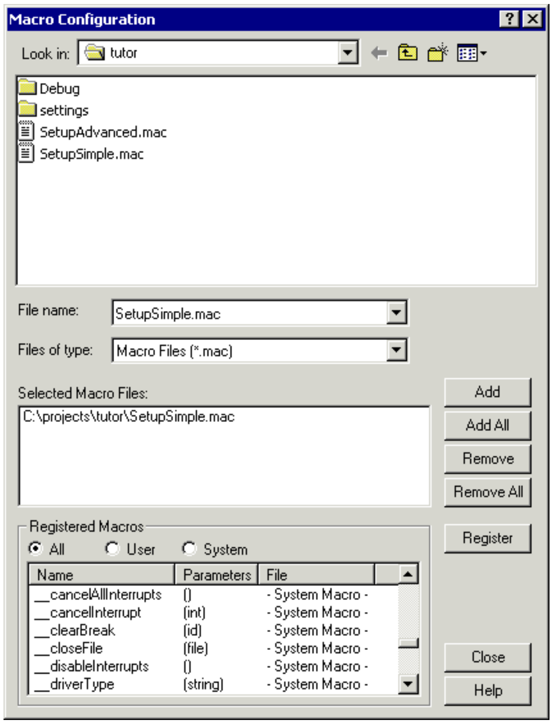
The drop-down menu lists the available step commands.

The **Delay** text box lets you specify the delay between each step.

Macro Configuration dialog box

In the **Macro Configuration** dialog box—available by choosing **Debug>Macros**—you can list, register, and edit your macro files and functions.

Macro functions that have been registered using the dialog box will be deactivated when you exit the debug session, and will not automatically be registered at the next debug session.



Look in: tutor

Debug
settings
SetupAdvanced.mac
SetupSimple.mac

File name: SetupSimple.mac

Files of type: Macro Files (*.mac)

Selected Macro Files:
C:\projects\tutor\SetupSimple.mac

Registered Macros
[✓ All] User System

Name	Parameters	File
__cancelAllInterrupts	()	- System Macro -
__cancelInterrupt	(int)	- System Macro -
__clearBreak	(id)	- System Macro -
__closeFile	(file)	- System Macro -
__disableInterrupts	()	- System Macro -
__driverType	(string)	- System Macro -

Figure 181: Macro Configuration dialog box

Registering macro files

Select the macro files you want to register in the file selection list, and click **Add** or **Add All** to add them to the **Selected Macro Files** list. Conversely, you can remove files from the **Selected Macro Files** list using **Remove** or **Remove All**.

Once you have selected the macro files you want to use click **Register** to register them, replacing any previously defined macro functions or variables. Registered macro functions are displayed in the scroll window under **Registered Macros**. Note that system macros cannot be removed from the list, they are always registered.

Listing macro functions

Selecting **All** displays all macro functions, selecting **User** displays all user-defined macros, and selecting **System** displays all system macros.

Clicking on either **Name** or **File** under **Registered Macros** displays the column contents sorted by macro names or by file. Clicking a second time sorts the contents in the reverse order.

Modifying macro files

Double-clicking a user-defined macro function in the **Name** column automatically opens the file in which the function is defined, allowing you to modify it, if needed.

Log File dialog box

The **Log File** dialog box—available by choosing **Debug>Logging>Set Log File** —allows you to log output from C-SPY to a file.

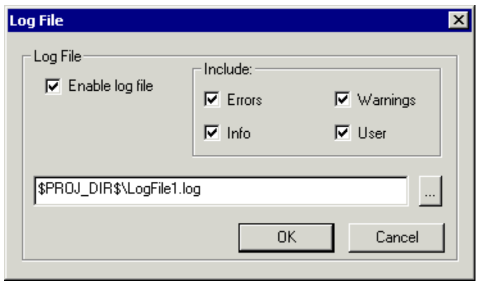


Figure 182: Log File dialog box

Enable or disable logging to the file with the **Enable Log file** check box.

The information printed in the file is, by default, the same as the information listed in the Log window. To change the information logged, use the **Include** options:

Option	**Description**
Errors	C-SPY has failed to perform an operation.
Warnings	A suspected error.
Info	Progress information about actions C-SPY has performed.
User	Printouts from C-SPY macros, that is, your printouts using the `__message` statement.

Table 89: Log file options

Click the browse button, to override the default file type and location of the log file. Click **Save** to select the specified file—the default filename extension is `log`.

Terminal I/O Log File dialog box

The **Terminal I/O Log Files** dialog box—available by choosing **Debug>Logging**—allows you to select a destination log file, and to log terminal I/O input and output from C-SPY to this file.

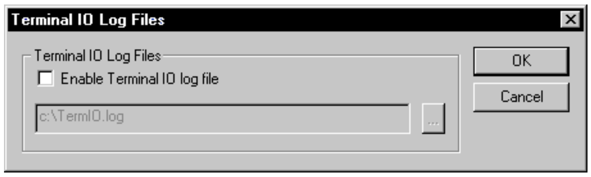


Figure 183: Terminal I/O Log File dialog box

Click the browse button to open a standard **Save As** dialog box. Click **Save** to select the specified file—the default filename extension is `log`.

General options

This chapter describes the general options in the IAR Embedded Workbench® IDE.

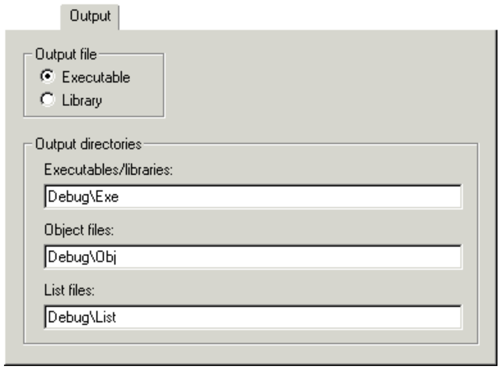
For information about how to set options, see *Setting options*, page 71.

Target

For information about the **Target** options, see the online help system available from the **Help** menu.

Output

With the **Output** options you can specify the type of output file—**Executable** or **Library**. You can also specify the destination directories for executable files, object files, and list files.



Output file

(●) Executable

( ) Library

Output directories

Executables/libraries: Debug\Exe

Object files: Debug\Obj

List files: Debug\List

Figure 184: Output options

OUTPUT FILE

Use these options to choose the type of output file. Choose between:

Executable (default)	As a result of the build process, the linker will create an *application* (an executable output file). When this option is selected, linker options will be available in the **Options** dialog box. Before you create the output you should set the appropriate linker options.
Library	As a result of the build process, the library builder will create a *library file*. When this option is selected, library builder options will be available in the **Options** dialog box, and **Linker** will disappear from the list of categories. Before you create the library you can set the options.

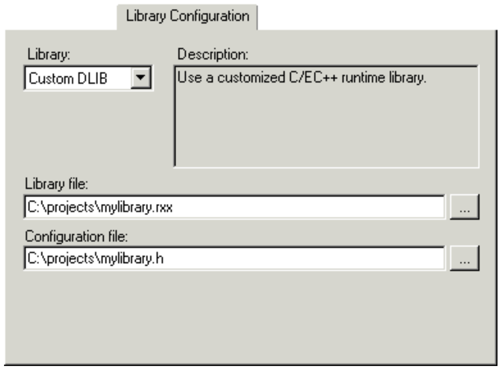
OUTPUT DIRECTORIES

Use these options to specify paths to destination directories. Note that incomplete paths are relative to your project directory. You can specify the paths to these destination directories:

Executables/libraries	Use this option to override the default directory for executable or library files. Type the name of the directory where you want to save executable files for the project.
Object files	Use this option to override the default directory for object files. Type the name of the directory where you want to save object files for the project.
List files	Use this option to override the default directory for list files. Type the name of the directory where you want to save list files for the project.

Library Configuration

With the **Library Configuration** options you can specify which library to use.



Library: Custom DLIB

Description: Use a customized C/EC++ runtime library.

Library file: C:\projects\mylibrary.rxx

Configuration file: C:\projects\mylibrary.h

Figure 185: Library Configuration options

For information about the runtime library, library configurations, the runtime environment they provide, and the possible customizations, see the compiler documentation.

LIBRARY

This option applies to the XLINK linker only.

In the **Library** drop-down list you choose which runtime library to use. For information about available libraries, see the compiler documentation.

Note: For C++ projects, you must use one of the DLIB library variants.

The names of the library object file and library configuration file that actually will be used are displayed in the **Library file** and **Configuration file** text boxes, respectively.

LIBRARY FILE

This option applies to the XLINK linker only.

The **Library file** text box displays the library object file that will be used. A library object file is automatically chosen depending on some of your settings, see the compiler documentation.

If you have chosen **Custom** library in the **Library** drop-down list, you must specify your own library object file.

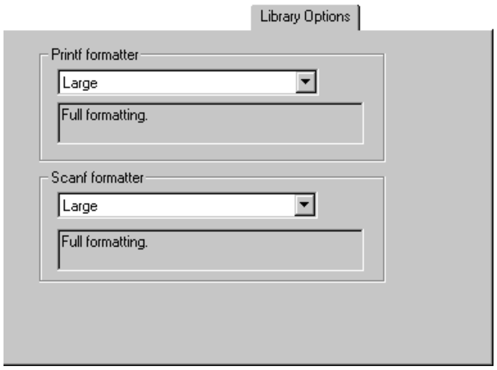
CONFIGURATION FILE

The **Configuration file** text box displays the library configuration file that will be used. A library configuration file is chosen automatically depending on the project settings. If you have chosen **Custom DLIB** in the **Library** drop-down list, you must specify your own library configuration file.

Note: A library configuration file is only required for the DLIB library, but note that not all product packages include the DLIB library.

Library Options

With the options on the **Library Options** page you can choose `printf` and `scanf` formatters.



Printf formatter: Large
Full formatting.

Scanf formatter: Large
Full formatting.

Figure 186: Library Options page

See the compiler documentation for more information about the formatting capabilities.

PRINTF FORMATTER

The full formatter version is memory-consuming, and provides facilities that are not required in many embedded applications. To reduce the memory consumption, alternative versions are also provided:

- Printf formatters in the IAR DLIB Library are: **Full**, **Large**, **Small**, and **Tiny**
- Printf formatters in the IAR CLIB Library are: **Large**, **Medium**, and **Small**.

Choose a formatter that suits the requirements of your application.

For information about available `printf` formatters, see the compiler documentation.

SCANF FORMATTER

The full formatter version is memory-consuming, and provides facilities that are not required in many embedded applications. To reduce the memory consumption, alternative versions are also provided:

- Scanf formatters in the IAR DLIB Library are: **Full**, **Large**, and **Small**
- Scanf formatters in the IAR CLIB Library are: **Large**, and **Medium**.

Choose a formatter that suits the requirements of your application.

For information about available `scanf` formatters, see the compiler documentation.

Stack/Heap

With the options on the **Stack/Heap** page you can customize the heap and stack sizes. For more information, see the online help system available from the **Help** menu.

MISRA C

Use the options on the **MISRA-C:1998** and **MISRA-C:2004** pages to control how the IDE checks the source code for deviations from the MISRA C rules. The settings are used for both the compiler and the linker.

For details about specific option, see the *IAR Embedded Workbench® MISRA C:2004 Reference Guide* or the *IAR Embedded Workbench® MISRA C:1998 Reference Guide* available from the **Help** menu.

The MISRA C options might not be available in the product package you are using.

Compiler options

This chapter describes the compiler options available in the IAR Embedded Workbench® IDE.

For information about how to set options, see *Setting options*, page 71.

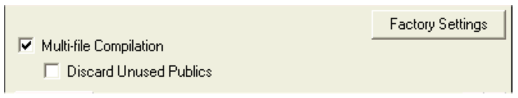
Multi-file compilation

The **Multi-file Compilation** option might not be available in the product package you are using.

Before you set specific compiler options, you can decide if you want to use multi-file compilation, which is an optimization technique. If the compiler is allowed to compile multiple source files in one invocation, it can in many cases optimize more efficiently.

You can use this option for the entire project or for individual groups of files. All C/C++ source files in such a group are compiled together using one invocation of the compiler.

In the **Options** dialog box, select **Multi-file Compilation** to enable multi-file compilation for the group of project files that you have selected in the workspace window. Use **Discard Unused Publics** to discard any unused public functions and variables from the compilation unit.



[✓] Multi-file Compilation

[ ] Discard Unused Publics

Figure 187: Multi-file Compilation

If you use this option, all files included in the selected group are compiled using the compiler options which have been set on the group or nearest higher enclosing node which has any options set. Any overriding compiler options on one or more files are ignored when building, because a group compilation must use exactly one set of options.

For information about how multi-file compilation is displayed in the workspace window, see *Workspace window*, page 182.

For more information about multi-file compilation and discarding unused public functions, see the compiler documentation.

Language

The **Language** options enable the use of target-dependent extensions to the C or C++ language.

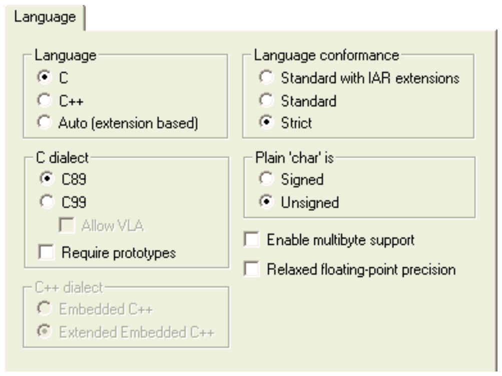


Figure 188: Compiler language options

LANGUAGE

With the **Language** options you can specify compiler support for either C or C++, provided that your product package supports C++. Choose between:

C	By default, the IAR C/C++ Compiler runs in C mode, in which features specific to C++ cannot be used.
C++	In C++ mode, the compiler treats the source code as Embedded C++ or Extended Embedded C++. This means that some features specific to C++, such as classes and overloading, can be used. C++ requires that a DLIB library (C/C++ library) is used.
Auto	If you select **Auto**, language support is decided automatically depending on the filename extension of the file being compiled: • Files with the filename extension `c` will be treated as C source files. • Files with the filename extension `cpp` will be treated as C++ source files.

Note: Not all product packages support C++. For products without C++ support, the **Language** options will not be available.

C DIALECT

If you have selected C as the supported language, you can specify the language dialect with the **C dialect** options. Depending on your product package, the available options are:

C89	Select this option to enable the C89 standard instead of Standard C. Note: This option is mandatory when the MISRA C checking is enabled. This option might not be available in the product package you are using. In this case, C89 is the default standard. For more information, see the compiler documentation.
C99	Select this option to enable the C99 standard, also known as Standard C. This is the default standard used in the compiler, and it is stricter than C89. Features specific to C89 cannot be used. This option might not be available in the product package you are using. In this case, C89 is the default standard and there is only limited support for C99. For more information, see the compiler documentation.
Allow VLA	Select this option to allow variable length arrays. This option might not be available in the product package you are using.
Require prototypes	This option forces the compiler to verify that all functions have proper prototypes. Using this option means that code containing any of the following will generate an error: • A function call of a function with no declaration, or with a Kernighan & Ritchie C declaration. • A function definition of a public function with no previous prototype declaration. • An indirect function call through a function pointer with a type that does not include a prototype

.C++ DIALECT

With the **C++ dialect** options you can specify the C++ dialect if you have selected **C++** or **Auto** as the supported language. Choose between:

Embedded C++	In Embedded C++ mode, the compiler treats the source code as Embedded C++. This means that features specific to C++, such as classes and overloading, can be used.

Extended Embedded C++	In Extended Embedded C++ mode, you can take advantage of features like namespaces or the standard template library in your source code.

C++ requires that a DLIB library **(**C/C++ library**)** is used. For information about Embedded C++ and Extended Embedded C++, see the compiler documentation.

Note: Not all product packages support C++. For products without C++ support, the **C++ dialect** options will not be available.

LANGUAGE CONFORMANCE

With the **Language conformance** options you can specify how strictly the compiler shall adhere to the standard C or C++ language. Choose between:

Standard with IAR extensions	When this option is selected, the compiler accepts target-specific keywords as extensions to the standard C or C++ language. In the IDE, this option is enabled by default.
Standard	This option disables IAR Systems extensions, but does not adhere strictly to the C or C++ dialect you have selected. Some very useful relaxations to C or C++ are still available.
Strict	Select this option to adhere strictly to the C or C++ dialect you have selected. This option disables a great number of useful extensions and relaxations to C or C++.

For details about language extensions, see the compiler documentation.

PLAIN 'CHAR' IS

Normally, the compiler interprets the plain `char` type as `unsigned char` or `signed char`. The runtime library is compiled with the same setting as the default type used in the compiler. For information about which, refer to the compiler documentation.

Use the **Plain 'char' is** option to make the compiler override the default type, for example for compatibility with another compiler.

Note: If you use this option to override the default behavior, references to library functionality that uses plain characters will not work as the library then is built with a different type setting.

ENABLE MULTIBYTE SUPPORT

By default, multibyte characters cannot be used in C or Embedded C++ source code. If you use this option, multibyte characters in the source code are interpreted according to the host computer’s default setting for multibyte support.

Multibyte characters are allowed in C and C++ style comments, in string literals, and in character constants. They are transferred untouched to the generated code.

RELAXED FLOATING-POINT PRECISION

This option might not be available in the product package you are using.

Select this option to allow the compiler to relax the language rules and perform more aggressive optimization of floating-point expressions. This option improves performance for floating-point expressions that fulfill these conditions:

- The expression consists of both single- and double-precision values
- The double-precision values can be converted to single precision without loss of accuracy
- The result of the expression is converted to single precision.

Note that performing the calculation in single precision instead of double precision might cause a loss of accuracy.

ENABLE IAR MIGRATION PREPROCESSOR EXTENSIONS

Migration preprocessor extensions extend the preprocessor, to ease migration of code from earlier IAR Systems compilers. If you need to migrate code from an earlier IAR C or C++ compiler, you might want to use this option. Note that, depending on your product installation, this option might not be available.

Note: If you use this option, not only will the compiler accept code that is not standard conformant, but it will also reject some code that *does* conform to standard.

Important! Do not depend on these extensions in newly written code. Support for them might be removed in future compiler versions.

This option might not be available in the product package you are using.

Code

With the options on the **Code** page you can customize the code generation. For more information, see the online help system available from the **Help** menu. Note that, depending on your product package, this page might not be available.

Optimizations

The **Optimizations** options determine the type and level of optimization for generation of object code.

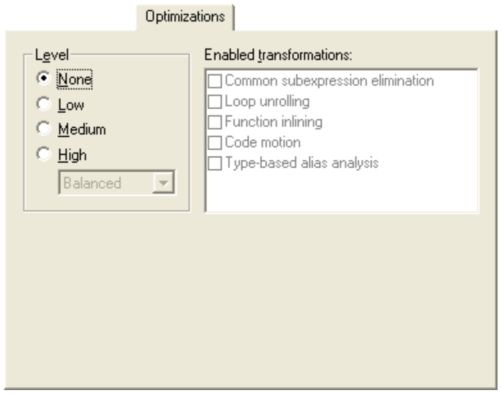


Figure 189: Compiler optimizations options

OPTIMIZATIONS

The compiler supports various levels of optimizations, and for the highest level you can fine-tune the optimizations explicitly for an optimization goal—size or speed. Choose between:

- **None** (best debug support)
- **Low**
- **Medium**
- **High, balanced** (balancing between speed and size)
- **High, speed** (favors speed)
- **High, size** (favors size).

By default, a debug project will have a size optimization that is fully debuggable, while a release project will have a high balanced optimization that generates small code without sacrificing speed.

For a list of optimizations performed at each optimization level, see the compiler documentation.

Enabled transformations

These transformations are available on different level of optimizations:

- Common subexpression elimination
- Loop unrolling
- Function inlining
- Code motion
- Type-based alias analysis.

Note: Depending on your product package, there might be additional transformations available.

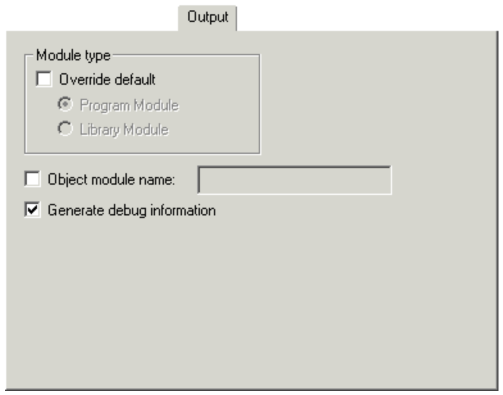
When a transformation is available, you can enable or disable it by selecting its check box.

In a *debug* project the transformations are, by default, disabled. In a *release* project the transformations are, by default, enabled.

For a brief description of the transformations that can be individually disabled, see the compiler documentation.

Output

The **Output** page provide settings for the generated compiler output.


Output

Module type
- [ ] Override default
  - (●) Program Module
  - ( ) Library Module
- [ ] Object module name:
- [✓] Generate debug information

Figure 190: Compiler output options

The options on this page depend on the linker used, either the XLINK linker or the ILINK linker.

MODULE TYPE

This option applies to the XLINK linker only.

By default, the compiler generates *program* modules. Use this option to make a *library* module that will only be included if it is referenced in your application. Select the **Override default** check box and choose one of:

Program Module	The object file will be treated as a program module rather than as a library module.
Library Module	The object file will be treated as a library module rather than as a program module.

For information about program and library modules, and working with libraries, see the XLIB and XAR chapters in the *IAR Linker and Library Tools Reference Guide*, available from the **Help** menu.

OBJECT MODULE NAME

This option applies to the XLINK linker only.

Normally, the internal name of the object module is the name of the source file, without a directory name or extension. Use this option to set the object module name explicitly.

First select the **Object module name** check box, then type a name in the entry field.

This option is particularly useful when several modules have the same filename, because the resulting duplicate module name would normally cause a linker error; for example, when the source file is a temporary file generated by a preprocessor.

GENERATE DEBUG INFORMATION

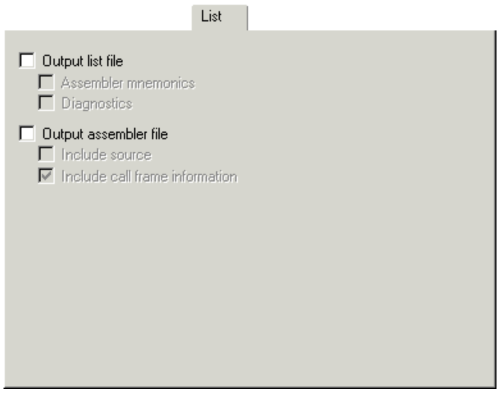
This option causes the compiler to include additional information in the object modules that is required by C-SPY® and other symbolic debuggers.

The **Generate debug information** option is selected by default. Deselect this option if you do not want the compiler to generate debug information.

Note: The included debug information increases the size of the object files.

List

The **List** options determine whether a list file is produced, and the information is included in the list file.



- [ ] Output list file
  - [ ] Assembler mnemonics
  - [ ] Diagnostics
- [ ] Output assembler file
  - [ ] Include source
  - [x] Include call frame information

Figure 191: Compiler list file options

Normally, the compiler does not generate a list file. Select any of the following options to generate a list file or an assembler file. The list file will be saved in the `List` directory, and its filename will consist of the source filename, plus the filename extension `lst`. You can open the output files directly from the **Output** folder which is available in the Workspace window.

OUTPUT LIST FILE

Select the **Output list file** option and choose the type of information to include in the list file:

Assembler mnemonics	Includes assembler mnemonics in the list file.
Diagnostics	Includes diagnostic information in the list file.

OUTPUT ASSEMBLER FILE

Select the **Output assembler file** option and choose the type of information to include in the list file:

Include source	Includes source code in the assembler file.
Include call frame information	Includes compiler-generated information for runtime model attributes, call frame information, and frame size information.

Preprocessor

The **Preprocessor** options allow you to define symbols and include paths for use by the compiler.

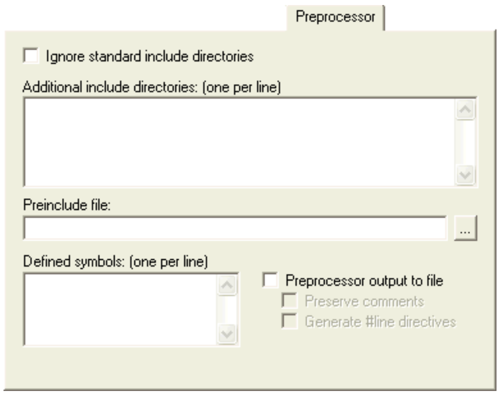

Preprocessor
Ignore standard include directories
Additional include directories: (one per line)
Preinclude file:
...
Defined symbols: (one per line)
Preprocessor output to file
Preserve comments
Generate #line directives

Figure 192: Compiler preprocessor options

IGNORE STANDARD INCLUDE DIRECTORIES

If you select this option, the standard include files will not be used when the project is built.

ADDITIONAL INCLUDE DIRECTORIES

The **Additional include directories** option adds a path to the list of `#include` file paths. The paths required by the product are specified automatically based on your choice of runtime library.

Type the full file path of your `#include` files.

Note: Any additional directories specified using this option are searched before the standard include directories.

To make your project more portable, use the argument variable `$TOOLKIT_DIR$` for the subdirectories of the active product and `$PROJ_DIR$` for the directory of the current project. For an overview of the argument variables, see *Argument variables summary*, page 228.

PREINCLUDE FILE

Use this option to make the compiler include the specified include file before it starts to read the source file. This is useful if you want to change something in the source code for the entire application, for instance if you want to define a new symbol.

DEFINED SYMBOLS

The **Defined symbols** option is useful for conveniently specifying a value or choice that would otherwise be specified in the source file.

Type the symbols that you want to define for the project, for example:

```
TESTVER=1
```

Note that there should be no space around the equal sign.

The **Defined symbols** option has the same effect as a `#define` statement at the top of the source file.

For example, you might arrange your source to produce either the test or production version of your application depending on whether the symbol `TESTVER` was defined. To do this you would use include sections such as:

```
#ifdef  TESTVER
  ...  ; additional code lines for test version only
#endif
```

You would then define the symbol `TESTVER` in the Debug target but not in the Release target.

PREPROCESSOR OUTPUT TO FILE

By default, the compiler does not generate preprocessor output.

Select the **Preprocessor output to file** option if you want to generate preprocessor output. You can also choose to preserve comments and/or to generate `#line` directives.

Diagnostics

The **Diagnostics** options determine how diagnostics are classified and displayed. Use the diagnostics options to override the default classification of the specified diagnostics.

Note: The diagnostics cannot be suppressed for fatal errors, and fatal errors cannot be reclassified.

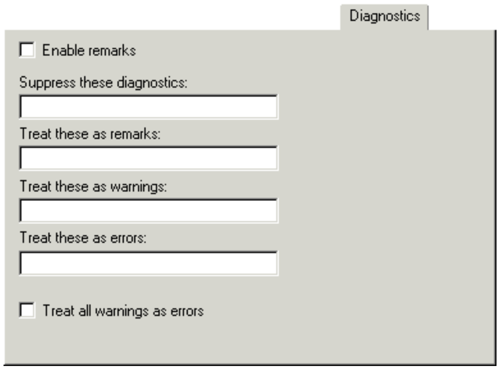


Figure 193: Compiler diagnostics options

ENABLE REMARKS

The least severe diagnostic messages are called *remarks*. A remark indicates a source code construct that might cause strange behavior in the generated code.

By default, remarks are not issued. Select the **Enable remarks** option if you want the compiler to generate remarks.

SUPPRESS THESE DIAGNOSTICS

This option suppresses the output of diagnostics for the tags that you specify.

For example, to suppress the warnings `Pe117` and `Pe177`, type:

```
Pe117,Pe177
```

TREAT THESE AS REMARKS

A remark is the least severe type of diagnostic message. It indicates a source code construct that might cause strange behavior in the generated code. Use this option to classify diagnostics as remarks.

For example, to classify the warning `Pe177` as a remark, type:

```
Pe177
```

TREAT THESE AS WARNINGS

A *warning* indicates an error or omission that is of concern, but which will not cause the compiler to stop before compilation is completed. Use this option to classify diagnostic messages as warnings.

For example, to classify the remark `Pe826` as a warning, type:

```
Pe826
```

TREAT THESE AS ERRORS

An *error* indicates a violation of the C or C++ language rules, of such severity that object code will not be generated, and the exit code will be non-zero. Use this option to classify diagnostic messages as errors.

For example, to classify the warning `Pe117` as an error, type:

```
Pe117
```

TREAT ALL WARNINGS AS ERRORS

Use this option to make the compiler treat all warnings as errors. If the compiler encounters an error, object code is not generated.

MISRA C

Use these options to override the options set on the **MISRA-C:1998** and **MISRA-C:2004** pages of the **General Options** category.

For details about specific option, see the *IAR Embedded Workbench® MISRA C:2004 Reference Guide* or the *IAR Embedded Workbench® MISRA C:1998 Reference Guide* available from the **Help** menu.

The MISRA C options might not be available in the product package you are using.

Extra Options

The **Extra Options** page provides you with a command line interface to the compiler.

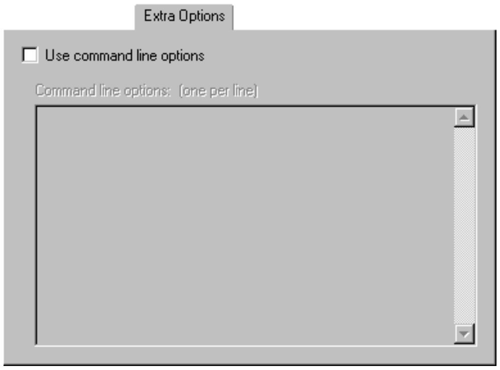


Figure 194: Extra Options page for the compiler

USE COMMAND LINE OPTIONS

Additional command line arguments for the compiler (not supported by the GUI) can be specified here.

Assembler options

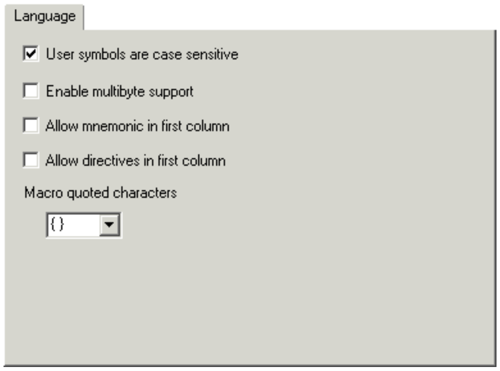
This chapter describes the assembler options available in the IAR Embedded Workbench® IDE.

For information about how to set options, see *Setting options*, page 71.

Language

The **Language** options control the code generation of the assembler.

Note: Some of the options described here might not be available in the product package you are using.



- [✓] User symbols are case sensitive
- [ ] Enable multibyte support
- [ ] Allow mnemonic in first column
- [ ] Allow directives in first column

Macro quoted characters: {}

Figure 195: Assembler language options

USER SYMBOLS ARE CASE SENSITIVE

By default, case sensitivity is on. This means that, for example, `LABEL` and `label` refer to different symbols. You can deselect **User symbols are case sensitive** to turn case sensitivity off, in which case `LABEL` and `label` will refer to the same symbol.

ENABLE MULTIBYTE SUPPORT

By default, multibyte characters cannot be used in assembler source code. If you use this option, multibyte characters in the source code are interpreted according to the host computer's default setting for multibyte support.

Multibyte characters are allowed in comments, in string literals, and in character constants. They are transferred untouched to the generated code.

ALLOW MNEMONICS IN FIRST COLUMN

This option might not be available in the product package you are using.

The default behavior of the assembler is to treat all identifiers starting in the first column as labels.

Use this option to make mnemonics names (without a trailing colon) starting in the first column to be recognized as mnemonics.

ALLOW DIRECTIVES IN FIRST COLUMN

This option might not be available in the product package you are using.

The default behavior of the assembler is to treat all identifiers starting in the first column as labels.

Use this option to make directive names (without a trailing colon) that start in the first column to be recognized as directives.

MACRO QUOTE CHARACTERS

The **Macro quote characters** option sets the characters used for the left and right quotes of each macro argument.

By default, the characters are < and >. This option allows you to change the quote characters to suit an alternative convention or simply to allow a macro argument to contain < or >.

From the drop-down list, choose one of four types of brackets to be used as macro quote characters:

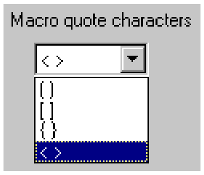
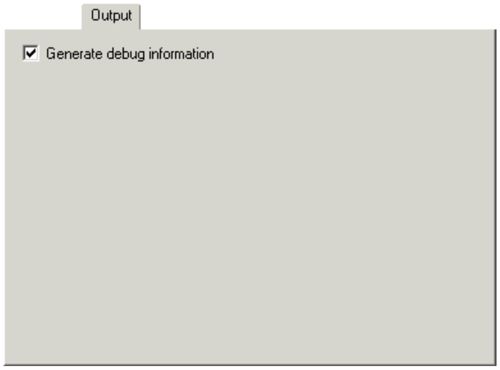


Figure 196: Choosing macro quote characters

Output

The **Output** options allow you to generate information to be used by a debugger such as the IAR C-SPY® Debugger.



Output

☑ Generate debug information

Figure 197: Assembler output options

GENERATE DEBUG INFORMATION

The **Generate debug information** option must be selected if you want to use a debugger with your application. By default, this option is selected in a Debug project, but not in a Release project.

List

The **List** options are used for making the assembler generate a list file and for selecting the list file contents. For reference information about each option, see the online help system available from the **Help** menu.

Preprocessor

The **Preprocessor** options allow you to define include paths and symbols in the assembler.

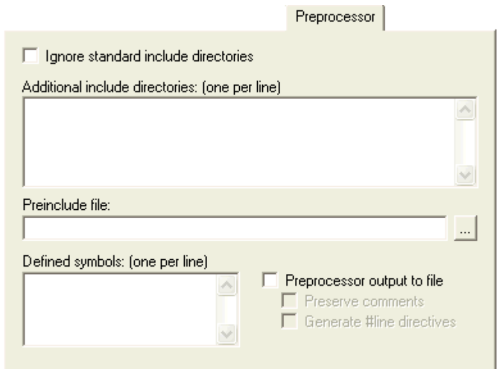

Preprocessor
Ignore standard include directories
Additional include directories: (one per line)
Preinclude file:
...
Defined symbols: (one per line)
Preprocessor output to file
Preserve comments
Generate #line directives

Figure 198: Assembler preprocessor options

IGNORE STANDARD INCLUDE DIRECTORIES

If you select this option, the standard include files will not be used when the project is built.

ADDITIONAL INCLUDE DIRECTORIES

The **Additional include directories** option adds paths to the list of `#include` file paths. The path required by the product is specified automatically.

Type the full path of the directories that you want the assembler to search for `#include` files.

To make your project more portable, use the argument variable `$TOOLKIT_DIR$` for the subdirectories of the active product and `$PROJ_DIR$` for the directory of the current project. For an overview of the argument variables, see *Argument variables summary*, page 228.

See the *IAR Assembler Reference Guide* for information about the `#include` directive.

Note: By default, the assembler also searches for `#include` files in the paths specified in the `A`*`CPUNAME`*`_INC` (for XLINK) and `IASM`*`CPUNAME`*`_INC` (for ILINK) environment variable. We do not, however, recommend that you use environment variables in the IDE.

DEFINED SYMBOLS

This option provides a convenient way of specifying a value or choice that you would otherwise have to specify in the source file.

Type the symbols you want to define, one per line.

- For example, you might arrange your source to produce either the test or production version of your application depending on whether the symbol `TESTVER` was defined. To do this you would use include sections such as:

  ```
  #ifdef  TESTVER
  ...  ; additional code lines for test version only
  #endif
  ```

  You would then define the symbol `TESTVER` in the Debug target but not in the Release target.

- Alternatively, your source might use a variable that you need to change often, for example `FRAMERATE`. You would leave the variable undefined in the source and use this option to specify a value for the project, for example `FRAMERATE=3`.

To delete a user-defined symbol, select in the **Defined symbols** list and press the Delete key.

PREPROCESSOR OUTPUT TO FILE

By default, the assembler does not generate preprocessor output.

Select the **Preprocessor output to file** option if you want to generate preprocessor output. You can also choose to preserve comments and/or to generate `#line` directives.

Note: This option might not be available in the product version you are using.

Diagnostics

The **Diagnostics** options determine how diagnostics are classified and displayed. Use the diagnostics options to override the default classification of the specified diagnostics.

For reference information about each option, see the online help system available from the **Help** menu.

Extra Options

The **Extra Options** page provides you with a command line interface to the assembler.

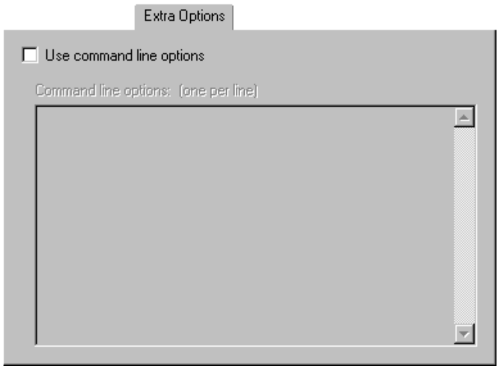


Figure 199: Extra Options page for the assembler

USE COMMAND LINE OPTIONS

Additional command line arguments for the assembler (not supported by the GUI) can be specified here.

Converter options

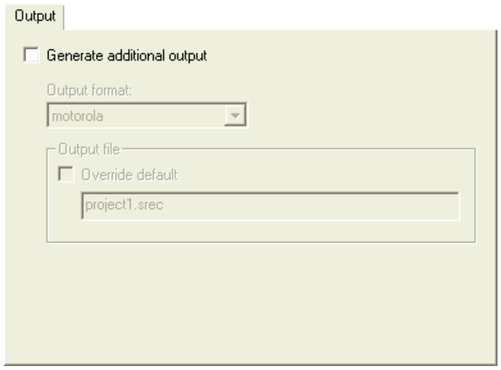
This chapter describes the options available in the IAR Embedded Workbench® IDE for converting output files from the ELF format.

For information about how to set options, see *Setting options*, page 71.

Output

The converter **Output** options apply to the ILINK linker only.

The **Output** options are used for specifying details about the promable output format and the level of debugging information included in the output file.



☐ Generate additional output

Output format: motorola

Output file

☐ Override default

project1.srec

Figure 200: Converter output file options

PROMABLE OUTPUT FORMAT

The ILINK linker generates ELF as output, optionally including DWARF for debug information. Use the **Promable output format** drop-down list to convert the ELF output to a different format, for example Motorola or Intel-extended. The `ielftool` converter is used for converting the file. For more information about the converter, see the compiler documentation.

OUTPUT FILE

Use **Output file** to specify the name of the `iarchive` converted output file. If a name is not specified, the linker will use the project name with a filename extension. The filename extension depends on which output format you choose; for example, either `srec` or `hex`.

Override default

Use this option to specify a filename or filename extension other than the default.

Custom build options

This chapter describes the Custom Build options available in the IAR Embedded Workbench® IDE.

For information about how to set options, see *Setting options*, page 71.

Custom Tool Configuration

To set custom build options in the IDE, choose **Project>Options** to display the **Options** dialog box. Then select **Custom Build** in the **Category** list to display the **Custom Tool Configuration** page:

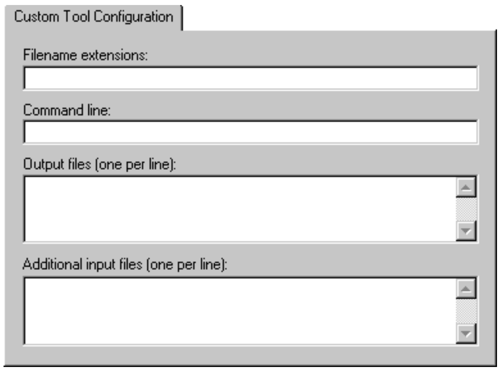

Custom Tool Configuration
Filename extensions:
Command line:
Output files (one per line):
Additional input files (one per line):

Figure 201: Custom tool options

In the **Filename extensions** text box, specify the filename extensions for the types of files that are to be processed by this custom tool. You can enter several filename extensions. Use commas, semicolons, or blank spaces as separators. For example:

```
.htm; .html
```

In the **Command line** text box, type the command line for executing the external tool.

In the **Output files** text box, enter the output files from the external tool.

If any additional files are used by the external tool during the building process, these files should be added in the **Additional input files** text box. If these additional input files, *dependency* files, are modified, the need for a rebuild is detected.

For an example, see *Extending the toolchain*, page 75.

Build actions options

This chapter describes the options for pre-build and post-build actions available in the IAR Embedded Workbench® IDE.

For information about how to set options, see *Setting options*, page 71.

Build Actions Configuration

To set options for pre-build and post-build actions in the IDE, choose **Project>Options** to display the **Options** dialog box. Then select **Build Actions** in the **Category** list to display the **Build Actions Configuration** page.

These options apply to the whole build configuration, and cannot be set on groups or files.

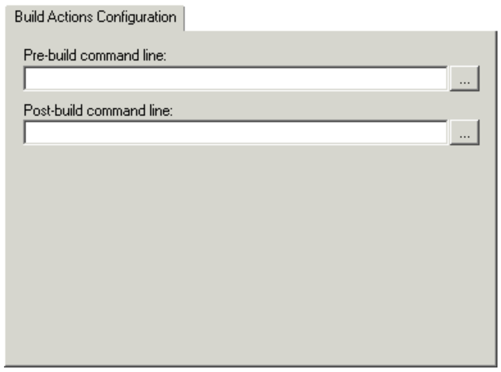


Figure 202: Build actions options

PRE-BUILD COMMAND LINE

Type a command line to be executed directly before a build; a browse button for locating an extended command line file is available for your convenience. The commands will not be executed if the configuration is already up-to-date.

POST-BUILD COMMAND LINE

Type a command line to be executed directly after each successful build; a browse button is available for your convenience. The commands will not be executed if the configuration was up-to-date. This is useful for copying or post-processing the output file.

XLINK linker options

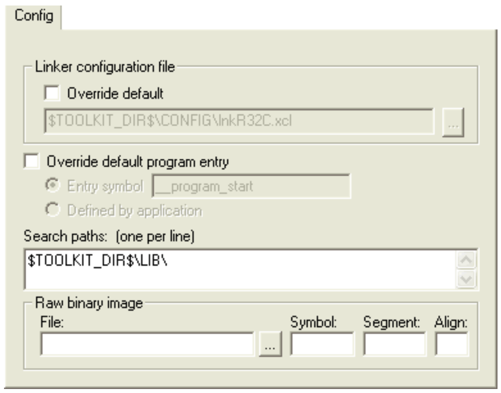
This chapter describes the XLINK linker options available in the IAR Embedded Workbench® IDE. If you have the ILINK linker, instead refer to *ILINK linker options*, page 353.

For information about how to set options, see *Setting options*, page 71.

Note that the XLINK command line options that are used for defining segments in a linker configuration file are described in the *IAR Linker and Library Tools Reference Guide.*

Config

With the **Config** options you can specify the path and name of the linker configuration file, override the default program entry, and specify the library search path.



Linker configuration file

☐ Override default

$TOOLKIT_DIR$\CONFIG\lnkR32C.xcl

☐ Override default program entry

● Entry symbol __program_start

○ Defined by application

Search paths: (one per line)

```
$TOOLKIT_DIR$\LIB\
```

Raw binary image

File: Symbol: Segment: Align:

Figure 203: Linker config options

LINKER CONFIGURATION FILE

A default linker configuration file is selected automatically for the chosen **Target** settings in the **General Options** category. To override this, select the **Override default** option and specify an alternative file.

The argument variables `$TOOLKIT_DIR$` or `$PROJ_DIR$` can be used here too, to specify a project-specific or predefined linker configuration file.

OVERRIDE DEFAULT PROGRAM ENTRY

By default, the program entry is the symbol `__program_start`. The linker will make sure that a module containing the program entry symbol is included, and that the segment part containing the symbol is not discarded.

To override the default program handling, select **Override default program entry**.

Selecting the option **Entry symbol** will make it possible to specify a symbol other than `__program_start` to use for the program entry.

Selecting the option **Defined by application** disables the use of a start symbol. The linker will, as always, include all program modules, and enough library modules to satisfy all symbol references, keeping all segment parts that are marked with the `root` attribute or that are referenced, directly or indirectly, from such a segment part.

SEARCH PATHS

The **Search paths** option specifies the names of the directories which XLINK will search if it fails to find the object files to be linked in the current working directory. Add the full paths of any further directories that you want XLINK to search.

The paths required by the product are specified automatically based on your choice of runtime library. If the box is left empty, XLINK searches for object files only in the current working directory.

Type the full file path of your `#include` files. To make your project more portable, use the argument variable `$TOOLKIT_DIR$` for the subdirectories of the active product and `$PROJ_DIR$` for the directory of the current project. For an overview of the argument variables, see *Argument variables summary*, page 228.

RAW BINARY IMAGE

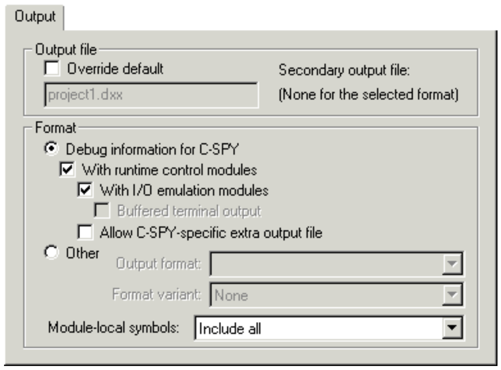
Use the **Raw binary image** options to link pure binary files in addition to the ordinary input files. Use the text boxes to specify these parameters:

File	The pure binary file you want to link.
Symbol	The symbol defined by the segment part where the binary data is placed.
Segment	The segment where the binary data is placed.
Align	The alignment of the segment part where the binary data is placed.

The entire contents of the file are placed in the segment you specify, which means it can only contain pure binary data, for example, the raw-binary output format. The segment part where the contents of the specified file is placed, is only included if the specified symbol is required by your application. Use the `-g` linker option if you want to force a reference to the symbol. Read more about single output files and the `-g` option in the *IAR Linker and Library Tools Reference Guide*.

Output

The **Output** options are used for specifying the output format and the level of debugging information included in the output file.



- [ ] Override default
- project1.dxx
- Secondary output file: (None for the selected format)
- (●) Debug information for C-SPY
  - [✓] With runtime control modules
    - [✓] With I/O emulation modules
      - [ ] Buffered terminal output
  - [ ] Allow C-SPY-specific extra output file
- ( ) Other
  - Output format:
  - Format variant: None
- Module-local symbols: Include all

Figure 204: XLINK output file options

OUTPUT FILE

Use **Output file** to specify the name of the XLINK output file. If a name is not specified, the linker will use the project name with a filename extension. The filename extension depends on which output format you choose. If you choose **Debug information for C-SPY**, the output file will have the filename extension `dxx`.

Note: If you select a format that generates two output files, the file type that you specify will only affect the primary output file (first format).

Override default

Use this option to specify a filename or filename extension other than the default.

FORMAT

The output options determine the format of the output file generated by the IAR XLINK Linker. The output file is used as input to either a debugger or as input for programming the target system. The IAR Systems proprietary output format is called UBROF, Universal Binary Relocatable Object Format.

The default output settings are:

- In a *debug* project, **Debug information for C-SPY**, **With runtime control modules**, and **With I/O emulation modules** are selected by default
- In a *release* project, an output format suitable for target download is selected automatically.

Note: For debuggers other than C-SPY®, check the user documentation supplied with that debugger for information about which format/variant should be used.

For more information about the debugger runtime interface, see the compiler documentation.

Debug information for C-SPY

This option creates a UBROF output file, with a `d`*`xx`* filename extension, to be used with C-SPY.

With runtime control modules

This option produces the same output as the **Debug information for C-SPY** option, but also includes debugger support for handling program abort, exit, and assertions. Special C-SPY variants for the corresponding library functions are linked with your application.

With I/O emulation modules

This option produces the same output as the **Debug information for C-SPY** and **With runtime control modules** options, but also includes debugger support for I/O handling, which means that `stdin` and `stdout` are redirected to the Terminal I/O window, and that you can access files on the host computer during debugging.

Buffered terminal output

During program execution in C-SPY, instead of instantly printing each new character to the C-SPY Terminal I/O window, this option will buffer the output. This option is useful when using debugger systems that have slow communication.

Allow C-SPY-specific extra output file

Use this option to enable the options available on the **Extra Output** page.

If you choose any of the options **With runtime control modules** or **With I/O emulation modules**, the generated output file will contain dummy implementations for certain library functions, such as `putchar`, and extra debug information required by C-SPY to handle those functions. In this case, the options available on the **Extra Output** page are disabled, which means you cannot generate an extra output file. The reason is that the extra output file would still contain the dummy functions, but would lack the required extra debug information, and would therefore normally be useless.

However, for *some* debugger systems, two output files from the same build process are required—one with the required debug information, and one that you can burn to your hardware before debugging. This is useful when you want to debug code that is located in non-volatile memory. In this case, you must choose the **Allow C-SPY-specific extra output file** option to make it possible to generate an extra output file.

Other

Use this option to generate output other than those generated by the options **Debug information for C-SPY**, **With runtime control modules**, and **With I/O emulation modules**.

Use the **Output format** drop-down list to select the appropriate output. If applicable, use **Format variant** to select variants available for some of the output formats. The alternatives depend on the output format chosen.

When you specify the **Other>Output format** option as either **debug (ubrof)**, or **ubrof**, a UBROF output file with the filename extension `dbg` is created. The generated output file will not contain debugging information for simulating facilities such as stop at program exit, long jump instructions, and terminal I/O. If you need support for these facilities during debugging, use the **Debug information for C-SPY**, **With runtime control modules**, and **With I/O emulation modules** options, respectively.

For more information, see the *IAR Linker and Library Tools Reference Guide*.

Module-local symbols

Use this option to specify whether local (non-public) symbols in the input modules should be included or not by the IAR XLINK Linker. If suppressed, the local symbols will not appear in the listing cross-reference and they will not be passed on to the output file.

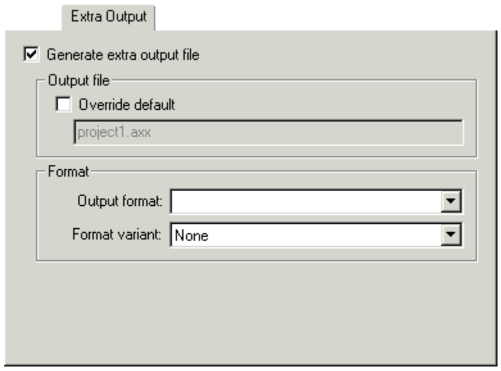
You can choose to ignore just the compiler-generated local symbols, such as jump or constant labels. Usually these are only of interest when debugging at assembler level.

Note: Local symbols are only included in files if they were compiled or assembled with the appropriate option to specify this.

Extra Output

The **Extra Output** options are used for generating an extra output file and for specifying its format.

Note: If you have chosen any of the options **With runtime control modules** or **With I/O emulation modules** available on the **Output** page, you must also choose the option **Allow C-SPY-specific extra output file** to enable the **Extra Output** options.



☑ Generate extra output file

☐ Override default

project1.axx

Output format:

Format variant: None

Figure 205: XLINK extra output file options

Use the **Generate extra output file** option to generate an additional output file from the build process.

Use the **Override default** option to override the default file name. If a name is not specified, the linker will use the project name and a filename extension which depends on the output format you choose.

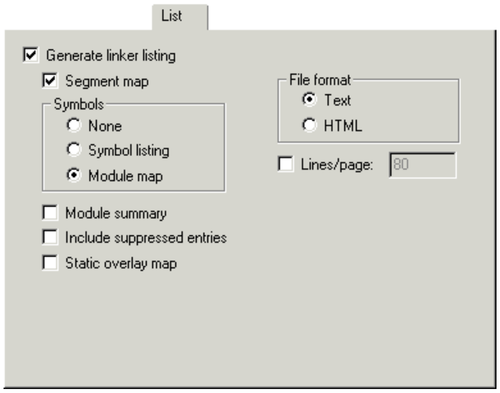
Note: If you select a format that generates two output files, the file type that you specify will only affect the primary output file (first format).

Use the **Output format** drop-down list to select the appropriate output. If applicable, use **Format variant** to select variants available for some of the output formats. The alternatives depend on the output format you have chosen.

When you specify the **Output format** option as either **debug (ubrof)**, or **ubrof**, a UBROF output file with the filename extension `dbg` is created.

List

The **List** options determine the generation of an XLINK cross-reference listing.



[✓] Generate linker listing
[✓] Segment map
Symbols: None / Symbol listing / [✓ Module map]
[ ] Module summary
[ ] Include suppressed entries
[ ] Static overlay map
File format: [✓ Text] / HTML
[ ] Lines/page: 80

Figure 206: Linker list file options

GENERATE LINKER LISTING

Causes the linker to generate a listing and send it to the file `projectname.map`.

Segment map

Use **Segment map** to include a segment map in the XLINK listing file. The segment map will contain a list of all the segments in dump order.

Symbols

These options are available:

Option	Description
None	Symbols are excluded from the linker listing.
Symbol listing	An abbreviated list of every entry (global symbol) in every module. This entry map is useful for quickly finding the address of a routine or data element.
Module map	A list of all segments, local symbols, and entries (public symbols) for every module in the application.

Table 90: XLINK list file options

Module summary

Use the **Module summary** option to generate a summary of the contributions to the total memory use from each module.

Only modules with a contribution to memory use are listed.

Include suppressed entries

Use this option to include all segment parts in a linked module in the list file, not just the segment parts that were included in the output. This makes it possible to determine exactly which entries that were not needed.

Static overlay map

If the compiler uses static overlay, this option includes a listing of the static overlay system in the list file. Read more about static overlay maps in the *IAR Linker and Library Tools Reference Guide.*

File format

These options are available:

Option	Description
Text	Plain text file
HTML	HTML format, with hyperlinks

Table 91: XLINK list file format options

Lines/page

Sets the number of lines per page for the XLINK listings to `lines`, which must be in the range 10 to 150.

#define

You can define symbols with the **#define** option.

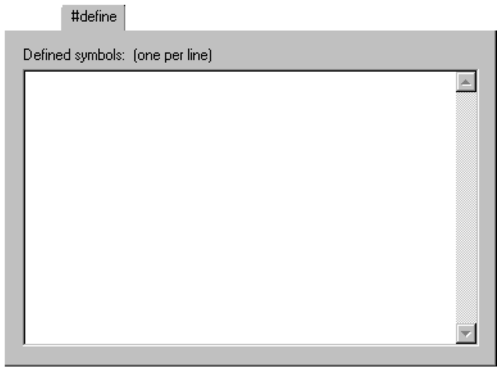


Figure 207: Linker defined symbols options

DEFINED SYMBOLS

Use **Defined symbols** to define absolute symbols at link time. This is especially useful for configuration purposes.

Type the symbols that you want to define for the project, for example:

```
TESTVER=1
```

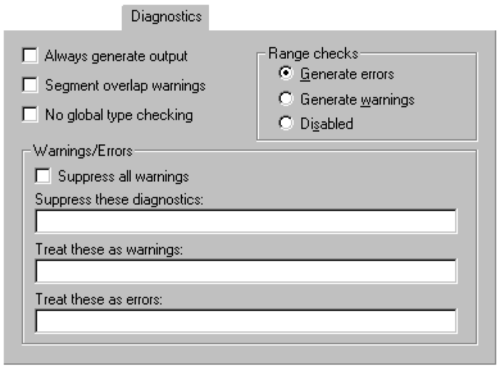
Note that there should be no space around the equal sign.

Any number of symbols can be defined in a linker configuration file. The symbol(s) defined in this manner will be located in a special module called `?ABS_ENTRY_MOD`, which is generated by the linker.

The linker will display an error message if you attempt to redefine an existing symbol.

Diagnostics

The **Diagnostics** options determine the error and warning messages generated by the IAR XLINK Linker.



☐ Always generate output
☐ Segment overlap warnings
☐ No global type checking

Range checks: [✓ Generate errors] Generate warnings Disabled

☐ Suppress all warnings

Figure 208: Linker diagnostics options

ALWAYS GENERATE OUTPUT

Use **Always generate output** to generate an output file even if a non-fatal error was encountered during the linking process, such as a missing global entry or a duplicate declaration. Normally, XLINK will not generate an output file if an error is encountered.

Note: XLINK always aborts on fatal errors, even when this option is used.

The **Always generate output** option allows missing entries to be patched in later in the absolute output image.

SEGMENT OVERLAP WARNINGS

Use **Segment overlap warnings** to reduce segment overlap errors to warnings, making it possible to produce cross-reference maps, etc.

NO GLOBAL TYPE CHECKING

Use **No global type checking** to disable type checking at link time. While a well-written application should not need this option, there might be occasions where it is helpful.

By default, XLINK performs link-time type checking between modules by comparing the external references to an entry with the `PUBLIC` entry (if the information exists in the object modules involved). A warning is generated if there are mismatches.

RANGE CHECKS

Use **Range checks** to specify the address range check. This table shows the range check options in the IDE:

Option	Description
Generate errors	An error message is generated
Generate warnings	Range errors are treated as warnings
Disabled	Disables the address range checking

Table 92: XLINK range check options

If an address is relocated outside address range of the target CPU —code, external data, or internal data address—an error message is generated. This usually indicates an error in an assembler language module or in the segment placement.

WARNINGS/ERRORS

By default, the IAR XLINK Linker generates a warning when it detects that something might be wrong, although the generated code might still be correct. The **Warnings/Errors** options allow you to suppress or enable all warnings, and to change the severity classification of errors and warnings.

Refer to the *IAR Linker and Library Tools Reference Guide* for information about the various warning and error messages.

Use these options to control the generation of warning and error messages:

Suppress all warnings

Use this option to suppress all warnings.

Suppress these diagnostics

This option suppresses the output of diagnostics for the tags that you specify.

For example, to suppress the warnings `w117` and `w177`, type `w117,w177`.

Treat these as warnings

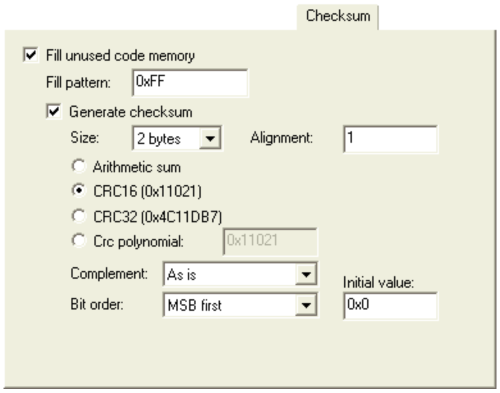
Use this option to specify errors that should be treated as warnings instead. For example, to make error 106 become treated as a warning, type `e106`.

Treat these as errors

Use this option to specify warnings that should be treated as errors instead. For example, to make warning 26 become treated as an error, type `w26`.

Checksum

With the **Checksum** options you can specify details about how the code is generated.



Checksum

[✓] Fill unused code memory

Fill pattern: 0xFF

[✓] Generate checksum

Size: 2 bytes   Alignment: 1

○ Arithmetic sum
● CRC16 (0x11021)
○ CRC32 (0x4C11DB7)
○ Crc polynomial: 0x11021

Complement: As is   Initial value:
Bit order: MSB first   0x0

Figure 209: Linker checksum and fill options

FILL UNUSED CODE MEMORY

Use **Fill unused code memory** to fill all gaps between segment parts introduced by the linker with the value you enter. The linker can introduce gaps either because of alignment restrictions, or at the end of ranges given in segment placement options.

The default behavior, when this option is not used, is that these gaps are not given a value in the output file.

Use **Fill unused code memory** to fill unused memory in the supplied range.

Fill pattern

Use this option to specify size, in hexadecimal notation, of the filler to be used in gaps between segment parts.

Start address

Use this option to specify the start address of the range to be filled.

End address

Use this option to specify the end address of the range to be filled.

Generate checksum

Use **Generate checksum** to checksum all generated raw data bytes. This option can only be used if the **Fill unused code memory** option has been specified.

Use **Generate checksum** to checksum the supplied range.

Size

Size specifies the number of bytes in the checksum, which can be 1, 2, or 4.

Alignment

Use this option to specify an optional alignment for the checksum. If you do not specify an alignment explicitly, an alignment of 2 is used.

Algorithms

One of the following algorithms can be used:

Algorithms	Description
Arithmetic sum	Simple arithmetic sum. The result is truncated to one byte. Use the **Result in full size** option to get the result in the specified size.
CRC16	CRC16, generating polynomial 0x11021 (default)
CRC32	CRC32, generating polynomial 0x104C11DB7
Crc polynomial	CRC with a generating polynomial of the value you enter

Table 93: Linker checksum algorithms

Complement

Use the **Complement** drop-down list to specify the one's complement or two's complement.

Bit order

By default it is the most significant 1, 2, or 4 bytes (**MSB**) of the result that will be output, in the natural byte order for the processor. Choose **LSB** from the **Bit order** drop-down list if you want the least significant bytes to be output.

Initial value

Use this option to specify the initial value of the checksum. This is useful if the microcontroller you are using has its own checksum calculation and you want that calculation to correspond to the calculation performed by the linker.

Extra Options

The **Extra Options** page provides you with a command line interface to the linker.

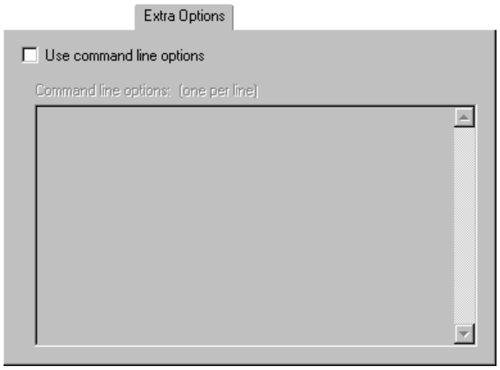


Figure 210: Extra Options page for the linker

USE COMMAND LINE OPTIONS

Additional command line arguments for the linker (not supported by the GUI) can be specified here.

ILINK linker options

This chapter describes the linker options available in the IAR Embedded Workbench® IDE. If you have the XLINK linker, instead refer to *XLINK linker options*, page 339.

For information about how to set options, see *Setting options*, page 71.

Config

With the **Config** options you can specify the path and name of the linker configuration file and define symbols for the configuration file.

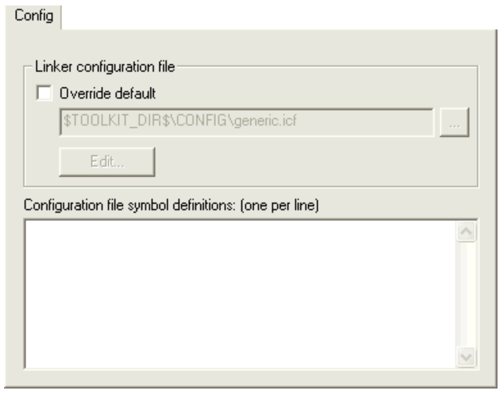

Config
Linker configuration file
Override default
$TOOLKIT_DIR$\CONFIG\generic.icf
...
Edit...
Configuration file symbol definitions: (one per line)

Figure 211: Linker configuration options

LINKER CONFIGURATION FILE

A default linker configuration file is selected automatically based on your project settings. To override this, select the **Override default** option and specify an alternative file.

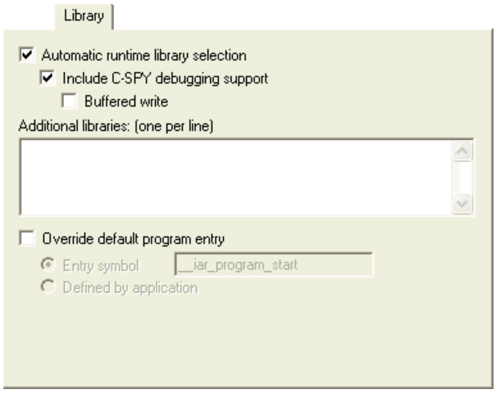
The argument variables `$TOOLKIT_DIR$` or `$PROJ_DIR$` can be used here too, to specify a project-specific or predefined configuration file.

CONFIGURATION FILE SYMBOL DEFINITIONS

Define constant configuration symbols to be used in the configuration file. Such a symbol has the same effect as a symbol defined using the `define symbol` directive in the linker configuration file.

Library

With the options on the **Library** page you can make settings for library usage.



- [✓] Automatic runtime library selection
  - [✓] Include C-SPY debugging support
    - [ ] Buffered write

Additional libraries: (one per line)

- [ ] Override default program entry
  - ● Entry symbol `__iar_program_start`
  - ○ Defined by application

Figure 212: Library Usage page

See the compiler documentation for more information about available libraries.

AUTOMATIC RUNTIME LIBRARY SELECTION

Use this option to make ILINK automatically choose the appropriate library based on your project settings.

INCLUDE C-SPY DEBUGGING SUPPORT

Select this option to include a debug library for communication between the application you debug and the debugger itself.

BUFFERED WRITE

During program execution in C-SPY, instead of instantly printing each new character to the C-SPY Terminal I/O window, this option will buffer the output. This option is useful when you use debugger systems that have slow communication.

ADDITIONAL LIBRARIES

Use the text box to specify additional libraries that you want the linker to include during the link process. You can only specify one library per line and you must specify the full path to the library. The argument variables `$PROJ_DIR$` and `$TOOLKIT_DIR$` can be used.

Alternatively, you can add an additional library directly to your project in the workspace window. You can find an example of this in the tutorial for creating and using libraries.

OVERRIDE DEFAULT PROGRAM ENTRY

By default, the program entry is the label `__iar_program_start`. The linker will make sure that a module containing the program entry label is included, and that the section containing that label is not discarded.

Use the option **Override default program entry** to override the default entry label. Choose between:

Entry symbol	Specifies a different entry symbol than used by default. Use the text field to specify a symbol other than `__iar_program_start` to use for the program entry.
Defined by application	Disables the use of an entry symbol. The linker will, as always, include all program modules, and enough library modules to satisfy all symbol references, keeping all sections that are marked with the root attribute or that are referenced, directly or indirectly, from such a section.

Input

The **Input** options are used for specifying how to handle input to the linker.

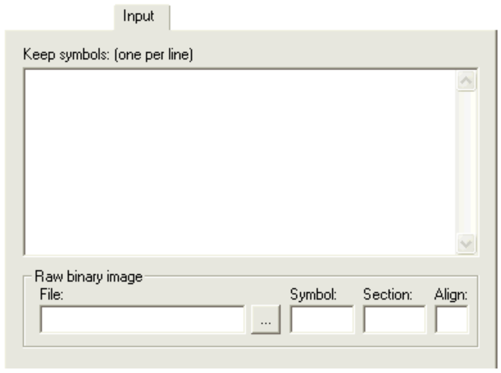


Figure 213: ILINK input file options

KEEP SYMBOLS

Normally, the linker keeps a symbol only if your application needs it.

Use the text box to specify a symbol, or several symbols separated by commas, that you want to always be included in the final application.

RAW BINARY IMAGE

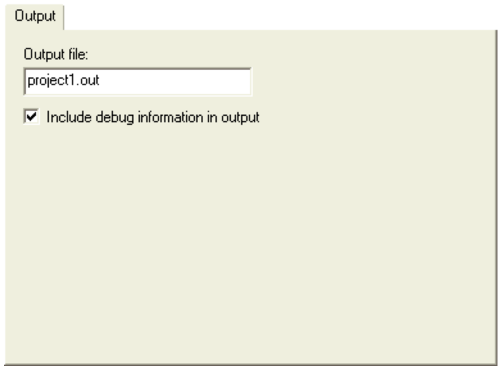
Use the **Raw binary image** options to link pure binary files in addition to the ordinary input files. Use the text boxes to specify these parameters:

File	The pure binary file you want to link.
Symbol	The symbol defined by the section where the binary data is placed.
Section	The section where the binary data is placed.
Align	The alignment of the section where the binary data is placed.

The entire contents of the file are placed in the section you specify, which means it can only contain pure binary data, for example, the raw-binary output format. The section where the contents of the specified file is placed, is only included if the specified symbol is required by your application. Use the `--keep` linker option if you want to force a reference to the symbol. Read more about single output files and the `--keep` option in the compiler documentation.

Output

The **Output** options are used for specifying details about the output.



Output file:
project1.out
[✓] Include debug information in output

Figure 214: ILINK output file options

OUTPUT FILE

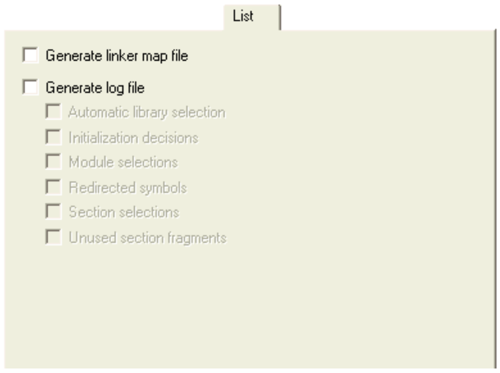
Use **Output file** to specify the name of the ILINK output file. If a name is not specified, the linker will use the project name with the filename extension `axx`.

INCLUDE DEBUG INFORMATION IN OUTPUT

Use **Include debug information in output** to make the linker generate an ELF output file including DWARF for debug information.

List

The **List** options determine the generation of an linker listing.



Generate linker map file

Generate log file

Automatic library selection

Initialization decisions

Module selections

Redirected symbols

Section selections

Unused section fragments

Figure 215: Linker diagnostics options

GENERATE LINKER MAP FILE

Use the **Generate linker map file** option to produce a linker memory map file. The map file has the filename extension `map`. For detailed information about the map file and its contents, see the compiler documentation.

GENERATE LOG FILE

Use the **Generate log file** options to save log information to a file. The log file will be placed in the `list` directory and have the filename extension `log`. The log information can be useful for understanding why an executable image became the way it is. You can optionally choose to log:

- Automatic library selection
- Initialization decisions
- Module selections
- Redirected symbols
- Section selections
- Unused section fragments.

#define

You can define symbols with the **#define** option.

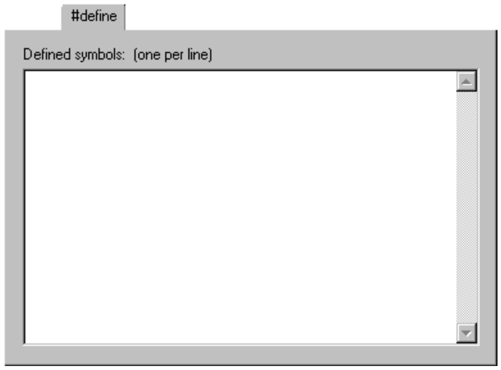


Figure 216: Linker defined symbols options

DEFINED SYMBOLS

Use **Defined symbols** to define absolute symbols at link time. This is especially useful for configuration purposes.

Type the symbols that you want to define for the project, for example:

```
TESTVER=1
```

Note that there should be no space around the equal sign.

Any number of symbols can be defined in a linker configuration file. The symbol(s) defined in this manner will be located in a special module called `?ABS_ENTRY_MOD`, which is generated by the linker.

The linker will display an error message if you attempt to redefine an existing symbol.

Diagnostics

The **Diagnostics** options determine how diagnostics are classified and displayed. Use the diagnostics options to override the default classification of the specified diagnostics.

Note: The diagnostics cannot be suppressed for fatal errors, and fatal errors cannot be reclassified.

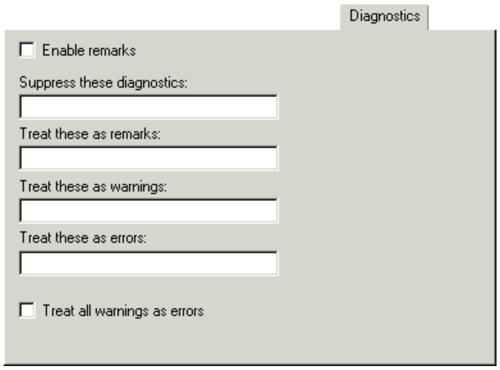


Figure 217: Linker diagnostics options

ENABLE REMARKS

The least severe diagnostic messages are called *remarks*. A remark indicates a construction that might cause strange behavior in the generated code.

By default, remarks are not issued. Select the **Enable remarks** option if you want the linker to generate remarks.

SUPPRESS THESE DIAGNOSTICS

This option suppresses the output of diagnostics for the tags that you specify.

For example, to suppress the warnings `Pe117` and `Pe177`, type:

```
Pe117,Pe177
```

TREAT THESE AS REMARKS

A remark is the least severe type of diagnostic message. It indicates a construction that might cause strange behavior in the generated code or the executable image. Use this option to classify diagnostics as remarks.

For example, to classify the warning `Pe177` as a remark, type:

```
Pe177
```

TREAT THESE AS WARNINGS

A *warning* indicates an error or omission that is of concern, but which will not cause the linker to stop before linking is completed. Use this option to classify diagnostic messages as warnings.

For example, to classify the remark `Pe826` as a warning, type:

```
Pe826
```

TREAT THESE AS ERRORS

An *error* indicates a violation of the linking rules, of such severity that an executable image will not be generated, and the exit code will be non-zero. Use this option to classify diagnostic messages as errors.

For example, to classify the warning `Pe117` as an error, type:

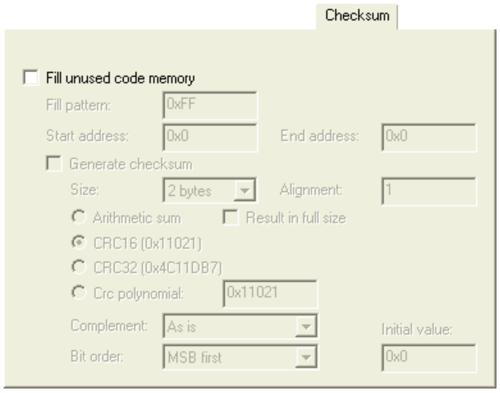
```
Pe117
```

TREAT ALL WARNINGS AS ERRORS

Use this option to make the linker treat all warnings as errors. If the linker encounters an error, an executable image is not generated.

Checksum

With the **Checksum** options you can specify details about how the code is generated.



☐ Fill unused code memory
Fill pattern: 0xFF
Start address: 0x0 End address: 0x0
☐ Generate checksum
Size: 2 bytes Alignment: 1
○ Arithmetic sum ☐ Result in full size
● CRC16 (0x11021)
○ CRC32 (0x4C11DB7)
○ Crc polynomial: 0x11021
Complement: As is
Bit order: MSB first
Initial value: 0x0

Figure 218: Linker checksum and fill options

For more information about filling and checksumming, see the compiler documentation.

FILL UNUSED CODE MEMORY

Use **Fill unused code memory** to fill all gaps between segment parts introduced by the linker with the value you enter. The linker can introduce gaps either because of alignment restrictions, or at the end of ranges given in segment placement options.

The default behavior, when this option is not used, is that these gaps are not given a value in the output file.

Use **Fill unused code memory** to fill unused memory in the supplied range.

Fill pattern

Use this option to specify size, in hexadecimal notation, of the filler to be used in gaps between segment parts.

Start address

Use this option to specify the start address of the range to be filled.

End address

Use this option to specify the end address of the range to be filled.

Generate checksum

Use **Generate checksum** to checksum all generated raw data bytes. This option can only be used if the **Fill unused code memory** option has been specified.

Use **Generate checksum** to checksum the supplied range.

Size

Size specifies the number of bytes in the checksum, which can be 1, 2, or 4.

Alignment

Use this option to specify an optional alignment for the checksum. If you do not specify an alignment explicitly, an alignment of 2 is used.

Algorithms

One of the following algorithms can be used:

Algorithms	Description
Arithmetic sum	Simple arithmetic sum. The result is truncated to one byte. Use the **Result in full size** option to get the result in the specified size.

Table 94: Linker checksum algorithms

Algorithms	Description
CRC16	CRC16, generating polynomial 0x11021 (default)
CRC32	CRC32, generating polynomial 0x104C11DB7
Crc polynomial	CRC with a generating polynomial of the value you enter

Table 94: Linker checksum algorithms (Continued)

Complement

Use the **Complement** drop-down list to specify the one's complement or two's complement.

Bit order

By default it is the most significant 1, 2, or 4 bytes (**MSB**) of the result that will be output, in the natural byte order for the processor. Choose **LSB** from the **Bit order** drop-down list if you want the least significant bytes to be output.

Initial value

Use this option to specify the initial value of the checksum. This is useful if the microcontroller you are using has its own checksum calculation and you want that calculation to correspond to the calculation performed by the linker.

Extra Options

The **Extra Options** page provides you with a command line interface to the linker.

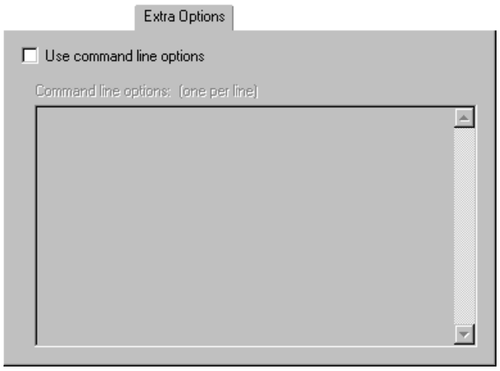


Figure 219: Extra Options page for the linker

USE COMMAND LINE OPTIONS

Additional command line arguments for the linker (not supported by the GUI) can be specified here.

Library builder options

This chapter describes the library builder options available in the IAR Embedded Workbench® IDE.

For information about how to set options, see *Setting options*, page 71.

Output

Options for the library builder are not available by default. Before you can set these options in the IDE, you must add the library builder tool to the list of categories. Choose **Project>Options** to display the **Options** dialog box, and select the **General Options** category. On the **Output** page, select the **Library** option.

If you select the **Library** option, **Library Builder** appears as a category in the **Options** dialog box. As a result of the build process, the library builder will create a library output file. Before you create the library you can set output options.

To set options, select **Library Builder** from the category list to display the options.

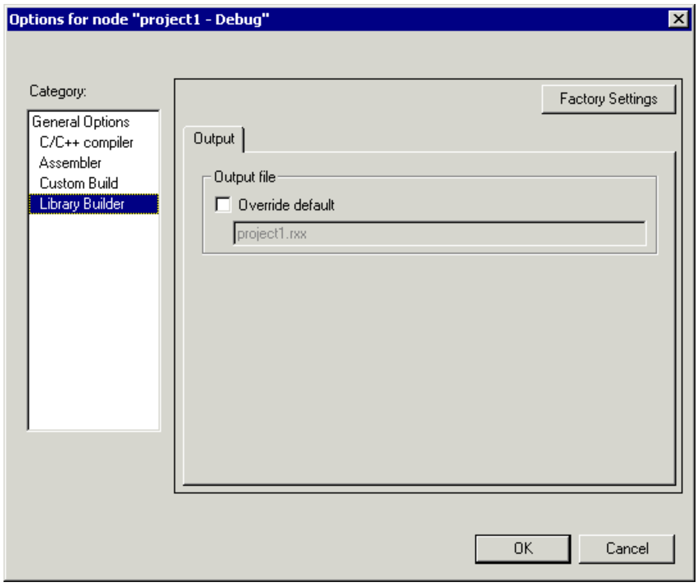


Figure 220: Library builder output options

To restore all settings to the default factory settings, click the **Factory Settings** button.

The **Output file** option overrides the default name of the output file. Enter a new name in the **Override default** text box.

Debugger options

This chapter describes the C-SPY® options available in the IAR Embedded Workbench® IDE.

For information about how to set options, see *Setting options*, page 71.

In addition, for information about options specific to the C-SPY hardware debugger systems, see the online help system available from the Help menu.

Setup

To set C-SPY options in the IDE, choose **Project>Options** to display the **Options** dialog box. Then select **Debugger** in the **Category** list. The **Setup** page contains the generic C-SPY options.

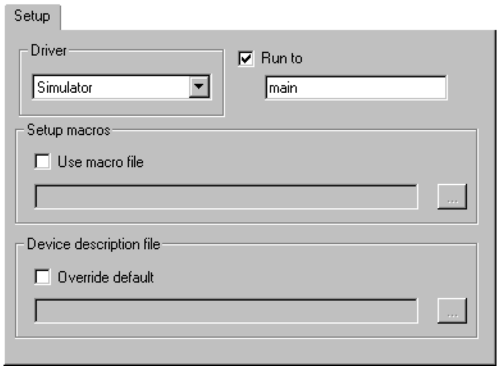


Figure 221: Generic C-SPY options

To restore all settings to the default factory settings, click the **Factory Settings** button.

The **Setup** options specify the C-SPY driver, the setup macro file, and device description file to be used, and which default source code location to run to.

DRIVER

Selects the appropriate driver for use with C-SPY, for example a simulator or an emulator.

Contact your distributor or IAR Systems representative, or visit the IAR Systems web site at **www.iar.com** for the most recent information about the available C-SPY drivers.

RUN TO

Use this option to specify a location you want C-SPY to run to when you start the debugger and after a reset.

The default location to run to is the `main` function. Type the name of the location if you want C-SPY to run to a different location. You can specify assembler labels or whatever can be evaluated to such, for example function names.

If the option is deselected, the program counter will contain the regular hardware reset address at each reset.

SETUP MACROS

To register the contents of a setup macro file in the C-SPY startup sequence, select **Use macro file** and enter the path and name of the setup file, for example `SetupSimple.mac`. If no extension is specified, the extension `mac` is assumed. A browse button is available for your convenience.

DEVICE DESCRIPTION FILE

Use this option to load a device description file that contains device-specific information.

For details about the device description file, see *Selecting a device description file*, page 97.

Device description files are provided in the directory `*cpuname*\config` and have the filename extension `ddf`.

Download

Options specific to the C-SPY drivers are described in the online help system available from the **Help** menu.

Extra Options

The **Extra Options** page provides you with a command line interface to C-SPY.

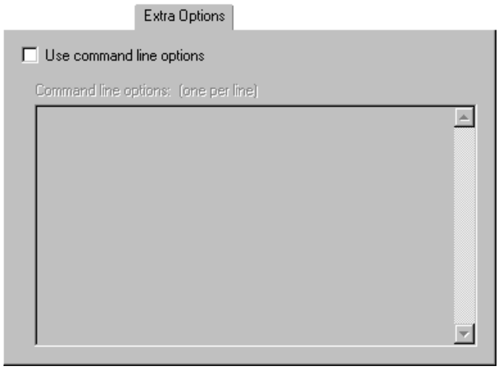


Figure 222: Extra Options page for C-SPY

USE COMMAND LINE OPTIONS

Additional command line arguments for C-SPY (not supported by the GUI) can be specified here.

Images

On the **Images** page you can specify additional debug files to be downloaded.

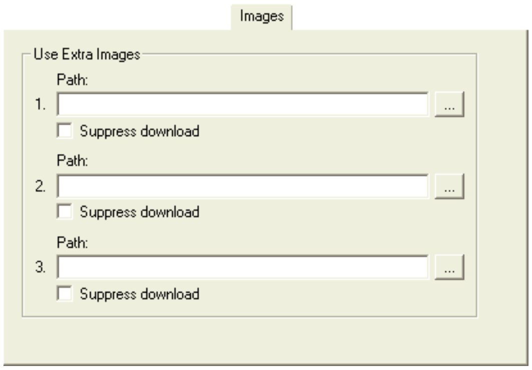


Figure 223: Images page for C-SPY

USE EXTRA IMAGES

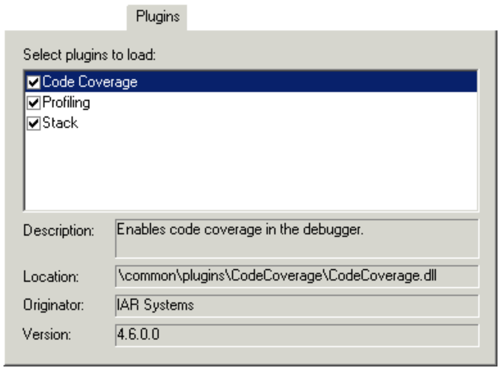
Use the text boxes to specify additional images that you want to be downloaded:

Path	Specifies the debug file to be downloaded. A browse button is available for your convenience.
Suppress download	Downloads only debug information, and not the complete debug file.

If you want to download more than three images, use the related C-SPY macro, see *__loadImage*, page 391.

Plugins

On the **Plugins** page you can specify C-SPY plugin modules to be loaded and made available during debug sessions. Plugin modules can be provided by IAR Systems, and by third-party suppliers. Contact your software distributor or IAR Systems representative, or visit the IAR Systems web site, for information about available modules.



Select plugins to load:

☑ Code Coverage
☑ Profiling
☑ Stack

Description:	Enables code coverage in the debugger.
Location:	\common\plugins\CodeCoverage\CodeCoverage.dll
Originator:	IAR Systems
Version:	4.6.0.0

Figure 224: C-SPY plugin options

By default, **Select plugins to load** lists the plugin modules delivered with the product installation.

If you have any C-SPY plugin modules delivered by any third-party vendor, these will also appear in the list.

The `common\plugins` directory is intended for generic plugin modules. The *`cpuname`*`\plugins` directory is intended for target-specific plugin modules.

The C-SPY Command Line Utility—cspybat

You can execute the IAR C-SPY Debugger in batch mode, using the C-SPY Command Line Utility—cspybat.exe—which is described in this chapter.

Using C-SPY in batch mode

You can execute C-SPY in batch mode if you use the command line utility `cspybat`, installed in the directory `common\bin`.

INVOCATION SYNTAX

The invocation syntax for `cspybat` is:

```
cspybat processor_DLL driver_DLL debug_file [cspybat_options]
        --backend driver_options
```

Note: In those cases where a filename is required—including the DLL files—you are recommended to give a full path to the filename.

Parameters

The parameters are:

Parameter	Description
processor_DLL	The processor-specific DLL file; available in *cpuname*`\bin`.
driver_DLL	The C-SPY driver DLL file; available in *cpuname*`\bin`.
debug_file	The object file that you want to debug (filename extension `d`*xx*).
cspybat_options	The command line options that you want to pass to `cspybat`. Note that these options are optional. For information about each option, see *Descriptions of C-SPY command line options*, page 374.
`--backend`	Marks the beginning of the parameters to the C-SPY driver; all options that follow will be sent to the driver. Note that this option is mandatory.
driver_options	The command line options that you want to pass to the C-SPY driver. Note that some of these options are mandatory and some are optional. For information about each option, see *Descriptions of C-SPY command line options*, page 374.

Table 95: cspybat parameters

Example

This example starts `cspybat` using the simulator driver:

```
EW_DIR\common\bin\cspybat EW_DIR\cpuname\bin\cpunameproc.dll
EW_DIR\cpuname\bin\cpunamesim.dll PROJ_DIR\myproject.dxx --plugin
EW_DIR\cpuname\bin\cpunamebat.dll --backend -B -p
EW_DIR\cpuname\bin\config\devicedescription.ddf
```

where *`EW_DIR`* is the full path of the directory where you have installed IAR Embedded Workbench

and where *`PROJ_DIR`* is the path of your project directory.

For a complete example, see the online help system available from the **Help** menu, alternatively the file `Help`*`CPUNAME`*`IDE2.chm` available in the *`cpuname`*`\doc` directory.

OUTPUT

When you run `cspybat`, these types of output can be produced:

- Terminal output from `cspybat` itself

  All such terminal output is directed to `stderr`. Note that if you run `cspybat` from the command line without any arguments, the `cspybat` version number and all available options including brief descriptions are directed to `stdout` and displayed on your screen.
- Terminal output from the application you are debugging

  All such terminal output is directed to `stdout`.
- Error return codes

  `cspybat` return status information to the host operating system that can be tested in a batch file. For *successful*, the value `int 0` is returned, and for *unsuccessful* the value `int 1` is returned.

USING AN AUTOMATICALLY GENERATED BATCH FILE

When you use C-SPY in the IDE, C-SPY generates a batch file *`projectname`*`.cspy.bat` every time C-SPY is initialized. You can find the file in the directory `$PROJ_DIR$\settings`. This batch file contains the same settings as in the IDE, and with minimal modifications, you can use it from the command line to start `cspybat`. The file also contains information about required modifications.

C-SPY command line options

GENERAL CSPYBAT OPTIONS

`--backend`	Marks the beginning of the parameters to be sent to the C-SPY driver (mandatory).
`--code_coverage_file`	Enables the generation of code coverage information and places it in a specified file.
`--cycles`	Specifies the maximum number of cycles to run.
`--download_only`	Executes the flash loader without starting a debug session afterwards.
`--flash_loader`	Specifies a flash loader specification XML file. Applies only to product packages that support the IAR flash loader mechanism.
`--macro`	Specifies a macro file to be used.
`--plugin`	Specifies a plugin file to be used.
`--silent`	Omits the sign-on message.
`--timeout`	Limits the maximum allowed execution time.

OPTIONS AVAILABLE FOR ALL C-SPY DRIVERS

`-B`	Enables batch mode (mandatory).
`-p`	Specifies the device description file to be used.

Note that there might be additional target-specific options available. For a list of available options, see the online help system available from the **Help** menu, alternatively the file `Help`*`CPUNAME`*`IDE2.chm` available in the *`cpuname`*`\doc` directory.

OPTIONS AVAILABLE FOR THE SIMULATOR DRIVER

`--disable_interrupts`	Disables the interrupt simulation.
`--mapu`	Activates memory access checking.

For a list of available options, see the online help system available from the **Help** menu, alternatively the file `Help`*`CPUNAME`*`IDE2.chm` available in the *`cpuname`*`\doc` directory.

OPTIONS AVAILABLE FOR THE C-SPY HARDWARE DRIVER

For a list of available options, see the online help system available from the **Help** menu, alternatively the `Help`*`CPUNAME`*`HW.chm` file available in the *`cpuname`*`\doc` directory.

Descriptions of C-SPY command line options

This section gives detailed reference information about each `cspybat` option and each option available to the C-SPY drivers.

-B

Syntax `-B`

Applicability All C-SPY drivers.

Description Use this option to enable batch mode.

--backend

Syntax `--backend {driver options}`

Parameters

driver options	Any option available to the C-SPY driver you are using.

Applicability Sent to `cspybat` (mandatory).

Description Use this option to send options to the C-SPY driver. All options that follow `--backend` will be passed to the C-SPY driver, and will not be processed by `cspybat` itself.

--code_coverage_file

Syntax `--code_coverage_file file`

Parameters

file	The name of the destination file for the code coverage information.

Applicability Sent to `cspybat`.

Description Use this option to enable the generation of code coverage information. The code coverage information will be generated after the execution has completed and you can find it in the specified file.

Note that this option requires that the C-SPY driver you are using supports code coverage. If you try to use this option with a C-SPY driver that does not support code coverage, an error message will be directed to `stderr`.

See also

Code Coverage window, page 290.

--cycles

Syntax

`--cycles` *`cycles`*

Parameters

`cycles`	The number of cycles to run.

Applicability

Sent to `cspybat`.

Description

Use this option to specify the maximum number of cycles to run. If the target program executes longer than the number of cycles specified, the target program will be aborted. Using this option requires that the C-SPY driver you are using supports a cycle counter, and that it can be sampled while executing.

--disable_interrupts

Syntax

`--disable_interrupts`

Applicability

The C-SPY Simulator driver.

Description

Use this option to disable the interrupt simulation.

To set this option, choose **Simulator>Interrupt Setup** and deselect the **Enable interrupt simulation** option.

--download_only

Syntax

`--download_only`

Applicability

Sent to `cspybat`.

Description

Use this option to execute the flash loader without starting a debug session afterwards.

See also

The *IAR Embedded Workbench flash loader User Guide*.

To set related options, choose:

Project>Download

--flash_loader

Syntax `--flash_loader filename`

Parameters

`filename`	The flash loader specification XML file.

Applicability Sent to `cspybat`.

Description Use this option to specify a flash loader specification xml file which contains all relevant information about the flash loading. There can be more than one such argument, in which case each argument will be processed in the specified order, resulting in several flash programming passes.

See also The *IAR Embedded Workbench flash loader User Guide*.

--macro

Syntax `--macro filename`

Parameters

`filename`	The C-SPY macro file to be used (filename extension `mac`).

Applicability Sent to `cspybat`.

Description Use this option to specify a C-SPY macro file to be loaded before executing the target application. This option can be used more than once on the command line.

See also *The macro file, page 130*.

--mapu

Syntax `--mapu`

Applicability Sent to C-SPY simulator driver.

Description Specify this option to use the segment/section information in the debug file for memory access checking. During the execution, the simulator will then check for accesses to unspecified ranges. If any such access is found, a message will be printed on `stdout` and the execution will stop.

See also	*Memory access checking*, page 146

To set related options, choose:

Simulator>Memory Access Setup

-p

Syntax	`-p filename`
Parameters	*`filename`* — The device description file to be used.
Applicability	All C-SPY drivers.
Description	Use this option to specify the device description file to be used.
See also	*Selecting a device description file*, page 97

--plugin

Syntax	`--plugin filename`
Parameters	*`filename`* — The plugin file to be used (filename extension `dll`).
Applicability	Sent to `cspybat`.

Description

Certain C/C++ standard library functions, for example `printf`, can be supported by C-SPY—for example, the C-SPY Terminal I/O window—instead of by real hardware devices. To enable such support in `cspybat`, a dedicated plugin module called *`cpuname`*`LibSupport.dll` or *`cpuname`*`bat.dll` located in the *`cpuname`*`\bin` directory must be used.

Use this option to include this plugin during the debug session. This option can be used more than once on the command line.

Note: You can use this option to include also other plugin modules, but in that case the module must be able to work with `cspybat` specifically. This means that the C-SPY plugin modules located in the `common\plugin` directory cannot normally be used with `cspybat`.

--silent

Syntax	`--silent`
Applicability	Sent to `cspybat`.
Description	Use this option to omit the sign-on message.

--timeout

Syntax	`--timeout` *`milliseconds`*
Parameters	

`milliseconds`	The number of milliseconds before the execution stops.

Applicability	Sent to `cspybat`.
Description	Use this option to limit the maximum allowed execution time.

This option is not available in the IDE.

C-SPY macros reference

This chapter gives reference information about the C-SPY® macros. First a syntax description of the macro language is provided. Then, the available setup macro functions and the pre-defined system macros are summarized. Finally, each system macro is described in detail.

The macro language

The syntax of the macro language is very similar to the C language. There are *macro statements*, which are similar to C statements. You can define *macro functions*, with or without parameters and return value. You can use built-in system macros, similar to C library functions. Finally, you can define global and local *macro variables*. You can collect your macro functions in a *macro file* (filename extension `mac`).

MACRO FUNCTIONS

C-SPY macro functions consist of C-SPY variable definitions and macro statements which are executed when the macro is called. An unlimited number of parameters can be passed to a macro function, and macro functions can return a value on exit.

A C-SPY macro has this form:

```
macroName (parameterList)
{
  macroBody
}
```

where *`parameterList`* is a list of macro parameters separated by commas, and *`macroBody`* is any series of C-SPY variable definitions and C-SPY statements.

Type checking is neither performed on the values passed to the macro functions nor on the return value.

PREDEFINED SYSTEM MACRO FUNCTIONS

The macro language also includes a wide set of predefined system macro functions (built-in functions), similar to C library functions. For detailed information about each system macro, see *Description of C-SPY system macros*, page 387.

MACRO VARIABLES

A macro variable is a variable defined and allocated outside your application space. It can then be used in a C-SPY expression. For detailed information about C-SPY expressions, see the chapter *C-SPY expressions*, page 109.

The syntax for defining one or more macro variables is:

```
__var nameList;
```

where `nameList` is a list of C-SPY variable names separated by commas.

A macro variable defined outside a macro body has global scope, and it exists throughout the whole debugging session. A macro variable defined within a macro body is created when its definition is executed and destroyed on return from the macro.

By default, macro variables are treated as signed integers and initialized to 0. When a C-SPY variable is assigned a value in an expression, it also acquires the type of that expression. For example:

Expression	What it means
`myvar = 3.5;`	`myvar` is now type `float`, value `3.5`.
`myvar = (int*)i;`	`myvar` is now type pointer to `int`, and the value is the same as `i`.

Table 96: Examples of C-SPY macro variables

In case of a name conflict between a C symbol and a C-SPY macro variable, C-SPY macro variables have a higher precedence than C variables. Note that macro variables are allocated on the debugger host and do not affect your application.

Macro strings

In addition to C types, macro variables can hold values of *macro strings*. Note that macro strings differ from C language strings.

When you write a string literal, such as `"Hello!"`, in a C-SPY expression, the value is a macro string. It is not a C-style character pointer `char*`, because `char*` must point to a sequence of characters in target memory and C-SPY cannot expect any string literal to actually exist in target memory.

You can manipulate a macro string using a few built-in macro functions, for example `__strFind` or `__subString`. The result can be a new macro string. You can concatenate macro strings using the + operator, for example `str + "tail"`. You can also access individual characters using subscription, for example `str[3]`. You can get the length of a string using `sizeof(str)`. Note that a macro string is not NULL-terminated.

The macro function `__toString` is used for converting from a NULL-terminated C string in your application (`char*` or `char[]`) to a macro string. For example, assume this definition of a C string in your application:

```
char const *cstr = "Hello";
```

Then examine these examples:

```
__var str;          /* A macro variable */
str = cstr          /* str is now just a pointer to char */
sizeof str          /* same as sizeof (char*), typically 2 or 4 */
str = __toString(cstr,512)  /* str is now a macro string */
sizeof str          /* 5, the length of the string */
str[1]              /* 101, the ASCII code for 'e' */
str += " World!"     /* str is now "Hello World!" */
```

See also *Formatted output*, page 382.

MACRO STATEMENTS

Statements are expected to behave in the same way as the corresponding C statements would do. The following C-SPY macro statements are accepted:

Expressions

```
expression;
```

For detailed information about C-SPY expressions, see *C-SPY expressions*, page 109.

Conditional statements

```
if (expression)
  statement

if (expression)
  statement
else
  statement
```

Loop statements

```
for (init_expression; cond_expression; update_expression)
  statement

while (expression)
  statement

do
  statement
```

```
while (expression);
```

Return statements

```
return;

return expression;
```

If the return value is not explicitly set, `signed int 0` is returned by default.

Blocks

Statements can be grouped in blocks.

```
{
  statement1
  statement2
  .
  .
  .
  statementN
}
```

FORMATTED OUTPUT

C-SPY provides various methods for producing formatted output:

`__message` *`argList`*`;`	Prints the output to the Debug Log window.
`__fmessage` *`file`*`,` *`argList`*`;`	Prints the output to the designated file.
`__smessage` *`argList`*`;`	Returns a string containing the formatted output.

where *`argList`* is a comma-separated list of C-SPY expressions or strings, and *`file`* is the result of the `__openFile` system macro, see *__openFile*, page 393.

Examples

Use the `__message` statement, as in this example:

```
var1 = 42;
var2 = 37;
__message "This line prints the values ", var1, " and ", var2,
" in the Log window.";
```

This should produce this message in the Log window:

```
This line prints the values 42 and 37 in the Log window.
```

Use `__fmessage` to write the output to the designated file, for example:

```
__fmessage myfile, "Result is ", res, "!\n";
```

Finally, use `__smessage` to produce strings, for example:

```
myMacroVar = __smessage 42, " is the answer.";
```

`myMacroVar` now contains the string `"42 is the answer"`.

Specifying display format of arguments

To override the default display format of a scalar argument (number or pointer) in *`argList`*, suffix it with a `:` followed by a format specifier. Available specifiers are `%b` for binary, `%o` for octal, `%d` for decimal, `%x` for hexadecimal and `%c` for character. These match the formats available in the Watch and Locals windows, but number prefixes and quotes around strings and characters are not printed. Another example:

```
__message "The character '", cvar:%c, "' has the decimal value
", cvar;
```

This might produce:

```
The character 'A' has the decimal value 65
```

Note: A character enclosed in single quotes (a character literal) is an integer constant and is not automatically formatted as a character. For example:

```
__message 'A', " is the numeric value of the character ",
'A':%c;
```

would produce:

```
65 is the numeric value of the character A
```

Note: The default format for certain types is primarily designed to be useful in the Watch window and other related windows. For example, a value of type `char` is formatted as 'A' (0x41), while a pointer to a character (potentially a C string) is formatted as 0x8102 "Hello", where the string part shows the beginning of the string (currently up to 60 characters).

When printing a value of type `char*`, use the `%x` format specifier to print just the pointer value in hexadecimal notation, or use the system macro `__toString` to get the full string value.

Setup macro functions summary

This table summarizes the available setup macro functions:

Macro	Description
`execUserPreload`	Called after communication with the target system is established but before downloading the target application. Implement this macro to initialize memory locations and/or registers which are vital for loading data properly.
`execUserFlashInit`	Called once before the flash loader is downloaded to RAM. Implement this macro typically for setting up the memory map required by the flash loader. This macro is only called when you are programming flash, and it should only be used for flash loader functionality. Applies only to product packages that support using flash loaders.
`execUserSetup`	Called once after the target application is downloaded. Implement this macro to set up the memory map, breakpoints, interrupts, register macro files, etc.
`execUserFlashReset`	Called once after the flash loader is downloaded to RAM, but before execution of the flash loader. This macro is only called when you are programming flash, and it should only be used for flash loader functionality. Applies only to product packages that support using flash loaders.
`execUserReset`	Called each time the reset command is issued. Implement this macro to set up and restore data.
`execUserExit`	Called once when the debug session ends. Implement this macro to save status data etc.
`execUserFlashExit`	Called once when the debug session ends. Implement this macro to save status data etc. This macro is useful for flash loader functionality. Applies only to product packages that support using flash loaders.

Table 97: C-SPY setup macros

Note: If you define interrupts or breakpoints in a macro file that is executed at system start (using `execUserSetup`) we strongly recommend that you also make sure that they are removed at system shutdown (using `execUserExit`). An example is available in `SetupSimple.mac`, see *Simulating an interrupt*, page 37.

The reason for this is that the simulator saves interrupt settings between sessions and if they are not removed they will get duplicated every time `execUserSetup` is executed again. This seriously affects the execution speed.

C-SPY system macros summary

This table summarizes the pre-defined system macros:

Macro	Description
`__cancelAllInterrupts`	Cancels all ordered interrupts
`__cancelInterrupt`	Cancels an interrupt
`__clearBreak`	Clears a breakpoint
`__closeFile`	Closes a file that was opened by `__openFile`
`__delay`	Delays execution
`__disableInterrupts`	Disables generation of interrupts
`__driverType`	Verifies the driver type
`__enableInterrupts`	Enables generation of interrupts
`__evaluate`	Interprets the input string as an expression and evaluates it.
`__isBatchMode`	Checks if C-SPY is running in batch mode or not.
`__loadImage`	Loads an image.
`__memoryRestore`	Restores the contents of a file to a specified memory zone
`__memorySave`	Saves the contents of a specified memory area to a file
`__openFile`	Opens a file for I/O operations
`__orderInterrupt`	Generates an interrupt
`__popSimulatorInterruptExecutingStack`	Informs the interrupt simulation system that an interrupt handler has finished executing
`__readFile`	Reads from the specified file
`__readFileByte`	Reads one byte from the specified file
`__readMemory8`, `__readMemoryByte`	Reads one byte from the specified memory location
`__readMemory16`	Reads two bytes from the specified memory location
`__readMemory32`	Reads four bytes from the specified memory location
`__registerMacroFile`	Registers macros from the specified file
`__resetFile`	Rewinds a file opened by `__openFile`
`__setCodeBreak`	Sets a code breakpoint
`__setDataBreak`	Sets a data breakpoint
`__setLogBreak`	Sets a log breakpoint

Table 98: Summary of system macros

Macro	Description
`__setSimBreak`	Sets a simulation breakpoint
`__setTraceStartBreak`	Sets a trace start breakpoint
`__setTraceStopBreak`	Sets a trace stop breakpoint
`__sourcePosition`	Returns the file name and source location if the current execution location corresponds to a source location
`__strFind`	Searches a given string for the occurrence of another string
`__subString`	Extracts a substring from another string
`__targetDebuggerVersion`	Returns the version of the target debugger
`__toLower`	Returns a copy of the parameter string where all the characters have been converted to lower case
`__toString`	Prints strings
`__toUpper`	Returns a copy of the parameter string where all the characters have been converted to upper case
`__writeFile`	Writes to the specified file
`__writeFileByte`	Writes one byte to the specified file
`__writeMemory8`, `__writeMemoryByte`	Writes one byte to the specified memory location
`__writeMemory16`	Writes a two-byte word to the specified memory location
`__writeMemory32`	Writes a four-byte word to the specified memory location

Table 98: Summary of system macros (Continued)

Description of C-SPY system macros

This section gives reference information about each of the C-SPY system macros.

__cancelAllInterrupts

Syntax	`__cancelAllInterrupts()`
Return value	`int 0`
Description	Cancels all ordered interrupts.
Applicability	This system macro is only available in the C-SPY Simulator.

__cancelInterrupt

Syntax `__cancelInterrupt(`*`interrupt_id`*`)`

Parameter

`interrupt_id`	The value returned by the corresponding `__orderInterrupt` macro call (unsigned long)

Return value

Result	Value
Successful	`int 0`
Unsuccessful	Non-zero error number

Table 99: __cancelInterrupt return values

Description Cancels the specified interrupt.

Applicability This system macro is only available in the C-SPY Simulator.

__clearBreak

Syntax `__clearBreak(`*`break_id`*`)`

Parameter

`break_id`	The value returned by any of the set breakpoint macros

Return value `int 0`

Description
Clears a user-defined breakpoint.

See also
Defining breakpoints, page 117.

__closeFile

Syntax
`__closeFile(fileHandle)`

Parameter

fileHandle	The macro variable used as filehandle by the `__openFile` macro

Return value
`int 0`

Description
Closes a file previously opened by `__openFile`.

__delay

Syntax
`__delay(value)`

Parameter

value	The number of milliseconds to delay execution

Return value
`int 0`

Description
Delays execution the specified number of milliseconds.

__disableInterrupts

Syntax
`__disableInterrupts()`

Return value

Result	Value
Successful	`int 0`
Unsuccessful	Non-zero error number

Table 100: __disableInterrupts return values

Description
Disables the generation of interrupts.

Applicability
This system macro is only available in the C-SPY Simulator.

__driverType

Syntax `__driverType(`*`driver_id`*`)`

Parameter

`driver_id`	A string corresponding to the driver you want to check for. For a list of supported strings, see the online help system available from the **Help** menu.

Return value

Result	Value
Successful	`1`
Unsuccessful	`0`

Table 101: __driverType return values

Description Checks to see if the current C-SPY driver is identical to the driver type of the *`driver_id`* parameter.

Example `__driverType("sim")`

If a simulator is the current driver, the value `1` is returned. Otherwise `0` is returned.

__enableInterrupts

Syntax `__enableInterrupts()`

Return value

Result	Value
Successful	`int 0`
Unsuccessful	Non-zero error number

Table 102: __enableInterrupts return values

Description Enables the generation of interrupts.

Applicability This system macro is only available in the C-SPY Simulator.

__evaluate

Syntax

`__evaluate(string, valuePtr)`

Parameter

string	Expression string
valuePtr	Pointer to a macro variable storing the result

Return value

Result	Value
Successful	`int 0`
Unsuccessful	`int 1`

Table 103: __evaluate return values

Description

This macro interprets the input string as an expression and evaluates it. The result is stored in a variable pointed to by *valuePtr*.

Example

This example assumes that the variable `i` is defined and has the value 5:

```
__evaluate("i + 3", &myVar)
```

The macro variable `myVar` is assigned the value 8.

__isBatchMode

Syntax

`__isBatchMode()`

Return value

Result	Value
True	`int 1`
False	`int 0`

Table 104: __isBatchMode return values

Description

This macro returns True if the debugger is running in batch mode, otherwise it returns False.

__loadImage

Syntax

`__loadImage(`*`filename`*`, `*`suppressDownload`*`)`

Parameter

`filename`	The debug file to be loaded. The filename must include a path, which must either be absolute or use argument variables. See *Argument variables summary*, page 228.
`suppressDownload`	A *non-zero value* if no code or data should be downloaded to the target system, which means that C-SPY will only read the debug information from the debug file. Or, `0` (zero) for download.

Return value

Value	**Result**
Non-zero integer number	A unique module identification.
`int 0`	Loading failed.

Table 105: __loadModule return values

Description

Loads an image (debug file).

Example 1

Your system consists of a ROM library and an application. The application is your active project, but you have a debug file corresponding to the library. In this case you can add this macro call in the `execUserSetup` macro in a C-SPY macro file associated with your project:

`__loadImage(`*`ROMfile`*`, 1);`

This macro call loads the debug information for the ROM library *`ROMfile`* without downloading its contents (because it is presumably already in ROM). Then you can debug your application together with the library.

Example 2

Your system consists of a ROM library and an application, but your main concern is the library. The library needs to be programmed into flash memory before a debug session. While you are developing the library, the library project must be the active project in the IDE. In this case you can add this macro call in the `execUserSetup` macro in a C-SPY macro file associated with your project:

`__loadImage(`*`ApplicationFile`*`, 0);`

The macro call loads the debug information for the application and downloads its contents (presumably into RAM). Then you can debug your library together with the application.

See also

Images, page 369 and *Loading multiple images*, page 100.

__memoryRestore

Syntax	`__memoryRestore(`*`zone, filename`*`)`
Parameters	

zone	The memory zone name (string); for a list of available zones, see the online help system available from the **Help** menu
filename	A string that specifies the file to be read. The filename must include a path, which must either be absolute or use argument variables. See *Argument variables summary*, page 228.

Return value `int 0`

Description Reads the contents of a file and saves it to the specified memory zone.

Example

```
__memoryRestore("Memory", "c:\\temp\\saved_memory.hex");
```

See also *Memory Restore dialog box*, page 277.

__memorySave

Syntax `__memorySave(`*`start, stop, format, file`*`)`

Parameters

start	A string that specifies the first location of the memory area to be saved
stop	A string that specifies the last location of the memory area to be saved

format	A string that specifies the format to be used for the saved memory. Choose between:
	`intel-extended`
	`motorola`
	`motorola-s19`
	`motorola-s28`
	`motorola-s37`.

filename	A string that specifies the file to write to. The filename must include a path, which must either be absolute or use argument variables. See *Argument variables summary*, page 228.

Return value `int 0`

Description Saves the contents of a specified memory area to a file.

Example

```
__memorySave("Memory:0x00", "Memory:0xFF", "intel-extended",
"c:\\temp\\saved_memory.hex");
```

See also

Memory Save dialog box, page 276.

__openFile

Syntax

`__openFile(`*`filename, access`*`)`

Parameters

filename	The file to be opened. The filename must include a path, which must either be absolute or use argument variables. See *Argument variables summary*, page 228.
access	The access type (string).

These are mandatory but mutually exclusive:

`"a"`	append, new data will be appended at the end of the open file
`"r"`	read
`"w"`	write

These are optional and mutually exclusive:

`"b"`	binary, opens the file in binary mode
`"t"`	ASCII text, opens the file in text mode

This access type is optional:

`"+"`	together with `r`, `w`, or `a`; `r+` or `w+` is *read* and *write*, while `a+` is *read* and *append*

Return value

Result	Value
Successful	The file handle
Unsuccessful	An invalid file handle, which tests as False

Table 106: __openFile return values

Description

Opens a file for I/O operations. The default base directory of this macro is where the currently open project file (`*.ewp`) is located. The argument to `__openFile` can specify a location relative to this directory. In addition, you can use argument variables such as `$PROJ_DIR$` and `$TOOLKIT_DIR$` in the path argument.

Example

```
__var myFileHandle;          /* The macro variable to contain */
                           /* the file handle */
myFileHandle = __openFile("$PROJ_DIR$\\Debug\\Exe\\test.tst",
"r");
if (myFileHandle)
{
    /* successful opening */
}
```

See also

Argument variables summary, page 228.

__orderInterrupt

Syntax

```
__orderInterrupt(specification, first_activation,
                 repeat_interval, variance, infinite_hold_time,
                 hold_time, probability)
```

Parameters

specification	The interrupt (string). The specification can either be the full specification used in the device description file (`ddf`) or only the name. In the latter case the interrupt system will automatically get the description from the device description file.
first_activation	The first activation time in cycles (integer)
repeat_interval	The periodicity in cycles (integer)
variance	The timing variation range in percent (integer between 0 and 100)
infinite_hold_time	1 if infinite, otherwise 0.
hold_time	The hold time (integer)
probability	The probability in percent (integer between 0 and 100)

Return value

The macro returns an interrupt identifier (`unsigned long`).

If the syntax of *`specification`* is incorrect, it returns -1.

Description

Generates an interrupt.

Applicability

This system macro is only available in the C-SPY Simulator.

Example

This example generates a repeating interrupt using an infinite hold time first activated after 4000 cycles:

```
__orderInterrupt( "USARTR_VECTOR", 4000, 2000, 0, 1, 0, 100 );
```

__popSimulatorInterruptExecutingStack

Syntax

```
__popSimulatorInterruptExecutingStack(void)
```

Return value

This macro has no return value.

Description

Informs the interrupt simulation system that an interrupt handler has finished executing, as if the normal instruction used for returning from an interrupt handler was executed.

This is useful if you are using interrupts in such a way that the normal instruction for returning from an interrupt handler is not used, for example in an operating system with task-switching. In this case, the interrupt simulation system cannot automatically detect that the interrupt has finished executing.

Applicability

This system macro is only available in the C-SPY Simulator.

__readFile

Syntax

`__readFile(`*`fileHandle`*`, `*`valuePtr`*`)`

Parameters

`fileHandle`	A macro variable used as filehandle by the `__openFile` macro
`valuePtr`	A pointer to a variable

Return value

Result	Value
Successful	0
Unsuccessful	Non-zero error number

Table 107: __readFile return values

Description

Reads a sequence of hexadecimal digits from the given file and converts them to an `unsigned long` which is assigned to the *`value`* parameter, which should be a pointer to a macro variable.

Example

```
__var number;
if (__readFile(myFileHandle, &number) == 0)
{
  // Do something with number
}
```

__readFileByte

Syntax

`__readFileByte(`*`fileHandle`*`)`

Parameter

`fileHandle`	A macro variable used as filehandle by the `__openFile` macro

Return value	`-1` upon error or end-of-file, otherwise a value between `0` and `255`.
Description	Reads one byte from a file.

Example

```
__var byte;
while ( (byte = __readFileByte(myFileHandle)) != -1 )
{
  /* Do something with byte */
}
```

__readMemory8, __readMemoryByte

Syntax

`__readMemory8(`*`address`*`, `*`zone`*`)`
`__readMemoryByte(`*`address`*`, `*`zone`*`)`

Parameters

address	The memory address (integer)
zone	The memory zone name (string); for a list of available zones, see the online help system available from the **Help** menu

Return value	The macro returns the value from memory.
Description	Reads one byte from a given memory location.
Example	`__readMemory8(0x0108, "Memory");`

__readMemory16

Syntax

`__readMemory16(`*`address`*`, `*`zone`*`)`

Parameters

address	The memory address (integer)
zone	The memory zone name (string); for a list of available zones, see the online help system available from the **Help** menu

Return value	The macro returns the value from memory.
Description	Reads a two-byte word from a given memory location.

Example `__readMemory16(0x0108, "Memory");`

__readMemory32

Syntax `__readMemory32(`*`address`*`, `*`zone`*`)`

Parameters

address	The memory address (integer)
zone	The memory zone name (string); for a list of available zones, see the online help system available from the **Help** menu

Return value The macro returns the value from memory.

Description Reads a four-byte word from a given memory location.

Example `__readMemory32(0x0108, "Memory");`

__registerMacroFile

Syntax `__registerMacroFile(`*`filename`*`)`

Parameter

filename	A file containing the macros to be registered (string). The filename must include a path, which must either be absolute or use argument variables. See *Argument variables summary*, page 228.

Return value `int 0`

Description Registers macros from a setup macro file. With this function you can register multiple macro files during C-SPY startup.

Example `__registerMacroFile("c:\\testdir\\macro.mac");`

See also *Registering and executing using setup macros and setup files*, page 133.

__resetFile

Syntax `__resetFile(`*`fileHandle`*`)`

Parameter

`fileHandle`	A macro variable used as filehandle by the `__openFile` macro

Return value `int 0`

Description Rewinds a file previously opened by `__openFile`.

__setCodeBreak

Syntax `__setCodeBreak(`*`location, count, condition, cond_type, action`*`)`

Parameters

`location`	A string with a location description. This can be either: A source location on the form `{`*`filename`*`}.`*`line`*`.`*`col`* (for example `{D:\\src\\prog.c}.12.9`) An absolute location on the form *`zone`*`:`*`hexaddress`* or simply *`hexaddress`* (for example `Memory:0x42`) An expression whose value designates a location (for example `main`)
`count`	The number of times that a breakpoint condition must be fulfilled before a break occurs (integer)
`condition`	The breakpoint condition (string)
`cond_type`	The condition type; either “`CHANGED`” or “`TRUE`” (string)
`action`	An expression, typically a call to a macro, which is evaluated when the breakpoint is detected

Return value

Result	Value
Successful	An unsigned integer uniquely identifying the breakpoint. This value must be used to clear the breakpoint.
Unsuccessful	`0`

Table 108: __setCodeBreak return values

Description Sets a code breakpoint, that is, a breakpoint which is triggered just before the processor fetches an instruction at the specified location.

Examples

```
__setCodeBreak("{D:\\src\\prog.c}.12.9", 3, "d>16", "TRUE",
"ActionCode()");
```

This example sets a code breakpoint on the label `main` in your source:

```
__setCodeBreak("main", 0, "1", "TRUE", "");
```

See also

Defining breakpoints, page 117.

__setDataBreak

Syntax

```
__setDataBreak(location, count, condition, cond_type, access,
               action)
```

Parameters

location	A string with a location description. This can be either: A *source location* on the form `{`*filename*`}.`*line*`.`*col* (for example `{D:\\src\\prog.c}.12.9`), although this is not very useful for data breakpoints An *absolute location* on the form *zone*`:`*hexaddress* or simply *hexaddress* (for example `Memory:0x42`) An *expression* whose value designates a location (for example `my_global_variable`).
count	The number of times that a breakpoint condition must be fulfilled before a break occurs (integer)
condition	The breakpoint condition (string)
cond_type	The condition type; either `"CHANGED"` or `"TRUE"` (string)
access	The memory access type: `"R"` for read, `"W"` for write, or `"RW"` for read/write
`action`	An expression, typically a call to a macro, which is evaluated when the breakpoint is detected

Return value

Result	**Value**
Successful	An unsigned integer uniquely identifying the breakpoint. This value must be used to clear the breakpoint.
Unsuccessful	0

Table 109: __setDataBreak return values

Description

Sets a data breakpoint, that is, a breakpoint which is triggered directly after the processor has read or written data at the specified location.

Applicability

This system macro is only available in the C-SPY Simulator.

Example

```
__var brk;
brk = __setDataBreak("Memory:0x4710", 3, "d>6", "TRUE",
      "W", "ActionData()");
...
__clearBreak(brk);
```

See also

Defining breakpoints, page 117.

__setLogBreak

Syntax

```
__setLogBreak(location, message, mesg_type, condition,
              cond_type)
```

Parameters

location	A string with a location description. This can be either: A source location on the form `{`*filename*`}.`*line*`.`*col* (for example `{D:\\src\\prog.c}.12.9`) An absolute location on the form *zone*`:`*hexaddress* or simply *hexaddress* (for example `Memory:0x42`) An expression whose value designates a location (for example `main`)
message	The message text
msg_type	The message type; choose between: `TEXT`, the message is written word for word. `ARGS`, the message is interpreted as a comma-separated list of C-SPY expressions or strings.
condition	The breakpoint condition (string)
cond_type	The condition type; either `"CHANGED"` or `"TRUE"` (string)

Return value

Result	Value
Successful	An unsigned integer uniquely identifying the breakpoint. The same value must be used when you want to clear the breakpoint.
Unsuccessful	0

Table 110: __setLogBreak return values

Description

Sets a log breakpoint, that is, a breakpoint which is triggered when an instruction is fetched from the specified location. If you have set the breakpoint on a specific machine instruction, the breakpoint will be triggered and the execution will temporarily halt and print the specified message in the C-SPY Debug Log window.

Example

```
__var logBp1;
__var logBp2;

logOn()
{
  logBp1 = __setLogBreak ("{C:\\temp\\Utilities.c}.23.1",
    "\"Entering trace zone at :\", #PC:%X", "ARGS", "1", "TRUE");
  logBp2 = __setLogBreak ("{C:\\temp\\Utilities.c}.30.1",
    "Leaving trace zone...", "TEXT", "1", "TRUE");
}

logOff()
{
  __clearBreak(logBp1);
  __clearBreak(logBp2);
}
```

See also

Formatted output, page 382, *Log breakpoints dialog box*, page 204, and *Defining breakpoints*, page 117.

__setSimBreak

Syntax

`__setSimBreak(`*`location, access, action`*`)`

Parameters

`location`	A string with a location description. This can be either: A source location on the form `{`*`filename`*`}.`*`line`*`.`*`col`* (for example `{D:\\src\\prog.c}.12.9`) An absolute location on the form *`zone`*`:`*`hexaddress`* or simply *`hexaddress`* (for example `Memory:0x42`) An expression whose value designates a location (for example `main`)
`access`	The memory access type: `"R"` for read or `"W"` for write
`action`	An expression, typically a call to a macro function, which is evaluated when the breakpoint is detected

Return value

Result	Value
Successful	An unsigned integer uniquely identifying the breakpoint. This value must be used to clear the breakpoint.
Unsuccessful	0

Table 111: __setSimBreak return values

Description

Use this system macro to set *immediate* breakpoints, which will halt instruction execution only temporarily. This allows a C-SPY macro function to be called when the processor is about to read data from a location or immediately after it has written data. Instruction execution will resume after the action.

This type of breakpoint is useful for simulating memory-mapped devices of various kinds (for instance serial ports and timers). When the processor reads at a memory-mapped location, a C-SPY macro function can intervene and supply the appropriate data. Conversely, when the processor writes to a memory-mapped location, a C-SPY macro function can act on the value that was written.

Applicability

This system macro is only available in the C-SPY Simulator.

__setTraceStartBreak

Syntax

`__setTraceStartBreak(`*`location`*`)`

Parameters

`location`	A string with a location description. This can be either: A source location on the form `{`*`filename`*`}.`*`line`*`.`*`col`* (for example `{D:\\src\\prog.c}.12.9`) An absolute location on the form *`zone`*`:`*`hexaddress`* or simply *`hexaddress`* (for example `Memory:0x42`) An expression whose value designates a location (for example `main`)

Return value

Result	Value
Successful	An unsigned integer uniquely identifying the breakpoint. The same value must be used when you want to clear the breakpoint.
Unsuccessful	0

Table 112: __setTraceStartBreak return values

Description

Sets a breakpoint at the specified location. When that breakpoint is triggered, the trace system is started.

Applicability

This system macro is available in the C-SPY Simulator; it might not be available in the C-SPY driver you are using for hardware debugging.

Example

```
__var startTraceBp;
__var stopTraceBp;

traceOn()
{
  startTraceBp = __setTraceStartBreak
    ("{C:\\TEMP\\Utilities.c}.23.1");
  stopTraceBp = __setTraceStopBreak
    ("{C:\\temp\\Utilities.c}.30.1");
}

traceOff()
{
  __clearBreak(startTraceBp);
  __clearBreak(stopTraceBp);
}
```

See also

Defining breakpoints, page 117.

__setTraceStopBreak

Syntax

`__setTraceStopBreak(`*`location`*`)`

Parameters

`location`	A string with a location description. This can be either: A source location on the form `{`*`filename`*`}.`*`line`*`.`*`col`* (for example `{D:\\src\\prog.c}.12.9`) An absolute location on the form *`zone`*`:`*`hexaddress`* or simply *`hexaddress`* (for example `Memory:0x42`) An expression whose value designates a location (for example `main`)

Return value

Result	Value
Successful	An unsigned integer uniquely identifying the breakpoint. The same value must be used when you want to clear the breakpoint.
Unsuccessful	`int 0`

Table 113: __setTraceStopBreak return values

Description

Sets a breakpoint at the specified location. When that breakpoint is triggered, the trace system is stopped.

Applicability

This system macro is available in the C-SPY Simulator; it might not be available in the C-SPY driver you are using for hardware debugging.

Example

```
__var brk;
brk = __setDataBreak("Memory:0x4710", 3, "d>6", "TRUE",
      "W", "ActionData()");
...
__clearBreak(brk);
```

See also

Defining breakpoints, page 117.

__sourcePosition

Syntax

`__sourcePosition(`*`linePtr, colPtr`*`)`

Parameters

linePtr	Pointer to the variable storing the line number
colPtr	Pointer to the variable storing the column number

Return value

Result	Value
Successful	Filename string
Unsuccessful	Empty ("") string

Table 114: __sourcePosition return values

Description

If the current execution location corresponds to a source location, this macro returns the filename as a string. It also sets the value of the variables, pointed to by the parameters, to the line and column numbers of the source location.

__strFind

Syntax

`__strFind(macro`*`String`*`, `*`pattern`*`, `*`position`*`)`

Parameters

macroString	The macro string to search in
pattern	The string pattern to search for
position	The position where to start the search. The first position is `0`

Return value	The position where the pattern was found or `-1` if the string is not found.
Description	This macro searches a given string for the occurrence of another string.

Example

```
__strFind("Compiler", "pile", 0)  = 3
__strFind("Compiler", "foo", 0)   = -1
```

See also *Macro strings*, page 380.

__subString

Syntax `__subString(`*`macroString`*`, `*`position`*`, `*`length`*`)`

Parameters

`macroString`	The macro string from which to extract a substring
`position`	The start position of the substring. The first position is 0.
`length`	The length of the substring

Return value A substring extracted from the given macro string.

Description This macro extracts a substring from another string.

Example

```
__subString("Compiler", 0, 2)
```

The resulting macro string contains `Co`.

```
__subString("Compiler", 3, 4)
```

The resulting macro string contains `pile`.

See also *Macro strings*, page 380.

__targetDebuggerVersion

Syntax `__targetDebuggerVersion`

Return value A string that represents the version number of the C-SPY debugger processor module.

Description This macro returns the version number of the C-SPY debugger processor module.

Example

```
__var toolVer;
toolVer = __targetDebuggerVersion();
__message "The target debugger version is, ", toolVer;
```

__toLower

Syntax	`__toLower(`*`macroString`*`)`

Parameter

`macroString`	Any macro string

Return value	The converted macro string.
Description	This macro returns a copy of the parameter string where all the characters have been converted to lower case.

Example

```
__toLower("IAR")
```

The resulting macro string contains `iar`.

```
__toLower("Mix42")
```

The resulting macro string contains `mix42`.

See also *Macro strings*, page 380.

__toString

Syntax	`__toString(C_`*`string`*`, `*`maxlength`*`)`

Parameter

`string`	Any null-terminated C string
`maxlength`	The maximum length of the returned macro string

Return value	Macro string.
Description	This macro is used for converting C strings (`char*` or `char[]`) into macro strings.

Example

Assuming your application contains this definition:

```
char const * hptr = "Hello World!";
```

this macro call:

```
__toString(hptr, 5)
```

would return the macro string containing `Hello`.

See also *Macro strings*, page 380.

__toUpper

Syntax	`__toUpper(`*`macroString`*`)`
Parameter	*`macroString`* is any macro string.
Return value	The converted string.
Description	This macro returns a copy of the parameter *`macroString`* where all the characters have been converted to upper case.
Example	`__toUpper("string")` The resulting macro string contains `STRING`.
See also	*Macro strings*, page 380.

__writeFile

Syntax	`__writeFile(`*`file, value`*`)`
Parameters	

`fileHandle`	A macro variable used as filehandle by the `__openFile` macro
`value`	An integer

Return value	`int 0`
Description	Prints the integer value in hexadecimal format (with a trailing space) to the file *`file`*. **Note:** The `__fmessage` statement can do the same thing. The `__writeFile` macro is provided for symmetry with `__readFile`.

__writeFileByte

Syntax	`__writeFileByte(`*`file`*`, `*`value`*`)`
Parameters	

`fileHandle`	A macro variable used as filehandle by the `__openFile` macro
`value`	An integer in the range `0-255`

Return value	`int 0`
Description	Writes one byte to the file *`file`*.

__writeMemory8, __writeMemoryByte

Syntax

```
__writeMemory8(value, address, zone)
__writeMemoryByte(value, address, zone)
```

Parameters

value	The value to be written (integer)
address	The memory address (integer)
zone	The memory zone name (string); for a list of available zones, see the online help system available from the **Help** menu

Return value `int 0`

Description Writes one byte to a given memory location.

Example

```
__writeMemory8(0x2F, 0x8020, "Memory");
```

__writeMemory16

Syntax

```
__writeMemory16(value, address, zone)
```

Parameters

value	The value to be written (integer)
address	The memory address (integer)
zone	The memory zone name (string); for a list of available zones, see the online help system available from the **Help** menu

Return value `int 0`

Description Writes two bytes to a given memory location.

Example

```
__writeMemory16(0x2FFF, 0x8020, "Memory");
```

__writeMemory32

Syntax `__writeMemory32(`*`value, address, zone`*`)`

Parameters

`value`	The value to be written (integer)
`address`	The memory address (integer)
`zone`	The memory zone name (string); for a list of available zones, see the online help system available from the **Help** menu

Return value `int 0`

Description Writes four bytes to a given memory location.

Example

```
__writeMemory32(0x5555FFFF, 0x8020, "Memory");
```

Glossary

This is a general glossary for terms relevant to embedded systems programming. Some of the terms do not apply to the IAR Embedded Workbench® version that you are using.

A

Absolute location
A specific memory address for an object specified in the source code, as opposed to the object being assigned a location by the linker.

Absolute segments
Segments that have fixed locations in memory before linking.

Address expression
An expression which has an address as its value.

Application
The program developed by the user of the IAR Systems toolkit and which will be run as an embedded application on a target processor.

Ar
The GNU binary utility for creating, modifying, and extracting from archives, that is, libraries. See also *Iarchive*.

Architecture
A term used by computer designers to designate the structure of complex information-processing systems. It includes the kinds of instructions and data used, the memory organization and addressing, and the methods by which the system is implemented. The two main architecture types used in processor design are *Harvard architecture* and *von Neumann architecture*.

Archive
See *Library*.

Assembler directives
The set of commands that control how the assembler operates.

Assembler options
Parameters you can specify to change the default behavior of the assembler.

Assembler language
A machine-specific set of mnemonics used to specify operations to the target processor and input or output registers or data areas. Assembler language might sometimes be preferred over C/C++ to save memory or to enhance the execution speed of the application.

Attributes
See *Section attributes (ILINK)*.

Auto variables
The term refers to the fact that each time the function in which the variable is declared is called, a new instance of the variable is created automatically. This can be compared with the behavior of local variables in systems using static overlay, where a local variable only exists in one instance, even if the function is called recursively. Also called local variables. Compare *Register variables*.

B

Backtrace
Information for keeping call frame information up to date so that the IAR C-SPY® Debugger can return from a function correctly. See also *Call frame information*.

Bank
See *Memory bank*.

Bank switching
Switching between different sets of memory banks. This software technique increases a computer's usable memory by allowing different pieces of memory to occupy the same address space.

Banked code
Code that is distributed over several banks of memory. Each function must reside in only one bank.

Banked data
Data that is distributed over several banks of memory. Each data object must fit inside one memory bank.

Banked memory
Has multiple storage locations for the same address. See also *Memory bank*.

Bank-switching routines
Code that selects a memory bank.

Batch files
A text file containing operating system commands which are executed by the command line interpreter. In Unix, this is called a "shell script" because it is the Unix shell which includes the command line interpreter. Batch files can be used as a simple way to combine existing commands into new commands.

Bitfield
A group of bits considered as a unit.

Block, in linker configuration file (ILINK)
A continuous piece of code or data. It is either built up of blocks, overlays, and sections or it is empty. A block has a name, and the start and end address of the block can be referred to from the application. It can have attributes such as a maximum size, a specific size, or a minimum alignment. The contents can have a specific order or not.

Breakpoint
1. Code breakpoint. A point in a program that, when reached, triggers some special behavior useful to the process of debugging. Generally, breakpoints are used for stopping program execution or dumping the values of some or all of the program variables. Breakpoints can be part of the program itself, or they can be set by the programmer as part of an interactive session with a debugging tool for scrutinizing the program's execution.

2. Data breakpoint. A point in memory that, when accessed, triggers some special behavior useful to the process of debugging. Generally, data breakpoints are used to stop program execution when an address location is accessed either by a read operation or a write operation.

3. Immediate breakpoint. A point in memory that, when accessed, trigger some special behavior useful in the process of debugging. Immediate breakpoints are generally used for halting the program execution in the middle of a memory access instruction (before or after the actual memory access depending on the access type) while performing some user-specified action. The execution is then resumed. This feature is only available in the simulator version of C-SPY.

C

Call frame information
Information that allows the IAR C-SPY® Debugger to show, without any runtime penalty, the complete stack of function calls—*call stack*—wherever the program counter is, provided that the code comes from compiled C functions. See also *Backtrace*.

Calling convention
A calling convention describes the way one function in a program calls another function. This includes how register parameters are handled, how the return value is returned, and which registers that will be preserved by the called function. The compiler handles this automatically for all C and C++ functions. All code written in assembler language must conform to the rules in the calling convention to be callable from C or C++, or to be able to call C and C++ functions. The C calling convention and the C++ calling conventions are not necessarily the same.

Cheap
As in *cheap memory access*. A cheap memory access either requires few cycles to perform, or few bytes of code to implement. A cheap memory access is said to have a low cost. See *Memory access cost*.

Checksum
A computed value which depends on the ROM content of the whole or parts of the application, and which is stored along with the application to detect corruption of the data. The checksum is produced by the linker to be verified with the application. Several algorithms are supported. Compare *CRC (cyclic redundancy checking)*.

Code banking
See *Banked code*.

Code model
The code model controls how code is generated for an application. Typically, the code model controls behavior such as how functions are called and in which code segment/section functions will be located. All object files of an application must be compiled using the same code model.

Code pointers
A code pointer is a function pointer. As many microcontrollers allow several different methods of calling a function, compilers for embedded systems usually provide the users with the ability to use all these methods.

Do not confuse code pointers with data pointers.

Code segments/sections
Read-only segments/sections that contain code. See also *Segment (XLINK)* and *Section (ILINK)*.

Compilation unit
See *Translation unit*.

Compiler function directives
The compiler function directives are generated by the compiler to pass information about functions and function calls to the IAR XLINK Linker. To view these directives, you must create an assembler list file. These directives are primarily intended for compilers that support static overlay, a feature which is useful in smaller microcontrollers.

Compiler options
Parameters you can specify to change the default behavior of the compiler.

Cost
See *Memory access cost*.

CRC (cyclic redundancy checking)
A number derived from, and stored with, a block of data to detect corruption. A CRC is based on polynomials and is a more advanced way of detecting errors than a simple arithmetic checksum. Compare *Checksum*.

C-SPY options
Parameters you can specify to change the default behavior of the IAR C-SPY Debugger.

Cstartup
Code that sets up the system before the application starts executing.

C-style preprocessor
A preprocessor is either a stand-alone application or an integrated part of a compiler, that performs preprocessing of the input stream before the actual compilation occurs. A C-style preprocessor follows the rules set up in Standard C and implements commands like `#define`, `#if`, and `#include`, which are used to handle textual macro substitution, conditional compilation, and inclusion of other files.

D

Data banking
See *Banked data*.

Data model
The data model specifies the default memory type. This means that the data model typically controls one or more of the following: The method used and the code generated to access static and global variables, dynamically allocated data, and the runtime stack. It also controls the default pointer type and in which data segments/sections static and global variables will be located. A project can only use one data model at a time, and the same model must be used by all user modules and all library modules in the project.

Data pointers
Many microcontrollers have different addressing modes to access different memory types or address spaces. Compilers for embedded systems usually have a set of different data pointer types so they can access the available memory efficiently.

Data representation
How different data types are laid out in memory and what value ranges they represent.

Declaration
A specification to the compiler that an object, a variable or function, exists. The object itself must be defined in exactly one translation unit (source file). An object must either be declared or defined before it is used. Normally an object that is used in many files is defined in one source file. A declaration is normally placed in a header file that is included by the files that use the object.

For example:

```
/* Variable "a" exists somewhere. Function
 "b" takes two int parameters and returns an
 int. */

extern int a;
int b(int, int);
```

Definition
The variable or function itself. Only one definition can exist for each variable or function in an application. See also *Tentative definition*.

For example:

```
int a;
int b(int x, int y)
{
   return x + y;
}
```

Demangling (ILINK)
To restore a mangled name to the more common C/C++ name. See also *Mangling (ILINK)*.

Derivative
One of two or more processor variants in a series or family of microprocessors or microcontrollers.

Device description file
A file used by C-SPY that contains various device-specific information such as I/O registers (SFR) definitions, interrupt vectors, and control register definitions.

Device driver
Software that provides a high-level programming interface to a particular peripheral device.

Digital signal processor (DSP)
A device that is similar to a microprocessor, except that the internal CPU is optimized for use in applications involving discrete-time signal processing. In addition to standard microprocessor instructions, digital signal processors usually support a set of complex instructions to perform common signal-processing computations quickly.

Disassembly window
A C-SPY window that shows the memory contents disassembled as machine instructions, interspersed with the corresponding C source code (if available).

DWARF
An industry-standard debugging format which supports source level debugging. This is the format used by the IAR ILINK Linker for representing debug information in an object.

Dynamic initialization
Variables in a program written in C are initialized during the initial phase of execution, before the main function is called. These variables are always initialized with a static value, which is determined either at compile time or at link time. This is called static initialization. In C++, variables might require initialization to be performed by executing code, for example, running the constructor of global objects, or performing dynamic memory allocation.

Dynamic memory allocation
There are two main strategies for storing variables: statically at link time, or dynamically at runtime. Dynamic memory allocation is often performed from the heap and it is the size of the heap that determines how much memory that can be used for dynamic objects and variables. The advantage of dynamic memory allocation is that several variables or objects that are not active at the same time can be stored in the same memory, thus reducing the memory requirements of an application. See also *Heap memory*.

Dynamic object
An object that is allocated, created, destroyed, and released at runtime. Dynamic objects are almost always stored in memory that is dynamically allocated. Compare *Static object*.

E

EEPROM
Electrically Erasable, Programmable Read-Only Memory. A type of ROM that can be erased electronically, and then be re-programmed.

ELF
Executable and Linking Format, an industry-standard object file format. This is the format used by the IAR ILINK Linker. The debug information is formatted using DWARF.

EPROM
Erasable, Programmable Read-Only Memory. A type of ROM that can be erased by exposing it to ultraviolet light, and then be re-programmed.

Embedded C++
A subset of the C++ programming language, which is intended for embedded systems programming. The fact that performance and portability are particularly important in embedded systems development was considered when defining the language.

Embedded system
A combination of hardware and software, designed for a specific purpose. Embedded systems are often part of a larger system or product.

Emulator
An emulator is a hardware device that performs emulation of one or more derivatives of a processor family. An emulator can often be used instead of the actual microcontroller and connects directly to the printed circuit board—where the microcontroller would have been connected—via a connecting device. An emulator always behaves exactly as the processor it emulates, and is used when debugging requires all systems actuators, or when debugging device drivers.

Enea OSE Load module format
A specific ELF format that is loadable by the OSE operating system. See also *ELF*.

Enumeration
A type which includes in its definition an exhaustive list of possible values for variables of that type. Common examples include Boolean, which takes values from the list [true, false], and day-of-week which takes values [Sunday, Monday, Tuesday, Wednesday, Thursday, Friday, Saturday]. Enumerated types are a feature of typed languages, including C and Ada.

Characters, (fixed-size) integers, and even floating-point types might be (but are not usually) considered to be (large) enumerated types.

Executable image
Contains the executable image; the result of linking several relocatable object files and libraries. The file format used for an object file is UBROF for XLINK and for ILINK, ELF with embedded DWARF for debug information.

Exceptions
An exception is an interrupt initiated by the processor hardware, or hardware that is tightly coupled with the processor, for instance, a memory management unit (MMU). The exception signals a violation of the rules of the architecture (access to protected memory), or an extreme error condition (division by zero).

Do not confuse this use of the word exception with the term *exception* used in the C++ language (but not in Embedded C++).

Expensive
As in *expensive memory access*. An expensive memory access either requires many cycles to perform, or many bytes of code to implement. An expensive memory access is said to have a high cost. See *Memory access cost*.

Extended keywords
Non-standard keywords in C and C++. These usually control the definition and declaration of objects (that is, data and functions). See also *Keywords*.

F

Filling
How to fill up bytes—with a specific fill pattern—that exists between the segments/sections in an executable image. These bytes exist because of the alignment demands on the segments/sections.

Format specifiers
Used to specify the format of strings sent by library functions such as `printf`. In the following example, the function call contains one format string with one format specifier, `%c`, that prints the value of `a` as a single ASCII character:

```
printf("a = %c", a);
```

G

General options
Parameters you can specify to change the default behavior of all tools that are included in the IDE.

Generic pointers
Pointers that have the ability to point to all different memory types in, for example, a microcontroller based on the Harvard architecture.

H

Harvard architecture
A microcontroller based on the Harvard architecture has separate data and instruction buses. This allows execution to occur in parallel. As an instruction is being fetched, the current instruction is executing on the data bus. Once the current instruction is complete, the next instruction is ready to go. This theoretically allows for much faster execution than a von Neumann architecture, but adds some silicon complexity. Compare *von Neumann architecture*.

Heap memory
The heap is a pool of memory in a system that is reserved for dynamic memory allocation. An application can request parts of the heap for its own use; once memory is allocated from the heap it remains valid until it is explicitly released back to the heap by the application. This type of memory is useful when the number of objects is not known until the application executes. Note that this type of memory is risky to use in systems with a limited amount of memory or systems that are expected to run for a very long time.

Heap size
Total size of memory that can be dynamically allocated.

Host
The computer that communicates with the target processor. The term is used to distinguish the computer on which the debugger is running from the microcontroller the embedded application you develop runs on.

I

Iarchive
The IAR Systems utility for creating archives, that is, libraries. Iarchive is delivered with IAR Embedded Workbench.

IDE (integrated development environment)
A programming environment with all necessary tools integrated into one single application.

Ielfdump
The IAR Systems utility for creating a text representation of the contents of ELF relocatable or executable image.

Ielftool
The IAR Systems utility for performing various transformations on an ELF executable image, such as fill, checksum, and format conversion.

ILINK
The IAR ILINK Linker which produces absolute output in the ELF/DWARF format.

ILINK configuration
The definition of available physical memories and the placement of sections—pieces of code and data—into those memories. ILINK requires a configuration to build an executable image.

Image
See *Executable image*.

Include file
A text file which is included into a source file. This is often done by the preprocessor.

Initialization setup in linker configuration file (ILINK)
Defines how to initialize RAM sections with their initializers. Normally, only non-constant non-noinit variables are initialized but, for example, pieces of code can be initialized as well.

Initialized segments/sections
Read-write segments/sections that should be initialized with specific values at startup. See also *Segment (XLINK)* and *Section (ILINK)*.

Inline assembler
Assembler language code that is inserted directly between C statements.

Inlining
An optimization that replaces function calls with the body of the called function. This optimization increases the execution speed and can even reduce the size of the generated code.

Instruction mnemonics
A word or acronym used in assembler language to represent a machine instruction. Different processors have different instruction sets and therefore use a different set of mnemonics to represent them, such as, `ADD`, `BR` (branch), `BLT` (branch if less than), `MOVE`, `LDR` (load register).

Interrupt vector
A small piece of code that will be executed, or a pointer that points to code that will be executed when an interrupt occurs.

Interrupt vector table
A table containing interrupt vectors, indexed by interrupt type. This table contains the processor's mapping between interrupts and interrupt service routines and must be initialized by the programmer.

Interrupts
In embedded systems, the use of interrupts is a method of detecting external events immediately, for example a timer overflow or the pressing of a button.

Interrupts are asynchronous events that suspend normal processing and temporarily divert the flow of control through an “interrupt handler” routine. Interrupts can be caused by both hardware (I/O, timer, machine check) and software (supervisor, system call or trap instruction). Compare *Trap*.

Intrinsic
An adjective describing native compiler objects, properties, events, and methods.

Intrinsic functions
1. Function calls that are directly expanded into specific sequences of machine code. 2. Functions called by the compiler for internal purposes (that is, floating-point arithmetic etc.).

Iobjmanip
The IAR Systems utility for performing low-level manipulation of ELF object files.

K

Key bindings
Key shortcuts for menu commands used in the IDE.

Keywords
A fixed set of symbols built into the syntax of a programming language. All keywords used in a language are reserved—they cannot be used as identifiers (in other words, user-defined objects such as variables or procedures). See also *Extended keywords*.

L

L-value
A value that can be found on the left side of an assignment and thus be changed. This includes plain variables and de-referenced pointers. Expressions like `(x + 10)` cannot be assigned a new value and are therefore not L-values.

Language extensions
Target-specific extensions to the C language.

Library
See *Runtime library*.

Library configuration file
A file that contains a configuration of the runtime library. The file contains information about what functionality is part of the runtime environment. The file is used for tailoring a build of a runtime library. See also *Runtime library*.

Linker configuration file (XLINK)
A file used by the IAR XLINK Linker. It contains command line options which specify the locations where the memory segments can be placed, thereby assuring that your application fits on the target chip.

Because many of the chip-specific details are specified in the linker configuration file and not in the source code, the linker configuration file also helps to make the code portable.

In particular, the linker specifies the placement of segments, the stack size, and the heap size.

Linker configuration file (ILINK)
A file that contains a configuration used by the IAR ILINK Linker when building an executable image. See also *ILINK configuration*.

Local variable
See *Auto variables*.

Location counter
See *Program location counter (PLC)*.

Logical address
See *Virtual address (logical address)*.

M

MAC (Multiply and accumulate)
A special instruction, or on-chip device, that performs a multiplication together with an addition. This is very useful when performing signal processing where many filters and transforms have the form:

$$y_j = \sum_{i=0}^{N} c_i \cdot x_{i+j}$$

The accumulator of the MAC usually has a higher precision (more bits) than normal registers. See also *Digital signal processor (DSP)*.

Macro
1. Assembler macros are user-defined sets of assembler lines that can be expanded later in the source file by referring to the given macro name. Parameters will be substituted if referred to.

2. C macro. A text substitution mechanism used during preprocessing of source files. Macros are defined using the `#define` preprocessing directive. The replacement text of each macro is then substituted for any occurrences of the macro name in the rest of the translation unit.

3. C-SPY macros are programs that you can write to enhance the functionality of C-SPY. A typical application of C-SPY macros is to associate them with breakpoints; when such a breakpoint is hit, the macro is run and can for example be used to simulate peripheral devices, to evaluate complex conditions, or to output a trace.

The C-SPY macro language is like a simple dialect of C, but is less strict with types.

Mailbox
A mailbox in an RTOS is a point of communication between two or more tasks. One task can send messages to another task by placing the message in the mailbox of the other task. Mailboxes are also known as message queues or message ports.

Mangling (ILINK)
Mangling is a technique used for mapping a complex C/C++ name into a simple name. Both mangled and unmangled names can be produced for C/C++ symbols in ILINK messages.

Memory, in linker configuration file (ILINK)
A physical memory. The number of units it contains and how many bits a unit consists of, are defined in the linker configuration file. The memory is always addressable from `0x0` to size -1.

Memory access cost
The cost of a memory access can be in clock cycles, or in the number of bytes of code needed to perform the access. A memory which requires large instructions or many instructions is said to have a higher access cost than a memory which can be accessed with few, or small instructions.

Memory area
A region of the memory.

Memory bank
The smallest unit of continuous memory in banked memory. One memory bank at a time is visible in a microcontroller's physical address space.

Memory map
A map of the different memory areas available to the microcontroller.

Memory model
Specifies the memory hierarchy and how much memory the system can handle. Your application must use only one memory model at a time, and the same model must be used by all user modules and all library modules.

Microcontroller
A microprocessor on a single integrated circuit intended to operate as an embedded system. In addition to a CPU, a microcontroller typically includes small amounts of RAM, PROM, timers, and I/O ports.

Microprocessor
A CPU contained on one (or a few) integrated circuits. A single-chip microprocessor can include other components such as memory, memory management, caches, floating-point unit, I/O ports and timers. Such devices are also known as microcontrollers.

Multi-file compilation
A technique which means that the compiler compiles several source files as one compilation unit, which enables for interprocedural optimizations such as inlining, cross call, and cross jump on multiple source files in a compilation unit.

Module
An object. An object file contains a module and library contains one or more objects. The basic unit of linking. A module contains definitions for symbols (exports) and references to external symbols (imports). When you compile C/C++, each translation unit produces one module.

N

Nested interrupts
A system where an interrupt can be interrupted by another interrupt is said to have nested interrupts.

Non-banked memory
Has a single storage location for each memory address in a microcontroller's physical address space.

Non-initialized memory
Memory that can contain any value at reset, or in the case of a soft reset, can remember the value it had before the reset.

No-init segments/sections
Read-write sections that should not be initialized at startup. See also *Segment (XLINK)* and *Section (ILINK)*.

Non-volatile storage
Memory devices such as battery-backed RAM, ROM, magnetic tape and magnetic disks that can retain data when electric power is shut off. Compare *Volatile storage*.

NOP
No operation. This is an instruction that does not do anything, but is used to create a delay. In pipelined architectures, the `NOP` instruction can be used for synchronizing the pipeline. See also *Pipeline*.

O

Objcopy
A GNU binary utility for converting an absolute object file in ELF format into an absolute object file, for example the format Motorola-std or Intel-std. See also *Ielftool*.

Object
An object file or a library member.

Object file, absolute
See *Executable image*.

Object file, relocatable
The result of compiling or assembling a source file. The file format used for an object file is UBROF for XLINK and for ILINK, ELF with embedded DWARF for debug information.

Operator
A symbol used as a function, with infix syntax if it has two arguments (`+`, for example) or prefix syntax if it has only one (for instance, bitwise negation, ~). Many languages use operators for built-in functions such as arithmetic and logic.

Operator precedence
Each operator has a precedence number assigned to it that determines the order in which the operator and its operands are evaluated. The highest precedence operators are evaluated first. Use parentheses to group operators and operands to control the order in which the expressions are evaluated.

Output image
The resulting application after linking. This term is equivalent to *executable image*, which is the term used in the IAR Systems user documentation.

Overlay, in linker configuration file (ILINK)
Like a block, but it contains several overlaid entities, each built up of blocks, overlays, and sections. The size of an overlay is determined by its largest constituent.

P

Parameter passing
See *Calling convention*.

Peripheral unit
A hardware component other than the processor, for example memory or an I/O device.

Pipeline
A structure that consists of a sequence of stages through which a computation flows. New operations can be initiated at the start of the pipeline even though other operations are already in progress through the pipeline.

Placement, in linker configuration file (ILINK)
How to place blocks, overlays, and sections into a region. It determines how pieces of code and data are actually placed in the available physical memory.

Pointer
An object that contains an address to another object of a specified type.

#pragma
During compilation of a C/C++ program, the #pragma preprocessing directive causes the compiler to behave in an implementation-defined manner. This can include, for example, producing output on the console, changing the declaration of a subsequent object, changing the optimization level, or enabling/disabling language extensions.

Pre-emptive multitasking
An RTOS task is allowed to run until a higher priority process is activated. The higher priority task might become active as the result of an interrupt. The term preemptive indicates that although a task is allotted to run a given length of time (a timeslice), it might lose the processor at any time. Each time an interrupt occurs, the task scheduler looks for the highest priority task that is active and switches to that task. If the located task is different from the task that was executing before the interrupt, the previous task is suspended at the point of interruption.

Compare *Round Robin*.

Preprocessing directives
A set of directives that are executed before the parsing of the actual code is started.

Preprocessor
See *C-style preprocessor*.

Processor variant
The different chip setups that the compiler supports. See *Derivative*.

Program counter (PC)
A special processor register that is used to address instructions. Compare *Program location counter (PLC)*.

Program location counter (PLC)
Used in the IAR Assembler to denote the code address of the current instruction. The `PLC` is represented by a special symbol (typically `$`) that can be used in arithmetic expressions. Also called simply location counter (`LC`).

PROM
Programmable Read-Only Memory. A type of ROM that can be programmed only once.

Project
The user application development project.

Project options
General options that apply to an entire project, for example the target processor that the application will run on.

Q

Qualifiers
See *Type qualifiers*.

R

Range, in linker configuration file (ILINK)
A range of consecutive addresses in a memory. A region is built up of ranges.

R-value
A value that can be found on the right side of an assignment. This is just a plain value. See also *L-value*.

Read-only segments/sections
Segments/sections that contain code or constants. See also *Segment (XLINK)* and *Section (ILINK)*.

Real-time operating system (RTOS)
An operating system which guarantees the latency between an interrupt being triggered and the interrupt handler starting, and how tasks are scheduled. An RTOS is typically much smaller than a normal desktop operating system. Compare *Real-time system*.

Real-time system
A computer system whose processes are time-sensitive. Compare *Real-time operating system (RTOS)*.

Region, in linker configuration file (ILINK)
A set of non-overlapping ranges. The ranges can lie in one or more memories. Blocks, overlays, and sections are placed into regions in the linker configuration file.

Region expression, in linker configuration file (ILINK)
A region built up from region literals, regions, and the common set operations possible in the linker configuration file.

Region literal, in linker configuration file (ILINK)
A literal that defines a set of one or more non-overlapping ranges in a memory.

Register constant
A register constant is a value that is loaded into a dedicated processor register when the system is initialized. The compiler can then generate code that assumes that the constants are present in the dedicated registers.

Register
A small on-chip memory unit, usually just one or a few bytes in size, which is particularly efficient to access and therefore often reserved as a temporary storage area during program execution.

Register locking
Register locking means that the compiler can be instructed that some processor registers shall not be used during normal code generation. This is useful in many situations. For example, some parts of a system might be written in assembler language to gain speed. These parts might be given dedicated processor registers. Or the register might be used by an operating system, or by other third-party software.

Register variables
Typically, register variables are local variables that are placed in registers instead of on the (stack) frame of the function. Register variables are much more efficient than other variables because they do not require memory accesses, so the compiler can use shorter/faster instructions when working with them. See also *Auto variables*.

Relocatable segments/sections
Segments/sections that have no fixed location in memory before linking.

Reset
A reset is a restart from the initial state of a system. A reset can originate from hardware (hard reset), or from software (soft reset). A hard reset can usually not be distinguished from the power-on condition, which a soft reset can be.

ROM-monitor
A piece of embedded software designed specifically for use as a debugging tool. It resides in the ROM of the evaluation board chip and communicates with a debugger via a serial port or network connection. The ROM-monitor provides a set of primitive commands to view and modify memory locations and registers, create and remove breakpoints, and execute your application. The debugger combines these primitives to fulfill higher-level requests like program download and single-step.

Round Robin
Task scheduling in an operating system, where all tasks have the same priority level and are executed in turn, one after the other. Compare *Pre-emptive multitasking*.

RTOS
See *Real-time operating system (RTOS)*.

Runtime library
A collection of relocatable object files that will be included in the executable image only if referred to from an object file, in other words conditionally linked.

Runtime model attributes
A mechanism that is designed to prevent modules that are not compatible to be linked into an application. A runtime attribute is a pair constituted of a named key and its corresponding value.

For XLINK, two modules can only be linked together if they have the same value for each key that they both define. ILINK uses the runtime model attributes when automatically choosing library to verify that the correct one is used.

S

Saturation arithmetics
Most, if not all, C and C++ implementations use mod–2^N 2-complement-based arithmetics where an overflow wraps the value in the value domain, that is, (127 + 1) = -128. Saturation arithmetics, on the other hand, does *not* allow wrapping in the value domain, for instance, (127 + 1) = 127, if 127 is the upper limit. Saturation arithmetics is often used in signal processing, where an overflow condition would have been fatal if value wrapping had been allowed.

Scheduler
The part of an RTOS that performs task-switching. It is also responsible for selecting which task that should be allowed to run. Many scheduling algorithms exist, but most of them are either based on static scheduling (performed at compile-time), or on dynamic scheduling (where the actual choice of which task to run next is taken at runtime, depending on the state of the system at the time of the task-switch). Most real-time systems use static scheduling, because it makes it possible to prove that the system will not violate the real-time requirements.

Scope
The section of an application where a function or a variable can be referenced by name. The scope of an item can be limited to file, function, or block.

Section (ILINK)
An entity that either contains data or text. Typically, one or more variables, or functions. A section is the smallest linkable unit.

Section attributes (ILINK)
Each section has a name and an attribute. The attribute defines what a section contains, that is, if the section content is read-only, read/write, code, data, etc.

Section fragment (ILINK)
A part of a section, typically a variable or a function.

Section selection (ILINK)
In the linker configuration file, defining a set of sections by using section selectors. A section belongs to the most restrictive section selector if it can be part of more than one selection. Three different selectors can be used individually or in conjunction to select the set of sections: *section attribute* (selecting by the section content), *section name* (selecting by the section name), and *object name* (selecting from a specific object).

Segment (XLINK)
A chunk of data or code that should be mapped to a physical location in memory. The segment can either be placed in RAM (read-and-writeable memory) or in ROM (read-only memory).

Segment map (XLINK)
A set of segments and their locations.

Semaphore
A semaphore is a type of flag that is used for guaranteeing exclusive access to resources. The resource can be a hardware port, a configuration memory, or a set of variables. If several tasks must access the same resource, the parts of the code (the critical sections) that access the resource must be made exclusive for every task. This is done by obtaining the semaphore that protects that resource, thus blocking all other tasks from it. If another task wishes to use the resource, it also must obtain the semaphore. If the semaphore is already in use, the second task must wait until the semaphore is released. After the semaphore is released, the second task is allowed to execute and can obtain the semaphore for its own exclusive access.

Severity level
The level of seriousness of the diagnostic response from the assembler, compiler, or debugger, when it notices that something is wrong. Typical severity levels are remarks, warnings, errors, and fatal errors. A remark just points to a possible problem, while a fatal error means that the programming tool exits without finishing.

Sharing (ILINK)
A physical memory that can be addressed in several ways; defined in the linker configuration file.

Short addressing
Many microcontrollers have special addressing modes for efficient access to internal RAM and memory mapped I/O. Short addressing is therefore provided as an extended feature by many compilers for embedded systems. See also *Data pointers*.

Side effect
An expression in C or C++ is said to have a side-effect if it changes the state of the system. Examples are assignments to a variable, or using a variable with the post-increment operator. The C and C++ standards state that a variable that is subject to a side-effect should not be used more that once in an expression.

As an example, this statement violates that rule:

```
*d++ = *d;
```

Signal
Signals provide event-based communication between tasks. A task can wait for one or more signals from other tasks. Once a task receives a signal it waits for, execution continues. A task in an RTOS that waits for a signal does not use any processing time, which allows other tasks to execute.

Simulator
A debugging tool that runs on the host and behaves as similar to the target processor as possible. A simulator is used to debug the application when the hardware is unavailable, or not needed for proper debugging. A simulator is usually not connected to any physical peripheral devices. A simulated processor is often slower, or even much slower, than the real hardware.

Single stepping
Executing one instruction or one C statement at a time in the debugger.

Skeleton code
An incomplete code framework that allows the user to specialize the code.

Special function register (SFR)
A register that is used to read and write to the hardware components of the microcontroller.

Stack frames
Data structures containing data objects like preserved registers, local variables, and other data objects that must be stored temporary for a particular scope (usually a function).

Earlier compilers usually had a fixed size and layout on a stack frame throughout a complete function, while modern compilers might have a very dynamic layout and size that can change anywhere and anytime in a function.

Stack segments/sections
The segment/section or segments/sections that reserve space for the stack(s). Most processors use the same stack for calls and parameters, but some have separate stacks.

Standard libraries
The C and C++ library functions as specified by the C and C++ standard, and support routines for the compiler, like floating-point routines.

Statically allocated memory
This kind of memory is allocated once and for all at link-time, and remains valid all through the execution of the application. Variables that are either global or declared `static` are allocated this way.

Static object
An object whose memory is allocated at link-time and is created during system startup (or at first use). Compare *Dynamic object*.

Static overlay (XLINK)
Instead of using a dynamic allocation scheme for parameters and auto variables, the linker allocates space for parameters and auto variables at link time. This generates a worst-case scenario of stack usage, but might be preferable for small chips with expensive stack access or no stack access at all.

Structure value
A collecting names for structs and unions. A struct is a collection of data object placed sequentially in memory (possibly with pad bytes between them). A union is a collection of data sharing the same memory location.

Symbolic location
A location that uses a symbolic name because the exact address is unknown.

T

Target
1. An architecture. 2. A piece of hardware. The particular embedded system you are developing the application for. The term is usually used to distinguish the system from the host system.

Task (thread)
A task is an execution thread in a system. Systems that contain many tasks that execute in parallel are called multitasking systems. Because a processor only executes one instruction stream at the time, most systems implement some sort of task-switch mechanism (often called context switch) so that all tasks get their share of processing time. The process of determining which task that should be allowed to run next is called scheduling. Two common scheduling methods are *Pre-emptive multitasking* and *Round Robin*.

Tentative definition
A variable that can be defined in multiple files, provided that the definition is identical and that it is an absolute variable.

Terminal I/O
A simulated terminal window in C-SPY.

Timeslice
The (longest) time an RTOS allows a task to run without running the task-scheduling algorithm. A task might be allowed to execute during several consecutive timeslices before being switched out. A task might also not be allowed to use its entire time slice, for example if, in a preemptive system, a higher priority task is activated by an interrupt.

Timer
A peripheral that counts independent of the program execution.

Translation unit
A source file together with all the header files and source files included via the preprocessor directive `#include`, except for the lines skipped by conditional preprocessor directives such as `#if` and `#ifdef`.

Trap
A trap is an interrupt initiated by inserting a special instruction into the instruction stream. Many systems use traps to call operating system functions. Another name for trap is software interrupt.

Type qualifiers
In Standard C/C++, `const` or `volatile`. IAR Systems compilers usually add target-specific type qualifiers for memory and other type attributes.

U

UBROF (Universal Binary Relocatable Object Format)
File format produced by some of the IAR Systems programming tools, if your product package includes the XLINK linker.

V

Value expressions, in linker configuration file (ILINK)
A constant number that can be built up out of expressions that has a syntax similar to C expressions.

Virtual address (logical address)
An address that must be translated by the compiler, linker or the runtime system into a physical memory address before it is used. The virtual address is the address seen by the application, which can be different from the address seen by other parts of the system.

Virtual space
An IAR Embedded Workbench Editor feature which allows you to place the insertion point outside of the area where there are actual characters.

Volatile storage
Data stored in a volatile storage device is not retained when the power to the device is turned off. To preserve data during a power-down cycle, you should store it in non-volatile storage. This should not be confused with the C keyword `volatile`. Compare *Non-volatile storage*.

von Neumann architecture
A computer architecture where both instructions and data are transferred over a common data channel. Compare *Harvard architecture*.

W

Watchpoints
Watchpoints keep track of the values of C variables or expressions in the C-SPY Watch window as the application is being executed.

X

XAR options
The set of commands that control how the IAR XAR Library Builder operates.

XLIB options
The set of commands that control how the IAR XLIB Librarian operates.

XLINK
The IAR XLINK Linker which uses the UBROF output format.

XLINK options
Parameters you can specify to change the default behavior of the IAR XLINK Linker.

Z

Zero-initialized segments/sections
Segments/sections that should be initialized to zero at startup. See also *Segment (XLINK)* and *Section (ILINK)*.

Zero-overhead loop
A loop in which the loop condition, including branching back to the beginning of the loop, does not take any time at all. This is usually implemented as a special hardware feature of the processor and is not available in all architectures.

Zone
Different processors have widely differing memory architectures. *Zone* is the term C-SPY uses for a named memory area. For example, on processors with separately addressable code and data memory there would be at least two zones. A processor with an intricate banked memory scheme might have several zones.