



**IAR Embedded  
Workbench**

# IAR Assembler User Guide

for the Renesas  
**RX Family**

## **COPYRIGHT NOTICE**

© 2009–2023 IAR Systems AB.

No part of this document may be reproduced without the prior written consent of IAR Systems AB. The software described in this document is furnished under a license and may only be used or copied in accordance with the terms of such a license.

## **DISCLAIMER**

The information in this document is subject to change without notice and does not represent a commitment on any part of IAR Systems. While the information contained herein is assumed to be accurate, IAR Systems assumes no responsibility for any errors or omissions.

In no event shall IAR Systems, its employees, its contractors, or the authors of this document be liable for special, direct, indirect, or consequential damage, losses, costs, charges, claims, demands, claim for lost profits, fees, or expenses of any nature or kind.

## **TRADEMARKS**

IAR Systems, IAR Embedded Workbench, Embedded Trust, C-Trust, IAR Connect, C-SPY, C-RUN, C-STAT, IAR Visual State, IAR KickStart Kit, I-jet, I-jet Trace, I-scope, IAR Academy, IAR, and the logotype of IAR Systems are trademarks or registered trademarks owned by IAR Systems AB.

Microsoft and Windows are registered trademarks of Microsoft Corporation.

Renesas is a registered trademark of Renesas Electronics Corporation. RX is a trademark of Renesas Electronics Corporation.

Adobe and Acrobat Reader are registered trademarks of Adobe Systems Incorporated.

All other product names are trademarks or registered trademarks of their respective owners.

## **EDITION NOTICE**

Fifth edition: August 2023

Part number: ARX-5

This guide applies to version 5.x of IAR Embedded Workbench® for the Renesas RX family.

Internal reference: BB15, tut2017, asrct2010.3, V\_110411, ISHP.

# Contents

Tables .....	11
Preface .....	13
<b>Who should read this guide</b> .....	13
<b>How to use this guide</b> .....	13
<b>What this guide contains</b> .....	14
<b>Other documentation</b> .....	14
User and reference guides .....	14
The online help system .....	15
<b>Document conventions</b> .....	15
Typographic conventions .....	16
Naming conventions .....	17
Introduction to the IAR Assembler for RX .....	19
<b>Introduction to assembler programming</b> .....	19
Getting started .....	19
<b>Modular programming</b> .....	20
<b>External interface details</b> .....	21
Assembler invocation syntax .....	21
Passing options .....	22
Environment variables .....	22
Error return codes .....	22
<b>Source format</b> .....	23
<b>RX architecture considerations</b> .....	24
Assembler instructions .....	24
Code and data in big-endian applications .....	24
<b>Expressions, operands, and operators</b> .....	24
Integer constants .....	25
ASCII character constants .....	25
Floating-point constants .....	26
True and false .....	26
Symbols .....	26

Labels .....	27
Register symbols .....	27
Predefined symbols .....	28
Absolute and relocatable expressions .....	30
Expression restrictions .....	31
<b>List file format</b> .....	32
Header .....	32
Body .....	32
Summary .....	32
Symbol and cross-reference table .....	32
<b>Programming hints</b> .....	33
Using C-style preprocessor directives .....	33
<b>Tracking call frame usage</b> .....	33
Call frame information overview .....	34
Call frame information in more detail .....	34
Defining a names block .....	35
Defining a common block .....	36
Annotating your source code within a data block .....	36
Specifying rules for tracking resources and the stack depth .....	37
Using CFI expressions for tracking complex cases .....	39
Stack usage analysis directives .....	40
Examples of using CFI directives .....	40
<b>Assembler options</b> .....	43
<b>Using command line assembler options</b> .....	43
Specifying command line options .....	43
Specifying parameters .....	44
Extended command line file .....	44
<b>Summary of assembler options</b> .....	45
<b>Description of assembler options</b> .....	47
--case_insensitive .....	47
--core .....	48
-D .....	48
--data_model .....	49

--debug, -r .....	49
--dependencies .....	50
--diag_error .....	51
--diag_remark .....	51
--diag_suppress .....	52
--diag_warning .....	52
--diagnostics_tables .....	52
--dir_first .....	53
--double .....	53
--endian .....	54
--error_limit .....	54
-f .....	55
--f .....	55
--fpu .....	56
--header_context .....	56
-I .....	56
--int .....	57
-l .....	58
-M .....	58
--macro_positions_in_diagnostics .....	59
--mnem_first .....	59
--no_bom .....	60
--no_call_frame_info .....	60
--no_normalize_file_macros .....	60
--no_path_in_file_macros .....	61
--no_system_include .....	61
--no_warnings .....	61
--no_wrap_diagnostics .....	61
--nonportable_path_warnings .....	62
--only_stdout .....	62
--output, -o .....	62
--patch .....	63
--predef_macros .....	63
--preinclude .....	63

--preprocess .....	64
--remarks .....	65
--silent .....	65
--source_encoding .....	65
--system_include_dir .....	66
--text_out .....	66
--use_paths_as_written .....	67
--use_unix_directory_separators .....	67
--utf8_text_in .....	67
--version .....	68
--warnings_affect_exit_code .....	68
--warnings_are_errors .....	68
<b>Assembler operators .....</b>	<b>69</b>
<b>Precedence of assembler operators .....</b>	<b>69</b>
<b>Summary of assembler operators .....</b>	<b>69</b>
Parenthesis operator .....	69
Function operators .....	70
Unary operators .....	70
Multiplicative arithmetic operators .....	70
Additive arithmetic operators .....	71
Shift operators .....	71
Comparison operators .....	71
Equivalence operators .....	72
Logical operators .....	72
Conditional operator .....	72
<b>Description of assembler operators .....</b>	<b>72</b>
() Parenthesis .....	72
* Multiplication .....	73
+ Unary plus .....	73
+ Addition .....	73
– Unary minus .....	73
– Subtraction .....	74
/ Division .....	74

? : Conditional operator .....	74
< Less than .....	75
<= Less than or equal to .....	75
<>, != Not equal to .....	75
=, == Equal to .....	75
> Greater than .....	76
>= Greater than or equal to .....	76
&& Logical AND .....	76
& Bitwise AND .....	77
~ Bitwise NOT .....	77
Bitwise OR .....	77
^ Bitwise exclusive OR .....	77
% Modulo .....	78
! Logical NOT .....	78
Logical OR .....	78
<< Logical shift left .....	78
>> Logical shift right .....	79
BYTE1 First byte .....	79
BYTE2 Second byte .....	79
BYTE3 Third byte .....	80
BYTE4 Fourth byte .....	80
DATE Current time/date .....	80
HIGH High byte .....	81
HWRD High word .....	81
LOW Low byte .....	81
LWRD Low word .....	81
SFB section begin .....	82
SFE section end .....	82
SIZEOF section size .....	83
UGT Unsigned greater than .....	84
ULT Unsigned less than .....	84
UPPER Third byte .....	84
XOR Logical exclusive OR .....	84

Assembler directives .....	85
<b>Summary of assembler directives</b> .....	85
<b>Description of assembler directives</b> .....	89
Module control directives .....	89
Symbol control directives .....	91
Mode control directives .....	93
Section control directives .....	94
Value assignment directives .....	98
Conditional assembly directives .....	100
Macro processing directives .....	101
Listing control directives .....	109
C-style preprocessor directives .....	113
Data definition or allocation directives .....	118
Assembler control directives .....	120
Function directives .....	123
Call frame information directives for names blocks .....	123
Call frame information directives for common blocks .....	124
Call frame information directives for data blocks .....	126
Call frame information directives for tracking resources and CFAs .....	127
Call frame information directives for stack usage analysis .....	129
Pragma directives .....	131
<b>Summary of pragma directives</b> .....	131
<b>Descriptions of pragma directives</b> .....	131
diag_default .....	131
diag_error .....	132
diag_remark .....	132
diag_suppress .....	133
diag_warning .....	133
message .....	133



Diagnostics ..... 135

**Message format** ..... 135

**Severity levels** ..... 135

        Remark ..... 135

        Warning ..... 135

        Error ..... 135

        Fatal error ..... 136

        Setting the severity level ..... 136

        Internal error ..... 136

Index ..... 137



# Tables

1: Typographic conventions used in this guide .....	16
2: Naming conventions used in this guide .....	17
3: Assembler environment variables .....	22
4: Assembler error return codes .....	22
5: Integer constant formats .....	25
6: ASCII character constant formats .....	25
7: Floating-point constants .....	26
8: Predefined register symbols .....	27
9: Predefined symbols .....	28
10: Symbol and cross-reference table .....	32
11: Code sample with call frame information .....	41
12: Assembler options summary .....	45
13: Assembler directives summary .....	85
14: Module control directives .....	90
15: Symbol control directives .....	92
16: Mode control directives .....	93
17: Section control directives .....	96
18: Value assignment directives .....	98
19: Macro processing directives .....	102
20: Listing control directives .....	109
21: C-style preprocessor directives .....	113
22: Data definition or allocation directives .....	118
23: Assembler control directives .....	121
24: Call frame information directives names block .....	124
25: Call frame information directives common block .....	125
26: Call frame information directives for data blocks .....	126
27: Unary operators in CFI expressions .....	127
28: Binary operators in CFI expressions .....	128
29: Ternary operators in CFI expressions .....	129
30: Call frame information directives for tracking resources and CFAs .....	129
31: Call frame information directives for stack usage analysis .....	130

32: Pragma directives summary .....	131
-------------------------------------	-----

# Preface

Welcome to the *IAR Assembler User Guide for RX*. The purpose of this guide is to provide you with detailed reference information that can help you to use the IAR Assembler for RX to develop your application according to your requirements.

---

## Who should read this guide

You should read this guide if you plan to develop an application, or part of an application, using assembler language for the RX microcontroller, and need to get detailed reference information on how to use the IAR Assembler for RX. In addition, you should have working knowledge of the following:

- The architecture and instruction set of the RX microcontroller (refer to the chip manufacturer's documentation)
- General assembler language programming
- Application development for embedded systems
- The operating system of your host computer.

---

## How to use this guide

When you first begin using the IAR Assembler for RX, you should read the chapter *Introduction to the IAR Assembler for RX*.

If you are an intermediate or advanced user, you can focus more on the reference chapters that follow the introduction.

If you are new to using IAR Embedded Workbench, we suggest that you first go through the tutorials, which you can find in IAR Information Center in the product, under **Product Explorer**. They will help you get started.

---

## What this guide contains

Below is a brief outline and summary of the chapters in this guide.

- *Introduction to the IAR Assembler for RX* provides programming information. It also describes the source code format, and the format of assembler listings.
- *Assembler options* first explains how to set the assembler options from the command line and how to use environment variables. It then gives an alphabetical summary of the assembler options, and contains detailed reference information about each option.
- *Assembler operators* gives a summary of the assembler operators, arranged in order of precedence, and provides detailed reference information about each operator.
- *Assembler directives* gives an alphabetical summary of the assembler directives, and provides detailed reference information about each of the directives, classified into groups according to their function.
- *Pragma directives* describes the pragma directives available in the assembler.
- *Diagnostics* contains information about the formats and severity levels of diagnostic messages.

---

## 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 IAR 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 development tools is described in a series of guides. Information about:

- System requirements and information about how to install and register the IAR products are available in the *Installation and Licensing Quick Reference Guide* and the *Licensing Guide*.
- Using the IDE for project management and building, is available in the *IDE Project Management and Building Guide for RX*.
- Using the IAR C-SPY® Debugger and C-RUN runtime error checking, is available in the *C-SPY® Debugging Guide for RX*.
- Programming for the IAR C/C++ Compiler for RX and linking, is available in the *IAR C/C++ Development Guide for RX*.

- Programming for the IAR Assembler for RX, is available in the *IAR Assembler User Guide for RX*.
- Performing a static analysis using C-STAT and the required checks, is available in the *C-STAT® Static Analysis Guide*.
- Porting application code and projects created with a previous version of the IAR Embedded Workbench for RX, is available in the *IAR Embedded Workbench® Migration Guide*.
- Migrating from an older UBROF-based product version to a newer version that uses the ELF/DWARF object format, is available in the guide *IAR Embedded Workbench® Migrating from UBROF to ELF/DWARF*.
- Migrating from the Renesas High-performance Embedded Workshop and e2studio toolchains for RX to IAR Embedded Workbench® for RX, is available in the guide *Migrating from Renesas to IAR Embedded Workbench*.

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

## THE ONLINE HELP SYSTEM

The context-sensitive online help contains information about:

- IDE project management and building
- Debugging using the IAR C-SPY® Debugger
- The IAR C/C++ Compiler and Linker
- The IAR Assembler
- C-STAT

---

## Document conventions

When, in the IAR documentation, 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 `rx\doc`, the full path to the location is assumed, for example `c:\Program Files\IAR Systems\Embedded Workbench N.n\rx\doc`, where the initial digit of the version number reflects the initial digit of the version number of the IAR Embedded Workbench shared components.

TYPOGRAPHIC CONVENTIONS

The IAR documentation set uses the following typographic conventions:





Style	Used for
computer	<ul style="list-style-type: none"><li>• Source code examples and file paths.</li><li>• Text on the command line.</li><li>• Binary, hexadecimal, and octal numbers.</li></ul>
parameter	A placeholder for an actual value used as a parameter, for example <i>filename.h</i> where <i>filename</i> represents the name of the file.
[option]	An optional part of a linker or stack usage control directive, where [ and ] are not part of the actual directive, but any [, ], {, or } are part of the directive syntax.
{option}	A mandatory part of a linker or stack usage control directive, where { and } are not part of the actual directive, but any [, ], {, or } are part of the directive syntax.
[option]	An optional part of a command line option, pragma directive, or library filename.
[a b c]	An optional part of a command line option, pragma directive, or library filename with alternatives.
{a b c}	A mandatory part of a command line option, pragma directive, or library filename with alternatives.
bold	Names of menus, menu commands, buttons, and dialog boxes that appear on the screen.
italic	<ul style="list-style-type: none"><li>• A cross-reference within this guide or to another guide.</li><li>• Emphasis.</li></ul>
...	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



## NAMING CONVENTIONS

The following naming conventions are used for the products and tools from IAR, when referred to in the documentation:

Brand name	Generic term
IAR Embedded Workbench® for RX	IAR Embedded Workbench®
IAR Embedded Workbench® IDE for RX	the IDE
IAR C-SPY® Debugger for RX	C-SPY, the debugger
IAR C-SPY® Simulator	the simulator
IAR C/C++ Compiler™ for RX	the compiler
IAR Assembler™ for RX	the assembler
IAR ILINK Linker™	ILINK, the linker
IAR DLIB Runtime Environment™	the DLIB runtime environment

Table 2: Naming conventions used in this guide



# Introduction to the IAR Assembler for RX

- Introduction to assembler programming
- Modular programming
- External interface details
- Source format
- RX architecture considerations
- Expressions, operands, and operators
- List file format
- Programming hints
- Tracking call frame usage

---

## Introduction to assembler programming

Even if you do not intend to write a complete application in assembler language, there might be situations where you find it necessary to write parts of the code in assembler, for example, when using mechanisms in the RX microcontroller that require precise timing and special instruction sequences.

To write efficient assembler applications, you should be familiar with the architecture and instruction set of the RX microcontroller. Refer to the Renesas hardware documentation for syntax descriptions of the instruction mnemonics.

### GETTING STARTED

To ease the start of the development of your assembler application, you can:

- Work through the tutorials—especially the one about mixing C and assembler modules—that you find in the Information Center, under **Product Explorer**
- Read about the assembler language interface—also useful when mixing C and assembler modules—in the *IAR C/C++ Development Guide for RX*

- In the IAR Embedded Workbench IDE, you can base a new project on a *template* for an assembler project.

---

## Modular programming

It is widely accepted that modular programming is a prominent feature of good software design. If you structure your code in small modules—in contrast to one single monolith—you can organize your application code in a logical structure, which makes the code easier to understand, and which aids:

- efficient program development
- reuse of modules
- maintenance.

The IAR development tools provide different facilities for achieving a modular structure in your software.

Typically, you write your assembler code in assembler source files—each file becomes a named *module*. If you divide your source code into many small source files, you will get many small modules. You can divide each module further into different subroutines.

A *section* is a logical entity containing a piece of data or code that should be mapped to a physical location in memory. Use the section control directives to place your code and data in sections. A section is *relocatable*. An address for a relocatable section is resolved at link time. Sections enable you to control how your code and data is placed in memory. A section is the smallest linkable unit, which allows the linker to include only those units that are referred to.

If you are working on a large project you will soon accumulate a collection of useful routines that are used by several of your applications. To avoid ending up with a huge amount of small object files, collect modules that contain such routines in a *library* object file. Note that a module in a library is always conditionally linked. In the IAR Embedded Workbench IDE, you can set up a library project, to collect many object files in one library. For an example, see the tutorials in the Information Center.

To summarize, your software design benefits from modular programming, and to achieve a modular structure you can:

- Create many small modules, one per source file
- In each module, divide your assembler source code into small subroutines (corresponding to *functions* on the C level)
- Divide your assembler source code into *sections*, to gain more precise control of how your code and data finally is placed in memory

- Collect your routines in libraries, which means that you can reduce the number of object files and make the modules conditionally linked.

---

## External interface details

This section provides information about how the assembler interacts with its environment:

- *Assembler invocation syntax*, page 21
- *Passing options*, page 22
- *Environment variables*, page 22
- *Error return codes*, page 22

You can use the assembler either from the IAR Embedded Workbench IDE or from the command line. Refer to the *IDE Project Management and Building Guide for RX* for information about using the assembler from the IAR Embedded Workbench IDE.

### ASSEMBLER INVOCATION SYNTAX

The invocation syntax for the assembler is:

```
iasmrx [options][sourcefile][options]
```

For example, when assembling the source file `prog.s`, use this command to generate an object file with debug information:

```
iasmrx prog --debug
```

By default, the IAR Assembler for RX recognizes the filename extensions `s`, `asm`, and `msa` for source files. The default filename extension for assembler output is `o`.

Generally, the order of options on the command line, both relative to each other and to the source filename, is not significant. However, there is one exception—when you use the `-I` option—the directories are searched in the same order that they are specified on the command line.

If you run the assembler from the command line without any arguments, the assembler version number and all available options, including brief descriptions, are directed to `stdout` and displayed on the screen.

PASSING OPTIONS

You can pass options to the assembler in three different ways:

- Directly from the command line  
Specify the options on the command line after the `iasmrx` command, see *Assembler invocation syntax*, page 21.
- Via environment variables  
The assembler automatically appends the value of the environment variables to every command line, so it provides a convenient method of specifying options that are required for every assembly, see *Environment variables*, page 22.
- Via a text file by using the `-f` option, see *-f*, page 55.

For general guidelines for the option syntax, an options summary, and more information about each option, see the *Assembler options* chapter.

ENVIRONMENT VARIABLES

You can use these environment variables with the IAR Assembler:

Environment variable	Description
IASMRX	Specifies command line options, for example: set IASMRX=la . --warnings_are_errors
IASMRX_INC	Specifies directories to search for include files, for example: set IASMRX_INC=c:\myinc\

Table 3: Assembler environment variables

For example, setting this environment variable always generates a list file with the name `temp.lst`:

```
set IASMRX=-l temp.lst
```

For information about the environment variables used by the compiler and linker, see the *IAR C/C++ Development Guide for RX*.

ERROR RETURN CODES

When using the IAR Assembler from within a batch file, you might have to determine whether the assembly was successful to decide what step to take next. For this reason, the assembler returns these error return codes:

Return code	Description
0	Assembly successful, warnings might appear.

Table 4: Assembler error return codes

Return code	Description
1	Warnings occurred, provided that the option <code>--warnings_affect_exit_code</code> was used.
2	Non-fatal errors or fatal assembly errors occurred (making the assembler abort).
3	Crashing errors occurred.

Table 4: Assembler error return codes (Continued)

## Source format

The format of an assembler source line is as follows:

`[label [:]] [operation] [operands] [; comment]`

where the components are as follows:

<i>label</i>	A definition of a label, which is a symbol that represents an address. If the label starts in the first column—that is, at the far left on the line—the <code>:</code> (colon) is optional.
<i>operation</i>	An assembler instruction or directive. This must not start in the first column—there must be some whitespace to the left of it.
<i>operands</i>	<p>An assembler instruction or directive can have zero, one, or more operands. The operands are separated by commas. An operand can be:</p> <ul style="list-style-type: none"><li>• a constant representing a numeric value or an address</li><li>• a symbolic name representing a numeric value or an address (where the latter also is referred to as a label)</li><li>• a floating-point constant</li><li>• a register</li><li>• a predefined symbol</li><li>• the program location counter (PLC)</li><li>• an expression.</li></ul>
<i>comment</i>	<p>Comment, preceded by a <code>;</code> (semicolon)</p> <p>C or C++ comments are also allowed.</p>

The components are separated by spaces or tabs.

A source line cannot exceed 2,047 characters.

Tab characters, ASCII 09H, are expanded according to the most common practice, that is, to columns 8, 16, 24 etc. This affects the source code output in list files and debug information. Because tabs might be set up differently in different editors, do not use tabs in your source files.

---

## RX architecture considerations

### ASSEMBLER INSTRUCTIONS

The IAR Assembler for RX supports the syntax for assembler instructions as described in the Renesas hardware documentation. It complies with the requirement of the RX architecture on word alignment.

### CODE AND DATA IN BIG-ENDIAN APPLICATIONS

When you assemble big-endian applications, the linker must be able to distinguish code from data. This is done using the assembly directives `CODE` and `DATA`. Any object read as data must be preceded by a `DATA` directive, and any lines that are to be executed must be preceded by a `CODE` directive.

There is no default mode for the assembler, and there will be no assembly error messages if these directives are omitted—but you will not be able to link successfully.

For more information, see *Mode control directives*, page 93.

---

## Expressions, operands, and operators

Expressions consist of expression operands and operators.

The assembler accepts a wide range of expressions, including both arithmetic and logical operations. All operators use 64-bit two's complement integers. Range checking is performed if a value is used for generating code.

Expressions are evaluated from left to right, unless this order is overridden by the priority of operators. See also *Assembler operators*.

These operands are valid in an expression:

- Constants for data or addresses, excluding floating-point constants
- Symbols—symbolic names—which can represent either data or addresses, where the latter also is referred to as *labels*
- The program location counter (PLC), \$ (dollar).





Format	Value
\\	\, for \ within a string
\ "	", for double quote within a string

Table 6: ASCII character constant formats (Continued)

FLOATING-POINT CONSTANTS

The IAR Assembler accepts floating-point values as constants and converts them into IEEE single-precision (32-bit) or double-precision (64-bit) floating-point format, or fractional format.

Floating-point numbers can be written in the format:

[+|-] [digits] . [digits] [{E|e} [+|-] digits]

This table shows valid examples:

Format	Value
10.23	1.023 × 10 <sup>1</sup>
1.23456E-24	1.23456 × 10 <sup>-24</sup>
1.0E3	1.0 × 10 <sup>3</sup>

Table 7: Floating-point constants

Spaces and tabs are not allowed in floating-point constants.

**Note:** Floating-point constants do not give meaningful results when used in expressions.

When a fractional format is used—for example, DQ15—the range that can be represented is -1.0 ≤ x < 1.0. Any value outside that range is silently saturated into the maximum or minimum value that can be represented.

If the word length of the fractional data is n, the fractional number will be represented as the 2-complement number: x \* 2<sup>(n-1)</sup>.

TRUE AND FALSE

In expressions, a zero value is considered false, and a non-zero value is considered true.

Conditional expressions return the value 0 for false and 1 for true.

SYMBOLS

User-defined symbols can be up to 255 characters long, and all characters are significant. Depending on what kind of operation a symbol is followed by, the symbol is either a data symbol or an address symbol where the latter is referred to as a label. A

symbol before an instruction is a label and a symbol before, for example the EQU directive, is a data symbol. A symbol can be:

- absolute—its value is known by the assembler
- relocatable—its value is resolved at link time.

Symbols must begin with a letter, a–z or A–Z, ? (question mark), or \_ (underscore). Symbols can include the digits 0–9 and \$ (dollar).

Symbols may contain any printable characters if they are quoted with ` (backquote), for example:

```
`strange#label`
```

Case is insignificant for built-in symbols like instructions, registers, operators, and directives. For user-defined symbols, case is by default significant but can be turned on and off using the **Case sensitive user symbols** (`--case_insensitive`) assembler option. For more information, see `--case_insensitive`, page 47.

Use the symbol control directives to control how symbols are shared between modules. For example, use the PUBLIC directive to make one or more symbols available to other modules. The EXTERN directive is used for importing an untyped external symbol.

Note that symbols and labels are byte addresses. See also *Data definition or allocation directives*, page 118.

LABELS

Symbols used for memory locations are referred to as labels.

Program location counter (PLC)

The assembler keeps track of the start address of the current instruction. This is called the *program location counter*.

To refer to the program location counter in your assembler source code, use the \$ (dollar) character. For example:

```
bra    $          ; Loop forever
```

REGISTER SYMBOLS

This table shows the existing predefined register symbols:

Name	Size	Description
R1–R15	32 bits	General purpose registers
SP/R0	32 bits	Register R0, the currently active SP

Table 8: Predefined register symbols

Name	Size	Description
PSW	32 bits	Status register
PC	32 bits	Program counter
USP	32 bits	User mode stack pointer
ISP	32 bits	Supervisor mode stack pointer
FPSW	32 bits	Floating-point status register
BPSW	32 bits	Backup status register (fast interrupt)
BPC	32 bits	Backup program counter (fast interrupt)
FINTV	32 bits	The fast interrupt vector register
INTB	32 bits	The INTVEC maskable interrupt vector base register

Table 8: Predefined register symbols

PREDEFINED SYMBOLS

The IAR Assembler for RX defines a set of symbols for use in assembler source files. The symbols provide information about the current assembly, allowing you to test them in preprocessor directives or include them in the assembled code.

These predefined symbols are available:

Symbol	Value
__BIG_ENDIAN__	An integer that identifies the setting of the option <code>--endian</code> . If <code>--endian=b</code> has been specified, the value of this symbol is defined to 1 (TRUE). If <code>--endian=1</code> has been specified, the value of this symbol is defined to 0 (FALSE).
__BUILD_NUMBER__	A unique integer that identifies the build number of the assembler currently in use. The build number does not necessarily increase with an assembler that is released later.
__CORE__	An integer that identifies the chip core in use. The value reflects the setting of the <code>--core</code> option and is defined to 1 for the RXv1 architecture, 2 for the RXv2 architecture, or 3 for the RXv3 architecture.
__DATA_MODEL__	An integer that identifies the data model in use. The symbol reflects the <code>--data_model</code> option and can be defined to <code>__NEAR__</code> , <code>__FAR__</code> , or <code>__HUGE__</code> .
__DATE__	The current date in <code>dd/Mmm/yyyy</code> format (string).

Table 9: Predefined symbols

Symbol	Value
__DOUBLE__	Either 32 or 64, depending on the setting of the option <code>--double</code> .
__FPU__	An integer that is set to 1 when the code is assembled with support for a hardware floating-point unit, and to 0 otherwise.
__FILE__	The name of the current source file (string).
__IAR_SYSTEMS_ASM__	IAR assembler identifier (number). The current value is 8. Note that the number could be higher in a future version of the product. This symbol can be tested with <code>#ifdef</code> to detect whether the code was assembled by an assembler from IAR Systems.
__IASMRX__	An integer that is set to 1 when the code is assembled with the IAR Assembler for RX.
__INTSIZE__	Either 16 or 32, depending on the setting of the option <code>--int</code> .
__LINE__	The current source line number (number).
__LITTLE_ENDIAN__	An integer that identifies the setting of the option <code>--endian</code> . If <code>--endian=1</code> has been specified, the value of this symbol is defined to 1 (TRUE). If <code>--endian=b</code> has been specified, the value of this symbol is defined to 0 (FALSE).
__TIME__	The current time in <code>hh:mm:ss</code> format (string).
__VER__	The version number in integer format; for example, version 4.17 is returned as 417 (number).

Table 9: Predefined symbols (Continued)

## Including symbol values in code

Several data definition directives make it possible to include a symbol value in the code. These directives define values or reserve memory. To include a symbol value in the code, use the symbol in the appropriate data definition directive.

For example, to include the time of assembly as a string for the program to display:

```

        name      timeOfAssembly
        extern    printStr
        public    printTime
        section   CODE:CODE
        data8
        ; select data mode
        ; (required for big-endian)
time:    dc8  __TIME__    ; String representing the
                        ; time of assembly.
        code
        ; select code mode
        ; (required for big-endian)
printTime:
        mov.l    #time,R1    ; Load address of time
                        ; string in R1.
        bsr     printStr    ; Call string output routine.
        end

```

### Testing symbols for conditional assembly

To test a symbol at assembly time, use one of the conditional assembly directives. These directives let you control the assembly process at assembly time.

For example, if you want to assemble separate code sections depending on whether you are using an old assembler version or a new assembler version, do as follows:

```

#if ( __VER__ > 300)                ; New assembler version
;...
;...
#else                               ; Old assembler version
;...
;...
#endif

```

For more information, see *Conditional assembly directives*, page 100.

### ABSOLUTE AND RELOCATABLE EXPRESSIONS

Depending on what operands an expression consists of, the expression is either *absolute* or *relocatable*. Absolute expressions are those expressions that only contain absolute symbols or relocatable symbols that cancel each other out.

Expressions that include symbols in relocatable sections cannot be resolved at assembly time, because they depend on the location of sections. These are referred to as *relocatable expressions*.

Such expressions are evaluated and resolved at link time, by the IAR ILINK Linker. They can only be built up out of a maximum of one symbol reference and an offset after the assembler has reduced it.

For example, a program could define absolute and relocatable expressions as follows:

```

                                name    simpleExpressions
                                section MYCONST:CONST(2)
first      dc32    5              ; A relocatable label.
second     equ     10 + 5         ; An absolute expression.

                                dc32    first          ; Examples of some legal
                                dc32    first + 1       ; relocatable expressions.
                                dc32    first + second
                                end

```

**Note:** At assembly time, there is no range check. The range check occurs at link time and, if the values are too large, there is a linker error.

## EXPRESSION RESTRICTIONS

Expressions can be categorized according to restrictions that apply to some of the assembler directives. One such example is the expression used in conditional statements like `IF`, where the expression must be evaluated at assembly time, and therefore cannot contain any external symbols.

The following expression restrictions are referred to in the description of each directive they apply to.

### No forward

All symbols referred to in the expression must be known, no forward references are allowed.

### No external

No external references in the expression are allowed.

### Absolute

The expression must evaluate to an absolute value, a relocatable value (section offset) is not allowed.

### Fixed

The expression must be fixed, which means that it must not depend on variable-sized instructions. A variable-sized instruction is an instruction that might vary in size depending on the numeric value of its operand.

---

# List file format

The format of an assembler list file is as follows:

## HEADER

The header section contains product version information, the date and time when the file was created, and which options were used.

## BODY

The body of the listing contains the following fields of information:

- The line number in the source file. Lines generated by macros, if listed, have a . (period) in the source line number field.
- The address field shows the location in memory, which can be absolute or relative depending on the type of section. The notation is hexadecimal.
- The data field shows the data generated by the source line. The notation is hexadecimal. Unresolved values are represented by ..... (periods), where two periods signify one byte. These unresolved values are resolved during the linking process.
- The assembler source line.

## SUMMARY

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

## SYMBOL AND CROSS-REFERENCE TABLE

When you specify the **Include cross-reference** option, or if the `LSTXRF+` directive was included in the source file, a symbol and cross-reference table is produced.

This information is provided for each symbol in the table:

Information	Description
Symbol	The symbol's user-defined name.
Mode	ABS (Absolute), or REL (Relocatable).
Sections	The name of the section that this symbol is defined relative to.
Value/Offset	The value (address) of the symbol within the current module, relative to the beginning of the current section.

*Table 10: Symbol and cross-reference table*



---

## Programming hints

This section gives hints on how to write efficient code for the IAR Assembler. For information about projects including both assembler and C or C++ source files, see the *IAR C/C++ Development Guide for RX*.

### USING C-STYLE PREPROCESSOR DIRECTIVES

The C-style preprocessor directives are processed before other assembler directives. Therefore, do not use preprocessor directives in macros, and do not mix them with assembler-style comments. For more information about comments, see *Assembler control directives*, page 120.

C-style preprocessor directives like `#define` are valid in the remainder of the source code file, while assembler directives like `EQU` only are valid in the current module.

---

## Tracking call frame usage

In this section, these topics are described:

- *Call frame information overview*, page 34
- *Call frame information in more detail*, page 34

These tasks are described:

- *Defining a names block*, page 35
- *Defining a common block*, page 36
- *Annotating your source code within a data block*, page 36
- *Specifying rules for tracking resources and the stack depth*, page 37
- *Using CFI expressions for tracking complex cases*, page 39
- *Stack usage analysis directives*, page 40
- *Examples of using CFI directives*, page 40

For reference information, see:

- *Call frame information directives for names blocks*, page 123
- *Call frame information directives for common blocks*, page 124
- *Call frame information directives for data blocks*, page 126
- *Call frame information directives for tracking resources and CFAs*, page 127
- *Call frame information directives for stack usage analysis*, page 129

## CALL FRAME INFORMATION OVERVIEW

*Call frame information* (CFI) is information about the *call frames*. Typically, a call frame contains a return address, function arguments, saved register values, compiler temporaries, and local variables. Call frame information holds enough information about call frames to support two important features:

- C-SPY can use call frame information to reconstruct the entire call chain from the current PC (program counter) and show the values of local variables in each function in the call chain. This information is used, for example, in the **Call Stack** window.
- Call frame information can be used, together with information about possible calls for calculating the total stack usage in the application. Note that this feature might not be supported by the product you are using.

The compiler automatically generates call frame information for all C and C++ source code. Call frame information is also typically provided for each assembler routine in the system library. However, if you have other assembler routines and want to enable C-SPY to show the call stack when executing these routines, you must add the required call frame information annotations to your assembler source code. Stack usage can also be handled this way (by adding the required annotations for each function call), but you can also specify stack usage information for any routines in a *stack usage control file* (see the *IAR C/C++ Development Guide for RX*), which is typically easier.

## CALL FRAME INFORMATION IN MORE DETAIL

You can add call frame information to assembler files by using `cfi` directives. You can use these to specify:

- The *start address* of the call frame, which is referred to as the *canonical frame address* (CFA). There are two different types of call frames:
  - On a stack—*stack frames*. For stack frames the CFA is typically the value of the stack pointer after the return from the routine.
  - In static memory, as used in a static overlay system—*static overlay frames*. This type of call frame is not required by the RX microcontroller and is therefore not supported.
- How to find the return address.
- How to restore various resources, like registers, when returning from the routine.

When adding the call frame information for each assembler module, you must:

- 1 Provide a *names block* where you describe the resources to be tracked.
- 2 Provide a *common block* where you define the resources to be tracked and specify their default values. This information must correspond to the calling convention used by the compiler.

- 3 Annotate the resources used in your source code, which in practice means that you describe the changes performed on the call frame. Typically, this includes information about when the stack pointer is changed, and when permanent registers are stored or restored on the stack.

To do this you must define a *data block* that encloses a continuous piece of source code where you specify *rules* for each resource to be tracked. When the descriptive power of the rules is not enough, you can instead use *CFI expressions*.

A full description of the calling convention might require extensive call frame information. In many cases, a more limited approach will suffice. The recommended way to create an assembler language routine that handles call frame information correctly is to start with a C skeleton function that you compile to generate assembler output. For an example, see the *IAR C/C++ Development Guide for RX*.

## DEFINING A NAMES BLOCK

A *names block* is used for declaring the resources available for a processor. Inside the names block, all resources that can be tracked are defined.

Start and end a names block with the directives:

```
CFI NAMES name
CFI ENDNAMES name
```

where *name* is the name of the block.

Only one names block can be open at a time.

Inside a names block, four different kinds of declarations can appear—a resource declaration, a stack frame declaration, a static overlay frame declaration, and a base address declaration:

- To declare a resource, use one of the directives:

```
CFI RESOURCE resource : bits
CFI VIRTUALRESOURCE resource : bits
```

The parameters are the name of the resource and the size of the resource in bits. The name must be one of the register names defined in the RX ABI specification. A virtual resource is a logical concept, in contrast to a *physical* resource such as a processor register. Virtual resources are usually used for the return address.

To declare more than one resource, separate them with commas.

A resource can also be a composite resource, made up of at least two parts. To declare the composition of a composite resource, use the directive:

```
CFI RESOURCEPARTS resource part, part, ...
```

The parts are separated with commas. The resource and its parts must have been previously declared as resources, as described above.

- To declare a stack frame CFA, use the directive:

```
CFI STACKFRAME cfa resource type
```

The parameters are the name of the stack frame CFA, the name of the associated resource (the stack pointer), and the memory type (to get the address space). To declare more than one stack frame CFA, separate them with commas.

When going *back* in the call stack, the value of the stack frame CFA is copied into the associated stack pointer resource to get a correct value for the previous function frame.

## DEFINING A COMMON BLOCK

The *common block* is used for declaring the initial contents of all tracked resources. Normally, there is one common block for each calling convention used.

Start a common block with the directive:

```
CFI COMMON name USING namesblock
```

where *name* is the name of the new block and *namesblock* is the name of a previously defined names block.

Declare the return address column with the directive:

```
CFI RETURNADDRESS resource type
```

where *resource* is a resource defined in *namesblock* and *type* is the memory in which the calling function resides. You must declare the return address column for the common block.

Inside a common block, you can declare the initial value of a CFA or a resource by using the directives available for common blocks, see *Call frame information directives for common blocks*, page 124. For more information about how to use these directives, see *Specifying rules for tracking resources and the stack depth*, page 37 and *Using CFI expressions for tracking complex cases*, page 39.

End a common block with the directive:

```
CFI ENDCOMMON name
```

where *name* is the name used to start the common block.

## ANNOTATING YOUR SOURCE CODE WITHIN A DATA BLOCK

The *data block* contains the actual tracking information for one continuous piece of code.

Start a data block with the directive:

```
CFI BLOCK name USING commonblock
```

where *name* is the name of the new block and *commonblock* is the name of a previously defined common block.

If the piece of code for the current data block is part of a defined function, specify the name of the function with the directive:

```
CFI FUNCTION label
```

where *label* is the code label starting the function.

If the piece of code for the current data block is not part of a function, specify this with the directive:

```
CFI NOFUNCTION
```

End a data block with the directive:

```
CFI ENDBLOCK name
```

where *name* is the name used to start the data block.

Inside a data block, you can manipulate the values of the resources by using the directives available for data blocks, see *Call frame information directives for data blocks*, page 126. For more information on how to use these directives, see *Specifying rules for tracking resources and the stack depth*, page 37, and *Using CFI expressions for tracking complex cases*, page 39.

## SPECIFYING RULES FOR TRACKING RESOURCES AND THE STACK DEPTH

To describe the tracking information for individual resources, two sets of simple rules with specialized syntax can be used:

- Rules for tracking resources

```
CFI resource { UNDEFINED | SAMEVALUE | CONCAT }
CFI resource { resource | FRAME(cfa, offset) }
```

- Rules for tracking the stack depth (CFAs)

```
CFI cfa { NOTUSED | USED }
CFI cfa { resource | resource + constant | resource - constant }
```

You can use these rules both in common blocks to describe the initial information for resources and CFAs, and inside data blocks to describe changes to the information for resources or CFAs.

In those rare cases where the descriptive power of the simple rules are not enough, you can use a full *CFI expression* with dedicated *operators* to describe the information, see *Using CFI expressions for tracking complex cases*, page 39. However, whenever possible, you should always use a rule instead of a CFI expression.

## Rules for tracking resources

The rules for resources conceptually describe where to find a resource when going back one call frame. For this reason, the item following the resource name in a CFI directive is referred to as the *location* of the resource.

To declare that a tracked resource is restored, in other words, already correctly located, use `SAMEVALUE` as the location. Conceptually, this declares that the resource does not have to be restored because it already contains the correct value. For example, to declare that a register `R11` is restored to the same value, use the directive:

```
CFI R11 SAMEVALUE
```

To declare that a resource is not tracked, use `UNDEFINED` as location. Conceptually, this declares that the resource does not have to be restored (when going back one call frame) because it is not tracked. Usually it is only meaningful to use it to declare the initial location of a resource. For example, to declare that `R11` is a scratch register and does not have to be restored, use the directive:

```
CFI R11 UNDEFINED
```

To declare that a resource is temporarily stored in another resource, use the resource name as its location. For example, to declare that a register `R11` is temporarily located in a register `R12` (and should be restored from that register), use the directive:

```
CFI R11 R12
```

To declare that a resource is currently located somewhere on the stack, use `FRAME(cfa, offset)` as location for the resource, where *cfa* is the CFA identifier to use as “frame pointer” and *offset* is an offset relative the CFA. For example, to declare that a register `R11` is located at offset `-4` counting from the frame pointer `CFA_SP`, use the directive:

```
CFI R11 FRAME(CFA_SP, -4)
```

For a composite resource there is one additional location, `CONCAT`, which declares that the location of the resource can be found by concatenating the resource parts for the composite resource. For example, consider a composite resource `RET` with resource parts `RETLO` and `RETHI`. To declare that the value of `RET` can be found by investigating and concatenating the resource parts, use the directive:

```
CFI RET CONCAT
```

This requires that at least one of the resource parts has a definition, using the rules described above.

## Rules for tracking the stack depth (CFAs)

In contrast to the rules for resources, the rules for CFAs describe the address of the beginning of the call frame. The call frame often includes the return address pushed by

the assembler call instruction. The CFA rules describe how to compute the address of the beginning of the current stack frame.

Each stack frame CFA is associated with a stack pointer. When going back one call frame, the associated stack pointer is restored to the current CFA. For stack frame CFAs, there are two possible rules—an offset from a resource (not necessarily the resource associated with the stack frame CFA) or `NOTUSED`.

To declare that a CFA is not used, and that the associated stack pointer should be tracked as a normal resource, use `NOTUSED` as the address of the CFA. For example, to declare that the CFA with the name `CFA_SP` is not used in this code block, use the directive:

```
CFI CFA_SP NOTUSED
```

To declare that a CFA has an address that is offset relative the value of a resource, specify the stack pointer and the offset. For example, to declare that the CFA with the name `CFA_SP` can be obtained by adding 4 to the value of the `SP` resource, use the directive:

```
CFI CFA_SP SP + 4
```

## USING CFI EXPRESSIONS FOR TRACKING COMPLEX CASES

You can use *call frame information expressions* (CFI expressions) when the descriptive power of the rules for resources and CFAs is not enough. However, you should always use a simple rule if there is one.

CFI expressions consist of operands and operators. Three sets of operators are allowed in a CFI expression:

- Unary operators
- Binary operators
- Ternary operators

In most cases, they have an equivalent operator in the regular assembler expressions.

In this example, `R12` is restored to its original value. However, instead of saving it, the effect of the two post increments is undone by the subtract instruction.

```

AddTwo:
    cfi block addTwoBlock using myCommon
    cfi function addTwo
    cfi nocalls
    cfi r12 samevalue
    add @r12+, r13
    cfi r12 sub(r12, 2)
    add @r12+, r13
    cfi r12 sub(r12, 4)
    sub #4, r12
    cfi r12 samevalue
    ret
    cfi endblock addTwoBlock

```

For more information about the syntax for using the operators in CFI expressions, see *Call frame information directives for tracking resources and CFAs*, page 127.

## STACK USAGE ANALYSIS DIRECTIVES

The stack usage analysis directives (CFI FUNCALL, CFI TAILCALL, CFI INDIRECTCALL, and CFI NOCALLS) are used for building a call graph which is needed for stack usage analysis. These directives can be used only in data blocks. When the data block is a function block (in other words, when the CFI FUNCTION directive has been used in the data block), you should not specify a *caller* parameter. When a stack usage analysis directive is used in code that is shared between functions, you must use the *caller* parameter to specify which of the possible functions the information applies to.

The CFI FUNCALL, CFI TAILCALL, and CFI INDIRECTCALL directives must be placed immediately before the instruction that performs the call. The CFI NOCALLS directive can be placed anywhere in the data block.

## EXAMPLES OF USING CFI DIRECTIVES

The following is a generic example of how to add and use the required CFI directives. The example is not created for the RX microcontroller. To obtain an example specific to the RX microcontroller, generate assembler output when you compile a C source file.

Consider a generic processor with a stack pointer SP, and two registers R0 and R1. Register R0 is used as a scratch register—the register may be destroyed by a function call—whereas register R1 must be restored after the function call. To simplify, all instructions, registers, and addresses are assumed to have a width of 16 bits.

Consider the following short code example with the corresponding call frame information. At entry, assume that the stack contains a 16-bit return address. The stack



grows from high addresses toward zero. The CFA denotes the top of the call frame, in other words, the value of the stack pointer after returning from the function.

Address	CFA	R0	R1	RET	Assembler code
0000	SP + 2	undefined	SAME	CFA - 2	func1: PUSH R1
0002	SP + 4		CFA - 4		MOV R1, #4
0004					CALL func2
0006					POP R0
0008	SP + 2		R0		MOV R1, R0
000A			SAME		RET

Table 11: Code sample with call frame information

Each row describes the state of the tracked resources *before* the execution of the instruction. As an example, for the `MOV R1, R0` instruction the original value of the R1 register is located in the R0 register and the top of the function frame (the CFA column) is `SP + 2`. The row at address 0000 is the initial row and the result of the calling convention used for the function.

The RET column is the return address column—that is, the location of the return address. The value of R0 is undefined because it does not need to be restored on exit from the function. The R1 column has `SAME` in the initial row to indicate that the value of the R1 register will be restored to the same value it already has.

Defining the names block

The names block for the small example above would be:

```
cfi      names trivialNames
cfi      resource SP:16, R0:16, R1:16
cfi      stackframe CFA SP DATA

; The virtual resource for the return address column.
cfi      virtualresource RET:16
cfi      endnames trivialNames
```

## Defining the common block

The common block for the simple example above would be:

```

cfi      common trivialCommon using trivialNames
cfi      returnaddress RET DATA
cfi      CFA SP + 2
cfi      R0 undefined
cfi      R1 samevalue

; Offset -2 from top of frame.
cfi RET frame(CFA,-2)
cfi      endcommon trivialCommon

```

**Note:** SP cannot be changed using a CFI directive as it is the resource associated with CFA.

## Annotating your source code within a data block

You should place the CFI directives at the point where the call frame information has changed, in other words, immediately *after* the instruction that changes the call frame information.

Continuing the simple example, the data block would be:

```

rseg     CODE:CODE
cfi      block func1block using trivialCommon
cfi      function func1

func1    push     r1
cfi      CFA SP + 4
cfi      R1 frame(CFA,-4)
mov      r1,#4
call     func2
pop      r0
cfi      R1 R0
cfi      CFA SP + 2
mov      r1,r0
cfi      R1 samevalue
ret
cfi      endblock func1block

```

# Assembler options

- Using command line assembler options
- Summary of assembler options
- Description of assembler options

---

## Using command line assembler options

Assembler options are parameters you can specify to change the default behavior of the assembler. You can specify options from the command line—which is described in more detail in this section—and from within the IAR Embedded Workbench® IDE.



The *IDE Project Management and Building Guide for RX* describes how to set assembler options in the IDE, and gives reference information about the available options.

### SPECIFYING COMMAND LINE OPTIONS

To set assembler options from the command line, include them on the command line after the `iasmrx` command, either before or after the source filename. For example, when assembling the source file `prog.s`, use this command to generate an object file with debug information:

```
iasmrx prog.s --debug
```

Some options accept a filename, included after the option letter with a separating space. For example, to generate a listing to the file `prog.lst`:

```
iasmrx prog.s -l prog.lst
```

Some other options accept a string that is not a filename. The string is included after the option letter, but without a space. For example, to define a symbol:

```
iasmrx prog.s -DDEBUG=1
```

Generally, the order of options on the command line, both relative to each other and to the source filename, is not significant. However, there is one exception—when you use the `-I` option, the directories are searched in the same order as they are specified on the command line.

Notice that a command line option has a short name and/or a long name:

- A short option name consists of one character, with or without parameters. You specify it with a single dash, for example `-r`.

- A long name consists of one or several words joined by underscores, with or without parameters. You specify it with double dashes, for example `--debug`.

## SPECIFYING PARAMETERS

When a parameter is needed for an option with a short name, you can specify it either immediately following the option or as the next command line argument.

For instance, you can specify an include file path of `\usr\include` either as:

```
-I\usr\include
```

or as

```
-I \usr\include
```

**Note:** You can use `/` instead of `\` as directory delimiter. A trailing slash or backslash can be added to the last directory name, but is not required.

Additionally, some options can take a parameter that is a directory name. The output file then receives a default name and extension.

When a parameter is needed for an option with a long name, you can specify it either immediately after the equal sign (`=`) or as the next command line argument, for example:

```
--diag_suppress=Pe0001
```

or

```
--diag_suppress Pe0001
```

Options that accept multiple values can be repeated, and can also have comma-separated values (without space), for example:

```
--diag_warning=Be0001,Be0002
```

The current directory is specified with a period (`.`), for example:

```
iasmrx prog -l .
```

A file specified by `-` (a single dash) is standard input or output, whichever is appropriate.

**Note:** When an option takes a parameter, the parameter cannot start with a dash (`-`) followed by another character. Instead you can prefix the parameter with two dashes (`--`). This example generates a list on standard output:

```
iasmrx prog -l ---
```

## EXTENDED COMMAND LINE FILE

In addition to accepting options and source filenames from the command line, the assembler can accept them from an extended command line file.

By default, extended command line files have the extension `.xcl`, and can be specified using the `-f` command line option. For example, to read the command line options from `extend.xcl`, enter:

```
iasmrx -f extend.xcl
```

## Summary of assembler options

This table summarizes the assembler options available from the command line:

Command line option	Description
--case_insensitive	Case-insensitive user symbols
--core	Makes the assembler accept instructions specific to a certain core
-D	Defines preprocessor symbols
--data_model	Defines the symbol <code>__DATA_MODEL__</code>
--debug	Generates debug information
--dependencies	Lists file dependencies
--diag_error	Treats these diagnostics as errors
--diag_remark	Treats these diagnostics as remarks
--diag_suppress	Suppresses these diagnostics
--diag_warning	Treats these diagnostics as warnings
--diagnostics_tables	Lists all diagnostic messages
--dir_first	Allows directives in the first column
--double	Defines the symbol <code>__DOUBLE__</code>
--endian	Defines the symbols <code>__BIG_ENDIAN__</code> and <code>__LITTLE_ENDIAN__</code>
--error_limit	Specifies the allowed number of errors before the assembler stops
-f	Extends the command line
--f	Extends the command line, optionally with a dependency
--fpu	Configures how the assembler handles floating-point arithmetic
--header_context	Lists all referred source files
-I	Adds a search path for a header file

Table 12: Assembler options summary

Command line option	Description
-int	Defines the symbol <code>__INTSIZE__</code>
-l	Generates a list file
-M	Macro quote characters
--macro_positions_in_diagnostics	Obtains positions inside macros in diagnostic messages
--mnem_first	Allows mnemonics in the first column
--no_bom	Omits the Byte Order Mark for UTF-8 output files
--no_call_frame_info	Disables output of call frame information
--no_normalize_file_macros	Disables normalization of paths in the symbols <code>__FILE__</code> and <code>__BASE_FILE__</code>
--no_path_in_file_macros	Removes the path from the return value of the symbols <code>__FILE__</code> and <code>__BASE_FILE__</code>
--no_system_include	Disables the automatic search for system include files
--no_warnings	Disables all warnings
--no_wrap_diagnostics	Disables wrapping of diagnostic messages
--nonportable_path_warnings	Generates a warning when the path used for opening a source header file is not in the same case as the path in the file system.
-o	Sets the object filename. Alias for <code>--output</code> .
--only_stdout	Uses standard output only
--output	Sets the object filename
--patch	Prevents the assembler from accepting assembler instructions specific to a certain CPU type
--predef_macros	Lists the predefined symbols
--preinclude	Includes an include file before reading the source file
--preprocess	Preprocessor output to file
-r	Generates debug information. Alias for <code>--debug</code> .
--remarks	Enables remarks
--silent	Sets silent operation
--source_encoding	Specifies the encoding for source files
--system_include_dir	Specifies the path for system include files
--text_out	Specifies the encoding for text output files

Table 12: Assembler options summary (Continued)

Command line option	Description
--use_paths_as_written	Use paths as written in debug information
--use_unix_directory_separators	Uses / as directory separator in paths
--utf8_text_in	Uses the UTF-8 encoding for text input files
--version	Sends assembler output to the console and then exits.
--warnings_affect_exit_code	Warnings affect exit code
--warnings_are_errors	Treats all warnings as errors

Table 12: Assembler options summary (Continued)

## Description of assembler options

The following sections give detailed reference information about each assembler option.



If you use the page **Extra Options** to specify specific command line options, the IDE does not perform an instant check for consistency problems like conflicting options, duplication of options, or use of irrelevant options.

### --case\_insensitive

Syntax

--case\_insensitive

Description

Use this option to make user symbols case-insensitive. By default, case sensitivity is on.

You can also use the assembler directives `CASEON` and `CASEOFF` to control case sensitivity for user-defined symbols.

**Note:** The `--case_insensitive` option does not affect preprocessor symbols. Preprocessor symbols are always case-sensitive, regardless of whether they are defined in the IDE or on the command line.

Example

By default, for example, `LABEL` and `label` refer to different symbols. When `--case_insensitive` is used, `LABEL` and `label` instead refer to the same symbol.



See also

*Assembler control directives*, page 120 and information about defining and undefining preprocessor symbols under *C-style preprocessor directives*, page 113.



**Project>Options>Assembler >Language>User symbols are case sensitive**

**--core**

Syntax	<code>--core={rxv1 rxv2 rxv3}</code>	
Parameters	<code>rxv1</code> (default)	Generates code for the RXv1 architecture.
	<code>rxv2</code>	Generates code for the RXv2 architecture.
	<code>rxv3</code>	Generates code for the RXv3 architecture.
Description	Use this option to make the assembler accept assembler instructions specific to a certain core. As a result of using this option, the symbol <code>__CORE__</code> will be defined accordingly. See <i>Predefined symbols</i> , page 28.	
		To find out which core a device is based on, open the *.menu file for that device in an editor and look at the value of the <core> attribute. The *.menu files are located in the rx\config\devices\ directory.
		To set related options, choose: <b>Project&gt;Options&gt;General Options&gt;Target&gt;Device</b>

**-D**

Syntax	<code>-Dsymbol[=value]</code>	
Parameters	<code>symbol</code>	The name of the symbol you want to define.
	<code>value</code>	The value of the symbol. If no value is specified, 1 is used.
Description	Use this option to define a symbol to be used by the preprocessor.	
Example	You might want to arrange your source code to produce either the test version or the production version of your application, depending on whether the symbol <code>TESTVER</code> was defined. To do this, use include sections such as:	
	<pre>#ifdef TESTVER ... ; additional code lines for test version only #endif</pre>	
	Then select the version required on the command line as follows:	
	Production version:	<code>iasmrx prog</code>
	Test version:	<code>iasmrx prog -DTESTVER</code>



Alternatively, your source might use a variable that you must change often. You can then leave the variable undefined in the source, and use `-D` to specify the value on the command line, for example:

```
iasmrx prog -DFRAMERATE=3
```



**Project>Options>Assembler>Preprocessor>Defined symbols**

**--data\_model**

Syntax

```
--data_model={near|n|far|f|huge|h}
```

Parameters

near n	Sets the predefined symbol <code>__DATA_MODEL__</code> to <code>__NEAR__</code>
far f (default)	Sets the predefined symbol <code>__DATA_MODEL__</code> to <code>__FAR__</code>
huge h	Sets the predefined symbol <code>__DATA_MODEL__</code> to <code>__HUGE__</code>

Description

Use this option to define the symbol `__DATA_MODEL__`.

See also

*Predefined symbols*, page 28.



**Project>Options>General Options>Target>Data model**

**--debug, -r**

Syntax

```
--debug  
-r
```

Description

Use this option to make the assembler generate debug information, which means the generated output can be used in a symbolic debugger such as IAR C-SPY® Debugger.

To reduce the size and link time of the object file, the assembler does not generate debug information by default.



**Project>Options>Assembler>Output>Generate debug information**

# --dependencies

Syntax	<code>--dependencies [= [i m n] [s]] {filename directory +}</code>	
Parameters		
	i (default)	Lists only the names of files
	m	Lists in makefile style (multiple rules)
	n	Lists in makefile style (one rule)
	s	Suppresses system files
	+	Gives the same output as <code>-o</code> , but with the filename extension <code>d</code>

For information about specifying a filename or directory, see *Specifying parameters*, page 44.

**Description** Use this option to make the assembler list the names of all source and header files opened for input into a file with the default filename extension `i`.

**Example** If `--dependencies` or `--dependencies=i` is used, the name of each opened input file, including the full path, if available, is output on a separate line. For example:

```
c:\iar\product\include\stdio.h
d:\myproject\include\foo.h
```

If `--dependencies=m` is used, the output is in makefile style. For each input file, one line containing a makefile dependency rule is produced. Each line consists of the name of the object file, a colon, a space, and the name of an input file. For example:

```
foo.o: c:\iar\product\include\stdio.h
foo.o: d:\myproject\include\foo.h
```

An example of using `--dependencies` with a popular make utility, such as GMake (GNU make):

- 1 Set up the rule for assembling files to be something like:

```
%.o : %.c
$(ASM) $(ASMFLAGS) $< --dependencies=m $*.d
```

That is, in addition to producing an object file, the command also produces a dependency file in makefile style—in this example, using the extension `.d`.

- 2 Include all the dependency files in the makefile using, for example:

```
-include $(sources:.c=.d)
```

Because of the dash (`-`) it works the first time, when the `.d` files do not yet exist.



This option is not available in the IDE.

**--diag\_error**

Syntax

`--diag_error=tag, tag, ...`

Parameters

*tag*                      The number of a diagnostic message, for example the message number As001.

Description

Use this option to classify diagnostic messages as errors.  
An error indicates a violation of the assembler language rules, of such severity that object code is not generated, and the exit code will not be 0. The option can be used more than once on the command line.

Example

This example classifies warning As001 as an error:  
`--diag_error=As001`



**Project>Options>Assembler >Diagnostics>Treat these as errors**

**--diag\_remark**

Syntax

`--diag_remark=tag, tag, ...`

Parameters

*tag*                      The number of a diagnostic message, for example the message number As001.

Description

Use this option to classify diagnostic messages as remarks.  
A remark is the least severe type of diagnostic message and indicates a source code construct that might cause strange behavior in the generated code.

Example

This example classifies the warning As001 as a remark:  
`--diag_remark=As001`



**Project>Options>Assembler >Diagnostics>Treat these as remarks**

### --diag\_suppress

Syntax	<code>--diag_suppress=tag, tag, ...</code>	
Parameters	<i>tag</i>	The number of a diagnostic message, for example the message number As001.
Description	Use this option to suppress diagnostic messages.	
Example	This example suppresses the warnings As001 and As002: <code>--diag_suppress=As001,As002</code>	



**Project>Options>Assembler >Diagnostics>Suppress these diagnostics**

### --diag\_warning


Syntax	<code>--diag_warning=tag, tag, ...</code>	
Parameters	<i>tag</i>	The number of a diagnostic message, for example the message number As001.
Description	Use this option to classify diagnostic messages as warnings.  A warning indicates an error or omission that is of concern, but which does not cause the assembler to stop before the assembly is completed.	
Example	This example classifies the remark As028 as a warning: <code>--diag_warning=As028</code>	




**Project>Options>Assembler >Diagnostics>Treat these as warnings**

### --diagnostics\_tables

Syntax	<code>--diagnostics_tables {filename directory}</code>	
Parameters	<i>filename</i>	The diagnostic messages are stored in the specified file.

	<i>directory</i>	The diagnostic messages are stored in a file (filename extension <i>i</i> ) which is stored in the specified directory.
	For information about specifying a filename or directory, see <i>Specifying parameters</i> , page 44.	
Description	Use this option to list all possible diagnostic messages in a named file. This can be very convenient, for example, if you used a <code>#pragma</code> directive to suppress or change the severity level of any diagnostic messages, but forgot to document why.  This option cannot be given together with other options.	
Example	To output a list of all possible diagnostic messages to the file <code>diag.txt</code> , use:  <code>--diagnostics_tables diag</code>   This option is not available in the IDE.	

## --dir\_first

Syntax	<code>--dir_first</code>
Description	Use this option to make directive names (without a trailing colon) that start in the first column to be recognized as directives.  The default behavior of the assembler is to treat all identifiers starting in the first column as labels.   <b>Project&gt;Options&gt;Assembler &gt;Language&gt;Allow directives in first column</b>

## --double

Syntax	<code>--double={32 64}</code>				
Parameters	<table><tr><td>32 (default)</td><td>Sets the predefined symbol <code>__DOUBLE__</code> to 32</td></tr><tr><td>64</td><td>Sets the predefined symbol <code>__DOUBLE__</code> to 64</td></tr></table>	32 (default)	Sets the predefined symbol <code>__DOUBLE__</code> to 32	64	Sets the predefined symbol <code>__DOUBLE__</code> to 64
32 (default)	Sets the predefined symbol <code>__DOUBLE__</code> to 32				
64	Sets the predefined symbol <code>__DOUBLE__</code> to 64				
Description	Use this option to define the symbol <code>__DOUBLE__</code> .				
See also	<i>Predefined symbols</i> , page 28.				



**Project>Options>General Options>Target>Size of type 'double'**

**--endian**

Syntax

`--endian={b|big|l|little}`

Parameters

<code>b big</code>	Sets the predefined symbol <code>__BIG_ENDIAN__</code> to 1 and <code>__LITTLE_ENDIAN__</code> to 0
<code>l little</code> (default)	Sets the predefined symbol <code>__BIG_ENDIAN__</code> to 0 and <code>__LITTLE_ENDIAN__</code> to 1

Description

Use this option to define the symbols `__BIG_ENDIAN__` and `__LITTLE_ENDIAN__`.

See also

*Predefined symbols*, page 28.



**Project>Options>General Options>Target>Byte order**

**--error\_limit**

Syntax

`--error_limit=n`

Parameters

<code>n</code>	The number of errors before the assembler stops the assembly. <i>n</i> must be a positive integer—0 indicates no limit.
----------------	---

Description

Use this option to specify the number of errors allowed before the assembler stops. By default, 100 errors are allowed.



This option is not available in the IDE.

**-f**

Syntax `-f filename`

## Parameters

*filename*                      The commands that you want to extend the command line with are read from the specified file. Notice that there must be a space between the option itself and the filename.

For information about specifying a filename, see *Specifying parameters*, page 44.

## Description

Use this option to extend the command line with text read from the specified file.

The `-f` option is particularly useful if there are many options which are more conveniently placed in a file than on the command line itself.

## Example

To run the assembler with further options taken from the file `extend.xcl`, use:

```
iasmrx prog -f extend.xcl
```

## See also

`-f`, page 55 and *Extended command line file*, page 44.



To set this option, use:

**Project>Options>Assembler>Extra Options**

**--f**

Syntax `--f filename`

## Parameters

*filename*                      The commands that you want to extend the command line with are read from the specified file. Notice that there must be a space between the option itself and the filename.

For information about specifying a filename, see *Specifying parameters*, page 44.

## Description

Use this option to make the assembler read command line options from the named file, with the default filename extension `xcl`.

In the command file, you format the items exactly as if they were on the command line itself, except that you may use multiple lines, because the newline character acts just as a space or tab character.

Both C and C++ style comments are allowed in the file. Double quotes behave in the same way as in the Microsoft Windows command line environment.

If you use the assembler option `--dependencies`, extended command line files specified using `--f` will generate a dependency, but those specified using `-f` will not generate a dependency.

See also

`--dependencies`, page 50 and `-f`, page 55.



To set this option, use **Project>Options>Assembler>Extra Options**.

## --fpu

Syntax

`--fpu={none|32}`

Parameters

- |      |   |
|------|---|
| none | Prevents the assembler from accepting FPU instructions for floating-point arithmetic. |
| 32   | Makes the assembler accept FPU instructions for 32-bit floating-point arithmetic.     |

Description

Use this option to configure how the assembler handles floating-point arithmetic.



This option is set automatically when you choose:

**Project>Options>General Options>Target>Device**

## --header\_context

Syntax

`--header_context`

Description

Occasionally, you must know which header file that was included from what source line, to find the cause of a problem. Use this option to list, for each diagnostic message, not only the source position of the problem, but also the entire include stack at that point.



This option is not available in the IDE.

## -I


Syntax

`-Ipath`


Parameters

- |      |  |
|------|--|
| path | The search path for <code>#include</code> files. |
|------|--|




Description	<p>Use this option to specify paths to be used by the preprocessor. This option can be used more than once on the command line.</p> <p>By default, the assembler searches for <code>#include</code> files in the current working directory, in the system header directories, and in the paths specified in the <code>IASMRX_INC</code> environment variable. The <code>-I</code> option allows you to give the assembler the names of directories which it will also search if it fails to find the file in the current working directory.</p>
Example	<p>For example, using the options:</p> <pre>-Ic:\global\ -Ic:\thisproj\headers\</pre> <p>and then writing:</p> <pre>#include "asmlib.hdr"</pre> <p>in the source code, make the assembler search first in the current directory, then in the directory <code>c:\global\</code>, and then in the directory <code>C:\thisproj\headers\</code>. Finally, the assembler searches the directories specified in the <code>IASMRX_INC</code> environment variable, provided that this variable is set, and in the system header directories.</p> <div> <b>Project&gt;Options&gt;Assembler&gt;Preprocessor&gt;Additional include directories</b></div>

--int

Syntax	<code>--int={16 32}</code>	
Parameters	16	Sets the predefined symbol <code>__INTSIZE__</code> to 16
	32 (default)	Sets the predefined symbol <code>__INTSIZE__</code> to 32
Description	Use this option to define the symbol <code>__INTSIZE__</code> .	
See also	<i>Predefined symbols</i> , page 28.	
	<div> <b>Project&gt;Options&gt;General Options&gt;Target&gt;Size of type 'int'</b></div>	

**-l**

Syntax	<code>-l [a] [d] [e] [m] [o] [x] [N] [H] {filename directory}</code>	
Parameters		
	<code>a</code>	Assembled lines only.
	<code>d</code>	The <code>LSTOUT</code> directive controls if lines are written to the list file or not. Using <code>-ld</code> turns the start value for this to off.
	<code>e</code>	No macro expansions.
	<code>m</code>	Macro definitions.
	<code>o</code>	Multiline code.
	<code>x</code>	Includes cross-references.
	<code>N</code>	Do not include diagnostics.
	<code>H</code>	Includes header file source lines.
	<code>filename</code>	The output is stored in the specified file.
	<code>directory</code>	The output is stored in a file (filename extension <code>i</code> ) which is stored in the specified directory.
	For information about specifying a filename or directory, see <i>Specifying parameters</i> , page 44.	
Description	By default, the assembler does not generate a listing. Use this option to generate a listing to a file.	
Example	To generate a listing to the file <code>list.lst</code> , use:  <code>iasm sourcefile -l list</code>	
	To set related options, select:	
	 <b>Project&gt;Options&gt;Assembler &gt;List</b>	

**-M**

Syntax	$\text{-Mab}$	
Parameters	$ab$	The characters to be used as left and right quotes of each macro argument, respectively.

Description	<p>Use this option to sets the characters to be used as left and right quotes of each macro argument to <i>a</i> and <i>b</i> respectively.</p> <p>By default, the characters are &lt; and &gt;. The -M option allows you to change the quote characters to suit an alternative convention, or simply allows a macro argument to contain &lt; or &gt; themselves.</p>
Example	<p>For example, using the option:</p> <pre>-M[]</pre> <p>in the source you would write, for example:</p> <pre>print [&gt;]</pre> <p>to call a macro <code>print</code> with <code>&gt;</code> as the argument.</p> <p><b>Note:</b> Depending on your host environment, it might be necessary to use quote marks with the macro quote characters, for example:</p> <pre>iasmrx filename -M'&lt;&gt;'</pre>



**Project>Options>Assembler >Language>Macro quote characters**

**--macro\_positions\_in\_diagnostics**

Syntax	<code>--macro_positions_in_diagnostics</code>
Description	<p>Use this option to obtain position references inside macros in diagnostic messages. This is useful for detecting incorrect source code constructs in macros.</p>



To set this option, use **Project>Options>Assembler>Extra Options**.

**--mnem\_first**

Syntax	<code>--mnem_first</code>
Description	<p>Use this option to make mnemonics names (without a trailing colon) starting in the first column be recognized as mnemonics.</p> <p>The default behavior of the assembler is to treat all identifiers starting in the first column as labels.</p>



**Project>Options>Assembler >Language>Allow mnemonics in first column**

## --no\_bom

Syntax	--no_bom
Description	Use this option to omit the Byte Order Mark (BOM) when generating a UTF-8 output file.
See also	--text_out, page 66. For more information about encodings, see the <i>IAR C/C++ Development Guide for RX</i> .



**Project>Options>Assembler>Encodings>Text output file encoding**

## --no\_call\_frame\_info

Syntax	--no_call_frame_info
Description	By default, the assembler generates call frame information in object files for assembler code that is annotated with such information (but only for such code). Use this option to disable the generation of call frame information entirely.
See also	<i>Tracking call frame usage</i> , page 33.



To set this option, use **Project>Options>Assembler>Extra Options**.

## --no\_normalize\_file\_macros

Syntax	--no_normalize_file_macros
Description	Normally, apparently unneeded uses of <code>..</code> and <code>.</code> components are collapsed in the paths returned by the predefined preprocessor symbols <code>__FILE__</code> and <code>__BASE_FILE__</code> . Use this option to prevent this.
Example	The path <code>"D:\foo\..\bar\baz.s"</code> will be returned as <code>"D:\bar\baz.s"</code> by the symbols <code>__FILE__</code> and <code>__BASE_FILE__</code> unless this option is used.
See also	<i>Predefined symbols</i> , page 28.



This option is not available in the IDE.

## --no\_path\_in\_file\_macros

Syntax `--no_path_in_file_macros`

Description Use this option to exclude the path from the return value of the predefined preprocessor symbols `__FILE__` and `__BASE_FILE__`.



This option is not available in the IDE.

## --no\_system\_include

Syntax `--no_system_include`

Description By default, the assembler automatically locates the system include files. Use this option to disable the automatic search for system include files. In this case, you might need to set up the search path by using the `-I` assembler option.



**Project>Options>Assembler>Preprocessor>Ignore standard include directories**

## --no\_warnings

Syntax `--no_warnings`

Description By default, the assembler issues standard warning messages. Use this option to disable all warning messages.



This option is not available in the IDE.

## --no\_wrap\_diagnostics


Syntax `--no_wrap_diagnostics`

Description By default, long lines in assembler diagnostic messages are broken into several lines to make the message easier to read. Use this option to disable line wrapping of diagnostic messages.




This option is not available in the IDE.


### --nonportable\_path\_warnings

Syntax	<code>--nonportable_path_warnings</code>
Description	Use this option to make the assembler generate a warning when characters in the path used for opening a source file or header file are lower case instead of upper case, or vice versa, compared with the path in the file system.
	 This option is not available in the IDE.

### --only\_stdout

Syntax	<code>--only_stdout</code>
Description	Use this option to make the assembler direct messages to <code>stdout</code> instead of to <code>stderr</code> .
	 This option is not available in the IDE.

### --output, -o

Syntax	<code>--output {filename directory}</code> <code>-o {filename directory}</code>				
Parameters	<table><tr><td><i>filename</i></td><td>The object code is stored in the specified file.</td></tr><tr><td><i>directory</i></td><td>The object code is stored in a file (filename extension <code>o</code>) which is stored in the specified directory.</td></tr></table> <p>For information about specifying a filename or directory, see <i>Specifying parameters</i>, page 44.</p>	<i>filename</i>	The object code is stored in the specified file.	<i>directory</i>	The object code is stored in a file (filename extension <code>o</code> ) which is stored in the specified directory.
<i>filename</i>	The object code is stored in the specified file.				
<i>directory</i>	The object code is stored in a file (filename extension <code>o</code> ) which is stored in the specified directory.				
Description	By default, the object code produced by the assembler is located in a file with the same name as the source file, but with the extension <code>o</code> . Use this option to specify a different output filename for the object code output.				
	 <b>Project&gt;Options&gt;General Options&gt;Output&gt;Output directories&gt;Object files</b>				

## --patch

Syntax	<code>--patch=rx610</code>
Description	Prevents the assembler from accepting assembler instructions specific to a certain CPU type. Specifying <code>--patch=rx610</code> makes the assembler report an error if the <code>MVTIPL</code> instruction (which causes a problem in the RX610 group) is used in your assembler source code.



This option is not available in the IDE.

## --predef\_macros

Syntax	<code>--predef_macros {filename directory}</code>				
Parameters	<table> <tr> <td><i>filename</i></td><td>The list of predefined macros is stored in the specified file.</td></tr> <tr> <td><i>directory</i></td><td>The list of predefined macros is stored in a file (filename extension <code>predef</code>) which is stored in the specified directory.</td></tr> </table>	<i>filename</i>	The list of predefined macros is stored in the specified file.	<i>directory</i>	The list of predefined macros is stored in a file (filename extension <code>predef</code> ) which is stored in the specified directory.
<i>filename</i>	The list of predefined macros is stored in the specified file.				
<i>directory</i>	The list of predefined macros is stored in a file (filename extension <code>predef</code> ) which is stored in the specified directory.				

For information about specifying a filename or directory, see *Specifying parameters*, page 44.

Description	Use this option to list all symbols defined by the assembler or on the command line. When using this option, make sure to also use the same options as for the rest of your project.
-------------	--

Note that this option requires that you specify a source file on the command line.



This option is not available in the IDE.

## --preinclude

Syntax	<code>--preinclude includefile</code>		
Parameters	<table> <tr> <td><i>includefile</i></td><td>The header file to be included.</td></tr> </table>	<i>includefile</i>	The header file to be included.
<i>includefile</i>	The header file to be included.		

**Description** Use this option to make the assembler include the specified include file before it starts to read the source file. This is useful if you want to change something in the source code for the entire application, for instance if you want to define a new symbol.

To set this option, use:



**Project>Options>Assembler>Preprocessor>Preinclude file**

**--preprocess**

**Syntax** `--preprocess=[c][n][s] {filename|directory}`

**Parameters**

No parameter	A preprocessed file.
<i>c</i>	Preserves C and C++ style comments that otherwise are removed by the preprocessor. Assembler style comments are always preserved.
<i>n</i>	Preprocess only.
<i>s</i>	Suppress #line directives.
<i>filename</i>	The output is stored in the specified file.
<i>directory</i>	The output is stored in a file (filename extension i) which is stored in the specified directory. The filename is the same as the name of the assembled source file.

For information about specifying a filename or directory, see *Specifying parameters*, page 44.

**Description** Use this option to direct preprocessor output to a named file.

**Example** To store the assembler output with preserved comments to the file `output.i`, use:  
`iasmrx sourcefile --preprocess=c output`



**Project>Options>Assembler>Preprocessor>Preprocessor output to file**



--remarks

Syntax	--remarks
Description	Use this option to make the assembler generate remarks, which is the least severe type of diagnostic message and which indicates a source code construct that might cause strange behavior in the generated code. By default, remarks are not generated.
See also	<i>Severity levels</i> , page 135.



**Project>Options>Assembler >Diagnostics>Enable remarks**

--silent

Syntax	--silent
Description	<p>By default, the assembler sends various minor messages via the standard output stream. Use this option to make the assembler operate without sending any messages to the standard output stream.</p> <p>The assembler sends error and warning messages to the error output stream, so they are displayed regardless of this setting.</p>



This option is not available in the IDE.

--source\_encoding


Syntax	--source_encoding {locale utf8}				
Parameters	<table><tr><td>locale</td><td>The default source encoding is the system locale encoding.</td></tr><tr><td>utf8</td><td>The default source encoding is the UTF-8 encoding.</td></tr></table>	locale	The default source encoding is the system locale encoding.	utf8	The default source encoding is the UTF-8 encoding.
locale	The default source encoding is the system locale encoding.				
utf8	The default source encoding is the UTF-8 encoding.				
Description	When reading a source file with no Byte Order Mark (BOM), use this option to specify the encoding. If this option is not specified and the source file does not have a BOM, the Raw encoding will be used.				

See also	For more information about encodings, see the <i>IAR C/C++ Development Guide for RX</i> .
----------	---




**Project>Options>Assembler>Encodings>Default source file encoding**

**--system\_include\_dir**

Syntax	<code>--system_include_dir path</code>	
Parameters	<i>path</i>	The path to the system include files.
Description	By default, the assembler automatically locates the system include files. Use this option to explicitly specify a different path to the system include files. This might be useful if you have not installed IAR Embedded Workbench in the default location.	
		This option is not available in the IDE.

**--text\_out**

Syntax	<code>--text_out {utf8 utf16le utf16be locale}</code>	
Parameters	<i>utf8</i>	Uses the UTF-8 encoding
	<i>utf16le</i>	Uses the UTF-16 little-endian encoding
	<i>utf16be</i>	Uses the UTF-16 big-endian encoding
	<i>locale</i>	Uses the system locale encoding
Description	Use this option to specify the encoding to be used when generating a text output file.  The default for the assembler list files is to use the same encoding as the main source file. The default for all other text files is UTF-8 with a Byte Order Mark (BOM).  If you want text output in UTF-8 encoding without a BOM, use the option <code>--no_bom</code> .	
See also	<code>--no_bom</code> , page 60. For more information about encodings, see the <i>IAR C/C++ Development Guide for RX</i> .	
		<b>Project&gt;Options&gt;Assembler&gt;Encodings&gt;Text output file encoding</b>

## --use\_paths\_as\_written

Syntax	<code>--use_paths_as_written</code>
Description	<p>By default, the assembler ensures that all paths in the debug information are absolute, even if not originally specified that way.</p> <p>If you use this option, paths that were originally specified as relative will be relative in the debug information.</p> <p>The paths affected by this option are:</p> <ul style="list-style-type: none"> <li>• the paths to source files</li> <li>• the paths to header files that are found using an include path that was specified as relative</li> </ul> <p>To set this option, use <b>Project&gt;Options&gt;Assembler&gt;Extra Options</b>.</p>



## --use\_unix\_directory\_separators

Syntax	<code>--use_unix_directory_separators</code>
Description	<p>Use this option to make DWARF debug information use / (instead of \) as directory separators in file paths.</p> <p>This option can be useful if you have a debugger that requires directory separators in UNIX style.</p> <p>To set this option, use <b>Project&gt;Options&gt;Assembler&gt;Extra Options</b>.</p>




## --utf8\_text\_in


Syntax	<code>--utf8_text_in</code>
Description	<p>Use this option to specify that the assembler shall use UTF-8 encoding when reading a text input file with no Byte Order Mark (BOM).</p> <p><b>Note:</b> This option does not apply to source files.</p>
See also	<p>The <i>IAR C/C++ Development Guide for RX</i> for more information about encodings.</p> <p><b>Project&gt;Options&gt;Assembler&gt;Encodings&gt;Default input file encoding</b></p>




### **--version**

Syntax	<code>--version</code>
Description	Use this option to make the assembler send version information to the console and then exit.
	 This option is not available in the IDE.

### **--warnings\_affect\_exit\_code**

Syntax	<code>--warnings_affect_exit_code</code>
Description	By default, the exit code is not affected by warnings, only errors produce a non-zero exit code. Use this option to make warnings generate a non-zero exit code.
	 This option is not available in the IDE.

### **--warnings\_are\_errors**

Syntax	<code>--warnings_are_errors</code>
Description	<p>Use this option to make the assembler treat all warnings as errors. If the assembler encounters an error, no object code is generated.</p> <p>If you want to keep some warnings, use this option in combination with the option <code>--diag_warning</code>. First make all warnings become treated as errors and then reset the ones that should still be treated as warnings, for example:</p> <pre>--diag_warning=As001</pre>
See also	<code>--diag_warning</code> , page 52.
	 <b>Project&gt;Options&gt;Assembler&gt;Diagnostics&gt;Treat all warnings as errors</b>

# Assembler operators

- Precedence of assembler operators
- Summary of assembler operators
- Description of assembler operators

---

## Precedence of assembler operators

Each operator has a precedence number assigned to it that determines the order in which the operator and its operands are evaluated. The precedence numbers range from 1 (the highest precedence, that is, first evaluated) to 15 (the lowest precedence, that is, last evaluated).

These rules determine how expressions are evaluated:

- The highest precedence operators are evaluated first, then the second highest precedence operators, and so on until the lowest precedence operators are evaluated.
- Operators of equal precedence are evaluated from left to right in the expression.
- Parentheses ( and ) can be used for grouping operators and operands, and for controlling the order in which the expressions are evaluated. For example, this expression evaluates to 1:

$7 / (1 + (2 * 3))$

---

## Summary of assembler operators

The following tables give a summary of the operators, in order of precedence. Synonyms, where available, are shown after the operator name.

### PARENTHESIS OPERATOR

Precedence: 1

( )	Parenthesis.
-----	--------------

**FUNCTION OPERATORS**

Precedence: 2

BYTE1	First byte
BYTE2	Second byte
BYTE3	Third byte
BYTE4	Fourth byte
DATE	Current date/time
HIGH	High byte
HWRD	High word
LOW	Low byte
LWRD	Low word
SFB	Section begin
SFE	Section end
SIZEOF	Section size
UPPER	Third byte

**UNARY OPERATORS**

Precedence: 3

+	Unary plus
BINNOT [~]	Bitwise NOT
NOT [!]	Logical NOT
-	Unary minus

**MULTIPLICATIVE ARITHMETIC OPERATORS**

Precedence: 4

*	Multiplication
/	Division
MOD [%]	Modulo

## ADDITIVE ARITHMETIC OPERATORS

Precedence: 5

+	Addition
−	Subtraction

## SHIFT OPERATORS

Precedence: 6

SHL [ << ]	Logical shift left
SHR [ >> ]	Logical shift right

## COMPARISON OPERATORS

Precedence: 7

GE [ >= ]	Greater than or equal
GT [ > ]	Greater than
LE [ <= ]	Less than or equal
LT [ < ]	Less than
UGT	Unsigned greater than
ULT	Unsigned less than

**EQUIVALENCE OPERATORS**

Precedence: 8

EQ [ = ] [ == ]	Equal
NE [ <> ] [ != ]	Not equal

**LOGICAL OPERATORS**

Precedence: 9–14

BINAND [ & ]	Bitwise AND (9)
BINXOR [ ^ ]	Bitwise exclusive OR (10)
BINOR [   ]	Bitwise OR (11)
AND [ && ]	Logical AND (12)
XOR	Logical exclusive OR (13)
OR [    ]	Logical OR (14)

**CONDITIONAL OPERATOR**

Precedence: 15

? :	Conditional operator
-----	----------------------

---

**Description of assembler operators**

This section gives detailed descriptions of each assembler operator.  
See also *Expressions, operands, and operators*, page 24.

**() Parenthesis**

Precedence	1
Description	( and ) group expressions to be evaluated separately, overriding the default precedence order.
Example	1+2*3 -> 7 (1+2)*3 -> 9



**\* Multiplication**

Precedence	4
Description	* produces the product of its two operands. The operands are taken as signed 32-bit integers, and the result is also a signed 32-bit integer.
Example	$2 * 2 \rightarrow 4$ $-2 * 2 \rightarrow -4$

**+ Unary plus**

Precedence	3
Description	Unary plus operator; performs nothing.
Example	$+3 \rightarrow 3$ $3 * +2 \rightarrow 6$

**+ Addition**

Precedence	5
Description	The + addition operator produces the sum of the two operands which surround it. The operands are taken as signed 32-bit integers, and the result is also a signed 32-bit integer.
Example	$92 + 19 \rightarrow 111$ $-2 + 2 \rightarrow 0$ $-2 + -2 \rightarrow -4$

**- Unary minus**

Precedence	3
Description	<p>The unary minus operator performs arithmetic negation on its operand.</p> <p>The operand is interpreted as a 32-bit signed integer, and the result of the operator is the two's complement negation of that integer.</p>
Example	$-3 \rightarrow -3$ $3 * -2 \rightarrow -6$ $4 -- 5 \rightarrow 9$

## – Subtraction

Precedence	5
Description	The subtraction operator produces the difference when the right operand is taken away from the left operand. The operands are taken as signed 32-bit integers, and the result is also signed 32-bit integer.
Example	<pre>92-19 -&gt; 73 -2-2 -&gt; -4 -2--2 -&gt; 0</pre>

## / Division

Precedence	4
Description	/ produces the integer quotient of the left operand divided by the right operator. The operands are taken as signed 32-bit integers, and the result is also a signed 32-bit integer.
Example	<pre>9/2 -&gt; 4 -12/3 -&gt; -4 9/2*6 -&gt; 24</pre>

## ? : Conditional operator

Syntax	<i>condition ? expr : expr</i>
Precedence	15
Description	<p>? results in the first <i>expr</i> if <i>condition</i> evaluates to true, and the second <i>expr</i> if <i>condition</i> evaluates to false.</p> <p><b>Note:</b> The question mark and a following label must be separated by space or a tab, otherwise the ? is considered the first character of the label.</p>
Example	<pre>5 ? 6 : 7 -&gt;6 0 ? 6 : 7 -&gt;7</pre>

**< Less than**

Precedence	7
Description	< or <code>LT</code> evaluates to 1 (true) if the left operand has a numeric value that is less than the right operand, otherwise it is 0 (false).
Example	<pre>-1 &lt; 2 -&gt; 1 2 &lt; 1 -&gt; 0 2 &lt; 2 -&gt; 0</pre>

**<= Less than or equal to**

Precedence	7
Description	<= or <code>LE</code> evaluates to 1 (true) if the left operand has a numeric value that is less than or equal to the right operand, otherwise it is 0 (false).
Example	<pre>1 &lt;= 2 -&gt; 1 2 &lt;= 1 -&gt; 0 1 &lt;= 1 -&gt; 1</pre>

**<>, != Not equal to**

Precedence	8
Description	<>, !=, or <code>NE</code> evaluates to 0 (false) if its two operands are identical in value or to 1 (true) if its two operands are not identical in value.
Example	<pre>1 &lt;&gt; 2 -&gt; 1 2 &lt;&gt; 2 -&gt; 0 'A' &lt;&gt; 'B' -&gt; 1</pre>

**=, == Equal to**

Precedence	8
Description	=, ==, or <code>EQ</code> evaluates to 1 (true) if its two operands are identical in value, or to 0 (false) if its two operands are not identical in value.

Example	<pre>1 = 2 -&gt; 0 2 == 2 -&gt; 1 'ABC' = 'ABCD' -&gt; 0</pre>
---------	--

## > Greater than

Precedence	7
Description	> or GT evaluates to 1 (true) if the left operand has a higher numeric value than the right operand, otherwise it is 0 (false).
Example	<pre>-1 &gt; 1 -&gt; 0 2 &gt; 1 -&gt; 1 1 &gt; 1 -&gt; 0</pre>

## >= Greater than or equal to

Precedence	7
Description	>= or GE evaluates to 1 (true) if the left operand is equal to or has a greater numeric value than the right operand, otherwise it is 0 (false).
Example	<pre>1 &gt;= 2 -&gt; 0 2 &gt;= 1 -&gt; 1 1 &gt;= 1 -&gt; 1</pre>

## && Logical AND

Precedence	12
Description	&& or AND performs logical AND between its two integer operands. If both operands are non-zero the result is 1 (true), otherwise it is 0 (false).
Example	<pre>1010B &amp;&amp; 0011B -&gt; 1 1010B &amp;&amp; 0101B -&gt; 1 1010B &amp;&amp; 0000B -&gt; 0</pre>

## & Bitwise AND

Precedence	9
Description	& or BINAND performs bitwise AND between the integer operands. Each bit in the 32-bit result is the logical AND of the corresponding bits in the operands.
Example	<pre> 1010B &amp; 0011B -&gt; 0010B 1010B &amp; 0101B -&gt; 0000B 1010B &amp; 0000B -&gt; 0000B </pre>

**~ Bitwise NOT**

[illegible]

## | Bitwise OR

Precedence	11
Description	or BINOR performs bitwise OR on its operands. Each bit in the 32-bit result is the inclusive OR of the corresponding bits in the operands.
Example	<pre> 1010B   0101B -&gt; 1111B 1010B   0000B -&gt; 1010B </pre>

**^ Bitwise exclusive OR**

Precedence	10
Description	$\wedge$ or BINXOR performs bitwise XOR on its operands. Each bit in the 32-bit result is the exclusive OR of the corresponding bits in the operands.
Example	<pre> 1010B ^ 0101B -&gt; 1111B 1010B ^ 0011B -&gt; 1001B </pre>

**% Modulo**

Precedence	4
Description	% or MOD produces the remainder from the integer division of the left operand by the right operand. The operands are taken as signed 32-bit integers, and the result is also a signed 32-bit integer.  X % Y is equivalent to X-Y* (X/Y) using integer division.
Example	2 % 2 -> 0 12 % 7 -> 5 3 % 2 -> 1

**! Logical NOT**

Precedence	3
Description	! or NOT negates a logical argument.
Example	! 0101B -> 0 ! 0000B -> 1

**|| Logical OR**

Precedence	14
Description	or OR performs a logical OR between two integer operands.
Example	1010B    0000B -> 1 0000B    0000B -> 0

**<< Logical shift left**

Precedence	6
Description	<< or SHL shifts the left operand, which is always treated as unsigned, to the left. The number of bits to shift is specified by the right operand, interpreted as an integer value between 0 and 32.

Example	<pre>00011100B &lt;&lt; 3 -&gt; 11100000B 0000011111111111B &lt;&lt; 5 -&gt; 1111111111100000B 14 &lt;&lt; 1 -&gt; 28</pre>
---------	---

## >> Logical shift right

Precedence	6
Description	>> or SHR shifts the left operand, which is always treated as <code>unsigned</code> , to the right. The number of bits to shift is specified by the right operand, interpreted as an integer value between 0 and 32.
Example	<pre>01110000B &gt;&gt; 3 -&gt; 00001110B 1111111111111111B &gt;&gt; 20 -&gt; 0 14 &gt;&gt; 1 -&gt; 7</pre>

## BYTE1 First byte

Precedence	2
Description	BYTE1 takes a single operand, which is interpreted as an unsigned 32-bit integer value. The result is the unsigned, 8-bit integer value of the lower order byte of the operand.
Example	<pre>BYTE1 0xABCD -&gt; 0xCD</pre>

## BYTE2 Second byte

Precedence	2
Description	BYTE2 takes a single operand, which is interpreted as an unsigned 32-bit integer value. The result is the middle-low byte (bits 15 to 8) of the operand.
Example	<pre>BYTE2 0x12345678 -&gt; 0x56</pre>

**BYTE3 Third byte**

Precedence	2
Description	BYTE3 takes a single operand, which is interpreted as an unsigned 32-bit integer value. The result is the middle-high byte (bits 23 to 16) of the operand.
Example	BYTE3 0x12345678 -> 0x34

**BYTE4 Fourth byte**

Precedence	2
Description	BYTE4 takes a single operand, which is interpreted as an unsigned 32-bit integer value. The result is the high byte (bits 31 to 24) of the operand.
Example	BYTE4 0x12345678 -> 0x12

**DATE Current time/date**

Precedence	2												
Description	<p>DATE gets the time when the current assembly began.</p> <p>The DATE operator takes an absolute argument (expression) and returns:</p> <table><tr><td>DATE 1</td><td>Current second (0–59).</td></tr><tr><td>DATE 2</td><td>Current minute (0–59).</td></tr><tr><td>DATE 3</td><td>Current hour (0–23).</td></tr><tr><td>DATE 4</td><td>Current day (1–31).</td></tr><tr><td>DATE 5</td><td>Current month (1–12).</td></tr><tr><td>DATE 6</td><td>Current year MOD 100 (1998 -&gt;98, 2000 -&gt;00, 2002 -&gt;02).</td></tr></table>	DATE 1	Current second (0–59).	DATE 2	Current minute (0–59).	DATE 3	Current hour (0–23).	DATE 4	Current day (1–31).	DATE 5	Current month (1–12).	DATE 6	Current year MOD 100 (1998 ->98, 2000 ->00, 2002 ->02).
DATE 1	Current second (0–59).												
DATE 2	Current minute (0–59).												
DATE 3	Current hour (0–23).												
DATE 4	Current day (1–31).												
DATE 5	Current month (1–12).												
DATE 6	Current year MOD 100 (1998 ->98, 2000 ->00, 2002 ->02).												
Example	<p>To specify the date of assembly:</p> <p>today: DC8 DATE 5, DATE 4, DATE 3</p>												



## HIGH High byte

Precedence	2
Description	<code>HIGH</code> takes a single operand to its right which is interpreted as an unsigned, 16-bit integer value. The result is the unsigned 8-bit integer value of the higher order byte of the operand.
Example	<code>HIGH 0xABCD -&gt; 0xAB</code>

## HWRD High word

Precedence	2
Description	<code>HWRD</code> takes a single operand, which is interpreted as an unsigned, 32-bit integer value. The result is the high word (bits 31 to 16) of the operand.
Example	<code>HWRD 0x12345678 -&gt; 0x1234</code>

## LOW Low byte

Precedence	2
Description	<code>LOW</code> takes a single operand, which is interpreted as an unsigned, 32-bit integer value. The result is the unsigned, 8-bit integer value of the lower order byte of the operand.
Example	<code>LOW 0xABCD -&gt; 0xCD</code>

## LWRD Low word

Precedence	2
Description	<code>LWRD</code> takes a single operand, which is interpreted as an unsigned, 32-bit integer value. The result is the low word (bits 15 to 0) of the operand.
Example	<code>LWRD 0x12345678 -&gt; 0x5678</code>

SFB section begin

Syntax	<i>SFB</i> ( <i>section</i> [{+ -} <i>offset</i> ])	
Precedence	2	
Parameters	<i>section</i>	The name of a section, which must be defined before <i>SFB</i> is used.
	<i>offset</i>	An optional offset from the start address. The parentheses are optional if <i>offset</i> is omitted.

Description *SFB* accepts a single operand to its right. The operator evaluates to the absolute address of the first byte of that section. This evaluation occurs at linking time.

Example	<pre>name      sectionBegin section MYCODE:CODE    ; Forward declaration of MYCODE section SEGTAB:CONST(2) data32      ; Disassembled as 32-bit data start      dc32      sfb(MYCODE) end</pre>	
	Even if this code is linked with many other modules, <code>start</code> is still set to the address of the first byte of the section.	

SFE section end

Syntax	<i>SFE</i> ( <i>section</i> [{+ -} <i>offset</i> ])	
Precedence	2	
Parameters	<i>section</i>	The name of a section, which must be defined before <i>SFE</i> is used.
	<i>offset</i>	An optional offset from the start address. The parentheses are optional if <i>offset</i> is omitted.

Description *SFE* accepts a single operand to its right. The operator evaluates to the address of the first byte after the section end. This evaluation occurs at linking time.

Example

```
name      sectionEnd
section MYCODE:CODE    ; Forward declaration of MYCODE
section SEGTAB:CONST
data32          ; Disassembled as 32-bit data
endmycode dc32      sfe(MYCODE)
end
```

Even if this code is linked with many other modules, `end` is still set to the first byte after the section `MYCODE`.

The size of the section `MYCODE` can be achieved by using the `SIZEOF` operator.

SIZEOF section size

Syntax

```
SIZEOF section
```

Precedence

2

Parameters

```
section          The name of a relocatable section, which must be defined
                  before SIZEOF is used.
```

Description

`SIZEOF` generates `SFE-SFB` for its argument. That is, it calculates the size in bytes of a section. This is done when modules are linked together.

Example

These two files set `size` to the size of the section `MYCODE`.

Table.s:

```
name      table
section MYCODE:CODE    ; Forward declaration of MYCODE
section SEGTAB:CONST
data32          ; Disassembled as 32-bit data
size      dc32      sizeof(MYCODE)
end
```

Application.s:

```
name      application
section MYCODE:CODE
code          ; Disassembled as code
nop          ; Placeholder for application
end
```

## UGT Unsigned greater than

Precedence	7
Description	UGT evaluates to 1 (true) if the left operand has a larger value than the right operand, otherwise it is 0 (false). The operation treats the operands as unsigned values.
Example	<pre>2 UGT 1 -&gt; 1 -1 UGT 1 -&gt; 1</pre>

## ULT Unsigned less than

Precedence	7
Description	ULT evaluates to 1 (true) if the left operand has a smaller value than the right operand, otherwise it is 0 (false). The operation treats the operands as unsigned values.
Example	<pre>1 ULT 2 -&gt; 1 -1 ULT 2 -&gt; 0</pre>

## UPPER Third byte

Precedence	2
Description	UPPER takes a single operand, which is interpreted as an unsigned 32-bit integer value. The result is the middle-high byte (bits 23 to 16) of the operand.
Example	UPPER 0x12345678 -> 0x34

## XOR Logical exclusive OR

Precedence	13
Description	XOR evaluates to 1 (true) if either the left operand or the right operand is non-zero, but to 0 (false) if both operands are zero or both are non-zero. Use XOR to perform logical XOR on its two operands.
Example	<pre>0101B XOR 1010B -&gt; 0 0101B XOR 0000B -&gt; 1</pre>

# Assembler directives

This chapter gives a summary of the assembler directives and provides detailed reference information for each category of directives.

---

## Summary of assembler directives

The assembler directives are classified into these groups according to their function:

- *Module control directives*, page 89
- *Symbol control directives*, page 91
- *Mode control directives*, page 93
- *Section control directives*, page 94
- *Value assignment directives*, page 98
- *Conditional assembly directives*, page 100
- *Macro processing directives*, page 101
- *Listing control directives*, page 109
- *C-style preprocessor directives*, page 113
- *Data definition or allocation directives*, page 118
- *Assembler control directives*, page 120
- *Function directives*, page 123
- *Call frame information directives for names blocks*, page 123.
- *Call frame information directives for common blocks*, page 124
- *Call frame information directives for data blocks*, page 126
- *Call frame information directives for tracking resources and CFAs*, page 127
- *Call frame information directives for stack usage analysis*, page 129

This table gives a summary of all the assembler directives:

Directive	Description	Section
#define	Assigns a value to a label.	C-style preprocessor
#elif	Introduces a new condition in an #if...#endif block.	C-style preprocessor
#else	Assembles instructions if a condition is false.	C-style preprocessor
#endif	Ends an #if, #ifdef, or #ifndef block.	C-style preprocessor

Table 13: Assembler directives summary

Directive	Description	Section
<code>#error</code>	Generates an error.	C-style preprocessor
<code>#if</code>	Assembles instructions if a condition is true.	C-style preprocessor
<code>#ifdef</code>	Assembles instructions if a symbol is defined.	C-style preprocessor
<code>#ifndef</code>	Assembles instructions if a symbol is undefined.	C-style preprocessor
<code>#include</code>	Includes a file.	C-style preprocessor
<code>#line</code>	Changes the line numbers.	C-style preprocessor
<code>#pragma</code>	Controls extension features.	C-style preprocessor
<code>#undef</code>	Undefines a label.	C-style preprocessor
<code>_args</code>	Is set to number of arguments passed to macro.	Macro processing
<code>/*comment*/</code>	C-style comment delimiter.	Assembler control
<code>//</code>	C++ style comment delimiter.	Assembler control
<code>=</code>	Assigns a permanent value local to a module.	Value assignment
<code>_args</code>	Is set to number of arguments passed to macro.	Macro processing
<code>ALIGN</code>	Aligns the program location counter by inserting zero-filled bytes.	Section control
<code>ALIGNRAM</code>	Aligns the program location counter.	Section control
<code>ASEGN</code>	Begins a named absolute segment.	Segment control
<code>ASSIGN</code>	Assigns a temporary value.	Value assignment
<code>CALL_GRAPH_ROOT</code>	Specifies that a function is a call graph root.	Function
<code>CASEOFF</code>	Disables case sensitivity.	Assembler control
<code>CASEON</code>	Enables case sensitivity.	Assembler control
<code>CFI</code>	Specifies call frame information.	Call frame information
<code>CODE</code>	Subsequent instructions are assembled, linked, and disassembled as code.	Mode control
<code>DATA</code>	Subsequent instructions are assembled, linked, and disassembled as 8-bit data.	Mode control
<code>DATA8</code>	Subsequent instructions are assembled, linked, and disassembled as 8-bit data.	Mode control
<code>DATA16</code>	Subsequent instructions are assembled, linked, and disassembled as 16-bit data.	Mode control

Table 13: Assembler directives summary (Continued)

Directive	Description	Section
DATA32	Subsequent instructions are assembled, linked, and disassembled as 32-bit data.	Mode control
DATA64	Subsequent instructions are assembled, linked, and disassembled as 64-bit data.	Mode control
DC8	Generates 8-bit constants, including strings.	Data definition or allocation
DC16	Generates 16-bit constants.	Data definition or allocation
DC24	Generates 24-bit constants.	Data definition or allocation
DC32	Generates 32-bit constants.	Data definition or allocation
DC64	Generates 64-bit constants.	Data definition or allocation
DEFINE	Defines a file-wide value.	Value assignment
DF32	Generates 32-bit floating-point constants.	Data definition or allocation
DF64	Generates 64-bit floating-point constants.	Data definition or allocation
DQ15	Generates 16-bit fractional constants.	Data definition or allocation
DQ31	Generates 32-bit fractional constants.	Data definition or allocation
DS8	Allocates space for 8-bit integers.	Data definition or allocation
DS16	Allocates space for 16-bit integers.	Data definition or allocation
DS24	Allocates space for 24-bit integers.	Data definition or allocation
DS32	Allocates space for 32-bit integers.	Data definition or allocation
DS64	Allocates space for 64-bit integers.	Data definition or allocation
ELSE	Assembles instructions if a condition is false.	Conditional assembly

Table 13: Assembler directives summary (Continued)

Directive	Description	Section
ELSEIF	Specifies a new condition in an IF...ENDIF block.	Conditional assembly
END	Ends the assembly of the last module in a file.	Module control
ENDIF	Ends an IF block.	Conditional assembly
ENDM	Ends a macro definition.	Macro processing
ENDR	Ends a repeat structure.	Macro processing
EQU	Assigns a permanent value local to a module.	Value assignment
ERROR	Generates an error.	Assembler control
EVEN	Aligns the program counter to an even address.	Section control
EXITM	Exits prematurely from a macro.	Macro processing
EXTERN	Imports an external symbol.	Symbol control
EXTWEAK	Imports an external symbol (which can be undefined).	Symbol control
IF	Assembles instructions if a condition is true.	Conditional assembly
IMPORT	Imports an external symbol.	Symbol control
LIBRARY	Retained for backward compatibility reasons. Recognized but ignored.	Module control
LOCAL	Creates symbols local to a macro.	Macro processing
LSTCND	Controls conditional assembler listing.	Listing control
LSTCOD	Controls multi-line code listing.	Listing control
LSTEXP	Controls the listing of macro generated lines.	Listing control
LSTMAC	Controls the listing of macro definitions.	Listing control
LSTOUT	Controls assembler-listing output.	Listing control
LSTPAG	Retained for backward compatibility reasons; recognized but ignored.	Listing control
LSTREP	Controls the listing of lines generated by repeat directives.	Listing control
LSTXRF	Generates a cross-reference table.	Listing control
MACRO	Defines a macro.	Macro processing

Table 13: Assembler directives summary (Continued)



Directive	Description	Section
MODULE	Retained for backward compatibility reasons. Recognized but ignored.	Module control
NAME	Retained for backward compatibility reasons. Recognized but ignored.	Module control
ODD	Aligns the program location counter to an odd address.	Section control
OVERLAY	Recognized but ignored.	Symbol control
PROGRAM	Retained for backward compatibility reasons. Recognized but ignored.	Module control
PUBLIC	Exports symbols to other modules.	Symbol control
PUBWEAK	Exports symbols to other modules, multiple definitions allowed.	Symbol control
RADIX	Sets the default base.	Assembler control
REPT	Assembles instructions a specified number of times.	Macro processing
REPTC	Repeats and substitutes characters.	Macro processing
REPTI	Repeats and substitutes strings.	Macro processing
REQUIRE	Forces a symbol to be referenced.	Symbol control
RSEG	Begins a section.	Section control
RTMODEL	Declares runtime model attributes.	Module control
SECTION	Begins a section.	Section control
SECTION_TYPE	Sets ELF type and flags for a section.	Section control
SET	Assigns a temporary value.	Value assignment
VAR	Assigns a temporary value.	Value assignment

Table 13: Assembler directives summary (Continued)

## Description of assembler directives

The following pages give reference information about the assembler directives.

### Module control directives

Syntax

END

RTMODEL *key*, *value*

Parameters

<i>key</i>	A text string specifying the key.
<i>value</i>	A text string specifying the value.

Description

Module control directives are used for marking the end of source program modules, and for enforcing consistency between them. For information about the restrictions that apply when using a directive in an expression, see *Expression restrictions*, page 31.

Directive	Description	Expression restrictions
END	Ends the assembly of the last module in a file.	Only locally defined labels or integer constants
RTMODEL	Declares runtime model attributes.	Not applicable

Table 14: Module control directives

Terminating the source file

Use `END` to indicate the end of the source file. Any lines after the `END` directive are ignored. The `END` directive also ends the module in the file.

Declaring runtime model attributes

Use `RTMODEL` to enforce consistency between modules. All modules that are linked together and define the same runtime attribute key must have the same value for the corresponding key value, or the special value `*`. Using the special value `*` is equivalent to not defining the attribute at all. It can however be useful to explicitly state that the module can handle any runtime model.

A module can have several runtime model definitions.

**Note:** The compiler runtime model attributes start with double underscores. In order to avoid confusion, this style must not be used in the user-defined assembler attributes.

If you are writing assembler routines for use with C or C++ code, and you want to control the module consistency, refer to the *IAR C/C++ Development Guide for RX*.

The following examples defines three modules in one source file each, where:

- `MOD_1` and `MOD_2` cannot be linked together since they have different values for runtime model `CAN`.
- `MOD_1` and `MOD_3` can be linked together since they have the same definition of runtime model `RTOS` and no conflict in the definition of `CAN`.
- `MOD_2` and `MOD_3` can be linked together since they have no runtime model conflicts. The value `*` matches any runtime model value.

Assembler source file `f1.s`:

```
module mod_1
rtmodel "CAN", "ISO11519"
rtmodel "Platform", "M7"
; ...
end
```

Assembler source file `f2.s`:

```
module mod_2
rtmodel "CAN", "ISO11898"
rtmodel "Platform", "*"
; ...
end
```

Assembler source file `f3.s`:

```
module mod_3
rtmodel "Platform", "M7"
; ...
end
```

## Symbol control directives

### Syntax

```
EXTERN symbol [,symbol] ...
EXTWEAK symbol [,symbol] ...
IMPORT symbol [,symbol] ...
PUBLIC symbol [,symbol] ...
PUBWEAK symbol [,symbol] ...
REQUIRE symbol
```

### Parameters

<i>label</i>	Label to be used as an alias for a C/C++ symbol.
<i>symbol</i>	Symbol to be imported or exported.

Description

These directives control how symbols are shared between modules:

Directive	Description
EXTERN, IMPORT	Imports an external symbol.
EXTWEAK	Imports an external symbol. The symbol can be undefined.
OVERLAY	Recognized but ignored.
PUBLIC	Exports symbols to other modules.
PUBWEAK	Exports symbols to other modules, multiple definitions allowed.
REQUIRE	Forces a symbol to be referenced.

Table 15: Symbol control directives

Exporting symbols to other modules

Use `PUBLIC` to make one or more symbols available to other modules. Symbols defined `PUBLIC` can be relocatable or absolute, and can also be used in expressions (with the same rules as for other symbols).

The `PUBLIC` directive always exports full 32-bit values, which makes it feasible to use global 32-bit constants also in assemblers for 8-bit and 16-bit processors. With the `LOW`, `HIGH`, `>>`, and `<<` operators, any part of such a constant can be loaded in an 8-bit or 16-bit register or word.

There can be any number of `PUBLIC`-defined symbols in a module.

Exporting symbols with multiple definitions to other modules

`PUBWEAK` is similar to `PUBLIC` except that it allows the same symbol to be defined in more than one module. Only one of those definitions is used by `ILINK`. If a module containing a `PUBLIC` definition of a symbol is linked with one or more modules containing `PUBWEAK` definitions of the same symbol, `ILINK` uses the `PUBLIC` definition.

Note: Library modules are only linked if a reference to a symbol in that module is made, and that symbol was not already linked. During the module selection phase, no distinction is made between `PUBLIC` and `PUBWEAK` definitions. This means that to ensure that the module containing the `PUBLIC` definition is selected, you should link it before the other modules, or make sure that a reference is made to some other `PUBLIC` symbol in that module.

Importing symbols

Use `EXTERN` or `IMPORT` to import an untyped external symbol.

The `REQUIRE` directive marks a symbol as referenced. This is useful if the section containing the symbol must be loaded even if the code is not referenced.

**Example**

The following example defines a subroutine to print an error message, and exports the entry address `err` so that it can be called from other modules.

Because the message is enclosed in double quotes, the string will be followed by a zero byte.

It defines `print` as an external routine; the address is resolved at link time.

```

                                name    errorMessage
                                extern  print
                                public  err
                                section CODE:CODE
                                code
err:                             bra    print
                                data8
                                dc8     "*** Error *"
                                code
                                rts
                                end

```

**Mode control directives****Syntax**

```

CODE
DATA
DATA8
DATA16
DATA32
DATA64

```

**Description**

These directives provide control over the assembly mode:

Directive	Description
CODE	Subsequent instructions are assembled, linked, and disassembled as code.
DATA, DATA8	Subsequent instructions are assembled, linked, and disassembled as 8-bit data.
DATA16	Subsequent instructions are assembled, linked, and disassembled as 16-bit data.
DATA32	Subsequent instructions are assembled, linked, and disassembled as 32-bit data.
DATA64	Subsequent instructions are assembled, linked, and disassembled as 64-bit data.

*Table 16: Mode control directives*

The `CODE` and `DATA` directives set the assembly mode for code and data sections. This information is used by C-SPY and IAR ELF Dumper.

**Note:** The `CODE` or `DATA` directives are required for big-endian applications, but they improve the disassembly for all applications.

The `CODE` or `DATA` directives can be used for:

- Starting a code/data producing a section fragment (`RSEGSECTION`) that actually generates bytes that end up in the image, either code or data
- Changing the assembly mode in the middle of a section fragment.

The directive should come after the section fragment start (for example after the `RSEGSECTION` directive) and immediately precede any code-generating part (instructions or DC declarations).

You do not need the `CODE` or `DATA` directives for declaring sections, extern labels etc, and not when you declare RAM space.

In big-endian mode, the two least significant address bits are inverted on the RX microcontroller. This means that the chip operates on four-byte chunks. If you change the byte order, as you do when you switch between the code and data assembly modes, you must make sure that each segment part begins on a 4-byte aligned address when you toggle the assembly mode between code and data, or linking will fail with an alignment error.

Example

In this example, the disassembly mode changes several times to accommodate different types of data:

```

                                name      codedata
                                extern    printStr
                                public    printDate
                                section    __DEFAULT_CODE_SECTION__:CODE

                                code                ; Disassembled as code
printDate: mov.l      #a_date,R1                ; Load address of date
                                                ; string in R0.
                                bsr         printStr    ; Call string output routine.
                                rts
                                data8                ; Disassembled as 8-bit data.
a_date:      dc8      __DATE__                ; String representing the
                                                ; date of assembly.
                                end
```

Section control directives

Syntax

```
ALIGN align [,value]
ALIGNRAM align
```

```

EVEN [value]
ODD [value]
RSEG section :type [:flag] [(align)]
SECTION section :type [:flag] [(align)]
SECTION_TYPE type-expr {, flags-expr}

```

## Parameters

<i>address</i>	Address where this section part is placed.
<i>align</i>	The power of two to which the address should be aligned. The default align value is 0, except for code sections where the default is 1.
<i>flag</i>	<p>ROOT, NOROOT</p> <p>ROOT (the default mode) indicates that the section fragment must not be discarded.</p> <p>NOROOT means that the section fragment is discarded by the linker if no symbols in this section fragment are referred to. Normally, all section fragments except startup code and interrupt vectors should set this flag.</p> <p>REORDER, NOREORDER</p> <p>NOREORDER (the default mode) starts a new fragment in the section with the given name, or a new section if no such section exists.</p> <p>REORDER starts a new section with the given name.</p>
<i>section</i>	The name of the section. The section name is a user-defined symbol that follows the rules described in <i>Symbols</i> , page 26.
<i>type</i>	The memory type, which can be either CODE, CONST, or DATA.
<i>value</i>	Byte value used for padding, default is zero.
<i>type-expr</i>	A constant expression identifying the ELF type of the section.
<i>flags-expr</i>	A constant expression identifying the ELF flags of the section.

**Description** The section directives control how code and data are located. For information about the restrictions that apply when using a directive in an expression, see *Expression restrictions*, page 31.

Directive	Description	Expression restrictions
ALIGN	Aligns the program location counter by inserting zero-filled bytes.	No external references Absolute
ALIGNRAM	Aligns the program location counter.	No external references Absolute
ASEGN	Begins a named absolute section.	No external references Absolute
EVEN	Aligns the program counter to an even address.	No external references Absolute
ODD	Aligns the program counter to an odd address.	No external references Absolute
RSEG	Begins an ELF section; alias to SECTION.	No external references Absolute
SECTION	Begins an ELF section.	No external references Absolute
SECTION_TYPE	Sets ELF type and flags for a section.	

Table 17: Section control directives

**Beginning a named absolute section**

Use ASEG<sub>N</sub> to start a named absolute section located at the address *address*.

This directive has the advantage of allowing you to specify the memory type of the section.

**Beginning a relocatable section**

Use SECTION (or RSEG) to start a new section. The assembler maintains separate location counters (initially set to zero) for all sections, which makes it possible to switch sections and mode anytime without having to save the current program location counter.

**Note:** The first instance of a SECTION or RSEG directive must not be preceded by any code generating directives, such as DC8 or DS8, or by any assembler instructions.

To set the ELF type, and possibly the ELF flags for the newly created section, use SECTION\_TYPE. By default, the values of the flags are zero. For information about valid values, refer to the ELF documentation.

In the following example, the data following the first SECTION directive is placed in a section called TABLE.



The code following the second `SECTION` directive is placed in a relocatable section called `CODE`:

```

                                module  calculate
                                extern  operator
                                extern  addOperator, subOperator

                                section TABLE:CONST(8)
                                data8
operatorTable:
                                dc8      addOperator, subOperator

                                section CODE:CODE
                                code
calculate  mov.l  #operator,r1
                                mov.l  [R1],R1
                                mov.l  #operatorTable,R2
                                cmp     [R2].ub,R1
                                beq     add
                                add     #1,R2
                                cmp     [R2].ub,R1
                                beq     sub
                                ;...
                                rts

                                add     ;...
                                rts
                                nop
                                sub     ;...
                                rts
                                nop

                                end

```

### Aligning a section

Use `ALIGN` to align the program location counter to a specified address boundary. You do this by specifying an expression for the power of two to which the program counter should be aligned. That is, a value of 1 aligns to an even address and a value of 2 aligns to an address evenly divisible by 4.

The alignment is made relative to the section start; normally this means that the section alignment must be at least as large as that of the alignment directive to give the desired result.

ALIGN aligns by inserting zero/filled bytes, up to a maximum of 255. The EVEN directive aligns the program counter to an even address (which is equivalent to ALIGN 1) and the ODD directive aligns the program location counter to an odd address. The value used for padding bytes must be within the range 0 to 255.

Use ALIGNRAM to align the program location counter by incrementing it; no data is generated. The parameter align can be within the range 0 to 30.

This example starts a section, moves to an even address, and adds some data. It then aligns to a 64-byte boundary before creating a 64-byte table.

```

                                name      alignment
                                section DATA:DATA ; Start a relocatable data section.
                                data16      ; Disassembled as 16-bit data
                                even        ; Ensure it is on an even boundary.
target    dc16      1      ; target and best will be on an
best      dc16      1      ; even boundary.
                                data8      ; Disassembled as 8-bit data
                                align      6      ; Now, align to a 64-byte boundary,
results   ds8        64    ; and create a 64-byte table.
                                end
```

Value assignment directives

Syntax

```
label = expr
label ASSIGN expr
label DEFINE const_expr
label EQU expr
label SET expr
label VAR expr
```

Parameters

const_expr	Constant value assigned to symbol.
expr	Value assigned to symbol or value to be tested.
label	Symbol to be defined.

Description

These directives are used for assigning values to symbols:

Directive	Description
=, EQU	Assigns a permanent value local to a module.

Table 18: Value assignment directives

Directive	Description
ASSIGN, SET, VAR	Assigns a temporary value.
DEFINE	Defines a file-wide value.

Table 18: Value assignment directives (Continued)

### Defining a temporary value

Use `ASSIGN`, `SET`, or `VAR` to define a symbol that might be redefined, such as for use with macro variables. Symbols defined with `ASSIGN`, `SET`, or `VAR` cannot be declared `PUBLIC`.

This example uses `SET` to redefine the symbol `cons` in a loop to generate a table of the first 8 powers of 3:

```

                                name    table
cons                          set      1

; Generate table of powers of 3.
cr_tabl    macro    times
            dc32    cons
cons       set      cons * 3
            if      times > 1
            cr_tabl times - 1
            endif
            endm

                                section .text:CODE(2)
table      cr_tabl 4
            end

```

### Defining a permanent local value

Use `EQU` or `=` to create a local symbol that denotes a number or offset. The symbol is only valid in the module in which it was defined, but can be made available to other modules with a `PUBLIC` directive (but not with a `PUBWEAK` directive).

Use `EXTERN` to import symbols from other modules.

### Defining a permanent global value

Use `DEFINE` to define symbols that should be known to the module containing the directive. After the `DEFINE` directive, the symbol is known.

A symbol which was given a value with `DEFINE` can be made available to modules in other files with the `PUBLIC` directive.

Symbols defined with `DEFINE` cannot be redefined within the same file. Also, the expression assigned to the defined symbol must be constant.

Conditional assembly directives

Syntax	<div>ELSE</div> <div>ELSEIF <i>condition</i></div> <div>ENDIF</div> <div>IF <i>condition</i></div>		
Parameters	<i>condition</i>	One of these:	
	An absolute expression	The expression must not contain forward or external references, and any non-zero value is considered as true.	
	<i>string1</i> == <i>string2</i>	The condition is true if <i>string1</i> and <i>string2</i> have the same length and contents.	
	<i>string1</i> != <i>string2</i>	The condition is true if <i>string1</i> and <i>string2</i> have different length or contents.	
Description	<p>Use the IF, ELSE, ELSEIF, and ENDIF directives to control the assembly process at assembly time. If the condition following the IF directive is not true, the subsequent instructions do not generate any code (that is, it is not assembled or syntax checked) until an ELSEIF condition is true or ELSE or ENDIF directive is found.</p> <p>Use ELSEIF to introduce a new condition after an IF directive. Conditional assembly directives can be used anywhere in an assembly, but have their greatest use in conjunction with macro processing.</p> <p>All assembler directives (except for END) as well as the inclusion of files can be disabled by the conditional directives. Each IF directive must be terminated by an ENDIF directive. The ELSE and ELSEIF directives are optional, and if used, they must be inside an IF . . .ENDIF block. IF . . .ENDIF and IF . . .ELSE . . .ENDIF blocks can be nested to any level.</p>		

**Example**

This example uses a macro to add a constant to a direct page memory location:

```
addMem      macro    loc,val                ; loc is a direct page memory
                                                ; location, and val is an
                                                ; 32-bit value to add to that
                                                ; location.

            if      val = 0                    ; Do nothing.

            elseif  val < 16

            mov.l   #loc,R1
            mov.l   [R1],R2
            add     #val,R2
            mov.l   R2,[R1]
            else

            mov.l   #loc,R1
            mov.l   [R1],R2
            add     #val,R2,R2
            mov.l   R2,[R1]
            endif
            endm

            module  addWithMacro
            section CODE:CODE
            code
addSome      addMem 0xa0,0                    ; Add 0 to memory loc. 0xa0
            addMem 0xa0,1                    ; Add 1 to the same address
            addMem 0xa0,2                    ; Add 2 to the same address
            addMem 0xa0,3                    ; Add 3 to the same address
            addMem 0xa0,47                   ; Add 47 to the same address
            rts
            end
```

**Macro processing directives****Syntax**

```
_args
ENDM
ENDR
EXITM
LOCAL symbol [,symbol] ...
name MACRO [argument] [,argument] ...
REPT expr
```

```
REPTC formal,actual
REPTI formal,actual [,actual] ...
```

Parameters

<i>actual</i>	Strings to be substituted.
<i>argument</i>	Symbolic argument names.
<i>expr</i>	An expression.
<i>formal</i>	An argument into which each character of <i>actual</i> (REPTC) or each string of <i>actual</i> (REPTI) is substituted.
<i>name</i>	The name of the macro.
<i>symbol</i>	Symbols to be local to the macro.

Description

These directives allow user macros to be defined. For information about the restrictions that apply when using a directive in an expression, see *Expression restrictions*, page 31.

Directive	Description	Expression restrictions
<code>_args</code>	Is set to number of arguments passed to macro.	
<code>ENDM</code>	Ends a macro definition.	
<code>ENDR</code>	Ends a repeat structure.	
<code>EXITM</code>	Exits prematurely from a macro.	
<code>LOCAL</code>	Creates symbols local to a macro.	
<code>MACRO</code>	Defines a macro.	
<code>REPT</code>	Assembles instructions a specified number of times.	No forward references No external references Absolute Fixed
<code>REPTC</code>	Repeats and substitutes characters.	
<code>REPTI</code>	Repeats and substitutes text.	

Table 19: Macro processing directives

A macro is a user-defined symbol that represents a block of one or more assembler source lines. Once you have defined a macro, you can use it in your program like an assembler directive or assembler mnemonic.

When the assembler encounters a macro, it looks up the macro’s definition, and inserts the lines that the macro represents as if they were included in the source file at that position.

Macros perform simple text substitution effectively, and you can control what they substitute by supplying parameters to them.

The macro process consists of three distinct phases:

- 1 The assembler scans and saves macro definitions. The text between `MACRO` and `ENDM` is saved but not syntax checked.
- 2 A macro call forces the assembler to invoke the macro processor (expander). The macro expander switches (if not already in a macro) the assembler input stream from a source file to the output from the macro expander. The macro expander takes its input from the requested macro definition.

The macro expander has no knowledge of assembler symbols since it only deals with text substitutions at source level. Before a line from the called macro definition is handed over to the assembler, the expander scans the line for all occurrences of symbolic macro arguments, and replaces them with their expansion arguments.

- 3 The expanded line is then processed as any other assembler source line. The input stream to the assembler continues to be the output from the macro processor, until all lines of the current macro definition have been read.

## Defining a macro

You define a macro with the statement:

```
name MACRO [argument] [,argument] ...
```

Here *name* is the name you are going to use for the macro, and *argument* is an argument for values that you want to pass to the macro when it is expanded.

For example, you could define a macro `errMac` as follows:

```
errMac      name      errMacro
            macro      text
            extern     abort
            bsr        abort
            data8
            dc8        text,0
            endm
```

**Note:** This example only works in little-endian mode.

This macro uses a parameter `text` to set up an error message for a routine `abort`. You would call the macro with a statement such as:

```
errMac 'Disk not ready'
```

The assembler expands this to:

```
bsr    abort
data8
dc8    'Disk not ready',0
```

If you omit a list of one or more arguments, the arguments you supply when calling the macro are called \1 to \9 and \A to \Z.

The previous example could therefore be written as follows:

```
errMac      name    errMacro
             macro   text
             extern  abort
             bsr     abort
             data8
             dc8     \1,0
             endm
```

Use the `EXITM` directive to generate a premature exit from a macro.

`EXITM` is not allowed inside `REPT...ENDR`, `REPTC...ENDR`, or `REPTI...ENDR` blocks.

Use `LOCAL` to create symbols local to a macro. The `LOCAL` directive must be used before the symbol is used.

Each time that a macro is expanded, new instances of local symbols are created by the `LOCAL` directive. Therefore, it is legal to use local symbols in recursive macros.

**Note:** It is illegal to redefine a macro.

### Passing special characters

Macro arguments that include commas or white space can be forced to be interpreted as one argument by using the matching quote characters `<` and `>` in the macro call.

For example:

```
movMac      name    macroUser
             macro   op
             mov.l   op
             endm
```

The macro can be called using the macro quote characters:

```
movMac <0x19a0,R1>
```

You can redefine the macro quote characters with the `-M` command line option; see *-M*, page 58.



## Predefined macro symbols

The symbol `_args` is set to the number of arguments passed to the macro. This example shows how `_args` can be used:

```
fill      macro
            if      _args == 2
            rept     \2
            dc8      \1
            endr
            else
            dc8      \1
            endif
            endm

            module   filler
            section   .text:CODE(2)
            fill      3
            fill      4, 3
            end
```

It generates this code:

19		module	fill
20	000000	section	CODE:CODE
21	000000	data	
22	000000	fill	3
22.1	000000	if	_args == 2
22.2	000000	else	
22.3	000000 03	dc8	3
22.4	000001	endif	
23	000001	fill	4, 3
23.1	000001	if	_args == 2
23.2	000001	rept	3
23.3	000001 04	dc8	4
23.4	000002 04	dc8	4
23.5	000003 04	dc8	4
23.6	000004	endr	
23.7	000004	else	
23.8	000004	endif	
24	000004	end	

## Repeating statements

Use the `REPT...ENDR` structure to assemble the same block of instructions several times. If *expr* evaluates to 0 nothing is generated.

Use `REPTC` to assemble a block of instructions once for each character in a string. If the string contains a comma it should be enclosed in quotation marks.

Only double quotes have a special meaning and their only use is to enclose the characters to iterate over. Single quotes have no special meaning and are treated as any ordinary character.

Use REPTI to assemble a block of instructions once for each string in a series of strings. Strings containing commas should be enclosed in quotation marks.

This example assembles a series of calls to a subroutine plot to plot each character in a string:

```

                                name      reptc
                                section CODE:CODE
                                code
banner      reptc      chr, "Welcome"
            mov.l      #'chr',r1
            bsr        plotc
            endr
            rts
            end
```

This produces this code:

9			name	reptc
10	000000		extern	plotc
11	000000		section	CODE:CODE
12	000000		CODE	
13	000000	banner	reptc	chr, "Welcome"
13.1	000000 FB1657		mov.l	#'W',r1
13.2	000003 05000000		bsr	plotc
13.3	000007 FB1665		mov.l	#'e',r1
13.4	00000A 05000000		bsr	plotc
13.5	00000E FB166C		mov.l	#'l',r1
13.6	000011 05000000		bsr	plotc
13.7	000015 FB1663		mov.l	#'c',r1
13.8	000018 05000000		bsr	plotc
13.9	00001C FB166F		mov.l	#'o',r1
13.10	00001F 05000000		bsr	plotc
13.11	000023 FB166D		mov.l	#'m',r1
13.12	000026 05000000		bsr	plotc
13.13	00002A FB1665		mov.l	#'e',r1
13.14	00002D 05000000		bsr	plotc
13.15	000031		endr	
17	000031 02		rts	
18	000032		end	

This example uses `REPTI` to clear several memory locations:

```

                                name    repti
                                extern  base, count, init
                                section CODE:CODE
                                code
banner    repti    adds, base, count, init
                                mov.l   #adds,R1
                                mov.l   #0,[R1]
                                endr
                                rts
                                end

```

This produces this code:

9			name	repti
10	000000		extern	base, count, init
			section	CODE:CODE
11	000000		code	
12	000000		code	
13	000000	banner	repti	adds, base, count, init
13.1	000000 FB1200000000		mov.l	#base,R1
13.2	000006 F81600		mov.l	#0,[R1]
13.3	000009 FB1200000000		mov.l	#count,R1
13.4	00000F F81600		mov.l	#0,[R1]
13.5	000012 FB1200000000		mov.l	#init,R1
13.6	000018 F81600		mov.l	#0,[R1]
13.7	00001B		endr	
17	00001B 02		rts	
18	00001C		end	

### Coding inline for efficiency

In time-critical code it is often desirable to code routines inline to avoid the overhead of a subroutine call and return. Macros provide a convenient way of doing this.

This example outputs bytes from a buffer to a port:

```

                                name    ioBufferSubroutine
                                public  copyBuffer
ptbd    equ    0x0002           ; Definition of the port B
                                ; data register.

                                section DATA16:DATA
                                data
buffer   ds8 256

                                section CODE:CODE
                                code
copyBuffer mov.l #buffer,R1 ; Initialize the loop counter.
                                mov.l #ptbd,R3
                                mov.l #256,R4
loop     mov.b [R1+],R2
                                mov.b R2,[R3]
                                sub #1,R4
                                bne loop      ; Have we copied 256 bytes?
                                rts
                                end

```

The main program calls this routine as follows:

For efficiency we can recode this using a macro:

```

                                name    ioBufferInline
ptbd    equ    0x0002           ; Definition of the port B
                                ; data register.

                                section DATA16:DATA
                                data
buffer   ds8 256

                                section CODE:CODE
                                code
copyBuffer macro
                                mov.l #buffer,R1 ; Initialize the loop counter.
                                mov.l #ptbd,R3
                                mov.l #256,R4
loop     mov.b [R1+],R2
                                mov.b R2,[R3]
                                sub #1,R4
                                bne loop      ; Have we copied 256 bytes?
                                endm
                                end

```

Notice the use of the `LOCAL` directive to make the label `loop` local to the macro; otherwise an error is generated if the macro is used twice, as the `loop` label already exists.

## Listing control directives

Syntax	LSTCND{+ -}
	LSTCOD{+ -}
	LSTEXP{+ -}
	LSTMAC{+ -}
	LSTOUT{+ -}
	LSTREP{+ -}
	LSTXRF{+ -}

### Description

These directives provide control over the assembler list file:

Directive	Description
LSTCND	Controls conditional assembly listing.
LSTCOD	Controls multi-line code listing.
LSTEXP	Controls the listing of macro-generated lines.
LSTMAC	Controls the listing of macro definitions.
LSTOUT	Controls assembly-listing output.
LSTREP	Controls the listing of lines generated by repeat directives.
LSTXRF	Generates a cross-reference table.

Table 20: Listing control directives

**Note:** The directives COL, LSTPAGE, PAGE, and PAGESIZ are included for backward compatibility reasons; they are recognized but no action is taken.

### Turning the listing on or off

Use LSTOUT- to disable all list output except error messages. This directive overrides all other listing control directives.

The default is LSTOUT+, which lists the output (if a list file was specified).

To disable the listing of a debugged section of program:

```
lstout-
; This section has already been debugged.
lstout+
; This section is currently being debugged.
end
```

**Listing conditional code and strings**

Use `LSTCND+` to force the assembler to list source code only for the parts of the assembly that are not disabled by previous conditional `IF` statements.

The default setting is `LSTCND-`, which lists all source lines.

Use `LSTCOD+` to list more than one line of code for a source line, if needed; that is, long ASCII strings produce several lines of output.

The default setting is `LSTCOD-`, which restricts the listing of output code to just the first line of code for a source line.

Using the `LSTCND` and `LSTCOD` directives does not affect code generation.

This example shows how `LSTCND+` hides a call to a subroutine that is disabled by an `IF` directive:

```

                                name    lstcndTest
                                extern  print
                                section FLASH:CODE
                                code
debug    set      0
begin    if      debug
          bsr     print
          endif

          lstcnd+
begin2    if      debug
          bsr     print
          endif

                                end
```

This generates the following listing:

```

9                                name    lstcndTest
10                               extern  print
11                               section FLASH:CODE
12                               code
13                               debug    set      0
14                               begin    if      debug
15                               bsr     print
16                               endif
17
18                               lstcnd+
19                               begin2    if      debug
21                               endif
22
23                               end
```

## Controlling the listing of macros

Use `LSTEXP-` to disable the listing of macro-generated lines. The default is `LSTEXP+`, which lists all macro-generated lines.

Use `LSTMAC+` to list macro definitions. The default is `LSTMAC-`, which disables the listing of macro definitions.

This example shows the effect of `LSTMAC` and `LSTEXP`:

```

                                name    lstmacTest
                                extern  memLoc
                                section FLASH:CODE(2)
                                code

dec2      macro    arg
          mov.l    #arg, R1
          mov.l    [R1], R2
          sub      #2, R1
          mov.l    R2, [R1]
          endm

                                lstmac+
inc2      macro    arg
          mov.l    #arg, R1
          mov.l    [R1], R2
          add      #2, R2
          mov.l    R2, [R1]
          endm

begin     dec2      memLoc
          lstexp-
          inc2      memLoc
          rts
; Restore default values for
; listing control directives.

          lstmac-
          lstexp+

          end

```

This produces the following output:

```

9                                     name    lstmacTest
10      000000                       extern  memLoc
11      000000                       section  FLASH:CODE(2)
12      000000                       code
13
20
21                                     lstmac+
22                                     macro    arg
23                                     mov.l    #arg,R1
24                                     mov.l    [R1],R2
25                                     add     #2,R2
26                                     mov.l    R2,[R1]
27                                     endm
28
29      000000                       begin    dec2    memLoc
29.1  000000 FB1200000000          mov.l    #memLoc,R1
29.2  000006 EC12                  mov.l    [R1],R2
29.3  000008 6021                  sub     #2,R1
29.4  00000A E312                  mov.l    R2,[R1]
30                                     lstexp-
31      00000C                       inc2     memLoc
32      000018 02                   rts
33                                     ; Restore default values for
34                                     ; listing control directives.
35
36                                     lstmac-
37                                     lstexp+
38
39      000019                       end
```

**Controlling the listing of generated lines**

Use `LSTREP-` to turn off the listing of lines generated by the directives `REPT`, `REPTC`, and `REPTI`.

The default is `LSTREP+`, which lists the generated lines.

**Generating a cross-reference table**

Use `LSTXRF+` to generate a cross-reference table at the end of the assembler list for the current module. The table shows values and line numbers, and the type of the symbol.

The default is `LSTXRF-`, which does not give a cross-reference table.



## C-style preprocessor directives

Syntax	<pre>#define <i>symbol</i> <i>text</i>  #elif <i>condition</i>  #else  #endif  #error "<i>message</i>"  #if <i>condition</i>  #ifdef <i>symbol</i>  #ifndef <i>symbol</i>  #include {"<i>filename</i>"   &lt;<i>filename</i>&gt;}  #line <i>line-no</i> {"<i>filename</i>"}  #undef <i>symbol</i></pre>												
Parameters	<table><tr><td><i>condition</i></td><td>An absolute assembler expression, see <i>Expressions, operands, and operators</i>, page 24.  The expression must not contain any assembler labels or symbols, and any non-zero value is considered as true. The C preprocessor operator <code>defined</code> can be used.</td></tr><tr><td><i>filename</i></td><td>Name of file to be included or referred.</td></tr><tr><td><i>line-no</i></td><td>Source line number.</td></tr><tr><td><i>message</i></td><td>Text to be displayed.</td></tr><tr><td><i>symbol</i></td><td>Preprocessor symbol to be defined, undefined, or tested.</td></tr><tr><td><i>text</i></td><td>Value to be assigned.</td></tr></table>	<i>condition</i>	An absolute assembler expression, see <i>Expressions, operands, and operators</i> , page 24.  The expression must not contain any assembler labels or symbols, and any non-zero value is considered as true. The C preprocessor operator <code>defined</code> can be used.	<i>filename</i>	Name of file to be included or referred.	<i>line-no</i>	Source line number.	<i>message</i>	Text to be displayed.	<i>symbol</i>	Preprocessor symbol to be defined, undefined, or tested.	<i>text</i>	Value to be assigned.
<i>condition</i>	An absolute assembler expression, see <i>Expressions, operands, and operators</i> , page 24.  The expression must not contain any assembler labels or symbols, and any non-zero value is considered as true. The C preprocessor operator <code>defined</code> can be used.												
<i>filename</i>	Name of file to be included or referred.												
<i>line-no</i>	Source line number.												
<i>message</i>	Text to be displayed.												
<i>symbol</i>	Preprocessor symbol to be defined, undefined, or tested.												
<i>text</i>	Value to be assigned.												
Description	<p>The assembler has a C-style preprocessor that follows the C99 standard.</p> <p>These C-language preprocessor directives are available:</p>												

Directive	Description
<code>#define</code>	Assigns a value to a preprocessor symbol.
<code>#elif</code>	Introduces a new condition in an <code>#if...#endif</code> block.

Table 21: C-style preprocessor directives

Directive	Description
<code>#else</code>	Assembles instructions if a condition is false.
<code>#endif</code>	Ends an <code>#if</code> , <code>#ifdef</code> , or <code>#ifndef</code> block.
<code>#error</code>	Generates an error.
<code>#if</code>	Assembles instructions if a condition is true.
<code>#ifdef</code>	Assembles instructions if a preprocessor symbol is defined.
<code>#ifndef</code>	Assembles instructions if a preprocessor symbol is undefined.
<code>#include</code>	Includes a file.
<code>#line</code>	Changes the source references in the debug information.
<code>#pragma</code>	Controls extension features. The supported <code>#pragma</code> directives are described in the chapter <i>Pragma directives</i> .
<code>#undef</code>	Undefines a preprocessor symbol.

Table 21: C-style preprocessor directives (Continued)

You should not mix assembler language and C-style preprocessor directives. Conceptually, they are different languages and mixing them might lead to unexpected behavior because an assembler directive is not necessarily accepted as a part of the C preprocessor language.

Note that the preprocessor directives are processed before other directives. As an example avoid constructs like:

```
redef      macro                                ; Avoid the following!
#define \1 \2
          endm
```

because the `\1` and `\2` macro arguments are not available during the preprocessing phase.

**Defining and undefining preprocessor symbols**

Use `#define` to define a value of a preprocessor symbol.

```
#define symbol value
```

Use `#undef` to undefine a symbol; the effect is as if it had not been defined.

**Conditional preprocessor directives**

Use the `#if...#else...#endif` directives to control the assembly process at assembly time. If the condition following the `#if` directive is not true, the subsequent instructions will not generate any code (that is, it will not be assembled or syntax checked) until an `#endif` or `#else` directive is found.

All assembler directives (except for `END`) and file inclusion can be disabled by the conditional directives. Each `#if` directive must be terminated by an `#endif` directive. The `#else` directive is optional and, if used, it must be inside an `#if...#endif` block.

`#if...#endif` and `#if...#else...#endif` blocks can be nested to any level.

Use `#ifdef` to assemble instructions up to the next `#else` or `#endif` directive only if a symbol is defined.

Use `#ifndef` to assemble instructions up to the next `#else` or `#endif` directive only if a symbol is undefined.

This example defines the labels `tweak` and `adjust`. If `adjust` is defined, then register 16 is decremented by an amount that depends on `adjust`, in this case 30.

```

                                name    calibrate
                                extern  calibrationConstant
                                section CODE:CODE
                                code
#define tweak 1
#define adjust 3

calibrate  mov.l    #calibrationConstant,R1
           mov.l    [R1],R2
#ifdef tweak
           adjust==1
           if
           sub      #4,R2
           elif
           adjust==2
           add      #-20,R2
           elif
           adjust==3
           add      #-30,R2,R2
           endif
           endif
           /* ifdef tweak */
           mov.b    R2,[R1]
           rts
           end

```

### Including source files

Use `#include` to insert the contents of a file into the source file at a specified point. The filename can be specified within double quotes or within angle brackets.

Following is the full description of the assembler's `#include` file search procedure:

- If the name of the `#include` file is an absolute path, that file is opened.
- When the assembler encounters the name of an `#include` file in angle brackets such as:

```
#include <iorx62n.h>
```

it searches the following directories for the file to include:

- 1 The directories specified with the `-I` option, in the order that they were specified.
  - 2 Any directories specified using the `ARX_INC` environment variable.
  - 3 The automatically set up library system include directories. See `--no_system_include`, page 61 and `--system_include_dir`, page 66.
- When the assembler encounters the name of an `#include` file in double quotes such as:

```
#include "vars.h"
```

it searches the directory of the source file in which the `#include` statement occurs, and then performs the same sequence as for angle-bracketed filenames.

If there are nested `#include` files, the assembler starts searching the directory of the file that was last included, iterating upwards for each included file, searching the source file directory last.

Use angle brackets for header files provided with the IAR Assembler for rx, and double quotes for header files that are part of your application.

This example uses `#include` to include a file defining macros into the source file. For example, these macros could be defined in `Macros.inc`:

```
; Exchange registers a and b.
; Use the stack for temporary storage.

xch      macro    a,b
          push.l  \1
          push.l  \2
          pop     \2
          pop     \1
        endm
```

The macro definitions can then be included, using `#include`, as in this example:

```
        program includeFile
        public xchRegs
        section CODE:CODE
        code
; Standard macro definitions
#include "Macros.inc"

xchRegs      xch      r1,r3
              xch      r2,r4
              rts

              end
```

## Displaying errors

Use `#error` to force the assembler to generate an error, such as in a user-defined test.

## Changing the source line numbers

Use the `#line` directive to change the source line numbers and the source filename used in the debug information. `#line` operates on the lines following the `#line` directive.

## Comments in C-style preprocessor directives

If you make a comment within a define statement, use:

- the C comment delimiters `/* ... */` to comment sections
- the C++ comment delimiter `//` to mark the rest of the line as comment.

Do not use assembler comments within a define statement as it leads to unexpected behavior.

This expression evaluates to 3 because the comment character is preserved by `#define`:

```
#define x 3      ; This is a misplaced comment.

        module misplacedComment1
expression equ    x * 8 + 5
        ;...
        end
```

This example illustrates some problems that might occur when assembler comments are used in the C-style preprocessor:

```
#define five 5      ; This comment is not OK.
#define six 6       // This comment is OK.
#define seven 7     /* This comment is OK. */

        module misplacedComment2
        section MYCONST:CONST(2)

            DC32    five, 11, 12
; The previous line expands to:
;            "DC32    5      ; This comment is not OK., 11, 12"

            DC32    six + seven, 11, 12
; The previous line expands to:
;            "DC32    6 + 7, 11, 12"

        end
```

Data definition or allocation directives

Syntax	DC8 <i>expr</i> [, <i>expr</i> ] ... DC16 <i>expr</i> [, <i>expr</i> ] ... DC24 <i>expr</i> [, <i>expr</i> ] ... DC32 <i>expr</i> [, <i>expr</i> ] ... DC64 <i>expr</i> [, <i>expr</i> ] ... DF32 <i>value</i> [, <i>value</i> ] ... DF64 <i>value</i> [, <i>value</i> ] ... DQ15 <i>value</i> [, <i>value</i> ] ... DQ31 <i>value</i> [, <i>value</i> ] ... DS <i>count</i> DS8 <i>count</i> DS16 <i>count</i> DS24 <i>count</i> DS32 <i>count</i> DS64 <i>count</i>	
Parameters	<i>count</i>	A valid absolute expression specifying the number of elements to be reserved.
	<i>expr</i>	A valid absolute, relocatable, or external expression, or an ASCII string. ASCII strings are zero filled to a multiple of the data size implied by the directive. Double-quoted strings are zero-terminated. For DC64, <i>expr</i> cannot be relocatable or external.
	<i>value</i>	A valid absolute expression or floating-point constant.
Description	These directives define values or reserve memory.  Use DC8, DC16, DC24, DC32, DC64, DF32, or DF64 to create a constant, which means an area of bytes is reserved big enough for the constant.  Use DS8, DS16, DS24, DS32, or DS64 to reserve a number of uninitialized bytes.  For information about the restrictions that apply when using a directive in an expression, see <i>Expression restrictions</i> , page 31.  The column <i>Alias</i> in the following table shows the Renesas directive that corresponds to the IAR Systems directive.	

Directive	Alias	Description
DC8		Generates 8-bit constants, including strings.
DC16		Generates 16-bit constants.
DC24		Generates 24-bit constants.

Table 22: Data definition or allocation directives

Directive	Alias	Description
DC32		Generates 32-bit constants.
DC64		Generates 64-bit constants.
DF32		Generates 32-bit floating-point constants.
DF64		Generates 64-bit floating-point constants.
DQ15		Generates 16-bit fractional constants.
DQ31		Generates 32-bit fractional constants.
DS8	DS	Allocates space for 8-bit integers.
DS16		Allocates space for 16-bit integers.
DS24		Allocates space for 24-bit integers.
DS32		Allocates space for 32-bit integers.
DS64		Allocates space for 64-bit integers.

Table 22: Data definition or allocation directives (Continued)

### Generating a lookup table

This example generates a constant table of 8-bit data that is accessed via the `call` instruction and added up to a sum.

```

                                module  sumTableAndIndex
                                section  DATA16:CONST
                                DATA
table      dc8      12
           dc8      15
           dc8      17
           dc8      16
           dc8      14
           dc8      11
           dc8      9

                                section  CODE:CODE
                                code
count      set      0

addTable   mov      #0,R1
           mov.l    #table,R2

```

```

                                rept      7
                                if        count == 7
                                exitm
                                endif
                                mov.b    [R2+],R4
                                add R4,R1
count    set      count + 1
                                endr

                                rts
                                end
```

**Defining strings**

To define a string:

```
myMsg    DC8 'Please enter your name'
```

To define a string which includes a trailing zero:

```
myCstr   DC8 "This is a string."
```

To include a single quote in a string, enter it twice; for example:

```
errMsg   DC8 'Don't understand!'
```

**Reserving space**

To reserve space for 10 bytes:

```
table    DS8    10
```

**Assembler control directives**

Syntax	<pre>/*comment*/ //comment CASEOFF CASEON ERROR "message" RADIX expr</pre>
--------	--

Parameters	<pre>comment</pre>	Comment ignored by the assembler.
	<pre>expr</pre>	Default base; default 10 (decimal).



	<i>message</i>	Text to be displayed.
Description	These directives provide control over the operation of the assembler. For information about the restrictions that apply when using a directive in an expression, see <i>Expression restrictions</i> , page 31.	

Directive	Description	Expression restrictions
<code>/*comment*/</code>	C-style comment delimiter.	
<code>//</code>	C++ style comment delimiter.	
<code>CASEOFF</code>	Disables case sensitivity.	
<code>CASEON</code>	Enables case sensitivity.	
<code>ERROR</code>	Generates an error.	
<code>RADIX</code>	Sets the default base on all numeric values.	No forward references No external references Absolute Fixed

Table 23: Assembler control directives

Use `/* . . . */` to comment sections of the assembler listing.

Use `//` to mark the rest of the line as comment.

Use `RADIX` to set the default base for constants. The default base is 10.

### Controlling case sensitivity

Use `CASEON` or `CASEOFF` to turn on or off case sensitivity for user-defined symbols. By default, case sensitivity is on.

When `CASEOFF` is active all symbols are stored in upper case, and all symbols used by `ILINK` should be written in upper case in the linker configuration file.

When `CASEOFF` is set, `label` and `LABEL` are identical in this example:

```

                                module caseSensitivity1
                                section CODE:CODE

                                caseoff
                                CODE
label    nop                    ; Stored as "LABEL".
          bra      LABEL
          nop
          end

```

The following will generate a duplicate label error:

```

                                module caseSensitivity2
                                section CODE:CODE
                                CODE
                                caseoff
label      nop                  ; Stored as "LABEL".
LABEL     nop                  ; Error, "LABEL" already defined.
                                end

```

### Generating errors

Use `ERROR` to force the assembler to generate an error. It is useful in, for example, macros:

```

MyMacro    macro
            if \0 == 7
            error "Wrong first parameter"
            endif
            endm

```

### Defining comments

This example shows how `/*...*/` can be used for a multi-line comment:

```

/*
Program to read serial input.
Version 1: 19.2.11
Author: mjp
*/

```

See also *C-style preprocessor directives*, page 113.

### Changing the base

To set the default base to 16:

```

                                radix    16                ; With the default base set
                                mov.l    #12,R1              ; to 16, the immediate value
                                ;...                          ; of the load instruction is
                                                                ; interpreted as 0x12.

```

; To reset the base from 16 to 10 again, the argument must be written in hexadecimal format.

```

                                radix    0x0a              ; Reset the default base to 10
                                mov.l    #12,R2              ; Now, the immediate value of
                                ;...                          ; the load instruction is
                                                                ; interpreted as 0x0c.

```

## Function directives

Syntax	<code>CALL_GRAPH_ROOT <i>function</i> [, <i>category</i>]</code>	
Parameters	<i>function</i>	The function, a symbol.
	<i>category</i>	An optional call graph root category, a string.
Description	<p>Use this directive to specify that, for stack usage analysis purposes, the function <i>function</i> is a call graph root. You can also specify an optional category, a quoted string.</p> <p>The compiler will generate this directive in assembler list files, when needed.</p>	
Example	<code>CALL_GRAPH_ROOT my_interrupt, "interrupt"</code>	
See also	<p><i>Call frame information directives for stack usage analysis</i>, page 129, for information about CFI directives required for stack usage analysis.</p> <p><i>IAR C/C++ Development Guide for RX</i> for information about how to enable and use stack usage analysis.</p>	

## Call frame information directives for names blocks

Syntax	<b>Names block directives:</b>	
	<code>CFI NAMES <i>name</i></code> <code>CFI ENDNAMES <i>name</i></code> <code>CFI RESOURCE <i>resource</i> : <i>bits</i> [, <i>resource</i> : <i>bits</i>] ...</code> <code>CFI VIRTUALRESOURCE <i>resource</i> : <i>bits</i> [, <i>resource</i> : <i>bits</i>] ...</code> <code>CFI RESOURCEPARTS <i>resource part</i>, <i>part</i> [, <i>part</i>] ...</code> <code>CFI STACKFRAME <i>cfa resource type</i> [, <i>cfa resource type</i>] ...</code> <code>CFI BASEADDRESS <i>cfa type</i> [, <i>cfa type</i>] ...</code>	
Parameters	<i>bits</i>	The size of the resource in bits.
	<i>cfa</i>	The name of a CFA (canonical frame address).
	<i>name</i>	The name of the block.

<i>namesblock</i>	The name of a previously defined names block.
<i>offset</i>	The offset relative the CFA. An integer with an optional sign.
<i>part</i>	A part of a composite resource. The name of a previously declared resource.
<i>resource</i>	The name of a resource.
<i>size</i>	The size of the frame cell in bytes.
<i>type</i>	The segment memory type, such as CODE, CONST, or DATA. In addition, any of the memory types supported by the IAR ILINK Linker. It is only used for denoting an address space.

Description Use these directives to define a names block:

Directive	Description
CFI BASEADDRESS	Declares a base address CFA (Canonical Frame Address).
CFI ENDNAMES	Ends a names block.
CFI FRAMECELL	Creates a reference into the caller's frame.
CFI NAMES	Starts a names block.
CFI RESOURCE	Declares a resource.
CFI RESOURCEPARTS	Declares a composite resource.
CFI STACKFRAME	Declares a stack frame CFA.
CFI VIRTUALRESOURCE	Declares a virtual resource.

Table 24: Call frame information directives names block

Example *Examples of using CFI directives, page 40*

See also *Tracking call frame usage, page 33*

Call frame information directives for common blocks

Syntax Common block directives:

```
CFI COMMON name USING namesblock

CFI ENDCOMMON name

CFI CODEALIGN codealignfactor

CFI DATAALIGN dataalignfactor
```

```
CFI DEFAULT { UNDEFINED | SAMEVALUE }  
CFI RETURNADDRESS resource type
```

Parameters

<i>codealignfactor</i>	The smallest common factor of all instruction sizes. Each CFI directive for a data block must be placed according to this alignment. 1 is the default and can always be used, but a larger value reduces the produced call frame information in size. The possible range is 1–256.
<i>commonblock</i>	The name of a previously defined common block.
<i>dataalignfactor</i>	The smallest common factor of all frame sizes. If the stack grows toward higher addresses, the factor is negative; if it grows toward lower addresses, the factor is positive. 1 is the default, but a larger value reduces the produced call frame information in size. The possible ranges are –256 to –1 and 1 to 256.
<i>name</i>	The name of the block.
<i>namesblock</i>	The name of a previously defined names block.
<i>resource</i>	The name of a resource.
<i>type</i>	The memory type, such as CODE, CONST, or DATA. In addition, any of the segment memory types supported by the IAR ILINK Linker. It is only used for denoting an address space.

Description

Use these directives to define a common block:

Directive	Description
CFI CODEALIGN	Declares code alignment.
CFI COMMON	Starts or extends a common block.
CFI DATAALIGN	Declares data alignment.
CFI DEFAULT	Declares the default state of all resources.
CFI ENDCOMMON	Ends a common block.
CFI RETURNADDRESS	Declares a return address column.

Table 25: Call frame information directives common block

In addition to these directives you might also need the call frame information directives for specifying rules, or CFI expressions for resources and CFAs, see *Call frame information directives for tracking resources and CFAs*, page 127.

Example

*Examples of using CFI directives*, page 40

See also *Tracking call frame usage*, page 33

Call frame information directives for data blocks

Syntax

CFI BLOCK *name* USING *commonblock*

CFI ENDBLOCK *name*

CFI { NOFUNCTION | FUNCTION *label* }

CFI { INVALID | VALID }

CFI { REMEMBERSTATE | RESTORESTATE }

CFI PICKER

CFI CONDITIONAL *label* [, *label*] ...

Parameters

*commonblock*

The name of a previously defined common block.

*label*

A function label.

*name*

The name of the block.

Description

These directives allow call frame information to be defined in the assembler source code:

Directive	Description
CFI BLOCK	Starts a data block.
CFI CONDITIONAL	Declares a data block to be a conditional thread.
CFI ENDBLOCK	Ends a data block.
CFI FUNCTION	Declares a function associated with a data block.
CFI INVALID	Starts a range of invalid call frame information.
CFI NOFUNCTION	Declares a data block to not be associated with a function.
CFI PICKER	Declares a data block to be a picker thread. Used by the compiler for keeping track of execution paths when code is shared within or between functions.
CFI REMEMBERSTATE	Remembers the call frame information state.
CFI RESTORESTATE	Restores the saved call frame information state.
CFI VALID	Ends a range of invalid call frame information.

Table 26: Call frame information directives for data blocks

In addition to these directives, you might also need the call frame information directives for specifying rules, or CFI expressions for resources and CFAs, see *Call frame information directives for tracking resources and CFAs*, page 127.

Example *Examples of using CFI directives*, page 40

See also *Tracking call frame usage*, page 33

## Call frame information directives for tracking resources and CFAs

**Syntax**

```
CFI cfa { resource | resource + constant | resource - constant }
CFI cfa cfiexpr
CFI resource { UNDEFINED | SAMEVALUE | CONCAT }
CFI resource { resource | FRAME(cfa, offset) }
CFI resource cfiexpr
```

### Parameters

<i>cfa</i>	The name of a CFA (canonical frame address).
<i>cfiexpr</i>	A CFI expression, which can be one of these: <ul style="list-style-type: none"> <li>● A CFI operator with operands</li> <li>● A numeric constant</li> <li>● A CFA name</li> <li>● A resource name.</li> </ul>
<i>constant</i>	A constant value or an assembler expression that can be evaluated to a constant value.
<i>offset</i>	The offset relative the CFA. An integer with an optional sign.
<i>resource</i>	The name of a resource.

### Unary operators

Overall syntax: *OPERATOR*(*operand*)

CFI operator	Operand	Description
COMPLEMENT	<i>cfiexpr</i>	Performs a bitwise NOT on a CFI expression.
LITERAL	<i>expr</i>	Get the value of the assembler expression. This can insert the value of a regular assembler expression into a CFI expression.

Table 27: Unary operators in CFI expressions

CFI operator	Operand	Description
NOT	<i>cfiexpr</i>	Negates a logical CFI expression.
UMINUS	<i>cfiexpr</i>	Performs arithmetic negation on a CFI expression.

Table 27: Unary operators in CFI expressions (Continued)

Binary operators

Overall syntax: *OPERATOR*(*operand1*, *operand2*)

CFI operator	Operands	Description
ADD	<i>cfiexpr</i> , <i>cfiexpr</i>	Addition
AND	<i>cfiexpr</i> , <i>cfiexpr</i>	Bitwise AND
DIV	<i>cfiexpr</i> , <i>cfiexpr</i>	Division
EQ	<i>cfiexpr</i> , <i>cfiexpr</i>	Equal to
GE	<i>cfiexpr</i> , <i>cfiexpr</i>	Greater than or equal to
GT	<i>cfiexpr</i> , <i>cfiexpr</i>	Greater than
LE	<i>cfiexpr</i> , <i>cfiexpr</i>	Less than or equal to
LSHIFT	<i>cfiexpr</i> , <i>cfiexpr</i>	Logical shift left of the left operand. The number of bits to shift is specified by the right operand. The sign bit will not be preserved when shifting.
LT	<i>cfiexpr</i> , <i>cfiexpr</i>	Less than
MOD	<i>cfiexpr</i> , <i>cfiexpr</i>	Modulo
MUL	<i>cfiexpr</i> , <i>cfiexpr</i>	Multiplication
NE	<i>cfiexpr</i> , <i>cfiexpr</i>	Not equal to
OR	<i>cfiexpr</i> , <i>cfiexpr</i>	Bitwise OR
RSHIFTA	<i>cfiexpr</i> , <i>cfiexpr</i>	Arithmetic shift right of the left operand. The number of bits to shift is specified by the right operand. In contrast with RSHIFTL, the sign bit is preserved when shifting.
RSHIFTL	<i>cfiexpr</i> , <i>cfiexpr</i>	Logical shift right of the left operand. The number of bits to shift is specified by the right operand. The sign bit will not be preserved when shifting.
SUB	<i>cfiexpr</i> , <i>cfiexpr</i>	Subtraction
XOR	<i>cfiexpr</i> , <i>cfiexpr</i>	Bitwise XOR

Table 28: Binary operators in CFI expressions



## Ternary operators

Overall syntax: `OPERATOR(operand1, operand2, operand3)`

Operator	Operands	Description
FRAME	<i>cfa, size, offset</i>	Gets the value from a stack frame. The operands are: <i>cfa</i> , an identifier that denotes a previously declared CFA. <i>size</i> , a constant expression that denotes a size in bytes. <i>offset</i> , a constant expression that denotes a size in bytes. Gets the value at address <i>cfa+offset</i> of size <i>size</i> .
IF	<i>cond, true, false</i>	Conditional operator. The operands are: <i>cond</i> , a CFI expression that denotes a condition. <i>true</i> , any CFI expression. <i>false</i> , any CFI expression. If the conditional expression is non-zero, the result is the value of the <i>true</i> expression; otherwise the result is the value of the <i>false</i> expression.
LOAD	<i>size, type, addr</i>	Gets the value from memory. The operands are: <i>size</i> , a constant expression that denotes a size in bytes. <i>type</i> , a memory type. <i>addr</i> , a CFI expression that denotes a memory address. Gets the value at address <i>addr</i> in the segment memory type <i>type</i> of size <i>size</i> .

Table 29: Ternary operators in CFI expressions

## Description

Use these directives to track resources and CFAs in common blocks and data blocks:

Directive	Description
CFI <i>cfa</i>	Declares the value of a CFA.
CFI <i>resource</i>	Declares the value of a resource.

Table 30: Call frame information directives for tracking resources and CFAs

## Example

*Examples of using CFI directives*, page 40

## See also

*Tracking call frame usage*, page 33

## Call frame information directives for stack usage analysis

## Syntax

```
CFI FUNCALL { caller } callee
CFI INDIRECTCALL { caller }
CFI NOCALLS { caller }
CFI TAILCALL { callee }
```

Parameters

<i>callee</i>	The label of the called function.
<i>caller</i>	The label of the calling function.

Description

These directives allow call frame information to be defined in the assembler source code:

Directive	Description
CFI FUNCALL	Declares function calls for stack usage analysis.
CFI INDIRECTCALL	Declares indirect calls for stack usage analysis.
CFI NOCALLS	Declares absence of calls for stack usage analysis.
CFI TAILCALL	Declares tail calls for stack usage analysis.

Table 31: Call frame information directives for stack usage analysis

See also

*Tracking call frame usage*, page 33  
The *IAR C/C++ Development Guide for RX* for information about stack usage analysis.

# Pragma directives

This chapter describes the pragma directives of the IAR Assembler for RX.

The pragma directives control the behavior of the assembler, for example whether it outputs warning messages. The pragma directives are preprocessed, which means that macros are substituted in a pragma directive.

---

## Summary of pragma directives

This table lists the pragma directives of the assembler:

#pragma directive	Description
diag_default	Changes the severity level of diagnostic messages
diag_error	Changes the severity level of diagnostic messages
diag_remark	Changes the severity level of diagnostic messages
diag_suppress	Suppresses diagnostic messages
diag_warning	Changes the severity level of diagnostic messages
message	Prints a message

*Table 32: Pragma directives summary*

---

## Descriptions of pragma directives

The following pages describe each pragma directive.

Note that all pragma directives using = for value assignment should be entered like:

```
#pragma pragmaname=pragmavalue
```

or

```
#pragma pragmaname = pragmavalue
```

### diag\_default

Syntax

```
#pragma diag_default=tag, tag, ...
```

Parameters

*tag*

The number of a diagnostic message, for example the message number Pe117.

Description	Use this pragma directive to change the severity level back to the default, or to the severity level defined on the command line by any of the options <code>--diag_error</code> , <code>--diag_remark</code> , <code>--diag_suppress</code> , or <code>--diag_warning</code> , for the diagnostic messages specified with the tags.
Example	<code>#pragma diag_default=Pe117</code>
See also	The chapter <i>Diagnostics</i> .

**diag\_error**

Syntax	<code>#pragma diag_error=tag, tag, ...</code>	
Parameters	<i>tag</i>	The number of a diagnostic message, for example the message number <code>Pe117</code> .
Description	Use this pragma directive to change the severity level to <code>error</code> for the specified diagnostic messages.	
Example	<code>#pragma diag_error=Pe117</code>	
See also	The chapter <i>Diagnostics</i> .	

**diag\_remark**

Syntax	<code>#pragma diag_remark=tag, tag, ...</code>	
Parameters	<i>tag</i>	The number of a diagnostic message, for example the message number <code>Pe117</code> .
Description	Use this pragma directive to change the severity level to <code>remark</code> for the specified diagnostic messages.	
Example	<code>#pragma diag_remark=Pe177</code>	
See also	The chapter <i>Diagnostics</i> .	

## diag\_suppress

Syntax	#pragma diag_suppress= <i>tag</i> , <i>tag</i> , ...	
Parameters	<i>tag</i>	The number of a diagnostic message, for example the message number Pe117.
Description	Use this pragma directive to suppress the specified diagnostic messages.	
Example	#pragma diag_suppress=Pe117, Pe177	
See also	The chapter <i>Diagnostics</i> .	

## diag\_warning

Syntax	#pragma diag_warning= <i>tag</i> , <i>tag</i> , ...	
Parameters	<i>tag</i>	The number of a diagnostic message, for example the message number Pe826.
Description	Use this pragma directive to change the severity level to <code>warning</code> for the specified diagnostic messages.	
Example	#pragma diag_warning=Pe826	
See also	The chapter <i>Diagnostics</i> .	

## message

Syntax	#pragma message( <i>string</i> )	
Parameters	<i>string</i>	The message that you want to direct to the standard output stream.
Description	Use this pragma directive to make the assembler print a message on <code>stdout</code> when the file is assembled.	

**Example**

```
#ifdef TESTING  
#pragma message("Testing")  
#endif
```

# Diagnostics

The following pages describe the format of the diagnostic messages and explains how diagnostic messages are divided into different levels of severity.

---

## Message format

All diagnostic messages are issued as complete, self-explanatory messages. A typical diagnostic message from the assembler is produced in the form:

```
filename,linenumber level[tag]: message
```

where *filename* is the name of the source file in which the error was encountered; *linenumber* is the line number at which the assembler detected the error; *level* is the level of seriousness of the diagnostic; *tag* is a unique tag that identifies the diagnostic message; *message* is a self-explanatory message, possibly several lines long.

Diagnostic messages are displayed on the screen, and printed in the optional list file. In the IAR Embedded Workbench IDE, diagnostic messages are displayed in the **Build** messages window.

---

## Severity levels

The diagnostics are divided into different levels of severity:

### REMARK

A diagnostic message that is produced when the assembler finds a source code construct that can possibly lead to erroneous behavior in the generated code. Remarks are, by default, not issued but can be enabled, see *--remarks*, page 65.

### WARNING

A diagnostic message that is produced when the assembler finds a programming error or omission which is of concern but not so severe as to prevent the completion of compilation. Warnings can be disabled with the command line option *--no\_warnings*, see *--no\_warnings*, page 61.

### ERROR

A diagnostic message that is produced when the assembler finds a construct which clearly violates the language rules, such that code cannot be produced. An error produces a non-zero exit code.

## FATAL ERROR

A diagnostic message that is produced when the assembler finds a condition that not only prevents code generation, but which makes further processing of the source code pointless. After the diagnostic is issued, assembly ends. A fatal error produces a non-zero exit code.

## SETTING THE SEVERITY LEVEL

The diagnostic messages can be suppressed or the severity level can be changed for all types of diagnostics except for fatal errors and some of the regular errors.

For information about the assembler options that are available for setting severity levels, see *Summary of assembler options*, page 45.

For information about the pragma directives that are available for setting severity levels, see the chapter *Pragma directives*.

## INTERNAL ERROR

An internal error is a diagnostic message that signals that there was a serious and unexpected failure due to a fault in the assembler. It is produced using this form:

Internal error: *message*

where *message* is an explanatory message. If internal errors occur, they should be reported to your software distributor or IAR Technical Support. Please include information enough to reproduce the problem. This would typically include:

- The product name
- The version number of the assembler, which can be seen in the header of the list files generated by the assembler
- Your license number
- The exact internal error message text
- The source file of the program that generated the internal error
- A list of the options that were used when the internal error occurred.



# A

absolute expressions	30
ADD (CFI operator)	128
addition (assembler operator)	73
address field, in assembler list file	32
ALIGN (assembler directive)	96
alignment error, possible reason for	94
alignment, of sections	97
ALIGNRAM (assembler directive)	96
AND (CFI operator)	128
_args (assembler directive)	102
_args (predefined macro symbol)	105
ASCII character constants	25
ASEGN (assembler directive)	96
asm (filename extension)	21
assembler control directives	120
assembler diagnostics	135
assembler directives	
assembler control	120
CFI directives for common blocks	124
CFI directives for data blocks	126
CFI directives for names blocks	123
CFI directives for tracking resources and CFAs	127
CFI for stack usage analysis	129
conditional assembly	100
<i>See also</i> C-style preprocessor directives	
C-style preprocessor	113
data definition or allocation	118
function	123
list file control	109
macro processing	101
module control	89
segment control	94
summary	85
symbol control	91
value assignment	98
#pragma	131
assembler environment variables	22

assembler expressions	24
assembler instructions	24
assembler invocation syntax	21
assembler labels	27
format of	23
assembler list files	
address field	32
comments	121
conditional code and strings	110
cross-references	
generating (LSTXRF)	112
generating (-l)	58
data field	32
enabling and disabling (LSTOUT)	109
filename, specifying (-l)	58
generated lines, controlling (LSTREP)	112
macro-generated lines, controlling	111
symbol and cross-reference table	32
assembler macros	
arguments, passing to	105
defining	103
generated lines, controlling in list file	111
inline routines	107
predefined symbol	105
quote characters, specifying	58
special characters, using	104
assembler operators	69
in expressions	24
precedence	69
assembler options	
passing to assembler	22
reading from file (--f)	55
extended command file, setting	44
specifying parameters	44
summary	45
assembler output, including debug information	49
assembler source files, including	115
assembler source format	23
assembler symbols	26

exporting	92
importing	92
in relocatable expressions	30
predefined	28
assembling, invocation syntax	21
assembly messages format	135
ASSIGN (assembler directive)	99

## B

bitwise AND (assembler operator)	77
bitwise exclusive OR (assembler operator)	77
bitwise NOT (assembler operator)	77
bitwise OR (assembler operator)	77
bold style, in this guide	16
__BUILD_NUMBER__ (predefined symbol)	28
byte order	
specifying	54
BYTE1 (assembler operator)	79
BYTE2 (assembler operator)	79
BYTE3 (assembler operator)	80
BYTE4 (assembler operator)	80

## C

call frame information directives	123–124, 126–127, 129
call frame information, disabling (--no_call_frame_info)	60
CALL_GRAPH_ROOT (assembler directive)	123
case sensitivity, controlling	47, 121
CASEOFF (assembler directive)	121
CASEON (assembler directive)	121
--case_insensitive (assembler option)	47
CFA, CFI directives for tracking	127
CFI BASEADDRESS (assembler directive)	124
CFI BLOCK (assembler directive)	126
CFI cfa (assembler directive)	129
CFI CODEALIGN (assembler directive)	125
CFI COMMON (assembler directive)	125
CFI CONDITIONAL (assembler directive)	126

CFI DATAALIGN (assembler directive)	125
CFI DEFAULT (assembler directive)	125
CFI directives for common blocks	124
CFI directives for data blocks	126
CFI directives for names blocks	123
CFI directives for stack usage analysis	129
CFI directives for tracking resources and CFAs	127
CFI ENDBLOCK (assembler directive)	126
CFI ENDCOMMON (assembler directive)	125
CFI ENDNAMES (assembler directive)	124
CFI expressions	39
CFI FRAMECELL (assembler directive)	124
CFI FUNCALL (assembler directive)	130
CFI FUNCTION (assembler directive)	126
CFI INDIRECTCALL (assembler directive)	130
CFI INVALID (assembler directive)	126
CFI NAMES (assembler directive)	124
CFI NOCALLS (assembler directive)	130
CFI NOFUNCTION (assembler directive)	126
CFI PICKER (assembler directive)	126
CFI REMEMBERSTATE (assembler directive)	126
CFI RESOURCE (assembler directive)	124
CFI resource (assembler directive)	129
CFI RESOURCEPARTS (assembler directive)	124
CFI RESTORESTATE (assembler directive)	126
CFI RETURNADDRESS (assembler directive)	125
CFI STACKFRAME (assembler directive)	124
CFI TAILCALL (assembler directive)	130
CFI VALID (assembler directive)	126
CFI VIRTUALRESOURCE (assembler directive)	124
character constants, ASCII	25
COL (assembler directive)	109
command line options	
part of invocation syntax	21
passing	22
typographic convention	16
command line, extending	55
command prompt icon, in this guide	16
comments	

in assembler list file .....	121
in assembler source code .....	23
in C-style preprocessor directives .....	117
multi-line, using with assembler directives .....	122
common blocks	
call frame information .....	34
common blocks, CFI directives for .....	124
common block, defining .....	36
COMPLEMENT (CFI operator) .....	127
computer style (monospace font), typographic convention ..	16
conditional assembly directives .....	100
<i>See also</i> C-style preprocessor directives	
conditional code and strings, listing .....	110
constants	
default base of .....	121
integer .....	25
conventions, used in this guide .....	15
copyright notice .....	2
--core (assembler option) .....	48
CRC, in assembler list file .....	32
cross-references, in assembler list file	
generating (LSTXRF) .....	112
generating (-l) .....	58
current time/date (assembler operator) .....	80
C-RUN runtime error checking, documentation .....	14
C-STAT for static analysis, documentation for .....	15
C-style preprocessor directives .....	113

## D

-D (assembler option) .....	48
data allocation directives .....	118
data blocks	
call frame information .....	35
data blocks, CFI directives for .....	126
data definition directives .....	118
data field, in assembler list file .....	32
__DATE__ (predefined symbol) .....	28
DATE (assembler operator) .....	80
DC8 (assembler directive) .....	118
DC16 (assembler directive) .....	118
DC24 (assembler directive) .....	118
DC32 (assembler directive) .....	119
DC64 (assembler directive) .....	119
--debug (assembler option) .....	49
debug information, including in assembler output .....	49
default base, for constants .....	121
#define (assembler directive) .....	113
DEFINE (assembler directive) .....	99
defining a common block .....	36
--dependencies (assembler option) .....	50
DF32 (assembler directive) .....	119
DF64 (assembler directive) .....	119
diagnostic messages .....	135
classifying as errors .....	51
classifying as remarks .....	51
classifying as warnings .....	52
disabling warnings .....	61
disabling wrapping of .....	61
enabling remarks .....	65
listing all .....	52
suppressing .....	52
--diagnostics_tables (assembler option) .....	52
diag_default (pragma directive) .....	131
--diag_error (assembler option) .....	51
diag_error (pragma directive) .....	132
--diag_remark (assembler option) .....	51
diag_remark (#pragma directive) .....	132
--diag_suppress (assembler option) .....	52
diag_suppress (pragma directive) .....	133
--diag_warning (assembler option) .....	52
diag_warning (pragma directive) .....	133
directives. <i>See</i> assembler directives	
--dir_first (assembler option) .....	53
disassembly mode, directives .....	93
disclaimer .....	2
DIV (CFI operator) .....	128
division (assembler operator) .....	74

DLIB	
naming convention . . . . .	17
document conventions . . . . .	15
documentation	
overview of guides . . . . .	14
--double (assembler option) . . . . .	53
DQ15 (assembler directive) . . . . .	119
DQ31 (assembler directive) . . . . .	119
DS (assembler directive) . . . . .	119
DS8 (assembler directive) . . . . .	119
DS16 (assembler directive) . . . . .	119
DS24 (assembler directive) . . . . .	119
DS32 (assembler directive) . . . . .	119
DS64 (assembler directive) . . . . .	119

## E

edition, of this guide . . . . .	2
efficient coding techniques . . . . .	33
#elif (assembler directive) . . . . .	113
#else (assembler directive) . . . . .	114
END (assembler directive) . . . . .	90
--endian (assembler option) . . . . .	54
#endif (assembler directive) . . . . .	114
ENDM (assembler directive) . . . . .	102
ENDR (assembler directive) . . . . .	102
environment variables	
assembler . . . . .	22
EQ (CFI operator) . . . . .	128
EQU (assembler directive) . . . . .	98
equal to (assembler operator) . . . . .	75
#error (assembler directive) . . . . .	114
error checking (C-RUN), documentation . . . . .	14
error messages . . . . .	135
classifying . . . . .	51
ERROR directive . . . . .	122
#error, using to display . . . . .	117
ERROR (assembler directive) . . . . .	121
--error_limit (assembler option) . . . . .	54

EVEN (assembler directive) . . . . .	96
EXITM (assembler directive) . . . . .	102
expressions . . . . .	24
extended command line file	
for assembler . . . . .	55
extended command line file (extend.xcl) . . . . .	44, 55
EXTERN (assembler directive) . . . . .	92
EXTWEAK (assembler directive) . . . . .	92

## F

-f (assembler option) . . . . .	44, 55
--f (assembler option) . . . . .	55
false value, in assembler expressions . . . . .	26
fatal error messages . . . . .	136
__FILE__ (predefined symbol) . . . . .	29
file dependencies, tracking . . . . .	50
file extensions. <i>See</i> filename extensions	
file types	
assembler output . . . . .	21
assembler source . . . . .	21
extended command line . . . . .	44, 55
#include, specifying path . . . . .	56
filename extensions	
asm . . . . .	21
msa . . . . .	21
o . . . . .	21
s . . . . .	21
xcl . . . . .	44, 55
filenames, specifying for assembler object file . . . . .	62
first byte (assembler operator) . . . . .	79
floating-point constants . . . . .	26
formats	
assembler source code . . . . .	23
diagnostic messages . . . . .	135
in list files . . . . .	32
fourth byte (assembler operator) . . . . .	80
--fpu (assembler option) . . . . .	56
fractions . . . . .	26

FRAME (CFI operator) . . . . . 129  
 function directives . . . . . 123

## G

GE (CFI operator) . . . . . 128  
 global value, defining . . . . . 99  
 greater than or equal to (assembler operator) . . . . . 76  
 greater than (assembler operator) . . . . . 76  
 GT (CFI operator) . . . . . 128

## H

--header\_context (assembler option) . . . . . 56  
 high byte (assembler operator) . . . . . 81  
 high word (assembler operator) . . . . . 81  
 HIGH (assembler operator) . . . . . 81  
 High-performance Embedded Workshop, migrating from . 15  
 HWRD (assembler operator) . . . . . 81

## I

-I (assembler option) . . . . . 56  
 IAR Technical Support . . . . . 136  
 \_\_IAR\_SYSTEMS\_ASM\_\_ (predefined symbol) . . . . . 29  
 icons, in this guide . . . . . 16  
 #if (assembler directive) . . . . . 114  
 IF (CFI operator) . . . . . 129  
 #ifdef (assembler directive) . . . . . 114  
 #ifndef (assembler directive) . . . . . 114  
 IMPORT (assembler directive) . . . . . 92  
 #include files, specifying . . . . . 56  
 #include (assembler directive) . . . . . 114  
 include paths, specifying . . . . . 56  
 inline coding, using macros . . . . . 107  
 installation directory . . . . . 15  
 --int (assembler option) . . . . . 57  
 integer constants . . . . . 25  
 internal error . . . . . 136

invocation syntax . . . . . 21  
 italic style, in this guide . . . . . 16

## L

-l (assembler option) . . . . . 58  
 labels. *See* assembler labels  
 LE (CFI operator) . . . . . 128  
 less than or equal to (assembler operator) . . . . . 75  
 less than (assembler operator) . . . . . 75  
 LIBRARY (assembler directive) . . . . . 88  
 lightbulb icon, in this guide . . . . . 16  
 \_\_LINE\_\_ (predefined symbol) . . . . . 29  
 #line (assembler directive) . . . . . 114  
 linker options  
     typographic convention . . . . . 16  
 list file format . . . . . 32  
     body . . . . . 32  
     CRC . . . . . 32  
     header . . . . . 32  
     symbol and cross reference . . . . . 32  
 list files  
     control directives for . . . . . 109  
     generating (-l) . . . . . 58  
 LITERAL (CFI operator) . . . . . 127  
 LOAD (CFI operator) . . . . . 129  
 local value, defining . . . . . 99  
 LOCAL (assembler directive) . . . . . 102  
 logical AND (assembler operator) . . . . . 76  
 logical exclusive OR (assembler operator) . . . . . 84  
 logical NOT (assembler operator) . . . . . 78  
 logical OR (assembler operator) . . . . . 78  
 logical shift left (assembler operator) . . . . . 78  
 logical shift right (assembler operator) . . . . . 79  
 low byte (assembler operator) . . . . . 81  
 low word (assembler operator) . . . . . 81  
 LOW (assembler operator) . . . . . 81  
 LSHIFT (CFI operator) . . . . . 128  
 LSTCND (assembler directive) . . . . . 109

LSTCOD (assembler directive) . . . . .	109
LSTEXP (assembler directives) . . . . .	109
LSTMAC (assembler directive) . . . . .	109
LSTOUT (assembler directive) . . . . .	109
LSTPAGE (assembler directive) . . . . .	109
LSTREP (assembler directive) . . . . .	109
LSTXRF (assembler directive) . . . . .	109
LT (CFI operator) . . . . .	128
LWRD (assembler operator) . . . . .	81

## M

-M (assembler option) . . . . .	58
macro processing directives . . . . .	101
macro quote characters . . . . .	104
specifying . . . . .	58
MACRO (assembler directive) . . . . .	102
macros. <i>See</i> assembler macros	
--macro_positions_in_diagnostics (assembler option) . . . . .	59
memory, reserving space in . . . . .	118
message (pragma directive) . . . . .	133
messages, excluding from standard output stream . . . . .	65
migration	
from a UBROF-based product . . . . .	15
from Renesas HEW . . . . .	15
migration, from earlier IAR compilers . . . . .	15
--mnem_first (assembler option) . . . . .	59
MOD (CFI operator) . . . . .	128
mode control directives . . . . .	93
module consistency . . . . .	90
module control directives . . . . .	89
MODULE (assembler directive) . . . . .	89
monospace font, meaning of in guide. <i>See</i> computer style	
msa (filename extension) . . . . .	21
MUL (CFI operator) . . . . .	128
multiplication (assembler operator) . . . . .	73

## N

NAME (assembler directive) . . . . .	89
names blocks	
call frame information . . . . .	34
CFI directives for . . . . .	123
defining . . . . .	35
naming conventions . . . . .	17
NE (CFI operator) . . . . .	128
--nonportable_path_warnings (assembler option) . . . . .	62
not equal to (assembler operator) . . . . .	75
NOT (CFI operator) . . . . .	128
--no_bom (assembler option) . . . . .	60
--no_call_frame_info (assembler option) . . . . .	60
--no_normalize_file_macros (compiler option) . . . . .	60
--no_path_in_file_macros (assembler option) . . . . .	61
--no_system_include (assembler option) . . . . .	61
--no_warnings (assembler option) . . . . .	61
--no_wrap_diagnostics (assembler option) . . . . .	61

## O

-o (assembler option) . . . . .	46
o (filename extension) . . . . .	21
ODD (assembler directive) . . . . .	96
--only_stdout (assembler option) . . . . .	62
operands	
format of . . . . .	23
in assembler expressions . . . . .	24
operations	
format of . . . . .	23
silent . . . . .	65
operators. <i>See</i> assembler operators	
option summary . . . . .	45
OR (CFI operator) . . . . .	128
--output (assembler option) . . . . .	62
OVERLAY (assembler directive) . . . . .	92

## P

PAGE (assembler directive) . . . . .	109
PAGSIZ (assembler directive) . . . . .	109
parameters . . . . .	
specifying . . . . .	44
typographic convention . . . . .	16
part number, of this guide . . . . .	2
--patch (assembler option) . . . . .	63
#pragma (assembler directive) . . . . .	114, 131
precedence, of assembler operators . . . . .	69
predefined register symbols . . . . .	27
predefined symbols . . . . .	28
in assembler macros . . . . .	105
--predef_macros (assembler option) . . . . .	63
--preinclude (assembler option) . . . . .	63
--preprocess (assembler option) . . . . .	64
preprocessor symbols . . . . .	
defining and undefining . . . . .	114
defining on command line . . . . .	48
program location counter (PLC) . . . . .	27
PROGRAM (assembler directive) . . . . .	89
programming hints . . . . .	33
PUBLIC (assembler directive) . . . . .	92
publication date, of this guide . . . . .	2
PUBWEAK (assembler directive) . . . . .	92

## R

-r (assembler option) . . . . .	46
RADIX (assembler directive) . . . . .	121
reference information, typographic convention . . . . .	16
registered trademarks . . . . .	2
registers . . . . .	27
relocatable expressions . . . . .	30
remark (diagnostic message) . . . . .	135
classifying . . . . .	51
enabling . . . . .	65
--remarks (assembler option) . . . . .	65

Renesas HEW, migrating from . . . . .	15
repeating statements . . . . .	105
REPT (assembler directive) . . . . .	102
REPTC (assembler directive) . . . . .	102
REPTI (assembler directive) . . . . .	102
REQUIRE (assembler directive) . . . . .	92
resources, CFI directives for tracking . . . . .	127
RSEG (assembler directive) . . . . .	96
RSHIFTA (CFI operator) . . . . .	128
RSHIFTL (CFI operator) . . . . .	128
RTMODEL (assembler directive) . . . . .	90
rules, in CFI directives . . . . .	37
runtime error checking, documentation . . . . .	14
runtime model attributes, declaring . . . . .	90

## S

s (filename extension) . . . . .	21
second byte (assembler operator) . . . . .	79
SECTION (assembler directive) . . . . .	96
sections . . . . .	
aligning . . . . .	97
beginning . . . . .	96
SECTION_TYPE (assembler directive) . . . . .	96
segment begin (assembler operator) . . . . .	82
segment control directives . . . . .	94
segment end (assembler operator) . . . . .	82
segment size (assembler operator) . . . . .	83
SET (assembler directive) . . . . .	99
severity level, of diagnostic messages . . . . .	135
specifying . . . . .	136
SFB (assembler operator) . . . . .	82
SFE (assembler operator) . . . . .	82
SFR. <i>See</i> special function registers . . . . .	
--silent (assembler option) . . . . .	65
silent operations, specifying . . . . .	65
simple rules, in CFI directives . . . . .	37
SIZEOF (assembler operator) . . . . .	83
source files . . . . .	

including	115
list all referred	56
source format, assembler	23
source line numbers, changing	117
--source_encoding (assembler option)	65
stack usage analysis, CFI directives for	129
standard error	62
standard output streams, disabling messages to	65
standard output, specifying	62
statements, repeating	105
static analysis tool, documentation for	15
stderr, messages to	62
stdout, direct messages to	62
SUB (CFI operator)	128
subtraction (assembler operator)	74
Support, Technical	136
symbol and cross-reference table, in assembler list file	32
<i>See also</i> Include cross-reference	
symbol control directives	91
symbols	
<i>See also</i> assembler symbols	
exporting to other modules	92
predefined, in assembler	28
predefined, in assembler macro	105
user-defined, case sensitive	47
--system_include_dir (assembler option)	66

## T

Technical Support, IAR	136
temporary values, defining	99
--text_out (assembler option)	66
third byte (assembler operator)	80
__TIME__ (predefined symbol)	29
time-critical code	107
tools icon, in this guide	16
trademarks	2
true value, in assembler expressions	26
typographic conventions	16

## U

UGT (assembler operator)	84
ULT (assembler operator)	84
UMINUS (CFI operator)	128
unary minus (assembler operator)	73
unary plus (assembler operator)	73
#undef (assembler directive)	114
unsigned greater than (assembler operator)	84
unsigned less than (assembler operator)	84
UPPER (assembler operator)	84
user symbols, case sensitive	47
--use_paths_as_written (assembler option)	67
--use_unix_directory_separators (assembler option)	67
--utf8_text_in (assembler option)	67

## V

value assignment directives	98
values, defining	118
VAR (assembler directive)	99
__VER__ (predefined symbol)	29
version	
of this guide	2
--version (assembler option)	68

## W

warnings	135
classifying	52
disabling	61
exit code	68
treating as errors	68
warnings icon, in this guide	16
--warnings_affect_exit_code (assembler option)	23, 68
--warnings_are_errors (assembler option)	68



# X

xcl (filename extension) . . . . .	44, 55
XOR (assembler operator) . . . . .	84
XOR (CFI operator) . . . . .	128

# Symbols

_args (assembler directive) . . . . .	102
_args (predefined macro symbol) . . . . .	105
__BUILD_NUMBER__ (predefined symbol) . . . . .	28
__DATE__ (predefined symbol) . . . . .	28
__FILE__ (predefined symbol) . . . . .	29
__IAR_SYSTEMS_ASM__ (predefined symbol) . . . . .	29
__LINE__ (predefined symbol) . . . . .	29
__TIME__ (predefined symbol) . . . . .	29
__VER__ (predefined symbol) . . . . .	29
- (assembler operator) . . . . .	73–74
-D (assembler option) . . . . .	48
-f (assembler option) . . . . .	44, 55
-I (assembler option) . . . . .	56
-l (assembler option) . . . . .	58
-M (assembler option) . . . . .	58
-o (assembler option) . . . . .	46
-r (assembler option) . . . . .	46
--case_insensitive (assembler option) . . . . .	47
--core (assembler option) . . . . .	48
--debug (assembler option) . . . . .	49
--dependencies (assembler option) . . . . .	50
--diagnostics_tables (assembler option) . . . . .	52
--diag_error (assembler option) . . . . .	51
--diag_remark (assembler option) . . . . .	51
--diag_suppress (assembler option) . . . . .	52
--diag_warning (assembler option) . . . . .	52
--dir_first (assembler option) . . . . .	53
--double (assembler option) . . . . .	53
--endian (assembler option) . . . . .	54
--error_limit (assembler option) . . . . .	54
--f (assembler option) . . . . .	55

--fpu (assembler option) . . . . .	56
--header_context (assembler option) . . . . .	56
--int (assembler option) . . . . .	57
--macro_positions_in_diagnostics (assembler option) . . . . .	59
--mnem_first (assembler option) . . . . .	59
--nonportable_path_warnings (assembler option) . . . . .	62
--no_bom (assembler option) . . . . .	60
--no_call_frame_info (assembler option) . . . . .	60
--no_normalize_file_macros (compiler option) . . . . .	60
--no_path_in_file_macros (assembler option) . . . . .	61
--no_system_include (assembler option) . . . . .	61
--no_warnings (assembler option) . . . . .	61
--no_wrap_diagnostics (assembler option) . . . . .	61
--only_stdout (assembler option) . . . . .	62
--output (assembler option) . . . . .	62
--patch (assembler option) . . . . .	63
--prefdef_macros (assembler option) . . . . .	63
--preinclude (assembler option) . . . . .	63
--preprocess (assembler option) . . . . .	64
--remarks (assembler option) . . . . .	65
--silent (assembler option) . . . . .	65
--source_encoding (assembler option) . . . . .	65
--system_include_dir (assembler option) . . . . .	66
--text_out (assembler option) . . . . .	66
--use_paths_as_written (assembler option) . . . . .	67
--use_unix_directory_separators (assembler option) . . . . .	67
--utf8_text_in (assembler option) . . . . .	67
--version (assembler option) . . . . .	68
--warnings_affect_exit_code (assembler option) . . . . .	23, 68
--warnings_are_errors (assembler option) . . . . .	68
! (assembler operator) . . . . .	78
!= (assembler operator) . . . . .	75
? (assembler operator) . . . . .	74
() (assembler operator) . . . . .	72
* (assembler operator) . . . . .	73
/ (assembler operator) . . . . .	74
/*...*/ (assembler directive) . . . . .	121
// (assembler directive) . . . . .	121
& (assembler operator) . . . . .	77

&& (assembler operator) . . . . .	76
#define (assembler directive) . . . . .	113
#elif (assembler directive). . . . .	113
#else (assembler directive) . . . . .	114
#endif (assembler directive) . . . . .	114
#error (assembler directive) . . . . .	114
#if (assembler directive) . . . . .	114
#ifdef (assembler directive) . . . . .	114
#ifndef (assembler directive) . . . . .	114
#include files, specifying . . . . .	56
#include (assembler directive) . . . . .	114
#line (assembler directive) . . . . .	114
#pragma (assembler directive) . . . . .	114, 131
#undef (assembler directive). . . . .	114
^ (assembler operator). . . . .	77
+ (assembler operator) . . . . .	73
< (assembler operator) . . . . .	75
<< (assembler operator) . . . . .	78
<= (assembler operator) . . . . .	75
<> (assembler operator) . . . . .	75
= (assembler directive) . . . . .	98
= (assembler operator) . . . . .	75
== (assembler operator) . . . . .	75
> (assembler operator) . . . . .	76
>= (assembler operator) . . . . .	76
>> (assembler operator) . . . . .	79
(assembler operator) . . . . .	77
(assembler operator). . . . .	78
~ (assembler operator) . . . . .	77
\$ (program location counter). . . . .	27