TMS320C2xx C Source Debugger User's Gude
Collation List—Electronic Transfer List

TDS Job Number: 65121
Literature Number: SPRU151
Engineering Part Number: D412006–9761 revision *

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Symbol A
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Symbols
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Operating System: SunOS 4.1.3

Authoring/Word Processing Software: Interleaf 5.4.1

Media: 1/4" tape cartridge (DC6150)

PostScript Information: All fonts should be self-contained in the PostScript files. PostScript files are FTPs or written to tape in UNIX TAR format by default; other formats can be arranged with prior conditions

TMS320C2xx C Source Debugger User's Guide

Literature Number: SPRU151A
Manufacturing Part Number: D412006-9761 revision A
October 1996

TEXAS INSTRUMENTS

Preface

Read This First

About This Manual

This book tells you how to use the TMS320C2xx C source debugger with these debugging tools:

- ❑ Emulator
- ❑ Simulator

Each tool has its own version of the debugger. These versions operate almost identically; however, the executable files that invoke them are very different. For example, the simulator version won't work with the emulator, and vice versa. Separate commands are provided for invoking each version of the debugger.

For the simulator version of the debugger, there are two debugger environments: the basic debugger environment and the profiling environment. The basic debugger environment is a general-purpose debugging environment. The profiling environment is a special environment for collecting statistics about code execution. Both environments have the same interface.

In addition to the debugger environment, you can use the parallel debug manager (PDM) with the emulator version of the debugger. The PDM allows you to control and coordinate multiple debuggers, giving you the flexibility and power to debug your entire application for your multiprocessing system. The PDM and its functions and features are described in this book.

Before you use this book, you should use the appropriate installation guide to install the C source debugger and any necessary hardware.

How to Use This Manual

The goal of this book is to help you learn to use the Texas Instruments standard programmer's interface for debugging. 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 lists the key features of the debugger, describes additional 'C2xx software tools, tells you how to prepare a 'C2xx program for debugging, and provides instructions and options for invoking the debugger and the PDM.

  ■ Chapter 2 describes the PDM and the commands that you can use to control multiple debuggers.

  ■ Chapter 3 is a 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 4 describes all of the debugger's windows and tells you how to move them and size them; Chapter 5 describes everything you need to know about entering commands.

❑ **Part III: Reference Material** provides supplementary information.

  ■ Chapter 5 gives 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 14 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 mighy want to:
  - Read the introductory material in Chapter 1.
  - If you plan to debug an application for a multiprocessing system, read Chapter 2.
  - Complete the tutorial in Chapter 3.
  - Read the alphabetical command reference in Chapter 5.
- ❑ If this is the first time that you have used a debugger or similar tool, then you might want to:
  - Read the introductory material in Chapter 1.
  - If you plan to debug an application for a multiprocessing system, read Chapter 2.
  - Complete the tutorial in Chapter 3.
  - Read all of the chapters in Part II.

Notational Conventions

This document uses the following conventions.

- ❑ The TMS320C203 and TMS320C209 are referred to collectively as the ’C2xx. ’C2xx also refers to any other cDSP that uses the LP25 core.
- ❑ 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; 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 that 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 of both. To emphasize this fact, commands are shown throughout this user's guide in both uppercase and lowercase.

- Program listings, program examples, and interactive displays are shown in a `special typeface` similar to a typewriter's. Examples use a **`bold version`** of the special typeface for emphasis; interactive displays use a **`bold version`** of the special typeface to distinguish commands that you enter from items that the system displays (such as prompts, command output, error messages, etc.). Here is an example:

Command / **Result displayed in the COMMAND window**

```
whatis aai          int aai[10][5];

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 display area of the COMMAND window.

- In syntax descriptions, the instruction, command, or directive is in a **bold typeface** font and parameters are in an *italic typeface*. Portions of a syntax that are in **bold** should be entered as shown; portions of a syntax that are in *italics* describe the type 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.

- Braces ({ and }) indicate a list. The symbol **|** (read as *or*) separates items within the list. Here's an example of a list:

  sound {**on** | **off**}

  This provides two choices: **sound on** or **sound off**.

  Unless the list is enclosed in square brackets, you must choose one item from the list.

Information About Cautions

This book contains cautions.

This is an example of a caution statement.

A caution statement describes a situation that could potentially damage your software or equipment.

CAUTION

The information in a caution is provided for your protection. Please read each caution carefully.

Related Documentation From Texas Instruments

The following books describe the TMS320C2xx DSPs and related support tools. To obtain a copy of any of these TI documents, call the Texas Instruments Literature Response Center at (800) 477−8924. When ordering, please identify the book by its title and literature number.

TMS320C1x/C2x/C2xx/C5x Assembly Language Tools User's Guide (literature number SPRU018) 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 'C1x, 'C2x, 'C2xx, and 'C5x generations of devices.

TMS320C2x/C2xx/C5x Optimizing C Compiler User's Guide (literature number SPRU024) describes the 'C2x/C2xx/C5x C compiler. This C compiler accepts ANSI standard C source code and produces TMS320 assembly language source code for the 'C2x, 'C2xx, and 'C5x generations of devices.

TMS320C2xx User's Guide (literature number SPRU127) discusses the hardware aspects of the 'C2xx fixed-point digital signal processors. It describes pin assignments, architecture, instruction set, and software and hardware applications. It also includes electrical specifications and package mechanical data for all 'C2xx devices. The book features a section comparing instructions from 'C2x to 'C2xx.

Related Documentation

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

American National Standard for Information Systems—Programming Language C X3.159-1989, American National Standards Institute (ANSI standard for C)

Programming in C, Kochan, Steve G., Hayden Book Company

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

FCC Warning

This equipment is intended for use in a laboratory test environment only. It generates, uses, and can radiate radio frequency energy and has not been tested for compliance with the limits of computing devices pursuant to subpart J of part 15 of FCC rules, which are designed to provide reasonable protection against radio frequency interference. Operation of this equipment in other environments may cause interference with radio communications, in which case the user at his own expense will be required to take whatever measures may be required to correct this interference.

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2) Please mention the full title of the book, the literature number from the lower-right corner of the back cover, and the publication date from the spine or front cover.

Contents

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Tables

Examples

Map monitor? Something that prevents you from setting breakpoints?? Roland mentioned it to Mary. Dave Matt knows something about it.

Chapter 1

Overview of a Code Development and Debugging System

The TMS320C2xx C source debugger is an advanced programmer's interface that helps you to develop, test, and refine 'C2xx C programs (compiled with the 'C2x/'C2xx/'C5x optimizing ANSI C compiler) and assembly language programs. The debugger is the interface to the 'C2xx simulator and scan-based emulator.

This chapter gives an overview of the programmer's interface, describes the 'C2xx code development environment, and provides instructions and options for invoking the debugger.

Topic **Page**

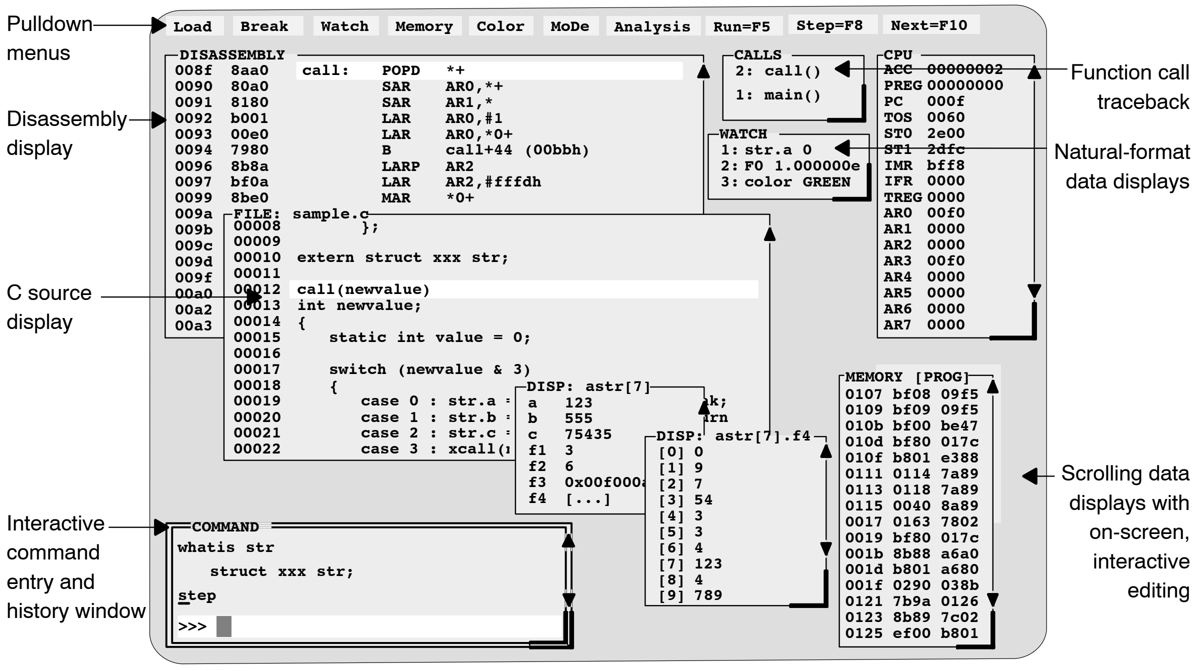
1.1 Description of the C Source Debugger

The ’C2xx C source debugging interface 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 ’C2xx debugger’s higher level features are available even when you’re debugging assembly language code.

The Texas Instruments advanced programmer’s interface 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. 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



```
008f  8aa0   call:   POPD   *+
0090  80a0           SAR    AR0,*+
0091  8180           SAR    AR1,*
0092  b001           LAR    AR0,#1
0093  00e0           LAR    AR0,*0+
0094  7980           B      call+44 (00bbh)
0096  8b8a           LARP   AR2
0097  bf0a           LAR    AR2,#fffdh
0099  8be0           MAR    *0+
009a
009b
009c
009d
009f
00a0
00a2
00a3
```

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

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

```
ACC  00000002
PREG 00000000
PC   000f
TOS  0060
ST0  2e00
ST1  2dfc
IMR  bff8
IFR  0000
TREG 0000
AR0  00f0
AR1  0000
AR2  0000
AR3  00f0
AR4  0000
AR5  0000
AR6  0000
AR7  0000
```

```
00008        };
00009
00010  extern struct xxx str;
00011
00012  call(newvalue)
00013  int newvalue;
00014  {
00015     static int value = 0;
00016
00017     switch (newvalue & 3)
00018     {
00019        case 0 : str.a =                  k;
00020        case 1 : str.b =                  rn
00021        case 2 : str.c =
00022        case 3 : xcall(
```

```
a   123
b   555
c   75435
f1  3
f2  6
f3  0x00f000a
f4  [...]
```

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

```
0107 bf08 09f5
0109 bf09 09f5
010b bf00 be47
010d bf80 017c
010f b801 e388
0111 0114 7a89
0113 0118 7a89
0115 0040 8a89
0017 0163 7802
0019 bf80 017c
001b 8b88 a6a0
001d b801 a680
001f 0290 038b
0121 7b9a 0126
0123 8b89 7c02
0125 ef00 b801
```

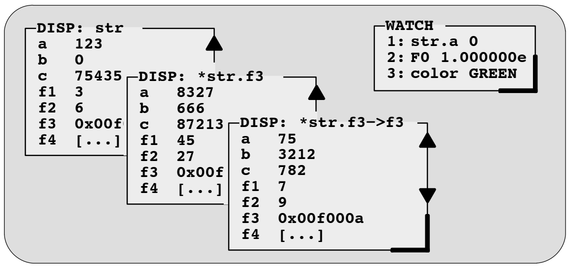
```
whatis str
   struct xxx str;
step
>>>
```

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 'C2xx C source debugger supports a small but powerful command set that makes full use of C expressions. One debugger command performs actions that would take 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 reenter 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 (Emulator Only)

In addition to the basic debugger features, the ’C2xx 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.

Key features of the analysis interface include:

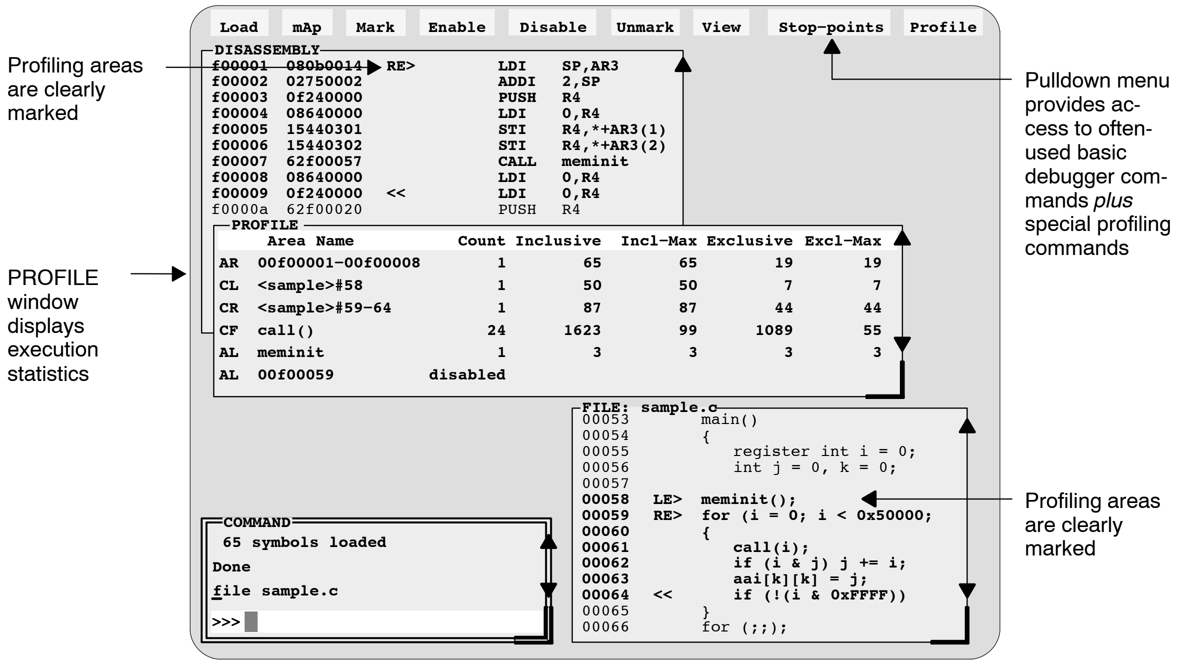
- **Hardware breakpoints.** You can also set up the analysis interface to halt the processor during execution of your program. The events that cause the processor to stop are called *break events*. A break event can define a variety of conditions, including:
  - Bus accesses
  - Low levels on EMU0/1 pins
- **Set up EMU0/1 pins.** In a system of multiple ’C2xx 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.

1.3 Description of the Profiling Environment (Simulator Only)

In addition to the basic debugging environment, a second environment—the *profiling environment*—is available for the simulator version of the debugger. 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


Load
mAp
Mark
Enable
Disable
Unmark
View
Stop-points
Profile
Profiling areas are clearly marked
PROFILE window displays execution statistics
Pulldown menu provides access to often-used basic debugger commands *plus* special profiling commands
Profiling areas are clearly marked

```
DISASSEMBLY
f00001  080b0014  RE>        LDI    SP,AR3
f00002  02750002             ADDI   2,SP
f00003  0f240000             PUSH   R4
f00004  08640000             LDI    0,R4
f00005  15440301             STI    R4,*+AR3(1)
f00006  15440302             STI    R4,*+AR3(2)
f00007  62f00057             CALL   meminit
f00008  08640000             LDI    0,R4
f00009  0f240000  <<         LDI    0,R4
f0000a  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 has 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 toward 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 Description of the Parallel Debug Manager (Emulator Only)

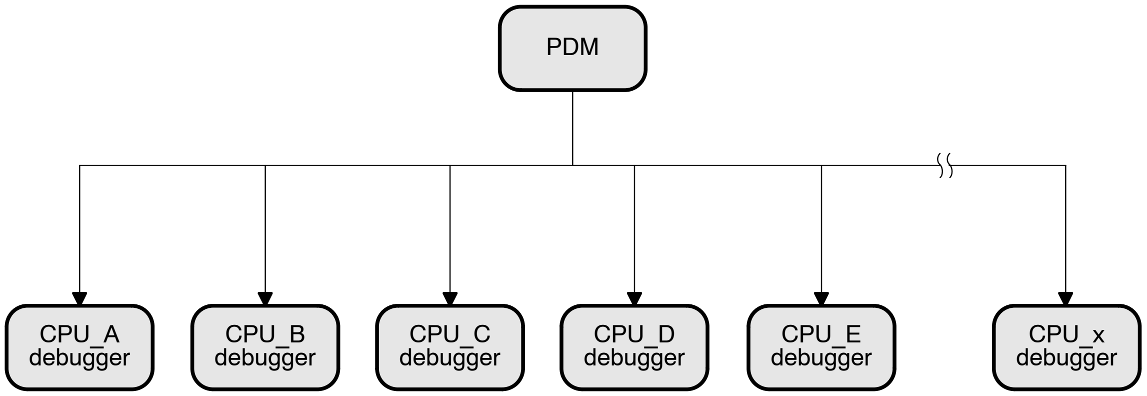
The TMS320C2xx emulation system is a true multiprocessing debugging system. It allows you to debug your entire application by using the parallel debug manager (PDM). The PDM is a command shell that controls and coordinates multiple debuggers, providing you with the ability to:

- ❑ Create and control debuggers for one or more processors
- ❑ Organize debuggers into groups
- ❑ Send commands to one or more debuggers
- ❑ Synchronously run, step, and halt multiple processors in parallel
- ❑ Gather system information in a central location

You can operate the PDM only on a PC™ running OS/2™ or a SPARCstation™ running SunOS™. The PDM is invoked and PDM commands are executed from a command shell window under the host windowing system. From the PDM, you can invoke and control debuggers for each of the processors in your multiprocessing system.

As Figure 1–3 shows, you can run multiple debuggers under the control of the PDM.

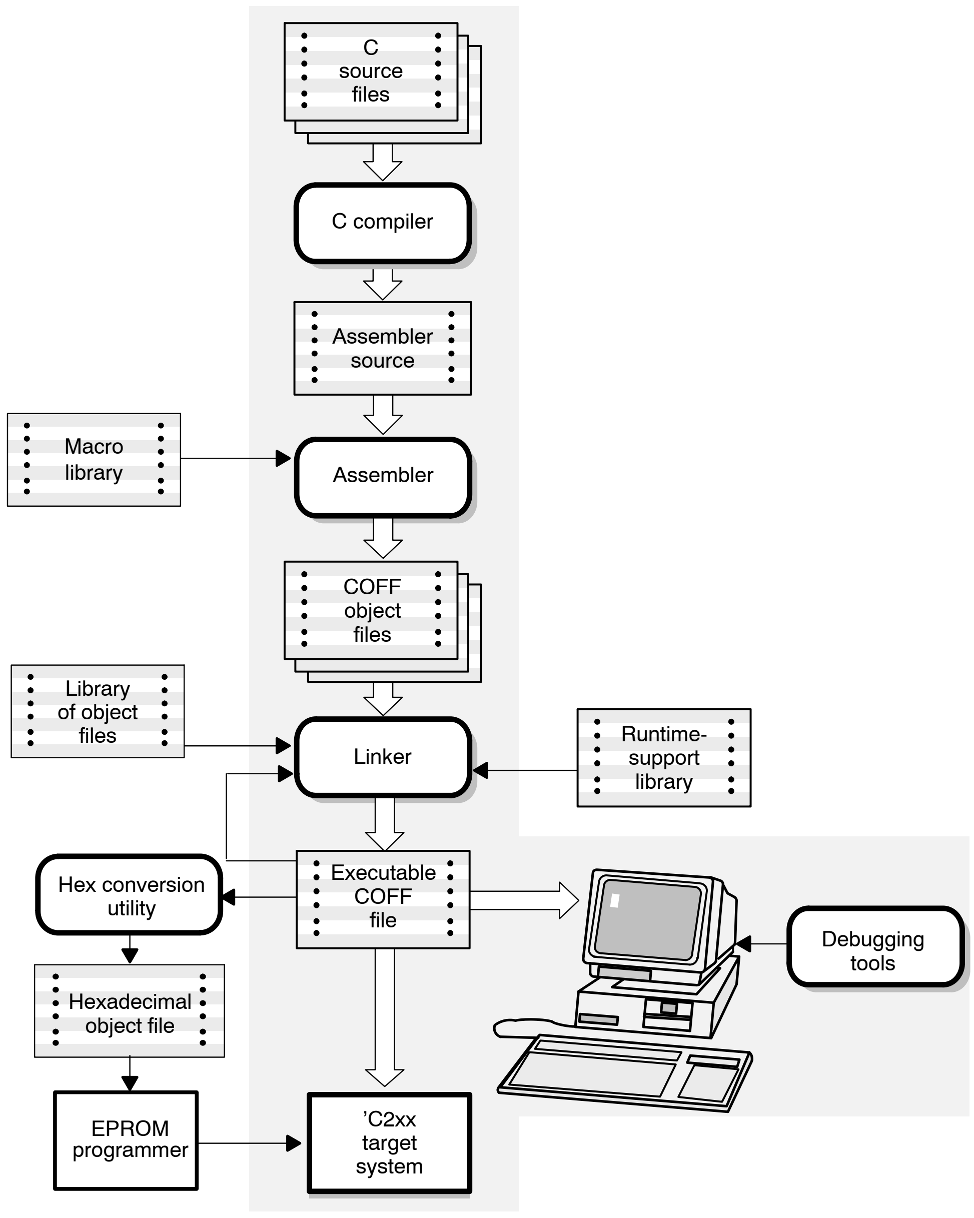
Figure 1–3. The PDM Environment



1.5 Developing Code for the 'C2xx

The 'C2xx is well supported by a complete set of hardware and software development tools, including a C compiler, assembler, and linker. Figure 1−4 illustrates the 'C2xx code development flow. The most common paths of software development are highlighted in grey; the other portions are optional.

Figure 1−4. 'C2xx 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 1−4.

C compiler

The ’C2x/’C2xx/’C5x optimizing ANSI **C compiler** is a full-featured optimizing compiler that translates standard ANSI C programs into ’C2xx 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 operations, and hyperbolic operations. 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 ’C2xx 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 **’C2xx target system.** You can use a **debugging tool** to refine and correct your code. Available products include:

❑ A scan-based **emulator**
❑ A software **simulator**

Each of these tools uses the ’C2xx debugger as a software interface.

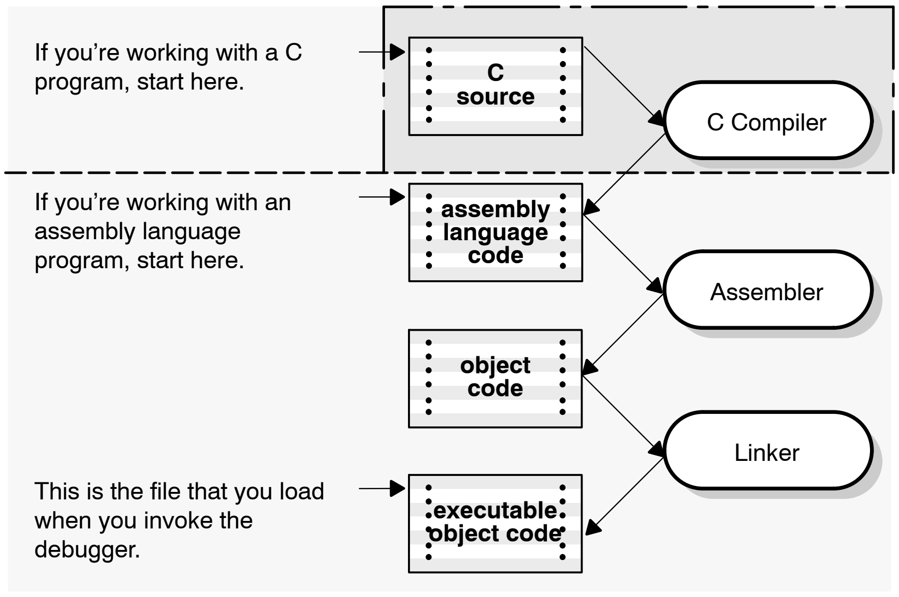
hex conversion utility

A **hex conversion utility** is also available; it converts a COFF object file into an ASCII-Hex, Intel, Motorola-S, Tektronix, or TI-tagged object-format file that can be downloaded to an EPROM programmer.

1.6 Preparing Your Program for Debugging

Figure 1−5 illustrates the steps you must go through to prepare a program for debugging.

Figure 1−5. 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 option.** If you plan to use the profiler, compile the program with the −as option. 2) Assemble the resulting assembly language program. (The compiler does this automatically.) 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 dspcl shell program. The *TMS320C1x/C2x/C2xx/C5x Assembly Language Tools User's Guide* and the *TMS320C2x/C2xx/C5x 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:

dspcl [–*options*] **–g** *filenames* [**–z** [*link options*]]

dspcl	invokes the compiler and assembler.
options	affect the way the shell processes input files. If you plan to use the debugger's profiling environment, include the –as option.
–g	tells the C compiler to produce symbolic debugging information. When preparing a C program for debugging, you must use the –g option, or you won't be able to access symbolic debugging information (such as C labels, variables, etc.).
filenames	are one or more C source files, assembly language source files, or object files. Filenames are not case sensitive.
–z	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, and it must precede all linker options.

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

Extension	File type	The shell will...
.c	C source	Compile, assemble, and link the file
.asm	Assembly language source	Assemble and link the file
.s* (any extension that begins with s)	Assembly language source	Assemble and link the file
.o* (extension begins with o)	Object file	Link the file
none (.c assumed)	C source	Compile, assemble, and link the file

Note: The shell links files only if you specify the –z option.

1.7 Invoking the Debuggers and the PDM

If you are using an emulator, there are two ways to invoke the debugger:

- ❑ You can invoke a standalone debugger that is *not* controlled by the parallel debug manager (PDM).
- ❑ You can invoke several debuggers that are under control of the PDM.

If you are using a simulator, you can invoke only a standalone debugger.

This section describes how to invoke any version of the debugger and how to invoke the PDM.

Invoking a standalone debugger

Here's the basic format for the command that invokes a standalone debugger:

```
emulator:  emu2xx  [filename]  [options]
simulator: sim2xx  [filename]  [options]
```

emu2xx and **sim2xx**	Invoke the debugger. Enter one of these commands from the operating-system command line. Note that **emu2xx** refers to the emu2xx, emu2xxo, emu2xxw, and emu2xxwm executables.
filename	An optional parameter that names an object file that the debugger loads 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. See Section 1.8, page 1-17, for a complete list of debugger options.

Invoking multiple debuggers (emulator only)

Before you can invoke multiple debuggers in a multiprocessing environment, you must first invoke the parallel debug manager (PDM). The PDM is invoked and PDM commands are executed from a command shell window under the host windowing system. The format for invoking the PDM is:

pdm [**–t** *filename*]

Once the PDM is invoked, you will see the PDM command prompt (PDM:1>>) and can begin entering commands.

When you invoke the PDM, it looks for a file called init.pdm. This file contains initialization commands for the PDM. The PDM searches for the init.pdm file in the current directory and in the directories you specify with the D_DIR environment variable. If the PDM can't find the initialization file, you will see this message: Cannot open take file.

Note:

The PDM environment uses the interprocess communication (IPC) features of UNIX™ (shared memory, message queues, and semaphores) to provide and manage communications between the different tasks. If you are not sure whether the IPC features are enabled, see your system administrator. To use the PDM environment, you should be familiar with the IPC status (ipcs) and IPC remove (ipcrm) UNIX commands. If you use the UNIX task kill (kill) command to terminate execution of tasks, you will also need to use the ipcrm command to terminate the shared memory, message queues, and semaphores used by the PDM.

When you debug a multiprocessing application, each processor must have its own debugger. These debuggers can be invoked individually from the PDM command line.

To invoke a debugger, use the SPAWN command. Here's the basic format for this command:

```
spawn   emu2xx   [filename]   [options]
```

emu2xx	Invokes the debugger. Note that **emu2xx** refers to the emu2xx, emu2xxo, emu2xxw, and emu2xxwm executables. In order to invoke a debugger, the PDM must be able to find the executable file for that debugger. The PDM will first search the current directory and then search the directories listed with the PATH statement or path environment variable.
–n *processor name*	Supplies a processor name. You *must* use the –n option because the PDM uses processor names to identify the various debuggers that are running. The processor name can consist of up to eight alphanumeric characters or underscore characters and must begin with an alphanumeric character. Note that the name is not case sensitive. The processor name must match one of the names defined in your board configuration file (see Appendix B, *Describing Your Target System to the Debugger*). For example, to invoke a debugger for a 'C2xx that you had defined as CPU_A, you would enter: `spawn emu2xx –n CPU_A`
filename	An optional parameter that names an object file that the debugger loads 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. See Section 1.8, page 1-17, for a complete list of debugger options.

1.8 Debugger Options

Table 1−1 lists the debugger options that you can use when invoking a debugger, and the subsections that follow the table describe these options. You can also specify filename and option information with the D_OPTIONS environment variable (see *Setting up the environment variables* in your installation guide).

Table 1−1. Summary of Debugger Options

Option	Brief Description	Debugger Tools	See Page
−@	Recognize commands from the BTT software	Emulator	1-17
−b	Select a preset screen size	All	1-18
−bb	Select a preset screen size	All	1-18
−bl	Select the screen length	All	1-18
−bw	Select the screen width	All	1-18
−c	Clear the .bss section	All	1-19
−d *machinename*	Display the debugger on different machine	All (X Window System™ only)	1-19
−f *filename*	Identify a new board configuration file	Emulator	1-19
−i *pathname*	Identify additional directories	All	1-19
−min	Select the minimal debugging mode	All	1-20
−mv	Select the device version to simulate	Simulator	1-20
−n *processor name*	Identify processor for debugging	Emulator	1-20
−p *port address*	Identify the port address	Emulator	1-21
−profile	Enter the profiling environment	Simulator	1-21
−r	Use the debugger in real-time mode	Emulator	1-21
−s	Load the symbol table only	All	1-22
−t *filename*	Identify a new initialization file	All	1-22
−v	Load without the symbol table	All	1-22
−x	Ignore D_OPTIONS	All	1-22

Recognizing commands from the BTT software (−@ option)

This option is valid only when you are using the emulator. The −@ option allows the debugger to recognize commands that you send from the XDS522A BTT software. If you do not invoke the debugger with the −@ option, the debugger will not respond to commands from the BTT software.

Selecting the screen size (−b, −bb, −bl, −bw options)

By default, the debugger uses an 80-character-by-25-line screen. If you'd like to use a different screen size, the method for doing so varies, depending on the type of system that you're using:

- **PC systems.** You can change the default screen size by using one of the −b options, which provides a preset screen size, or specifies the screen size at startup.
  - **Using a preset screen size.** Use the −b or −bb option to select one of these preset screen sizes:

−b	Screen size is 80 characters by 37 lines for EGA or VGA displays.
−bb	Screen size is 80 characters by 50 lines for a VGA display only.

  - **Resizing the screen at startup.** Use the −bl or −bw option to specify the screen length or width. The maximum size of the debugger screen is 132 characters by 60 lines.

−bl	Screen length in lines equals the number entered. If the setting you specify is too long, the default length of 25 lines is used.
−bw	Screen width in characters equals the number entered. If the setting you specify is too wide, the default width of 80 characters is used.

- **SPARCstations.** When you run multiple debuggers, the default screen size is a good choice because you can easily fit up to five default-size debuggers on your screen. However, you can change the default screen size by using one of the −b options, which provides a preset screen size, or by resizing the screen at run time. (Note that when you are running a standalone debugger, you can also change the screen size by using one of these methods.)
  - **Using a preset screen size.** Use the −b or −bb option to select one of these preset screen sizes:

−b	Screen size is 80 characters by 43 lines.
−bb	Screen size is 80 characters by 50 lines.

  - **Resizing the screen at run time.** You can resize the screen at run time by using your mouse to change the size of the operating-system window that contains the debugger. The maximum size of the debugger screen is 132 characters by 60 lines.

Clearing the .bss section (–c option)

The –c option clears the .bss section when the debugger loads code. You can use this option when you have C programs that use the RAM initialization model (specified with the –cr linker option).

Displaying the debugger on a different machine (–d option)

If you are using the X Window System, you can use the -d option to display the debugger on a different machine than the one the program is running on. For example, if you are running a debugger on a machine called opie and you want the debugger display to appear on a machine called barney, use the following command to invoke the debugger:

```
emu2xx –d barney:0 ↵
```

You can also specify a different machine by using the DISPLAY environment variable (see the appropriate installation guide for more information). If you use both the DISPLAY environment variable and –d, the –d option overrides DISPLAY.

Identifying a new board configuration file (–f option)

This option is valid only when you are using the emulator. The –f option allows you to specify a board configuration file that will be used instead of board.dat. The format for this option is:

–f *filename*

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:

emu2xx –i *pathname*$_1$ **–i** *pathname*$_2$ **–i** *pathname*$_3$ . . .

Using –i is similar to using the D_SRC environment variable (see *Setting up the environment variables* in the appropriate 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).

Selecting the minimal debugging mode (–min option)

The debugger automatically displays whatever code is currently running: assembly language or C. Depending on the code that is currently running, the debugger displays various windows, such as the DISASSEMBLY, COMMAND, CPU, MEMORY, or CALLS window.

The debugger has a *minimal* debugging mode that displays the COMMAND, WATCH, and DISP windows only. The WATCH and DISP windows are displayed only if you cause them to display (by entering the WA or DISP commands). Minimal mode may be useful when you need to debug a memory problem.

To invoke the debugger and enter minimal mode, use the −min option:

emu2xx −min . . .

For more information about the windows in the debugger interface, see Section 4.2, *Descriptions of the Different Kinds of Windows and Their Contents*.

Selecting the device version (–mv option)

The −mv option specifies which memory map the simulator loads. By default, the simulator loads the siminit.cmd file, which is a generic memory map. Each of the provided memory maps simulates a different ’C2xx device, as described in the following table:

Option	Device Simulated	Initialization File Used	Peripherals Simulated
−mv203	TMS320C203	sim203.cmd	Synchronous serial port, asynchronous serial port, timer, wait-state generator
−mv209	TMS320C209	sim209.cmd	Timer, wait-state generator

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

The −n option is valid only when using the emulator. The −n option allows you to specify which particular ’C2xx you plan to debug. The processor name must match one of the names defined in your board.cfg file. For example, if you wanted to debug a ’C2xx that you defined as cpu_a, you would specify:

```
spawn emu2xx −n cpu_a ↵
```

Processor 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, see Appendix B, *Describing Your Target System to the Debugger*.

Identifying the port address (−p option)

The −p option is valid only when you are 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 the appropriate installation guide; depending on your switch settings, replace *port address* with one of these values:

Switch 1	Switch 2	Option
on	on	−p 240 (optional)
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 will see an error message when you invoke the debugger. (See the appropriate installation guide for more information.)

Entering the profiling environment (−profile option)

This option is valid only when you are using the simulator. The −profile option allows you to bring up the debugger in a profiling environment so that you can collect statistics about code execution. Note that only a subset of the basic debugger features is available in the profiling environment.

Using the debugger in real-time mode (−r option)

The −r option is valid only when you are using the emulator. By default, the debugger operates in stop mode, which causes the processor to stop when you want to view register or memory contents. To use the real-time mode and prevent the processor from stopping, do the following:

- ❑ Load the real-time monitor program into your target memory or embed the monitor program in your application code.
- ❑ Invoke the debugger with the −r option.

For more information about stop mode and real-time mode, see Section 1.11, *Understanding the Operating Modes of the Debugger*, on page 1-24.

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 option 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). Using this option is similar to loading a file by using 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 siminit.cmd, emuinit.cmd, or init.cmd. The format for this option is:

–t *filename*

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.

The –v option affects all loads, including those performed when you invoke the debugger and those performed 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 the D_OPTIONS environment variable (described in the installation guide).

1.9 Exiting a Debugger or the PDM

To exit any version of the debugger, enter the following command from the COMMAND window of the debugger you want to close:

```
quit ⏎
```

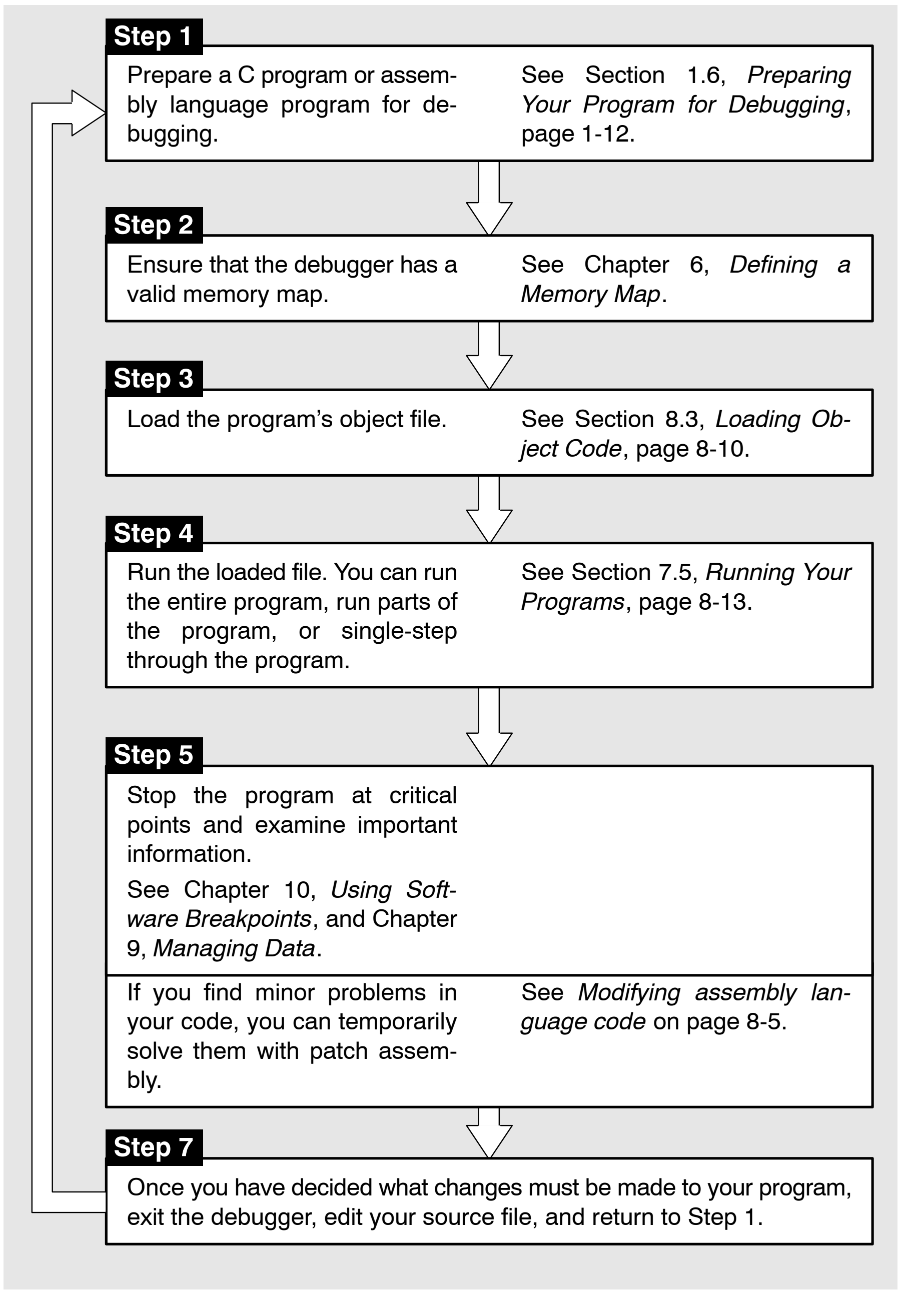
You don't need to worry about where the cursor is in the debugger window—just type. If a program is running, press ESC to halt program execution before you quit the debugger.

If you're running a standalone debugger under Windows™, you can exit the debugger by selecting the close option from the Windows menu bar.

You can also enter QUIT from the command line of the PDM to quit **all** of the debuggers (and also close the PDM).

1.10 Debugging ’C2xx 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 1.6, *Preparing Your Program for Debugging*, page 1-12.

Step 2

Ensure that the debugger has a valid memory map.

See Chapter 6, *Defining a Memory Map*.

Step 3

Load the program’s object file.

See Section 8.3, *Loading Object Code*, page 8-10.

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 7.5, *Running Your Programs*, page 8-13.

Step 5

Stop the program at critical points and examine important information.

See Chapter 10, *Using Software Breakpoints*, and Chapter 9, *Managing Data*.

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

See *Modifying assembly language code* on page 8-5.

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.

1.11 Understanding the Operating Modes of the Debugger

By default, the ’C2xx debugger operates in *stop mode*. When you use the debugger in stop mode and you want to view information about memory or register contents, the debugger stops the ’C2xx processor and causes the processor to execute instructions that provide memory or register values to the debugger. When the processor is providing information to the debugger, the ’C2xx processor is halted from executing code, and the processor cannot respond to interrupts or execute interrupt-driven real-time tasks.

If you are debugging a system that requires the ’C2xx processor to respond to interrupt-driven tasks or you do not want to stop the processor to view register or memory contents, you can use the debugger in *real-time mode*. In real-time mode, the processor is never halted and is able to respond to interrupts and execute interrupt-driven real-time tasks.

Switching to the real-time mode

To use real-time mode, you must load the real-time monitor program (c200mnrt.out) into target memory or embed the monitor program in your application code. The monitor program is included in the debugger package. You can load the monitor program at any time. However, you cannot use the real-time mode before the monitor program is loaded into memory or embedded in your application code.

The steps for entering the real-time mode vary according when or how you load the monitor program:

❑ If you do not embed the monitor program in your application code or load the monitor program into target memory *before* you invoke the debugger, follow these steps to use the real-time mode:

1) Invoke the debugger *without* the −r option. (The −r option selects real-time mode.)

2) Load the monitor program into target memory:

   `load c200mnrt.out`

3) Run the monitor program to the MON_GO label:

   `go MON_GO`

   In order to use the debugger in real-time mode, the processor must execute the monitor program up to the MON_GO label.

4) Switch to the real-time mode:

   `realtime` ⏎

   The REALTIME command switches the debugger from stop mode to real-time mode. When you use the REALTIME command, the debugger deletes all breakpoints that you might have set in stop mode.

5) Load your application code.

- ❑ If you embeded the monitor program in your application code or loaded into target memory before you invoked the debugger, follow these steps to enter the real-time mode:

  1) Invoke the debugger with the −r (real-time mode) option.
  2) Load your application code.

Note:

If you have the monitor program embedded in your application code, your target system is running, and use use −r when you invoke the debugger, the ’C2xx processor is halted momentarily until the debugger completes a short initialization sequence.

To return to stop mode, use the STOPMODE command. When you enter this command, the debugger deletes all breakpoints that you might have set in real-time mode.

Optimizing performance in real-time mode

Chapter 2

Using the Parallel Debug Manager

The TMS320C2xx emulation system is a true multiprocessing debugging system. It allows you to debug your entire application by using the parallel debug manager (PDM). The PDM is a command shell that controls and coordinates multiple debuggers. This chapter describes the functions that you can perform with the PDM. You can operate the PDM only with the emulator version of the debugger on a PC running OS/2 or a SPARCstation running SunOS.

Refer to Chapter 1, *Overview of a Code Development and Debugging System,* for information about invoking the PDM and debuggers.

Topic **Page**

2.1 Identifying Processors and Groups

You can send commands to an individual processor or to a group of processors. To do this, you must assign names to the individual processors or to groups of processors. Individual processor names are assigned when you invoke the individual debuggers; you can assign group names with the SET command after the individual processor names have been assigned.

Note:

Each debugger that runs under the PDM must have a unique processor name. The PDM does not keep track of existing processor names. When you send a command to a debugger, the PDM will validate the existence of a debugger invoked with that processor name.

Assigning names to individual processors

You must associate each debugger within the multiprocessing system with a unique name, referred to as a *processor name*. The processor name is used for:

- Identifying a processor to send commands to.
- Assigning a processor to a group.
- Setting the default prompts for the associated debuggers. For example, if you invoke a debugger with a processor name of CPU_A, that debugger's prompt will be CPU_A>.
- Identifying the individual debuggers on the screen (SPARCstations only). The processor name that you assign will appear at the top of the operating-system window that contains the debugger. Additionally, if you turn one of the windows into an icon, the icon name is the same as the processor name that you assigned.

To assign a processor name, you can use the −n option when you invoke a debugger. For example, to name one of the 'C2xx processors CPU_B, use the following command to invoke the debugger:

```
spawn emu2xx −n CPU_B
```

From this point onward, whenever you need to identify this debugger, you can identify it by its processor name, *CPU_B.*

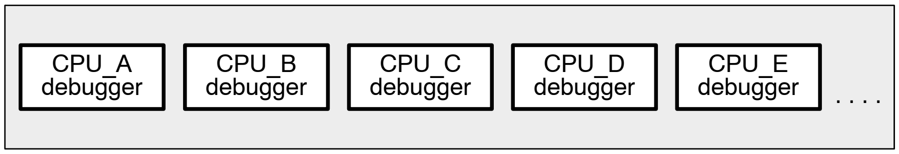
The processor name that you supply can consist of up to eight alphanumeric characters or underscore characters and must begin with an alphabetic character. Note that the name is not case sensitive. The processor name must match one of the names defined in your board configuration file (see Appendix B, *Describing Your Target System to the Debugger*).

Organizing processors into groups

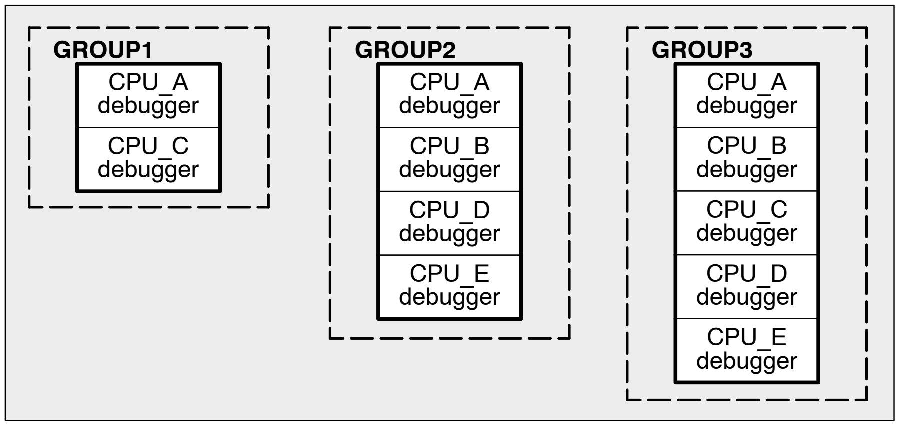
Processors can be organized into groups; these groups are identified by names defined with the SET command. Each processor can belong to any group, all groups, or a group of its own. Figure 2−1 *(a)* shows an example of processors that could exist in a system, and Figure 2−1 *(b)* illustrates three examples of named groups. GROUP1 contains two processors, GROUP2 contains four processors, and GROUP3 contains five processors.

Figure 2−1. Grouping Processors

(a) All possible processors in a system



(b) Examples of how processors could be grouped



To define and manipulate software groupings of named processors, use the SET and UNSET commands.

❑ **Defining a group of processors**

To define a group, use the SET command. The format for this command is:

set [*group name* [= *list of processor names*]]

This command allows you to specify a group name and the list of processors you want in the group. The *group name* can consist of up to 128 alphanumeric characters or underscore characters.

For example, to create the GROUP1 group illustrated in Figure 2–1 *(b)*, you could enter the following on the PDM command line:

```
set GROUP1 = CPU_A CPU_C
```

The result is a group called GROUP1 that contains the processors named CPU_A and CPU_C. Note that the order in which you add processors to a group is the same order in which commands will be sent to the members of that group.

❑ **Setting the default group**

Many of the PDM commands can be sent to groups; if you often send commands to the same group and you want to avoid typing the group name each time, you can assign a default group.

To set the default group, use the SET command with a special group name called dgroup. For example, if you want the default group to contain the processors called CPU_B, CPU_D, and CPU_E, enter:

```
set dgroup = CPU_B CPU_D CPU_E
```

The PDM will automatically send commands to the default group when you don't specify a group name.

❑ **Modifying an existing group or creating a group based on another group**

Once you've created a group, you can add processors to it by using the SET command and preceding the existing *group name* with a dollar sign ($) in the list of processors. You can also use a group as part of another group by preceding the existing group's name with a dollar sign. The dollar sign tells the PDM to use the processors listed previously in the group as part of the new list of processors.

Suppose GROUPA contained CPU_C and CPU_D. If you wanted to add CPU_E to the group, you'd enter:

```
set GROUPA = $GROUPA CPU_E
```

After entering this command, GROUPA would contain CPU_C, CPU_D, and CPU_E.

If you decided to send numerous commands to GROUPA, you could make it the default group:

```
set dgroup = $GROUPA
```

❑ **Listing all groups of processors**

To list all groups of processors in the system, use the SET command without any parameters:

```
set
```

The PDM lists all of the groups and the processors associated with them:

```
GROUP1   ”CPU_A CPU_C”
GROUPA   ”CPU_C CPU_D CPU_E”
dgroup   ”CPU_C CPU_D CPU_E”
```

You can also list all of the processors associated with a particular group by supplying a group name:

```
set dgroup
dgroup   ”CPU_C CPU_D CPU_E”
```

❑ **Deleting a group**

To delete a group, use the UNSET command. The format for this command is:

unset *group name*

You can use this command in conjunction with the SET command to remove a particular processor from a group. For example, suppose GROUPB contained CPU_A, CPU_C, CPU_D, and CPU_E. If you wanted to remove CPU_E, you could enter:

```
unset GROUPB
set GROUPB = CPU_A CPU_C CPU_D
```

If you want to delete all of the groups you have created, use the UNSET command with an asterisk instead of a group name:

```
unset *
```

Note that the asterisk *does not* work as a wild card.

Note:

When you use UNSET * to delete all of your groups, the default group (dgroup) is also deleted. As a result, if you issue a command such as PRUN and don’t specify a group or processor, the command will fail because the PDM can’t find the default group name (dgroup).

2.2 Sending Debugger Commands to One or More Debuggers

The SEND command sends a debugger command to an individual processor or to a group of processors. The command is sent directly to the command interpreter of the individual debuggers. You can send any valid debugger command string.

The syntax for the SEND command is:

send [**–r**] [**–g** {*group* | *processor name*}] *debugger command*

- The **–g** option specifies the group or processor that the debugger command should be sent to. If you don't use this option, the command is sent to the default group (dgroup).
- The **–r** (return) option determines when control returns to the PDM command line:
  - **Without –r**, control is not returned to the command line until each debugger in the group finishes running code. Any results that would be printed in the COMMAND window of the individual debuggers will also be echoed in the PDM command window. These results will be displayed by processor. For example:

    ```
    send ?pc
    [CPU_C]  0x400A
    [CPU_D]  0x4010
    ```

    If you want to break out of a synchronous command and regain control of the PDM command line, press CONTROL C in the PDM window. This will return control to the PDM command line. However, no debugger executing the command will be interrupted.
  - **With –r**, control is returned to the command line immediately, even if a debugger is still executing a command. When you use –r, you *do not* see the results of the commands that the debuggers are executing.

    The –r option is useful when you want to exit from a debugger but not from the PDM. When you send the QUIT command to a debugger or group of debuggers without using the –r command, you will not be able to enter another PDM command until all debuggers to which QUIT was sent to finish quitting; the PDM waits for a response from all of the debuggers have finished quitting. By using –r, you can gain immediate control of the PDM and continue sending commands to the remaining debuggers.

The SEND command is useful for loading a common object file into a group of debuggers. For example, to load a file called test.out into the debuggers contained in GROUP_A, you could use the following command:

```
send –g GROUP_A load test.out
```

2.3 Running and Halting Code

The PRUN, PRUNF, and PSTEP commands synchronize the debuggers to cause the processors to begin execution at the same real time.

- PRUNF starts the processors running free, which means they are disconnected from the emulator.
- PRUN starts the processors running under the control of the emulator.
- PSTEP causes the processors to single-step synchronously through assembly language code with interrupts disabled.

The formats for these commands are:

prunf [**–g** {*group* | *processor name*}]

prun [**–r**] [**–g** {*group* | *processor name*}]

pstep [**–g** {*group* | *processor name*}] [*count*]

- The **–g** option identifies the group or processor that the command should be sent to. If you don't use this option, the command is sent to the default group (dgroup).
- The **–r** (return) option for the PRUN command determines when control returns to the PDM command line:
  - **Without –r**, control is not returned to the command line until each debugger in the group finishes running code. If you want to break out of a synchronous command and regain control of the PDM command line, press CONTROL C in the PDM window. This will return control to the PDM command line. However, no debugger executing the command will be interrupted.
  - **With –r**, control is returned to the command line immediately, even if a debugger is still executing a command. You can type new commands, but the processors can't execute the commands until they finish with the current command; however, you can perform PHALT, PESC, and STAT commands when the processors are still executing.
- You can specify a *count* for the PSTEP command so that each processor in the group will step for *count* number of times.

Note:

If the current statement that a processor is pointing to has a breakpoint, that processor will not step synchronously with the other processors when you use the PSTEP command. However, that processor will still single-step.

Halting processors at the same time

You can use the PHALT command after you enter a PRUNF command to stop an individual processor or a group of processors (global halt). Each processor in the group is halted at the same real time. The syntax for the PHALT command is:

phalt [**–g** {*group* | *processor name*}]

Sending ESCAPE to all processors

Use the PESC command to send the escape key to an individual processor or to a group of processors after you execute a PRUN command. Entering PESC is essentially like typing an escape key in all of the individual debuggers. However, the PESC command is *asynchronous;* the processors don't halt at the same real time. When you halt a group of processors, the individual processors are halted in the order in which they were added to the group.

The syntax for this command is:

pesc [**–g** {*group* | *processor name*}]

Finding the execution status of a processor or a group of processors

The STAT command tells you whether a processor is running or halted. If a processor is halted when you execute this command, then the PDM also lists the current PC value for that processor. The syntax for the command is:

stat [**–g** {*group* | *processor name*}]

For example, to find the execution status of all of the processors in GROUP_A after you've executed a global PRUN, enter:

```
stat –g GROUP_A ↵
```

After entering this command, you'll see something similar to this in the PDM window:

```
[CPU_C] Running
[CPU_D] Halted   PC=201A
[CPU_E] Running
```

2.4 Entering PDM Commands

The PDM provides a flexible command-entry interface that allows you to:

- Execute PDM commands from a batch file
- Record the information shown in the PDM display area
- Conditionally execute or loop through PDM commands
- Echo strings to the PDM display area
- Pause command execution
- Repeat previously entered commands (use the command history)

This section describes the PDM commands that you can use to perform these tasks.

Executing PDM commands from a batch file

The TAKE command tells the PDM to execute commands from a batch file. The syntax for the PDM version of this command is:

take *batch filename*

The *batch filename* **must** have a .pdm extension, or the PDM will not be able to read the file. If you don't supply a pathname as part of the filename, the PDM first looks in the current directory and then searches directories named with the D_DIR environment variable.

The TAKE command is similar to the debugger version of this command (described on page 5-17). However, there are some differences when you enter TAKE as a PDM command instead of a debugger command.

- **Similarities.** As with the debugger version of the TAKE command, you can nest batch files up to 10 deep.
- **Differences.** Unlike the debugger version of the TAKE command:
  - There is no suppress-echo-flag parameter. Therefore, all command output is echoed to the PDM window, and this behavior cannot be changed.
  - To halt batch-file execution, you must press CONTROL C instead of ESC.
  - The batch file must contain only PDM commands (no debugger commands).

The TAKE command is advantageous for executing a batch file in which you have defined often-used aliases. Additionally, you can use the SET command in a batch file to set up group configurations that you use frequently, and then execute that file with the TAKE command. You can also put your flow-control commands (described on page 2-11) in a batch file and execute the file with the TAKE command.

Recording information from the PDM display area

By using the DLOG command, you can record the information shown in the PDM display area into a log file. This command is identical to the debugger DLOG command (described on page 5-6).

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

  dlog *filename*

  This command opens a log file called *filename* that the information is recorded into. If you plan to execute the log file with the TAKE command, the filename **must** have a .pdm extension.

- 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 control how the log file is created and/or used:

- **Appending to an existing file.** Use the **a** parameter to open an existing file and append the information in the display area.
- **Writing over an existing file.** Use the **w** parameter to open an existing file and 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.

Controlling PDM command execution

You can control the flow of PDM commands in a batch file or interactively. With the IF/ELIF/ELSE/ENDIF or LOOP/BREAK/CONTINUE/ENDLOOP flow-control commands, you can conditionally execute debugger commands or set up a looping situation, respectively.

❑ To conditionally execute PDM commands, use the IF/ELIF/ELSE/ENDIF commands. The syntax is:

  if *expression*
  PDM commands
  [**elif** *expression*
  PDM commands]
  [**else**
  PDM commands]
  endif

  ■ If the expression for the IF is nonzero, the PDM executes all commands between the IF and ELIF, ELSE, or ENDIF.

  ■ The ELIF is optional. If the expression for the ELIF is nonzero, the PDM executes all commands between the ELIF and ELSE or ENDIF.

  ■ The ELSE is optional. If the expressions for the IF and ELIF (if present) are false (zero), the PDM executes the commands between the ELSE and ENDIF.

❑ To set up a looping situation to execute PDM commands, use the LOOP/BREAK/CONTINUE/ENDLOOP commands. The syntax is:

  loop *Boolean expression*
  PDM commands
  [**break**]
  [**continue**]
  endloop

  The PDM version of the LOOP command is different from the debugger version of this command (described on page 5-20). Instead of accepting any expression, the PDM version of the LOOP command evaluates only Boolean expressions. If the Boolean expression evaluates to true (1), the PDM executes all commands between the LOOP and BREAK, CONTINUE, or ENDLOOP. If the Boolean expression evaluates to false (0), the loop is not entered.

- The optional BREAK command allows you to exit the loop without having to reach the ENDLOOP. This is helpful when you are testing a group of processors and want to exit if an error is detected.

- The CONTINUE command, which is also optional, acts as a goto and returns command flow to the enclosing LOOP command. CONTINUE is useful when the part of the loop that follows is complicated, and returning to the top of the loop avoids further nesting.

You can enter the flow-control commands interactively or include the commands in a batch file that is executed by the TAKE command. When you enter LOOP or IF from the PDM command line, a question mark (?) prompts you for the next entry:

```
PDM:11>>if $i > 10
?echo ERROR IN TEST CASE
?endif
ERROR IN TEST CASE

PDM:12>>
```

The PDM continues to prompt you for input using the ? until you enter ENDIF (for an IF command) or ENDLOOP (for a LOOP command). After you enter ENDIF or ENDLOOP, the PDM immediately executes the IF or LOOP command.

If you are in the middle of interactively entering a LOOP or IF statement and want to abort it, type CONTROL C.

You can use the IF/ENDIF and LOOP/ENDLOOP commands together to perform a series of tests. For example, within a batch file, you can create a loop like the following (the SET and @ commands are described in Section 2.8, *Using System Variables*):

```
set i = 10                                    Set the counter (i) to 10
loop $i > 0                               Loop while i is greater than 0
  .
  test commands
  .
  if $k > 500                                 Test for error condition
    echo ERROR ON TEST CASE 8               Display an error message
  endif
  .
  @ i = $i - 1                                   Decrement the counter
endloop
```

You can record the results of this loop in a log file (refer to page 2-10) to examine which test cases failed during the testing session.

Echoing strings to the PDM display area

You can display a string in the PDM display area by using the ECHO command. This command is especially useful when you are executing a batch file or running a flow-control command such as IF or LOOP. The syntax for the command is:

echo *string*

This displays the *string* in the PDM display area.

You can also use ECHO to show the contents of a system variable (system variables are described in Section 2.8):

```
echo $var_proc1 ⏎
34
```

The PDM version of the ECHO command works exactly the same as the debugger version (described on page 5-18), except that you can use the PDM version outside of a batch file.

Pausing command execution

Sometimes you may want the PDM to pause while it's running a batch file or when it's executing a flow control command such as LOOP/ENDLOOP. Pausing is especially helpful in debugging the commands in a batch file.

The syntax for the PAUSE command is:

pause

When the PDM reads this command in a batch file or during a flow control command segment, the PDM stops execution and displays the following message:

```
<< pause - type return >>
```

To continue processing, press ⏎.

Using the command history

The PDM supports a command history that is similar to the UNIX command history. The PDM prompt identifies the number of the current command. This number is incremented with every command. For example, PDM:12>> indicates that eleven commands have previously been entered, and the PDM is now ready to accept the twelfth command.

The PDM command history allows you to reenter any of the last twenty commands:

- To repeat the last command that you entered, type:

  !!

- To repeat any of the last twenty commands, use the following command:

  !*number*

  The *number* is the number of the PDM prompt that contains the command that you want to reenter. For example,

  ```
  PDM:100>>echo hello
  hello
  PDM:101>>echo goodbye
  goodbye
  PDM:102>>!100
  echo hello
  hello
  ```

  Notice that the PDM displays the command that you are reentering.

- An alternate way to repeat any of the last twenty commands is to use:

  !*string*

  This command tells the PDM to execute the last command that began with *string.* For example,

  ```
  PDM:103>>pstep -g GROUPA
  PDM:104>>send -g GROUPA ?pc
  [CPU_C]  0x4000
  [CPU_D]  0x4004
  PDM:103>>pstep -g GROUPB
  PDM:104>>send -g GROUPB ?pc
  [CPU_A]  0x401A
  [CPU_E]  0x4014
  PDM:105>>!p
  pstep -g GROUPB
  ```

- To see a list of the last twenty commands that you entered, type:

  history

The command history for the PDM works differently from that of the debugger (described on page 5-5); the TAB and F2 keys have no command-history meaning for the PDM.

2.5 Defining Your Own Command Strings

The ALIAS command provides a shorthand method of entering often-used commands or command sequences. The UNALIAS command deletes one or more ALIAS definitions. The syntax for the PDM version of each of these commands is:

alias [*alias name* [, "*command string*"]]
unalias {*alias name* | *}

The PDM versions of the ALIAS and UNALIAS commands are similar to the debugger versions of these commands. You can:

- ❑ Include several commands in the command string by separating the individual commands with semicolons.
- ❑ Define parameters in the command string by using a percent sign and a number (%1, %2, etc.) to represent a parameter whose value will be supplied when you execute the aliased command.
- ❑ List all currently defined PDM aliases by entering ALIAS with no parameters.
- ❑ Find the definition of a PDM alias by entering ALIAS with only an alias-name parameter.
- ❑ Nest alias definitions.
- ❑ Redefine an alias.
- ❑ Delete a single PDM alias by supplying the UNALIAS command with an alias name, or delete all PDM aliases by entering UNALIAS *.

Like debugger aliases, PDM alias definitions are lost when you exit the PDM. However, individual commands within a PDM command string don't have an expanded-length limit.

For more information about these features, see Section 5.5, *Defining Your Own Command Strings*, on page 5-21.

The PDM version of this command is especially useful for aliasing often-used command strings involving the SEND and SET commands.

- ❑ You can use the ALIAS command to create PDM versions of debugger commands. For example, the ML debugger command lists the memory ranges that are currently defined. To make a PDM version of the ML command to list the memory ranges of all the debuggers in a particular group, enter:

  ```
  alias ml, "send -g %1 ml"
  ```

You could then list the memory maps of a group of processors such as those in group GROUPA:

```
ml GROUPA
```

- ❑ The ALIAS command can be helpful if you frequently change the default group. For example, suppose you plan to switch between two groups. You can set up the following alias:

  ```
  alias switch, ″set dgroup $%1; set prompt %1″
  ```

  The %1 parameter will be filled in with the group information that you enter when you execute SWITCH. Notice that the %1 parameter is preceded by a dollar sign ($) to set up the default group. The dollar sign tells the PDM to evaluate (take the list of processor names defined in the group instead of the actual group name). However, to change the prompt, you don't want the PDM to evaluate (use the processors associated with the group name as the prompt)—you just want the group name. As a result, you don't need to use the dollar sign when you want to use only the group name.

  Assume that GROUP3 contains CPU_A, CPU_B, and CPU_D. To make GROUP3 the current default group and make the PDM prompt the same name as your default group, enter:

  ```
  switch GROUP3
  ```

  This causes the default group (dgroup) to contain CPU_A, CPU_B, and CPU_D, and changes the PDM prompt to GROUP3:x>>.

2.6 Entering Operating-System Commands

The SYSTEM command provides you with a method of entering operating-system commands. The format for the SYSTEM command is:

system *operating-system command*

The SYSTEM command allows you to enter a single operating-system command without explicitly exiting the PDM environment.

2.7 Understanding the PDM’s Expression Analysis

The PDM analyzes expressions differently than individual debuggers do (expression analysis for the debugger is described in Chapter 14, *Basic Information About C Expressions*). The PDM uses a simple integral expression analyzer. You can use expressions to cause the PDM to make decisions as part of the @ command and the flow control commands (described on pages 2-18 and 2-11, respectively).

Note that you cannot evaluate string variables with the PDM expression analyzer. You can evaluate only constant expressions.

Table 2−1 summarizes the PDM operators. The PDM interprets the operators in the order that they’re listed in Table 2−1 (left to right, top to bottom).

Table 2−1. PDM Operators

Operator	Definition	Operator	Definition
( )	take highest precedence	*	multiplication
/	division	%	modulo
+	addition (binary)	−	subtraction (binary)
< <	left shift	~	complement
<	less than	> >	right shift
>	greater than	< =	less than or equal to
= =	is equal to	> =	greater than or equal to
&	bitwise AND	! =	is not equal to
|	bitwise OR	^	bitwise exclusive-OR
| |	logical OR	&&	logical AND

2.8 Using System Variables

You can use the SET, @, and UNSET commands to create, modify, and delete system variables. In addition, you can use the SET command with system-defined variables.

Creating your own system variables

The SET command lets you create system variables that you can use with PDM commands. The syntax for the SET command is:

set [*variable name* [= *string*]]

The *variable name* can consist of up to 128 alphanumeric characters or underscore characters.

For example, suppose you have an array that you want to examine frequently. You can use the SET command to define a system variable that represents that array value:

```
set result = ar1[0] + 100
```

In this case, **result** is the variable name, and **ar1[0] + 100** is the expression that will be evaluated whenever you use the variable result.

Once you have defined result, you can use it with other PDM commands such as the SEND command:

```
send CPU_D ? $result
```

The dollar sign (**$**) tells the PDM to replace result with ar1[0] + 100 (the string defined in result) as the expression parameter for the ? command. You *must* precede the name of a system variable with a $ when you want to use the string value you defined with the variable as a parameter.

You can also use the SET command to concatenate and substitute strings.

❑ **Concatenating strings**

The dollar sign followed by a system variable name enclosed in braces (**{** and **}**) tells the PDM to append the contents of the variable name to a string that precedes or follows the braces. For example:

```
set k = Hel                              Set k to the string Hel
set i = ${k}lo ${k}en       Concatenate the contents of k before
                                 lo and en and set the result to i
echo $i                                Show the contents of i
Hello Helen
```

- **Substituting strings**

  You can substitute defined system variables for parts of variable names or strings. This series of commands illustrates the substitution feature:

  ```
  set err0 = 25                                   Set err0 to 25
  set j = 0                                        Set j to 0
  echo $err$j             Show the value of $err$j → $err0 → 25
  25
  ```

  Note that substitution stops when the PDM detects recursion (for example, $k = k).

Assigning a variable to the result of an expression

The @ (substitute) command is similar to the SET command. You can use the @ command to assign the result of an expression to a variable. The syntax for the @ command is:

@ *variable name* = *expression*

The following series of commands illustrates the differences between the @ command and the SET command. Assume that mask1 equals 36 and mask2 equals 47.

```
set mask3 = $mask1+$mask2     Set mask3 to the contents of mask1
                                        plus the contents of mask2
echo $mask3                           Show the contents of mask3
36+47
@ mask3 = $mask1+$mask2             Set mask3 to the result of the
                                         expression $mask1+$mask2
echo $mask3                           Show the contents of mask3
83
```

Notice the difference between the two commands. The @ command evaluates the expression and assigns the result to the variable name.

The @ command is useful in setting loop counters. For example, you can initialize a counter with the following command:

```
@ j = 0
```

Inside the loop, you can increment the counter with the following statement:

```
@ j = $j + 1
```

Changing the PDM prompt

The PDM recognizes a system variable called prompt. You can change the PDM prompt by setting the prompt variable to a string. For example, to change the PDM prompt to 3PROCs, enter:

```
set prompt = 3PROCs
```

After entering this command, the PDM prompt will look like this: 3PROCs:x>>.

Checking the execution status of the processors

In addition to displaying the execution status of a processor or group of processors, the STAT command (described on page 2-8) sets a system variable called status.

- ❑ If *all* of the processors in the specified group are running, the status variable is set to 1.
- ❑ If one or more of the processors in the group is halted, the status variable is set to 0.

You can use this variable when you want an instruction loop to execute until a processor halts:

```
loop stat == 1
send ?pc
.
.
```

Listing system variables

To list all system variables, use the SET command without parameters:

```
set
```

You can also list the contents of a single variable. For example,

```
set j
j  ″100″
```

Deleting system variables

To delete a system variable, use the UNSET command. The format for this command is:

unset *variable name*

If you want to delete all of the variables you have created and any groups you have defined (as described on page 2-4), use the UNSET command with an asterisk instead of a variable name:

```
unset *
```

Note:

When you use UNSET * to delete all of your system variables and processor groups, variables such as prompt, status, and dgroup are also deleted.

2.9 Evaluating Expressions

The debugger includes an EVAL command that evaluates an expression (see Section 9.2, *Basic Commands for Managing Data,* on page 9-2 for more information about the debugger version of the EVAL command). The PDM has a similar command called EVAL that you can send to a processor or a group of processors. The EVAL command evaluates an expression in a debugger and sets a variable to the result of the expression. The syntax for the PDM version of the EVAL command is:

eval [**–g** {*group* | *processor name*}] *variable name*=*expression*[**,** *format*]

- The **–g** option specifies the group or processor that EVAL should be sent to. If you don't use this option, the command is sent to the default group (dgroup).
- When you send the EVAL command to more than one processor, the PDM takes the *variable name* that you supply and appends a suffix for each processor. The suffix consists of the underscore character (_) followed by the name that you assigned the processor. That way, you can differentiate between the resulting variables.
- The *expression* can be any expression that uses the symbols described in Section 2.7, *Understanding the PDM's Expression Analysis*.
- When you use the optional *format* parameter, the value that the variable is set to will be in one of the following formats:

Parameter	Result	Parameter	Result
*****	Default for the data type	**o**	Octal
c	ASCII character (bytes)	**p**	Valid address
d	Decimal	**s**	ASCII string
e	Exponential floating point	**u**	Unsigned decimal
f	Decimal floating point	**x**	Hexadecimal

Suppose the program that CPU_A is running has two variables defined: j is equal to 5, and k is equal to 17. Also assume that the program that CPU_B is running contains variables j and k: j is equal to 12, and k is equal to 22.

```
set dgroup = CPU_A CPU_B
eval val = j + k
set
dgroup     ”CPU_A CPU_B”
val_CPU_A  ”22”
val_CPU_B  ”34”
```

Notice that the PDM created a system variable for each processor: val_CPU_A for CPU_A and val_CPU_B for CPU_B.

Chapter 3

An Introductory Tutorial to the C Source Debugger

This chapter provides a step-by-step, hands-on demonstration of the ’C2xx C source debugger’s basic features. This is not the kind of tutorial that you can take home to read—it is effective only if you’re sitting at your terminal, performing the lessons in the order that they’re presented. The tutorial contains two sets of lessons (11 in the first, 13 in the second) and takes about 1 hour to complete.

Topic **Page**

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 that 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 or operating-system commands as instructed in the installation guide).

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 individual installation guides).

Invoke the debugger and load the sample program:

- ❑ For the *emulator,* enter:

```
emu2xx c:\c2xxhll\sample ↵
```

- ❑ For the *simulator,* enter:

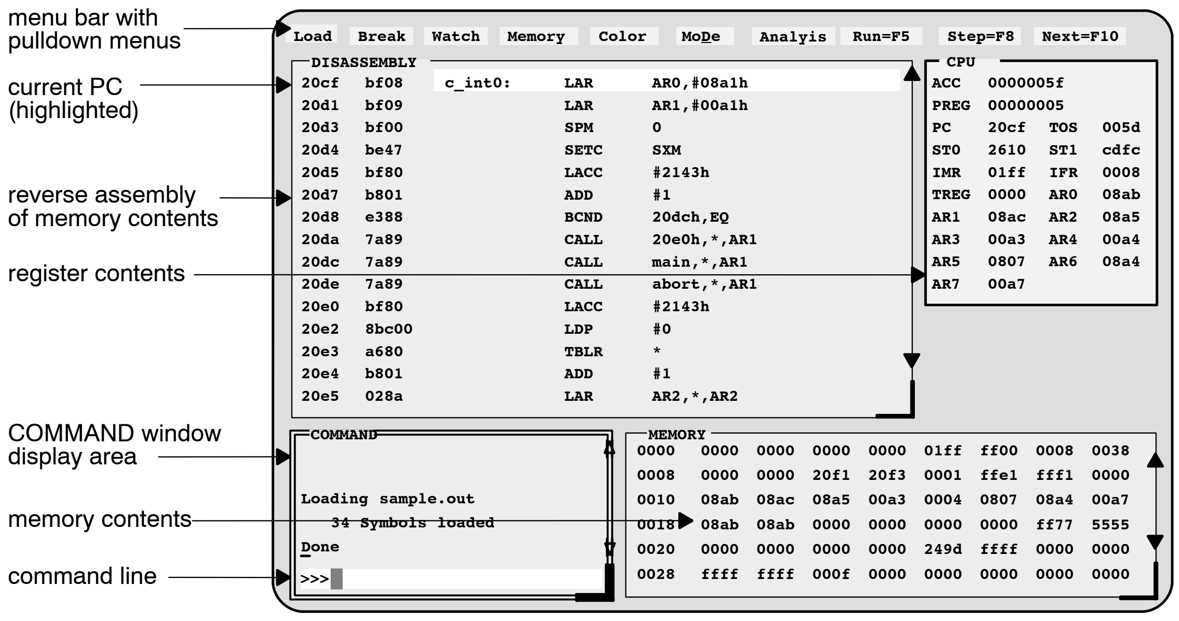
```
sim2xx c:\sim2xx\sample ↵
```

If you are using a window manager and have an icon for the debugger, simply double-click on the debugger icon to invoke the debugger. Once the debugger screen is displayed, enter the following from the debugger command line to load the sample program:

```
load c:\c2xxhll\sample ↵
```

Take a look at the display. . .

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



```
20cf   bf08   c_int0:     LAR      AR0,#08a1h
20d1   bf09               LAR      AR1,#00a1h
20d3   bf00               SPM      0
20d4   be47               SETC     SXM
20d5   bf80               LACC     #2143h
20d7   b801               ADD      #1
20d8   e388               BCND     20dch,EQ
20da   7a89               CALL     20e0h,*,AR1
20dc   7a89               CALL     main,*,AR1
20de   7a89               CALL     abort,*,AR1
20e0   bf80               LACC     #2143h
20e2   8bc00              LDP      #0
20e3   a680               TBLR     *
20e4   b801               ADD      #1
20e5   028a               LAR      AR2,*,AR2
```

```
ACC    0000005f
PREG   00000005
PC     20cf   TOS   005d
ST0    2610   ST1   cdfc
IMR    01ff   IFR   0008
TREG   0000   AR0   08ab
AR1    08ac   AR2   08a5
AR3    00a3   AR4   00a4
AR5    0807   AR6   08a4
AR7    00a7
```

```
Loading sample.out
   34 Symbols loaded
Done
>>>
```

```
0000   0000  0000  0000  0000  01ff  ff00  0008  0038
0008   0000  0000  20f1  20f3  0001  ffe1  fff1  0000
0010   08ab  08ac  08a5  00a3  0004  0807  08a4  00a7
0018   08ab  08ab  0000  0000  0000  0000  ff77  5555
0020   0000  0000  0000  0000  249d  ffff  0000  0000
0028   ffff  ffff  000f  0000  0000  0000  0000  0000
```

❑ 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 'C2xx processor:

   `reset` ↵

2) Load the sample program again:

   `load c:\c2xxhll\sample` ↵ (emulator)

   `load c:\sim2xx\sample` ↵ (simulator)

- After reset, if you're using the emulator and you see a display and the first few lines of the DISASSEMBLY window still show ADD instructions or say *Invalid address* after resetting the 'C2xx processor, you can check the following:
  - Your emulator board may not be installed snugly. Check your board to see if it is correctly installed, and reenter the commands above.
  - Your default memory map may not be correct. Enter the following command to turn off the default map:

    ```
    map off
    ```

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 0x20cf.

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

```
mem 0x20cf@prog
```

Notice that the addresses in the first column in the DISASSEMBLY window corresponds to the addresses in first column of the MEMORY window; the values in the second column in the DISASSEMBLY window corresponds to the memory contents displayed in second, third, and fourth columns of the MEMORY window.

Try This: The 'C2xx has separate program and data spaces. You can access either program or data memory by following the location with **@prog** for program memory or **@data** for data memory. If you'd like to see the contents of location 0x0060 in data memory, enter:

```
mem 0x60@data
```

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

```
mem PC@prog
```

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
```

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 parameter in uppercase, as shown.

Try This: Press the F6 key to "cycle" through the windows in the display, making each one active in turn.

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.

Resize the active window

This lesson shows you how to resize the active window.

Important! Be sure the CPU window is still active.

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 screen-size 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*

lesson continues on the next page →

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

Try This: You can 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, backward 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! Be sure the CPU window is still active.

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 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 steps 1 and 2.

Move the active window

This lesson shows you how to move the active window.

Important! Be sure the CPU window is still active.

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 screen-size 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 as if only the border is moving—this is normal)*
ESC *Press ESC when you finish moving the window*

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

lesson continues on the next page →

Try This: You can 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 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 5.5, *Summary of Special Keys*, on page 18-75 summarizes the functions of all the special keys and key sequences and how they affect 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 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. If you can't see the label, press F6 until the FILE window becomes the active window.

The CALLS window is displayed also. The CALLS window tracks the C functions as they are called. Right now, the CALLS window lists **UNKNOWN as the first function, because it is waiting for a function to be called.

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 ⏎
```

The label in the COMMAND window changes to COMMAND [RUNNING...] to indicate that your program is executing.

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 several statements in the DISASSEMBLY window are highlighted because these statements are associated with the current C statement (which is highlighted in the FILE window).

❑ The CALLS window, which tracks functions as they're called, now points to main().

- ❑ The color for the values of the PC and TOS (and possibly some additional registers) in the CPU window have changed because those values were changed during program execution.

Become familiar with the four debugging modes

The debugger has four 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.
- ❑ *Minimal mode* shows only the COMMAND window (no C or disassembly).

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). To do so, choose one of these methods:
   - ❑ 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. The statement that defines the main() label should still be highlighted. The DISASSEMBLY window is not displayed, because the processor is in the C portion of your program. Auto mode automatically switches between an assembly and 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 ↵
```

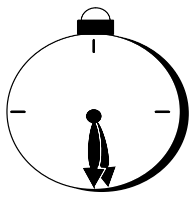
You're still in auto mode, but you should now see the DISASSEMBLY window. The current PC should be at the statement that defines the meminit label.

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
minimal	switches to minimal mode

Switch back to mixed mode before continuing:

```
mix ↵
```



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 come back, reinvoke the debugger and load the sample program (page 3-4) 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:

```
file init.cmd  ↵
```

This replaces sample.c in the FILE window with your init.cmd file.

Remember, you can tell which file you're displaying by the label in the FILE window. Right now, the label should say FILE: init.cmd.

Redisplay another C source file (sample.c):

```
func call ↵
```

Now the FILE window label should say FILE: sample.c because the call() function is in sample.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 ⏎ *The label in the COMMAND window changes to COMMAND [RUNNING...] to indicate that your program is executing.*

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 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 38 in the FILE window (the meminit() statement) and set a breakpoint at that line:

   a) Point the mouse cursor at the statement on line 38.

   b) Click the left mouse button. *Notice that BP> (for breakpoint) appears at the beginning of the line and that the line is highlighted.*

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 38 in the FILE window.

Clear the breakpoint:

1) Point the mouse cursor at the statement on line 38. (It should still be highlighted from setting the breakpoint.)

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

Watch some values and single-step through code

Now you know how to update the display without running your entire program; you can set software 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 and change to mixed mode:

```
wa ar1, Stack Pointer
wa pc
wa *0x2059@prog, Call:
wa i
mix
```

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.

lesson continues on the next page →

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 20
```

Try This: Notice that the step command single-stepped each assembly language statement (in fact, you single-stepped through 20 assembly language statements). Did you also notice that the FILE window displayed the source for the meminit() function when it was called? The debugger supports additional single-step commands that have a slightly different flavor.

- For example, if you enter:

  ```
  cstep 20
  ```

  you'll single-step 20 *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 20 assembly language statements, *but the FILE window won't display the source for the meminit() function when meminit() is executed.*

  ```
  next 20
  ```

  (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 1
wd 1
```

The variable 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.

Set up for the conditional run examples:

1) Set software breakpoints at lines 39 and 41.
2) Reset the program entry point:

   ```
   restart
   ```
3) Run the first part of the program:

   ```
   go main
   ```
4) Reset the value of i:

   ```
   ?i=0
   ```

Now initiate the conditional run:

```
run i<10
```

This causes the debugger to run through the loop as long as the value of i is less than 10. 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. If you are using Windows™, you can use the following commands:

cd ..	*Change back to the main directory*
dir	*Show a listing of the current directory*
cd c2xxhll	*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 small

Close the DISP window:

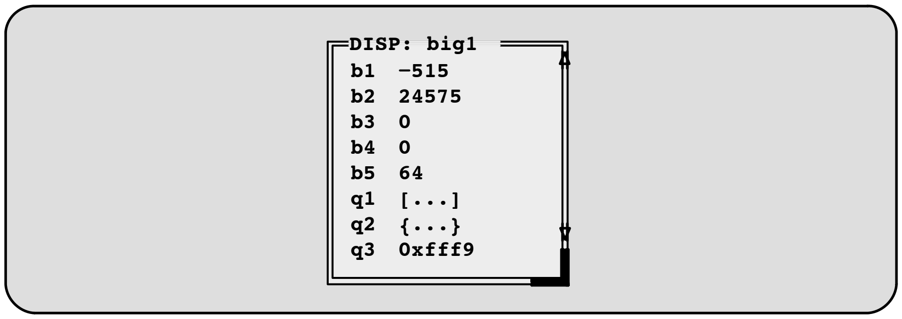
F4

Show another structure in a DISP window:

disp big1

lesson continues on the next page →

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  -515
b2  24575
b3  0
b4  0
b5  64
q1  [...]
q2  {...}
q3  0xfff9
```

(Note that the values displayed in this diagram may be different from what you see on the screen.)

❑ 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.

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 two-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.
4) F9 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 want 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 0x100 as type float (exponential floating-point format).

Display memory contents in floating-point format:

```
disp *(float *)0x100
```

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 0x0100—*it isn't memory location 0*. Note that you can scroll through the memory displayed in the DISP window; item [1] is at 0x0101, and item [–1] is at 0x0ffe.

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 (set format) 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
```

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, MEWi
   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 the ? and WA commands—DISP and MEM work similarly.

Use display formats with the ? and WA commands:

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

   ```
   ? small.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.*

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.

Important! Make sure no other windows are obscuring your view of the MEMORY window.

Change a value in memory:

1) Display memory beginning with address 0x0100:

   `mem 0x100` ↵

2) Point to the contents of memory location 0x0100. (The contents of memory location 0x0100 are in the second column of the MEMORY window.) ↖

3) Click the left mouse button. *Notice that this highlights and identifies the field to be edited.*

4) Type 0000.

5) Press ↵ to enter the new value.

6) Press ESC to conclude editing.

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 2000.

↓ 5) Press ↓ enough times to point at the contents of register AR0.

6) Type ffff.

↵ 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 the initialization batch file included in the c2xxhll or sim2xx directory. For the purposes of the sample program, that's fine (which is why this lesson was saved for the end).

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. The 'C2xx supports separate program and data spaces. Page 0 in the memory map is for program memory; page 1 is for data memory.

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 program memory:

   md 0x0,0

   This deletes the block of memory beginning at address 0 in program memory.

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

   ma 0x0,0,0x20,ROM
   ma 0x100,1,0x7f,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 0x0,0,0x20,ROM;
             ma 0x100,1,0x7f,RAM;ml"
```

(Note: Because of space constraints, the command is shown on two lines.)

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

```
mymap
```

This is equivalent to entering the following four commands:

```
mr
ma 0x0,0,0x20,ROM
ma 0x100,1,0x7f,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 4

The Debugger Display

The ’C2xx C source debugger has a window-oriented display. This chapter shows what windows look like and describes the basic types of windows that you’ll use.

Topic **Page**

4.1 Debugging Modes and Default Displays

The debugger has four debugging modes:

- ❑ Auto
- ❑ Assembly
- ❑ Mixed
- ❑ Minimal

Each mode changes the debugger display by adding or hiding specific windows. This section shows the default displays and the windows that the debugger automatically displays for these modes. These modes cannot be used within the profiling environment (simulator only); the COMMAND, PROFILE, DISASSEMBLY, and FILE windows are the only available windows in the profiling environment.

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 display similar to Figure 4−1. Auto mode has two types of displays:

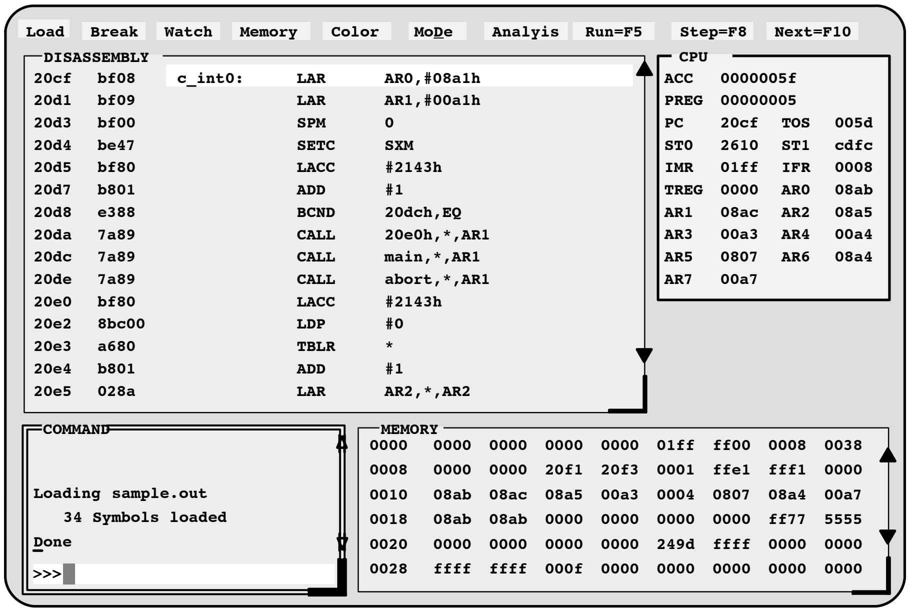
- ❑ When the debugger is running assembly language code, you'll see an assembly display similar to the one in Figure 4−1. The DISASSEMBLY window displays the reverse assembly of memory contents.

- ❑ When the debugger is running C code, you'll see a C display similar to the one in Figure 4−2. (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.)

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.

Figure 4−1. Typical Assembly Display (for Auto Mode and Assembly Mode)



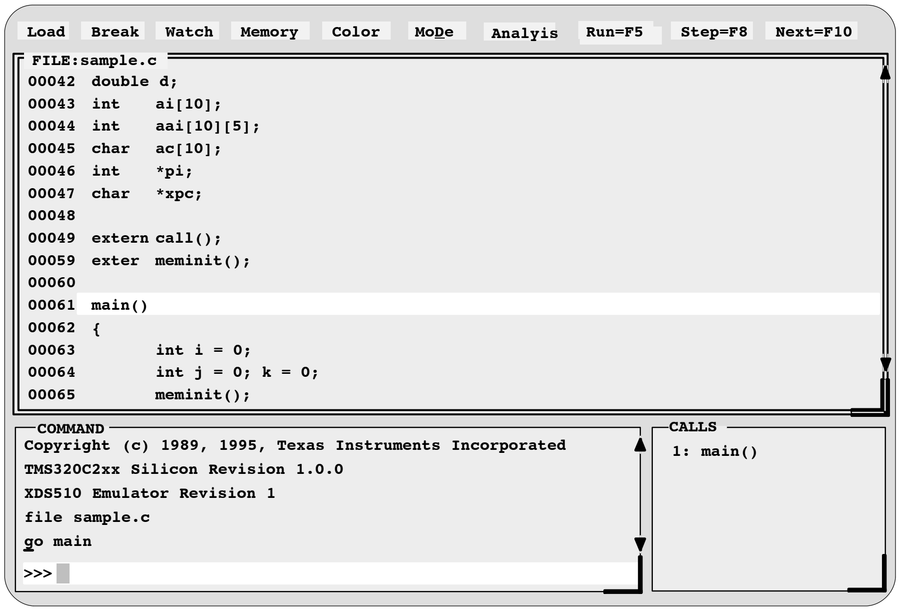
```
20cf   bf08    c_int0:    LAR     AR0,#08a1h
20d1   bf09               LAR     AR1,#00a1h
20d3   bf00               SPM     0
20d4   be47               SETC    SXM
20d5   bf80               LACC    #2143h
20d7   b801               ADD     #1
20d8   e388               BCND    20dch,EQ
20da   7a89               CALL    20e0h,*,AR1
20dc   7a89               CALL    main,*,AR1
20de   7a89               CALL    abort,*,AR1
20e0   bf80               LACC    #2143h
20e2   8bc00              LDP     #0
20e3   a680               TBLR    *
20e4   b801               ADD     #1
20e5   028a               LAR     AR2,*,AR2
```

```
ACC   0000005f
PREG  00000005
PC    20cf   TOS   005d
ST0   2610   ST1   cdfc
IMR   01ff   IFR   0008
TREG  0000   AR0   08ab
AR1   08ac   AR2   08a5
AR3   00a3   AR4   00a4
AR5   0807   AR6   08a4
AR7   00a7
```

```
Loading sample.out
   34 Symbols loaded
Done
>>>
```

```
0000  0000  0000  0000  0000  01ff  ff00  0008  0038
0008  0000  0000  20f1  20f3  0001  ffe1  fff1  0000
0010  08ab  08ac  08a5  00a3  0004  0807  08a4  00a7
0018  08ab  08ab  0000  0000  0000  0000  ff77  5555
0020  0000  0000  0000  0000  249d  ffff  0000  0000
0028  ffff  ffff  000f  0000  0000  0000  0000  0000
```

Figure 4−2. Typical C Display (for Auto Mode Only)



```
00042  double d;
00043  int    ai[10];
00044  int    aai[10][5];
00045  char   ac[10];
00046  int    *pi;
00047  char   *xpc;
00048
00049  extern call();
00059  exter  meminit();
00060
00061  main()
00062  {
00063         int i = 0;
00064         int j = 0; k = 0;
00065         meminit();
```

```
Copyright (c) 1989, 1995, Texas Instruments Incorporated
TMS320C2xx Silicon Revision 1.0.0
XDS510 Emulator Revision 1
file sample.c
go main
>>>
```

```
1: main()
```

Assembly mode

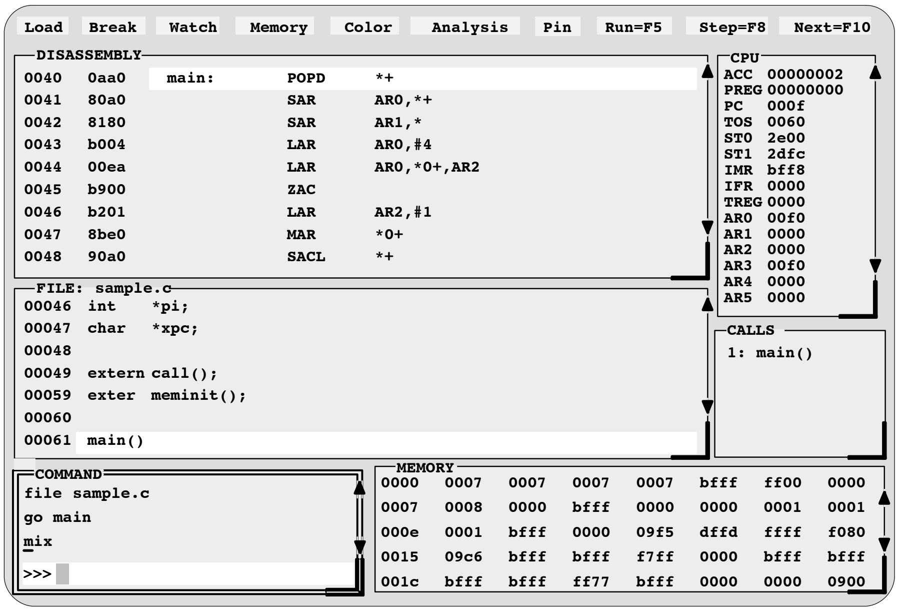
Assembly mode is for viewing assembly language programs only. In this mode, you'll see a display similar to the one shown in Figure 4−1. When you're in assembly mode, you'll always see the assembly display, regardless of whether C or assembly language is currently running.

Windows that are automatically displayed in assembly mode include the MEMORY window, the DISASSEMBLY window, the CPU register window, and the COMMAND window. If you choose, 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 4−3 shows the default display for mixed mode.

Figure 4−3. Typical Mixed Display (for Mixed Mode Only)



```
0040  0aa0   main:    POPD    *+
0041  80a0            SAR     AR0,*+
0042  8180            SAR     AR1,*
0043  b004            LAR     AR0,#4
0044  00ea            LAR     AR0,*0+,AR2
0045  b900            ZAC
0046  b201            LAR     AR2,#1
0047  8be0            MAR     *0+
0048  90a0            SACL    *+
```

```
ACC  00000002
PREG 00000000
PC   000f
TOS  0060
ST0  2e00
ST1  2dfc
IMR  bff8
IFR  0000
TREG 0000
AR0  00f0
AR1  0000
AR2  0000
AR3  00f0
AR4  0000
AR5  0000
```

```
00046  int    *pi;
00047  char   *xpc;
00048
00049  extern call();
00059  exter  meminit();
00060
00061  main()
```

```
1: main()
```

```
file sample.c
go main
mix
>>>
```

```
0000  0007  0007  0007  0007  bfff  ff00  0000
0007  0008  0000  bfff  0000  0000  0001  0001
000e  0001  bfff  0000  09f5  dffd  ffff  f080
0015  09c6  bfff  bfff  f7ff  0000  bfff  bfff
001c  bfff  bfff  ff77  bfff  0000  0000  0900
```

In mixed mode, the debugger displays all windows that can be displayed in auto and assembly mode, 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 'C2xx.

Minimal mode

Minimal mode allows you to query the target system without displaying any additional information. You can display the contents of CPU registers, memory addresses, or symbols within the COMMAND window by using the WA, DISP, and ?/EVAL commands (described on page 9-3). You can use any of the standard debugger commands in the COMMAND window. If you use the C, ASM, or MIX commands, the debugging mode changes to the auto, assembly, or mixed mode, respectively. To return to minimal mode, use the MINIMAL command.

Restrictions associated with debugging modes

The assembly language code that the debugger shows you is the disassembly (reverse assembly) of the memory contents. If you load object code into memory, 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

4.2 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.

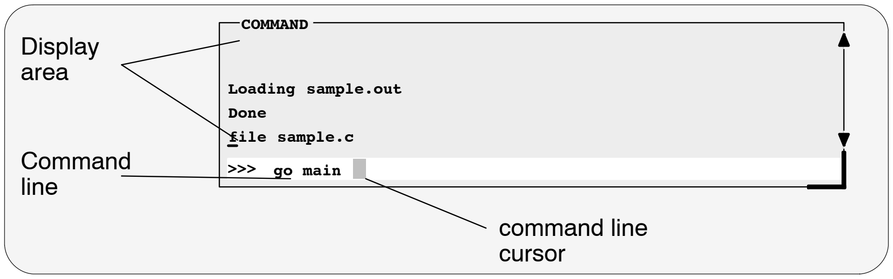
Every window is identified by a name in its upper left corner. Each type of window serves a specific purpose and has unique characteristics. There are nine different windows, divided into these general categories:

- 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 display 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 and previous function calls (when C code is running).
- The PROFILE window displays statistics about code execution. This window is only available when you are using the simulator 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 multiple MEMORY windows at one time.
  - The CPU window displays the contents of 'C2xx 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 display multiple WATCH windows at one time.

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 4.4, *The Active Window*.

The remainder of this section describes the individual windows.

COMMAND window



```
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

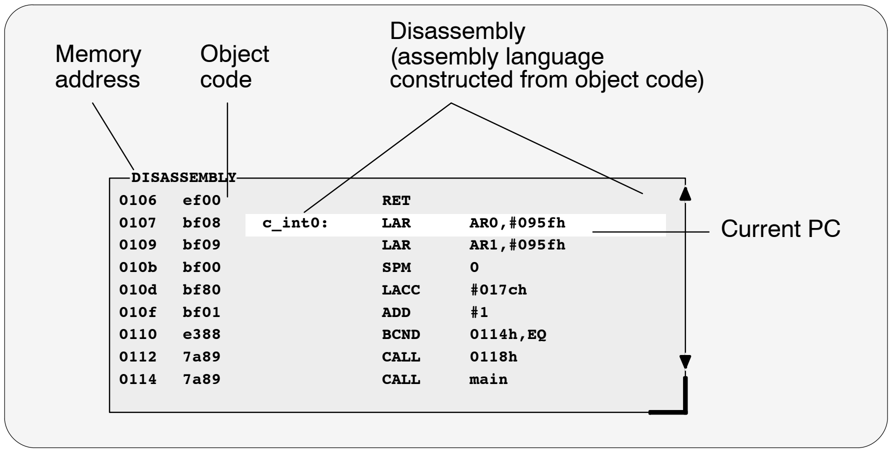
The COMMAND window has two parts:

❑ *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 reenter commands from the list without retyping them. (For more information, see *Using the command history,* page 5-5.)

❑ *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, see Chapter 5, *Entering and Using Commands*.

DISASSEMBLY window


Memory address
Object code
Disassembly (assembly language constructed from object code)
Current PC

```
DISASSEMBLY
0106   ef00                 RET
0107   bf08   c_int0:       LAR      AR0,#095fh
0109   bf09                 LAR      AR1,#095fh
010b   bf00                 SPM      0
010d   bf80                 LACC     #017ch
010f   bf01                 ADD      #1
0110   e388                 BCND     0114h,EQ
0112   7a89                 CALL     0118h
0114   7a89                 CALL     main
```

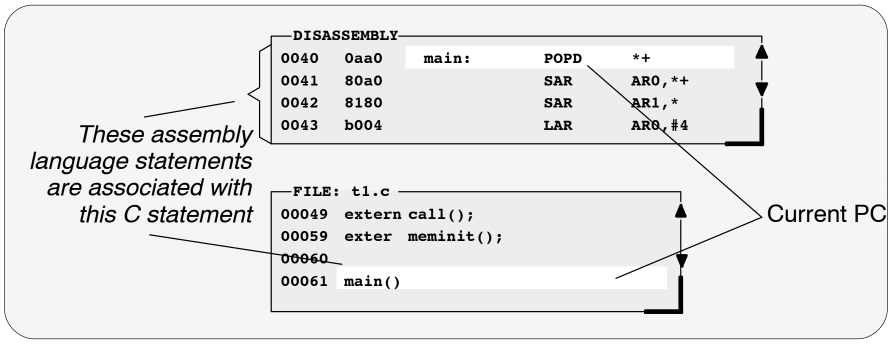
Purpose	Displays the disassembly (or reverse assembly) of memory contents
Editable?	No; pressing the edit key (F9) or the left mouse button sets a software breakpoint on an assembly language statement
Modes	Auto (assembly display only), assembly, and mixed
Created	Automatically
Affected by	❑ DASM and ADDR commands ❑ Breakpoint and run commands

Within the DISASSEMBLY window, the debugger highlights:

❑ The statement that the program counter (PC) is pointing to (if that line is in the current display)

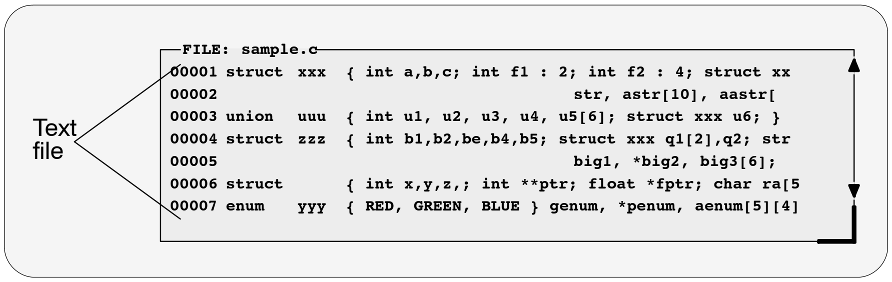
❑ Any statements with software breakpoints

❑ The address and object code fields for all statements associated with the current C statement, as shown below


These assembly language statements are associated with this C statement
Current PC

```
DISASSEMBLY
0040   0aa0   main:      POPD     *+
0041   80a0              SAR      AR0,*+
0042   8180              SAR      AR1,*
0043   b004              LAR      AR0,#4

FILE: t1.c
00049  extern call();
00059  exter  meminit();
00060
00061  main()
```

FILE window



```
FILE: sample.c
00001 struct  xxx  { int a,b,c; int f1 : 2; int f2 : 4; struct xx
00002                                    str, astr[10], aastr[
00003 union   uuu  { int u1, u2, u3, u4, u5[6]; struct xxx u6; }
00004 struct  zzz  { int b1,b2,be,b4,b5; struct xxx q1[2],q2; str
00005                                    big1, *big2, big3[6];
00006 struct       { int x,y,z,; int **ptr; float *fptr; char ra[5
00007 enum    yyy  { RED, GREEN, BLUE } genum, *penum, aenum[5][4]
```

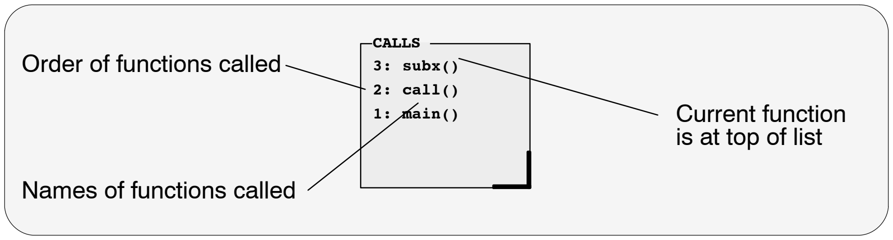
Purpose	Shows any text file you want to display
Editable?	No; if the FILE window displays C code, pressing the edit key (F9) or the left mouse button sets a software breakpoint on a C statement
Modes	Auto (C display only) and mixed
Created	❑ With the FILE command ❑ Automatically when you're in auto or 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 its caller, etc., as long as each function is a C function

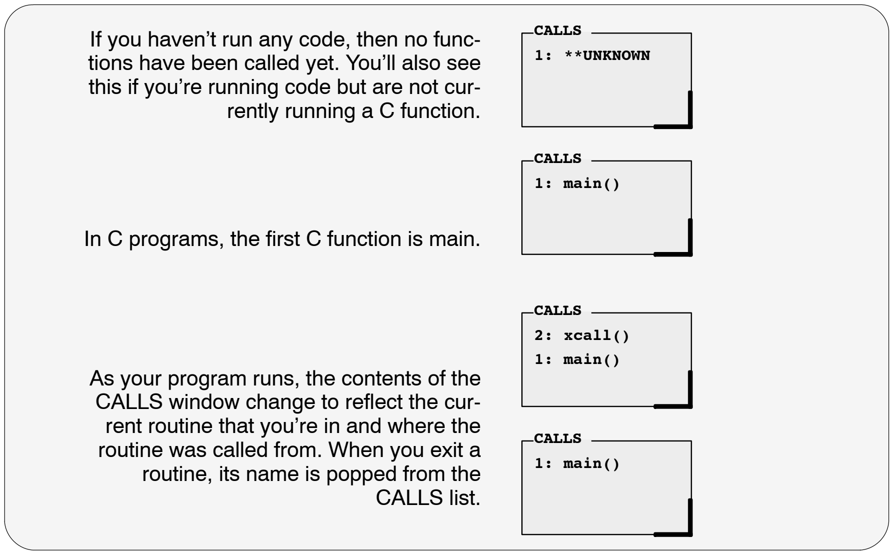
Editable? No; pressing the edit key (F9) or the left mouse button changes the FILE display to show the source associated with the called function

Modes Auto (C display only) and mixed

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

1) Make the CALLS window the active window (see Section 4.4, on page 4-20).

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

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

You can close and reopen the CALLS window.

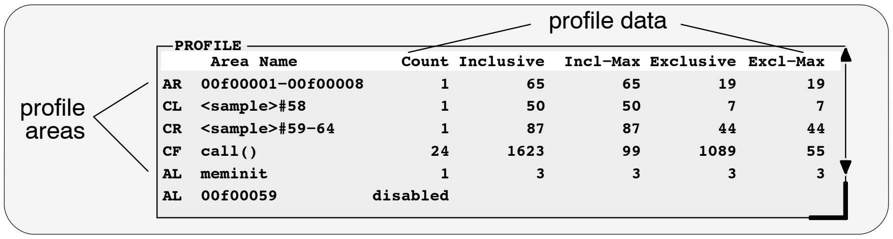
❑ Closing the window is a two-step process:

   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
```

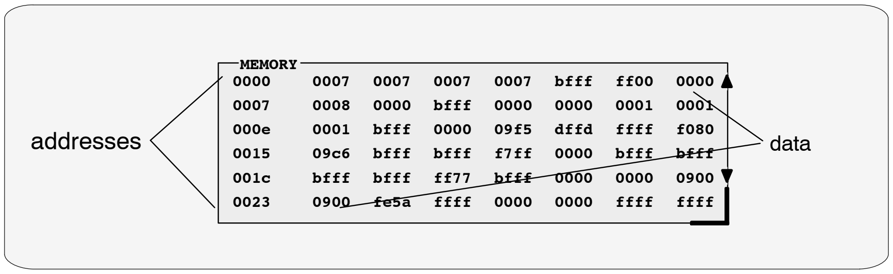
Purpose	Displays statistics collected during a profiling session
Editable?	No
Modes	Auto
Created	By invoking the debugger with the –profile option
Affected by	❑ The PF and PQ commands ❑ Any commands on the View menu ❑ Clicking in the header area of the window

The PROFILE window is visible only when you are in the profiling environment (available for the simulator only). 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 available windows are the COMMAND window, the DISASSEMBLY window, and the FILE window.

For more information about the PROFILING window (and about profiling in general), see Chapter 13, *Profiling Code Execution.*

MEMORY window



```
MEMORY
0000     0007  0007  0007  0007  bfff  ff00  0000
0007     0008  0000  bfff  0000  0000  0001  0001
000e     0001  bfff  0000  09f5  dffd  ffff  f080
0015     09c6  bfff  bfff  f7ff  0000  bfff  bfff
001c     bfff  bfff  ff77  bfff  0000  0000  0900
0023     0900  fe5a  ffff  0000  0000  ffff  ffff
```

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) ❑ With the MEM command and a unique *window name*
Affected by	MEM command

The 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.

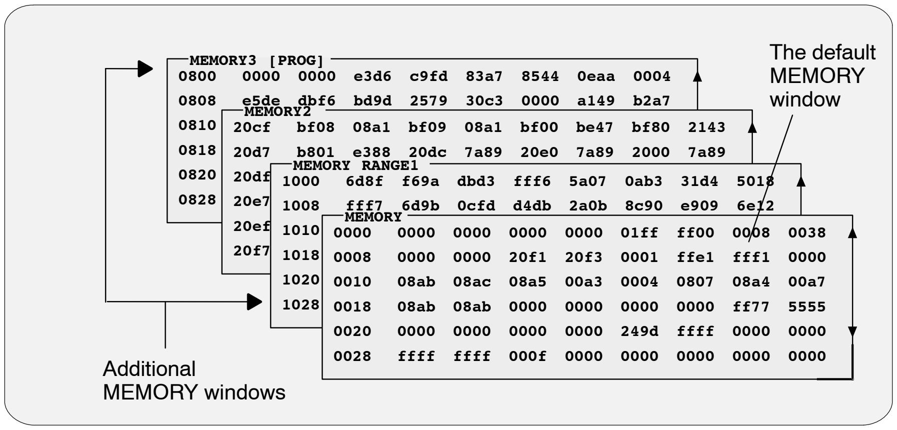
❑ *Data*. The remaining columns display the values at the listed addresses. The data is shown in hexadecimal format as 8-bit words. You can display more data by making the window wider and/or longer.

The MEMORY window above has seven columns of data, so each new address is incremented by seven. Although the window shows seven columns of data, there is still only one column of addresses; the first value is at address 0x0000, the second at address 0x0001, etc.; the eighth value (first value in the second row) is at address 0x0007, the ninth at address 0x0008, 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).

The debugger opens one MEMORY window by default. You can open any number of additional MEMORY windows to display different ranges of memory. See Figure 4–4.

Figure 4–4. The Default and Additional MEMORY Windows



```
MEMORY3 [PROG]
0800   0000  0000  e3d6  c9fd  83a7  8544  0eaa  0004
0808   e5de  dbf6  bd9d  2579  30c3  0000  a149  b2a7
0810
0818
0820
0828
```

```
MEMORY2
20cf   bf08  08a1  bf09  08a1  bf00  be47  bf80  2143
20d7   b801  e388  20dc  7a89  20e0  7a89  2000  7a89
20df
20e7
20ef
20f7
```

```
MEMORY RANGE1
1000   6d8f  f69a  dbd3  fff6  5a07  0ab3  31d4  5018
1008   fff7  6d9b  0cfd  d4db  2a0b  8c90  e909  6e12
1010
1018
1020
1028
```

```
MEMORY
0000   0000  0000  0000  0000  01ff  ff00  0008  0038
0008   0000  0000  20f1  20f3  0001  ffe1  fff1  0000
0010   08ab  08ac  08a5  00a3  0004  0807  08a4  00a7
0018   08ab  08ab  0000  0000  0000  0000  ff77  5555
0020   0000  0000  0000  0000  249d  ffff  0000  0000
0028   ffff  ffff  000f  0000  0000  0000  0000  0000
```

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

❑ **Opening an additional MEMORY window**

To open an additional MEMORY window, enter the MEM command with a unique *window name*:

mem *address,* [*display format*] **,** *window name*

For example, if you want to open a new memory window starting at address 0x8000 named RANGE1, you would enter:

`mem 0x8000,,RANGE1` ⏎

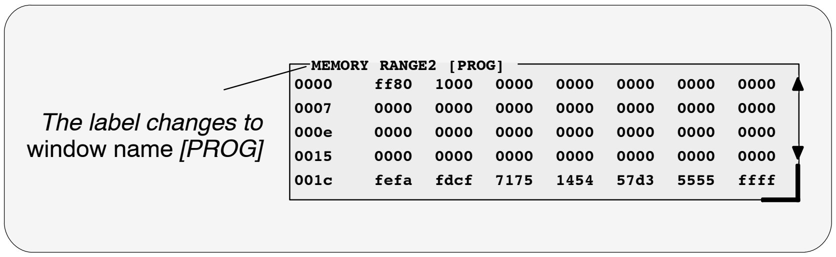
This displays a new window, labeled MEMORY RANGE1, showing the contents of memory starting at the address 0x8000.

The ’C2xx has separate data, program, and I/O spaces. By default, the MEMORY window shows data memory. If you want to display program memory, you can enter the MEM command like this:

mem *address***@prog**, , *window name*

The **@prog** suffix identifies the *address* as a program memory address. You can also use **@data** to display data memory. However, if you are displaying data memory, the @data is unnecessary because data memory is the default. If you are using an emulator, you can display I/O space by using **@io**.

When you display program memory, the MEMORY window's label changes to remind you that you are no longer displaying data memory:



```
MEMORY RANGE2 [PROG]
0000    ff80  1000  0000  0000  0000  0000  0000
0007    0000  0000  0000  0000  0000  0000  0000
000e    0000  0000  0000  0000  0000  0000  0000
0015    0000  0000  0000  0000  0000  0000  0000
001c    fefa  fdcf  7175  1454  57d3  5555  ffff
```

❑ **Displaying a new memory range in a MEMORY window**

You can use the MEM command to display a different memory range in a window:

mem *address,* [*display format*] **,** *window name*

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.

The *window name* parameter is optional if you are displaying a different memory range in the default MEMORY window. Use the *window name* parameter when you want display a new memory range in one of the additional MEMORY windows.

The *display format* parameter for the MEM command is optional. When used, the data is displayed in the selected format as shown in Table 9–2 on page 9-19.

You can close and reopen any of the MEMORY windows as often as you like.

❑ **Closing a MEMORY window**

Closing a window is a two-step process:

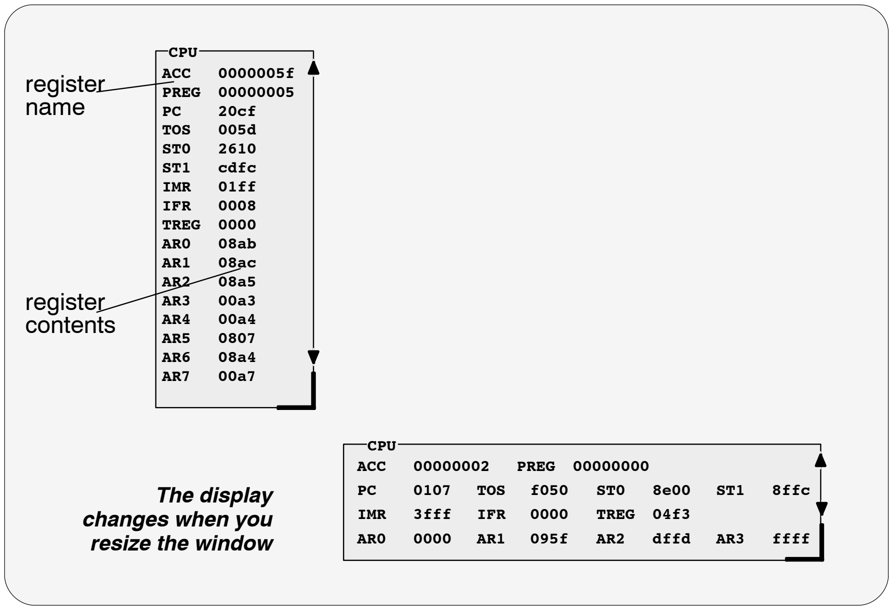
1) Make the appropriate MEMORY window the active window (see Section 4.4, on page 4-20).

2) Press F4 .

❑ **Reopening a MEMORY window**

To reopen an additional MEMORY window after you've closed it, enter the MEM command with a unique window name. To reopen the default MEMORY window, use the MEM command with no window name.

CPU window



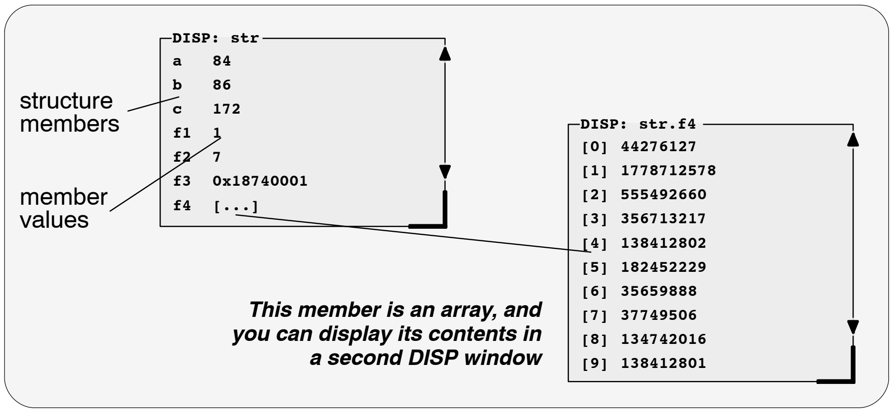
```
ACC   0000005f
PREG  00000005
PC    20cf
TOS   005d
ST0   2610
ST1   cdfc
IMR   01ff
IFR   0008
TREG  0000
AR0   08ab
AR1   08ac
AR2   08a5
AR3   00a3
AR4   00a4
AR5   0807
AR6   08a4
AR7   00a7
```

```
ACC   00000002   PREG  00000000
PC    0107   TOS   f050   ST0   8e00   ST1   8ffc
IMR   3fff   IFR   0000   TREG  04f3
AR0   0000   AR1   095f   AR2   dffd   AR3   ffff
```

Purpose	Shows the contents of the ’C2xx 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 changed values.

DISP windows


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

```
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
```

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), mixed, and minimal
Created	With the DISP command
Affected by	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:

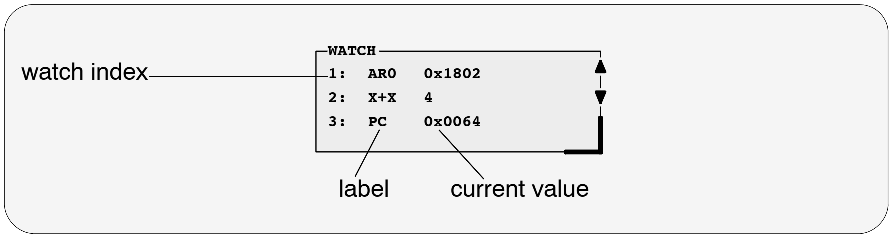
disp *expression*

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   0x1802
2:  X+X   4
3:  PC    0x0064
```

Purpose	Displays the values of selected expressions
Editable?	Yes—you can edit the value of any expression whose value corresponds to a single 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	All modes
Created	With the WA command
Affected by	WA, WD, and WR commands

A WATCH window helps you to track the values of arbitrary expressions, variables, and registers. Although the CPU window displays register contents, you might 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 are interested in.

To display the values of expressions, variables, or registers, use the WA command; the syntax is:

wa *expression* [**,**[*label*]**,** [*display format*]**,** *window name*]]

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

❑ The *display format* parameter is optional. When used, the data is displayed in the selected format as shown in Table 9–2 on page 9-19.

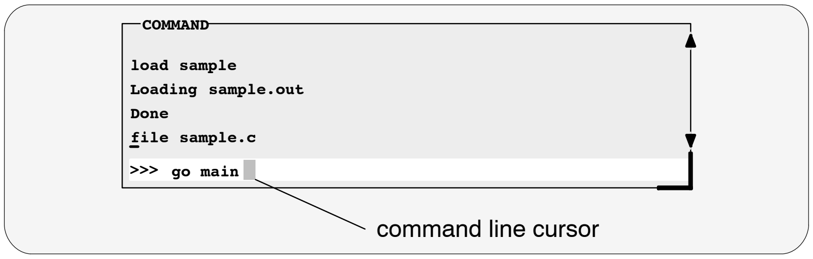
❑ If you omit the *window name* parameter, the debugger displays the expression in the default WATCH window (labeled WATCH). You can open additional WATCH windows by using the *window name* parameter. When you open an additional WATCH window, the debugger appends the *window name* to the WATCH window label. You can create as many WATCH windows as you need.

To delete individual entries from a WATCH window, use the WD command with the appropriate *window name*. To delete all entries at once and close a WATCH window, use the WR command with the appropriate *window name*. Note that you don't need to specify a *window name* if you are deleting items from the default WATCH window.

4.3 Cursors

The debugger display has three types of cursors:

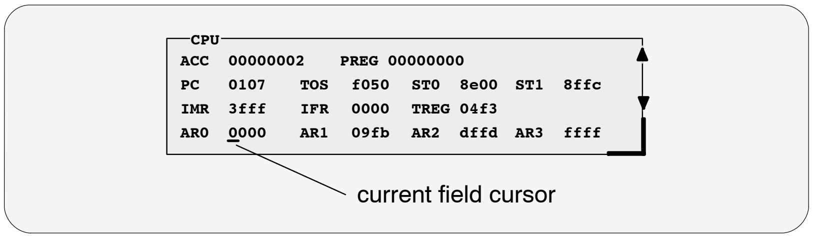
❑ The *command-line cursor* is a block-shaped cursor that identifies the current character position on the command line. When the COMMAND window is active (see Section 4.4, *The Active Window*), arrow keys affect the position of this cursor.



```
COMMAND

load sample
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
ACC  00000002    PREG 00000000
PC   0107   TOS  f050  ST0  8e00  ST1  8ffc
IMR  3fff   IFR  0000  TREG 04f3
AR0  0000   AR1  09fb  AR2  dffd  AR3  ffff
```

4.4 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*.

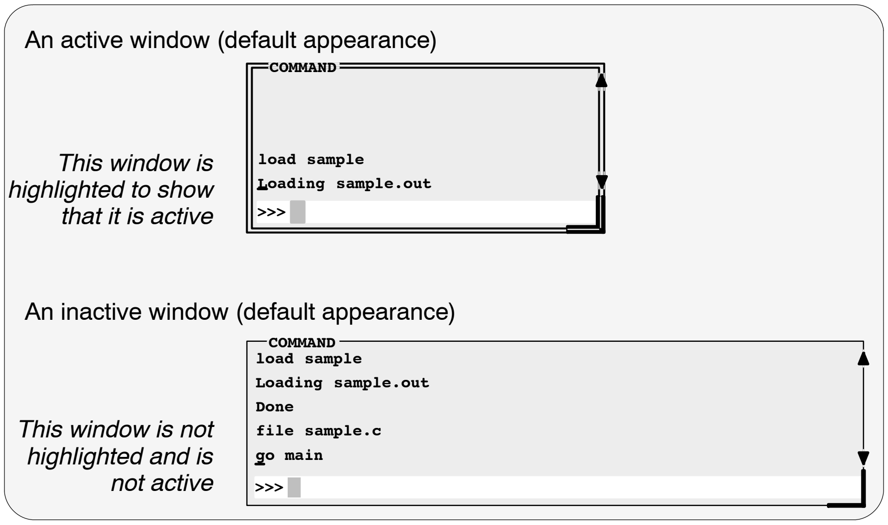
You can move, resize, zoom, or close *only one window at a time*; thus, only one window at a time can be the *active window*. Whether or not a window is active doesn't affect the debugger's ability to update information in a window—it affects only your ability to manipulate a window.

Identifying the active window

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

You can alter the active window's border style and colors if you wish; Figure 4–5 illustrates the default appearance of an active window and an inactive window.

Figure 4–5. Default Appearance of an Active and an Inactive Window


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

```
load sample
Loading sample.out
>>>
```

```
load sample
Loading sample.out
Done
file sample.c
go main
>>>
```

Note: On monochrome 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).

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 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 can 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.

4.5 Manipulating a Window

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, see Section 4.4 on page 4-20.

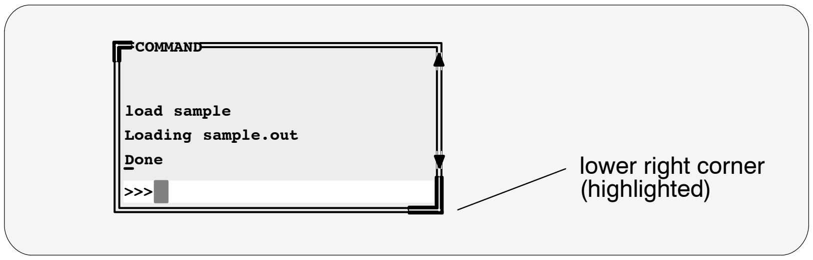
Resizing a window

The minimum window size is three lines by four characters. The maximum window size varies, depending on which screen size option 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

load sample
Loading sample.out
Done
>>>
```

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 4-24.

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

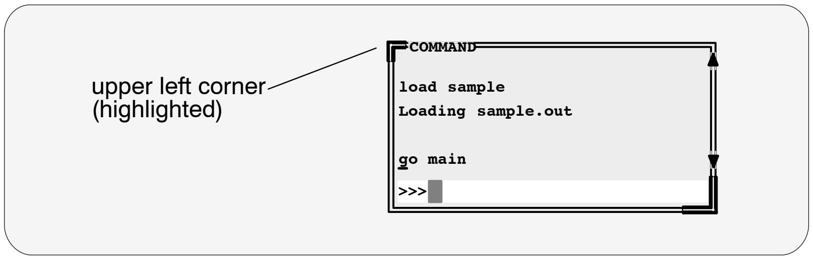
Another way to resize the active window is to zoom it. Zooming a window makes it as large as possible, so that it takes up the entire display (except for the menu bar) and hides all the other windows. Unlike the SIZE command, zooming is not affected by the window's position in the display.

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 or unzoom 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:



```
load sample
Loading sample.out

go main
>>>
```

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

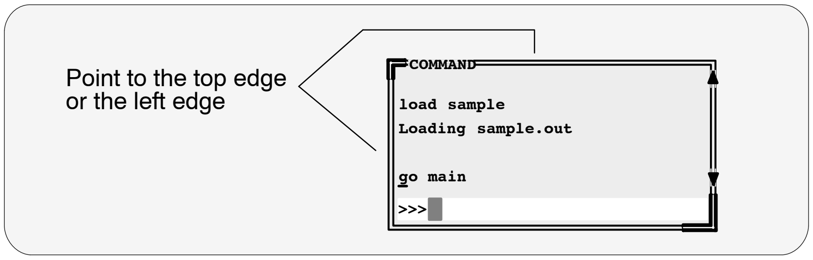
Moving a window

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.



```
load sample
Loading sample.out

go main
>>>
```

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 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 is valid in this example.

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 (see page 4-23).

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
```

4.6 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, see Section 4.4 on page 4-20.

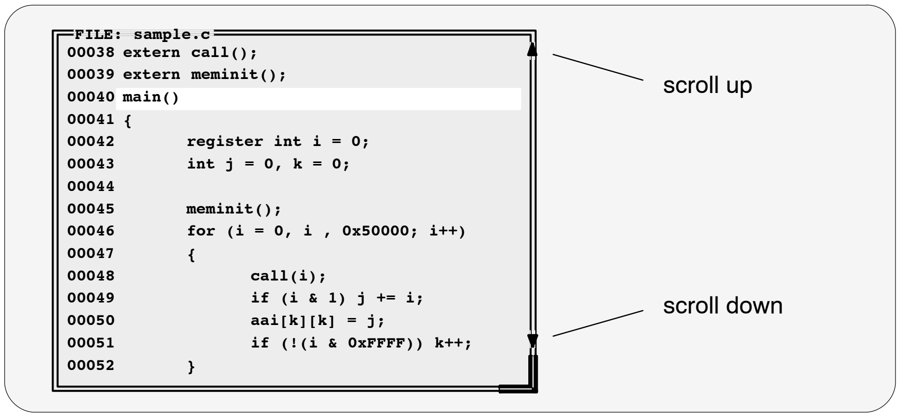
Scrolling through a window's contents

If you resize a window to make it smaller, you may hide information. Sometimes, a window contains 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 right-hand side of the active window. This is what the scroll arrows look like:



```
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++;
        }
```

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 contents of the active window, 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 contents of the active window, 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.
↑	Pressing this key moves the field cursor up one line at a time.
↓	Pressing this key moves the field cursor down one line at a time.
← →	When a field is selected for editing, the ← and → keys move the cursor within the field. You can use CONTROL ← or CONTROL → to move to the next field, except when the COMMAND window is active; in this case, the cursor moves to the beginning of the preceding or next word.

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 9.3, *Basic Methods for Changing Data Values*, page 9-4.

Note:

In the following 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 F9 or 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.

4.7 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, WATCH, and MEMORY windows. To close one of these windows:

1) Make the appropriate window active.

2) Press F4.

You can also close the WATCH window by using the WR command:

wr [*window name*]

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. When you open a DISP, WATCH, or MEMORY window, it will occupy the same position as the last one of that type that you closed.

Chapter 5

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

Mouse use and function key use differ from situation to situation and are described throughout this book whenever applicable. This chapter includes specific rules that apply to entering commands and using pulldown menus.

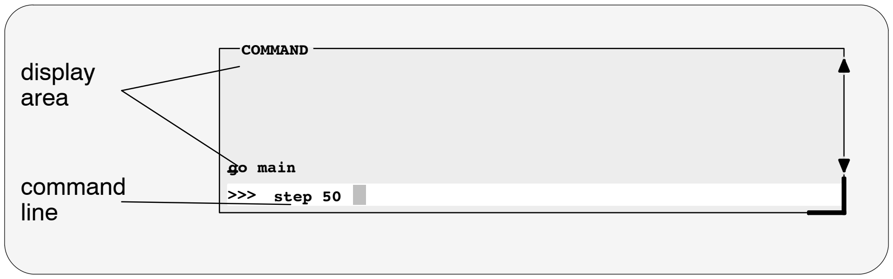
Topic **Page**

5.1 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 the various sections throughout this book, as they apply to the topic that is being discussed. Chapter 5, *Summary of Commands and Special Keys*, summarizes all of the debugger commands with an alphabetic 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 5–1 shows the COMMAND window.

Figure 5–1. The COMMAND Window



```
go main
>>>  step 50
```

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 5–1 shows that a STEP command was typed in (but not yet entered).

❑ The *display area* provides the debugger with a space for echoing commands, displaying command output, or displaying errors and messages for you to read. For example, the command output in Figure 5–1 shows the messages that are displayed when you first bring up the debugger and also shows that a GO MAIN command was entered.

  If you enter a command through 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	← †
Move forward through text without erasing characters	→ † or CONTROL L
Move to the beginning of the previous word without erasing characters	CONTROL ← †
Move to the beginning of the next word without erasing characters	CONTROL → †
Move to the beginning of the line without erasing characters	ALT ← †
Move to the end of the line without erasing characters	ALT → †
Move back over text while erasing characters	CONTROL H or BACK SPACE or DEL
Move forward through text while erasing characters	SPACE
Insert text into the characters that are already on the command line	INSERT
Delete text from the right of the cursor position	CONTROL K

† You can use the arrow keys only when the COMMAND window is selected.

Note:

1) When the COMMAND window is not active, you cannot use the arrow keys to move through or edit text on the command line.
2) Typing a command doesn't make the COMMAND window the active window.

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 for the current field in the box. See Section 5.3 on page 5-11 for more information on dialog boxes.

Using the command history

The debugger keeps an internal list, or *command history*, of the commands that you enter. It remembers the last 50 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...
Move forward through the list of executed commands, one by one	SHIFT TAB
Move backward through the list of executed commands, one by one	TAB
Repeat the last command that you entered	F2

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.

For information about using the PDM's command history, see page 2-14.

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.

You can execute log files by using the TAKE command. When you use DLOG to record the information from the display area of the COMMAND window, 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 display area of the COMMAND window, 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:

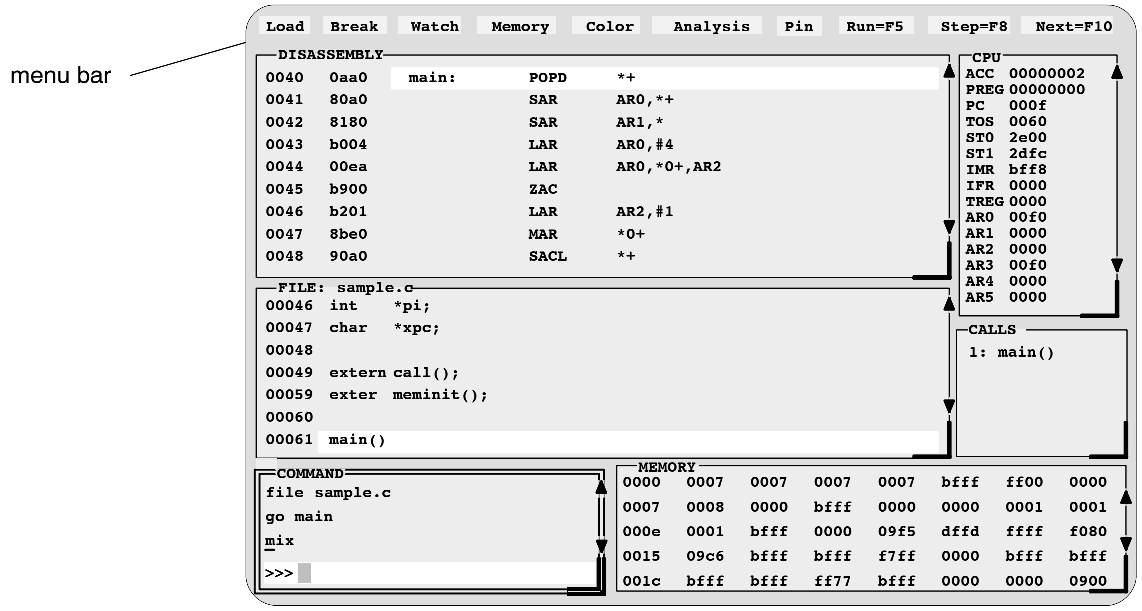
- **Creating a new log file.** If you use the DLOG command without one of the optional parameters, the debugger creates a new file that it records the information into. If you are recording to a log file already, entering a new DLOG command and filename closes the previous log file and opens a new one.
- **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** option; you will lose the contents of an existing file if you don't use the append (a) option.

For more information about the PDM version of the DLOG command, see page 2-10.

5.2 Using the Menu Bar and the Pulldown Menus

In all four 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 5−2 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.

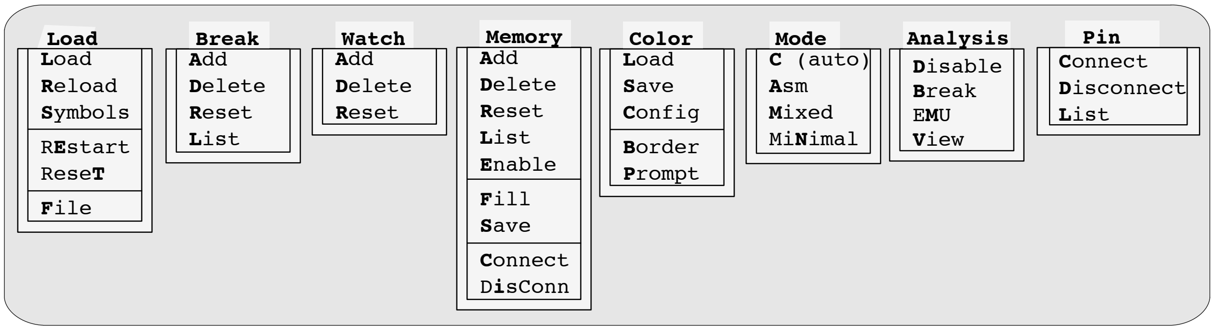
Figure 5−2. The Menu Bar in the Basic Debugger Display



```
DISASSEMBLY
0040   0aa0    main:        POPD     *+
0041   80a0                 SAR      AR0,*+
0042   8180                 SAR      AR1,*
0043   b004                 LAR      AR0,#4
0044   00ea                 LAR      AR0,*0+,AR2
0045   b900                 ZAC
0046   b201                 LAR      AR2,#1
0047   8be0                 MAR      *0+
0048   90a0                 SACL     *+

CPU
ACC  00000002
PREG 00000000
PC   000f
TOS  0060
ST0  2e00
ST1  2dfc
IMR  bff8
IFR  0000
TREG 0000
AR0  00f0
AR1  0000
AR2  0000
AR3  00f0
AR4  0000
AR5  0000

FILE: sample.c
00046  int    *pi;
00047  char   *xpc;
00048
00049  extern call();
00059  exter  meminit();
00060
00061  main()

CALLS
1: main()

COMMAND
file sample.c
go main
mix
>>>

MEMORY
0000   0007   0007   0007   0007   bfff   ff00   0000
0007   0008   0000   bfff   0000   0000   0001   0001
000e   0001   bfff   0000   09f5   dffd   ffff   f080
0015   09c6   bfff   bfff   f7ff   0000   bfff   bfff
001c   bfff   bfff   ff77   bfff   0000   0000   0900
```

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 5−3.

Figure 5−3. All of the Pulldown Menus (Basic Debugger Display)

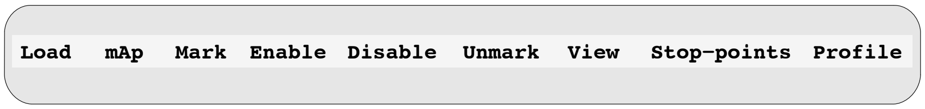


Note: The Pin menu and the Connect and DisConn entries in the Memory menu are available for the simulator only. The Analysis menu is available for the emulator only.

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.

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

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 has the same effect as executing a command by typing it in.

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

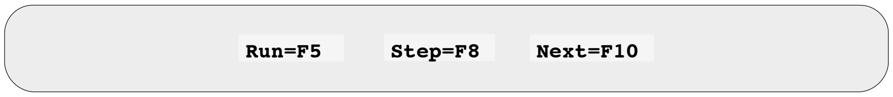
  or

- 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) Click 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.

For more information about the RUN, STEP, and NEXT commands, see Section 8.5, *Running Your Programs*, page 8-13.

5.3 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.

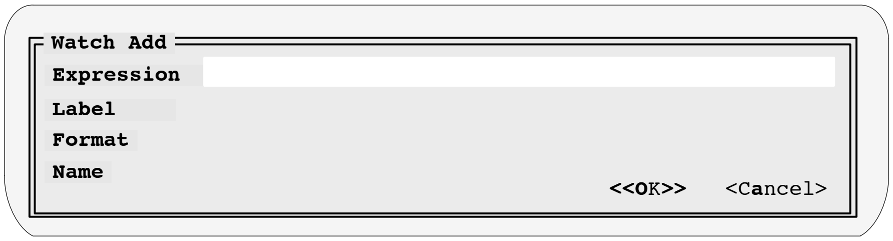
Some debugger commands have very simple dialog boxes that provide you with an alternative method for typing in values. Other commands, such as analysis commands, have more complex dialog boxes; in addition to typing in values, you may be asked to make selections from a list of predefined parameters.

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 four parameters:

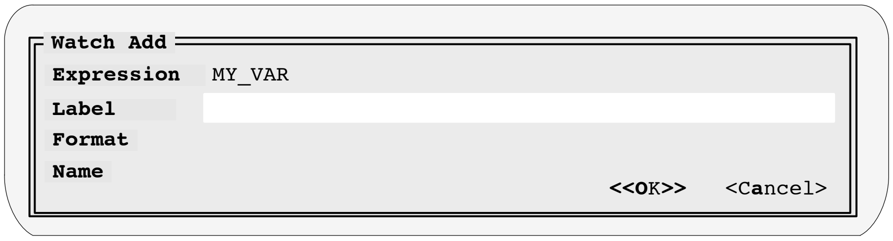
wa *expression* [,[*label*] [, [*display format*] [, *window name*]]]

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
Name
                                   <<OK>>   <Cancel>
```

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



```
Watch Add
Expression   MY_VAR
Label
Format
Name
                                   <<OK>>   <Cancel>
```

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 *label*, *format*, and *window name* parameters are optional. If you want to enter one of these parameters, you can 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, 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 5.1 on page 5-2 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 on Cancel to discard your changes; the debugger closes the dialog box and executes the command with the parameter values you supplied. You can also choose between the OK and Cancel options by using the arrow keys and pressing ↵ on your desired choice.

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.

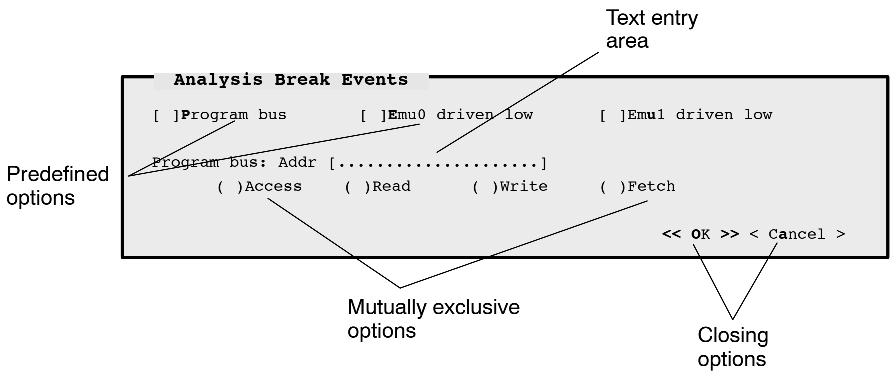
❑ **Choose from a list of predefined options.** There are two types of predefined options in a dialog box. The first type of option allows you to enable one or more predefined options. Options of the second type are *mutually exclusive*; therefore, you can enable only one at a time.

  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. To close the dialog box, just point and click on the appropriate option: either OK or Cancel.

Figure 5−4 shows you the components of a complex dialog box used with the analysis module.

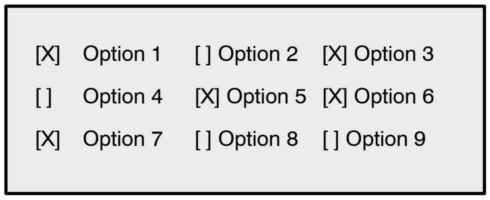
Figure 5−4. The Components of a Dialog Box



```
 Analysis Break Events
 [ ]Program bus       [ ]Emu0 driven low       [ ]Emu1 driven low

 Program bus: Addr [.....................]
        ( )Access    ( )Read      ( )Write     ( )Fetch

                                                    << OK >> < Cancel >
```

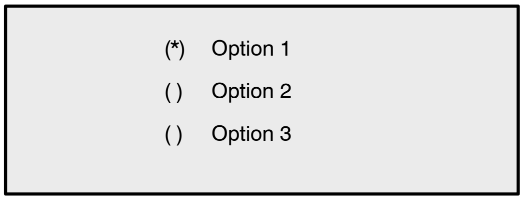
When you display a dialog box for the first time during a debugging session, nothing is enabled. When you bring up the same dialog box again, though, your previous selections are remembered. (This is similar to having a command history.)

As Figure 5−4 shows, options are preceded by either square brackets or parentheses; mutually exclusive options are 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.

key

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.

5.4 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 to enable 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 in the specified directory only.
- ■ If you don't supply path information with the *filename*, the debugger looks for the file in the current directory.
- ■ 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 operating-system environment; the command for doing this is:

SET D_DIR=*pathname;pathname*	For Windows or OS/2
setenv D_DIR "*pathname;pathname*"	For UNIX™

This allows you to name several directories that the debugger can search.

❑ By default, the debugger echoes the commands in the display area of the COMMAND window 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, the debugger behaves in the default manner.
- ■ If you want to suppress the echoing and updating, use the value 0 for the *suppress echo flag* parameter.

For information about the PDM version of the TAKE command, see page 2-9.

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.

For more information about the PDM version of the ECHO command, see page 2-13.

Controlling command execution in a batch file

In batch files, you can control the flow of debugger commands. You can choose to execute debugger commands conditionally 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 5−1 shows the constants and their corresponding tools.

Table 5−1. 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 14, *Basic Information About C Expressions*, 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 \c2xxhll
take emuinit.cmd
.
.
.
endif

if $$SIM$$
echo Invoking initialization batch file for simulator.
use \sim2xx
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 14, *Basic Information About C Expressions*, 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
step
.
.
.
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 trace some register values continuously, 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.

See *Controlling PDM command execution*, page 2-11, for more information about the PDM versions of the IF and LOOP commands.

5.5 Defining Your Own Command Strings

The debugger provides a shorthand method of entering often-used commands or command sequences. This processing 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. Be sure to enclose the *command string* in quotes.

  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. 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, %4;mem %1"
```

Then you could enter:

```
mfil 0xff80,1,0x18,0x1122
```

In this example, the first value (0xff80) is substituted for the first FILL parameter and the MEM parameter (%1). The second, third, and fourth values are substituted for the second, third, and fourth FILL parameters (%2, %3, and %4).

❑ **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 enter:

```
alias
```

you'll see:

```
  Alias      Command
-----------------------------------------
INIT    -->  load test.out;file source.c;go main
MFIL    -->  fill %1,%2,%3,%4;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, reenter the ALIAS command with the same alias name and a new command string.

- ❑ **Deleting aliases.** To delete 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:

1) Alias definitions are lost when you exit the debugger. If you want to reuse aliases, define them in a batch file.
2) 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.

For information about the PDM versions of the ALIAS and UNALIAS commands, see page 2-15.

5.6 Changing and Listing the Current Working Directory

If you're using the debugger with Windows, the debugger 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 the asterisk wildcard as part of the *directory name*.

Chapter 6

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 also be entered by using the Memory pulldown menu (see Section 5.2, *Using the Menu Bar and the Pulldown Menus*, page 5-7).

Topic **Page**

6.1 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 the 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) It checks to see whether 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 looks for the default initialization batch file. The batch filename differs for each version of the debugger:

   - ❑ For the emulator, this file is called *emuinit.cmd*.
   - ❑ For the simulator, this file is called *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 search mechanism 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 (for more information, see *Controlling command execution in a batch file*, on page 5-18) to indicate which memory map applies to each tool.

Potential memory map problems

You may experience these problems 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, 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 memory map. If you attempt to access an undefined or protected area, the debugger displays an error message. For specific error messages, see Appendix C, *Debugger and PDM Messages.*
- **Loading a COFF file with sections that cross a memory range.** Be sure that the map ranges you specify in a COFF file match those that you define with the MA command (described on page 6-7). Alternatively, you can turn memory mapping off during a load by using the MAP OFF command (described on page 6-11).

6.2 A Sample Memory Map

Because you must define a memory map before you can run any programs, it's convenient to define the memory map in the initialization batch files. Figure 6−1 shows the memory map commands that are defined in the initialization batch file that accompanies the 'C2xx emulator. You must edit the file to your configuration. This file is configured for the 'C209. You can use the file as is, edit it, or create your own memory map batch file to match your own configuration. The files shipped with the simulator are similar to those of the emulator.

The MA (map add) commands define valid memory ranges and identify the read/write characteristics of the memory ranges. Figure 6−2 illustrates the 'C209 memory map defined by the default initialization batch file. For reference, Figure 6−3 shows the memory map for the 'C203.

Figure 6−1. Memory Map Commands in the Sample Initialization Batch File (for the 'C209 Emulator)

```
; Uncomment following line if MP/MC = 0
; MA 0x0000,0,0x1000,ROM
; Uncomment following line if RAMEN = 1
; MA 0x1000,0,0x1000,RAM
; Uncomment following line if CNF = 1
; MA 0xFE00,0,0x200,RAM
MA 0x0004,1,0x3,RAM
MA 0x0060,1,0x20,RAM
; Uncomment following line if CNF = 0
; MA 0x100,1,0x200,RAM
MA 0x0300,1,0x200,RAM
MA 0x1000,1,0x1000,RAM
```

Figure 6–2. Sample Memory Map for Use With a 'C209

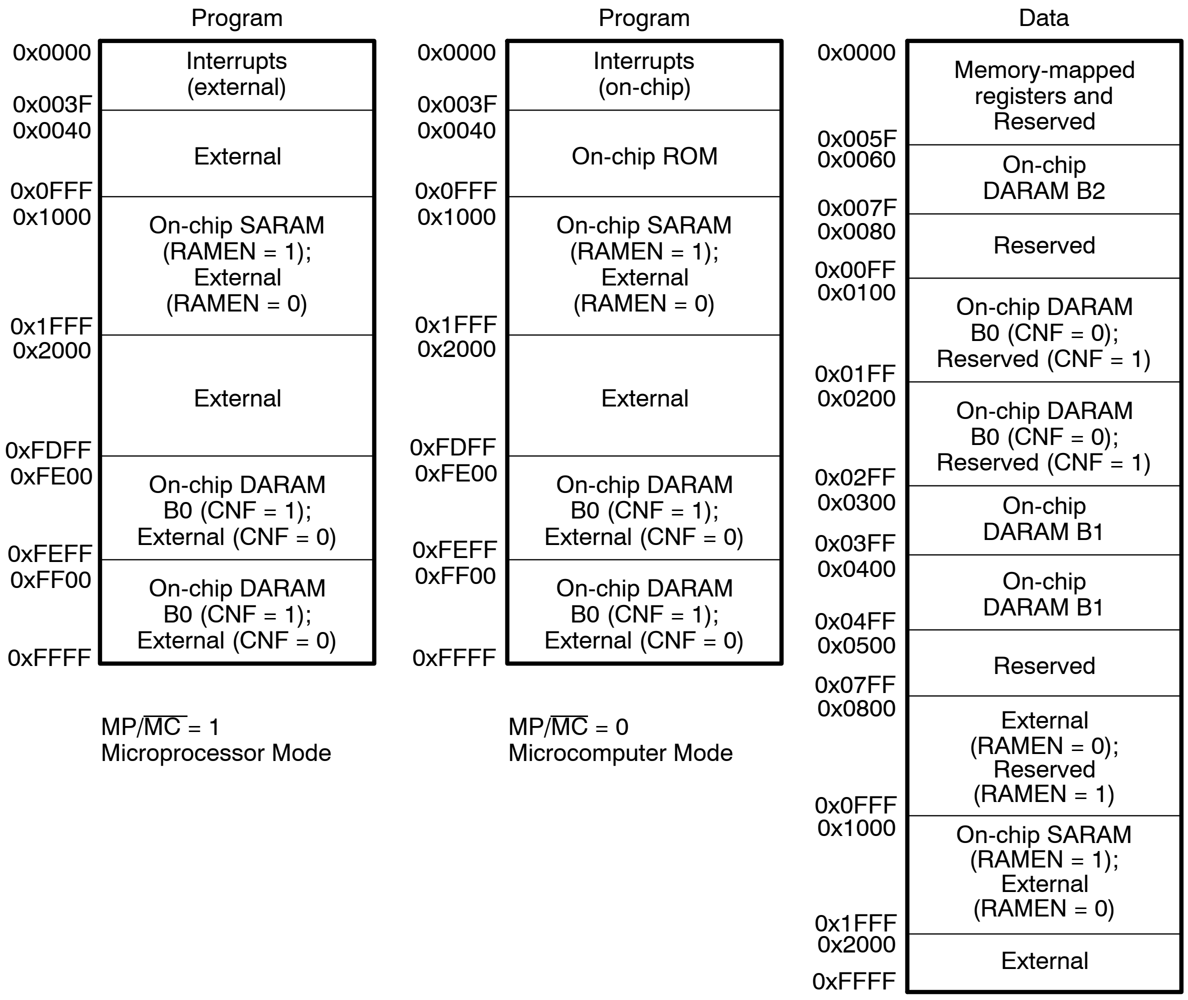
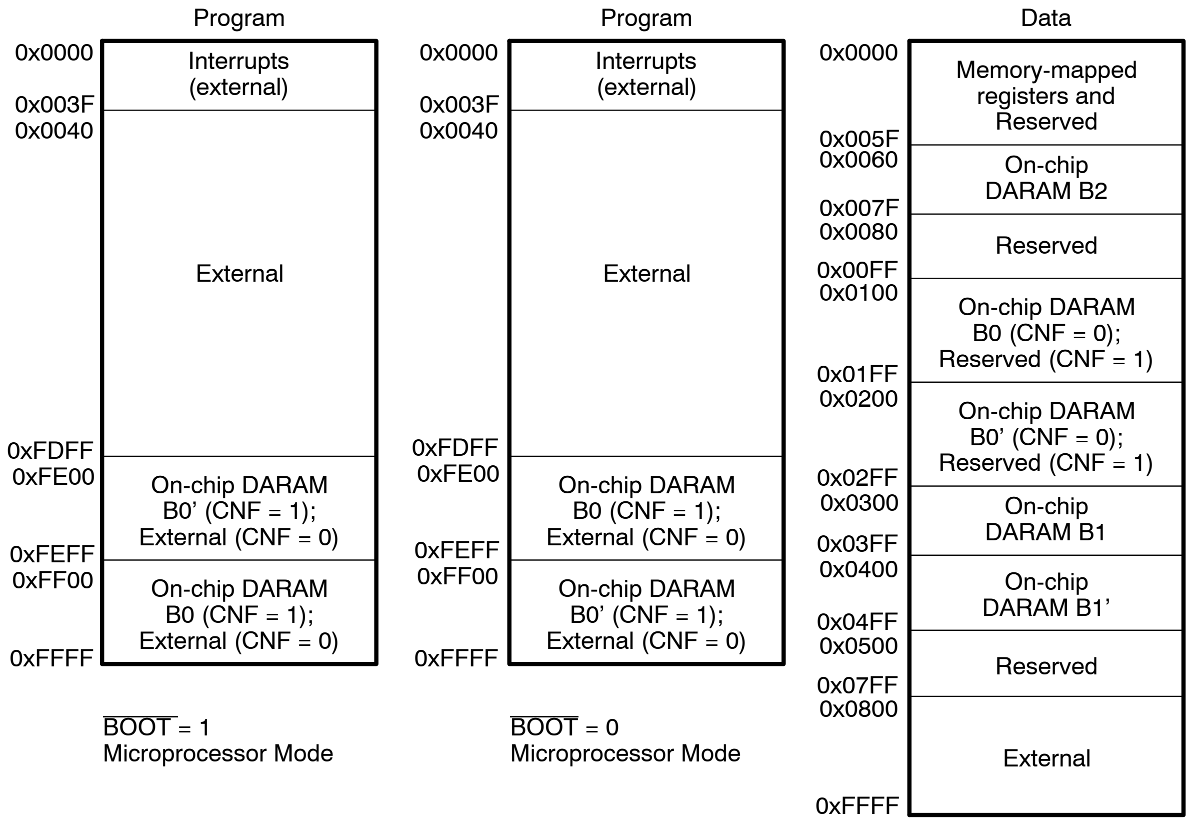


Figure 6–3. Memory Map for Use With a ’C203



6.3 Identifying Usable Memory Ranges

ma The debugger's MA (map add) command identifies valid ranges of target memory. The syntax for this command is:

ma *address, page, 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, 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 display area of the COMMAND window:

```
Conflicting map range
```

❑ The *page* parameter is a one-digit number that identifies the type of memory (program, data, or I/O) that the range occupies:

To identify this page,	Use this value as the *page* parameter
Program memory	**0**
Data memory	**1**
I/O space	**2**

- 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** or **ROM**
Write-only memory	**W** or **WOM**
Read/write memory	**R|W** or **RAM**
No-access memory	**PROTECT**
Dual-access memory	**DA**
Single-access memory	**SA**
Input port	**INPORT** or **P|R**
Output port	**OUTPORT** or **P|W**
Input/output port	**IOPORT** or **P|R|W**

Notes:

1) The debugger caches memory that is not defined as a port type (INPORT, OUTPORT, or IOPORT). For ranges that you don't want cached, be sure to map them as ports.
2) When you are using the simulator, you can use the parameter values INPORT, OUTPORT, and IOPORT to simulate I/O ports. Refer to Section 6.9, *Simulating I/O Space*, on page 6-16.
3) Be sure that the map ranges that you specify in a COFF file match those that you define with the MA command. Moreover, a command sequence such as:

   ```
   ma x,y,ram; ma x+y,z,ram
   ```

   doesn't equal

   ```
   ma x,y+z,ram
   ```

   If you were planning to load two COFF blocks, where the first block spanned the length of y and the second block spanned the length of z, you would use the first MA command example. However, if you were planning to load a COFF block that spanned the length of y + z, you would use the second MA command example. Alternatively, you could turn memory mapping off during a load by using the MAP OFF command.
4) Adding input FIFOs to your memory map as readable by the debugger can cause your program to execute incorrectly. Input FIFOs can only be read once, regardless of whether the FIFO is read by the debugger or your program.

Memory mapping with the simulator (MS-DOS version only)

Unlike the emulator, the 'C2xx simulator has memory cache capabilities that allow you to allocate as much memory as you need. However, to use memory cache capabilities effectively with the 'C2xx, do not allocate more than 20K words of memory in your memory map. For example, the following memory map allocates 64K words of 'C2xx program memory.

Example 6–1. Sample Memory Map for the 'C2xx Using Memory Cache Capabilities

```
MA 0,0,0x5000,R|W
MA 0x5000,0,0x5000,R|W
MA 0xa000,0,0x5000,R|W
MA 0xf000,0,0x1000,R|W
```

The simulator creates temporary files in a separate directory on your disk. For example, when you enter an MA command, the simulator creates a temporary file in the root directory of your current disk. Therefore, if you are currently running your simulator on the C drive, temporary files are placed in the C:\ directory. This prevents the processor from running out of memory space while you are executing the simulator.

Note:

If you execute the simulator from a floppy drive (for example, drive A), the temporary files are created in the A:\ directory.

All temporary files are deleted when you leave the simulator via the QUIT command. If, however, you exit the simulator with a soft reboot of your computer, the temporary files are not deleted; you must delete these files manually. (Temporary files usually have numbers for names.)

Your memory map is now restricted only by your PC's capabilities. As a result, there should be sufficient free space on your disk to run any memory map you want to use. If you use the MA command to allocate 20K words (40K bytes) of memory in your memory map, your disk should have at least 40K bytes of free space available. To do this, you can enter:

```
ma 0x0, 0, 0x5000, ram ↵
```

Note:

You can also use the memory cache capability feature for the data memory.

6.4 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

Note that disabling memory mapping can cause bus fault problems in the target 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 display area of the COMMAND window:

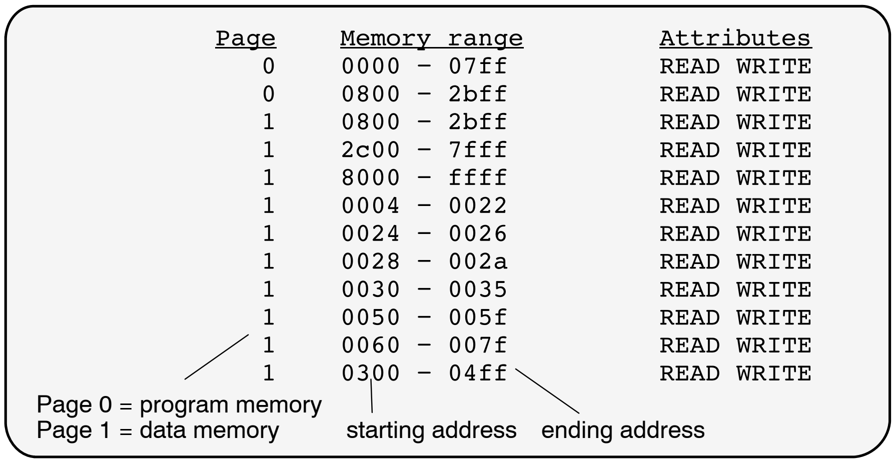
```
Error in expression
```

6.5 Checking the Memory Map

ml If you want to see which memory ranges are defined, use the ML (list memory map) command. The syntax for this command is:

ml

The ML command lists the page, starting address, ending address, and read/write characteristics of each defined memory range. Here is an example of the results shown in the display area of the COMMAND window when you enter the ML command:



```
Page     Memory range         Attributes
   0     0000 - 07ff          READ WRITE
   0     0800 - 2bff          READ WRITE
   1     0800 - 2bff          READ WRITE
   1     2c00 - 7fff          READ WRITE
   1     8000 - ffff          READ WRITE
   1     0004 - 0022          READ WRITE
   1     0024 - 0026          READ WRITE
   1     0028 - 002a          READ WRITE
   1     0030 - 0035          READ WRITE
   1     0050 - 005f          READ WRITE
   1     0060 - 007f          READ WRITE
   1     0300 - 04ff          READ WRITE
```

6.6 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, page*

- ❑ The *address* parameter identifies the starting address of the range of program, data, or I/O 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
```

- ❑ The *page* parameter is a one-digit number that identifies the type of memory (program, data, or I/O) that the range occupies:

To identify this page,	Use this value as the *page* parameter
Program memory	**0**
Data memory	**1**
I/O space	**2**

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 6.9, *Simulating I/O Space (Simulator Only)*, on page 6-16.

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 (map add) command. The syntax for this command is:

ma *address, page, length, type*

The MA command is described in detail on page 6-7.

Returning to the original memory map

If you modify the memory map, you might 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 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.

6.7 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 the initialization batch file during invocation. 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.

You can also use the –t option instead of the TAKE command when you invoke the debugger. The –t option allows you to specify a new batch file to be used instead of the default initialization batch file.

6.8 A Sample Memory Map for the Simulator

The simulator does not restrict the size, number, or starting address of the internal SARAM, DARAMS, and ROM blocks. Example 6−2 illustrates the concept:

Example 6−2. Sample Memory Map for the ’C2xx Simulator

```
ma 0x0000,    1,    0x0050,    RAM|R|W
ma 0x0050,    1,    0x0030,    R|W|DA
ma 0x0100,    1,    0x0200,    R|W|DA
ma 0x0300,    1,    0x1000,    R|W|EX
ma 0x0000,    0,    0x00ff,    ROM
ma 0x0100,    0,    0x1000,    RAM|EX|R|W
```

The code in Example 6−2 configures address 0x0050 to 0x0080 as DARAM. Note that the starting address and length does not correspond to that of the B0, B1, or B2 blocks. The address from 0x0100 to 0x0300 is configured as another DARAM block. In the data space, the address 0x0300 to 0x1300 is configured as external memory. In the program space, the address 0x0000 to 0x00ff is configured as ROM and address 0x0100 to 0x1100 is configured as external memory.

All the IO space for the peripheral registers must be configured in the ’C203/’C209 simulator initialization files. See Section NO TAG, *Simulating Peripherals (Simulator Only)* on page NO TAG, for the commands that must be included in the ’C203 or ’C209 initialization file. The ’C200 simulator does not have any of these peripherals.

6.9 Simulating I/O Space (Simulator Only)

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 INPORT (input port), OUTPORT (output port), or IOPORT (input/output port) as the memory type. Use page 1 to simulate serial ports; use page 2 to simulate parallel ports. 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 INPORT, OUTPORT, or IOPORT to an input or output file. The syntax for this command is:

mc *port address, page, length, 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 *page* parameter is a one-digit number that identifies the page that the port occupies. Parallel ports are on page 2 (the I/O space), and serial ports are on page 1 (data space).
- ❑ The *length* parameter defines the length of the range. This parameter can be any C expression.
- ❑ 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 IN or OUT instruction to the associated port address. Any port in I/O space can be connected 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.

Example 6–3 shows how an input port can be connected to an input file named in.dat.

Example 6–3. 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:

```
0A00
1000
2000
  .
  .
  .
```

These two debugger instructions set up and connect an input port:

```
MA     0x50,2,0x1,IOPORT            Configure port address 50h
                                               as an input port
MC     0x50,2,in.dat,READ                  Open file in.dat and
                                      connect to port address 50h
```

Assume that this ’C2xx instruction is part of your ’C2xx program. It reads from the file in.dat.

```
       IN    00h,50h               IN instruction reads from file
```

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, page,* {**READ** | **WRITE**}

The *port address* and *page* identify the port that is to be closed. The read/write characteristics must match the parameter used when the port was connected.

6.10 Simulating External Interrupts (Simulator Only)

The ’C2xx simulator supports different external pins and pulses according to the device simulated. The ’C200 and ’C209 external pins are the $\overline{\text{INT1}}$–$\overline{\text{INT3}}$ interrupt pins and the $\overline{\text{BIO}}$ pin.

The ’C203 supports the following external pins and pulses:

- ❑ $\overline{\text{INT1}}$–$\overline{\text{INT3}}$ interrupt pins
- ❑ FSX and FSR pulses
- ❑ AFSX pulse
- ❑ $\overline{\text{IO0}}$–$\overline{\text{IO3}}$ pins
- ❑ $\overline{\text{BIO}}$ pin

To simulate these pins and pulses, create a data file and connect the file to the appropriate pin or pulse. The format of the data in the file depends on the pin or pulse simulated.

Note:

The time interval is expressed as a function of CPU clock cycles. Simulation begins at the first clock cycle.

Setting up your input file

In order to simulate interrupts or the synchronization pulses, you must first set up an input file that lists interrupt intervals. Your file must contain a clock cycle in the following format:

[*clock cycle, logic value*] **rpt** {*n* | **EOS**}

Note that the square brackets are used only with logic values for the $\overline{\text{BIO}}$ pin, and, for the ’C203, the $\overline{\text{IO0}}$–$\overline{\text{IO3}}$ pins.

- The *clock cycle* parameter represents the CPU clock cycle where you want an interrupt to occur.

  You can have two types of CPU clock cycles:

  - **Absolute**. To use an absolute clock cycle, your cycle value must represent the actual CPU clock cycle where you want to simulate an interrupt. For example:

    ```
    12 34 56
    ```

    Interrupts are simulated at the 12th, 34th, and 56th CPU clock cycles. Notice that no operation is done to the clock cycle value; the interrupt occurs exactly as the clock cycle value is written.

  - **Relative**. You can also select a clock cycle that is relative to the time at which the last event occurred. For example:

    ```
    12 +34 55
    ```

    In this example, a total of three interrupts are simulated at the 12th, 46th (12 + 34), and 55th CPU clock cycles. A plus sign (+) before a clock cycle adds that value to the total clock cycles preceding it. Notice that you can mix both relative and absolute values in your input file.

- The *logic value* parameter is valid for the $\overline{\text{BIO}}$ and $\overline{\text{IO0–IO3}}$ pins. You must use a value to force the signal to go high or low at the corresponding clock cycle. A value of 1 forces the signal to go high, and a value of 0 forces the signal to go low. For example:

  ```
  [12,1] [56,0] [78,1]
  ```

  This causes the $\overline{\text{BIO}}$ pin to go high at the 12th cycle, low at the 56th cycle, and high again at the 78th cycle. You can also select the clock cycle that is relative to the time at which the last event occurred. For example:

  ```
  [12,1] [+44,0] [+22,1] [100,0]
  ```

  This causes the $\overline{\text{BIO}}$ pin to go high at the 12th cycle, low at the 56th cycle, and high again at the 78th cycle. At the 100th cycle the signal becomes 0. As seen here, you can mix relative and absolute clock cycles.

- The **rpt** {n | **EOS**} parameter is optional and represents a repetition value.

  You can have two forms of repetition to simulate interrupts:

  - **Repetition on a fixed number of times**. You can format your input file to repeat a particular pattern for a fixed number of times. For example:

    ```
    5 (+10 +20) rpt 2
    ```

    The values inside of the parentheses represent the portion that is repeated. Therefore, an interrupt is simulated at the 5th CPU cycle, then the15th (5 + 10), 35th (15 + 20), 45th (35 + 10), and 65th (45 + 20) CPU clock cycles.

    Note that n is a positive integer value.

    Repetition can also be done for the signal logic value pair types. For example:

    ```
    [5,1] ([+10,0] [+10,1]) rpt 2
    ```

    This causes the signal to go high at the 5th cycle, low at the 15th cycle, high at the 25th cycle, low at the 35th cycle, and high at the 45th cycle.

  - **Repetition to the end of simulation**. To repeat the same pattern throughout the simulation, add the string EOS to the line. For example:

    ```
    10 (+5 +20) rpt EOS
    ```

    Interrupts are simulated at the 10th CPU cycle, then the 15th (10 + 5), 35th (15 + 20), 40th (35 + 5), 60th (40 + 20), 65th (60 + 5), and 85th (65 + 20) CPU cycles, continuing in that pattern until the end of simulation.

    The logic value parameter's pattern can be repeated throughout the end of simulation by adding the string EOS to the end of the line. For example:

    ```
    [5,1] {[+10,0] [+10,1]) rpt eos
    ```

    This causes the signal to go high at the 5th cycle, low at the 10th cycle, and then alternate going from 0 to 1 every 10 cycles.

Programming the simulator

After you have created your input file, you can use debugger commands to connect, list, and disconnect the interrupt pin to your input file. Use these commands as described below, or use them from the PIN pulldown menu.

pinc To connect your input file to the pin, use the following command:

pinc *pinname, filename*

- ❑ The *pinname* identifies the devices' input pin. The input pins supported vary by device:

  For the 'C200 and 'C209, the pin name must be one of the following:

  - ■ $\overline{\text{INT}}$1–$\overline{\text{INT}}$3
  - ■ $\overline{\text{BIO}}$

  For the 'C203, the pin name must be one of the following:

  - ■ $\overline{\text{INT}}$1–$\overline{\text{INT}}$3
  - ■ $\overline{\text{BIO}}$
  - ■ FSX pulse
  - ■ FSR pulse
  - ■ AFSX pulse
  - ■ IO0–IO3

- ❑ The *filename* is the name of your input file.

Example 6–4 shows you how to connect your input file using the PINC command.

Example 6–4. Connecting the Input File With the PINC Command

Suppose you want to generate an $\overline{\text{INT}}$2 external interrupt at the 12th, 34th, 56th, and 89th clock cycles.

First, create a data file with an arbitrary name such as myfile:

```
12 34 56 89
```

Then use the PINC command in the pin pulldown menu to connect the input file to the $\overline{\text{INT}}$2 pin.

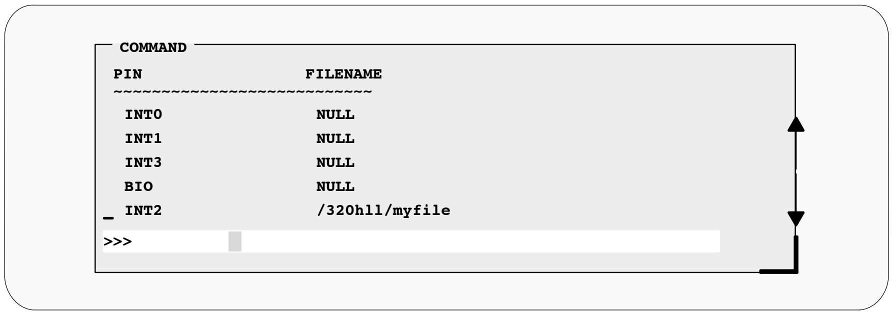
```
pinc  int2, myfile
```
Connects your data file to the specific interrupt pin

This command connects myfile to the $\overline{\text{INT}}$2 pin. As a result, the simulator generates an $\overline{\text{INT}}$2 external interrupt at the 12th, 34th, 56th, and 89th clock cycles.

pinl To verify that your input file is connected to the correct pin, use the PINL command. The syntax for this command is:

pinl

The PINL command displays all of the unconnected pins first, followed by the connected pins. For a pin that has been connected, it displays the name of the pin and the absolute pathname of the file in the COMMAND window. The following is the COMMAND window display for the 'C200 and 'C209 simulators.



```
PIN                   FILENAME
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
 INT0                  NULL
 INT1                  NULL
 INT3                  NULL
 BIO                   NULL
 INT2                  /320hll/myfile
>>>
```

pind To end the interrupt simulation, disconnect the pin. You can do this with the following command:

pind *pinname*

The *pinname* parameter identifies the interrupt pin and must be one of the external interrupt pins:

For the 'C200 and 'C209, the pin name must be one of the following:

- $\overline{\text{INT}}$1–$\overline{\text{INT}}$3
- $\overline{\text{BIO}}$

For the 'C203, the pin name must be one of the following:

- $\overline{\text{INT}}$1–$\overline{\text{INT}}$3
- $\overline{\text{BIO}}$
- FSX
- FSR
- AFSX
- IO0–IO3

The PIND command detaches the file from the input pin. After executing this command, you can connect another file to the same pin.

Chapter 7

Using the Debugger With Extended Addressing

The TMS320C2xx is limited to 64K bytes of address space in program, data, and I/O space. Some applications require access to memory beyond the 64K limit for program and data space. By adding memory and additional logic to your target system, you can *extend* the memory of your system. The emulator version of the debugger includes an extended addressing feature that enables the 'C2xx to access this extended memory when you debug your system.

This chapter defines extended addressing and describes what you need to do in your debugger to enable extended addressing for the TMS320C2xx.

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7.1 Understanding the Use of Extended Addressing

With the extended addressing feature, you have the ability to add additional memory to your target system for use by the 'C2xx.

About extended addressing

Once you modify your target system to include extended memory, you can use the debugger to access the extended memory. To determine which memory location you want to access, the debugger must have a unique address.

In an extended memory system, you logically split the 16-bit 'C2xx address space into two pieces. The low-ordered addresses are common or *unmapped* memory. The high-ordered addresses are extended or *mapped* memory. The address that defines the boundary between unmapped and mapped memory, the *mapped start address*, is defined based on the external registers and memory that you add to your target system.

You can add and define multiple banks of physical memory that overlay each other in a single, mapped address range. The use of extended pages of memory extends the native 16-bit address space. Because the 16-bit address space is extended, the debugger uses addresses that are 32 bits wide. The 32-bit address is composed of the following:

- The 16 most significant bits (MSBs) represent the extended page number. In your source code, you store this number in one of the following registers:
  - The program mapper register (PMR) stores the extended page number for extended program-memory pages. The value that you use in the PMR is the same extended-page number that you use in the linker command file.
  - The data mapper register (DMR) stores the extended page number for extended data-memory pages. The value that you use in the DMR is the same extended-page number that you use in the linker command file.

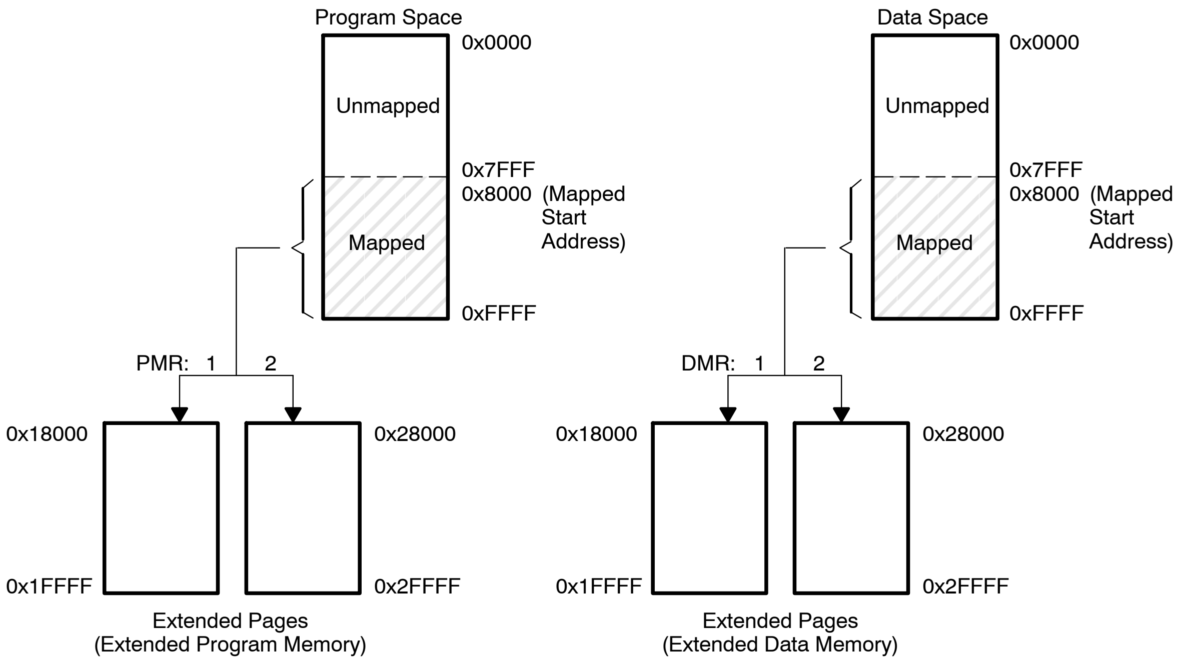
  You create the PMR or DMR when you build your extended memory system.
- The 16 least significant bits (LSBs) represent the native 16-bit address for the symbol.

Sample extended memory system

Figure 7–1 illustrates a sample extended memory system. In this example, the program and data space are allocated in the same manner:

- ❑ The unmapped memory region is from 0x0000 to 0x7FFF.
- ❑ The mapped memory region is from 0x8000 to 0xFFFF.
- ❑ Two extended pages extend the mapped address space.
- ❑ The mapper register (PMR or DMR) qualifies the mapped address, creating a unique address for each location in each extended page.

Figure 7–1. Sample Extended Memory System



7.2 Setting Up Extended Addressing

Before you can use extended memory, you must build a target system that includes extended memory, including hardware that assigns an extended page to an extended memory region. The *TMS320C2xx Emulator Getting Started Guide* describes how to set up your target system with extended memory.

Once you have built your extended memory system, you must set up the debugger to use extended addressing by doing the following:

- ❑ Describe your extended memory configuration to the debugger
- ❑ Enable extended addressing

This section describes how to perform these tasks.

Describing your extended memory configuration to the debugger

You must describe to the debugger your extended memory configuration and where to look for the PMR or DMR register. To do so, use the EXT_ADDR_DEF command. The syntax for this command is:

ext_addr_def *map start* [{**@prog** | **@data**}], *reg addr* [{**@prog** | **@data** | **@io**}], *mask*

- ❑ The *map start* parameter defines the beginning of the mapped memory range. By default, the *map start* parameter is treated as a program-memory address. However, you can follow it with **@prog** to identify program memory or with **@data** to identify data memory.
- ❑ The *reg addr* parameter defines the location of the mapper register (PMR or DMR).
  - ■ If you are defining program memory, use the address for the PMR.
  - ■ If you are defining data memory, use the address for the DMR.

  By default, the *reg addr* parameter is treated as a data-memory address. However, you can follow it with **@prog** to identify program memory, with **@data** to identify data memory, or with **@io** to identify I/O space.
- ❑ The *mask* parameter is a bit mask that represents the size of the PMR or DMR.

For example, if you designed an extended memory system that begins mapping at address 0x8000 in program memory, with the 8-bit PMR located at 0x0100 in I/O space, you would enter:

```
ext_addr_def 0x8000@prog, 0x0100@io, 0xff
```

To avoid entering the EXT_ADDR_DEF command each time you invoke the debugger, you can modify your emuinit.cmd file to include the command. The debugger reads and executes the commands in the emuinit.cmd file each time you invoke the debugger.

Enabling extended addressing

Before you load your target code, you must enable extended addressing. To do so, use the EXT_ADDR ON command. The syntax for this command is:

ext_addr {**on** | **off**}

You cannot use this command before you define your extended memory configuration with the EXT_ADDR_DEF command.

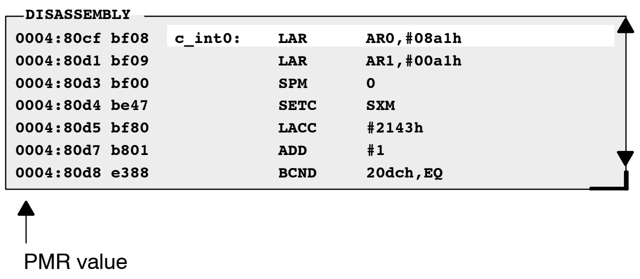
To avoid entering the EXT_ADDR command each time you invoke the debugger, you can modify your emuinit.cmd file to include the command.

7.3 Debugging With Extended Addressing

Once you have set up the debugger for extended addressing (as described in Section 7.2, *Setting Up Extended Memory*, on page 7-4), you can use the debugger to access data or code stored in the extended memory of your system.

When the debugger loader loads a section of code that contains extended addresses, the loader places the addresses in the proper overlays automatically. The debugger also changes the display of the DISASSEMBLY or MEMORY window to show extended addresses. It uses the PMR or DMR value (which contains the extended page number) as a prefix to the address. The DISASSEMBLY window in Figure 7–2 shows addresses that have been accessed from extended memory. The debugger used the PMR value (4) as a prefix to the addresses in extended memory.

Figure 7–2. The DISASSEMBLY Window With Extended Addressing In Use



```
DISASSEMBLY
0004:80cf bf08  c_int0:   LAR      AR0,#08a1h
0004:80d1 bf09            LAR      AR1,#00a1h
0004:80d3 bf00            SPM      0
0004:80d4 be47            SETC     SXM
0004:80d5 bf80            LACC     #2143h
0004:80d7 b801            ADD      #1
0004:80d8 e388            BCND     20dch,EQ
```

Note:

The extended-page number that is shown in the DISASSEMBLY or MEMORY window does not always represent the value currently stored in the PMR or DMR. However, while stepping through the code, the PMR and the extended-page number are the same.

Registers associated with extended addressing: PMR, DMR, and EPC

When you turn extended addressing on (using the EXT_ADDR ON command), the debugger adds the following registers to the CPU window:

❑ One of the following mapper registers:

  ■ The program mapper register (PMR) displays the current value of the external PMR that you created in your target system.

  ■ The data mapper register (DMR) displays the current value of the external DMR that you created in your target system.

❑ The extended program counter (EPC). The EPC is 32 bits wide and represents the PMR or DMR value concatenated with the PC value.

You can use these registers in expressions. For example, this command sets the PMR to 4 and the program counter (PC) to 0x8000:

```
? EPC= 0x48000
```

This DASM command causes the DISASSEMBLY window to display the current extended PC location:

```
DASM EPC
```

When you turn extended addressing off (using the EXT_ADDR OFF command), the CPU window no longer displays the PMR, DMR, and EPC registers, and you cannot use these registers in expressions.

New expression syntax

When you enter one of the commands listed in Table 7–1, you can use an address as one of the command parameters. You can append a suffix to the address to specify whether the address is in program memory (@prog), data memory (@data), or I/O space (@io). When extended addressing is enabled, you can use two new suffixes with the commands in Table 7–1:

❑ The @prog16 suffix identifies an address in extended program memory. The debugger uses the current value in the PMR to qualify the address that you enter.

❑ The @data16 suffix identifies an address in extended data memory. The debugger uses the current value in the DMR to qualify the address that you enter.

Table 7–1. Commands That Use the @prog16 and @data16 Suffixes

Command	See Page	Command	See Page
? (evaluate expression)	18-13	EVAL	18-27
ADDR	18-15	MEM	18-39
DASM	18-22	WA	18-67
DISP	18-23		

How extended addressing affects symbols

When you use the debugger with symbol names, the debugger uses the entire extended address associated with the symbol.

When you use a pointer in an expression, the debugger uses the current PMR or DMR value to determine the pointer value. Likewise, if you use the contents of a register as an address, the debugger uses the current PMR or DMR value to determine the correct address. For example, if the PC=0x8000 and the PMR=2 and you enter:

```
? *PC
```

The debugger returns the value at location 0x28000.

Table 7−2 shows typical commands that you could use with the debugger and how the results of the commands are affected by extended addressing.

Table 7−2. Sample Commands and Results Using Extended Addressing

If you enter this...	The result is...
`dasm 0x8000`	Disassembly starting at 0:8000, regardless of the PMR value
`dasm 0x8000@prog16`	Disassembly starting at *x*:8000, where *x* represents the current PMR value
`dasm label0`	Where label0 is a label located at 0x8000, the result is disassembly starting at 0:8000, regardless of the PMR value
`dasm label4`	Where label4 is a label located at 0x48000, the result is disassembly starting at 4:8000, regardless of the PMR value
`dasm pc`	Where PC=0x8000, the result is disassembly starting at *x*:8000, where *x* represents the current PMR value
`dasm ptr`	Where ptr is a VOID* pointing to 0x8000, the result is disassembly starting at *x*:8000, where *x* represents the current PMR value
`dasm (ptr+1)`	Where ptr is a VOID* pointing to 0x8000, the result is disassembly starting at *x*:8001, where *x* represents the current PMR value

Note:

In the DISASSEMBLY window, addresses associated with symbols are shown as 16-bit addresses. Moreover, if a symbol represents an extended address, you cannot see the entire 32-bit address in the DISASSEMBLY window. However, when you use the symbol name in an expression, the debugger accesses the correct address.

Using 16-bit expressions with 32-bit extended addressing

Extended addressing allows you to use 32-bit addresses to reference locations in extended memory. When you use the debugger and specify a 16-bit expression, the debugger uses the following algorithm to determine which memory location to access:

1) If you use the @prog16 suffix, the debugger uses the current PMR value as a prefix to the address that you entered. Likewise, if you use the @data16 suffix, the debugger uses the current DMR value as a prefix to the address that you entered.

2) If you use a pointer in an expression, the debugger uses the current PMR or DMR value as a prefix to the pointer value, as applicable.

3) If you use the contents of a register as an address, the debugger uses the PMR or DMR value as a prefix to the address, as applicable.

4) If none of the above is true, the debugger uses 0 as a prefix to the address. This applies to constants and program labels.

Hardware breakpoints and extended addressing

Do not use extended addressing when you are using hardware breakpoints. A hardware breakpoint set at a particular address causes the debugger to stop at that address not only for the native ’C2xx memory but for every extended page defined by your extended memory. This might confuse the emulator and can cause unexpected results.

Chapter 8

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 the commands described in this chapter can also be executed from the Load pulldown menu (see Section 5.2, *Using the Menu Bar and the Pulldown Menus*, page 5-7).

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8.1 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

❏ 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 4.1, *Debugging Modes and Default Displays*, on page 4-2.

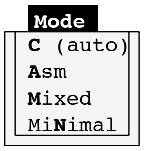
Use this mode	**To view**	**The debugger uses these code-display windows**
Assembly mode	*Assembly language code only* (even if your program is executing C code)	DISASSEMBLY
Auto mode	*Assembly language code* (when that's what your program is running)	DISASSEMBLY
Auto mode	*C code only* (when that's what your program is running)	❏ FILE ❏ CALLS
Mixed mode	Both assembly language and C code	❏ DISASSEMBLY ❏ FILE ❏ CALLS
Minimal mode	No code	None

You can switch freely between the modes. If you choose auto mode, the debugger displays C code *or* assembly language code, depending on the type of code that is currently executing.

Selecting a debugging mode

Unless you use the −min command-line option (which selects minimal mode and is discussed on page 1-20), 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:



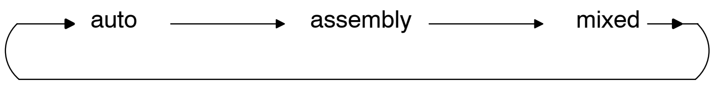
1) Point to the menu name.

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 5.2, *Using the Menu Bar and the Pulldown Menus*, on page 5-7.

F3 Pressing this key causes the debugger to switch modes in this order:



Note that you can't select the minimal mode with F3.

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
minimal	Changes from the current mode to minimal mode

If the debugger is already in the desired mode when you enter a mode command, then the command has no effect.

8.2 Displaying Your Source Programs (or Other Text Files)

The debugger displays two types of code:

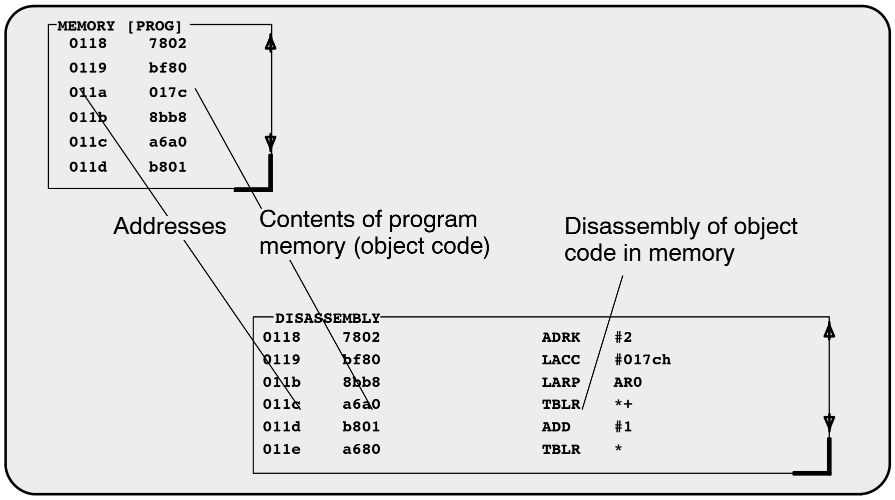
- ❑ It displays *assembly language code* in the DISASSEMBLY window in auto, assembly, or mixed mode.
- ❑ It displays *C code* in the FILE window in auto and mixed modes.

The DISASSEMBLY and FILE windows are primarily intended for displaying code that the program counter (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, but 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 program-memory contents. (This code doesn't come from any of your text files or from the intermediate assembly files produced by the compiler.)


```
MEMORY [PROG]
 0118    7802
 0119    bf80
 011a    017c
 011b    8bb8
 011c    a6a0
 011d    b801
```

```
DISASSEMBLY
0118    7802                  ADRK    #2
0119    bf80                  LACC    #017ch
011b    8bb8                  LARP    AR0
011c    a6a0                  TBLR    *+
011d    b801                  ADD     #1
011e    a680                  TBLR    *
```
Addresses
Contents of program memory (object code)
Disassembly of object code in memory

When you invoke the debugger, it comes up in auto mode. If you load an object file when you invoke the debugger, 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.

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).

Patch assembly may, at times, cause undesirable side effects:

❑ Patching a multiple-word instruction with an instruction of lesser length will leave “garbage” or an unwanted new instruction in the remaining old instruction fragment. This fragment must be patched with either a valid instruction or a NOP, or else unpredictable results may occur when running code.

❑ Substituting a larger instruction for a smaller one partially or entirely overwrites the following instruction; you lose the instruction and might be left with another fragment.

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.

CAUTION

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, recompile or reassemble it, and reload the new object file into the debugger.

Additional information about modifying assembly language code

When using 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. See the *TMS320C1x/C2x/C2xx/C5x Assembly Language Tools User's Guide* for the constants syntax.

❑ **Error messages.** The error messages for the patch assembler are the same as the corresponding DSP assembler error messages. See the *TMS320C1x/C2x/C2xx/C5x 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. Note that you can also access this command from the Load pulldown menu.

(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 8.3, *Loading Object Code*, on page 8-10.)

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 works similarly to FILE, but you don't need to identify the name of the file that contains the function.

addr Use the ADDR command to display C or assembly 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 the 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 4-10 for details.)

Displaying other text files

The DISASSEMBLY window always displays the reverse assembly of memory contents, no matter 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 might, for example, want to examine system files such as autoexec.bat or an initialization batch file. You can also view your original assembly language source files in the FILE window.

You are restricted to displaying files that are 400K bytes long or less.

8.3 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 1.6, *Preparing Your Program for Debugging*, on page 1-12.)

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 the appropriate debugger-invocation command along with the name of the object file.

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 the appropriate debugger-invocation command along with the name of the object file and specify –s (see page 1-22 for more information).

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*]

If you enter the RELOAD command without specifying a filename, the debugger reloads the file that you loaded last.

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.

Note:

Loading code does not clear the cache on the ’C2xx. Unless your program explicitly clears the cache, the code in the cache may be executed instead of the code in your program. You can explicitly clear the cache prior to loading your program by using this command:

```
e ST|=0x1000
```

8.4 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, 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.
  - **cd** Alternatively, you can 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 operating-system environment, you can name additional directories with the D_SRC environment variable. The format for doing this is:

    SET D_SRC=*pathname;pathname* For Windows or OS/2

    setenv D_SRC "*pathname;pathname*" For UNIX

    This allows you to name several directories that the debugger can search.
  - 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 option is **–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.

8.5 Running Your Programs

To debug your programs, you must execute them on one of two 'C2xx debugging tools (emulator or simulator). The debugger provides two basic types of commands to help you run your code:

❑ Basic *run commands* run your code 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 ending point.
   ■ Press ESC.
   ■ Press the left mouse button.

❑ *Single-step* commands execute assembly language or C code, one statement at a time, and update the display after each execution.

Note:

Whenever the 'C2xx accesses unresponsive memory, the emulator might have to break the memory cycle, such as with single stepping, escaping from a run, or halting a run. Unresponsive memory accesses refers to reading from full or empty FIFOs, reading from memory that doesn't exist, or a memory read or write that requires waiting indefinitely for completion such as with interlocked instructions. Since the emulator break the memory operation, bad data may be exchanged.

Defining the starting point for program execution

All run and single-step commands begin executing from the current PC. 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

❑ Finding the appropriately highlighted line in the FILE or DISASSEMBLY window. To do this, execute one of these commands:

dasm PC
or
addr PC

Sometimes you might 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 8-18).
- ❑ 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.

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 8-18).

❑ 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.

For more information about the compiler's −g option, see the *TMS320C6200 Optimizing C Compiler User's Guide*.

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*]

You can also single-step through programs by using function keys:

F8 Acts as a STEP command.

F10 Acts as a NEXT command.

When you use the function keys to single-step through programs, you can't enter an expression for the 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.

When you use the menu-bar selections to single-step through programs, you can't enter an expression for the command.

Running code while disconnected from the target system

emulator only

runf Use the RUNF command to disconnect the emulator from the target system while code is executing. The format for this command is:

runf

When you enter RUNF, the debugger clears all breakpoints, disconnects the emulator from the target system, and causes the processor to begin execution at the current PC. You can quit the debugger, or you can continue to enter commands. However, any command that causes the debugger to access the target at this time will produce an error.

RUNF is useful in a multiprocessor system. It's also useful in a system in which several target systems share an emulator; RUNF enables you to disconnect the emulator from one system and connect it to another.

halt Use the HALT command to halt the target system after you've entered a RUNF command. The format for this command is:

halt

When you invoke the debugger, it automatically executes a HALT command. Thus, if you enter a RUNF, quit the debugger, and later reinvoke the debugger, you will effectively reconnect the emulator to the target system and run the debugger in its normal mode of operation. When you invoke the debugger, use the –s option to preserve the current PC and memory contents.

reset The RESET command resets the target system. This is a *software* reset. The format for this command is:

reset

If you are using the simulator and execute the RESET command, the simulator simulates the ’C2xx processor and peripheral reset operation, putting the processor in a known state.

Running code conditionally

The RUN, STEP, CSTEP, NEXT, and CNEXT commands all 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; the expression is evaluated each time the debugger encounters a breakpoint. 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 to use that variable in the expression.

8.6 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.

Chapter 9

Managing Data

The debugger allows you to examine and modify many different types of data related to the ’C2xx and to your program. You can display and modify the values of:

❑ Individual memory locations or a range of memory

❑ ’C2xx registers

❑ Variables, including scalar types (ints, chars, etc.) and aggregate types (arrays, structures, etc.)

Topic **Page**

9.1 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 data memory, program memory, or I/O space
Register values	**CPU window** Displays the contents of ’C2xx registers
Pointer data or selected variables of an aggregate type	**DISP window** Displays 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**.

9.2 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 *symbol’*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 aai`	`int aai[10][5];`

`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 COMMAND window display area. The 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

`? aai`	`aai[0][0]  1`
	`aai[0][1]  23`
	`aai[0][2]  45`
	etc.

`? j`	`4194425`
`? j=0x5a`	`90`

Note that the DISP command (described in detail on page 9-14) 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 COMMAND window display area. 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).

For information about the PDM version of the EVAL command, refer to Section 2.9, *Evaluating Expressions*, on page 2-21.

9.3 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 a MEMORY window
- ❑ Elements displayed in a DISP window
- ❑ Values displayed in the WATCH window

There are two similar methods for overwriting displayed data:

This method is sometimes referred to as the "click and type" method.

↖ 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 4.4, *The Active Window*, on page 4-20.)

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.

Note:

If you press ↵ when the cursor is in the middle of text, the debugger truncates the input text at the point where you press ↵. Likewise, if you use ← or → to move to the beginning of the previous or next field, the debugger truncates the input text at the point where you press the ← or →.

Advanced "editing"—using expressions with side effects

Using the overwrite editing feature to modify data is straightforward. However, data-management methods 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 to see what's in auxiliary register AR3, you can enter:

`? AR3` ↵

You can also use this type of command to modify AR3's contents. Here are some examples of how you might do this:

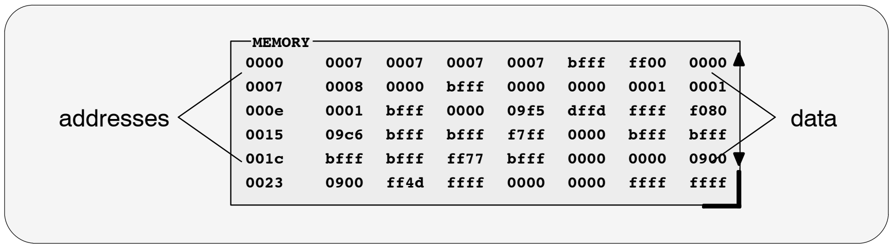
`? AR3++` ↵	*Side effect: increments the contents of AR3 by 1*
`eval --AR3` ↵	*Side effect: decrements the contents of AR3 by 1*
`? AR3 = 8` ↵	*Side effect: sets AR3 to 8*
`eval AR3/=2` ↵	*Side effect: divides contents of AR3 by 2*

Note that not all expressions have side effects. For example, if you enter **? AR3+4**, the debugger displays the result of adding 4 to the contents of AR3 but does not modify AR3'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:

=	+=	−=	*=	/=
%=	&=	^=	|=	<<=
	>>=	++	− −	

9.4 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 *MEMORY windows* on page 4-13.



```
MEMORY
0000    0007  0007  0007  0007  bfff  ff00  0000
0007    0008  0000  bfff  0000  0000  0001  0001
000e    0001  bfff  0000  09f5  dffd  ffff  f080
0015    09c6  bfff  bfff  f7ff  0000  bfff  bfff
001c    bfff  bfff  ff77  bfff  0000  0000  0900
0023    0900  ff4d  ffff  0000  0000  ffff  ffff
```

The debugger has commands that show the memory values at a specific location or that display a different range of memory in the MEMORY window. The debugger allows you to change the values at individual locations; for more information, refer to Section 9.3, *Basic Methods for Changing Data Values*.

Displaying memory contents

The main way to observe memory contents is to view the display in a MEMORY window. Multiple MEMORY windows are available: the default window is labeled MEMORY, and additional windows are given the unique name you assign them. Having multiple windows allows you to view many 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. You can do this by typing a command or using the mouse.

mem If you want to display a different memory range in the MEMORY window, use the MEM command. The basic syntax for this command is:

mem *expression*

To view different memory locations in an additional MEMORY window, use the MEM command with a unique window name. For example:

To do this. . .	Enter this. . .
View the block of memory starting at address 0x8000 in the MEMORYA window	`mem 0x8000,, MEMORYA`
View the same block of memory (starting at address 0x8000) but in the MEMORYB window	`mem 0x8000,, MEMORYB`

Note:

If you want to view a different block of memory explicitly in the default MEMORY window, you can use the MEM command without a window name. To use this command, enter:

mem *address*

For more information, see *MEMORY windows* on page 4-13.

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. For more information, see *Resizing a window* on page 4-22.

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 data 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 as an *expression* parameter. 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 – AR0 + label
  ```

You can also change the display of any data-display window—including the MEMORY window—by scrolling through the window's contents. For more details, see *Scrolling through a window's contents* on page 4-27.

Displaying extended memory, program memory, and I/O space

By default, the MEMORY window displays data memory. You can display other types of memory using one of these suffixes after the *expression*. The debugger changes the MEMORY window label to remind you what type of memory is being displayed.

To display . . .	Use this suffix . . .	MEMORY window label
Program memory	**@prog**	MEMORY [PROG]
Extended program memory†	**@prog16**	MEMORY [PROG16]
Extended data memory†	**@data16**	MEMORY [DATA16]
I/O space‡	**@io**	MEMORY [IO]
Data memory	**@data**	MEMORY

† Valid only when extended addressing is enabled.
‡ Valid only with the emulator.

Any of the examples presented in this section could be modified to display extended memory, program memory, or I/O space:

```
mem 0x00@prog16
mem &SYM@prog
mem (SP – AR0 + label)@data16
? *0x26@io
wa *0x26@prog
disp *(float *)0x26@io
```

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 data memory location 26 (hex), you could enter:

  ```
  ? *0x26
  ```

  The debugger displays the memory value in the display area of the COMMAND window.

- ❑ 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
  ```

  The debugger displays one element of the array at a time, so the memory is shown in a structure display window. To see other elements of the array, use CONTROL PAGE UP and CONTROL PAGE DOWN.

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. The syntax for the MS command is:

ms *address, page, length, filename*

- The *address* parameter identifies the first address in the block.
- The *page* is a one-digit number that identifies the type of memory (program, data, or I/O) to save:

To save this type of memory	Use this value as the *page* parameter
Program memory	**0**
Data memory	**1**
I/O space	**2** (Emulator only)

- 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 0x0000 – 0x0010 to a file named memsave, you could enter:

```
ms 0x0,1,0x10,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, page, length, data*

- ❑ The *address* parameter identifies the first address in the block.
- ❑ The *page* is a one-digit number that identifies the type of memory (program or data) to fill:

To fill this type of memory	Use this value as the *page* parameter
Program memory	**0**
Data memory	**1**
I/O space	**2** (Emulator Only)

- ❑ 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 program memory locations 0x10FF–0x110D with the value 0xABCD, you would enter:

```
fill 0x10ff,0,0xf,0xabcd
```

If you want to check whether memory has been filled correctly, you can enter:

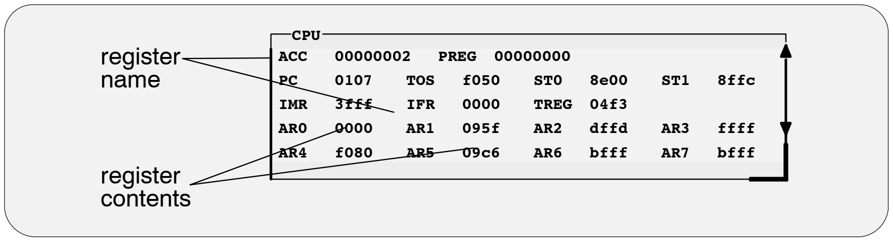
```
mem 0x10ff@prog
```

This changes the MEMORY window display to show the block of memory beginning at program memory address 0x10FF.

Note that the FILL command can also be executed from the Memory pulldown menu.

9.5 Managing Register Data

In mixed and assembly modes, the debugger maintains a CPU window that displays the contents of individual registers. For details, see *CPU window* on page 4-16.



```
CPU
ACC   00000002   PREG  00000000
PC    0107    TOS   f050    ST0   8e00    ST1   8ffc
IMR   3fff    IFR   0000    TREG  04f3
AR0   0000    AR1   095f    AR2   dffd    AR3   ffff
AR4   f080    AR5   09c6    AR6   bfff    AR7   bfff
```

The debugger provides commands that allow you to display and modify the contents of specific registers. 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. For more information, refer to Section 9.3, *Basic Methods for Changing Data Values*.

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 a few 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 AR0, you could enter:

  `? AR0` ⏎

  The debugger displays AR0's current contents in the COMMAND window display area.

❑ If you want to observe a register over a longer period of time, you can use the WA command to display the register in a WATCH window. For example, if you want to observe the status register, you could enter:

  `wa ST0,Status Register 0` ⏎

  This adds the ST0 to the WATCH window and labels it as *Status Register 0*. 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.

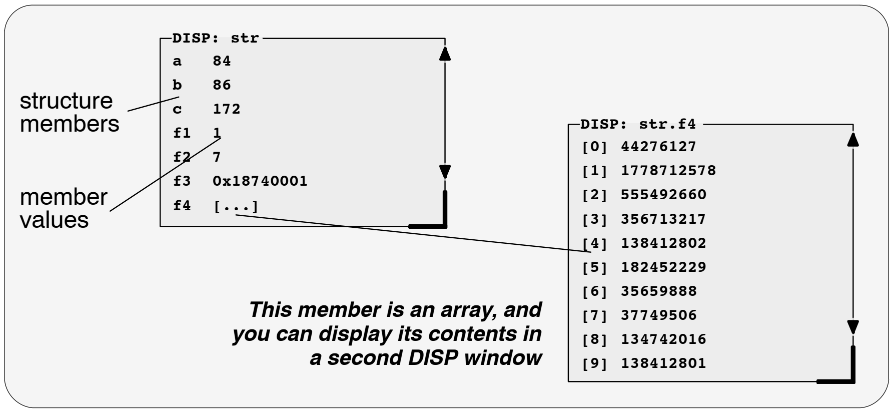
Accessing the hardware stacks (simulator only)

The simulator provides access to the eight-level hardware stack, which is used for saving the PC value during interrupts and subroutines. The pseudoregister symbols STK0–STK7 represent hardware stack levels 0–7, respectively. You can view the contents of these stack levels by adding the appropriate STK symbol to the WATCH window. For example, to watch hardware stack level 0, enter:

```
wa STK0
```

9.6 Managing Data in a DISP (Display) Window

The main purpose of the DISP window is to display 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 more details, see *DISP windows* on page 4-17.



```
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. For more information, refer to Section 9.3, *Basic Methods for Changing Data Values*.

Displaying data in a DISP window

disp To open a DISP window, use the DISP command. Its basic syntax is:

disp *expression*

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	0x0000

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 4.4, *The Active Window*, on page 4-20).

Step 2: Press F4 .

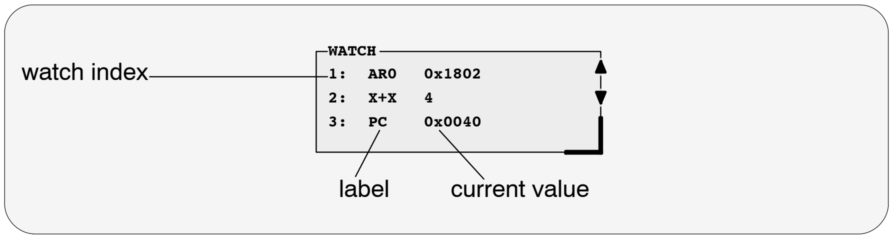
Note that you can close a window and all of its children by closing the original window.

Note:

The debugger automatically closes any DISP windows when you execute a LOAD or SLOAD command.

9.7 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.



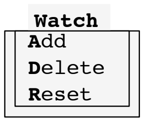
```
WATCH
1:  AR0   0x1802
2:  X+X   4
3:  PC    0x0040
```

The debugger displays a WATCH window *only when you specifically request a WATCH window* with the WA command (described below). For additional details concerning the WATCH window, see *WATCH window* on page 4-18.

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. For more information, refer to Section 9.3, *Basic Methods for Changing Data Values*.

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 5.2, *Using the Menu Bar and the Pulldown Menus*, on page 5-7.



Displaying data in the WATCH window

The debugger has one command for adding items to a WATCH window.

wa To open a WATCH window, use the WA (watch add) command. The syntax is:

wa *expression* [, [*label*] [, [*display format*] [, *window name*]]

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.

- If you want to use the *contents* of an address as a parameter, be sure to prefix the address with the C indirection operator (*****). Use the WA command to do this:

  ```
  wa *0x26
  ```

- 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.
- The *display format* parameter is optional. When used, the data is displayed in the selected format as shown in Table 9–2 on page 9-19.
- The *window name* parameter is optional. When used, it allows you to watch your expression in an alternate WATCH window. For more information, see the WA command discussion on page 18-67.

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 a WATCH window and delete all of the items in a single step, use the WR (watch reset) command. The syntax is:

wr[* | *window name*

The optional *window name* parameter is used to delete a particular WATCH window; * deletes all WATCH windows.

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* [, *window name*]

Whenever you add an item to a WATCH window, the debugger assigns it an index number. (The illustration of the WATCH window on page 9-16 points to these watch indexes.) The WD command's *index number* parameter must correspond to one of the watch indexes in the named 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 a WATCH window closes that WATCH window.

Note:

The debugger automatically closes any WATCH windows when you execute a LOAD or SLOAD command.

9.8 Managing Pipeline Information (Simulator Only)

The simulator supports additional features that allow you to monitor the pipeline. The simulator supports pseudoregisters that you can query with ? or DISP or add to the WATCH window.

Monitoring the pipeline

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, ARAU 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. Table 9−1 identifies these registers.

Table 9−1. 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.

9.9 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*. Table 9–2 lists the available formats and the corresponding characters that can be used as the *display format* parameter.

Table 9–2. Display Formats for Debugger Data

Display Format	Parameter	Display Format	Parameter
Default for the data type	*	Octal	**o**
ASCII character (bytes)	**c**	Valid address	**p**
Decimal	**d**	ASCII string	**s**
Exponential floating point	**e**	Unsigned decimal	**u**
Decimal floating point	**f**	Hexadecimal	**x**

Table 9–3 lists the C data types that can be used for the *data type* parameter. Only a subset of the display formats applies to each data type, so Table 9–3 also shows valid combinations of data types and display formats.

Table 9–3. 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 an unsigned decimal, 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. Additionally, you cannot use the **s** display format parameter with the MEM command.

Chapter 10

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 software 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.

Software breakpoints are especially useful in combination with conditional execution (described on page 8-18).

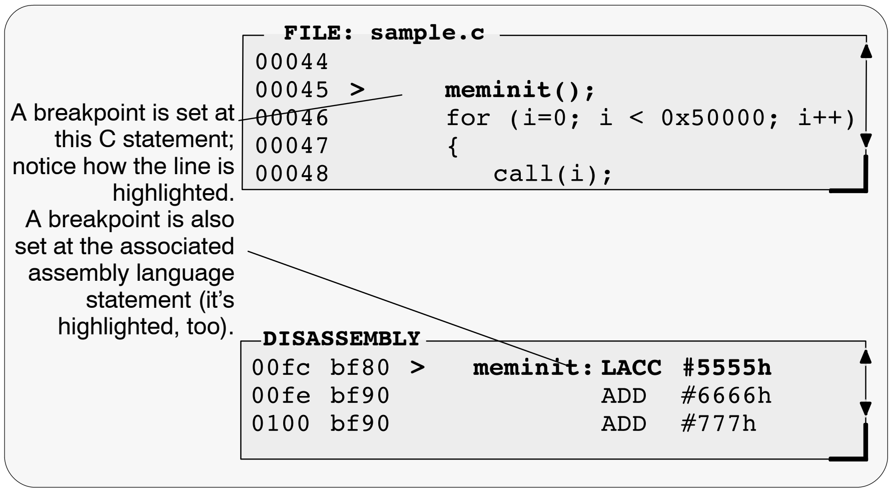
Topic **Page**

10.1 Setting a Software Breakpoint

When you set a software breakpoint, the debugger highlights the breakpointed line in two ways:

- ❑ It prefixes the statement with the character >.
- ❑ It shows the line 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
DISASSEMBLY

```
00044
00045 >     meminit();
00046       for (i=0; i < 0x50000; i++)
00047       {
00048          call(i);
```

```
00fc  bf80 >   meminit: LACC  #5555h
00fe  bf90              ADD   #6666h
0100  bf90              ADD   #777h
```

Notes:

1) After execution is halted by a breakpoint, you can continue program execution by reissuing any of the run or single-step commands.

2) Up to 200 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.

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.

10.2 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.

10.3 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
004d        in main, at line 60, "c:\c2xxhll\sample.c"
0051
```

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 11

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, how 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**

11.1 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 11–1 lists the valid values for the *attribute* parameters.

Table 11–1. 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 11–2 lists valid values for the *area name* parameters. This is a long list; the subsections following the table further identify these areas.

Table 11–2. Summary of Area Names for the COLOR and SCOLOR Commands

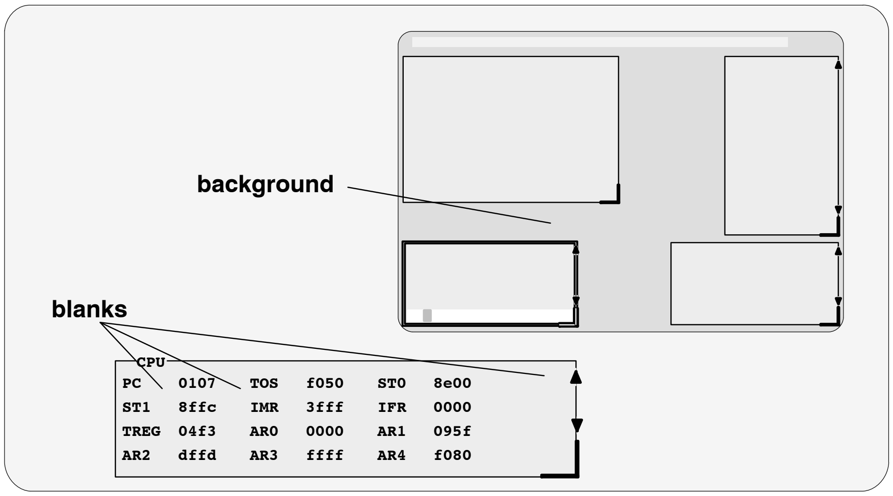
menu_bar	menu_border	menu_entry	menu_cmd
menu_hilite	menu_hicmd	win_border	win_hiborder
win_resize	field_text	field_hilite	field_edit
field_label	field_error	cmd_prompt	cmd_input
cmd_cursor	cmd_echo	asm_data	asm_cdata
asm_label	asm_clabel	background	blanks
error_msg	file_line	file_eof	file_text
file_brk	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 to 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 11–2 (left to right, top to bottom).

The remainder of this section identifies these areas.

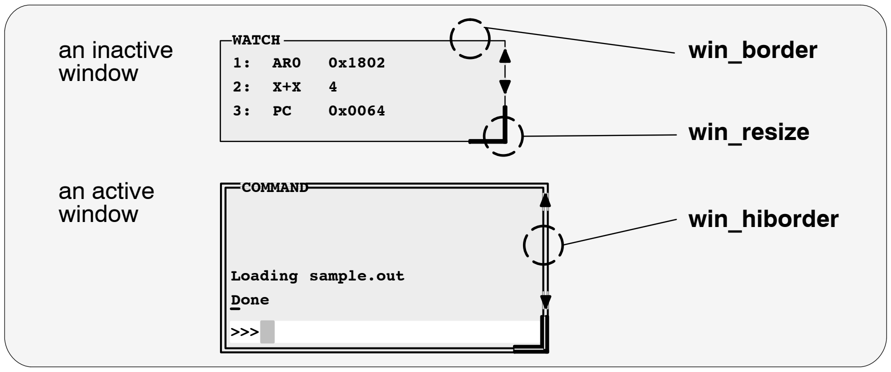
Area names: common display areas



```
PC    0107   TOS   f050   ST0   8e00
ST1   8ffc   IMR   3fff   IFR   0000
TREG  04f3   AR0   0000   AR1   095f
AR2   dffd   AR3   ffff   AR4   f080
```

Area identification	Parameter name
Screen background (behind all windows)	background
Window background (inside windows)	blanks

Area names: window borders

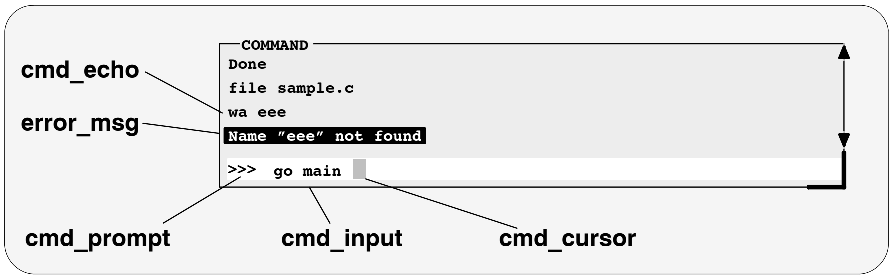


```
WATCH
1:  AR0   0x1802
2:  X+X   4
3:  PC    0x0064
```

```
COMMAND
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

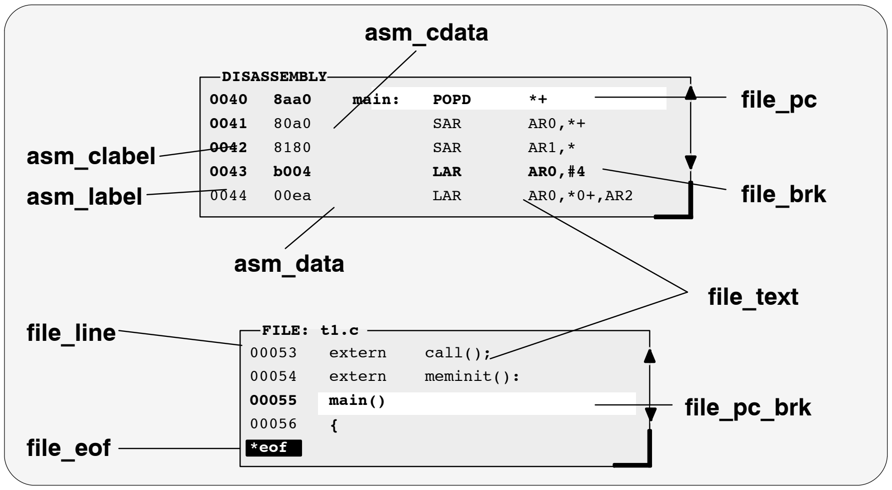
Area names: COMMAND window



```
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

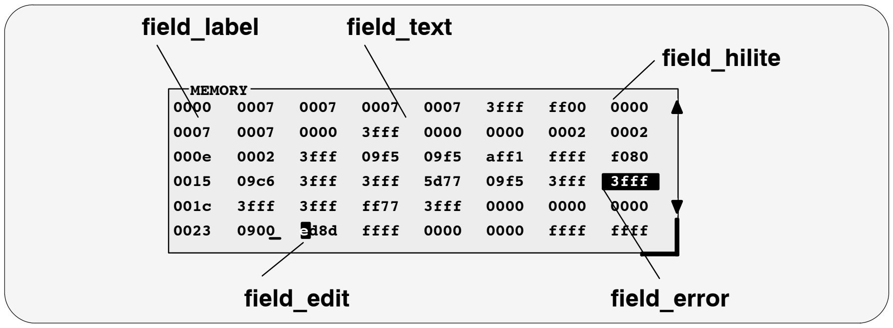


```
DISASSEMBLY
0040   8aa0    main:    POPD      *+
0041   80a0             SAR       AR0,*+
0042   8180             SAR       AR1,*
0043   b004             LAR       AR0,#4
0044   00ea             LAR       AR0,*0+,AR2
```

```
FILE: t1.c
00053   extern    call();
00054   extern    meminit():
00055   main()
00056   {
*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

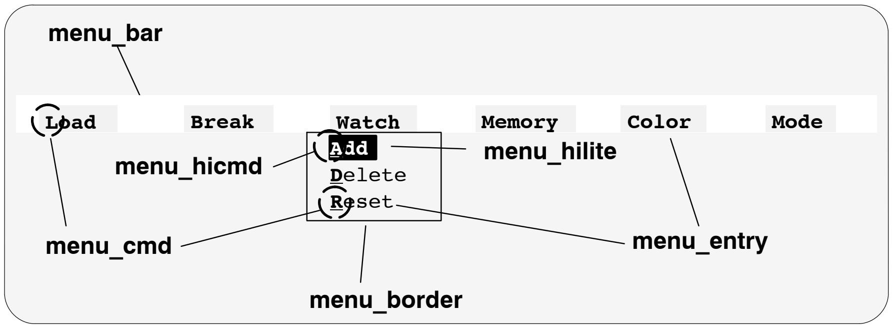
Area names: data-display windows



```
MEMORY
0000   0007   0007   0007   0007   3fff   ff00   0000
0007   0007   0000   3fff   0000   0000   0002   0002
000e   0002   3fff   09f5   09f5   aff1   ffff   f080
0015   09c6   3fff   3fff   5d77   09f5   3fff   3fff
001c   3fff   3fff   ff77   3fff   0000   0000   0000
0023   0900_  ed8d   ffff   0000   0000   ffff   ffff
```

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

11.2 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
```

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*.

11.3 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. Initially, init.clr defines screen configurations that exactly match the default 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 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) Next, 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, 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 that you can execute this command as the Load selection on the Color pulldown menu.

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 batch file that the debugger executes at invocation time (init.cmd). 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, 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.

11.4 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 init.cmd batch file that the debugger executes at invocation time.

You can also execute this command as the Prompt selection on the Color pulldown menu.

Note:

Whenever you select a default group of processors, the group name becomes the command-line prompt for the PDM. You **cannot** use the PROMPT command to change the PDM's command-line prompt. To change the PDM prompt, use the SET command (see page 2-19).

Chapter 12

Using the Analysis Interface

The ’C2xx on-chip analysis module allows the emulator to monitor hardware functions. The debugger provides you with easy-to-use windows, dialog boxes, and analysis commands that let you set hardware breakpoints on certain 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, *Customizing the Analysis Interface*.

Topic **Page**

12.1 Introducing the Analysis Interface

The ’C2xx analysis interface provides a detailed look into events occurring in hardware, thereby expanding your debugging capabilities beyond software breakpoints. The analysis interface examines ’C2xx bus cycle information in real time and reacts to this information through actions such as hardware breakpoints.

The analysis interface allows you to:

❑ **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:

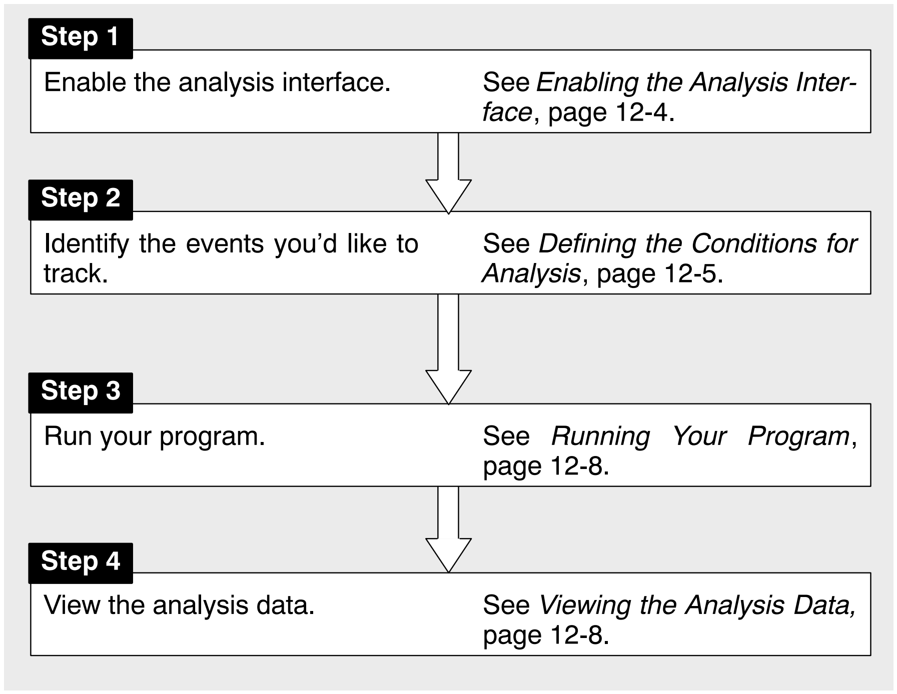
  ■ Program accesses
  ■ Low levels on EMU0/1 pins (EMU0 and EMU1)

  Hardware break events allow you to set breakpoints in ROM. 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 ’C2xx processors connected by EMU0/1 (emulation event) pins, you can set up the EMU0/1 pins to create global breakpoints. Whenever one processor in your system reaches a breakpoint (software or hardware), *all* processors in the system can be halted.

12.2 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 12-4.

Step 2
Identify the events you'd like to track. See *Defining the Conditions for Analysis*, page 12-5.

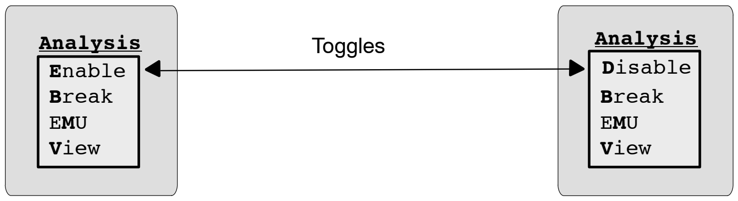
Step 3
Run your program. See *Running Your Program*, page 12-8.

Step 4
View the analysis data. See *Viewing the Analysis Data,* page 12-8.

12.3 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 12−1. 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. 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 have to enable the analysis interface only once during a debugging session. It is not necessary to enable the analysis interface each time you run your program.

12.4 Defining the 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 Break Events or Emulator Pins dialog boxes found on the Analysis menu.

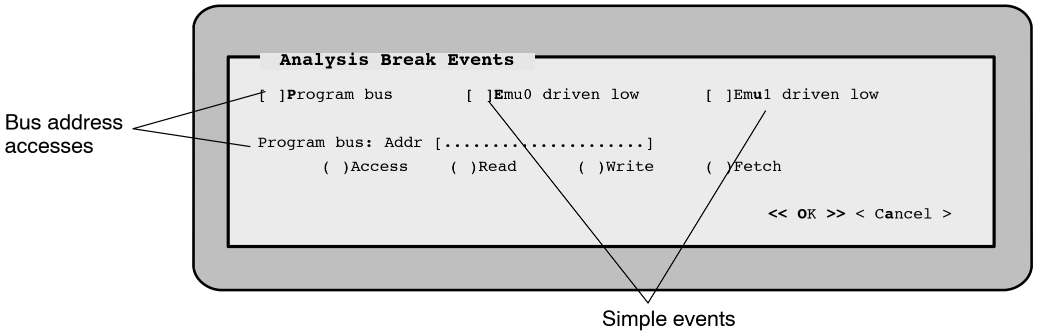
Halting the processor

You can set a hardware breakpoint on two basic types of events:

- ❑ EMU0/EMU1 events
- ❑ Program bus address accesses

Figure 12−2 shows the Analysis Break Events dialog box and the different types of break events that you can select.

Figure 12−2. Basic Types of Break Events

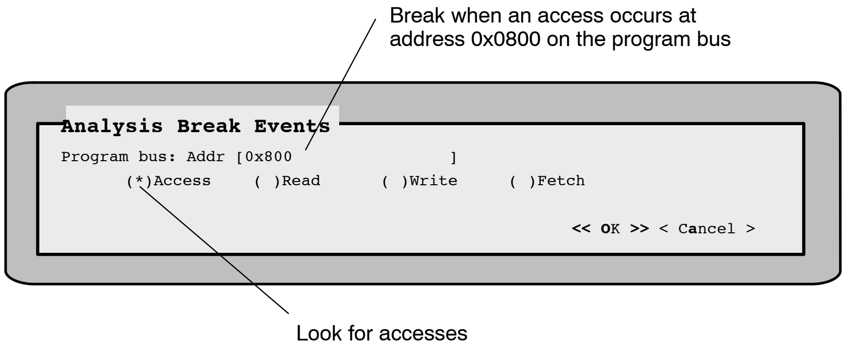


```
  Analysis Break Events
[ ]Program bus       [ ]Emu0 driven low       [ ]Emu1 driven low

Program bus: Addr [.....................]
      ( )Access    ( )Read      ( )Write     ( )Fetch

                                                << OK >> < Cancel >
```

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.

Setting up the event comparators

The program bus supports noninstruction read and write accesses and instruction fetches. If you enable the Access qualifier, noninstruction reads and writes are detected. If you enable the Fetch qualifier, only program fetches are detected.


Break when an access occurs at address 0x0800 on the program bus
Look for accesses
Analysis Break Events
<< OK >> < Cancel >

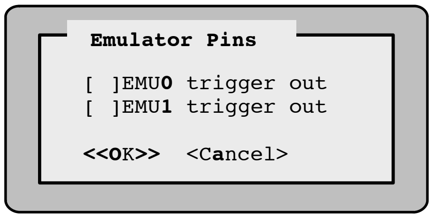
```
Program bus: Addr [0x800                ]
       (*)Access    ( )Read      ( )Write     ( )Fetch
```

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 to set global breakpoints.

Selecting EMU0/1 from the Analysis menu opens the Emulator Pins dialog box shown in Figure 12–3.

Figure 12–3. The Emulator Pins Dialog Box



```
[ ]EMU0 trigger out
[ ]EMU1 trigger out
```

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 set up only *one* ’C2xx 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.

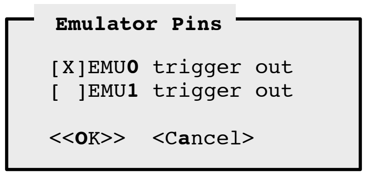
The EMU1 pin provides a ripple-carry output signal from the internal counter that increments the emulator counter. The ’C2xx EMU0 pin is set up to send a signal to the debugger when a hardware or software breakpoint occurs. Other devices in the system can still be programmed to detect low levels on the EMU0 pin to provide you with global breakpoint capabilities.

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 ’C2xx 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 12−4.

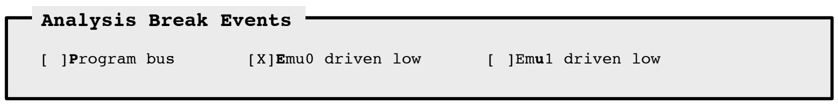
Figure 12−4. Setting Up Global Breakpoints on a System of Two ’C2xx Processors

Processor 1
and
Processor 2



```
Emulator Pins

[X]EMU0 trigger out
[ ]EMU1 trigger out

<<OK>>  <Cancel>
```

Processor 1
and
Processor 2



```
Analysis Break Events
[ ]Program bus       [X]Emu0 driven low       [ ]Emu1 driven low
```

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.

12.5 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 8, *Loading, Displaying, and Running Code*, except the RUNF (run free) command.

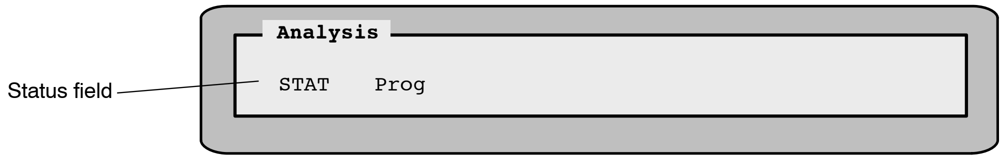
Note:

The conditions for the analysis session must be defined *before* your analysis session begins; you cannot change conditions *during* execution of your program.

12.6 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. An example of the Analysis window is shown below.

Figure 12–5. Analysis Interface View Window, Displaying an Ongoing Status Report



```
STAT   Prog
```

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.

Chapter 13

Profiling Code Execution

The profiling environment is a special debugger environment that lets you collect execution statistics for your code. This environment is available only with the simulator.

Note that 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**

13.1 An Overview of the Profiling Process

Profiling consists of five simple steps:

Step 1	Enter the profiling environment.	See *Entering the Profiling Environment*, page 13-3.
Step 2	Identify the areas of code where you'd like to collect statistics.	See *Defining Areas for Profiling*, page 13-5.
Step 3	Identify the profiling session stopping points.	See *Defining a Stopping Point,* page 13-13.
Step 4	Begin profiling.	See *Running a Profiling Session,* page 13-15.
Step 5	View the profile data.	See *Viewing Profile Data,* page 13-17.

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.

13.2 Entering the Profiling Environment

The profiling environment is available with the simulator only. To enter the profiling environment, invoke the debugger with the **–profile** option. At the system command line, enter the appropriate command:

```
sim2xx –profile
```

Use any additional debugger options that you desire (–b, –p, etc.).

Restrictions of the profiling environment

Some 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* when you mark sections of code for profiling.)
- The profiling environment supports only a subset of the debugger commands. Table 13–1 lists the debugger commands that can and can't be used in the profiling environment.

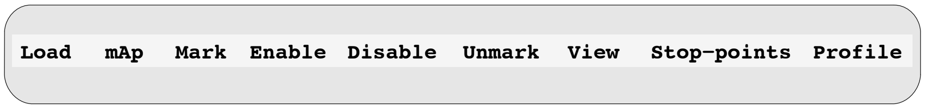
Table 13–1. Debugger Commands That Can/Can't Be Used in the Profiling Environment

Can be used		**Can't be used**	
?	ML	ADDR	MIX
ALIAS	MOVE	ASM	MS
CD	MR	BA	NEXT
CLS	PROMPT	BD	PATCH
DASM	QUIT	BL	RETURN
DIR	RELOAD	BORDER	RUN
DLOG	RESET	BR	RUNB
ECHO	RESTART	C	RUNF
EVAL	SCONFIG	CALLS	SCOLOR
FILE	SIZE	CNEXT	SETF
FUNC	SLOAD	COLOR	SOUND
IF/ELSE/ENDIF	SYSTEM	CSTEP	SSAVE
LOAD	TAKE	DISP	STEP
LOOP/ENDLOOP	UNALIAS	FILL	WA
MA	USE	GO	WD
MAP	VERSION	HALT	WHATIS
MC	WIN	MEM	WR
MD	ZOOM		
MI			

Be sure you don't use any of the "can't be used" commands in your initialization batch file.

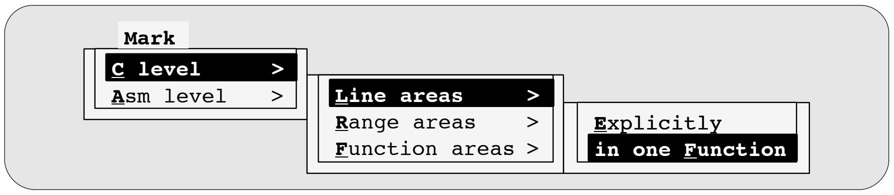
Using pulldown menus in the profiling environment

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


Load mAp Mark Enable Disable Unmark View Stop-points Profile

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 menu. The other entries provide access to profiling commands and features.

The profiling environment's pulldown menus operate similarly to 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 5, *Summary of Commands and Special Keys*, 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.

13.3 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, mark the line, range, or function. You can disable areas so that they won't affect the profile data, and you can reenable areas that have been disabled. You can also unmark areas that you are no longer interested in.

The mouse is the simplest way to mark, disable, enable, and unmark tasks. The pulldown menus also support these tasks and more complex tasks.

The following subsections explain how to mark, disable, reenable, 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 13-3. *Restrictions on profiling areas* are summarized on page 13-12.

Marking an area

Marking an area qualifies it for profiling so that the debugger can collect timing statistics about the area.

Remember, to display C code, use the FILE or FUNC command; to display disassembly, use the DASM command.

Notes:

1) Marking an area in C *does not* mark the associated code in disassembly.

2) 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.

3) Ranges cannot overlap, and they cannot span function boundaries.

Marking a line. These instructions apply to both C and disassembly.

4) Point to the line you want to mark.

5) Click the left mouse button.

   The beginning of the line will be highlighted with a blinking >>.

6) 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 13–2 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 13–2. 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	
❑ By function name	→**E**xplicitly	not applicable
❑ 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 you don't want to 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 declares the function.

2) Click the left mouse button once.

   The beginning of the line will be highlighted with Fd> *(function disabled).*

Table 13–3 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 13–3. 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	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.

Reenabling 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, you can enable an area by using one of the commands listed in Table 13–4. However, the easiest way to enter these commands is by accessing them from the Enable menu.

Table 13–4. 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		→**F**unction areas
❑ By function name	→**E**xplicitly	not applicable	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 or key method.

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 declares the function.

2) Click the right mouse button once.

The line will no longer be highlighted.

Table 13–5 lists the selections on the Unmark menu.

Table 13–5. 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	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.

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.

13.4 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

13.5 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 13.6, *Viewing Profile Data*). 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 restarts and runs 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:

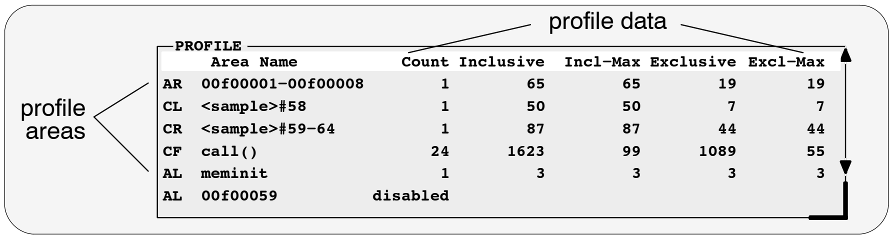
0	The profiler will continue to collect data (adding it to the existing data for the profiled areas) and to use the previous internal profile stacks. 0 is the default value.
nonzero	All previously collected profile data and internal profile stacks are cleared.

The *update rate* parameter is the same as for the PF and PQ commands.

13.6 Viewing Profile Data

The statistics collected during a profiling session are displayed in the PROFILE window. Figure 13−1 shows an example of this window.

Figure 13−1. 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 13−1 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

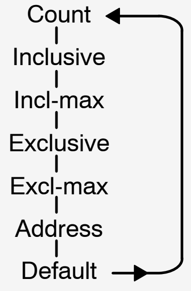
By default, the PROFILE window shows a set of statistics labeled as Count, Inclusive, Incl-Max, Exclusive, and Excl-Max. The Address field, which is not part of the default statistics, can also be displayed. Table 13−6 describes the statistic that each field represents.

Table 13–6. 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
→**In**clusive Max
→**E**xclusive
→E**x**clusive Max
→**A**ddress
→Al**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 area to other profiled areas should not change.

Sorting profile data

By default, the data displayed in the PROFILE window is sorted according to 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 on the basis of the values of the Inclusive field, use View→Sort→Inclusive; the area with the highest Count field will display first, and the area with the lowest Count field will display 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 13–7.

Table 13−7. Menu Selections for Displaying Areas in the PROFILE Window

To view these areas	C only: View→Filter→C level	Disassembly only: View→Filter→Asm level	C *and* disassembly: View→Filter→Both 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	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 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** shows 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 be accessed only when the target is not running.

13.7 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. You can use two commands to 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 14

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. This reduces 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.

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14.1 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 be familiar with the rules governing C expressions. You should obtain a copy of *The C Programming Language* (first or 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.

14.2 Using 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, a few limitations, as well as a few additional features, are 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 capability 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.) Floats are represented in IEEE floating-point format.
- All registers can be referenced by name. The TMS320C2xx's auxiliary registers are treated as integers and/or pointers.
- 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. Note that 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.

Note that 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.

Note that 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
*AR5
*(AR2 + 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 O

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. Note that the PDM executes the first step. (For more information on the environment variables mentioned below, refer to your installation guide.)

1) Establishes the connection between the processor name that you provide and the actual processor.
2) Reads options from the command line.
3) Reads any information specified with the D_OPTIONS environment variable.
4) Reads information from the D_DIR and D_SRC environment variables.
5) Looks for the init.clr screen configuration file.

   (The debugger searches for the screen configuration file in directories named with D_DIR.)
6) Initializes the debugger screen and windows but initially displays only the COMMAND window.
7) 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:

   - 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.
   - If you have not used 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.

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 *Controlling command execution in a batch file* on page 5-18 for more information) to indicate which memory map applies to each tool.

8) Loads any object filenames specified with D_OPTIONS or specified on the command line during invocation.

9) Determines the initial mode (auto, assembly, mixed, or minimal) and displays the appropriate windows on the screen.

At this point, the debugger is ready to process any commands that you enter.

Appendix A

Customizing the Analysis Interface

The interface to the ’C2xx analysis module is register-based. In most cases, the Analysis Break Events dialog box provides a sufficient means of 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 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.

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A.1 Summary of Aliased Commands

A basic set of analysis commands is defined in the analysis.cmd file supplied in your 'C2xx 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 display 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.

The aliased commands, created in the analysis.cmd file, are provided to help you familiarize yourself with the analysis registers and how they work. The 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

Command	Menu → Dialog Box	Description	Page
asys_emu0out	Emulator pins → EMU0 trigger out	Set EMU0 pin to output	14-3
asys_emu1out	Emulator pins → EMU0 trigger out	Set EMU1 pin to output	14-3
asys_off	Analysis → Enable/Disable	Turn off the analysis interface	14-3
asys_on	Analysis → Disable/Enable	Turn on the analysis interface	14-3
asys_reset	none	Reset the analysis interface	14-6
prog_brk_add *address or function name*	Break → Program bus: Address field	Set a breakpoint on a program address	14-4
prog_qual_iaq	Break → Program bus: Fetch	Program instruction acquisition	14-5
prog_qual_r	Count/Break → Program bus: Read	Program read qualifier	14-5

Table A-1. The Analysis Commands Found in the analysis.cmd File (Continued)

Command	Menu → Dialog Box	Description	Page
prog_qual_rw	Count/Break → Program bus: Access	Program read/write qualifier	14-5
prog_qual_w	Count/Break → Program bus: Write	Program write qualifier	14-5
stop_emu0	Break → EMU0 driven low	Halt the processor when the EMU0 pin is low	14-5
stop_emu1	Break → EMU1 driven low	Halt the processor when the EMU1 pin is low	14-5
stop_off	none	Disable break events	14-5
stop_prog	Break → Program bus	Halt the processor on a program bus access	14-4

In addition to these predefined commands, you can create your own by using the ALIAS and EVAL commands. Refer to Section 5.5, *Defining Your Own Command Strings*, on page 5-21 and Section 9.2, *Basic Commands for Managing Data*, on page 9-2 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 the EMU0/1 pins

To set the EMU0/1 pins to output or to use the external counter, enter the appropriate command:

To do this...	Enter this...
Set the EMU0 pin to output	`asys_emu0out`
Set the EMU1 pin to output	`asys_emu1out`

Setting breakpoints on a single program address

The simplest events to detect are those that 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_qual_iaq`	*Qualify on a program instruction acquisition*
`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−2 shows the breakpoint commands for setting single address breakpoints; their respective menu selections can be found in the Analysis Break Events dialog box. You can set breakpoints on any combination of these events.

Table A−2. Breakpoint Commands for Program Addresses

Command	Dialog Box Selection	Description
prog_brk_add *address*	Program bus: Addr	Set a program breakpoint address
prog_qual_iaq	Program bus: Fetch	Program instruction acquisition
stop_off	none	Disable break events
stop_prog	Program bus	Stop the processor when the program breakpoint condition executes

Breaking on event occurrences

You can 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 either EMU pin reaching a logic low, enter:

`asys_on`	*Turn the analysis interface on*
`stop_emu0`	*Enable the processor to stop when it detects an interrupt*
`stop_emu1`	*Enable the processor to stop when it detects a call taken*

Table A–3 shows the commands for stopping the processor when an event occurs. You can set breakpoints on any combination of these events.

Table A–3. Breakpoint Commands for Event Occurrences

Command	Menu Selection	Description
stop_emu0	EMU0 driven low	Stop the processor when the EMU0 pin reaches a logic low of zero
stop_emu1	EMU1 driven low	Stop the processor when the EMU1 pin reaches a logic low of zero
stop_off	none	Disable break events

Qualifying on a read or a write

Program accesses can be qualified, depending on whether the memory cycle is a read or write. Table A–4 shows the qualifier commands for data and program break events. You can use only one of these commands at a time.

Table A–4. Read and Write Qualifying Commands for Data and Program Accesses

Command	Menu Selection	Description
prog_qual_iaq	Program bus: Fetch	Program instruction acquisition
prog_qual_r	Program bus: Read	Look only at data reads
prog_qual_rw	Program bus: Access	Look at both data reads and writes
prog_qual_w	Program bus: Write	Look only at data writes

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 manually deselecting 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 = 1”
```

To create your own analysis commands, you must familiarize yourself with the 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. Set the bit to 1 to enable or to 0 to disable.

Bit Number	Description
0	enable analysis module
1	reserved (set to 0)
2	reserved (set to 0)
4	enable EMU0 output
5	enable EMU1 output

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
5	program address
9	EMU0 detected low
10	EMU1 detected low

Run commands will not interfere with the status bits, because they are cleared before command execution.

hbpenbl (Select Hardware Breakpoints)

By setting the appropriate enable bit to 1 in the hbpenbl register, the ’C2xx can break on multiple events. Setting the bit to 0 disables the breakpoint and clears the register. The breakpoint enable bits are defined below.

Bit Number	Definition
5	program address
9	EMU0 detected low
10	EMU1 detected low

pgabrkp (Program Address Breakpoint)

You can specify a breakpoint address for the program bus in the ’C2xx path. When a valid bus cycle occurs and the bus value matches the breakpoint address, then a breakpoint condition can occur.

pgaqual (Program Breakpoint Qualifier)

The program address breakpoint register has four qualifier bits. The qualifier definitions are shown below.

Qualifier Code	Definition
0	read
1	write
2	program instruction acquisition
3	read/write

Appendix B

Describing Your Target System to the Debugger

In order for the debugger to understand how you have configured your target system, you must supply a file for the debugger to read.

❑ If you're using an emulation scan path that contains only one 'C2xx and no other devices, you can use the *board.dat* file that comes with the 'C2xx emulator kit. This file describes to the debugger the single 'C2xx in the scan path and gives the 'C2xx the name CPU_A. Since the debugger automatically looks for a file called board.dat in the current directory and in the directories specified with the D_DIR environment variable, you can skip this appendix.

❑ If you plan to use a different target system, you must follow these steps:

Step 1: Create the board configuration text file.

Step 2: Translate the board configuration text file to a binary, structured format so that the debugger can read it.

Step 3: Specify the formatted configuration file when invoking the debugger.

These steps are described in this appendix.

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B.1 Step 1: Create the Board Configuration Text File

To describe the emulation scan path of your target system to the debugger, you must create a board configuration file. The file consists of a series of entries, each describing one device on your scan path. You must list, in order, the individual devices on your system in the board configuration file for the debugger to work. The text version of the configuration file will be referred to as *board.cfg* in this book.

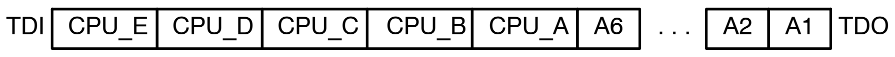
Example B−1 shows a board.cfg file that describes a possible 'C2xx device chain. It lists six octals named A1−A6, followed by five 'C2xx devices named CPU_A, CPU_B, CPU_C, CPU_D, and CPU_E.

Example B−1. A Sample 'C2xx Device Chain

(a) A sample board.cfg file

Device Name	**Device Type**	**Comments**
`"A1"`	`BYPASS08`	`;the first device nearest TDO` `;(test data out)`
`"A2"`	`BYPASS08`	`;the next device nearest TDO`
`"A3"`	`BYPASS08`	
`"A4"`	`BYPASS08`	
`"A5"`	`BYPASS08`	
`"A6"`	`BYPASS08`	
`"CPU_A"`	`TI320C2xx`	`;the first 'C2xx`
`"CPU_B"`	`TI320C2xx`	
`"CPU_C"`	`TI320C2xx`	
`"CPU_D"`	`TI320C2xx`	
`"CPU_E"`	`TI320C2xx`	`;the last 'C2xx nearest TDI` `;(test data in)`

(b) A sample 'C2xx device chain



The order in which you list each device is important. The emulator scans the devices, assuming that the data from one device is followed by the data of the next device on the chain. Data from the device that is closest to the emulation header's TDO reaches the emulator first. Moreover, in the board.cfg file, the devices should be listed in the order in which their data reaches the emulator. For example, the device whose data reaches the emulator first is listed first in the board.cfg file; the device whose data reaches the emulator last is listed last in the board.cfg file.

The board.cfg file can have any number of each of the three types of entries:

- **Debugger devices** such as the 'C2xx. These are the only devices that the debugger can recognize.
- The **TI ACT8997 scan path linker**, or **SPL**. The SPL allows you to have up to four secondary scan paths that can each contain debugger devices ('C2xxs) and other devices.
- **Other devices**. These are any other devices in the scan path. For example, you can have devices such as the TI BCT 8244 octals that are used on the 'C4x PPDS board. These devices cannot be debugged and must be worked around or "bypassed" when trying to access the 'C2xxs.

Each entry in the board.cfg file consists of at least two pieces of data:

- **The name of the device.** The device name always appears first and is enclosed in double quotes:

  "device name"

  This is the same name that you use with the −n debugger option, which tells the debugger the name of the 'C2xx. The *device name* can consist of up to eight alphanumeric characters or underscore characters and must begin with an alphabetic character.

- **The type of the device.** The debugger supports the following device types:

  - **TI320C2xx** is an example of a debugger-device type.
    - TI320C2xx describes the 'C2xx.
    - TI320C4x describes the 'C4x.
    - TI320C5x describes the 'C5x.
    - TI320C5xx describes the 'C54x.
    - TI320C8x describes the 'C8x.

- **SPL** specifies the scan path linker and must be followed by four subpaths, as in this syntax:

  ”*device name*” **SPL** {*subpath0*} {*subpath1*} {*subpath2*} {*subpath3*}

  Each *subpath* can contain any number of devices. However, an SPL subpath **cannot** contain another SPL.

- **BYPASS##** describes devices other than the debugger devices or SPL. The ## is the hexadecimal number that describes the number of bits in the device’s JTAG instruction register. For example, TI BCT 8244 octals have a device type of BYPASS08.

Example B−2 shows a file that contains an SPL.

Example B−2. A board.cfg File Containing an SPL

```
Device Name    Device Type    Comments
”A1”           BYPASS08       ;the first device nearest TDO
”A2”           BYPASS08
”CPU_A”        TI320C2xx      ;the first ’C2xx
”HUB”          SPL            ;the scan path linker
  {                           ;first subpath
  ”B1”         BYPASS08
  ”B2”         BYPASS08
  ”CPU_B”      TI320C2xx      ;the second ’C2xx
  }
  {                           ;second subpath
  ”C1”         BYPASS08
  ”C2”         BYPASS08
  ”CPU_C”      TI320C2xx      ;the third ’C2xx
  }
  {                           ;third subpath (contains nothing)
  }
  {                           ;fourth subpath
  ”D1”         BYPASS08
  ”D2”         BYPASS08
  ”CPU_D”      TI320C2xx      ;the fourth ’C2xx
  }
”CPU_E”        TI320C2xx      ;the last ’C2xx nearest TDI
```

Note: The indentation in the file is for readability only.

B.2 Step 2: Translate the Configuration File to a Debugger-Readable Format

After you have created the board.cfg file, you must translate it from text to a binary, conditioned format so that the debugger can understand it. To translate the file, use the composer utility that is included with the emulator kit. At the system prompt, enter the following command:

composer [*input file* [*output file*]]

- ❑ The *input file* is the name of the board.cfg file that you created in step 1; if the file isn't in the current directory, you must supply the entire pathname. If you omit the input filename, the composer utility looks for a file called board.cfg in your current directory.
- ❑ The *output file* is the name that you can specify for the resulting binary file; ideally, use the name board.dat. If you want the output file to reside in a directory other than the current directory, you must supply the entire pathname. If you omit an output filename, the composer utility creates a file called board.dat and places it in the current directory.

To avoid confusion, use a .cfg extension for your text filenames and a .dat extension for your binary filenames. If you enter only one filename on the command line, the composer utility assumes that it is an input filename.

B.3 Step 3: Specify the Configuration File When Invoking the Debugger

When you invoke a debugger (either from the PDM or at the system prompt), the debugger must be able to find the board.dat file so that it knows how you have set up your scan path. The debugger looks for the board.dat file in the current directory and in the directories named with the D_DIR environment variable.

If you used a name other than board.dat or if the board.dat file is not in the current directory nor in a directory named with D_DIR, you must use the −f option when you invoke the debugger. The −f option allows you to specify a board configuration file (and pathname) that will be used instead of board.dat. The format for this option is:

−f *filename*

Appendix C

Debugger and PDM Messages

This appendix contains an alphabetical listing of the progress and error messages that the debugger or PDM might display in the display area of the COMMAND window or in the PDM 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.

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C.1 Associating Sound With Error Messages

You can associate a beeping sound with the display of error messages. 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 bracket symbol “**[**” but didn’t contain a closing bracket symbol “**]**”.

Action See Section C.4, *Additional Instructions for Expression Errors*, page 14-27.

‘)’ expected

Description This is an expression error—it means that the parameter contained an opening parenthesis symbol “**(**” but didn’t contain a closing parenthesis symbol “**)**”.

Action See Section C.4, *Additional Instructions for Expression Errors*, page 14-27.

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 reenter 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 software breakpoints, or use the BD command to delete individual software breakpoints.

C

Cannot allocate host memory

Description This is a fatal error—it means that the debugger is running out of memory.

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.

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 detect target power

Description This hardware error occurs after the emurst command is reset. 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 your target board to be sure it is getting the correct voltage.
- ❑ Check your emulator scan path to be sure it is uninterrupted.
- ❑ Ensure that your port address is set correctly:
  - ■ Check to be sure the –p option used with the D_OPTIONS environment variable matches the I/O address defined by your switch settings. (Refer to the *TMS320C2xx PC Emulator 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 init.cmd file.

Action Be sure that init.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 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 or initdb.bat file; then invoke the debugger again.

Cannot initialize target system

Description This error occurs while you are invoking the debugger with the emulator. 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.

- ❑ Ensure that your port address is set correctly:
  - ■ Check to be sure the −p option used with the D_OPTIONS environment variable matches the I/O address defined by your switch settings.
  - ■ 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.
- ❑ Check the end of your autoexec.bat or initdb.bat file for the emurst.exe command. Execute this command *after* powering up the target board.

For more details, refer to the *TMS320C2xx PC Emulator Installation Guide.*

Cannot map into reserved memory: ?

Description The debugger tried to access unconfigured/reserved/nonexistent memory.

Action Remap the reserved memory accesses.

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, reenter the command with the correct name. If it was, reenter the command and specify full path information with the filename.

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 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 dspcl again to create an executable object file).

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, DISP, and additional MEMORY windows. To close the WATCH window, enter WD. To close the CALLS, DISP, or a MEMORY window, make the desired window active and press F4.

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 or initdb.bat file, then invoke the debugger again. If you are using the emulator, check the cable connections, also.

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. If you are using the emulator, there may be a problem with the target system; check the cable connections.

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. This may also happen when you enable or disable on-chip memory while using breakpoints.

Action Check your memory map. If the address that you wanted to breakpoint wasn't in ROM, see Section C.5, *Additional Instructions for Hardware Errors*, page 14-27.

Cannot step

Description There is a problem with the target system.

Action See Section C.5, *Additional Instructions for Hardware Errors*, page 14-27.

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.4, *Additional Instructions for Expression Errors*, page 14-27.

Command "*cmd*" not found

Description The debugger didn't recognize the command that you typed.

Action Reenter the correct command. Refer to Chapter 5, *Summary of Commands and Special Keys*, 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.5, *Additional Instructions for Hardware Errors*, page 14-27.

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 that existing block that the new block would overlap. If the existing block is not necessary, delete it with the MD command and reenter the MA command. If the existing block is necessary, reenter 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 program stack was overwritten in target memory. Another reason you may have this message is that you are debugging code that has optimization enabled (for example, you did not use the −g compile switch); if this is the case, ignore this message—code execution is not affected.

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.

Disabling window updating

Description You entered the UPDATE OFF command to tell the debugger to not update any windows during realtime emulation.

Action None required.

E

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 *TMS320C2xx PC Emulator Installation Guide*.

Enabling WATCH window updating

Description	You entered the UPDATE WA command to tell the debugger to update only the WATCH window during realtime emulation.
Action	None required.

Enabling WATCH/MEMORY/CPU window updating

Description	You entered the UPDATE ALL command to tell the debugger to update the WATCH, MEMORY, and CPU windows during realtime emulation.
Action	None required.

Error in expression

Description	This is an expression error.
Action	See Section C.4, *Additional Instructions for Expression Errors*, page 14-27.

Execution error

Description	There is a problem with the target system.
Action	See Section C.5, *Additional Instructions for Hardware Errors*, page 14-27.

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 connected to a file.

File already tied to this pin

Description You attempted to connect an input file to an interrupt pin that already has a file connected to it.

Action Use the PINC command to connect the file to another interrupt pin that is not 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 was, reenter 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 was, reenter 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 dsplnk to relink the program with fewer modules.

Float not allowed

Description	This is an expression error—a floating-point value was used incorrectly.
Action	See Section C.4, *Additional Instructions for Expression Errors*, page 14-27.

Function required

Description	The parameter for the FUNC command must be the name of a function in the program that is loaded.
Action	Reenter the FUNC command with a valid function name.

I

Illegal addressing mode

Description	An illegal ’C2xx addressing mode was encountered.
Action	Refer to the *TMS320C2xx 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.4, *Additional Instructions for Expression Errors*, page 14-27.

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 lefthand side of an assignment expression doesn’t meet C language assignment rules.
Action	See Section C.4, *Additional Instructions for Expression Errors*, page 14-27.

Illegal memory access

Description Your program tried to access unmapped memory.

Action Modify your source code.

Illegal opcode

Description An invalid 'C2xx 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.4, *Additional Instructions for Expression Errors*, page 14-27.

Illegal pointer math

Description This is an expression error—some types of pointer math are not valid in C expressions.

Action See Section C.4, *Additional Instructions for Expression Errors*, page 14-27.

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.4, *Additional Instructions for Expression Errors*, page 14-27.

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.4, *Additional Instructions for Expression Errors*, page 14-27.

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.4, *Additional Instructions for Expression Errors*, page 14-27.

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.4, *Additional Instructions for Expression Errors*, page 14-27.

Integer not allowed

Description This is an expression error—the command did not accept an integer as a parameter.

Action See Section C.4, *Additional Instructions for Expression Errors*, page 14-27.

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 Reenter the command with valid parameters. Refer to the appropriate command description in Chapter 5, *Summary of Commands and Special Keys*.

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 Reenter the COLOR or SCOLOR command with a valid area name parameter. Valid area names are listed in Table 11–2 (page 11-3).

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 Reenter the COLOR or SCOLOR command with a valid color parameter. Valid color attributes are listed in Table 11–1 (page 11-2).

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 Reenter the MA command. Use one of the following valid parameters to identify the memory type:

R, ROM	(read-only memory)
W, WOM	(write-only memory)
R|W, RAM	(read/write memory)
PROTECT	(no-access memory)
OUTPORT, P|W	(output port)
INPORT, P|R	(input port)
IOPORT, P|R|W	(input/output port)

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 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 instead of a watch index.

Action Reenter 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.5, *Additional Instructions for Hardware Errors*, page 14-27.

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.5, *Additional Instructions for Hardware Errors*, page 14-27.

Lval required

Description	This is an expression error—an assignment expression was entered that requires a legal left-hand side.
Action	See Section C.4, *Additional Instructions for Expression Errors*, page 14-27.

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.5, *Additional Instructions for Hardware Errors*, page 14-27.

Memory map table full

Description Too many blocks have been added to the memory map. This will rarely happen unless blocks are added 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, reenter the command with the correct name. If it was, then be sure that the associated object file is loaded.

Nesting of repeats cannot exceed 100

Description The debugger cannot simulate more than 100 levels of repeat nesting in an input data file. If this happens, the debugger disconnects the input file from the pin.

Action Correct the input file so that the data does not include nesting repetition exceeding 100. Use the PINC command to reconnect the input file to the desired pin.

No file connected to this pin

Description You tried to disconnect the input file from a pin that was not previously connected to that pin.

Action Use the PINL command to list all of the pins and the files connected to them. Use the PIND command to reenter the correct pinname and filename.

Non-repeatable instruction

Description The instruction following the RPT instruction is not a repeatable instruction.

Action Modify your code.

P

Pinname not valid for this chip

Description You attempted to connect or disconnect an input file to an invalid interrupt pin.

Action Reconnect or disconnect the input file to an unused interrupt pin ($\overline{\text{INT}}$1–$\overline{\text{INT}}$4 or $\overline{\text{BIO}}$).

Pointer not allowed

Description This is an expression error.

Action See Section C.4, *Additional Instructions for Expression Errors*, page 14-27.

Processor is already running

Description One of the RUN commands was entered while the debugger was running free from the target system.

Action Enter the HALT command to stop the free run, then reenter the desired RUN command.

R

Read not allowed for port

Description You attempted 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.5, *Additional Instructions for Hardware Errors*, page 14-27.

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 non-existent structure member.

Action See Section C.4, *Additional Instructions for Expression Errors*, page 14-27.

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.4, *Additional Instructions for Expression Errors*, page 14-27.

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.4, *Additional Instructions for Expression Errors*, page 14-27.

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 deep.

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.

Timeout waiting for device – Press Control-C to abort

Description

Action

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 software breakpoints or use the BD command to delete individual software 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 Don't enter the USE command before entering another command that has a *filename* parameter. 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.

Action Verify the address of the port to be connected or disconnected.

Updating at rate *n*

Description You entered the UPDATE command with a value. The value is the update rate that the debugger uses to udpate windows in realtime emulation.

Action None required.

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 Reenter 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	**CP**U	**DISP**
COMMAND	**DISA**SSEMBLY	**F**ILE
MEMORY	**P**ROFILE	**W**ATCH

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 Either change the ’C2xx software to write a port that is configured for write, or change the attributes of the port.

C.3 Alphabetical Summary of PDM Messages

This section contains an alphabetical listing of the error messages that the PDM might display. Each message contains both a description of the situation that causes the message and an action to take.

Note:

If errors are detected in a TAKE file, the PDM aborts the batch file execution, and the file line number of the invalid command is displayed along with the error message.

Cannot communicate with *"name"*

Description The PDM cannot communicate with the named debugger, because the debugger either crashed or was exited.

Action Spawn the debugger again.

Cannot communicate with the child debugger

Description This error occurs when you are spawning a debugger. The PDM was able to find the debugger executable file, but the debugger could not be invoked for some reason, and the communication between the debugger and PDM was never established. This usually occurs when you have a problem with your target system.

Action Exit the PDM and go back though the installation instructions in the installation guide. Reinvoke the PDM and try to spawn the debugger again.

Cannot create mailbox

Description The PDM was unable to create a mailbox for the new debugger that you were trying to spawn; the PDM must be able to create a mailbox in order to communicate with each debugger. This message usually indicates a resource limitation (you have more debuggers invoked than your system can handle).

Action If you have numerous debuggers invoked and you're not using all of them, close some of them. If you are under a UNIX environment, use the ipcs command to check your message queues; use ipcrm to clean up the message queues.

Cannot open log file

Description The PDM cannot find the filename that you supplied when you entered the DLOG command.

Action Be sure that the file resides in the current directory or in one of the directories specified by the D_DIR environment variable.

- ❑ Check to see if you mistyped the filename.

Cannot open take file

Description The PDM cannot find the batch filename supplied for the TAKE command. You will also see this message if you try to execute a batch file that does not have a .pdm extension.

Action Be sure that the file resides in the current directory or in one of the directories specified by the D_DIR environment variable.

- ❑ Check to see whether you mistyped the filename.
- ❑ Be sure that the batch filename has a .pdm extension.
- ❑ Be sure that the file has executable rights.

Cannot open temporary file

Description The PDM is unable to create a temporary file in the current directory.

Action Change the permissions of the current directory.

Cannot seek in file

Description While the PDM was reading a file, the file was deleted or modified.

Action Be sure that the files the PDM reads are not deleted or modified during the read.

Cannot spawn child debugger

Description The PDM couldn't spawn the debugger that you specified, because the PDM couldn't find the debugger executable file (emu2xx). The PDM will first search for the file in the current directory and then search the directories listed with the PATH statement.

Action Check to see if the executable file is in the current directory or in a directory that is specified by the PATH statement. Modify the PATH statement if necessary, or change the current directory.

Command error

Description	The syntax for the command that you entered was invalid (for example, you used the wrong options or arguments).
Action	Reenter the command with valid parameters.

D

Debugger spawn limit reached

Description	The PDM spawned the maximum number of debuggers that it can keep track of in its internal tables. The maximum number of debuggers that the PDM can track is 2048. However, your system may not have enough resources to support that many debuggers.
Action	Before trying to spawn an additional debugger, close any debuggers that you don't need to run.

I

Illegal flow control

Description	One of the flow control commands (IF/ELIF/ELSE/ENDIF or LOOP/BREAK/CONTINUE/ENDLOOP) has an error. This error usually occurs when there is some type of imbalance in one of these commands.
Action	Check the flow command construct for such problems as an IF without an ENDIF, a LOOP without an ENDLOOP, or a BREAK that does not appear between a LOOP and an ENDLOOP. Edit the batch file that contains the problem flow command, or interactively reenter the correct command.

Input buffer overflow

Description	The PDM is trying to execute or manipulate an alias or shell variable that has been recursively defined.
Action	Use the SET and/or ALIAS commands to check the definitions of your aliases and system variables. Modify them as necessary.

Invalid command

Description	The command that you entered was not valid.
Action	Refer to the command summary in Chapter 5, *Summary of Commands and Special Keys,* for a complete list of commands and their syntax.

Invalid expression

Description	The expression that you used with a flow control command or the @ command is invalid. You may see specific messages before this one that provide more information about the problem with the expression. The most common problem is the failure to use the $ character when evaluating the contents of a system variable.
Action	Check the expression that you used. Refer to Section 2.7, *Understanding the PDM's Expression Analysis*, page 2-17, for more information about expression analysis.

Invalid shell variable name

Description	The system variable name that you used the SET command to assign is invalid. Variable names can contain any alphanumeric characters or underscore characters.
Action	Use a different name.

Maximum loop depth exceeded

Description	The LOOP/ENDLOOP command that you tried to execute had more than 10 nested LOOP/ENDLOOP constructs. LOOP/ENDLOOP constructs can be nested up to 10 deep.
Action	Edit the batch file that contains the LOOP/ENDLOOP construct, or reenter the LOOP/ENDLOOP command interactively.

Maximum take file depth exceeded

Description	The batch file that you tried to execute with the TAKE command called or nested more than 10 other batch files. The TAKE command can handle batch files that are nested up to 10 deep.
Action	Edit the batch file.

U

Unknown processor name *"name"*

Description	The processor name that you specified with the −g option or a processor name within a group that you specified with the −g option does not match any of the names of the debuggers that were spawned under the PDM.
Action	Be sure that you've correctly entered the processor name.

C.4 Additional Instructions for Expression Errors

Whenever you receive an expression error, you should reenter 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.5 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 ’C2xx must be reset before you can use the emulator. Most target systems reset the ’C2xx at power-up; your target system may not be doing this.

Chapter 4

Glossary

A

active window: The 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 in which 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 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 and 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 contains DOS 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

C: A high-level, general-purpose programming language useful for writing compilers and operating systems and for programming microprocessors.

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.

click: To press and release a mouse button without moving the mouse.

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 fixed-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 that provides an area for you to enter commands and for the debugger to echo command entry, show command output, and list progress or error messages.

CPU window: A window that displays the contents of ’C2xx 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 'C2xx programs running on a 'C2xx emulator or simulator.

disassembly: Assembly language code formed from the reverse-assembly of the contents of memory.

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 instructions that load the PC with new values, such as branches, calls, and returns.

DISP window: A window that displays the members of an aggregate data type.

display area: The portion of the COMMAND window or PDM 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.

dspcl: A shell utility that invokes the TMS320C1x/C2x/C2xx/C5x compiler, assembler, and linker to create an executable object file version of your program.

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 ’C2xx 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.

F

FILE window: A window that displays the contents of the current C code. The FILE window is intended primarily for displaying C code but can be used to display any text file.

I

init.cmd: A batch file that contains debugger-initialization commands. If this file isn’t present when you first invoke the debugger, then all memory is invalid.

I/O switches: Hardware switches on the emulator or EVM board that identify the PC I/O memory space used for emulator-debugger or EVM-debugger communications.

ISA: *Industry Standard Architecture*. A subset of the EISA standard.

M

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.

minimal mode: A debugging mode that displays the COMMAND window, WATCH window, and DISP window only.

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.

PDM: *Parallel Debug Manager.* A program used for creating and controlling multiple debuggers for the purpose of debugging code in a parallel-processing environment.

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 or EVM. The port address is selected via switches on the emulator or EVM 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, 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.

simulator: A development tool that simulates the operation of the 'C2xx and lets you execute and debug applications programs by using the 'C2xx debugger.

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 'C2xx program.

T

target system: A 'C2xx board that works with the emulator; the emulator doesn't contain a 'C2xx device, so it must use a 'C2xx 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.

*This template is for the "*See*" and "*See also*" references in your index. Since these entries do not have a page number associated with them, it's extremely difficult to locate one if you need to modify or delete it and you don't remember which chapter it's in. By using this template, you can alphabetize your entries according to the first letter of the first level entry.*

K

L

M

N

O

P

Q

R

S

T

U

V

Chapter 5

Summary of Commands and Special Keys

This chapter summarizes the basic debugger, profiling, and parallel debug manager (PDM) commands and the debugger's special key sequences.

Topic **Page**

5.1 Functional Summary of Debugger Commands

This section summarizes the debugger commands according to these categories:

- **Managing multiple debuggers.** These commands allow you to group debuggers, run code on multiple processors, and send commands to a group of debuggers.
- **Changing operating modes.** These commands (listed on page 16-4) enable you to switch between real-time mode and stop mode.
- **Changing debugging modes.** These commands (listed on page 16-4) enable you to switch between the debugging modes (auto, mixed, minimal, and assembly).
- **Managing windows.** These commands (listed on page 16-4) enable you to select the active window and move or resize the active window.
- **Displaying and changing data.** These commands (listed on page 16-5) enable you to display and evaluate a variety of data items.
- **Using extended addressing.** These commands (listed on page 16-5) allow you to access the extended memory that you built in your target system.
- **Performing system tasks.** These commands (listed on page 16-6) enable you to perform several DOS-like functions and provide you with some control over the target system.
- **Managing breakpoints.** These commands (listed on page 16-6) provide you with a command line method for controlling software breakpoints.
- **Displaying files and loading programs.** These commands (listed on page 16-7) enable you to change the displays in the FILE and DISASSEMBLY windows and to load object files into memory.
- **Customizing the screen.** These commands (listed on page 16-7) allow you to customize the debugger display, then save and later reuse the customized displays.
- **Memory mapping.** These commands (listed on page 16-8) enable you to define the areas of target memory that the debugger can access.
- **Running programs.** These commands (listed on page 16-8) provide you with a variety of methods for running your programs in the debugger environment.
- **Profiling commands.** These commands (listed on page 16-9) enable you to collect execution statistics for your code.

Managing multiple debuggers

To do this	Use this command	See page
Assign a variable to the result of an expression	@	16-14
Use the command history	!	16-14
Define a custom command string	alias	16-16
Record the information shown in the PDM display area	dlog	16-25
Display a string to the PDM display area	echo	16-26
Evaluate an expression in a debugger or group of debuggers and set a variable to the result	eval	16-27
List available PDM commands	help	16-31
View the description of a PDM command	help	16-31
List the last twenty commands	history	16-31
Conditionally execute PDM commands	if/elif/else/endif	16-32
Loop through PDM commands	loop/break/con-tinue/endloop	16-34
Pause the PDM	pause	16-45
Halt code execution	pesc	16-45
Perform a global halt	phalt	16-46
Run code globally	prun	16-49
Run free globally	prunf	16-49
Single-step globally	pstep	16-50
Exit any debugger and/or the PDM	quit	16-50
Send a command to an individual processor or a group of processors	send	16-56
Change the PDM prompt	set	16-57
Create your own system variables	set	16-57
Define or modify a group of processors	set	16-57
List all system variables or groups of processors	set	16-57
Set the default group	set	16-57
Invoke an individual debugger	spawn	16-61
Find the execution status of a processor or a group of processors	stat	16-62
Enter an operating-system command	system	16-63
Execute a batch file	take	16-64
Delete an alias definition	unalias	16-64
Delete a group or system variable	unset	16-65

Using the real-time features

To put the debugger in	Use this command	See page
Switch to real-time mode	realtime	16-50
Switch to stop mode	stopmode	16-63
	update	16-65

Changing debugging modes

To put the debugger in	Use this command	See page
Assembly mode	asm	16-16
Auto mode for debugging C code	c	16-19
Minimal mode	minimal	16-40
Mixed mode	mix	16-41

Managing windows

To do this	Use this command	See page
Reposition the active window	move	16-42
Resize the active window	size	16-59
Select the active window	win	16-69
Make the active window as large as possible	zoom	16-70

Displaying and changing data

To do this	Use this command	See page
Evaluate and display the result of a C expression	?	16-13
Display the values in an array or structure or display the value that a pointer is pointing to	disp	16-23
Evaluate a C expression without displaying the results	eval	16-27
Display a different range of memory in a MEMORY window or display an additional MEMORY window	mem	16-39
Change the default format for displaying data values	setf	16-58
Continuously display the value of a variable, register, or memory location within a WATCH window	wa	16-67
Delete a data item from a WATCH window	wd	16-68
Show the type of a data item	whatis	16-69
Delete all data items from a WATCH window and close the WATCH window	wr	16-69

Using extended addressing

To do this	Use this command	See page
Enable or disable extended addressing	ext_addr	16-28
Describe your extended memory system to the debugger	ext_addr_def	16-28

Performing system tasks

To do this	Use this command	See page
Define your own command string	alias	16-16
Change the current working directory from within the debugger environment	cd/chdir	16-19
Clear all displayed information from the display area of the COMMAND window	cls	16-20
List the contents of the current directory or any other directory	dir	16-23
Record the information shown in the display area of the COMMAND window	dlog	16-25
Display a string to the COMMAND window while executing a batch file	echo	16-26
Conditionally execute debugger commands in a batch file	if/else/endif	16-33
Loop debugger commands in a batch file	loop/endloop	16-35
Exit the debugger	quit	16-50
Reconnects the debugger and the emulator	reconnect	16-51
Reset the target system	reset	16-51
Set safehalt mode to control target device halting	safehalt	16-53
Associate a beeping sound with the display of error messages	sound	16-61
Execute commands from a batch file	take	16-64
Delete an alias definition	unalias	16-64
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Managing breakpoints

To do this	Use this command	See page
Add a software breakpoint	ba	16-17
Delete a software breakpoint	bd	16-17
Display a list of all the software breakpoints that are set	bl	16-17
Reset (delete) all software breakpoints	br	16-18

Displaying files and loading programs

To do this	Use this command	See page
Display C and/or assembly language code at a specific point	addr	16-15
Reopen the CALLS window	calls	16-19
Display assembly language code at a specific address	dasm	16-22
Display a text file in the FILE window	file	16-29
Display a specific C function	func	16-30
Load an object file	load	16-33
Modify disassembly with the patch assembler	patch	16-44
Load only the object-code portion of an object file	reload	16-51
Load only the symbol-table portion of an object file	sload	16-60

Customizing the screen

To do this	Use this command	See page
Change the border style of any window	border	16-18
Change the screen colors, but don't update the screen immediately	color	16-21
Change the command-line prompt	prompt	16-48
Change the screen colors and update the screen immediately	scolor	16-54
Load and use a previously saved custom screen configuration	sconfig	16-55
Save a custom screen configuration	ssave	16-62

Memory mapping

To do this	Use this command	See page
Initialize a block of memory	fill	16-30
Add an address range to the memory map	ma	16-35
Enable or disable memory mapping	map	16-36
Connect a simulated I/O port to an input or output file (simulator only)	mc	16-37
Delete an address range from the memory map	md	16-38
Disconnect a simulated I/O port (simulator only)	mi	16-40
Display a list of the current memory map settings	ml	16-41
Reset the memory map (delete all ranges)	mr	16-43
Save a block of memory to a system file	ms	16-43
Connect an input file to the pin (simulator only)	pinc	16-47
Disconnect the input file from the pin (simulator only)	pind	16-47
List the pins that are connected to the input files (simulator only)	pinl	16-47

Running programs

To do this	Use this command	See page
Single-step through assembly language or C code, one C statement at a time; step over function calls	cnext	16-20
Single-step through assembly language or C code, one C statement at a time	cstep	16-22
Run a program up to a certain point	go	16-31
Single-step through assembly language or C code; step over function calls	next	16-44
Reset the target system	reset	16-51
Reset the program entry point	restart	16-52
Execute code in a function and return to the function's caller	return	16-52
Run a program	run	16-52
Disconnect the emulator from the target system and run free	runf	16-53
Single-step through assembly language or C code	step	16-63
Execute commands from a batch file	take	16-64

Profiling commands (Simulator only)

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 5.4, *Summary of Profiling Commands (Simulator Only)*, on page 16-71.

To do this	**Use this command**	**See page**
Run a full profiling session	pf	16-46
Run a quick profiling session	pq	16-48
Resume a profiling session	pr	16-48
Add a stopping point	sa	16-53
Delete a stopping point	sd	16-55
List all the stopping points	sl	16-60
Delete all the stopping points	sr	16-61
Save all the profile data to a file	vaa	16-66
Save currently displayed profile data to a file	vac	16-66
Reset the display in the PROFILE window to show all areas and the default set of data	vr	16-67

5.2 How the Menu Selections Correspond to Commands

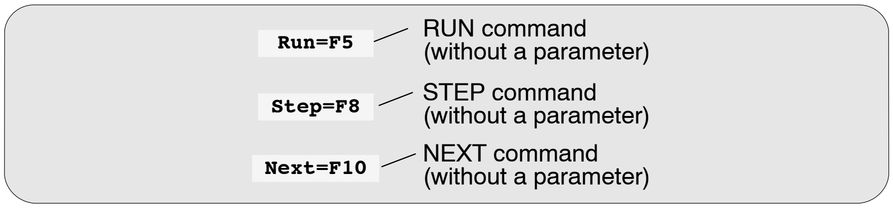
The following sample screens illustrate the relationship of the basic debugger commands to the menu bar and pulldown menus.

You can use the menus with or without a mouse. To access a menu from the keyboard, press the ALT key and the letter that's highlighted in the menu name. (For example, to display the Load menu, press ALT L.) Then, to make a selection from the menu, press the letter that's highlighted in the command you've selected. (For example, on the Load menu, to execute File, press F.) If you don't want to execute a command, press ESC to close the menu.

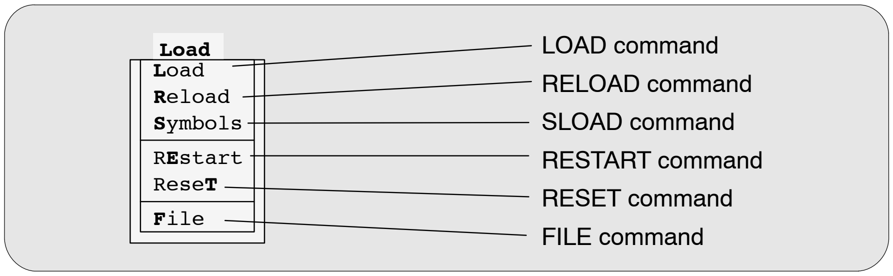
Note:

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

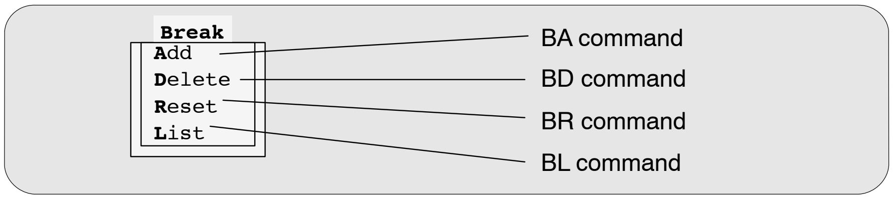
Program-execution commands


Run=F5
RUN command (without a parameter)
Step=F8
STEP command (without a parameter)
Next=F10
NEXT command (without a parameter)

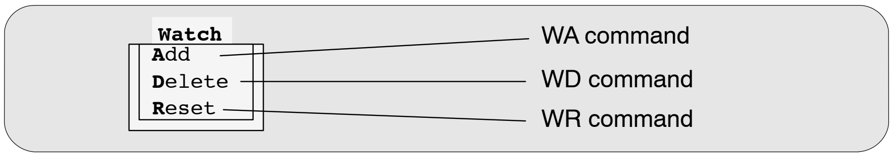
File/load commands



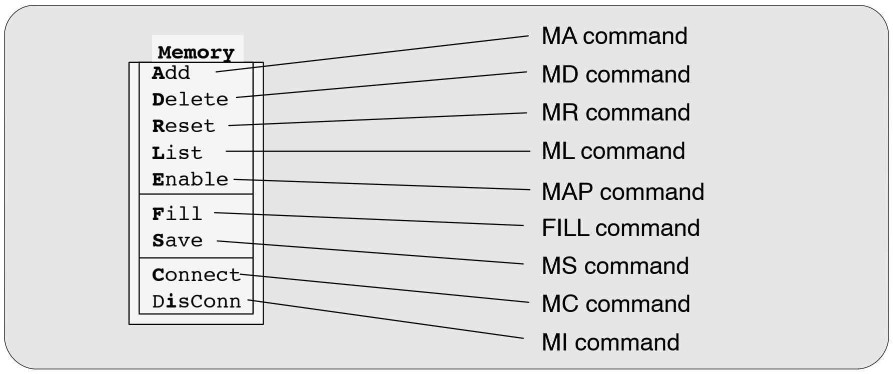
Breakpoint commands



Watch commands

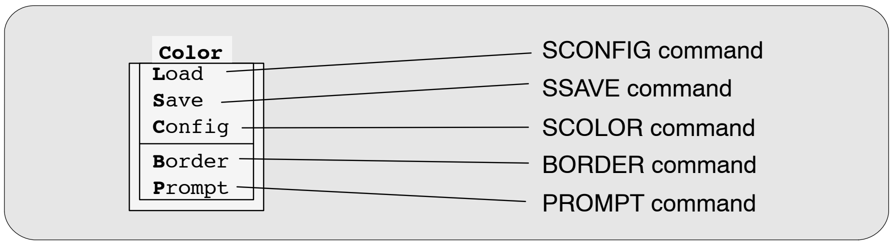


Memory commands

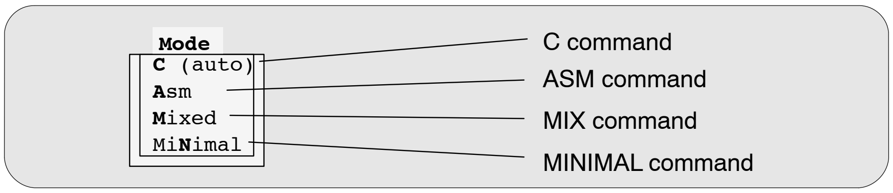


Note: The Connect and DisConn entries are for the simulator only.

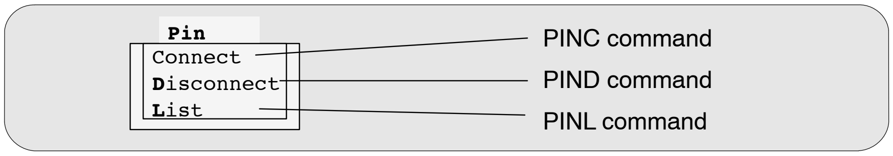
Screen-configuration commands



Mode commands

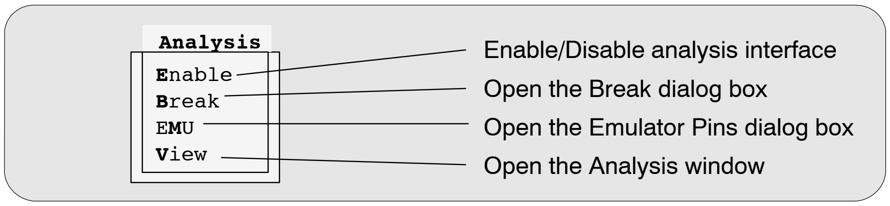


Interrupt-simulation commands (Simulator only)



Analysis menu (Emulator only)

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
Break
EMU
View
Enable/Disable analysis interface
Open the Break dialog box
Open the Emulator Pins dialog box
Open the Analysis window

5.3 Alphabetical Summary of Debugger and PDM Commands

Most of the commands can be used in the basic debugger environment and/or the profiling environment. Other commands can be used only by the parallel debug manager (PDM). A few commands can be used in two or more 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 ☐ PDM ✓ profiling

Description The ? (evaluate expression) command evaluates an expression and shows the result in the display area of the COMMAND window. 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 *expression* identifies an address, you can follow it with one of these suffixes:

To identify . . .	Use this suffix . . .
Program memory	**@prog**
Extended program memory†	**@prog16**
Data memory	**@data**
Extended data memory†	**@data16**

† Valid only when extended addressing is enabled.

Without the suffix, the debugger treats an address expression as a program-memory location.

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 ESC.

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	**o**	Octal
c	ASCII character (bytes)	**p**	Valid address
d	Decimal	**s**	ASCII string
e	Exponential floating point	**u**	Unsigned decimal
f	Decimal floating point	**x**	Hexadecimal

!

Use the PDM Command History

Syntax

!{*prompt number* | *string*}
!!

Menu selection

none

Environments

☐ basic debugger ☑ PDM ☐ profiling

Description

The PDM supports a command history that is similar to the UNIX command history. The PDM prompt identifies the number of the current command. This number is incremented with every command. The PDM command history allows you to reenter any of the last twenty commands.

- The *number* parameter is the number of the PDM prompt that contains the command that you want to reenter.
- The *string* parameter tells the PDM to execute the last command that began with *string.*
- The !! command tells the PDM to execute the last command that you entered.

@

Substitute Result of an Expression

Syntax

@ *variable name* = *expression*

Menu selection

none

Environments

☐ basic debugger ☑ PDM ☐ profiling

Description

Unlike the SET command, the @ command first evaluates the *expression*, and then sets the *variable name* to the result. The *expression* can be any expression that uses the symbols described in Section 2.7, *Understanding the PDM's Expression Analysis*, on page 2-17. The *variable name* can consist of up to 128 alphanumeric characters or underscore characters.

addr — *Display Code at Specified Address*

Syntax

addr *address* [{**@prog** | **@data** | **@io** | **@prog16** | **@data16**}]
addr *function name*

Menu selection

none

Environments

☑ basic debugger ☐ PDM ☐ profiling

Description

Use the ADDR command to display C code or the disassembly at a specific point. ADDR's behavior changes, depending on the current debugging mode:

- 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.

By default, the *address* parameter is treated as a program-memory address. However, you can follow it with one of these suffixes:

To identify . . .	Use this suffix . . .
Program memory	**@prog**
Extended program memory†	**@prog16**
Data memory	**@data**
Extended data memory†	**@data16**
I/O space‡	**@io**

† Valid only when extended addressing is enabled.
‡ Valid only with the emulator.

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 ✓ PDM ✓ profiling

Description You can use the ALIAS command to define customized command strings for the debugger or for the PDM:

- ❑ The debugger version of the ALIAS command allows you to associate one or more debugger commands with a single *alias name.*
- ❑ The PDM version of the ALIAS command allows you to associate one or more PDM commands with a single alias name *or* associate one or more debugger commands with a single alias name.

You can include as many 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 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 (this restriction applies to the debugger version of the ALIAS command only).

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 ☐ PDM ☐ profiling

Description The ASM command changes from 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 ☐ PDM ☐ 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.

Breakpoints can be set in program memory (RAM) only; the *address* parameter is treated as a program-memory address.

bd — *Delete Software Breakpoint*

Syntax	**bd** *address*
Menu selection	**B**reak→ **D**elete
Environments	☑ basic debugger ☐ PDM ☐ 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. The *address* is treated as a program-memory address.

bl — *List Software Breakpoints*

Syntax	**bl**
Menu selection	**B**reak→**L**ist
Environments	☑ basic debugger ☐ PDM ☐ 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 display area of the COMMAND window. 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 ☐ PDM ☐ profiling

Description The BORDER command changes the border style of the active window, the inactive windows, and the border style of 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 identify 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 ☐ PDM ☐ profiling

Description The BR command clears all software breakpoints that are set.

c — *Enter Auto Mode*

Syntax **c**

Menu selection Mo**De**→**C** (auto)

Environments ✓ basic debugger ☐ PDM ☐ 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 ☐ PDM ☐ 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 again.

cd, chdir — *Change Directory*

Syntax

cd [*directory name*]
chdir [*directory name*]

Menu selection none

Environments ✓ basic debugger ☐ PDM ✓ 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. Note that this command can affect any other command whose parameter is a filename, such as the FILE, LOAD, and TAKE commands, when used with the USE command. You can also use the CD command to change the current drive. For example,

```
cd c:
cd d:\csource
cd c:\c2xxhll
```

cls — *Clear Screen*

Syntax **cls**

Menu selection none

Environments ✓ basic debugger ☐ PDM ✓ profiling

Description The CLS command clears all displayed information from the display area of the COMMAND window.

cnext — *Single-Step C, Next Statement*

Syntax **cnext** [*expression*]

Menu selection Next=**F10** (in C code)

Environments ✓ basic debugger ☐ PDM ☐ 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 (*Running code conditionally*, page 8-18, 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 ☐ PDM ☐ 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 areas of the display that are affected. The *attributes* identify how the areas are 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 to 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 ☐ PDM ☐ 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 (*Running code conditionally*, page 8-18, discusses this in detail).

dasm — *Display Disassembly at Specified Address*

Syntax **dasm** *address* [{**@prog** | **@data** | **@prog16** | **@data16**}]
dasm *function name*

Menu selection none

Environments ✓ basic debugger ☐ PDM ✓ profiling

Description The DASM command displays code beginning at a specific point within the DISASSEMBLY window. By default, the *address* parameter is treated as a program-memory address. However, you can follow it with one of these suffixes:

To identify . . .	Use this suffix . . .
Program memory	**@prog**
Extended program memory[†]	**@prog16**
Data memory	**@data**
Extended data memory[†]	**@data16**

[†] Valid only when extended addressing is enabled.

dir — *List Directory Contents*

Syntax **dir** [*directory name*]

Menu selection none

Environments ✓ basic debugger ☐ PDM ✓ 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 a *directory name*, the debugger lists the contents of the current directory.

You can list only files that match a specific format within a directory by using the asterisk (*) wildcard character. If the *directory name* ends in a partial filename with an asterisk, the debugger lists only the files which match the wildcard string. For example, to list every file in the home directory that has a cmd extension, you would enter:

```
dir /home/*.cmd
```

disp — *Open DISP Window*

Syntax **disp** *expression* [, *display format*]

Menu selection none

Environments ✓ basic debugger ☐ PDM ☐ profiling

Description The DISP command opens a DISP window to display the contents of an array, structure, or pointer expressions to a scalar type (of the form **pointer*). If the *expression* is not one of these types, then DISP acts like a ? command. If the *expression* identifies an address, you can follow it with one of these suffixes:

To identify . . .	Use this suffix . . .
Program memory	**@prog**
Extended program memory†	**@prog16**
Data memory	**@data**
Extended data memory†	**@data16**
I/O space‡	**@io**

† Valid only when extended addressing is enabled.
‡ Valid only with the emulator.

Without the suffix, the debugger treats an address expression as a program-memory location.

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	0x0000

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.

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. You can have up to 120 DISP windows open at the same time.

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	**o**	Octal
c	ASCII character (bytes)	**p**	Valid address
d	Decimal	**s**	ASCII string
e	Exponential floating point	**u**	Unsigned decimal
f	Decimal floating point	**x**	Hexadecimal

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 Display Window*

Syntax

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

Menu selection none

Environments ✓ basic debugger ✓ PDM ✓ profiling

Description

The DLOG command allows you to record the information displayed in the COMMAND window or in the PDM display area into a log file.

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

  dlog *filename*

  Log files can be executed with the TAKE command. When you use DLOG to record the information from the display area into a log file called *filename*, the debugger (or PDM) automatically precedes all error or progress messages and command results with a semicolon to turn them into comments. This way, you can easily reexecute 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 Display Area*

Syntax **echo** *string*

Menu selection none

Environments ✓ basic debugger ✓ PDM ✓ profiling

Description The ECHO command displays *string* in the display area of the COMMAND window or in the display area of the PDM. You can't use quote marks around the *string,* and any leading blanks in your command string are removed when the ECHO command is executed.

- ❑ You can execute the debugger version of the ECHO command only in a batch file.
- ❑ You can execute the PDM version of the ECHO command in a batch file or from the command line.

elif — *Test for Alternate Condition*

Description ELIF provides an alternative test by which you can execute PDM commands in the IF/ELIF/ELSE/ENDIF command sequence. See page 16-32 for more information about these commands.

else — *Execute Alternative Commands*

Description ELSE provides an alternative list of debugger or PDM commands in the IF/ ELSE/ENDIF or IF/ELIF/ELSE/ENDIF command sequences, respectively. See pages 16-33 and 16-32 for more information about these commands.

endif — *Terminate Conditional Sequence*

Description ENDIF identifies the end of a conditional-execution command sequence begun with an IF command. See pages 16-32 and 16-33 for more information about these commands.

endloop — *Terminate Looping Sequence*

Description ENDLOOP identifies the end of the LOOP/ENDLOOP command sequence. See pages 16-34 and 16-35 for more information about the LOOP/ENDLOOP commands.

eval — *Evaluate Expression*

Syntax

eval *expression*
e *expression*

Menu selection none

Environments ✓ basic debugger ☐ PDM ✓ profiling

Description

The EVAL command evaluates an expression like 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).

If the *expression* identifies an address, you can follow it with one of these suffixes:

To identify . . .	Use this suffix . . .
Program memory	**@prog**
Extended program memory[†]	**@prog16**
Data memory	**@data**
Extended data memory[†]	**@data16**
I/O space[‡]	**@io**

[†] Valid only when extended addressing is enabled.
[‡] Valid only with the emulator.

Without the suffix, the debugger treats an address expression as a program-memory location.

eval — *Evaluate Expression and Set to Variable*

Syntax

eval [**–g** {*group* | *processor name*}] *variable name*=*expression*[**,** *format*]

Menu selection none

Environments ☐ basic debugger ✓ PDM ☐ profiling

Description

The EVAL command evaluates an expression in a debugger and sets a variable to the result of the expression.

- The **–g** option specifies the group or processor that EVAL should be sent to. If you don't use this option, the command is sent to the default group (dgroup).
- When you send the EVAL command to more than one processor, the PDM takes the *variable name* that you supply and appends a suffix for each

processor. The suffix consists of the underscore character (_) followed by the name that you assigned the processor.

- The *expression* can be any expression that uses the symbols described in Section 2.7, *Understanding the PDM's Expression Analysis*, on page 2-17.
- When you use the optional *format* parameter, the value that the variable is set to will be in one of the following formats:

Parameter	Result	Parameter	Result
*****	Default for the data type	**o**	Octal
c	ASCII character (bytes)	**p**	Valid address
d	Decimal	**s**	ASCII string
e	Exponential floating point	**u**	Unsigned decimal
f	Decimal floating point	**x**	Hexadecimal

ext_addr — *Enable Extended Addressing*

Syntax **ext_addr** {**on** | **off**}

Menu selection none

Environments ✓ basic debugger ✓ PDM ✓ profiling

Description The EXT_ADDR ON command enables extended addressing. The EXT_ADDR OFF command disables extended addressing. You cannot enable extended addressing before you define your extened memory configuration with the EXT_ADDR_DEF command.

ext_addr_def — *Define Extended Memory Configuration*

Syntax **ext_addr_def** *map start* [{**@prog** | **@data**}], *reg addr* [{**@prog** | **@data** | **@io**}], *mask*

Menu selection none

Environments ✓ basic debugger ✓ PDM ✓ profiling

Description The EXT_ADDR_DEF command describes your extended memory system to the debugger.

- ❑ The *map start* parameter defines the beginning of the mapped memory range. By default, the *map start* parameter is treated as a program-memory address. However, you can follow it with **@prog** to identify program memory or with **@data** to identify data memory.
- ❑ The *reg addr* parameter defines the location of the memory mapped register (PMR or DMR).
  - ■ If you are defining program memory, use the address for the PMR.
  - ■ If you are defining data memory, use the address for the DMR.

  By default, the *reg addr* parameter is treated as a program-memory address. However, you can follow it with **@prog** to identify program memory, with **@data** to identify data memory, or with **@io** to identify I/O space.
- ❑ The *mask* parameter is a bit-mask that represents the size of the PMR or DMR.

file — *Display Text File*

Syntax **file** *filename*

Menu selection **L**oad→**F**ile

Environments ✓ basic debugger ☐ PDM ✓ 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 400K bytes long or less.

fill — *Fill Memory*

Syntax **fill** *address, page, length, data*

Menu selection **M**emory→**F**ill

Environments [✓] basic debugger ☐ PDM ☐ profiling

Description The FILL command fills a block of memory with a specified value.

- The *address* parameter identifies the first address in the block.
- The *page* parameter is a one-digit number that identifies the type of memory (program or data) to fill:

To save this type of memory	Use this value as the *page* parameter
Program memory	**0**
Data memory	**1**
I/O space	**2** (emulator only)

- 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.

func — *Display Function*

Syntax **func** *function name*
func *address*

Menu selection none

Environments [✓] basic debugger ☐ PDM [✓] 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; an *address* parameter is treated as a program-memory 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 ☐ PDM ☐ profiling

Description The GO command executes code up to a specific point in your program. The *address* parameter is treated as a program-memory address. If you don't supply an *address*, then GO acts like a RUN command without an *expression* parameter.

halt

Halt Target System **Emulator Only**

Syntax	**halt**
Menu selection	none
Environments	✓ basic debugger ☐ PDM ☐ profiling

Description The HALT command halts the target system after you've entered a RUNF command. When you invoke the debugger, it automatically executes a HALT command. Thus, if you enter a RUNF, quit the debugger, and later reinvoke the debugger, you will effectively reconnect the emulator to the target system and run the debugger in its normal mode of operation.

help

List PDM Commands

Syntax	**help** [*command*]
Menu selection	none
Environments	☐ basic debugger ✓ PDM ☐ profiling

Description The HELP command provides a brief description of the requested PDM command. If you omit the *command* parameter, the PDM lists all of the available PDM commands.

history

List the Last Twenty PDM Commands

Syntax	**history**
Menu selection	none
Environments	☐ basic debugger ✓ PDM ☐ profiling

Description The HISTORY command displays the last twenty PDM commands that you've entered.

if/elif/else/endif *Conditionally Execute PDM Commands*

Syntax

if *expression*
PDM commands
[**elif** *expression*
PDM commands]
[**else**
PDM commands]
endif

Menu selection none

Environments ☐ basic debugger ☑ PDM ☐ profiling

Description

These commands allow you to execute PDM commands conditionally in a batch file or from the command line.

- If the expression for the IF is nonzero, the PDM executes all commands between the IF and ELIF, ELSE, or ENDIF.
- The ELIF is optional. If the expression for the ELIF is nonzero, the PDM executes all commands between the ELIF and ELSE or ENDIF.
- The ELSE is optional. If the expressions for the IF and ELIF (if present) are false (zero), the PDM executes the commands between the ELSE and ENDIF.

The IF/ELIF/ELSE/ENDIF can be entered interactively or included in a batch file that is executed by the TAKE command. When you enter IF from the PDM command line, a question mark (?) prompts you for the next entry. The PDM continues to prompt you for input using the ? until you enter ENDIF. After you enter ENDIF, the PDM immediately executes the IF command.

If you are in the middle of interactively entering an IF statement and want to abort it, type CONTROL C.

if/else/endif

Conditionally Execute Debugger Commands

Syntax

if *expression*
debugger commands
[**else**
debugger commands]
endif

Menu selection none

Environments ✓ basic debugger ☐ PDM ✓ profiling

Description

These commands allow you to execute debugger commands conditionally in a batch file. If the *expression* if nonzero, the debugger executes the commands between the IF and the ELSE or ENDIF. Note that the ELSE portion of the command sequence is optional.

You can substitute a keyword for the expression. Keywords evaluate to true (1) or false (0). You can use the following keywords with the IF command:

- **$$EMU$$** (tests for the emulator version of the debugger)
- **$$SIM$$** (tests for the simulator version of the debugger)

The conditional commands work with the following provisions:

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

load

Load Executable Object File

Syntax **load** *object filename*

Menu selection **L**oad→ **L**oad

Environments ✓ basic debugger ☐ PDM ✓ 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. If you don't supply an extension, the debugger looks for *filename*.out. Note that the LOAD command clears the old symbol table and closes the WATCH and DISP windows.

loop/break/continue/endloop

Loop Through PDM Commands

Syntax

loop *Boolean expression*
*PDM command*s
[**break**]
[**continue**]
endloop

Menu selection none

Environments ☐ basic debugger ✓ PDM ☐ profiling

Description

The LOOP/BREAK/CONTINUE/ENDLOOP commands allow you to set up a looping situation in a batch file or from the command line. Unlike the debugger version of the LOOP/ENDLOOP commands, the PDM version of the LOOP command evaluates only Boolean expressions:

- If the *Boolean expression* evaluates to true (1), the PDM executes all commands between the LOOP and BREAK, CONTINUE, or ENDLOOP.
- If the *Boolean expression* evaluates to false (0), the loop is not entered.

The optional BREAK command allows you to exit the loop without having to reach the ENDLOOP. This is helpful when you are testing a group of processors and want to exit if an error is detected.

The CONTINUE command, which is also optional, acts as a goto and returns command flow to the enclosing LOOP command. CONTINUE is useful when the part of the loop that follows is complicated; returning to the top of the loop avoids further nesting.

The LOOP/BREAK/CONTINUE/ENDLOOP commands can be entered interactively or included in a batch file that is executed by the TAKE command. When you enter LOOP from the PDM command line, a question mark (?) prompts you for the next entry. The PDM continues to prompt you for input using the ? until you enter ENDLOOP. After you enter ENDLOOP, the PDM immediately executes the LOOP command.

If you are in the middle of interactively entering an LOOP statement and want to abort it, type CONTROL C.

loop/endloop — *Loop Through Debugger Commands*

Syntax

loop *expression*
debugger commands
endloop

Menu selection none

Environments ☑ basic debugger ☐ PDM ☑ 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 file.
- ❑ You can't nest LOOP/ENDLOOP commands within the same file.

ma — *Add Block to Memory Map*

Syntax **ma** *address, page, length, type*

Menu selection **M**emory→**A**dd

Environments ☑ basic debugger ☐ PDM ☑ profiling

Description

The MA command identifies valid ranges of target memory. Note that 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.

- ❑ The *address* parameter defines the starting address of a range in data or program memory. This parameter can be an absolute address, any C expression, the name of a C function, or an assembly language label.

- The *page* parameter is a one-digit number that identifies the type of memory (program, data, or I/O) that the range occupies:

To identify this page,	Use this value as the *page* parameter
Program memory	**0**
Data memory	**1**
I/O space	**2**

- 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	**INPORT** or **P|R**
Output port	**OUTPORT** or **P|W**
Input/output port	**IOPORT** or **P|R|W**

You can use the INPORT, OUTPORT, and IOPORT type parameters and the page 2 parameter in conjunction with the MC command to simulate I/O ports.

map — *Enable Memory Mapping*

Syntax **map** {**on** | **off**}

Menu selection **M**emory→**E**nable

Environments ☑ basic debugger ☐ PDM ☑ 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 a File* — **Simulator Only**

Syntax **mc** *port address, page, length, filename,* {**READ** | **WRITE**}

Menu selection **M**emory→**C**onnect

Environments ☑ basic debugger ☐ PDM ☐ profiling

Description

The MC command connects INPORT, OUTPORT, 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 *page* parameter is a one-digit number that identifies the page that the port occupies.

To identify this page,	Use this value as the *page* parameter
Program memory	**0**
Data memory	**1**
I/O space	**2**

- ❑ The *length* parameter defines the length of the range. This parameter can be any C expression.
- ❑ 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 IN or OUT instruction to the associated port address. Any port in I/O space can be connected 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.

md — *Delete Block From Memory Map*

Syntax **md** *address, page*

Menu selection **M**emory→**D**elete

Environments ✓ basic debugger ☐ PDM ✓ 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 program, data, or I/O 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
```

- The *page* parameter is a one-digit number that identifies the type of memory (program, data, or I/O) that the range occupies:

To identify this page,	Use this value as the *page* parameter
Program memory	**0**
Data memory	**1**
I/O space	**2**

Note:

If you want to use the MD command to remove a simulated I/O port, you must first disconnect the port with the MI command.

mem *Modify MEMORY Window Display*

Syntax **mem** *expression* [, *display format*] [, *window name*]]

Menu selection none

Environments [✓ basic debugger] ☐ PDM ☐ profiling

Description The MEM command identifies a new starting address for the block of memory displayed in the MEMORY window. The optional *window name* parameter 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.

By default, the MEMORY window displays data memory. You can display other types of memory using one of these suffixes after the *expression*:

To identify . . .	Use this suffix . . .	MEMORY window label
Program memory	**@prog**	MEMORY [PROG]
Extended program memory†	**@prog16**	MEMORY [PROG16]
Data memory	**@data**	MEMORY
Extended data memory†	**@data16**	MEMORY [DATA16]
I/O space‡	**@io**	MEMORY [IO]

† Valid only when extended addressing is enabled.
‡ Valid only with the emulator.

When you use the optional *display format* parameter, memory is displayed in one of the following formats:

Parameter	Result	Parameter	Result
*	Default for the data type	**o**	Octal
c	ASCII character (bytes)	**p**	Valid address
d	Decimal	**u**	Unsigned decimal
e	Exponential floating point	**x**	Hexadecimal
f	Decimal floating point		

mi

Disconnect I/O Port **Simulator Only**

Syntax **mi** *port address, page,* {**READ** | **WRITE**}

Menu selection **M**emory→D**i**sConn

Environments ✓ basic debugger ☐ PDM ✓ 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.
- The *page* parameter is a one-digit number that identifies the type of memory (program, data, or I/O) that the port occupies:

To identify this page,	Use this value as the *page* parameter
Program memory	**0**
Data memory	**1**
I/O space	**2**

The page parameter for the MI command must match the page parameter that was used with the MC command to connect the port.

minimal

Enter Minimal Mode

Syntax **minimal**

Menu selection Mo**D**e→Mi**N**imal

Environments ✓ basic debugger ☐ PDM ☐ profiling

Description The MINIMAL command changes from the current debugging mode to minimal mode. If you're already in minimal mode, the MINIMAL command has no effect.

mix — *Enter Mixed Mode*

Syntax	**mix**
Menu selection	Mo**D**e→**M**ixed
Environments	✓ basic debugger ☐ PDM ☐ profiling
Description	The MIX command changes from 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 ☐ PDM ✓ 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 ☐ PDM ☑ 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 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.

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 arrow keys, you *must* press ESC or ↵.

mr — *Reset Memory Map*

Syntax **mr**

Menu selection **M**emory→**R**eset

Environments ✓ basic debugger ☐ PDM ✓ 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 File*

Syntax **ms** *address, page, length, filename*

Menu selection **M**emory→**S**ave

Environments ✓ basic debugger ☐ PDM ✓ profiling

Description The MS command saves the values in a block of memory to a system file; files are saved in COFF format.

- The *address* parameter identifies the first address in the block.
- The *page* is a one-digit number that identifies the type of memory (program, data, or I/O) to save:

To save this type of memory	Use this value as the *page* parameter
Program memory	**0**
Data memory	**1**
I/O space	**2** (emulator only)

- 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.

next — *Single-Step, Next Statement*

Syntax **next** [*expression*]

Menu selection Next=**F10** (in disassembly)

Environments ✓ basic debugger ☐ PDM ☐ 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 (*Running code conditionally*, page 8-18, discusses this in detail).

patch — *Patch Assemble*

Syntax **patch** *address, assembly language instruction*

Menu selection none

Environments ✓ basic debugger ☐ PDM ☐ 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*.

pause — *Pause Execution*

Syntax **pause**

Menu selection none

Environments ✓ basic debugger ✓ PDM ☐ profiling

Description The PAUSE command allows you to pause the debugger or PDM while running a batch file or executing a flow control command. Pausing is especially helpful in debugging the commands in a batch file.

When the debugger or PDM reads this command in a batch file or during a flow control command segment, the debugger/PDM stops execution and displays the following message:

```
<< pause - type return >>
```

To continue processing, press ⏎.

pesc — *Send ESC Key to Debuggers*

Syntax **pesc** [**–g** {*group* | *processor name*}]

Menu selection none

Environments ☐ basic debugger ✓ PDM ☐ profiling

Description The PESC command sends the ESC key to an individual debugger or to a group of debuggers. PESC halts program execution, but all processors in a group don't halt at the same real time; individual processors halt in the order in which they were added to the group.

The **–g** option identifies the group or processor that the command should be sent to. If you don't use this option, the ESC key is sent to the default group (dgroup).

pf — *Profile, Full* **Simulator Only**

Syntax **pf** *starting point* [, *update rate*]

Menu selection **P**rofile→**F**ull

Environments ☑ basic debugger ☐ PDM ☑ 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 until the profiling session is halted, and the “spinning wheel” character is not displayed.

phalt — *Halt Processors in Parallel*

Syntax **phalt** [{**–g** *group* | *processor name*}]

Menu selection none

Environments ☐ basic debugger ☑ PDM ☐ profiling

Description The PHALT command halts one or more processors. If you send a PRUN or PRUNF command to a group or to an individual processor, you can use PHALT to halt the group or the individual processor. Each processor in a group is halted at the same real time. If you don’t use the **–g** option to specify a group or a processor name, the PHALT command will be sent to the default group (dgroup).

pinc — *Connect Pin* — **Simulator Only**

Syntax **pinc** *pinname, filename*

Menu selection **P**in→**C**onnect

Environments ✓ basic debugger ☐ PDM ☐ profiling

Description The PINC command connects an input file to interrupt pin.

- The *pinname* parameter identifies the interrupt pin and must be one of the five interrupt pins ($\overline{\text{INT}}$1–$\overline{\text{INT}}$4 or $\overline{\text{BIO}}$).
- The *filename* parameter is the name of your input file.

pind — *Disconnect Pin* — **Simulator Only**

Syntax **pind** *pinname*

Menu selection **P**in→**D**isconnect

Environments ✓ basic debugger ☐ PDM ☐ profiling

Description The PIND command disconnects an input file from an interrupt pin. The *pinname* parameter identifies the interrupt pin and must be one of the five interrupt pins, ($\overline{\text{INT}}$1–$\overline{\text{INT}}$4 or $\overline{\text{BIO}}$).

pinl — *List Pin* — **Simulator Only**

Syntax **pinl**

Menu selection **P**in→**L**ist

Environments ✓ basic debugger ☐ PDM ☐ profiling

Description The PINL command displays all of the pins—unconnected pins first, followed by the connected pins. For a connected pin, the simulator displays the name of the pin and the absolute pathname of the file in the COMMAND window.

pq

Profile, Quick **Simulator Only**

Syntax **pq** *starting point* [, *update rate*]

Menu selection **P**rofile→**Q**uick

Environments ☐ basic debugger ☐ PDM ✓ 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 **Simulator Only**

Syntax **pr** [*clear data* [, *update rate*]]

Menu selection **P**rofile→**R**esume

Environments ☐ basic debugger ☐ PDM ✓ 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 ☐ PDM ✓ 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).

prun — *Run Code in Parallel*

Syntax **prun** [**–r**] [**–g** {*group* | *processor name*}]

Menu selection none

Environments ☐ basic debugger ✓ PDM ☐ profiling

Description The PRUN command is the basic command for running an entire program. You enter the command from the PDM command line to begin execution at the same real time for an individual processor or a group of processors. The **–g** option identifies the group or processor that the command should be sent to. If you don't use this option, then code will run on the default group (dgroup). You can use the PHALT command to stop a global run.

The **–r** (return) option for the PRUN command determines when control returns to the PDM command line:

- **Without –r**, control is not returned to the command line until each debugger in the group finishes running code. If you want to to break out of a synchronous command and regain control of the PDM command line, press CONTROL C in the PDM window. This will return control to the PDM command line. However, no debugger executing the command will be interrupted.
- **With –r**, control is returned to the command line immediately, even if a debugger is still executing a command. You can type new commands, but the processors can't execute the commands until they finish with the current command; however, you can perform PHALT, PESC, and STAT commands when the processors are still executing.

prunf — *Run Free in Parallel*

Syntax **prunf** [**–g** {*group* | *processor name*}]

Menu selection none

Environments ☐ basic debugger ✓ PDM ☐ profiling

Description The PRUNF command starts the processors running free, which means they are disconnected from the emulator. RUNF synchronizes the debuggers to cause the processors to begin execution at the same real time. The **–g** option identifies the group or processor that the command should be sent to. If you don't use this option, then code will run on the default group (dgroup).

The PHALT command stops a PRUNF; note that the debugger automatically executes a PHALT when the debugger is invoked.

pstep — *Single-Step in Parallel*

Syntax	**pstep** [**–g** {*group* | *processor name*}] [*count*]
Menu selection	none
Environments	☐ basic debugger ☑ PDM ☐ profiling

Description

The PSTEP command single-steps synchronously through assembly language code with interrupts disabled. RUNF synchronizes the debuggers to cause the processors to begin execution at the same real time. The **–g** option identifies the group or processor that the command should be sent to. If you don't use this option, then code will run on the default group (dgroup). You can use the PHALT command to stop a global run.

You can use the *count* parameter to specify the number of statements that you want to single-step.

Note:

If the current statement that a processor is pointing to has a breakpoint, that processor will not step synchronously with the other processors when you use the PSTEP command. However, that processor will still single-step.

quit — *Exit Debugger*

Syntax	**quit**
Menu selection	none
Environments	☑ basic debugger ☑ PDM ☑ profiling

Description

The QUIT command exits the debugger and returns to the operating system. If you enter this command from the PDM, the PDM and all debuggers running under the PDM are exited.

realtime — *Switch to the Real-Time Mode*

Syntax	**realtime**
Menu selection	none
Environments	☑ basic debugger ☑ PDM ☑ profiling

Description

The REALTIME command switches the debugger from stop mode to real-time mode. When you use the REALTIME command, the debugger deletes all breakpoints that you might have set in stop mode.

Before you use the REALTIME command, you must load the real-time monitor program into target memory or embed the monitor program in your application code. For more information, see the *Switching to the real-time mode* subsection on page 1-24.

reconnect

Reset Communication With Emulator

Syntax	**reconnect**
Menu selection	none
Environments	✓ basic debugger ✓ PDM ✓ profiling

Description

The RECONNECT command reinitializes communication between the debugger and the emulator. This command can be used after an unrecoverable fatal error.

Note that any software breakpoints set before a reconnect may still reside in memory after the reconnect. However, the debugger will not recognize that the breakpoints are set. You should reload memory in order to clear out any residual breakpoints.

reload

Reload Object Code

Syntax	**reload** [*object filename*]
Menu selection	**L**oad→**R**eload
Environments	✓ basic debugger ☐ PDM ✓ 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. If you enter the RELOAD command without specifying a filename, the debugger reloads the file that you loaded last.

reset

Reset Target System

Syntax	**reset**
Menu selection	**L**oad→**R**eseT
Environments	✓ basic debugger ☐ PDM ✓ profiling

Description

The RESET command resets the target system (emulator only) or simulator and reloads the monitor. Note that this is a *software* reset.

If you are using the simulator and execute the RESET command, the simulator simulates the ’C2xx processor and peripheral reset operation, putting the processor in a known state.

restart — *Reset PC to Program Entry Point*

Syntax

restart
rest

Menu selection **L**oad→R**E**start

Environments ☑ basic debugger ☐ PDM ☑ 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 ☐ PDM ☐ 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 ESC .

run — *Run Code*

Syntax **run** [*expression*]

Menu selection Run=**F5**

Environments ☑ basic debugger ☐ PDM ☐ 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 ESC .
- If you supply a logical or relational *expression*, the run becomes conditional (*Running code conditionally*, page 8-18, discusses this in detail).
- 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.

runf — *Run Free* — **Emulator Only**

Syntax **runf**

Menu selection none

Environments ☑ basic debugger ☐ PDM ☐ profiling

Description The RUNF command disconnects the emulator from the target system while code is executing. When you enter RUNF, the debugger clears all breakpoints, disconnects the emulator from the target system, and causes the processor to begin execution at the current PC. You can quit the debugger, or you can continue to enter commands. However, any command that causes the debugger to access the target at this time produces an error.

The HALT command stops a RUNF; note that the debugger automatically executes a HALT when the debugger is invoked.

sa — *Add Stopping Point* — **Simulator Only**

Syntax **sa** *address*

Menu selection **S**top-points→**A**dd

Environments ☐ basic debugger ☐ PDM ☑ profiling

Description The SA command adds a stopping point at *address*. The *address* can be a label, a function name, or a memory address.

safehalt — *Toggle Safehalt Mode*

Syntax **safehalt** {**on** | **off**}

Menu selection none

Environments ☑ basic debugger ☑ PDM ☑ profiling

Description The SAFEHALT command places the debugger in safehalt mode. When safehalt mode is off (the default), you can halt a running target device either by pressing ESC or by cllicking a mouse button. When safehalt mode is on, you can halt a running target device only by pressing ESC; mouse clicks are ignored.

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 ☐ PDM ☐ 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 to 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 ☐ PDM ✓ 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 *filename*, the debugger looks for init.clr. The debugger searches for the specified file in the current directory and then in directories named with the D_DIR environment variable.

When you use the SCONFIG command to restore a configuration that includes multiple WATCH or MEMORY windows, the additional windows are not displayed automatically. However, when you open an additional window using the same name that you used before you saved the configuration, the debugger displays the window in the correct location.

sd — *Delete Stopping Point* **Simulator Only**

Syntax	**sd** *address*
Menu selection	**S**top-points→**D**elete
Environments	☐ basic debugger ☐ PDM ✓ profiling

Description

The SD command deletes the stopping point at *address*.

send — *Send Debugger Command to Individual Debuggers*

Syntax **send** [**–r**] [**–g** {*group* | *processor name*}] *debugger command*

Menu selection none

Environments ☐ basic debugger ☑ PDM ☐ profiling

Description

The SEND command sends any debugger command to an individual processor or to a group of processors. If the command produces a message, it will be displayed in the COMMAND window for the appropriate debugger(s) and also in the PDM window.

- The **–g** option specifies the group or processor that the debugger command should be sent to. If you don't use this option, the command is sent to the default group (dgroup).
- The **–r** (return) option determines when control returns to the PDM command line:
  - **Without –r**, control is not returned to the command line until each debugger in the group finishes running code. Any results that are printed in the COMMAND window of the individual debuggers will also be echoed in the PDM command window. These results will be displayed by processor.

    If you want to break out of a synchronous command and regain control of the PDM command line, press CONTROL C in the PDM window. This will return control to the PDM command line. However, no debugger executing the command will be interrupted.
  - **With –r**, control is returned to the command line immediately, even if a debugger is still executing a command. When you use –r, you *do not* see the results of the commands that the debuggers are executing.

set — *Set a Variable to a String*

Syntax

set [*group name* [= *list of processor names*]]
set [*variable* [= *string value*]]

Menu selection none

Environments ☐ basic debugger ✓ PDM ☐ profiling

Description

The SET command allows you to create groups of processors to which you can send commands. With the SET command you can:

- **Define a group of processors.** It is useful to define a group when you plan to send commands to the same set of processors. The commands are sent to the processors in the same order in which you added the processors to the group. To define a group, specify a *group name* and then list the processors you want in the group.
- **Set the default group.** Defining a default group provides you with a shorthand method of maintaining members in a group or of sending commands to the same group. To set up the default group, use the SET command with a special *group name* called dgroup.
- **Modify an existing group or creating a group based on another group.** Once you've created a group, you can add processors to it by using the SET command and preceding the existing *group name* with a dollar sign ($) in the list of processors. You can also use a group as part of another group by preceding the existing group's name with a dollar sign. The dollar sign tells the PDM to use the processors listed previously in the group as part of the new list of processors.
- **List all groups of processors.** You can use the SET command without any parameters to list all the processors that belong to a group, in the order in which they were added to the group.

You can also use the SET command with system-defined variables to:

- **Change the prompt for the PDM.** To change the PDM prompt, use the SET command with the system variable called prompt. For example, to change the PDM prompt to 3PROCs, enter:

```
set prompt = 3PROCs ↵
```

- **Check the execution status of the processors.** In addition to displaying the execution status of a processor or group of processors, the STAT command (described on page 16-62) sets a system variable called status. If *all* of the processors in the specified group are running, the status variable is set to 1. If one or more of the processors in the group is halted, the status variable is set to 0.

  You can use this variable when you want an instruction loop to execute until a processor halts (the LOOP/ENDLOOP command is described on page 16-34):

- **Create your own system variables.** You can use the SET command to create your own system variables that you can use with PDM commands. For more information about creating your own system variables, see page 2-18.

setf — *Set Default Data-Display Format*

Syntax **setf** [*data type*, *display format*]

Menu selection none

Environments ☑ basic debugger ☐ PDM ☐ 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	short	uint	ulong	double
uchar	int	long	float	ptr

- The *display format* parameter can be any of the following characters:

Parameter	Result	Parameter	Result
*****	Default for the data type	**o**	Octal
c	ASCII character (bytes)	**p**	Valid address
d	Decimal	**s**	ASCII string
e	Exponential floating point	**u**	Unsigned decimal
f	Decimal floating point	**x**	Hexadecimal

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 Type	Valid Display Formats									**Data Type**	Valid Display Formats								
	c	**d**	**o**	**x**	**e**	**f**	**p**	**s**	**u**		**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 ☐ PDM ☑ 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 (see *Zooming a window* on page 4-24).

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 arrow keys, you *must* press ESC or ↵.

sl

List Stopping Point **Simulator Only**

Syntax **sl**

Menu selection **S**top-points→**L**ist

Environments ☐ basic debugger ☐ PDM ☑ 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 ☐ PDM ☑ 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 ☐ PDM ☐ 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.

spawn — *Invoke the 'C2xx Debugger*

Syntax **spawn** **emu2xx** **–n** *processor name* [*invocation options*]

Menu selection none

Environments ☐ basic debugger ✓ PDM ☐ profiling

Description You must invoke a debugger for each processor that you want the PDM to control. To invoke a debugger, use the SPAWN command.

- **emu2xx** is the executable that invokes the debugger. Note that **emu2xx** refers to the emu2xx, emu2xxo, emu2xxw, and emu2xxwm executables.

  The PDM associates the *processor name* with the actual processor according to which executable you use. In order to invoke a debugger, the PDM must be able to find the executable file for that debugger. The PDM will first search the current directory and then search the directories listed with the PATH statement.

- **–n** *processor name* supplies a processor name. You *must* use the –n option since the PDM uses processor names to identify the various debuggers that are running. The processor name can consist of up to eight alphanumeric or underscore characters and must begin with an alphabetic character. Note that the name is not case sensitive. The processor name must match one of the names defined in your board configuration file (see Appendix B, *Describing Your Target System to the Debugger*).

sr — *Reset Stopping Point* **Simulator Only**

Syntax **sr**

Menu selection **S**top-points→**R**eset

Environments ☐ basic debugger ☐ PDM ✓ 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 ☐ PDM ☐ 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 SSAVE command also saves the location of multiple WATCH and MEMORY windows.

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.

stat — *Find the Execution Status of Processors*

Syntax **stat** [{**–g** *group* | *processor name*}]

Menu selection none

Environments ☐ basic debugger [✓] PDM ☐ profiling

Description The STAT command tells you whether a processor is running or halted. If a processor is halted when you execute this command, then the PDM also lists the current PC value for that processor. If you don't use the **–g** option, the PDM displays the status of the processors in the default group (dgroup).

step — *Single-Step*

Syntax	**step** [*expression*]
Menu selection	Step=**F8** (in disassembly)
Environments	☑ basic debugger ☐ PDM ☐ 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 (*Running code conditionally*, page 8-18, discusses this in detail).

stopmode — *Switch to the Stop Mode*

Syntax	**stopmode**
Menu selection	none
Environments	☑ basic debugger ☑ PDM ☑ profiling

Description

The STOPMODE command switches the debugger from real-time mode to stop mode. When you use the STOPMODE command, the debugger deletes all breakpoints that you might have set in real-time mode.

system — *Enter Operating-System Command*

Syntax	**system** *operating-system command*
Menu selection	none
Environments	☐ basic debugger ☑ PDM ☐ profiling

Description

The SYSTEM command allows you to enter a single operating-system command without explicitly exiting the PDM environment.

take — *Execute Batch File*

Syntax

Basic debugger:	**take**	*batch filename*	[*, suppress echo flag*]
PDM:	**take**	*batch filename*	

Menu selection none

Environments ✓ basic debugger ✓ PDM ✓ profiling

Description

The TAKE command tells the debugger or the PDM to read and execute commands from a batch file. The *batch filename* parameter identifies the file that contains commands. If you don't supply a pathname as part of the filename, the PDM first looks in the current directory and then searches directories named with the D_DIR environment variable.

The *batch filename* for the PDM version of this command must have a .pdm extension, or the PDM will not be able to read the file. In addition, the batch file that the PDM reads can contain only PDM commands.

By default, the debugger echoes the commands to the display area of the COMMAND window and updates the display as it reads the commands from the batch file. For the debugger, you can change this behavior:

- 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 ✓ PDM ✓ 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.

unset — *Delete Group*

Syntax

unset *group name*
unset *****

Menu selection

none

Environments

☐ basic debugger ☑ PDM ☐ profiling

Description

The UNSET command deletes a group of processors. You can use this command in conjunction with the SET command to remove a particular processor from a group.

To delete all groups, enter an asterisk instead of a group name:

```
unset * ⏎
```

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

Note:

When you use UNSET * to delete all of your system variables and processor groups, variables such as prompt, status, and dgroup are also deleted.

update — *Control*

Syntax

update [{**off** | **wa** | **all** | *value*}]

Menu selection

Environments

☑ basic debugger ☑ PDM ☐ profiling

Description

The UPDATE command

To . . .	Use this command . . .
Update the values in all windows (one time)	**update**
Update the values in all windows as the values change	**update all**
Update the values in the WATCH window as the values change	**update wa**
Set the update period (*value* can be in tenths of a second)	**update** *value*
Disable the periodic update of windows	**update off**

use — *Use New Directory*

Syntax **use** [*directory name*]

Menu selection none

Environments ✓ basic debugger ☐ PDM ✓ profiling

Description The USE command allows you to name an additional directory that the debugger can search when looking for source files. You can specify only one directory at a time.

If you enter the USE command without specifying a directory name, the debugger lists all of the current directories.

vaa — *Save All Profile Data to a File* **Simulator Only**

Syntax **vaa** *filename*

Menu selection **V**iew→S**a**ve→**A**ll views

Environments ☐ basic debugger ☐ PDM ✓ 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* **Simulator Only**

Syntax **vac** *filename*

Menu selection **V**iew→S**a**ve→**C**urrent view

Environments ☐ basic debugger ☐ PDM ✓ 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.

version — *Display the Current Debugger Version*

Syntax **version**

Menu selection none

Environments ✓ basic debugger ☐ PDM ✓ profiling

Description The VERSION command displays the debugger's copyright date and the current version number of the debugger, silicon, XDS, etc.

vr — *Reset PROFILE Window Display* **Simulator Only**

Syntax **vr**

Menu selection **V**iew→**R**eset

Environments ☐ basic debugger ☐ PDM ☑ profiling

Description The VR command resets the display in the PROFILE window so that all marked areas are listed and statistics are displayed with default labels and in the default sort order.

wa — *Add Item to WATCH Window*

Syntax **wa** *expression* [, [*label*] [, [*display format*] [, *window name*]]]

Menu selection **W**atch→**A**dd

Environments ☑ basic debugger ☐ PDM ☐ 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. If the *expression* identifies an address, you can follow it with one of these suffixes:

To identify . . .	Use this suffix . . .
Program memory	**@prog**
Extended program memory†	**@prog16**
Data memory	**@data**
Extended data memory†	**@data16**
I/O space‡	**@io**

† Valid only when extended addressing is enabled.
‡ Valid only with the emulator.

Without the suffix, the debugger treats an address expression as a program-memory location.

WA is most useful for watching an expression whose value changes over time; constant expressions serve 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	**o**	Octal
c	ASCII character (bytes)	**p**	Valid address
d	Decimal	**s**	ASCII string
e	Exponential floating point	**u**	Unsigned decimal
f	Decimal floating point	**x**	Hexadecimal

If you want to use a *display format* parameter without a *label* parameter, just insert an extra comma. For example:

```
wa PC,,d ⏎
```

You can open additional WATCH windows by using the *window name* parameter. When you open an additional WATCH window, the debugger appends the *window name* to the WATCH window label. You can create as many WATCH windows as you need.

If you omit the *window name* parameter, the debugger displays the expression in the default WATCH window (labeled WATCH).

wd — *Delete Item From WATCH Window*

Syntax **wd** *index number* [, *window name*]

Menu selection **W**atch→**D**elete

Environments ☑ basic debugger ☐ PDM ☐ 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. The optional *window name* parameter is used to specify a particular WATCH window.

whatis — *Find Data Type*

Syntax **whatis** *symbol*

Menu selection none

Environments ✓ basic debugger ☐ PDM ☐ profiling

Description The WHATIS command shows the data type of *symbol* 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.

win — *Select Active Window*

Syntax **win** *WINDOW NAME*

Menu selection none

Environments ✓ basic debugger ☐ PDM ✓ 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 to specify only enough letters to identify the window.

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.

wr — *Close WATCH Window*

Syntax **wr** [{***** | *window name*}]

Menu selection **W**atch→**R**eset

Environments ✓ basic debugger ☐ PDM ☐ profiling

Description The WR command deletes all items from a WATCH window and closes the window.

- To close the default WATCH window, enter:

```
wr ↵
```

- ❑ To close one of the additional WATCH windows, use this syntax:

  wr *windowname*

- ❑ To close all WATCH windows, enter:

  ```
  wr * ⏎
  ```

zoom — *Zoom Active Window*

Syntax **zoom**

Menu selection none

Environments ☑ basic debugger ☐ PDM ☑ 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.

5.4 Summary of Profiling Commands (Simulator Only)

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 them in batch files.

Table 5–1. 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 5–2. 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**

Table 5–2. Disabling Marked Areas (Continued)

To disable this area	C only	Disassembly only	C *and* disassembly
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 5–3. 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 5–4. 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 5–5. 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**

5.5 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
Move back over text without erasing characters	CONTROL H or BACK SPACE
Move forward through text without erasing characters	CONTROL 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: $\begin{tikzcd} \text{auto} \arrow[r] & \text{assembly} \arrow[r] & \text{mixed} \arrow[ll, bend left] \end{tikzcd}$	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	ESC
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	

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 command without an *expression* parameter)	F8
Single-step code from the current PC; step over function calls (equivalent to the NEXT command 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, WATCH, DISP, or additional MEMORY 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 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 eight characters at a time ❑ *Other windows:* Move the field cursor left one 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 eight characters at a time ❑ *Other windows:* Move the field cursor right one 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	CONTROL PAGE UP
DISP windows only: Scroll down through an array of structures	CONTROL 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 these function keys
FILE or DISASSEMBLY window: Set or clear a breakpoint	F9
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	

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