IAR Embedded Workbench®

C-SPY® Debugging Guide

for Advanced RISC Machines Ltd's
ARM Cores

UCSARM-1

IAR SYSTEMS

EDITION NOTICE

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This guide applies to version 6.1x of IAR Embedded Workbench® for Advanced RISC Machines Ltd's ARM cores family.

Internal reference: M7, Too6.1, IMAE.

Brief contents

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Preface

Welcome to the *C-SPY® Debugging Guide for ARM*. The purpose of this guide is to help you fully use the features in the IAR C-SPY® Debugger for debugging your application based on the ARM core.

Who should read this guide

Read this guide if you want to get the most out of the features available in C-SPY. 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 ARM core (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 25.

How to use this guide

If you are new to using IAR Embedded Workbench, 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, the tutorials which you can find in the IAR Information Center is a good place to begin. The process of managing projects and building, as well as editing, is described in the *IDE Project Management and Building Guide for ARM®*, whereas information about how to use C-SPY for debugging is described in this guide.

This guide describes a number of *topics*, where each topic section contains an introduction which also covers concepts related to the topic. This will give you a good understanding of the features in C-SPY. Furthermore, the topic section provides procedures with step-by-step descriptions to help you use the features. Finally, each topic section gives all relevant reference information.

We also recommend the Glossary which you can find in the *IDE Project Management and Building Guide for ARM®* if you should encounter any unfamiliar terms in the IAR Systems user and reference guides.

What this guide contains

This is a brief outline and summary of the chapters in this guide:

- *The IAR C-SPY Debugger* introduces you to the C-SPY debugger and to the concepts that are related to debugging in general and to C-SPY in particular. The chapter also introduces the various C-SPY drivers. The chapter briefly shows the difference in functionality that the various C-SPY drivers provide.
- *Getting started using C-SPY* helps you get started using C-SPY, which includes setting up, starting, and adapting C-SPY for target hardware.
- *Executing your application* describes 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* describes 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 set breakpoints.
- *Monitoring memory and registers* shows how you can examine memory and registers.
- *Collecting and using trace data* describes how you can inspect the program flow up to a specific state using trace data.
- *Using the profiler* describes how the profiler can help you find the functions in your application source code where the most time is spent during execution.
- *Code coverage* describes how the code coverage functionality can help you verify whether all parts of your code have been executed, thus identifying parts which have not been executed.
- *Data and interrupt logging* describes how you can locate frequently accessed data and how you can get comprehensive information about the interrupt events.
- *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.
- *Using C-SPY macros* describes the C-SPY macro system, its features, the purposes of these features, and how to use them.

- *The C-SPY Command Line Utility—cspybat* describes how to use C-SPY in batch mode.
- *Additional reference on C-SPY drivers* describes menus and features provided by the C-SPY drivers not described in any dedicated topics.
- *Using flash loaders* describes the flash loader, what it is and how to use it.

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.

USER AND REFERENCE GUIDES

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

- 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*.
- Getting started using IAR Embedded Workbench and the tools it provides, refer to the guide *Getting Started with IAR Embedded Workbench®*.
- Using the IDE for project management and building, refer to the *IDE Project Management and Building Guide for ARM®*
- Programming for the IAR C/C++ Compiler for ARM and linking using the IAR ILINK Linker, refer to the *IAR C/C++ Development Guide for ARM®*
- Programming for the IAR Assembler for ARM, refer to the *ARM® IAR Assembler Reference Guide.*
- IAR J-Link and IAR J-Trace, refer to the *IAR J-Link and IAR J-Trace User Guide for JTAG Emulators for ARM Cores*.
- Using the IAR DLIB Library, refer to the *DLIB Library Reference information*, available in the online help system.
- Porting application code and projects created with a previous version of the IAR Embedded Workbench for ARM, refer to *ARM® IAR Embedded Workbench® Migration Guide*.
- 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.

THE ONLINE HELP SYSTEM

The context-sensitive online help contains:

- Comprehensive information about debugging using the IAR C-SPY® Debugger
- Reference information about the menus, windows, and dialog boxes in the IDE
- Compiler reference information
- 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.

WEB SITES

Recommended web sites:

- The Advanced RISC Machines Ltd web site, **www.arm.com**, contains information and news about the ARM cores.
- 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 `arm\doc`, the full path to the location is assumed, for example `c:\Program Files\IAR Systems\Embedded Workbench 6.`*`n`*`\arm\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.

Table 1: Typographic conventions used in this guide

Style	Used for
`parameter`	A placeholder for an actual value used as a parameter, for example `filename.h` where `filename` represents the name of the file.
`[option]`	An optional part of a command.
`[a|b|c]`	An optional part of a command with alternatives.
`{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.
💡	Identifies helpful tips and programming hints.
⚠	Identifies warnings.

Table 1: 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 ARM	IAR Embedded Workbench®
IAR Embedded Workbench® IDE for ARM	the IDE
IAR C-SPY® Debugger for ARM	C-SPY, the debugger
IAR C-SPY® Simulator	the simulator
IAR C/C++ Compiler™ for ARM	the compiler
IAR Assembler™ for ARM	the assembler
IAR ILINK Linker™	ILINK, the linker
IAR DLIB Library™	the DLIB library

Table 2: Naming conventions used in this guide

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. The chapter also introduces the various C-SPY drivers. More specifically, this means:

- Introduction to C-SPY
- Debugger concepts
- C-SPY drivers overview
- The IAR C-SPY Simulator
- The C-SPY J-Link driver
- The C-SPY RDI driver
- The C-SPY Macraigor driver
- The C-SPY GDB Server driver
- The C-SPY ST-LINK driver
- The C-SPY TI Stellaris FTDI driver
- The C-SPY Angel debug monitor driver
- The C-SPY IAR ROM-monitor driver

Introduction to C-SPY

This section covers these topics:

- An integrated environment
- General C-SPY debugger features
- RTOS awareness.

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 in the same source code window that is used for controlling 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 be preserved 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.

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 is 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 available registers.
- 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 on their own 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
- Graphical stack view with overflow detection
- Support for code coverage and function level profiling
- The target application can access files on the host PC using file I/O
- Optional terminal I/O emulation.

RTOS AWARENESS

C-SPY supports real-time OS aware debugging. These operating systems are currently supported:

- IAR PowerPac RTOS

- CMX CMX-RTX and CMX-Tiny+ real-time operating systems
- Micriμm μC/OS-II
- Express Logic ThreadX
- RTXC Quadros RTOS
- Fusion RTOS
- OSEK (ORTI)
- OSE Epsilon
- Micro Digital SMX RTOS
- NORTi MiSPO
- Segger embOS.

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.

Provided that one or more real-time operating system plugin modules are supported for the IAR Embedded Workbench version you are using, you can load one for use with C-SPY. A C-SPY RTOS awareness plugin module gives 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 menu, 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. For links to the RTOS documentation, see the release notes that are available from the **Help** menu.

Debugger concepts

This section introduces some of the concepts and terms that are related to debugging in general and to C-SPY in particular. This section does not contain specific information related to C-SPY features. Instead, you will find such information in each chapter of this part of the documentation. The IAR Systems user documentation uses the terms described in this section 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 gives an overview of C-SPY and possible target systems:

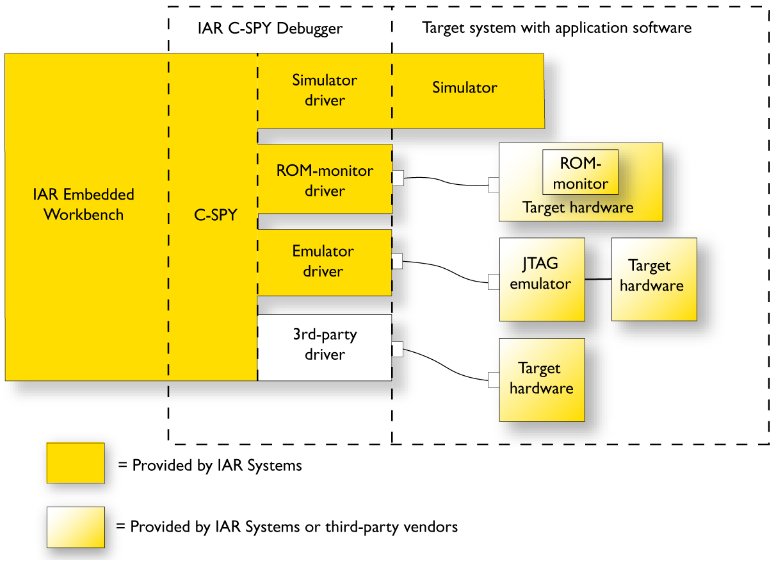


Figure 1: C-SPY and target systems

THE DEBUGGER

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

THE 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.

THE 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 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.

C-SPY is available with a simulator driver, and depending on your product package, optional drivers for hardware debugger systems. For an overview of the available C-SPY drivers and the functionality provided by each driver, see *C-SPY drivers overview*, page 35.

THE 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 ELF/DWARF, Intel-extended, or Motorola. For information about which format to use with a third-party debugger, 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 seamlessly integrated in the IDE.

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

- Code Coverage 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 aware debugging.
- Peripheral simulation modules make C-SPY simulate peripheral units. Such plugin modules are not provided by IAR Systems, but can be developed and distributed by third-party suppliers.

- 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.

C-SPY drivers overview

At the time of writing this guide, the IAR C-SPY Debugger for the ARM cores is available with drivers for these target systems:

- Simulator
- J-Link / J-Trace JTAG probes
- RDI (Remote Debug Interface)
- Macraigor JTAG probes
- GDB Server
- ST-LINK JTAG probe (for ST Cortex-M devices only)
- TI Stellaris FTDI JTAG interface (for Cortex devices only)
- Angel debug monitor
- IAR ROM-monitor for Analog Devices ADuC7xxx boards, and IAR Kickstart Card for Philips LPC210x.

Note: In addition to the drivers supplied with the IAR Embedded Workbench, you can also load debugger drivers supplied by a third-party vendor; see *Third-Party Driver options*, page 345.

DIFFERENCES BETWEEN THE C-SPY DRIVERS

This table summarizes the key differences between the C-SPY drivers:

Feature	Simulator	J-Link/ J-Trace	RDI	Mac- raigor	GDB Server	ST- Link	TI Stellaris FTDI	Angel	IAR ROM- monitor
Code breakpoints	Unlimited	x 1) 2)	x	x 1)	x	x	x 2)	x	x
Data breakpoints	x	x 1) 2)	x 1)	x 1)	x 1)	--	x 2)	--	--
Execution in real time	--	x	x	x	x	x	x	x	x
Zero memory footprint	x	x	x	x	x 8)	x	x	--	--
Simulated interrupts	x	--	--	--	--	--	--	--	--
Real interrupts	--	x	x	x	x	x	x	x	x

Table 3: Driver differences

Feature	Simulator	J-Link/ J-Trace	RDI	Mac-raigor	GDB Server	ST-Link	TI Stellaris FTDI	Angel	IAR ROM-monitor
Interrupt logging	x	x 6)	--	--	--	--	--	--	--
Data logging	--	x 6)	--	--	--	--	--	--	--
Live watch	--	x 4)	--	--	--	--	--	--	--
Cycle counter	x	x 7)	--	--	--	--	--	--	--
Code coverage	x	x 3)	--	--	--	--	--	--	--
Data coverage	x	--	--	--	--	--	--	--	--
Function/instruction profiler	x	x 5)	--	--	--	--	--	--	--
Trace	x	x 5)	x 5)	--	--	--	--	--	--

Table 3: Driver differences (Continued)

1) Limited number, implemented using the ARM EmbeddedICE™ macrocell.
2) Limited number, implemented using the Data watchpoint and trigger unit (for data breakpoints) and the Flash patch and breakpoint unit (for code breakpoints).
3) Supported by J-Trace and J-link with ETB. For Cortex-M devices, J-Link with SWO supports partial code coverage. For detailed information about code coverage, see *Code coverage*, page 213.
4) Supported by Cortex devices. For ARM7/9 devices Live watch is supported if you add a DCC handler to your application. See *Live watch and use of DCC*, page 351.
5) Requires either SWD/SWO interface or ETM trace.
6) Cortex with SWD/SWO.
7) For Cortex-M devices only.
8) Depends on the hardware connection type.

The IAR C-SPY Simulator

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:

1. In the IDE, choose **Project>Options** and click the **Setup** tab in the **Debugger** category.
2. Choose **Simulator** from the **Driver** drop-down list.

The C-SPY J-Link driver

Using the IAR J-Link/J-Trace driver, C-SPY can connect to the IAR J-Link JTAG debug probe and the IAR J-Trace JTAG debug probe. JTAG is a standard on-chip debug connection available on most ARM processors.

Before you can use the J-Link/J-Trace JTAG probe over the USB port, the Segger J-Link/J-Trace USB driver must be installed; see *Installing the J-Link USB driver*, page 38. You can find the driver on the IAR Embedded Workbench for ARM installation CD.

Starting a debug session with the J-Link driver will add the **J-Link** menu to the debugger menu bar. For further information about the menu commands, see *J-Link menu*, page 350.

FEATURES

In addition to the general features of C-SPY, the J-Link driver also provides:

- Execution in real time
- Communication through USB
- Zero memory footprint on the target system
- Use of the two available hardware breakpoints in the ARM core to allow debugging code in non-volatile memory such as flash. Cortex devices have support for six hardware breakpoints
- Direct access to the ARM core watchpoint/DWT registers
- An unlimited number of breakpoints when debugging code in RAM
- A possibility for the debugger to attach to a running application without resetting or halting the target system.

Note: Code coverage is supported by J-Trace and J-Link with ETB. For Cortex-M devices, J-Link with SWO supports partial code coverage. Live watch is supported by the C-SPY J-Link/J-Trace driver for Cortex devices. For ARM7/9 devices it is supported if a DCC handler is added to your application.

COMMUNICATION OVERVIEW

The C-SPY J-Link driver communicates with the JTAG probe over a USB connection. The JTAG probe, in turn, communicates with the JTAG module on the hardware.

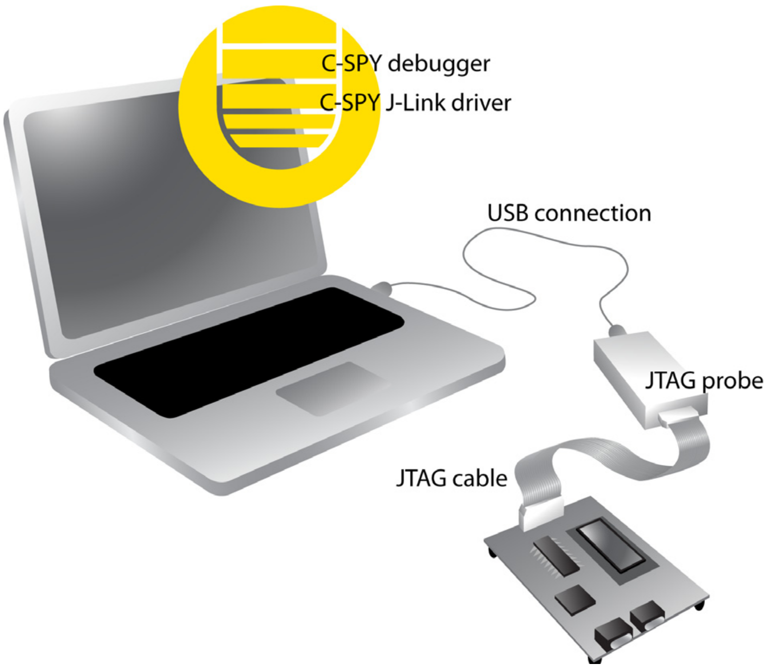


Figure 2: C-SPY J-Link communication overview

INSTALLING THE J-LINK USB DRIVER

Before you can use the J-Link JTAG probe over the USB port, the Segger J-Link USB driver must be installed.

1 Install IAR Embedded Workbench for ARM.

2 Use the USB cable to connect the computer and J-Link. Do not connect J-Link to the target board yet. The green LED on the front panel of J-Link will blink for a few seconds while Windows searches for a USB driver.

Because this is the first time J-Link and the computer are connected, Windows will open a dialog box and ask you to locate the USB driver. The USB driver can be found in the product installation in the `arm\drivers\JLink` directory:

`x86\JLink.inf`, `x64\JLinkx64.inf`

`x86\JLink.sys`, `x64\JLinkx64.sys`

Once the initial setup is completed, you will not have to install the driver again.

Note that J-Link will continuously blink until the USB driver has established contact with the J-Link probe. When contact has been established, J-Link will start with a steady light to indicate that it is connected.

The C-SPY RDI driver

Using the IAR C-SPY RDI driver, C-SPY can connect to an RDI-compliant debug system. This can, for example, be a simulator, a ROM-monitor, a JTAG probe, or an emulator. The IAR C-SPY RDI driver is compliant with the RDI specification 1.5.1.

In this section, an RDI-based connection to a JTAG probe is assumed. JTAG is a standard on-chip debug connection available on most ARM processors.

Before you can use an RDI-based JTAG probe, you must install the RDI driver DLL provided by the JTAG probe vendor.

In the Embedded Workbench IDE, you must then locate the RDI driver DLL file. To do this, choose **Project>Options** and select the **C-SPY Debugger** category. On the **Setup** page, choose **RDI** from the **Driver** drop-down list. On the **RDI** page, locate the RDI driver DLL file using the **Manufacturer RDI Driver** browse button. For more information about the other options available, see *RDI*, page 342. When you have loaded the RDI driver DLL, the **RDI** menu will appear on the Embedded Workbench IDE menu bar. This menu provides a configuration dialog box associated with the selected RDI driver DLL. Note that this dialog box is unique to each RDI driver DLL.

FEATURES

In addition to the general features of the IAR C-SPY Debugger, the RDI driver also provides:

- Execution in real time
- High-speed communication through USB, Ethernet, or the parallel port depending on the RDI-compatible JTAG probe used
- Zero memory footprint on the target system
- Use of the two available hardware breakpoints in the ARM core to allow debugging code in non-volatile memory, such as flash
- An unlimited number of breakpoints when debugging code in RAM
- A possibility for the debugger to attach to a running application without resetting the target system.

Note: Code coverage and live watch are not supported by the C-SPY RDI driver.

COMMUNICATION OVERVIEW

The RDI driver DLL communicates with the JTAG probe over a parallel, serial, Ethernet, or USB connection. The JTAG probe, in turn, communicates with the JTAG module on the hardware.

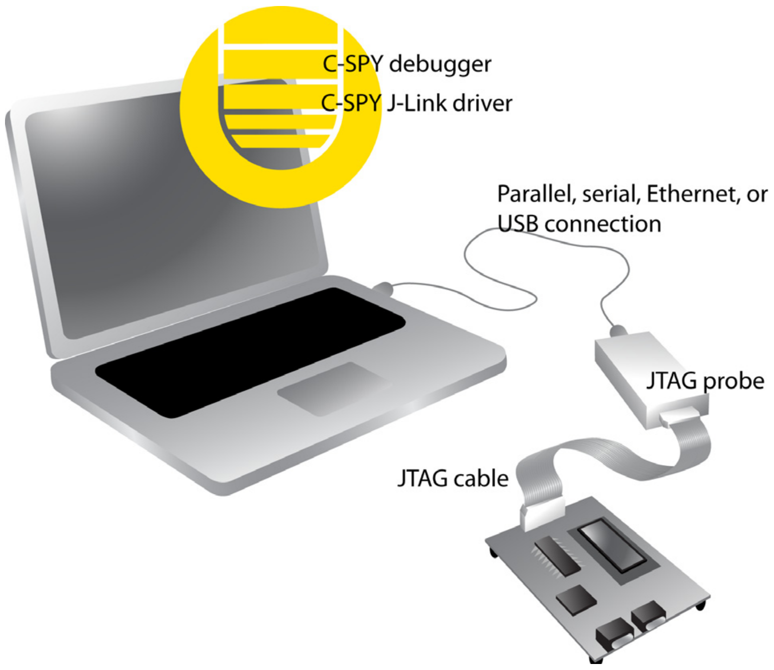


Figure 3: C-SPY RDI communication overview

For further information, see the `rdi_quickstart.html` file, available in the `arm\doc\infocenter` directory, or refer to the manufacturer's documentation.

The C-SPY Macraigor driver

Using the IAR C-SPY Macraigor driver, C-SPY can connect to the Macraigor mpDemon, USB2 Demon, and USB2 Sprite JTAG probes. JTAG is a standard on-chip debug connection available on most ARM processors.

Before you can use Macraigor JTAG probes over the parallel port or the USB port, the Macraigor OCDemon drivers must be installed. You can find the drivers on the IAR Embedded Workbench CD for ARM. This is not needed for serial and Ethernet connections.

Starting a debug session with the Macraigor driver will add the **JTAG** menu to the debugger menu bar. This menu provides commands for configuring JTAG watchpoints, and setting breakpoints on exception vectors (also known as *vector catch*). For further information about the menu commands, see *Macraigor JTAG menu*, page 353.

FEATURES

In addition to the general features of the IAR C-SPY Debugger, the Macraigor JTAG driver also provides:

- Execution in real time
- Communication through the Ethernet or USB
- Zero memory footprint on the target system
- Use of the two available hardware breakpoints in the ARM core to allow debugging code in non-volatile memory such as flash
- Direct access to the ARM core watchpoint registers
- An unlimited number of breakpoints when debugging code in RAM
- A possibility for the debugger to attach to a running application without resetting the target system.

Note: Code coverage and live watch are not supported by the C-SPY Macraigor JTAG driver.

COMMUNICATION OVERVIEW

The C-SPY Macraigor driver communicates with the JTAG probe over a USB or Ethernet connection. The JTAG probe, in turn, communicates with the JTAG module on the hardware.

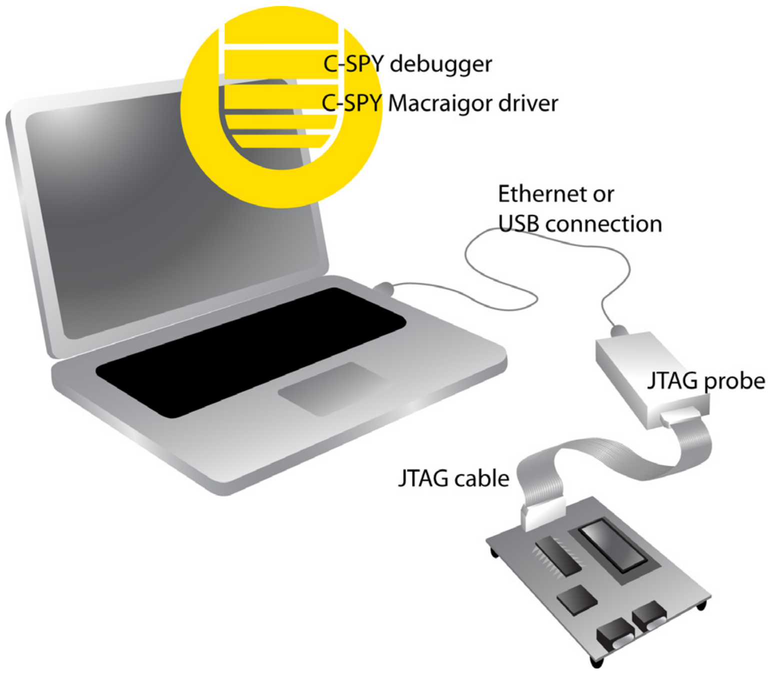


Figure 4: C-SPY Macraigor communication overview

The C-SPY GDB Server driver

Using the IAR GDB Server driver, C-SPY can connect to the available GDB Server-based JTAG solutions, currently Open OCD with STR9-comStick. JTAG is a standard on-chip debug connection available on most ARM processors.

To use any of the GDB server-based JTAG solutions, you must configure the hardware and the software drivers involved; see *Configuring the OpenOCD Server*, page 44.

Starting a debug session with the C-SPY GDB Server driver will add the **GDB Server** menu to the debugger menu bar. For further information about the menu commands, see *GDB Server menu*, page 349.

FEATURES

In addition to the general features of the IAR C-SPY Debugger, the GDB Server driver (through OpenOCD) also provides:

- Support for STR9, Cortex-M, and other devices
- Execution in real time
- Communication through USB
- Zero memory footprint on the target system
- Use of the two or six available hardware breakpoints, for ARM7/9 or Cortex devices respectively
- An unlimited number of breakpoints when debugging code in RAM.

Note: Code coverage and live watch are not supported by the GDB Server driver.

COMMUNICATION OVERVIEW

The C-SPY GDB Server driver communicates with the GDB Server via an Ethernet connection, and the GDB Server communicates with the JTAG probe over a USB connection. The JTAG probe, in turn, communicates with the JTAG module on the hardware.

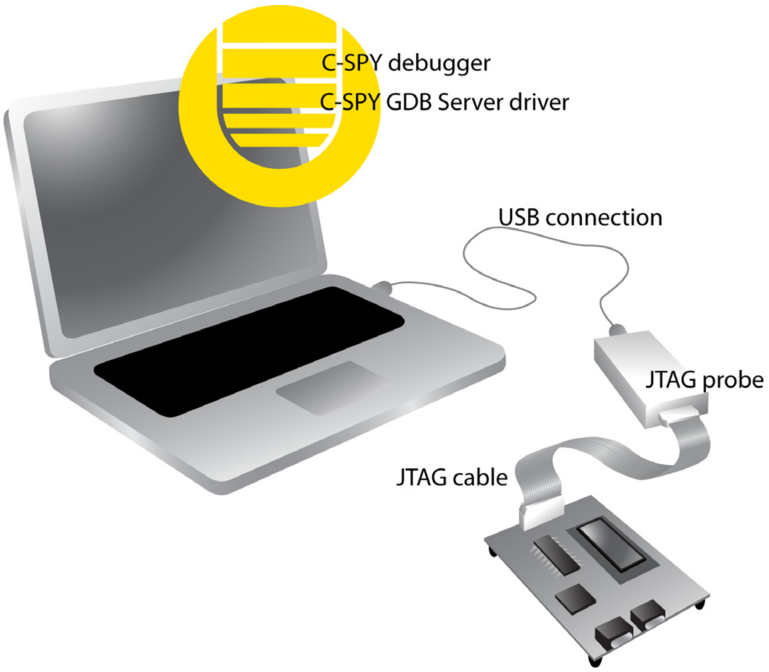


Figure 5: C-SPY GDB Server communication overview

CONFIGURING THE OPENOCD SERVER

For further information, see the `gdbserv_quickstart.html` file, available in the `arm\doc\infocenter` directory, or refer to the manufacturer's documentation.

The C-SPY ST-LINK driver

Using the IAR C-SPY ST-LINK driver, C-SPY can connect to the ST-LINK JTAG probe. JTAG is a standard on-chip debug connection available on most ARM processors.

USB drivers for the ST-LINK JTAG probe are automatically installed on the host computer when you connect the ST-LINK JTAG probe for the first time. Normally, you do not have to do anything else.

FEATURES

In addition to the general features of the IAR C-SPY Debugger, the ST-LINK driver also provides:

- Support for ST Cortex-M devices
- Execution in real time
- Communication through USB
- Zero memory footprint on the target system
- Use of the six available hardware breakpoints
- An unlimited number of breakpoints when debugging code in RAM.

Note: Code coverage and live watch are not supported by the ST-LINK driver.

COMMUNICATION OVERVIEW

The C-SPY ST-LINK driver communicates with the JTAG probe over a USB connection. The JTAG probe, in turn, communicates with the JTAG module on the hardware.

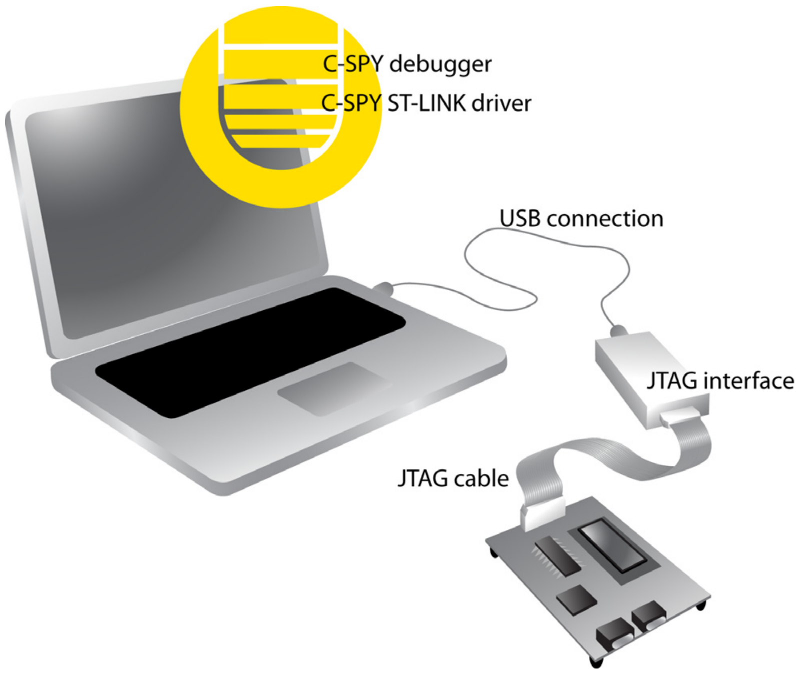


Figure 6: C-SPY ST-LINK communication overview

For more information about the C-SPY environment when using the ST-LINK driver, see *ST-LINK menu*, page 355.

The C-SPY TI Stellaris FTDI driver

Using the IAR C-SPY TI Stellaris FTDI driver, C-SPY can connect to the TI Stellaris FTDI onboard JTAG interface for Cortex-M devices.

Before you can use the FTDI JTAG interface over the USB port, the FTDI USB driver must be installed. You can find the driver on the IAR Embedded Workbench for ARM installation CD.

Starting a debug session with the FTDI driver will add the **TI Stellaris FTDI** menu to the debugger menu bar. For further information about the menu commands, see *TI Stellaris FTDI menu*, page 353.

FEATURES

In addition to the general features of the IAR C-SPY Debugger, the TI Stellaris FTDI driver also provides:

- Support for TI Stellaris FTDI Cortex-M devices
- Execution in real time
- Communication through USB
- Zero memory footprint on the target system
- Use of the six available hardware breakpoints
- An unlimited number of breakpoints when debugging code in RAM.

Note: Code coverage is not supported by the TI Stellaris FTDI driver. Live watch is supported.

COMMUNICATION OVERVIEW

The C-SPY TI Stellaris FTDI driver communicates via USB with the FTDI JTAG interface chip on the hardware. The FTDI JTAG interface, in turn, is connected to the JTAG port of the microcontroller.

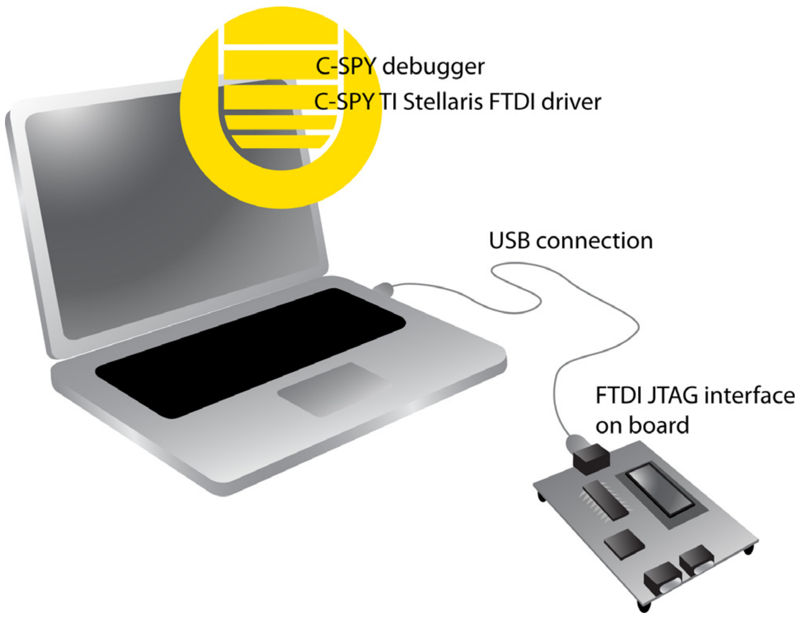


Figure 7: C-SPY TI Stellaris FTDI communication overview

INSTALLING THE FTDI USB DRIVER

Before you can use the TI Stellaris FTDI JTAG interface over the USB port, the FTDI USB driver must be installed.

1 Install IAR Embedded Workbench for ARM.

2 Use the USB cable to connect the computer to the TI board.

Because this is the first time FTDI and the computer are connected, Windows will open a dialog box and ask you to locate the USB driver. The USB driver can be found in the product installation in the `arm\drivers\StellarisFTDI` directory.

Once the initial setup is completed, you will not have to install the driver again.

The C-SPY Angel debug monitor driver

Using the IAR Angel debug monitor driver, you can communicate with any device compliant with the Angel debug monitor protocol. In most cases these are evaluation boards. When connecting to an evaluation board, the Angel firmware will run in parallel with your application software.

The rest of this section assumes the Angel connection is made to an evaluation board.

FEATURES

In addition to the general features of the IAR C-SPY Debugger, the Angel debug monitor driver also provides:

- Execution in real time
- Communication through the serial port or Ethernet
- Support for all Angel equipped evaluation boards.

Note: Code coverage and live watch are not supported by the C-SPY Angel debug monitor driver.

COMMUNICATION OVERVIEW

The evaluation board contains firmware (the Angel debug monitor itself) that runs in parallel with your application software. The firmware receives commands from the IAR C-SPY debugger over a serial port or Ethernet connection, and controls the execution of your application.

Using the Angel protocol, C-SPY can connect to a target system equipped with an Angel monitor in flash. This is an inexpensive solution to debug a target, because only a serial cable is needed.

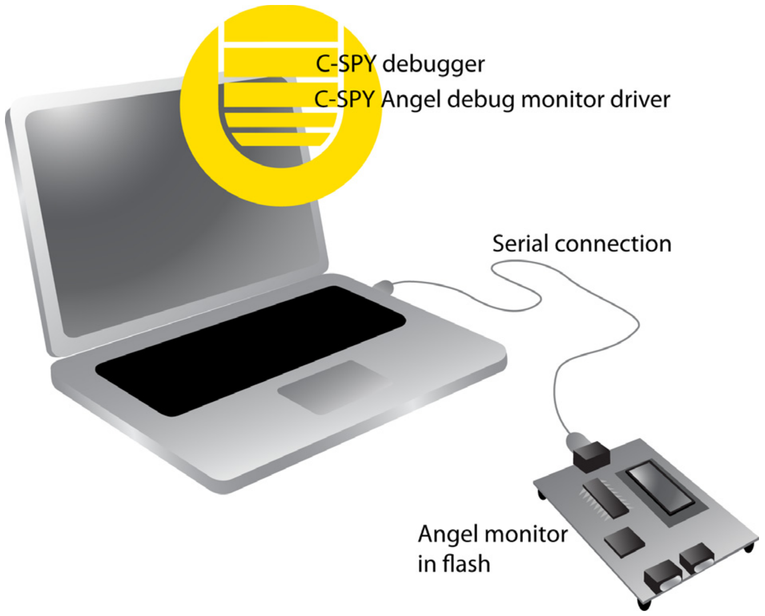


Figure 8: C-SPY Angel debug monitor communication overview

All the parts of your code that you want to debug must be located in RAM. The only way you can set breakpoints and step in your application code is to download it into RAM.

For further information, see the `angel_quickstart.html` file, available in the `arm\doc\infocenter` directory, or refer to the manufacturer's documentation.

The C-SPY IAR ROM-monitor driver

Using the IAR ROM-monitor driver, C-SPY can connect to the Analog Devices ADuC7xxx boards and the IAR Kickstart Card for Philips LPC210x. Most ROM-monitors require that the code that you want to debug is located in RAM, because the only way you can set breakpoints and step in your application code is to download it to RAM. For some ROM-monitors, for example for Analog Devices ADuC7xxx, the code that you want to debug can be located in flash memory. To maintain debug functionality, the ROM-monitor might simulate some instructions, for example when single stepping.

FEATURES FOR ANALOG DEVICES EVALUATION BOARDS

In addition to the general features of the IAR C-SPY Debugger, the ROM-monitor driver also provides:

- Execution in real time
- Communication through the serial port
- Support for the Analog Devices ADuC7xxx evaluation board
- Download and debug in flash memory
- An unlimited number of breakpoints in both flash memory and RAM.

Note: Code coverage and live watch are not supported by the C-SPY ROM-monitor driver.

FEATURES FOR IAR KICKSTART CARD FOR PHILIPS LPC210X

In addition to the general features of the IAR C-SPY Debugger, the ROM-monitor driver also provides:

- Execution in real time
- Communication through the RS232 serial port
- Support for the IAR Kickstart Card for Philips LPC210x.

Note: Code coverage and live watch are not supported by the C-SPY ROM-monitor driver.

COMMUNICATION OVERVIEW

The boards contain firmware (the ROM-monitor itself) that runs in parallel with your application software. The firmware receives commands from the IAR C-SPY debugger over a serial port, and controls the execution of your application.

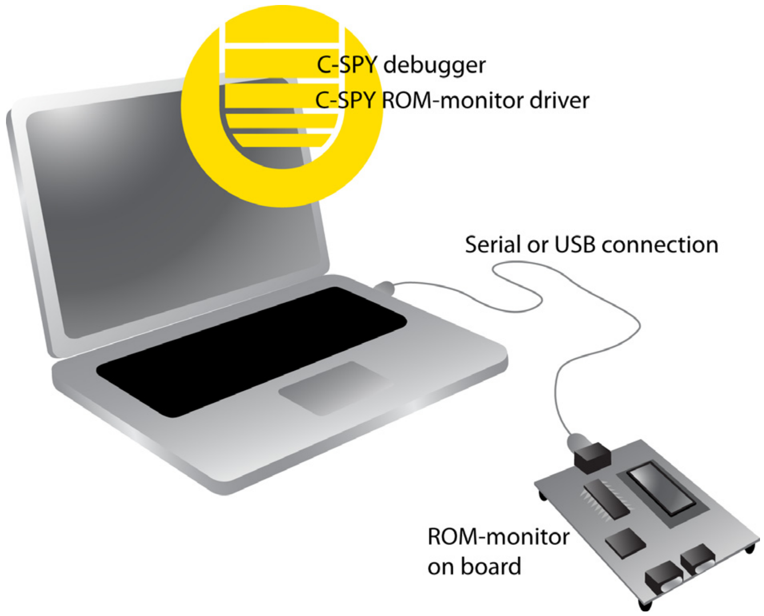


Figure 9: C-SPY ROM-monitor communication overview

For further information, see the `iar_rom_quickstart.html` file, available in the `arm\doc\infocenter` directory, or refer to the manufacturer's documentation.

Getting started using C-SPY

This chapter helps you get started using C-SPY®. More specifically, this means:

- Setting up C-SPY
- Starting C-SPY
- Adapting for target hardware
- An overview of the debugger startup
- Running example projects
- Reference information on starting C-SPY.

Setting up C-SPY

This section describes the steps involved for setting up C-SPY.

More specifically, you will get information about:

- Setting up for debugging
- Executing from reset
- Using a setup macro file
- Selecting a device description file
- Loading plugin modules.

SETTING UP FOR DEBUGGING

1. Before you start C-SPY, choose **Project>Options>Debugger>Setup** and select the C-SPY driver that matches your debugger system: simulator or a hardware debugger system.

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

2. In the **Category** list, select the appropriate C-SPY driver and make your settings.

   For information about these options, see *Debugger options*, page 323.

3 Click **OK**.

4 Choose **Tools>Options>Debugger** to configure:

- The debugger behavior
- The debugger's tracking of stack usage.

For further information about these options, see Debugger options in *IDE Project Management and Building Guide for ARM®*.

The following documents containing information about how to set up various debugging systems are available in the `arm\doc\infocenter` subdirectory:

File	Debugger system
`rdi_quickstart.html`	Quickstart reference for RDI-controlled JTAG debug interfaces
`gdbserver_quickstart.html`	Quickstart reference for a GDB Server using OpenOCD together with STR9-comStick
`angel_quickstart.html`	Quickstart reference for Angel ROM-monitors and JTAG interfaces
`iar_rom_quickstart.html`	Quickstart reference for IAR ROM-monitor

Table 4: Available quickstart reference information

See also *Adapting for target hardware*, page 58.

EXECUTING FROM RESET

The **Run to** option—available on the **Debugger>Setup** page—specifies 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 temporary 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 contain the regular hardware reset address at each reset. The reset address is set by C-SPY.

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.

USING A SETUP MACRO FILE

A setup macro file is a 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.

For detailed information about setup macro files and functions, see *Briefly about setup macro functions and files, page 244*. For an example about how to use a setup macro file, see the chapter *Initializing target hardware before C-SPY starts*, page 59.

To register a setup macro file:

1 Before you start C-SPY, choose **Project>Options>Debugger>Setup**.

2 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.

SELECTING A DEVICE DESCRIPTION FILE

C-SPY uses device description files to handle device-specific information. Device description files can be of two different formats—IAR-specific device description files or CMSIS System View Description files (SVD).

A default device description file is automatically used based on your project settings. If you want to override the default file, you must select your device description file. IAR-specific device description files are provided in the `arm\config` directory and they have the filename extension `ddf`.

For more information about device description files, see *Adapting for target hardware*, page 58.

To override the default device description file:

1 Before you start C-SPY, choose **Project>Options>Debugger>Setup**.

2 Enable the use of a device description file and select a file using the **Device description file** browse button.

LOADING PLUGIN MODULES

On the **Plugins** page you can specify C-SPY plugin modules to load and make 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 more information, see *Plugins*, page 329.

Starting C-SPY

When you have set up the debugger, you are ready to start a debug session; this section describes the steps involved.

More specifically, you will get information about:

- Starting the debugger
- Loading executable files built outside of the IDE
- Starting a debug session with source files missing
- Loading multiple images.

STARTING THE DEBUGGER

You can choose to start the debugger with or without loading the current project.

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**.

LOADING 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 load an externally built executable file and to set build options you must first create a project for it in your workspace.

To create a project for an externally built file:

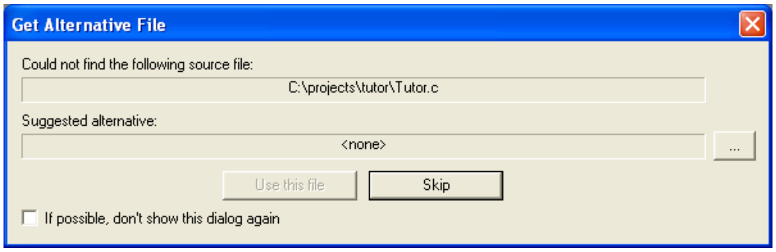
1. Choose **Project>Create New Project**, and specify a project name.
2. To add the executable file to the project, choose **Project>Add Files** and make sure to choose **All Files** in the **Files of type** drop-down list. Locate the executable file.
3. To start the executable file, click the **Download and 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.

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:


Get Alternative File

Could not find the following source file:

C:\projects\tutor\Tutor.c

Suggested alternative:

<none>

Figure 10: Get Alternative File dialog box

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 file 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.

For more information, see *Get Alternative File dialog box*, page 73.

LOADING MULTIPLE IMAGES

Normally, a debuggable application consists of exactly one file that you debug. However, you can also load additional debug files (images). 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.

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.

To load additional images at C-SPY startup:

1 Choose **Project>Options>Debugger>Images** and specify up to three additional images to be loaded. For more information, see *Images*, page 328.

2 Start the debug session.

To load additional images at a specific moment:

Use the `__loadImage` system macro and execute it using either one of the methods described in *Procedures for using C-SPY macros*, page 246.

To display a list of loaded images:

Choose **Images** from the **View** menu. The Images window is displayed, see *Images window*, page 72.

Adapting for target hardware

This section provides information about how to describe the target hardware to C-SPY, and how you can make C-SPY initialize the target hardware before your application is downloaded to memory.

More specifically, you will get information about:

- Modifying a device description file
- Initializing target hardware before C-SPY starts
- Remapping memory.

MODIFYING A DEVICE DESCRIPTION FILE

C-SPY uses device description files provided with the product to handle several of the target-specific adaptations, see *Selecting a device description file*, page 55. They contain device-specific information such as:

- Definitions of registers in peripheral units and groups of these
- Interrupt definitions (for Cortex-M devices only).

Normally, you do not need to modify the device description file. However, if the predefinitions are not sufficient for some reason, you can edit the file. The syntax is described in the files. Note, however, that the format of these descriptions might be updated in future upgrade versions of the product.

Make a copy of the device description file that best suits your needs, and modify it according to the description in the file.

Note: The syntax of the device description files is described in the *Writing device header files* guide (`EWARM_DDFFormat.pdf`) located in the `arm\doc` directory.

For information about how to load a device description file, see *Selecting a device description file*, page 55.

INITIALIZING TARGET HARDWARE BEFORE C-SPY STARTS

If your hardware uses external memory that must be enabled before code can be downloaded to it, C-SPY needs a macro to perform this action before your application can be downloaded. For example:

1. Create a new text file and define your macro function. For example, a macro that enables external SDRAM might look like this:

```
/* Your macro function. */
enableExternalSDRAM()
{
  __message "Enabling external SDRAM\n";
  __writeMemory32( /* Place your code here. */ );
  /* And more code here, if needed. */
}

/* Setup macro determines time of execution. */
execUserPreload()
{
  enableExternalSDRAM();
}
```

   Because the built-in `execUserPreload` setup macro function is used, your macro function will be executed directly after the communication with the target system is established but before C-SPY downloads your application.

2. Save the file with the filename extension `mac`.

3. Before you start C-SPY, choose **Project>Options>Debugger** and click the **Setup** tab.

4. Select the option **Use Setup file** and choose the macro file you just created.

   Your setup macro will now be loaded during the C-SPY startup sequence.

REMAPPING MEMORY

A common feature of many ARM-based processors is the ability to remap memory. After a reset, the memory controller typically maps address zero to non-volatile memory, such as flash. By configuring the memory controller, the system memory can be remapped to place RAM at zero and non-volatile memory higher up in the address map. By doing this, the exception table will reside in RAM and can be easily modified when you download code to the target hardware.

You must configure the memory controller before you download your application code. You can do this best by using a C-SPY macro function that is executed before the code download takes place—`execUserPreload()`. The macro function `__writeMemory32()` will perform the necessary initialization of the memory controller.

The following example illustrates a macro used for setting up the memory controller and remapping memory on the Atmel AT91EB55 chip, similar mechanisms exist in processors from other ARM vendors.

```
execUserPreload()
{
  __message "Setup memory controller, do remap command\n";

  // Flash at 0x01000000, 16MB, 2 hold, 16 bits, 3 WS
  __writeMemory32(0x01002529, 0xffe00000, "Memory");

  // RAM   at 0x02000000, 16MB, 0 hold, 16 bits, 1 WS
  __writeMemory32(0x02002121, 0xffe00004, "Memory");

  // unused
  __writeMemory32(0x20000000, 0xffe00008, "Memory");

  // unused
  __writeMemory32(0x30000000, 0xffe0000c, "Memory");

  // unused
  __writeMemory32(0x40000000, 0xffe00010, "Memory");

  // unused
  __writeMemory32(0x50000000, 0xffe00014, "Memory");

  // unused
  __writeMemory32(0x60000000, 0xffe00018, "Memory");

  // unused
  __writeMemory32(0x70000000, 0xffe0001c, "Memory");
  // REMAP command
  __writeMemory32(0x00000001, 0xffe00020, "Memory");

  // standard read
  __writeMemory32(0x00000006, 0xffe00024, "Memory");
}
```

Note that the setup macro `execUserReset()` might have to be defined in the same way to reinitialize the memory mapping after a C-SPY reset. This can be needed if you have set up your hardware debugger system to do a hardware reset on C-SPY reset, for example by adding `__hwReset()` to the `execUserReset()` macro.

For instructions on how to install a macro file in C-SPY, see *Registering and executing using setup macros and setup files*, page 248. For details about the macro functions used, see *Reference information on C-SPY system macros*, page 257.

An overview of the debugger startup

To make it easier to understand and follow the startup flow, the following figures show the flow of actions performed by C-SPY, and by the target hardware, as well as the execution of any predefined C-SPY setup macros. There is one figure for debugging code located in flash and one for debugging code located in RAM.

To read more about C-SPY system macros, see the chapter *Using C-SPY macros* available in this guide.

DEBUGGING CODE IN FLASH

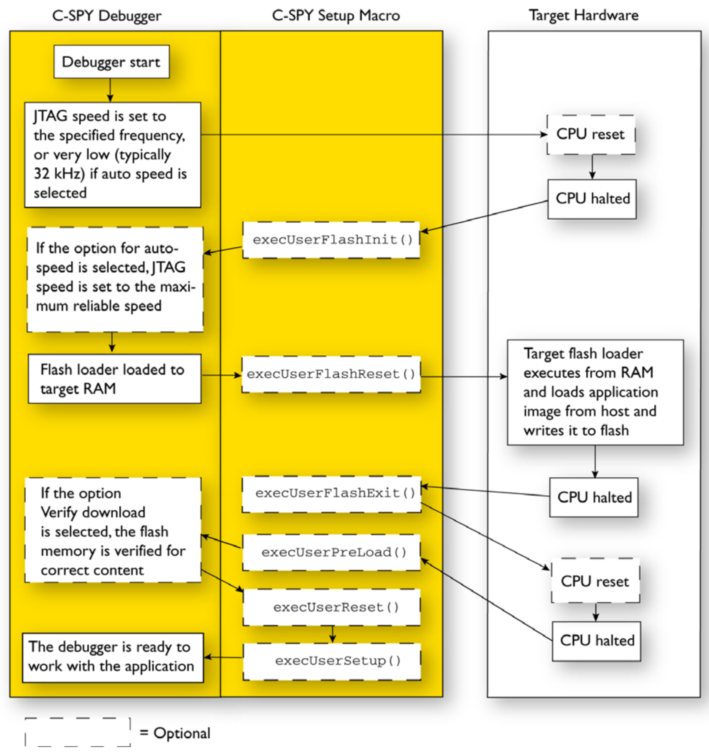

C-SPY Debugger
C-SPY Setup Macro
Target Hardware
Debugger start
JTAG speed is set to the specified frequency, or very low (typically 32 kHz) if auto speed is selected
CPU reset
CPU halted
execUserFlashInit()
If the option for auto-speed is selected, JTAG speed is set to the maximum reliable speed
Flash loader loaded to target RAM
execUserFlashReset()
Target flash loader executes from RAM and loads application image from host and writes it to flash
execUserFlashExit()
CPU halted
If the option Verify download is selected, the flash memory is verified for correct content
execUserPreLoad()
CPU reset
execUserReset()
CPU halted
The debugger is ready to work with the application
execUserSetup()
= Optional

Figure 11: Debugger startup when debugging code in flash

DEBUGGING CODE IN RAM

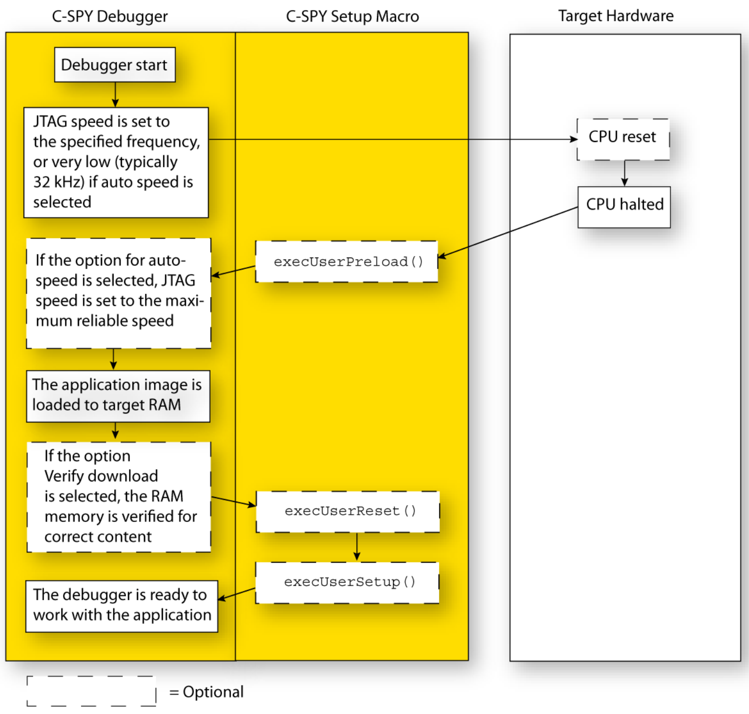

C-SPY Debugger
C-SPY Setup Macro
Target Hardware
Debugger start
JTAG speed is set to the specified frequency, or very low (typically 32 kHz) if auto speed is selected
CPU reset
CPU halted
execUserPreload()
If the option for auto-speed is selected, JTAG speed is set to the maximum reliable speed
The application image is loaded to target RAM
If the option Verify download is selected, the RAM memory is verified for correct content
execUserReset()
execUserSetup()
The debugger is ready to work with the application
= Optional

Figure 12: Debugger startup when debugging code in RAM

Running example projects

IAR Embedded Workbench comes with example applications. You can use these examples to get started using the development tools from IAR Systems or simply to verify that contact has been established with your target board. You can also use the examples as a starting point for your application project.

You can find the examples in the `arm\examples` directory. The examples are ready to be used as is. They are supplied with ready-made workspace files, together with source code files and all other related files.

RUNNING AN EXAMPLE PROJECT

To run an example project:

1 Choose **Help>Information Center** and click **EXAMPLE PROJECTS**.

2 Browse to the example that matches the specific evaluation board or starter kit you are using.

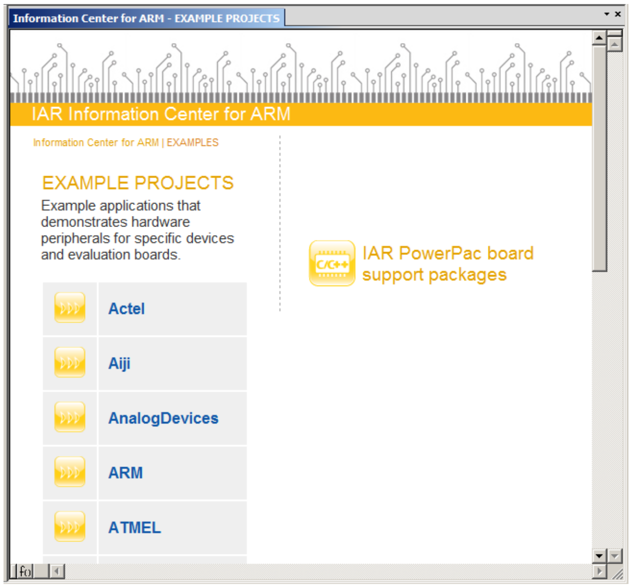

Information Center for ARM - EXAMPLE PROJECTS
IAR Information Center for ARM
Information Center for ARM | EXAMPLES
EXAMPLE PROJECTS
Example applications that demonstrates hardware peripherals for specific devices and evaluation boards.
Actel
Aiji
AnalogDevices
ARM
ATMEL
IAR PowerPac board support packages

Figure 13: Example applications

Click the **Open Project** button.

3 In the dialog box that appears, choose a destination folder for your project location. Click **Select** to confirm your choice.

4 The available example projects are displayed in the workspace window. Select one of the projects, and if it is not the active project (highlighted in bold), right-click it and choose **Set As Active** from the context menu.

5 To view the project settings, select the project and choose **Options** from the context menu. Verify the settings for **General Options>Target>Processor variant** and **Debugger>Setup>Driver**. As for other settings, the project is set up to suit the target system you selected.

For further details about the C-SPY options and how to configure C-SPY to interact with the target board, see *Debugger options*, page 323.

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

6 To compile and link the application, choose **Project>Make** or click the **Make** button.

7 To start C-SPY, choose **Project>Debug** or click the **Download and Debug** button.

8 Choose **Debug>Go** or click the **Go** button to start the application.

Click the **Stop** button to stop execution.

Reference information on starting C-SPY

This section gives reference information about these windows and dialog boxes:

- *C-SPY Debugger main window*, page 65
- *Images window*, page 72
- *Get Alternative File dialog box*, page 73

For related information, see:

- Tools options for the debugger in the *IDE Project Management and Building Guide for ARM®*.

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, often referred to as the ***Driver menu*** in this documentation. Typically, this menu contains menu commands for opening driver-specific windows and dialog boxes.
- A special debug toolbar
- Several windows and dialog boxes specific to C-SPY.

The C-SPY main window might look different depending on which components of the product installation you are using.

Menu bar

These menus are available when C-SPY is running:

Debug	Provides commands for executing and debugging the source application; see *Disassembly menu*, page 70. Most of the commands are also available as icon buttons on the debug toolbar.
Disassembly	Provides commands for controlling the disassembly processor mode; see *Disassembly menu*, page 70.
Simulator	Provides access to the dialog boxes for setting up interrupt simulation and memory access checking. This menu is only available when the C-SPY Simulator is used; see *Simulator menu*, page 348.
GDB Server	Provides commands specific to the C-SPY GDB Server driver. This menu is only available when the driver is used; see *GDB Server menu*, page 349.
J-Link	Provides commands specific to the C-SPY J-Link driver. This menu is only available when the driver is used; see *J-Link menu*, page 350.
TI Stellaris FTDI	Provides commands specific to the C-SPY TI Stellaris FTDI driver. This menu is only available when the driver is used; see *TI Stellaris FTDI menu*, page 353.
JTAG	Provides commands specific to the C-SPY Macraigor driver. This menu is only available when the driver is used; see *Macraigor JTAG menu*, page 353.
RDI	Provides commands specific to the C-SPY RDI driver. This menu is only available when the driver is used; see *RDI menu*, page 354.
ST-LINK	Provides commands specific to the C-SPY ST-LINK driver. This menu is only available when the driver is used; see *ST-LINK menu*, page 355.

Debug menu

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.

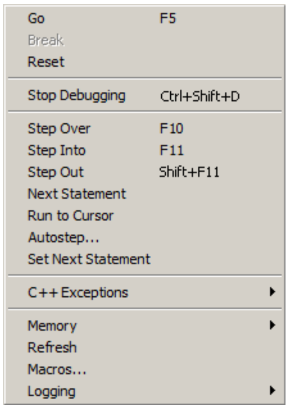


Figure 14: Debug menu

These commands are available:

Go F5	Executes from the current statement or instruction until a breakpoint or program exit is reached.
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, or function call, 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 a dialog box where you can customize and perform autostepping; see *Autostep settings dialog box*, page 91.
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.
C++ Exceptions> Break on Throw	Specifies that the execution shall break when the target application executes a `throw` statement. To use this feature, your application must be built with the option **Library low-level interface implementation** selected.
C++ Exceptions> Break on Uncaught Exception	Specifies that the execution shall break when the target application throws an exception that is not caught by any matching `catch` statement. To use this feature, your application must be built with the option **Library low-level interface implementation** selected.
Memory>Save	Displays a dialog box where you can save the contents of a specified memory area to a file, see *Memory Save dialog box*, page 148.
Memory>Restore	Displays a 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 149.
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 a dialog box where you can list, register, and edit your macro files and functions; see *Using the Macro Configuration dialog box*, page 247.

Logging>Set Log file	Displays a dialog box where you can choose to log the contents of the Debug Log window 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. See *Log File dialog box*, page 90.
Logging> Set Terminal I/O Log file	Displays a dialog box where you can choose to log simulated target access communication to a file. You can select the destination of the log file. See *Terminal I/O Log File dialog box*, page 88.

Disassembly menu

The **Disassembly** menu is available when C-SPY is running. This menu provides commands for executing and debugging the source application. Most of the commands are also available as icon buttons on the debug toolbar.

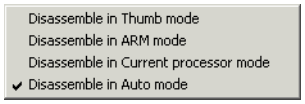

Disassemble in Thumb mode
Disassemble in ARM mode
Disassemble in Current processor mode
✓ Disassemble in Auto mode

Figure 15: Disassembly menu

Use the commands on the menu to select which disassembly mode to use.

Note: After changing disassembly mode, use the **Refresh** command on the **Debug** menu to refresh the view of the Disassembly window contents.

These commands are available:

Disassemble in Thumb mode	Disassembles your application in Thumb mode.
Disassemble in ARM mode	Disassembles your application in ARM mode.
Disassemble in Current processor mode	Disassembles your application in the current processor mode.
Disassemble in Auto mode	Disassembles your application in automatic mode. This is the default option.

See also *Disassembly window*, page 81.

C-SPY windows

These windows specific to C-SPY are available when C-SPY is running:

- C-SPY Debugger main window
- Disassembly window
- Memory window
- Symbolic Memory window
- Register window
- Watch window
- Locals window
- Auto window

- Live Watch window
- Quick Watch window
- Statics window
- Call Stack window
- Terminal I/O window
- Code Coverage window
- Function Profiler window
- Images window
- Stack window
- Symbols window.

Additional windows are available depending on which C-SPY driver you are using.

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:

Enter	Makes an item editable and saves the new value.
Esc	Cancels a new value.

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:

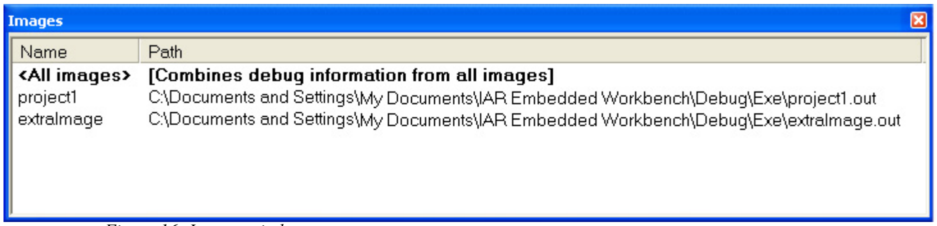
```
myArray;3
```

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
```

Images window

The Images window is available from the **View** menu.



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 16: Images window

The Images window lists all currently loaded images (debug files).

Normally, a source application consists of exactly one image that you debug. However, you can also load additional images. This means that the complete debuggable unit consists of several images.

Display area

This area lists the loaded images in these columns:

Name	The name of the loaded image.
Path	The path to the loaded image.

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.

Context menu

This context menu is available:

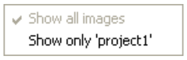


Figure 17: Images window context menu

These commands are available:

Show all images	Shows debug information for all loaded debug images.
Show only *image*	Shows debug information for the selected debug image.

Related information

For related information, see:

- *Loading multiple images*, page 57
- *Images*, page 328
- *__loadImage*, page 273.

Get Alternative File dialog box

The **Get Alternative File** dialog box is displayed if C-SPY cannot automatically find the source files to be loaded, for example if the application was built on another computer.

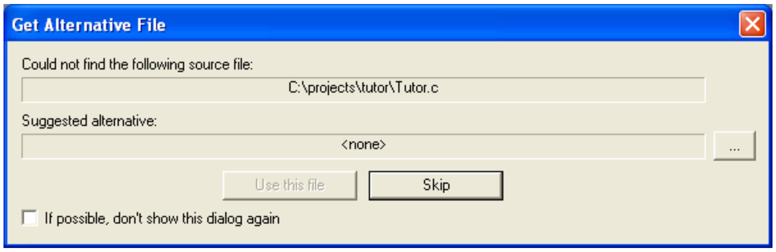

Get Alternative File
Could not find the following source file:
C:\projects\tutor\Tutor.c
Suggested alternative:
<none>
...
Use this file
Skip
If possible, don't show this dialog again

Figure 18: Get Alternative File dialog box

Could not find the following source file

The missing source file.

Suggested alternative

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.

Skip

C-SPY will assume that the source file is not available for this debug session.

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.

Related information

For related information, see *Starting a debug session with source files missing*, page 57.

Executing your application

This chapter contains information about executing your application in C-SPY®. More specifically, this means:

- Introduction to application execution
- Reference information on application execution.

Introduction to application execution

This section covers these topics:

- Briefly about application execution
- Source and disassembly mode debugging
- Single stepping
- Running the application
- Highlighting
- Call stack information
- Terminal input and output
- Debug logging.

BRIEFLY ABOUT APPLICATION EXECUTION

C-SPY allows you to monitor and control the execution of your application. By single-stepping through it, and setting breakpoints, you can examine details about the application execution, for example the values of variables and registers. You can also use the call stack to step back and forth in the function call chain.

The terminal I/O and debug log features let you interact with your application.

You can find commands for execution on the **Debug** menu and on the toolbar.

SOURCE AND DISASSEMBLY MODE DEBUGGING

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

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 of the application code. 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 machine instruction at a time.

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

SINGLE STEPPING

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**.

Using the **Autostep settings** dialog box, you can automate the single stepping. For more information, see *Autostep settings dialog box*, page 91.

If your application contains an exception that is caught outside the code which would normally be executed as part of a step, C-SPY terminates the step at the `catch` statement.

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

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

Step Into

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, `g(n-1)`:

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

Step Over

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 `g(n-2)` function call, which is not a statement on its own but part of the same statement as `g(n-1)`. Thus, you can skip uninteresting calls which are parts of statements and instead focus on critical parts:

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

Next Statement

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

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

Step Out

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:

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

RUNNING THE APPLICATION

Go

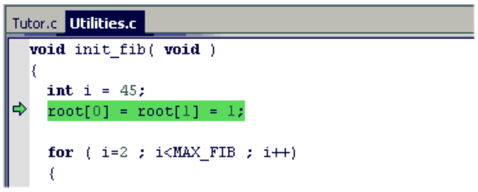
The **Go** command continues execution from the current position until a breakpoint or program exit is reached.

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 windows was last active.



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

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

Figure 19: 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.

CALL STACK INFORMATION

The compiler generates extensive backtrace information. This allows C-SPY to show, without any runtime penalty, the complete function 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 in parameters, thus locating the function in the call chain where the problem occurred.

The Call Stack window shows a list of function calls, with the current function at the top. When you inspect a function in the call chain, 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 (---).

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 to execute to that function.

Assembler source code does not automatically contain any backtrace information. To see the call chain also for your assembler modules, you can add the appropriate `CFI` assembler directives to the assembler source code. For further information, see the *ARM® 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 lets you enter input to your application, and display output from it. You can also direct terminal I/O to a file, using the **Terminal I/O Log Files** dialog box.

This facility is useful in two different contexts:

- If your application uses `stdin` and `stdout`
- For producing debug trace printouts.

For reference information, see *Terminal I/O window*, page 87 and *Terminal I/O Log File dialog box*, page 88.

DEBUG LOGGING

The Debug Log window displays debugger output, such as diagnostic messages, macro-generated output, event log messages, and information about trace.

It can sometimes be convenient to log the information to a file where you can easily inspect it. 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, which breakpoints that have been triggered etc.

Reference information on application execution

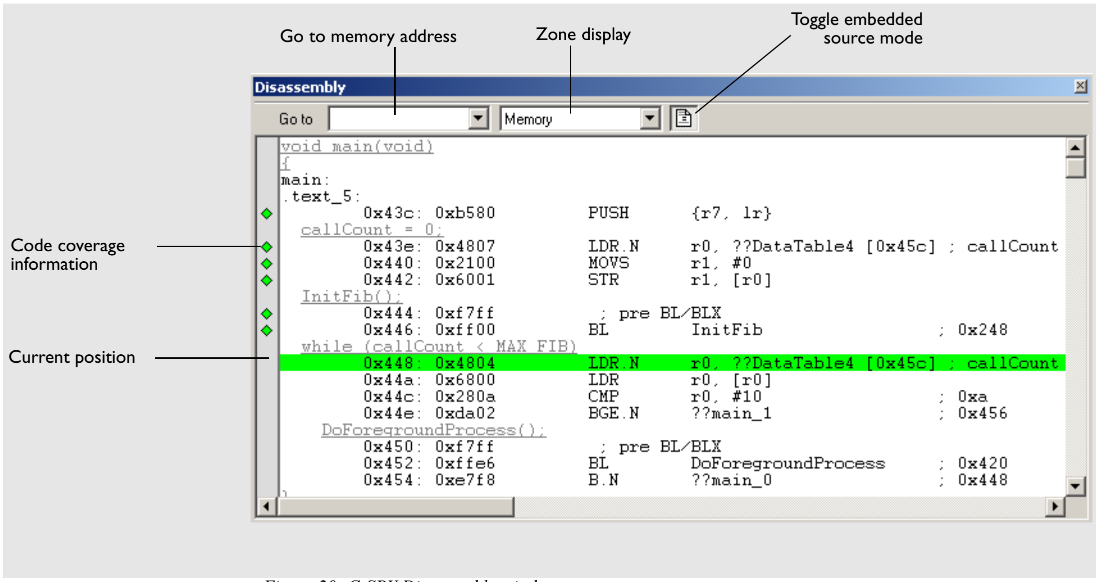
This section gives reference information about these windows and dialog boxes:

- *Disassembly window*, page 81
- *Call Stack window*, page 85
- *Terminal I/O window*, page 87
- *Terminal I/O Log File dialog box*, page 88
- *Debug Log window*, page 89
- *Log File dialog box*, page 90
- *Autostep settings dialog box*, page 91.

For related information, see Terminal I/O options in *IDE Project Management and Building Guide for ARM®*.

Disassembly window

The C-SPY Disassembly window is available from the **View** menu.



```
void main(void)
{
main:
.text_5:
        0x43c: 0xb580        PUSH      {r7, lr}
  callCount = 0;
        0x43e: 0x4807        LDR.N     r0, ??DataTable4 [0x45c] ; callCount
        0x440: 0x2100        MOVS      r1, #0
        0x442: 0x6001        STR       r1, [r0]
  InitFib();
        0x444: 0xf7ff         ; pre BL/BLX
        0x446: 0xff00        BL        InitFib                  ; 0x248
  while (callCount < MAX_FIB)
        0x448: 0x4804        LDR.N     r0, ??DataTable4 [0x45c] ; callCount
        0x44a: 0x6800        LDR       r0, [r0]
        0x44c: 0x280a        CMP       r0, #10                  ; 0xa
        0x44e: 0xda02        BGE.N     ??main_1                 ; 0x456
    DoForegroundProcess();
        0x450: 0xf7ff         ; pre BL/BLX
        0x452: 0xffe6        BL        DoForegroundProcess      ; 0x420
        0x454: 0xe7f8        B.N       ??main_0                 ; 0x448
```

Figure 20: C-SPY Disassembly window

This window shows the application being debugged as disassembled application code.

To change the default color of the source code in the Disassembly window:

1 Choose **Tools>Options>Debugger**.

2 Set the default color using the **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.

Toolbar

The toolbar contains:

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, see *C-SPY memory zones*, page 143.
Toggle Mixed-Mode	Toggles between displaying 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.

Display area

The display area shows the disassembled application code.

This area contains these graphic elements:

Green highlight	Indicates the current position, that is the next assembler instruction to be executed. To move the cursor to any line in the Disassembly window, click the line. Alternatively, move the cursor using the navigation keys.
Yellow highlight	Indicates a position other than the current position, such as when navigating between frames in the Call Stack window or between items in the Trace window.
Red dot	Indicates a breakpoint. Double-click in the gray left-side margin of the window to set a breakpoint. For more information, see *Using breakpoints*, page 109.
Green diamond	Indicates code that has been executed—that is, code coverage.

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.

Context menu

This context menu is available:

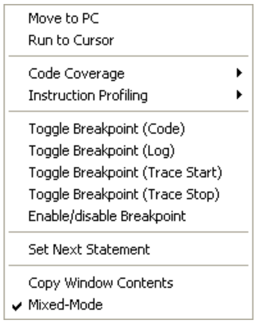


Figure 21: Disassembly window context menu

Note: The contents of this menu are dynamic, which means it might look different depending on your product package.

These commands are available:

Move to PC	Displays code at the current program counter location.
Run to Cursor	Executes the application from the current position up to the line containing the cursor.
Code Coverage	Displays a submenu that provides commands for controlling code coverage. This command is only enabled if the driver you are using supports it.

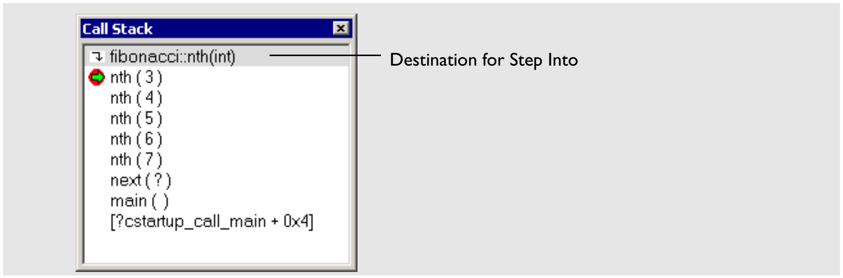
Enable, toggles code coverage on or off.
Show, toggles the display of code coverage on or off. Executed code is indicated by a green diamond.
Clear, clears all code coverage information.

Instruction Profiling	Displays 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 or off. **Show**, toggles the display of instruction profiling on or off. 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 and any corresponding label at which code breakpoints have been set are highlighted in red. For more information, see *Code breakpoints dialog box*, page 123.
Toggle Breakpoint (Log)	Toggles a log breakpoint for trace printouts. Assembler instructions at which log breakpoints have been set are highlighted in red. For more information, see *Log breakpoints dialog box*, page 128.
Toggle Breakpoint (Trace Start)	Toggles a Trace Start breakpoint. When the breakpoint is triggered, the trace data collection starts. Note that this menu command is only available if the C-SPY driver you are using supports trace. For more information, see *Trace Start breakpoints dialog box (simulator)*, page 190.
Toggle Breakpoint (Trace Stop)	Toggles a Trace Stop breakpoint. When the breakpoint is triggered, the trace data collection stops. Note that this menu command is only available if the C-SPY driver you are using supports trace. For more information, see *Trace Stop breakpoints dialog box (simulator)*, page 194.
Enable/Disable Breakpoint	Enables and Disables a breakpoint. If there is more than one breakpoint at a specific line, all those breakpoints are affected by the **Enable/Disable** command.
Edit Breakpoint	Displays the breakpoint dialog box to let you edit the currently selected breakpoint. If there is 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 program counter to the address of the instruction at 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.

Call Stack window

The Call Stack window is available from the **View** menu.



```
fibonacci::nth(int)
nth ( 3 )
nth ( 4 )
nth ( 5 )
nth ( 6 )
nth ( 7 )
next ( ? )
main ( )
[?cstartup_call_main + 0x4]
```

Figure 22: Call Stack window

This window 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.

If the next **Step Into** command would step to 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.

Display area

Provided that the command **Show Arguments** is enabled, each entry in the display area 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.

Context menu

This context menu is available:

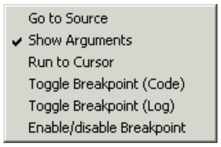


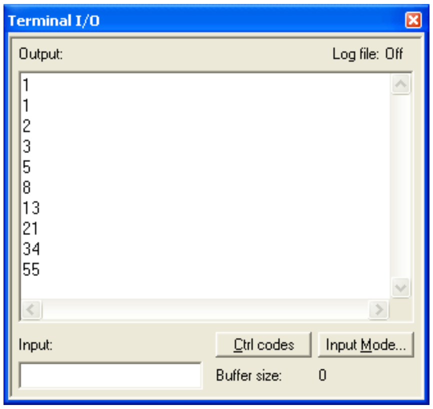
Figure 23: Call Stack window context menu

These commands are available:

Go to Source	Displays the selected function in the Disassembly or editor windows.
Show Arguments	Shows function arguments.
Run to Cursor	Executes until return 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

The Terminal I/O window is available from the **View** menu.



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

Figure 24: Terminal I/O window

Use this window to enter input to your application, and display output from it.

To use this window, you must:

- Build your application with the option **Semihosted** or the **IAR breakpoint** option.

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.

Input

Type the text that you want to input to your application.

Ctrl codes

Opens a menu for input of special characters, such as `EOF` (end of file) and `NUL`.

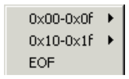


Figure 25: Ctrl codes menu

Input Mode

Opens the **Input Mode** dialog box where you choose whether to input data from the keyboard or from a file.

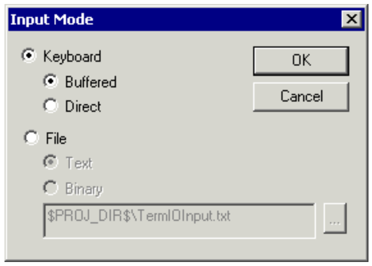


Figure 26: Input Mode dialog box

For reference information about the options available in this dialog box, see Terminal I/O options in *IDE Project Management and Building Guide for ARM®*.

Terminal I/O Log File dialog box

The **Terminal I/O Log File** dialog box is available by choosing **Debug>Logging>Set Terminal I/O Log File**.

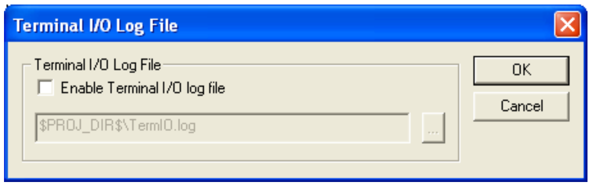


Figure 27: Terminal I/O Log File dialog box

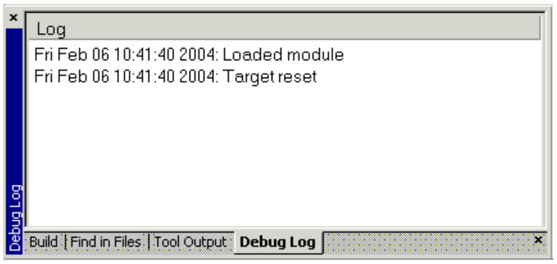
Use this dialog box to select a destination log file for terminal I/O from C-SPY.

Terminal IO Log Files

Controls the logging of terminal I/O. To enable logging of terminal I/O to a file, select **Enable Terminal IO log file** and specify a filename. The default filename extension is `log`. A browse button is available for your convenience.

Debug Log window

The Debug Log window is available by choosing **View>Messages**.



```
Fri Feb 06 10:41:40 2004: Loaded module
Fri Feb 06 10:41:40 2004: Target reset
```

Figure 28: Debug Log window (message window)

This window displays debugger output, such as diagnostic messages, macro-generated output, event log messages, and information about trace. 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 *IDE Project Management and Building Guide for ARM®*.

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>
```

Context menu

This context menu is available:

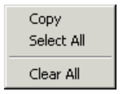


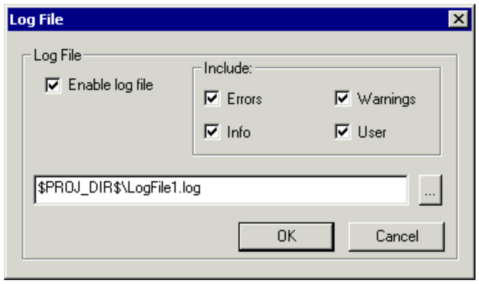
Figure 29: Debug Log window context menu

These commands are available:

Copy	Copies the contents of the window.
Select All	Selects the contents of the window.
Clear All	Clears the contents of the window.

Log File dialog box

The **Log File** dialog box is available by choosing **Debug>Logging>Set Log File**.



- [✓] Enable log file
- [✓] Errors
- [✓] Warnings
- [✓] Info
- [✓] User

$PROJ_DIR$\LogFile1.log

Figure 30: Log File dialog box

Use this dialog box to log output from C-SPY to a file.

Enable Log file

Enables or disables logging to the file.

Include

The information printed in the file is, by default, the same as the information listed in the Log window. To change the information logged, choose between:

Errors	C-SPY has failed to perform an operation.
Warnings	An error or omission of concern.
Info	Progress information about actions C-SPY has performed.
User	Messages from C-SPY macros, that is, your messages using the `__message` statement.

Use the browse button, to override the default file and location of the log file (the default filename extension is `log`).

Autostep settings dialog box

The **Autostep settings** dialog box is available from the **Debug** menu.

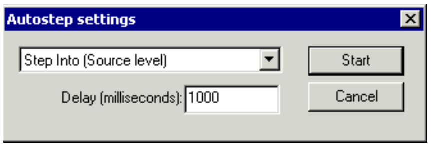


Figure 31: Autostep settings dialog box

Use this dialog box to customize autostepping.

The drop-down menu lists the available step commands.

Delay

Specify the delay between each step in milliseconds.

Working with variables and expressions

This chapter describes how variables and expressions can be used in C-SPY®. More specifically, this means:

- Introduction to working with variables and expressions
- Reference information on working with variables and expressions.

Introduction to working with variables and expressions

This section covers these topics:

- Briefly about working with variables and expressions
- C-SPY expressions
- Limitations on variable information
- Viewing assembler variables.

BRIEFLY ABOUT WORKING WITH 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 mouse pointer. The value is displayed next to the variable.
- The Auto window displays a useful selection of variables and expressions in, or near, the current statement. The window is automatically updated when execution stops.
- The Locals window displays the local variables, that is, auto variables and function parameters for the active function. The window is automatically updated when execution stops.
- The Watch window allows you to monitor the values of C-SPY expressions and variables. The window is automatically updated when execution stops.
- The Live Watch window repeatedly samples and displays the values of expressions while your application is executing. Variables in the expressions must be statically located, such as global variables.

- The Statics window displays the values of variables with static storage duration. The window is automatically updated when execution stops.
- The Quick Watch window gives you precise control over when to evaluate an expression.
- The Symbols window 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.
- The Trace-related windows let you inspect the program flow up to a specific state. For more information, see *Collecting and using trace data*, page 161.

Details about using these windows

All the windows are easy to use. You can add, modify, and remove expressions, and change the display format.

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 the **Value** field and modify its content. To remove an expression, select it and press the Delete key.

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.

Right-click in any of the windows to access the context menu which contains additional commands. Convenient drag-and-drop between windows is supported, except for in the Locals window and the Quick Watch window where it is not relevant.

C-SPY EXPRESSIONS

C-SPY expressions can include any type of C expression, except for calls to functions. 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.

Expressions that are built with these types of symbols are called C-SPY expressions and there are several methods for monitoring these in C-SPY. Examples of valid C-SPY expressions are:

```
i + j
i = 42
#asm_label
#R2
#PC
```

```
my_macro_func(19)
```

C/C++ symbols

C symbols are symbols that you have defined in the C source code of your application, for instance variables, constants, and functions (functions can be used as symbols but cannot be executed). C symbols can be referenced by their names. Note that C++ symbols might implicitly contain function calls which are not allowed in C-SPY symbols and expressions.

Assembler symbols

Assembler symbols can be assembler labels or register names. That is, general purpose registers, such as `R4–R15`, 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 *Modifying a device description file*, page 58.

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 5: 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 6: 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 window*, page 156.

C-SPY macro functions

Macro functions consist of C-SPY macro 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 *Briefly about the macro language*, page 245.

C-SPY 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 assign both its value and type.

For details of C-SPY macro variables and how to use them, see *Reference information on the macro language*, page 251.

Using sizeof

According to standard C, there are two syntactical forms of `sizeof`:

```
sizeof(type)
sizeof expr
```

The former is for types and the latter for expressions.

Note: 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)`.

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. The optimization can affect the code so that 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 = computer(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 that C-SPY will not be able to display the value until it is actually used. If you try to view the value of a variable that is temporarily unavailable, C-SPY will display the text:

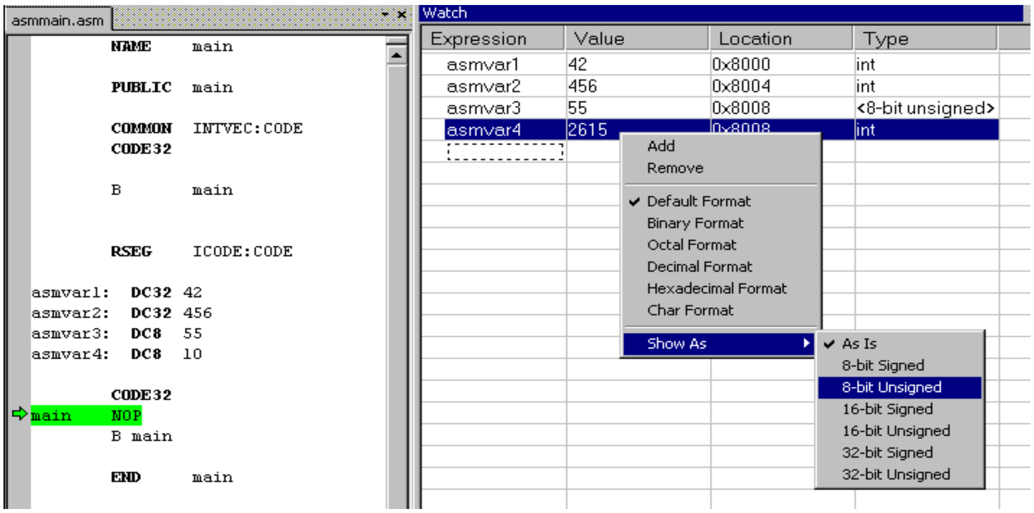
```
Unavailable
```

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 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 by default treats 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:



```
        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
```

Expression	Value	Location	Type
asmvar1	42	0x8000	int
asmvar2	456	0x8004	int
asmvar3	55	0x8008	<8-bit unsigned>
asmvar4	2615	0x8008	int

Figure 32: 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.

Reference information on working with variables and expressions

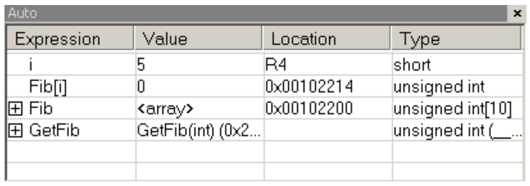
This section gives reference information about these windows and dialog boxes:

- *Auto window*, page 98
- *Locals window*, page 99
- *Watch window*, page 99
- *Live Watch window*, page 101
- *Statics window*, page 102
- *Select Statics dialog box*, page 104
- *Quick Watch window*, page 105
- *Symbols window*, page 106
- *Resolve Symbol Ambiguity dialog box*, page 107.

For trace-related reference information, see *Reference information on trace*, page 168.

Auto window

The Auto window is available from the **View** menu.



Expression	Value	Location	Type
i	5	R4	short
Fib[i]	0	0x00102214	unsigned int
⊞ Fib	<array>	0x00102200	unsigned int[10]
⊞ GetFib	GetFib(int) (0x2...		unsigned int (__...

Figure 33: Auto window

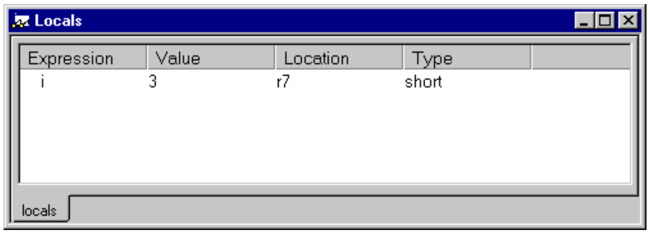
This window displays a useful selection of variables and expressions in, or near, the current statement. Every time execution in C-SPY stops, the values in the Auto window are recalculated. Values that have changed since the last stop are highlighted in red.

Context menu

For a description of the context menu, see *Watch window*, page 99.

Locals window

The Locals window is available from the **View** menu.



Expression	Value	Location	Type
i	3	r7	short

Figure 34: Locals window

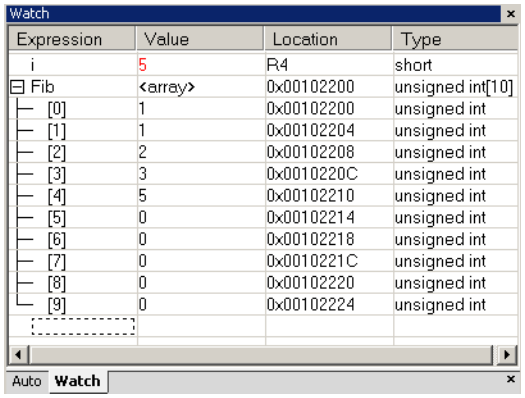
This window displays the local variables and parameters for the current function. Every time execution in C-SPY stops, the values in the Locals window are recalculated. Values that have changed since the last stop are highlighted in red.

Context menu

For a description of the context menu, see *Watch window*, page 99.

Watch window

The Watch window is available from the **View** menu.



Expression	Value	Location	Type
i	5	R4	short
⊟ Fib	<array>	0x00102200	unsigned int[10]
[0]	1	0x00102200	unsigned int
[1]	1	0x00102204	unsigned int
[2]	2	0x00102208	unsigned int
[3]	3	0x0010220C	unsigned int
[4]	5	0x00102210	unsigned int
[5]	0	0x00102214	unsigned int
[6]	0	0x00102218	unsigned int
[7]	0	0x0010221C	unsigned int
[8]	0	0x00102220	unsigned int
[9]	0	0x00102224	unsigned int

Figure 35: Watch window

Use this window to monitor the values of C-SPY expressions or variables. You can view, add, modify, and remove expressions. Tree structures of arrays, structs, and unions are expandable, which means that you can study each item of these.

Every time execution in C-SPY stops, the values in the Watch window are recalculated. Values that have changed since the last stop are highlighted in red.

Context menu

This context menu is available:

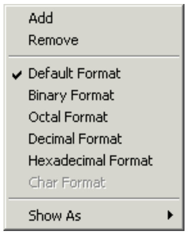


Figure 36: Watch window context menu

These commands are available:

Add	Adds an expression.
Remove	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 7, *Effects of display format setting on different types of expressions*. Your selection of display format is saved between debug sessions.
Show As	Displays a submenu that provides 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 97.

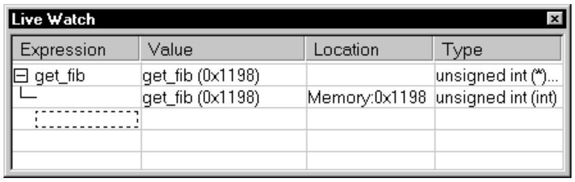
The display format setting affects different types of expressions in these ways:

Type of expression	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, the same display format is used for each array element.
Structure field	All elements with the same definition—the same field name and C declaration type—are affected by the display setting.

Table 7: Effects of display format setting on different types of expressions

Live Watch window

The Live Watch window is available from the **View** menu.



Expression	Value	Location	Type
⊟ get_fib	get_fib (0x1198)		unsigned int (*)...
└	get_fib (0x1198)	Memory:0x1198	unsigned int (int)

Figure 37: Live Watch window

This window 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.

This window can only be used for hardware target systems supporting this feature.

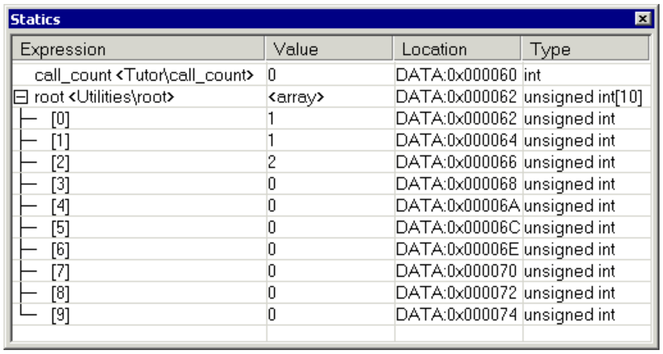
Context menu

For a description of the context menu, see *Watch window*, page 99.

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.

Statics window

The Statics window is available from the **View** menu.


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 38: Statics window

This window 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.

Every time execution in C-SPY stops, the values in the Statics window are recalculated. Values that have changed since the last stop are highlighted in red.

Display area

This area contains these columns:

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.

Context menu

This context menu is available:

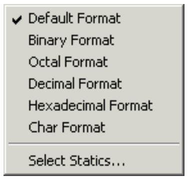


Figure 39: Statics window context menu

These commands are available:

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 7, *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 104.

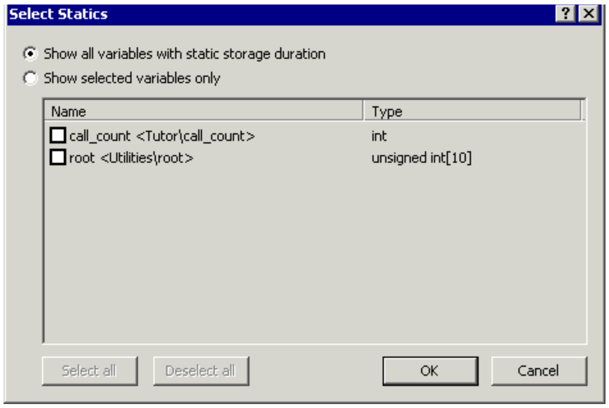
The display format setting affects different types of expressions in these ways:

Type of expression	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, the same display format is used for each array element.
Structure field	All elements with the same definition—the same field name and C declaration type—are affected by the display setting.

Table 8: Effects of display format setting on different types of expressions

Select Statics dialog box

The **Select Statics** dialog box is available from the context menu in the Statics window.


Select Statics
Show all variables with static storage duration
Show selected variables only
Select all
Deselect all
OK
Cancel

Name	Type
☐ call_count <Tutor\call_count>	int
☐ root <Utilities\root>	unsigned int[10]

Figure 40: Select Statics dialog box

Use this dialog box to select which variables should be displayed in the Statics window.

Show all variables with static storage duration

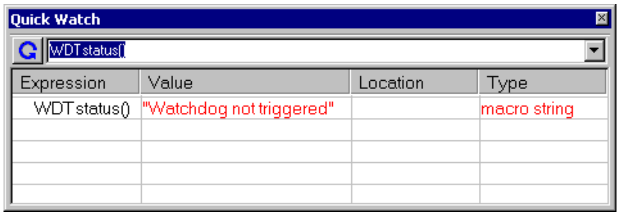
Makes *all* variables be displayed in the Statics window, including new variables that are added to your application between debug sessions.

Show selected variables only

Selects which variables to be displayed in the Statics window. Note that if you add a new variable to your application between two debug sessions, this variable will not automatically be displayed in the Statics window. Select the check box next to a variable to make that variable be displayed. Alternatively, click **Select All**.

Quick Watch window

The Quick Watch window is available from the **View** menu and from the context menu in the editor window.



Expression	Value	Location	Type
WDTstatus()	"Watchdog not triggered"		macro string

Figure 41: Quick Watch window

Use this window to watch the value of a variable or expression and evaluate expressions at a specific point in time.

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 possible side effects, such as assignments and C-SPY macro functions, it allows you to perform evaluations under controlled conditions.

To evaluate an expression:

1. In the editor window, right-click on the expression you want to examine and choose Quick Watch from the context menu that appears.
2. The expression will automatically appear in the Quick Watch window.

Alternatively:

1. In the Quick Watch window, type the expression you want to examine in the **Expressions** text box.
2. Click the **Recalculate** button to calculate the value of the expression.

For an example, see *Executing macros using Quick Watch*, page 249.

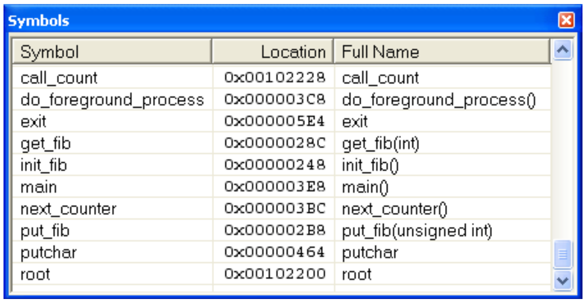
Context menu

For a description of the context menu, see *Watch window*, page 99.

In addition, the menu contains the **Add to Watch window** command, which adds the selected expression to the Watch window.

Symbols window

The Symbols window is available from the **View** menu.



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 42: Symbols window

This window 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.

Display area

This area contains these columns:

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.

Click the column headers to sort the list by symbol name, location, or full name.

Context menu

This context menu is available:

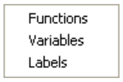


Figure 43: Symbols window context menu

These commands are available:

Functions	Toggles the display of function symbols on or off in the list.
Variables	Toggles the display of variables on or off in the list.
Labels	Toggles the display of labels on or off in the list.

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.

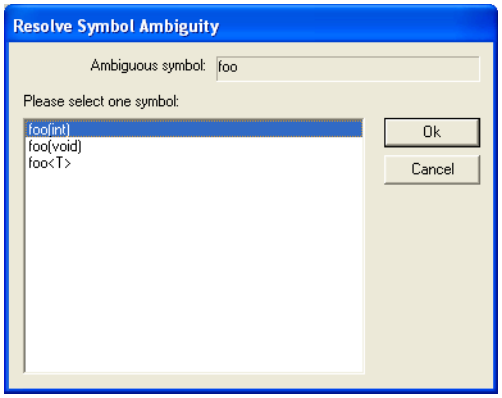


Figure 44: Resolve Symbol Ambiguity dialog box

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 use.

Using breakpoints

This chapter describes breakpoints and the various ways to define and monitor them. More specifically, this means:

- Introduction to setting and using breakpoints
- Procedures for setting breakpoints
- Reference information on breakpoints.

Introduction to setting and using breakpoints

This section introduces breakpoints.

These topics are covered:

- Reasons for using breakpoints
- Briefly about setting breakpoints
- Breakpoint types
- Breakpoint icons
- Breakpoints in the C-SPY simulator
- Breakpoints in the C-SPY hardware drivers
- Breakpoint consumers
- Breakpoints options
- Breakpoints on vectors
- Setting breakpoints in __ramfunc declared functions.

REASONS FOR USING BREAKPOINTS

C-SPY® lets you set various types 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.

You can let the execution stop under certain *conditions*, which you specify. You can also let the breakpoint trigger a *side effect*, for instance executing a C-SPY macro function, by transparently stopping the execution and then resuming. The macro function can be defined to perform a wide variety of actions, for instance, simulating hardware behavior.

All these possibilities provide you with a flexible tool for investigating the status of your application.

BRIEFLY ABOUT SETTING BREAKPOINTS

You can set breakpoints in many various ways, allowing for different levels of interaction, precision, timing, and automation. All 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. The **Breakpoint Usage** dialog box also lists all internally used breakpoints, see *Breakpoint consumers*, page 113.

Breakpoints are set with a higher precision than single lines, using the same mechanism as when stepping; for more details about the precision, see *Single stepping*, page 76.

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.

Note: For most hardware debugger systems it is only possible to set breakpoints when the application is not executing.

BREAKPOINT TYPES

Depending on the C-SPY driver you are using, C-SPY supports different types of breakpoints.

Code breakpoints

Code breakpoints are used for code locations to investigate whether your program logic is correct or to get trace printouts. 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.

Log breakpoints

Log breakpoints provide a convenient way to add trace printouts without having to add any code to your application source code. 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 stop and print the specified message in the C-SPY Debug Log window.

Trace breakpoints

Trace Start and Stop breakpoints start and stop trace data collection—a convenient way to analyze instructions between two execution points. A trace filter specifies conditions that, when fulfilled, activate the trace data collection during execution.

Data breakpoints

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. Data breakpoints are triggered when data is accessed at the specified location. The execution will usually stop directly after the instruction that accessed the data has been executed.

Immediate 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 simulated 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 simulated processor reads from a memory-mapped location, a C-SPY macro function can intervene and supply appropriate data. Conversely, when the simulated processor writes to a memory-mapped location, a C-SPY macro function can act on the value that was written.

Data Log breakpoints

Data Log breakpoints are available for the J-Link/J-Trace driver when you are using a Cortex-M device.

Data Log breakpoints are triggered when data is accessed at the specified location. If you have set a log breakpoint on a specific address or a range, a log message is displayed in the SWO Trace window for each access to that location. A log message can also be displayed in the Data Log window, if that window is enabled. However, these log messages require that you have set up trace data in the SWO Configuration dialog box, see *SWO Configuration dialog box*, page 173.

JTAG watchpoints

The C-SPY J-Link/J-Trace driver and the C-SPY Macraigor driver can take advantage of the JTAG watchpoint mechanism in ARM7/9 cores.

The watchpoints are implemented using the functionality provided by the ARM EmbeddedICE™ macrocell. The macrocell is part of every ARM core that supports the

JTAG interface. The EmbeddedICE watchpoint comparator compares the address bus, data bus, CPU control signals and external input signals with the defined watchpoint in real time. When all defined conditions are true, the program will break.

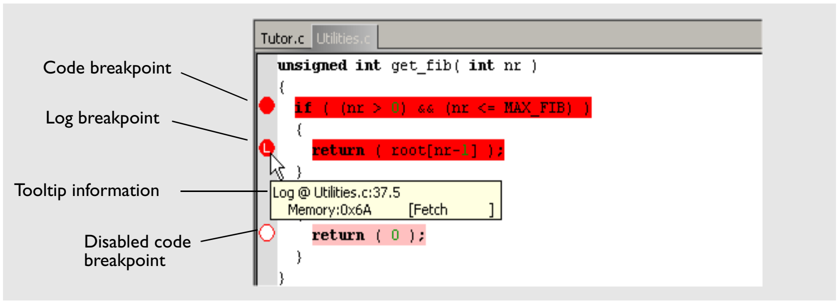
The watchpoints are implicitly used by C-SPY to set code breakpoints or data breakpoints in the application. When setting breakpoints in read/write memory, only one watchpoint is needed by the debugger. When setting breakpoints in read-only memory, one watchpoint is needed for each breakpoint. Because the macrocell only implements two hardware watchpoints, the maximum number of breakpoints in read-only memory is two.

For a more detailed description of the ARM JTAG watchpoint mechanism, refer to these documents from Advanced RISC Machines Ltd:

- *ARM7TDMI (rev 3) Technical Reference Manual:* chapter 5, *Debug Interface*, and appendix B, *Debug in Depth*
- Application Note 28, *The ARM7TDMI Debug Architecture*.

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 45: Breakpoint icons

If the breakpoint icon does not appear, make sure the option **Show bookmarks** is selected, see Editor options in the *IDE Project Management and Building Guide for ARM®*.

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.

BREAKPOINTS IN THE C-SPY SIMULATOR

The C-SPY simulator supports all breakpoint types and you can set an unlimited amount of breakpoints.

BREAKPOINTS IN THE C-SPY HARDWARE DRIVERS

Using the C-SPY drivers for hardware debugger systems you can set various breakpoint types. The amount of breakpoints you can set depends on the number of *hardware breakpoints* available on the target system or whether you have enabled *software breakpoints*, in which case the number of breakpoints you can set is unlimited.

When software breakpoints are enabled, the debugger will first use any available hardware breakpoints before using software breakpoints. Exceeding the number of available hardware breakpoints, when software breakpoints are not enabled, causes the debugger to single step. This will significantly reduce the execution speed. For this reason you must be aware of the different breakpoint consumers.

For information about the characteristics of breakpoints for the different target systems, see the manufacturer's documentation.

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 physical breakpoint each, but this can vary greatly. Some user breakpoints consume several physical breakpoints and conversely, several user breakpoints can share one physical 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

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 Breakpoints window.
- The **Semihosted** or the **IAR breakpoint** option 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 one physical breakpoint.

To disable the breakpoint used by the Stack window:

1. Choose **Tools>Options>Stack**.
2. Deselect the **Stack pointer(s) not valid until program reaches:** ***label*** option.

BREAKPOINTS OPTIONS

For the following hardware debugger systems it is possible to set some driver-specific breakpoint options before you start C-SPY:

- GDB Server
- J-Link/J-Trace JTAG probes
- Macraigor JTAG probes.

For more information, see *Breakpoints options*, page 133.

BREAKPOINTS ON VECTORS

You can set breakpoints on vectors for ARM9, Cortex-R4, and Cortex-M3 devices. Use the **Vector Catch** dialog box to set a breakpoint directly on a vector in the interrupt vector table, without using a hardware breakpoint. For more information, see *Vector Catch dialog box*, page 136.

For the J-Link/J-Trace driver and for RDI drivers, it is also possible to set breakpoints directly on a vector already in the options dialog box, see *Setup options for J-Link/J-Trace*, page 333 and *RDI*, page 342.

SETTING BREAKPOINTS IN __RAMFUNC DECLARED FUNCTIONS

To set a breakpoint in a `__ramfunc` declared function, the program execution must have reached the `main` function. The system startup code moves all `__ramfunc` declared functions from their stored location—normally flash memory—to their RAM location, which means the `__ramfunc` declared functions are not in their proper place and breakpoints cannot be set until you have executed up to the `main` function. Use the **Restore software breakpoints** option to solve this problem, see *Restore software breakpoints at*, page 134.

In addition, breakpoints in `__ramfunc` declared functions added from the editor have to be disabled prior to invoking C-SPY and prior to exiting a debug session.

For information about the `__ramfunc` keyword, see the *IAR C/C++ Development Guide for ARM®*.

Procedures for setting breakpoints

This section gives you step-by-step descriptions about how to set and use breakpoints.

More specifically, you will get information about:

- Various ways to set a breakpoint
- Toggling a simple code breakpoint
- Setting breakpoints using the dialog box
- Setting a data breakpoint in the Memory window
- Setting breakpoints using system macros
- Setting a breakpoint on a vector
- Useful breakpoint hints.

VARIOUS 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 offer 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.

SETTING 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.

To set a new breakpoint:

You can open the dialog box from the context menu available in the editor window, Breakpoints window, and in the Disassembly window.

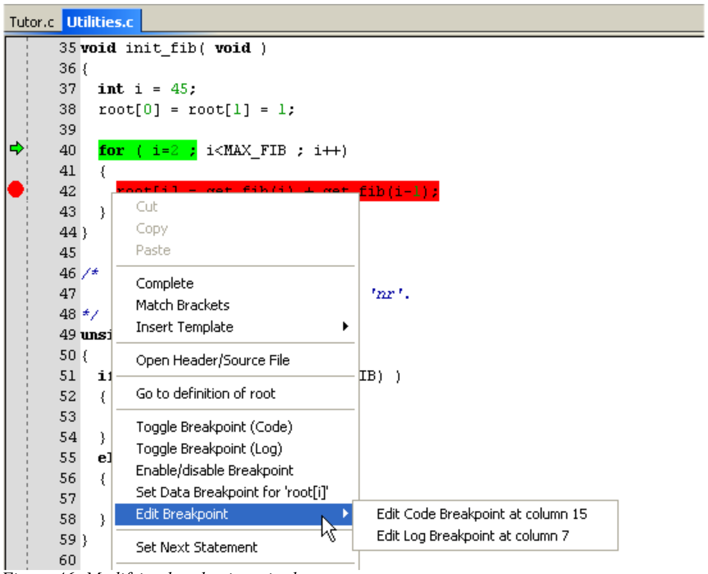
1. Choose **View>Breakpoints** to open the Breakpoints window.
2. In the Breakpoints window, right-click, and choose **New Breakpoint** from the context menu.
3. On the submenu, choose the breakpoint type you want to set.

   Depending on the C-SPY driver you are using, different breakpoint types are available.
4. In the breakpoint dialog box that appears, specify the breakpoint settings and click **OK**.

   The breakpoint is displayed in the Breakpoints window.

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 46: Modifying breakpoints via the context menu

If there are several breakpoints on the same source code line, the breakpoints will be listed on a submenu.

2 On the context menu, choose the appropriate command.

3 In the breakpoint dialog box that appears, specify the breakpoint settings and click **OK**.

The breakpoint is displayed in the Breakpoints window.

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 in the Memory window; instead, you can see, edit, and remove it using the Breakpoints window, which is available from the **View** menu. The breakpoints you set in the Memory window will be triggered for both read and write accesses. All breakpoints defined in this window are preserved between debug sessions.

Note: Setting breakpoints directly in the Memory window is only possible if the driver you use supports this.

SETTING BREAKPOINTS USING SYSTEM MACROS

You can set breakpoints not only in the breakpoint dialog box but also by using built-in C-SPY system macros. When you use system macros for setting breakpoints, the breakpoint characteristics are specified as macro 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.

Note: 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.

These breakpoint macros are available:

C-SPY macro for breakpoints	Simulator	J-Link	RDI	Mac-raigor	GDB Server	ST-Link	LMI FTDI	Angel	IAR ROM-monitor
`__setCodeBreak`	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
`__setDataBreak`	Yes	No	No	No	No	No	No	No	No
`__setLogBreak`	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
`__setSimBreak`	Yes	No	No	No	No	No	No	No	No
`__setTraceStartBreak`	Yes	No	No	No	No	No	No	No	No
`__setTraceStopBreak`	Yes	No	No	No	No	No	No	No	No
`__clearBreak`	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 9: C-SPY macros for breakpoints

For details of each breakpoint macro, see *Reference information on C-SPY system macros*, page 257.

Setting 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 248.

SETTING A BREAKPOINT ON A VECTOR

This procedure applies to J-Link/J-Trace and Macraigor.

To set a breakpoint on a vector:

1. Select the correct device. Before starting C-SPY, choose **Project>Options** and select the **General Options** category. Choose the appropriate core or device from one of the **Processor variant** drop-down lists available on the **Target** page.
2. Start C-SPY.
3. Choose **J-Link>Vector Catch**. By default, vectors are selected according to your settings on the Breakpoints options page, see *Breakpoints options*, page 133.
4. In the **Vector Catch** dialog box, select the vector you want to set a breakpoint on, and click **OK**. The breakpoint will only be triggered at the beginning of the exception.

USEFUL BREAKPOINT HINTS

Below are some useful hints related to setting breakpoints.

Performing a task and continue execution

You can perform a task when a breakpoint is triggered and then automatically continue 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. In this case, the execution will not continue automatically.

Instead, you can set a condition which returns `0` (false). When the breakpoint is triggered, the condition—which can be a call to a C-SPY macro that performs a task—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.

Reference information on breakpoints

This section gives reference information about these windows and dialog boxes:

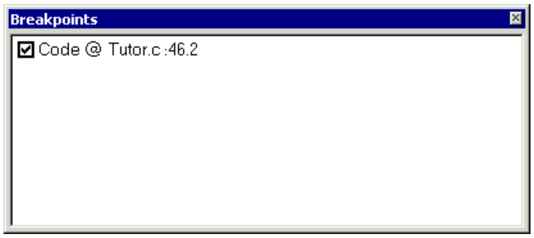
- *Breakpoints window*, page 120
- *Breakpoint Usage dialog box*, page 122
- *Code breakpoints dialog box*, page 123
- *JTAG Watchpoints dialog box*, page 125
- *Log breakpoints dialog box*, page 128
- *Data breakpoints dialog box*, page 129
- *Data breakpoints dialog box*, page 129
- *Breakpoints options*, page 133
- *Immediate breakpoints dialog box*, page 135
- *Vector Catch dialog box*, page 136
- *Enter Location dialog box*, page 137
- *Resolve Source Ambiguity dialog box*, page 138.

For related information, see also:

- *Reference information on C-SPY system macros*, page 257
- *Reference information on trace*, page 168.

Breakpoints window

The Breakpoints window is available from the **View** menu.



☑ Code @ Tutor.c:46.2

Figure 47: Breakpoints window

The Breakpoints window lists all breakpoints you define.

Use this window to conveniently monitor, enable, and disable breakpoints; you can also define new breakpoints and modify existing breakpoints.

Display area

This area lists all breakpoints you define. For each breakpoint, information about the breakpoint type, source file, source line, and source column is provided.

Context menu

This context menu is available:

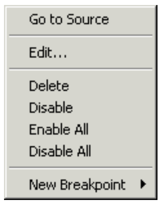


Figure 48: Breakpoints window context menu

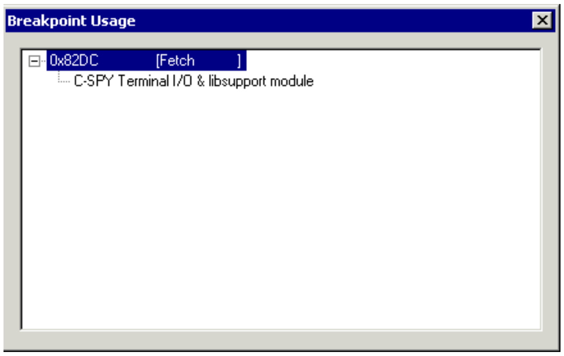
These commands are available:

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 breakpoint dialog box for the breakpoint you selected.
Delete	Deletes the breakpoint. Press the Delete key to perform the same command.
Enable	Enables the 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 breakpoint is disabled.
Disable	Disables the breakpoint. The check box at the beginning of the line will be deselected. You can also perform this command by manually deselecting the check box. This command is only available if the 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 breakpoint dialog box for the available breakpoint types. All breakpoints you define using this dialog box are preserved between debug sessions.

Breakpoint Usage dialog box

The **Breakpoint Usage** dialog box is available from the menu specific to the C-SPY driver you are using.



```
0x82DC          [Fetch        ]
   C-SPY Terminal I/O & libsupport module
```

Figure 49: 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. The format of the items in this dialog box depends on the 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 displayed in the Breakpoints window.

C-SPY uses breakpoints when stepping. If your target system has a limited number of hardware breakpoints and software breakpoints are not enabled, exceeding the number of available hardware 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 hardware breakpoints, you can use the **Breakpoint Usage** dialog box for:

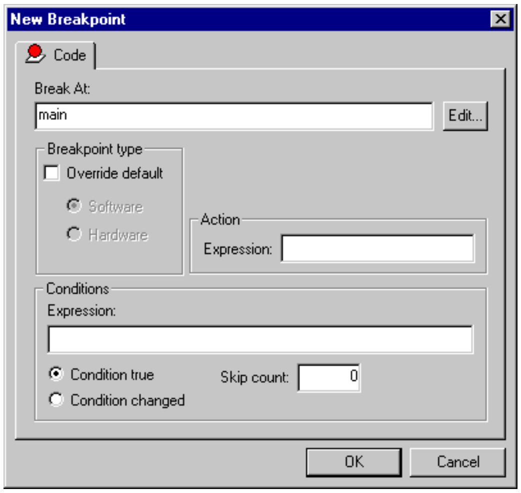
- Identifying all breakpoint consumers
- Checking that the number of active breakpoints is supported by the target system
- Configuring the debugger to use the available breakpoints in a better way, if possible.

Display area

For each breakpoint in the list, the address and access type are displayed. Each breakpoint in the list can also be expanded to show its originator.

Code breakpoints dialog box

The **Code** breakpoints dialog box is available from the context menu in the editor window, Breakpoints window, and in the Disassembly window.



Break At: main

Override default [ ]

[✓ Software] Hardware

Expression:

Expression:

[✓ Condition true] Condition changed

Skip count: 0

Figure 50: Code breakpoints dialog box

Use the **Code** breakpoints dialog box to set a code breakpoint.

Note: The **Code** breakpoints dialog box depends on the C-SPY driver you are using. For information about support for breakpoints in the C-SPY driver you are using, see *Breakpoints in the C-SPY hardware drivers*, page 113.

Break At

Specify the location of the breakpoint in the text box. Alternatively, click the **Edit** button to open the **Enter Location** dialog box; see *Enter Location dialog box*, page 137.

Breakpoint type

Overrides the default breakpoint type. Select the **Override default** check box and choose between the **Software** and **Hardware** options.

You can specify the breakpoint type for these C-SPY drivers:

- GDB Server
- J-Link/J-Trace JTAG probes
- Macraigor JTAG probes.

Action

Determines whether there is an action connected 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.

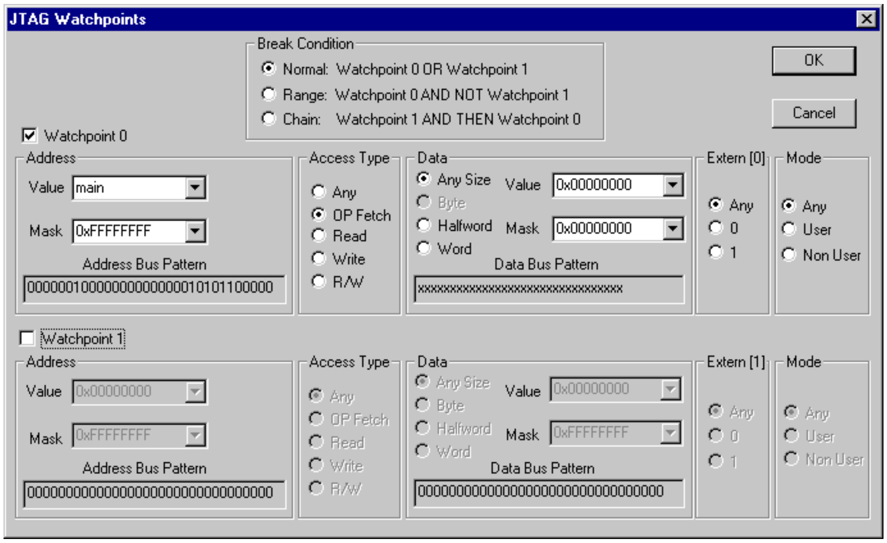
Conditions

Specify simple or complex conditions:

Expression	Specify 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 condition must be fulfilled before the breakpoint starts triggering. After that, the breakpoint will trigger every time the condition is fulfilled. The counter is reset when you reset the debug session.

JTAG Watchpoints dialog box

The **JTAG Watchpoints** dialog box is available from the driver-specific menu.


JTAG Watchpoints

Break Condition: [✓ Normal: Watchpoint 0 OR Watchpoint 1] Range: Watchpoint 0 AND NOT Watchpoint 1 / Chain: Watchpoint 1 AND THEN Watchpoint 0

[✓ Watchpoint 0]
- Address: Value main; Mask 0xFFFFFFFF; Address Bus Pattern 00000010000000000000001010110000
- Access Type: Any [✓ OP Fetch] Read Write R/W
- Data: [✓ Any Size] Byte Halfword Word; Value 0x00000000; Mask 0x00000000; Data Bus Pattern xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
- Extern [0]: [✓ Any] 0 1
- Mode: [✓ Any] User Non User

Watchpoint 1 (unchecked)
- Address: Value 0x00000000; Mask 0xFFFFFFFF; Address Bus Pattern 00000000000000000000000000000000
- Access Type: [✓ Any] OP Fetch Read Write R/W
- Data: [✓ Any Size] Byte Halfword Word; Value 0x00000000; Mask 0xFFFFFFFF; Data Bus Pattern 00000000000000000000000000000000
- Extern [1]: [✓ Any] 0 1
- Mode: [✓ Any] User Non User

Figure 51: JTAG Watchpoints dialog box

Use this dialog box to directly control the two hardware watchpoint units. If the number of needed watchpoints (including implicit watchpoints used by the breakpoint system) exceeds two, an error message will be displayed when you click the **OK** button. This check is also performed for the C-SPY **Go** button.

Address

Specify the address to watch for.

Value	Specify an address or a C-SPY expression that evaluates to an address. Alternatively, you can select an address you have previously watched for from the drop-down list. For detailed information about C-SPY expressions, see *C-SPY expressions*, page 94.

Mask	Qualifies each bit in the value. A zero bit in the mask will cause the corresponding bit in the value to be ignored in the comparison. To match any address, enter `0`. Note that the mask values are inverted with respect to the notation used in the ARM hardware manuals.
Address Bus Pattern	Shows the bit pattern to be used by the address comparator. Ignored bits as specified in the mask are shown as `x`.

Access Type

Selects the access type of the data to watch for:

Any	Matches any access type.
OP Fetch	Matches an operation code (instruction) fetch.
Read	Reads from location.
Write	Writes to location.
R/W	Reads from or writes to location.

Data

Specifies the data to watch for. For size, choose between:

Any Size	Matches data accesses of any size.
Byte	Matches byte size accesses.
Halfword	Matches halfword size accesses.
Word	Matches word size accesses.

You can specify a value to watch for. Choose between:

Value	Specify a value or a C-SPY expression. Alternatively, you can select a value you have previously watched for from the drop-down list. For detailed information about C-SPY expressions, see *C-SPY expressions*, page 94.

Mask	Qualifies each bit in the value. A zero bit in the mask will cause the corresponding bit in the value to be ignored in the comparison. To match any address, enter `0`. Note that the mask values are inverted with respect to the notation used in the ARM hardware manuals.
Data Bus Pattern	Shows the bit pattern to be used by the address comparator. Ignored bits as specified in the mask are shown as `x`.

Extern

Defines the state of the external input. Choose between:

Any	Ignores the state.
0	Defines the state as low.
1	Defines the state as high.

Mode

Selects which CPU mode that must be active for a match. Choose between:

User	Selects the CPU mode USER.
Non User	Selects one of the CPU modes SYSTEM SVC, UND, ABORT, IRQ, or FIQ.
Any	Ignores the CPU mode.

Break Condition

Selects how the defined watchpoints will be used. Choose between:

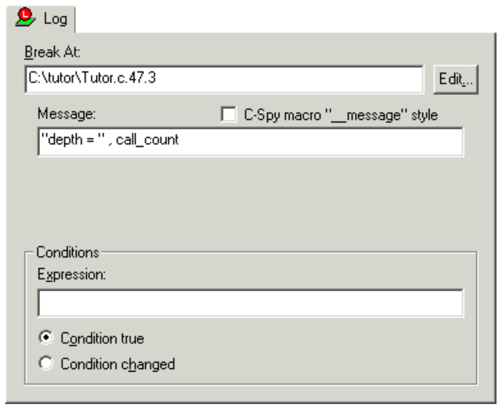
Normal	Uses the two watchpoints individually (OR).
Range	Combines both watchpoints to cover a range where watchpoint 0 defines the start of the range and watchpoint 1 the end of the range. Selectable ranges are restricted to being powers of 2.
Chain	Makes a trigger of watchpoint 1 arm watchpoint 0. A program break will then occur when watchpoint 0 is triggered.

To cause a trigger for accesses in the range 0x20-0xFF:

1. Set **Break Condition** to **Range**.
2. Set the address value of watchpoint 0 to 0 and the mask to `0xFF`.
3. Set the address value of watchpoint 1 to 0 and the mask to `0x1F`.

Log breakpoints dialog box

The **Log** breakpoints dialog box is available from the context menu in the editor window, Breakpoints window, and in the Disassembly window.



Break At: C:\tutor\Tutor.c.47.3

Message: "depth = " , call_count

C-Spy macro "__message" style [ ]

Expression:

(●) Condition true
( ) Condition changed

Figure 52: Log breakpoints dialog box

Use the **Log** breakpoints dialog box to set a log breakpoint.

Note: The **Log** breakpoints dialog box depends on the C-SPY driver you are using. This figure reflects the C-SPY simulator. For information about support for breakpoints in the C-SPY driver you are using, see *Breakpoints in the C-SPY hardware drivers*, page 113.

Break At

Specify the location of the breakpoint. Alternatively, click the **Edit** button to open the **Enter Location** dialog box; see *Enter Location dialog box*, page 137.

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 254.

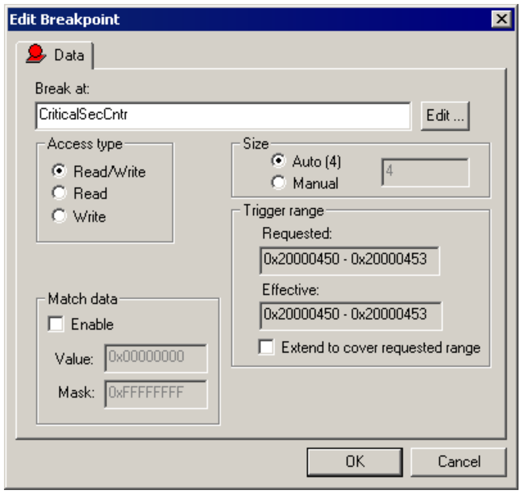
Conditions

Specify simple or complex conditions:

Expression	Specify 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.

Data breakpoints dialog box

The **Data** breakpoints dialog box is available from the context menu in the editor window, Breakpoints window, the Memory window, and in the Disassembly window.



Break at: CriticalSecCntr

Access type: [✓ Read/Write] Read Write

Size: [✓ Auto (4)] Manual 4

Trigger range
Requested: 0x20000450 - 0x20000453
Effective: 0x20000450 - 0x20000453
Extend to cover requested range

Match data
Enable
Value: 0x00000000
Mask: 0xFFFFFFFF

Figure 53: Data breakpoints dialog box

Use the **Data** breakpoints dialog box to set a data breakpoint. Data breakpoints never stop execution within a single instruction. They are recorded and reported after the instruction is executed.

Note: The **Data** breakpoints dialog box depends on the C-SPY driver you are using. For information about support for breakpoints in the C-SPY driver you are using, see *Breakpoints in the C-SPY hardware drivers*, page 113.

Break At

Specify the location for 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 137.

Access Type

Selects the type of memory access that triggers data breakpoints:

Read/Write	Reads from or writes to location.
Read	Reads from location.
Write	Writes to location.

Size

Determines whether there should be a size—in practice, a range—of locations where the breakpoint will trigger. Each fetch 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. Select between 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	Specify the size of the breakpoint range in the text box.

Trigger range

Shows the requested range and the effective range to be covered by the trace. The range suggested is either within or exactly the area specified by the **Break At** and the **Size** options.

Extend to cover requested range	Extends the breakpoint so that a whole data structure is covered. For data structures that do not fit the size of the possible breakpoint ranges supplied by the hardware breakpoint unit, for example three bytes, the breakpoint range will not cover the whole data structure. Note that the breakpoint range will be extended beyond the size of the data structure, which might cause false triggers at adjacent data.

Match data

Enables matching of the accessed data. Use the **Match data** options in combination with the access types for data. This option can be useful when you want a trigger when a variable has a certain value.

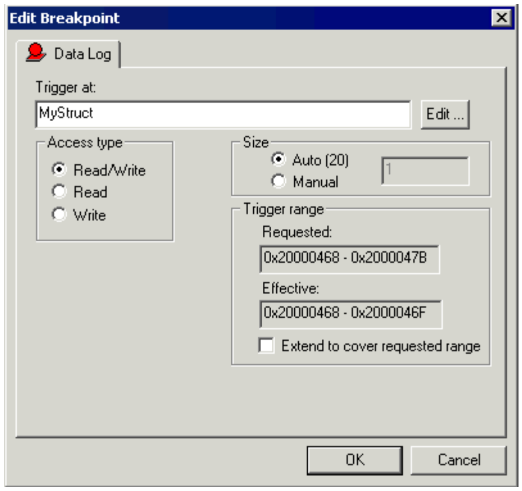
Value	Specify a data value.
Mask	Specify which part of the value to match (word, halfword, or byte).

The **Match data** options are only available for J-Link/J-Trace and when using an ARM7/9 or a Cortex-M device.

Note: For Cortex-M devices, only one breakpoint with **Match data** can be set. Such a breakpoint uses two hardware breakpoints.

Data Log breakpoints dialog box

The **Data Log** breakpoints dialog box is available from the context menu in the editor window, Breakpoints window, the Memory window, and in the Disassembly window.



Trigger at: MyStruct

Access type: [✓ Read/Write] Read Write

Size: [✓ Auto (20)] Manual 1

Trigger range

Requested: 0x20000468 - 0x2000047B

Effective: 0x20000468 - 0x2000046F

☐ Extend to cover requested range

Figure 54: Data Log breakpoints dialog box

Data Log breakpoints are triggered when data is accessed at the specified location. If you have set a log breakpoint on a specific address or a range, a log message is displayed in the SWO Trace window for each access to that location. A log message can also be displayed in the Data Log window, if that window is enabled. However, these log messages require that you have set up trace data in the **SWO Configuration** dialog box, see *SWO Configuration dialog box*, page 173.

Note: Setting **Data Log** breakpoints is possible only for Cortex-M with SWO using the J-Link debug probe.

Trigger at

Specify the location for the breakpoint in the **Trigger at** text box. Alternatively, click the **Edit** button to open the **Enter Location** dialog box; see *Enter Location dialog box*, page 137.

Access Type

Selects the type of memory access that triggers data breakpoints:

Read/Write	Reads from or writes to location.

Read	Reads from location; for Cortex-M3, revision 2 devices only.
Write	Writes to location; for Cortex-M3, revision 2 devices only.

Size

Determines whether there should be a size—in practice, a range—of locations where the breakpoint will trigger. Each fetch 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. Select between two different ways to specify the size:

Auto	The size will automatically be based on the type of expression the breakpoint is set on. This can be useful if **Trigger at** contains a variable.
Manual	Specify the size of the breakpoint range in the text box.

Trigger range

Shows the requested range and the effective range to be covered by the trace. The range suggested is either within or exactly the area specified by the **Trigger at** and the **Size** options.

Extend to cover requested range	Extends the breakpoint so that a whole data structure is covered. For data structures that do not fit the size of the possible breakpoint ranges supplied by the hardware breakpoint unit, for example three bytes, the breakpoint range will not cover the whole data structure. Note that the breakpoint range will be extended beyond the size of the data structure, which might cause false triggers at adjacent data.

Breakpoints options

For the following hardware debugger systems it is possible to set some driver-specific breakpoint options before you start C-SPY:

- GDB Server
- J-Link/J-Trace JTAG probes
- Macraigor JTAG probes.

In the IAR Embedded Workbench IDE, choose **Project>Options**, select the category specific to the debugger system you are using, and click the **Breakpoints** tab.

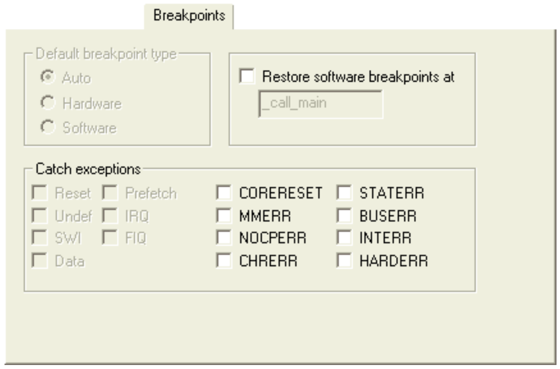


Figure 55: Breakpoints options

Default breakpoint type

Selects the type of breakpoint resource to be used when setting a breakpoint. Choose between:

Auto	Uses a software breakpoint. If this is not possible, a hardware breakpoint will be used. The debugger will use read/write sequences to test for RAM; in that case, a software breakpoint will be used. The Auto option works for most applications. However, there are cases when the performed read/write sequence will make the flash memory malfunction. In that case, use the **Hardware** option.
Hardware	Uses hardware breakpoints. If it is not possible, no breakpoint will be set.
Software	Uses software breakpoints. If it is not possible, no breakpoint will be set.

Restore software breakpoints at

Automatically restores any breakpoints that were destroyed during system startup.

This can be useful if you have an application that is copied to RAM during startup and is then executing in RAM. This can, for example, be the case if you use the `initialize by copy` linker directive for code in the linker configuration file or if you have any `__ramfunc` declared functions in your application.

In this case, all breakpoints will be destroyed during the RAM copying when the C-SPY debugger starts. By using the **Restore software breakpoints at** option, C-SPY will restore the destroyed breakpoints.

Use the text field to specify the location in your application at which point you want C-SPY to restore the breakpoints. The default location is the label `-call_main`.

Catch exceptions

Sets a breakpoint directly on a vector in the interrupt vector table, without using a hardware breakpoint. This option is available for ARM9, Cortex-R4, and Cortex-M3 devices. The settings you make will work as default settings for the project. However, you can override these default settings during the debug session by using the **Vector Catch** dialog box, see *Breakpoints on vectors*, page 114.

The settings you make will be preserved during debug sessions.

This option is supported by the C-SPY J-Link/J-Trace driver only.

Immediate breakpoints dialog box

The **Immediate** breakpoints dialog box is available from the context menu in the editor window, Breakpoints window, the Memory window, and in the Disassembly window.

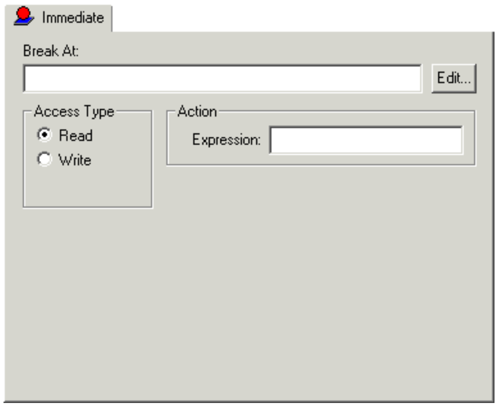


Figure 56: Immediate breakpoints dialog box

In the C-SPY simulator, use the **Immediate** breakpoints dialog box to set an immediate breakpoint. Immediate breakpoints do not stop execution at all; they only suspend it temporarily.

Break At

Specify the location for 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 137.

Access Type

Selects the type of memory access that triggers immediate breakpoints:

Read	Reads from location.
Write	Writes to location.

Action

Determines whether there is an action connected 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.

Vector Catch dialog box

The **Vector Catch** dialog box is available from the **J-Link** menu for J-Link/J-Trace and Macraigor.

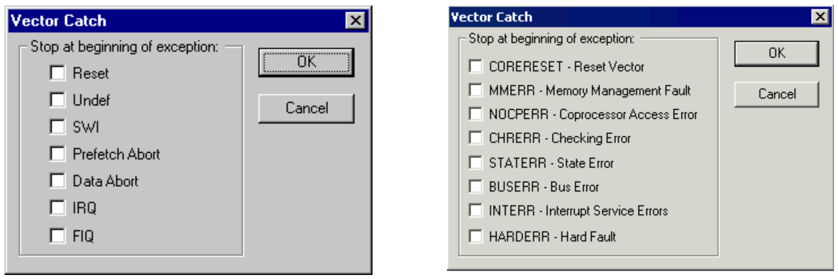


Figure 57: The Vector Catch dialog box—for ARM9/Cortex-R4 versus for Cortex-M3

Use this dialog box to set a breakpoint directly on a vector in the interrupt vector table, without using a hardware breakpoint. You can set breakpoints on vectors for ARM9, Cortex-R4, and Cortex-M3 devices. Note that the settings you make here will not be preserved between debug sessions.

Note: For the J-Link/J-Trace driver and for RDI drivers, it is also possible to set breakpoints directly on a vector already in the options dialog box, see *Setup options for J-Link/J-Trace*, page 333 and *RDI*, page 342.

Enter Location dialog box

The **Enter Location** dialog box is available from the breakpoints dialog box, either when you set a new breakpoint or when you edit a breakpoint.

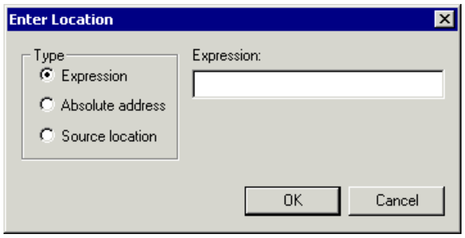


Figure 58: Enter Location dialog box

Use the **Enter Location** dialog box to specify the location of the breakpoint.

Note: This dialog box looks different depending on the **Type** you select.

Type

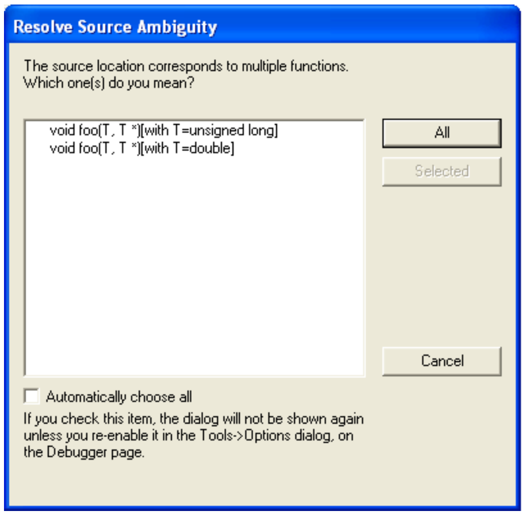
Selects the type of location to be used for the breakpoint:

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 refers to C-SPY memory zones and specifies in which memory the address belongs. For example `Memory:0x42`.

Source location	A location in the C source code using the syntax: `{`*`file_path`*`}.`*`row`*`.`*`column`*`.` *`file_path`* 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. 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`. Note that the Source location type is usually meaningful only for code breakpoints.

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 59: Resolve Source Ambiguity dialog box

To resolve a source ambiguity, perform one of these actions:

- In the text box, select one or several of the listed locations and click **Selected**.
- Click **All**.

All

The breakpoint will be set on all listed locations.

Selected

The breakpoint will be set on the source locations that you have selected in the text box.

Cancel

No location will be used.

Automatically choose all

Determines that 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 in the *IDE Project Management and Building Guide for ARM®*.

Monitoring memory and registers

This chapter describes how to use the features available in C-SPY® for examining memory and registers. More specifically, this means information about:

- Introduction to monitoring memory and registers
- Reference information on memory and registers.

Introduction to monitoring memory and registers

This section covers these topics:

- Briefly about monitoring memory and registers
- C-SPY memory zones
- Stack display
- Memory access checking.

BRIEFLY ABOUT 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. The content of the window can be regularly updated while your application is executing.
- 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. You can open several instances of this window, each showing different stacks or different display modes of the same 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. Except for the hardwired group of CPU registers, additional registers are defined in the device description file. These registers are the device-specific memory-mapped control and status registers for the peripheral units on the ARM devices.

  Due to the large amount of registers, it is inconvenient to show all registers concurrently in the Register window. Instead you can divide registers into *register groups*. The device description file defines one group for each peripheral unit in the device. You can also define your own groups by choosing **Tools>Options>Register Filter**. You can open several instances of this window, each showing a different register group.

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.

Reading the value of some registers might influence the runtime behavior of your application. For example, reading the value of a UART status register might reset a pending bit, which leads to the lack of an interrupt that would have processed a received byte. To prevent this from happening, make sure that the Register window containing any such registers is closed when debugging a running application.

C-SPY MEMORY ZONES

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. The ARM architecture has only one zone, `Memory`, which covers the whole ARM memory range.

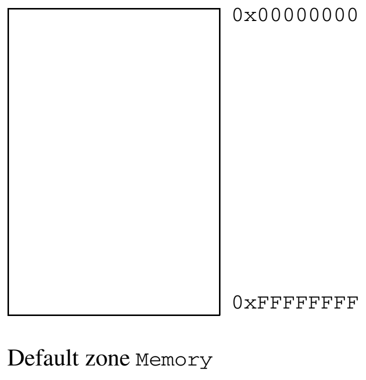


Figure 60: Zones in C-SPY

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.

For normal memory, the default zone `Memory` can be used, but certain I/O registers might require to be accessed as 8, 16, or 32 bits to give correct results. By using different memory zones, you can control the access width used for reading and writing in, for example, the Memory window.

STACK DISPLAY

The Stack window displays the contents of the stack, overflow warnings, and it has a graphical stack bar. These 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
- Determining the optimal stack size
- Detecting stack overflows.

For cores with multiple stacks, you can select which stack to view.

Stack usage

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 area, without actually modifying any of the bytes near the stack range. Likewise, your application might modify memory within the stack area by mistake.

The Stack window cannot detect a stack overflow when it happens, but can only detect the signs it leaves behind. However, when the graphical stack bar is enabled, the functionality needed to detect and warn about stack overflows is also enabled.

Note: The size and location of the stack is retrieved from the definition of the section holding the stack, 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 section definition in the linker configuration file accordingly; otherwise the Stack window cannot track the stack usage. To read more about this, see the *IAR C/C++ Development Guide for ARM®*.

MEMORY ACCESS CHECKING

The C-SPY simulator 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. Also, a memory access to memory which is not defined is regarded 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 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.

Reference information on memory and registers

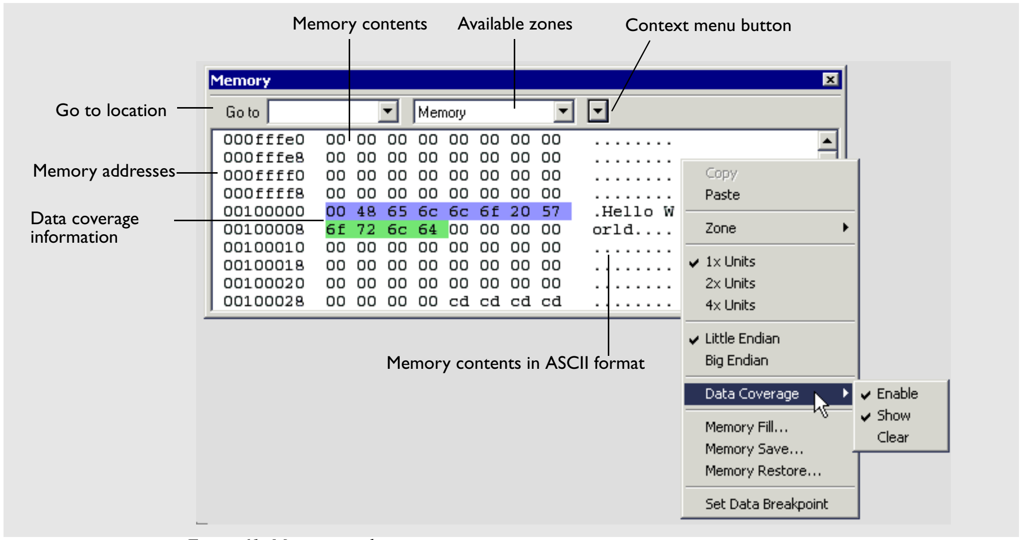
This section gives reference information about these windows and dialog boxes:

- *Memory window*, page 145

- *Memory Save dialog box*, page 148
- *Memory Restore dialog box*, page 149
- *Fill dialog box*, page 150
- *Symbolic Memory window*, page 151
- *Stack window*, page 153
- *Register window*, page 156
- *Memory Access Setup dialog box*, page 158
- *Edit Memory Access dialog box*, page 160.

Memory window

The Memory window is available from the **View** menu.



```
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 61: Memory window

This window gives an up-to-date display of a specified area of memory—a memory zone—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.

To view the memory corresponding to a variable, you can select it in the editor window and drag it to the Memory window.

Toolbar

The toolbar contains:

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	Selects a memory zone to display; see *C-SPY memory zones*, page 143.
Context menu button	Displays the context menu, see *Context menu*, page 147.
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.
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.

Display area

The display area shows the addresses currently being viewed, the memory contents in the format you have chosen, and—provided that the display mode is set to **1x Units**—the memory contents in ASCII format. You can edit the contents of the display area, both in the hexadecimal part and the ASCII part of the area.

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.

Context menu

This context menu is available:

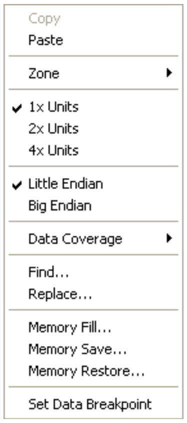


Figure 62: Memory window context menu

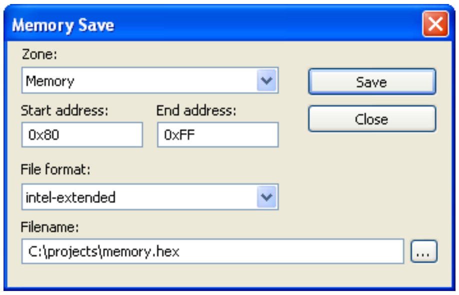
These commands are available:

Copy, Paste	Standard editing commands.
Zone	Selects a memory zone to display; see *C-SPY memory zones*, page 143.
1x Units	Displays the memory contents in units of 8 bits.
2x Units	Displays the memory contents in units of 16 bits.
4x Units	Displays the memory contents in units of 32 bits.
Little Endian	Displays the contents in little-endian byte order.
Big Endian	Displays the contents in big-endian byte order.
Data Coverage	Choose between: **Enable** toggles data coverage on or off. **Show** toggles between showing or hiding data coverage. **Clear** clears all data coverage information. These commands are only available if your C-SPY driver supports data coverage.

Find	Displays a dialog box where you can search for text within the Memory window; read about the **Find** dialog box in the *IDE Project Management and Building Guide for ARM®*.
Replace	Displays a dialog box where you can search for a specified string and replace each occurrence with another string; read about the **Replace** dialog box in the *IDE Project Management and Building Guide for ARM®*.
Memory Fill	Displays a dialog box, where you can fill a specified area with a value, see *Fill dialog box*, page 150.
Memory Save	Displays a dialog box, where you can save the contents of a specified memory area to a file, see *Memory Save dialog box*, page 148.
Memory Restore	Displays a 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 149.
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. For more information, see *Setting a data breakpoint in the Memory window*, page 117.

Memory Save dialog box

The **Memory Save** dialog box is available by choosing **Debug>Memory>Save** or from the context menu in the Memory window.


Memory Save

Zone: Memory

Start address: 0x80

End address: 0xFF

File format: intel-extended

Filename: C:\projects\memory.hex

Figure 63: Memory Save dialog box

Use this dialog box to save the contents of a specified memory area to a file.

Zone

Selects a memory zone.

Start address

Specify the start address of the memory range to be saved.

End address

Specify the end address of the memory range to be saved.

File format

Selects the file format to be used, which is Intel-extended by default.

Filename

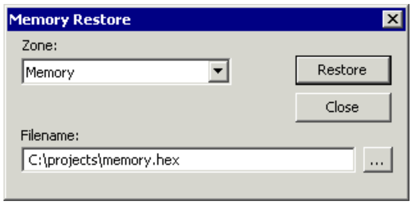
Specify the destination file to be used; a browse button is available for your convenience.

Save

Saves the selected range of the memory zone to the specified file.

Memory Restore dialog box

The **Memory Restore** dialog box is available by choosing **Debug>Memory>Restore** or from the context menu in the Memory window.



Zone: Memory

Filename: C:\projects\memory.hex

Figure 64: Memory Restore dialog box

Use this dialog box to load the contents of a file in Intel-extended or Motorola S-record format to a specified memory zone.

Zone

Selects a memory zone.

Filename

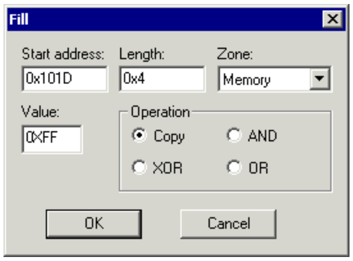
Specify the file to be read; a browse button is available for your convenience.

Restore

Loads the contents of the specified file to the selected memory zone.

Fill dialog box

The **Fill** dialog box is available from the context menu in the Memory window.



Start address: 0x101D
Length: 0x4
Zone: Memory
Value: 0XFF
Operation: [✓ Copy] AND XOR OR

Figure 65: Fill dialog box

Use this dialog box to fill a specified area of memory with a value.

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

Selects a memory zone.

Value

Type the 8-bit value to be used for filling each memory location.

Operation

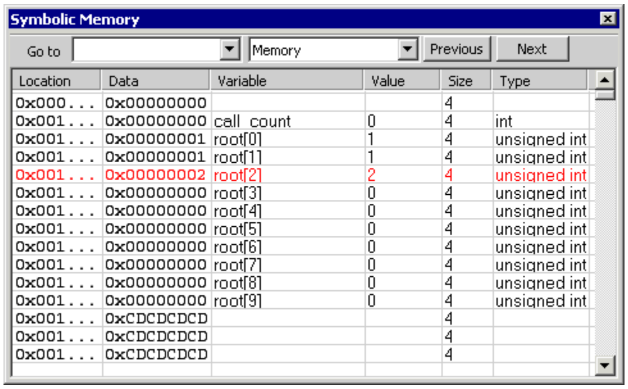
These are the available memory fill operations:

Copy	**Value** will be copied to the specified memory area.
AND	An AND operation will be performed between **Value** and the existing contents of memory before writing the result to memory.

XOR	An `XOR` operation will be performed between **Value** and the existing contents of memory before writing the result to memory.
OR	An `OR` operation will be performed between **Value** and the existing contents of memory before writing the result to memory.

Symbolic Memory window

The Symbolic Memory window is available from the **View** menu when the debugger is running.



Location	Data	Variable	Value	Size	Type
0x000...	0x00000000			4	
0x001...	0x00000000	call count	0	4	int
0x001...	0x00000001	root[0]	1	4	unsigned int
0x001...	0x00000001	root[1]	1	4	unsigned int
0x001...	0x00000002	root[2]	2	4	unsigned int
0x001...	0x00000000	root[3]	0	4	unsigned int
0x001...	0x00000000	root[4]	0	4	unsigned int
0x001...	0x00000000	root[5]	0	4	unsigned int
0x001...	0x00000000	root[6]	0	4	unsigned int
0x001...	0x00000000	root[7]	0	4	unsigned int
0x001...	0x00000000	root[8]	0	4	unsigned int
0x001...	0x00000000	root[9]	0	4	unsigned int
0x001...	0xCDCDCDCD			4	
0x001...	0xCDCDCDCD			4	
0x001...	0xCDCDCDCD			4	

Figure 66: Symbolic Memory window

This window 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 better understanding memory usage or for investigating problems caused by variables being overwritten, for example buffer overruns. Other areas of use are spotting alignment holes or for understanding problems caused by buffers being overwritten.

To view the memory corresponding to a variable, you can select it in the editor window and drag it to the Symbolic Memory window.

Toolbar

The toolbar contains:

Go to	The memory location or symbol you want to view.
Zone display	Selects a memory zone to display; *C-SPY memory zones*, page 143.

Previous	Highlights the previous symbol in the display area.
Next	Highlights the next symbol in the display area.

Display area

This area contains these columns:

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.
Value	The value of the variable. This column is editable.
Type	The type of the variable.

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.

Context menu

This context menu is available:

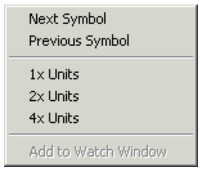


Figure 67: Symbolic Memory window context menu

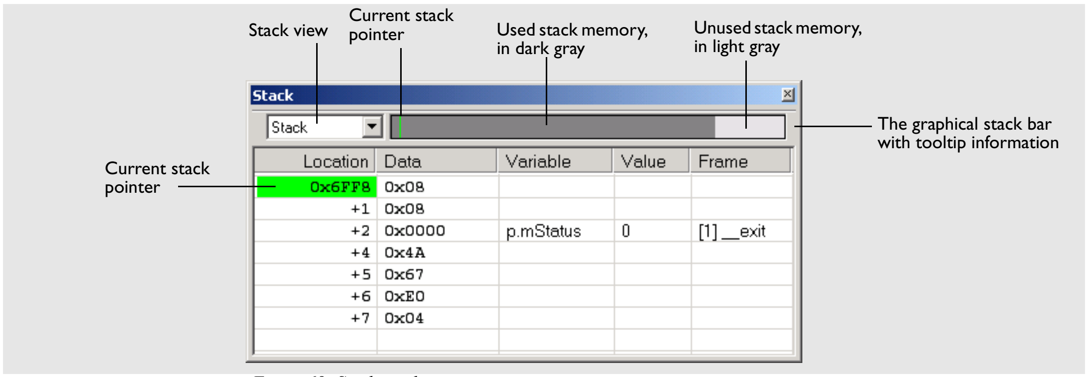
These commands are available:

Next Symbol	Highlights the next symbol in the display area.
Previous Symbol	Highlights the previous symbol in the display area.

1x Units	Displays the memory contents in units of 8 bits. This applies only to rows which do not contain a variable.
2x Units	Displays the memory contents in units of 16 bits.
4x Units	Displays the memory contents in units of 32 bits.
Add to Watch Window	Adds the selected symbol to the Watch window.

Stack window

The Stack window is available from the **View** menu.


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 68: Stack window

This 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.

Overriding the default stack setup

The Stack window retrieves information about the stack size and placement from the definition of the sections holding the stacks made in the linker configuration file. The sections are described in the *IAR C/C++ Development Guide for ARM®*.

For applications that set up the stacks using other mechanisms, it is possible to override the default mechanism. Use one of the C-SPY command line option variants, see *--proc_stack_stack*, page 318.

To view the graphical stack bar:

- Choose **Tools>Options>Stack**.

2 Select the option **Enable graphical stack display and stack usage**.

You can open several Stack windows, each showing a different stack—if several stacks are available—or the same stack with different display settings.

Note: By default, this window uses one physical breakpoint. For more information, see *Breakpoint consumers*, page 113.

For information about options specific to the Stack window, see the *IDE Project Management and Building Guide for ARM®.*

Toolbar

Stack	Selects which stack to view. This applies to cores with multiple stacks.

The graphical stack bar

Displays the state of the stack graphically.

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. The graphical stack bar turns red when the stack usage exceeds a threshold that you can specify.

When the stack bar is enabled, the functionality needed to detect and warn about stack overflows is also enabled.

Place the mouse pointer over the stack bar to get tooltip information about stack usage.

Display area

This area contains these columns:

Location	Displays the location in memory. The addresses are displayed in increasing order. 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 that the call frame corresponds to.

Context menu

This context menu is available:

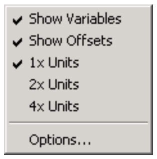


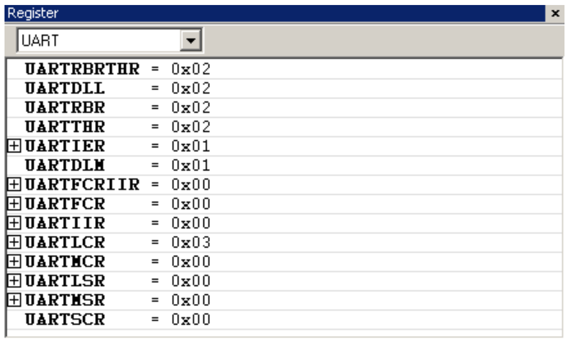
Figure 69: Stack window context menu

These commands are available:

Show variables	Displays separate columns named **Variables**, **Value**, and **Frame** in the Stack window. Variables located at memory addresses listed in the Stack window are displayed in these columns.
Show offsets	Displays locations in the **Location** column as offsets from the stack pointer. When deselected, locations are displayed as absolute addresses.
1x Units	Displays data in the **Data** column as single bytes.
2x Units	Displays data in the **Data** column as 2-byte groups.
4x Units	Displays data in the **Data** column as 4-byte groups.
Options	Opens the **IDE Options** dialog box where you can set options specific to the Stack window, see the *IDE Project Management and Building Guide for ARM®*.

Register window

The Register window is available from the **View** menu.



```
 UARTRBRTHR  = 0x02
 UARTDLL     = 0x02
 UARTRBR     = 0x02
 UARTTHR     = 0x02
⊞UARTIER     = 0x01
 UARTDLM     = 0x01
⊞UARTFCRIIR  = 0x00
⊞UARTFCR     = 0x00
⊞UARTIIR     = 0x00
⊞UARTLCR     = 0x03
⊞UARTMCR     = 0x00
⊞UARTLSR     = 0x00
⊞UARTMSR     = 0x00
 UARTSCR     = 0x00
```

Figure 70: Register window

This window gives an up-to-date display of the contents of the processor registers and special function registers, and allows you to edit their contents. Optionally, you can choose to load either predefined register groups or to define your own application-specific groups

You can open several instances of this window, which is very convenient if you want to keep track of different register groups.

To enable predefined register groups:

1. Select a device description file that suits your device, see *Selecting a device description file*, page 55.
2. The register groups appear in the Register window, provided that they are defined in the device description file. Note that the available register groups are also listed on the **Register Filter** page.

To define application-specific register groups, read about register filter options in the *IDE Project Management and Building Guide for ARM®*.

Toolbar

Drop-down list	Selects which register group to display. By default, there are two register groups in the debugger: **Current CPU Registers** contains the registers that are available in the current processor mode. **CPU Registers** contains both the current registers and their banked counterparts available in other processor modes. Additional register groups are predefined in the device description files—available in the `arm\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.

Display area

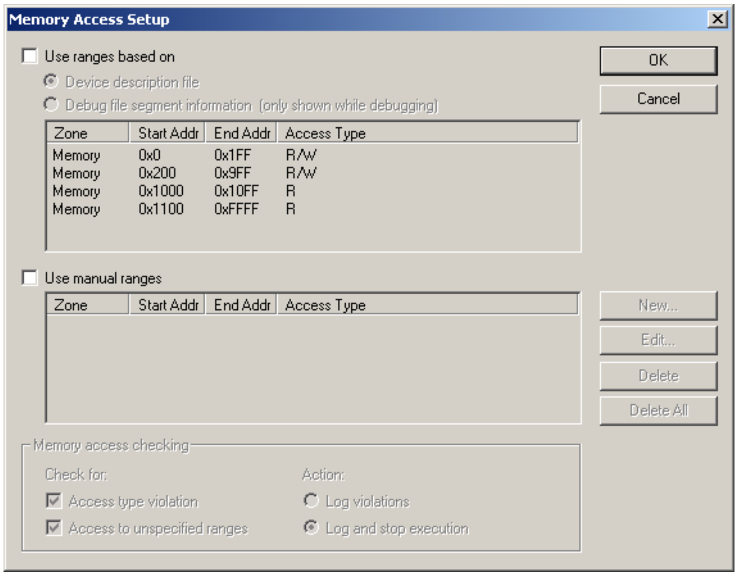
Displays registers and their values. Every time C-SPY stops, a value that has changed since the last stop is highlighted. To edit the contents of a register, click it, and modify the value.

Some registers are expandable, which means that the register contains interesting bits or subgroups of bits.

To change the display format, change the **Base** setting on the **Register Filter** page—available by choosing **Tools>Options**.

Memory Access Setup dialog box

The **Memory Access Setup** dialog box is available from the **Simulator** menu.



☐ Use ranges based on

[● Device description file] ○ Debug file segment information (only shown while debugging)

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

☐ Use manual ranges

Zone	Start Addr	End Addr	Access Type

Memory access checking

Check for:

☑ Access type violation

☑ Access to unspecified ranges

Action:

○ Log violations [● Log and stop execution]

Figure 71: Memory Access Setup dialog box

This dialog box 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.

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 160.

Use ranges based on

Selects any of the predefined alternatives for the memory access setup. Choose between:

Device description file	Loads properties from the device description file.

Debug file segment information	Properties are based on the 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

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 160.

The ranges you define manually are saved between debug sessions.

Memory access checking

Check for determines what to check for;

- Access type violation
- Access to unspecified ranges.

Action selects 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

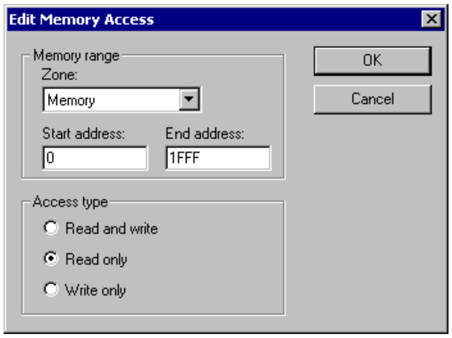
These buttons are available:

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 160.
Edit	Opens the **Edit Memory Access** dialog box, where you can edit the selected memory area. See *Edit Memory Access dialog box*, page 160.
Delete	Deletes the selected memory area definition.
Delete All	Deletes all defined memory area definitions.

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

The **Edit Memory Access** dialog box is available from the **Memory Access Setup** dialog box.



Memory range
Zone: Memory
Start address: 0
End address: 1FFF

Access type
Read and write [✓ Read only] Write only

Figure 72: Edit Memory Access dialog box

Use this dialog box to specify the memory ranges, and assign an access type to each memory range, for which you want to detect illegal accesses during the simulation.

Memory range

Defines the memory area for which you want to check the memory accesses:

Zone	Selects a memory zone; see *C-SPY memory zones*, page 143.
Start address	Specify the start address for the address range, in hexadecimal notation.
End address	Specify the end address for the address range, in hexadecimal notation.

Access type

Selects an access type to the memory range; choose between:

- **Read and write**
- **Read only**
- **Write only**.

Collecting and using trace data

This chapter gives you information about collecting and using trace data in C-SPY®. More specifically, this means:

- Introduction to using trace
- Procedures for using trace
- Reference information on trace.

Introduction to using trace

This section introduces trace.

These topics are covered:

- Reasons for using trace
- Briefly about trace
- Requirements for using trace.

For related information, see also:

- *Data and interrupt logging*, page 217
- *Using the profiler*, page 203.

REASONS FOR USING TRACE

By using trace, you can inspect the program flow up to a specific state, for instance an application crash, and use the trace data to locate the origin of the problem. Trace data can be useful for locating programming errors that have irregular symptoms and occur sporadically.

Reasons for using the J-Link trace triggers and trace filters

By using trace trigger and trace filter conditions, you can select the interesting parts of your source code and use the trace buffer in J-Trace more efficiently. Trace triggers—Trace Start and Trace Stop breakpoints—specify for example a code section for which you want to collect trace data. A trace filter specifies conditions that, when fulfilled, activate the trace data collection during execution.

For ARM7/9 devices, you can specify up to 16 trace triggers and trace filters in total, of which 8 can be trace filters.

For Cortex-M devices, you can specify up to 4 trace triggers and trace filters in total.

BRIEFLY ABOUT TRACE

Your target system must be able to generate trace data. Once generated, C-SPY can collect it and you can visualize and analyze the data in various windows and dialog boxes.

C-SPY supports collecting trace data from these target systems:

- Devices with support for ETM (Embedded Trace Macrocell)—ETM trace
- Devices with support for the SWD (Serial Wire Debug) interface using the SWO (Serial Wire Output) communication channel—SWO trace
- The C-SPY simulator.

Depending on your target system, different types of trace data can be generated.

ETM trace

ETM trace (also known as full trace) is a continuously collected sequence of every executed instruction for a selected portion of the execution. Usually, it is not possible to collect very long sequences of data in real time without saturating the communication channel that transmits the data to C-SPY.

The debug probe contains a trace buffer that collects trace data in real time, but the data is not displayed in the C-SPY windows until after the execution has stopped.

SWO trace

SWO trace is a sequence of events of various kinds, generated by the on-chip debug hardware. The events are transmitted in real time from the target system over the SWO communication channel. This means that the C-SPY windows are continuously updated while the target system is executing. The most important events are:

- PC sampling

  The hardware can sample and transmit the value of the program counter at regular intervals. This is not a continuous sequence of executed instructions (like ETM trace), but a sparse regular sampling of the `PC`. A modern ARM CPU typically executes millions of instructions per second, while the `PC` sampling rate is usually counted in thousands per second.
- Interrupt logs

  The hardware can generate and transmit data related to the execution of interrupts, generating events when entering and leaving an interrupt handler routine.

- Data logs

  Using Data Log breakpoints, the hardware can be configured to generate and transmit events whenever a certain variable, or simply an address range, is accessed by the CPU.

The SWO channel does not have unlimited throughput, so it is usually not possible to use all the above features at the same time, at least not if either the frequency of PC sampling, of interrupts, or of accesses to the designated variables is high.

Trace features in C-SPY

In C-SPY, you can use the trace-related windows Trace, Function Trace, Timeline, and Find in Trace. In the C-SPY simulator, you can also use the Trace Expressions window. Depending on your C-SPY driver, you can set various types of trace breakpoints and triggers to control the collection of trace data.

In addition, several other features in C-SPY also use trace data, features such as the Profiler, Code coverage, and Instruction profiling.

If you use the C-SPY J-Link/J-Trace driver, you have access to windows such as the Interrupt Log, Interrupt Log Summary, Data Log, and Data Log Summary windows.

When you are debugging, two buttons labeled **ETM** and **SWO**, respectively, are visible on the IDE main window toolbar. If any of these buttons is green, it means that the corresponding trace hardware is generating trace data. Just point at the button with the mouse pointer to get detailed tooltip information about which C-SPY features that have requested trace data generation. This is useful, for example, if your SWO communication channel often overflows because too many of the C-SPY features are currently using trace data. Clicking on the buttons opens the corresponding setup dialog boxes.

REQUIREMENTS FOR USING TRACE

To use trace-related functionality in C-SPY, you need debug components (hardware, a debug probe, and a C-SPY driver) that all support trace. Alternatively, you can use the trace features provided by the C-SPY simulator.

Note: The specific set of debug components you are using determine which of the trace features in C-SPY that are supported.

Requirements for using ETM trace

ETM trace is available for some ARM devices.

To use ETM trace you need one of these combinations:

- A J-Trace debug probe and a device that supports ETM. Make sure to use the C-SPY J-Link/J-Trace driver.
- A J-Link debug probe and a device that supports ETM with ETB (Embedded Trace Buffer). Make sure to use the C-SPY J-Link/J-Trace driver.
- The C-SPY RDI driver, and a debug probe and a device that both support ETM.

Requirements for using SWO trace

To use SWO trace you need a J-Link or J-Trace debug probe that supports the SWO communication channel and a device that supports the SWD/SWO interface.

Requirements for using the J-Link trace triggers and trace filters

The trace triggering and trace filtering features are available only for J-Trace and when using an ARM7/9 or Cortex-M device.

Procedures for using trace

This section gives you step-by-step descriptions about how to collect and use trace data.

More specifically, you will get information about:

- Getting started with trace in the C-SPY simulator
- Getting started with ETM trace
- Getting started with SWO trace
- Setting up concurrent use of ETM and SWO
- Trace data collection using breakpoints
- Searching in trace data
- Browsing through trace data
- Reference information on trace.

GETTING STARTED WITH TRACE IN THE C-SPY SIMULATOR

To collect trace data using the C-SPY simulator, no specific build settings are required.

1 After you have built your application and started C-SPY, choose **Simulator>Trace** to open the Trace window, and click the **Activate** button to enable collecting trace data.

2 Start the execution. When the execution stops, for instance because a breakpoint is triggered, trace data is displayed in the Trace window. For more information about the window, see *Trace window*, page 176.

GETTING STARTED WITH ETM TRACE

To set up ETM trace, follow these steps:

1 Before you start C-SPY:

- For the C-SPY RDI driver, choose **Project>Options>RDI>ETM trace**
- For J-Trace no specific settings are required before starting C-SPY
- The trace port must be set up. For some devices this is done automatically when the trace logic is enabled. However, for some devices, typically Atmel and ST devices based on ARM 7 or ARM 9, you need to set up the trace port explicitly. You do this by means of a C-SPY macro file. You can find examples of such files (`ETM_init*.mac`) in the example projects. To use a macro file, choose **Project>Options>Debugger>Setup>Use macro files**. Specify your macro file; a browse button is available for your convenience.

  Note that the pins used on the hardware for the trace signals cannot be used by your application.

2 After you have started C-SPY, choose **Trace Settings** from the driver-specific menu. In the **Trace Settings** dialog box that appears, check if you need to change any of the default settings. For details, see *ETM Trace Settings dialog box*, page 169.

3 Open the Trace window—available from the driver-specific menu—and click the **Activate** button to enable trace data collection.

4 Start the execution. When the execution stops, for instance because a breakpoint is triggered, trace data is displayed in the Trace window. For more information about the window, see *Trace window*, page 176.

GETTING STARTED WITH SWO TRACE

To set up SWO trace, follow these steps:

1 Before you start C-SPY, choose **Project>Options>J-Link/J-Trace** and click the **Connection** tab. Choose **Interface>SWD**.

2 After you have started C-SPY, choose **SWO Trace Windows Settings** from the **J-Link** menu. In the **SWO Trace Windows Settings** dialog box that appears, make your settings for controlling the output in the Trace window. For details, see *SWO Trace Window Settings dialog box*, page 171.

3 To configure the hardware's generation of trace data, click the **SWO Configuration** button available in the **SWO Configuration** dialog box. For details, see *SWO Configuration dialog box*, page 173.

Note specifically these settings:

- The value of the **CPU clock** option must reflect the frequency of the CPU clock speed at which the application executes. Note also that the settings you make are preserved between debug sessions.
- To decrease the amount of transmissions on the communication channel, you can disable the **Timestamp** option. Alternatively, set a lower rate for PC Sampling or use a higher SWO clock frequency.

4 Open the Trace window—available from the **J-Link/J-Trace** menu—and click the **Activate** button to enable trace data collection.

5 Start the execution. The Trace window is continuously updated with trace data. For more information about this window, see *Trace window*, page 176.

SETTING UP CONCURRENT USE OF ETM AND SWO

If you have a J-Trace debug probe for Cortex-M3, you can use ETM trace and SWO trace concurrently.

In this case, if you activate the ETM trace and the SWO trace, SWO trace data will also be collected in the ETM trace buffer, instead of being streamed via the SWO channel. This means that the SWO trace data will not be displayed until the execution has stopped, instead of being continuously updated live in the Trace window.

TRACE DATA COLLECTION USING BREAKPOINTS

A convenient way to collect trace data between two execution points is to start and stop the data collection using dedicated breakpoints. Choose between these alternatives:

- In the editor or Disassembly window, position your insertion point, right-click, and toggle a **Trace Start** or **Trace Stop** breakpoint from the context menu.
- In the Breakpoints window, choose **Trace Start**, **Trace Stop**, or **Trace Filter**.
- The C-SPY system macros `__setTraceStartBreak` and `__setTraceStopBreak` can also be used.

For details about these breakpoints, see *Trace Start breakpoints dialog box (simulator)*, page 190 and *Trace Stop breakpoints dialog box (simulator)*, page 194, respectively.

Using the J-Link trace triggers and trace filters:

1 Use the **Trace Start** dialog box to set a start condition—a start trigger—to start collecting trace data.

2 Use the **Trace Stop** dialog box to set a stop condition—a stop trigger—to stop collecting trace data.

3 Optionally, set additional conditions for the trace data collection to continue. Then set one or more trace filters, using the **Trace Filter** dialog box.

4 If needed, set additional trace start or trace stop conditions.

5 Enable the Trace window and start the execution.

6 Stop the execution.

7 You can view the trace data in the Trace window and in browse mode also in the Disassembly window, where also the trace marks for your trace triggers and trace filters are visible.

8 If you have set a trace filter, the trace data collection is performed while the condition is true plus some further instructions. When viewing the trace data and looking for a certain data access, remember that the access took place one instruction earlier.

SEARCHING IN TRACE DATA

When you have collected trace data, you can perform searches in the collected data to locate the parts of your code or data that you are interested in, for example, a specific interrupt or accesses of a specific variable.

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.

To search in your trace data, follow these steps:

1 In the Trace window toolbar, click the **Find** button.

2 In the **Find in Trace** dialog box, specify your search criteria.

Typically, you can choose to search for:

- A specific piece of text, for which you can apply further search criteria
- An address range
- A combination of these, like a specific piece of text within a specific address range.

For detailed information about the different options, see *Find in Trace dialog box*, page 201.

3 When you have specified your search criteria, click **Find**. The Find in Trace window is displayed, which means you can start analyzing the trace data. For detailed reference information, see *Find in Trace window*, page 202.

BROWSING THROUGH TRACE DATA

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 data 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. This is like stepping backward and forward through the execution history.

Double-click again to leave browse mode.

Reference information on trace

This section gives reference information about these windows and dialog boxes:

- *ETM Trace Settings dialog box*, page 169
- *SWO Trace Window Settings dialog box*, page 171
- *SWO Configuration dialog box*, page 173
- *Trace window*, page 176
- *Function Trace window*, page 181
- *Timeline window*, page 182
- *Power Log window*, page 187
- *Trace Start breakpoints dialog box (simulator)*, page 190 (for the C-SPY simulator only)
- *Trace Start breakpoints dialog box (J-Link/J-Trace)*, page 191 (for the C-SPY J-Link/J-Trace driver only)
- *Trace Stop breakpoints dialog box (simulator)*, page 194 (for the C-SPY simulator only)
- *Trace Stop breakpoints dialog box (J-Link/J-Trace)*, page 195 (for the C-SPY J-Link/J-Trace driver only)
- *Trace Filter breakpoints dialog box*, page 197 (for the C-SPY J-Link/J-Trace driver only)
- *Trace Expressions window*, page 200 (for the C-SPY simulator only)
- *Find in Trace dialog box*, page 201
- *Find in Trace window*, page 202.

ETM Trace Settings dialog box

The **ETM Trace Settings** dialog box is available from the driver-specific menu.

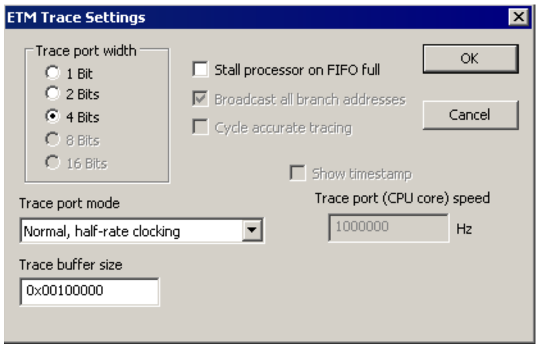


Figure 73: ETM Trace Settings dialog box

Note: This dialog box looks slightly different for the RDI drivers.

Use this dialog box to configure ETM trace generation and collection.

See also *Getting started with ETM trace*, page 165.

Trace port width

Specifies the trace bus width, which can be set to 1, 2, 4, 8, or 16 bits. The value must correspond with what is supported by the hardware and the debug probe. For Cortex-M3, 1, 2, and 4 bits are supported by the J-Trace debug probe. For ARM7/9, only 4 bits are supported by the J-Trace debug probe.

Trace port mode

Specifies the used trace clock rate:

- Normal, full-rate clocking
- Normal, half-rate clocking
- Multiplexed
- Demultiplexed
- Demultiplexed, half-rate clocking.

Note: For RDI drivers, only the two first alternatives are available. For the J-Trace driver, the available alternatives depend on the device you are using.

Trace buffer size

Specify the size of the trace buffer. By default, the number of trace frames is `0x10000`. For ARM7/9 the maximum number is `0x100000`, and for Cortex-M3 the maximum number is `0x400000`.

For ARM7/9, one trace frame corresponds to 2 bytes of the physical J-Trace buffer size. For Cortex-M3, one trace frame corresponds to approximately 1 byte of the buffer size.

Note: The **Trace buffer size** option is only available for the J-Trace driver.

Cycle accurate tracing

Emits trace frames synchronous to the processor clock even when no trace data is available. This makes it possible to use the trace data for real-time timing calculations. However, if you select this option, the risk for FIFO buffer overflow increases.

Note: This option is only available for ARM7/9 devices.

Broadcast all branches

Makes the processor send more detailed address trace information. However, if you select this option, the risk for FIFO buffer overflow increases.

Note: This option is only available for ARM7/9 devices. For Cortex, this option is always enabled.

Stall processor on FIFO full

Stalls the processor in case the FIFO buffer fills up. The trace FIFO buffer might in some situations become full—FIFO buffer overflow—which means trace data will be lost.

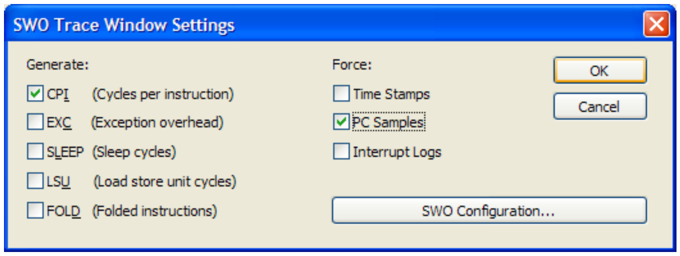
Show timestamp

Makes the Trace window display seconds instead of cycles in the **Index** column. To make this possible you must also specify the appropriate speed for your CPU in the **Trace port (CPU core) speed** text box.

Note: This option is only available when you use the J-Trace driver with ARM7/9 devices.

SWO Trace Window Settings dialog box

The **SWO Trace Window Settings** dialog box is available from the **J-Link** menu, alternatively from the SWO Trace window toolbar.



Generate:

- [✓] CPI (Cycles per instruction)
- [ ] EXC (Exception overhead)
- [ ] SLEEP (Sleep cycles)
- [ ] LSU (Load store unit cycles)
- [ ] FOLD (Folded instructions)

Force:

- [ ] Time Stamps
- [✓] PC Samples
- [ ] Interrupt Logs

Figure 74: SWO Trace Window Settings dialog box

Use this dialog box to specify what to display in the Trace window.

Note that you also need to configure the generation of trace data, click **SWO Configuration**. For more information, see *SWO Configuration dialog box*, page 173.

Force

Enables data generation, if it is not already enabled by other features using SWO trace data. The Trace window displays all generated SWO data. Other features in C-SPY, for example Profiling, can also enable SWO trace data generation. If no other feature has enabled the generation, use the **Force** options to generate SWO trace data.

The generated data will be displayed in the Trace window. Choose between:

Time Stamps	Enables timestamps for various SWO trace packets, that is sent over the SWO communication channel. Use the resolution drop-down list to choose the resolution of the timestamp value. For example, 1 to count every cycle, or 16 to count every 16th cycle. Note that the lowest resolution is only useful if the time between each event packet is long enough. 16 is useful if using a low SWO clock frequency.
PC samples	Enables sampling the program counter register, PC, at regular intervals. To choose the sampling rate, see *PC Sampling*, page 173.
Interrupt Logs	Enables generation of interrupt logs. For information about other C-SPY features that also use trace data for interrupts, see *Data and interrupt logging*, page 217.

Generate

Enables trace data generation for these events. The generated data will be displayed in the Trace window. The value of the counters are displayed in the **Comment** column in the SWO Trace window. Choose between:

CPI	Enables generation of trace data for the CPI counter.
EXC	Enables generation of trace data for the EXC counter.
SLEEP	Enables generation of trace data for the SLEEP counter.
LSU	Enables generation of trace data for the LSU counter.
FOLD	Enables generation of trace data for the FOLD counter.

Trace buffer size

Specify the size of the trace buffer. By default, the number of trace frames is `0xFFFF`. For ARM7/9 the maximum number is `0xFFFFF`, and for Cortex-M3 the maximum number is `0x3FFFFF`.

For ARM7/9, one trace frame corresponds to 2 bytes of the physical J-Trace buffer size. For Cortex-M3, one trace frame corresponds to approximately 1 byte of the buffer size.

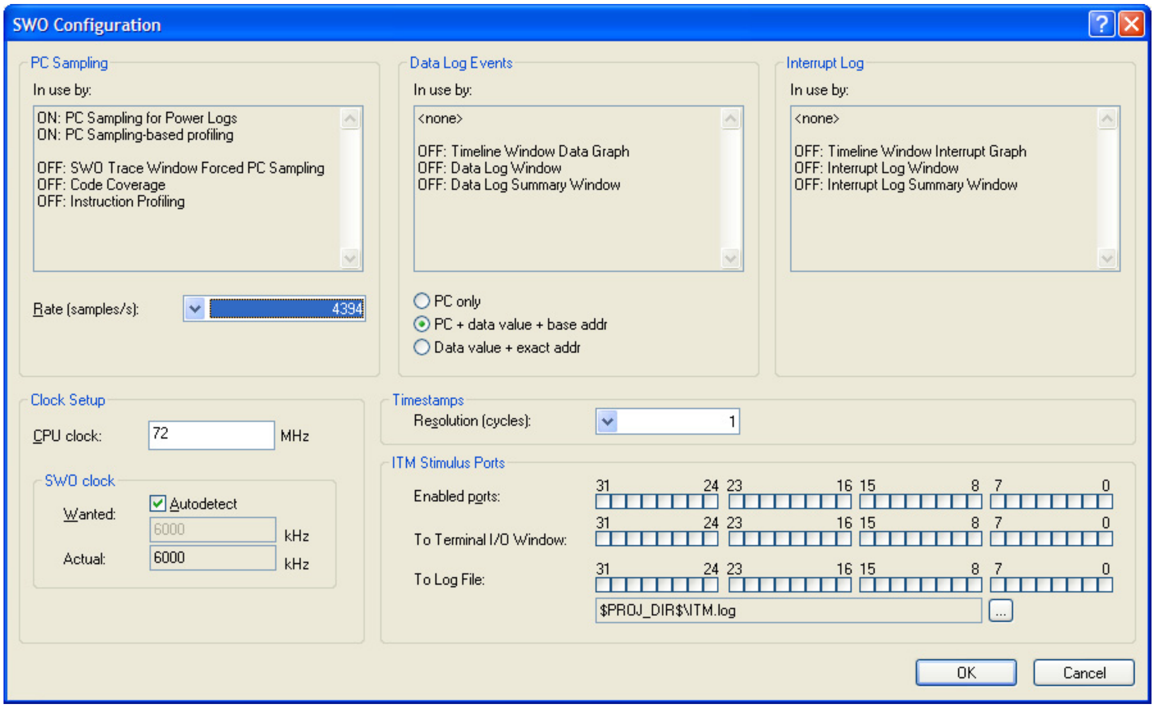
Note: The **Trace buffer size** option is only available for the J-Trace driver.

SWO Configuration

Displays the **SWO Configuration** dialog box where you can configure the hardware's generation of trace data. See *SWO Configuration dialog box*, page 173.

SWO Configuration dialog box

The **SWO Configuration** dialog box is available from the **J-Link** menu, alternatively from the **SWO Trace Window Settings** dialog box.



SWO Configuration

PC Sampling

In use by:

ON: PC Sampling for Power Logs
ON: PC Sampling-based profiling

OFF: SWO Trace Window Forced PC Sampling
OFF: Code Coverage
OFF: Instruction Profiling

Rate (samples/s): 4394

Data Log Events

In use by:

<none>

OFF: Timeline Window Data Graph
OFF: Data Log Window
OFF: Data Log Summary Window

PC only [✓ PC + data value + base addr] Data value + exact addr

Interrupt Log

In use by:

<none>

OFF: Timeline Window Interrupt Graph
OFF: Interrupt Log Window
OFF: Interrupt Log Summary Window

Clock Setup

CPU clock: 72 MHz

SWO clock

Wanted: [✓ Autodetect] 6000 kHz

Actual: 6000 kHz

Timestamps

Resolution (cycles): 1

ITM Stimulus Ports

Enabled ports: 31 24 23 16 15 8 7 0

To Terminal I/O Window: 31 24 23 16 15 8 7 0

To Log File: 31 24 23 16 15 8 7 0

$PROJ_DIR$\ITM.log

Figure 75: SWO Configuration dialog box

Use this dialog box to configure the serial-wire output communication channel and the hardware's generation of trace data.

See also *Getting started with SWO trace*, page 165.

PC Sampling

Controls the behavior of the sampling of the program counter. You can specify:

In use by	Lists the features in C-SPY that can use trace data for PC Sampling. ON indicates features currently using trace data. OFF indicates features currently not using trace data.

Rate	Use the drop-down list to choose the sampling rate, that is, the number of samples per second. The highest possible sampling rate depends on the SWO clock value and on how much other data that is sent over the SWO communication channel. The higher values in the list will not work if the SWO communication channel is not fast enough to handle that much data.

Data Log Events

Specifies what to log when a Data Log breakpoint is triggered. These items are available:

In use by	Lists the features in C-SPY hat can use trace data for Data Log Events. On indicates features currently using trace data. OFF indicates features currently not using trace data.
PC only	Logs the value of the program counter.
PC + data value + base addr	Logs the value of the program counter, the value of the data object, and its base address.
Data value + exact addr	Logs the value of the data object and the exact address of the data object that was accessed.

Interrupt Log

Lists the features in C-SPY that can use trace data for Interrupt Logs. ON indicates features currently using trace data. OFF indicates features currently not using trace data.

For more information about interrupt logging, see *Data and interrupt logging*, page 217.

CPU clock

Specify the exact clock frequency used by the internal processor clock, `HCLK`, in MHz. The value can have decimals.

This value is used for configuring the SWO communication speed and for calculating time stamps.

SWO clock

Specify the clock frequency of the SWO communication channel in kHz. Choose between:

Autodetect	Automatically uses the highest possible frequency that the J-Link debug probe can handle. When it is selected, the **Wanted** text box displays that frequency.
Wanted	Manually selects the frequency to be used, if **Autodetect** is not selected. The value can have decimals. Use this option if data packets are lost during transmission.
Actual	Displays the frequency that is actually used. This can differ a little from the wanted frequency.

Timestamps

Selects the resolution of the timestamp value. For example, 1 to count every cycle, or 16 to count every 16th cycle. Note that the lowest resolution is only useful if the time between each event packet is long enough.

ITM Stimulus Ports

Selects which ports you want to redirect and to where. The ITM Stimulus Ports are used for sending data from your application to the debugger host without stopping the program execution. There are 32 such ports. Choose between:

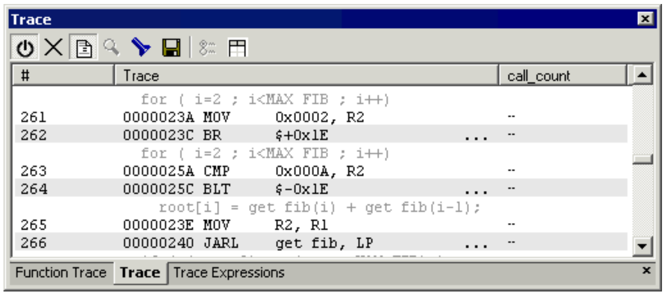
Enabled ports	Enables the ports to be used. Only enabled ports will actually send any data over the SWO communication channel to the debugger.
To Terminal I/O window	Specifies the ports to use for routing data to the Terminal I/O window.
To Log File	Specifies the ports to use for routing data to a log file. To use a different log file than the default one, use the browse button.

The `stdout` and `stderr` of your application can be routed via SWO to the C-SPY Terminal I/O window, instead of via semihosting. To achieve this, choose **Project>Options>General Options>Library Configuration>Library low-level interface implementation>stdout/stderr>Via SWO**. This will significantly improve the performance of `stdout`/`stderr`, compared to when semihosting is used.

This can be disabled if you deselect the port settings in the **Enabled ports** and **To Terminal I/O** options.

Trace window

The Trace window is available from the *C-SPY driver* menu when you are using the C-SPY simulator or any driver that supports trace.



```
#            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 76: The Trace window in the simulator

Note: There are three different Trace windows—ETM Trace, SWO Trace, and just Trace for the C-SPY simulator. The windows look slightly different.

This window displays the collected trace data, where the content differs depending on the C-SPY driver you are using and the trace support of your debug probe:

C-SPY simulator	The window displays a collected sequence of executed machine instructions. In addition, the window can display trace data for expressions.
ETM trace	The window displays the sequence of executed instructions—optionally with embedded source—which has been continuously collected during application execution, that is *full trace*. The data has been collected in the ETM trace buffer. The collected data is displayed after the execution has stopped. For information about the requirements for using ETM trace, see *Requirements for using ETM trace*, page 163.

SWO trace	The window displays all events transmitted on the SWO channel. The data is streamed from the target system, via the SWO communication channel, and continuously updated live in the Trace window. Note that if you use the SWO communication channel on a trace probe, the data will be collected in the trace buffer and displayed after the execution has stopped. For information about the requirements for using SWO trace, see *Requirements for using SWO trace*, page 164.

Trace toolbar

The toolbar in the Trace window and in the Function trace window contains:

Enable/Disable	Enables and disables collecting and viewing trace data in this window. 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 the corresponding source code.
Browse	Toggles browse mode on or off for a selected item in the Trace window; see *Browsing through trace data*, page 168.
Find	Displays a dialog box where you can perform a search; see *Find in Trace dialog box*, page 201.
Save	In the ETM Trace and SWO Trace windows this button displays the Trace Save dialog box, see *Trace Save dialog box*, page 180. In the C-SPY simulator this button displays a standard **Save As** dialog box where you can save the collected trace data to a text file, with tab-separated columns.

Edit Settings	In the ETM Trace window this button displays the **Trace Settings** dialog box, see *ETM Trace Settings dialog box*, page 169. In the SWO Trace window this buttons displays the **SWO Trace Window Settings** dialog box, see *SWO Trace Window Settings dialog box*, page 171. In the C-SPY RDI driver, this button is not available. In the C-SPY simulator this button is not enabled.
Edit Expressions (C-SPY simulator only)	Opens the Trace Expressions window; see *Trace Expressions window*, page 200.

Display area (in the C-SPY simulator)

This area contains these columns for the C-SPY simulator:

#	A serial number for each row in the trace buffer. Simplifies the navigation within the buffer.
Cycles	The number of cycles elapsed to this point.
Trace	The collected sequence of executed machine instructions. Optionally, the corresponding source code can also be displayed.
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 collect trace data in the Trace Expressions window; see *Trace Expressions window*, page 200.

Display area (for ETM trace)

This area contains these columns for ETM trace:

Index	A number that corresponds to each packet. Examples of ETM packets are instructions, synchronization points, and exception markers.

Frame|Time	When collecting trace data in cycle-accurate mode (requires ARM7/9)—enable **Cycle accurate tracing** in the **ETM Trace Settings** dialog box—the value corresponds to the number of elapsed cycles since the start of the execution. This column is only available for the J-Link/J-Trace driver. When collecting trace data in non-cycle-accurate mode, the value corresponds to an approximate amount of cycles. For Cortex-M devices, the value is repeatedly calibrated with the actual number of cycles. When the **Show timestamp** option is selected in the **ETM Trace Settings** dialog box, the value displays the time instead of cycles. To display the value as time requires collecting data in cycle-accurate mode, see *Cycle accurate tracing*, page 170, and the J-Link/J-Trace driver.
Address	The address of the executed instruction.
Opcode	The operation code of the executed instruction.
Trace	The collected sequence of executed machine instructions. Optionally, the corresponding source code can also be displayed.
Comment	This column is only available for the J-Link/J-Trace driver.

Note: For RDI drivers, this window looks slightly different.

Display area (for SWO trace)

This area contains these columns for SWO trace:

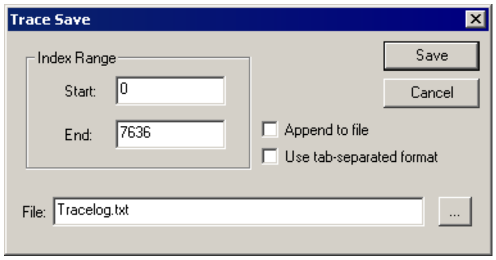
Index	An index number for each row in the trace buffer. Simplifies the navigation within the buffer.
SWO Packet	The contents of the captured SWO packet.
Cycles	The approximate number of cycles from the start of the execution until the event.

Event	The event type of the captured SWO packet. If the column displays `Overflow`, the data packet could not be sent, because too many SWO features use the SWO channel at the same time. To decrease the amount of transmissions on the communication channel, point at the SWO button—on the IDE main window toolbar—with the mouse pointer to get detailed tooltip information about which C-SPY features that have requested trace data generation. Disable some of the features.
Value	The event value, if any.
Trace	If the event is a sampled `PC` value, the instruction is displayed in this column. Optionally, the corresponding source code can also be displayed.
Comment	Additional information. This includes the values of the selected Trace Events counters, or the number of the comparator (hardware breakpoint) used for the Data Log breakpoint.

If the display area seems to show garbage, make sure you specified a correct value for the **CPU clock** in the **SWO Configuration** dialog box.

Trace Save dialog box

The **Trace Save** dialog box is available from the driver-specific menu, and from the Trace window and the SWO Trace window.



Start: 0
End: 7636
File: Tracelog.txt

Figure 77: Trace Save dialog box

Index Range

Saves a range of frames to a file. Specify a start index and an end index (as numbered in the index column in the Trace window).

Append to file

Appends the trace data to an existing file.

Use tab-separated format

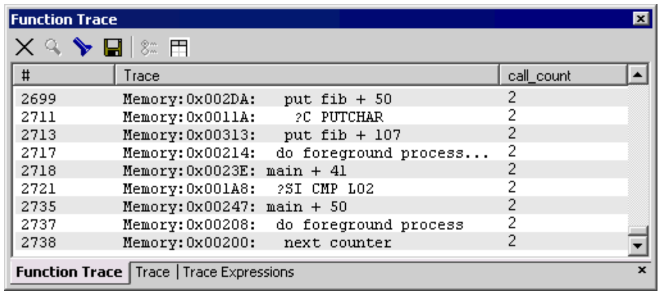
Saves the content in columns that are tab-separated, instead of separated by white spaces.

File

Specify a file for the trace data.

Function Trace window

The Function Trace window is available from the *C-SPY driver* menu when you are using the C-SPY simulator or any driver that supports ETM trace.



#	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 78: Function Trace window

This window 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.

Toolbar

For information about the toolbar, see *Trace toolbar*, page 177.

Display area

For information about the columns in the display area, see:

- *Display area (in the C-SPY simulator)*, page 178
- *Display area (for ETM trace)*, page 178.

Timeline window

The Timeline window is available from the *C-SPY driver* menu during a debug session.

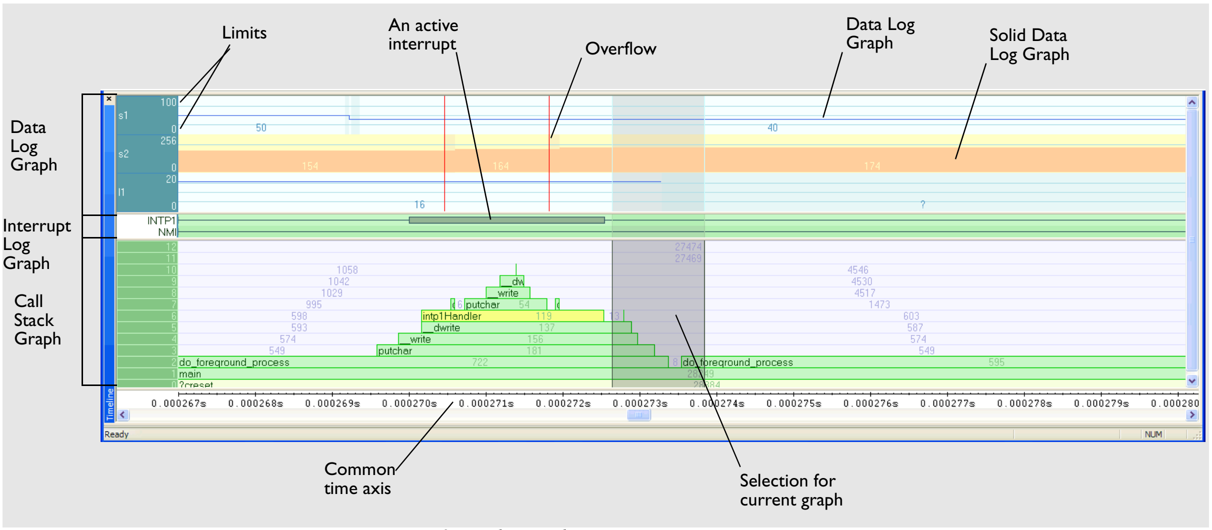


Figure 79: Timeline window

This window displays trace data—for interrupt logs, data logs, and for the call stack—as graphs in relation to a common time axis.

Display area

The display area can be populated with different graphs:

- Interrupt Log Graph
- Data Log Graph
- Call Stack Graph
- Power Log Graph.

At the bottom of the window, there is a common time axis that uses seconds as the time unit.

Interrupt Log Graph

The Interrupt Log Graph displays interrupts reported by SWO trace or by the C-SPY simulator. In other words, the graph provides a graphical view of the interrupt events during the execution of your application, where:

- The label area at the left end of the graph shows the names of the interrupts.
- The graph itself shows active interrupts as a thick green horizontal bar. This graph is a graphical representation of the information in the Interrupt Log window, see *Interrupt Log window*, page 224.

Data Log Graph

The Data Log Graph displays the data logs generated by SWO trace or by the C-SPY simulator, for up to four different variables or address ranges specified as Data Log breakpoints, where:

- Each graph is labeled with—in the left-side area—the variable name or address for which you have specified the Data Log breakpoint.
- The graph itself displays how the value of the variable changes over time. The label area also displays the limits, or range, of the Y-axis for a variable. You can use the context menu to change these limits. The graph can be displayed either as a thin line or as a color-filled solid graph. The graph is a graphical representation of the information in the Data Log window, see *Data Log window*, page 220.
- A red vertical line indicates overflow, which means that the communication channel failed to transmit all data logs from the target system.

Call Stack Graph

The Call Stack Graph displays the sequence of calls and returns collected by ETM trace. At the bottom of the graph you will usually find `main`, and above it, the functions called from `main`, and so on. The horizontal bars, which represent invocations of functions, use four different colors:

- Medium green for normal C functions with debug information
- Light green for functions known to the debugger only through an assembler label
- Medium or light yellow for interrupt handlers, with the same distinctions as for green.

The numbers represent the number of cycles spent in, or between, the function invocations.

Power Log Graph

The Power Log Graph displays power measurement samples generated by the debug probe or associated hardware.

Selection and navigation

Click and drag to select. The selection extends vertically over all graphs, but appears highlighted in a darker color for the selected graph. You can navigate backward and forward in the selected graph using the left and right arrow keys. Use the Home and End keys to move to the first or last relevant point, respectively. Use the navigation keys in combination with the Shift key to extend the selection.

Context menu

This context menu is available:

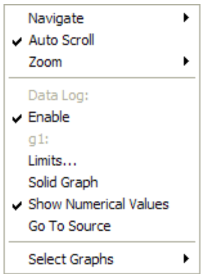


Figure 80: Timeline window context menu for the Data Log Graph

Note: The context menu contains some commands that are common to all graphs and some commands that are specific to each graph. The figure reflects the context menu for the Data Log Graph, which means that the menu looks slightly different for the other graphs.

These commands are available:

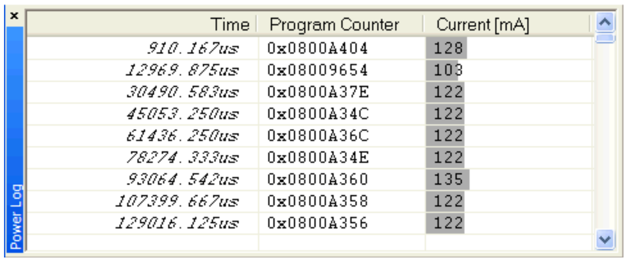
Navigate	All graphs	Commands for navigating over the graph(s); choose between: **Next** moves the selection to the next relevant point in the graph. Shortcut key: right arrow. **Previous** moves the selection backward to the previous relevant point in the graph. Shortcut key: left arrow. **First** moves the selection to the first data entry in the graph. Shortcut key: Home. **Last** moves the selection to the last data entry in the graph. Shortcut key: End. **End** moves the selection to the last data in any displayed graph, in other words the end of the time axis. Shortcut key: Ctrl+End.
Auto Scroll	All graphs	Toggles auto scrolling on or off. When on, the most recent collected data is automatically displayed.
Zoom	All graphs	Commands for zooming the window, in other words, changing the time scale; choose between: **Zoom to Selection** makes the current selection fit the window. Shortcut key: Return. **Zoom In** zooms in on the time scale. Shortcut key: +. **Zoom Out** zooms out on the time scale. Shortcut key: -. **10ns**, **100ns**, **1us**, etc makes an interval of 10 nanoseconds, 100 nanoseconds, 1 microsecond, respectively, fit the window. **1ms**, **10ms**, etc makes an interval of 1 millisecond or 10 milliseconds, respectively, fit the window. **10m**, **1h**, etc makes an interval of 10 minutes or 1 hour, respectively, fit the window.
Data Log	Data Log Graph	A heading that shows that the Data Log-specific commands below are available.

Power Log	Power Log Graph	A heading that shows that the Power Log-specific commands below are available.
Call Stack	Call Stack Graph	A heading that shows that the Call stack-specific commands below are available.
Interrupt	Interrupt Log Graph	A heading that shows that the Interrupt Log-specific commands below are available.
Enable	All graphs	Toggles the display of the graph on or off. If you disable a graph, that graph will be indicated as `OFF` in the Timeline window. If no trace data has been collected for a graph, *no data* will appear instead of the graph.
Variable	Data Log Graph	The name of the variable for which the Data Log-specific commands below apply. This menu command is context-sensitive, which means it reflects the Data Log Graph you selected in the Timeline window (one of up to four).
Limits	Data Log Graph	Specifies the limits, or value range, of the graph.
Solid Graph	Data Log Graph	Displays the graph as a color-filled solid graph instead of as a thin line.
Viewing range	Data and Power Log Graph	Displays a dialog box, see *Viewing Range dialog box*, page 189.
Size	Data and Power Log Graph	Determines the vertical size of the graph; choose between **Small**, **Medium**, and **Large**.
Show Numerical Value	Data and Power Log Graph	Shows the numerical value of the variable, in addition to the graph.
Go To Source	Common	Displays the corresponding source code in an editor window, if applicable.
Select Graphs	Common	Selects which graphs to be displayed in the Timeline window.
Time Axis Unit	Common	Selects the unit used in the time axis; choose between **Seconds** and **Cycles**.

Profile Selection	Common	Enables profiling time intervals in the Function Profiler window. Note that this command is only available if the C-SPY driver supports PC Sampling.

Power Log window

The Power Log window is available from the **J-Link** menu during a debug session.



Time	Program Counter	Current [mA]
910.167us	0x0800A404	128
12969.875us	0x08009654	103
30490.583us	0x0800A37E	122
45053.250us	0x0800A34C	122
61436.250us	0x0800A36C	122
78274.333us	0x0800A34E	122
93064.542us	0x0800A360	135
107399.667us	0x0800A358	122
129016.125us	0x0800A356	122

Figure 81: Power Log window

This window displays generated power samples.

Display area

This area contains these columns:

Time	The time for the data access, based on the clock frequency specified in the **SWO Configuration** dialog box. If the time is displayed in italics, the target system has not been able to collect a correct time, but instead had to approximate it. This column is available when you have selected **Show time** from the context menu.
Cycles	The number of cycles from the start of the execution until the event. This information is cleared at reset. If a cycle is displayed in italics, the target system has not been able to collect a correct time, but instead had to approximate it. This column is available when you have selected **Show cycles** from the context menu.

Program Counter	Displays one of these: An address, which is the content of the `PC`, that is, the address of the instruction that performed the memory access. `---`, the target system failed to provide the debugger with any information. `Overflow` in red, the communication channel failed to transmit all data from the target system. `Idle`, the log is sampled during idle mode.
Current [mA]	The power measurement value, expressed in milliampere. The gray area graphically visualizes the power value in percentage of the factory setting received from the properties of the measuring hardware; see *Viewing Range dialog box*, page 189.

Context menu

This context menu is available:

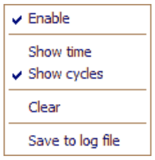


Figure 82: Power Log window context menu

Note: The commands are the same in each window, but they only operate on the specific window.

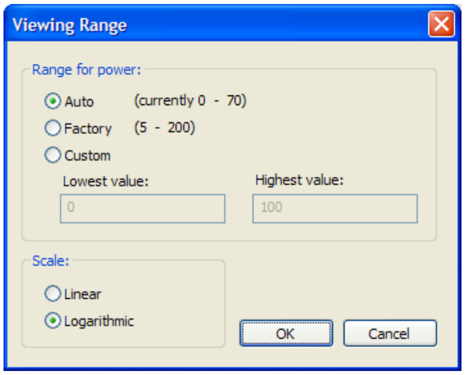
These commands are available:

Enable	Enables the logging system. The system will log information also when the window is closed.
Show time	Displays the **Time** column in the Power Log window, Data Log window, and in the Interrupt Log window, respectively.
Show cycles	Displays the **Cycles** column in the Data Log window and in the Interrupt Log window, respectively.
Clear	Deletes the log information. Note that this will happen when you reset the debugger, or if you change the execution frequency in the SWO Setup dialog box.

Save to log file Displays a dialog box where you can select the destination file for the log information. The entries in the log file are separated by `TAB` and `LF`. An `X` in the `Approx` column indicates that the time stamp is an approximation.

Viewing Range dialog box

The **Viewing Range** dialog box is available from the context menu that appears when you right-click in the Power Log window or the Data Log window.


Viewing Range

Range for power:

- Auto (currently 0 - 70) [✓]
- Factory (5 - 200)
- Custom

Lowest value: 0
Highest value: 100

Scale:

- Linear
- Logarithmic [✓]

Figure 83: Viewing Range dialog box

Use this dialog box to specify the value range, that is, the range for the Y-axis for the graph.

Range for *xxxx*

Selects the viewing range for the displayed values:

Auto Uses the range according to the range of the values that are actually collected, continuously keeping track of minimum or maximum values. The currently computed range, if any, is displayed in parentheses. The range is rounded to reasonably *even* limits.

Factory	For the Data Log Graph: Uses the range according to the value range of the variable, for example 0–65535 for an unsigned 16-bit integer. For the Power Log Graph: Uses the range according to the properties of the measuring hardware.
Custom	Use the text boxes to specify an explicit range.

Scale

Selects the scale type of the Y-axis:

- **Linear**
- **Logarithmic**.

Trace Start breakpoints dialog box (simulator)

The **Trace Start** dialog box is available from the context menu that appears when you right-click in the Breakpoints window.

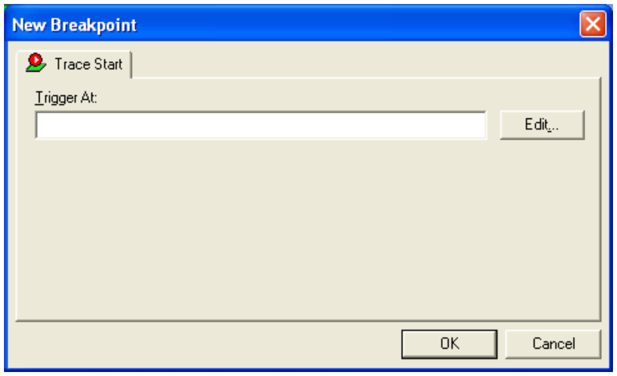


Figure 84: Trace Start breakpoints dialog box

This dialog box is available for the C-SPY simulator. See also *Trace Start breakpoints dialog box (J-Link/J-Trace)*, page 191.

To set a Trace Start breakpoint:

1 In the editor or Disassembly window, right-click and choose **Trace Start** from the context menu.

Alternatively, open the Breakpoints window by choosing **View>Breakpoints**.

2 In the Breakpoints window, right-click and choose **New Breakpoint>Trace Start**.

Alternatively, to modify an existing breakpoint, select a breakpoint in the Breakpoints window and choose **Edit** on the context menu.

3 In the **Trigger At** text box, specify an expression, an absolute address, or a source location. Click **OK**.

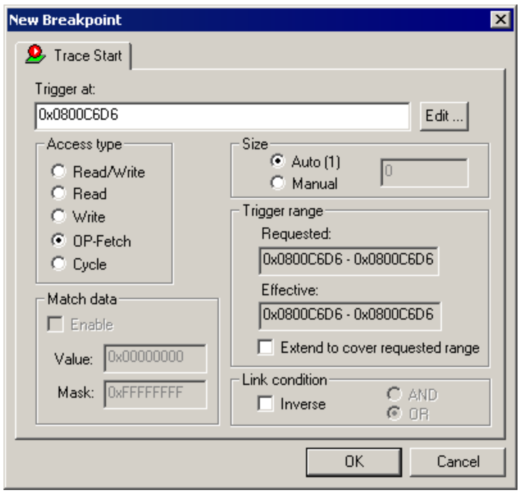
4 When the breakpoint is triggered, the trace data collection starts.

Trigger At

Specify the location for the breakpoint in the text box. Alternatively, click the **Edit** browse button to open the **Enter Location** dialog box; see *Enter Location dialog box*, page 137.

Trace Start breakpoints dialog box (J-Link/J-Trace)

The **Trace Start** dialog box is available from the context menu that appears when you right-click in the Breakpoints window. You can also right-click in the editor window or the Disassembly window, and then choose **Toggle Breakpoint (Trace Start)**.



New Breakpoint

Trace Start

Trigger at: 0x0800C6D6

Access type: Read/Write, Read, Write, [✓ OP-Fetch], Cycle

Size: [✓ Auto (1)], Manual 0

Trigger range

Requested: 0x0800C6D6 - 0x0800C6D6

Effective: 0x0800C6D6 - 0x0800C6D6

Extend to cover requested range

Match data: Enable

Value: 0x00000000

Mask: 0xFFFFFFFF

Link condition: Inverse, AND, [✓ OR]

Figure 85: Trace Start breakpoints dialog box

Use this dialog box to set the conditions that determine when to start collecting trace data. When the trace condition is triggered, the trace data collection is started.

This dialog box is available for the C-SPY J-Link/J-Trace driver.

Trigger at

Specify the starting point of the code section for which you want to collect trace data. You can specify a variable name, an address, or a cycle counter value.

Size

Controls the size of the address range, that when reached, will trigger the start of the trace data collection. Choose between:

Auto	Sets the size automatically. This can be useful if **Trigger at** contains a variable.
Manual	Specify the size of the breakpoint range manually.

Trigger range

Shows the requested range and the effective range to be covered by the trace data collection. The range suggested is either within or exactly the area specified by the **Trigger at** and the **Size** options.

Extend to cover requested range	Extends the range so that a whole data structure is covered. For data structures that do not fit the size of the possible ranges supplied by the hardware breakpoint unit, for example three bytes, the range will not cover the whole data structure. Note that the range will be extended beyond the size of the data structure, which might cause false triggers at adjacent data. This option is not enabled for ARM7/9 devices because the range for such devices will always cover the whole data structure.

Access type

Specifies the type of memory access that triggers the trace data collection. Choose between:

Read/Write	Read from or write to location.
Read	Read from location.
Write	Write to location.
OP-fetch	At execution address

Cycle	The number of counter cycles at a specific point in time, counted from where the execution started. This option is only available for Cortex-M devices.

Match data

Enables matching of the accessed data. Use the **Match data** options in combination with the Read/Write, Read, or Write access types for data. This option can be useful when you want a trigger when a variable has a certain value.

Value	Specify a data value.
Mask	Specify which part of the value to match (word, halfword, or byte).

The **Match data** options are only available for J-Link/J-Trace and when using a Cortex-M device.

Note: For Cortex-M devices, only one breakpoint with **Match data** can be set. Such a breakpoint uses two breakpoint resources.

Link condition

Specifies how trace conditions are combined, using **AND** and **OR**. When combining a condition that has the link condition **AND** with a condition that has the link condition **OR**, **AND** has precedence. The option **Inverse** inverts the trace condition and is individual for each trace filter condition. If one trace start or stop condition is inverted, all others will be too. An inverted trace start or stop condition means that the trace data collection is performed everywhere except for this section of the application code.

For ARM7/9 devices, trace filters are combined using the OR algorithm. Use the **Inverse** option to invert the trace filter; all trace filters are affected. The trace filter will be combined with the start and stop triggers, if any, using the AND algorithm.

Trace Stop breakpoints dialog box (simulator)

The **Trace Stop** dialog box is available from the context menu that appears when you right-click in the Breakpoints window.

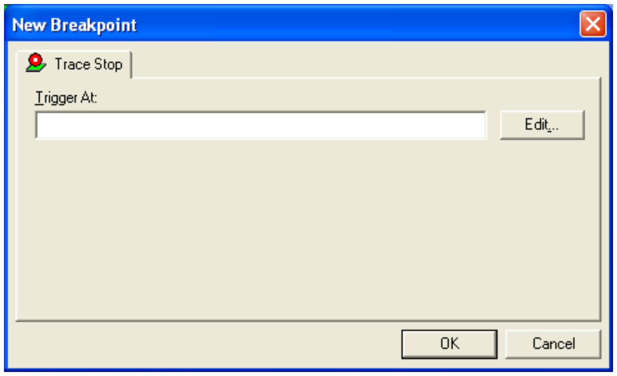


Figure 86: Trace Stop breakpoints dialog box

This dialog box is available for the C-SPY simulator. See also *Trace Stop breakpoints dialog box (J-Link/J-Trace)*, page 195.

To set a Trace Stop breakpoint:

1. In the editor or Disassembly window, right-click and choose **Trace Stop** from the context menu.

   Alternatively, open the Breakpoints window by choosing **View>Breakpoints**.

2. In the Breakpoints window, right-click and choose **New Breakpoint>Trace Stop**.

   Alternatively, to modify an existing breakpoint, select a breakpoint in the Breakpoints window and choose **Edit** on the context menu.

3. In the **Trigger At** text box, specify an expression, an absolute address, or a source location. Click **OK**.

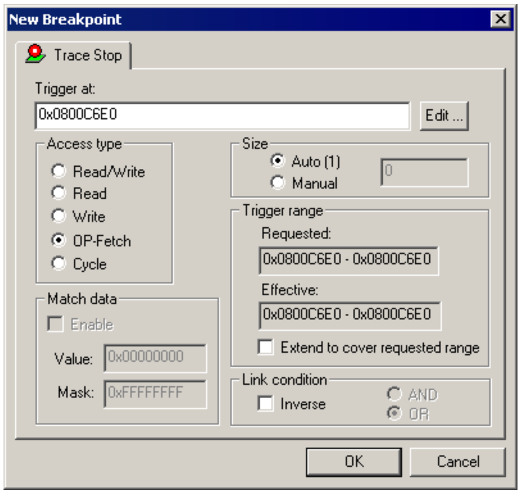
4. When the breakpoint is triggered, the trace data collection stops.

Trigger At

Specify the location for the breakpoint in the text box. Alternatively, click the **Edit** browse button to open the **Enter Location** dialog box; see *Enter Location dialog box*, page 137.

Trace Stop breakpoints dialog box (J-Link/J-Trace)

The **Trace Stop** dialog box is available from the context menu that appears when you right-click in the Breakpoints window. You can also right-click in the editor window or the Disassembly window, and then choose **Toggle Breakpoint (Trace Stop)**.


New Breakpoint

Trace Stop

Trigger at: 0x0800C6E0

Access type: Read/Write [✓ OP-Fetch] Read Write Cycle

Size: [✓ Auto (1)] Manual 0

Trigger range

Requested: 0x0800C6E0 - 0x0800C6E0

Effective: 0x0800C6E0 - 0x0800C6E0

☐ Extend to cover requested range

Match data

☐ Enable

Value: 0x00000000

Mask: 0xFFFFFFFF

Link condition

☐ Inverse

AND [✓ OR]

Figure 87: Trace Stop breakpoints dialog box

When the trace condition is triggered, the trace data collection is performed for some further instructions, and then the collection is stopped.

This dialog box is available for the C-SPY J-Link/J-Trace driver.

Trigger at

Specify the stopping point of the code section for which you want to collect trace data. You can specify a variable name, an address, or a cycle counter value.

Size

Controls the size of the address range, that when reached, will trigger the stop of the trace data collection. Choose between:

Auto	Sets the size automatically. This can be useful if **Trigger at** contains a variable.
Manual	Specify the size of the breakpoint range manually.

Trigger range

Shows the requested range and the effective range to be covered by the trace data collection. The range suggested is either within or exactly the area specified by the **Trigger at** and the **Size** options.

Extend to cover requested range	Extends the range so that a whole data structure is covered. For data structures that do not fit the size of the possible ranges supplied by the hardware breakpoint unit, for example three bytes, the range will not cover the whole data structure. Note that the range will be extended beyond the size of the data structure, which might cause false triggers at adjacent data. This option is not enabled for ARM7/9 devices because the range for such devices will always cover the whole data structure.

Access type

Specifies the type of memory access that triggers the trace data collection. Choose between:

Read/Write	Read from or write to location.
Read	Read from location.
Write	Write to location.
OP-fetch	At execution address
Cycle	The number of counter cycles at a specific point in time, counted from where the execution started. This option is only available for Cortex-M devices.

Match data

Enables matching of the accessed data. Use the **Match data** options in combination with the Read/Write, Read, or Write access types for data. This option can be useful when you want a trigger when a variable has a certain value.

Value	Specify a data value.
Mask	Specify which part of the value to match (word, halfword, or byte).

The **Match data** options are only available for J-Link/J-Trace and when using a Cortex-M device.

Note: For Cortex-M devices, only one breakpoint with **Match data** can be set. Such a breakpoint uses two breakpoint resources.

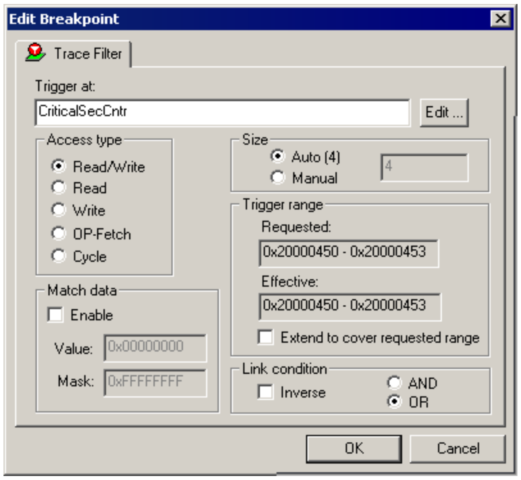
Link condition

Specifies how trace conditions are combined, using **AND** and **OR**. When combining a condition that has the link condition **AND** with a condition that has the link condition **OR**, **AND** has precedence. The option **Inverse** inverts the trace condition and is individual for each trace filter condition. If one trace start or stop condition is inverted, all others will be too. An inverted trace start or stop condition means that the trace data collection is performed everywhere except for this section of the application code.

For ARM7/9 devices, trace filters are combined using the OR algorithm. Use the **Inverse** option to invert the trace filter; all trace filters are affected. The trace filter will be combined with the start and stop triggers, if any, using the AND algorithm.

Trace Filter breakpoints dialog box

The **Trace Filter** dialog box is available from the context menu that appears when you right-click in the Breakpoints window. You can also right-click in the editor window or the Disassembly window, and then choose **Toggle Breakpoint (Trace Filter)**.


Edit Breakpoint

Trace Filter

Trigger at: CriticalSecCntr

Access type: [✓ Read/Write] Read Write OP-Fetch Cycle

Size: [✓ Auto (4)] Manual 4

Trigger range
Requested: 0x20000450 - 0x20000453
Effective: 0x20000450 - 0x20000453
Extend to cover requested range ☐

Match data
Enable ☐
Value: 0x00000000
Mask: 0xFFFFFFFF

Link condition
Inverse ☐
AND [✓ OR]

Figure 88: Trace Filter breakpoints dialog box

When the trace condition is triggered, the trace data collection is performed for some further instructions, and then the collection is stopped.

Trigger at

Specify the code section for which you want to collect trace data. You can specify a variable name, an address, or a cycle counter value.

Size

Controls the size of the address range where filtered trace is active. Choose between:

Auto	Sets the size automatically. This can be useful if **Trigger at** contains a variable.
Manual	Specify the size of the range manually.

Trigger range

Shows the requested range and the effective range to be covered by the filtered trace data collection. The range suggested is either within or exactly the area specified by the **Trigger at** and the **Size** options.

Extend to cover requested range	Extends the range so that a whole data structure is covered. For data structures that do not fit the size of the possible ranges supplied by the hardware breakpoint unit, for example three bytes, the range will not cover the whole data structure. Note that the range will be extended beyond the size of the data structure, which might cause false triggers at adjacent data. This option is not enabled for ARM7/9 devices because the range for such devices will always cover the whole data structure.

Access type

Specifies the type of memory access that activates the trace data collection. Choose between:

Read/Write	Read from or write to location.
Read	Read from location.
Write	Write to location.

OP-fetch	At execution address
Cycle	The number of counter cycles at a specific point in time, counted from where the execution started. This option is only available for Cortex-M devices.

Match data

Enables matching of the accessed data. Use the **Match data** options in combination with the Read/Write, Read, or Write access types for data. This option can be useful when you want a trigger when a variable has a certain value.

Value	Specify a data value.
Mask	Specify which part of the value to match (word, halfword, or byte).

The **Match data** options are only available for J-Link/J-Trace and when using a Cortex-M device.

Note: For Cortex-M devices, only one breakpoint with **Match data** can be set. Such a breakpoint uses two breakpoint resources.

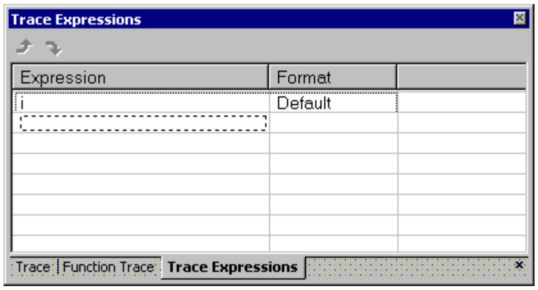
Link condition

Specifies how trace conditions are combined, using **AND** and **OR**. When combining a condition that has the link condition **AND** with a condition that has the link condition **OR**, **AND** has precedence. The option **Inverse** inverts the trace condition and is individual for each trace filter condition. If one trace start or stop condition is inverted, all others will be too. An inverted trace start or stop condition means that the trace data collection is performed everywhere except for this section of the application code.

For ARM7/9 devices, trace filters are combined using the OR algorithm. Use the **Inverse** option to invert the trace filter; all trace filters are affected. The trace filter will be combined with the start and stop triggers, if any, using the AND algorithm.

Trace Expressions window

The Trace Expressions window is available from the Trace window toolbar in the C-SPY simulator.



Expression	Format
i	Default

Figure 89: Trace Expressions window

Use this window to specify, for example, a specific variable (or an expression) for which you want to collect trace data.

Toolbar

The toolbar buttons change the order between the expressions:

Arrow up	Moves the selected row up.
Arrow down	Moves the selected row down.

Display area

Use the display area to specify expressions for which you want to collect trace data:

Expression	Specify any expression that you want to collect data from. 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. Note that you can change display format via the context menu.

Each row in this area will appear as an extra column in the Trace window.

Find in Trace dialog box

The **Find in Trace** dialog box is available by clicking the **Find** button on the Trace window toolbar or by choosing **Edit>Find and Replace>Find**.

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.

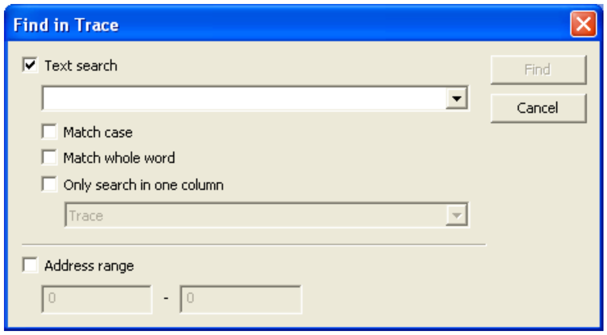


Figure 90: Find in Trace dialog box

Use this dialog box to specify the search criteria for advanced searches in the trace data.

The search results are displayed in the Find in Trace window—available by choosing the **View>Messages** command, see *Find in Trace window*, page 202.

See also *Searching in trace data*, page 167.

Text search

Specify the string you want to search for. To specify the search criteria, choose between:

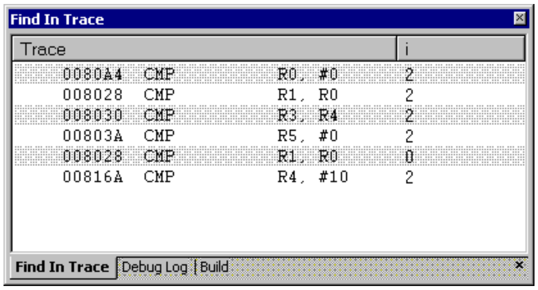
Match Case	Searches only for occurrences that exactly match the case of the specified text. Otherwise specifying `int` will also find `INT` and `Int` and so on.
Match whole word	Searches only for the string when it occurs as a separate word. Otherwise `int` will also find `print`, `sprintf` and so on.
Only search in one column	Searches only in the column you selected from the drop-down list.

Address Range

Specify the address range you want to display or search. 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.

Find in Trace window

The Find in Trace window is available from the **View>Messages** menu. Alternatively, it is automatically displayed when you perform a search using the **Find in Trace** dialog box.



```
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 91: Find in Trace window

This window displays the result of searches in the trace data. Double-click an item in the Find in Trace window to bring up the same item in the Trace window.

Before you can view any trace data, you must specify the search criteria in the **Find in Trace** dialog box, see *Find in Trace dialog box*, page 201.

See also, *Searching in trace data*, page 167.

Display area

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.

Using the profiler

This chapter describes how to use the profiler in C-SPY®. More specifically, this means:

- Introduction to the profiler
- Procedures for using the profiler
- Reference information on the profiler.

Introduction to the profiler

This section introduces the profiler.

These topics are covered:

- Reasons for using the profiler
- Briefly about the profiler
- Requirements for using the profiler.

REASONS FOR USING THE PROFILER

Function profiling can help you find the functions in your source code where the most time is spent during execution. You should focus on those functions when optimizing your code. A simple method of optimizing a function is to compile it using speed optimization. Alternatively, you can move the data used by the function into the memory which uses the most efficient addressing mode. For detailed information about efficient memory usage, see the *IAR C/C++ Development Guide for ARM®*.

Instruction profiling can help you fine-tune your code on a very detailed level, especially for assembler source code. Instruction profiling can also help you to understand where your compiled C/C++ source code spends most of its time, and perhaps give insight into how to rewrite it for better performance.

BRIEFLY ABOUT THE PROFILER

Function profiling information is displayed in the Function Profiler window, 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 enabled until it is turned off.

Instruction profiling information is displayed in the Disassembly window, that is, the number of times each instruction has been executed.

Profiling sources

The profiler can use different mechanisms, or *sources*, to collect profiling information. Depending on the available hardware features, one or more of the sources can be used for profiling:

- Trace (calls)

  The full instruction trace (ETM trace) is analyzed to determine all function calls and returns. When the collected instruction sequence is incomplete or discontinuous, as sometimes happens when using ETM trace, the profiling information is less accurate.
- Trace (flat) / Sampling

  Each instruction in the full instruction trace (ETM trace) or each PC Sample (from SWO trace) is assigned to a corresponding function or code fragment, without regard to function calls or returns. This is most useful when the application does not exhibit normal call/return sequences, such as when you are using an RTOS, or when you are profiling code which does not have full debug information.
- Breakpoints

  The profiler sets a breakpoint on every function entry point. During execution, the profiler collects information about function calls and returns as each breakpoint is hit. This assumes that the hardware supports a large number of breakpoints, and it has a huge impact on execution performance.

Power sampling

Some debug probes support regular sampling of the power consumption of the development board, or components on the board. Each sample is also associated with a PC sample and represents the power consumption (actually, the electrical current) for a small time interval preceding the time of the sample. When the profiler is set to use *Power Sampling*, additional columns are displayed in the Profiler window. Each power sample is associated with a function or code fragment, just as with regular PC Sampling. Note that this does not imply that all the energy corresponding to a sample can be attributed to that function or code fragment. The time scales of power samples and instruction execution are vastly different; during one power measurement, the CPU has typically executed many thousands of instructions. Power Sampling is a statistics tool.

REQUIREMENTS FOR USING THE PROFILER

The C-SPY simulator supports the profiler, and there are no specific requirements for using the profiler.

To use the profiler in your hardware debugger system, you need one of these setups:

- A J-Link or a J-Trace debug probe with an SWD/SWO interface between the probe and the target system, which must be based on a Cortex-M device
- A J-Trace debug probe and an ARM7/9 device with ETM trace.
- A J-Link or J-Trace Ultra probe.

Procedures for using the profiler

This section gives you step-by-step descriptions about how to use the profiler.

More specifically, you will get information about:

- Getting started using the profiler on function level
- Getting started using the profiler on instruction level
- Selecting a time interval for profiling information.

GETTING STARTED USING THE PROFILER ON FUNCTION LEVEL

To display function profiling information in the Function Profiler window, follow these steps:

1 Make sure you build your application using these options:

Category	Setting
C/C++ Compiler	Output>Generate debug information
Linker	Output>Include debug information in output

Table 10: Project options for enabling the profiler

2 To set up the profiler for function profiling:

- If you use ETM trace, make sure that the **Cycle accurate tracing** option is selected in the **Trace Settings** dialog box.
- If you use the SWD/SWO interface, no specific settings are required.

3 When you have built your application and started C-SPY, choose **J-Link>Function Profiler** to open the Function Profiler window, and click the **Enable** button to turn on the profiler. Alternatively, choose **Enable** from the context menu that is available when you right-click in the Function Profiler window.

4 Start executing your application to collect the profiling information.

5 Profiling information is displayed in the Function Profiler window. To sort, click on the relevant column header.

6 When you start a new sampling, you can click the **Clear** button—alternatively, use the context menu—to clear the data.

GETTING STARTED USING THE PROFILER ON INSTRUCTION LEVEL

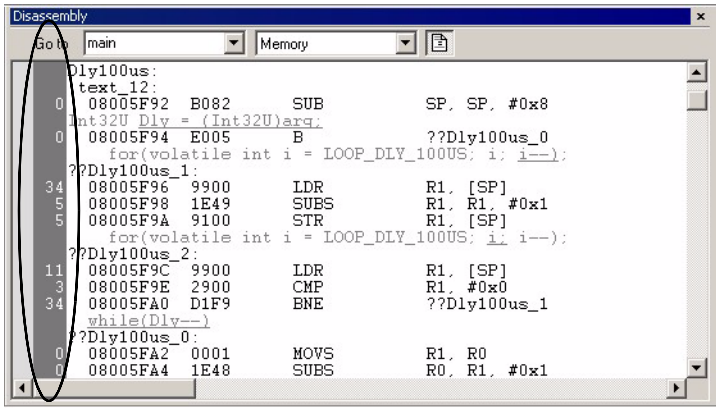
To display instruction profiling information in the Disassembly window, follow these steps:

1 When you have built your application and started C-SPY, choose **View>Disassembly** to open the Disassembly window, and choose **Enable** from the context menu that is available when you right-click in the Profiler window.

2 Make sure that the **Show** command on the context menu is selected, to display the profiling information.

3 Start executing your application to collect the profiling information.

4 When the execution stops, for instance because the program exit is reached or a breakpoint is triggered, you can view instruction level profiling information in the left-hand margin of the Disassembly window.



```
   Dly100us:
    text_12:
 0    08005F92  B082      SUB           SP, SP, #0x8
   Int32U Dly = (Int32U)arg;
 0    08005F94  E005      B             ??Dly100us_0
        for(volatile int i = LOOP_DLY_100US; i; i--);
   ??Dly100us_1:
34    08005F96  9900      LDR           R1, [SP]
 5    08005F98  1E49      SUBS          R1, R1, #0x1
 5    08005F9A  9100      STR           R1, [SP]
        for(volatile int i = LOOP_DLY_100US; i; i--);
   ??Dly100us_2:
11    08005F9C  9900      LDR           R1, [SP]
 3    08005F9E  2900      CMP           R1, #0x0
34    08005FA0  D1F9      BNE           ??Dly100us_1
    while(Dly--)
   ??Dly100us_0:
 0    08005FA2  0001      MOVS          R1, R0
 0    08005FA4  1E48      SUBS          R0, R1, #0x1
```

Figure 92: Instruction count in Disassembly window

For each instruction, the number of times it has been executed is displayed.

If more than one source for the profiling data is supported by the C-SPY driver that you are using, the driver will try to use trace information as the source, unless you have chosen to use a different source. You can change the source to be used from the context menu that is available in the Function Profiler window.

SELECTING A TIME INTERVAL FOR PROFILING INFORMATION

Normally, the profiler computes its information from all PC samples it receives, accumulating more and more information until you explicitly clear the profiling information. However, you can choose a time interval for which the profiler computes the PC samples. This function is supported by the J-Link/J-Trace Ultra probe.

To select a time interval, follow these steps:

1 Choose **Function Profiler** from the driver-specific menu.

2 In the Function Profiler window, right-click and choose **Source: Sampling** from the context menu.

3 Execute your application to collect samples.

4 Choose **View>Timeline**.

5 In the Timeline window, right-click and drag to select a time interval.

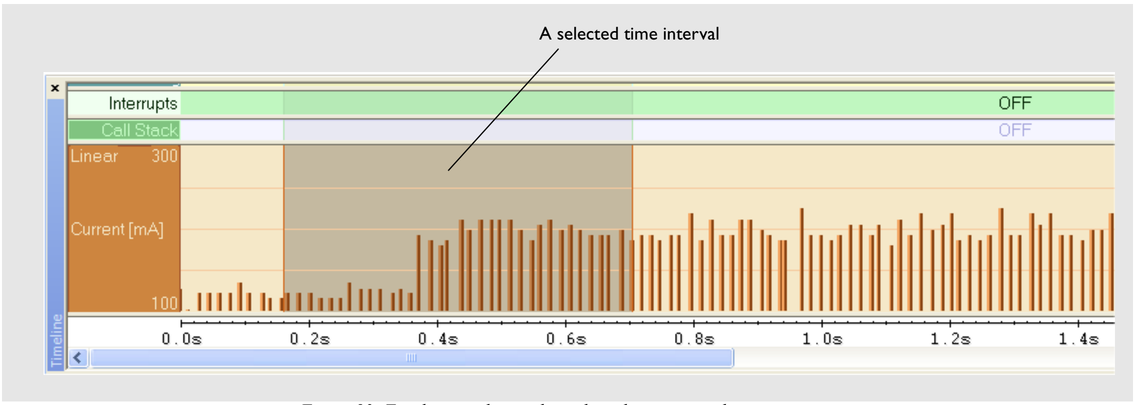
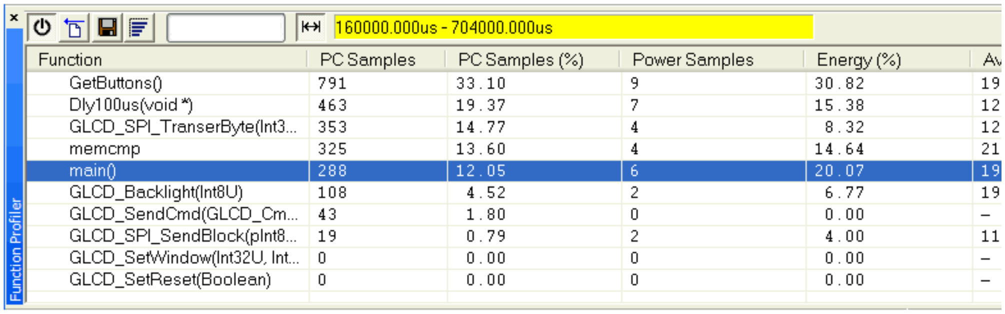


Figure 93: Timeline window with a selected time interval

6 In the selected time interval, right-click and choose **Profile Selection** from the context menu.

7 The Function Profiler window now displays profiling information for the selected time interval.



Function	PC Samples	PC Samples (%)	Power Samples	Energy (%)	Av
GetButtons()	791	33.10	9	30.82	19
Dly100us(void *)	463	19.37	7	15.38	12
GLCD_SPI_TranserByte(Int3...	353	14.77	4	8.32	12
memcmp	325	13.60	4	14.64	21
main()	288	12.05	6	20.07	19
GLCD_Backlight(Int8U)	108	4.52	2	6.77	19
GLCD_SendCmd(GLCD_Cm...	43	1.80	0	0.00	–
GLCD_SPI_SendBlock(pInt8...	19	0.79	2	4.00	11
GLCD_SetWindow(Int32U, Int...	0	0.00	0	0.00	–
GLCD_SetReset(Boolean)	0	0.00	0	0.00	–

Figure 94: Function Profiler window in time-interval mode

8 Click the **Full/Time-interval profiling** button to toggle the Full profiling view.

Reference information on the profiler

This section gives reference information about these windows and dialog boxes:

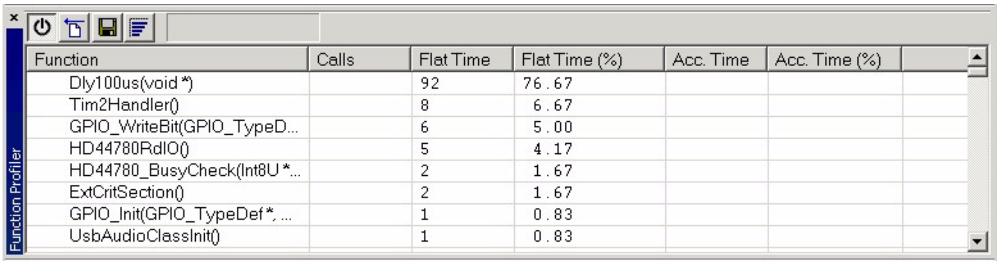
- *Function Profiler window*, page 209
- *Disassembly window*, page 81

For related information, see:

- *SWO Configuration dialog box*, page 173.
- *ETM Trace Settings dialog box*, page 169
- *SWO Trace Window Settings dialog box*, page 171.

Function Profiler window

The Function Profiler window is available from the **J-Link** menu.



Function	Calls	Flat Time	Flat Time (%)	Acc. Time	Acc. Time (%)
Dly100us(void *)		92	76.67		
Tim2Handler()		8	6.67		
GPIO_WriteBit(GPIO_TypeD...		6	5.00		
HD44780RdIO()		5	4.17		
HD44780_BusyCheck(Int8U *...		2	1.67		
ExtCritSection()		2	1.67		
GPIO_Init(GPIO_TypeDef *, ...		1	0.83		
UsbAudioClassInit()		1	0.83		

Figure 95: Function Profiler window

This window displays function profiling information.

Toolbar

The toolbar contains:

Enable/Disable	Enables or disables the profiler.
Clear	Clears all profiling data.
Save	Opens a standard **Save As** dialog box where you can save the contents of the window to a file, with tab-separated columns. Only non-expanded rows are included in the list file.
Graphical view	Overlays the values in the percentage columns with a graphical bar.
Progress bar	Displays a backlog of profiling data that is still being processed. If the rate of incoming data is higher than the rate of the profiler processing the data, a backlog is accumulated. The progress bar indicates that the profiler is still processing data, but also approximately how far the profiler has come in the process. Note that because the profiler consumes data at a certain rate and the target system supplies data at another rate, the amount of data remaining to be processed can both increase and decrease. The progress bar can grow and shrink accordingly.

Time-interval mode	Toggles between profiling a selected time interval or full profiling. This toolbar button is only available if PC Sampling is supported by the debug probe.
Status field	Displays the range of the selected time interval, in other words, the profiled selection. This field is yellow when Time-interval profiling mode is enabled. This field is only available if PC Sampling is supported by the debug probe (SWO trace).

Display area

The content in the display area depends on which source that is used for the profiling information:

- For the Breakpoints and Trace (calls) sources, the display area contains one line for each function compiled with debug information enabled. When some profiling information has been collected, it is possible to expand rows of functions that have called other functions. The child items for a given function list all the functions that have been called by the parent function and the corresponding statistics.
- For the Sampling and Trace (flat) sources, the display area contains one line for each C function of your application, but also lines for sections of code from the runtime library or from other code without debug information, denoted only by the corresponding assembler labels. This is because it is only known for each sample where the application was executing at that specific point in time. If the `PC` is sampled inside a runtime library function, it is not possible to know from which C function it was called.

Note: The available sources depend on the C-SPY driver you are using.

More specifically, the display area provides information in these columns:

Function	All sources	The name of the profiled C function. For Sampling source, also sections of code from the runtime library or from other code without debug information, denoted only by the corresponding assembler labels, is displayed.
Calls	Breakpoints and Trace (calls)	The number of times the function has been called.
Flat time	Breakpoints and Trace (calls)	The time in cycles spent inside the function.

Flat time (%)	Breakpoints and Trace (calls)	Flat time in cycles expressed as a percentage of the total time.
Acc. time	Breakpoints and Trace (calls)	The time in cycles spent in this function and everything called by this function.
Acc. time (%)	Breakpoints and Trace (calls)	Accumulated time in cycles expressed as a percentage of the total time.
PC Samples	Trace (flat) and Sampling	The number of PC samples associated with the function.
PC Samples (%)	Trace (flat) and Sampling	The number of PC samples associated with the function as a percentage of the total number of samples.
Power Samples	Power Sampling	The number of power samples associated with that function.
Energy (%)	Power Sampling	The accumulated value of all measurements associated with that function, expressed as a percentage of all measurements.
Avg Current [mA]	Power Sampling	The average measured value for all samples associated with that function.
Min Current [mA]	Power Sampling	The minimum measured value for all samples associated with that function.
Max Current [mA]	Power Sampling	The maximum measured value for all samples associated with that function.

Context menu

This context menu is available:

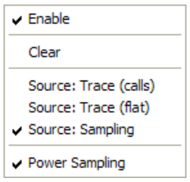


Figure 96: Function Profiler window context menu

These commands are available:

Enable	Enables the profiler. The system will collect information also when the window is closed.
Clear	Clears all profiling data.
Source[*]	Selects which source to be used for the profiling information. Choose between: **Sampling**—the instruction count for instruction profiling represents the number of samples for each instruction. This source is supported by the J-Link debug probe and the J-Trace debug probe. **Trace (calls)**—the instruction count for instruction profiling is only as complete as the collected trace data. This source is supported by the J-Trace debug probe. **Trace (flat)**—the instruction count for instruction profiling is only as complete as the collected trace data. This source is supported by the J-Trace debug probe.
Power Sampling	Toggles power sampling information on or off. This command is supported by the J-Link and J-Trace Ultra debug probes.

[*] **The available sources depend on the C-SPY driver you are using.**

Code coverage

This chapter describes the code coverage functionality in C-SPY®, which helps you verify whether all parts of your code have been executed. More specifically, this means:

- Introduction to code coverage
- Reference information on code coverage.

Introduction to code coverage

This section covers these topics:

- Reasons for using code coverage
- Briefly about code coverage
- Requirements for using code coverage.

REASONS FOR USING CODE COVERAGE

The code coverage functionality is useful when you design your test procedure to verify whether all parts of the code have been executed. It also helps you identify parts of your code that are not reachable.

BRIEFLY ABOUT CODE COVERAGE

The Code Coverage window reports the status of the current code coverage analysis. For every program, module, and function, the analysis shows the percentage of code that has been executed since code coverage was turned on up to the point where the application has stopped. In addition, all statements that have not been executed are listed. The analysis will continue until turned off.

REQUIREMENTS FOR USING CODE COVERAGE

Code coverage is not supported by all C-SPY drivers. For information about the driver you are using, see *Differences between the C-SPY drivers*, page 35. Code coverage is supported by the C-SPY Simulator.

Reference information on code coverage

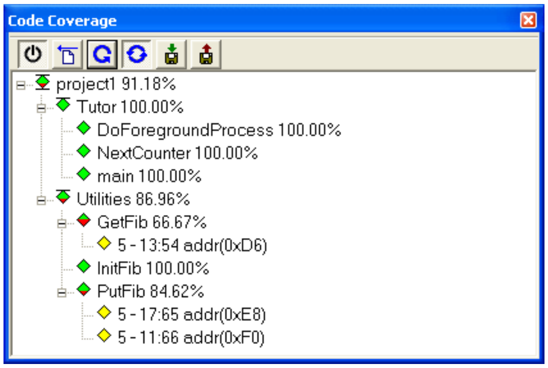
This section gives reference information about these windows and dialog boxes:

- *Code Coverage window*, page 214.

For related information, see *Single stepping*, page 76.

Code Coverage window

The Code Coverage window is available from the **View** menu.



```
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 97: Code Coverage window

This window reports the status of the current code coverage analysis. For every program, module, and function, the analysis shows the percentage of code that has been executed since code coverage was turned on up to the point where the application has stopped. In addition, all statements that have not been executed are listed. The analysis will continue until turned off.

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.

To get started using code coverage:

1 Before using the code coverage functionality you must build your application using these options:

Category	Setting
C/C++ Compiler	Output>Generate debug information

Table 11: Project options for enabling code coverage

Category	Setting
Linker	Output>Include debug information in output
Debugger	Plugins>Code Coverage

Table 11: Project options for enabling code coverage

2 After you have built your application and started C-SPY, choose **View>Code Coverage** to open the Code Coverage window.

3 Click the **Activate** button, alternatively choose **Activate** from the context menu, to switch on code coverage.

4 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.

Display area

The code coverage information is displayed in a tree structure, showing the program, module, function, and statement levels. The window displays only source code that was compiled with debug information. Thus, startup code, exit code, and library code is 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. The plus sign and minus sign icons allow you to expand and collapse the structure.

These icons give you an overview of the current status on all levels:

Red diamond	Signifies that 0% of the modules or functions has been executed.
Green diamond	Signifies that 100% of the modules or functions has been executed.
Red and green diamond	Signifies that some of the modules or functions have been executed.
Yellow diamond	Signifies a statement that has not been executed.

The percentage displayed at the end of every program, module, and function line shows the amount of statements that has been covered so far, that is, the number of executed statements divided with the total number of statements.

For statements that have not been executed (yellow diamond), the information displayed is the column number range and the row number of the statement in the source window, followed by the address of the step point:

```
<column_start>-<column_end>:row address.
```

A statement is considered to be executed when one of its instructions has been executed. When a statement has been executed, it is removed from the window and the percentage is increased correspondingly.

Double-clicking a statement or a function in the Code Coverage window displays that statement 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.

Context menu

This context menu is available:

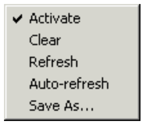


Figure 98: Code coverage window context menu

These commands are available:

	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. This is useful if you for some reason must abort your debug session, but want to continue the session later on. This command is available on the toolbar.
	Restore session	Restores previously saved code coverage session data. This is useful if you for some reason must abort your debug session, but want to continue the session later on. This command is available on the toolbar.

Data and interrupt logging

This chapter describes data and interrupt logging. More specifically, this means:

- Introduction to data and interrupt logging
- Procedures for data and interrupt logging
- Reference information on data and interrupt logging.

Introduction to data and interrupt logging

This section introduces data and interrupt logging.

These topics are covered:

- Reasons for using data and interrupt logging
- Briefly about data and interrupt logging
- Requirements for using data and interrupt logging.

REASONS FOR USING DATA AND INTERRUPT LOGGING

Data logging can help you locate frequently accessed data. You can then consider whether you should place that data in more efficient memory. Interrupt logging provides you with comprehensive information about the interrupt events. This might be useful, for example, to help you locate which interrupts you can fine-tune to become faster.

Thus, data and interrupt logging can help you both to make your application program more efficient and to debug it.

BRIEFLY ABOUT DATA AND INTERRUPT LOGGING

You can use data and interrupt logging for:

- Accesses to up to four different memory locations or areas you choose by setting Data Log breakpoints. The logs are displayed in the Data Log window and a summary is available in the Data Log Summary window.
- Entrances and exits to and from interrupts by enabling exception trace. The logs are displayed in the Interrupt Log window and a summary is available in the Interrupt Log Summary window. The Interrupt Graph window provides a graphical view of the interrupt events during the execution of your application program.

These windows are repeatedly updated and display the latest information read from the target:

- Data Log window
- Function Profiler window
- Interrupt Log window
- Timeline window
- Terminal I/O via SWO.

REQUIREMENTS FOR USING DATA AND INTERRUPT LOGGING

To use data and interrupt logging, you need:

- A J-Link debug probe
- An SWD interface between the J-Link debug probe and the target system.

Procedures for data and interrupt logging

This section gives you step-by-step descriptions about how to use data and interrupt logging.

More specifically, you will get information about:

- Getting started using data and interrupt logging.

Click the arrows below to display more information.

GETTING STARTED USING DATA AND INTERRUPT LOGGING

1. To set up for data logging, follow these steps:
   - In the Breakpoints or Memory window, right-click and choose **New Breakpoints>Data Log** to open the breakpoints dialog box.
   - Set a Data Log breakpoint on the data you want to collect log information for.
2. To set up for interrupt logging, follow these steps:
   - In the **SWO Configuration** dialog box, set up the serial-wire output communication channel for trace data. Note specifically the **CPU clock** option.
3. From the context menu, available in the Data Log and Interrupt Log windows, respectively, choose **Enable** to enable the logging.
4. Start executing your application program to collect the log information.

5. To view the data log information, choose **J-Link>Data Log**. For the summary, choose **J-Link>Data Log Summary**.
6. To view the interrupt log information, choose **J-Link>Interrupt Log**. For the summary, choose **J-Link>Interrupt Log Summary**.
7. If you want to save the log or summary to a file, choose **Save to log file** from the context menu in the window in question.
8. To disable data and interrupt logging, choose **Disable** from the context menu in each window where you have enabled it.

Reference information on data and interrupt logging

This section gives reference information about these windows and dialog boxes:

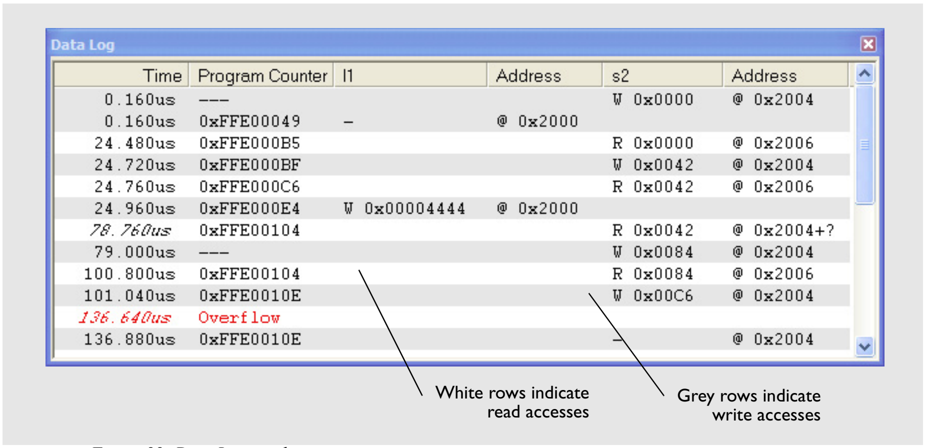
- *ETM Trace Settings dialog box*, page 169
- *Data Log window*, page 220
- *Data Log Summary window*, page 223
- *Interrupt Log window*, page 224
- *Interrupt Log Summary window*, page 226
- *Timeline window*, page 182.

For related information, see:

- *Data breakpoints dialog box*, page 129
- *Data breakpoints dialog box*, page 129.

Data Log window

The Data Log window is available from the **J-Link** menu.


Data Log
White rows indicate read accesses
Grey rows indicate write accesses

Time	Program Counter	I1	Address	s2	Address
0.160us	---			W 0x0000	@ 0x2004
0.160us	0xFFE00049	–	@ 0x2000		
24.480us	0xFFE000B5			R 0x0000	@ 0x2006
24.720us	0xFFE000BF			W 0x0042	@ 0x2004
24.760us	0xFFE000C6			R 0x0042	@ 0x2006
24.960us	0xFFE000E4	W 0x00004444	@ 0x2000		
78.760us	0xFFE00104			R 0x0042	@ 0x2004+?
79.000us	---			W 0x0084	@ 0x2004
100.800us	0xFFE00104			R 0x0084	@ 0x2006
101.040us	0xFFE0010E			W 0x00C6	@ 0x2004
136.640us	Overflow				
136.880us	0xFFE0010E			–	@ 0x2004

Figure 99: Data Log window

Use this window to log accesses to up to four different memory locations or areas.

To use this window you must:

- Enable data logging on the context menu
- Set Data Log breakpoints for the memory locations or areas you want to log accesses to, see *Data breakpoints dialog box*, page 129.
- Make sure to set the relevant **Data Log Events** option and optionally make sure that timestamps are enabled, see *SWO Trace Window Settings dialog box*, page 171.

Display area

Each row in the display area shows the time, the program counter, and, for every tracked data object, its value and address in these columns:

Time	The time for the data access, based on the clock frequency specified in the **SWO Configuration** dialog box. If the time is displayed in italics, the target system has not been able to collect a correct time, but instead had to approximate it. This column is available when you have selected **Show cycles** from the context menu.

Cycles	The number of cycles from the start of the execution until the event. This information is cleared at reset. If a cycle is displayed in italics, the target system has not been able to collect a correct time, but instead had to approximate it. This column is available when you have selected **Show cycles** from the context menu.
Program Counter*	The content of the `PC`, that is, the address of the instruction that performed the memory access. If the column displays **---**, the target system failed to provide the debugger with any information. If the column displays Overflow in red, the communication channel transmit to handle all data from the target system.
Value	Displays the access type and the value (using the access size) for the location or area you want to log accesses to. For example, if zero is read using a byte access it will be displayed as `0x00`, and for a long access it will be displayed as `0x00000000`. To specify what data you want to log accesses to, use the **Data Log** breakpoint dialog box. See *Data breakpoints dialog box*, page 129.
Address	The actual memory address that is accessed. For example, if only a byte of a word is accessed, only the address of the byte is displayed. The address is calculated as base address + offset, where the base address is retrieved from the **Data Log** breakpoint dialog box and the offset is retrieved from the logs. If the log from the target system does not provide the debugger with an offset, the offset contains + ?. If you want the offset to be displayed, select the **Data value + exact addr** option in the **SWO Configuration** dialog box.

*** You can double-click a line in the display area. If the value of the `PC` for that line is available in the source code, the editor window displays the corresponding source code (this does not include library source code).**

Data Log window context menu

This context menu is available in the Data Log window, Data Log Summary window, Interrupt Log window, and in the Interrupt Log Summary window:

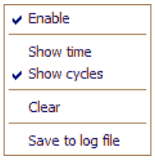


Figure 100: Data Log window context menu

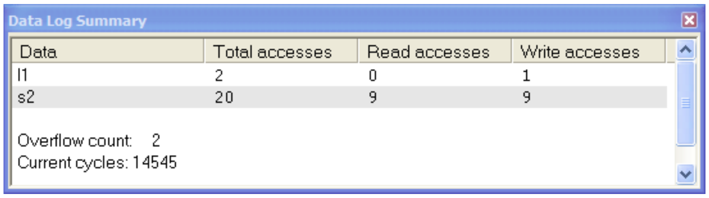
Note: The commands are the same in each window, but they only operate on the specific window.

These commands are available:

Enable	Enables the logging system. The system will log information also when the window is closed.
Show time	Displays the **Time** column in the Data Log window and in the Interrupt Log window, respectively.
Show cycles	Displays the **Cycles** column in the Data Log window and in the Interrupt Log window, respectively.
Clear	Deletes the log information. Note that this will happen also when you reset the debugger.
Save to log file	Displays a dialog box where you can select the destination file for the log information. The entries in the log file are separated by `TAB` and `LF`. An `X` in the Approx column indicates that the time stamp is an approximation.

Data Log Summary window

The Data Log Summary window is available from the **J-Link** menu.



Data Log Summary

Data	Total accesses	Read accesses	Write accesses
l1	2	0	1
s2	20	9	9

Overflow count: 2
Current cycles: 14545

Figure 101: Data Log Summary window

This window displays a summary of data accesses to specific memory location or areas.

To use this window you must:

- Enable data logging on the context menu
- Set Data Log breakpoints for the memory locations or areas you want to log accesses to, see *Data breakpoints dialog box*, page 129.
- Make sure to select the relevant **Data Log Events** option, see *SWO Trace Window Settings dialog box*, page 171.

Display area

Each row in this area displays the type and the number of accesses to each memory location or area in these columns:

Data*	The name of the data object you have selected to log accesses to. To specify what data object you want to log accesses to, use the **Data Log** breakpoint dialog box. See *Data breakpoints dialog box*, page 129.
Total accesses**	The number of total accesses.
Read accesses	The number of total read accesses.
Write accesses	The number of total write accesses.

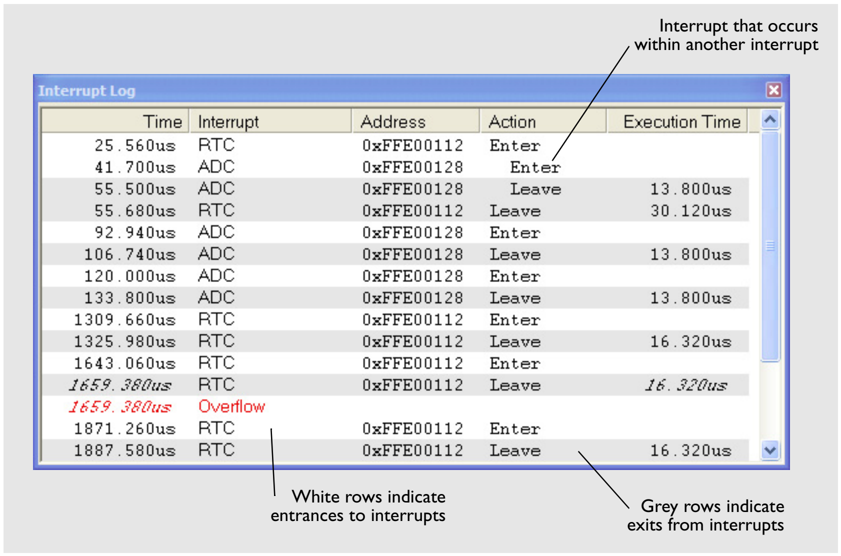
*** At the bottom of the column, overflow count displays the number of overflows.**
**** If the sum of read accesses and write accesses is less than the total accesses, there have been a number of access logs for which the target system for some reason did not provide valid access type information.**

Context menu

See *Data Log window context menu*, page 222.

Interrupt Log window

The Interrupt Log window is available from the **J-Link** menu.


Interrupt that occurs within another interrupt
Interrupt Log
White rows indicate entrances to interrupts
Grey rows indicate exits from interrupts

Time	Interrupt	Address	Action	Execution Time
25.560us	RTC	0xFFE00112	Enter	
41.700us	ADC	0xFFE00128	Enter	
55.500us	ADC	0xFFE00128	Leave	13.800us
55.680us	RTC	0xFFE00112	Leave	30.120us
92.940us	ADC	0xFFE00128	Enter	
106.740us	ADC	0xFFE00128	Leave	13.800us
120.000us	ADC	0xFFE00128	Enter	
133.800us	ADC	0xFFE00128	Leave	13.800us
1309.660us	RTC	0xFFE00112	Enter	
1325.980us	RTC	0xFFE00112	Leave	16.320us
1643.060us	RTC	0xFFE00112	Enter	
1659.380us	RTC	0xFFE00112	Leave	*16.320us*
1659.380us	Overflow			
1871.260us	RTC	0xFFE00112	Enter	
1887.580us	RTC	0xFFE00112	Leave	16.320us

Figure 102: Interrupt Log window

This window logs entrances and exits to and from interrupts.

To use this window you must:

- Enable interrupt logging on the context menu
- Make sure the options **Interrupt Log Events** and **Timestamps** are enabled. See the *SWO Trace Window Settings dialog box*, page 171.

Display area

Each row in this area displays the time, type of interrupt, address, and action for each logged event in these columns:

Time	The time for the interrupt entrance, based on the clock frequency specified in the **SWO Configuration** dialog box. If a time is displayed in italics, the target system has not been able to collect a correct time, but instead had to approximate it. This column is available when you have selected **Show time** from the context menu.
Cycles	The number of cycles from the start of the execution until the event. A cycle displayed in italics indicates an approximative value. Italics is used when the target system has not been able to collect a correct time, but instead had to approximate it. This column is available when you have selected **Show cycles** from the context menu.
Interrupt	The type of interrupt that occurred. If the column displays `Overflow` in red, the communication channel failed to transmit all interrupt logs from the target system.
Address*	The address of the entry in the interrupt vector table.
Action*	The type of event, either Enter for entering the interrupt or Leave for leaving the interrupt.
Execution time/cycles	The time spend in the interrupt, calculated using the enter and leave time stamps. This includes time spent in any subroutines or other interrupts that occurred in the specific interrupt.

*** You can double-click an address. If it is available in the source code, the editor window displays the corresponding source code, for example for the interrupt handler (this does not include library source code).**

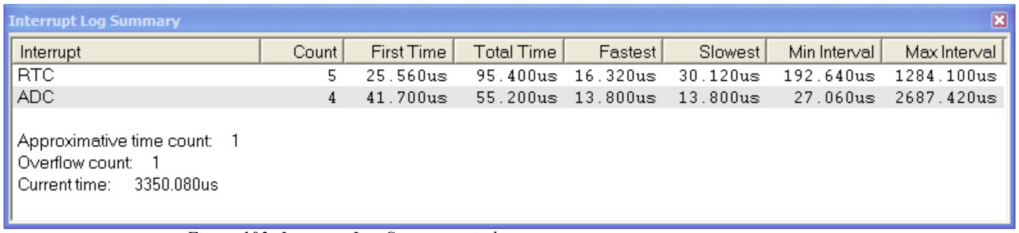
Note: If you change the clock frequency in the **SWO Configuration** dialog box, all current logs are deleted.

Context menu

See *Data Log window context menu*, page 222.

Interrupt Log Summary window

The Interrupt Log Summary window is available from the **J-Link** menu.



Interrupt	Count	First Time	Total Time	Fastest	Slowest	Min Interval	Max Interval
RTC	5	25.560us	95.400us	16.320us	30.120us	192.640us	1284.100us
ADC	4	41.700us	55.200us	13.800us	13.800us	27.060us	2687.420us

Approximative time count: 1
Overflow count: 1
Current time: 3350.080us

Figure 103: Interrupt Log Summary window

This window displays a summary of logs of entrances and exits to and from interrupts.

To use this window you must:

- Enable interrupt logging on the context menu
- Make sure the options **Interrupt Log Events** and **Timestamps** are enabled. See the *SWO Trace Window Settings dialog box*, page 171.

Display area

Each row in this area displays some statistics about the specific interrupt based on the log information in these columns:

Interrupt*	The type of interrupt that occurred.
Count	The number of times the interrupt occurred.
First time	The first time the interrupt was executed.
Total time**	The accumulated time spent in the interrupt.
Fastest**	The fastest execution of a single interrupt of this type.
Slowest**	The slowest execution of a single interrupt of this type.
Max interval†	The longest time between two interrupts of this type.

*** At the bottom of the column, approximative time count displays the number of logs that contain an approximative time. Overflow count displays the number of overflows. Approximative time count displays the number of logs that contain an approximative time.**
**** Calculated in the same way as for the Execution time/cycles in the Interrupt Log window.**
† The interval is specified as the time interval between the entry time for two consecutive interrupts.

Note: If you change the clock frequency in the **SWO Configuration** dialog box, all current logs are deleted.

Context menu

See *Data Log window context menu*, page 222.

Simulating interrupts

By simulating 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. More specifically, this means:

- Introduction to interrupt simulation
- Procedures for simulating interrupts
- Reference information on simulating interrupts.

Introduction to interrupt simulation

This section introduces the C-SPY interrupt simulation system.

These topics are covered:

- Reasons for using the interrupt simulation system
- Briefly about the interrupt simulation system
- Interrupt characteristics
- Interrupt simulation states
- C-SPY system macros for interrupts
- Target-adapting the interrupt simulation system.

For related information, see also:

- *Reference information on C-SPY system macros*, page 257
- *Using breakpoints*, page 109
- The *IAR C/C++ Development Guide for ARM®*.

REASONS FOR USING THE INTERRUPT SIMULATION SYSTEM

Simulated interrupts let you test the logic of your interrupt service routines and debug the interrupt handling in the target 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.

BRIEFLY ABOUT THE INTERRUPT SIMULATION SYSTEM

The C-SPY Simulator includes an interrupt simulation system where you can simulate the execution of interrupts during debugging. You can configure the interrupt simulation system so that it resembles your hardware interrupt system.

The interrupt system has the following features:

- Simulated interrupt support for the ARM core
- 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
- Configuration of interrupts using a dialog box or a C-SPY system macro—that is, one interactive and one automating interface. In addition, you can instantly force an interrupt.
- A log window which continuously displays events for each defined interrupt.

All interrupts you define using the **Interrupt Setup** dialog box are preserved between debug sessions, unless you remove them. A forced interrupt, on the other hand, exists only until it has been serviced and is not preserved between sessions.

The interrupt simulation system is activated by default, but if not required, you can turn off the interrupt simulation system to speed up the simulation. To turn it off, use either the **Interrupt Setup** dialog box or a system macro.

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*, a *variance*, and a *probability.*

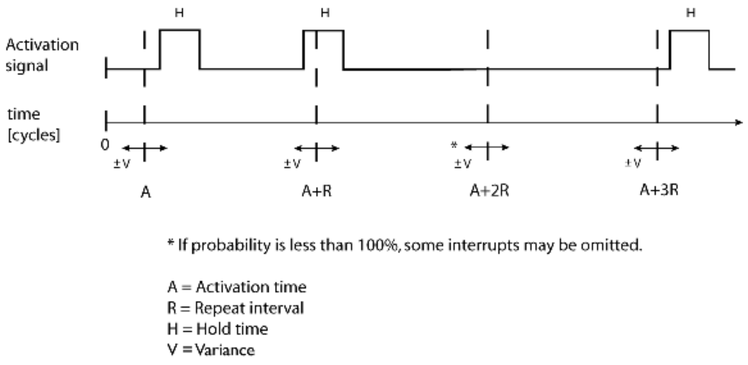


Figure 104: Simulated interrupt configuration

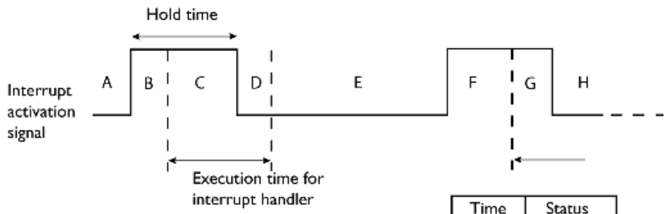
The interrupt simulation system uses the cycle counter as a clock to determine when an interrupt should be raised in the simulator. You specify the *first activation time*, which is based on the cycle counter. C-SPY will generate an interrupt when the cycle counter has passed the specified activation 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 states can be displayed: *Idle*, *Pending*, *Executing*, *Executed*, *Removed*, *Rejected*, or *Expired*.

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:

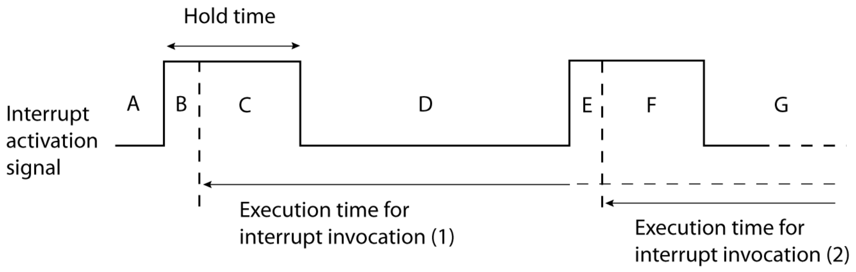

Hold time
Interrupt activation signal
A
B
C
D
E
F
G
H
Execution time for interrupt handler

Time	Status
A	Idle
B	Pending
C, D	Executing
E	Idle
F	Pending
G, H	Executing

Figure 105: 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 reentrant (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 106: 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.

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 these predefined 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.

For detailed reference information about each macro, see *Reference information on C-SPY system macros*, page 257.

TARGET-ADAPTING 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.

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 perform these actions for various devices, the interrupt system must have detailed information about each available interrupt. Except for default settings, this information is provided in the device description files. The default settings are used if no device description file has been specified.

For details of device description files, see *Selecting a device description file*, page 55.

Procedures for simulating interrupts

This section gives you step-by-step descriptions about how to use the interrupt simulation system.

More specifically, you will get information about:

- Simulating a simple interrupt
- Simulating an interrupt in a multi-task system.

For related information, see also:

- *Registering and executing using setup macros and setup files*, page 248 for details about how to use a setup file to define simulated interrupts at C-SPY startup
- The tutorial *Simulating an interrupt* in the Information Center.

SIMULATING A SIMPLE INTERRUPT

This example demonstrates the method for simulating a system timer interrupt for OKI ML674001. However, the procedure can also be used for other types of interrupts.

Read more about how to write your own interrupt handler in the *IAR C/C++ Development Guide for ARM®.*

To simulate and debug an interrupt:

1 Assume this simple application which contains an IRQ handler routine that handles system timer interrupts. It increments a tick variable. The main function sets the necessary status registers. The application exits when 100 interrupts have been generated.

```
/* Enables use of extended keywords */
#pragma language=extended

#include <intrinsics.h>
#include <oki/ioml674001.h>
#include <stdio.h>

unsigned int ticks = 0;

/* IRQ handler */
__irq __arm void IRQ_Handler(void)
{
  /* We use only system timer interrupts, so we do not need
     to check the interrupt source. */
  ticks += 1;
  TMOVFR_bit.OVF = 1; /* Clear system timer overflow flag */
}
```

```
int main( void )
{
  __enable_interrupt();
  /* Timer setup code */
  ILC0_bit.ILR0 = 4;     /* System timer interrupt priority */
  TMRLR_bit.TMRLR = 1E5; /* System timer reload value */
  TMEN_bit.TCEN = 1;     /* Enable system timer */
  while (ticks < 100);
  printf("Done\n");
}
```

2 Add your interrupt service routine to your application source code and add the file to your project.

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. For the Timer example, verify these settings:

Option	Settings
Interrupt	IRQ
First activation	4000
Repeat interval	2000
Hold time	10
Probability (%)	100
Variance (%)	0

Table 12: 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.

6 To watch the interrupt in action, choose **Simulator>Interrupt Log** to open the Interrupt Log window.

SIMULATING AN INTERRUPT 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 simulate a normal interrupt exit:

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.

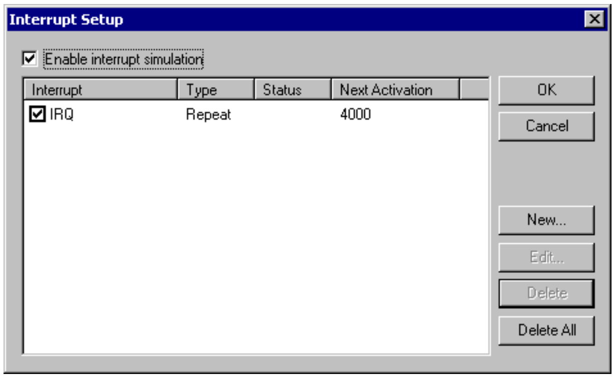
Reference information on simulating interrupts

This section gives reference information about these windows and dialog boxes:

- *Interrupt Setup dialog box*, page 236
- *Edit Interrupt dialog box*, page 238
- *Forced Interrupt window*, page 240
- *Interrupt Log window*, page 241.

Interrupt Setup dialog box

The **Interrupt Setup** dialog box is available by choosing **Simulator>Interrupt Setup**.



☑ Enable interrupt simulation

Interrupt	Type	Status	Next Activation
☑ IRQ	Repeat		4000

Figure 107: Interrupt Setup dialog box

This dialog box lists all defined interrupts. Use this dialog box to enable or disable the interrupt simulation system, as well as to enable or disable individual interrupts.

Enable interrupt simulation

Enables or disables interrupt simulation. If the interrupt simulation is disabled, the definitions remain but no interrupts are generated. Note that 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.

Display area

This area contains these columns:

Interrupt	Lists all interrupts. Use the check box to enable or disable the interrupt.
Type	Shows the type of the interrupt. The type can be one of: **Forced**, a single-occasion interrupt defined in the Forced Interrupt Window. **Single**, a single-occasion interrupt. **Repeat**, a periodically occurring interrupt. For repeatable interrupts there might be additional information about how many interrupts of the same type that are 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.
Status	Shows the state of the interrupt: **Idle**, the interrupt activation signal is low (deactivated). **Pending**, the 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, but because the interrupt is currently executing it is visible until it is finished. **Rejected**, the interrupt has been rejected because the necessary interrupt registers are not set up to accept the interrupt. **Expired**, this is a single-occasion interrupt which was not serviced while the interrupt activation signal was active.
Next Activation	Shows the next activation time in cycles.

Buttons

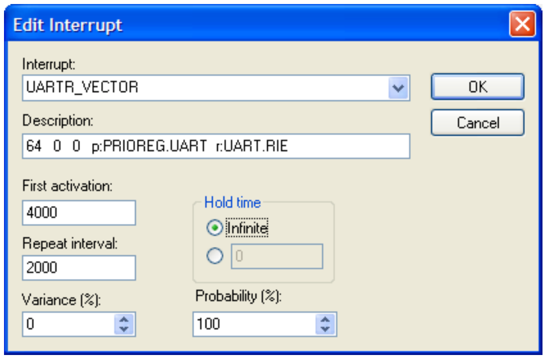
These buttons are available:

New	Opens the **Edit Interrupt** dialog box, see *Edit Interrupt dialog box*, page 238.
Edit	Opens the **Edit Interrupt** dialog box, see *Edit Interrupt dialog box*, page 238.
Delete	Removes the selected interrupt.
Delete All	Removes all interrupts.

Note: You can only edit or remove non-forced interrupts.

Edit Interrupt dialog box

The **Edit Interrupt** dialog box is available from the **Interrupt Setup** dialog box.



Interrupt: UARTR_VECTOR

Description: 64 0 0 p:PRIOREG.UART r:UART.RIE

First activation: 4000

Repeat interval: 2000

Variance (%): 0

Hold time: [✓ Infinite] 0

Probability (%): 100

Figure 108: Edit Interrupt dialog box

Use this dialog box to interactively fine-tune the interrupt parameters. You can add the parameters and quickly test that the interrupt is generated according to your needs.

Interrupt

Selects the interrupt that you want to edit. The drop-down list contains all available interrupts. Your selection will automatically update the **Description** box. For Cortex-M devices, the list is populated with entries from the device description file that you have selected. For other devices, only two interrupts are available: IRQ and FIQ.

Description

A description of the selected interrupt, if available. The description is retrieved from the selected device description file and consists of a string describing the priority, vector offset, enable bit, and pending bit, separated by space characters. The enable bit and pending bit are optional. It is possible to have none, only the enable bit, or both.

For Cortex-M devices, the description is retrieved from the selected device description file and is editable. Enable bit and pending bit are not available from the `ddf` file; they must be manually edited if wanted. The priority is as in the hardware: the lower the number, the higher the priority. NMI and HardFault are special, and their descriptions should not be edited. Cortex-M interrupts are also affected by the `PRIMASK`, `FAULTMASK`, and `BASEPRI` registers, as described in the ARM documentation.

For other devices, the description strings for IRQ and FIQ are hardcoded and cannot be edited. In those descriptions, a higher priority number means a higher priority.

For interrupts specified using the system macro `__orderInterrupt`, the **Description** box is empty.

First activation

Specify the value of the cycle counter after which the specified type of interrupt will be generated.

Repeat interval

Specify the periodicity of the interrupt in cycles.

Variance %

Selects 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

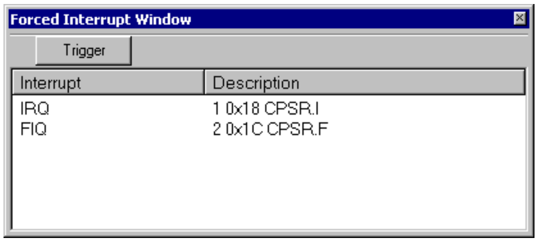
Specify how long, in cycles, the interrupt remains pending until removed if it has not been processed. If you select **Infinite**, the corresponding pending bit will be set until the interrupt is acknowledged or removed.

Probability %

Selects the probability, in percent, that the interrupt will actually occur within the specified period.

Forced Interrupt window

The **Forced Interrupt** window is available from the **Simulator** menu.



Interrupt	Description
IRQ	1 0x18 CPSR.I
FIQ	2 0x1C CPSR.F

Figure 109: Forced Interrupt window

Use this window to force an interrupt instantly. This is useful when you want to check your interrupt logistics and interrupt routines.

The hold time for a forced interrupt is infinite, and the interrupt exists until it has been serviced or until a reset of the debug session.

To force an interrupt:

1. Enable the interrupt simulation system, see *Interrupt Setup dialog box*, page 236.
2. Double-click the interrupt in the Forced Interrupt window, or select the interrupt and click **Trigger**.

Display area

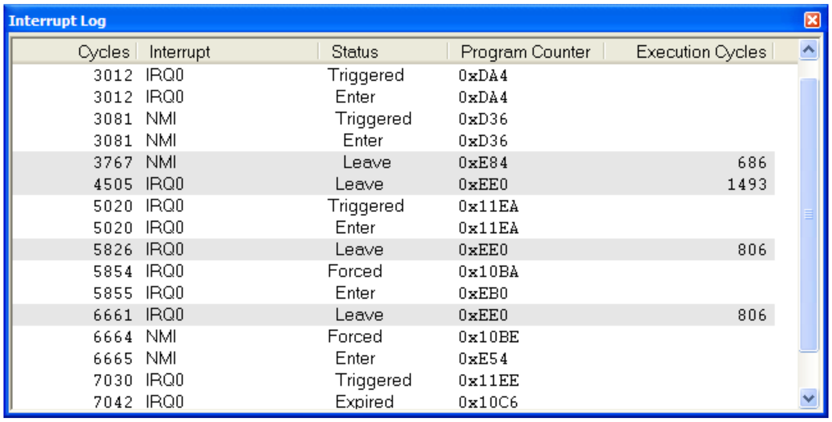
Lists all available interrupts and their definitions. The information is retrieved from the selected device description file. See this file for a detailed description.

Trigger

Triggers the interrupt you selected in the display area.

Interrupt Log window

The **Interrupt Log** window is available from the **Simulator** menu.



Interrupt Log

Cycles	Interrupt	Status	Program Counter	Execution Cycles
3012	IRQ0	Triggered	0xDA4	
3012	IRQ0	Enter	0xDA4	
3081	NMI	Triggered	0xD36	
3081	NMI	Enter	0xD36	
3767	NMI	Leave	0xE84	686
4505	IRQ0	Leave	0xEE0	1493
5020	IRQ0	Triggered	0x11EA	
5020	IRQ0	Enter	0x11EA	
5826	IRQ0	Leave	0xEE0	806
5854	IRQ0	Forced	0x10BA	
5855	IRQ0	Enter	0xEB0	
6661	IRQ0	Leave	0xEE0	806
6664	NMI	Forced	0x10BE	
6665	NMI	Enter	0xE54	
7030	IRQ0	Triggered	0x11EE	
7042	IRQ0	Expired	0x10C6	

Figure 110: Interrupt Log window

This window displays runtime information about the interrupts that you have activated in the **Edit Interrupts** dialog box or forced via the Forced Interrupt window. The information is useful for debugging the interrupt handling in the target system.

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.

Display area

This area contains these columns:

Cycles	The point in time, measured in cycles, when the event occurred.
Interrupt	The interrupt name as defined in the **Interrupt** text box of the **Edit Interrupt** dialog box.

Status	Shows the event status of the interrupt: **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. **Rejected**, the interrupt has been rejected because the necessary interrupt registers are not set up to accept the interrupt.
Program Counter	The value of the program counter when the event occurred.
Execution Cycles	The duration of the interrupt in execution cycles.

Using C-SPY macros

C-SPY® includes a comprehensive macro language which allows you to automate the debugging process and to simulate peripheral devices.

This chapter describes the C-SPY macro language, its features, for what purpose these features can be used, and how to use them. More specifically, this means:

- Introduction to C-SPY macros
- Procedures for using C-SPY macros
- Reference information on the macro language
- Reference information on reserved setup macro function names
- Reference information on C-SPY system macros.

Introduction to C-SPY macros

This section covers these topics:

- Reasons for using C-SPY macros
- Briefly about using C-SPY macros
- Briefly about setup macro functions and files
- Briefly about the macro language.

REASONS FOR USING C-SPY MACROS

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.
- Feeding your application with simulated data during runtime.

- Simulating peripheral devices, see the chapter *Simulating interrupts*. This only applies if you are using the simulator driver.
- Developing small debug utility functions, for instance calculating the stack depth, see the provided example `stack.mac` located in the directory `\arm\src\sim`.

BRIEFLY ABOUT USING C-SPY MACROS

To use C-SPY macros, you should:

- Write your macro variables and functions and collect them in in one or several *macro files*
- Register your macros
- Execute your macros.

For registering and executing macros, there are several methods to choose between. Which method you choose depends on which level of interaction or automation you want, and depending on at which stage you want to register or execute your macro.

BRIEFLY ABOUT SETUP MACRO FUNCTIONS AND FILES

There are some reserved *setup macro function names* that you can use for defining macro functions which will be called at specific times, such as:

- Once 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 one of the reserved names. For instance, if you want to clear a specific memory area before you load your application software, the macro setup function `execUserPreload` should be used. This function is also suitable if you want to initialize some CPU registers or memory-mapped peripheral units before you load your application software.

You should define these functions in a *setup macro file*, which you can load before C-SPY starts. Your macro functions will then be automatically registered each time you start C-SPY. This is convenient if you want to automate the initialization of C-SPY, or if you want to register multiple setup macros.

For detailed information about each setup macro function, see *Reference information on reserved setup macro function names*, page 256.

Remapping memory

A common feature of many ARM-based processors is the ability to remap memory. After a reset, the memory controller typically maps address zero to non-volatile memory, such as flash. By configuring the memory controller, the system memory can be remapped to place RAM at zero and non-volatile memory higher up in the address map. By doing this, the exception table will reside in RAM and can be easily modified when you download code to the target hardware. To handle this in C-SPY, the setup macro function `execUserPreload()` is suitable. For an example, see *Remapping memory*, page 60.

BRIEFLY ABOUT 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.
- *Macro functions*, which you can define with or without parameters and return values.
- Predefined built-in *system macros*, similar to C library functions, which perform useful tasks such as opening and closing files, setting breakpoints, and defining simulated interrupts.
- *Macro variables*, which can be global or local, and can be used in C-SPY expressions.
- *Macro strings*, which you can manipulate using predefined system macros.

For a detailed description of the macro language components, see *Reference information on the macro language*, page 251.

Example

Consider this example of a macro function which illustrates the various components of the macro language:

```
__var oldVal;
CheckLatest(val)
{
 if (oldval != val)
 {
  __message "Message: Changed from ", oldval, " to ", val, "\n";
  oldval = val;
 }
}
```

Note: Reserved macro words begin with double underscores to prevent name conflicts.

Procedures for using C-SPY macros

This section gives you step-by-step descriptions about how to register and execute C-SPY macros.

More specifically, you will get information about:

- Registering C-SPY macros—an overview
- Executing C-SPY macros—an overview
- Using the Macro Configuration dialog box
- Registering and executing using setup macros and setup files
- Executing macros using Quick Watch
- Executing a macro by connecting it to a breakpoint.

For more examples using C-SPY macros, see:

- The tutorial *Simulating an interrupt* in the Information Center
- *Initializing target hardware before C-SPY starts*, page 59.

REGISTERING C-SPY MACROS—AN OVERVIEW

C-SPY must know that you intend to use your defined macro functions, and thus you must *register* your macros. There are various ways to register macro functions:

- You can register macros interactively in the **Macro Configuration** dialog box, see *Using the Macro Configuration dialog box*, page 247.
- You can register macro functions during the C-SPY startup sequence, see *Registering and executing using setup macros and setup files*, page 248.
- 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 280.

Which method you choose depends on which level of interaction or automation you want, and depending on at which stage you want to register your macro.

EXECUTING C-SPY MACROS—AN OVERVIEW

There are various ways to execute macro functions:

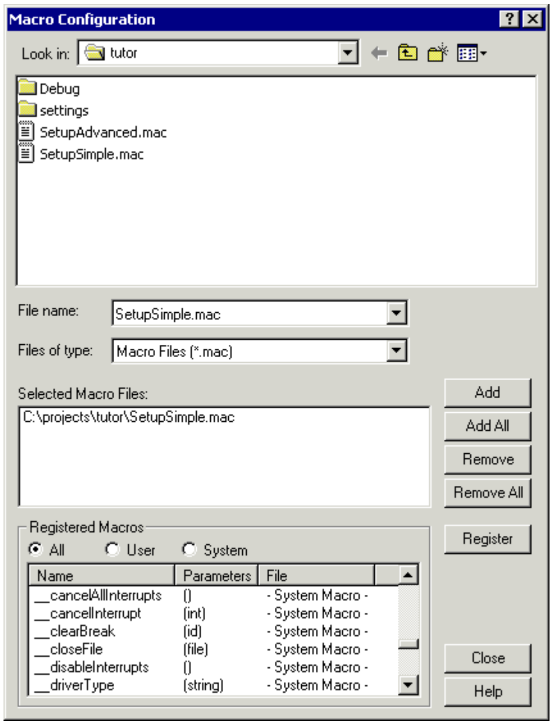
- You can execute macro functions during the C-SPY startup sequence and at other predefined stages during the debug session by defining setup macro functions in a setup macro file, see *Registering and executing using setup macros and setup files*, page 248.

- The Quick Watch window lets you evaluate expressions, and can thus be used for executing macro functions. For an example, see *Executing macros using Quick Watch*, page 249.
- A macro can be connected to a breakpoint; when the breakpoint is triggered the macro is executed. For an example, see *Executing a macro by connecting it to a breakpoint*, page 250.

Which method you choose depends on which level of interaction or automation you want, and depending on at which stage you want to execute your macro.

USING THE MACRO CONFIGURATION DIALOG BOX

The **Macro Configuration** dialog box is available by choosing **Debug>Macros**.



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 111: Macro Configuration dialog box

Use this dialog box to 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.

To register a macro file:

1. 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**.
2. Click **Register** to register the macro functions, replacing any previously defined macro functions or variables. Registered macro functions are displayed in the scroll list under **Registered Macros**.

   Note: System macros cannot be removed from the list, they are always registered.

To list macro functions:

1. Select **All** to display all macro functions, select **User** to display all user-defined macros, or select **System** to display all system macros.
2. Click either **Name** or **File** under **Registered Macros** to display the column contents sorted by macro names or by file. Clicking a second time sorts the contents in the reverse order.

To modify a macro file:

Double-click a user-defined macro function in the **Name** column to open the file where the function is defined, allowing you to modify it.

REGISTERING AND EXECUTING USING SETUP MACROS AND SETUP FILES

It can be convenient to register a macro file during the C-SPY startup sequence. 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 the debugger.

If you use the reserved setup macro function names to define the macro functions, you can define exactly at which stage you want the macro function to be executed.

To define a setup macro function and load it during C-SPY startup:

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 additional macro files `MyMacroUtils.mac` and `MyDeviceSimulation.mac`. Because the macro function is defined with the function name `execUserSetup`, 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>Debugger>Setup**. Select **Use Setup file** and choose the macro file you just created.

The macros will now be registered during the C-SPY startup sequence.

EXECUTING MACROS USING QUICK WATCH

The Quick Watch window lets you dynamically choose when to execute a macro function.

1 Consider this simple macro function that checks the status of a watchdog timer interrupt enable bit:

```
WDTstatus()
{
  if (#WD_SR & 0x01 != 0) /* Checks the status of WDOVF */
    return "Watchdog triggered"; /* C-SPY macro string used */
  else
    return "Watchdog not triggered"; /* C-SPY macro string used*/
}
```

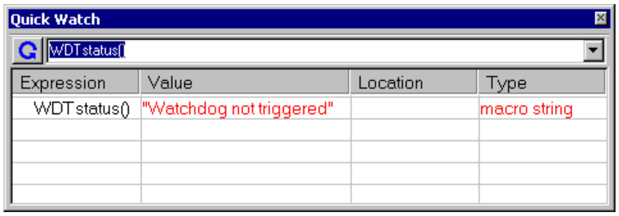
2 Save the macro function using the filename extension `mac`.

3 To register the macro file, choose **Debug>Macros**. The **Macro Configuration** dialog box appears.

4 Locate the file, click **Add** and then **Register**. The macro function appears in the list of registered macros.

5 Choose **View>Quick Watch** to open the Quick Watch window, type the macro call `WDTstatus()` in the text field and press Return,

Alternatively, 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()	"Watchdog not triggered"		macro string

Figure 112: Quick Watch window

The macro will automatically be displayed in the Quick Watch window.

For reference information, see *Quick Watch window*, page 105.

EXECUTING A MACRO BY CONNECTING IT TO A BREAKPOINT

You can connect a macro to a breakpoint. The macro will then be executed 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 change. 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.

To create a log macro and connect it to a breakpoint:

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 To register the macro, choose **Debug>Macros** to open the **Macro Configuration** dialog box 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 To set a code breakpoint, click the **Toggle Breakpoint** button on the first statement within the function `fact` in your application source code. Choose **View>Breakpoints** to open the Breakpoints window. Select your breakpoint in the list of breakpoints and choose the **Edit** command from the context menu.

5 To connect the log macro function to the breakpoint, type the name of the macro function, `logfact()`, in the **Action** field and click **Apply**. Close the dialog box.

6 Execute your application source code. When the breakpoint is triggered, the macro function will be executed. You can see the result in the Log window.

Note that the expression in the **Action** field is evaluated only when the breakpoint causes the execution to really stop. If you want to log a value and then automatically continue execution, you can either:

- Use a Log breakpoint, see *Log breakpoints dialog box*, page 128
- Use the **Condition** field instead of the **Action** field. For an example, see *Performing a task and continue execution*, page 119.

7 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 254.

For a complete example where a serial port input buffer is simulated using the method of connecting a macro to a breakpoint, see the tutorial *Simulating an interrupt* in the Information Center.

Reference information on the macro language

This section gives reference information on the macro language:

- *Macro functions*, page 252
- *Macro variables*, page 252
- *Macro strings*, page 253
- *Macro statements*, page 253
- *Formatted output*, page 254.

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.

MACRO VARIABLES

A macro variable is a variable defined and allocated outside your application. It can then be used in a C-SPY expression, or you can assign application data—values of the variables in your application—to it. For detailed information about C-SPY expressions, see *C-SPY expressions*, page 94.

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 13: 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 macro 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 254.

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 94.

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 275.

To produce messages in the Debug Log window:

```
var1 = 42;
var2 = 37;
__message "This line prints the values ", var1, " and ", var2,
" in the Log window.";
```

This produces this message in the Log window:

```
This line prints the values 42 and 37 in the Log window.
```

To write the output to a designated file:

```
__fmessage myfile, "Result is ", res, "!\n";
```

To produce strings:

```
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 scalar arguments
`%o`	for octal scalar arguments
`%d`	for decimal scalar arguments
`%x`	for hexadecimal scalar arguments
`%c`	for character scalar arguments

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;
```

Depending on the value of the variables, this produces this message:

```
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.

Reference information on reserved setup macro function names

There are reserved setup macro function names that you can use for defining your setup macro functions. By using these reserved names, your function will be executed at defined stages during execution. For more information, see *Briefly about setup macro functions and files, page 244*.

This table summarizes the reserved setup macro function names:

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.
`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.
`execUserReset`	Called each time the reset command is issued. Implement this macro to set up and restore data.

Table 14: C-SPY setup macros

Macro	Description
`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.

Table 14: C-SPY setup macros (Continued)

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 43 in the Information Center.

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.

Reference information on C-SPY system macros

This section gives reference information about each of the C-SPY system macros.

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
`__emulatorSpeed`	Sets the emulator clock frequency
`__emulatorStatusCheckOnRead`	Enables or disables the verification of the `CPSR` register after each read operation
`__enableInterrupts`	Enables generation of interrupts
`__evaluate`	Interprets the input string as an expression and evaluates it.
`__gdbserver_exec_command`	Send strings or commands to the GDB Server.
`__hwReset`	Performs a hardware reset and halt of the target CPU

Table 15: Summary of system macros

Macro	Description
`__hwResetRunToBp`	Performs a hardware reset and then executes to the specified address
`__hwResetWithStrategy`	Performs a hardware reset and halt with delay of the target CPU
`__isBatchMode`	Checks if C-SPY is running in batch mode or not.
`__jlinkExecCommand`	Sends a low-level command to the J-Link/J-Trace driver.
`__jtagCommand`	Sends a low-level command to the JTAG instruction register
`__jtagCP15IsPresent`	Checks if coprocessor CP15 is available
`__jtagCP15ReadReg`	Returns the coprocessor CP15 register value
`__jtagCP15WriteReg`	Writes to the coprocessor CP15 register
`__jtagData`	Sends a low-level data value to the JTAG data register
`__jtagRawRead`	Returns the read data from the JTAG interface
`__jtagRawSync`	Writes accumulated data to the JTAG interface
`__jtagRawWrite`	Accumulates data to be transferred to the JTAG
`__jtagResetTRST`	Resets the ARM TAP controller via the TRST JTAG signal
`__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`

Table 15: Summary of system macros (Continued)

Macro	Description
`__restoreSoftwareBreakpoints`	Restores any breakpoints that were destroyed during system startup.
`__setCodeBreak`	Sets a code breakpoint
`__setDataBreak`	Sets a data breakpoint
`__setLogBreak`	Sets a log breakpoint
`__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
`__unloadImage`	Unloads a debug image.
`__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 15: Summary of system macros (Continued)

__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 16: __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 *Using breakpoints*, page 109.

__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 17: __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. Choose one of these: `"angel"` corresponds to the Angel driver `"gdbserv"` corresponds to the GDB Server driver `"generic"` corresponds to third-party drivers `"jlink"` corresponds to the J-Link/J-Trace driver `"jtag"` corresponds to the Macraigor driver `"lmiftdi"` corresponds to the TI Stellaris FTDI driver `"rdi"` corresponds to the RDI driver `"rom"` corresponds to the IAR ROM-monitor driver `"sim"` corresponds to the simulator driver `"stlink"` corresponds to the ST-LINK driver

Return value

Result	Value
Successful	`1`
Unsuccessful	`0`

Table 18: __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 the simulator is the current driver, the value `1` is returned. Otherwise `0` is returned.

__emulatorSpeed

Syntax `__emulatorSpeed(`*`speed`*`)`

Parameter

`speed`	The emulator speed in Hz. Use `0` (zero) to make the speed automatically detected. Use `-1` for adaptive speed (only for emulators supporting adaptive speed).

Return value

Result	Value
Successful	The previous speed, or `0` (zero) if unknown
Unsuccessful; the speed is not supported by the emulator	`-1`

Table 19: __emulatorSpeed return values

Description

Sets the emulator clock frequency. For JTAG interfaces, this is the JTAG clock frequency as seen on the `TCK` signal.

Applicability

This system macro is available for J-Link/J-Trace.

Example

```
__emulatorSpeed(0)
```

Sets the emulator speed to be automatically detected.

__emulatorStatusCheckOnRead

Syntax

`__emulatorStatusCheckOnRead(`*`status`*`)`

Parameter

`status`	Use `0` to enable checks (default). Use `1` to disable checks.

Return value

`int 0`

Description

Enables or disables the driver verification of `CPSR` (current processor status register) after each read operation. Typically, this macro can be used for initiating JTAG connections on some CPUs, like Texas Instruments' TMS470R1B1M.

Note: Enabling this verification can cause problems with some CPUs, for example if invalid `CPSR` values are returned. However, if this verification is disabled (`SetCheckModeAfterRead = 0`), the success of read operations cannot be verified and possible data aborts are not detected.

Applicability

This system macro is available for J-Link/J-Trace.

Example

```
__emulatorStatusCheckOnRead(1)
```

Disables the checks for data aborts on memory reads.

__enableInterrupts

Syntax

`__enableInterrupts()`

Return value

Result	Value
Successful	`int 0`
Unsuccessful	Non-zero error number

Table 20: __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 21: __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.

__gdbserver_exec_command

Syntax `__gdbserver_exec_command("`*`string`*`")`

Parameter

`"`*`string`*`"`	String or command sent to the GDB Server; see its documentation for more information.

Description Use this option to send strings or commands to the GDB Server.

Applicability This system macro is available for the GDB Server interfaces.

__hwReset

Syntax `__hwReset(`*`halt_delay`*`)`

Parameter

`halt_delay`	The delay, in microseconds, between the end of the reset pulse and the halt of the CPU. Use `0` (zero) to make the CPU halt immediately after reset

Return value

Result	**Value**
Successful. The actual delay value implemented by the emulator	`>=0`
Successful. The delay feature is not supported by the emulator	`-1`
Unsuccessful. Hardware reset is not supported by the emulator	`-2`

Table 22: __hwReset return values

Description Performs a hardware reset and halt of the target CPU.

Applicability This system macro is available for all JTAG interfaces.

Example

```
__hwReset(0)
```

Resets the CPU and immediately halts it.

__hwResetRunToBp

Syntax

`__hwResetRunToBp(`*`strategy`*`, `*`breakpoint_address`*`, `*`timeout`*`)`

Parameter

`strategy`	For information about supported reset strategies, see the *IAR J-Link and IAR J-Trace User Guide for JTAG Emulators for ARM Cores*.
`breakpoint_address`	The address of the breakpoint to execute to, specified as an integer value (symbols cannot be used).
`timeout`	A time out for the breakpoint, specified in milliseconds. If the breakpoint is not reached within the specified time, the core will be halted.

Return value

Value	Result
`>=0`	Successful. The approximate execution time in ms until the breakpoint is hit.
`-2`	Unsuccessful. Hardware reset is not supported by the emulator.
`-3`	Unsuccessful. The reset strategy is not supported by the emulator.

Table 23: __hwResetRunToBp return values

Description

Performs a hardware reset, sets a breakpoint at the specified address, executes to the breakpoint, and then removes it. The breakpoint address should be the start address of the downloaded image after it has been copied to RAM.

This macro is intended for running a boot loader that copies the application image from flash to RAM. The macro should be executed after the image has been downloaded to flash, but before the image is verified. The macro can be run in `execUserFlashExit` or `execUserPreload`.

Applicability

This system macro is available for J-Link/J-Trace.

Example

```
__hwResetRunToBp(0,0x400000,10000)
```

Resets the CPU with the reset strategy `0` and executes to the address `0x400000`. If the breakpoint is not reached within 10 seconds, execution stops in accordance with the specified time out.

__hwResetWithStrategy

Syntax

`__hwResetWithStrategy(`*`halt_delay`*`, `*`strategy`*`)`

Parameter

`halt_delay`	The delay, in milliseconds, between the end of the reset pulse and the halt of the CPU. Use `0` (zero) to make the CPU halt immediately after reset; only when *`strategy`* is set to `0`.
`strategy`	For information about supported reset strategies, see the *IAR J-Link and IAR J-Trace User Guide for JTAG Emulators for ARM Cores*.

Return value

Result	Value
Successful. The actual delay in milliseconds, as implemented by the emulator	`>=0`
Successful. The delay feature is not supported by the emulator	`-1`
Unsuccessful. Hardware reset is not supported by the emulator	`-2`
Unsuccessful. The reset strategy is not supported by the emulator	`-3`

Table 24: __hwResetWithStrategy return values

Description

Performs a hardware reset and a halt with delay of the target CPU.

Applicability

This system macro is available for J-Link/J-Trace.

Example

```
__hwResetWithStrategy(0,1)
```

Resets the CPU and halts it using a breakpoint at memory address zero.

__isBatchMode

Syntax

```
__isBatchMode()
```

Return value

Result	Value
True	`int 1`
False	`int 0`

Table 25: __isBatchMode return values

Description

This macro returns True if the debugger is running in batch mode, otherwise it returns False.

__jlinkExecCommand

Syntax `__jlinkExecCommand(`*`cmdstr`*`)`

Parameter

`cmdstr`	J-Link/J-Trace command string

Return value `int 0`

Description Sends a low-level command to the J-Link/J-Trace driver, see the *IAR J-Link and IAR J-Trace User Guide for JTAG Emulators for ARM Cores*.

Applicability This system macro is available for J-Link/J-Trace.

__jtagCommand

Syntax `__jtagCommand(`*`ir`*`)`

Parameter *`ir`* can be one of:

`2`	`SCAN_N`
`4`	`RESTART`
`12`	`INTEST`
`14`	`IDCODE`
`15`	`BYPASS`

Return value `int 0`

Description Sends a low-level command to the JTAG instruction register `IR`.

Applicability This system macro is available for J-Link/J-Trace.

Example

```
__jtagCommand(14);
Id = __jtagData(0,32);
```

Returns the JTAG ID of the ARM target device.

__jtagCP15IsPresent

Syntax	`__jtagCP15IsPresent()`
Return value	`1` if CP15 is available, otherwise `0`.
Description	Checks if the coprocessor CP15 is available.
Applicability	This system macro is available for J-Link/J-Trace.

__jtagCP15ReadReg

Syntax	`__jtagCP15ReadReg(CRn, CRm, op1, op2)`
Parameter	The parameters—registers and operands—of the `MRC` instruction. For details, see the *ARM Architecture Reference Manual*. Note that *op1* should always be `0`.
Return value	The register value.
Description	Reads the value of the CP15 register and returns its value.
Applicability	This system macro is available for J-Link/J-Trace.

__jtagCP15WriteReg

Syntax	`__jtagCP15WriteReg(CRn, CRm, op1, op2, value)`
Parameter	The parameters—registers and operands—of the `MCR` instruction. For details, see the *ARM Architecture Reference Manual*. Note that *op1* should always be `0`. *value* is the value to be written.
Description	Writes a value to the CP15 register.
Applicability	This system macro is available for J-Link/J-Trace.

__jtagData

Syntax `__jtagData(dr, bits)`

Parameter

dr	32-bit data register value

bits	Number of valid bits in *dr*, both for the macro parameter and the return value; starting with the least significant bit (`1...32`)

Return value

Returns the result of the operation; the number of bits in the result is given by the *bits* parameter.

Description

Sends a low-level data value to the JTAG data register `DR`. The bit shifted out of `DR` is returned.

Applicability

This system macro is available for J-Link/J-Trace.

Example

```
__jtagCommand(14);
Id = __jtagData(0,32);
```

Returns the JTAG ID of the ARM target device.

__jtagRawRead

Syntax

`__jtagRawRead(`*bitpos*`,` *numbits*`)`

Parameter

bitpos	The start bit position in the returned JTAG bits to return data from
numbits	The number of bits to read. The maximum value is 32.

Description

Returns the data read from the JTAG `TDO`. Only the least significant bits contain data; the last bit read is from the least significant bit. This function can be called an arbitrary number of times to get all bits returned by an operation. This function also makes an implicit synchronization of any accumulated write bits.

Applicability

This system macro is available for J-Link/J-Trace.

Example

The following piece of pseudocode illustrates how the data is written to the JTAG (on the `TMS` and `TDI` pins) and read (from `TDO`):

```
__var Id;
__var BitPos;
/*****************************************************************
*
* ReadId()
*/
ReadId() {
__message "Reading JTAG Id\n";
__jtagRawWrite(0, 0x1f, 6); /* Goto IDLE via RESET state */
__jtagRawWrite(0, 0x1, 3); /* Enter DR scan chain */
BitPos = __jtagRawWrite(0, 0x80000000, 32); /* Shift 32 bits
                   into DR. Remember BitPos for Read operation */
__jtagRawWrite(0, 0x1, 2); /* Goto IDLE */
Id = __jtagRawRead(BitPos, 32); /* Read the Id */
__message "JTAG Id: ", Id:%x, "\n";
}
```

__jtagRawSync

Syntax

`__jtagRawSync()`

Return value

`int 0`

Description

Sends arbitrary data to the JTAG interface. All accumulated bits using `__jtagRawWrite` will be written to the JTAG scan chain. The data is sent synchronously with `TCK` and typically sampled by the device on rising edge of `TCK`.

Applicability

This system macro is available for J-Link/J-Trace.

Example

The following piece of pseudocode illustrates how the data is written to the JTAG (on the `TMS` and `TDI` pins) and read (from `TDO`):

```
int i;
U32 tdo;
for (i = 0; i < numBits; i++) {
  TDI = tdi & 1; /* Set TDI pin */
  TMS = tms & 1; /* Set TMS pin */
  TCK = 0;
  TCK = 1;
  tdo <<= 1;
  if (TDO) {
    tdo |= 1;
  }
  tdi >>= 1;
  tms >>= 1;
}
```

__jtagRawWrite

Syntax

`__jtagRawWrite(tdi, tms, numbits)`

Parameter

tdi	The data output to the `TDI` pin. This data is sent with the least significant bit first.
tms	The data output to the `TMS` pin. This data is sent with the least significant bit first.
numbits	The number of bits to transfer. Every bit results in a falling and rising edge of the JTAG `TCK` line. The maximum value is 64.

Return value

Returns the bit position of the data in the accumulated packet. Typically, this value is used when reading data from the JTAG.

Description

Accumulates bits to be transferred to the JTAG. If 32 bits are not enough, this function can be called multiple times. Both data output lines (`TMS` and `TDI`) can be controlled separately.

Applicability

This system macro is available for J-Link/J-Trace.

Example

```
/* Send five 1 bits on TMS to go to TAP-RESET state */
__jtagRawWrite(0x1F, 0, 5);   /* Store bits in buffer */
__jtagRawSync();  /* Transfer buffer, writing tms, tdi,
                     reading tdo */
```

Returns the JTAG ID of the ARM target device.

__jtagResetTRST

Syntax

`__jtagResetTRST()`

Return value

Result	Value
Successful	`int 0`
Unsuccessful	Non-zero error number

Table 26: __jtagResetTRST return values

Description

Resets the ARM TAP controller via the TRST JTAG signal.

Applicability

This system macro is available for J-Link/J-Trace.

__loadImage

Syntax

`__loadImage(`*`path`*`, `*`offset`*`, `*`debugInfoOnly`*`)`

Parameter

`path`	A string that identifies the path to the image to download. The path must either be absolute or use argument variables. Read more about argument variables in the *IDE Project Management and Building Guide for ARM®*.
`offset`	An integer that identifies the offset to the destination address for the downloaded image.
`debugInfoOnly`	A non-zero integer 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 27: __loadImage 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, which you associate with your project:

```
__loadImage(ROMfile, 0x8000, 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, which you associate with your project:

```
__loadImage(ApplicationFile, 0x8000, 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 328 and *Loading multiple images*, page 57.

__memoryRestore

Syntax

`__memoryRestore(`*`zone, filename`*`)`

Parameters

`zone`	The memory zone name (string); for a list of available zones, see *C-SPY memory zones*, page 143.
`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. For information about argument variables, see the *IDE Project Management and Building Guide for ARM®*.

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 149.

__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. For information about Argument variables, see the *C-SPY® Debugging Guide for ARM®*.

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 148.

__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. For information about argument variables, see the *IDE Project Management and Building Guide for ARM®*.

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 28: __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

For information about argument variables, see the *IDE Project Management and Building Guide for ARM®*.

__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( "IRQ", 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.

See also

Simulating an interrupt in a multi-task system, page 235.

__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 29: __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 *C-SPY memory zones*, page 143.

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 *C-SPY memory zones*, page 143.

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 *C-SPY memory zones*, page 143.

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. For information about argument variables, see the *IDE Project Management and Building Guide for ARM®*.

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 248.

__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`.

__restoreSoftwareBreakpoints

Syntax `__restoreSoftwareBreakpoints()`

Return value `int 0`

Description Restores automatically any breakpoints that were destroyed during system startup.

This can be useful if you have an application that is copied to RAM during startup and is then executing in RAM. This can, for example, be the case if you use the `initialize by copy` directive for code in the linker configuration file or if you have any `__ramfunc` declared functions in your application. In this case, any breakpoints will be destroyed during the RAM copying when the C-SPY debugger starts.

By using the this macro, C-SPY will restore the destroyed breakpoints.

Applicability This system macro is available for J-Link/J-Trace, the TI Stellaris FTDI interface, and the Macraigor interface.

__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 30: __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

Using breakpoints, page 109.

__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 31: __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

Using breakpoints, page 109.

__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 32: __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 254 and *Using breakpoints*, page 109.

__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 33: __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 34: __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 only available in the C-SPY Simulator.

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

Using breakpoints, page 109.

__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 35: __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 only available in the C-SPY Simulator.

Example

See *__setTraceStartBreak*, page 286.

See also *Using breakpoints*, page 109.

__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 36: __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 253.

__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 253.

__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 253.

__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 253.

__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 253.

__unloadImage

Syntax: `__unloadImage(`*`module_id`*`)`

Parameter

module_id	An integer which represents a unique module identification, which is retrieved as a return value from the corresponding `__loadImage` C-SPY macro.

Return value

Value	Result
module_id	A unique module identification (the same as the input parameter).
`int 0`	The unloading failed.

Table 37: __unloadImage return values

Description: Unloads debug information from an already downloaded image.

See also: *Loading multiple images*, page 57 and *Images*, page 328.

__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 *C-SPY memory zones*, page 143.

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 *C-SPY memory zones*, page 143.

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 *C-SPY memory zones*, page 143.

Return value `int 0`

Description Writes four bytes to a given memory location.

Example

```
__writeMemory32(0x5555FFFF, 0x8020, "Memory");
```

The C-SPY Command Line Utility—cspybat

This chapter describes how you can execute C-SPY® in batch mode, using the C-SPY Command Line Utility—cspybat.exe. More specifically, this means:

- Using C-SPY in batch mode
- Summary of C-SPY command line options
- Reference information on C-SPY command line options.

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 `arm\bin`.
driver_DLL	The C-SPY driver DLL file; available in `arm\bin`.
debug_file	The object file that you want to debug (filename extension `out`).
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 *Reference information on C-SPY command line options*, page 301.

Table 38: cspybat parameters

Parameter	Description
`--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 *Reference information on C-SPY command line options*, page 301.

Table 38: cspybat parameters (Continued)

Example

This example starts `cspybat` using the simulator driver:

```
EW_DIR\common\bin\cspybat EW_DIR\arm\bin\armproc.dll
EW_DIR\arm\bin\armsim.dll PROJ_DIR\myproject.out --plugin
EW_DIR\arm\bin\armbat.dll --backend sim -B --cpu arm -p
EW_DIR\arm\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.

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`, provided that you have used the `--plugin` option. See *--plugin*, page 318.

- 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.

Summary of 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`	Downloads a code image without starting a debug session afterwards.
`--flash_loader`	Specifies a flash loader specification XML file.
`--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

`--BE8`	Uses the big-endian format BE8. For reference information, see the *IAR C/C++ Development Guide for ARM®*.
`--BE32`	Uses the big-endian format BE32. For reference information, see the *IAR C/C++ Development Guide for ARM®*.
`--cpu`	Specifies a processor variant. For reference information, see the *IAR C/C++ Development Guide for ARM®*.
`--device`	Specifies the name of the device.

`--drv_attach_to_program`	Attaches the debugger to a running application at its current location. For reference information, see *Attach to program*, page 326.
`--drv_catch_exceptions`	Makes the application stop for certain exceptions.
`--drv_communication`	Specifies the communication link to be used.
`--drv_communication_log`	Creates a log file.
`--drv_default_breakpoint`	Sets the type of breakpoint resource to be used when setting breakpoints.
`--drv_reset_to_cpu_start`	Omits setting the `PC` when starting or resetting the debugger.
`--drv_restore_breakpoints`	Restores automatically any breakpoints that were destroyed during system startup.
`--drv_suppress_download`	Suppresses download of the executable image. For reference information, see *Suppress download*, page 326.
`--drv_vector_table_base`	Specifies the location of the Cortex-M reset vector and the initial stack pointer value.
`--drv_verify_download`	Verifies the target program. For reference information, see *Verify download*, page 326. Available for Angel, GDB Server, IAR ROM-monitor, J-Link/J-Trace, TI Stellaris FTDI, Macraigor, RDI, and ST-LINK.
`--endian`	Specifies the byte order of the generated code and data. For reference information, see the *IAR C/C++ Development Guide for ARM®*.
`--fpu`	Selects the type of floating-point unit. For reference information, see the *IAR C/C++ Development Guide for ARM®*.
`-p`	Specifies the device description file to be used.
`--proc_stack_stack`	Provides information to the C-SPY plugin module about reserved stacks.
`--semihosting`	Enables semihosted I/O.

OPTIONS AVAILABLE FOR THE SIMULATOR DRIVER

`--disable_interrupts`	Disables the interrupt simulation.
`--mapu`	Activates memory access checking.

OPTIONS AVAILABLE FOR THE C-SPY ANGEL DEBUG MONITOR DRIVER

`--rdi_heartbeat`	Makes C-SPY poll your target system periodically. For reference information, see *Send heartbeat*, page 330.
`--rdi_step_max_one`	Executes one instruction.

OPTIONS AVAILABLE FOR THE C-SPY GDB SERVER DRIVER

`--gdbserv_exec_command`	Sends a command string to the GDB Server.

OPTIONS AVAILABLE FOR THE C-SPY IAR ROM-MONITOR DRIVER

There are no additional options specific to the C-SPY IAR ROM-monitor driver.

OPTIONS AVAILABLE FOR THE C-SPY J-LINK/J-TRACE DRIVER

`--jlink_device_select`	Selects a specific device in the JTAG scan chain.
`--jlink_exec_command`	Calls the `__jlinkExecCommand` macro after target connection has been established.
`--jlink_initial_speed`	Sets the initial JTAG communication speed in kHz.
`--jlink_interface`	Specifies the communication between the J-Link debug probe and the target system.
`--jlink_ir_length`	Sets the number of IR bits before the ARM device to be debugged.
`--jlink_reset_strategy`	Selects the reset strategy to be used at debugger startup.
`--jlink_script_file`	Specifies the script file for setting up hardware.
`--jlink_speed`	Sets the JTAG communication speed in kHz.

OPTIONS AVAILABLE FOR THE C-SPY TI STELLARIS FTDI DRIVER

`--lmiftdi_speed`	Sets the JTAG communication speed in kHz.

OPTIONS AVAILABLE FOR THE C-SPY MACRAIGOR DRIVER

`--mac_handler_address`	Specifies the location of the debug handler used by Intel XScale devices.
`--mac_interface`	Specifies the communication between the Macraigor debug probe and the target system.
`--mac_jtag_device`	Selects the device corresponding to the hardware interface.
`--mac_multiple_targets`	Specifies the device to connect to, if there are more than one device on the JTAG scan chain.
`--mac_reset_pulls_reset`	Makes C-SPY generate an initial hardware reset.
`--mac_set_temp_reg_buffer`	Provides the driver with a physical RAM address for accessing the coprocessor.
`--mac_speed`	Sets the JTAG speed between the JTAG probe and the ARM JTAG ICE port.
`--mac_xscale_ir7`	Specifies that the XScale ir7 architecture is used.

OPTIONS AVAILABLE FOR THE C-SPY RDI DRIVER

`--rdi_allow_hardware_reset`	Performs a hardware reset.
`--rdi_driver_dll`	Specifies the path to the RDI driver DLL file.
`--rdi_use_etm`	Enables C-SPY to use and display ETM trace.
`--rdi_step_max_one`	Executes one instruction.

OPTIONS AVAILABLE FOR THE C-SPY ST-LINK DRIVER

`--stlink_interface`	Specifies the communication between the ST-LINK debug probe and the target system.

OPTIONS AVAILABLE FOR THE C-SPY THIRD-PARTY DRIVERS

For information about any options specific to the third-party driver you are using, see its documentation.

Reference information on C-SPY command line options

This section gives detailed reference information about each `cspybat` option and each option available to the C-SPY drivers.

--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*, page 213.

--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.

--device

Syntax

```
--device=device_name
```

Parameters

device_name	The name of the device, for example, `ADuC7030`, `AT91SAM7S256`, `LPC2378`, `STR912FM44`, or `TMS470R1B1M`.

Applicability

All C-SPY drivers.

Description

Use this option to specify the name of the device.

To set related option, choose:

Project>Options>General Options>Target>Device

--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 download the code image without starting a debug session afterwards.

To set related options, choose:

Project>Download

--drv_catch_exceptions

Syntax `--drv_catch_exceptions=`*`value`*

Parameters

`value` (for ARM9 and Cortex-R4)	A value in the range of `0-0x1FF`. Each bit specifies which exception to catch: Bit 0 = Reset Bit 1 = Undefined instruction Bit 2 = SWI Bit 3 = Not used Bit 4 = Data abort Bit 5 = Prefetch abort Bit 6 = IRQ Bit 7 = FIQ Bit 8 = Other errors
`value` (for Cortex-M)	A value in the range of `0-0x7FF`. Each bit specifies which exception to catch: Bit 0 = CORERESET - Reset Vector Bit 4 = MMERR - Memory Management Fault Bit 5 = NOCPERR - Coprocessor Access Error Bit 6 = CHKERR - Checking Error Bit 7 = STATERR - State Error Bit 8 = BUSERR - Bus Error Bit 9 = INTERR - Interrupt Service Errors Bit 10 = HARDERR - Hard Fault

Applicability The C-SPY Angel debug monitor driver.

The C-SPY J-Link/J-Trace driver

The C-SPY RDI driver.

Description

Use this option to make the application stop when a certain exception occurs.

See also

Breakpoints on vectors, page 114.

For the C-SPY Angel debug monitor driver, use:

Project>Options>Debugger>Extra Options

For the C-SPY J-Link/J-Trace driver, use:

Project>Options>Debugger>J-Link/J-Trace>Catch exceptions

For the C-SPY RDI driver, use:

Project>Options>Debugger>RDI>Catch exceptions

--drv_communication

Syntax

`--drv_communication=`*`connection`*

Parameters

Where *`connection`* is one of these for the C-SPY Angel debug monitor driver:

Via Ethernet	`UDP:`*`ip_address`*
	`UDP:`*`ip_address,port`*
	`UDP:`*`hostname`*
	`UDP:`*`hostname,port`*

Via serial port	*`port:baud,parity,stop_bit,handshake`* *`port`* `= COM1-COM256` (default COM1) *`baud`* `= 9600`, `19200`, `38400`, `57600`, or `115200` (default `9600` baud) *`parity`* `= N` (no parity) *`stop_bit`* `= 1` (one stop bit) *`handshake`* `= NONE` or `RTSCTS` (default `NONE` for no handshaking) For example, `COM1:9600,N,8,1,NONE`.

Where *connection* is one of these for the C-SPY GDB Server driver:

Via Ethernet	`TCPIP:`*`ip_address`*
	`TCPIP:`*`ip_address,port`*
	`TCPIP:`*`hostname`*
	`TCPIP:`*`hostname,port`*
	Note that if no port is specified, port `3333` is used by default.

Where *connection* is one of these for the C-SPY IAR ROM-monitor driver:

Via serial port	*`port:baud,parity,stop_bit,handshake`* *`port`* `=` `COM1-COM256` (default `COM1`) *`baud`* `=` `9600`, `19200`, `38400`, `57600`, or `115200` (default `9600` baud) *`parity`* `=` `N` (no parity) *`stop_bit`* `=` `1` (one stop bit) *`handshake`* `=` `NONE` or `RTSCTS` (default `NONE` for no handshaking) For example, `COM1:9600,N,8,1,NONE`.

Where *connection* is one of these for the C-SPY J-Link/J-Trace driver:

Via USB directly to J-Link	`USB0-USB3`

Via J-Link server	`TCPIP:`*`ip_address`*
	`TCPIP:`*`ip_address,port`*
	`TCPIP:`*`hostname`*
	`TCPIP:`*`hostname,port`*
	Note that if no port is specified, port `19020` is used by default.

Where *connection* is one of these for the C-SPY Macraigor driver:

For mpDemon	*`port:baud`*
	`port` `=` `COM1-COM4`
	`baud` `=` `9600`, `19200`, `38400`, `57600`, or `115200` (default `9600` baud)

For mpDemon	`TCPIP:`*`ip_address`*
	`TCPIP:`*`ip_address,port`*
	`TCPIP:`*`hostname`*
	`TCPIP:`*`hostname,port`*
	Note that if no port is specified, port `19020` is used by default.

Via USB to usbDemon and usb2Demon	USB ports = `USB0–USB3`

Applicability

The C-SPY Angel debug monitor driver

The C-SPY GDB Server driver

The C-SPY IAR ROM-monitor driver.

The C-SPY J-Link/J-Trace driver

The C-SPY Macraigor driver.

Description

Use this option to choose communication link.

Project>Options>Debugger>Angel>Communication

Project>Options>Debugger>GDB Server>TCP/IP address or hostname [,port]

Project>Options>Debugger>IAR ROM-monitor>Communication

Project>Options>Debugger>J-Link/J-Trace>Connection>Communication

To set related options for the C-SPY Macraigor driver, choose:

Project>Options>Debugger>Macraigor

--drv_communication_log

Syntax

`--drv_communication_log=`*`filename`*

Parameters

`filename`	The name of the log file.

Applicability

All C-SPY drivers.

Description

Use this option to log the communication between C-SPY and the target system to a file. To interpret the result, detailed knowledge of the communication protocol is required.

Project>Options>Debugger>Driver>Log communication

--drv_default_breakpoint

Syntax `--drv_default_breakpoint={0|1|2}`

Parameters

`0`	Auto (default)
`1`	Hardware
`2`	Software

Applicability

The C-SPY GDB Server driver

The C-SPY J-Link/J-Trace driver.

The C-SPY Macraigor driver.

Description

Use this option to select the type of breakpoint resource to be used when setting a breakpoint.

See also

Default breakpoint type, page 134.

Project>Options>Debugger>Driver>Breakpoints>Default breakpoint type

--drv_reset_to_cpu_start

Syntax `--drv_reset_to_cpu_start`

Applicability

The C-SPY Angel debug monitor driver

The C-SPY GDB Server driver

The C-SPY J-Link/J-Trace driver

The C-SPY TI Stellaris FTDI driver

The C-SPY Macraigor driver

The C-SPY RDI driver.

Description

Use this option to omit setting the `PC` when starting or resetting the debugger. Instead `PC` will have the original value set by the CPU, which is the address of the application entry point.

To set this option, use **Project>Options>Debugger>Extra Options**.

--drv_restore_breakpoints

Syntax `--drv_restore_breakpoints=`*`location`*

Parameters

`location`	Address or function name label

Applicability

The C-SPY GDB Server driver

The C-SPY J-Link/J-Trace driver

The C-SPY Macraigor driver.

Description

Use this option to restore automatically any breakpoints that were destroyed during system startup.

See also

Restore software breakpoints at, page 134.

Project>Options>Debugger>Driver>Breakpoints>Restore software breakpoints at

--drv_vector_table_base

Syntax `--drv_vector_table_base=`*`expression`*

Parameters

`expression`	A label or an address

Applicability

The C-SPY GDB Server driver

The C-SPY J-Link/J-Trace driver

The C-SPY TI Stellaris FTDI driver

The C-SPY Macraigor driver

The C-SPY RDI driver

The C-SPY Simulator driver.

The C-SPY ST-LINK driver.

Description

Use this option for Cortex-M to specify the location of the reset vector and the initial stack pointer value. This is useful if you want to override the default `__vector_table` label—defined in the system startup code—in the application or if the application lacks this label, which can be the case if you debug code that is built by tools from another vendor.

To set this option, use **Project>Options>Debugger>Extra Options**.

--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*.

--gdbserv_exec_command

Syntax `--gdbserv_exec_command="*string*"`

Parameters

"*`string`*"	String or command sent to the GDB Server; see its documentation for more information.

Applicability The C-SPY GDB Server driver.

Description Use this option to send strings or commands to the GDB Server.

Project>Options>Debugger>Extra Options

--jlink_device_select

Syntax `--jlink_device_select=*tap_number*`

Parameters		
	tap_number	The TAP position of the device you want to connect to.

Applicability	The C-SPY J-Link/J-Trace driver.
Description	If there is more than one device on the JTAG scan chain, use this option to select a specific device.
See also	*JTAG scan chain*, page 338.

Project>Options>Debugger>J-Link/J-Trace>Connection>JTAG scan chain>TAP number

--jlink_exec_command

Syntax `--jlink_exec_commmand=`*`cmdstr1; cmdstr2; cmdstr3 ...`*

Parameters		
	cmdstrn	J-Link/J-Trace command string.

Applicability	The C-SPY J-Link/J-Trace driver.
Description	Use this option to make the debugger call the `__jlinkExecCommand` macro with one or several command strings, after target connection has been established.
See also	*__jlinkExecCommand*, page 268.

Project>Options>Debugger>Extra Options

--jlink_initial_speed

Syntax `--jlink_initial_speed=`*`speed`*

Parameters		
	speed	The initial communication speed in kHz. If no speed is specified, 32 kHz will be used as the initial speed.

Applicability	The C-SPY J-Link/J-Trace driver.
Description	Use this option to set the initial JTAG communication speed in kHz.

See also *JTAG/SWD speed*, page 336.

Project>Options>Debugger>J-Link/J-Trace>Setup>JTAG speed>Fixed

--jlink_interface

Syntax `--jlink_interface={JTAG|SWD}`

Parameters

`JTAG`	Uses JTAG communication with the target system (default).
`SWD`	Uses SWD communication with the target system (Cortex-M only); uses fewer pins than JTAG communication.

Applicability The C-SPY J-Link/J-Trace driver.

Description Use this option to specify the communication channel between the J-Link debug probe and the target system.

See also *Interface*, page 338.

Project>Options>Debugger>J-Link/J-Trace>Connection>Interface

--jlink_ir_length

Syntax `--jlink_ir_length=`*`length`*

Parameters

`length`	The number of IR bits before the ARM device to be debugged, for JTAG scan chains that mix ARM devices with other devices.

Applicability The C-SPY J-Link/J-Trace driver.

Description Use this option to set the number of IR bits before the ARM device to debugged.

See also *JTAG scan chain*, page 338.

Project>Options>Debugger>J-Link/J-Trace>Connection>JTAG scan chain>Preceding bits

--jlink_reset_strategy

Syntax `--jlink_reset_strategy={delay|strategy}`

Parameters

delay	For Cortex-M and ARM 7/9/11 with strategies `1-9`, *delay* should be `0` (ignored). For ARM 7/9/11 with strategy `0`, the delay should be one of `0-10000`.
strategy	For information about supported reset strategies, see the *IAR J-Link and IAR J-Trace User Guide for JTAG Emulators for ARM Cores*.

Applicability The C-SPY J-Link/J-Trace driver.

Description Use this option to select the reset strategy to be used at debugger startup.

See also *Reset*, page 333.

Project>Options>Debugger>J-Link/J-Trace>Setup>Reset

--jlink_script_file

Syntax `--jlink_script_file=filename`

Parameters

filename	The name of the J-Link script file.

Applicability The C-SPY J-Link/J-Trace driver.

Description Use this option to specify the J-Link script file to be used.

J-Link has a script language that can be used for setting up hardware. For certain targets, ready-made script files are automatically pointed out by IAR Embedded Workbench. In command line mode, the script file needs to be manually specified by using this option.

When using a non-predefined script file, this option can be passed to C-SPY on the **Project>Options>Debugger>Extra Options** page.

See also The *J-Link/J-Trace ARM User Guide* (`JLinkARM.pdf`, document number UM08001), section 5.10, for a detailed description of the script language.

--jlink_speed

Syntax	`--jlink_speed={`*`fixed`*`|auto|adaptive}`
Parameters	

`fixed`	`1-12000`
`auto`	The highest possible frequency for reliable operation (default)
`adaptive`	For ARM devices that have the RTCK JTAG signal available

Applicability	The C-SPY J-Link/J-Trace driver.
Description	Use this option to set the JTAG communication speed in kHz.
See also	*JTAG/SWD speed*, page 336.

Project>Options>Debugger>J-Link/J-Trace>Setup>JTAG speed

--lmiftdi_speed

Syntax	`--lmiftdi_speed=`*`frequency`*
Parameters	

`frequency`	The frequency in kHz.

Applicability	The C-SPY TI Stellaris FTDI driver.
Description	Use this option to set the JTAG communication speed in kHz.
See also	*JTAG/SWD speed*, page 339.

Project>Options>Debugger>TI Stellaris FTDI>Setup>JTAG speed

--mac_handler_address

Syntax	`--mac_handler_address=`*`address`*
Parameters	

`address`	The start address of the memory area for the debug handler.

Applicability	The C-SPY Macraigor driver

Description	Use this option to specify the location—the memory address—of the debug handler used by Intel XScale devices.
See also	*Debug handler address*, page 342.

Project>Options>Debugger>Macraigor>Debug handler address

--mac_interface

Syntax `--mac_interface={JTAG|SWO}`

Parameters

`JTAG`	Uses JTAG communication with the target system (default).
`SWD`	Uses SWD communication with the target system (Cortex-M only); uses fewer pins than JTAG communication.

Applicability	The C-SPY Macraigor driver.
Description	Use this option to specify the communication channel between the Macraigor debug probe and the target system.

Project>Options>Debugger>Macraigor>Interface

--mac_jtag_device

Syntax `--mac_jtag_device=`*`device`*

Parameters

`device`	The device corresponding to the hardware interface that is used. Choose between Macraigor `mpDemon`, `usbdemon`, and `usb2demon`.

Applicability	The C-SPY Macraigor driver.
Description	Use this option to select the device corresponding to the hardware interface that is used.
See also	*OCD interface device*, page 340.

Project>Options>Debugger>Macraigor>OCD interface device

--mac_multiple_targets

Syntax	`--mac_multiple_targets=<tap-no>@dev0,dev1,dev2,dev3,...`

Parameters

tap-no	The TAP number of the device to connect to, where `0` connects to the first device, `1` to the second, and so on.
dev0-devn	The nearest TDO pin on the Macraigor JTAG probe.

Applicability	The C-SPY Macraigor driver.
Description	If there is more than one device on the JTAG scan chain, each device must be defined. Use this option to specify which device you want to connect to.
Example	`--mac_multiple_targets=0@ARM7TDMI,ARM7TDMI`
See also	*JTAG scan chain with multiple targets*, page 341.

Project>Options>Debugger>Macraigor>JTAG scan chain with multiple targets

--mac_reset_pulls_reset

Syntax	`--mac_reset_pulls_reset=time`

Parameters

time	`0-2000` which is the delay in milliseconds after reset.

Applicability	The C-SPY Macraigor driver.
Description	Use this option to make C-SPY perform an initial hardware reset when the debugger is started, and to specify the delay for the reset.
See also	*Hardware reset*, page 341.

Project>Options>Debugger>Macraigor>Hardware reset

--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 *Briefly about using C-SPY macros*, page 244.

--mac_set_temp_reg_buffer

Syntax `--mac_set_temp_reg_buffer=*address*`

Parameters

address	The start address of the RAM area.

Applicability The C-SPY Macraigor driver.

Description Use this option to specify the start address of the RAM area that is used for controlling the MMU and caching via the CP15 coprocessor.

To set this option, use **Project>Options>Debugger>Extra Options**.

--mac_speed

Syntax `--mac_speed={*factor*}`

Parameters

factor	The factor by which the JTAG probe clock is divided when generating the scan clock. The number must be in the range `1-8` where `1` is the fastest.

Applicability The C-SPY Macraigor driver.

Description Use this option to set the JTAG speed between the JTAG probe and the ARM JTAG ICE port.

See also *JTAG speed*, page 340.

Project>Options>Debugger>Macraigor>JTAG speed

--mac_xscale_ir7

Syntax `--mac_xscale_ir7`

Applicability The C-SPY Macraigor driver.

Description Use this option to specify that the XScale ir7 core is used, instead of XScale ir5. Note that this option is mandatory when using the XScale ir7 core.

These XScale cores are supported by the C-SPY Macraigor driver:

Intel XScale Core 1 (5-bit instruction register—ir5)

Intel XScale Core 2 (7-bit instruction register—ir7)

To set this option, use **Project>Options>Debugger>Extra Options**.

--mapu

Syntax `--mapu`

Applicability Sent to C-SPY simulator driver.

Description Specify this option to use the 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 144.

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 55.

--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 *`arm`*`bat.dll` located in the `arm\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`.

--proc_stack_*stack*

Syntax

`--proc_stack_`*`stack`*`=`*`startaddress`*`,`*`endaddress`*

where *`stack`* is one of `main` or `proc` for Cortex-M and

where *`stack`* is one of `usr`, `svc`, `irq`, `fiq`, `und`, or `abt` for other ARM cores

Parameters

startaddress	The start address of the stack, specified either as a value or as an expression.
endaddress	The end address of the stack, specified either as a value or as an expression.

Applicability

All C-SPY drivers. Note that this command line option is only available when using C-SPY from the IDE; not in batch mode using `cspybat`.

Description

Use this option to provide information to the C-SPY stack plugin module about reserved stacks. By default, C-SPY receives this information from the system startup code, but if you for some reason want to override the default values, this option can be useful.

Example

```
--proc_stack_irq=0x8000,0x80FF
```

To set this option, use **Project>Options>Debugger>Extra Options.**

--rdi_allow_hardware_reset

Syntax

```
--rdi_allow_hardware_reset
```

Applicability

The C-SPY RDI driver.

Description

Use this option to allow the emulator to perform a hardware reset of the target. Requires support by the emulator.

See also

Allow hardware reset, page 342.

Project>Options>Debugger>RDI>Allow hardware reset

--rdi_driver_dll

Syntax

`--rdi_driver_dll` *`filename`*

Parameters

filename	The file or path to the RDI driver DLL file.

Applicability

The C-SPY RDI driver.

Description	Use this option to specify the path to the RDI driver DLL file provided with the JTAG pod.
See also	*Manufacturer RDI driver*, page 342.
	Project>Options>Debugger>RDI>Manufacturer RDI driver

--rdi_use_etm

Syntax	`--rdi_use_etm`
Applicability	The C-SPY RDI driver.
Description	Use this option to enable C-SPY to use and display ETM trace.
See also	*ETM trace*, page 343.
	Project>Options>Debugger>RDI>ETM trace

--rdi_step_max_one

Syntax	`--rdi_step_max_one`
Applicability	The C-SPY Angel debug monitor driver The C-SPY RDI driver.
Description	Use this option to execute only one instruction. The debugger will turn off interrupts while stepping and, if necessary, simulate the instruction instead of executing it.
	To set this option, use **Project>Options>Debugger>Extra Options**.

--semihosting

Syntax `--semihosting={none|iar_breakpoint}`

Parameters

No parameter	Use standard semihosting.
`none`	Does not use semihosted I/O.
`iar_breakpoint`	Uses the IAR proprietary semihosting variant.

Applicability	All C-SPY drivers.
Description	Use this option to enable semihosted I/O and to choose the kind of semihosting interface to use. Note that if this option is not used, semihosting will by default be enabled and C-SPY will try to choose the correct semihosting mode automatically. This means that normally you do not have to use this option if your application is linked with semihosting. To make semihosting work, your application must be linked with a semihosting library.
See also	The *IAR C/C++ Development Guide for ARM®* for more information about linking with semihosting.

Project>Options>General Options>Library Configuration

--silent

Syntax	`--silent`
Applicability	Sent to `cspybat`.
Description	Use this option to omit the sign-on message.

--stlink_interface

Syntax `--stlink_interface={JTAG|SWD}`

Parameters

`JTAG`	Uses JTAG communication with the target system (default).
`SWD`	Uses SWD communication with the target system.

Applicability	The C-SPY ST-LINK driver.
Description	Use this option to specify the communication channel between the ST-LINK debug probe and the target system.
See also	*Interface*, page 344.

Project>Options>Debugger>ST-LINK>ST-LINK>Interface

--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.

--verify_download

Syntax	`--verify_download`
Applicability	All C-SPY drivers.
Description	Use this option to verify that the downloaded code image can be read back from target memory with the correct contents.
	Project>Options>Debugger>*driver*>Suppress download

Debugger options

This chapter describes the C-SPY® options available in the IAR Embedded Workbench® IDE. More specifically, this means:

- Setting debugger options
- Reference information on debugger options.

Setting debugger options

Before you start the C-SPY debugger you must set some options—both C-SPY generic options and options required for the target system (C-SPY driver-specific options). This section gives detailed information about the options in the **Debugger** category.

To set debugger options in the IDE:

1. Choose **Project>Options** to display the **Options** dialog box.
2. Select **Debugger** in the **Category** list.

   For reference information on the generic options, see:

   - *Setup*, page 324
   - *Download*, page 326
   - *Images*, page 328
   - *Extra Options*, page 327
   - *Plugins*, page 329.
3. On the **Setup** page, select the appropriate C-SPY driver from the **Driver** drop-down list.
4. To set the driver-specific options, select the appropriate driver from the **Category** list. Depending on which C-SPY driver you are using, different sets of option pages appear.

C-SPY driver	Available options pages
C-SPY Angel debug monitor driver	*Angel*, page 330
C-SPY GDB Server driver	*GDB Server*, page 331 *Breakpoints options*, page 133
C-SPY IAR ROM-monitor driver	*IAR ROM-monitor*, page 332

Table 39: Options specific to the C-SPY drivers you are using

C-SPY driver	Available options pages
C-SPY J-Link/J-Trace driver	*Setup options for J-Link/J-Trace*, page 333 *Connection options for J-Link/J-Trace*, page 337 *Breakpoints options*, page 133
C-SPY TI Stellaris FTDI driver	*Setup options for TI Stellaris FTDI*, page 339
C-SPY Macraigor driver	*Macraigor*, page 340 *Breakpoints options*, page 133
RDI driver	*RDI*, page 342
ST-LINK driver	*ST-LINK*, page 344
Third-party driver	*Third-Party Driver options*, page 345.

Table 39: Options specific to the C-SPY drivers you are using (Continued)

5 To restore all settings to the default factory settings, click the **Factory Settings** button.

6 When you have set all the required options, click **OK** in the **Options** dialog box.

Reference information on debugger options

This section gives reference information on C-SPY debugger options.

Setup

The **Setup** options select the C-SPY driver, the setup macro file, and device description file to use, and specify which default source code location to run to.

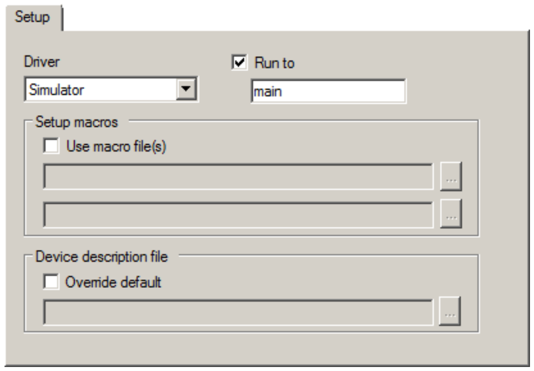


Figure 113: Debugger setup options

Driver

Selects the C-SPY driver for the target system you have:

Simulator

Angel

GDB Server

IAR ROM-monitor

J-Link/J-Trace

TI Stellaris FTDI

Macraigor

RDI

ST-LINK

Run to

Specifies the location C-SPY runs to when the debugger starts after a reset. By default, C-SPY runs to the `main` function.

To override the default location, specify the name of a different location you want C-SPY to run to. You can specify assembler labels or whatever can be evaluated as such, for example function names.

If the option is deselected, the program counter will contain the regular hardware reset address at each reset. The reset address is set by C-SPY.

Setup macros

Registers the contents of a setup macro file in the C-SPY startup sequence. Select **Use macro file** and specify 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.

It is possible to specify up to two different macro files.

Device description file

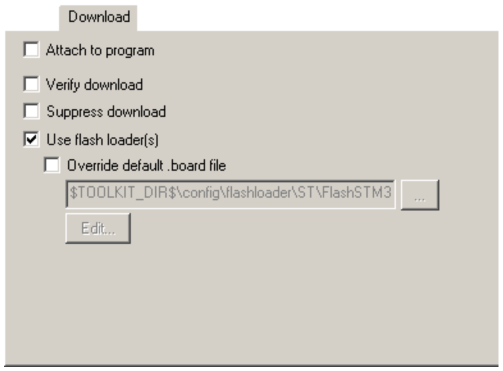
A default device description file—either an IAR-specific `ddf` file or a CMSIS System View Description file—is selected automatically based on your project settings. To override the default file, select **Override default** and specify an alternative file. A browse button is available for your convenience.

For details about the device description file, see *Modifying a device description file*, page 58.

IAR-specific device description files for each ARM device are provided in the directory `arm\config` and have the filename extension `ddf`.

Download

By default, C-SPY downloads the application to RAM or flash when a debug session starts. The **Download** options let you modify the behavior of the download.



- [ ] Attach to program
- [ ] Verify download
- [ ] Suppress download
- [x] Use flash loader(s)
  - [ ] Override default .board file
  - $TOOLKIT_DIR$\config\flashloader\ST\FlashSTM3

Figure 114: C-SPY Download options

Attach to program

Makes the debugger attach to a running application at its current location, without resetting or halting (for J-Link only) the target system. To avoid unexpected behavior when using this option, the **Debugger>Setup** option **Run to** should be deselected.

Verify download

Verifies that the downloaded code image can be read back from target memory with the correct contents.

Suppress download

Disables the downloading of code, while preserving the present content of the flash. This command is useful if you want to debug an application that already resides in target memory.

If this option is combined with the **Verify download** option, the debugger will read back the code image from non-volatile memory and verify that it is identical to the debugged application.

Note: It is important that the image that resides in target memory is linked consistently with how you use C-SPY for debugging. This applies, for example, if you first link your application using an output format without debug information, such as Intel-hex, and then load the application separately from C-SPY. If you then use C-SPY only for debugging without downloading, you cannot build the debugged application with any of the options **Semihosted** or **IAR breakpoint** —on the **General Options>Library Configuration** page—as that would add extra code, resulting in two different code images.

Use flash loader(s)

Use this option to use one or several flash loaders for downloading your application to flash memory. If a flash loader is available for the selected chip, it is used by default. Press the **Edit** button to display the **Flash Loader Overview** dialog box.

To read more about flash loaders, see *Using flash loaders*, page 357.

Override default .board file

A default flash loader is selected based on your choice of device on the **General Options>Target** page. To override the default flash loader, select **Override default .board file** and specify the path to the flash loader you want to use. A browse button is available for your convenience. Click **Edit** to display the **Flash Loader Overview** dialog box. For more information, see *Flash Loader Overview dialog box*, page 359.

Extra Options

The **Extra Options** page provides you with a command line interface to C-SPY.

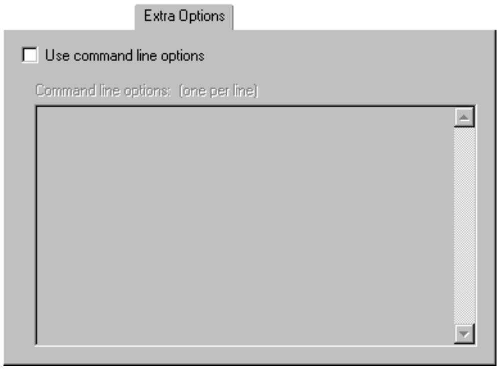


Figure 115: Debugger extra options

Use command line options

Specify additional command line arguments to be passed to C-SPY (not supported by the GUI).

Images

The **Images** options control the use of additional debug files to be downloaded.

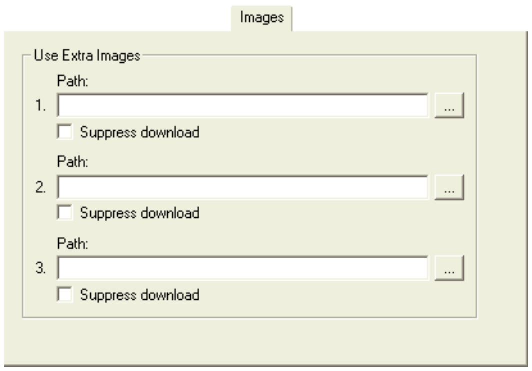


Figure 116: Debugger images options

Use Extra Images

Controls the use of additional debug files to be downloaded:

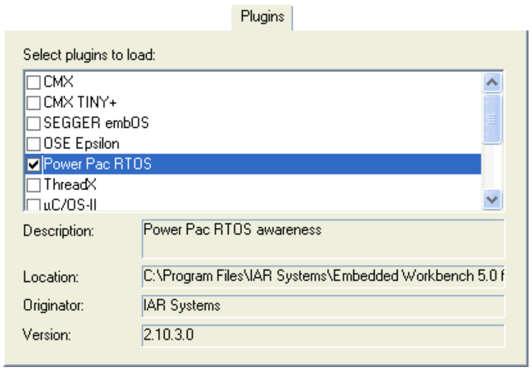
Path	Specify the debug file to be downloaded. A browse button is available for your convenience.
Suppress download	Makes the debugger download only debug information, and not the complete debug file.

If you want to download more than three images, use the related C-SPY macro, see *__loadImage*, page 273.

For more information, see *Loading multiple images*, page 57.

Plugins

The **Plugins** options select the C-SPY plugin modules to be loaded and made available during debug sessions.



Select plugins to load:

☐ CMX
☐ CMX TINY+
☐ SEGGER embOS
☐ OSE Epsilon
☑ Power Pac RTOS
☐ ThreadX
☐ µC/OS-II

Description:	Power Pac RTOS awareness
Location:	C:\Program Files\IAR Systems\Embedded Workbench 5.0 f
Originator:	IAR Systems
Version:	2.10.3.0

Figure 117: Debugger plugin options

Select plugins to load

Selects the plugin modules to be loaded and made available during debug sessions. The list contains the plugin modules delivered with the product installation.

Any plugin modules for real-time operating systems will also appear in the list of plugin modules. Some information about the CMX-RTX plugin module can be found in the document `cmx_quickstart.pdf`, delivered with this product. The µC/OS-II plugin module is documented in the *mC/OS-II Kernel Awareness for C-SPY User Guide*, available from Micriµm, Inc.

Description

Describes the plugin module.

Location

Informs about the location of the plugin module.

Generic plugin modules are stored in the `common\plugins` directory. Target-specific plugin modules are stored in the `arm\plugins` directory.

Originator

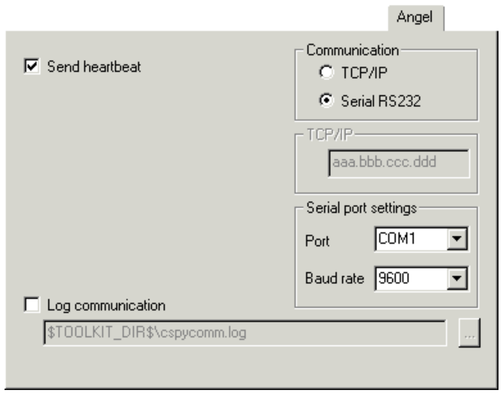
Informs about the originator of the plugin module, which can be modules provided by IAR Systems or by third-party vendors.

Version

Informs about the version number.

Angel

The **Angel** options control the C-SPY Angel debug monitor driver.



[✓] Send heartbeat

Communication: ○ TCP/IP [● Serial RS232]

TCP/IP: aaa.bbb.ccc.ddd

Port: COM1

Baud rate: 9600

[ ] Log communication

$TOOLKIT_DIR$\cspycomm.log

Figure 118: C-SPY Angel options

Send heartbeat

Makes C-SPY poll the target system periodically while your application is running. That way, the debugger can detect if the target application is still running or has terminated abnormally. Enabling the heartbeat will consume some extra CPU cycles from the running program.

Communication

Selects the Angel communication link. RS232 serial port connection and TCP/IP via an Ethernet connection are supported.

TCP/IP

Specify the IP address of the target device in the text box.

Serial port settings

Configures the serial port. You can specify

Port	Selects which port on the host computer to use as the Angel communication link.
Baud rate	Sets the communication speed.

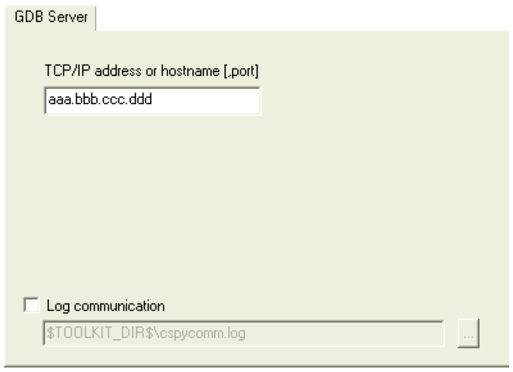
The initial Angel serial speed is always 9600 baud. After the initial handshake, the link speed is changed to the specified speed. Communication problems can occur at very high speeds; some Angel-based evaluation boards will not work above 38,400 baud.

Log communication

Logs the communication between C-SPY and the target system to a file. To interpret the result, a detailed knowledge of the Angel monitor protocol is required.

GDB Server

The **GDB Server** options control the C-SPY GDB Server for the STR9-comStick evaluation board.



aaa.bbb.ccc.ddd

☐ Log communication

$TOOLKIT_DIR$\cspycomm.log

Figure 119: GDB Server options

TCP/IP address or hostname

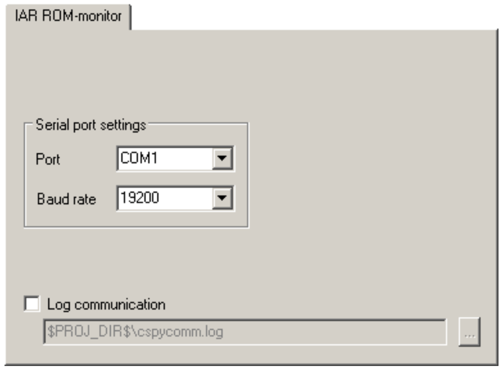
Specify the IP address and port number of a GDB server; by default the port number `3333` is used. The TCP/IP connection is used for connecting to a J-Link server running on a remote computer.

Log communication

Logs the communication between C-SPY and the target system to a file. To interpret the result, a detailed knowledge of the JTAG interface is required.

IAR ROM-monitor

The **IAR ROM-monitor** options control the C-SPY IAR ROM-monitor interface.



Port: COM1
Baud rate: 19200
☐ Log communication
$PROJ_DIR$\cspycomm.log

Figure 120: IAR ROM-monitor options

Serial port settings

Configures the serial port. You can specify

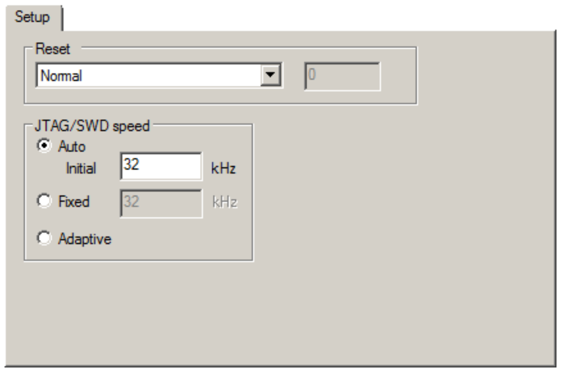
Port	Selects which port on the host computer to use as the ROM-monitor communication link.
Baud rate	Sets the communication speed. The serial port communication link speed must match the speed selected on the target board.

Log communication

Logs the communication between C-SPY and the target system to a file. To interpret the result, a detailed knowledge of the ROM-monitor protocol is required.

Setup options for J-Link/J-Trace

The **Setup** options specify the J-Link/J-Trace probe.



Reset: Normal, 0

JTAG/SWD speed: [✓ Auto] Initial 32 kHz; Fixed 32 kHz; Adaptive

Figure 121: J-Link/J-Trace Setup options

Reset

Selects the reset strategy to be used when the debugger starts. Note that Cortex-M uses a different set of strategies than other devices. The actual reset strategy type number is specified for each available choice. Choose between:

Normal (0, default)	Tries to reset the core via the reset strategy **Core and peripherals** first. If this fails, the reset strategy **Core only** is used. It is recommended that you use this strategy to reset the target.
Core (1)	Resets the core via the `VECTRESET` bit; the peripheral units are not affected.
Reset Pin (2)	J-Link pulls its `RESET` pin low to reset the core and the peripheral units. Normally, this causes the CPU `RESET` pin of the target device to go low as well, which results in a reset of both the CPU and the peripheral units.
Connect during reset (3)	J-Link connects to the target while keeping Reset active (reset is pulled low and remains low while connecting to the target). This is the recommended reset strategy for STM32 devices. This strategy is available for STM32 devices only.

Halt after bootloader (4 or 7)	NXP Cortex-M0 devices. This is the same strategy as the Normal strategy, but the target is halted when the bootloader has finished executing. This is the recommended reset strategy for LPC11xx and LPC13xx devices. Analog Devices Cortex-M3 devices (7), Resets the core and peripheral units by setting the `SYSRESETREQ` bit in the AIRCR. The core is allowed to perform the ADI kernel (which enables the debug interface), but the core is halted before the first instruction after the kernel is executed to guarantee that no user application code is performed after reset.
Halt before bootloader (5)	This is the same strategy as the Normal strategy, but the target is halted before the bootloader has started executing. This strategy is normally not used, except in situations where the bootloader needs to be debugged. This strategy is available for LPC11xx and LPC13xx devices only.
Normal, disable watchdog (6)	First performs a Normal reset, to reset the core and peripheral units and halt the CPU immediately after reset. After the CPU is halted, the watchdog is disabled, because the watchdog is by default running after reset. If the target application does not feed the watchdog, J-Link loses connection to the device because it is permanently reset. This strategy is available for Freescale Kinetis devices.

All of these strategies are available for both the JTAG and the SWD interface, and all strategies halt the CPU after the reset.

For other cores, choose between these strategies:

Hardware, halt after delay (ms) (0)	Specify the delay between the hardware reset and the halt of the processor. This is used for making sure that the chip is in a fully operational state when C-SPY starts to access it. By default, the delay is set to zero to halt the processor as quickly as possible. This is a hardware reset.
Hardware, halt using Breakpoint (1)	After reset, J-Link continuously tries to halt the CPU using a breakpoint. Typically, this halts the CPU shortly after reset; the CPU can in most systems execute some instructions before it is halted. This is a hardware reset.

Hardware, halt at 0 (4)	Halts the processor by placing a breakpoint at the address zero. Note that this is not supported by all ARM microcontrollers. This is a hardware reset.
Hardware, halt using DBGRQ (5)	After reset, J-Link continuously tries to halt the CPU using DBGRQ. Typically, this halts the CPU shortly after reset; the CPU can in most systems execute some instructions before it is halted. This is a hardware reset.
Software (-)	Sets `PC` to the program entry address. This is a software reset.
Software, Analog devices (2)	Uses a reset sequence specific for the Analog Devices ADuC7xxx family. This strategy is only available if you have selected such a device from the **Device** drop-down list on the **General Options>Target** page. This is a software reset.
Hardware, NXP LPC (9)	This strategy is only available if you have selected such a device from the **Device** drop-down list on the **General Options>Target** page. This is a hardware reset specific to NXP LPC devices.
Hardware, Atmel AT91SAM7 (8)	This strategy is only available if you have selected such a device from the **Device** drop-down list on the **General Options>Target** page. This is a hardware reset specific for the **Atmel AT91SAM7** family.

For more details about the different reset strategies, see the *IAR J-Link and IAR J-Trace User Guide for JTAG Emulators for ARM Cores* available in the `arm\doc` directory.

A software reset of the target does not change the settings of the target system; it only resets the program counter and the mode register `CPSR` to its reset state. Normally, a C-SPY reset is a software reset only. If you use the **Hardware reset** option, C-SPY will generate an initial hardware reset when the debugger is started. This is performed once before download, and if the option **Use flash loader(s)** is selected, also once after flash download, see Figure 11, *Debugger startup when debugging code in flash*, and Figure 12, *Debugger startup when debugging code in RAM*.

Hardware resets can be a problem if the low-level setup of your application is not complete. If the low-level setup does not set up memory configuration and clocks, the application will not work after a hardware reset. To handle this in C-SPY, the setup macro function `execUserReset()` is suitable. For a similar example where `execUserPreload()` is used, see *Remapping memory*, page 60.

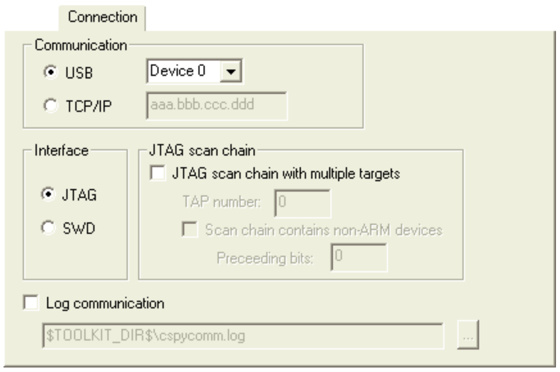
JTAG/SWD speed

Specify the JTAG communication speed in kHz. Choose between:

Auto	Automatically uses the highest possible frequency for reliable operation. The initial speed is the fixed frequency used until the highest possible frequency is found. The default initial frequency—32 kHz—can normally be used, but in cases where it is necessary to halt the CPU after the initial reset, in as short time as possible, the initial frequency should be increased. A high initial speed is necessary, for example, when the CPU starts to execute unwanted instructions—for example power down instructions—from flash or RAM after a reset. A high initial speed would in such cases ensure that the debugger can quickly halt the CPU after the reset. The initial value must be in the range 1–12000 kHz.
Fixed	Sets the JTAG communication speed in kHz. The value must be in the range 1–12000 kHz. If there are JTAG communication problems or problems in writing to target memory (for example during program download), these problems might be avoided if the speed is set to a lower frequency.
Adaptive	Works only with ARM devices that have the `RTCK` JTAG signal available. For more information about adaptive speed, see the *IAR J-Link and IAR J-Trace User Guide for JTAG Emulators for ARM Cores* available in the `arm\doc` directory.

Connection options for J-Link/J-Trace

The **Connection** options specify the connection with the J-Link/J-Trace probe.



Connection

Communication
- [✓ USB] Device 0
- TCP/IP aaa.bbb.ccc.ddd

Interface
- [✓ JTAG]
- SWD

JTAG scan chain
- ☐ JTAG scan chain with multiple targets
- TAP number: 0
- ☐ Scan chain contains non-ARM devices
- Preceeding bits: 0

☐ Log communication

$TOOLKIT_DIR$\cspycomm.log

Figure 122: J-Link/J-Trace Connection options

Communication

Selects the communication channel between C-SPY and the debug probe. Choose between:

USB	Selects the USB connection.
TCP/IP	Specify the IP address of a J-Link server. The TCP/IP connection is used for connecting to a J-Link server running on a remote computer.

Interface

Selects the communication interface between the J-Link debug probe and the target system. Choose between:

JTAG (default)	Uses the JTAG interface.
SWD	Uses fewer pins than JTAG. Select SWD if you want to use the serial-wire output (SWO) communication channel. Note that if you select stdout/stderr via SWO on the **General Options>Library Configuration** page, SWD is selected automatically. For more information about SWO settings, see *SWO Trace Window Settings dialog box*, page 171.

JTAG scan chain

Selects the reset strategy to be used when the debugger starts. Note that Cortex-M uses a different set of strategies than other devices. Choose between:

JTAG scan chain with multiple targets	Specifies that there is more than one device on the JTAG scan chain.
TAP number	Specify the TAP (Test Access Port) position of the device you want to connect to. The TAP numbers start from zero.
Scan chain contains non-ARM devices	Enables JTAG scan chains that mix ARM devices with other devices like, for example, FPGA.
Preceding bits	Specify the number of IR bits before the ARM device to be debugged.

Log communication

Logs the communication between C-SPY and the target system to a file. To interpret the result, a detailed knowledge of the JTAG interface is required.

Setup options for TI Stellaris FTDI

The **Setup** options specify the TI Stellaris FTDI interface.

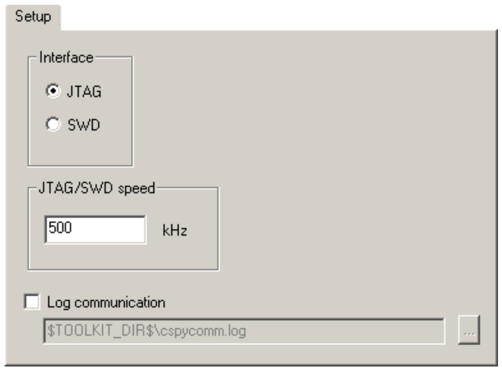


Figure 123: TI Stellaris FTDI Setup options

Interface

Selects the communication interface between the J-Link debug probe and the target system. Choose between:

JTAG (default)	Uses the JTAG interface.
SWD	Uses fewer pins than JTAG. Select SWD if you want to use the serial-wire output (SWO) communication channel. Note that if you select stdout/stderr via SWO on the **General Options>Library Configuration** page, SWD is selected automatically. For more information about SWO settings, see *SWO Trace Window Settings dialog box*, page 171.

JTAG/SWD speed

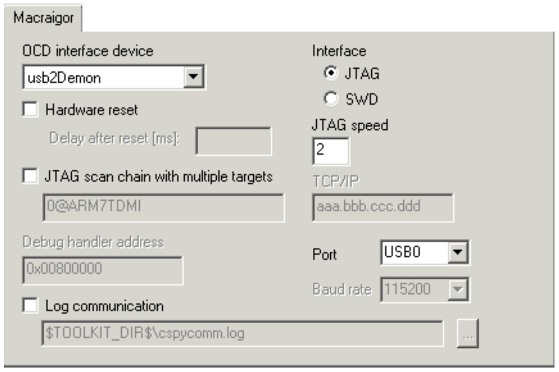
Specify the JTAG communication speed in kHz.

Log communication

Logs the communication between C-SPY and the target system to a file. To interpret the result, a detailed knowledge about the communication protocol is required.

Macraigor

The **Macraigor** options specify the Macraigor interface.



OCD interface device: usb2Demon
☐ Hardware reset
Delay after reset [ms]:
☐ JTAG scan chain with multiple targets
0@ARM7TDMI
Debug handler address
0x00800000
☐ Log communication
$TOOLKIT_DIR$\cspycomm.log
Interface
(•) JTAG
( ) SWD
JTAG speed
2
TCP/IP
aaa.bbb.ccc.ddd
Port: USB0
Baud rate: 115200

Figure 124: Macraigor options

OCD interface device

Selects the device corresponding to the hardware interface you are using. Supported Macraigor JTAG probes is Macraigor **mpDemon**.

Interface

Selects the communication interface between the J-Link debug probe and the target system. Choose between:

JTAG (default)	Uses the JTAG interface.
SWD	Uses fewer pins than JTAG. Select SWD if you want to use the serial-wire output (SWO) communication channel. Note that if you select stdout/stderr via SWO on the **General Options>Library Configuration** page, SWD is selected automatically. For more information about SWO settings, see *SWO Trace Window Settings dialog box*, page 171.

JTAG speed

Specify the speed between the JTAG probe and the ARM JTAG ICE port. The number must be in the range 1–8 and sets the factor by which the JTAG probe clock is divided when generating the scan clock.

The mpDemon interface might require a higher setting such as `2` or `3`, that is, a lower speed.

TCP/IP

Specify the IP address of a JTAG probe connected to the Ethernet/LAN port.

Port

Selects which serial port or parallel port on the host computer to use as communication link. Select the host port to which the JTAG probe is connected.

In the case of parallel ports, you should normally use LPT1 if the computer is equipped with a single parallel port. Note that a laptop computer might in some cases map its single parallel port to LPT2 or LPT3. If possible, configure the parallel port in EPP mode because this mode is fastest; bidirectional and compatible modes will work but are slower.

Baud rate

Selects the serial communication speed.

Hardware reset

Generates an initial hardware reset when the debugger is started. This is performed once before download, and if the option **Use flash loader(s)** is selected, also once after flash download, see Figure 11, *Debugger startup when debugging code in flash*, and Figure 12, *Debugger startup when debugging code in RAM*.

A software reset of the target does not change the settings of the target system; it only resets the program counter to its reset state. Normally, a C-SPY reset is a software reset only.

Hardware resets can be a problem if the low-level setup of your application is not complete. If low-level setup does not set up memory configuration and clocks, the application will not work after a hardware reset. To handle this in C-SPY, the setup macro function `execUserReset()` is suitable. For a similar example where `execUserPreload()` is used, see *Remapping memory*, page 60.

JTAG scan chain with multiple targets

Defines each device on the JTAG scan chain, if there is more than one. Also, you must state which device you want to connect to. The syntax is:

```
<0>@dev0,dev1,dev2,dev3,...
```

where `0` is the TAP number of the device to connect to, and *`dev0`* is the nearest TDO pin on the Macraigor JTAG probe.

Debug handler address

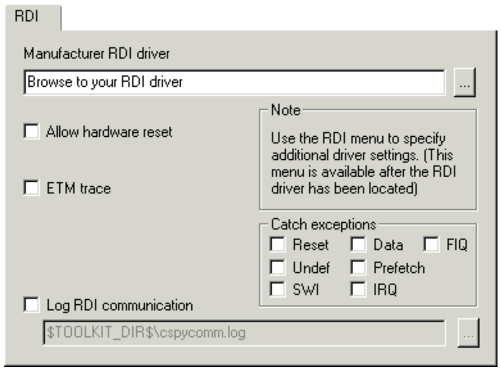
Specify the location—the memory address—of the debug handler used by Intel XScale devices. To save memory space, you should specify an address where a small portion of cache RAM can be mapped, which means the location should not contain any physical memory. Preferably, find an unused area in the lower 16-Mbyte memory and place the handler address there.

Log communication

Logs the communication between C-SPY and the target system to a file. To interpret the result, a detailed knowledge of the JTAG interface is required.

RDI

With the **RDI** options you can use JTAG interfaces compliant with the ARM Ltd. RDI 1.5.1 specification. One example of such an interface is the ARM RealView Multi-ICE JTAG interface.


RDI

Manufacturer RDI driver

Browse to your RDI driver

☐ Allow hardware reset

☐ ETM trace

Note

Use the RDI menu to specify additional driver settings. (This menu is available after the RDI driver has been located)

Catch exceptions

☐ Reset ☐ Data ☐ FIQ

☐ Undef ☐ Prefetch

☐ SWI ☐ IRQ

☐ Log RDI communication

$TOOLKIT_DIR$\cspycomm.log

Figure 125: RDI options

Manufacturer RDI driver

Specify the file path to the RDI driver DLL file provided with the JTAG pod.

Allow hardware reset

Allows the emulator to perform a hardware reset of the target.

A software reset of the target does not change the settings of the target system; it only resets the program counter to its reset state.

You should only allow hardware resets if the low-level setup of your application is complete. If the low-level setup does not set up memory configuration and clocks, the application will not work after a hardware reset. To handle this in C-SPY, the setup macro function `execUserReset()` is suitable. For a similar example where `execUserPreload()` is used, see *Remapping memory*, page 60.

Note: This option requires that hardware resets are supported by the RDI driver you are using.

ETM trace

Enables the debugger to use and display ETM trace. When the option is selected, the debugger will check that the connected JTAG probe supports RDI ETM and that the target processor supports ETM. If the connected hardware supports ETM, the **RDI** menu will contain the following commands:

- **ETM Trace Window**, see *Trace window*, page 176
- **Trace Settings**, see *ETM Trace Settings dialog box*, page 169
- **Trace Save**, see *Trace Save dialog box*, page 180.

Catch exceptions

Causes exceptions to be treated as breakpoints. Instead of handling the exception as defined by the running program, the debugger will stop.

The ARM core exceptions that can be caught are:

Exception	Description
Reset	Reset
Undef	Undefined instruction
SWI	Software interrupt
Data	Data abort (data access memory fault)
Prefetch	Prefetch abort (instruction fetch memory fault)
IRQ	Normal interrupt
FIQ	Fast interrupt

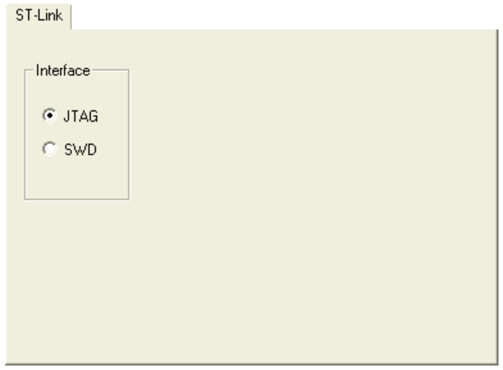
Table 40: Catching exceptions

Log RDI communication

Logs the communication between C-SPY and the target system to a file. To interpret the result, detailed knowledge of the RDI interface is required.

ST-LINK

The **ST-LINK** page contains options for the ST-LINK probe.



Interface

[✓ JTAG] SWD

Figure 126: ST-LINK Setup options

Interface

Selects the communication interface between the ST-LINK debug probe and the target system. Choose between:

JTAG (default)	Uses the JTAG interface.
SWD	Uses fewer pins than JTAG.

Third-Party Driver options

The **Third-Party Driver** options are used for loading any driver plugin provided by a third-party vendor. These drivers must be compatible with the C-SPY debugger driver specification.

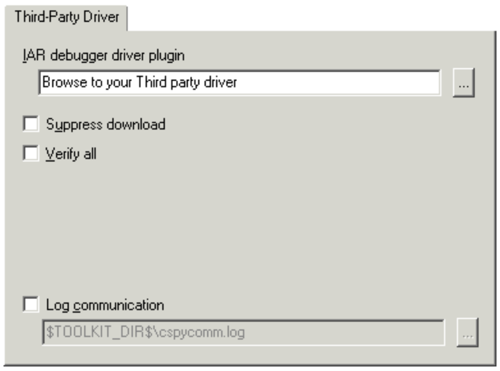

Third-Party Driver
IAR debugger driver plugin
Browse to your Third party driver
...
Suppress download
Verify all
Log communication
$TOOLKIT_DIR$\cspycomm.log
...

Figure 127: C-SPY Third-Party Driver options

IAR debugger driver plugin

Specify the file path to the third-party driver plugin DLL file. A browse button is available for your convenience.

Suppress download

Disables the downloading of code, while preserving the present content of the flash. This command is useful if you need to exit C-SPY for a while and then continue the debug session without downloading code. The implicit RESET performed by C-SPY at startup is not disabled though.

If this option is combined with **Verify all**, the debugger will read your application back from the flash memory and verify that it is identical with the application currently being debugged.

This option can be used if it is supported by the third-party driver.

Verify all

Verifies that the memory on the target system is writable and mapped in a consistent way. A warning message will appear if there are any problems during download. Every byte is checked after it is loaded. This is a slow but complete check of the memory. This option can be used if is supported by the third-party driver.

Log communication

Logs the communication between C-SPY and the target system to a file. To interpret the result, detailed knowledge of the interface is required. This option can be used if is supported by the third-party driver.

Additional reference on C-SPY drivers

This chapter describes the additional menus and features provided by the C-SPY® drivers. More specifically, this means:

- Reference information on the C-SPY simulator
- Reference information on the C-SPY GDB Server driver
- Reference information on the C-SPY J-Link/J-Trace driver
- Reference information on the C-SPY TI Stellaris FTDI driver
- Reference information on the C-SPY Macraigor driver
- Reference information on the C-SPY RDI driver
- Reference information on the C-SPY ST-LINK driver.

Reference information on the C-SPY simulator

This section gives additional reference information the C-SPY simulator, reference information not provided elsewhere in this documentation.

More specifically, this means:

- *Simulator menu*, page 348

Simulator menu

When you use the simulator driver, the **Simulator** menu is added to the menu bar.

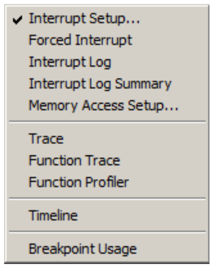


Figure 128: Simulator menu

These commands are available on the menu:

Interrupt Setup	Displays a dialog box where you can configure C-SPY interrupt simulation; see *Interrupt Setup dialog box*, page 236.
Forced Interrupts	Opens a window from where you can instantly trigger an interrupt; see *Forced Interrupt window*, page 240.
Interrupt Log	Opens a window which displays the status of all defined interrupts; see *Interrupt Log window*, page 241.
Interrupt Log Summary	Opens a window which displays a summary of logs of entrances to and exits from interrupts, see *Data Log Summary window*, page 223.
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 158.
Trace	Opens a window which displays the collected trace data; see *Trace window*, page 176.
Function Trace	Opens a window which displays the trace data for function calls and function returns; see *Function Trace window*, page 181.
Timeline	Opens a window which displays trace data as graphs in relation to a common time axis, see *Timeline window*, page 182.

Function Profiler	Opens a window which shows timing information for the functions; see *Function Profiler window*, page 209.
Breakpoint Usage	Displays a dialog box which lists all active breakpoints; see *Breakpoint Usage dialog box*, page 122.

Reference information on the C-SPY GDB Server driver

This section gives additional reference information on the C-SPYGDB Server driver, reference information not provided elsewhere in this documentation.

More specifically, this means:

- *GDB Server menu*, page 349.

GDB Server menu

When you are using the C-SPY GDB Server driver, the **GDB Server** menu is added to the menu bar.

Figure 129: The GDB Server menu

This command is available on the menu:

Breakpoint Usage	Displays a dialog box which lists all active breakpoints; see *Breakpoint Usage dialog box*, page 122.

Reference information on the C-SPY J-Link/J-Trace driver

This section gives additional reference information the C-SPY Driver1 driver, reference information not provided elsewhere in this documentation.

More specifically, this means:

- *J-Link menu*, page 350

J-Link menu

When you are using the C-SPY J-Link driver, the **J-Link** menu is added to the menu bar.

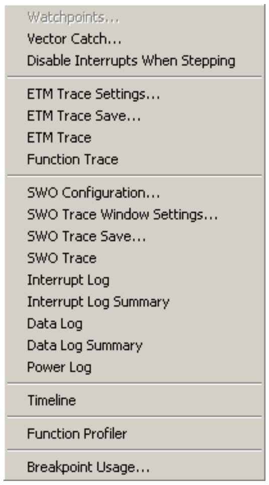


Figure 130: The J-Link menu

These commands are available on the menu:

Watchpoints	Displays a dialog box for setting watchpoints, see *Code breakpoints dialog box*, page 123.
Vector Catch	Displays a dialog box for setting a breakpoint directly on a vector in the interrupt vector table, see *Breakpoints on vectors*, page 114. Note that this command is not available for all ARM cores.
Disable Interrupts When Stepping	Ensures that only the stepped instructions will be executed. Interrupts will not be executed. This command can be used when not running at full speed and some interrupts interfere with the debugging process.
ETM Trace Settings[2]	Displays a dialog box to configure ETM trace data generation and collection; see *ETM Trace Settings dialog box*, page 169.
ETM Trace Save[2]	Displays a dialog box to save the collected trace data to a file; see *Trace Save dialog box*, page 180.
ETM Trace[2]	Opens the ETM Trace window to display the collected trace data; see *Trace window*, page 176.

Function Trace[2]	Opens a window which displays the trace data for function calls and function returns; see *Function Trace window*, page 181.
SWO Configuration[1]	Displays a dialog box; see *SWO Configuration dialog box*, page 173.
SWO Trace Window Settings[1]	Displays a dialog box; see *SWO Trace Window Settings dialog box*, page 171.
SWO Trace Save[1]	Displays a dialog box to save the collected trace data to a file; see *Trace Save dialog box*, page 180.
SWO Trace[1]	Opens the SWO Trace window to display the collected trace data; see *Trace window*, page 176.
Interrupt Log[1]	Opens a window; see *Interrupt Log window*, page 241.
Interrupt Log Summary[1]	Opens a window; see *Interrupt Log Summary window*, page 226.
Data Log[1]	Opens a window; see *Data Log window*, page 220.
Data Log Summary[1]	Opens a window; see *Data Log Summary window*, page 223.
Power Log	Opens a window; see *Power Log window*, page 187.
Timeline[3]	Opens a window; see *Timeline window*, page 182.
Function Profiler	Opens a window which shows timing information for the functions; see *Function Profiler window*, page 209.
Breakpoint Usage	Displays a dialog box which lists all active breakpoints; see *Breakpoint Usage dialog box*, page 122.

1 Only available when the SWD/SWO interface is used.
2 Only available when using either ETM or J-Link with ETB.
3 Available when using either ETM or SWD/SWO.

LIVE WATCH AND USE OF DCC

The following possibilities for using live watch apply:

For Cortex-M

Access to memory or setting breakpoints is always possible during execution. The DCC (Debug Communications Channel) unit is not available.

For ARMxxx-S devices

Setting hardware breakpoints is always possible during execution.

For ARM7/ARM9 devices, including ARMxxx-S

Memory accesses must be made by your application. By adding a small program—a *DCC handler*—that communicates with the debugger through the DCC unit to your application, memory can be read/written during execution. Software breakpoints can also be set by the DCC handler.

Just add the files `JLINKDCC_Process.c` and `JLINKDCC_HandleDataAbort.s` located in `arm\src\debugger\dcc` to your project and call the `JLINKDCC_Process` function regularly, for example every millisecond.

In your local copy of the `cstartup` file, modify the interrupt vector table so that data aborts will call the `JLINKDCC_HandleDataAbort` handler.

TERMINAL I/O AND USE OF DCC

The following possibilities for using Terminal I/O apply:

For Cortex-M

See *ITM Stimulus Ports*, page 175.

For ARM7/ARM9 devices, including ARMxxx-S

DCC can be used for Terminal I/O output by adding the file `arm\src\debugger\dcc\DCC_Write.c` to your project. `DCC_write.c` overrides the library function `write`. Functions such as `printf` can then be used to output text in real time to the C-SPY Terminal I/O window.

In this case, you can disable semihosting which means that the breakpoint it uses is freed for other purposes. To disable semihosting, choose **General Options>Library Configuration>Library low-level interface implementation>None**.

Reference information on the C-SPY TI Stellaris FTDI driver

This section gives additional reference information on the C-SPY TI Stellaris FTDI driver, reference information not provided elsewhere in this documentation.

More specifically, this means:

- *TI Stellaris FTDI menu*, page 353.

TI Stellaris FTDI menu

When you are using the C-SPY TI Stellaris FTDI driver, the **TI Stellaris FTDI** menu is added to the menu bar.

Figure 131: The TI Stellaris FTDI menu

This command is available on the menu:

Breakpoint Usage	Displays a dialog box which lists all active breakpoints; see *Breakpoint Usage dialog box*, page 122.

Reference information on the C-SPY Macraigor driver

This section gives additional reference information on the C-SPY Macraigor driver, reference information not provided elsewhere in this documentation.

More specifically, this means:

- *Macraigor JTAG menu*, page 353.

Macraigor JTAG menu

When you are using the C-SPY Macraigor driver, the **JTAG** menu is added to the menu bar.

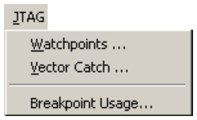


Figure 132: The Macraigor JTAG menu

These commands are available on the menu:

Watchpoints	Opens a dialog box for setting watchpoints, see *Code breakpoints dialog box*, page 123.
Vector Catch	Opens a dialog box for setting a breakpoint directly on a vector in the interrupt vector table, see *Breakpoints on vectors*, page 114. Note that this command is not available for all ARM cores.

Breakpoint Usage	Displays a dialog box which lists all active breakpoints; see *Breakpoint Usage dialog box*, page 122.

Reference information on the C-SPY RDI driver

This section gives additional reference information on the C-SPY RDI driver, reference information not provided elsewhere in this documentation.

More specifically, this means:

- *RDI menu*, page 354.

RDI menu

When you are using the C-SPY RDI driver, the **RDI** menu is added to the menu bar.

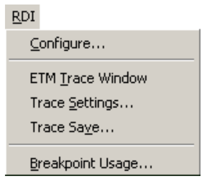


Figure 133: The RDI menu

These commands are available on the menu:

Configure	Opens a dialog box that originates from the RDI driver vendor. For information about details in this dialog box, refer to the driver documentation.
ETM Trace Window	Opens the ETM Trace window to display the collected trace data; see *Trace window*, page 176.
Trace Settings	Displays a dialog box to configure the ETM trace; see *ETM Trace Settings dialog box*, page 169.
Trace Save	Displays a dialog box to save the collected trace data to a file; see *Trace Save dialog box*, page 180.
Breakpoint Usage	Displays a dialog box which lists all active breakpoints; see *Breakpoint Usage dialog box*, page 122.

Note: To get the default settings in the configuration dialog box, it is for some RDI drivers necessary to just open and close the dialog box even though you do no need any specific settings for your project.

Reference information on the C-SPY ST-LINK driver

This section gives additional reference information on the C-SPY ST-LINK driver, reference information not provided elsewhere in this documentation.

More specifically, this means:

- *ST-LINK menu*, page 355.

ST-LINK menu

When you are using the C-SPY ST-LINK driver, the **ST-LINK** menu is added to the menu bar.

Figure 134: The ST-LINK menu

These commands are available on the menu:

Breakpoint Usage	Displays a dialog box which lists all active breakpoints; see *Breakpoint Usage dialog box*, page 122.

Using flash loaders

This chapter describes the flash loader, what it is and how to use it. More specifically, this means:

- Introduction to the flash loader
- Reference information on the flash loader.

Introduction to the flash loader

This section introduces the flash loader.

These topics are covered:

- Briefly about the flash loader
- Setting up the flash loader(s)
- The flash loading mechanism
- Build considerations.

BRIEFLY ABOUT THE FLASH LOADER

A flash loader is an agent that is downloaded to the target. It fetches your application from the debugger and programs it into flash memory. The flash loader uses the file I/O mechanism to read the application program from the host. You can select one or several flash loaders, where each flash loader loads a selected part of your application. This means that you can use different flash loaders for loading different parts of your application.

A set of flash loaders for various microcontrollers is provided with IAR Embedded Workbench for ARM. In addition to these, more flash loaders are provided by chip manufacturers and third-party vendors. The flash loader API, documentation, and several implementation examples are available to make it possible for you to implement your own flash loader.

SETTING UP THE FLASH LOADER(S)

To use a flash loader for downloading your application:

1. Choose **Project>Options**.
2. Choose the **Debugger** category and click the **Download** tab.

3 Select the **Use Flash loader(s)** option. A default flash loader configured for the device you have specified will be used. The configuration is specified in a preconfigured `board` file.

4 To override the default flash loader or to modify the behavior of the default flash loader to suit your board, select the **Override default .board file** option, and **Edit** to open the **Flash Loader Configuration** dialog box. A copy of the `*.board` file will be created in your project directory and the path to the `*.board` file will be updated accordingly.

5 The **Flash Loader Overview** dialog box lists all currently configured flash loaders; see *Flash Loader Overview dialog box*, page 359. You can either select a flash loader or open the **Flash Loader Configuration** dialog box.

In the **Flash Loader Configuration** dialog box, you can configure the download. For reference information about the various flash loader options, see *Flash Loader Configuration dialog box*, page 360.

THE FLASH LOADING MECHANISM

When the **Use flash loader(s)** option is selected and one or several flash loaders have been configured, these steps are performed when the debug session starts:

1 C-SPY downloads the flash loader into target RAM.

2 C-SPY starts execution of the flash loader.

3 The flash loader programs the application code into flash memory.

4 The flash loader terminates.

5 C-SPY switches context to the user application.

Steps 2 to 4 are performed for each memory range of the application.

The steps 1 to 4 are performed for each selected flash loader.

BUILD CONSIDERATIONS

When you build an application that will be downloaded to flash, special consideration is needed. Two output files must be generated. The first is the usual ELF/DWARF file (`out`) that provides the debugger with debug and symbol information. The second file is a simple-code file (filename extension `sim`) that will be opened and read by the flash loader when it downloads the application to flash memory.

The simple-code file must have the same path and name as the ELF/DWARF file except for the filename extension.

To create the extra output file,

Reference information on the flash loader

This section gives reference information about these windows and dialog boxes:

- *Flash Loader Overview dialog box*, page 359
- *Flash Loader Configuration dialog box*, page 360.

Flash Loader Overview dialog box

The **Flash Loader Overview** dialog box is available from the **Debugger>Download** page.

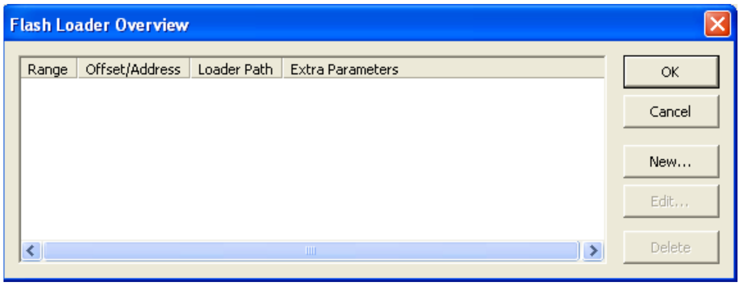


Figure 135: Flash Loader Overview dialog box

This dialog box lists all defined flash loaders. If you have selected a device on the **General Options>Target** page for which there is a flash loader, this flash loader is by default listed in the **Flash Loader Overview** dialog box.

The display area

Each row in the display area shows how you have set up one flash loader for flashing a specific part of memory:

Range	The part of your application to be programmed by the selected flash loader.
Offset/Address	The start of the memory where your application will be flashed. If the address is preceded with a, the address is absolute. Otherwise, it is a relative offset to the start of the memory.
Loader Path	The path to the flash loader `*.flash` file to be used (`*.out` for old-style flash loaders).
Extra Parameters	List of extra parameters that will be passed to the flash loader.

Click on the column headers to sort the list by range, offset/address, etc.

Function buttons

These function buttons are available:

OK	The selected flash loader(s) will be used for downloading your application to memory.
Cancel	Standard cancel.
New	Displays a dialog box where you can specify what flash loader to use; see *Flash Loader Configuration dialog box*, page 360.
Edit	Displays a dialog box where you can modify the settings for the selected flash loader; see *Flash Loader Configuration dialog box*, page 360.
Delete	Deletes the selected flash loader configuration.

Flash Loader Configuration dialog box

The **Flash Loader Configuration** dialog box is available from the **Flash Loader Overview** dialog box.

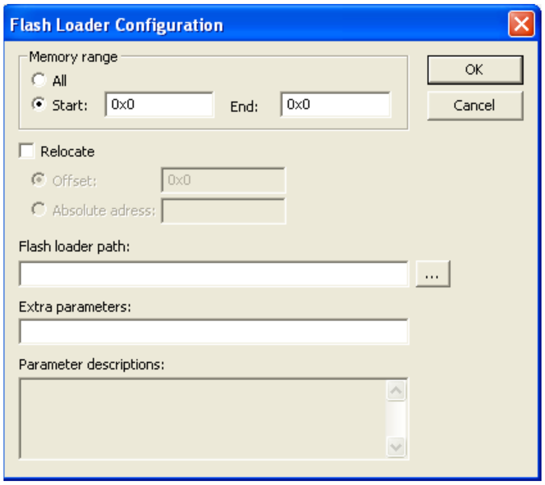


Figure 136: Flash Loader Configuration dialog box

Use the **Flash Loader Configuration** dialog box to configure the download to suit your board. A copy of the default `board` file will be created in your project directory.

Memory range

Specify the part of your application to be downloaded to flash memory. Choose between:

All	The whole application is downloaded using this flash loader.
Start/End	Specify the start and the end of the memory area for which part of the application will be downloaded.

Relocate

Overrides the default flash base address, that is relocate the location of the application in memory. This means that you can flash your application to a different location from where it was linked. Choose between:

Offset	A numeric value for a relative offset. This offset will be added to the addresses in the application file.
Absolute address	A numeric value for an absolute base address where the application will be flashed. The lowest address in the application will be placed on this address. Note that you can only use one flash loader for your application when you specify an absolute address.

You can use these numeric formats:

`123456`	Decimal numbers.
`0x123456`	Hexadecimal numbers
`0123456`	Octal numbers

The default base address used for writing the first byte—the lowest address—to flash is specified in the linker configuration file used for your application. However, it can sometimes be necessary to override the flash base address and start at a different location in the address space. This can, for example, be necessary for devices that remap the location of the flash memory.

Flash loader path

Use the text box to specify the path to the flash loader file (`*.flash`) to be used by your board configuration.

Extra parameters

Some flash loaders define their own set of specific options. Use this text box to specify options to control the flash loader. For information about available flash loader options, see the **Parameter descriptions** field.

Parameter descriptions

The **Parameter descriptions** field displays a description of the extra parameters specified in the **Extra parameters** text box.

Symbols