TEXAS INSTRUMENTS

TMS320C4x C Source Debugger

User's Guide

1992

Microprocessor Development Systems

Printed in U.S.A., May 1992; reprinted August 1996
2547296–9761 revison A

SPRU054

User’s
Guide

TMS320C4x
C Source Debugger

1992

User’s Guide

TMS320C4x C Source Debugger User’s Guide

SPRU054
May 1992

Texas Instruments

IMPORTANT NOTICE

Texas Instruments (TI) reserves the right to make changes to its products or to discontinue any semiconductor product or service without notice, and advises its customers to obtain the latest version of relevant information to verify, before placing orders, that the information being relied on is current.

TI warrants performance of its semiconductor products and related software to the specifications applicable at the time of sale in accordance with TI's standard warranty. Testing and other quality control techniques are utilized to the extent TI deems necessary to support this warranty. Specific testing of all parameters of each device is not necessarily performed, except those mandated by government requirements.

Certain applications using semiconductor products may involve potential risks of death, personal injury, or severe property or environmental damage ("Critical Applications").

TI SEMICONDUCTOR PRODUCTS ARE NOT DESIGNED, INTENDED, AUTHORIZED, OR WARRANTED TO BE SUITABLE FOR USE IN LIFE-SUPPORT APPLICATIONS, DEVICES OR SYSTEMS OR OTHER CRITICAL APPLICATIONS.

Inclusion of TI products in such applications is understood to be fully at the risk of the customer. Use of TI products in such applications requires the written approval of an appropriate TI officer. Questions concerning potential risk applications should be directed to TI through a local SC sales office.

In order to minimize risks associated with the customer's applications, adequate design and operating safeguards should be provided by the customer to minimize inherent or procedural hazards.

TI assumes no liability for applications assistance, customer product design, software performance, or infringement of patents or services described herein. Nor does TI warrant or represent that any license, either express or implied, is granted under any patent right, copyright, mask work right, or other intellectual property right of TI covering or relating to any combination, machine, or process in which such semiconductor products or services might be or are used.

Preface

Read This First

What Is This Book About?

This book tells you how to use the 'C4x C source debugger with these debugging tools:

- ❑ 'C4x emulator in the following operating systems:
  - ■ OS/2
  - ■ DOS
- ❑ 'C4x simulator in the following operating systems:
  - ■ DOS
  - ■ VMS
  - ■ SunOS

Each tool has its own version of the debugger. These versions operate almost identically; however, the executable files that invoke them are very different. A separate installation book is included in your package which provides installation information for each tool and operating system. Be sure to install the correct version of the debugger for your environment.

How to Use This Manual

The goal of this book is to help you learn how to use the 'C4x C source debugger. This book is divided into three distinct parts:

- ❑ **Part I: Hands-On Information** is presented first so that you can start using your debugger the same day you receive it.
  - ■ Chapter 1 is analogous to a traditional manual introduction. It lists the key features of the debugger, describes additional 'C4x software tools, and tells you how to prepare a 'C4x program for debugging.
  - ■ Chapter 2 is a basic tutorial that introduces you to many of the debugger features.

- ❑ **Part II: Debugger Description** contains detailed information about using the debugger.
  - The chapters in Part II detail the individual topics that are introduced in the tutorial. For example, Chapter 3 describes all of the debugger's windows and tells you how to move them and size them; Chapter 4 describes everything you need to know about entering commands.
- ❑ **Part III: Reference Material** provides supplementary information.
  - Chapter 12 provides a complete reference to all the tasks introduced in Parts I and II. This includes a functional and an alphabetical reference of the debugger commands and a topical reference of function key actions.
  - Chapter 13 provides information about C expressions. The debugger commands are powerful because they accept C expressions as parameters; however, the debugger can also be used to debug assembly language programs. The information about C expressions will aid assembly language programmers who are unfamiliar with C.
  - Part III also includes a glossary and an index.

The way you use this book should depend on your experience with similar products. As with any book, it would be best for you to begin on page 1 and read to the end. Because most people don't read technical manuals from cover to cover, here are some suggestions about what you should read.

- ❑ If you have used TI development tools or other debuggers before, then you may want to:
  - Use the appropriate installation chapter in your accompanying Installation Guide.
  - Complete the tutorial in Chapter 2.
  - Browse through the alphabetical command reference in Chapter 12.
- ❑ If this is the first time that you have used a debugger or similar tool, then you may want to:
  - Use the appropriate installation chapter in your accompanying Installation Guide.
  - Complete the tutorial in Chapter 2.
  - Read all of the chapters in Part II.

Notational Conventions

This document uses the following conventions.

- The TMS320C40 processor is referred to as the **’C4x**.
- The C source debugger has a very flexible command-entry system; there are usually a variety of ways to perform any specific action. For example, you may be able to perform the same action by typing in a command, using the mouse, or using function keys. This document uses three symbols to identify the methods that you can use to perform an action:

Symbol	**Description**
🖱	Identifies an action that you perform by using the mouse.
key	Identifies an action that you perform by using function keys.
⌨	Identifies an action that you perform by typing in a command.

- The following symbols identify mouse actions. For simplicity, these symbols represent a mouse with two buttons. However, you can use a mouse with only one button or a mouse with more than two buttons.

Symbol	**Action**
↖	*Point*. Without pressing a mouse button, move the mouse to point the cursor at a window or field on the display. (Note that the mouse cursor displayed on the screen is not shaped like an arrow unless you are in the OS/2 environment; it’s shaped like a block.)
▮▯	*Press and hold.* Press a mouse button. If your mouse has only one button, press it. If your mouse has more than one button, press the left button.
▯▯	*Release.* Release the mouse button you pressed.
▮▯	*Click*. Press a mouse button and, without moving the mouse, release the button.
▮▯	*Drag.* While pressing the left mouse button, move the mouse.

- Debugger commands are not case sensitive; you can enter them in lowercase, uppercase, or a combination. To emphasize this fact, commands are shown throughout this user's guide in both uppercase and lowercase.

- Program listings and examples, interactive displays, and window contents are shown in a `special font`. Some examples use a **`bold version`** to identify code, commands, or portions of an example that *you* enter. Here is an example:

Command	Result displayed in the COMMAND window
`whatis giant`	`struct zzz giant[100];`

`whatis xxx`	`struct xxx    {`
	`    int a;`
	`    int b;`
	`    int c;`
	`    int f1 : 2;`
	`    int f2 : 4;`
	`    struct xxx *f3;`
	`    int f4[10];`
	`}`

  In this example, the left column identifies debugger commands that you type in. The right column identifies the result that the debugger displays in the COMMAND window display area.

- In syntax descriptions, the instruction or command is in a **bold face font,** and parameters are in *italics*. Portions of a syntax that are in **bold face** should be entered as shown; portions of a syntax that are in *italics* describe the kind of information that should be entered. Here is an example of a command syntax:

  mem *expression* [, *display format*]

  mem is the command. This command has two parameters, indicated by *expression* and *display format*. The first parameter must be an actual C expression; the second parameter, which identifies a specific display format, is optional.

- Square brackets (**[** and **]**) identify an optional parameter. If you use an optional parameter, you specify the information within the brackets; you don't enter the brackets themselves. Here's an example of a command that has an optional parameter:

  run [*expression*]

  The RUN command has one parameter, *expression*, which is optional.

Information About Cautions

> **This is an example of a caution statement.**
>
> **A caution statement describes a situation that could potentially damage your software or equipment.**
>
> CAUTION

Please read each caution statement carefully.

Related Documentation From Texas Instruments

The following books describe the DEVICE NUMBER(S) and related support tools. To obtain a copy of any of these TI documents, call the Texas Instruments Customer Response Center (CRC) at (214) 995–6611. When ordering, please identify the book by its title and literature number.

TMS320C4x Emulator Installation Guide tells you how to install the C source debugger interface along with the ’C4x emulator (using the OS/2 and DOS operating systems). It also covers specifications for connecting your target system to the emulator.

TMS320C4x Simulator Installation Guide tells you how to install the C source debugger interface along with the ’C4x simulator (using the DOS, VMS, and SunOS operating systems).

TMS320C4x User’s Guide (literature number SPRU063) describes the ’C4x 32-bit floating-point processor, developed for digital signal processing as well as parallel processing applications. Covered are its architecture, internal register structure, instruction set, pipeline, specifications, and operation of its six DMA channels and six communication ports. Software and hardware applications are included.

TMS320 Floating-Point DSP Assembly Language Tools User’s Guide (literature number SPRU035) describes the assembly language tools (assembler, linker, and other tools used to develop assembly language code), assembler directives, macros, common object file format, and symbolic debugging directives for the ’C3x and ’C4x generations of devices.

TMS320 Floating-Point DSP Optimizing C Compiler User’s Guide (literature number SPRU024) describes the TMS320 floating-point C compiler. This C compiler accepts ANSI standard C source code and produces TMS320 assembly language source code for the ’C3x and ’C4x generations of devices.

If you are an assembly language programmer and would like more information about C or C expressions, you may find this book useful:

The C Programming Language (second edition, 1988), by Brian W. Kernighan and Dennis M. Ritchie, published by Prentice–Hall, Englewood Cliffs, New Jersey.

If You Need Assistance. . .

If you want to. . .	**Do this. . .**
Request more information about Texas Instruments Digital Signal Processing (DSP) products	Call the CRC† **(800) 336–5236** Or write to Market Communications Manager, MS 736 Texas Instruments Incorporated P.O. Box 1443 Houston, Texas 77251–1443
Order Texas Instruments documentation	Call the CRC† **(800) 336–5236**
Ask questions about product operation or report suspected problems	Call the DSP hotline: **(713) 274–2320**
Report mistakes in this document or any other TI documentation	Fill out and return the reader response card at the end of this book, or send your comments to Technical Publications Manager, MS 702 Texas Instruments Incorporated P.O. Box 1443 Houston, Texas 77251–1443

† Texas Instruments Customer Response Center

Trademarks

PC-DOS and OS/2 are trademarks of International Business Machines Corp.

MS-DOS and Windows are trademarks of Microsoft Corp.

VAX and VMS are trademarks of Digital Equipment Corp.

Sun-3, Sun-4, and SunView are trademarks of Sun Microsystems, Inc.

UNIX is a registered trademark of Unix System Laboratories, Inc.

Contents

Part I: Hands-On Information

Part II: Debugger Description

Part III: Reference Material

Figures

Tables

Chapter 1

Overview of a Code Development and Debugging System

The ’C4x C source debugger is an advanced software interface that helps you to develop, test, and refine ’C4x C programs (compiled with the ’C4x optimizing ANSI C compiler) and assembly language programs. The debugger is the interface to the TI ’C4x simulator and unique scan-based, realtime ’C4x emulator.

The chapter provides an overview of the C source debugger, describes the ’C4x code development environment, and provides instructions and options for invoking the debugger.

Topic **Page**

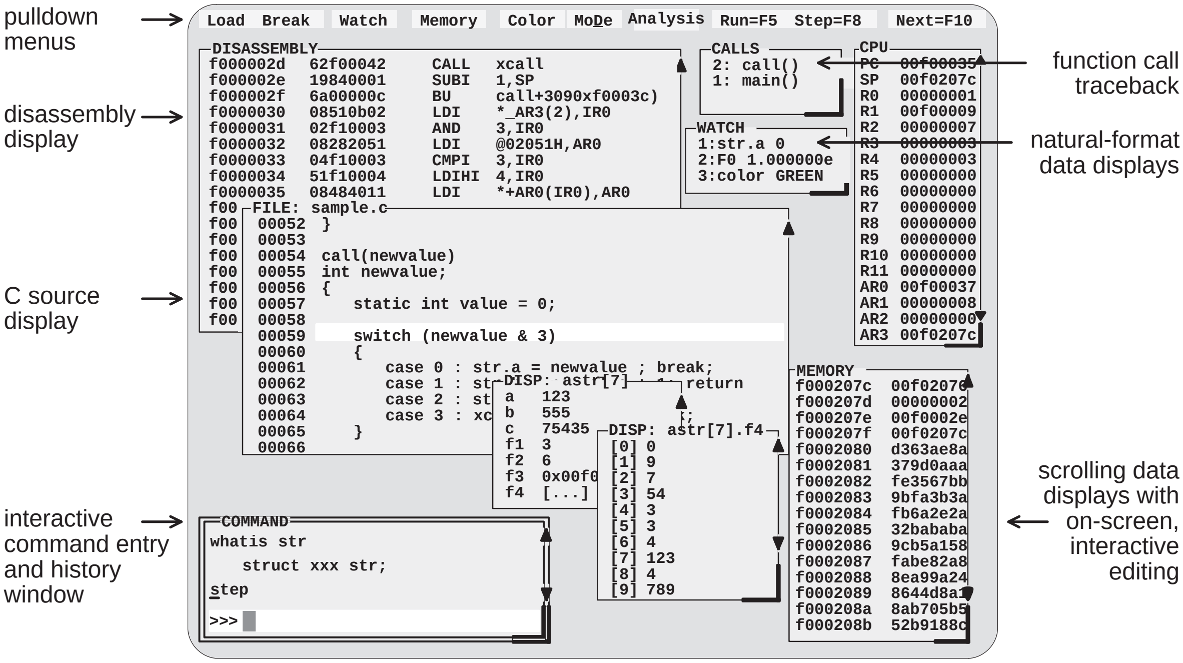
1.1 Description of the ’C4x C Source Debugger

The ’C4x C source debugger improves productivity by allowing you to debug a program in the language it was written in. You can choose to debug your programs in C, assembly language, or both. And, unlike many other debuggers, the ’C4x debugger’s higher level features are available even when you’re debugging assembly language code.

The debugger is easy to learn and use. Its friendly window-, mouse-, and menu-oriented interface reduces learning time and eliminates the need to memorize complex commands. The debugger’s customizable displays and flexible command entry let you develop a debugging environment that suits your needs—you won’t be locked into a rigid environment. A shortened learning curve and increased productivity reduce the software development cycle, so you’ll get to market faster.

Figure 1–1 identifies several features of the debugger display.

Figure 1–1. The Basic Debugger Display



```
f000002d  62f00042    CALL   xcall
f000002e  19840001    SUBI   1,SP
f000002f  6a00000c    BU     call+3090xf0003c)
f0000030  08510b02    LDI    *_AR3(2),IR0
f0000031  02f10003    AND    3,IR0
f0000032  08282051    LDI    @02051H,AR0
f0000033  04f10003    CMPI   3,IR0
f0000034  51f10004    LDIHI  4,IR0
f0000035  08484011    LDI    *+AR0(IR0),AR0
f00
f00
f00
f00
f00
f00
f00
f00
```

```
2: call()
1: main()
```

```
1:str.a 0
2:F0 1.000000e
3:color GREEN
```

```
PC   00f00035
SP   00f0207c
R0   00000001
R1   00f00009
R2   00000007
R3   00000003
R4   00000003
R5   00000000
R6   00000000
R7   00000000
R8   00000000
R9   00000000
R10  00000000
R11  00000000
AR0  00f00037
AR1  00000008
AR2  00000000
AR3  00f0207c
```

```
00052  }
00053
00054  call(newvalue)
00055  int newvalue;
00056  {
00057     static int value = 0;
00058
00059     switch (newvalue & 3)
00060     {
00061        case 0 : str.a = newvalue ; break;
00062        case 1 : st                    return
00063        case 2 : st
00064        case 3 : xc                   ;
00065     }
00066
```

```
a   123
b   555
c   75435
f1  3
f2  6
f3  0x00f0
f4  [...]
```

```
[0] 0
[1] 9
[2] 7
[3] 54
[4] 3
[5] 3
[6] 4
[7] 123
[8] 4
[9] 789
```

```
f000207c  00f0207
f000207d  00000002
f000207e  00f0002e
f000207f  00f0207c
f0002080  d363ae8a
f0002081  379d0aaa
f0002082  fe3567bb
f0002083  9bfa3b3a
f0002084  fb6a2e2a
f0002085  32bababa
f0002086  9cb5a158
f0002087  fabe82a8
f0002088  8ea99a24
f0002089  8644d8a1
f000208a  8ab705b5
f000208b  52b9188c
```

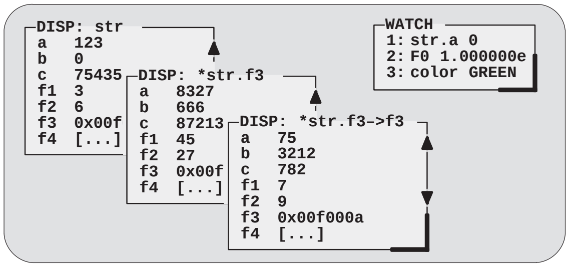
```
whatis str
   struct xxx str;
step
>>>
```

Key features of the debugger

- **Multilevel debugging**. The debugger allows you to debug both C and assembly language code. If you’re debugging a C program, you can choose to view just the C source, the disassembly of the object code created from the C source, or both. You can also use the debugger as an assembly language debugger.

- **Fully configurable, state-of-the-art, window-oriented interface.** The C source debugger separates code, data, and commands into manageable portions. Use any of the default displays. Or select the windows you want to display, size them, and move them where you want them.

- **Comprehensive data displays.** You can easily create windows for displaying *and editing* the values of variables, arrays, structures, pointers—any kind of data—in their natural format (float, int, char, enum, or pointer). You can even display entire linked lists.



```
DISP: str
a   123
b   0
c   75435
f1  3
f2  6
f3  0x00f
f4  [...]
```

```
DISP: *str.f3
a   8327
b   666
c   87213
f1  45
f2  27
f3  0x00f
f4  [...]
```

```
DISP: *str.f3−>f3
a   75
b   3212
c   782
f1  7
f2  9
f3  0x00f000a
f4  [...]
```

```
WATCH
1: str.a 0
2: F0 1.000000e
3: color GREEN
```

- **On-screen editing.** Change any data value displayed in any window—just point the mouse, click, and type.

- **Continuous update.** The debugger continuously updates information on the screen, highlighting changed values.

- **Powerful command set.** Unlike many other debugging systems, this debugger doesn’t force you to learn a large, intricate command set. The ’C4x C source debugger supports a small but powerful command set that makes full use of C expressions. One debugger command performs actions that would require several commands in another system.

- **Flexible command entry.** There are a variety of ways to enter commands. You can type commands or use a mouse, function keys, or the pulldown menus; choose the method that you like best. Want to re-enter a command? No need to retype it—simply use the command history.

- **Create your own debugger.** The debugger display is completely configurable, allowing you to create the interface that is best suited for your use.

  - If you’re using a color display, you can change the colors of any area on the screen.
  - You can change the physical appearance of display features such as window borders.
  - You can interactively set the size and position of windows in the display.

  Create and save as many custom configurations as you like, or use the defaults. Use the debugger with a color display or a black-and-white display. A color display is preferable; the various types of information on the display are easier to distinguish when they are highlighted with color.

- **Variety of screen sizes.** The debugger’s default configuration is set up for a typical PC display, with 25 lines by 80 characters. If you use a sophisticated graphics card, you can take advantage of the debugger’s additional screen sizes. A larger screen size allows you to display more information and provides you with more screen space for organizing the display—bringing the benefits of workstation displays to your PC.

- **All the standard features you expect in a world-class debugger.** The debugger provides you with complete control over program execution with features like conditional execution and single-stepping (including single-stepping into or over function calls). You can set or clear a breakpoint with a click of the mouse or by typing commands. You can define a memory map that identifies the portions of target memory that the debugger can access. You can choose to load only the symbol table portion of an object file to work with systems that have code in ROM. The debugger can execute commands from a batch file, providing you with an easy method for entering often-used command sequences.

1.2 Description of the Analysis Interface

In addition to the basic debugger features, the ’C4x has an analysis module on the chip that allows the emulator to monitor the operations of your target system, this expands your debugging capabilities beyond simple software breakpoints.

The interface to the analysis module provides you with easy-to-use windows, dialog boxes, and commands that give you a detailed look into the operations of your target system. The analysis interface captures ’C4x bus cycle information in real time and reacts to this information through actions such as hardware breakpoints and event counting. Such features give you the ability to stop the processor and track the path your program took before reaching the breakpoint or event.

Key features of the analysis interface

❑ **Event Counting.** The analysis interface can count nine types of *events*. You have the option of counting the number of times a defined event occurred during execution of your program or stopping after a certain number of events are detected. You can count only one event at a time, including:

  - Bus accesses
  - CPU clock cycles
  - Calls/branches taken
  - Interrupts or traps taken
  - Returns from interrupts, traps, or calls
  - Instruction fetches

❑ **Set hardware breakpoints**. You can also set up the analysis interface to halt the processor during execution of your program. The events that cause the processor to stop are called *break events*. A break event can define a variety of conditions, including:

  - Bus accesses
  - CPU clock cycles
  - Calls/branches taken
  - Low levels on EMU0/1 pins (EMU0/1 and EMU0/1)
  - Interrupts or traps taken
  - Returns from interrupts, traps, or calls
  - Instruction fetches

❑ **Set up EMU0/1 pins.** In a system of multiple ’C4x processors connected by EMU0/1 (emulation event) pins, setting up the EMU0/1 pins allows you to create global breakpoints. Whenever one processor in your system reaches a breakpoint (software or hardware), *all* processors in the system can be halted.

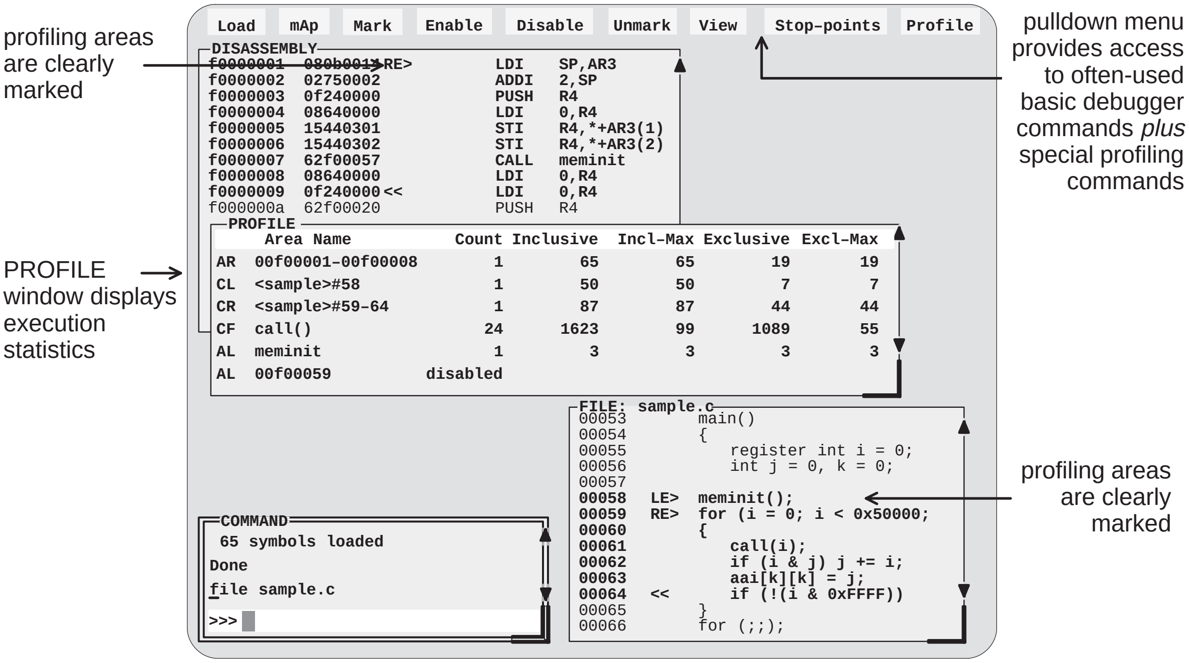
❑ **View the PC discontinuity stack.** *Discontinuity* occurs when the addresses fetched by the debugger become nonsequential as a result of loading the PC (through branches, calls, return instructions, for example) with new values. You can view these values through the PC discontinuity stack and easily track the progress of your program to see exactly how the debugger reached its current state.

1.3 Description of the Profiling Environment

In addition to the basic debugging environment, a second environment—the *profiling environment*—is available. The profiling environment provides a method for collecting execution statistics about specific areas in your code. This gives you immediate feedback on your application's performance.

Figure 1–2 identifies several features of the debugger display within the profiling environment.

Figure 1–2. The Profiling-Environment Display



profiling areas are clearly marked

pulldown menu provides access to often-used basic debugger commands *plus* special profiling commands

PROFILE window displays execution statistics

profiling areas are clearly marked

```
DISASSEMBLY
f0000001  080b0011RE>        LDI    SP,AR3
f0000002  02750002           ADDI   2,SP
f0000003  0f240000           PUSH   R4
f0000004  08640000           LDI    0,R4
f0000005  15440301           STI    R4,*+AR3(1)
f0000006  15440302           STI    R4,*+AR3(2)
f0000007  62f00057           CALL   meminit
f0000008  08640000           LDI    0,R4
f0000009  0f240000 <<        LDI    0,R4
f000000a  62f00020           PUSH   R4
```

```
PROFILE
     Area Name             Count Inclusive  Incl–Max Exclusive Excl–Max
AR  00f00001–00f00008          1        65        65        19       19
CL  <sample>#58                1        50        50         7        7
CR  <sample>#59–64             1        87        87        44       44
CF  call()                    24      1623        99      1089       55
AL  meminit                    1         3         3         3        3
AL  00f00059            disabled
```

```
FILE:  sample.c
00053        main()
00054        {
00055           register int i = 0;
00056           int j = 0, k = 0;
00057
00058  LE>   meminit();
00059  RE>   for (i = 0; i < 0x50000;
00060        {
00061           call(i);
00062           if (i & j) j += i;
00063           aai[k][k] = j;
00064  <<       if (!(i & 0xFFFF))
00065        }
00066        for (;;);
```

```
COMMAND
 65 symbols loaded
Done
file sample.c
>>>
```

Key features of the profiling environment

The profiling environment builds on the same easy-to-use interface available in the basic debugging environment and provides these additional features:

- ❑ **More efficient code.** Within the profiling environment, you can quickly identify busy sections in your programs. This helps you to direct valuable development time at streamlining the sections of code that most dramatically affect program performance.
- ❑ **Statistics on multiple areas.** You can collect statistics about individual statements in disassembly or C, about ranges in disassembly or C, and

about C functions. When you are collecting statistics on many areas, you can choose to view the statistics for all the areas or a subset of the areas.

- **Comprehensive display of statistics.** The profiler provides all the information you need for identifying bottlenecks in your code:
  - The number of times each area was entered during the profiling session.
  - The total execution time of an area, including or excluding the execution time of any subroutines called from within the area.
  - The maximum time for one iteration of an area, including or excluding the execution time of any subroutines called from within the area.

  Statistics may be updated continuously during the profiling session, or at selected intervals.

- **Configurable display of statistics.** Display the entire set of data, or display one type of data at a time. Display all the areas you're profiling, or display a selected subset of the areas.

- **Visual representation of statistics.** When you choose to display one type of data at a time, the statistics will be accompanied by histograms for each area, showing the relationship of each area's statistics to those of the other profiled areas.

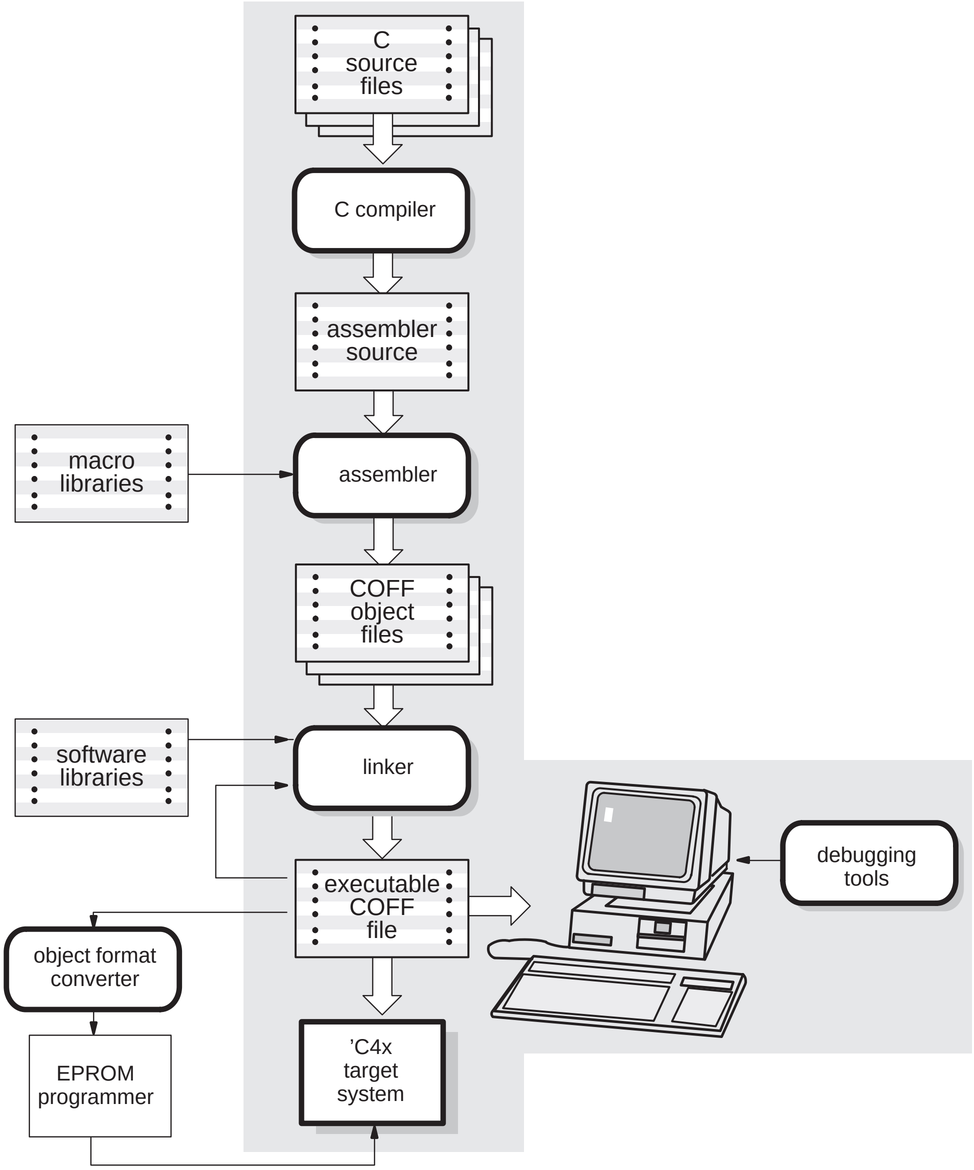
- **Disabled areas.** In addition to identifying areas that you can collect statistics on, you can also identify areas that you don't want to affect the statistics. This removes the timing impact from code such as a standard library function or a fully optimized portion of code.

- **Special profiling commands.** The profiling environment supports a rich set of commands to help you select areas and display information. Some of the basic debugger commands—such as the memory map commands—may be necessary during profiling, and are available within the profiling environment. Other commands—such as breakpoint commands and run commands—are not necessary and are therefore not available within the profiling environment.

1.4 Developing Code for the ’C4x

The ’C4x is well supported by a complete set of hardware and software development tools, including a C compiler, assembler, and linker. Figure 1–3 illustrates the ’C4x code development flow. The figure highlights the most common paths of software development; the other portions are optional.

Figure 1–3. ’C4x Software Development Flow



These tools use common object file format (COFF), which encourages modular programming. COFF allows you to divide your code into logical blocks, define your system’s memory map, and then link code into specific memory areas. COFF also provides rich support for source-level debugging.

The following list describes the tools shown in Figure 1–3.

C compiler

The ’C4x **optimizing ANSI C compiler** is a full-featured optimizing compiler that translates standard ANSI C programs into ’C4x assembly language source. Key characteristics include:

❑ *Standard ANSI C.* The ANSI standard is a precise definition of the C language, agreed upon by the C community. The standard encompasses most of the recent extensions to C. To an increasing degree, ANSI conformance is a requirement for C compilers in the DSP community.

❑ *Optimization.* The compiler uses several advanced techniques for generating efficient, compact code from C source.

❑ *Assembly language output.* The compiler generates assembly language source that you can inspect (and modify, if desired).

❑ *ANSI standard runtime support.* The compiler package comes with a complete runtime library that conforms to the ANSI C library standard. The library includes functions for string manipulation, dynamic memory allocation, data conversion, timekeeping, trigonometry, exponential, and hyperbolic functions. Functions for I/O and signal handling are not included because they are application specific.

❑ *Flexible assembly language interface.* The compiler has straightforward calling conventions, allowing you to easily write assembly and C functions that call each other.

❑ *Shell program.* The compiler package includes a shell program that enables you to compile, assemble, and link programs in a single step.

❑ *Source interlist utility.* The compiler package includes a utility that interlists your original C source statements into the assembly language output of the compiler. This utility provides you with an easy method for inspecting the assembly code generated for each C statement.

assembler

The **assembler** translates ’C4x assembly language source files into machine language object files.

linker

The **linker** combines object files into a single, executable object module. As the linker creates the executable module, it performs relocation and resolves external references. The linker is a tool that allows you to define your system’s memory map and to associate blocks of code with defined memory areas.

debugging tools

The main purpose of the development process is to produce a module that can be executed in a **’C4x target system.** You can use one of several **debugging tools** to refine and correct your code. Available products include:

- ❑ A realtime in-circuit **emulator**,
- ❑ A software **simulator**, and
- ❑ A **parallel processing development system (PPDS).**

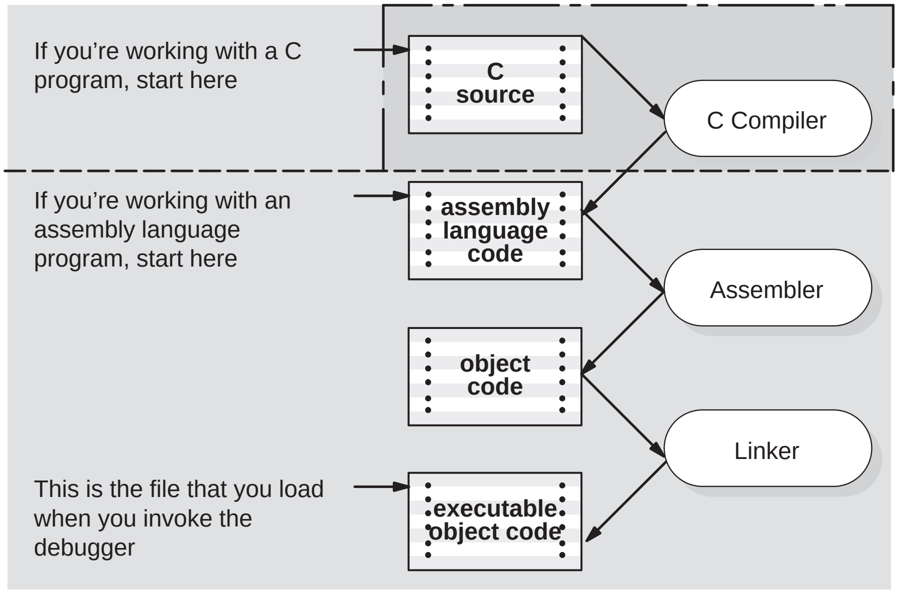
object format converter

The **object format converter** converts a COFF object file into an Intel, Tektronix, or TI-tagged object-format file that can be downloaded to an EPROM programmer.

1.5 Preparing Your Program for Debugging

Figure 1–4 illustrates the steps you must go through to prepare a program for debugging.

Figure 1–4. Steps You Go Through to Prepare a Program


If you're working with a C program, start here
C source
C Compiler
If you're working with an assembly language program, start here
assembly language code
Assembler
object code
Linker
This is the file that you load when you invoke the debugger
executable object code

If you're preparing to debug a C program. . .	1) Compile the program; **use the –g and –v40 options.** 2) Assemble the resulting assembly language program. 3) Link the resulting object file. This produces an object file that you can load into the debugger.
If you're preparing to debug an assembly language program. . .	1) Assemble the assembly language source file. 2) Link the resulting object file. This produces an object file that you can load into the debugger.

You can compile, assemble, and link a program by invoking the compiler, assembler, and linker in separate steps, or you can perform all three actions in a single step by using the CL30 shell program. Be sure to use the –v40 option to indicate to the debugger that you are compiling 'C4x source code. The *TMS320 Floating-Point DSP Assembly Language Tools User's Guide* and *TMS320 Floating-Point DSP Optimizing C Compiler User's Guide* contain complete instructions for invoking the tools individually and for using the shell program.

For your convenience, here's the command for invoking the shell program when preparing a program for debugging:

```
cl30  [–options]  –v40 –g  [filenames]  [–z [link options]]
```

cl30 is the command that invokes the compiler and assembler.

options affect the way the compiler processes input files. If you plan to use the debugger's profiling environment, include the –as option.

–v40 identifies your code as a 'C4x program. This ensures that the intermediate assembly language code is produced for the 'C4x rather than the 'C3x.

–g is an option that tells the C compiler to produce symbolic debugging information. When preparing a C program for debugging, you must use the –g option.

filenames are one or more C source files, assembly language source files, or object files. Filenames are not case sensitive.

–z is an option that invokes the linker. After compiling/assembling your programs, you can invoke the linker in a separate step. If you want the shell to automatically invoke the linker, however, use –z.

link options affect the way the linker processes input files; use these options only when you use –z.

Options and filenames can be specified in any order on the command line, but if you use –z, it must follow all C/assembly language source filenames and compiler options.

The shell identifies a file's type by the filename's extension.

Extension	File Type	File Description
.c	C source	compiled, assembled, and linked
.asm	assembly language source	assembled and linked
.s* (any extension that begins with s)	assembly language source	assembled and linked
.o* (extension begins with o)	object file	linked
none (.c assumed)	C source	compiled, assembled, and linked

1.6 Invoking the Debugger

Here’s the basic format for the commands that invoke the debugger:

```
emulator:    emu40   [filename]   [–options]   [–n device name]
simulator:   sim40   [filename]   [–options]
```

emu40
and **sim40** are the commands that invoke the debugger for each tool.

filename is an optional parameter that names an object file that the debugger will load into memory during invocation. The debugger looks for the file in the current directory; if the file isn’t in the current directory, you must supply the entire pathname. If you don’t supply an extension for the filename, the debugger assumes that the extension is .out.

–options supply the debugger with additional information (Table 1–1 summarizes the available options).

–n is required when running the emulator under OS/2, but *cannot* be used with the emulator under DOS or with the simulator.

You can also specify filename and option information with the D_OPTIONS environment variable (see *Setting up the environment variables* in the appropriate chapter of your installation book). Table 1–1 lists the debugger options and specifies which debugger tools use the options; the subsections following the table describe the options.

Table 1–1. Summary of Debugger Options

Option	Brief description	Debugger Tools
–b{b}	Select the screen size	All
–i *pathname*	Identify additional directories	All
–n *device name*	Identify device for debugging	Emulator under OS/2
–p *port address*	Identify the port address	Emulator
–profile	Enter the profiling environment	All
–s	Load the symbol table only	All
–t *filename*	Identify a new initialization file	All
–v	Load without the symbol table	All
–x	Ignore D_OPTIONS	All

Selecting the screen size (–b option)

By default, the debugger uses an 80-character-by-25-line screen. You can use one of the options in Table 1–2 to specify a different screen size. On Sun systems, you can resize the screen at runtime also.

Table 1–2. Screen Size Options (for Use With the –b Option)

Option	Description	Notes
none	80 characters by 25 lines	Default display
–b	80 characters by 43 lines	Any EGA or VGA display (Note using this option in an OS/2 environment may cause problems.)
–bb	80 characters by 50 lines	VGA only

Note:

On Sun systems, the maximum size of the debugger screen is 132 characters by 60 lines.

Identifying additional directories (–i option)

The –i option identifies additional directories that contain your source files. Replace *pathname* with an appropriate directory name. You can specify several pathnames; use the –i option as many times as necessary. For example:

emu40 **–i** *path*$_1$ **–i** *path*$_2$ **–i** *path*$_3$ . . .

Using –i is similar to using the D_SRC environment variable (see *Setting up the environment variables* in the appropriate chapter of your installation guide). If you name directories with both –i and D_SRC, the debugger first searches through directories named with –i. The debugger can track a cumulative total of 20 paths (including paths specified with –i, D_SRC, and the debugger USE command).

Identifying the device that will be debugged (–n option)

The –n option is valid only when using the emulator under OS/2. The –n option allows you to specify which particular ’C4x you plan to debug. The device name must match one of the names defined in your board.cfg file. For example, if you wanted to debug a ’C4x that you had defined as C40_A, you would specify:

```
–n C40_A
```

Device names can be any string less than 32 characters long; however, they cannot contain double quotes, a line feed, or a newline character. For more information about the board.cfg file, refer to Chapter 1 of the *TMS320C4x Emulator Installation Guide.*

Identifying the port address (–p option)

The –p option is valid only when using the emulator. The –p option identifies the I/O port address that the debugger uses for communicating with the emulator. If you used the default switch settings, you don’t need to use the –p option. **If you used nondefault switch settings, you must use –p**. Refer to your entries in the *Your Settings* table in Chapter 1 (OS/2) or Chapter 2 (DOS) of the installation guide; depending on your switch settings, replace *port address* with one of these values:

Switch 1	Switch 2	Option
on	on	none needed
on	off	–p 280
off	on	–p 320
off	off	–p 340

If you didn’t note the I/O switch settings, you can use a trial-and-error approach to find the correct –p setting. If you use the wrong setting, you’ll see this error message when you try to invoke the debugger:

```
CANNOT INITIALIZE TARGET SYSTEM ! !
      – Check I/O configuration
  – Check cabling and target power
```

Entering the profiling environment (–profile option)

The –profile option allows you to bring up the debugger in a profiling environment so you can collect statistics about code execution. Note that only a subset of the base debugger features is available in the profiling environment.

Loading the symbol table only (–s option)

If you supply a *filename* when you invoke the debugger, you can use the –s option to tell the debugger to load only the file's symbol table (without the file's object code). This is similar to the debugger's SLOAD command.

Identifying a new initialization file (–t option)

The –t option allows you to specify an initialization command file that will be used instead of emuinit.cmd (for the emulator) or siminit.cmd (for the simulator). If –t is present on the command line, the file specified by *filename* will be invoked as the command file instead of emuinit.cmd or siminit.cmd.

Loading without the symbol table (–v option)

The –v option prevents the debugger from loading the entire symbol table when you load an object file. The debugger loads only the global symbols and later loads local symbols as it needs them. This speeds up the loading time and consumes less memory space.

The –v option affects all loads, including those performed when you invoke the debugger and those executed with the LOAD command within the debugger environment.

Ignoring D_OPTIONS (–x option)

The –x option tells the debugger to ignore any information supplied with D_OPTIONS. For more information about D_OPTIONS, refer to the *TMS320C4x Emulator Installation Guide* and the *TMS320C4x Simulator Installation Guide.*

1.7 Exiting the Debugger

To exit any version of the debugger and return to the operating system, enter this command:

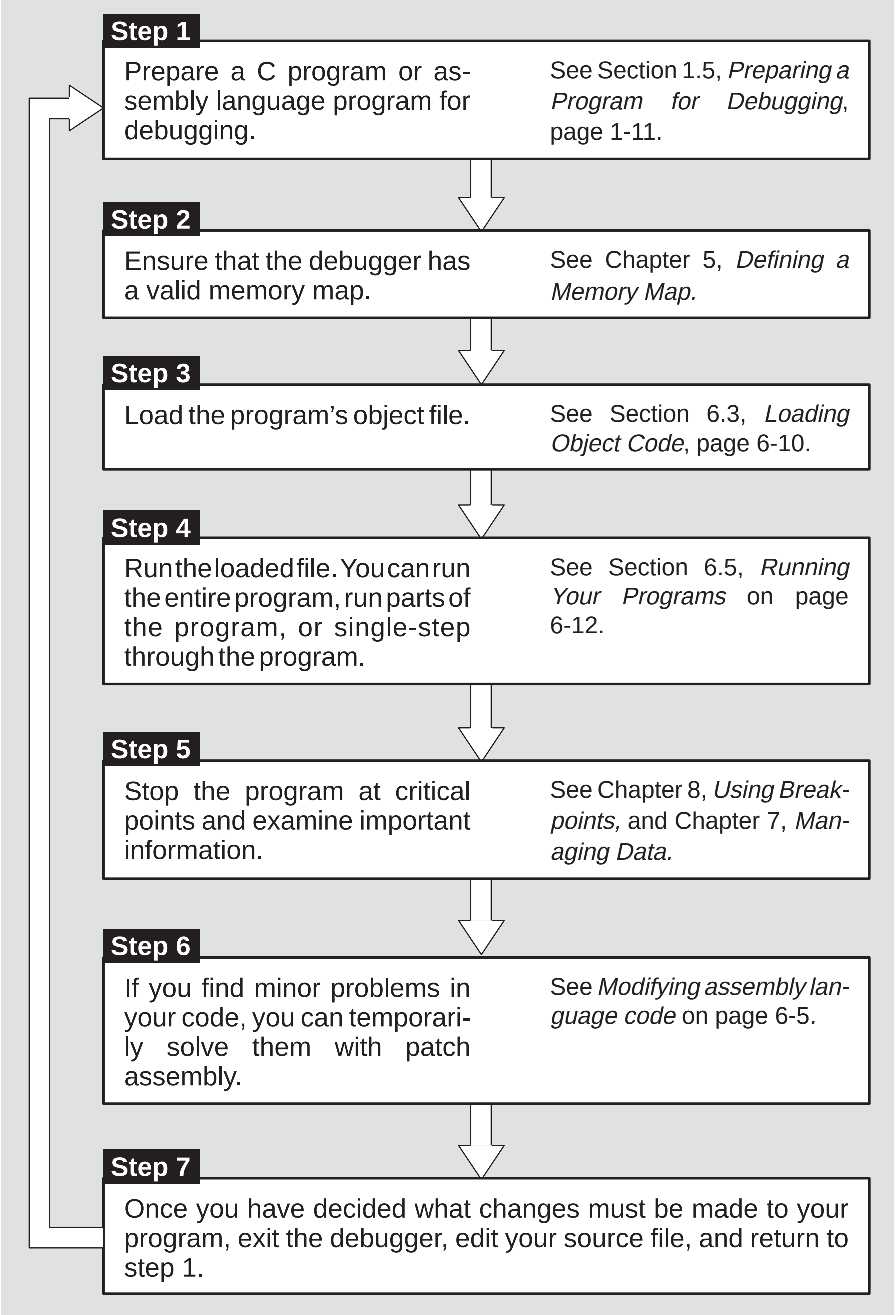
```
quit ↵
```

You don’t need to worry about where the cursor is or which window is active—just type. If a program is running, press ESC to halt program execution before you quit the debugger.

If you are running the debugger under Microsoft Windows, you can also exit the debugger by selecting the exit option from the Microsoft Windows menu bar.

1.8 Debugging ’C4x Programs

Debugging a program is a multiple-step process. These steps are described below, with references to parts of this book that will help you accomplish each step.



Step 1

Prepare a C program or assembly language program for debugging.

See Section 1.5, *Preparing a Program for Debugging*, page 1-11.

Step 2

Ensure that the debugger has a valid memory map.

See Chapter 5, *Defining a Memory Map.*

Step 3

Load the program’s object file.

See Section 6.3, *Loading Object Code*, page 6-10.

Step 4

Run the loaded file. You can run the entire program, run parts of the program, or single-step through the program.

See Section 6.5, *Running Your Programs* on page 6-12.

Step 5

Stop the program at critical points and examine important information.

See Chapter 8, *Using Breakpoints,* and Chapter 7, *Managing Data.*

Step 6

If you find minor problems in your code, you can temporarily solve them with patch assembly.

See *Modifying assembly language code* on page 6-5*.*

Step 7

Once you have decided what changes must be made to your program, exit the debugger, edit your source file, and return to step 1.

Chapter 2

An Introductory Tutorial

This chapter provides a step-by-step demonstration of the ’C4x C source debugger’s basic features. This is not the kind of tutorial that you can take home to read—this tutorial is effective only if you’re sitting at your PC, performing the lessons in the order that they’re presented. This tutorial contains two sets of lessons (11 in the first, 13 in the second) and takes about one hour to complete.

How to use this tutorial

This tutorial contains three basic types of information:

Primary actions

Primary actions identify the main lessons in the tutorial; they're boxed so you can find them easily. A primary action looks like this:

> Make the CPU window the active window:
>
> **`win CPU`** ↵

Important information

In addition to primary actions, important information ensures that the tutorial works correctly. Important information is marked like this:

Important! The CPU window should still be active from the previous step.

Alternative actions

Alternative actions show additional methods for performing the primary actions. Alternative actions are marked like this:

Try This: Another way to display the current code in MEMORY is to show memory beginning from the current PC. . .

Important! This tutorial assumes that you have correctly and completely installed your debugger (including invoking any files, DOS, or OS/2 commands as instructed in Section 1.6, page 1-13, or in the installation guides).

A note about entering commands

Whenever this tutorial tells you to type a debugger command, just type—the debugger automatically places the text on the command line. You don't have to worry about moving the cursor to the command line; the debugger takes care of this for you. (There are a few instances when this isn't true—for example, when you're editing data in the CPU or MEMORY window—but this is explained later in the tutorial.)

Also, you don't have to worry about typing commands in uppercase or lowercase—either is fine. There are a few instances when a command's *parameters* must be entered in uppercase, and the tutorial points this out.

An escape route (just in case)

The steps in this tutorial create a path for you to follow. The tutorial won't purposely lead you off the path. But sometimes when people use new products, they accidently press the wrong key, push the wrong mouse button, or mistype a command. Suddenly, they're off the path without any idea of where they are or how they got there.

This probably won't happen to you. But, if it does, you can almost always get back to familiar ground by pressing ESC. If you were running a program when you pressed ESC, you should also type RESTART ↵. Then go back to the beginning of whatever lesson you were in and try again.

Invoke the debugger and load the sample program's object code

Included with the debugger is a demonstration program named *sample*. This lesson shows you how to invoke the debugger and load the sample program.

Important! If you are using the emulator, this step assumes that you are using the default I/O address or that you have identified the I/O address with the D_OPTIONS environment variable, as described in the *TMS320C4x C Source Debugger Installation Guide* in Chapters 1 (OS/2 environment) and 2 (DOS environment).

Invoke the debugger and load the sample program:

- □ For the **emulator**, enter:

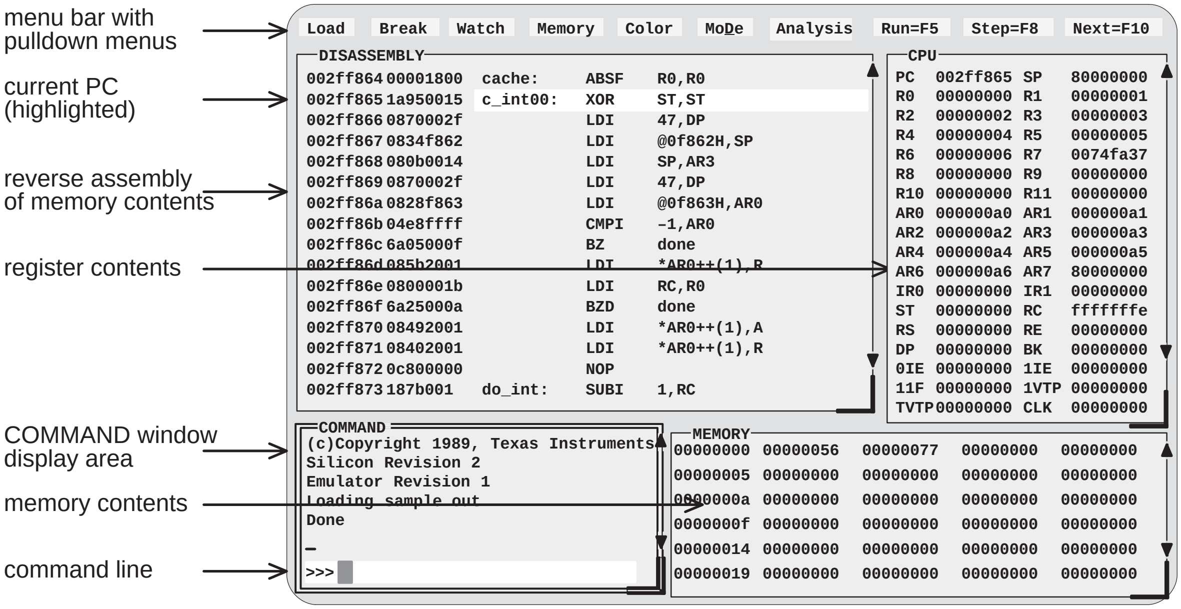
  ```
  emu40 c:\c4xhll\sample     ↵
  ```

- □ For the **simulator**, enter:

  ```
  sim40 c:\sim4x\sample     ↵
  ```

Take a look at the display. . .

Now you should see a display similar to this (it may not be exactly the same display, but it should be close).



```
DISASSEMBLY
002ff864 00001800  cache:     ABSF    R0,R0
002ff865 1a950015  c_int00:   XOR     ST,ST
002ff866 0870002f             LDI     47,DP
002ff867 0834f862             LDI     @0f862H,SP
002ff868 080b0014             LDI     SP,AR3
002ff869 0870002f             LDI     47,DP
002ff86a 0828f863             LDI     @0f863H,AR0
002ff86b 04e8ffff             CMPI    –1,AR0
002ff86c 6a05000f             BZ      done
002ff86d 085b2001             LDI     *AR0++(1),R
002ff86e 0800001b             LDI     RC,R0
002ff86f 6a25000a             BZD     done
002ff870 08492001             LDI     *AR0++(1),A
002ff871 08402001             LDI     *AR0++(1),R
002ff872 0c800000             NOP
002ff873 187b001   do_int:    SUBI    1,RC
```

```
CPU
PC   002ff865 SP   80000000
R0   00000000 R1   00000001
R2   00000002 R3   00000003
R4   00000004 R5   00000005
R6   00000006 R7   0074fa37
R8   00000000 R9   00000000
R10  00000000 R11  00000000
AR0  000000a0 AR1  000000a1
AR2  000000a2 AR3  000000a3
AR4  000000a4 AR5  000000a5
AR6  000000a6 AR7  80000000
IR0  00000000 IR1  00000000
ST   00000000 RC   fffffffe
RS   00000000 RE   00000000
DP   00000000 BK   00000000
0IE  00000000 1IE  00000000
11F  00000000 1VTP 00000000
TVTP 00000000 CLK  00000000
```

```
COMMAND
(c)Copyright 1989, Texas Instruments
Silicon Revision 2
Emulator Revision 1
Loading sample out
Done

–
>>>
```

```
MEMORY
00000000 00000056  00000077  00000000  00000000
00000005 00000000  00000000  00000000  00000000
0000000a 00000000  00000000  00000000  00000000
0000000f 00000000  00000000  00000000  00000000
00000014 00000000  00000000  00000000  00000000
00000019 00000000  00000000  00000000  00000000
```

❑ If you **don’t** see a display, then your debugger or board may not be installed properly. Go back through the installation instructions and be sure that you followed each step correctly; then reinvoke the debugger.

❑ If you **do** see a display, *check the first few lines of the DISASSEMBLY window*. If these lines aren’t the same—if, for example, they show ADD instructions or say invalid address—then enter the following commands on the debugger command line. (Just type; you don’t have to worry about where the cursor is.)

1) Reset the ’C4x processor:

   `reset` ↵

2) Load the sample program again:

   `load c:\c4xhll\sample` ↵ (emulator)

   `load c:\sim4x\sample` ↵ (simulator)

❑ If you see a display and the first few lines of the DISASSEMBLY window still show ADD instructions or they say invalid address after resetting the ’C4x processor, your emulator board may not be inserted snugly. Check your board and see if it is installed correctly, then reenter the above commands.

What’s in the DISASSEMBLY window?

The DISASSEMBLY window always shows the reverse assembly of memory contents; in this case, it shows an assembly language version of sample.out. The MEMORY window displays the current contents of memory. Because you loaded the object file sample.out when you invoked the debugger, memory contains the object code version of the sample file.

This tutorial step demonstrates that the code shown in the DISASSEMBLY window corresponds to memory contents. Initially, memory is displayed starting at address 0; if you look at the first line of the DISASSEMBLY window, you’ll see that its display starts at address 0x002ff864.

Modify the MEMORY display to show the same object code that is displayed in the DISASSEMBLY window:

mem 0x002ff864 ⏎

Notice that the first column in the DISASSEMBLY window corresponds to the addresses in the MEMORY window; the second column in the DISASSEMBLY window corresponds to the memory contents displayed in the MEMORY window.

Try This: The highlighted statement in the DISASSEMBLY window shows that the PC is currently pointing to address 0x002ff865. You can modify the MEMORY display to show memory beginning from the current PC:

mem PC ⏎

Select the active window

This lesson shows you how to make a window into the *active window.* You can move and resize any window; you can close some windows. Whenever you type a command or press a function key to move, resize, or close a window, the debugger must have some method of understanding which window you want to affect. The debugger does this by designating one window at a time to be the *active window*. Any window can be the active window, but only one window at a time can be active.

Make the CPU window the active window:

win CPU ⏎

lesson continues on the next page →

Important! Notice the appearance of the CPU window (especially its borders) in contrast to the other, inactive windows. This is how you can tell which window is active.

Important! If you don't see a change in the appearance of the CPU window, look at the way you entered the command. Did you enter **CPU** in uppercase letters? For this command, it's important that you enter the parameters in uppercase as shown.

Try This: Press the F6 key to "cycle" through the windows in the display, making each one active in turn. Press F6 as many times as necessary until the CPU window becomes the active window.

Try This: You can also use the mouse to make a window active:

1) Point to any location on the window's border.

2) Click the left mouse button.

Be careful! If you point *inside* the window, the window becomes active when you press the mouse button, but something else may happen as well:

- ❑ If you're pointing inside the CPU window, then the register you're pointing at becomes active. The debugger then treats the text you type as a new value for that register. Similarly, if you're pointing inside the MEMORY window, the address you're pointing at becomes active.

  Press ESC *to get out of this.*

- ❑ If you're pointing inside the DISASSEMBLY or FILE window, you'll set a breakpoint on the statement that you were pointing to.

  Point to the same statement; press the button again to delete the breakpoint.

Size the active window

This lesson shows you how to resize the active window.

Important! The CPU window should still be active from the previous step.

Make the CPU window as small as possible:

`size 4,3` ↵

This tells the debugger to make the window 4 characters by 3 lines, which is the smallest a window can be. (If it were any smaller, the debugger wouldn't be able to display all four corners of the window.) If you try to enter smaller values, the debugger will warn you that you've entered an *Invalid window size*. The maximum width and length depend on which –b option you used when you invoked the debugger.

Make the CPU window larger:

`size` ↵	*Enter the SIZE command without parameters*
↓ ↓ ↓	*Make the window 3 lines longer*
→ → → →	*Make the window 4 characters wider*
ESC	*Press this key when you finish sizing the window*

You can also use ↑ to make the window shorter and ← to make the window narrower.

Try This: You can also use the mouse to resize the window (note that this process forces the selected window to become the active window).

↖ 1) If you examine any window, you'll see a highlighted, backwards "L" in the lower right corner. Point to the lower right corner of the CPU window.

▮▯ 2) Press the left mouse button, but don't release it; move the mouse while you're holding in the button. This resizes the window.

▯▯ 3) Release the mouse button when the window reaches the desired size.

Zoom the active window

Another way to resize the active window is to zoom it. Zooming the window makes it as large as possible.

Important! The CPU window should still be active from the previous steps.

Make the active window as large as possible:

```
zoom ⏎
```

The window should now be as large as possible, taking up the entire display (except for the menu bar) and hiding all the other windows.

“Unzoom” or return the window to its previous size by entering the ZOOM command again:

```
zoom ⏎
```

The ZOOM command will be recognized even though the COMMAND window is hidden by the CPU window.

The window should now be back to the size it was before zooming.

Try This: You can also use the mouse to zoom the window.

Zoom the active window:

↖ 1) Point to the upper left corner of the active window.

▮▯ 2) Click the left mouse button.

Return the window to its previous size by repeating these steps.

Move the active window

This lesson shows you how to move the active window.

Important! The CPU window should still be active from the previous steps.

Move the CPU window to the upper left portion of the screen:

```
move 0,1 ⏎          The debugger doesn't let you move the window
                     to the very top—that would hide the menu bar
```

The MOVE command's first parameter identifies the window's new X position on the screen. The second parameter identifies the window's new Y position on the screen. The maximum X and Y positions depend on which –b option you used when you invoked the debugger and on the position of the window before you tried to move it.

Try This: You can use the MOVE command with no parameters and then use arrow keys to move the window:

```
move ⏎
→→→→                Press → until the CPU window is back where it was
               (it may seem like only the border is moving—this is normal)
ESC                       Press ESC when you finish moving the window
```

You can also use ↑ to move the window up, ↓ to move the window down, and ← to move the window left.

Try This: You can also use the mouse to move the window (note that this process forces the selected window to become the active window).

↖ 1) Point to the top edge or left edge of the window border.

2) Press the left mouse button, but don't release the button; move the mouse while you're holding in the button.

3) Release the mouse button when the window reaches the desired position.

Scroll through a window's contents

Many of the windows contain more information than can possibly be displayed at one time. You can view hidden information by moving through a window's contents. The easiest way to do this is to use the mouse to scroll the display up or down.

If you examine most windows, you'll see an up arrow near the top of the right border and a down arrow near the bottom of the right border. These are scroll arrows.

> Scroll through the contents of the DISASSEMBLY window:
>
> ↖ 1) Point to the up or down scroll arrow.
>
> ▮▯ 2) Press the left mouse button; continue pressing it until the display has scrolled several lines.
>
> ▯▯ 3) Release the button.

Try This: You can also use several of the keys to modify the display in the active window.

Make the MEMORY window the active window:

`win MEMORY` ⏎

Now try pressing these keys; observe their effects on the window's contents.

↓ ↑ PAGE DOWN PAGE UP

These keys don't work the same for all windows; Section 12.5 (page 12-51) summarizes the functions of all the special keys, key sequences, and how their effects vary for the different windows.

Display the C source version of the sample file

Now that you can find your way around the debugger interface, you can become familiar with some of the debugger’s more significant features. It’s time to load some C code.

Display the contents of a C source file:

```
file sample.c ↵
```

This opens a FILE window that displays the contents of the file sample.c (sample.c was one of the files that contributed to making the sample object file). You can always tell which file you’re displaying by the label in the FILE window. Right now, the label should say `FILE: sample.c`.

Execute some code

Let’s run some code—not the whole program, just a portion of it.

Execute a portion of the sample program:

```
go main ↵
```

You’ve just executed your program up to the point where main() is declared. Notice how the display has changed:

- The current PC is highlighted in both the DISASSEMBLY and FILE windows.
- The addresses and object codes of the first four statements in the DISASSEMBLY window are highlighted; this is because these statements are associated with the current C statement (line 27 in the FILE window).
- The CALLS window, which tracks functions as they’re called, now points to main().
- The values of the PC and SP (and possibly some additional registers) are highlighted in the CPU window because they were changed by program execution.

Become familiar with the three debugging modes

The debugger has three basic debugging modes:

❑ **Mixed mode** shows both disassembly and C at the same time.

❑ **Auto mode** shows disassembly or C, depending on what part of your program happens to be running.

❑ **Assembly mode** shows only the disassembly, no C, even if you're executing C code.

When you opened the FILE window in a previous step, the debugger switched to mixed mode; you should be in mixed mode now. (You can tell that you're in mixed mode if both the FILE and DISASSEMBLY windows are displayed.)

The following steps show you how to switch debugging modes.

Use the **MoDe** menu to select assembly mode:

1) Look at the top of the display: the first line shows a row of pull-down menu selections.

↖ 2) Point to the word MoDe on the menu bar.

▮▯ 3) Press the left mouse button, but don't release it; drag the mouse downward until Asm (the second entry) is highlighted.

▯▯ 4) Release the button.

This switches to assembly mode. You should see the DISASSEMBLY window, but not the FILE window.

Switch to auto mode:

1) Press ALT D. This displays and freezes the MoDe menu.

2) Now select C(auto). Choose one of these methods for doing this:

❑ Press the arrow keys to move up/down through the menu; when C(auto) is highlighted, press ↵.

❑ Type **C** ↵ .

❑ Point the mouse cursor at C(auto), then click the left mouse button.

You should be in auto mode now, and you should see the FILE window but not the DISASSEMBLY window (because your program is in C code). Auto mode automatically switches between an assembly or a C display, depending on where you are in your program. Here's a demonstration of that:

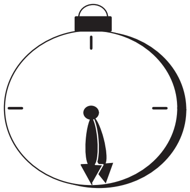
> Run to a point in your program that executes assembly language code:
>
> **`go meminit`** ↵

You're still in auto mode, but you should now see the DISASSEMBLY window. The current PC should be at the statement that defines the meminit label.

Try This: You can also switch modes by typing one of these commands:

asm	switches to assembly-only mode
c	switches to auto mode
mix	switches to mixed mode

> Switch back to mixed mode.



Halfway Point

You've finished the first half of the tutorial and the first set of lessons.

If you want to close the debugger, just type **`QUIT`** ↵. When you return to the debugger, you must reinvoke it and load the sample program (refer to page 2-3). Turn to page 2-14 and continue with the second set of lessons.

Open another text file, then redisplay a C source file

In addition to what you already know about the FILE window and the FILE command, you should also know that:

- ❑ You can display any text file in the FILE window.
- ❑ If you enter any command that requires the debugger to display a C source file, it automatically displays that code in the FILE window (regardless of whether the window is open or not and regardless of what is already displayed in the FILE window).

Display a file that isn't a C source file:

- ❑ Emulator:

```
file emuinit.cmd ↵
```

- ❑ Simulator:

```
file siminit.cmd ↵
```

This replaces sample.c in the FILE window with the initialization batch file (emuinit.cmd or siminit.cmd) that comes with your debugger.

Remember, you can tell which file you're displaying by the label in the FILE window. Right now, the label should say FILE: emuinit.cmd (if you're using the emulator), or FILE: siminit.cmd (if you're using the simulator).

Redisplay another C source file (sample1.c):

```
func call ↵
```

Now the FILE window label should say FILE: sample1.c because the call() function is in sample1.c.

Use the basic RUN command

The debugger provides you with several ways of running code, but it has one basic run command.

Run your entire program:

```
run ↵
```

Entered this way, the command basically means “run forever”. You may not have that much time!

This isn’t very exciting: halt program execution:

ESC

Set some software breakpoints

When you halted execution in the previous step, you should have seen changes in the display similar to the changes you saw when you entered *go main* earlier in the tutorial. When you pressed ESC, you had little control over where the program stopped. Knowing that information changed was nice, but what part of the program affected the information?

This information would be much more useful if you picked an explicit stopping point before running the program. Then, when the information changed, you’d have a better understanding of what caused the changes. You can stop program execution in this way by setting *software breakpoints*.

Important! This lesson assumes that you’re displaying the contents of sample.c in the FILE window. If you aren’t, enter:

```
file sample.c ↵
```

lesson continues on the next page →

Set a software breakpoint and run your program:

1) Scroll to line 32 in the FILE window (the meminit() statement) and set a breakpoint at that line:

   ↖ a) Point the mouse cursor at the statement on line 32.

   b) Click the left mouse button. *Notice how the line is highlighted; this identifies a breakpointed statement.*

2) Reset the program entry point:

   `restart` ↵

3) Enter the run command:

   `run` ↵ *Program execution halts at the breakpoint*

Once again, you should see that some statements are highlighted in the CPU window, showing that they were changed by program execution. But this time, you know that the changes were caused by code from the beginning of the program to line 58 in the FILE window.

Clear the breakpoint:

↖ 1) Point the mouse cursor at the statement on line 32. (It should still be highlighted from setting the breakpoint.)

2) Click the left mouse button. *The line is no longer highlighted.*

Benchmark a section of code (emulator and simulator)

You can use breakpoints to help you benchmark a section of code. This means that you'll ask the debugger to count the number of CPU clock cycles that are consumed by a certain portion of code.

Benchmark some code:

1) In sample.c (displayed in the FILE window), set two breakpoints: one at line 32 (the meminit() statement) and one at line 40 (the for(;;); statement).

2) Reset the program entry point:

   `restart` ↵

3) Enter the run command:

   `run` ↵ — *This runs to the first breakpoint*

4) Enter the runb command:

   `runb` ↵ — *This runs to the second breakpoint (this may take several seconds)*

5) Now use the ? command to examine the contents of the CLK pseudoregister:

   `? clk` ↵

The debugger now shows a number in the display area; this is the number of CPU clock cycles consumed by the portion of code between the two breakpointed C statements.

Important! The value in the CLK pseudoregister is valid *only* when you execute the RUNB command and when that execution is halted on breakpointed statements.

Delete both breakpoints:

`br` ↵ — *The BR (breakpoint reset) command deletes all breakpoints that were set*

Watch some values and single-step through code

Now you know how to update the display without running your entire program; you can set breakpoints to obtain information at specific points in your program. But what if you want to update the display after each statement? No, you don't have to set a breakpoint at every statement—you can use single-step execution.

Set up for the single-step example:

```
restart ↵
go main ↵
```

The debugger has another type of window called a WATCH window that's very useful in combination with single-step execution. What's a WATCH window for? Suppose you are interested in only a few specific register values, not *all* of the registers shown in the CPU window. Or suppose you are interested in a particular memory location or in the value of some variable. You can observe these data items in a WATCH window.

Set up the WATCH window before you start the single-step execution.

Open a WATCH window:

```
wa sp ↵
wa pc, Program Counter ↵
wa *0x002ff81f, call:↵
wa i ↵
```

You may have noticed that the WA (watch add) command can have one or two parameters. The first parameter is the item that you're watching. The second parameter is an optional label.

If the WATCH window isn't wide enough to display the PC value, resize the window.

Now try out the single-step commands. **Hint:** Watch the PC in the FILE and DISASSEMBLY windows; watch the value of i in the WATCH window.

> Single-step through the sample program:
>
> **`step 50`** ⏎

Try This: Notice that the step command single-stepped each assembly language statement (in fact, you single-stepped through 50 assembly language statements). Did you also notice that the FILE window displayed the source for the call() function when it was called? The debugger supports more single-step commands that have a slightly different flavor.

- For example, if you enter:

  ```
  cstep 50 ⏎
  ```

  you'll single-step 50 *C statements,* not assembly language statements (notice how the PC "jumps" in the DISASSEMBLY window).

- Reset the program entry point and run to main().

  ```
  restart ⏎
  go main ⏎
  ```

  Now enter the NEXT command, as shown below. You'll be single-stepping 50 assembly language statements, *but the FILE window doesn't display the source for the call() function when call() is executed.*

  ```
  next 50 ⏎
  ```

  (There's also a CNEXT command that "nexts" in terms of C statements.)

Run code conditionally

Try executing this loop one more time. Take a look at this code; it’s doing a lot of work with a variable named i. You may want to check the value of i at specific points instead of after each statement. To do this, you set software breakpoints at the statements you’re interested in and then initiate a conditional run.

First, clear out the WATCH window so that you won’t be distracted by any superfluous data items.

Delete the first three data items from the WATCH window (don’t watch them anymore).

```
wd 3 ↵
wd 2 ↵
wd 1 ↵
```

i was the fourth item added to the WATCH window in the previous tutorial step, and it should now be the only remaining item in the window. (The sample program declares two variables named i: one is a global variable, and one is local to main(). Because you executed the wa i command while in main(), you’re watching the i variable that’s local to main().

Set up for the conditional run examples:

1) Set software breakpoints at lines 29 and 38.

2) Reset the program entry point:

```
restart ↵
```

3) Run the first part of the program:

```
go main ↵
```

4) Reset the value of *i* :

```
? = 0   ↵
```

Now initiate the conditional run:

```
run i < 100
```

This causes the debugger to run through the loop as long as the value of i is less than 100. Each time the debugger encounters the breakpoints in the loop, it updates the value of i in the WATCH window.

When the conditional run completes, close the WATCH window.

Close the WATCH window:

```
wr ⏎
```

WHATIS that?

At some point, you might like to obtain some information about the types of data in your C program. Maybe things won't be working quite the way you'd planned, and you'll find yourself saying something like "... but isn't that supposed to point to an integer?" Here's how you can check on this kind of information: be sure to watch the COMMAND window display area as you enter these commands.

Use the WHATIS command to find the types of some of the variables declared in the sample program:

```
whatis genum ⏎
      enum yyy genum;              genum is an enumerated type
whatis tiny6 ⏎
      struct {                             tiny6 is a structure
          int u;
          int v;
          int x;
          int y;
          int z;
      } tiny6;
whatis call ⏎
      int call();         call is a function that returns an integer
whatis s ⏎
      short s;                      s is a short unsigned integer
whatis zzz ⏎
      struct zzz {                   zzz is a very long structure
          int b1;
          int b2;
```

Press ESC *to halt long listings*

Clear the COMMAND window display area

After displaying all of these types, you may want to clear them away. This is easy to do.

> Clear the COMMAND window display area:
>
> **`cls`** ↵

Try This: CLS isn't the only system-type command that the debugger supports.

`cd ..`	*Change back to the main directory*
`dir`	*Show a listing of the current directory*
`cd` *`directory name`*	*Change back to the debugger directory*

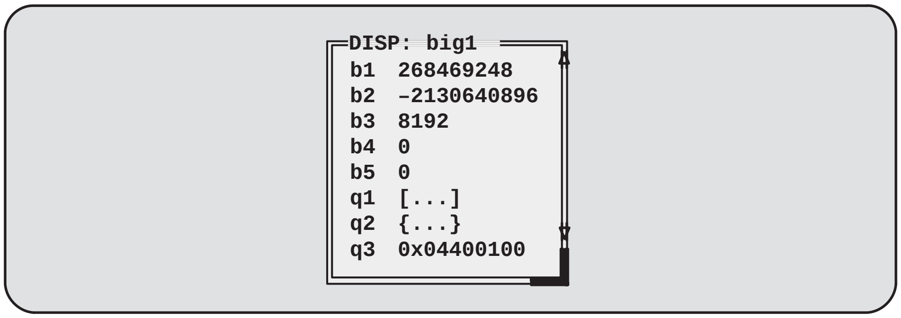
Display the contents of an aggregate data type

The WATCH window is convenient for watching single, or *scalar*, values. When you're debugging a C program, though, you may need to observe values that aren't scalar; for example, you might need to observe the effects of program execution on an array. The debugger provides another type of window called a DISP window where you can display the individual members of an array or structure.

> Show a structure in a DISP window:
>
> **`disp tiny6`** ↵
>
> Close the DISP window:
>
> F4

> Show another structure in a DISP window:
>
> **`disp big1`** ↵

Now you should see a display like the one below. The newly opened DISP window becomes the active window. Like the FILE window, you can always tell what's being displayed because of the way the DISP window is labeled. Right now, it should say DISP: big1.



```
DISP: big1
b1  268469248
b2  -2130640896
b3  8192
b4  0
b5  0
q1  [...]
q2  {...}
q3  0x04400100
```

- ❑ Members b1, b2, b3, b4, and b5 are ints; you can tell because they're displayed as integers (shown as plain numbers without prefixes).
- ❑ Member q1 is an array; you can tell because q1 shows [. . .] instead of a value.
- ❑ Member q2 is another structure; you can tell because q2 shows {. . .} instead of a value.
- ❑ Member q3 is a pointer; you can tell because it is displayed as a hexadecimal address (indicated by a 0x prefix) instead of an integer value.

If a member of a structure or an array is itself a structure or an array, or even a pointer, you can display its members (or the data it points to) in additional DISP windows (referred to as the original DISP window's *children*).

Display what q3 is pointing to:

↖ 1) Point at the address displayed next to the q3 label in big1's display.

▮▯ 2) Click the left mouse button.

lesson continues on the next page →

This opens a second DISP window, named big1.q3, that shows what q3 is pointing to (it's pointing to another structure). Close this DISP window or move it out of the way.

Display array q1 in another DISP window:

↖ 1) Point at the [. . .] displayed next to the q1 label in big1's display.

2) Click the left mouse button.

This opens another DISP window labeled DISP: big1.q1.

Important! q1 is actually a 2-member array of structures. To view the two different structures, use CONTROL PAGE DOWN and CONTROL PAGE UP. (Look at the name of this DISP window when you're switching.)

Try This: Display structure q2 in another DISP window.

1) Close the additional DISP windows or move them out of the way so that you can clearly see the original DISP window that you opened to display big1.

2) Make big1's DISP window the active window.

↓ ↑ 3) Use these arrow keys to move the field cursor (_) through the list of big1's members until the cursor points to q2.

F9 4) Now press F9.

Close all of the DISP windows:

1) Make big1's DISP window the active window.

2) Press F4

When you close the main DISP window, the debugger closes all of its children as well.

Display data in another format

Usually, when you add an item to the WATCH window or open a DISP window, the data is shown in its *natural format*. This means that ints are shown as integers, floats are shown as floating-point values, etc. Occasionally, you may wish to view data in a different format. This can be especially important if you want to show memory or register contents in another format.

One way to display data in another format is through casting (which is part of the C language). In the expression below, the *(float *) portion of the expression tells the debugger to treat address 0x80009c00 as type float (exponential floating-point format).

> Display memory contents in floating-point format:
>
> ```
> disp *(float *)0x002ff8e4 ↵
> ```

This opens a DISP window to show memory contents in an array format. The "array" member identifiers don't necessarily correspond to actual addresses—they're relative to the first address you request with the DISP command. In this case, the item displayed as item [0] is the contents of address 0x002ff8e4—*it isn't memory location 0*. Note that you can scroll through the memory displayed in the DISP window; item [1] is at 0x002ff8e5, and item [–1] is at 0x002f.

You can also change display formats according to data type. This affects all data of a specific C data type.

> Change display formats according to data types by using the SETF command:
>
> 1) For comparison, watch the following variables. Their C data types are listed on the right.
>
> ```
> wa i ↵                                   Type int
> wa f ↵                                 Type float
> wa d ↵                                Type double
> ```
>
> 2) You can list all the data types and their current display formats:
>
> ```
> setf ↵
> ```

lesson continues on the next page →

3) Now display the following data types with new formats:

```
setf int, c ⏎                                  Ints as characters
setf float, o ⏎                          Floats as octal integers
setf double, x ⏎                          Doubles as hex integers
```

4) List the data types to display formats again; note the changes in the display:

```
setf ⏎
```

5) Add the variables to the WATCH window again; use labels to identify the additions:

```
wa i, NEWi ⏎
wa f, NEWf ⏎
wa d, NEWd ⏎
```

Notice the differences in the display formats between the first versions you added and these new versions.

6) Now reset all data types back to their defaults:

```
setf * ⏎
```

A third way to display data in another format is to use the DISP, ?, MEM, or WA command with an optional parameter that identifies the new display format. The following examples are for ? and WA—DISP and MEM work similarly.

Use display formats with the ? and WA commands:

1) Evaluate a variable and display it as a character:

```
? big1.ra[1],c ⏎
```

2) Add a variable to the watch window and display it as an octal integer:

```
wa str.a,,o ⏎
```

(Notice that because no label was used with WA, an extra comma was inserted—otherwise, the o parameter would have been interpreted as a label.)

Try This: You can also watch registers R0–R11 as floating-point values by using the special symbols F0–F11. You might also want to display memory contents in floating-point format. For example, you can display the contents of location 0x809800 in floating-4000point format:

```
disp *(float *)0x809800 ↵
```

To get ready for the next step, close the DISP and WATCH windows.

Change some values

You can edit the values displayed in the MEMORY, CPU, WATCH, and DISP windows.

Change a value in memory:

1) Move or close the WATCH window if it's obscuring the MEMORY window, then display memory beginning with address 0x80009800:

```
mem 0x80009800 ↵
```

↖ 2) Point to the contents of memory location 0x80009800.

3) Click the left mouse button. This highlights the field to identify it as the field that will be edited.

4) Type 00000000.

5) Press ↵ to enter the new value.

6) Press ESC to conclude editing.

lesson continues on the next page →

Try This: Here’s another method for editing data that lets you edit a few more values at once.

1) Make the CPU window the active window:

```
win CPU ↵
```

↑ ↓ 2) Press the arrow keys until the field cursor (_) points to the PC contents.

F9 3) Press F9.

4) Type 002ff863.

↓ 5) Press ↓ twice. You should now be pointing at the contents of register R0.

6) Type 000174f9.

↵ 7) Press ↵ to enter the new value.

ESC 8) Press ESC to conclude editing.

Define a memory map

You can set up a memory map to tell the debugger which areas of memory it can and can’t access. This is called *memory mapping*. When you invoked the debugger for this tutorial, the debugger automatically read a default memory map from a batch file included in the c4xhll or sim4x directory. For the purposes of the sample program, that’s fine (which is why this lesson was saved for next-to-last).

View the default memory map settings:

```
ml ↵
```

Look in the COMMAND window display area—you’ll see a listing of the areas that are currently mapped.

It’s easy to add new ranges to the map or delete existing ranges.

Change the memory map:

1) Use the MD (memory delete) command to delete the block of memory:

   ```
   md 0x0 ↵
   ```

   This deletes the block of memory beginning at address 0.

2) Use the MA (memory add) command to define a new block of memory:

   ```
   ma 0x00002000,0xffff,RAM ↵
   ```

Define your own command string

If you find that you often enter a command with the same parameters, or often enter the same commands in sequence, you will find it helpful to have a shorthand method for entering these commands. The debugger provides an *aliasing* feature that allows you to do this.

This lesson shows you how you can define an alias to set up a memory map, defining the same map that was defined in the previous lesson.

Define an alias for setting up the memory map:

1) Use the ALIAS command to associate a nickname with the commands used for defining a memory map:

   `alias mymap,”mr;ma 0x2000,0xffff,RAM;ml”` ↵

2) Now, to use this memory map, just enter the alias name:

   `mymap` ↵

   This is equivalent to entering the following three commands:

   ```
   mr
   ma 0x2000,0xffff,RAM
   ml
   ```

Close the debugger

This is the end of the tutorial—close the debugger.

Close the debugger and return to the operating system:

`quit` ↵

Chapter 3

The Debugger Display

The ’C4x C source debugger has a window-oriented display. This chapter shows what windows can look like and describes the basic types of windows you will use.

Topic **Page**

3.1 Debugging Modes and Default Displays

The basic debugger environment has three debugging modes:

- ❑ Auto mode
- ❑ Assembly mode
- ❑ Mixed mode

Each mode changes the debugger display by adding or hiding specific windows. Some windows, such as the COMMAND window, may be present in all modes. The following figures show the default displays for these modes and show the windows that the debugger automatically displays for these modes.

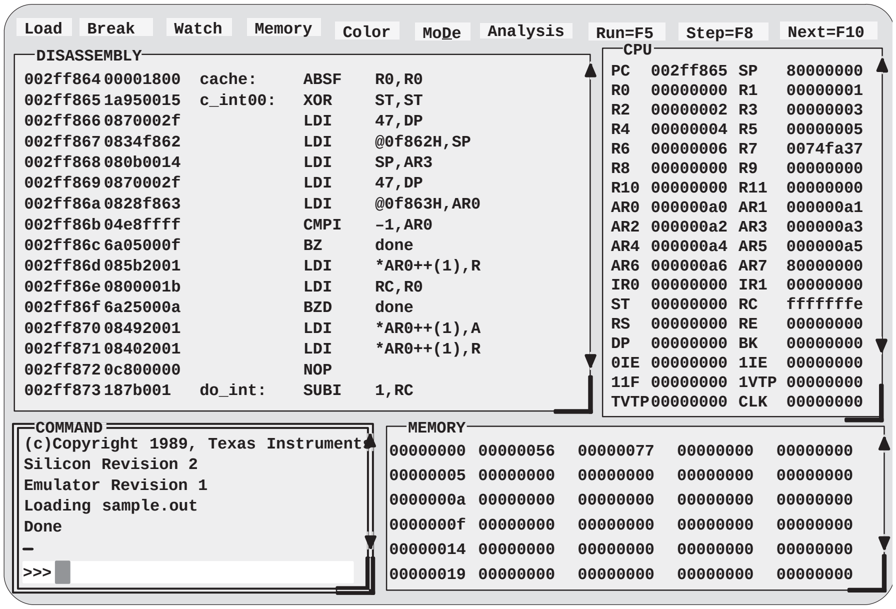
These modes cannot be used within the profiling environment; only the COMMAND, PROFILE, DISASSEMBLY, and FILE windows are available.

Auto mode

In **auto mode**, the debugger automatically displays whatever type of code is currently running—assembly language or C. This is the default mode; when you first invoke the debugger, you'll see a a display similar to Figure 3–1. Auto mode has two types of displays:

- ❑ When the debugger is running assembly language code, you'll see an assembly display similar to the one in Figure 3–1. The DISASSEMBLY window displays the reverse assembly of memory contents.

Figure 3–1. Typical Assembly Display (for Auto Mode and Assembly Mode)



```
002ff864 00001800  cache:    ABSF   R0,R0
002ff865 1a950015  c_int00:  XOR    ST,ST
002ff866 0870002f            LDI    47,DP
002ff867 0834f862            LDI    @0f862H,SP
002ff868 080b0014            LDI    SP,AR3
002ff869 0870002f            LDI    47,DP
002ff86a 0828f863            LDI    @0f863H,AR0
002ff86b 04e8ffff            CMPI   –1,AR0
002ff86c 6a05000f            BZ     done
002ff86d 085b2001            LDI    *AR0++(1),R
002ff86e 0800001b            LDI    RC,R0
002ff86f 6a25000a            BZD    done
002ff870 08492001            LDI    *AR0++(1),A
002ff871 08402001            LDI    *AR0++(1),R
002ff872 0c800000            NOP
002ff873 187b001   do_int:   SUBI   1,RC
```

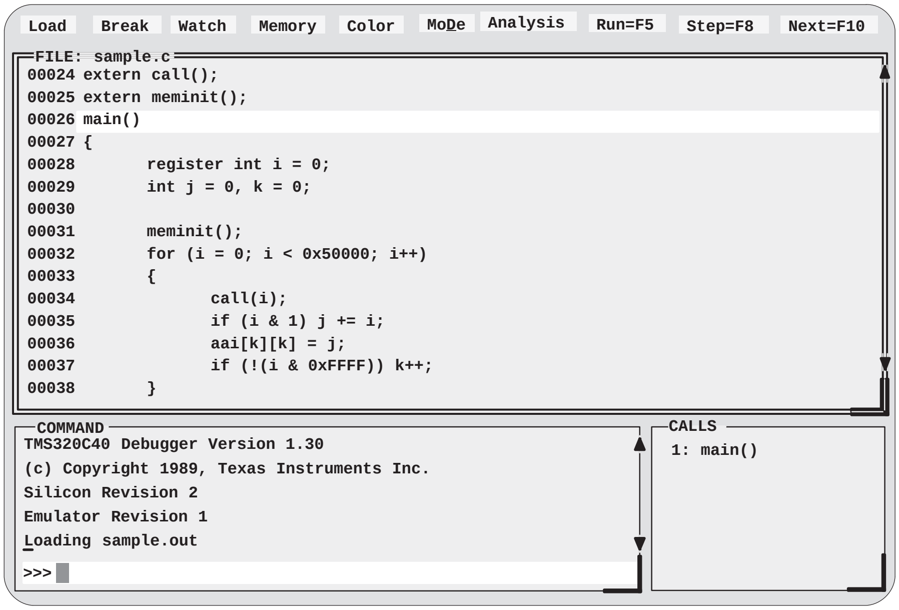
```
PC   002ff865 SP   80000000
R0   00000000 R1   00000001
R2   00000002 R3   00000003
R4   00000004 R5   00000005
R6   00000006 R7   0074fa37
R8   00000000 R9   00000000
R10  00000000 R11  00000000
AR0  000000a0 AR1  000000a1
AR2  000000a2 AR3  000000a3
AR4  000000a4 AR5  000000a5
AR6  000000a6 AR7  80000000
IR0  00000000 IR1  00000000
ST   00000000 RC   fffffffe
RS   00000000 RE   00000000
DP   00000000 BK   00000000
0IE  00000000 1IE  00000000
11F  00000000 1VTP 00000000
TVTP 00000000 CLK  00000000
```

```
(c)Copyright 1989, Texas Instruments
Silicon Revision 2
Emulator Revision 1
Loading sample.out
Done
_
>>>
```

```
00000000 00000056  00000077  00000000  00000000
00000005 00000000  00000000  00000000  00000000
0000000a 00000000  00000000  00000000  00000000
0000000f 00000000  00000000  00000000  00000000
00000014 00000000  00000000  00000000  00000000
00000019 00000000  00000000  00000000  00000000
```

- ❑ When the debugger is running C code, you'll see a C display similar to the one in Figure 3–2. (This assumes that the debugger can find your C source file to display in the FILE window. If the debugger can't find your source, then it switches to mixed mode.)

Figure 3–2. Typical C Display (for Auto Mode Only)



```
extern call();
extern meminit();
main()
{
        register int i = 0;
        int j = 0, k = 0;

        meminit();
        for (i = 0; i < 0x50000; i++)
        {
                call(i);
                if (i & 1) j += i;
                aai[k][k] = j;
                if (!(i & 0xFFFF)) k++;
        }
```

```
TMS320C40 Debugger Version 1.30
(c) Copyright 1989, Texas Instruments Inc.
Silicon Revision 2
Emulator Revision 1
Loading sample.out
>>>
```

```
1: main()
```

When you're running assembly language code, the debugger automatically displays windows as described for assembly mode.

When you're running C code, the debugger automatically displays the COMMAND, CALLS, and FILE windows. If you want, you can also open a WATCH window and DISP windows.

Assembly mode

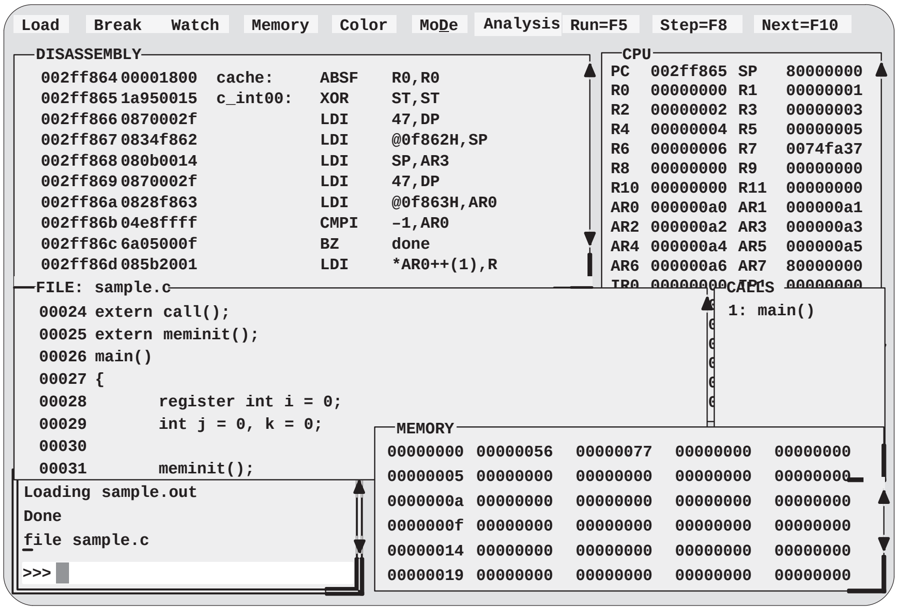
Assembly mode is for viewing assembly language programs only. In this mode, you'll see a display similar to the one shown in Figure 3–1. When you're in assembly mode, you'll always see the assembly display, regardless of whether C or assembly language is currently running.

Windows that are automatically displayed in assembly mode include the MEMORY window, the DISASSEMBLY of memory contents, the CPU register window, and the COMMAND window. If you want, you can also open a WATCH window in assembly mode.

Mixed mode

Mixed mode is for viewing assembly language and C code at the same time. Figure 3–3 shows the default display for mixed mode.

Figure 3–3. Typical Mixed Display (for Mixed Mode Only)



```
002ff864 00001800  cache:     ABSF    R0,R0
002ff865 1a950015  c_int00:   XOR     ST,ST
002ff866 0870002f             LDI     47,DP
002ff867 0834f862             LDI     @0f862H,SP
002ff868 080b0014             LDI     SP,AR3
002ff869 0870002f             LDI     47,DP
002ff86a 0828f863             LDI     @0f863H,AR0
002ff86b 04e8ffff             CMPI    –1,AR0
002ff86c 6a05000f             BZ      done
002ff86d 085b2001             LDI     *AR0++(1),R
```

```
PC   002ff865 SP    80000000
R0   00000000 R1    00000001
R2   00000002 R3    00000003
R4   00000004 R5    00000005
R6   00000006 R7    0074fa37
R8   00000000 R9    00000000
R10  00000000 R11   00000000
AR0  000000a0 AR1   000000a1
AR2  000000a2 AR3   000000a3
AR4  000000a4 AR5   000000a5
AR6  000000a6 AR7   80000000
```

```
00024 extern call();
00025 extern meminit();
00026 main()
00027 {
00028       register int i = 0;
00029       int j = 0, k = 0;
00030
00031       meminit();
```

```
1: main()
```

```
00000000 00000056  00000077  00000000  00000000
00000005 00000000  00000000  00000000  00000000
0000000a 00000000  00000000  00000000  00000000
0000000f 00000000  00000000  00000000  00000000
00000014 00000000  00000000  00000000  00000000
00000019 00000000  00000000  00000000  00000000
```

```
Loading sample.out
Done
file sample.c

>>>
```

In mixed mode, the debugger displays all windows that can be displayed in auto and assembly modes—regardless of whether you’re currently running assembly language or C code. This is useful for finding bugs in C programs that exploit specific architectural features of the ’C4x.

Restrictions associated with debugging modes

The assembly language code that the debugger shows you is the disassembly (reverse assembly) of memory’s contents. If you load object code into memory, then the assembly language code is the disassembly of that object code. If you don’t load an object file, then the disassembly won’t be very useful.

Some commands are valid only in certain modes, especially if a command applies to a window that is visible only in certain modes. In this case, entering the command causes the debugger to switch to the mode that is appropriate for the command. This applies to these commands:

dasm	func	mem
calls	file	disp

3.2 Descriptions of the Different Kinds of Windows and Their Contents

The debugger can show several types of windows. This section lists the various types of windows and describes their characteristics.

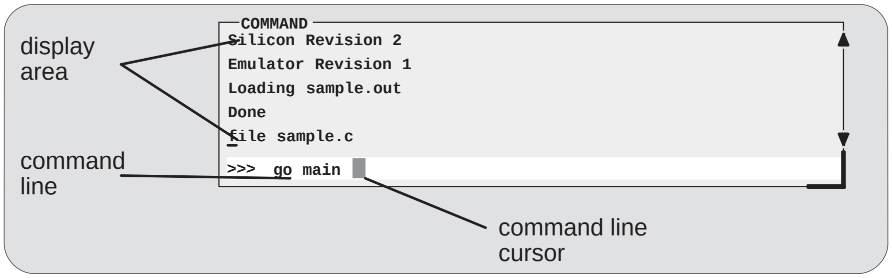
Every window is identified by a name in it’s upper left corner. Each type of window serves a specific purpose and has unique characteristics. There are nine different windows, divided into four general categories:

- The **COMMAND window** provides an area for typing in commands and for displaying various types of information such as progress messages, error messages, or command output.
- **Code-display windows** are for displaying assembly language or C code. There are three code-display windows:
  - The DISASSEMBLY window displays the disassembly (assembly language version) of memory contents.
  - The FILE window displays any text file that you want to display; its main purpose, however, is to display C source code.
  - The CALLS window identifies the current function traceback (when C code is running).
- The **PROFILE window** displays statistics about code execution. This window is available only when you are in the profiling environment.
- **Data-display windows** are for observing and modifying various types of data. There are four data-display windows:
  - A MEMORY window displays the contents of a range of memory. You can display up to four MEMORY windows at one time.
  - A CPU window displays the contents of ’C4x registers.
  - A DISP window displays the contents of an aggregate type such as an array or structure, showing the values of the individual members. You can display up to 120 DISP windows at one time.
  - A WATCH window displays selected data such as variables, specific registers, or memory locations.

You can move or resize any of these windows; you can also edit any value in a data-display window. Before you can perform any of these actions, however, you must select the window you want to move, resize, or edit, and make it *the active window*. For more information about making a window active, see Section 3.4, *The Active Window*, on page 3-19.

The remainder of this section describes the individual windows.

COMMAND window



```
COMMAND
Silicon Revision 2
Emulator Revision 1
Loading sample.out
Done
file sample.c
>>>  go main
```

Purpose
- Provides an area for entering commands
- Provides an area for echoing commands and displaying command output, errors, and messages

Editable? Command line is editable; command output isn’t

Modes All modes

Created Automatically

Affected by
- All commands entered on the command line
- All commands that display output in the display area
- Any input that creates an error

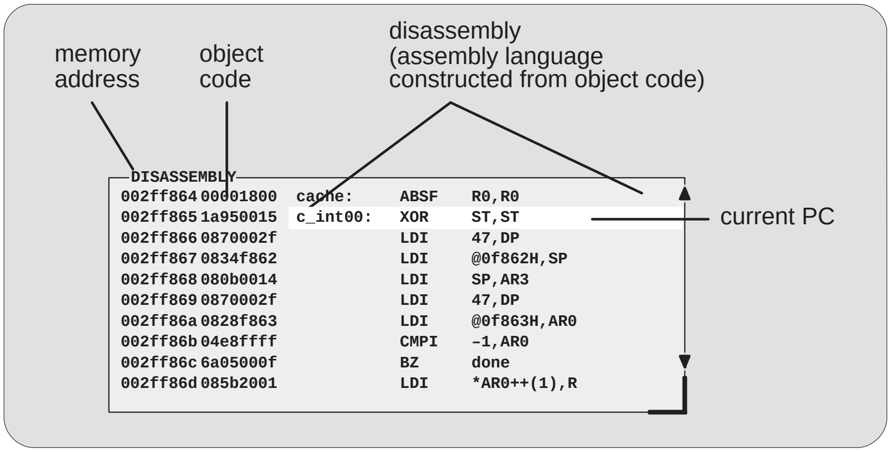
The COMMAND window has two parts:

- **Command line.** This is where you enter commands. When you want to enter a command, just type—no matter which window is active. The debugger keeps a list of the last 50 commands that you entered. You can select and re-enter commands from the list without retyping them. (For more information on using the command history, see *Using the command history*, page 4-5.)

- **Display area**. This area of the COMMAND window echoes the command that you entered, shows any output from the command, and displays debugger messages.

For more information about the COMMAND window and entering commands, refer to Chapter 4.

DISASSEMBLY window



```
DISASSEMBLY
002ff864 00001800  cache:     ABSF    R0,R0
002ff865 1a950015  c_int00:   XOR     ST,ST
002ff866 0870002f             LDI     47,DP
002ff867 0834f862             LDI     @0f862H,SP
002ff868 080b0014             LDI     SP,AR3
002ff869 0870002f             LDI     47,DP
002ff86a 0828f863             LDI     @0f863H,AR0
002ff86b 04e8ffff             CMPI    –1,AR0
002ff86c 6a05000f             BZ      done
002ff86d 085b2001             LDI     *AR0++(1),R
```

Purpose Displays the disassembly (or reverse assembly) of memory contents

Editable? No; pressing the edit key (F9) or the left mouse button sets a software breakpoint on an assembly language statement

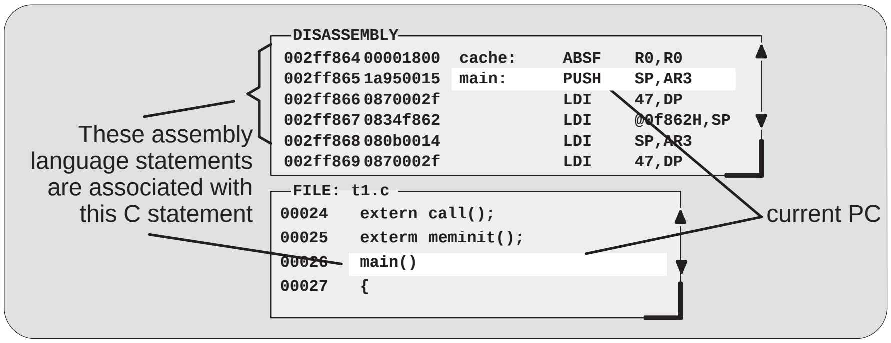
Modes Auto (assembly display only), assembly, and mixed

Created Automatically

Affected by
- DASM and ADDR commands
- Breakpoint and run commands

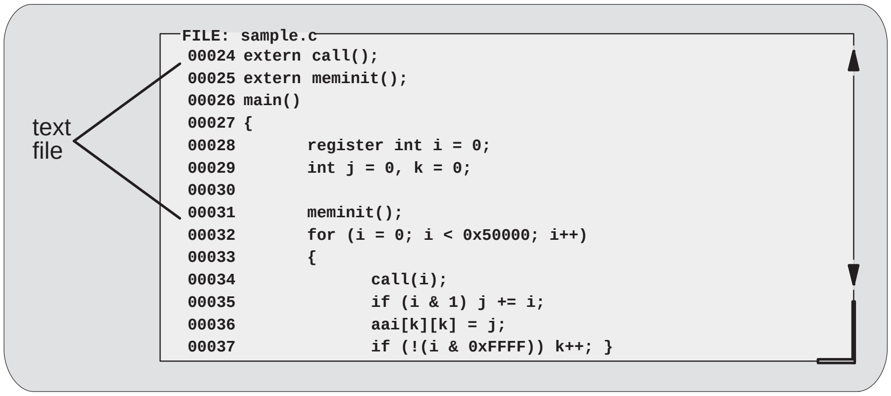
Within the DISASSEMBLY window, the debugger highlights

- The statement that the PC is pointing to (if that line is in the current display)
- Any breakpointed statements with software breakpoints
- The address and object code fields for all statements associated with the current C statement, as shown below



```
DISASSEMBLY
002ff864 00001800  cache:     ABSF    R0,R0
002ff865 1a950015  main:      PUSH    SP,AR3
002ff866 0870002f             LDI     47,DP
002ff867 0834f862             LDI     @0f862H,SP
002ff868 080b0014             LDI     SP,AR3
002ff869 0870002f             LDI     47,DP

FILE: t1.c
00024   extern call();
00025   exterm meminit();
00026   main()
00027   {
```

FILE window



```
FILE: sample.c
extern call();
extern meminit();
main()
{
        register int i = 0;
        int j = 0, k = 0;

        meminit();
        for (i = 0; i < 0x50000; i++)
        {
                call(i);
                if (i & 1) j += i;
                aai[k][k] = j;
                if (!(i & 0xFFFF)) k++; }
```

Purpose Shows any text file you want to display

Editable? No; Pressing the edit key (F9) or the left mouse button sets a software breakpoint on a C statement

Modes Auto (C display only) and mixed

Created
- With FILE command
- Automatically when you're in auto or mixed mode and your program begins executing C code

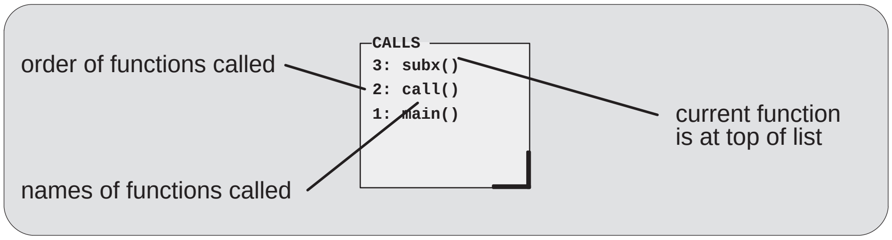
Affected by
- FILE, FUNC, and ADDR commands
- Breakpoint and run commands

You can use the FILE command to display the contents of any file within the FILE window, but this window is especially useful for viewing C source files. Whenever you single-step a program or run a program and halt execution, the FILE window automatically displays the C source associated with the current point in your program. This overwrites any other file that may have been displayed in the window.

Within the FILE window, the debugger highlights:

- The statement that the PC is pointing to (if that line is in the current display)
- Any statements where you've set a software breakpoint

CALLS window


order of functions called
names of functions called
current function is at top of list

```
CALLS
3: subx()
2: call()
1: main()
```

Purpose Lists the function you're in, its caller, and the caller's caller, etc., as long as each function is a C function

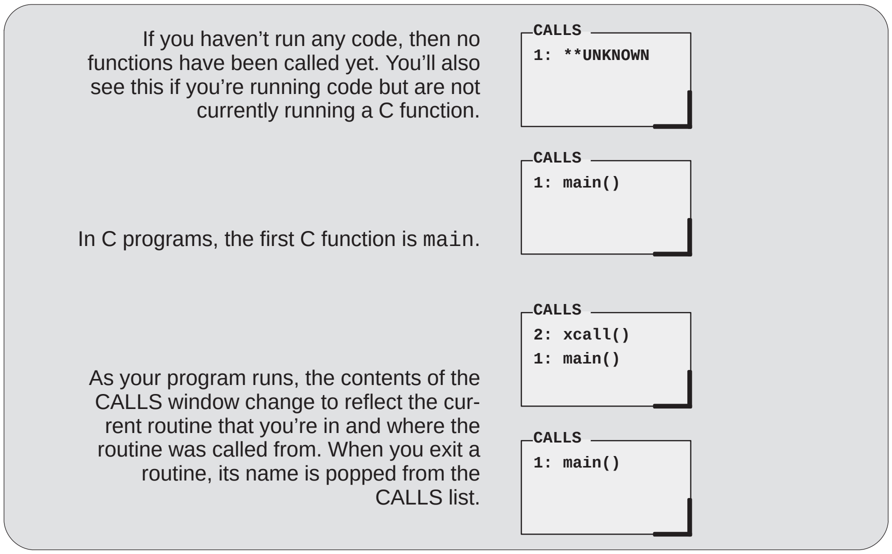
Editable? No; you can't edit the window's contents

Modes Auto (C display only) and mixed

Created
- ❑ Automatically when you're displaying C code
- ❑ With the CALLS command if you closed the window

Affected by Run and single-step commands

The display in the CALLS window changes automatically to reflect the latest function call.



If you haven't run any code, then no functions have been called yet. You'll also see this if you're running code but are not currently running a C function.

```
CALLS
1: **UNKNOWN
```

In C programs, the first C function is `main`.

```
CALLS
1: main()
```

As your program runs, the contents of the CALLS window change to reflect the current routine that you're in and where the routine was called from. When you exit a routine, its name is popped from the CALLS list.

```
CALLS
2: xcall()
1: main()
```

```
CALLS
1: main()
```

If a function name is listed in the CALLS window, you can easily display the function in the FILE window:

↖ 1) Point the mouse cursor at the appropriate function name that is listed in the CALLS window.

2) Click the left mouse button. This displays the selected function in the FILE window.

---

key

1) Make the CALLS window the active window (see Section 3.4, *The Active Window,* page 3-19).

↓ ↑ 2) Use the arrow keys to move up/down through the list of function names until the appropriate function is indicated.

F9 3) Press F9 . This displays the selected function in the FILE window.

You can close and reopen the CALLS window.

❑ Closing the window is a two-step process:

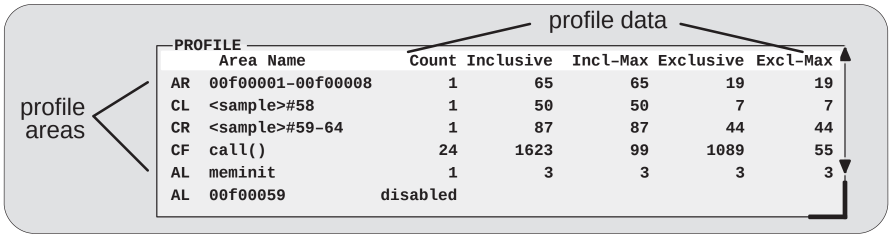
   1) Make the CALLS window the active window.

   2) Press F4 .

❑ To reopen the CALLS window after you've closed it, enter the CALLS command. The format for this command is:

   calls

PROFILE window



```
PROFILE
     Area Name             Count Inclusive  Incl–Max Exclusive  Excl–Max
AR  00f00001–00f00008          1        65        65        19        19
CL  <sample>#58                1        50        50         7         7
CR  <sample>#59–64             1        87        87        44        44
CF  call()                    24      1623        99      1089        55
AL  meminit                    1         3         3         3         3
AL  00f00059            disabled
```

Purpose Displays statistics collected during a profiling session

Editable? No

Modes Auto

Created By invoking the debugger with the –profile option

Affected by

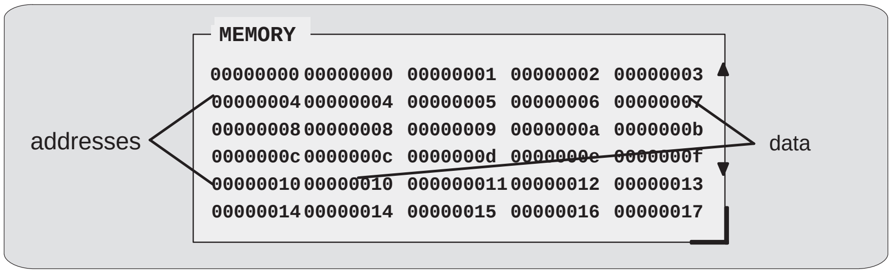
- The PF and PQ commands
- Any commands on the View menu
- Clicking in the header area of the window

The PROFILE window is visible only when you are in the profiling environment. The illustration above shows the window with a default set of data, but the display can be modified to show specific sets of data collected during a profiling session.

Note that within the profiling environment, the only other windows that are available are the COMMAND window, the DISASSEMBLY window, and the FILE window.

For more information about the PROFILE window (and about profiling in general), refer to Chapter 11, *Profiling Code Execution.*

MEMORY windows



```
MEMORY
00000000 00000000  00000001  00000002  00000003
00000004 00000004  00000005  00000006  00000007
00000008 00000008  00000009  0000000a  0000000b
0000000c 0000000c  0000000d  0000000e  0000000f
00000010 00000010  000000011 00000012  00000013
00000014 00000014  00000015  00000016  00000017
```

Purpose Displays the contents of memory

Editable? Yes—you can edit the data (but not the addresses)

Modes Auto (assembly display only), assembly, and mixed

Created
- ❑ Automatically (the default MEMORY window only)
- ❑ You can display up to three additional MEMORY windows with the MEM# commands

Affected by MEM commands: MEM, MEM1, MEM2, and MEM3

A MEMORY window has two parts:

- ❑ **Addresses.** The first column of numbers identifies the addresses of the first column of displayed data. No matter how many columns of data you display, only one address column is displayed. Each address in this column identifies the address of the data immediately to its right.

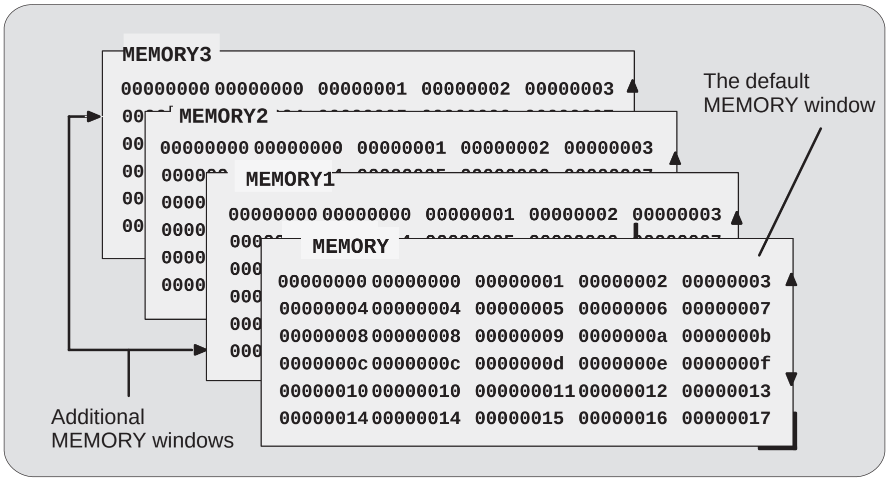
- ❑ **Data.** The remaining columns display the values at the listed addresses. You can display more data by making the window wider and/or longer.

  The MEMORY window above has four columns of data, so each new address is incremented by four. Although the window shows four columns of data, there is still only one column of addresses; the first value is at address 0x000000, the second at address 0x000004, etc.; the fifth value (first value in the second row) is at address 0x000010, the sixth at address 0x0000014, etc.

As you run programs, some memory values change as the result of program execution. The debugger highlights the changed values. Depending on how you configure memory for your application, some locations may be invalid/unconfigured. The debugger also highlights these locations (by default, it shows these locations in red).

Three additional MEMORY windows called MEMORY1, MEMORY2, and MEMORY3 are available. The default MEMORY window does not have an extension number in its name; this is because MEMORY1, MEMORY2, and MEMORY3 are optional windows and can be opened and closed throughout your debugging session. Having four windows allows you to view four different memory ranges. Refer to Figure 3–4.

Figure 3–4. The Default and Additional MEMORY Windows



```
MEMORY3
00000000 00000000  00000001  00000002  00000003

MEMORY2
00000000 00000000  00000001  00000002  00000003

MEMORY1
00000000 00000000  00000001  00000002  00000003

MEMORY
00000000 00000000  00000001  00000002  00000003
00000004 00000004  00000005  00000006  00000007
00000008 00000008  00000009  0000000a  0000000b
0000000c 0000000c  0000000d  0000000e  0000000f
00000010 00000010  000000011 00000012  00000013
00000014 00000014  00000015  00000016  00000017
```

To create an additional MEMORY window or to display another range of memory in the current window, use the MEM command.

❑ **Creating a new MEMORY window.**

If the default MEMORY window is the only window open and you want to open another MEMORY window, enter the MEM command with the appropriate extension number:

mem[#] *address*

For example, if you want to create a new memory window starting at address 0x8000, you would enter:

```
mem1 0x8000 ↵
```

This displays a new window, MEMORY1, showing the contents of memory starting at address 0x8000.

❑ **Displaying a new memory range in the current MEMORY window.**

Displaying another block of memory identifies a new starting address for the memory range shown in the current MEMORY window. The debugger displays the contents of memory at *address* in the first data position in your MEMORY window. The end of the range is defined by the size of the window.

If the only memory window open is the default MEMORY window, you can view different memory locations by entering:

mem *address*

To view different memory locations in the optional MEMORY windows, use the MEM command with the appropriate extension number on the end. For example:

To do this. . .	Enter this. . .
View the block of memory starting at address 0x8000 in the MEMORY1 window	**mem1** 0x8000
View another block of memory starting at address 0x002f in the MEMORY2 window	**mem2** 0x002f

Note:

If you want to view a different block of memory explicitly in the default MEMORY window, you can use the alias command MEM0. This works *exactly* the same as the MEM command. To use this command, enter:

mem0 *address*

You can close and reopen additional MEMORY windows as often as you like.

❑ **Closing an additional MEMORY window.**

Closing a window is a two-step process:

1) Make the appropriate MEMORY window the active window (see Section 3.4, on page 3-19).

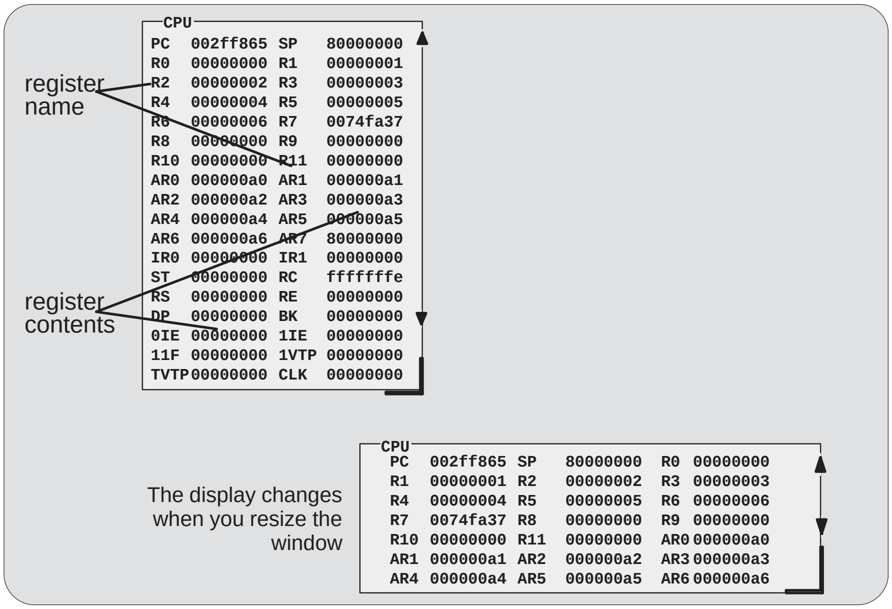
2) Press F4 .

Remember, you cannot close the default MEMORY window.

❑ **Reopening an additional MEMORY window.**

To reopen an additional MEMORY window after you've closed it, enter the MEM command with its appropriate extension number.

CPU window



```
CPU
PC   002ff865 SP   80000000
R0   00000000 R1   00000001
R2   00000002 R3   00000003
R4   00000004 R5   00000005
R6   00000006 R7   0074fa37
R8   00000000 R9   00000000
R10  00000000 R11  00000000
AR0  000000a0 AR1  000000a1
AR2  000000a2 AR3  000000a3
AR4  000000a4 AR5  000000a5
AR6  000000a6 AR7  80000000
IR0  00000000 IR1  00000000
ST   00000000 RC   fffffffe
RS   00000000 RE   00000000
DP   00000000 BK   00000000
0IE  00000000 1IE  00000000
11F  00000000 1VTP 00000000
TVTP 00000000 CLK  00000000
```

```
CPU
PC   002ff865 SP   80000000  R0  00000000
R1   00000001 R2   00000002  R3  00000003
R4   00000004 R5   00000005  R6  00000006
R7   0074fa37 R8   00000000  R9  00000000
R10  00000000 R11  00000000  AR0 000000a0
AR1  000000a1 AR2  000000a2  AR3 000000a3
AR4  000000a4 AR5  000000a5  AR6 000000a6
```

Purpose Displays the contents of the ’C4x registers

Editable? Yes—you can edit the value of any displayed register

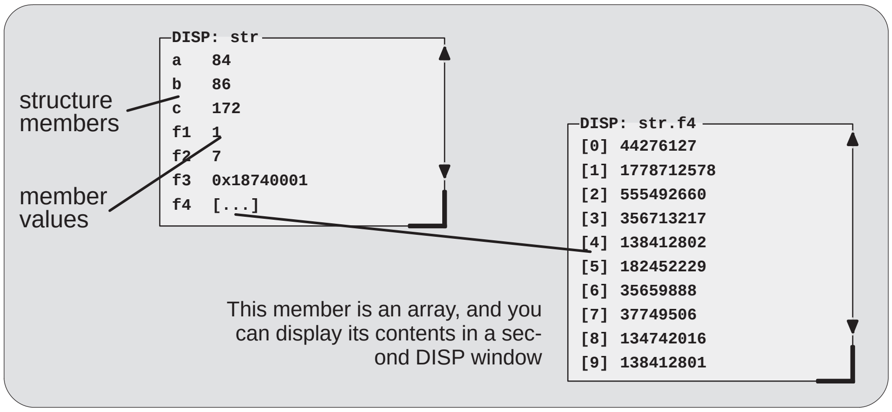
Modes Auto (assembly display only), assembly, and mixed

Created Automatically

Affected by Data-management commands

As you run programs, some values displayed in the CPU window change as the result of program execution. The debugger highlights the changed values.

DISP windows



```
DISP: str
a   84
b   86
c   172
f1  1
f2  7
f3  0x18740001
f4  [...]
```

```
DISP: str.f4
[0] 44276127
[1] 1778712578
[2] 555492660
[3] 356713217
[4] 138412802
[5] 182452229
[6] 35659888
[7] 37749506
[8] 134742016
[9] 138412801
```

structure members

member values

This member is an array, and you can display its contents in a second DISP window

Purpose	Displays the members of a selected structure, array, or pointer, and the value of each member
Editable?	Yes—you can edit individual values
Modes	Auto (C display only) and mixed
Created	With the DISP command
Affected by	The DISP command

A DISP window is similar to a WATCH window, but it shows the values of an entire array or structure instead of a single value. Use the DISP command to open a DISP window; the basic syntax is:

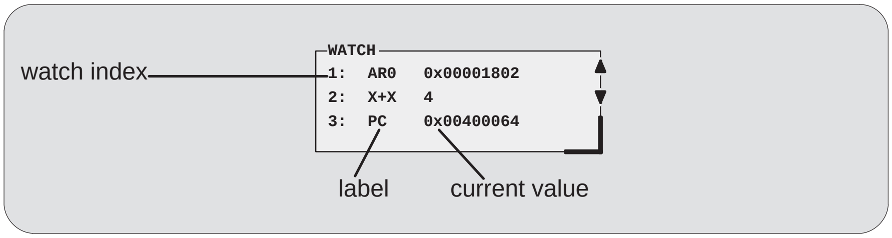
disp *expression*

Data is displayed in its natural format:

❑ Integer values are displayed in decimal.
❑ Floating-point values are displayed in floating-point format.
❑ Pointers are displayed as hexadecimal addresses (with a 0x prefix).
❑ Enumerated types are displayed symbolically.

If any of the displayed members are arrays, structures, or pointers, you can bring up additional DISP windows to display their contents—up to 120 DISP windows can be open at once.

WATCH window



```
WATCH
1:  AR0   0x00001802
2:  X+X   4
3:  PC    0x00400064
```

Purpose Displays the values of selected expressions

Editable? Yes—you can edit the value of any expression whose value specifies a storage location (in registers or memory). In the window above, for example, you could edit the value of PC but couldn't edit the value of X+X.

Modes Auto, assembly, and mixed

Created With the WA command

Affected by WA, WD, and WR commands

The WATCH window helps you to track the values of arbitrary expressions, variables, and registers. Use the WA command for this; the syntax is:

wa *expression* [, [*label*] [*, format*]]

WA adds *expression* to the WATCH window. (If there's no WATCH window, then WA also opens a WATCH window).

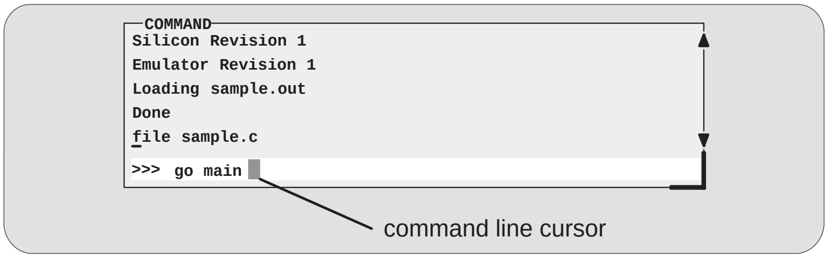
To delete individual entries from the WATCH window, use the WD command. To delete all entries at once and close the WATCH window, use the WR command.

Although the CPU window displays register contents, you may not be interested in the values of all these registers. In this situation, it is convenient to use the WATCH window to track the values of the specific registers you're interested in.

3.3 Cursors

The debugger display has three types of cursors:

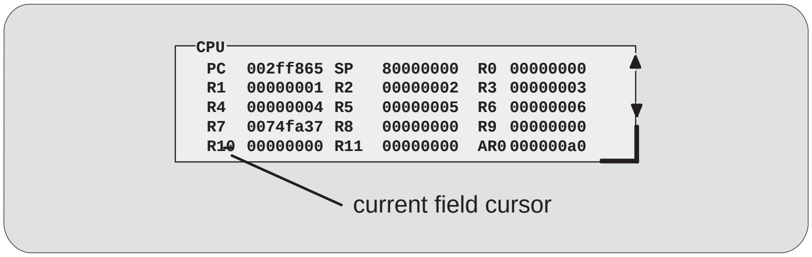
- The **command-line cursor** is a block-shaped cursor that identifies the current character position on the command line. Arrow keys *do not affect* the position of this cursor.



```
COMMAND
Silicon Revision 1
Emulator Revision 1
Loading sample.out
Done
file sample.c
>>> go main
```

- The **mouse cursor** is a block-shaped cursor that tracks mouse movements over the entire display. This cursor is controlled by the mouse driver installed on your system; if you haven't installed a mouse, you won't see a mouse cursor on the debugger display.

- The **current-field cursor** identifies the current field in the active window. On PCs, this is the hardware cursor that is associated with your graphics card. Arrow keys *do* affect this cursor's movement.



```
CPU
  PC   002ff865 SP   80000000  R0  00000000
  R1   00000001 R2   00000002  R3  00000003
  R4   00000004 R5   00000005  R6  00000006
  R7   0074fa37 R8   00000000  R9  00000000
  R10  00000000 R11  00000000  AR0 000000a0
```

3.4 The Active Window

The windows in the debugger display aren’t fixed in their position or in their size. You can resize them, move them around, and, in some cases, close them. The window that you’re going to move, resize, or close must be **active**.

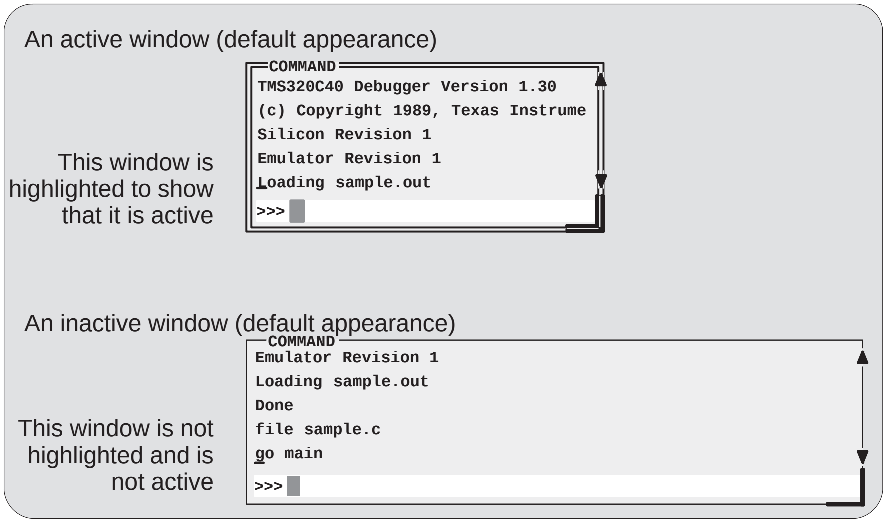
You can move, resize, or close *only one window at a time*; thus, only one window at a time can be the **active window**. Whether or not a window is active doesn’t affect the debugger’s ability to update information in a window—it affects only your ability to manipulate a window.

Identifying the active window

The debugger highlights the active window. When windows overlap on your display, the debugger pops the active window to be on top of other windows.

You can alter the active window’s border style and colors if you wish; Figure 3–5 illustrates the default appearance of an active window and an inactive window.

Figure 3–5. Default Appearance of an Active and an Inactive Window


An active window (default appearance)
This window is highlighted to show that it is active
COMMAND
An inactive window (default appearance)
This window is not highlighted and is not active
COMMAND

```
TMS320C40 Debugger Version 1.30
(c) Copyright 1989, Texas Instrume
Silicon Revision 1
Emulator Revision 1
Loading sample.out
>>>
```

```
Emulator Revision 1
Loading sample.out
Done
file sample.c
go main
>>>
```

Note: On **black-and-white monitors**, the border and selection corner are highlighted as shown in the illustration. On **color monitors**, the border and selection corner are highlighted as shown in the illustration, but they also change color (by default, they change from white to yellow when the window becomes active) when the window becomes active.

Selecting the active window

You can use one of several methods for selecting the active window.

1) Point to any location within the boundaries or on any border of the desired window.

2) Click the left mouse button.

Note that if you point within the window, you might also select the current field. For example,

- If you point inside the CPU window, then the register you're pointing at becomes active, and the debugger treats any text that you type as a new register value. If you point inside the MEMORY window, then the address value you're pointing at becomes active, and the debugger treats any text that you type as a new memory value.

  Press ESC *to get out of this.*

- If you point inside the DISASSEMBLY or FILE window, you'll set a breakpoint on the statement you're pointing to.

  Press the mouse button again to clear the breakpoint.

F6 This key cycles through the windows on your display, making each one active in turn and making the previously active window inactive. Pressing this key highlights one of the windows, showing you that the window is active. Pressing F6 again makes a different window active. Press F6 as many times as necessary until the desired window becomes the active window.

win The WIN command allows you to select the active window by name. The format of this command is

win *WINDOW NAME*

Note that the *WINDOW NAME* is in uppercase (matching the name exactly as displayed). You can spell out the entire window name, but you really need to specify only enough letters to identify the window.

For example, to select the DISASSEMBLY window as the active window, you could enter either of these two commands:

```
   win  DISASSEMBLY ↵
or win  DISA ↵
```

If several windows of the same type are visible on the screen, don't use the WIN command to select one of them.

If you supply an ambiguous name (such as C, which could stand for CPU or CALLS), the debugger selects the first window it finds whose name matches the name you supplied. If the debugger doesn't find the window you asked for (because you closed the window or misspelled the name), then the WIN command has no effect.

3.5 Manipulating Windows

A window’s size and its position in the debugger display aren’t fixed—you can resize and move windows.

> **Note:**
>
> You can resize or move any window, but first the window must be **active**. For information about selecting the active window, refer to Section 3.4 (page 3-19).

Resizing a window

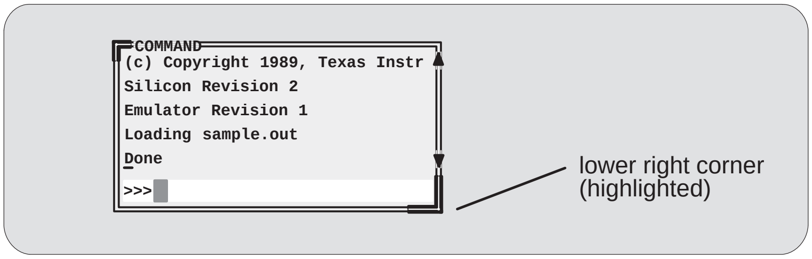
The minimum window size is three lines by four characters. The maximum window size varies, depending on which screen size you’re using, but you can’t make a window larger than the screen.

There are two basic ways to resize a window:

❑ By using the mouse.

❑ By using the SIZE command.

1) Point to the lower right corner of the window. This corner is highlighted—here’s what it looks like.



```
COMMAND
(c) Copyright 1989, Texas Instr
Silicon Revision 2
Emulator Revision 1
Loading sample.out
Done
>>>
```

lower right corner (highlighted)

2) Grab the highlighted corner by pressing one of the mouse buttons; while pressing the button, move the mouse in any direction. This resizes the window.

3) Release the mouse button when the window reaches the desired size.

size The SIZE command allows you to size the active window. The format of this command is:

size [*width*, *length*]

You can use the SIZE command in one of two ways:

Method 1 Supply a specific *width* and *length*

Method 2 Omit the *width* and *length* parameters and use arrow keys to interactively resize the window.

SIZE, method 1: Use the *width* and *length* parameters. Valid values for the width and length depend on the screen size and the window position on the screen. If the window is in the upper left corner of the screen, the maximum size of the window is the same as the screen size minus one line. (The extra line is needed for the menu bar.) For example, if the screen size is 80 characters by 25 lines, the largest window size is 80 characters by 24 lines.

If a window is in the middle of the display, you can't size it to the maximum height and width—you can size it only to the right and bottom screen borders. The easiest way to make a window as large as possible is to zoom it, as described on page 3-24.

For example, if you want to use commands to make the CALLS window 8 characters wide by 20 lines long, you could enter:

```
win  CALLS ⏎
size 8, 20 ⏎
```

SIZE, method 2: Use arrow keys to interactively resize the window. If you enter the SIZE command without *width* and *length* parameters, you can use arrow keys to size the window.

↓	Makes the active window one line longer.
↑	Makes the active window one line shorter.
←	Makes the active window one character narrower.
→	Makes the active window one character wider.

> When you're finished using the cursor keys, you *must* press ESC or ↵ .

For example, if you want to make the CPU window three lines longer and two characters narrower, you can enter:

```
win  CPU ↵
size ↵
↓  ↓  ↓      ←  ←      ESC
```

Zooming a window

Another way to resize the active window is to zoom it. Zooming a window makes it as large as possible so that it takes up the entire display (except for the menu bar) and hides all the other windows. Unlike the SIZE command, zooming is not affected by the window's position in the display.

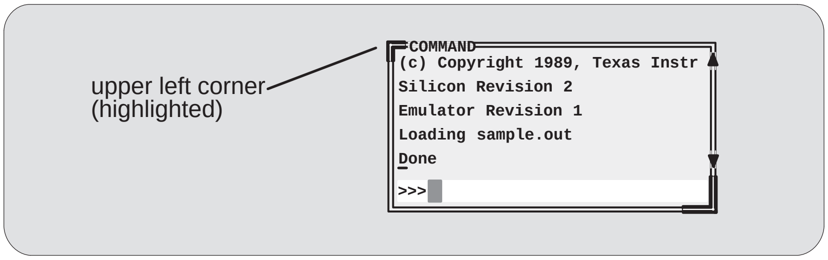
To "unzoom" a window, repeat the same steps you used to zoom it. This will return the window to its prezoom size and position.

There are two basic ways to zoom a window:

❑ By using the mouse

❑ By using the ZOOM command

↖ 1) Point to the upper left corner of the window. This corner is highlighted—here's what it looks like:



```
(c) Copyright 1989, Texas Instr
Silicon Revision 2
Emulator Revision 1
Loading sample.out
Done
>>>
```

2) Click the left mouse button.

zoom You can also use the ZOOM command to zoom/unzoom the window. The format for this command is:

zoom

Moving a window

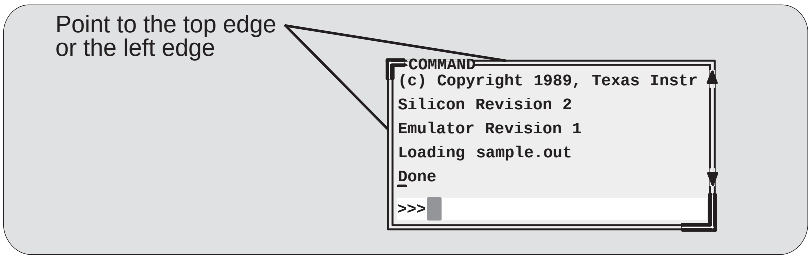
The windows in the debugger display don't have fixed positions–you can move them around.

There are two ways to move a window:

❑ By using the mouse

❑ By using the MOVE command

↖ 1) Point to the left or top edge of the window.



Point to the top edge or the left edge

```
(c) Copyright 1989, Texas Instr
Silicon Revision 2
Emulator Revision 1
Loading sample.out
Done
>>>
```

▮▯ 2) Press the left mouse button, but don't release it; now move the mouse in any direction.

▯▯ 3) Release the mouse button when the window is in the desired position.

move The MOVE command allows you to move the active window. The format of this command is:

move [*X position*, *Y position* [, *width*, *length*]]

You can use the MOVE command in one of two ways:

Method 1 Supply a specific *X position* and *Y position*

Method 2 Omit the *X position* and *Y position* parameters and use arrow keys to interactively resize the window

MOVE, method 1: Use the *X position* and *Y position* parameters. You can move a window by defining a new XY position for the window's upper left corner. Valid X and Y positions depend on the screen size and the window size. X positions are valid if the X position plus the window width in characters is less than or equal to the screen width in characters. Y positions are valid if the Y position plus the widow height is less than or equal to the screen height in lines.

For example, if the window is 10 characters wide and 5 lines high and the screen size is 80 x 25, the command **move 70, 20** would put the lower right-hand corner of the window in the lower right-hand corner of the screen. No X value greater than 70 or Y value greater than 20 would be valid in this example.

MOVE, method 2: Use arrow keys to interactively move the window. If you enter the MOVE command without *X position* and *Y position* parameters, you can use arrow keys to move the window:

↓ Moves the active window down one line.

↑ Moves the active window up one line.

← Moves the active window left one character position.

→ Moves the active window right one character position.

When you're finished using the cursor keys, you *must* press ESC or ⏎.

For example, if you want to move the COMMAND window up two lines and right five characters, you can enter:

```
win COM ⏎
move ⏎
↑ ↑      → → → → →      ESC
```

Note:

If you choose, you can resize a window at the same time you move it. To do this, use the *width* and *length* parameters in the same way that they are used for the SIZE command.

3.6 Manipulating a Window’s Contents

Although you may be concerned with changing the way windows appear in the display—where they are and how big/small they are—you’ll usually be interested in something much more important: *what’s in the windows*. Some windows contain more information than can be displayed on a screen; others contain information that you’d like to change. This section tells you how to view the hidden portions of data within a window and which data can be edited.

Note:

You can scroll and edit only the **active window**. For information about selecting the active window, refer to Section 3.4 (page 3-19).

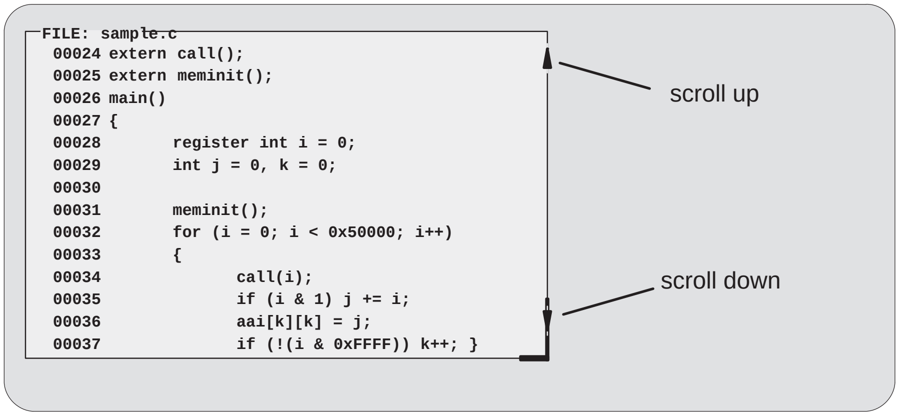
Scrolling through a window’s contents

If you resize a window to make it smaller, you may hide information. Sometimes, a window may contain more information than can be displayed on a screen. In these cases, the debugger allows you to scroll information up and down within the window.

There are two ways to view hidden portions of a window’s contents:

- ❑ You can use the mouse to scroll the contents of the window.
- ❑ You can use function keys and arrow keys.

You can use the mouse to point to the scroll arrows on the righthand side of the active window. This is what the scroll arrows look like:



```
FILE: sample.c
  00024 extern call();
  00025 extern meminit();
  00026 main()
  00027 {
  00028       register int i = 0;
  00029       int j = 0, k = 0;
  00030
  00031       meminit();
  00032       for (i = 0; i < 0x50000; i++)
  00033       {
  00034             call(i);
  00035             if (i & 1) j += i;
  00036             aai[k][k] = j;
  00037             if (!(i & 0xFFFF)) k++; }
```

To scroll window contents up or down:

↖ 1) Point to the appropriate scroll arrow.

▮▯ 2) Press the left mouse button; continue to press it until the information you're interested in is displayed within the window.

▯▯ 3) Release the mouse button when you're finished scrolling.

You can scroll up/down one line at a time by pressing the mouse button and releasing it immediately.

In addition to scrolling, the debugger supports the following methods for moving through a window's contents.

PAGE UP

The page-up key scrolls up through the window contents, one window length at a time. You can use CONTROL PAGE UP to scroll up through an array of structures displayed in a DISP window.

PAGE DOWN

The page-down key scrolls down through the window contents, one window length at a time. You can use CONTROL PAGE DOWN to scroll down through an array of structures displayed in a DISP window.

HOME When the FILE window is active, pressing HOME adjusts the window's contents so that the first line of the text file is at the top of the window. You can't use HOME outside of the FILE window.

END When the FILE window is active, pressing END adjusts the window's contents so that the last line of the file is at the bottom of the window. You can't use END outside of the FILE window.

↑ Moves the field cursor up one line at a time.

↓ Moves the field cursor down one line at a time.

← In the FILE window, scrolls the display left eight characters at a time. In other windows, moves the field cursor left one field; at the first field on a line, wraps back to the last fully displayed field on the previous line.

→ In the FILE window, scrolls the display right eight characters at a time. In other windows, moves the field cursor right one field; at the last field on a line, wraps around to the first field on the next line.

Editing the data displayed in windows

You can edit the data displayed in the MEMORY, CPU, DISP, and WATCH windows by using an overwrite “click and type” method or by using commands that change the values. (This is described in detail in Section 7.3, page 7-4.)

Note:

In the FILE, DISASSEMBLY, CALLS, and PROFILE windows, the “click and type” method of selecting data for editing—pointing at a line and pressing F9 or the left mouse button—does not allow you to modify data.

❑ In the FILE and DISASSEMBLY windows, pressing F9 or the mouse button sets or clears a breakpoint on any line of code that you select. You can’t modify text in a FILE or DISASSEMBLY window.

❑ In the CALLS window, pressing the mouse button shows the source for the function named on the selected line.

❑ In the PROFILE window, pressing F9 has no effect. Clicking the mouse button in the header displays a different set of data; clicking the mouse button on an area name shows the code associated with the area.

3.7 Closing a Window

The debugger opens various windows on the display according to the debugging mode you select. When you switch modes, the debugger may close some windows and open others. Additionally, you may choose to open DISP, WATCH, and MEMORY windows.

Most of the windows remain open—you can't close them. However, you can close the CALLS, DISP, MEMORY, and WATCH windows.

- To close the CALLS window,
  1) Make the CALLS window the active window.
  2) Press F4 .
- To close a DISP window,
  1) Make the appropriate DISP window the active window.
  2) Press F4 .

  If the DISP window that you close has any children, they are closed also.
- To close an additional MEMORY window,
  1) Make the appropriate MEMORY window the active window.
  2) Press F4 .

Note:

You cannot close the default MEMORY window.

- To close the WATCH window, enter:

  wr ↵

When you close a window, the debugger remembers the window's size and position. The next time you open the window, it will have the same size and position. That is, if you close the CALLS window, then reopen it, it will have the same size and position as it did before you closed it. Since you can open numerous DISP and MEM windows, when you open one, it will occupy the same position as the last one of that type that you closed.

Chapter 4

Entering and Using Commands

The debugger provides you with several methods for entering commands:

- ❑ From the command line
- ❑ From the pulldown menus (using keyboard combinations or the mouse)
- ❑ With function keys
- ❑ From a batch file

Various ways to use mouse and function keys in different situations are described throughout this book whenever applicable. This chapter includes specific rules that apply to entering and using pulldown menus. Also included is information about entering DOS commands and defining your own command strings.

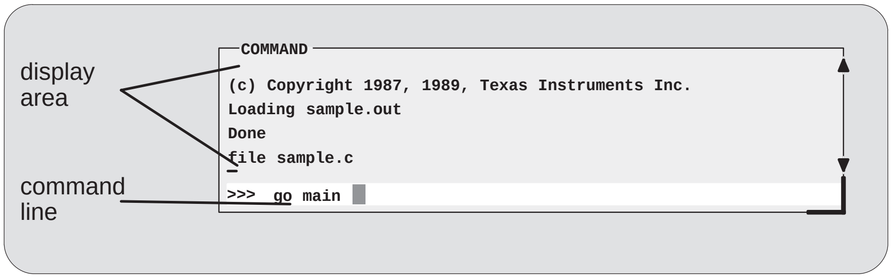
Topic **Page**

4.1 Entering Commands From the Command Line

The debugger supports a complete set of commands that help you to control and monitor program execution, customize the display, and perform other tasks. These commands are discussed in various sections throughout this book, as they apply to the current topic. Chapter 12 summarizes all of the debugger commands with an alphabetical reference.

Although there are a variety of methods for entering most of the commands, *all* of the commands can be entered by typing them on the command line in the COMMAND window. Figure 4–1 shows the COMMAND window.

Figure 4–1. The COMMAND Window



```
(c) Copyright 1987, 1989, Texas Instruments Inc.
Loading sample.out
Done
file sample.c
>>>  go main
```

The COMMAND window serves two purposes.

❑ The **command line** portion of the window provides you with an area for entering commands. For example, the command line in Figure 4–1 shows that a GO command was typed in (but not yet entered).

❑ The **display area** provides the debugger with an area for echoing commands, displaying command output, or displaying errors and messages for you to read. For example, the command output in Figure 4–1 shows the messages that are displayed when you first bring up the debugger and also shows that a FILE command was entered.

  If you enter a command by using an alternate method (using the mouse, a pulldown menu, or function keys), the COMMAND window doesn’t echo the entered command.

How to type in and enter commands

You can type a command at almost any time; the debugger automatically places the text on the command line when you type. When you want to enter a command, just type—no matter which window is active. You don't have to worry about making the COMMAND window active or moving the field cursor to the command line. When you start to type, the debugger usually assumes that you're typing a command and puts the text on the command line (except under certain circumstances, which are explained on the next page). Commands themselves are not case sensitive, although some parameters (such as window names) are.

To execute a command that you've typed, just press ↵. The debugger then:

1) Echoes the command to the display area,
2) Executes the command and displays any resulting output, and
3) Clears the command line when command execution completes.

Once you've typed a command, you can edit the text on the command line with these keystrokes.

To...	Press...
Move back over text without erasing characters	CTRL H or BACK SPACE
Move forward through text without erasing characters	CTRL L
Move back over text while erasing characters	DELETE
Move forward through text while erasing characters	SPACE
Insert text into the characters that are already on the command line	INSERT

Note:

❑ You cannot use the arrow keys to move through or edit text on the command line.

❑ Typing a command doesn't make the COMMAND window the active window.

❑ If you press ↵ when the cursor is in the middle of text, the debugger truncates the input text at the point where you press ↵.

Sometimes, you can’t type a command

At most times, you can press any alphanumeric or punctuation key on your keyboard (any printable character); the debugger interprets this as part of a command and displays the character on the command line. In a few instances, however, pressing an alphanumeric key is not interpreted as information for the command line.

- ❑ When you’re pressing the ALT key, typing certain letters causes the debugger to display a pulldown menu.
- ❑ When a pulldown menu is displayed, typing a letter causes the debugger to execute a selection from the menu.
- ❑ When you’re pressing the CONTROL key, pressing H or L moves the command-line cursor backward or forward through the text on the command line.
- ❑ When you’re editing a field, typing enters a new value in the field.
- ❑ When you’re using the MOVE or SIZE command interactively, pressing keys affects the size or position of the active window. Before you can enter any more commands, you must press ESC to terminate the interactive moving or sizing.
- ❑ When you’ve brought up a dialog box, typing enters a parameter value at the current field in the box.

Using the command history

The debugger keeps an internal list, or **command history**, of the commands that you enter. It remembers the last 100 commands that you entered. If you want to reenter a command, you can move through this list, select a command that you've already executed, and reexecute it.

Use these keystrokes to move through the command history.

To...	**Press...**
Repeat the last command that you entered	F2
Move forward through the list of executed commands on the command line, one by one	SHIFT TAB
Move backward through the list of executed commands, one by one	TAB

As you move through the command history, the debugger displays the commands, one by one, on the command line. When you see a command that you want to execute, simply press ↵ to execute the command. You can also edit these displayed commands in the same manner that you can edit new commands.

Clearing the display area

Occasionally, you may want to completely blank out the display area of the COMMAND window; the debugger provides a command for this.

cls Use the CLS command to clear all displayed information from the display area. The format for this command is:

cls

Recording information from the display area

The information shown in the display area of the COMMAND window can be written to a log file. The log file is a system file that contains commands you've entered, their results, and error or progress messages. To record this information in a log file, use the DLOG command.

Log files can be executed by using the TAKE command. When you use DLOG to record the information from the COMMAND window display area, the debugger automatically precedes all error or progress messages and command results with a semicolon to turn them into comments. This way, you can easily re-execute the commands in your log file by using the TAKE command.

- To begin recording the information shown in the COMMAND window display area, use:

  dlog *filename*

  This command opens a log file called *filename* that the information is recorded into.

- To end the recording session, enter:

  dlog close ↵

If necessary, you can write over existing log files or append additional information to existing files. The extended format for the DLOG command is:

dlog *filename* [**,**{**a** | **w**}]

The optional parameters of the DLOG command control how the log file is created and/or used:

- **Creating a new log file.** If you use the DLOG command without one of the optional parameters, the debugger creates a new file that it records the information into. If you are recording to a log file already, entering a new DLOG command and filename closes the previous log file and opens a new one.

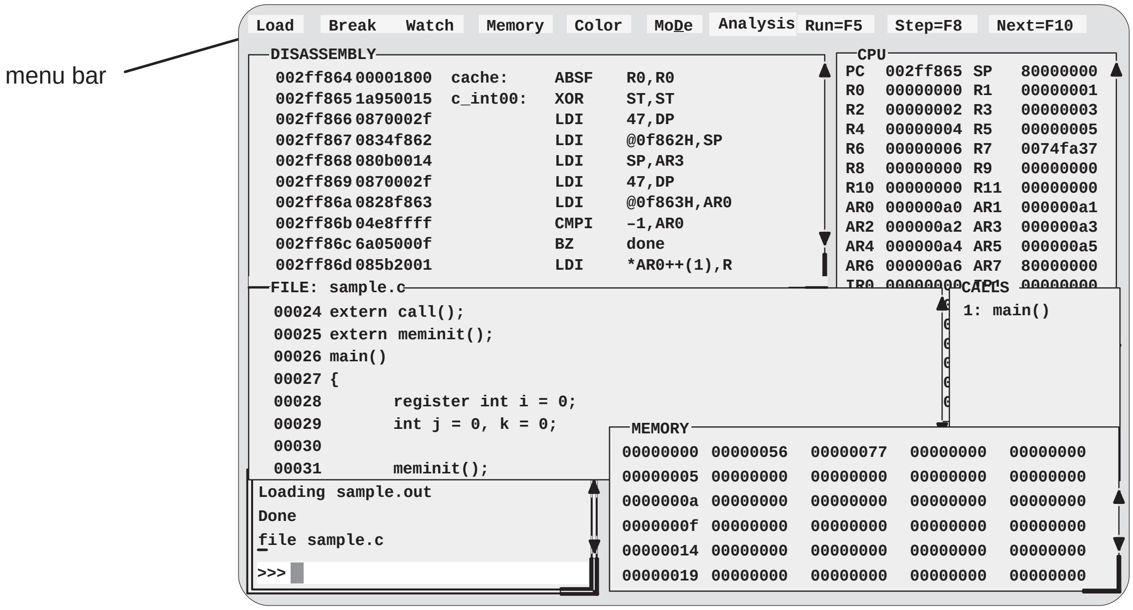
- **Appending to an existing file.** Use the **a** parameter to open an existing file to which to append the information in the display area.

- **Writing over an existing file.** Use the **w** parameter to open an existing file to write over the current contents of the file. Note that this is the default action if you specify an existing filename without using either the **a** or **w** options; you will lose the contents of an existing file if you don't use the append (a) option.

4.2 Using the Menu Bar and the Pulldown Menus

In all three of the debugger modes, you'll see a menu bar at the top of the screen. The menu selections offer you an alternative method for entering many of the debugger commands. Figure 4–2 points out the menu bar in a mixed-mode display. There are several ways to use the selections on the menu bar, depending on whether the selection has a pulldown menu or not.

Figure 4–2. The Menu Bar in the Basic Debugger Display



```
DISASSEMBLY
002ff864 00001800  cache:     ABSF    R0,R0
002ff865 1a950015  c_int00:   XOR     ST,ST
002ff866 0870002f             LDI     47,DP
002ff867 0834f862             LDI     @0f862H,SP
002ff868 080b0014             LDI     SP,AR3
002ff869 0870002f             LDI     47,DP
002ff86a 0828f863             LDI     @0f863H,AR0
002ff86b 04e8ffff             CMPI    –1,AR0
002ff86c 6a05000f             BZ      done
002ff86d 085b2001             LDI     *AR0++(1),R
```

```
CPU
PC  002ff865 SP  80000000
R0  00000000 R1  00000001
R2  00000002 R3  00000003
R4  00000004 R5  00000005
R6  00000006 R7  0074fa37
R8  00000000 R9  00000000
R10 00000000 R11 00000000
AR0 000000a0 AR1 000000a1
AR2 000000a2 AR3 000000a3
AR4 000000a4 AR5 000000a5
AR6 000000a6 AR7 80000000
TR0 00000000 TR1 00000000
```

```
FILE: sample.c
00024 extern call();
00025 extern meminit();
00026 main()
00027 {
00028        register int i = 0;
00029        int j = 0, k = 0;
00030
00031        meminit();
```

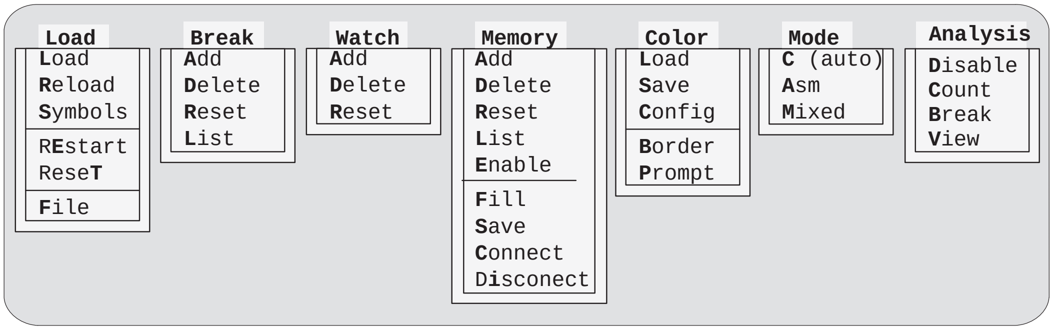
```
CALLS
1: main()
```

```
MEMORY
00000000 00000056  00000077  00000000  00000000
00000005 00000000  00000000  00000000  00000000
0000000a 00000000  00000000  00000000  00000000
0000000f 00000000  00000000  00000000  00000000
00000014 00000000  00000000  00000000  00000000
00000019 00000000  00000000  00000000  00000000
```

```
Loading sample.out
Done
file sample.c
>>>
```

Several of the selections on the menu bar have pulldown menus; if they could all be pulled down at once, they'd look like Figure 4–3.

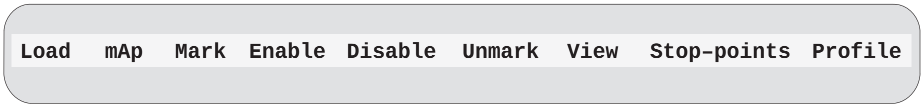
Figure 4–3. All of the Pulldown Menus (Basic Debugger Display)



Note: The connect and disconnect entries are available for the simulator only.

Pulldown menus in the profiling environment

The debugger displays a different menu bar in the profiling environment:



```
Load   mAp   Mark  Enable  Disable  Unmark  View   Stop–points  Profile
```

The Load menu corresponds to the Load menu available in the basic debugger environment. The other entries provide access to profiling commands. The mAp menu provides memory map commands available from the basic Memory menu.

Note that the menu bar and associated pulldown menus occupy fixed positions on the display. Unlike windows, you can't move, resize, or cover the menu bar or pulldown menus.

Using the pulldown menus

There are several ways to display the pulldown menus and then execute your selections from them. Executing a command from a menu is similar to executing a command by typing it in.

- If you select a command that has no parameters, then the debugger executes the command as soon as you select it.
- If you select a command that has one or more parameters, the debugger displays a **dialog box** when you make your selection. A dialog box offers you the chance to type in the parameter values for the command.

The following paragraphs describe several methods for selecting commands from the pulldown menus.

Mouse method 1

1) Point the mouse cursor at one of the appropriate selections in the menu bar.
2) Press the left mouse button, but don't release the button.
3) While pressing the mouse button, move the mouse downward until your selection is highlighted on the menu.
4) When your selection is highlighted, release the mouse button.

Mouse method 2

1) Point the cursor at one of the appropriate selections in the menu bar.

2) Click the left mouse button. This displays the menu until you are ready to make a selection.

3) Point the mouse cursor at your selection on the pulldown menu.

4) When your selection is highlighted, click the left mouse button.

Keyboard method 1

1) Press the ALT key; don't release it.

2) Press the key that corresponds to the highlighted letter in the selection name; release both keys. This displays the menu and freezes it.

3) Press and release the key that corresponds to the highlighted letter of your selection in the menu.

Keyboard method 2

1) Press the ALT key; don't release it.

2) Press the key that corresponds to the highlighted letter in the selection name; release both keys. This displays the menu and freezes it.

3) Use the arrow keys to move up and down through the menu.

4) When your selection is highlighted, press ↵.

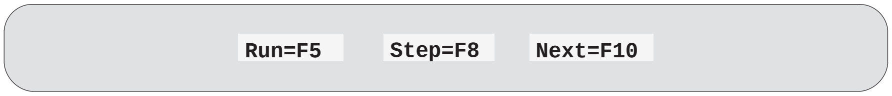
Escaping from the pulldown menus

- ❏ If you display a menu and then decide that you don't want to make a selection from this menu, you can:
  - ■ Press ESC

    or
  - ■ Point the mouse outside of the menu; press and then release the left mouse button.
- ❏ If you pull down a menu and see that it is not the menu you wanted, you can point the mouse at another entry and press the left mouse button, or you can use the ← and → keys to display adjacent menus.

Using menu bar selections that don't have pulldown menus

These three menu bar selections are single-level entries without pulldown menus:



```
Run=F5   Step=F8   Next=F10
```

There are two ways to execute these choices.

1) Point the cursor at one of these selections in the menu bar.

2) Press and release the left mouse button.

This executes your choice in the same manner as typing in the associated command without its optional *expression* parameter.

F5 Pressing this key is equivalent to typing in the RUN command without an *expression* parameter.

F8 Pressing this key is equivalent to typing in the STEP command without an *expression* parameter.

F10 Pressing this key is equivalent to typing in the NEXT command without an *expression* parameter.

Note:

Because the profiling environment supports over 100 profile-specific commands, it's not practical to show the commands associated with the menu choices.

4.3 Using Dialog Boxes

Many of the debugger commands have parameters. When you execute these commands from pulldown menus, you must have some way of providing parameter information. The debugger allows you to do this by displaying a **dialog box** that asks for this information.

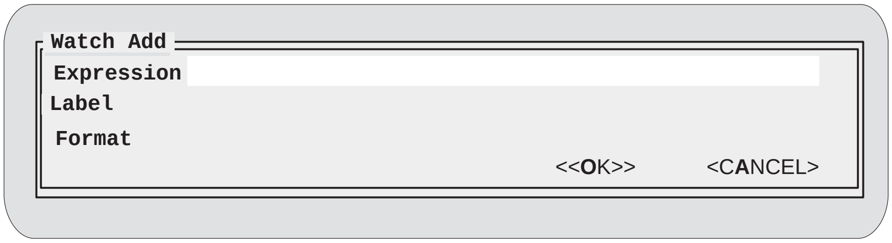
Some debugger commands have very simple dialog boxes that provide you with an alternative method for typing in values. Other commands, such as analysis commands, have more complex dialog boxes; in addition to typing in values, you may be asked to make selections from a list of predefined parameters.

Entering text in a dialog box

Entering text in a dialog box is much like entering commands on the command line. For example, the Add entry on the Watch menu is equivalent to entering the WA command. This command has three parameters:

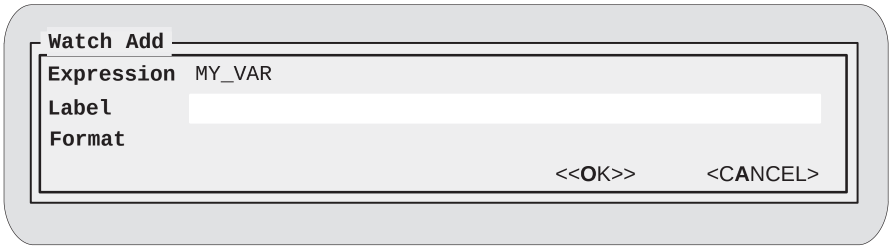
wa *expression* [, [*label*] [, *format*]]

When you select Add from the Watch menu, the debugger displays a dialog box that asks you for this parameter information. The dialog box looks like this:



```
Watch Add
Expression
Label
Format
```

You can enter an *expression* just as you would if you were to type the WA command, and then press TAB or ↓. The cursor moves down to the next parameter:



```
Watch Add
Expression  MY_VAR
Label
Format
```

When the dialog box displays more than one parameter, you can use the arrow keys to move from parameter to parameter. You can omit entries for optional parameters, but the debugger won't allow you to skip required parameters.

In the case of the WA command, the two parameters, *label* and *format*, are optional. If you want to enter a parameter, you may do so; if you don't want to use these optional parameters, don't type anything in their fields—just continue to the next parameter.

Modifying text in a dialog box is similar to editing text on the command line:

- ❑ When you display a dialog box for the first time during a debugging session, the parameter fields are empty. When you bring up the same dialog box again, though, the box displays the last values that you entered. (This is similar to having a command history.) If you want to use the same value, just press TAB or ↓ to move to the next parameter.
- ❑ You can edit what you type (or values that remain from a previous entry) in the same way that you can edit text on the command line. See Section 4.1 for more information on editing text on the command line.

When you've entered a value for the final parameter, point and click on <OK> to save your changes, or <CANCEL> to discard your changes; the debugger closes the dialog box and executes the command with the parameter values you supplied.

Selecting parameters in a dialog box

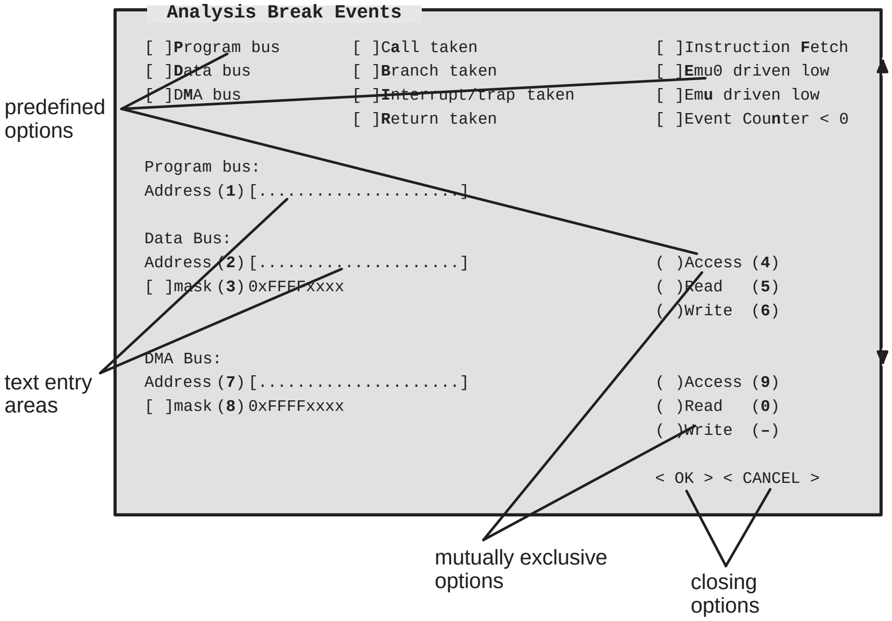
More complex dialog boxes, such as those associated with analysis commands, allow you to:

- ❑ **Enter text.** Entering text in a more complex dialog box is the same as entering text on the command line. Refer to the discussion above, *Entering text in a dialog box*, for more information.
- ❑ **Choose from a list of predefined options.** There are two types of predefined options in a dialog box. The first type of option allows you to enable one or more predefined options. The second type of option is *mutually exclusive*; therefore, you can enable only one at a time.

  Valid options (of the opened dialog box) are listed for you so that all you have to do is point and click to make your selections.
- ❑ **Close the dialog box.** The more complex dialog boxes do not close automatically. They allow you the option of saving or discarding any changes you made to your parameter choices. All you have to do to close the dialog box is point and click on the appropriate option, either OK or CANCEL.

Figure 4–4 shows you the components of a complex dialog box used with the analysis module.

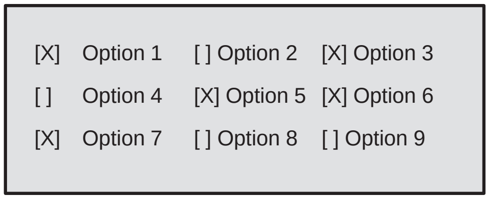
Figure 4–4. The Components of a Dialog Box



```
 Analysis Break Events
[ ]Program bus       [ ]Call taken                [ ]Instruction Fetch
[ ]Data bus          [ ]Branch taken              [ ]Emu0 driven low
[ ]DMA bus           [ ]Interrupt/trap taken      [ ]Emu driven low
                     [ ]Return taken              [ ]Event Counter < 0

Program bus:
Address (1) [....................]

Data Bus:
Address (2) [....................]                ( )Access (4)
[ ]mask (3) 0xFFFFxxxx                            ( )Read   (5)
                                                  ( )Write  (6)

DMA Bus:
Address (7) [....................]                ( )Access (9)
[ ]mask (8) 0xFFFFxxxx                            ( )Read   (0)
                                                  ( )Write  (–)

                                                  < OK > < CANCEL >
```

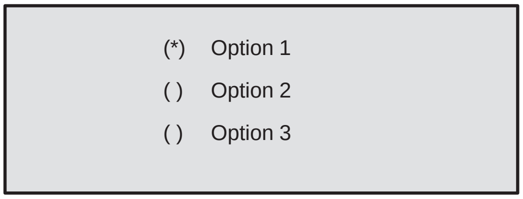
When you display a dialog box for the first time during a debugging session, nothing is enabled. When you bring up the same dialog box again, though, your previous selections are remembered. (This is similar to having a command history.)

As Figure 4–4 shows, options are preceded by either square brackets or parentheses; mutually exclusive options are only preceded by parentheses. Enabling options preceded by square brackets is like turning a switch on and off. When the option is enabled, the debugger displays an X inside the brackets preceding the option. You can enable as many of these options as you want:



```
[X]   Option 1    [ ] Option 2   [X] Option 3
[ ]   Option 4    [X] Option 5   [X] Option 6
[X]   Option 7    [ ] Option 8   [ ] Option 9
```

Mutually exclusive options, however, are enabled when the debugger displays an asterisk inside the parentheses preceding your selection. The following example illustrates this:



(*) Option 1

( ) Option 2

( ) Option 3

Notice that only one option is enabled at a time. There are several ways to enable both types of options:

1) Point the cursor at the option you want to enable.

2) Click the left mouse button. This enables the event and displays an X next to the option (or an asterisk next to a mutually exclusive option).

Repeat these two steps to disable an option. When the X (or asterisk) is no longer displayed, that option has been disabled.

Keyboard Method 1

ALT 1) Press the ALT key; don't release it.

X 2) Press and release the key that corresponds to the highlighted letter or number of the option you want to enable. The debugger displays an X (or asterisk) next to the option, indicating that selection is enabled.

Repeat these two steps to disable an option. When the X (or asterisk) is no longer displayed, that option has been disabled.

Keyboard Method 2

TAB 1) Press the TAB key to move throughout the dialog box until your cursor points to the option you want to enable.

↓ ↑ 2) Use the arrow keys to move up and down or left and right.

When you enable a mutually exclusive option, moving the arrow keys alone will place an asterisk inside the parentheses, indicating that the option is enabled. However, to enable an option preceded by square brackets, you must:

SPACE Press the SPACE bar. The debugger displays an X next to your selection, thus enabling that particular option.

or

F9 Press the F9 key. The debugger displays an X next to your selection, thus enabling that particular option.

Repeat these steps to disable an option.

Closing a dialog box

The more complex dialog boxes do not close automatically; the debugger expects input from you. When you close a dialog box, you can:

- ❑ Save the changes you made

or

- ❑ Discard any of the changes you made

Note:

The default option, <<OK>>, is highlighted; clicking on this option saves your changes and closes the dialog box.

There are several ways to close a dialog box:

↖ 1) Point the cursor at <<OK>> to close the dialog box and save your changes. Or you can opt to discard your changes by pointing the cursor at <<CANCEL>>.

2) Click the left mouse button. This executes your choice and closes the dialog box.

Keyboard Method 1

ALT 1) Press the ALT key; don't release it.

X 2) Press and release the O key to save your changes. Press and release the A key to discard your changes. Both of these actions execute your choice and close the dialog box.

Keyboard Method 2

TAB 1) Press the TAB key to move through the dialog box until your cursor is in the <<OK>> or <<CANCEL>> field.

← → 2) Use the arrow keys to switch between <<OK>> and <<CANCEL>>.

↵ 3) Press the ↵ key to accept your selection. This executes your choice and closes the dialog box.

4.4 Entering Commands From a Batch File

You can place debugger commands in a batch file and execute the file from within the debugger environment. This is useful, for example, for setting up a memory map that contains several MA commands followed by a MAP command that enables memory mapping.

take Use the TAKE command to tell the debugger to read and execute commands from a batch file. A batch file can call another batch file; they can be nested in this manner up to 10 deep. To halt the debugger's execution of a batch file, press ESC.

The format for the TAKE command is:

take *batch filename* [*, suppress echo flag*]

- ❑ The *batch filename* parameter identifies the file that contains commands.
  - ■ If you supply path information with the *filename*, the debugger looks for the file only in the specified directory.
  - ■ If you don't supply path information with the *filename*, the debugger looks for the file in the current directory.
  - ■ On PC systems, if the debugger can't find the file in the current directory, it looks in any directories that you identified with the D_DIR environment variable. You can set D_DIR within the DOS or OS/2 environments; the command for doing this is:

    SET D_DIR=*pathname; pathname*

This allows you to name several directories that the debugger can search. If you often use the same directories, it may be convenient to set D_DIR in your autoexec.bat file (for DOS) or your config.sys file (for OS/2). On DOS systems, you can also set D_DIR from within the debugger by using the SYSTEM command (see Section 4.6, *Entering Operating-System Commands*, page 4-23).

- ❑ By default, the debugger echoes the commands in the COMMAND window display area and updates the display as it reads commands from the batch file.
  - If you don't use the *suppress echo flag* parameter, or if you use it but supply a nonzero value, then the debugger behaves in the default manner.
  - If you would like to suppress the echoing and updating, use the value 0 for the *suppress echo flag* parameter.

Echoing strings in a batch file

When executing a batch file, you can display a string to the COMMAND window by using the ECHO command. The syntax for the command is:

echo *string*

This displays the *string* in the display area of the COMMAND window.

For example, you may want to document what is happening during the execution of a certain batch file. To do this, you could use the following line in your batch file to indicate that you are creating a new memory map for your device:

```
echo Creating new memory map
```

(Notice that the string should not be in quotes.)

When you execute the batch file, the following message appears:

```
.
.
Creating new memory map
.
.
```

Note that any leading blanks in your string are removed when the ECHO command is executed.

Controlling command execution in a batch file

In batch files, you can control the flow of debugger commands. You can choose to conditionally execute debugger commands or set up a looping situation by using IF/ELSE/ENDIF or LOOP/ENDLOOP, respectively.

- ❑ To conditionally execute debugger commands in a batch file, use the IF/ELSE/ENDIF commands. The syntax is:

  if *Boolean expression*
  debugger command
  debugger command
  .
  .
  [**else**
  debugger command
  debugger command
  .
  .]
  endif

  The debugger includes some predefined constants for use with IF. These constants evaluate to 0 (false) or 1 (true). Table 4–1 shows the constants and their corresponding tools.

Table 4–1. Predefined Constants for Use With Conditional Commands

Constant	Debugger Tool
$$EMU$$	emulator
$$SIM$$	simulator

If the Boolean expression evaluates to true (1), the debugger executes all commands between the IF and ELSE or ENDIF. Note that the ELSE portion of the command is optional. (See Chapter 13 for more information about expressions and expression analysis.)

One way you can use these predefined constants is to create an initialization batch file that works for any debugger tool. This is useful if you are using, for example, both the emulator and the simulator. To do this, you can set up the following batch file:

```
if $$EMU$$
echo Invoking initialization batch file for emulator.
use \c4xhll
take emuinit.cmd
.
.
.
endif

if $$SIM$$
echo Invoking initialization batch file for simulator.
use \sim4x
take siminit.cmd
.
.
.
endif
.
.
.
```

In this example, the debugger will execute only the initialization commands that apply to the debugger tool that you invoke.

- To set up a looping situation to execute debugger commands in a batch file, use the LOOP/ENDLOOP commands. The syntax is:

  loop *expression*
  debugger command
  debugger command
  .
  .
  endloop

  These looping commands evaluate in the same method as in the run conditional command expression. (See Chapter 13 for more information about expressions and expression analysis.)

  - If you use an *expression* that is not Boolean, the debugger evaluates the expression as a loop count. For example, if you wanted to execute a sequence of debugger commands ten times, you would use the following:

    ```
    loop 10
    runb
    .
    .
    .
    endloop
    ```

    The debugger treats the 10 as a counter and executes the debugger commands ten times.

- If you use a Boolean *expression*, the debugger executes the commands repeatedly as long as the expression is true. This type of expression has one of the following operators as the highest precedence operator in the expression:

>	>=	<
<=	==	!=
&&	||	!

  For example, if you want to continuously trace some register values, you can set up a looping expression like the following:

  ```
  loop !0
  step
  ? PC
  ? AR0
  endloop
  ```

The IF/ELSE/ENDIF and LOOP/ENDLOOP commands work with the following conditions:

- You can use conditional and looping commands only in a batch file.
- You must enter each debugger command on a separate line in the batch file.
- You can't nest conditional and looping commands within the same batch file.

4.5 Defining Your Own Command Strings

The debugger provides a shorthand method of entering often-used commands or command sequences. This process is called *aliasing*. Aliasing enables you to define an alias name for the command(s) and then enter the alias name as if it were a debugger command.

To do this, use the ALIAS command. The syntax for this command is:

alias [*alias name* [, “*command string*”]]

The primary purpose of the ALIAS command is to associate the *alias name* with the debugger command you've supplied as the *command string*. However, the ALIAS command is versatile and can be used in several ways:

- **Aliasing several commands.** The *command string* can contain more than one debugger command—just separate the commands with semicolons.

  For example, suppose you always began a debugging session by loading the same object file, displaying the same C source file, and running to a certain point in the code. You could define an alias to do all these tasks at once:

  ```
  alias init,"load test.out;file source.c;go main"
  ```

  Now you could enter init instead of the three commands listed within the quote marks.

- **Supplying parameters to the command string.** The *command string* can define parameters that you'll supply later. To do this, use a percent sign and a number (%1) to represent the parameter that will be filled in later. The numbers should be consecutive (%1, %2, %3) unless you plan to reuse the same parameter value for multiple commands.

  For example, suppose that every time you filled an area of memory, you also wanted to display that block in the MEMORY window:

  ```
  alias mfil,"fill %1, %2, %3;mem %1"
  ```

  Then you could enter:

  ```
  mfil 0x014,0x18,0x11112222
  ```

  The first value (0x014) would be substituted for the first FILL parameter and the MEM parameter (%1). The second and third values would be substituted for the second and third FILL parameters (%2 and %3).

- **Listing all aliases.** To display a list of all the defined aliases, enter the ALIAS command with no parameters. The debugger will list the aliases and their definitions in the COMMAND window.

  For example, assume that the init and mfil aliases had been defined as shown in the previous two examples. If you entered:

  `alias` ⏎

  you'd see:

  ```
     Alias       Command
  -----------------------------------------
  INIT     -->   load test.out;file source.c;go main
  MFIL     -->   fill %1,%2,%3;mem %1
  ```

- **Finding the definition of an alias.** If you know an alias name but are not sure of its current definition, enter the ALIAS command with just an alias name. The debugger will display the definition in the COMMAND window.

  For example, if you had defined the init alias as shown in the first example above, you could enter:

  `alias init` ↵

  Then you'd see:

  ```
  ”INIT” aliased as ”load test.out; file source.c;go main”
  ```

- **Nesting alias definitions.** You can include a defined alias name in the *command string* of another alias definition. This is especially useful when the command string would be longer than the debugger command line.

- **Redefining an alias.** To redefine an alias, re-enter the ALIAS command with the same alias name and a new command string.

- **Deleting aliases.** To get rid of a single alias, use the UNALIAS command:

  unalias *alias name*

  To delete *all* aliases, enter the UNALIAS command with an asterisk instead of an alias name:

  `unalias *`

  Note that the * symbol *does not* work as a wildcard.

Note:

- Alias definitions are lost when you exit the debugger. If you want to reuse aliases, define them in a batch file.
- Individual commands within a command string are limited to an expanded length of 132 characters. The expanded length of the command includes the length of any substituted parameter values.

4.6 Entering Operating-System Commands (DOS Only)

The debugger provides a simple method of entering DOS commands without explicitly exiting the debugger environment. To do this, use the SYSTEM command. The format for this command is:

system [*DOS command* [, *flag*]]

The SYSTEM command behaves in one of two ways, depending on whether or not you supply an operating-system command as a parameter:

- If you enter the SYSTEM command with a DOS command as a parameter, then you stay within the debugger environment.
- If you enter the SYSTEM command without parameters, the debugger opens a *system shell*. This means that the debugger will blank the debugger display and temporarily exit to the operating-system prompt.

Use the first method when you have only one command to enter; use the second method when you have several commands to enter.

Entering a single command from the debugger command line

If you need to enter only a single DOS command, supply it as a parameter to the SYSTEM command. For example, in MS-DOS, if you want to copy a file from another directory into the current directory, you might enter:

```
system ”copy a:\backup\sample.c sample.c” ↵
```

If the DOS command produces a display of some sort (such as a message), the debugger will blank the upper portion of the debugger display to show the information. In this situation, you can use the *flag* parameter to tell the debugger whether or not it should hesitate after displaying the results of the DOS command. *Flag* may be a 0 or a 1:

0 The debugger immediately returns to the debugger environment after the last item of information is displayed.

1 The debugger does not return to the debugger environment until you press ↵. (This is the default.)

In the example above, the debugger opens a system shell to display the following message:

```
         1 File(s) copied
Type Carriage Return To Return To Debugger
```

The message displays until you press ⏎.

If you want the debugger to display the message and then return immediately to the debugger environment, you can enter the command in this way:

```
system ”copy a:\backup\sample.c sample.c”,0 ⏎
```

Entering several commands from a system shell

If you need to enter several commands, enter the SYSTEM command without parameters. The debugger will open a system shell and display the DOS prompt. At this point, you can enter any DOS command.

When you are finished entering commands and are ready to return to the debugger environment, enter:

```
exit ⏎
```

Note:

On PC systems, available memory may limit the operating-system commands that you can enter from a system shell. For example, you would not be able to invoke another version of the debugger.

Additional system commands

The debugger also provides separate commands for changing directories and for listing the contents of a directory.

cd Use the CHDIR (CD) command to change the current working directory. The format for this command is:

chdir *directory name*
or **cd** *directory name*

This changes the current directory to the specified *directory name*. You can use relative pathnames as part of the directory name. Note that this command can affect any command whose parameter is a filename (such as the FILE, LOAD, and TAKE commands).

dir Use the DIR command to list the contents of a directory. The format for this command is:

dir [*directory name*]

This command displays a directory listing in the display area of the COMMAND window. If you use the optional *directory name* parameter, the debugger displays a list of the specified directory's contents. If you don't use this parameter, the debugger lists the contents of the current directory.

You can use wildcards as part of the *directory name*.

Chapter 5

Defining a Memory Map

Before you begin a debugging session, you must supply the debugger with a memory map. The memory map tells the debugger which areas of memory it can and can't access. Note that the commands described in this chapter can be entered using the Memory pulldown menu.

Topic **Page**

5.1 The Memory Map: What It Is and Why You Must Define It

A memory map tells the debugger which areas of memory it can and can't access. Memory maps vary, depending on the application. Typically, the map matches the MEMORY definition in your linker command file.

Note:

When the debugger compares memory accesses against the memory map, it performs this checking in software, not hardware. The debugger can't prevent your program from attempting to access nonexistent memory.

A special default initialization batch file included with the debugger package defines a memory map for your version of the debugger. This memory map may be sufficient when you first begin using the debugger. However, the debugger provides a complete set of memory-mapping commands that let you modify the default memory map or define a new memory map.

You can define the memory map interactively by entering the memory-mapping commands while you're using the debugger. This can be inconvenient because, in most cases, you'll set up one memory map before you begin debugging and will use this map for all of your debugging sessions. The easiest method for defining a memory map is to put the memory-mapping commands in a batch file.

Defining the memory map in a batch file

There are two methods for defining the memory map in a batch file:

❑ You can redefine the memory map defined in the initialization batch file.

❑ You can define a memory map in a separate batch file of your own.

When you invoke the debugger, it follows these steps to find the batch file that defines your memory map:

1) When you invoke the debugger, it checks to see if you've used the –t debugger option. The –t option allows you to specify a batch file other than the initialization batch file shipped with the debugger. If it finds the –t option, the debugger reads and executes the specified file.

2) If you don't use the –t option, the debugger next looks for the default initialization batch file. The batch file name differs for each version of the debugger:

   ❑ For the emulator, this file is named *emuinit.cmd.*
   ❑ For the simulator, this file is named *siminit.cmd.*

If the debugger finds the file corresponding to your tool, it reads and executes the file.

3) If the debugger does not find the –t option or the initialization batch file, it looks for a file called *init.cmd*. This allows you to have one initialization batch file for more than one debugger tool. To set up this file, you can use the IF/ELSE/ENDIF commands (see page 4-18 for more information) to indicate which memory map applies to each tool.

Potential memory map problems

The following are potential problems you may experience if the memory map isn't correctly defined and enabled:

- **Accessing invalid memory addresses.** If you don't supply a batch file containing memory-map commands, then the debugger is initially unable to access any target memory locations. Invalid memory addresses and their contents are highlighted in the data-display windows. (On color monitors, invalid memory locations, by default, are displayed in red.)
- **Accessing an undefined or protected area.** When memory mapping is enabled, the debugger checks each of its memory accesses against the provided memory map. If you attempt to access an undefined or protected area, the debugger displays an error message.

5.2 Sample Memory Maps

Because you must define a memory map before you can run any programs, it’s convenient to define the memory map in a batch file. The debugger is shipped with a sample initialization batch file. Figure 5–1 *(a)* and Figure 5–2 *(a)* list the contents of this file for the simulator and emulator. You can use any of the files as they are, edit them, or create your own memory map batch files.

The MA commands (shown in Figure 5–1 *(a)*) define valid memory ranges and identify the read/write characteristics of these memory ranges. The MAP command enables mapping (note that by default, mapping is enabled when you invoke the debugger). Figure 5–1 *(b)* and Figure 5–2 *(b)* illustrate the memory map defined by the default batch file.

Figure 5–1. Sample Memory Map for Use With a ’C4x Simulator

(a) Memory map commands (siminit.cmd)

```
MA 0,           0x1000, RAM
MA 0x100000,    0x40,   RAM
MA 0x2ff800,    0x400,  RAM
MA 0x2ffc00,    0x400,  RAM
MA 0x300000,    0x1000  RAM
MA 0x80000000,  0x1000, RAM
MAP ON
```

(b) Memory map defined by the siminit.cmd file

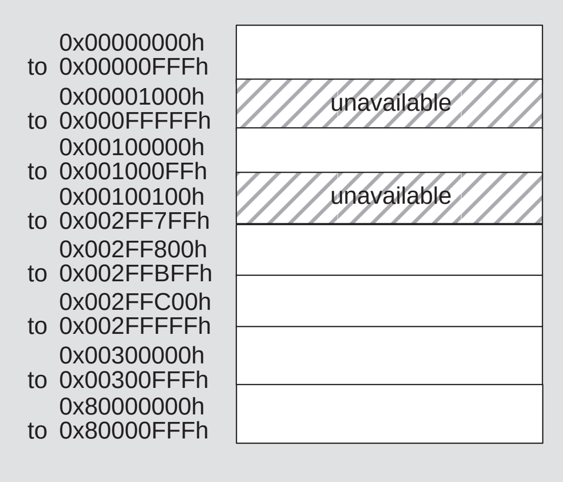


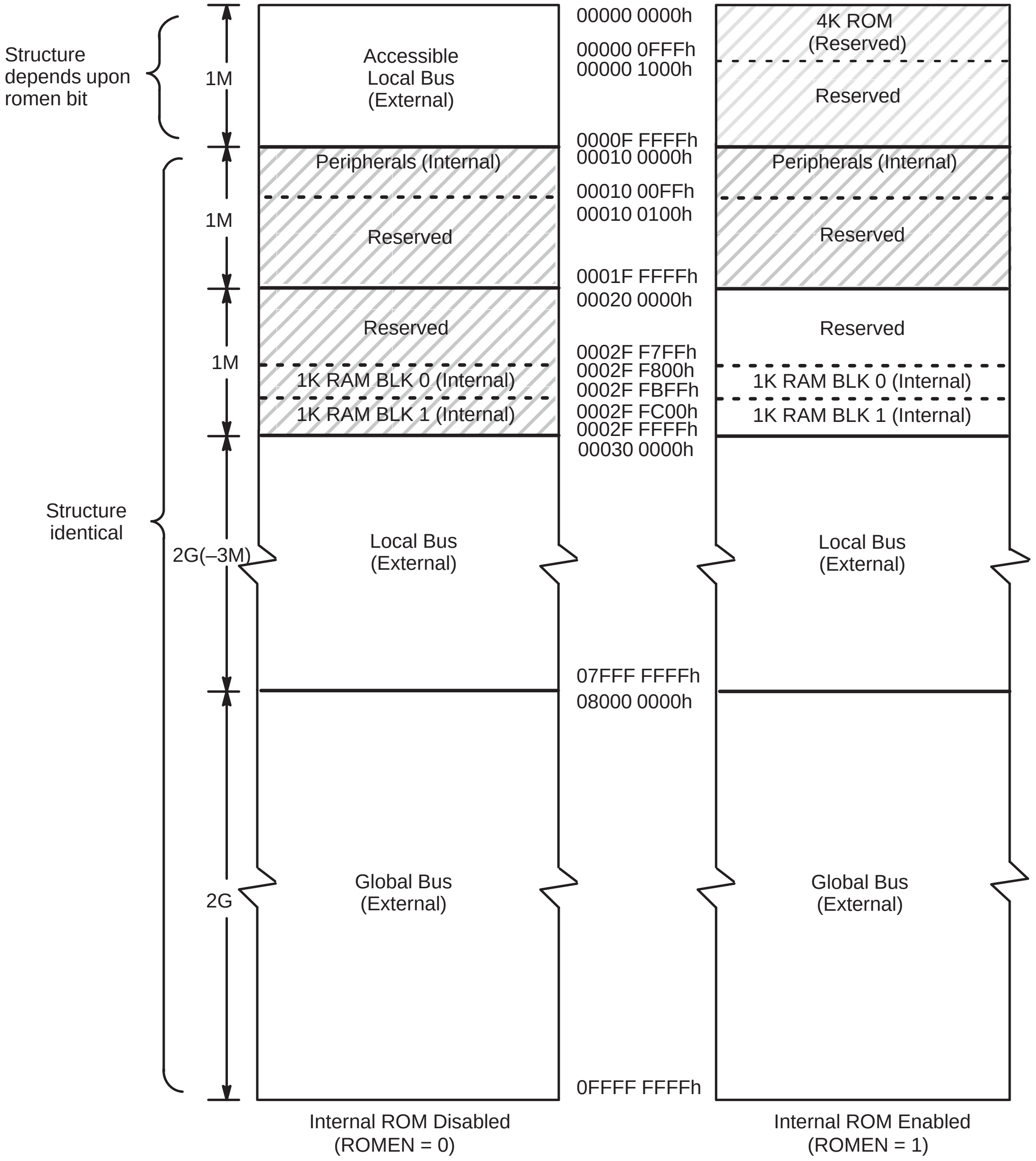
Figure 5–2. Sample Memory Map for Use With a ’C4x Emulator

(a) Memory Map Commands (emuinit.cmd)

```
MR
MA  0x000000,0x800,ROM
MA  0x002ff800,0x400,RAM
MA  0x002ffc00,0x400,RAM
MA  0x40000000,0x10000,RAM
MA  0x80000000,0x20000,RAM
MA  0x00100000,1,RAM
MA  0x00100004,1,RAM
MA  0x00100020,9,RAM
MA  0x00100030,9,RAM
MA  0x00100040,3,RAM
MA  0x00100050,3,RAM
MA  0x00100060,3,RAM
MA  0x00100070,3,RAM
MA  0x00100080,3,RAM
MA  0x00100090,3,RAM
MA  0x001000A0,9,RAM
MA  0x001000B0,9,RAM
MA  0x001000C0,9,RAM
MA  0x001000D0,9,RAM
MA  0x001000E0,9,RAM
MA  0x001000F0,9,RAM
```

Figure 5–2. Sample Memory Map for Use With a ’C4x Emulator (Continued)

(b) Memory Maps defined by the emuinit.cmd file



You can change the ROMEN pin by using the pseudo register ROMEN. If the value of the ROMEN pin is one, the memory range 0 – 0FFFh is considered to be ROM space, while the memory range 1000h – FFFFFh is considered to be reserved memory space.

You can set up the memory range 0 – FFFFFh, if the value of the ROMEN pin is zero. In this case, the debugger treats the memory range as external memory. To change the value of the ROMEN pin from one to zero, enter:

```
e romen = 0
```

The default value of the ROMEN pin is one.

5.3 Identifying Usable Memory Ranges

ma The debugger's MA command identifies valid ranges of target memory. The syntax of the MA command is:

ma *address, length, type*

- The *address* parameter defines the starting address of a range. This parameter can be an absolute address, any C expression, the name of a C function, variable, or an assembly language label.

  A new memory map must not overlap an existing entry. If you define a range that overlaps an existing range, the debugger ignores the new range and displays this error message in the COMMAND window display area:

  ```
  Conflicting map range
  ```

- The *length* parameter defines the length of the range. This parameter can be any C expression.
- The *type* parameter identifies the read/write characteristics of the memory range. The *type* must be one of these keywords:

To identify this kind of memory,	Use this keyword as the *type* parameter
read-only memory	**R**, **ROM**, or **READONLY**
write-only memory	**W**, **WOM**, or **WRITEONLY**
read/write memory	**WR** or **RAM**
no-access memory	**PROTECT**
input port	**IPORT** (valid for simulator only)
output port	**OPORT** (valid for simulator only)
input/output port	**IOPORT** (valid for simulator only)

Note:

When you are using the simulator, you can use the parameter values specified as valid for simulator only to simulate communication ports; see Section 5.8, page 5-11.

5.4 Enabling Memory Mapping

map By default, mapping is enabled when you invoke the debugger. In some instances, you may want to explicitly enable or disable memory. You can use the MAP command to do this; the syntax for this command is:

map on
or **map off**

Disabling memory mapping can cause bus fault problems in the target system because the debugger may attempt to access nonexistent memory.

Note:

When memory mapping is enabled, you cannot:

- ❑ Access memory locations that are not defined by an MA command.
- ❑ Modify memory areas that are defined as read only or protected.

If you attempt to access memory in these situations, the debugger displays this message in the COMMAND window display area:

```
Error in expression
```

5.5 Checking the Memory Map

ml If you want to see which memory ranges are defined, use the ML command. The syntax for this command is:

ml

The ML command lists the starting address, ending address, and read/write characteristics of each defined memory range. For example, if you're using the default memory map for the emulator and you enter the ml command, the debugger displays this:

```
Memory range                    Attributes
00000000 – 000007ff             READ
002ff800 – 002ffbff             READ WRITE
40000000 – 4000ffff             READ WRITE
80000000 – 8001ffff             READ WRITE
00100000 – 00100000             READ WRITE
00040000 – 00040000             READ WRITE
00100004 – 00100004             READ WRITE
00100020 – 00100028             READ WRITE
00100030 – 00100038             READ WRITE
```

5.6 Modifying the Memory Map During a Debugging Session

If you need to modify the memory map during a debugging session, use these commands.

md To delete a range of memory from the memory map, use the MD (memory delete) command. The syntax for this command is:

md *address*

The *address* parameter identifies the starting address of the range of memory. If you supply an *address* that is not the starting address of a range, the debugger displays this error message in the COMMAND window display area:

```
Specified map not found
```

Note:

If you are using the simulator and want to use the MD command to remove a simulated I/O port, you must first disconnect the port with the MI command. Refer to Section 5.8, page 5-11.

mr If you want to delete all defined memory ranges from the memory map, use the MR (memory reset) command. The syntax for this command is:

mr

This resets the debugger memory map.

ma If you want to add a memory range to the memory map, use the MA (memory add) command. The syntax for this command is:

ma *address, length, type*

The MA command is described in detail on page 5-7.

Returning to the original memory map

If you modify the memory map, you may want to go back to the original memory map without quitting and reinvoking the debugger. You can do this by resetting the memory map and then using the TAKE command to read in your original memory map from a batch file.

Suppose, for example, that you had set up your memory map in a batch file named mem.map. You could enter these commands to go back to this map:

```
mr ⏎                                      Reset the memory map
take mem.map ⏎                   Reread the default memory map
```

The MR command resets the memory map. (Note that you could put the MR command in the batch file, preceding the commands that define the memory map.) The TAKE command tells the debugger to execute commands from the specified batch file.

5.7 Using Multiple Memory Maps for Multiple Target Systems

If you're debugging multiple applications, you may need a memory map for each target system. Here's the simplest method for handling this situation.

Step 1: Let the initialization batch file define the memory map for one of your applications.

Step 2: Create a separate batch file that defines the memory map for the additional target system. The filename is unimportant, but for the purposes of this example, assume that the file is named filename.x. The general format of this file's contents should be:

```
mr                               Reset the memory map
MA commands                 Define the new memory map
map on                                 Enable mapping
```

(Of course, you can include any other appropriate commands in this batch file.)

Step 3: Invoke the debugger as usual.

Step 4: The debugger reads initialization batch file as usual. Before you begin debugging, read in the commands from the new batch file:

```
take filename.x ⏎
```

This redefines the memory map for the current debugging session.

5.8 Simulating Communication Ports and I/O Space (Simulator Only)

The simulator supports communication port simulation with the communication port control register, input port control register, and output port control register, and also supports communication port interrupts, and communication port input and output buffering.

The simulator supports communication port simulation with the communication port control register, input port control register, and output port control register. It also supports communication port interrupts and port input and output buffering. External signals pertaining to communication ports are not supported.

In addition to adding memory ranges to the memory map, you can use the MA command to add I/O ports to the memory map. To do this, use IPORT (input port), OPORT (output port), or IOPORT (input/output port) as the memory type. Then, you can use the MC command to connect a port to an input or output file. This simulates external I/O cycle reads and writes by allowing you to read data in from a file and/or write data out to a file.

Connecting an I/O port

mc The MC (memory connect) command connects IPORT, OPORT, or IOPORT to an input or output file. Before you can connect the port, you must add it to the memory map with the MA command. The syntax for this command is:

mc *port address, filename,* {**READ | WRITE**}

- The *port address* parameter defines the address of the I/O port. This parameter can be an absolute address, any C expression, the name of a C function, or an assembly language label.
- The *filename* parameter can be any filename. If you connect a port to read from a file, the file must exist, or the MC command will fail.
- The final parameter is specified as **READ** or **WRITE** and defines how the file will be used (for input or output, respectively).

The file is accessed during an LDI or STI instruction accessing the associated port address. You can treat any address in ’C4x memory space as an I/O port and can connect the address to a file. A maximum of one input and one output file can be connected to a single port; multiple ports can be connected to a single file. Memory-mapped ports can also be connected to files; any instruction that reads or writes to the memory-mapped port will read or write to the associated file.

Note:

When using the DOS version of the simulator, you can connect a maximum of 15 ports.

Example 5–1 shows how an input port can be connected to an input file named in.dat.

Example 5–1.Connecting an Input Port to an Input File

Assume that the file in.dat contains words of data in hexadecimal format, one per line, like this:

```
0x0A000000
0x10000000
0x20000000
  .
  .
  .
```

These two debugger instructions set up and connect an input port:

```
MA    0x50,0x1,IPORT              Configure port address 50h
                                            as an input port.
MC    0x50,in.dat,READ                   Open file in.dat and
                                connect to port address 50h.
```

Assume that this ’C4x instruction is part of your ’C4x program. This reads the data from the file in.dat.

```
LDI   @50h,R0            LDI instruction reads from the file.
```

Configuring memory to use communication port simulation

In order to use the communication port simulation, you must configure memory with the MA and MC commands. The simulator represents communication ports by “attaching” them to files. The following example sets the port control register, input port register, and output port register to configure communication port 0 and attach it to the files *datain* and *dataout*:

Example 5–2. Configuring Communication Port 0

```
ma 0x100040,1,RAM         ;Configure port control register
ma 0x100041,1,IPORT       ;Configure the input register as input port
mc 0x100042,datain,read   ;Connect input port to the file named datain
ma 0x100042,1,OPORT       ;Configure the output register as output port
mc 0x100042,dataout,write ;Connect output port to the file named dataout
```

Any instruction or DMA operation that accesses communication input port 0 will read from the data found in the file *datain*. Similarly, any instruction that accesses output port 0 will write to the file *dataout*.

The input file format for the communication port requires one number per line. You can enter the number in a hexadecimal, decimal, or octal format. The following is an acceptable format for an input file to the standard communication port:

```
101
0x65
0145
  ....
```

DMA autoinitialization limitations (unified mode vs. split mode)

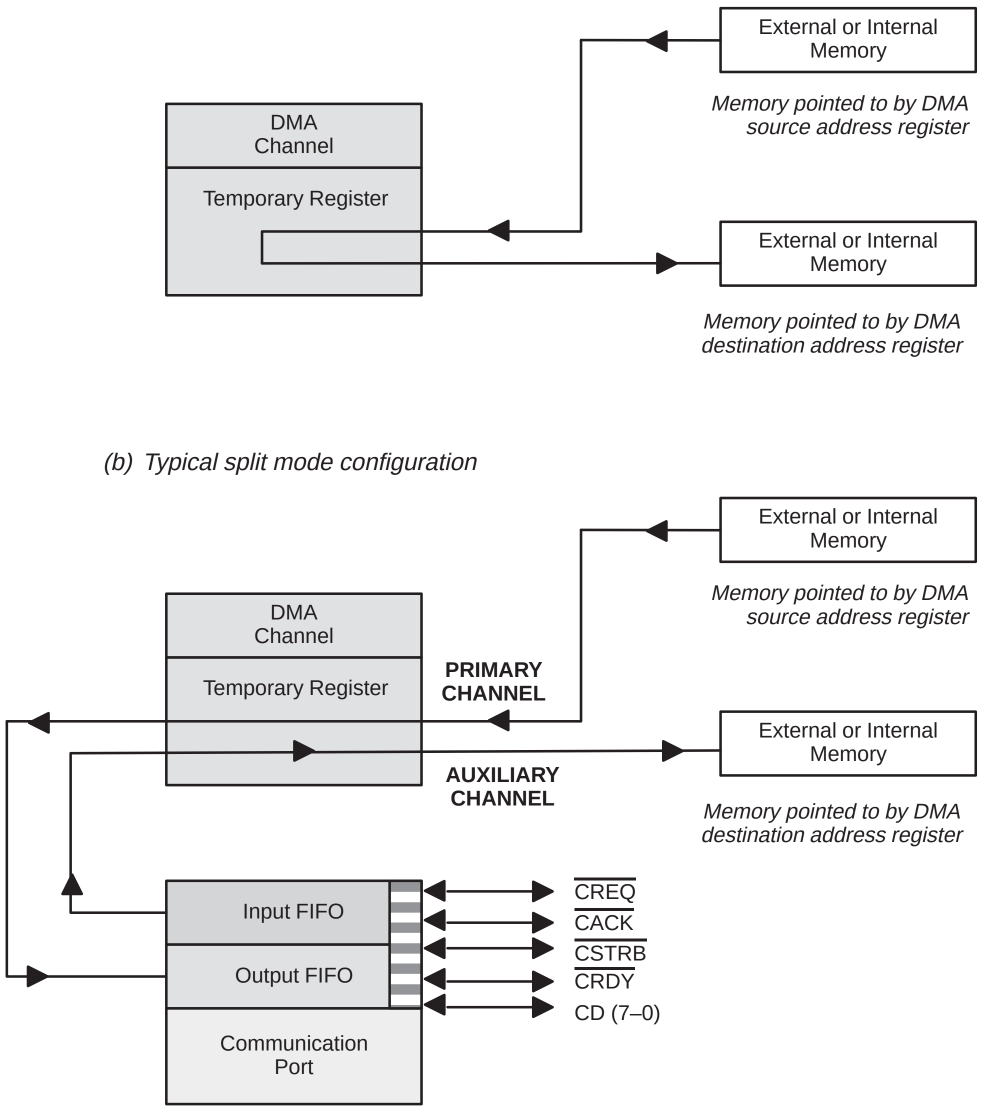
Autoinitialization is the process of initializing DMA channel registers when a DMA channel has transferred a block of data. Transfer of data is done through the link pointer and auxiliary link pointer registers. These registers contain memory addresses for data blocks that are loaded into the DMA register file. The process of autoinitialization is considered to be a DMA operation in itself, whereas the debugger reads from the link pointer and writes the value to a DMA register.

There are certain limitations using the simulator with autoinitialization capabilities. This is particularly true in a DMA channel in which autoinitialization is operating in the split mode. Refer to the *DMA Coprocessor and ’C40 Timers* chapter in the *TMS320C4x User’s Guide* for detailed information on autoinitialization and DMA channels in unified and split modes.

Using autoinitialization as a DMA operation is uncomplicated in unified mode. However, autoinitialization in split mode is a more complicated process. Figure 5–3 (a) and (b) shows the configuration of a DMA channel in unified and split modes.

Figure 5–3. DMA Channel Configuration

(a) Typical unified mode configuration


External or Internal Memory
Memory pointed to by DMA source address register
DMA Channel
Temporary Register
External or Internal Memory
Memory pointed to by DMA destination address register
External or Internal Memory
Memory pointed to by DMA source address register
DMA Channel
Temporary Register
PRIMARY CHANNEL
External or Internal Memory
AUXILIARY CHANNEL
Memory pointed to by DMA destination address register
Input FIFO
Output FIFO
Communication Port
$\overline{\text{CREQ}}$
$\overline{\text{CACK}}$
$\overline{\text{CSTRB}}$
$\overline{\text{CRDY}}$
CD (7–0)

(b) Typical split mode configuration

Autoinitialization in unified mode is treated as a DMA transfer and is cycle level accurate. However, autoinitialization in split mode is not treated as a DMA transfer; instead, it transfers the data block in a single transfer once autoinitialization is complete. As a result, it only takes one cycle to complete the DMA transfer in split mode; where in unified mode, this process can span across many cycles. Therefore, in split mode, autoinitialization is *not* level accurate. (This should not affect the flow of execution.)

Disconnecting an I/O port

Before you can use the MD command to delete a port from the memory map, you must use the MI command to disconnect the port.

mi The MI (memory disconnect) command disconnects a file from an I/O port. The syntax for this command is:

mi *port address,* {**READ | WRITE**}

The *port address* identifies the port that will be closed. The read/write characteristics must match the parameter used when the port was connected.

Note:

If you are using the simulator and want to use the MD command to remove a simulated I/O port, you must first disconnect the port with the MI command.

Chapter 6

Loading, Displaying, and Running Code

The main purpose of a debugging system is to allow you to load and run your programs in a test environment. This chapter tells you how to load your programs into the debugging environment, run them on the target system, and view the associated source code. Many of these commands described in this chapter can also be executed from the Load pulldown menu.

6.1 Code-Display Windows: Viewing Assembly Language Code, C Code, or Both

The debugger has three code-display windows:

- The DISASSEMBLY window displays the reverse assembly of program memory contents.
- The FILE window displays any text file; its main purpose is to display C source files.
- The CALLS window identifies the current function (when C code is running).

You can view code in several different ways. The debugger has three different code displays that are associated with the three debugging modes. The debugger's selection of the appropriate display is based on two factors:

- The mode you select, and
- Whether your program is currently executing assembly language code or C code.

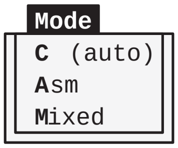
Here's a summary of the modes and displays; for a complete description of the three debugging modes, refer to Section 3.1, *Debugging Modes and Default Displays* (page 3-2).

Use this mode	**To view**	**The debugger uses these code-display windows**
assembly mode	*assembly language code only* (even if your program is executing C code)	❑ DISASSEMBLY
auto mode	*assembly language code* (when that's what your program is running)	❑ DISASSEMBLY
auto mode	*C code only* (when that's what your program is running)	❑ FILE ❑ CALLS
mixed mode	*both assembly language and C code*	❑ DISASSEMBLY ❑ FILE ❑ CALLS

You can switch freely between the modes. If you choose auto mode, then the debugger displays C code *or* assembly language code, depending on the type of code that is currently executing.

Selecting a debugging mode

When you first invoke the debugger, it automatically comes up in auto mode. You can then choose assembly or mixed mode. There are several ways to do this.



The Mode pulldown menu provides an easy method for switching modes. There are several ways to use the pulldown menus; here's one method.

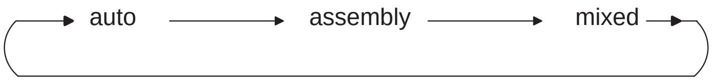
1) Point to the menu name.

2) Press the left mouse button; do not release the button. Move the mouse down the menu until your choice is highlighted.

3) Release the mouse button.

For more information about the pulldown menus, refer to Section 4.2, *Using the Pulldown Menus,* on page 4-7.

F3 Pressing this key causes the debugger to switch modes in this order:



Enter any of these commands to switch to the desired debugging mode:

c Changes from the current mode to auto mode.

asm Changes from the current mode to assembly mode.

mix Changes from the current mode to mixed mode.

If you are already in the desired mode when you enter a mode command, then the command has no effect.

6.2 Displaying Your Source Programs (or Other Text Files)

The debugger displays two types of code:

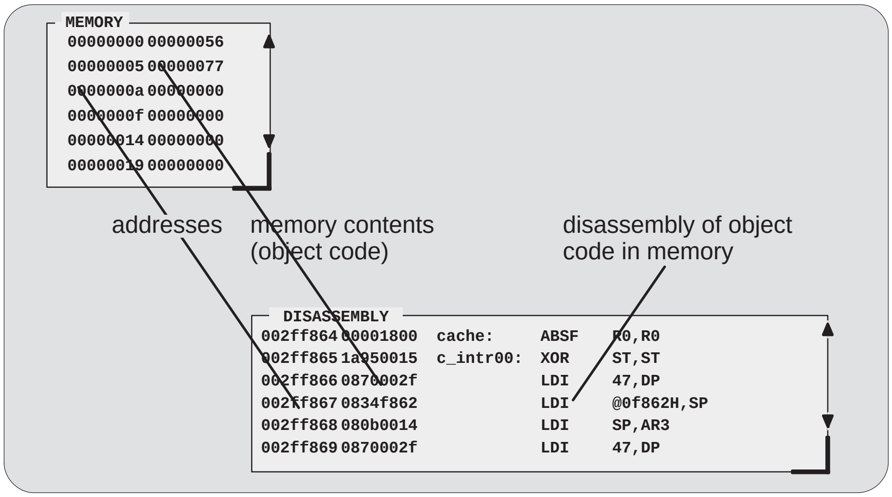
- It displays **assembly language code** in the DISASSEMBLY window in auto, assembly, or mixed mode.
- It displays **C code** in the FILE window in auto and mixed modes.

The DISASSEMBLY and FILE windows are primarily intended for displaying code that the PC points to. By default, the FILE window displays the C source for the current function (if any), and the DISASSEMBLY window shows the current disassembly.

Sometimes it's useful to display other files or different parts of the same file; for example, you may want to set a breakpoint at an undisplayed line. The DISASSEMBLY and FILE windows are not large enough to show the entire contents of most assembly language and C files. You can scroll through the windows. You can also tell the debugger to display specific portions of the disassembly or C source.

Displaying assembly language code

The assembly language code in the DISASSEMBLY window is the reverse assembly of memory contents. (This code doesn't come from any of your text files or from the intermediate assembly files produced by the compiler.)



```
MEMORY
00000000 00000056
00000005 00000077
0000000a 00000000
0000000f 00000000
00000014 00000000
00000019 00000000
```

```
DISASSEMBLY
002ff864 00001800  cache:     ABSF    R0,R0
002ff865 1a950015  c_intr00:  XOR     ST,ST
002ff866 0870002f             LDI     47,DP
002ff867 0834f862             LDI     @0f862H,SP
002ff868 080b0014             LDI     SP,AR3
002ff869 0870002f             LDI     47,DP
```

When you invoke the debugger, it comes up in auto mode. If you load an object file when you invoke the debugger, then the DISASSEMBLY window displays the reverse assembly of the object file that's loaded into memory. If you don't load an object file, the DISASSEMBLY window shows the reverse assembly of whatever happens to be in memory.

In assembly and mixed modes, you can use these commands to display a different portion of code in the DISASSEMBLY window.

dasm Use the DASM command to display code beginning at a specific point. The syntax for this command is:

dasm *address*
or **dasm** *function name*

This command modifies the display so that *address* or *function name* is displayed within the DISASSEMBLY window. The debugger continues to display this portion of the code until you run a program and halt it.

addr Use the ADDR command to display assembly language code beginning at a specific point. The syntax for this command is:

addr *address*
or **addr** *function name*

In assembly mode, ADDR works like the DASM command, positioning the code starting at *address* or at *function name* as the first line of code in the DISASSEMBLY window. In mixed mode, ADDR affects both the DISASSEMBLY and FILE windows.

Modifying assembly language code

You can modify the code in the disassembly window on a statement-by-statement basis. The method for doing this is called *patch assembly.* Patch assembly provides a simple way to temporarily correct minor problems by allowing you to change individual statements and instruction words.

You can patch-assemble code by using a command or by using the mouse.

patch Use the PATCH command to identify the address of the statement you want to change and the new statement you want to use at that address. The format for this command is:

patch *address, assembly language statement*

For patch assembly, use the **right** mouse button instead of the left. (Clicking the left mouse button sets a software breakpoint.)

1) Point to the statement that you want to modify.

2) Click the right button. The debugger will open a dialog box so that you can enter the new statement. The address field will already be filled in; clicking on the statement defines the address. The statement field will already be filled in with the current statement at that address (this is useful when only minor edits are necessary).

If you want to insert a large amount of new code or if you want to skip over a section of code, you can use a different patch assembly technique:

❑ To insert a large section of new code, patch a branch instruction to go to an area of memory not currently in use. Using the patch assembler, add new code to this area of memory, and branch back to the statement following the initial branch.

❑ To skip over a portion of code, patch a branch instruction to go beyond that section of code.

Effects of Patch Assembly

The patch assembler changes only the disassembled assembly language code—it does not change your source code. After determining the correct solution to problems in the disassembly, edit your source file, reassemble it, and reload the new object file into the debugger.

Additional information about modifying assembly language code

When you use patch assembly to modify code in the disassembly window, keep these things in mind:

❑ **Directives.** You cannot use directives (such as .global or .word).

❑ **Expressions.** You can use constants, but you cannot use arithmetic expressions. For example, an expression like 12 + 33 is not valid in patch assembly, but a constant such as 12 is allowed.

❑ **Labels.** You cannot define labels. For example, a statement such as the following is not allowed:

```
LOOP: B LOOP
```

However, an instruction can refer to a label as long as it is defined in a COFF file that is already loaded.

❑ **Constants.** You can use hexadecimal, octal, decimal, and binary constants. The syntax to input constants is the same as that for the DSP assembler. (Refer to the *TMS320 Floating-Point DSP Assembly Language Tools User's Guide.*)

❑ **Parallel instructions.** You can use parallel instructions. The syntax of these instructions is the same as that for the DSP assembler. (Refer to the *TMS320 Floating-Point DSP Assembly Language Tools User's Guide.*)

❑ **Error messages.** The error messages for the patch assembler are the same as the corresponding DSP assembler error messages. Refer to the *TMS320 Floating-Point DSP Assembly Language Tools User's Guide* for a detailed list of these messages.

Displaying C code

Unlike assembly language code, C code isn’t reconstructed from memory contents—the C code that you view is your original C source. You can display C code explicitly or implicitly:

- ❑ You can force the debugger to show C source by entering a FILE, FUNC, or ADDR command.
- ❑ In auto and mixed modes, the debugger automatically opens a FILE window if you’re currently running C code.

These commands are valid in C and mixed modes.

file Use the FILE command to display the contents of any text file. The syntax for this command is:

file *filename*

This uses the FILE window to display the contents of *filename*. The debugger continues to display this file until you run a program and halt in a C function. Although this command is most useful for viewing C code, you can use the FILE command for displaying any text file. You can view only one text file at a time. You can also access this command from the Load pulldown menu.

(Note that displaying a file *doesn’t* load that file’s object code. If you want to be able to run the program, you must load the file’s associated object code as described in Section 6.3 on page 6-10.)

func Use the FUNC command to display a specific C function. The syntax for this command is:

func *function name*
or **func** *address*

FUNC modifies the display so that *function name* or *address* is displayed within the window. If you supply an *address* instead of a *function name*, the FILE window displays the function containing *address* and places the cursor at that line.

Note that FUNC and FILE work similarly, but when you use FUNC, you don’t need to identify the name of the file that contains the function.

addr Use the ADDR command to display C code beginning at a specific point. The syntax for this command is:

addr *address*
or **addr** *function name*

In a C display, ADDR works like the FUNC command, positioning the code starting at *address* or at *function name* as the first line of code in the FILE window. In mixed mode, ADDR affects both the FILE and DISASSEMBLY windows.

Whenever the CALLS window is open, you can use the mouse or function keys to display a specific C function. This is similar to the FUNC or ADDR command but applies only to the functions listed in the CALLS window.

1) In the CALLS window, point to the name of C function.

2) Click the left mouse button.

(If the CALLS window is active, you can also use the arrow keys and F9 to display the function; see the *CALLS window* discussion on page 3-9 for details.)

Displaying other text files

The DISASSEMBLY window always displays the reverse assembly of memory contents, regardless of what is in memory.

The FILE window is primarily for displaying C code, but you can use the FILE command to display any text file within the FILE window. You may, for example, wish to examine system files such as autoexec.bat. You can also view your original assembly language source files in the FILE window.

You are restricted to displaying files that are 65,518 bytes long or less.

6.3 Loading Object Code

In order to debug a program, you must load the program's object code into memory. You can do this as you're invoking the debugger, or you can do it after you've invoked the debugger. (Note that you create an object file by compiling, assembling, and linking your source files; see Section 1.5, *Preparing Your Program for Debugging*, on page 1-11.)

Loading code while invoking the debugger

You can load an object file when you invoke the debugger (this has the same effect as using the debugger's LOAD command). To do this, enter:

Emulator:	Simulator:
emu40 *object filename*	**sim40** *object filename*

If you want to load a file's symbol table only, use the –s option (this has the same effect as using the debugger's SLOAD command). To do this, enter:

Emulator:	Simulator:
emu40 –s *object filename*	**sim40 –s** *object filename*

Loading code after invoking the debugger

After you invoke the debugger, you can use one of three commands to load object code and/or the symbol table associated with an object file. Use these commands as described below, or use them from the Load pulldown menu.

load Use the LOAD command to load both an object file and its associated symbol table. In effect, the LOAD command performs both a RELOAD and an SLOAD. The format for this command is:

load *object filename*

If you don't supply an extension, the debugger will look for *filename*.out.

reload Use the RELOAD command to load only an object file *without* loading its associated symbol table. This is useful for reloading a program when memory has been corrupted. The format for this command is:

reload *object filename*

sload Use the SLOAD command to load only a symbol table. The format for this command is:

sload *object filename*

SLOAD is useful in a debugging environment in which the debugger cannot, or need not, load the object code (for example, if the code is in ROM). SLOAD clears the existing symbol table before loading the new one but does not modify memory or set the program entry point.

6.4 Where the Debugger Looks for Source Files

Some commands (FILE, LOAD, RELOAD, and SLOAD) expect a filename as a parameter. If the filename includes path information, the debugger uses the file from the specified directory and does not search for the file in any other directory. If you don't supply path information, though, the debugger must search for the file. The debugger first looks for these files in the current directory. You may, however, have your files in several different directories.

- If you're using LOAD, RELOAD, or SLOAD, you have only two choices for supplying the path information:
  - Specify the path as part of the filename, or

cd

  - Use the CD command to change the current directory from within the debugger. The format for this command is:

    cd *directory name*

- If you're using the FILE command, you have several options:
  - Within the DOS or OS/2 environment, you can name additional directories with the `D_SRC` environment variable. The format for doing this is:

    SET D_SRC=*pathname; pathname*

    This allows you to name several directories that the debugger can search. If you use the same directories often, it may be convenient to set the `D_SRC` environment variable in your autoexec.bat or config.sys file. If you do this, then the list of directories is always available when you're using the debugger.
  - When you invoke the debugger, you can use the – i option to name additional source directories for the debugger to search. The format for this is:

    emu40 **–i** *pathname* [**–i** *pathname* ...]

    You can specify multiple pathnames by using several –i options (one pathname per option). The list of source directories that you create with –i options is valid until you quit the debugger.

use

  - Within the debugger environment, you can use the USE command to name additional source directories. The format for this command is:

    use *directory name*

    You can specify only one directory at a time.

In all cases, you can use relative pathnames such as ..\csource or ..\..\code. The debugger can recognize a cumulative total of 20 paths specified with D_SRC, –i, and USE.

6.5 Running Your Programs

To debug your programs, you must execute them on one of the two ’C4x debugging tools (emulator or simulator). The debugger provides two basic types of commands to help you run your code:

- **Run commands** run your code on the target system without updating the display until you explicitly halt execution.

  There are several ways to halt execution:

  - Set a breakpoint.
  - When you issue a run command, define a specific stopping point.
  - Press ESC.
  - Press the left mouse button.

- **Single-step** commands execute assembly language or C code, one statement at time, and update the display after each execution.

Defining the starting point for program execution

All run and single-step commands begin executing from the current PC (program counter). When you load an object file, the PC is automatically set to the starting point for program execution. You can easily identify the current PC by

- Finding its entry in the CPU window

  or

- Finding the appropriately highlighted line in the FILE or DISASSEMBLY window. You can do this by executing one of these commands:

  dasm PC
  or **addr PC**

Sometimes you may want to modify the PC to point to a different position in your program. There are two ways to do this:

rest

- If you executed some code and would like to rerun the program from the original program entry point, use the RESTART (REST) command. The format for this command is:

  restart
  or **rest**

  Note that you can also access this command from the Load pulldown menu.

?/eval

- You can directly modify the PC’s contents with one of these commands:

  ?PC=*new value*
  or **eval pc =** *new value*

After halting execution, you can continue from the current PC by reissuing any of the run or single-step commands.

Running code

The debugger supports several run commands.

run The RUN command is the basic command for running an entire program. The format for this command is:

run [*expression*]

The command's behavior depends on the type of parameter you supply:

- If you don't supply an *expression*, the program executes until it encounters a breakpoint or until you press ESC or the left mouse button.
- If you supply a logical or relational *expression*, this becomes a conditional run (see page 6-16).
- If you supply any other type of *expression*, the debugger treats the expression as a *count* parameter. The debugger executes *count* instructions, halts, then updates the display.

go Use the GO command to execute code up to a specific point in your program. The format for this command is:

go [*address*]

If you don't supply an *address* parameter, then GO acts like a RUN command without an *expression* parameter.

ret The RETURN (RET) command executes the code in the current C function and halts when execution returns to its caller. The format for this command is:

return
or **ret**

Breakpoints do not affect this command, but you can halt execution by pressing ESC or the left mouse button.

runb Use the RUNB (run benchmark) command to execute a specific section of code and count the number of clock cycles consumed by the execution. The format for this command is:

runb

Using the RUNB command to benchmark code is a multistep process, described later in this chapter (Section 6.7, *Benchmarking*, on page 6-18).

F5 Pressing this key runs code from the current PC. This is similar to entering a RUN command without an *expression* parameter.

Single-stepping through code

Single-step execution is similar to running a program that has a breakpoint set on each line. The debugger executes one statement, updates the display, and halts execution. (You can supply a parameter that tells the debugger to single-step more than one statement; the debugger updates the display after each statement.) You can single-step through assembly language code or C code.

The debugger supports several commands for single-stepping through a program. Command execution may vary, depending on whether you're single-stepping through C code or assembly language code.

Note that the debugger ignores interrupts when you use the STEP command to single-step through assembly language code.

Each of the single-step commands has an optional *expression* parameter that works like this:

- If you don't supply an *expression*, the program executes a single statement then halts.
- If you supply a logical or relational *expression*, this becomes a conditional single-step execution (see page 6-16).
- If you supply any other type of *expression*, the debugger treats the expression as a *count* parameter. The debugger single-steps *count* C or assembly language statements (depending on the type of code you're in).

step Use the STEP command to single-step through assembly language or C code. The format for this command is:

step [*expression*]

If you're in C code, the debugger executes one C statement at a time. In assembly or mixed mode, the debugger executes one assembly language statement at a time.

If you're single-stepping through C code and encounter a function call, the STEP command shows you the single-step execution of the called function (assuming that the function was compiled with the compiler's –g debug option). When function execution completes, single-step execution returns to the caller. If the function wasn't compiled with the debug option, the debugger executes the function but doesn't show single-step execution of the function.

cstep The CSTEP command is similar to STEP, but CSTEP always single-steps in terms of a C statement. If you're in C code, STEP and CSTEP behave identically. In assembly language code, however, CSTEP executes all assembly language statements associated with one C statement before updating the display. The format for this command is:

cstep [*expression*]

next
cnext The NEXT and CNEXT commands are similar to the STEP and CSTEP commands. The only difference is that NEXT/CNEXT never show single-step execution of called functions—they always step to the next consecutive statement. The formats for these commands are:

next [*expression*]
cnext [*expression*]

Note:

The single-stepping debugger commands (step, cstep, and next) turn off the global interrupt bit GIE and prevent stepping through an interrupt service routine. If you want to step into an interrupt service routine, set a breakpoint in the interrupt service routine and use one of the run commands.

You can also single-step through programs by using function keys.

F8 Acts as a STEP command.

F10 Acts as a NEXT command.

The debugger allows you to execute several single-step commands from the selections on the menu bar.

To execute a STEP,

↖ 1) Point to Step=F8 in the menu bar.

▌▯ 2) Press and release the left mouse button.

To execute a NEXT,

↖ 1) Point to Next=F10 in the menu bar.

▌▯ 2) Press and release the left mouse button.

Running code while disconnected from the target

reset The RESET command resets the target system. This is a *software* reset. The format for this command is:

reset

Running code conditionally

The RUN, GO, and single-step commands have an optional *expression* parameter that can be a relational or logical expression. This type of expression has one of the following operators as the highest precedence operator in the expression:

```
  >        > =       <
 < =       = =      ! =
 &&        | |       !
```

When you use this type of expression with these commands, the command becomes a conditional run. The debugger executes the command repeatedly for as long as the expression evaluates to true.

You must use software breakpoints with conditional runs; each time the debugger encounters a breakpoint, the expression is evaluated. Each time the debugger evaluates the conditional expression, it updates the screen. The debugger applies this algorithm:

```
top:
   if (expression = = 0) go to end;
   run or single-step (until breakpoint, ESC, or mouse button halts execution)
   if (halted by breakpoint, not by ESC or mouse button) go to top
end:
```

Generally, you should set the breakpoints on statements that are related in some way to the expression. For example, if you're watching a particular variable in a WATCH window, you may want to set breakpoints on statements that affect that variable and use that variable in the expression.

6.6 Halting Program Execution

Whenever you're running or single-stepping code, program execution halts automatically if the debugger encounters a breakpoint or if it reaches a particular point where you told it to stop (by supplying a *count* or an *address*). If you'd like to explicitly halt program execution, there are two ways to accomplish this:

Click the left mouse button.

ESC Press the escape key.

After halting execution, you can continue program execution from the current PC by reissuing any of the run or single-step commands.

6.7 Benchmarking (Emulator Only)

The debugger allows you to keep track of the number of CPU clock cycles consumed by a particular section of code. This process is referred to as *benchmarking*.

The debugger maintains the count in a pseudoregister named *CLK*.

Benchmarking code is a multiple-step process:

Step 1: Set a software breakpoint at the statement that marks the beginning of the section of code you'd like to benchmark.

Step 2: Set a software breakpoint at the statement that marks the end of the section of code you'd like to benchmark.

Step 3: Enter any RUN command to execute code up to the first breakpoint.

Step 4: Now enter the RUNB command:

```
runb ⏎
```

When the processor halts at the second breakpoint, the value of CLK is valid. To display it, use the ? command or enter it into the WATCH window with the WA command. This value is valid until you enter another RUN command.

Notes:

- The RUNB command counts CPU clock cycles from the current PC to the breakpoint. This count is not cumulative. You cannot add the number of clock cycles from point A to point B to the number of cycles from point B to point C in order to learn the number of cycles from point A to point C. This error occurs due to pipeline filling and flushing.
- The value in CLK is valid only after you use a RUNB command that is terminated by a software breakpoint.

Chapter 7

Managing Data

The debugger allows you to examine and modify many different types of data related to the target system and to your program. You can display and modify the values of:

- ❑ Individual memory locations or a range of memory
- ❑ ’C4x registers
- ❑ Variables, including scalar types (ints, chars, etc.) and aggregate types (arrays, structures, etc.)

Topic **Page**

7.1 Where Data Is Displayed

Four windows are dedicated to displaying the various types of data.

Type of data	Window name and purpose
memory locations	**MEMORY window** Displays the contents of a range of memory
register values	**CPU window** Displays the contents of ’C4x registers
pointer data or selected variables of an aggregate type	**DISP windows** Display the contents of aggregate types and show the values of individual members
selected variables (scalar types or individual members of aggregate types) and specific memory locations or registers	**WATCH window** Displays selected data

This group of windows is referred to as **data-display windows**.

7.2 Basic Commands for Managing Data

The debugger provides special-purpose commands for displaying and modifying data in dedicated windows. The debugger also supports several general-purpose commands that you can use to display or modify any type of data.

whatis If you want to know the type of a variable, use the WHATIS command. The syntax for this command is:

whatis *symbol*

This lists s*ymbol’*s data type in the display area of the COMMAND window. The *symbol* can be any variable (local, global, or static), a function name, structure tag, typedef name, or enumeration constant.

Command	Result displayed in the COMMAND window
`whatis giant`	`struct zzz giant[100];`

`whatis xxx`	`struct xxx {`
	`int a;`
	`int b;`
	`int c;`
	`int f1 : 2;`
	`int f2 : 4;`
	`struct xxx *f3;`
	`int f4[10];`
	`}`

? The ? (evaluate expression) command evaluates an expression and shows the result in the display area of the COMMAND window. The basic syntax for this command is:

? *expression*

The *expression* can be any C expression, including an expression with side effects. However, you cannot use a string constant or function call in the *expression.*

If the result of *expression* is scalar, then the debugger displays the result as a decimal value in the COMMAND window. If *expression* is a structure or array, ? displays the entire contents of the structure or array; you can halt long listings by pressing ESC.

Here are some examples that use the ? command:

Command	Result displayed in the COMMAND window
? giant	giant[0].b1 436547877 giant[0].b2 –791051538 giant[0].b3 1952557575 giant[0].b4 –1555212096 etc.
? j	4194425
? j=0x5a	90
? i	–12635
? i,x	0x000cea5

The DISP command (described in detail on page 7-12) behaves like the ? command when its *expression* parameter does not identify an aggregate type.

eval The EVAL (evaluate expression) command behaves like the ? command *but does not show the result* in the display area of the COMMAND window. The syntax for this command is:

eval *expression*
or **e** *expression*

EVAL is useful for assigning values to registers or memory locations in a batch file (where it's not necessary to display the result).

7.3 Basic Methods for Changing Data Values

The debugger provides you with a great deal of flexibility in modifying various types of data. You can use the debugger's overwrite editing capability, which allows you to change a value simply by typing over its displayed value. You can also use the data-management commands for more complex editing.

Editing data displayed in a window

Use overwrite editing to modify data in a data-display window; you can edit:

- ❑ Registers displayed in the CPU window.
- ❑ Memory contents displayed in the MEMORY window.
- ❑ Elements displayed in a DISP window.
- ❑ Values displayed in the WATCH window.

There are two similar methods for overwriting displayed data.

🖱

↖ 1) Point to the data item that you want to modify.

▮▯ 2) Click the left button. The debugger highlights the selected field. (Note that the window containing this field becomes active when you press the mouse button.)

ESC 3) Type the new information. If you make a mistake or change your mind, press ESC or move the mouse outside the field and press/release the left button; this resets the field to its original value.

↵ 4) When you finish typing the new information, press ↵ or any arrow key. This replaces the original value with the new value.

key

1) Select the window that contains the field you'd like to modify; make this the active window. (Use the mouse, the WIN command, or F6 . For more detail, see Section 3.4, *The Active Window,* on page 3-19.)

2) Use arrow keys to move the cursor to the field you'd like to edit.

↑	Moves up 1 field at a time.
↓	Moves down 1 field at a time.
←	Moves left 1 field at a time.
→	Moves right 1 field at a time.

F9 3) When the field you'd like to edit is highlighted, press F9. The debugger highlights the field that the cursor is pointing to.

ESC 4) Type the new information. If you make a mistake or change your mind, press ESC; this resets the field to its original value.

↵ 5) When you finish typing the new information, press ↵ or any arrow key. This replaces the original value with the new value.

Advanced "editing"—using expressions with side effects

Using the overwrite editing feature to modify is straightforward. However, there are additional data-management methods that take advantage of the fact that C expressions are accepted as parameters by most debugger commands, and that C expressions can have *side effects.* When an expression has a side effect, it means that the value of some variable in the expression changes as the result of evaluating the expression.

This means that you can coerce many commands into changing values for you. Specifically, it's most helpful to use ? and EVAL to change data as well as display it. For example, if you want see what's in register R3, you can enter:

```
? R3
```

However, you can also use this type of command to modify R3's contents. Here are some examples of how you might do this:

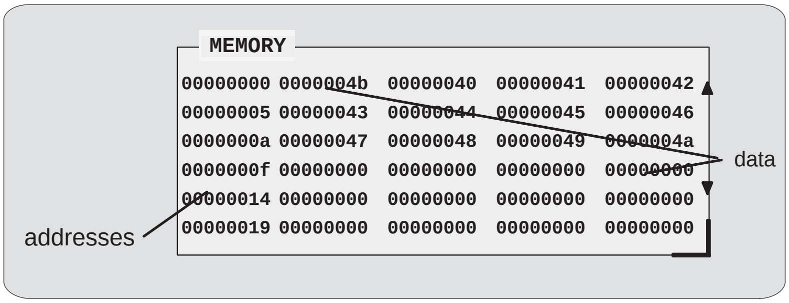
`? R3++`	*Side effect: increments the contents of R3 by 1*
`eval --R3`	*Side effect: decrements the contents of R3 by 1*
`? R3 = 8`	*Side effect: sets R3 to 8*
`eval R3/=2`	*Side effect: divides contents of R3 by 2*

Note that not all expressions have side effects. For example, if you enter **`? R3+4`**, the debugger displays the result of adding 4 to the contents of R3 but does not modify R3's contents. Expressions that have side effects must contain an assignment operator or an operator that implies an assignment. Operators that can cause a side effect are:

=	+=	–=	*=	/=
%=	&=	^=	|=	<<=
	>>=	++	– –	

7.4 Managing Data in Memory

In mixed and assembly modes, the debugger maintains a MEMORY window that displays the contents of memory. For details concerning the MEMORY window, see the *MEMORY windows* discussion (page 3-12).



```
MEMORY
00000000 0000004b  00000040  00000041  00000042
00000005 00000043  00000044  00000045  00000046
0000000a 00000047  00000048  00000049  0000004a
0000000f 00000000  00000000  00000000  00000000
00000014 00000000  00000000  00000000  00000000
00000019 00000000  00000000  00000000  00000000
```

The debugger has commands that show the data values at a specific location or display a different range of memory in the MEMORY window. The debugger allows you to change the values at individual locations; refer to Section 7.3, *Basic Methods for Changing Data Values*, (page 7-4) for more information.

Displaying memory contents

The main way to observe memory contents is to view the display in a MEMORY window. Four MEMORY windows are available: the default window is labeled MEMORY, and the three additional windows are called MEMORY1, MEMORY2, and MEMORY3. Notice that the default window does not have an extension number in its name; this is because MEMORY1, MEMORY2, and MEMORY3 are additional windows that can be opened and closed throughout your debugging session. Having four windows allows you to view four different memory ranges.

The amount of memory that you can display is limited by the size of the individual MEMORY windows (which is limited only by the screen size). During a debugging session, you may need to display different areas of memory within a window. The debugger provides two methods for doing this.

mem If you want to display a different memory range in the MEMORY window, use the MEM command. You can do this by entering:

mem *expression* [*, display format*]

To view different memory locations in an additional MEMORY window, use the MEM command with the appropriate extension number. For example:

To do this. . .	Enter this. . .
View the block of memory starting at address 0x8000 in the MEMORY1 window	`mem1 0x8000`
View the same block of memory (starting at address 0x8000) but in the MEMORY2 window	`mem2 0x8000`

Note:

If you want to view a different block of memory explicitly in the default MEMORY window, you can use the aliased command MEM0. This works *exactly* the same as the MEM command. To use this command, enter:

mem0 *address*

For more information, see the *MEMORY windows* discussion on page 3-12.

The *expression* you type in represents the address of the first entry in the MEMORY window. The end of the range is defined by the size of the window: to show more memory locations, make the window larger; to show fewer locations, make the window smaller. (See *Resizing a window*, page 3-22, for more information.)

Expression can be an absolute address, a symbolic address, or any C expression. Here are several examples.

- ***Absolute address.*** Suppose that you want to display memory, beginning from the very first address. You might enter this command:

  ```
  mem 0x00
  ```

  Hint: MEMORY window addresses are shown in hexadecimal format. If you want to specify a hex address, be sure to prefix the address number with **0x**; otherwise, the debugger treats the number as a decimal address.

- ***Symbolic address.*** You can use any defined C symbol. For example, if your program defined a symbol named SYM, you could enter this command:

  ```
  mem &SYM
  ```

  Hint: Prefix the symbol with the & operator to use the address of the symbol.

- ***C expression.*** If you use a C expression as a parameter, the debugger evaluates the expression and uses the result as a memory address.

  ```
  mem SP – R0+ label
  ```

You can also change the display of any data-display window—including the MEMORY window—by scrolling through the window's contents. See the *Scrolling through a window's contents* discussion (page 3-27) for more details.

Displaying memory contents while you're debugging C

If you're debugging C code in auto mode, you won't see a MEMORY window—the debugger doesn't show the MEMORY window in the C-only display. However, there are several ways to display memory in this situation.

Hint: If you want to use the *contents* of an address as a parameter, be sure to prefix the address with the C indirection operator (*****).

- If you have only a temporary interest in the contents of a specific memory location, you can use the ? command to display the value at this address. For example, if you want to know the contents of memory location 26 (hex), you could enter:

  ```
  ? *0x26
  ```

  The debugger displays the memory value in the COMMAND window display area.

- If you want the opportunity to observe a specific memory location over a longer period of time, you can display it in a WATCH window. Use the WA command to do this:

  ```
  wa *0x26
  ```

- You can also use the DISP command to display memory contents. The DISP window shows memory in an array format with the specified address as "member" [0]. In this situation, you can also use casting to display memory contents in a different numeric format:

  ```
  disp *(float *)0x26
  ```

Saving memory values to a file

ms Sometimes it's useful to save a block of memory values to a file. You can use the MS (memory save) command to do this; the files are saved in COFF format. (For more information about COFF, refer to the *TMS320 Floating-Point DSP Assembly Language Tools User's Guide*.) The syntax for the MS command is:

ms *address, length, filename*

- The *address* parameter identifies the first address in the block.
- The *length* parameter defines the length, in words, of the block. This parameter can be any C expression.
- The *filename* is a system file.

  If you don't supply an extension, the debugger adds an .obj extension.

For example, to save the values in data memory locations 0x0–0x10 to a file named memsave, enter:

```
ms 0x0,0x10,memsave ↵
```

To reload memory values that were saved in a file, use the LOAD command. For example, to reload the values that were stored in memsave, enter:

```
load memsave.obj ↵
```

Filling a block of memory

fill Sometimes it's useful to be able to fill an entire block of memory at once. You can do this by using the FILL command. The syntax for this command is:

fill *address, length, data*

- ❑ The *address* parameter identifies the first address in the block.
- ❑ The *length* parameter defines the number of words to fill.
- ❑ The *data* parameter is the value that is placed in each word in the block.

For example, to fill locations 0x00800000 to 0x00800300 with the value 0x1234abcd, enter:

```
fill 0x80000000,0x301,0x1234abcd ⏎
```

If you want to check to see that memory has been filled as you have asked, you can enter:

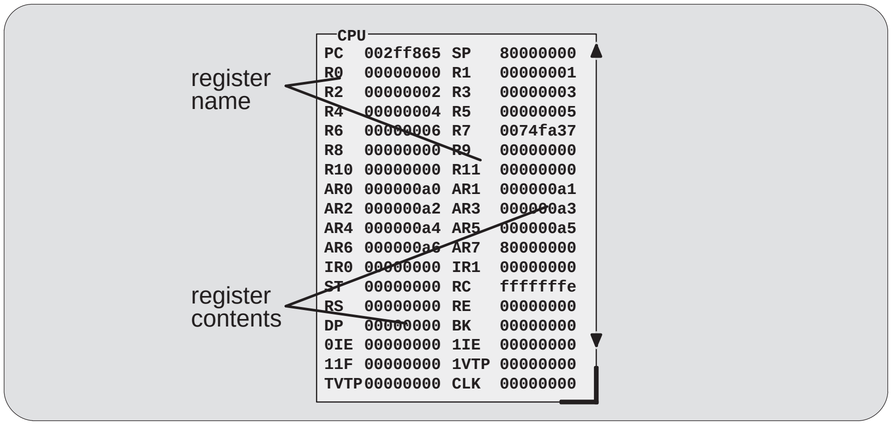
```
mem 0x80000000 ⏎
```

This changes the MEMORY window display to show the block of memory beginning at address 0x00800000.

Note that the FILL command can also be executed from the Memory pulldown menu.

7.5 Managing Register Data

In mixed and assembly modes, the debugger maintains a CPU window that displays the contents of individual registers. For details concerning the CPU window, see the *CPU window* discussion (page 3-15).



```
CPU
PC   002ff865 SP   80000000
R0   00000000 R1   00000001
R2   00000002 R3   00000003
R4   00000004 R5   00000005
R6   00000006 R7   0074fa37
R8   00000000 R9   00000000
R10  00000000 R11  00000000
AR0  000000a0 AR1  000000a1
AR2  000000a2 AR3  000000a3
AR4  000000a4 AR5  000000a5
AR6  000000a6 AR7  80000000
IR0  00000000 IR1  00000000
ST   00000000 RC   fffffffe
RS   00000000 RE   00000000
DP   00000000 BK   00000000
0IE  00000000 1IE  00000000
11F  00000000 1VTP 00000000
TVTP00000000 CLK  00000000
```

The debugger provides commands that allow you to display and modify the contents of specific registers. Remember, you can use the data-management commands or the debugger's overwrite editing capability to modify the contents of any register displayed in the CPU or WATCH window. Refer to Section 7.3 (page 7-4), for more information.

Displaying register contents

The main way to observe register contents is to view the display in the CPU window. However, you may not be interested in all of the registers: if you're interested in only two registers, you might want to make the CPU window small and use the extra screen space for the DISASSEMBLY or FILE display. In this type of situation, there are several ways to observe the contents of the selected registers.

- If you have only a temporary interest in the contents of a register, you can use the ? command to display the register's contents. For example, if you want to know the contents of the SP, enter:

  ```
  ? SP
  ```

  The debugger displays the SP's current contents in the COMMAND window display area.

- If you want the opportunity to observe a register over a longer period of time, you can display it in a WATCH window. Use the WA command to do this. For example, if you want to observe the status register, you could enter:

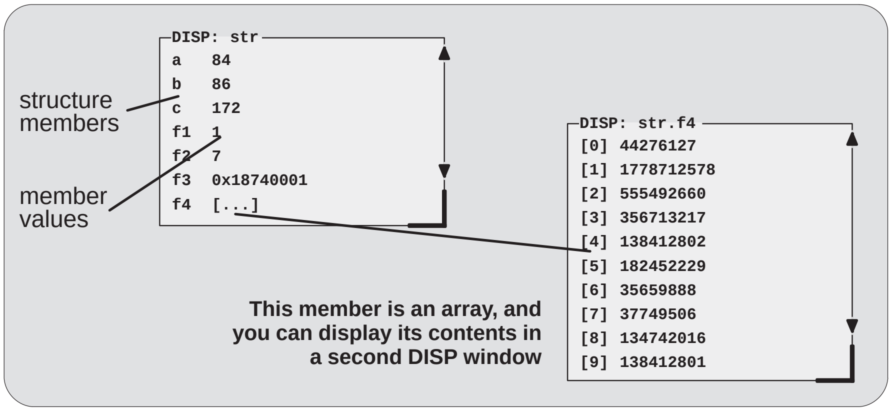
  ```
  WA ST,Status Reg
  ```

  This adds the ST to the WATCH window and labels it as Status Reg. The register's contents are continuously updated, just as if you were observing the register in the CPU window.

When you're debugging C in auto mode, these methods are also useful because the debugger doesn't show the CPU window in the C-only display.

7.6 Managing Data in a DISP (Display) Window

The main purpose of the DISP window is to display the values of members of complex, aggregate data types such as arrays and structures. The debugger shows DISP windows *only when you specifically request to see DISP windows* with the DISP command (described below). Note that you can have up to 120 DISP windows open at once. For additional details about DISP windows, see the *DISP window* discussion (page 3-16).



```
DISP: str
a   84
b   86
c   172
f1  1
f2  7
f3  0x18740001
f4  [...]
```

```
DISP: str.f4
[0] 44276127
[1] 1778712578
[2] 555492660
[3] 356713217
[4] 138412802
[5] 182452229
[6] 35659888
[7] 37749506
[8] 134742016
[9] 138412801
```

structure members
member values
This member is an array, and you can display its contents in a second DISP window

Remember, you can use the data-management commands or the debugger's overwrite editing capability to modify the contents of any value displayed in a DISP window. Refer to Section 7.3 (page 7-4), for more information.

Displaying data in a DISP window

disp To open a DISP window, use the DISP command. The basic syntax for this command is:

disp *expression* [*, display format*]

If the *expression* is not an array, structure, or pointer (of the form *pointer name), the DISP command behaves like the ? command. However, if *expression* **is** one of these types, the debugger opens a DISP window to display the values of the members.

If a DISP window contains a long list of members, you can use PAGE DOWN, PAGE UP, or arrow keys to scroll through the window. If the window contains an array of structures, you can use CONTROL PAGE DOWN and CONTROL PAGE UP to scroll through the array.

Once you open a DISP window, you may find that a displayed member is another one of these types. This is how you identify the members that are arrays, structures, or pointers:

A member that is an array looks like this	[. . .]
A member that is a structure looks like this	{. . .}
A member that is a pointer looks like an address	0x00000000

You can display the additional data (the data pointed to or the members of the array or structure) in additional DISP windows (these are referred to as *children*). There are three ways to do this.

Use the DISP command again; this time, *expression* must identify the member that has additional data. For example, if the first expression identifies a structure named *str* and one of str's members is an array named *f4*, you can display the contents of the array by entering this command:

```
disp str.f4
```

This opens a new DISP window that shows the contents of the array. If str has a member named *f3* that is a pointer, you could enter:

```
disp *str.f3
```

This opens a window to display what str.f3 points to.

Here's another method of displaying the additional data:

↖ 1) Point to the member in the DISP window.

2) Now click the left button.

Here's the third method:

↑ ↓ 1) Use the arrow keys to move the cursor up and down in the list of members.

F9 2) When the cursor is on the desired field, press F9.

When the debugger opens a second DISP window, the new window may at first be displayed on top of the original DISP window; if so, you can move the windows so that you can see both at once. If the new windows also have members that are pointers or aggregate types, you can continue to open new DISP windows.

Closing a DISP window

Closing a DISP window is a simple, two-step process.

Step 1: Make the DISP window that you want to close active (see Section 3.4, *The Active Window*, on page 3-19).

Step 2: Press F4.

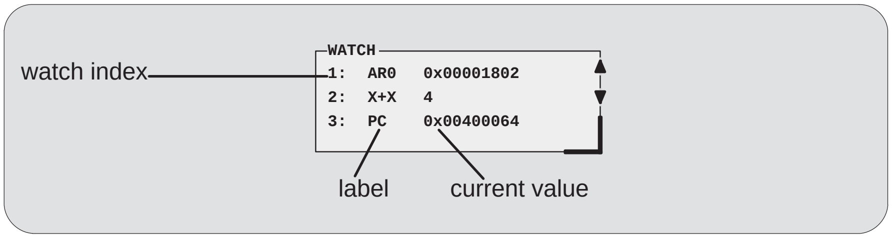
Note that you can close a window and all of its children by closing the original window.

Note:

The debugger automatically closes all DISP windows when you execute a LOAD or SLOAD command.

7.7 Managing Data in a WATCH Window

The debugger doesn't maintain a dedicated window that tells you about the status of all the symbols defined in your program. Such a window might be so large that it wouldn't be useful. Instead, the debugger allows you to create a WATCH window that shows you how program execution affects specific expressions, variables, registers, or memory locations.



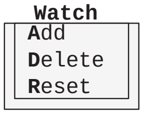
```
WATCH
1:  AR0   0x00001802
2:  X+X   4
3:  PC    0x00400064
```

The debugger displays a WATCH window *only when you specifically request a WATCH window* with the WA command (described below). Note that there is only one WATCH window. For additional details concerning the WATCH window, see the *WATCH window* discussion (page 3-17).

Remember, you can use the data-management commands or the debugger's overwrite editing capability to modify the contents of any value displayed in the WATCH window. Refer to Section 7.3 (page 7-4), for more information.

Note:

All of the watch commands described can also be accessed from the Watch pulldown menu. For more information about using the the pulldown menus, refer to Section 4.2, *Using the Menu Bar and the Pulldown Menus* (page 4-7).



Displaying data in the WATCH window

The debugger has one command for adding items to the WATCH window.

wa To open the WATCH window, use the WA (watch add) command. The basic syntax is:

wa *expression* [,[*label*], *display format*]

When you first execute WA, the debugger opens the WATCH window. After that, executing WA adds additional values to the WATCH window.

The *expression* parameter can be any C expression, including an expression that has side effects. It's most useful to watch an expression whose value will change over time; constant expressions provide no useful function in the watch window.

The *label* parameter is optional. When used, it provides a label for the watched entry. If you don't use a *label*, the debugger displays the *expression* in the label field.

Deleting watched values and closing the WATCH window

The debugger supports two commands for deleting items from the WATCH window.

wr If you'd like to close the WATCH window and delete all of the items in a single step, use the WR (watch reset) command. The syntax is:

wr

wd If you'd like to delete a specific item from the WATCH window, use the WD (watch delete) command. The syntax is:

wd *index number*

Whenever you add an item to the WATCH window, the debugger assigns it an index number. (The illustration of the WATCH window on page 7-14 points to these watch indexes.) The WD command's *index number* parameter must correspond to one of the watch indexes in the WATCH window.

Note that deleting an item (depending on where it is in the list) causes the remaining index numbers to be reassigned. Deleting the last remaining item in the WATCH window closes the WATCH window.

Note:

The debugger automatically closes the WATCH window when you execute a LOAD or SLOAD command.

7.8 Monitoring the Pipeline (Simulator Only)

The simulator allows you to monitor the pipeline through pseudoregisters that you can query with ? or DISP or that you can add to the WATCH window.

The instruction pipeline consists of four phases: instruction fetch, decode, operand fetch, and execution. During any cycle, one to four instructions can be active, each at a different stage of completion. Instruction operation occurs during the appropriate stages of the pipeline. For example, the instruction AR*n* (*n*= 0–7) updates of auxiliary registers occur during the decode phase.

The simulator provides eight pseudoregisters that display the opcode or address of the instructions in each phase of the pipeline. The following table identifies these registers.

Table 7–1. Pipeline Pseudoregisters

Pipeline phase	**Opcode pseudoregister**	**Address pseudoregister**
Instruction fetch	fins	faddr
Decode	dins	daddr
Operand fetch	rins	raddr
Execution	xins	xaddr

For example, if you wanted to observe the decode phase during program execution, you could watch the dins and daddr pseudoregisters in the WATCH window:

```
wa dins,Decode–Opcode ↵
wa daddr,Decode–Address ↵
```

This adds dins and daddr to the WATCH window and labels them as Decode-Opcode and Decode-Address, respectively.

7.9 Displaying Data in Alternative Formats

By default, all data is displayed in its natural format. This means that:

- ❑ Integer values are displayed as decimal numbers.
- ❑ Floating-point values are displayed in floating-point format.
- ❑ Pointers are displayed as hexadecimal addresses (with a 0x prefix).
- ❑ Enumerated types are displayed symbolically.

However, any data displayed in the COMMAND, MEMORY, WATCH, or DISP window can be displayed in a variety of formats.

Changing the default format for specific data types

To display specific types of data in a different format, use the SETF command. The syntax for this command is:

setf [*data type*, *display format*]

The *display format* parameter identifies the new display format for any data of type *data type*. The following is a list of available data formats:

Display Format	Parameter	Display Format	Parameter
Default for the data type	*****	Hexadecimal	**x**
ASCII character (bytes)	**c**	Octal	**o**
Decimal	**d**	Valid address	**p**
Exponential floating point	**e**	ASCII string	**s**
Decimal floating point	**f**	Unsigned decimal	**u**

Only a subset of the display formats applies to each data type. Table 7–2 lists of the C data types that can be used for the *data type* parameter, and shows valid combinations of data types and display formats.

Table 7–2. Data Types for Displaying Debugger Data

	Valid Display Formats									
Data Type	**c**	**d**	**o**	**x**	**e**	**f**	**p**	**s**	**u**	**Default Display Format**
char	√	√	√	√					√	ASCII (c)
uchar	√	√	√	√					√	Decimal (d)
short	√	√	√	√					√	Decimal (d)
int	√	√	√	√					√	Decimal (d)
uint	√	√	√	√					√	Decimal (d)
long	√	√	√	√					√	Decimal (d)
ulong	√	√	√	√					√	Decimal (d)
float			√	√	√	√				Exponential floating point (e)
double			√	√	√	√				Exponential floating point (e)
ptr			√	√			√	√		Address (p)

Here are some examples:

❑ To display all data of type short as unsigned decimals, enter:

```
setf short, u ↵
```

❑ To return all data of type short to its default display format, enter:

```
setf short, * ↵
```

❑ To list the current display formats for each data type, enter the SETF command with no parameters:

```
setf ↵
```

You'll see a display that looks something like this:

```
         Display Format Defaults
     Type char:           ASCII
     Type unsigned char:  Decimal
     Type int:            Decimal
     Type unsigned int:   Decimal
     Type short:          Decimal
     Type unsigned short: Decimal
     Type long:           Decimal
     Type unsigned long:  Decimal
     Type float:          Exponential floating point
     Type double:         Exponential floating point
     Type pointer:        Address
```

❑ To reset all data types back to their default display formats, enter:

```
setf * ↵
```

Changing the default format with ?, MEM, DISP, and WA

You can also use the ?, MEM, DISP, and WA commands to show data in alternative display formats. (The ? and DISP commands can use alternative formats only for scalar types, arrays of scalar types, and individual members of aggregate types.)

Each of these commands has an optional *display format* parameter that works in the same way as the *display format* parameter of the SETF command.

When you don't use a *display format* parameter, data is shown in its natural format (unless you have changed the format for the data type with SETF).

Here are some examples:

- To watch the PC in decimal, enter:

  ```
  wa pc,,d ⏎
  ```

- To display memory contents in octal, enter:

  ```
  mem 0x0,o ⏎
  ```

- To display an array of integers as characters, enter:

  ```
  disp ai,c ⏎
  ```

The valid combinations of data types and display formats listed for SETF also apply to the data displayed with DISP, ?, WA, and MEM. For example, if you want to use display format *e* or *f*, the data that you are displaying must be of type float or type double. However, there is one exception: you cannot use the *s* display format parameter with the MEM command.

7.10 Accessing Extended-Precision Registers

The simulator represents extended-precision registers in the register file, E*n* and R*n*. The *n* represents the register number. The register ranges are:

Range	Description
E0–E11	Represent the exponent of the floating-point number.
R0–R11	Represent the mantissa of the floating-point number or a 32-bit integer.

For example, if you loaded the 40-bit floating-point number 0340000000h into extended-precision register R1, the simulator will load it as:

```
E1 = 03h         (exponent)
R1 = 40000000h   (mantissa)
```

Register E1 is essentially a pseudoregister provided by the simulator. Floating-point instructions affect both the exponent and mantissa fields (E*n* and R*n*), but integer instructions affect only the mantissa field (R*n*).

The CPU window displays all of the registers in the primary register and expansion register files; however, the DISP window displays only the mantissa (Rn) portion of the register in the extended precision register file. You can use the eval command to obtain the value of the exponent (E*n*) portion of an extended-precision register, or you can add the value to the WATCH window.

Chapter 8

Using Software Breakpoints

During the debugging process, you may want to halt execution temporarily so that you can examine the contents of selected variables, registers, and memory locations before continuing with program execution. You can do this by setting software breakpoints at critical points in your code. You can set these breakpoints in assembly language code and in C code. A software breakpoint halts any program execution, whether you’re running or single-stepping through code.

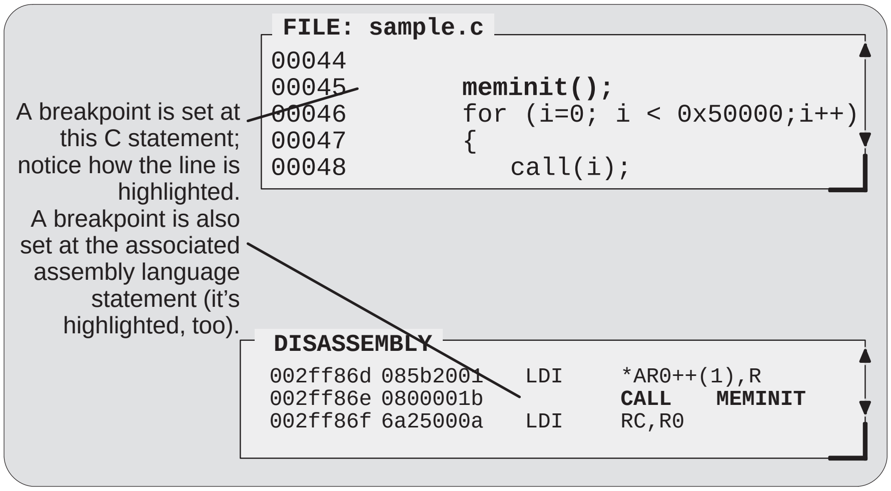
Breakpoints are especially useful in combination with conditional execution (described on page 6-16) and benchmarking (described on page 6-18).

Topic **Page**

8.1 Setting a Software Breakpoint

When you set a software breakpoint, the debugger highlights the breakpointed line by showing it in a bolder or brighter font. (You can use screen-customization commands to change this highlighting method.)

If you set a breakpoint in the disassembly, the debugger also highlights the associated C statement. If you set a breakpoint in the C source, the debugger also highlights the associated statement in the disassembly. (If more than one assembly language statement is associated with a C statement, the debugger highlights the first of the associated assembly language statements.)



A breakpoint is set at this C statement; notice how the line is highlighted.

A breakpoint is also set at the associated assembly language statement (it's highlighted, too).

```
FILE: sample.c
00044
00045          meminit();
00046          for (i=0; i < 0x50000;i++)
00047          {
00048             call(i);
```

```
DISASSEMBLY
002ff86d 085b2001   LDI     *AR0++(1),R
002ff86e 0800001b           CALL    MEMINIT
002ff86f 6a25000a   LDI     RC,R0
```

Note:

- After execution is halted by a breakpoint, you can continue program execution by reissuing any of the run or single-step commands.
- Up to 200 software breakpoints can be set.

There are several ways to set a software breakpoint:

↖ 1) Point to the line of assembly language code or C code where you'd like to set a breakpoint.

▌▯ 2) Click the left button.

Repeating this action clears the breakpoint.

1) Make the FILE or DISASSEMBLY window the active window.

(↑)(↓) 2) Use the arrow keys to move the cursor to the line of code where you'd like to set a breakpoint.

(F9) 3) Press the (F9) key.

Repeating this action clears the breakpoint.

ba If you know the address where you'd like to set a software breakpoint, you can use the BA (breakpoint add) command. This command is useful because it doesn't require you to search through code to find the desired line. The syntax for the BA command is:

ba *address*

This command sets a breakpoint at *address*. This parameter can be an absolute address, any C expression, the name of a C function, or the name of an assembly language label. You cannot set multiple breakpoints at the same statement.

8.2 Clearing a Software Breakpoint

There are several ways to clear a software breakpoint. If you clear a breakpoint from an assembly language statement, the breakpoint is also cleared from any associated C statement; if you clear a breakpoint from a C statement, the breakpoint is also cleared from the associated statement in the disassembly.

↖ 1) Point to a breakpointed assembly language or C statement.

▌▯ 2) Click the left button.

(↑)(↓) 1) Use the arrow keys or the DASM command to move the cursor to a breakpointed assembly language or C statement.

(F9) 2) Press the (F9) key.

---

br If you want to clear **all** the software breakpoints that are set, use the BR (breakpoint reset) command. This command is useful because it doesn't require you to search through code to find the desired line. The syntax for the BR command is:

br

bd If you'd like to clear one specific software breakpoint and you know the address of this breakpoint, you can use the BD (breakpoint delete) command. The syntax for the BD command is:

bd *address*

This command clears the breakpoint at *address*. This parameter can be an absolute address, any C expression, the name of a C function, or the name of an assembly language label. If no breakpoint is set at *address*, the debugger ignores the command.

8.3 Finding the Software Breakpoints That Are Set

bl Sometimes you may need to know where software breakpoints are set. For example, the BD command's *address* parameter must correspond to the address of a breakpoint that is set. The BL (breakpoint list) command provides an easy way to get a complete listing of all the software breakpoints that are currently set in your program. The syntax for this command is:

bl

The BL command displays a table of software breakpoints in the COMMAND window display area. BL lists all the software breakpoints that are set, in the order in which you set them. Here's an example of this type of list:

```
 Address    Symbolic Information
00400065
00400007    in main, at line 45, ”c:\c4xhll\sample.c”
00400066
```

The address is the memory address of the breakpoint. The symbolic information identifies the function, line number, and filename of the breakpointed C statement:

- If the breakpoint was set in assembly language code, you'll see only an address unless the statement defines a symbol.

- If the breakpoint was set in C code, you'll see the address together with symbolic information.

Chapter 9

Customizing the Debugger Display

The debugger display is completely configurable; you can create the interface that is best suited for your use. Besides being able to size and position individual windows, you can change the appearance of many of the display features, such as window borders, the way the current statement is highlighted, etc. In addition, if you're using a color display, you can change the colors of any area on the screen. Once you've customized the display to your liking, you can save the custom configuration for use in future debugging sessions.

Topic **Page**

9.1 Changing the Colors of the Debugger Display

You can use the debugger with a color or a monochrome display; the commands described in this section are most useful if you have a color display. If you are using a monochrome display, these commands change the shades on your display. For example, if you are using a black-and-white display, these commands change the shades of gray that are used.

color
scolor

You can use the COLOR or SCOLOR command to change the colors of areas in the debugger display. The format for these commands is:

color *area name*, *attribute*$_1$ [, *attribute*$_2$ [, *attribute*$_3$ [, *attribute*$_4$]]]
scolor *area name*, *attribute*$_1$ [, *attribute*$_2$ [, *attribute*$_3$ [, *attribute*$_4$]]]

These commands are similar. However, SCOLOR updates the screen immediately, and COLOR doesn't update the screen (the new colors/attributes take effect as soon as the debugger executes another command that updates the screen). Typically, you might use the COLOR command several times, followed by an SCOLOR command to put all of the changes into effect at once.

The *area name* parameter identifies the areas of the display that are affected. The *attributes* identify how the areas are affected. Table 9–1 lists the valid values for the *attribute* parameters.

Table 9–1. Colors and Other Attributes for the COLOR and SCOLOR Commands

(a) Colors

black	blue	green	cyan
red	magenta	yellow	white

(b) Other attributes

bright	blink

The first two *attribute* parameters usually specify the foreground and background colors for the area. If you do not supply a background color, the debugger uses black as the background.

Table 9–2 lists valid values for the *area name* parameters. This is a long list; the subsections following the table further identify these areas.

Table 9–2. Summary of Area Names for the COLOR and SCOLOR Commands

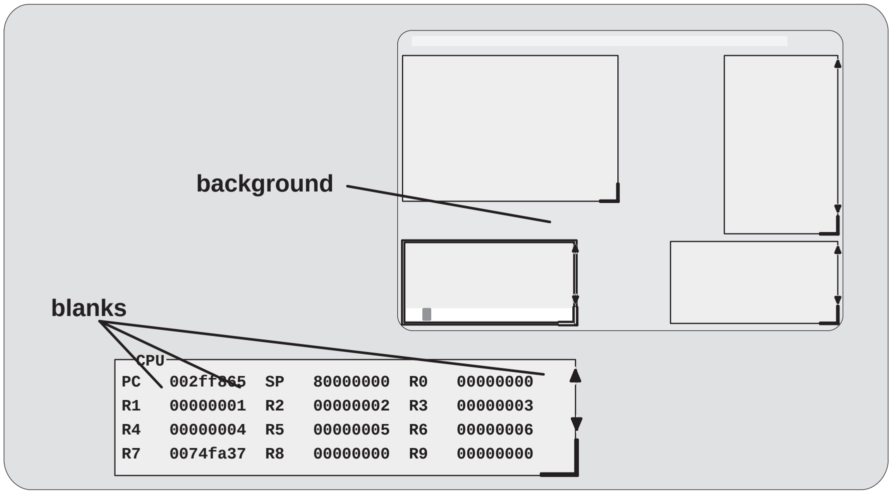
menu_bar	menu_border	menu_entry	menu_cmd
menu_hilite	menu_hicmd	win_border	win_hiborder
win_resize	field_text	field_hilite	field_edit
field_label	field_error	cmd_prompt	cmd_input
cmd_cursor	cmd_echo	asm_data	asm_cdata
asm_label	asm_clabel	background	blanks
error_msg	file_line	file_eof	file_text
file_brk	file_pc	file_pc_brk	

Note: Listing order is left to right, top to bottom.

You don’t have to type an entire *attribute* or *area name*; you need type only enough letters to uniquely identify either parameter. If you supply ambiguous *attribute* names, the debugger interprets the names in this order: black, blue, bright, blink. If you supply ambiguous *area names*, the debugger interprets them in the order that they’re listed in Table 9–2 (left to right, top to bottom).

The remainder of this section identifies these areas.

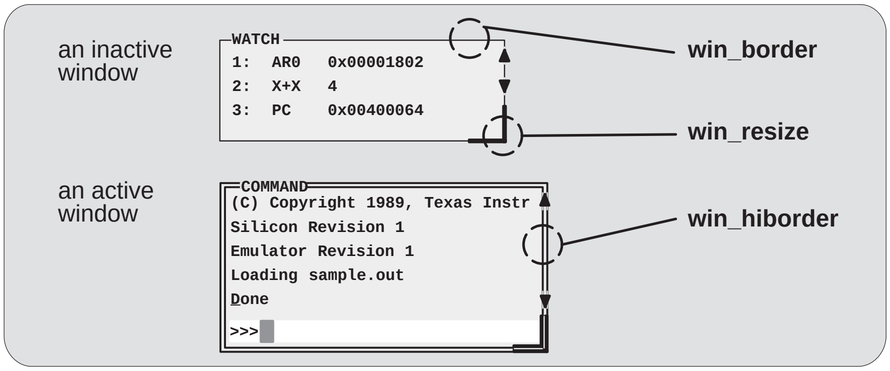
Area names: common display areas



```
PC   002ff865  SP   80000000  R0   00000000
R1   00000001  R2   00000002  R3   00000003
R4   00000004  R5   00000005  R6   00000006
R7   0074fa37  R8   00000000  R9   00000000
```

Area identification	Parameter name
Screen background (behind all windows)	background
Window background (inside windows)	blanks

Area names: window borders

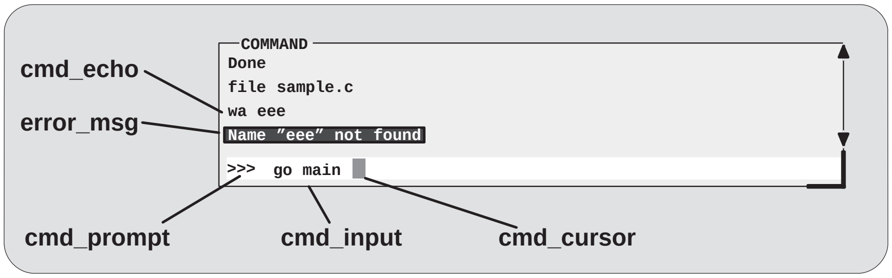


```
WATCH
1:  AR0   0x00001802
2:  X+X   4
3:  PC    0x00400064
```

```
COMMAND
(C) Copyright 1989, Texas Instr
Silicon Revision 1
Emulator Revision 1
Loading sample.out
Done
>>>
```

Area identification	Parameter name
Window border for any window that isn't active	win_border
The reversed "L" in the lower right corner of a resizable window	win_resize
Window border of the active window	win_hiborder

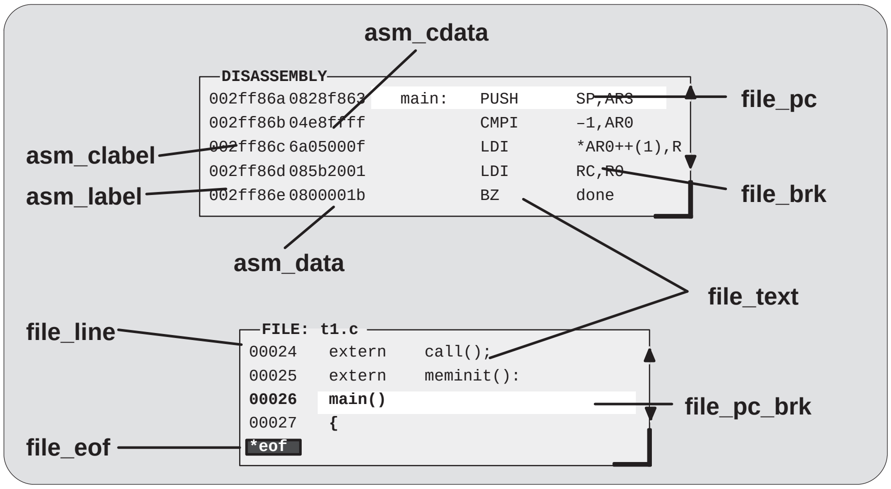
Area names: COMMAND window



```
COMMAND
Done
file sample.c
wa eee
Name "eee" not found
>>>  go main
```

Area identification	Parameter name
Echoed commands in display area	cmd_echo
Errors shown in display area	error_msg
Command-line prompt	cmd_prompt
Text that you enter on the command line	cmd_input
Command-line cursor	cmd_cursor

Area names: DISASSEMBLY and FILE windows

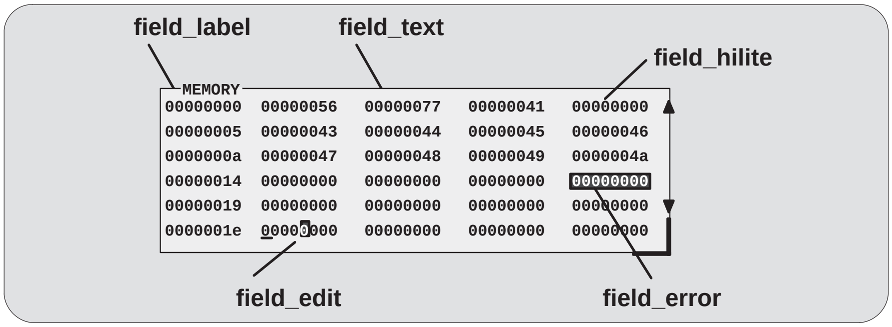


```
DISASSEMBLY
002ff86a 0828f863   main:   PUSH      SP,AR3
002ff86b 04e8ffff           CMPI      –1,AR0
002ff86c 6a05000f           LDI       *AR0++(1),R
002ff86d 085b2001           LDI       RC,R0
002ff86e 0800001b           BZ        done
```

```
FILE: t1.c
00024   extern    call();
00025   extern    meminit():
00026   main()
00027   {
*eof
```

Area identification	Parameter name
Object code in DISASSEMBLY window that is associated with current C statement	asm_cdata
Object code in DISASSEMBLY window	asm_data
Addresses in DISASSEMBLY window	asm_label
Addresses in DISASSEMBLY window that are associated with current C statement	asm_clabel
Line numbers in FILE window	file_line
End-of-file marker in FILE window	file_eof
Text in FILE or DISASSEMBLY window	file_text
Breakpointed text in FILE or DISASSEMBLY window	file_brk
Current PC in FILE or DISASSEMBLY window	file_pc
Breakpoint at current PC in FILE or DISASSEMBLY window	file_pc_brk

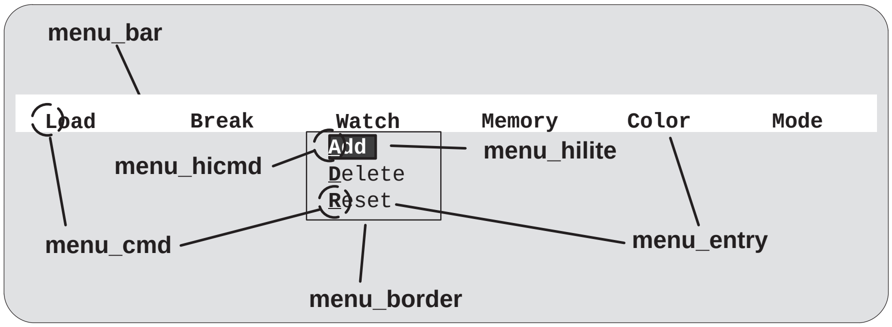
Area names: data-display windows



```
 MEMORY
00000000  00000056  00000077  00000041  00000000
00000005  00000043  00000044  00000045  00000046
0000000a  00000047  00000048  00000049  0000004a
00000014  00000000  00000000  00000000  00000000
00000019  00000000  00000000  00000000  00000000
0000001e  00000000  00000000  00000000  00000000
```

Area identification	Parameter name
Label of a window field (includes register names in CPU window, addresses in MEMORY window, index numbers and labels in WATCH window, member names in DISP window)	field_label
Text of a window field (includes data values for all data-display windows) and of most command output messages in command window	field_text
Text of a highlighted field	field_hilite
Text of a field that has an error (such as an invalid memory location)	field_error
Text of a field being edited (includes data values for all data-display windows)	field_edit

Area names: menu bar and pulldown menus



Area identification	Parameter name
Top line of display screen; background to main menu choices	menu_bar
Border of any pulldown menu	menu_border
Text of a menu entry	menu_entry
Invocation key for a menu or menu entry	menu_cmd
Text for current (selected) menu entry	menu_hilite
Invocation key for current (selected) menu entry	menu_hicmd

9.2 Changing the Border Styles of the Windows

In addition to changing the colors of areas in the display, the debugger allows you to modify the border styles of the windows.

border Use the BORDER command to change window border styles. The format for this command is:

border [*active window style*] [, [*inactive window style*] [, *resize style*]]

This command can change the border styles of the active window, the inactive windows, and any window that is being resized. The debugger supports nine border styles. Each parameter for the BORDER command must be one of the numbers that identifies these styles:

Index	Style
0	Double-lined box
1	Single-lined box
2	Solid 1/2-tone top, double-lined sides and bottom
3	Solid 1/4-tone top, double-lined sides and bottom
4	Solid box, thin border
5	Solid box, heavy sides, thin top and bottom
6	Solid box, heavy borders
7	Solid 1/2-tone box
8	Solid 1/4-tone box

Here are some examples of the BORDER command. Note that you can skip parameters, if desired.

```
border 6,7,8         Change style of active, inactive, and resize windows
border 1,,2                 Change style of active and resize windows
border ,3                               Change style of inactive window
```

Note that you can execute the BORDER command as the Border selection on the Color pulldown menu. The debugger displays a dialog box so that you can enter the parameter values; in the dialog box, *active window style* is called *foreground*, and *inactive window style* is called *background*.

9.3 Saving and Using Custom Displays

The debugger allows you to save and use as many custom configurations as you like.

When you invoke the debugger, it looks for a screen configuration file called init.clr. The screen configuration file defines how various areas of the display will appear. If the debugger doesn't find this file, it uses the default screen configuration.

The debugger supports two commands for saving and restoring custom screen configurations into files. The filenames that you use for restoring configurations must correspond to the filenames that you used for saving configurations. Note that these are binary files, not text files, so you can't edit the files with a text editor.

Changing the default display for monochrome monitors

The default display is most useful with color monitors. The debugger highlights changed values, messages, and other information with color; this may not be particularly helpful if you are using a monochrome monitor.

The debugger package includes another screen configuration file named mono.clr which defines a screen configuration file that can be used with monochrome monitors. The best way to use this configuration is to rename the file:

1) Rename the original init.clr file—you might want to call it color.clr.

2) Rename the mono.clr file. Call it init.clr. Now, whenever you invoke the debugger, it will automatically come up with a customized screen configuration for monochrome monitors.

If you aren't happy with the way that this file defines the screen configuration, you can customize it.

Saving a custom display

ssave Once you've customized the debugger display to your liking, you can use the SSAVE command to save the current screen configuration to a file. The format for this command is:

ssave [*filename*]

This saves the screen resolution, border styles, colors, window positions, window sizes, and (on PCs) video mode (EGA, VGA, CGA, etc.) for all debugging modes.

The *filename* parameter names the new screen configuration file. You can include path information (including relative pathnames); if you don't specify path information, the debugger places the file in the current directory. If you don't supply a filename, the debugger saves the current configuration into a file named init.clr.

Note that you can execute this command as the Save selection on the Color pulldown menu.

Loading a custom display

sconfig You can use the SCONFIG command to restore the display to a particular configuration. The format for this command is:

sconfig [*filename*]

This restores the screen resolution, colors, window positions, window sizes, border styles, and (on PCs) video mode (EGA, CGA, MDA, etc.) saved in *filename*. Screen resolution and video mode are restored either by changing the mode (on video cards with switchable modes) or by resizing the debugger screen (on other hosts).

If you don't supply a *filename*, the debugger looks for init.clr. The debugger searches for the file in the current directory and then in directories named with the D_DIR environment variable.

Note:

The file created by the SSAVE command in this version of the debugger saves positional, screen size, and video mode information that was not saved by SSAVE in previous versions of the debugger. The format of this new information is not compatible with the old format. If you attempt to load an earlier version's SCONFIG file, the debugger will issue an error message and stop the load.

Invoking the debugger with a custom display

If you set up the screen in a way that you like and always want to invoke the debugger with this screen configuration, you have two choices for accomplishing this:

- Save the configuration in init.clr.
- Add a line to the initialization batch file that the debugger executes at invocation time (emuinit.cmd for the emulator, siminit.cmd for the simulator). This line should use the SCONFIG command to load the custom configuration.

Returning to the default display

If you saved a custom configuration into init.clr but don't want the debugger to come up in that configuration, then rename the file or delete it. If you are in the debugger, have changed the configuration, and would like to revert to the default, just execute the SCONFIG command without a filename.

9.4 Changing the Prompt

prompt The debugger enables you to change the command-line prompt by using the PROMPT command. The format of this command is:

prompt *new prompt*

The *new prompt* can be any string of characters, excluding semicolons and commas. (If you type a semicolon or a comma, it terminates the prompt string.)

Note that the SSAVE command doesn't save the command-line prompt as part of a custom configuration. The SCONFIG command doesn't change the command-line prompt. If you change the prompt, it stays changed until you change it again, even if you use SCONFIG to load a different screen configuration.

If you always want to use a different prompt, you can add a PROMPT statement to the initialization batch file that the debugger executes at invocation time (emuinit.cmd for the emulator, siminit.cmd for the simulator).

You can also execute this command as the Prompt selection on the Color pulldown menu.

Chapter 10

Using the Analysis Interface

The ’C4x has an analysis module on the chip that allows the emulator to monitor hardware functions. The debugger provides you with easy-to-use windows, dialog boxes, and analysis commands that let you count occurrences of certain hardware functions or set hardware breakpoints on these occurrences.

The debugger accesses the on-chip analysis module through a special set of pseudoregisters. The dialog boxes described in this chapter provide a transparent means of loading these registers. You will, in most cases, access the analysis features, unlike many of the other debugger features, through dialog boxes rather than through commands. If the dialog boxes do not meet your needs, you can use the special set of aliased commands that deal directly with the analysis pseudoregisters. These commands are described in Appendix A.

Topic **Page**

10.1 Introducing the Analysis Interface

The ’C4x analysis interface provides a detailed look into events occurring in hardware, expanding your debugging capabilities beyond software breakpoints. The analysis interface examines ’C4x bus cycle information in real time and reacts to this information through actions such as hardware breakpoints and event counting.

The analysis interface allows you to:

- **Count events.** The analysis interface can count nine types of *events*. You have the option of counting the number of times a defined event occurred during execution of your program or stopping after a certain number of events are detected.

  The analysis module has an *internal counter* that can count bus events as well as detect other internal events. Events that can be counted include:

  - Data accesses
  - DMA accesses
  - Program accesses
  - CPU clock cycles
  - Calls taken
  - Interrupts or traps taken
  - Returns from interrupts, traps, or calls
  - Instruction fetches
  - Branches taken

  You can count only one event at a time.

- **Set hardware breakpoints**. You can also set up the analysis interface to halt the processor during execution of your program. The events that cause the processor to stop are called *break events*. A break event can define a variety of conditions, including:

  - Data accesses
  - DMA accesses
  - Program accesses
  - Calls taken
  - Interrupts or traps taken
  - Returns from interrupts, traps, or calls
  - Instruction fetches
  - Branches taken
  - Low levels on EMU0/1 pins (EMU0/1 and EMU0/1)

  Hardware break events allow you to set breakpoints in ROM as well as set separate breakpoints on program, data, and DMA accesses. This enables you to break on events that you cannot break on by using software breakpoints alone. In addition, any of the debugger’s basic features available with software breakpoints can also be used with hardware breakpoints. As a result, you can take advantage of all the step and run commands.

- ❑ **Set up EMU0/1 pins.** In a system of multiple ’C4x processors connected by EMU0/1 (emulation event) pins, setting up the EMU0/1 pins allows you to create global breakpoints. Whenever one processor in your system reaches a breakpoint (software or hardware), *all* processors in the system can be halted.

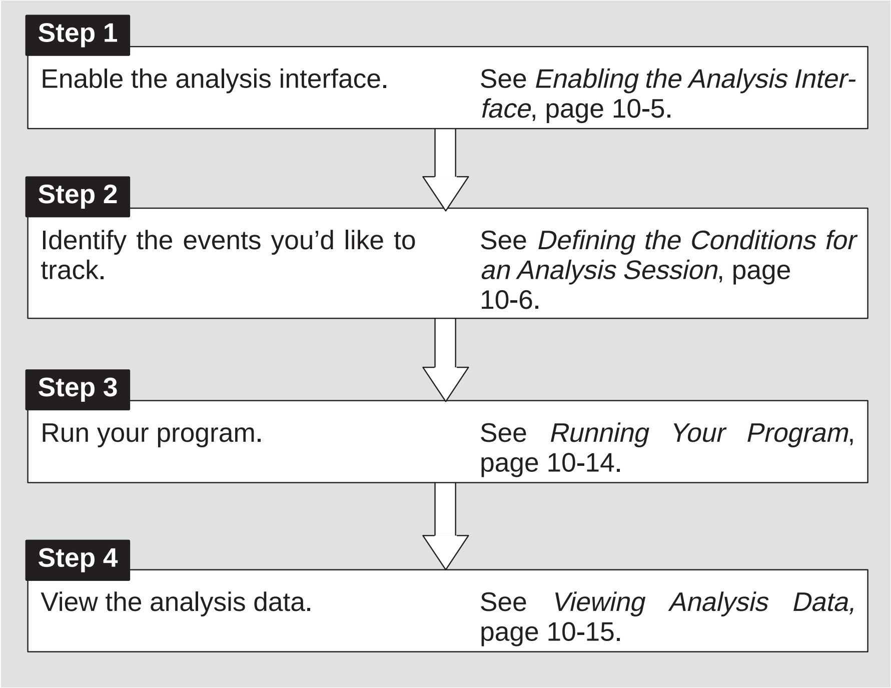
  In addition to setting global breakpoints, you can set up the EMU0/1 pins to take advantage of the emulator’s external counter. The *external counter* keeps track of the internal counter; each time the internal counter passes zero, a signal is sent through the EMU0/1 pins, incrementing the external counter.

- ❑ **View the PC discontinuity stack.** *Discontinuity* occurs when the addresses fetched by the debugger become nonsequential as a result of loading the PC (through branches, calls, return instructions, for example) with new values.

  You can view these values through the PC discontinuity stack and easily track the progress of your program to see exactly how the debugger reached its current state.

10.2 An Overview of the Analysis Process

Completing an analysis session consists of four simple steps:



Step 1

Enable the analysis interface. See *Enabling the Analysis Interface*, page 10-5.

Step 2

Identify the events you'd like to track. See *Defining the Conditions for an Analysis Session*, page 10-6.

Step 3

Run your program. See *Running Your Program*, page 10-14.

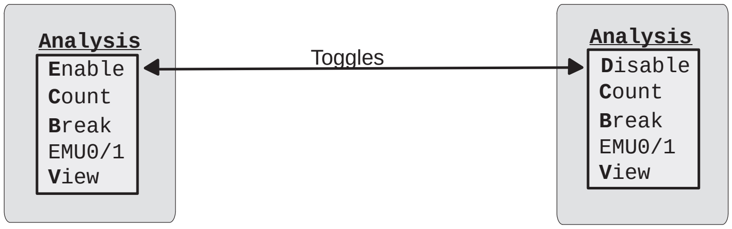
Step 4

View the analysis data. See *Viewing Analysis Data,* page 10-15.

10.3 Enabling the Analysis Interface

To begin tracking hardware events, you must explicitly enable the interface by selecting *Enable* on the Analysis menu. When you select enable, the next time you open the menu, Enable is replaced by *Disable*.

Figure 10–1. Enabling/Disabling the Analysis Interface



Selecting Disable turns the interface off; however, all events you previously enabled remain unchanged. By default, when the debugger comes up, the analysis interface is disabled.

During a single debugging session, you may want to change the parameters of the analysis module several times. For example, you may want to define new parameters such as DMA accesses, tracking CPU clock cycles, etc. To do this, you must open the individual dialog boxes, deselect any previous events, and select the new events you want to track.

Note:

You only have to enable the analysis interface once during a debugging session. It is not necessary to enable the analysis interface each time you run your program.

10.4 Defining Conditions for Analysis

The analysis module detects hardware events and monitors the internal signals of the processor. The interface to the analysis module allows you to define parameters that count events or halt the processor.

First, however, you must define the conditions the analysis interface must meet to track a particular event. To do this, select the events you want to track by enabling the appropriate conditions in the Analysis Count Events, Analysis Break Events, or emulator Pins dialog boxes found on the Analysis menu.

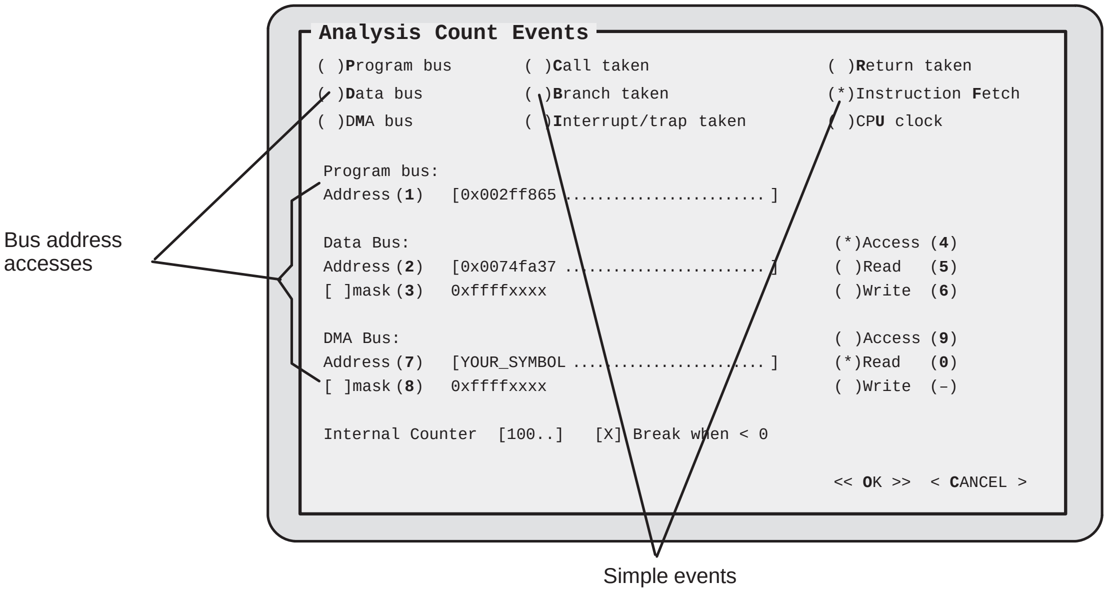
Counting events

You can count two basic types of events:

- Simple events
- Bus address accesses

Figure 10–2 shows the Analysis Count Events dialog box and the types of events that you can select.

Figure 10–2. Two Basic Types of Events Can Be Counted



```
Analysis Count Events
( )Program bus       ( )Call taken                  ( )Return taken
( )Data bus          ( )Branch taken                (*)Instruction Fetch
( )DMA bus           ( )Interrupt/trap taken        ( )CPU clock

 Program bus:
 Address (1)   [0x002ff865 ........................ ]

 Data Bus:                                             (*)Access (4)
 Address (2)   [0x0074fa37 ........................ ]   ( )Read   (5)
 [ ]mask (3)   0xffffxxxx                              ( )Write  (6)

 DMA Bus:                                              ( )Access (9)
 Address (7)   [YOUR_SYMBOL ....................... ]  (*)Read   (0)
 [ ]mask (8)   0xffffxxxx                              ( )Write  (–)

 Internal Counter  [100..]   [X] Break when < 0

                                                   << OK >>  < CANCEL >
```

Event counting is mutually exclusive; therefore, you can count only one event at a time. To show an enabled event in the Analysis Count Events dialog box, the debugger displays an asterisk inside the parentheses preceding your selection. In this example, the debugger counts the number of instructions fetched. (Refer to Section 4.3 on page 4-11 for more information on using dialog boxes.)

You can use event counting in one of two ways: you can either stop after a certain number of events are detected, or you can count the number of times a defined event occurs. To count the number of times an event occurred, simply enable the event in the Analysis Count Events dialog box as shown in Figure 10–2.

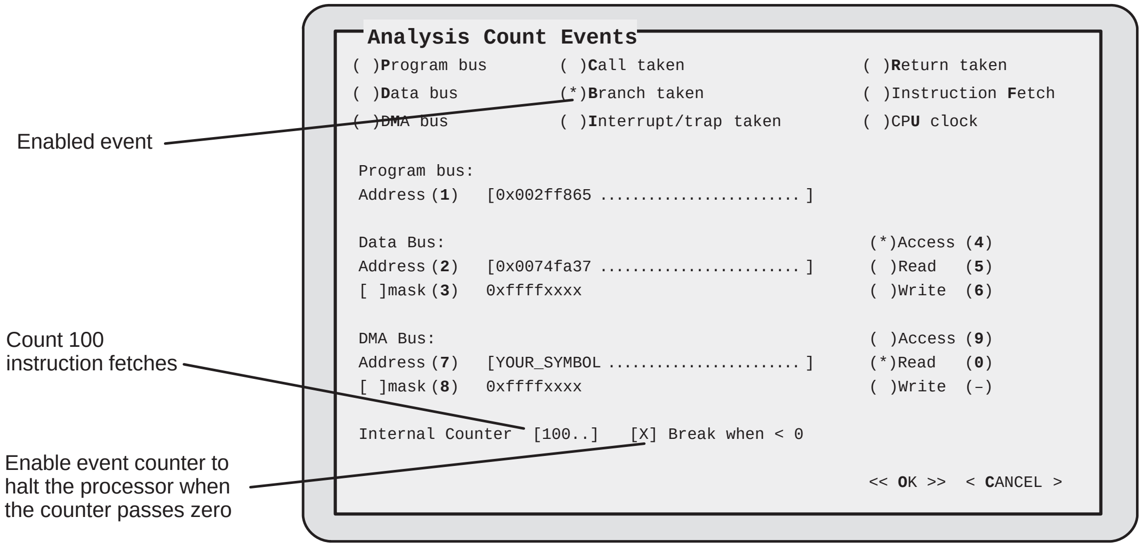
The analysis module has an internal counter that can count bus events as well as detect other internal events. This counter keeps track of how many times an event occurs. Therefore, in order to stop after a certain number of events are detected, you must:

- ❑ Specify the event you want to count,
- ❑ Enable the internal counter *(Break < 0*), and
- ❑ Load the counter with the number of events you want to count.

The internal counter decrements each time the specified event is detected.

For example, you may want to follow the progress of the branches taken during execution of your program, but you may want the processor to stop after 100 branches have occurred. In this case, the counter is responsible for keeping track of the branches taken and signaling the processor to stop after the 100th branch event occurs. When the internal counter passes zero, the debugger will halt the processor.

Figure 10–3. Enabling the Event Counter



```
Analysis Count Events
( )Program bus       ( )Call taken                 ( )Return taken
( )Data bus          (*)Branch taken               ( )Instruction Fetch
( )DMA bus           ( )Interrupt/trap taken       ( )CPU clock

 Program bus:
 Address (1)   [0x002ff865 ........................ ]

 Data Bus:                                           (*)Access (4)
 Address (2)   [0x0074fa37 ........................ ]     ( )Read   (5)
 [ ]mask (3)   0xffffxxxx                            ( )Write  (6)

 DMA Bus:                                            ( )Access (9)
 Address (7)   [YOUR_SYMBOL ....................... ]     (*)Read   (0)
 [ ]mask (8)   0xffffxxxx                            ( )Write  (–)

 Internal Counter  [100..]   [X] Break when < 0

                                                     << OK >>  < CANCEL >
```

Enabled event

Count 100 instruction fetches

Enable event counter to halt the processor when the counter passes zero

To watch the progress of the event counter, open the Analysis window by selecting View on the Analysis menu. For more information concerning the Analysis window, see Section 10.6 on page 10-15.

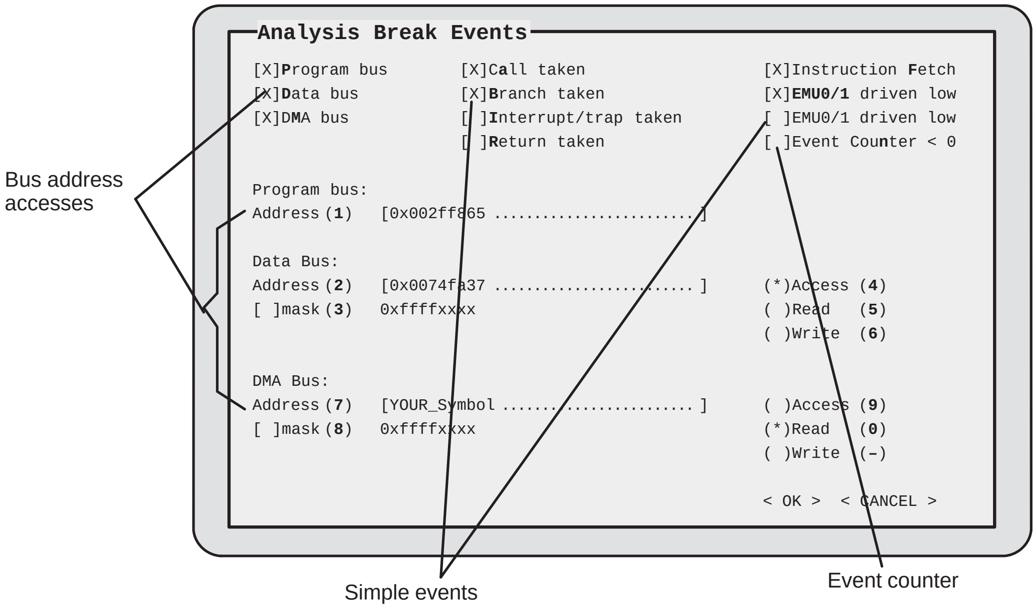
Halting the processor

You can set a hardware breakpoint on three basic types of events:

- ❑ Event counter passing zero
- ❑ Simple events
- ❑ Bus address accesses

Figure 10–4 shows the Analysis Break Events dialog box and the different types of break events that you can select.

Figure 10–4. Three Basic Types of Break Events



```
Analysis Break Events
[X]Program bus       [X]Call taken              [X]Instruction Fetch
[X]Data bus          [X]Branch taken            [X]EMU0/1 driven low
[X]DMA bus           [ ]Interrupt/trap taken    [ ]EMU0/1 driven low
                     [ ]Return taken            [ ]Event Counter < 0

Program bus:
Address (1)   [0x002ff865 ........................]

Data Bus:
Address (2)   [0x0074fa37 ........................ ]     (*)Access (4)
[ ]mask (3)   0xffffxxxx                                ( )Read   (5)
                                                        ( )Write  (6)

DMA Bus:
Address (7)   [YOUR_Symbol ....................... ]    ( )Access (9)
[ ]mask (8)   0xffffxxxx                                (*)Read   (0)
                                                        ( )Write  (–)

                                                        < OK >  < CANCEL >
```

The events that cause the processor to halt when a specified event is detected include:

- ❑ Event Counter < 0
- ❑ Calls taken
- ❑ Branches taken
- ❑ Instruction fetches
- ❑ Interrupts or traps taken
- ❑ Returns from interrupts, traps, or calls
- ❑ Low levels on EMU0/1 pins

Enabling events in the Analysis Break Events dialog box is like turning a switch on and off. When an event is enabled, the debugger displays an X next to the event. You can enable as many events as you want.

In Figure 10–4, the debugger halts the processor whenever it detects the occurrence of a call taken, branch taken, instruction fetch, or when an EMU pin is driven low.

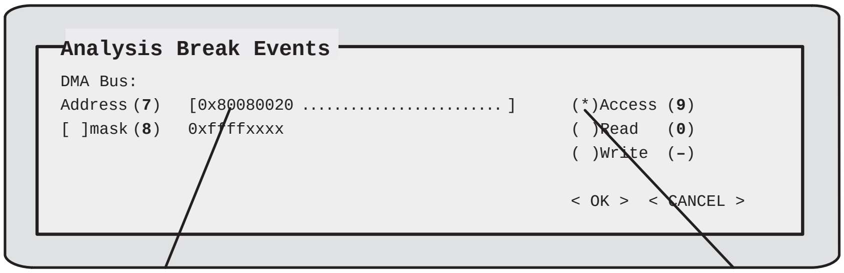
Setting up the event comparators

The analysis module has separate event comparators for the program, data, and DMA buses. You can set up the analysis interface either to count the number of accesses to a certain bus address, or to halt the processor on accesses to a specified address.

The program, data, and DMA bus fields in the Analysis Break Events dialog box are identical to the program, data, and DMA bus fields found in the Analysis Count Events dialog box. (Notice that the event comparators shown in Figure 10–2, Figure 10–3, and Figure 10–4 all have the same values.) As a result, changing the values in these fields in either dialog box affects *both* of these dialog boxes.

The program bus has read-only access. Therefore, if you enable the program bus and define the program address, the processor will halt each time an instruction fetch from that address occurs.

Similarly, if you were to load the DMA address field with 0x80080020 and select *Access* in the Analysis Break Events dialog box, the processor would halt every time the DMA coprocessor reads from or writes to address 0x80080020:



```
Analysis Break Events
DMA Bus:
Address (7)   [0x80080020 ........................ ]      (*)Access (9)
[ ]mask (8)   0xffffxxxx                                  ( )Read   (0)
                                                          ( )Write  (–)

                                                          < OK >  < CANCEL >
```

Break when a read or write occurs at address 0x80080020 on the DMA bus

Look for reads *or* writes

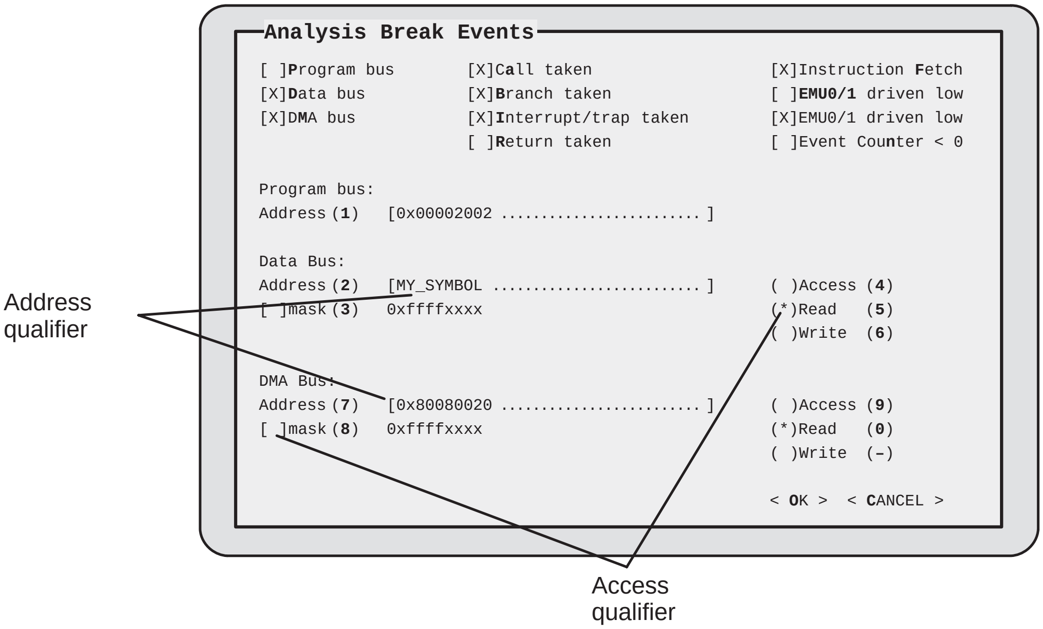
Enabling one of these comparators in the Analysis Count Events dialog box allows you to count the number of accesses that are detected or to stop after a certain number of accesses have occurred.

In Figure 10–5, several events, including the data bus, are enabled in the Analysis Break Events dialog box; however, data and DMA bus accesses need these additional qualifications:

- Address qualification
- Access qualification

For example, *Read* and *My_Symbol* selected in Figure 10–5 represent access and address qualifiers, respectively. They further define the conditions necessary to halt the emulator.

Figure 10–5. Enabling Break Events

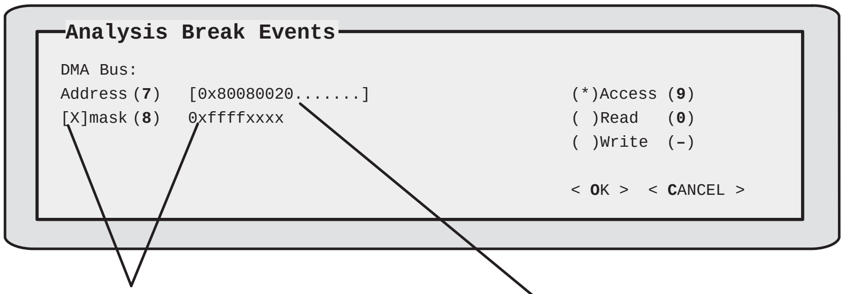


```
Analysis Break Events
[ ]Program bus       [X]Call taken                [X]Instruction Fetch
[X]Data bus          [X]Branch taken              [ ]EMU0/1 driven low
[X]DMA bus           [X]Interrupt/trap taken      [X]EMU0/1 driven low
                     [ ]Return taken              [ ]Event Counter < 0

Program bus:
Address (1)   [0x00002002 ........................ ]

Data Bus:
Address (2)   [MY_SYMBOL ......................... ]      ( )Access (4)
[ ]mask (3)   0xffffxxxx                                  (*)Read   (5)
                                                          ( )Write  (6)

DMA Bus:
Address (7)   [0x80080020 ........................ ]      ( )Access (9)
[ ]mask (8)   0xffffxxxx                                  (*)Read   (0)
                                                          ( )Write  (–)

                                                          < OK >  < CANCEL >
```

Address qualification allows you to enter an address expression (a specific address, symbol, or function name). Access qualification allows you to track reads, writes, or both reads and writes (accesses) to a single address. In Figure 10–5, the debugger halts the processor any time a read from the address at My_Symbol occurs.

In addition to read/write access, you also have the option of tracking these conditions on a range of addresses; this is referred to as *masking*. Masking the data or DMA bus allows you the flexibility to look for accesses occurring in a *64K range* of addresses. If you choose to mask the DMA bus, for example, the analysis module will ignore the last 16 bits of the specified address and look for DMA reads from or writes to any of the addresses with the first 16 bits.

For example, loading the DMA address field with 0x80080020 and enabling masking causes the processor to halt any time a DMA read from or write to any address in the range 0x80080000—0x8008ffff occurs:



```
Analysis Break Events
DMA Bus:
Address (7)   [0x80080020.......]                  (*)Access (9)
[X]mask (8)   0xffffxxxx                           ( )Read   (0)
                                                   ( )Write  (–)

                                                   < OK >  < CANCEL >
```

Masking enabled on any address within the range of 80080000 to 8008ffff

Breakpoint occurs when a DMA read from or write to any address with the prefix of 0x8008 is detected

If you set up the DMA bus the same way as in this example, but in the Analysis Count Events dialog box, the debugger would count the number of reads from or writes to any address in the range 0x80080000—0x8008ffff.

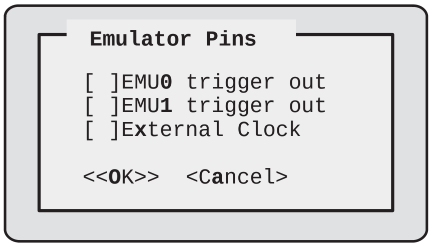
Setting up the EMU0/1 pins

The analysis interface allows you to access and set up the EMU0/1 (emulation event) pins on your processor. You can set these pins to:

- ❑ Use the emulator’s external counter, or
- ❑ Set global breakpoints.

Selecting EMU0/1 from the Analysis menu opens the Emulator Pins dialog box shown in Figure 10–6.

Figure 10–6. The Emulator Pins Dialog Box



```
Emulator Pins

[ ]EMU0 trigger out
[ ]EMU1 trigger out
[ ]External Clock

<<OK>>  <Cancel>
```

The emulator’s *external counter* keeps track of the internal counter. The internal counter is a 12-bit, count-down counter that can keep track of a maximum of 4096 events. The external counter, however, is a 32-bit, incremental counter. Each time the internal counter passes zero, a signal is sent through the EMU0/1 pins, that increments the external counter. To use the emulator’s external counter, simply enable the external clock parameter in the emulator Pins dialog box. (Refer to Section 4.3, page 4-11, for more information on enabling parameters in a dialog box.)

When you enable the external clock, the EMU0/1 pins are set up as totem-pole outputs; otherwise, the EMU0/1 pins are set up as open-collector outputs. You can only set up *one* ’C4x device in the system to use the external counter. In doing so, no other device in the system can have EMU0/1 pins set up to trigger out.

The EMU1 pin provides a ripple-carry output signal from the internal counter that is incremented by the emulator. The ’C4x EMU0 pin is set up to send a signal to the debugger when a hardware or software breakpoint occurs. Other devices in the system can still be programmed to detect low levels on EMU0 pins to provide you with global breakpoint capabilities.

Notes:

1) Enabling the external clock disables all options concerning the internal clock in the Analysis Break Events and Analysis Count Events dialog boxes.

2) Enabling the external clock in the Emulator Pins dialog box has the following restrictions:

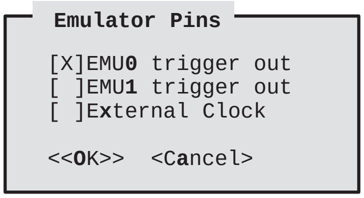
   - □ You can enable only one external clock when you have multiple processors in a system (which are connected by their EMU0/1 pins).
   - □ No other external devices can actively drive the EMU0/1 pins.

By default, the EMU0/1 pins are set up as input signals; however, you can set them up as output signals or *trigger out* whenever the processor is halted by a software or hardware breakpoint. This is extremely useful when you have multiple ’C4x processors in a system connected by their EMU0/1 pins.

Selecting EMU0/1 does not, however, automatically halt all processors in the system. To do so, you must enable the EMU0/1 driven low condition in the Analysis Break Events dialog box. For example, if you have a system consisting of two processors connected by their EMU0 pins, and you want to halt both processors when this pin is driven low, you would enable the *EMU0 trigger out* parameter. Then you must enable the parameter *EMU0 driven low* in the Analysis Break Events dialog box. See Figure 10–7.

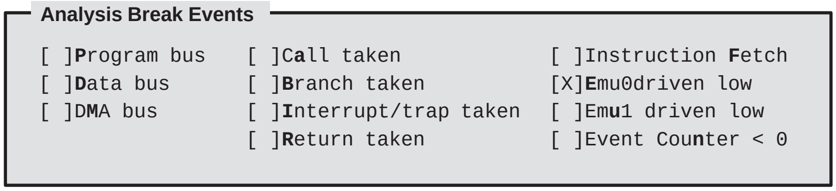
Figure 10–7. Setting Up Global Breakpoints on a System of Two ’C4x Processors

Processor 1 and Processor 2



```
Emulator Pins

[X]EMU0 trigger out
[ ]EMU1 trigger out
[ ]External Clock

<<OK>>  <Cancel>
```

Processor 1 and Processor 2



```
Analysis Break Events

[ ]Program bus   [ ]Call taken              [ ]Instruction Fetch
[ ]Data bus      [ ]Branch taken            [X]Emu0driven low
[ ]DMA bus       [ ]Interrupt/trap taken    [ ]Emu1 driven low
                 [ ]Return taken            [ ]Event Counter < 0
```

Setting up each processor in this way creates a global breakpoint so that any processor that reaches a breakpoint halts all the other processors in the system.

10.5 Running Your Program

Once you have defined your parameters, the analysis interface can begin collecting data as soon as you run your program. It will stop collecting data when the defined conditions are met. The analysis interface monitors the progress of the defined events while your program is running. The basic syntax for the RUN command is:

run [*expression*]

You can use any of the debugger run commands (STEP, CSTEP, NEXT, etc.) described in Chapter 6 except the RUNF (run free) command.

The analysis interface provides capabilities in addition to those provided by the RUNB command. You may notice that with the RUNB command you can count the number of CPU clock cycles only during the execution of a specific section of code. However, the analysis interface not only allows you to count and break on CPU clock cycles, it also allows you to count other events.

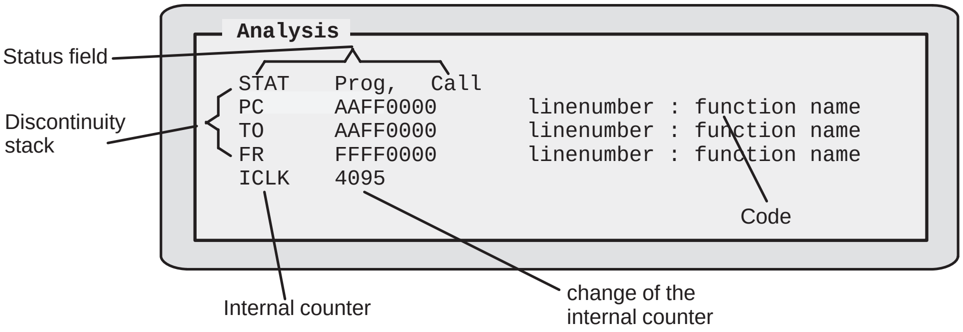
Note:

The conditions for the analysis session must be defined *before* your analysis session begins; you cannot change conditions *during* execution of your program.

10.6 Viewing the Analysis Data

You can monitor the status of the analysis interface by selecting View on the Analysis menu. This window displays an ongoing progress report of the analysis module's activity. Through this window, you can monitor the status of the break events, the value of both the internal and external event counters, and the values of the PC discontinuity stack. An example of the Analysis window is shown below.

Figure 10–8. Analysis Interface View Window, Displaying an Ongoing Status Report



```
Analysis
STAT    Prog,   Call
PC      AAFF0000        linenumber : function name
TO      AAFF0000        linenumber : function name
FR      FFFF0000        linenumber : function name
ICLK    4095
```

Interpreting the status field

The STAT field displays a list of the events that caused the processor to halt. If the analysis interface itself did not halt the processor, but something else (such as a software breakpoint) did, then the status line will display: "No event detected".

Multiple events can cause the processor to halt at the same time; these events are reflected in the STAT field of the Analysis window.

Interpreting the discontinuity stack

The PC discontinuity stack allows you to see how the program reached its current position. The Analysis window displays both the PC discontinuity stack values and the corresponding C code. A program discontinuity occurs when the program addresses fetched by the processor become nonsequential as a result of an action such as a branch or interrupt.

The PC, TO, and FR fields in the Analysis window represent the PC discontinuity stack. The FR field displays the original address from where the discontinuity took place, the TO field represents the address that was loaded into the PC, and the PC field displays the address of the current PC.

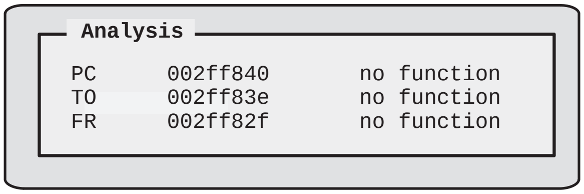
For example, suppose you set a software breakpoint at the address of 0x002ff840 and the processor stopped on it.

Example 10–1. Sample Code and PC Discontinuity Values

(a) Sample code

Address		Code	Comment
002ff82d		PUSH R0	
002ff82e		CALL XCALL	
002ff82f		SUBI 01H,SP	*FROM address*
.		.	
.		.	
.		.	
002ff83d		BU R1	
002ff83e	XCALL:	PUSH AR3	*TO address*
002ff83f		LDI SP,AR3	
002ff840		**LDI str+3,R0**	*PC address*
002ff841		ASH 26,R0	

(b) PC discontinuity stack



```
Analysis
PC      002ff840       no function
TO      002ff83e       no function
FR      002ff82f       no function
```

If you look at the PC discontinuity stack shown in Example 10–1 *(b)*, you see that your program reached this point through a call from address 0x002ff82f. This was a result of a call instruction taken at the previous address. (The PC points at the next address to fetch when a PC load occurs.) The value loaded into the PC is the destination of the call instruction and represents the TO address on the discontinuity stack. Finally, the PC address represents the current value of the PC when the breakpoint occurred.

The fields next to the PC, TO, and FR fields list the C code associated with these addresses. This includes the function name and the line number within the function that caused the discontinuity. If no corresponding C code exists, the debugger displays “no function”. Clicking on any field in the PC discontinuity stack will cause the FILE and DISASSEMBLY windows to open (in the ASM or Mixed mode). The address for that field is displayed in the DISASSEMBLY window, while the associated C code is shown in the FILE window. This allows you to easily track the PC discontinuity values back to their original source.

Interpreting the event counter

You can watch the progress of the event counters in the Analysis window. The CLK field displays the internal and external counter values with the appropriate prefix—I for internal, and X for external. The value shown next to the internal event counter represents the difference from the last counter value (*delta*). You can change the value of the internal counter by clicking on the appropriate field and entering a new value.

Note:

When CPU clock cycles are counted, the counter value reflects startup and latency cycles. Subtract six from the count value to get the actual number of CPU clock cycles detected.

Chapter 11

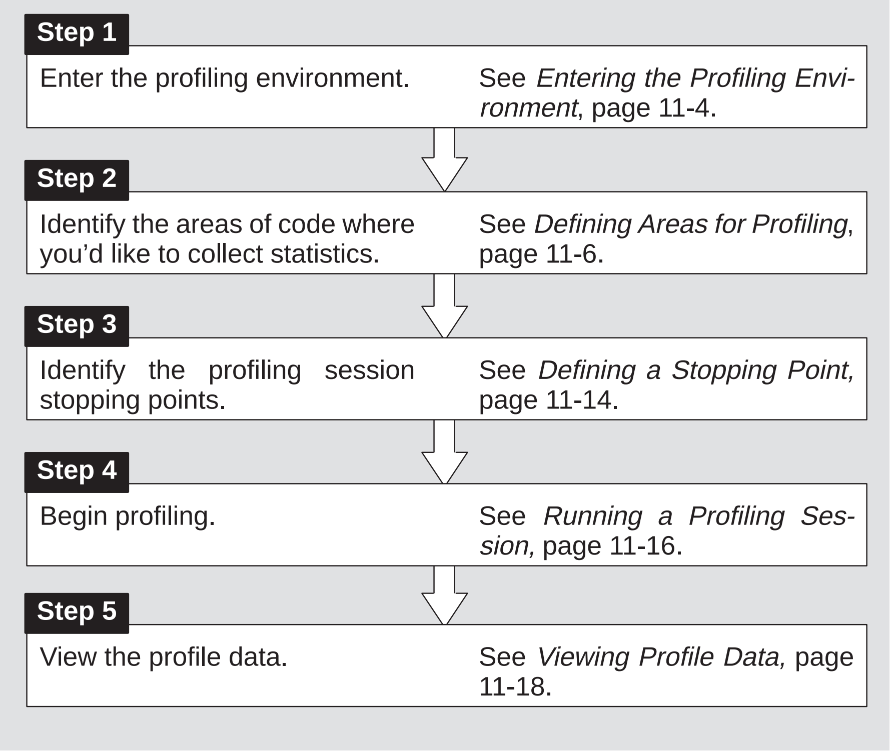
Profiling Code Execution

The profiling environment is a special debugger environment in which you can collect execution statistics for your code. The profiling environment is *separate* from the basic debugging environment; the only way to switch between the two environments is by exiting and then reinvoking the debugger.

Topic **Page**

11.1 An Overview of the Profiling Process

Profiling consists of five simple steps:



Step 1

Enter the profiling environment. See *Entering the Profiling Environment*, page 11-4.

Step 2

Identify the areas of code where you'd like to collect statistics. See *Defining Areas for Profiling*, page 11-6.

Step 3

Identify the profiling session stopping points. See *Defining a Stopping Point,* page 11-14.

Step 4

Begin profiling. See *Running a Profiling Session,* page 11-16.

Step 5

View the profile data. See *Viewing Profile Data,* page 11-18.

Note:

When you compile a program that will be profiled, you must use the –g and the –as options. The –g option includes symbolic debugging information; the –as option ensures that you will be able to include ranges as profile areas.

A profiling strategy

The profiling environment provides a method for collecting execution statistics about specific areas in your code. This gives you immediate feedback on your application's performance. Here's a suggestion for a basic approach to optimizing the performance of your program.

1) Mark all the functions in your program as profile areas.

2) Run a profiling session; find the busiest functions.

3) Unmark all the functions.

4) Mark the individual lines in the busy functions and run another profiling session.

11.2 Entering the Profiling Environment

To enter the profiling environment, invoke the debugger with the **–profile** option. At the system command line, enter the appropriate command:

emulator: **`db40 –profile`** ↵

simulator: **`sim40 –profile`** ↵

Use any additional debugger options that you desire (–b, –p, etc.).

Restrictions of the profiling environment

In addition to the special features supported by the profiling environment, several restrictions apply to the profiling environment:

- ❑ You'll always be in mixed mode.
- ❑ COMMAND, DISASSEMBLY, FILE, and PROFILE are the only windows available; additional windows, such as the WATCH window, cannot be opened.
- ❑ Breakpoints cannot be set. (However, you can use a similar feature called *stopping points* in marking sections of code for profiling.)
- ❑ The profiling environment supports only a subset of the debugger commands. Table 11–1 lists the debugger commands that can and can't be used in the profiling environment.

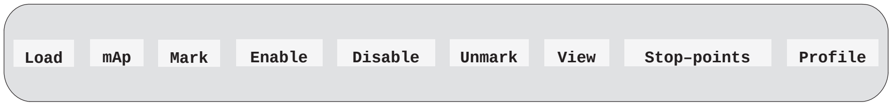
Table 11–1. Debugger Commands That Can/Can't Be Used in the Profiling Environment

Can be used		**Can't be used**	
?	MR	ADDR	MEM
ALIAS	PROMPT	ASM	MIX
CD	QUIT	BA	MS
CLS	RELOAD	BD	NEXT
DASM	RESET	BL	RETURN
DIR	RESTART	BORDER	RUN
EVAL	SCONFIG	BR	RUNB
FILE	SIZE	C	RUNF
FUNC	SLOAD	CALLS	SCOLOR
LOAD	SYSTEM	CNEXT	SSAVE
MA	TAKE	COLOR	STEP
MAP	UNALIAS	CSTEP	WA
MC	USE	DISP	WD
MD	VERSION	FILL	WHATIS
MI	WIN	GO	WR
ML	ZOOM	HALT	
MOVE			

Be sure you don't use any of the "can't be used" commands in your initialization batch file.

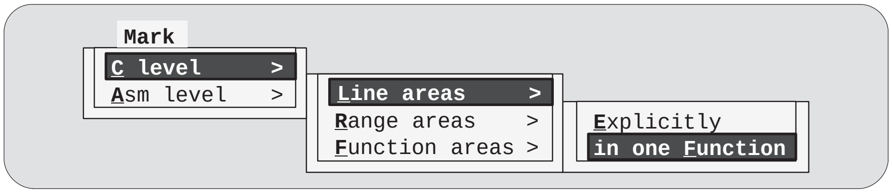
Using pulldown menus in the profiling environment

The debugger displays a different menu bar in the profiling environment:



The Load menu corresponds to the Load menu in the basic debugger environment. The mAp menu provides memory map commands available from the basic Memory winodw. The other entries provide access to profiling commands and features.

The profiling environment's pulldown menus operate like the basic debugger pulldown menus. However, several of the menus have additional submenus. A submenu is indicated by a > character following a menu item. For example, here's one of the submenus for the Mark menu:



Chapter 4, *Entering and Using Commands*, shows which debugger commands are associated with the menu items in the basic debugger pulldown menus. Because the profiling environment supports over 100 profile-specific commands, it's not practical to show the commands associated with the menu choices. Here's a tip to help you with the profiling commands: the highlighted menu letters form the name of the corresponding debugger command. For example, if you prefer the function-key approach to using menus, the highlighted letters in **M**ark→ **C** level→**L**ine areas→in one **F**unction show that you could press ALT M, C, L, F. This also shows that the corresponding debugger command is MCLF.

11.3 Defining Areas for Profiling

Within the profiling environment, you can collect statistics on three types of areas:

❑ **Individual lines** in C or disassembly
❑ **Ranges** in C or disassembly
❑ **Functions** in C only

To identify any of these areas for profiling, you *mark* the line, range, or function. You can disable areas so they won’t affect the profile data. You can re-enable areas that have been disabled. And, you can unmark areas that you are no longer interested in.

The mouse provides a means of accomplishing the simplest marking, disabling, enabling, and unmarking tasks. The pulldown menus also support these tasks; additionally, they provide a means of accomplishing more complex tasks.

The following subsections explain how to mark, disable, re-enable, and unmark profile areas by using the mouse or the pulldown menus. The individual commands are summarized in *Restrictions of the profiling environment* on page 11-4.

Marking an area

Marking an area qualifies it for profiling so that the debugger can collect timing statistics about the area.

Below are directions for using the mouse to mark a line area, a range area, or a function area. Remember, to display C code, use the FILE or FUNC command; to display disassembly, use the DASM command.

Note:

❑ Marking an area in C *does not* mark the associated code in disassembly.

❑ Areas can be nested; for example, you can mark a line within a marked range. The debugger will report statistics for both the line and the function.

❑ Ranges cannot overlap and they cannot span function boundaries.

Marking a line. These instructions apply to both C and disassembly.

1) Point to the line you want to mark.

2) Click the left mouse button.

   The beginning of the line will be highlighted with a blinking >>.

3) Click the left mouse button again.

   The beginning of the line will be highlighted with `Le>` *(line enabled).*

Marking a range. These instructions apply to both C and disassembly.

1) Point to the first line of the range you want to mark.

2) Click the left mouse button.

   The beginning of the line will be highlighted with a blinking >>.

3) Point to the last line of the range.

4) Click the left mouse button again.

   The beginning of the line will be highlighted with `Re>` *(range enabled), marking the beginning of the range. The last line will be highlighted with* <<, *marking the end of the range.*

Marking a function. These instructions apply to C only.

1) Point to the statement that declares the function you want to mark.

2) Click the left mouse button.

   The beginning of the line will be highlighted with `Fe>` *(function enabled).*

Table 11–2 lists the menu selections for marking areas. The highlighted areas show the keys that you can use if you prefer to use the function-key method of selecting menu choices.

Table 11–2. Menu Selections for Marking Areas

To mark this area	**C only:** **M**ark→**C** level	**Disassembly only:** **M**ark→**A**sm level
Lines	→**L**ine areas	→**L**ine areas
□ By line number[†]	→**E**xplicitly	→**E**xplicitly
□ All lines in a function	→in one **F**unction	→in one **F**unction
Ranges	→**R**ange areas	→**R**ange areas
□ By line numbers[†]	→**E**xplicitly	→**E**xplicitly
Functions	→**F**unction areas	not applicable
□ By function name	→**E**xplicitly	
□ All functions in a module	→in one **M**odule	
□ All functions everywhere	→**G**lobally	

[†] C areas are identified by line number; disassembly areas are identified by address.

Disabling an area

At times it is useful to identify areas that must not impact profile statistics. To do this, you should *disable* the appropriate area. Disabling effectively subtracts the timing information of the disabled area from all profile areas that include or call the disabled area. Areas must be marked before they can be disabled.

For example, if you have marked a function that calls a standard C function such as malloc(), you may not want malloc() to affect the statistics for the calling function. You could mark the line that calls malloc(), and then disable the line. This way, the profile statistics for the function would not include the statistics for malloc().

Note:

If you disable an area after you've already collected statistics on it, that information will be lost.

The simplest way to disable an area is to use the mouse, as described below.

Disabling a line area:

1) Point to the marked line.
2) Click the left mouse button once.

   The beginning of the line will be highlighted with `Ld>` *(line disabled).*

Disabling a range area:

1) Point to the marked line.
2) Click the left mouse button once.

   The beginning of the line will be highlighted with `Rd>` *(range disabled).*

Disabling a function area:

1) Point to the marked statement that defines the function.
2) Click the left mouse button once.

   The beginning of the line will be highlighted with `Fd>` *(function disabled).*

Table 11–3 lists the menu selections for disabling areas. The highlighted areas show the keys that you can use if you prefer to use the function-key method of selecting menu choices.

Table 11–3. Menu Selections for Disabling Areas

To disable this area	**C only:** **D**isable→**C** level	**Disassembly only:** **D**isable→**A**sm level	**C *and* disassembly:** **D**isable→**B**oth levels
Lines	→**L**ine areas	→**L**ine areas	→**L**ine areas
By line number[†]	→**E**xplicitly	→**E**xplicitly	not applicable
All lines in a function	→in one **F**unction	→in one **F**unction	→in one **F**unction
All lines in a module	→in one **M**odule	→in one **M**odule	→in one **M**odule
All lines everywhere	→**G**lobally	→**G**lobally	→**G**lobally
Ranges	→**R**ange areas	→**R**ange areas	→**R**ange areas
By line numbers[†]	→**E**xplicitly	→**E**xplicitly	not applicable
All ranges in a function	→in one **F**unction	→in one **F**unction	→in one **F**unction
All ranges in a module	→in one **M**odule	→in one **M**odule	→in one **M**odule
All ranges everywhere	→**G**lobally	→**G**lobally	→**G**lobally
Functions	→**F**unction areas		→**F**unction areas
By function name	→**E**xplicitly		not applicable
All functions in a module	→in one **M**odule	not applicable	→in one **M**odule
All functions everywhere	→**G**lobally		→**G**lobally
All areas	→**A**ll areas	→**A**ll areas	→**A**ll areas
All areas in a function	→in one **F**unction	→in one **F**unction	→in one **F**unction
All areas in a module	→in one **M**odule	→in one **M**odule	→in one **M**odule
All areas everywhere	→**G**lobally	→**G**lobally	→**G**lobally

[†] C areas are identified by line number; disassembly areas are identified by address.

Re-enabling a disabled area

When an area has been disabled and you would like to profile it once again, you must enable the area. To use the mouse, just point to the line, the function, or the first line of a range, and click the left mouse button; the range will once again be highlighted in the same way as a marked area.

In addition to using the mouse, the debugger supports an entire set of commands for enabling areas. These commands are easiest to enter by using the Enable menu. Table 11–4 lists these menu selections.

Table 11–4. Menu Selections for Enabling Areas

To enable this area	**C only:** **E**nable→**C** level	**Disassembly only:** **E**nable→**A**sm level	**C *and* disassembly:** **E**nable→**B**oth levels
Lines	→**L**ine areas	→**L**ine areas	→**L**ine areas
By line number[†]	→**E**xplicitly	→**E**xplicitly	not applicable
All lines in a function	→in one **F**unction	→in one **F**unction	→in one **F**unction
All lines in a module	→in one **M**odule	→in one **M**odule	→in one **M**odule
All lines everywhere	→**G**lobally	→**G**lobally	→**G**lobally
Ranges	→**R**ange areas	→**R**ange areas	→**R**ange areas
By line numbers[†]	→**E**xplicitly	→**E**xplicitly	not applicable
All ranges in a function	→in one **F**unction	→in one **F**unction	→in one **F**unction
All ranges in a module	→in one **M**odule	→in one **M**odule	→in one **M**odule
All ranges everywhere	→**G**lobally	→**G**lobally	→**G**lobally
Functions	→**F**unction areas	not applicable	→**F**unction areas
By function name	→**E**xplicitly		not applicable
All functions in a module	→in one **M**odule		→in one **M**odule
All functions everywhere	→**G**lobally		→**G**lobally
All areas	→**A**ll areas	→**A**ll areas	→**A**ll areas
All areas in a function	→in one **F**unction	→in one **F**unction	→in one **F**unction
All areas in a module	→in one **M**odule	→in one **M**odule	→in one **M**odule
All areas everywhere	→**G**lobally	→**G**lobally	→**G**lobally

[†] C areas are identified by line number; disassembly areas are identified by address.

Unmarking an area

If you want to stop collecting information about a specific area, unmark it. You can use the mouse as described below.

Unmarking a line area:

1) Point to the marked line.

2) Click the right mouse button once.

The line will no longer be highlighted.

Unmarking a range area:

1) Point to the marked line.

2) Click the right mouse button once.

The line will no longer be highlighted.

Unmarking a function area:

1) Point to the marked statement that defines the function.

2) Click the right mouse button once.

The line will no longer be highlighted.

Table 11–5 lists the selections on the Unmark menu.

Table 11–5. Menu Selections for Unmarking Areas

To unmark this area	**C only:** **U**nmark→**C** level	**Disassembly only:** **U**nmark→**A**sm level	**C *and* disassembly:** **U**nmark→**B**oth levels
Lines	→**L**ine areas	→**L**ine areas	→**L**ine areas
By line number[†]	→**E**xplicitly	→**E**xplicitly	not applicable
All lines in a function	→in one **F**unction	→in one **F**unction	→in one **F**unction
All lines in a module	→in one **M**odule	→in one **M**odule	→in one **M**odule
All lines everywhere	→**G**lobally	→**G**lobally	→**G**lobally
Ranges	→**R**ange areas	→**R**ange areas	→**R**ange areas
By line numbers[†]	→**E**xplicitly	→**E**xplicitly	not applicable
All ranges in a function	→in one **F**unction	→in one **F**unction	→in one **F**unction
All ranges in a module	→in one **M**odule	→in one **M**odule	→in one **M**odule
All ranges everywhere	→**G**lobally	→**G**lobally	→**G**lobally
Functions	→**F**unction areas		→**F**unction areas
By function name	→**E**xplicitly		not applicable
All functions in a module	→in one **M**odule	not applicable	→in one **M**odule
All functions everywhere	→**G**lobally		→**G**lobally
All areas	→**A**ll areas	→**A**ll areas	→**A**ll areas
All areas in a function	→in one **F**unction	→in one **F**unction	→in one **F**unction
All areas in a module	→in one **M**odule	→in one **M**odule	→in one **M**odule
All areas everywhere	→**G**lobally	→**G**lobally	→**G**lobally

[†] C areas are identified by line number; disassembly areas are identified by address.

Restrictions on profiling areas

The following restrictions apply to profiling areas:

- There must be a minimum of three instructions between a delayed branch and the beginning of an area.
- An area cannot begin or end on the RPTS instruction or on the instruction to be repeated.
- An area cannot begin or end on the last instruction of a repeat block.

11.4 Defining a Stopping Point

Before you run a profiling session, you must identify the point where the debugger should stop collecting statistics. By default, C programs contain an *exit* label, and this is defined as the default stopping point when you load your program. (You can delete exit as a stopping point, if you wish.) If your program does not contain an exit label, or if you prefer to stop at a different point, you can define another stopping point. You can set multiple stopping points; the debugger will stop at the first one it finds.

Each stopping point is highlighted in the FILE or DISASSEMBLY window with a ***** character at the beginning of the line. Even though no statistics can be gathered for areas following a stopping point, the areas will be listed in the PROFILE window.

You can use the mouse or commands to add or delete a stopping point; you can also use commands to list or reset all the stopping points.

Note:

You cannot set a stopping point on a statement that has already been defined as a part of a profile area.

To set a stopping point:

1) Point to the statement that you want to add as a stopping point.

2) Click the right mouse button.

To remove a stopping point:

1) Point to the statement marking the stopping point that you want to delete.

2) Click the right mouse button.

The debugger supports several commands for adding, deleting, resetting, and listing stopping points (described below); all of these commands can also be entered from the Stop-points menu.

sa To add a stopping point, use the SA (stop add) command. The syntax for this command is:

sa *address*

This adds *address* as a stopping point. The *address* parameter can be a label, a function name, or a memory address.

sd To delete a stopping point, use the SD (stop delete) command. The syntax for this command is:

sd *address*

This deletes *address* as a stopping point. As for SA, the *address* can be a label, a function name, or a memory address.

sr To delete all the stopping points at once, use the SR (stop reset) command. The syntax for this command is:

sr

This deletes all stopping points, including the default *exit* (if it exists).

sl To see a list of all the stopping points that are currently set, use the SL (stop list) command. The syntax for this command is:

sl

11.5 Running a Profiling Session

Once you have defined profile areas and a stopping point, you can run a profiling session. You can run two types of profiling sessions:

- A **full profile** collects a full set of statistics for the defined profile areas.
- A **quick profile** collects a subset of the available statistics (it doesn't collect exclusive or exclusive max data, which are described in Section 11.6). This reduces overhead because the debugger doesn't have to track entering/exiting subroutines within an area.

The debugger supports commands for running both types of sessions. In addition, the debugger supports a command that helps you to resume a profiling session. All of these commands can also be entered from the Profile menu.

pf To run a full profiling session, use the PF (profile full) command. The syntax for this command is:

pf *starting point* [*, update rate*]

pq To run a quick profiling session, use the PQ (profile quick) command. The syntax for this command is:

pq *starting point* [*, update rate*]

The debugger will collect statistics on the defined areas between the *starting point* and the stopping point. The *starting point* parameter can be a label, a function name, or a memory address. There is no default starting point.

The *update rate* is an optional parameter that determines how often the statistics listed in the PROFILE window will be updated. The *update rate* parameter can have one of these values:

0 An *update rate* of 0 means that the statistics listed in the PROFILE window are not updated until the profiling session is halted. A "spinning wheel" character will be shown at the beginning of the PROFILE window label line to indicate that a profiling session is in progress. 0 is the default value.

≥**1** If a number greater than or equal to 1 is supplied, the statistics in the PROFILE window are updated during the profiling session. If a value of **1** is supplied, the data will be updated as often as possible. When larger numbers are supplied, the data is updated less often.

<**0** If a negative number is supplied, the statistics listed in the PROFILE window are not updated until the profiling session is halted. The "spinning wheel" character is not displayed.

No matter which *update rate* you choose, you can force the PROFILE window to be updated during a profiling session by pointing to the window header and clicking a mouse button.

After you enter a PF or PQ command, your program is restarted and run up to the defined starting point. Profiling begins when the starting point is reached and continues until a stopping point is reached or until you halt the profiling session by pressing ESC.

pr Use the PR command to resume a profiling session that has halted. The syntax for this command is:

pr [*clear data* [, *update rate*]]

The optional *clear data* parameter tells the debugger whether or not it should clear out the previously collected data. The *clear data* parameter can have one of these values:

0 The profiler will continue to collect data, adding it to the existing data for the profiled areas and use the previous internal profile stacks. 0 is the default value.

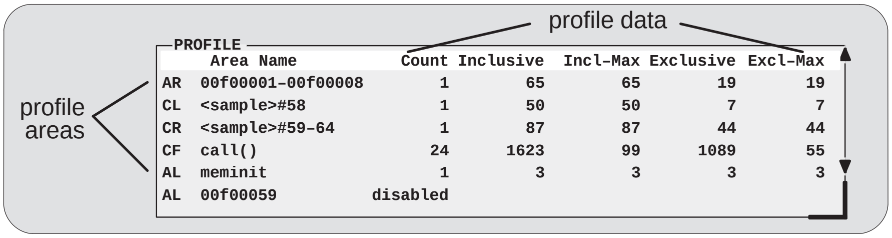
nonzero All previously collected profile data and internal profile stacks are cleared.

The *update rate* parameter is the same as for the PF and PQ commands.

11.6 Viewing Profile Data

The statistics collected during a profiling session are displayed in the PROFILE window. Figure 11–1 shows an example of this window.

Figure 11–1. An Example of the PROFILE Window



```
PROFILE
     Area Name            Count Inclusive  Incl–Max Exclusive  Excl–Max
AR  00f00001–00f00008        1        65        65        19        19
CL  <sample>#58              1        50        50         7         7
CR  <sample>#59–64           1        87        87        44        44
CF  call()                  24      1623        99      1089        55
AL  meminit                  1         3         3         3         3
AL  00f00059          disabled
```

The example in Figure 11–1 shows the PROFILE window with some default conditions:

- Column headings show the labels for the default set of profile data, including *Count, Inclusive, Incl-Max, Exclusive*, and *Excl-Max*.
- The data is sorted on the address of the first line in each area.
- All marked areas are listed, including disabled areas.

You can modify the PROFILE window to display selected profile areas or different data; you can also sort the data differently. The following subsections explain how to do these things.

Note:

To reset the PROFILE display back to its default characteristics, use View→Reset.

Viewing different profile data

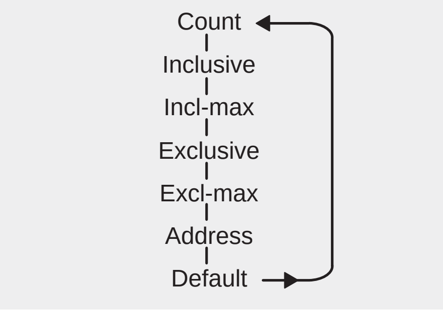
By default, the PROFILE window shows a set of statistics labelled as Count, Inclusive, Incl-Max, Exclusive, and Excl-Max. Another field that is not included as part of the default statics, Address, can also be displayed. Table 11–6 describes the statistic that each field represents.

Table 11–6. Types of Data Shown in the PROFILE Window

Label	Profile data
Count	The number of times a profile area is entered during a session.
Inclusive	The total execution time (cycle count) of a profile area, including the execution time of any subroutines called from within the profile area.
Incl-Max (inclusive maximum)	The maximum inclusive time for one iteration of a profile area. If the profiled code contains no flow control (such as conditional processing), inclusive-maximum will equal the inclusive timing divided by the count.
Exclusive	The total execution time (cycle count) of a profile area, excluding the execution time of any subroutines called from within the profile area. In general, the exclusive data provides the best statistics for comparing the execution time of one profile area to another area.
Excl-Max (exclusive maximum)	The maximum exclusive time for one iteration of a profile area.
Address	The memory address of the line. If the area is a function or range, the Address field shows the memory address of the first line in the area.

In addition to viewing this data in the default manner, you can view each of these statistics individually. The benefit of viewing them individually is that in addition to a cycle count, you are also supplied with a percentage indication and a histogram.

In order to view the fields individually, you can use the mouse—just point to the header line in the PROFILE window and click a mouse button. You can also use the View→Data menu to select the field you'd like to display. When you use the left mouse button to click on the header, fields are displayed individually in the order listed below on the left. (Use the right mouse button to go in the opposite direction.) On the right are the corresponding menu selections.



View→**D**ata →**C**ount
→**I**nclusive
→I**n**clusive Max
→**E**xclusive
→E**x**clusive Max
→**A**ddress
→A**l**l

One advantage of using the mouse is that you can change the display while you're profiling.

Data accuracy

During a profiling session, the debugger sets many internal breakpoints and issues a series of RUNB commands. As a result, the processor is momentarily halted when entering and exiting profiling areas. This stopping and starting can affect the cycle count information (due to pipeline flushing and the mechanics of software breakpoints) so that it varies from session to session. This method of profiling is referred to as *intrusive profiling*.

Treat the data as *relative*, not absolute. The percentages and histograms are relevant only to the cycle count from the starting point to the stopping point—not to overall performance. Even though the cycle counts may change if you profiled the same area twice, the relationship of that areas to other profiled areas should not change.

Sorting profile data

By default, the data displayed in the PROFILE window is sorted on the memory addresses of the displayed areas. The area with the least significant address is listed first, followed by the area with the most significant address, etc. When you view fields individually, the data is automatically sorted from highest cycle count to lowest (instead of by address).

You can sort the data on any of the data fields by using the View→Sort menu. For example, to sort all the data based on the values of the Inclusive field, use View→Sort→Inclusive; the areas will be redisplayed with the area with the highest Count field displayed first and the area with the lowest area displayed last. This applies even when you are viewing individual fields.

Viewing different profile areas

By default, all marked areas are listed in the PROFILE window. You can modify the window to display selected areas. To do this, use the selections on the View→Filter pulldown menu; these selections are summarized in Table 11–7.

Table 11–7. Menu Selections for Displaying Areas in the PROFILE Window

To view these areas	**C only:** **V**iew→**F**ilter→**C** level	**Disassembly only:** **V**iew→**F**ilter→**A**sm level	**C *and* disassembly:** **V**iew→**F**ilter→**B**oth levels
Lines	→**L**ine areas	→**L**ine areas	→**L**ine areas
❑ By line number	→**E**xplicitly	→**E**xplicitly	not applicable
❑ All lines in a function	→in one **F**unction	→in one **F**unction	→in one **F**unction
❑ All lines in a module	→in one **M**odule	→in one **M**odule	→in one **M**odule
❑ All lines everywhere	→**G**lobally	→**G**lobally	→**G**lobally
Ranges	→**R**ange areas	→**R**ange areas	→**R**ange areas
❑ By line numbers	→**E**xplicitly	→**E**xplicitly	not applicable
❑ All ranges in a function	→in one **F**unction	→in one **F**unction	→in one **F**unction
❑ All ranges in a module	→in one **M**odule	→in one **M**odule	→in one **M**odule
❑ All ranges everywhere	→**G**lobally	→**G**lobally	→**G**lobally
Functions	→**F**unction areas	not applicable	→**F**unction areas
❑ By function name	→**E**xplicitly		not applicable
❑ All functions in a module	→in one **M**odule		→in one **M**odule
❑ All functions everywhere	→**G**lobally		→**G**lobally
All areas	→**R**ange areas	→**R**ange areas	→**R**ange areas
❑ All areas in a function	→in one **F**unction	→in one **F**unction	→in one **F**unction
❑ All areas in a module	→in one **M**odule	→in one **M**odule	→in one **M**odule
❑ All areas everywhere	→**G**lobally	→**G**lobally	→**G**lobally

Interpreting session data

General information about a profiling session is displayed in the COMMAND window display area during and after the session. This information identifies the starting and stopping points. It also lists statistics for three important areas:

- **Run cycles** shows the number of execution cycles consumed by the program from the starting point to the stopping point.
- **Profile cycles** equals the run cycles minus the cycles consumed by disabled areas.

- **Hits** show the number of internal breakpoints encountered during the profiling session.

Viewing code associated with a profile area

You can view the code associated with a displayed profile area. The debugger will update the display so that the associated C or disassembly statements are shown in the FILE or DISASSEMBLY windows.

Use the mouse to select the profile area in the PROFILE window and display the associated code:

↖ 1) Point to the appropriate area name in the PROFILE window.

2) Click the right mouse button.

The area name and the associated C or disassembly statement will be highlighted. To view the code associated with another area, point-and-click again.

If you are attempting to show disassembly, you may have to make several attempts because program memory can only be accessed when the target is not running.

11.7 Saving Profile Data to a File

You may want to run several profiling sessions during a debugging session. Whenever you start a new profiling session,the results of the previous session are lost. However, you can save the results of the current profiling session to a system file. There are two ways that you can do this:

vac To save the contents of the PROFILE window to a system file, use the VAC (view save current) command. The syntax for this command is:

vac *filename*

This saves only the current view; if, for example, you are viewing only the Count field, then only that information will be saved.

vaa To save all data for the currently displayed areas, use the VAA (view save all) command. The syntax for this command is:

vaa *filename*

This saves all views of the data—including the individual count, inclusive, etc.—with the percentage indications and histograms.

Both commands write profile data to *filename*. The filename can include path information. There is no default filename. If *filename* already exists, the command will overwrite the file with the new data.

Note that if the PROFILE window displays only a subset of the areas that are marked for profiling, data is saved *only for those areas that are displayed*. (For VAC, the currently displayed data will be saved for the displayed areas. For VAA, all data will be saved for the displayed areas.) If some areas are hidden and you want to save all the data, be sure to select View→Reset before saving the data to a file.

The file contents are in ASCII and are formatted in exactly the same manner as they are displayed (or would be displayed) in the PROFILE window. The general profiling-session information that is displayed in the COMMAND window is also written to the file.

Chapter 12

Summary of Commands and Special Keys

This chapter summarizes the debugger's commands and special key sequences.

12.1 Functional Summary of Debugger Commands

This section summarizes the debugger commands according to these categories:

❑ **Changing modes.** These commands enable you to switch freely among the three debugging modes (auto, mixed, and assembly). You can also select these commands from the Mode pulldown menu.

❑ **Performing system tasks.** These commands enable you to perform several DOS-like functions and provide you with some control over the target system.

❑ **Managing windows.** These commands enable you to select the active window and move or resize the active window. You can also perform these functions with the mouse.

❑ **Displaying and changing data.** These commands enable you to display and evaluate a variety of data items. Some of these commands are also available on the Watch pulldown menu.

❑ **Displaying files and loading programs.** These commands enable you to change the displays in the FILE and DISASSEMBLY windows and to load object files into memory. Several of these commands are available on the Load pulldown menu.

❑ **Managing breakpoints.** These commands provide you with a command-line method for controlling software breakpoints. These commands are available through the Break pulldown menu. You can also set/clear breakpoints interactively.

❑ **Customizing the screen.** These commands allow you to customize the debugger display, then save and later reuse the customized displays. These commands are also available from the Color pulldown menu.

❑ **Memory mapping.** These commands enable you to define the areas of target memory that the debugger can access. These commands are also available on the Memory pulldown menu.

❑ **Running programs.** These commands provide you with a variety of methods for running your programs in the debugger environment. The basic run and single-step commands are available on the menu bar.

❑ **Profiling commands.** These commands enable you to collect execution statistics for your code. Commands can be entered from the pulldown menus or on the command line.

Changing modes

To do this	Use this command	See page
Put the debugger in assembly mode	asm	12-12
Put the debugger in auto mode for debugging C code	c	12-14
Put the debugger in mixed mode	mix	12-28

Performing system tasks

To do this	Use this command	See page
Associate a beeping sound with the display of error messages	sound	12-40
Change the current working directory from within the debugger environment	cd/chdir	12-15
Clear all displayed information from the COMMAND window display area	cls	12-15
Conditionally execute debugger commands in a batch file	if/else/endif	12-23
Define your own command string	alias	12-11
Delete an alias definition	unalias	12-43
Delete *all* defined aliases	unalias *	12-43
Display a string to the COMMAND window while executing a batch file	echo	12-21
Enter any operating-system command or exit to a system shell	system	12-42
Execute commands from a batch file	take	12-43
Exit the debugger	quit	12-33
List the contents of the current directory or any other directory	dir	12-18
Loop debugger commands in a batch file	loop/endloop	12-24
Name additional directories that can be searched when you load source files	use	12-44
Record the information shown in the COMMAND window display area	dlog	12-20
Reset the target system	reset	12-33

Managing windows

To do this	Use this command	See page
Make the active window as large as possible	zoom	12-47
Reposition the active window	move	12-29
Resize the active window	size	12-39
Select the active window	win	12-46

Displaying and changing data

To do this	Use this command	See page
Change the default format for displaying data values	setf	12-38
Continuously display the value of a variable, register, or memory location within the WATCH window	wa	12-45
Delete a data item from the WATCH window	wd	12-46
Delete all data items from the WATCH window and close the WATCH window	wr	12-47
Display a different range of memory in the MEMORY window	mem	12-27
Display a pop-up MEMORY window	mem1,mem2, mem3	12-27
Display the values in an array or structure or display the value that a pointer is pointing to	disp	12-19
Evaluate a C expression without displaying the results	eval	12-21
Evaluate and display the result of a C expression	?	12-10
Show the type of a data item	whatis	12-46

Displaying files and loading programs

To do this	Use this command	See page
Display a specific C function	func	12-22
Display a text file in the FILE window	file	12-21
Display assembly language code at a specific address	dasm	12-18
Display C and/or assembly language code at a specific point	addr	12-11
Load an object file	load	12-24
Load only the object-code portion of an object file	reload	12-33
Load only the symbol-table portion of an object file	sload	12-40
Modify disassembly with the patch assembler	patch	12-31
Reopen the CALLS window	calls	12-14

Managing breakpoints

To do this	Use this command	See page
Add a breakpoint	ba	12-12
Delete a breakpoint	bd	12-12
Display a list of all the breakpoints that are set	bl	12-13
Reset (delete) all breakpoints	br	12-14

Customizing the screen

To do this	Use this command	See page
Change the border style of any window	border	12-13
Change the command-line prompt	prompt	12-32
Change the screen colors and update the screen immediately	scolor	12-36
Change the screen colors, but don’t update the screen immediately	color	12-16
Load and use a previously saved custom screen configuration	sconfig	12-37
Save a custom screen configuration	ssave	12-41

Memory mapping

To do this	Use this command	See page
Add an address range to the memory map	ma	12-25
Connect a simulated I/O port to an input or output file (simulator only)	mc	12-26
Delete an address range from the memory map	md	12-26
Disconnect a simulated I/O port (simulator only)	mi	12-27
Display a list of the current memory map settings	ml	12-28
Enable or disable memory mapping	map	12-25
Initialize a block of memory	fill	12-22
Reset (delete all ranges) the memory map	mr	12-30
Save a block of memory to a system file	ms	12-30

Running programs

To do this	Use this command	See page
Execute code in a function and return to the function’s caller	return	12-34
Execute commands from a batch file	take	12-43
Reset the program entry point	restart	12-34
Reset the target system	reset	12-33
Run a program	run	12-34
Run a program up to a certain point	go	12-22
Run a program with benchmarking (count the number of CPU clock cycles consumed by the executing portion of code)	runb	12-35
Single-step through assembly language or C code	step	12-41
Single-step through assembly language or C code, one C statement at a time	cstep	12-17
Single-step through assembly language or C code one C statement at a time; step over function calls	cnext	12-16
Single-step through assembly language or C code; step over function calls	next	12-30

Profiling commands

All of the profiling commands can be entered from the pulldown menus. In many cases, using the pulldown menus is the easiest way to use some of these commands. For this reason and also because there are over 100 profiling commands, most of these commands are not described individually in this chapter (as the basic debugger commands are).

Listed below are some of the profiling commands that you might choose to enter from the command line instead of from a menu; these commands are also described in the alphabetical command summary. The remaining profiling commands are summarized in Section 12.4 on page 12-48.

To do this	Use this command	See page
Add a stopping point	sa	12-35
Delete a stopping point	sd	12-37
Delete all the stopping points	sr	12-40
List all the stopping points	sl	12-39
Reset the display in the PROFILE window to show all areas and the default set of data	vr	12-45
Resume a profiling session	pr	12-32
Run a full profiling session	pf	12-31
Run a quick profiling session	pq	12-32
Save all the profile data to a file	vaa	12-44
Save currently displayed profile data to a file	vac	12-44

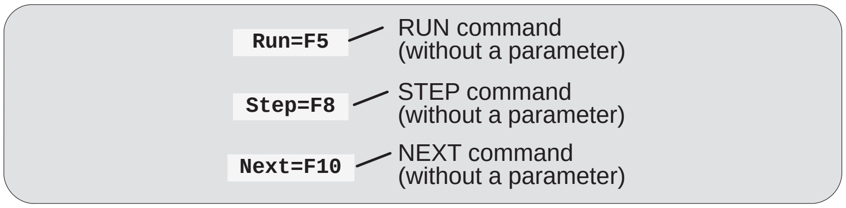
12.2 How Menu Selections Correspond to Commands

The following sample screens illustrate the relationship of the basic debugger commands to the menu bar and pulldown menus.

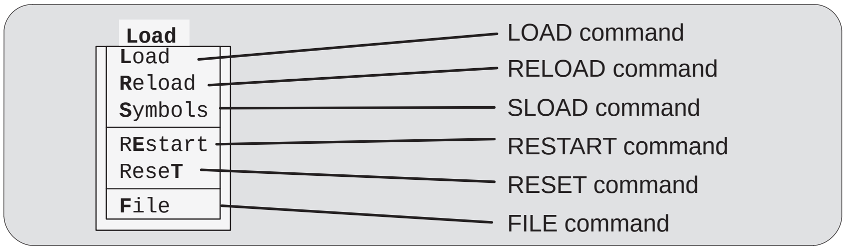
Note:

Because the profiling environment supports over 100 profile-specific commands, it's not practical to show the commands associated with the profile menu choices.

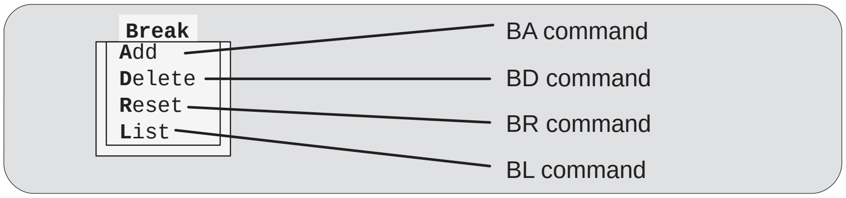
Program execution commands


Run=F5
RUN command (without a parameter)
Step=F8
STEP command (without a parameter)
Next=F10
NEXT command (without a parameter)

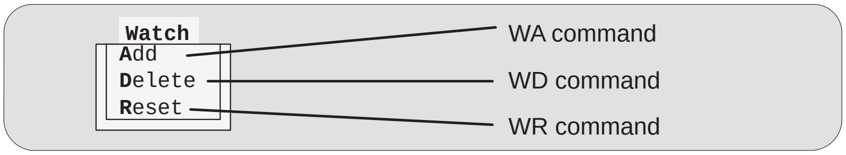
File/load commands



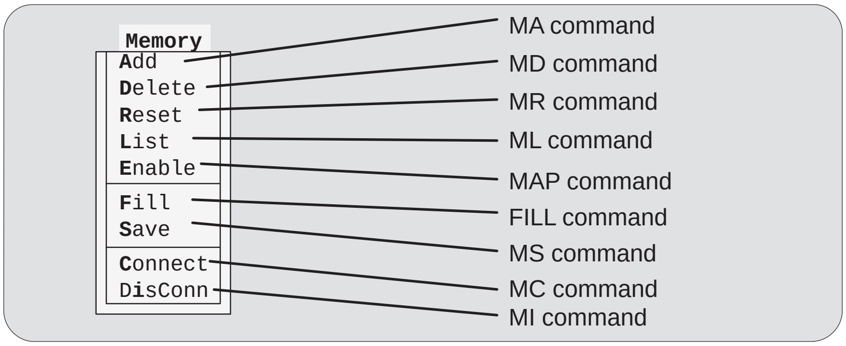
Breakpoint commands



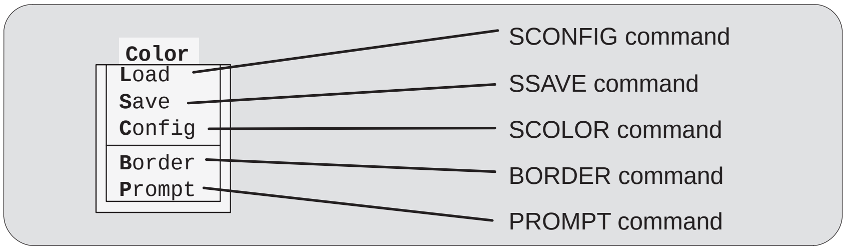
Watch commands



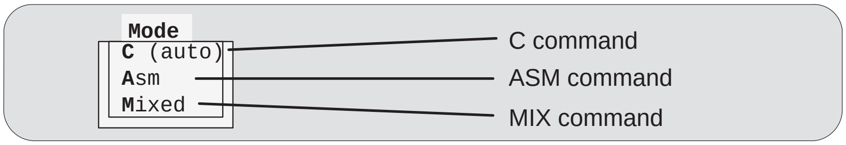
Memory commands



Screen-configuration commands

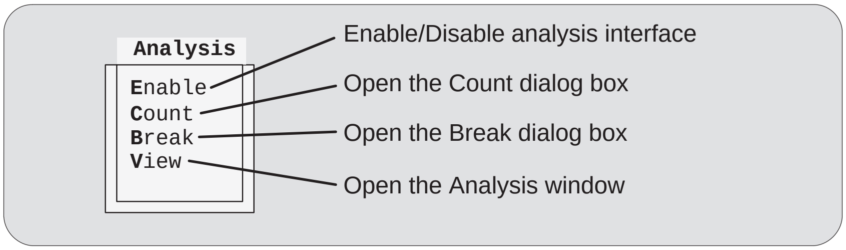


Mode commands



The Analysis menu

The Analysis pulldown menu does *not* correspond to specific debugger commands. Instead, the selections on this menu enable and disable the interface, as well as open dialog boxes that control the interface. Here are the functions of the Analysis menu selections.


Analysis
Enable
Count
Break
View
Enable/Disable analysis interface
Open the Count dialog box
Open the Break dialog box
Open the Analysis window

12.3 Alphabetical Summary of Debugger Commands

There are two debugger environments: the basic debugger environment and the profiling environment. Some debugger commands can be used in both environments; some can be used in only one of the environments. Each command description identifies the applicable environments for the command.

Commands are not case sensitive; to emphasize this, command names are shown in both uppercase and lowercase throughout this book.

? *Evaluate Expression*

Syntax **?** *expression* [*, display format*]

Menu selection none

Environments ☑ basic debugger □ profiling

Description The ? (evaluate expression) command evaluates an expression and shows the result in the COMMAND window display area. The *expression* can be any C expression, including an expression with side effects. However, you cannot use a string constant or function call in the *expression.* If the result of *expression* is not an array or structure, then the debugger displays the results in the COMMAND window. If *expression* is a structure or array, ? displays the entire contents of the structure or array; you can halt long listings by pressing SC .

When you use the optional *display format* parameter, data will be displayed in one of the following formats:

Parameter	Result	Parameter	Result
*****	Default for the data type	**x**	Hexadecimal
c	ASCII character (bytes)	**o**	Octal
d	Decimal	**p**	Valid address
e	Exponential floating point	**s**	ASCII string
f	Decimal floating point	**u**	Unsigned decimal

addr

Display Code at Specified Address

Syntax

addr *address*
addr *function name*

Menu selection none

Environments ☑ basic debugger □ profiling

Description

Use the ADDR command to display C code or the disassembly at a specific point.

- In assembly mode, ADDR works like the DASM command, positioning the code starting at *address* or at *function name* as the first line of code in the DISASSEMBLY window.
- In a C display, ADDR works like the FUNC command, displaying the code starting at *address* or at *function name* in the FILE window.
- In mixed mode, ADDR affects both the DISASSEMBLY and FILE windows.

Note:

ADDR affects the FILE window only if the specified *address* is in a C function.

alias

Define Custom Command String

Syntax

alias [*alias name* [, ”*command string*”]]

Menu selection none

Environments ☑ basic debugger ☑ profiling

Description

The ALIAS command allows you to associate one or more debugger commands with a single *alias name*. You can include as many debugger commands in the *command string* as you like, as long you separate them with semicolons and enclose the entire string of commands in quotation marks. You can also identify debugger-command parameters by a percent sign followed by a number (%1, %2, etc.). The total number of characters for an individual command (expanded to include parameter values) is limited to 132.

Previously defined alias names can be included as part of the definition for a new alias.

To find the current definition of an alias, enter the ALIAS command with the *alias name* only. To see a list of all defined aliases, enter the ALIAS command with no parameters.

asm *Enter Assembly Mode*

Syntax **asm**

Menu selection Mo**D**e→**A**sm

Environments ☑ basic debugger □ profiling

Description The ASM command changes the current debugging mode to assembly mode. If you're already in assembly mode, the ASM command has no effect.

ba *Add Software Breakpoint*

Syntax **ba** *address*

Menu selection **B**reak→**A**dd

Environments ☑ basic debugger □ profiling

Description The BA command sets a software breakpoint at a specific *address*. This command is useful because it doesn't require you to search through code to find the desired line. The *address* can be an absolute address, any C expression, the name of a C function, or the name of an assembly language label.

bd *Delete Software Breakpoint*

Syntax **bd** *address*

Menu selection **B**reak→ **D**elete

Environments ☑ basic debugger □ profiling

Description The BD command clears a software breakpoint at a specific *address*. The *address* can be an absolute address, any C expression, the name of a C function, or the name of an assembly language label.

bl

List Software Breakpoints

Syntax **bl**

Menu selection **B**reak→**L**ist

Environments ☑ basic debugger ☐ profiling

Description The BL command provides an easy way to get a complete listing of all the software breakpoints that are currently set in your program. It displays a table of breakpoints in the COMMAND window display area. BL lists all the breakpoints that are set, in the order in which you set them.

border

Change Style of Window Border

Syntax **border** [*active window style*] [, [*inactive window style*] [*,resize window style*]]

Menu selection **C**olor→**B**order

Environments ☑ basic debugger ☐ profiling

Description The BORDER command changes the border style of the active window, the inactive windows, and any window that you're resizing. The debugger supports nine border styles. Each parameter for the BORDER command must be one of the numbers that identifies these styles:

Index	Style
0	Double-lined box
1	Single-lined box
2	Solid 1/2-tone top, double-lined sides/bottom
3	Solid 1/4-tone top, double-lined sides/bottom
4	Solid box, thin border
5	Solid box, heavy sides, thin top/bottom
6	Solid box, heavy borders
7	Solid 1/2-tone box
8	Solid 1/4-tone box

Note that you can execute the BORDER command as the Border selection on the Color pulldown menu. The debugger displays a dialog box so that you can enter the parameter values; in the dialog box, *active window style* is called *foreground*, and *inactive window style* is called *background*.

br — *Reset Software Breakpoint*

Syntax **br**

Menu selection **B**reak→**R**eset

Environments ☑ basic debugger □ profiling

Description The BR command clears all software breakpoints that are set.

c — *Enter Auto Mode*

Syntax **c**

Menu selection Mo**D**e→**C** (auto)

Environments ☑ basic debugger □ profiling

Description The C command changes from the current debugging mode to auto mode. If you're already in auto mode, then the C command has no effect.

calls — *Open CALLS Window*

Syntax **calls**

Menu selection none

Environments ☑ basic debugger □ profiling

Description The CALLS command displays the CALLS window. The debugger displays this window automatically when you are in auto/C or mixed mode. However, you can close the CALLS window; the CALLS command opens the window up again.

cd, chdir — *Change Directory*

Syntax **cd** **[***directory name*]
chdir **[***directory name*]

Menu selection none

Environments ☑ basic debugger ☑ profiling

Description The CD or CHDIR command changes the current working directory from within the debugger. You can use relative pathnames as part of the *directory name*. If you don’t use a *pathname,* the CD command displays the name of the current directory. When it is implemented with the USE command, CD can affect any other command whose parameter is a filename, such as the FILE, LOAD, and TAKE commands. You can also use the CD command to change the current drive. For example,

```
cd c:
cd d:\csource
cd c:\c40hll
```

cls — *Clear Screen*

Syntax **cls**

Menu selection none

Environments ☑ basic debugger ☑ profiling

Description The CLS command clears all displayed information from the COMMAND window display area.

cnext

Single-Step C, Next Statement

Syntax **cnext** [*expression*]

Menu selection Next=**F10** (in C code)

Environments ☑ basic debugger □ profiling

Description The CNEXT command is similar to the CSTEP command. It runs a program one C statement at a time, updating the display after executing each statement. If you're using CNEXT to step through assembly language code, the debugger won't update the display until it has executed all assembly language statements associated with a single C statement. Unlike CSTEP, CNEXT steps over function calls rather than stepping into them—you don't see the single-step execution of the function call.

The *expression* parameter specifies the number of statements that you want to single-step. You can also use a conditional *expression* for conditional single-step execution (the *Running code conditionally* discussion, page 6-16, discusses this in detail).

color

Change Screen Colors

Syntax **color** *area name, attribute*$_1$ [*,attribute*$_2$ [*,attribute*$_3$ [*,attribute*$_4$]]]

Menu selection none

Environments ☑ basic debugger □ profiling

Description The COLOR command changes the color of specified areas of the debugger display. COLOR doesn't update the display; the changes take effect when another command, such as SCOLOR, updates the display. The *area name* parameter identifies the area of the display that is affected. The *attributes* identify how the area is affected. The first two *attribute* parameters usually specify the foreground and background colors for the area. If you do not supply a background color, the debugger uses black as the background.

Valid values for the *attribute* parameters include:

black	blue	green	cyan
red	magenta	yellow	white
bright		blink	

Valid values for the *area name* parameters include:

menu_bar	menu_border	menu_entry	menu_cmd
menu_hilite	menu_hicmd	win_border	win_hiborder
win_resize	field_text	field_hilite	field_edit
field_label	field_error	cmd_prompt	cmd_input
cmd_cursor	cmd_echo	asm_data	asm_cdata
asm_label	asm_clabel	background	blanks
error_msg	file_line	file_eof	file_text
file_brk	file_pc	file_pc_brk	

You don't have to type an entire *attribute* or *area name*; you need type only enough letters to uniquely identify the attribute. If you supply ambiguous *attribute* names, the debugger interprets the names in this order: black, blue, bright, blink. If you supply ambiguous *area names*, the debugger interprets them in the order that they're listed above (left to right, top to bottom).

cstep — *Single-Step C*

Syntax **cstep** [*expression*]

Menu selection Step=**F8** (in C code)

Environments ☑ basic debugger □ profiling

Description The CSTEP single-steps through a program one C statement at a time, updating the display after executing each statement. If you're using CSTEP to step through assembly language code, the debugger won't update the display until it has executed all assembly language statements associated with a single C statement.

If you're single-stepping through C code and encounter a function call, the STEP command shows you the single-step execution of the called function (assuming that the function was compiled with the compiler's –g debug option). When function execution completes, single-step execution returns to the caller. If the function wasn't compiled with the debug option, the debugger executes the function but doesn't show single-step execution of the function.

The *expression* parameter specifies the number of statements that you want to single-step. You can also use a conditional *expression* for conditional single-step execution (the *Running code conditionally* discussion, page 6-16, discusses this in detail).

dasm — *Display Disassembly at Specified Address*

Syntax

dasm *address*
dasm *function name*

Menu selection none

Environments ☑ basic debugger ☑ profiling

Description

The DASM command displays code beginning at a specific point within the DISASSEMBLY window.

dir — *List Directory Contents*

Syntax

dir [*directory name*]

Menu selection none

Environments ☑ basic debugger ☑ profiling

Description

The DIR command displays a directory listing in the display area of the COMMAND window. If you use the optional *directory name* parameter, the debugger displays a list of the specified directory's contents. If you don't use the parameter, the debugger lists the contents of the current directory.

disp — *Open DISP Window*

Syntax **disp** *expression* [*, display format*]

Menu selection none

Environments ☑ basic debugger ☐ profiling

Description The DISP command opens a DISP window to display the contents of an array, structure, or pointer expression to a scalar type (of the form **pointer*). If the *expression* is not one of these types, then DISP acts like a ? command. You can have up to 120 DISP windows open at the same time.

Once you open a DISP window, you may find that a displayed member is itself an array, structure, or pointer:

A member that is an array looks like this	[. . .]
A member that is a structure looks like this	{. . .}
A member that is a pointer looks like an address	0x00000000

You can display the additional data (the data pointed to or the members of the array or structure) in another DISP window by using the DISP command again, using the arrow keys to select the field and then pressing F9 , or pointing the mouse cursor to the field and pressing the left mouse button.

When you use the optional *display format* parameter, data will be displayed in one of the following formats:

Parameter	Result	Parameter	Result
*	Default for the data type	x	Hexadecimal
c	ASCII character (bytes)	o	Octal
d	Decimal	p	Valid address
e	Exponential floating point	s	ASCII string
f	Decimal floating point	u	Unsigned decimal

The *display format* parameter can be used only when you are displaying a scalar type, an array of scalar type, or an individual member of an aggregate type.

You can also use the DISP command with a typecast expression to display memory contents in any format. Here are some examples:

```
disp *0
disp *(float *)123
disp *(char *)0x111
```

This shows memory in the DISP window as an array of locations; the location that you specify with the *expression* parameter is member [0], and all other locations are offset from that location.

dlog

Record COMMAND Window Display

Syntax

dlog *filename* [,{**a** | **w**}]
or
dlog close

Menu selection

none

Environments

☑ basic debugger ☑ profiling

Description

The DLOG command allows you to record the information displayed in the command window into a log file.

- To begin recording the information shown in the COMMAND window display area, use:

  dlog *filename*

  Log files can be executed by using the TAKE command. When you use DLOG to record the information from the COMMAND window display area into a log file called *filename*, the debugger automatically precedes all error or progress messages and command results with a semicolon to turn them into comments. This way, you can easily re-execute the commands in your log file by using the TAKE command.

- To end the recording session, enter:

  dlog close ↵

If necessary, you can write over existing log files or append additional information to existing files. The optional parameters of the DLOG command control how existing log files are used:

- **Appending to an existing file.** Use the **a** parameter to open an existing file to which to append the information in the display area.

- **Writing over an existing file.** Use the **w** parameter to open an existing file to write over the current contents of the file. Note that this is the default action if you specify an existing filename without using either the **a** or **w** options; you will lose the contents of an existing file if you don't use the append (a) option.

echo — *Echo String to Command Window*

Syntax **echo** *string*

Menu selection none

Environments ☑ basic debugger ☑ profiling

Description The ECHO command displays *string* in the display area of the COMMAND window. This command works only in a batch file, and you can't use quote marks around the *string*. Note that any leading blanks in your command string are removed when the ECHO command is executed.

eval — *Evaluate Expression*

Syntax

eval *expression*
e *expression*

Menu selection none

Environments ☑ basic debugger ☑ profiling

Description The EVAL command evaluates an expression the same way the ? command does *but does not show the result* in the display area of the COMMAND window. EVAL is useful for assigning values to registers or memory locations in a batch file (where it's not necessary to display the result).

file — *Display Text File*

Syntax **file** *filename*

Menu selection **L**oad→**F**ile

Environments ☑ basic debugger ☑ profiling

Description The FILE command displays the contents of any text file in the FILE window. The debugger continues to display this file until you run a program and halt in a C function. This command is intended primarily for displaying C source code. You can view only one text file at a time.

You are restricted to displaying files that are 65,518 bytes long or less.

fill

Fill Memory

Syntax **fill** *address, length, data*

Menu selection **M**emory→**F**ill

Environments ☑ basic debugger □ profiling

Description The FILL command fills a block of memory with a specified value. This command has three parameters:

- The *address* parameter identifies the beginning of the block.
- The *length* parameter defines the number of 32-bit words that will be filled.
- The *data* is the value that the memory block will be filled with.

func

Display Function

Syntax

func *function name*
func *address*

Menu selection none

Environments ☑ basic debugger ☑ profiling

Description The FUNC command displays a specified C function in the FILE window. You can identify the function by its name or its address. Note that FUNC works the same way FILE works, but with FUNC you don't need to identify the name of the file that contains the function.

go

Run to Specified Address

Syntax **go** [*address*]

Menu selection none

Environments ☑ basic debugger □ profiling

Description The GO command executes code up to a specific point in your program. If you don't supply an *address* parameter, then GO acts like a RUN command without an *expression* parameter.

if/else/endif — *Conditionally Execute Debugger Commands*

Syntax

if *Boolean expression*
debugger command
debugger command
.
.
[**else**
debugger command
debugger command
.
.]
endif

Menu selection none

Environments ☑ basic debugger ☑ profiling

Description

These commands allow you to conditionally execute debugger commands in a batch file. If the Boolean expression evaluates to true (1), the debugger executes the commands between the IF and the ELSE or ENDIF. Note that the ELSE portion of the command is optional.

The IF, ELSE, and ENDIF conditional commands work with the following provisions:

- ❑ You can use IF, ELSE, and ENDIF commands only in a batch file.
- ❑ You must enter each debugger command on a separate line in the batch file.
- ❑ You can't nest IF, ELSE, and ENDIF commands within the same batch file.

load — *Load Executable Object File*

Syntax **load** *object filename*

Menu selection **L**oad→ **L**oad

Environments ☑ basic debugger ☑ profiling

Description The LOAD command loads both an object file and its associated symbol table into memory. In effect, the LOAD command performs both a RELOAD and an SLOAD. Note that the LOAD command clears the old symbol table and closes the WATCH and DISP windows. If you don't supply an extension, the debugger looks for *filename*.out.

loop/endloop — *Loop Through Debugger Commands*

Syntax

loop *expression*
debugger command
debugger command
.
.
endloop

Menu selection none

Environments ☑ basic debugger ☑ profiling

Description The LOOP/ENDLOOP commands allow you to set up a looping situation in a batch file. These looping commands evaluate in the same method as in the run conditional command expression:

- If you use an *expression* that is not Boolean, the debugger evaluates the expression as a loop count.
- If you use a Boolean *expression*, the debugger executes the command repeatedly as long as the expression is true.

The LOOP/ENDLOOP commands work under the following conditions:

- You can use LOOP/ENDLOOP commands only in a batch file.
- You must enter each debugger command on a separate line in the batch file.
- You can't nest LOOP/ENDLOOP commands within the same batch file.

ma — *Add Block to Memory Map*

Syntax **ma** *address, length, type*

Menu selection **M**emory→**A**dd

Environments ☑ basic debugger ☑ profiling

Description The MA command identifies valid ranges of target memory.

- The *address* parameter defines the starting address of a range. This parameter can be an absolute address, any C expression, the name of a C function, or an assembly language label.
- The *length* parameter defines the length of the range. This parameter can be any C expression.
- The *type* parameter identifies the read/write characteristics of the memory range. The *type* must be one of these keywords:

To identify this kind of memory	Use this keyword as the *type* parameter
read-only memory	**R**, **ROM**, or **READONLY**
write-only memory	**W***,* **WOM***,* or **WRITEONLY**
read/write memory	**WR** or **RAM**
no-access memory	**PROTECT**
input port	**IPORT** (valid for simulator only)
output port	**OPORT** (valid for simulator only)
input/output port	**IOPORT** (valid for simulator only)

A new memory map must not overlap an existing entry. If you define a range that overlaps an existing range, the debugger ignores the new range.

map — *Enable Memory Mapping*

Syntax **map** {**on** | **off**}

Menu selection **M**emory→**E**nable

Environments ☑ basic debugger ☑ profiling

Description The MAP command enables or disables memory mapping. In some instances, you may want to explicitly enable or disable memory. Note that disabling memory mapping can cause bus fault problems in the target because the debugger may attempt to access nonexistent memory.

mc — *Connect Simulated I/O Port to File*

Syntax **mc** *port address, filename,* {**READ** | **WRITE**}

Menu selection **M**emory→**C**onnect

Environments ☑ basic debugger ☑ profiling

Description The MC command connects IPORT, OPORT, or IOPORT to an input or output file. Before you can connect the port, you must add it to the memory map with the MA command.

- The *port address* parameter defines the address of the I/O port. This parameter can be an absolute address, any C expression, the name of a C function, or an assembly language label.
- The *filename* parameter can be any filename. If you connect a port to read from a file, the file must exist, or the MC command will fail.
- The final parameter is specified as **READ** or **WRITE** and defines how the file will be used (for input or output, respectively).

The file is accessed during an LDI or STI instruction to the associated port address. A maximum of one input and one output file can be connected to a single port; multiple ports can be connected to a single file.

This port-connect feature can also be used for simulation of communication ports. The input and output registers for communication port 0 through port 5 can be connected to files.

md — *Delete Block From Memory Map*

Syntax **md** *address*

Menu selection **M**emory→**D**elete

Environments ☑ basic debugger ☑ profiling

Description The MD command deletes a range of memory from the debugger’s memory map. The *address* parameter identifies the starting address of the range of memory. If you supply an address that is not the starting address of a range, the debugger displays this error message in the display area of the COMMAND window:

```
Specified map not found
```

mem

Modify MEMORY Window Display

Syntax

mem *expression* [, *display format*]
mem# *expression* [, *display format*]

Menu selection

none

Environments

☑ basic debugger □ profiling

Description

The MEM command identifies a new starting address for the block of memory displayed in a MEMORY window. The optional extension number (#) opens an additional MEMORY window, allowing you to view a separate block of memory. The debugger displays the contents of memory at *expression* in the first data position in the MEMORY window. The end of the range is defined by the size of the window. The *expression* can be an absolute address, a symbolic address, or any C expression.

When you use the optional *display format* parameter, memory will be displayed in one of the following formats:

Parameter	Result	Parameter	Result
*****	Default for the data type	**x**	Hexadecimal
c	ASCII character (bytes)	**o**	Octal
d	Decimal	**p**	Valid address
e	Exponential floating point	**u**	Unsigned decimal
f	Decimal floating point		

mi

Disconnect I/O Port

Syntax

mi *port address,* {**READ | WRITE**}

Menu selection

Memory→D**i**sConn

Environments

☑ basic debugger ☑ profiling

Description

The MI command disconnects a simulated I/O port from its associated system file.

The *port address* parameter identifies the address of the I/O port, which must have been previously defined with the MC command.

mix

Enter Mixed Mode

Syntax **mix**

Menu selection Mo**D**e→**M**ixed

Environments ☑ basic debugger □ profiling

Description The MIX command changes the current debugging mode to mixed mode. If you're already in mixed mode, the MIX command has no effect.

ml

List Memory Map

Syntax **ml**

Menu selection **M**emory→**L**ist

Environments ☑ basic debugger ☑ profiling

Description The ML command lists the memory ranges that are defined for the debugger's memory map. The ML command lists the starting address, ending address, and read/write characteristics of each defined memory range.

move — *Move Active Window*

Syntax **move** [*X position*, *Y position* [, *width*, *length*]]

Menu selection none

Environments ☑ basic debugger ☑ profiling

Description The MOVE command moves the active window to the specified XY position. If you choose, you can resize the window while you move it (see the SIZE command for valid *width* and *length* values). You can use the MOVE command in one of two ways:

- By supplying a specific *X position* and *Y position* or
- By omitting the *X position* and *Y position* parameters and using function keys to interactively move the window.

You can move a window by defining a new XY position for the window's upper left corner. Valid X and Y positions depend on the screen size and the window size. X positions are valid if the X position plus the window width in characters is less than or equal to the screen width in characters. Y positions are valid if the Y position plus the window height is less than or equal to the screen height in lines.

For example, if the window is 10 characters wide and 5 lines high and the screen size is 80 x 25, the command **move 70, 20** would put the lower right-hand corner of the window in the lower right-hand corner of the screen. No X value greater than 70 or Y value greater than 20 would be valid in this example.

If you enter the MOVE command without *X position* and *Y position* parameters, you can use arrow keys to move the window.

↓ Moves the active window down one line.

↑ Moves the active window up one line.

← Moves the active window left one character position.

→ Moves the active window right one character position.

> When you're finished using the cursor keys, you *must* press ESC or 🖱.

mr — *Reset Memory Map*

Syntax **mr**

Menu selection **M**emory→**R**eset

Environments ☑ basic debugger ☑ profiling

Description The MR command resets the debugger's memory map by deleting all defined memory ranges from the map.

ms — *Save Memory Block to a File*

Syntax **ms** *address, length, filename*

Menu selection **M**emory→**S**ave

Environments ☑ basic debugger ☑ profiling

Description The MS command saves the values in a block of memory to a system file. The command has three parameters:

- The *address* parameter identifies the beginning of the block.
- The *length* parameter defines the length, in words, of the block.
- The *filename* is a system file. If you don't supply an extension, the debugger adds an .obj extension.

next — *Single-Step, Next Statement*

Syntax **next** [*expression*]

Menu selection Next=**F10** (in disassembly or mixed mode)

Environments ☑ basic debugger □ profiling

Description The NEXT command is similar to the STEP command. If you're in C code, the debugger executes one C statement at a time. In assembly or mixed mode, the debugger executes one assembly language statement at a time. Unlike STEP, NEXT never updates the display when executing called functions; NEXT always steps to the next consecutive statement. Unlike STEP, NEXT steps over function calls rather than stepping into them—you don't see the single-step execution of the function call.

The *expression* parameter specifies the number of statements that you want to single-step. You can also use a conditional *expression* for conditional single-step execution (the *Running code conditionally* discussion, page 6-16, discusses this in detail).

patch

Patch Assemble

Syntax **patch** *address, assembly language instruction*

Menu selection none

Environments ☑ basic debugger □ profiling

Description The PATCH command allows you to patch-assemble disassembly statements. The *address* parameter identifies the address of the statement you want to change. The *assembly language instruction* parameter is the new statement you want to use at *address*.

pf

Profile, Full

Syntax **pf** *starting point* [, *update rate*]

Menu selection **P**rofile→**F**ull

Environments □ basic debugger ☑ profiling

Description The PF command initiates a RUN and collects a full set of statistics on the defined areas between the *starting point* and the first-encountered stopping point. The *starting point* parameter can be a label, a function name, or a memory address.

The optional *update rate* parameter determines how often the PROFILE window will be updated. The *update rate* parameter can have one of these values:

Value	Description
0	This is the default. Statistics are not updated until the session is halted (although you can force an update by clicking the mouse in the window header). A “spinning wheel” character is shown to indicate that a profiling session is in progress.
≥**1**	Statistics are updated during the session. A value of **1** means that data is updated as often as possible.
<**0**	Statistics are not updated and the “spinning wheel” character is not displayed.

pq

Profile, Quick

Syntax **pq** *starting point* [, *update rate*]

Menu selection **P**rofile→**Q**uick

Environments □ basic debugger ☑ profiling

Description The PQ command initiates a RUN command and collects a subset of the available statistics on the defined areas between the *starting point* and the first-encountered stopping point. PQ is similar to PF, except that PQ doesn't collect exclusive or exclusive max data.

The *update rate* parameter is the same as for the PF command.

pr

Resume Profiling Session

Syntax **pr** [*clear data* [, *update rate*]]

Menu selection **P**rofile→**R**esume

Environments □ basic debugger ☑ profiling

Description The PR command resumes the last profiling session (initiated by PF or PQ), starting from the current program counter.

The optional *clear data* parameter tells the debugger whether or not it should clear out the previously collected data. The *clear data* parameter can have one of these values:

Value	Description
0	This is the default. The profiler will continue to collect data, adding it to the existing data for the profiled areas, and to use the previous internal profile stacks.
nonzero	All previously collected profile data and internal profile stacks are cleared.

The *update rate* parameter is the same as for the PF and PQ commands.

prompt

Change Command-Line Prompt

Syntax **prompt** *new prompt*

Menu selection **C**olor→**P**rompt

Environments ☑ basic debugger ☑ profiling

Description The PROMPT command changes the command-line prompt. The *new prompt* can be any string of characters (note that a semicolon or comma ends the string).

quit — *Exit Debugger*

Syntax **quit**

Menu selection none

Environments ☑ basic debugger ☑ profiling

Description The QUIT command exits the debugger and returns to the DOS environment.

reload — *Reload Object Code*

Syntax **reload** *object filename*

Menu selection **L**oad→**R**eload

Environments ☑ basic debugger ☑ profiling

Description The RELOAD command loads only an object file *without* loading its associated symbol table. This is useful for reloading a program when target memory has been corrupted.

reset — *Reset Target System*

Syntax **reset**

Menu selection **L**oad→Rese**T**

Environments ☑ basic debugger ☑ profiling

Description The RESET command resets the target system. Note that this is a *software* reset.

restart — *Reset PC to Program Entry Point*

Syntax **restart**
rest

Menu selection **L**oad→R**E**start

Environments ☑ basic debugger ☑ profiling

Description The RESTART or REST command resets the program to its entry point. (This assumes that you have already used one of the load commands to load a program into memory.)

return — *Return to Function's Caller*

Syntax **return**
ret

Menu selection none

Environments ☑ basic debugger □ profiling

Description The RETURN or RET command executes the code in the current C function and halts when execution reaches the caller. Breakpoints do not affect this command, but you can halt execution by pressing the left mouse button or pressing SC .

run — *Run Code*

Syntax **run** [*expression*]

Menu selection Run=**F5**

Environments ☑ basic debugger □ profiling

Description The RUN command is the basic command for running an entire program. The command's behavior depends on the type of parameter you supply:

- If you don't supply an *expression*, the program executes until it encounters a breakpoint or until you press the left mouse button or press SC .
- If you supply a logical or relational *expression*, this becomes a conditional run (described in detail on page 6-16).
- If you supply any other type of *expression*, the debugger treats the expression as a *count* parameter. The debugger executes *count* instructions, halts, and updates the display.

runb — *Benchmark Code* *(Emulator Only)*

Syntax **runb**

Menu selection none

Environments ☑ basic debugger □ profiling

Description The RUNB command executes a specific section of code and counts the number of CPU clock cycles consumed by the execution. In order to operate correctly, *execution must be halted by a software breakpoint*. After RUNB execution halts, the debugger stores the number of cycles into the CLK pseudoregister. For a complete explanation of the RUNB command and the benchmarking process, read Section 6.7, *Benchmarking,* on page 6-18.

sa — *Add Stoppoint*

Syntax **sa** *address*

Menu selection **S**top-points→**A**dd

Environments □ basic debugger ☑ profiling

Description The SA command adds a stopping point at *address*. The *address* can be a label, a function name, or a memory address.

scolor — *Change Screen Colors*

Syntax **scolor** *area name*, *attribute*$_1$ [, *attribute*$_2$ [, *attribute*$_3$ [, *attribute*$_4$]]]

Menu selection **C**olor→**C**onfig

Environments ☑ basic debugger ☐ profiling

Description The SCOLOR command changes the color of specified areas of the debugger display and updates the display immediately. The *area name* parameter identifies the area of the display that is affected. The *attributes* identify how the area is affected. The first two *attribute* parameters usually specify the foreground and background colors for the area. If you do not supply a background color, the debugger uses black as the background.

Valid values for the *attribute* parameters include:

black	blue	green	cyan
red	magenta	yellow	white
bright		blink	

Valid values for the *area name* parameters include:

menu_bar	menu_border	menu_entry	menu_cmd
menu_hilite	menu_hicmd	win_border	win_hiborder
win_resize	field_text	field_hilite	field_edit
field_label	field_error	cmd_prompt	cmd_input
cmd_cursor	cmd_echo	asm_data	asm_cdata
asm_label	asm_clabel	background	blanks
error_msg	file_line	file_eof	file_text
file_brk	file_pc	file_pc_brk	

You don’t have to type an entire *attribute* or *area name*; you need type only enough letters to uniquely identify the attribute. If you supply ambiguous *attribute* names, the debugger interprets the names in this order: black, blue, bright, blink. If you supply ambiguous *area names*, the debugger interprets them in the order that they’re listed above (left to right, top to bottom).

sconfig — *Load Screen Configuration*

Syntax **sconfig** [*filename*]

Menu selection **C**olor→**L**oad

Environments ☑ basic debugger ☑ profiling

Description The SCONFIG command restores the display to a specified configuration. This restores the screen colors, window positions, window sizes, and border styles that were saved with the SSAVE command into *filename*. If you don't supply a *filena*me, the debugger looks for the init.clr file. The debugger searches for the specified file in the current directory and then in directories named with the D_DIR environment variable.

sd — *Delete Stoppoint*

Syntax **sd** *address*

Menu selection **S**top-points→**D**elete

Environments □ basic debugger ☑ profiling

Description The SD command deletes the stopping point at *address*.

setf

Set Default Data-Display Format

Syntax **setf** [*data type*, *display format*]

Menu selection none

Environments ☑ basic debugger □ profiling

Description

The SETF command changes the display format for a specific data type. If you enter SETF with no parameters, the debugger lists the current display format for each data type.

- The *data type* parameter can be any of the following C data types:

  char
  uchar
  short
  int
  uint
  long
  ulong
  float
  double
  ptr

- The *display format* parameter can be any of the following characters:

Parameter	Result	Parameter	Result
*****	Default for the data type	**x**	Hexadecimal
c	ASCII character (bytes)	**o**	Octal
d	Decimal	**p**	Valid address
e	Exponential floating point	**s**	ASCII string
f	Decimal floating point	**u**	Unsigned decimal

Only a subset of the display formats can be used for each data type. Listed below are the valid combinations of data types and display formats.

Data	Valid Display Formats									Data	Valid Display Formats								
Type	**c**	**d**	**o**	**x**	**e**	**f**	**p**	**s**	**u**	**Type**	**c**	**d**	**o**	**x**	**e**	**f**	**p**	**s**	**u**
char (c)	√	√	√	√					√	long (d)	√	√	√	√					√
uchar (d)	√	√	√	√					√	ulong (d)	√	√	√	√					√
short (d)	√	√	√	√					√	float (e)			√	√	√	√			
int (d)	√	√	√	√					√	double (e)			√	√	√	√			
uint (d)	√	√	√	√					√	ptr (p)			√	√			√	√	

To return all data types to their default display format, enter:

```
setf * ↵
```

size — *Size Active Window*

Syntax **size** [*width*, *length*]

Menu selection none

Environments ☑ basic debugger ☑ profiling

Description The SIZE command changes the size of the active window. You can use the SIZE command in one of two ways:

- By supplying a specific *width* and *length* or
- By omitting the *width* and *length* parameters and using function keys to interactively resize the window.

Valid values for the width and length depend on the screen size and the window position on the screen. If the window is in the upper left corner of the screen, the maximum size of the window is the same as the screen size minus one line. (The extra line is needed for the menu bar.) For example, if the screen size is 80 characters by 25 lines, the largest window size is 80 characters by 24 lines.

If a window is in the middle of the display, you can't size it to the maximum height and width—you can size it only to the right and bottom screen borders. The easiest way to make a window as large as possible is to zoom it, as described on page 3-24.

If you enter the SIZE command without *width* and *length* parameters, you can use arrow keys to size the window.

↓	Makes the active window one line longer.
↑	Makes the active window one line shorter.
←	Makes the active window one character narrower.
→	Makes the active window one character wider.

> When you're finished using the cursor keys, you *must* press ESC or ↵ .

sl — *List Stoppoints*

Syntax **sl**

Menu selection **S**top-points→**L**ist

Environments □ basic debugger ☑ profiling

Description The SL command lists all of the currently set stopping points.

sload — *Load Symbol Table*

Syntax **sload** *object filename*

Menu selection **L**oad→**S**ymbols

Environments ☑ basic debugger ☑ profiling

Description The SLOAD command loads the symbol table of the specified object file. SLOAD is useful in a debugging environment in which the debugger cannot, or need not, load the object code (for example, if the code is in ROM). SLOAD clears the existing symbol table before loading the new one but does not modify memory or set the program entry point. Note that SLOAD closes the WATCH and DISP windows.

sound — *Enable Error Beeping*

Syntax **sound on | off**

Menu selection none

Environments ☑ basic debugger □ profiling

Description You can cause a beep to sound every time a debugger error message is displayed. This is useful if the COMMAND window is hidden (because you wouldn't see the error message). By default, sound is off.

sr — *Reset Stoppoints*

Syntax **sr**

Menu selection **S**top-points→**R**eset

Environments □ basic debugger ☑ profiling

Description The SR command resets (deletes) *all* currently set stopping points.

ssave

Save Screen Configuration

Syntax **ssave** [*filename*]

Menu selection **C**olor→**S**ave

Environments ☑ basic debugger □ profiling

Description The SSAVE command saves the current screen configuration to a file. This saves the screen colors, window positions, window sizes, and border styles. The *filename* parameter names the new screen configuration file. You can include path information (including relative pathnames); if you don't supply path information, the debugger places the file in the current directory. If you don't supply a *filename*, then the debugger saves the current configuration into a file named init.clr and places the file in the current directory.

step

Single-Step

Syntax **step** [*expression*]

Menu selection Step=**F8** (in disassembly or mixed mode)

Environments ☑ basic debugger □ profiling

Description The STEP command single-steps through assembly language or C code. If you're in C code, the debugger executes one C statement at a time. In assembly or mixed mode, the debugger executes one assembly language statement at a time.

If you're single-stepping through C code and encounter a function call, the STEP command shows you the single-step execution of the called function (assuming that the function was compiled with the compiler's –g debug option). When function execution completes, single-step execution returns to the caller. If the function wasn't compiled with the debug option, the debugger executes the function but doesn't show single-step execution of the function.

The *expression* parameter specifies the number of statements that you want to single-step. You can also use a conditional *expression* for conditional single-step execution (the *Running code conditionally* discussion, page 6-16, discusses this in detail).

system — *Enter DOS Command*

Syntax **system** [*DOS command* [, *flag*]]

Menu selection none

Environments ☑ basic debugger ☑ profiling

Description The SYSTEM command allows you to enter DOS commands without explicitly exiting the debugger environment.

If you enter SYSTEM with no parameters, the debugger will open a system shell and display the operating-system prompt. At this point, you can enter any DOS command. (In MS-DOS, available memory may limit the commands that you can enter.) When you finish, enter the appropriate information to return to the debugger environment:

```
exit ↵
```

If you prefer, you can supply the DOS command as a parameter to the SYSTEM command. If the result of the command is a message or other display, the debugger will blank the top of the debugger display to show the information. In this case, you can use the *flag* parameter to tell the debugger whether or not it should hesitate after displaying the information. *Flag* may be a 0 or a 1.

0 If you supply a value of 0 for *flag*, the debugger immediately returns to the debugger environment after the last item of information is displayed.

1 If you supply a value of 1 for *flag*, the debugger does not return to the debugger environment until you press ↵. (This is the default.)

take — *Execute Batch File*

Syntax **take** *batch filename* [*, suppress echo flag*]

Menu selection none

Environments ☑ basic debugger ☑ profiling

Description The TAKE command tells the debugger to read and execute commands from a batch file. The *batch filename* parameter identifies the file that contains commands.

By default, the debugger echoes the commands to the output area of the COMMAND window and updates the display as it reads the commands from the batch file.

- If you don't use the *suppress echo flag* parameter, or if you use it but supply a nonzero value, then the debugger behaves in the default manner.
- If you would like to suppress the echoing and updating, use the value 0 for the *suppress echo flag* parameter.

unalias — *Delete Alias Definition*

Syntax **unalias** *alias name*
unalias *****

Menu selection none

Environments ☑ basic debugger ☑ profiling

Description The UNALIAS command deletes defined aliases.

- To delete a **single alias**, enter the UNALIAS command with an alias name. For example, to delete an alias named NEWMAP, enter:

  ```
  unalias NEWMAP ↵
  ```

- To delete **all aliases**, enter an asterisk instead of an alias name:

  ```
  unalias * ↵
  ```

  Note that the * symbol *does not* work as a wildcard.

use

Use New Directory

Syntax **use** *directory name*

Menu selection none

Environments ☑ basic debugger ☑ profiling

Description The USE command names an additional directory that the debugger can search when looking for source files. You can specify only one directory at a time.

You can specify a maximum of twenty directories between environment variables (D_SRC), the –i option, and the USE command collectively.

vaa

Save All Profile Data to a File

Syntax **vaa** *filename*

Menu selection **V**iew→S**a**ve→**A**ll views

Environments □ basic debugger ☑ profiling

Description The VAA command saves all statistics collected during the current profiling session. The data is stored in a system file.

vac

Save Displayed Profile Data to a File

Syntax **vac** *filename*

Menu selection **V**iew→S**a**ve→**C**urrent view

Environments □ basic debugger ☑ profiling

Description The VAC command saves all statistics currently displayed in the PROFILE window. (Statistics that aren’t displayed aren’t saved.) The data is stored in a system file.

vr — *Reset PROFILE Window Display*

Syntax **vr**

Menu selection **V**iew→**R**eset

Environments □ basic debugger ☑ profiling

Description The VR command resets the display in the PROFILE window so that all marked areas are listed and the statistics are displayed with the default labels and in the default sort order.

wa — *Add Item to WATCH Window*

Syntax **wa** *expression* [,[*label*], *display format*]

Menu selection **W**atch→**A**dd

Environments ☑ basic debugger □ profiling

Description The WA command displays the value of *expression* in the WATCH window. If the WATCH window isn't open, executing WA opens the WATCH window. The *expression* parameter can be any C expression, including an expression that has side effects. It's most useful to watch an expression whose value changes over time; constant expressions provide no useful function in the watch window. The *label* parameter is optional. When used, it provides a label for the watched entry. If you don't use a *label*, the debugger displays the *expression* in the label field.

When you use the optional *display format* parameter, data will be displayed in one of the following formats:

Parameter	Result	Parameter	Result
*****	Default for the data type	**x**	Hexadecimal
c	ASCII character (bytes)	**o**	Octal
d	Decimal	**p**	Valid address
e	Exponential floating point	**s**	ASCII string
f	Decimal floating point	**u**	Unsigned decimal

wd — *Delete Item From WATCH Window*

Syntax **wd** *index number*

Menu selection **W**atch→**D**elete

Environments ☑ basic debugger ☐ profiling

Description The WD command deletes a specific item from the WATCH window. The WD command's *index number* parameter must correspond to one of the watch indexes listed in the WATCH window.

whatis — *Find Data Type*

Syntax **whatis** *symbol*

Menu selection none

Environments ☑ basic debugger ☐ profiling

Description The WHATIS command shows the data type of *symbol* in the COMMAND window display area. The *symbol* can be any variable (local, global, or static), a function name, structure tag, typedef name, or enumeration constant.

win — *Select Active Window*

Syntax **win** *WINDOW NAME*

Menu selection none

Environments ☑ basic debugger ☑ profiling

Description The WIN command allows you to select the active window by name. Note that the *WINDOW NAME* is in uppercase (matching the name exactly as displayed). You can spell out the entire window name, but you really need specify only enough letters to identify the window.

If several of the same types of window are visible on the screen, don't use the WIN command to select one of them. If you supply an ambiguous name (such as C, which could stand for CPU or CALLS), the debugger selects the first window it finds whose name matches the name you supplied. If the debugger doesn't find the window you asked for (because you closed the window or misspelled the name), then the WIN command has no effect.

wr — *Reset WATCH Window*

Syntax **wr**

Menu selection **W**atch→**R**eset

Environments ☑ basic debugger □ profiling

Description The WR command deletes all items from the WATCH window and closes the window.

zoom — *Zoom Active Window*

Syntax **zoom**

Menu selection none

Environments ☑ basic debugger ☑ profiling

Description The ZOOM command makes the active window as large as possible. To “unzoom” a window, enter the ZOOM command a second time; this returns the window to its prezoom size and position.

12.4 Summary of Profiling Commands

The following tables summarize the profiling commands that are used for marking, enabling, disabling, and unmarking areas and for changing the display in the PROFILE window. These commands are easiest to use from the pulldown menus, so they are not included in the alphabetical command summary. The syntaxes for these commands are provided here so that you can include these commands in batch files.

Table 12–1. Marking Areas

To mark this area	C only	Disassembly only
Lines		
❑ By line number, address	**MCLE** *filename*, *line number*	**MALE** *address*
❑ All lines in a function	**MCLF** *function*	**MALF** *function*
Ranges		
❑ By line numbers	**MCRE** *filename*, *line number*, *line number*	**MARE** *address*, *address*
Functions		
❑ By function name	**MCFE** *function*	not applicable
❑ All functions in a module	**MCFM** *filename*	
❑ All functions everywhere	**MCFG**	

Table 12–2. Disabling Marked Areas

To disable this area	C only	Disassembly only	C *and* disassembly
Lines			
❑ By line number, address	**DCLE** *filename*, *line number*	**DALE** *address*	not applicable
❑ All lines in a function	**DCLF** *function*	**DALF** *function*	**DBLF** *function*
❑ All lines in a module	**DCLM** *filename*	**DALM** *filename*	**DBLM** *filename*
❑ All lines everywhere	**DCLG**	**DALG**	**DBLG**
Ranges			
❑ By line numbers,addresses	**DCRE** *filename*, *line number*	**DARE** *address*	not applicable
❑ All ranges in a function	**DCRF** *function*	**DARF** *function*	**DBRF** *function*
❑ All ranges in a module	**DCRM** *filename*	**DARM** *filename*	**DBRM** *filename*
❑ All ranges everywhere	**DCRG**	**DARG**	**DBRG**
Functions			
❑ By function name	**DCFE** *function*	not applicable	not applicable
❑ All functions in a module	**DCFM** *filename*		**DBFM** *filename*
❑ All functions everywhere	**DCFG**		**DBFG**
All areas			
❑ All areas in a function	**DCAF** *function*	**DAAF** *function*	**DBAF** *function*
❑ All areas in a module	**DCAM** *filename*	**DAAM** *filename*	**DBAM** *filename*
❑ All areas everywhere	**DCAG**	**DAAG**	**DBAG**

Table 12–3. Enabling Disabled Areas

To enable this area	C only	Disassembly only	C *and* disassembly
Lines			
□ By line number, address	**ECLE** *filename*, *line number*	**EALE** *address*	not applicable
□ All lines in a function	**ECLF** *function*	**EALF** *function*	**EBLF** *function*
□ All lines in a module	**ECLM** *filename*	**EALM** *filename*	**EBLM** *filename*
□ All lines everywhere	**ECLG**	**EALG**	**EBLG**
Ranges			
□ By line numbers,addresses	**ECRE** *filename*, *line number*	**EARE** *address*	not applicable
□ All ranges in a function	**ECRF** *function*	**EARF** *function*	**EBRF** *function*
□ All ranges in a module	**ECRM** *filename*	**EARM** *filename*	**EBRM** *filename*
□ All ranges everywhere	**ECRG**	**EARG**	**EBRG**
Functions			
□ By function name	**ECFE** *function*	not applicable	not applicable
□ All functions in a module	**ECFM** *filename*		**EBFM** *filename*
□ All functions everywhere	**ECFG**		**EBFG**
All areas			
□ All areas in a function	**ECAF** *function*	**EAAF** *function*	**EBAF** *function*
□ All areas in a module	**ECAM** *filename*	**EAAM** *filename*	**EBAM** *filename*
□ All areas everywhere	**ECAG**	**EAAG**	**EBAG**

Table 12–4. Unmarking Areas

To unmark this area	C only	Disassembly only	C *and* disassembly
Lines			
□ By line number, address	**UCLE** *filename*, *line number*	**UALE** *address*	not applicable
□ All lines in a function	**UCLF** *function*	**UALF** *function*	**UBLF** *function*
□ All lines in a module	**UCLM** *filename*	**UALM** *filename*	**UBLM** *filename*
□ All lines everywhere	**UCLG**	**UALG**	**UBLG**
Ranges			
□ By line numbers,addresses	**UCRE** *filename*, *line number*	**UARE** *address*	not applicable
□ All ranges in a function	**UCRF** *function*	**UARF** *function*	**UBRF** *function*
□ All ranges in a module	**UCRM** *filename*	**UARM** *filename*	**UBRM** *filename*
□ All ranges everywhere	**UCRG**	**UARG**	**UBRG**
Functions			
□ By function name	**UCFE** *function*	not applicable	not applicable
□ All functions in a module	**UCFM** *filename*		**UBFM** *filename*
□ All functions everywhere	**UCFG**		**UBFG**
All areas			
□ All areas in a function	**UCAF** *function*	**UAAF** *function*	**UBAF** *function*
□ All areas in a module	**UCAM** *filename*	**UAAM** *filename*	**UBAM** *filename*
□ All areas everywhere	**UCAG**	**UAAG**	**UBAG**

Table 12–5. Changing the PROFILE Window Display

(a) Viewing specific areas

To view this area	C only	Disassembly only	C *and* disassembly
Lines			
□ By line number, address	**VFCLE** *filename*, *line number*	**VFALE** *address*	not applicable
□ All lines in a function	**VFCLF** *function*	**VFALF** *function*	**VFBLF** *function*
□ All lines in a module	**VFCLM** *filename*	**VFALM** *filename*	**VFBLM** *filename*
□ All lines everywhere	**VFCLG**	**VFALG**	**VFBLG**
Ranges			
□ By line numbers,addresses	**VFCRE** *filename*, *line number*	**VFARE** *address*	not applicable
□ All ranges in a function	**VFCRF** *function*	**VFARF** *function*	**VFBRF** *function*
□ All ranges in a module	**VFCRM** *filename*	**VFARM** *filename*	**VFBRM** *filename*
□ All ranges everywhere	**VFCRG**	**VFARG**	**VFBRG**
Functions			
□ By function name	**VFCFE** *function*	not applicable	not applicable
□ All functions in a module	**VFCFM** *filename*		**VFBFM** *filename*
□ All functions everywhere	**VFCFG**		**VFBFG**
All areas			
□ All areas in a function	**VFCAF** *function*	**VFAAF** *function*	**VFBAF** *function*
□ All areas in a module	**VFCAM** *filename*	**VFAAM** *filename*	**VFBAM** *filename*
□ All areas everywhere	**VFCAG**	**VFAAG**	**VFBAG**

(b) Viewing different data

To view this information	Use this command
Count	**VDC**
Inclusive	**VDI**
Inclusive, maximum	**VDN**
Exclusive	**VDE**
Exclusive, maximum	**VDX**
Address	**VDA**
All	**VDL**

(c) Sorting the data

To sort on this data	Use this command
Count	**VSC**
Inclusive	**VSI**
Inclusive, maximum	**VSN**
Exclusive	**VSE**
Exclusive, maximum	**VSX**
Address	**VSA**
Data	**VSD**

12.5 Summary of Special Keys

The debugger provides function key, cursor key, and command key sequences for performing a variety of actions:

- Editing text on the command line
- Using the command history
- Switching modes
- Halting or escaping from an action
- Displaying the pulldown menus
- Running code
- Selecting or closing a window
- Moving or sizing a window
- Scrolling through a window's contents
- Editing data or selecting the active field

Editing text on the command line

To do this	Use these function keys
Enter the current command (note that if you press the return key in the middle of text, the debugger truncates the input text at the point where you press this key)	↵
Move back over text without erasing characters	CTRL H or BACK SPACE
Move forward through text without erasing characters	CTRL L
Move back over text while erasing characters	DELETE
Move forward through text while erasing characters	SPACE
Insert text into the characters that are already on the command line	INSERT

Using the command history

To do this	Use these function keys
Repeat the last command that you entered	F2
Move backward, one command at a time, through the command history	TAB
Move forward, one command at a time, through the command history	SHIFT TAB

Switching modes

To do this	Use this function key
Switch debugging modes in this order: → auto → assembly → mixed →	F3

Halting or escaping from an action

The escape key acts as an end or undo key in several situations.

To do this	Use this function key
❑ Halt program execution ❑ Close a pulldown menu ❑ Undo an edit of the active field in a data-display window (pressing this key leaves the field unchanged) ❑ Halt the display of a long list of data in the display area of the COMMAND window	ESC

Displaying pulldown menus

To do this	Use these function keys
Display the Load menu	ALT L
Display the Break menu	ALT B
Display the Watch menu	ALT W
Display the Memory menu	ALT M
Display the Color menu	ALT C
Display the MoDe menu	ALT D
Display an adjacent menu	← or →
Execute any of the choices from a displayed pulldown menu	Press the highlighted letter corresponding to your choice

Running code

To do this	Use these function keys
Run code from the current PC (equivalent to the RUN command without an *expression* parameter)	F5
Single-step code from the current PC (equivalent to the STEP and CSTEP commands without an *expression* parameter)	F8
Single-step code from the current PC; step over function calls (equivalent to the NEXT and CNEXT commands without an *expression* parameter)	F10

Selecting or closing a window

To do this	Use these function keys
Select the active window (pressing this key makes each window active in turn; stop pressing the key when the desired window becomes active)	F6
Close the CALLS or DISP window (the window must be active before you can close it)	F4

Moving or sizing a window

You can use the arrow keys to interactively move or size a window after entering the MOVE or SIZE command without parameters.

To do this	Use these function keys
❑ Move the window down one line ❑ Make the window one line longer	↓
❑ Move the window up one line ❑ Make the window one line shorter	↑
❑ Move the window left one character position ❑ Make the window one character narrower	←
❑ Move the window right one character position ❑ Make the window one character wider	→

Scrolling a window's contents

These descriptions and instructions for scrolling apply to the active window. Some of these descriptions refer to specific windows; if no specific window is named, then the description/instructions refer to any window that is active.

To do this	Use these function keys
Scroll up through the window contents, one window length at a time	PAGE UP
Scroll down through the window contents, one window length at a time	PAGE DOWN
Move the field cursor up one line at a time	↑
Move the field cursor down one line at a time	↓
❑ *FILE window only:* Scroll left 8 characters at a time ❑ *Other windows:* Move the field cursor left 1 field; at the first field on a line, wrap back to the last fully displayed field on the previous line	←
❑ *FILE window only:* Scroll right 8 characters at a time ❑ *Other windows:* Move the field cursor right 1 field; at the last field on a line, wrap around to the first field on the next line	→
FILE window only: Adjust the window's contents so that the first line of the text file is at the top of the window	HOME
FILE window only: Adjust the window's contents so that the last line of the text file is at the bottom of the window	END
DISP windows only: Scroll up through an array of structures	CTRL PAGE UP
DISP windows only: Scroll down through an array of structures	CTRL PAGE DOWN

Editing data or selecting the active field

The F9 function key makes the current field (the field that the cursor is pointing to) active. This has various effects, depending on the field.

To do this	Use this function key
❑ *FILE or DISASSEMBLY window:* Set or clear a breakpoint ❑ *CALLS window:* Display the source to a listed function ❑ *Any data-display window:* Edit the contents of the current field ❑ *DISP window:* Open an additional DISP window to display a member that is an array, structure, or pointer	F9

Chapter 13

Basic Information About C Expressions

Many of the debugger commands take C expressions as parameters. This allows the debugger to have a relatively small, yet powerful, instruction set. Because C expressions can have side effects—that is, the evaluation of some types of expressions can affect existing values—you can use the same command to display or to change a value, thus reducing the number of commands in the command set.

This chapter contains basic information that you'll need to know in order to use C expressions as debugger command parameters.

Topic **Page**

13.1 C Expressions for Assembly Language Programmers

It’s not necessary for you to be an experienced C programmer in order to use the debugger. However, in order to use the debugger’s full capabilities, you should at least be familiar with the rules governing C expressions. A helpful reference is ***The C Programming Language*** (second edition) by Brian W. Kernighan and Dennis M. Ritchie, published by Prentice-Hall, Englewood Cliffs, New Jersey. This book is referred to in the C community, and in Texas Instruments documentation, as **K&R.**

Note:

A single value or symbol is a legal C expression.

K&R contains a complete description of C expressions; to get you started, here’s a summary of the operators that you can use in expression parameters.

❑ **Reference operators**

–>	indirect structure reference	.	direct structure reference
[ ]	array reference	*	indirection (unary)
&	address (unary)		

❑ **Arithmetic operators**

+	addition (binary)	–	subtraction (binary)
*	multiplication	/	division
%	modulo	–	negation (unary)
(*type*)	typecast		

❑ **Relational and logical operators**

>	greater than	>=	greater than or equal to
<	less than	<=	less than or equal to
= =	is equal to	!=	is not equal to
&&	logical AND	||	logical OR
!	logical NOT (unary)		

- ❑ **Increment and decrement operators**

++	increment	– –	decrement

These unary operators can precede or follow a symbol. When the operator precedes a symbol, the symbol value is incremented/decremented before it is used in the expression; when the operator follows a symbol, the symbol value is incremented/decremented after it is used in the expression. Because these operators affect the symbol's final value, they have side effects.

- ❑ **Bitwise operators**

&	bitwise AND	|	bitwise OR
^	bitwise exclusive-OR	<<	left shift
>>	right shift	~	1s complement (unary)

- ❑ **Assignment operators**

=	assignment	+=	assignment with addition
–=	assignment with subtraction	/=	assignment with division
%=	assignment with modulo	&=	assignment with bitwise AND
^=	assignment with bitwise XOR	|=	assignment with bitwise OR
<<=	assignment with left shift	>>=	assignment with right shift
*=	assignment with multiplication		

These operators support a shorthand version of the familiar binary expressions; for example, X = X + Y can be written in C as X += Y. Because these operators affect a symbol's final value, they have side effects.

13.2 Restrictions and Features Associated With Expression Analysis in the Debugger

The debugger's expression analysis is based on C expression analysis. This includes all mathematical, relational, pointer, and assignment operators. However, there are a few limitations, as well as a few additional features not described in K&R C.

Restrictions

The following restrictions apply to the debugger's expression analysis features.

- ❑ The *sizeof* operator is not supported.
- ❑ The comma operator (,) is not supported (commas are used to separate parameter values for the debugger commands).
- ❑ Function calls and string constants are currently not supported in expressions.
- ❑ The debugger supports a limited number of type casts; the following forms are allowed.

  (*basic type* **)**
  (*basic type* ***** *...***)**
  ([*structure/union/enum* **]** *structure/union/enum tag* **)**
  ([*structure/union/enum* **]** *structure/union/enum tag* ***** *...* **)**

  Note that you can use up to six *****s in a cast.

Additional features

- ❑ All floating-point operations are performed in double precision using standard widening. (This is transparent.)
- ❑ All registers can be referenced by name. The 'C4x's extended-precision registers (R0–R7) are treated as integers and/or pointers. You can use the names F0–F7 to access the registers as floating-point values.
- ❑ Void expressions are legal (treated like integers).
- ❑ The specification of variables and functions can be qualified with context information. Local variables (including local statics) can be referenced with the expression form:

  *function name***.***local name*

This expression format is useful for examining the automatic variables of a function that is not currently being executed. Unless the variable is static, however, the function must be somewhere in the current call stack. If you want to see local variables from the currently executing function, you need not use this form; you can simply specify the variable name (just as in your C source).

File-scoped variables (such as statics or functions) can be referenced with the following expression form:

*filename***.***function name*
or *filename***.***variable name*

This expression format is useful for accessing a file-scoped static variable (or function) that may share its name with variables in other files.

In this expression, *filename* **does not include** the file extension; the debugger searches the object symbol table for any source filename that matches the input name, disregarding any extension. Thus, if the variable *ABC* is in file *source.c*, you can specify it as *source.ABC*.

These expression forms can be combined into an expression of the form:

*filename***.***function name***.***variable name*

- ❑ Any integral or void expression can be treated as a pointer and used with the indirection operator (*). Here are several examples of valid use of a pointer in an expression:

  ```
  *123
  *R5
  *(R2 + 123)
  *(I*J)
  ```

  By default, the values are treated as integers (that is, these expressions point to integer values).

- ❑ Any expression can be typecast to a pointer to a specific type (overriding the default of pointing to an integer, as described above).

  Hint: You can use casting with the WA and DISP commands to display data in a desired format.

  For example, the expression:

  ```
  *(float *)10
  ```

  treats 10 as a pointer to a floating-point value at location 10 in memory. In this case, the debugger fetches the contents of memory location 10 and treats the contents as a floating-point value. If you use this expression as a parameter for the DISP command, the debugger displays memory contents as an array of floating-point values within the DISP window, beginning with memory location 10 as array member [0].

Note how the first expression differs from the expression:

```
(float)*10
```

In this case, the debugger fetches an integer from address 10 and converts the integer to a floating-point value.

You can also typecast to user-defined types such as structures. For example, in the expression:

```
((struct STR *)10)–>field
```

the debugger treats memory location 10 as a pointer to a structure of type STR (assuming that a structure is at address 10) and accesses a field from that structure.

Appendix A

Customizing the Analysis Interface

The interface to the ’C4x analysis module is register based. In most cases, the Analysis Count Events and Analysis Break Events dialog boxes provide a sufficient mean of counting events and setting hardware breakpoints. In some cases, however, you may want to define more complex conditions for the processor to detect. Or, you may want to write a batch file that defines counting or breakpoint conditions. In either case, you can accomplish these tasks by accessing the analysis registers through the debugger. This appendix explains how to access these registers.

Topic **Page**

A.1 Summary of Aliased Commands

A basic set of analysis commands are defined in the analysis.cmd file supplied in your ’C4x debugger package. These commands, like the analysis dialog boxes, load the analysis registers with your specified values. You must TAKE the analysis.cmd file before you can use any of these commands. To do this, enter:

```
take analysis.cmd  ↵
```

By default, the debugger echoes the file to the output area of the COMMAND window. However, you can view the entire file by using the FILE command to display its contents in the FILE window. Table A–1 shows the predefined commands along with their menu equivalents.

These aliased commands, created in the analysis.cmd file, are provided to help you familarize yourself with the analysis registers and how they work. These aliases are simply a starting point for you to build upon to create your own commands.

Table A–1. The Analysis Commands Found in the analysis.cmd File

	Menu →		
Command	**Dialog Box**	**Description**	**Page**
asys_off	Analysis → Enable/Disable	Turn off the analysis interface	A-4
asys_on	Analysis → Disable/Enable	Turn on the analysis interface	A-4
asys_reset	none	Reset the analysis interface	A-9
cnt_br	Count → Branch taken	Count any branches detected	A-5
cnt_call	Count → Call taken	Count any calls detected	A-5
cnt_clock	Count → CPU clock	Count CPU clock cycles	A-5
cnt_data	Count → Data bus	Count any data accesses	A-5
cnt_dma	Count → DMA bus	Count any DMA accesses	A-5
cnt_ins	Count → Instruction fetch	Count any instructions fetched	A-5
cnt_intr	Count → Interrupt/trap taken	Count any interrupts/traps detected	A-5
cnt_load *value*	Count → Event counter	Load the analysis counter	A-4
cnt_none	none	Disable event counting	A-4
cnt_prog	Count → Program bus	Count any program address accesses	A-5

Table A-1. The Analysis Commands Found in the analysis.cmd File (continued)

Command	Menu → Dialog Box	Description	Page
cnt_ret	Count → Return taken	Count any returns from an interrupt/trap detected	A-5
data_brk_add *address or symbol name*	Break → Data bus: Address field	Set a breakpoint on a data address	A-6
data_qual_moff	Count/Break → Data bus: Mask	Disable 64K range masking	A-9
data_qual_mon	Count/Break → Data bus: Mask	Enable 64K range masking	A-9
data_qual_r	Count/Break → Data bus: Read	Data read qualifier	A-8
data_qual_rw	Count/Break → Data bus: Access	Data read/write qualifier	A-8
data_qual_w	Count/Break → Data bus: Write	Data write qualifier	A-8
dma_brk_add *address or symbol name*	Break → DMA bus: Address field	Set a breakpoint on a DMA address	A-6
dma_qual_moff	Count/Break → DMA bus: Mask	Disable 64K range masking	A-9
dma_qual_mon	Count/Break → DMA bus: Mask	Enable 64K range masking	A-9
dma_qual_r	Count/Break → DMA bus: Read	DMA read qualifier	A-8
dma_qual_rw	Count/Break → DMA bus:Access	DMA read/write qualifier	A-8
dma_qual_w	Count/Break → DMA bus: Write	DMA write qualifier	A-8
prog_brk_add *address or function name*	Break → Program bus: Address field	Set a breakpoint on a program address	A-6
stop_br	Break → Branch taken	Halt the processor when a branch is detected	A-7
stop_call	Break → Call taken	Halt the processor when a call is detected	A-7
stop_cnt	Count → Break when < 0	Halt the processor when the counter passes zero	A-4
stop_data	Break → Data bus	Halt the processor on a data bus access	A-6
stop_dma	Break → DMA bus	Halt the processor on a DMA bus access	A-6
stop_emu0	Break → EMU0 driven low	Halt the processor when the EMU0 pin is low	A-7
stop_emu1	Break → EMU1 driven low	Halt the processor when the EMU1 pin is low	A-7

Table A-1. The Analysis Commands Found in the Analysis.cmd File (continued)

Command	Menu → Dialog Box	Description	Page
stop_ins	Break → Instruction fetch	Halt the processor when an instruction fetch is detected	A-7
stop_intr	Break → Interrupt/ trap taken	Halt the processor when an interrupt/trap is detected	A-7
stop_off	none	Disable break events	A-7
stop_prog	Break → Program bus	Halt the processor on a program bus access	A-6
stop_ret	Break → Return taken	Halt the processor when a return from an interrupt/trap is detected	A-7

In addition to these predefined commands, you can create your own by using the ALIAS and EVAL commands. Refer to Sections 4.5 (page 4-20) and 7.2 (page 7-2) for more information on ALIAS and EVAL. The following subsections briefly describe the use of the analysis commands.

Enabling the analysis interface

Enabling the analysis interface is simply a matter of typing in a command. The basic syntax for this command is:

```
asys_on
```

To disable the analysis interface, enter:

```
asys_off
```

Enabling event counting

To enable and disable event counting (using the commands found in the analysis.cmd file), enter the appropriate command:

To do this...	Enter this...
Load or reset the event counter	`cnt_load` *value*
Disable event counting	`cnt_none`

Load *value* with a 1s complement of the number of times you want to count the specified event. For example, to stop the processor after ten instruction fetches have occurred, enter:

`cnt_load –11`	*Set the counter to count ten events and then stop –(count +1)*
`cnt_ins`	*Count instruction fetches*
`stop_cnt`	*Stop the processor when the counter reaches 0*

In this example, you must load the counter with a negative value because the evtcntr register represents a 1s complement of the loaded value.

To reset the internal event counter and count the number of instruction fetches detected, enter:

```
cnt_load 0                    Reset the counter
cnt_ins                       Count the number of instruction fetches detected
```

You can count only one event at a time. To count any of the other events, simply type in the appropriate command. Table A–2 shows the correct command for counting each of the nine events.

Table A–2. The Analysis Commands

Command	Menu Selection	Description
cnt_br	Branch taken	Count the number of branches detected
cnt_call	Call taken	Count the number of calls detected
cnt_clock	CPU clock	Count the number of CPU clock cycles
cnt_data	Data bus	Count the number of data cycles
cnt_dma	DMA bus	Count the number of DMA cycles
cnt_ins	Instruction fetch	Count the number of instruction fetches
cnt_intr	Interrupt/trap taken	Count the number of interrupts/traps detected
cnt_prog	Program bus	Count the number of program address accesses
cnt_ret	Return taken	Count the number of returns from interrupts, traps, or subroutine calls

Setting breakpoints on a single program, data, or DMA address

The simplest events to detect identify a single address. To define this type of event, follow the command with a C expression. For example, to set a program address breakpoint, enter:

asys_on	*Turn the analysis interface on*
prog_brk_add *main*	*Set a program address breakpoint on function_name*
stop_prog	*Enable the processor to stop on the breakpoint condition*
run	*Run the program*
prog_brk_add *My_Function*	*Set a new program address breakpoint on function_name2*
run	*Run to the new breakpoint*

The commands shown in bold represent the actual breakpoint commands used. *Main* and *My_Function* represent the addresses on which the processor will break. These function names can be replaced by specific address locations. Table A–3 shows the breakpoint commands for setting single address breakpoints; their respective menu selections can be found in the Analysis Break Events dialog box.

Table A–3. Breakpoint Commands for Program, Data, and DMA Addresses

Command	Dialog Box Selection	Description
data_brk_add *address*	Data bus	Set a data breakpoint address
dma_brk_add *address*	DMA bus	Set a DMA breakpoint address
prog_brk_add *address*	Program bus	Set a program breakpoint address
stop_data		Stop the processor when the data breakpoint condition executes
stop_dma		Stop the processor when the DMA breakpoint condition executes
stop_prog		Stop the processor when the program breakpoint condition executes

Note:

You can set breakpoints on any combination of these events.

Breaking on event occurrences

You can also set conditions on various types of processor operations. To define these conditions or events, simply enter the command. For example, to stop the processor when it detects an interrupt or a call taken, enter:

`asys_on`	*Turn the analysis interface on*
`stop_intr`	*Enable the processor to stop when it detects an interrupt*
`stop_call`	*Enable the processor to stop when it detects a call taken*

Table A–4 shows the commands for stopping the processor when an event occurs.

Table A–4. Breakpoint Commands for Event Occurrences

Command	Menu Selection	Description
stop_br	Branch taken	Stop the processor when a branch is taken
stop_call	Call taken	Stop the processor when a call is taken
stop_emu0	EMU0 driven low	Stop the processor when the EMU pin reaches a logic low of zero
stop_emu1	EMU1 driven low	Stop the processor when the EMU pin reaches a logic low of one
stop_ins	Instruction fetch	Stop the processor when an instruction fetch is detected
stop_intr	Interrupt/trap taken	Stop the processor when an interrupt is detected
stop_off	none	Disable break events
stop_ret	Return taken	Stop the processor when a return from an interrupt, branch, or call occurs

Note:

You can set breakpoints on any combination of these events.

Qualifying on a read or a write

Data and DMA accesses can be qualified, depending on whether the memory cycle is a read or write:

`go` *`function_name`*	*Run to the beginning of the function function_name*
`data_qual_w`	*Look on.ly at writes*
`data_brk_add` *`data_symbol`*	*Set a data address breakpoint*
`cnt_data`	*Enable the processor to count any writes to the specified data access*
`run`	*Count the number of any writes to* ***data_symbol***

This example sets a data address breakpoint that counts only when a write is detected. Table A–5 shows the qualifier commands for data and DMA break events.

Table A–5. Read and Write Qualifying Commands

Command	Menu Selection	Description
data_qual_r	Data bus: Read	Look only at data reads
data_qual_rw	Data bus: Access	Look at both data reads and writes
data_qual_w	Data bus: Write	Look only at data writes
dma_qual_r	DMA bus: Read	Look only at DMA reads
dma_qual_rw	DMA bus: Access	Look at both DMA reads and writes
dma_qual_w	DMA bus: Write	Look only at DMA writes

Note:

You can use only one of these commands at a time.

Qualifying on a range of addresses (masking)

Only DMA and data breakpoints provide read and write qualification. Both types of breakpoints also have the ability to *mask* a range of addresses. This lets you define a condition to track a read/write DMA break event on a range of data. To mask a range of data, enter:

`go` *`function_name`*	*Run to the beginning of the function function_name*
`data_qual_rw`	*Count both reads from and writes to*
`data_qual_mon`	*Enable data range masking*
`data_brk_add 002ff865`	*Set a data address breakpoint*
`cnt_data`	*Count any reads from or writes to the specified address range*
`run`	*Count all accesses (reads and writes) in a 64K range of 002f*

This example counts all reads or writes occurring within the masking range.

Table A–6 shows the masking qualifier commands for data and DMA break events.

Table A–6. Masking Commands

Command	Menu Selection	Description
data_qual_moff	Data bus: mask	Disable data range masking
data_qual_mon	Data bus: mask	Enable data range masking
dma_qual_moff	DMA bus: mask	Disable DMA range masking
dma_qual_mon	DMA bus: mask	Enable DMA range masking

Resetting the analysis interface

Whenever you begin a new analysis session, you may want to define new parameters or qualifier expressions. You can do this without having to manually deselect each defined condition. Just enter the ASYS_RESET command. To reset the analysis interface, type:

```
asys_reset ↵
```

Note:

To clear conditions or qualifier expressions previously defined via the Analysis menu, you must open the *Analysis Count Events* and *Analysis Break Events* dialog boxes and deselect each defined condition.

A.2 Using the Analysis Registers

By manipulating the analysis registers, you can customize commands for more complex instructions that do not exist on the Break or Count dialog boxes. Use the alias and evaluate commands to create your own commands. The basic syntax for creating customized analysis commands is:

alias *command_name*, ”**eval** *register name* = *code*”

For example, to create a new command for turning on the analysis interface, enter:

```
alias analysis_on, ”eval anaenbl = 7”
```

To create a new command for counting branches detected, enter:

```
alias cb, ”e evtselt = 6”
```

To create your own analysis commands, you must familiarize yourself with the thirteen analysis registers and how they work. The following subsections discuss the analysis registers briefly. (The registers are in alphabetical order.)

anaenbl (Enable Analysis)

You can enable and disable the analysis module by using the anaenbl register.

Register Setting	**Effect On Analysis Module**
0x7	enabled
0x0	disabled

When you disable analysis, all registers except anaenbl retain their previous state.

anastat (Analysis Status)

The anastat register records the occurrence of enabled events. The status bits are defined below:

Bit Number	Definition
0	program breakpoint
1	DMA breakpoint
2	data breakpoint, D2 bus
3	data breakpoint, D1 bus
4	return from interrupt/trap/subroutine
5	branch taken
6	call taken
7	instruction fetched
8	EMU0–1 event
9	interrupt/trap
10	event counter passed zero
11	an event occurred

Run commands will not interfere with the status bits because they are cleared before command execution.

datbrkp (Data Breakpoint Address)

You can specify a breakpoint address for each of the major buses in the ’C4x path. When a valid bus cycle occurs and the bus value matches the breakpoint address, then a breakpoint condition can occur.

datqual (Data Breakpoint Qualifier)

The data breakpoint register has three qualifier bits. Bits 0–1 provide read/write qualification, while bit 2 provides address range masking. The qualifier definitions are shown below.

Qualifier Code	Definition
0	read
1	write
2	reserved
3	read/write

When the address masking qualifier is applied, it masks off the lower 16 bits of an address range. This provides a fixed 64K masking range.

Bit	Setting	Effect On Masking
2	1	enabled
2	0	disabled

dcontfr/dcontto (Discontinuity From/To)

A program discontinuity occurs when the program addresses fetched by the processor become nonsequential as a result of branches, interrupts, and similar events.

If the discontinuity was *not* caused by a delayed instruction—for example, a branch delayed—the dcontfr register holds the discontinuity address plus one. Otherwise, it holds the discontinuity address. See Example A–1.

Example A–1. Program Discontinuity

(a) Discontinuity was not caused by a delayed instruction

Address		**Code**		**Comment**
`00000001`		`bu`	`dcon`	*discontinuity occurs*
`00000002`		`nop`		*branch from*
`00000003`		`nop`		
`00000004`		`nop`		
`00000005`		`nop`		
`00000006`	`dcon:`	`ldi`	`1,r1`	*branch to*
`00000007`		`nop`		

`DCONTFR`	`00000002`	*program discontinuity was **not** caused by a delayed instruction, so the dcontfr register holds the address of the discontinuity occurrence plus one*
`DCONTTO`	`00000006`	*dcontto represents the destination of the discontinuity*

(b) Discontinuity was caused by a delayed instruction

Address		Code		Comment
`00000001`		`bud`	`dcon`	*discontinuity occurs*
`00000002`		`nop`		*branch from*
`00000003`		`nop`		
`00000004`		`nop`		
`00000005`		`nop`		
`00000006`	`dcon:`	`ldi`	`1,r1`	*branch to*
`00000007`		`nop`		

`DCONTFR`	`00000001`	*program discontinuity* ***was*** *caused by a delayed instruction, so the dcontfr register holds the address of the discontinuity occurrence*
`DCONTTO`	`00000006`	*dcontto represents the destination of the discontinuity*

dmabrkp (DMA Breakpoint Address)

You can specify a breakpoint address for each of the major buses in the ’C4x path. When a valid bus cycle occurs and the bus value matches the breakpoint address, then a breakpoint condition occurs.

dmaqual (DMA Breakpoint Qualifier)

The DMA breakpoint register provides three qualifier bits. Bits 0–1 provide read/write qualification, while bit 2 provides address range masking. The qualifier definitions are shown below.

Qualifier Code	Definition
0	read
1	write
2	reserved
3	read/write

When the address masking qualifier is applied, it masks off the lower 16 bits of an address range. This provides a fixed 64K masking range.

Bit	Setting	Effect On Masking
2	1	enabled
2	0	disabled

evtcntr (Event Counter)

This register represents a true value in the ’C4x analysis module, which provides a twelve-bit decrementing event counter. For convenience, the pseudoregister, EVT_cntr, provides a 1s complement of the evtcntr value.

You can use the event counter in one of two ways:

❑ Count the number of events detected.
❑ Stop after *n* events have occurred.

To count the number of events detected, load the counter with its maximum value –1, or 0xFFF. The following example loads the counter and counts the instructions.

`cnt_load 0`	*Reset the counter*
`cnt_ins`	*Count the number of instruction fetches detected*

The EVT_cntr register will display the number of events detected after reaching a stop condition.

To stop after a certain number of events, load the counter with the number of events you want to occur before setting a breakpoint. The following example counts ten events and then stops.

`cnt_load –11`	*Set the counter to count ten events and then stop –(count + 1)*
`cnt_ins`	*Count instruction fetches*
`stop_cnt`	*Stop the processor when the counter reaches 0*

If a software breakpoint happens to halt the processor before the counter reaches zero, then the CNT_valu (displayed in the WATCH window) will contain the number of events remaining.

Note:

When CPU clock cycles are counted, the event counter includes startup and latency cycles. Subtract six from the count value to get the true number of CPU clock cycles.

evtenbl (Enable/Disable Counter Breakpoint)

You can set the event counter to generate a breakpoint when passing zero. This can be useful to break on the occurrence of *n* events.

Register Setting	**Effect When Counter Passes Zero**
0x3	enabled
0x0	disabled

evtselt (Select the Event for Counting)

The ’C4x can count nine types of events; however, only one event can be counted at a time. The count select codes are defined below.

Select Code	Definition
0	program address breakpoints
1	DMA address breakpoints
2	data address breakpoints
3	CPU clocks
4	interrupt/trap
5	return from interrupt/trap/subroutine
6	branch taken
7	call taken
8	instruction fetched
9–14	reserved
15	disable counting

hbpenbl (Select Hardware Breakpoints)

By setting the appropriate enable bit to one in the hbpenbl register, the ’C4x can break on multiple events. Setting the bit to zero disables the breakpoint and clears the register. The breakpoint enable bits are defined below.

Bit Number	Definition
0	program address
1	DMA address
2	data address
3	interrupt/trap taken
4	return from interrupt/trap/subroutine
5	branch taken
6	call taken
7	instruction fetched
8	EMU0 detected low
9	EMU1 detected low

pgabrkp (Program Address Breakpoint)

You can specify a breakpoint address for each of the major buses in the ’C4x path. When a valid bus cycle occurs and the bus value matches the breakpoint address, then a breakpoint condition can occur.

Appendix B

What the Debugger Does During Invocation

In some circumstances, you may find it helpful to know the steps that the debugger goes through during the invocation process. These are the steps, in order, that the debugger performs when you invoke it.

1) Reads options from the command line.

2) Reads any information specified with the D_OPTIONS environment variable.

3) Reads information from the D_DIR and D_SRC environment variables.

4) Looks for the init.clr screen configuration file:

   (The debugger searches for the screen configuration file in directories named with D_DIR.)

5) Initializes the debugger screen and windows but initially displays only the COMMAND window.

6) Finds the batch file that defines your memory map by searching in directories named with D_DIR. The debugger expects this file to set up the memory map and follows these steps to look for the batch file:

   a) When you invoke the debugger, it checks to see if you've used the –t debugger option. If it finds the –t option, the debugger reads and executes the specified file.

   b) If you don't use the –t option, the debugger looks for the default initialization batch file. The batch file name differs for each version of the debugger:

      ❑ For the emulator, this file is named *emuinit.cmd.*
      ❑ For the simulator, this file is named *siminit.cmd.*

      If the debugger finds the file corresponding to your tool, it reads and executes the file.

   c) If the debugger does not find the –t option or the initialization batch file, it looks for a file called *init.cmd*. This allows you to have one initialization batch file for more than one debugger tool. To set up this file, you can use the IF/ELSE/ENDIF commands (see page 4-18 for more information) to indicate which memory map applies to each tool.

7) Loads any object filenames specified with D_OPTIONS or specified on the command line during invocation.

8) Determines the initial mode (auto, assembly, or mixed) and displays the appropriate windows on the screen.

At this point, the debugger is ready to process any commands that you enter.

Appendix C

Debugger Messages

This appendix contains an alphabetical listing of the progress and error messages that the debugger might display in the COMMAND window display area. Each message contains both a description of the situation that causes the message and an action to take if the message indicates a problem or error.

Topic **Page**

C.1 Associating Sound With Error Messages

You can associate a beeping sound with the display of an error message. To do this, use the SOUND command. The format for this command is:

sound on | off

By default, no beep is associated with error messages (SOUND OFF). The beep is helpful if the COMMAND window is hidden behind other windows.

C.2 Alphabetical Summary of Debugger Messages

Symbols

‘]’ expected

Description This is an expression error—it means that the parameter contained an opening **[** symbol but didn’t contain a closing **]** symbol.

Action See Section C.3 (page C-22).

‘)’ expected

Description This is an expression error—it means that the parameter contained an opening **(** symbol but didn’t contain a closing **)** symbol.

Action See Section C.3 (page C-22).

A

Aborted by user

Description The debugger halted a long COMMAND display listing (from WHATIS, DIR, ML, or BL) because you pressed the ESC key.

Action None required; this is normal debugger behavior.

B

Breakpoint already exists at *address*

Description During single-step execution, the debugger attempted to set a breakpoint where one already existed. (This isn't necessarily a breakpoint that you set—it may have been an internal breakpoint that was used for single-stepping).

Action None should be required; you may want to reset the program entry point (RESTART) and re-enter the single-step command.

Breakpoint table full

Description 200 breakpoints are already set, and there was an attempt to set another. The maximum limit of 200 breakpoints includes internal breakpoints that the debugger may set for single-stepping. Under normal conditions, this should not be a problem; it is rarely necessary to set this many breakpoints.

Action Enter a BL command to see where breakpoints are set in your program. Use the BR command to delete all breakpoints, or use the BD command to delete individual breakpoints.

C

Cannot acquire emulator process

Description This is a parallel-processing specific error—you are unable to access the hardware. This is probably the result of another process being locked up with exclusive access.

Action Delete the locked process and decrease the number of programs running.

Cannot allocate host memory

Description This is a fatal error—it means that the debugger is running out of memory to run in.

Action You might try invoking the debugger with the –v option so that fewer symbols may be loaded. Or you might want to relink your program and link in fewer modules at a time.

Cannot allocate system memory

Description This is a fatal error—it means that the debugger is running out of memory to run in.

Action You might try invoking the debugger with the –v option so that fewer symbols may be loaded. Or you might want to relink your program and link in fewer modules at a time.

Cannot change directory

Description The directory name specified with the CD command either doesn't exist or is not in the current or auxiliary directories.

Action Check the directory name that you specified. If this is really the directory that you want, re-enter the CD command and specify the entire pathname for that directory (for example, specify C:\c4xhll, not just c4xhll).

Cannot detect target power

Description This hardware error occurs after resetting the emulator with the emurst command. Follow the steps described below and then restart your emulator.

Action

- Check the emulator board to be sure it is installed snugly.
- Check the cable connecting your emulator and target system to be sure it is not loose.
- Check the power to be sure it is on.
- Check your target board to be sure it is getting the correct voltage.
- Check your emulator scan path to be sure it is uninterrupted.
- Ensure your port address is set correctly:
  - Check to be sure the –p option of the D_OPTIONS environment variable matches the I/O address defined by your switch settings. (Refer to the *TMS320C4x C Source Debugger Installation Guide* for more information.)
  - Check to see if you have a conflict in address space with another bus setting. If you have a conflict, change the switches on your board to one of the alternate settings listed in the installation guide. Modify the –p option of the D_OPTIONS environment variable to reflect the change in your switch settings.

Cannot edit field

Description Expressions that are displayed in the WATCH window cannot be edited.

Action If you attempted to edit an expression in the WATCH window, you may have actually wanted to change the value of a symbol or register used in the expression. Use the ? or EVAL command to edit the actual symbol or register. The expression value will automatically be updated.

Cannot find/open initialization file

Description The debugger can’t find the emuinit.cmd or siminit.cmd file.

Action Be sure that the emuinit.cmd or the siminit.cmd is in the appropriate directory. If it isn’t, copy it from the debugger product diskette. If the file is already in the correct directory, verify that the D_DIR environment variable is set up to identify the directory. See *Setting Up the Debugger Environment* in the appropriate chapter in the installation guide.

Cannot halt the processor

Description This is a fatal error—for some reason, pressing ESC didn’t halt program execution.

Action Exit the debugger. Invoke the autoexec.bat file (DOS), or execute the emurst.exe command (OS/2); then invoke the debugger again.

Cannot initialize target system

Description This error occurs while you are invoking the debugger. Any combination of events may cause this error to occur.

Action

- ❑ Check the cable connecting the emulator to the target system to be sure it is not loose.
- ❑ Check the power to be sure it is on.
- ❑ Check the end of your autoexec.bat file or the beginning of your startup.cmd file for the emurst.exe command. Execute this command *after* powering up the target board.
- ❑ Ensure your port address is set correctly:
  - ■ Check to be sure the –p option of the D_OPTIONS environment variable matches the I/O address defined by your switch settings. (Refer to the *TMS320C4x C Source Debugger Installation Guide* for more information.)
  - ■ Check to see if you have a conflict in address space with another bus setting. If you have a conflict, change the switches on your board to one of the alternate settings listed in the installation guide. Modify the –p option of the D_OPTIONS environment variable to reflect the change in your switch settings.

Cannot map into reserved memory: ?

Description Your program tried to access unmapped memory.

Action Remap the reserved memory accesses. See the discussion on memory mapping in the *TMS320C4x User's Guide* for more information.

Cannot map port address

Description You attempted to do a connect/disconnect on an illegal port address.

Action Be sure that you are connecting to or disconnecting from an address that is mapped in as an input, output, or I/O port.

Cannot open config file

Description The SCONFIG command can't find the screen-customization file that you specified.

Action Be sure that the filename was typed correctly. If it wasn't, re-enter the command with the correct name. If it was, re-enter the command and specify full path information with the filename.

Cannot open emulator process

Description This error is OS/2 specific. The system is overloaded, the debugger cannot run.

Action Shut down all unnecessary programs.

Cannot open "*filename*"

Description The debugger attempted to show *filename* in the FILE window but could not find the file.

Action Be sure that the file exists as named. If it does, enter the USE command to identify the file's directory.

Cannot open new window

Description A maximum of 127 windows can be open at once. The last request to open a window would have made 128, which isn't possible.

Action Close any unnecessary windows. Windows that can be closed include WATCH, CALLS, and DISP. To close the WATCH window, enter WD. To close the CALLS window or a DISP window, make the desired window active and press F4 .

Cannot open object file: "*filename*"

Description The file specified with the LOAD, SLOAD, or RELOAD command is not an object file that the debugger can load.

Action Be sure that you're loading an actual object file. Be sure that the file was linked (you may want to run cl30 again to create an executable object file).

Cannot open port file

Description The debugger attempted to open the port file but could not find it.

Action Be sure that the file exists as named. If it does, enter the USE command to identify the file's directory.

Cannot read processor status

Description This is a fatal error—for some reason, pressing ESC didn't halt program execution.

Action Exit the debugger. Invoke the autoexec.bat file (DOS), or execute the emurst.exe command (OS/2); then invoke the debugger again.

Cannot release emulator process

Description This is an internal error and is OS/2 specific.

Action Shut down the debugger and restart it. If the problem recurs, call the hotline.

Cannot reset the processor

Description This is a fatal error—for some reason, pressing ESC didn't halt program execution.

Action Exit the debugger. Invoke the autoexec or initdb.bat file, then invoke the debugger again.

Cannot restart processor

Description If a program doesn't have an entry point, then RESTART won't reset the PC to the program entry point.

Action Don't use RESTART if your program doesn't have an explicit entry point.

Cannot set/verify breakpoint at *address*

Description Either you attempted to set a breakpoint in read-only or protected memory, or there are hardware problems with the target system.

Action Check your memory map. If the address that you wanted to breakpoint wasn't in ROM, see Section C.4 (page C-22).

Cannot take address of register

Description This is an expression error. C does not allow you to take the address of a register.

Action See Section C.3 (page C-22).

Command “*cmd*” not found

Description The debugger didn’t recognize the command that you typed.

Action Re-enter the correct command. Refer to Chapter 12 or the Quick Reference Card for a list of valid debugger commands.

Command timed out, emulator busy

Description There is a problem with the target system.

Action See Section C.4 (page C-22).

Conflicting map range

Description A block of memory specified with the MA command overlaps an existing memory map entry. Blocks cannot overlap.

Action Use the ML command to list the existing memory map; this will help you find the existing block that the new block would overlap. If the existing block is not necessary, delete it with the MD command and re-enter the MA command. If the existing block is necessary, re-enter the MA command with parameters that will not overlap the existing block.

Corrupt call stack

Description The debugger tried to update the CALLS window and couldn’t. This may be because a function was called that didn’t return. Or it could be that the call stack was overwritten in memory.

Action If your program called a function that didn’t return, then this is normal behavior (as long as you intended for the function not to return). Otherwise, you may be overwriting program memory.

E

Emulator error

Description A low-level hardware error has occurred.

Action See Section C.4 (page C-22).

Emulator I/O address is invalid

Description The debugger was invoked with the –p option and an invalid *port address* was used.

Action For valid *port address* values, refer to the appropriate emulator installation in the *TMS320C4x C Source Debugger Installation User's Guide*.

Emulator memory error

Description There is a problem with your emulator memory.

Action Be sure the emulator board is not damaged and is installed snugly in your PC. Be sure you do not have an I/O address conflict.

Emulator translation error

Description There is a problem with the target system.

Action See Section C.4 (page C-22).

Error in expression

Description This is an expression error.

Action See Section C.3 (page C-22).

Execution error

Description A low-level hardware error occurred while you were trying to run the device.

Action Be sure the device is not reset. See Section C.3 (page C-22).

F

File already tied to port

Description You attempted to connect to an address that already has a file connected to it.

Action Connect the file to a mapped port that is not yet connected to a file.

File does not exist

Description The port file could not be opened for reading.

Action Be sure that the file exists as named. If it does, enter the USE command to identify the file's directory.

Files must be disconnected from ports

Description You attempted to delete a memory map that has files connected to it.

Action You must disconnect a port with the MI command before you can delete it from the memory map.

File not found

Description The filename specified for the FILE command was not found in the current directory or any of the directories identified with D_SRC.

Action Be sure that the filename was typed correctly. If it wasn't, re-enter the FILE command with the correct name. If it was, re-enter the FILE command and specify full path information with the filename.

File not found : "*filename*"

Description The filename specified for the LOAD, RELOAD, SLOAD, or TAKE command was not found in the current directory or any of the directories identified with D_SRC.

Action Be sure that the filename was typed correctly. If it wasn't, re-enter the command with the correct name. If it was, re-enter the command and specify full path information with the filename.

File too large (*filename*)

Description You attempted to load a file that was more than 65,518 bytes long.

Action Try loading the file without the symbol table (SLOAD), or use gspcl to relink the program with fewer modules.

Float not allowed

Description This is an expression error—a floating-point value was used invalidly.

Action See Section C.3 (page C-22).

Function required

Description The parameter for the FUNC command entered was not the name of a function in the program that is loaded.

Action Re-enter the FUNC command with a valid function name.

I

Illegal addressing mode

Description An illegal ’C4x addressing mode was encountered.

Action Refer to the *TMS320C4x User’s Guide* for valid addressing modes.

Illegal cast

Description This is an expression error—the expression parameter uses a cast that doesn’t meet the C language rules for casts.

Action See Section C.3 (page C-22).

Illegal control transfer instruction

Description The instruction following a delayed branch/call instruction was modifying the program counter.

Action Modify your source code.

Illegal left hand side of assignment

Description This is an expression error—the left-hand side of an assignment expression doesn’t meet C language assignment rules.

Action See Section C.3 (page C-22).

Illegal memory access

Description Your program tried to access unmapped memory.

Action Modify your source code.

Illegal opcode

Description An invalid ’C4x instruction was encountered.

Action Modify your source code.

Illegal operand of &

Description This is an expression error—the expression attempts to take the address of an item that doesn't have an address.

Action See Section C.3 (page C-22).

Illegal pointer math

Description This is an expression error—some types of pointer math are not valid in C expressions.

Action See Section C.3 (page C-22).

Illegal pointer subtraction

Description This is an expression error—the expression attempts to use pointers in a way that is not valid.

Action See Section C.3 (page C-22).

Illegal structure reference

Description This is an expression error—either the item being referenced as a structure is not a structure, or you are attempting to reference a nonexistent portion of a structure.

Action See Section C.3 (page C-22).

Illegal use of structures

Description This is an expression error—the expression parameter is not using structures according to the C language rules.

Action See Section C.3 (page C-22).

Illegal use of void expression

Description This is an expression error—the expression parameter does not meet the C language rules.

Action See Section C.3 (page C-22).

Integer not allowed

Description This is an expression error—the command did not accept an integer as a parameter.

Action See Section C.3 (page C-22).

Invalid address
––– Memory access outside valid range: *address*

Description The debugger attempted to access memory at *address*, which is outside the memory map.

Action Check your memory map to be sure that you access valid memory.

Invalid argument

Description One of the command parameters does not meet the requirements for the command.

Action Re-enter the command with valid parameters. Refer to the appropriate command description in Chapter 12.

Invalid attribute name

Description The COLOR and SCOLOR commands accept a specific set of area names for their first parameter. The parameter entered did not match one of the valid attributes.

Action Re-enter the COLOR or SCOLOR command with a valid area name parameter. Valid area names are listed in Table 9–2 (page 9-3).

Invalid color name

Description The COLOR and SCOLOR commands accept a specific set of color attributes as parameters. The parameter entered did not match one of the valid attributes.

Action Re-enter the COLOR or SCOLOR command with a valid color parameter. Valid color attributes are listed in Table 9–1 (page 9-2).

Invalid memory attribute

Description The third parameter of the MA command specifies the type, or attribute, of the block of memory that MA adds to the memory map. The parameter entered did not match one of the valid attributes.

Action Re-enter the MA command. Use one of the following valid parameters to identify the memory type:

R, ROM, READONLY	(read-only memory)
W, WOM, WRITEONLY	(write-only memory)
RW, RAM	(read/write memory)
PROTECT	(no-access memory)
OPORT	(I/O memory, simulator only)
IPORT	(I/O memory, simulator only)
IOPORT	(I/O memory, simulator only)

Invalid object file

Description Either the file specified with the LOAD, SLOAD, or RELOAD command is not an object file that the debugger can load, or it has been corrupted.

Action Be sure that you're loading an actual object file. Be sure that the file was linked (you may want to run dspcl again to create an executable object file). If the file you attempted to load was a valid executable object file, then it was probably corrupted; recompile, assemble, and link with dspcl.

Invalid register

Description This is an internal error.

Action Shut down the debugger and restart it. If the problem recurs, call the hotline.

Invalid scan path

Description This is an internal error.

Action Shut down the debugger and restart it. If the problem recurs, call the hotline.

Invalid target revision

Description The debugger attempted to debug an unknown revision of the ’C4x processor.

Action Your debugger needs to be updated.

Invalid watch delete

Description The debugger can't delete the parameter supplied with the WD command. Usually, this is because the watch index doesn't exist or because a symbol name was typed in instead of a watch index.

Action Re-enter the WD command. Be sure to specify the watch index that matches the item you'd like to delete (this is the number in the left column of the WATCH window). Remember, you can't delete items symbolically—you must delete them by number.

Invalid window position

Description The debugger can't move the active window to the XY position specified with the MOVE command. Either the XY parameters are not within the screen limits, or the active window may be too large to move to the desired position.

Action

- You can use the mouse to move the window.
- If you don't have a mouse, enter the MOVE command without parameters; then use the arrow keys to move the window. When you're finished, you *must* press ESC or ↵.
- If you prefer to use the MOVE command with parameters, the minimum XY position is 0,1; the maximum position depends on which screen size you're using.

Invalid window size

Description The width and length specified with the SIZE or MOVE command may be too large or too small. If valid width and length were specified, then the active window is already at the far right or bottom of the screen and so cannot be made larger.

Action

- You can use the mouse to size the window.
- If you don't have a mouse, enter the SIZE command without parameters; then use the arrow keys to move the window. When you're finished, you *must* press ESC or ↵.
- If you prefer to use the SIZE command with parameters, the minimum size is 4 by 3; the maximum size depends on which screen size you're using.

L

Load aborted

Description This message always follows another message.

Action Refer to the message that preceded *Load aborted*.

Lost power (or cable disconnected)

Description Either the target cable is disconnected, or the target system is faulty.

Action Check the target cable connections. If the target seems to be connected correctly, see Section C.4 (page C-22).

Lost processor clock

Description Either the target cable is disconnected, or the target system is faulty.

Action Check the target cable connections. If the target seems to be connected correctly, see Section C.4 (page C-22).

Lost target power or clock

Description Either the target cable is disconnected, or the target system is faulty.

Action Check the target cable connections. If the target seems to be connected correctly, see Section C.4 (page C-22).

Lval required

Description This is an expression error—an assignment expression was entered that requires a legal left-hand side.

Action See Section C.3 (page C-22).

M

Memory access error at *address*

Description Either the processor is receiving a bus fault, or there are problems with target system memory.

Action See Section C.4 (page C-22).

Memory access outside valid range: *address*

Description Your program tried to access to unmapped memory.

Action Check your memory map.

Memory map table full

Description Too many blocks have been added to the memory map. This rarely happens unless someone is adding blocks word by word (which is inadvisable).

Action Stop adding blocks to the memory map. Consolidate any adjacent blocks that have the same memory attributes.

N

Name “*name*” not found

Description The command cannot find the object named *name*.

Action

- ❑ If *name* is a symbol, be sure that it was typed correctly. If it wasn’t, re-enter the command with the correct name. If it was, then be sure that the associated object file is loaded.
- ❑ If *name* was some other type of parameter, refer to the command’s description for a list of valid parameters.

No breakpoint at address

Description This is an internal error.

Action Shut down the debugger and restart it. If the problem recurs, call the hotline.

Nonrepeatable instruction

Description The instruction following the RPT instruction is not a repeatable instruction.

Action Modify your code.

P

Pointer not allowed

Description This is an expression error.

Action See Section C.3 (page C-22).

Processor access timeout at address

Description There is a problem with your target system.

Action See Section C.4 (page C-22).

R

Read not allowed for port

Description There was an attempt to connect a file for input operation to an address that is not configured for read.

Action Remap the port or correct the access in your source code.

Register access error

Description Either the processor is receiving a bus fault, or there are problems with target-system memory.

Action See Section C.4 (page C-22).

S

Specified map not found

Description The MD command was entered with an address or block that is not in the memory map.

Action Use the ML command to verify the current memory map. When using MD, you can specify only the first address of a defined block.

Structure member not found

Description This is an expression error—an expression references a nonexistent structure member.

Action See Section C.3 (page C-22).

Structure member name required

Description This is an expression error—a symbol name followed by a period but no member name.

Action See Section C.3 (page C-22).

Structure not allowed

Description This is an expression error—the expression is attempting an operation that cannot be performed on a structure.

Action See Section C.3 (page C-22).

SYS0197: The operating system is not presently configured to run this application.

Description This is a configuration error—it means that the IOPL in your config.sys file is not set correctly.

Action Be sure the command IOPL=YES is included in your config.sys file. For more details, see Chapter 1 of the *TMS320C4x Emulator Installation Guide.*

T

Take file stack too deep

Description Batch files can be nested up to 10 levels deep. Batch files can call other batch files, which can call other batch files, and so on. Apparently, the batch file that you are TAKEing calls batch files that are nested more than 10 levels.

Action Edit the batch file that caused the error. Instead of calling another batch file from within the offending file, you may want to copy the contents of the second file into the first. This will remove a level of nesting.

Too few instruction words in RPTB

Description Length of repeat block was less than three instruction words.

Action Modify your source code.

Too many breakpoints

Description 200 breakpoints are already set, and there was an attempt to set another. Note that the maximum limit of 200 breakpoints includes internal breakpoints that the debugger may set for single-stepping. Under normal conditions, this should not be a problem; it is rarely necessary to set this many breakpoints.

Action Enter a BL command to see where breakpoints are set in your program. Use the BR command to delete all breakpoints, or use the BD command to delete individual breakpoints.

Too many paths

Description More than 20 paths have been specified cumulatively with the USE command, D_SRC environment variable, and –i debugger option.

Action If you are entering the USE command before entering another command that has a *filename* parameter, don't enter the USE command. Instead, enter the second command and specify full path information for the *filename*.

U

Undeclared port address

Description You attempted to do a connect/disconnect on an address that isn't declared as a port.

User halt

Description The debugger halted program execution because you pressed the ESC key.

Action None required; this is normal debugger behavior.

W

Window not found

Description The parameter supplied for the WIN command is not a valid window name.

Action Re-enter the WIN command. Remember that window names must be typed in uppercase letters. Here are the valid window names; the bold letters show the smallest acceptable abbreviations:

CALLS
COMMAND
PROFILE
CPU
DISASSEMBLY
DISP
FILE
MEMORY
WATCH

Write not allowed for port

Description You attempted to connect a file for output operation to an address that is not configured for write.

Action Remap the port or correct the access in your source code.

C.3 Additional Instructions for Expression Errors

Whenever you receive an expression error, you should re-enter the command and edit the expression so that it follows the C language expression rules. If necessary, refer to a C language manual such as ***The C Programming Language*** by Brian W. Kernighan and Dennis M. Ritchie.

C.4 Additional Instructions for Hardware Errors

If you continue to receive the messages that send you to this section, this indicates persistent hardware problems.

❑ If a bus fault occurs, the emulator may not be able to access memory.

❑ The ’C4x must be reset before you can use the emulator. Most target systems reset the ’C4x at power-up; your target system may not be doing this.

Appendix D

Glossary

A

active window: Window that is currently selected for moving, sizing, editing, closing, or some other function.

aggregate type: A C data type, such as a structure or array, where a variable is composed of multiple variables, called members.

aliasing: A method of customizing debugger commands; aliasing provides a shorthand method for entering often-used command strings.

ANSI C: A version of the C programming language that conforms to the C standards defined by the *American National Standards Institute.*

assembly mode: A debugging mode that shows assembly language code in the DISASSEMBLY window and doesn't show the FILE window, no matter what type of code is currently running.

autoexec.bat: A batch file that contains DOS commands for initializing your PC.

auto mode: A context-sensitive debugging mode that automatically switches between showing assembly language code in the DISASSEMBLY window or C code in the FILE window, depending on what type of code is currently running.

B

batch file: One of two different types of files. One type of batch file contains DOS or OS/2 commands for the PC to execute. A second type of batch file contains debugger commands for the debugger to execute. The PC doesn't execute debugger batch files, and the debugger doesn't execute PC batch files.

benchmarking: A type of program execution that allows you to track the number of CPU cycles consumed by a specific section of code.

breakpoint: A point within your program where execution will halt because of a previous request from you.

break event: An event that causes the processor to halt.

C

CALLS window: A window that lists the functions called by your program.

casting: A feature of C expressions that allows you to use one type of data as if it were a different type of data.

children: Additional windows opened for aggregate types that are members of a parent aggregate type displayed in an existing DISP window.

cl30 –v40: A shell utility that invokes the TMS320 floating-point DSP compiler, assembler, and linker to create an executable object file version of your program.

click: To press and release a mouse button without moving the mouse.

CLK: A pseudoregister that shows the number of CPU cycles consumed during benchmarking. The value in CLK is valid only after entering a RUNB command but before entering another RUN command.

code-display windows: Windows that show code, text files, or code-specific information. This category includes the DISASSEMBLY, FILES, and CALLS windows.

COFF: *Common Object File Format*. An implementation of the object file format of the same name developed by AT&T. The TMS320 floating-point DSP compiler, assembler, and linker use and generate COFF files.

command line: The portion of the COMMAND window where you can enter commands.

command-line cursor: A block-shaped cursor that identifies the current character position on the command line.

COMMAND window: A window for you to enter commands and for the debugger to echo command entry, show command output, and list progress or error messages.

config.sys: A batch file that contains OS/2 commands for initializing your PC.

CPU window: Displays the contents of ’C4x on-chip registers, including the program counter, status register, A-file registers, and B-file registers.

current-field cursor: A screen icon that identifies the current field in the active window.

cursor: An icon on the screen (such as a rectangle or a horizontal line) that is used as a pointing device. The cursor is usually under mouse or keyboard control.

D

data-display windows: Windows for observing and modifying various types of data. This category includes the MEMORY, CPU, DISP, and WATCH windows.

D_DIR: An environment variable that identifies the directory containing the commands and files necessary for running the debugger.

debugger: A window-oriented software interface that helps you to debug ’320 programs running on a ’320 development board or ’32040 emulator.

disassembly: The reverse-assembly of the contents of memory to form assembly language code.

DISASSEMBLY window: A window that displays the disassembly of memory contents.

discontinuity: A state in which the addresses fetched by the debugger become nonsequential as a result of loading the PC through branches, calls, and return instructions, for example (these events load the PC with new values).

DISP window: A window that displays the members of an aggregate data type.

display area: The portion of the COMMAND window where the debugger echoes command entry, shows command output, and lists progress or error messages.

D_OPTIONS: An environment variable that you can use for identifying often-used debugger options.

drag: To move the mouse while pressing one of the mouse buttons.

D_SRC: An environment variable that identifies directories containing program source files.

E

EGA: *Enhanced Graphics Adaptor.* An industry standard for video cards.

EISA: *Extended Industry Standard Architecture.* A standard for PC buses.

emulator: A debugging tool that is external to the target system and provides direct control over the ’320 processor that is on the target system.

emurst: A utility that resets the emulator.

environment variable: A special system symbol that the debugger uses for finding directories or obtaining debugger options.

event: An operation performed in hardware such as branches, calls, and return instructions.

F

FILE window: A window that displays the contents of the current C code. The FILE window is primarily intended for displaying C code but can be used to display any text file.

I

I/O switches: Hardware switches on the emulator board that identify the PC I/O memory space used for emulator–debugger communications.

ISA: *Industry Standard Architecture*. A subset of the EISA standard.

M

masking: To ignore the last 16 bits of a specified address. The processor detects all reads from and writes to addresses containing the first 16 bits of the specified address. This allows you to follow the progress of events occurring on a range of addresses.

memory map: A map of memory space that tells the debugger which areas of memory can and can't be accessed.

MEMORY window: A window that displays the contents of memory.

menu bar: A row of pulldown menu selections found at the top of the debugger display.

mixed mode: A debugging mode that simultaneously shows both assembly language code in the DISASSEMBLY window and C code in the FILE window.

mouse cursor: A block-shaped cursor that tracks mouse movements over the entire display.

O

open-collector output: An output circuit that actively drives both high and low logic levels.

P

PC: Personal computer or program counter, depending on the context and where it's used in this book: 1) In installation instructions or information relating to hardware and boards, *PC* means *Personal Computer* (as in IBM PC). 2) In general debugger and program-related information, *PC* means *Program Counter*, which is the register that identifies the current statement in your program.

point: To move the mouse cursor until it overlays the desired object on the screen.

port address: The PC I/O memory space that the debugger uses for communicating with the emulator. The port address is selected via switches on the emulator board and communicated to the debugger with the –p debugger option.

pulldown menu: A command menu that is accessed by name or with the mouse from the menu bar at the top of the debugger display.

R

ripple-carry output signal: An output signal from a counter indicating that the counter has reached its maximum value.

S

scalar type: A C type in which the variable is a single variable itself, not composed of other variables.

scrolling: A method of moving the contents of a window up, down, left, or right to view contents that weren't originally shown.

side effects: A feature of C expressions in which using an assignment operator in an expression affects the value of one of the components used in the expression.

single-step: A form of program execution that allows you to see the effects of each statement. The program is executed statement by statement; the debugger pauses after each statement to update the data-display windows.

symbol table: A file that contains the names of all variables and functions in your ’320 program.

system shell: A method implemented with the SYSTEM command, by which the debugger can blank the debugger display and temporarily exit to the DOS prompt. This allows you to enter DOS commands *or* allows the debugger to display information resulting from a DOS command.

T

target system: A ’320 board that works with the emulator; the emulator doesn’t contain a ’320 device, so it must use a ’320 target board. Usually, the target system is a board that you have designed; you use the emulator and debugger to help you debug your design.

totem-pole output: An output circuit that actively drives both high and low logic levels.

V

VGA: *Video Graphics Array.* An industry standard for video cards.

W

WATCH window: A window that displays the values of selected expressions, symbols, addresses, and registers.

window: A defined rectangular area of virtual space on the display.

Index

Note: All page numbers preceded by the word *Emu* refer to the *TMS320C4x Emulator Installation Guide*; those page numbers preceded by *Sim* refer to the *TMS320C4x Simulator Installation Guide*. All other references refer to this user's guide.