gdb960 User's Manual

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1 The gdb960 Debugger

This manual tells you how to use the gdb960 debugger in Microsoft Windows* 95/Windows NT* and UNIX*. gdb960 is a source-level symbolic debugger that helps you find problems in your application code. When used with a target platform (such as a Cyclone evaluation platform) and monitor software running in the target (e.g., MON960) gdb960 lets you:

- Run your program with any command line arguments.
- Stop and restart your program at specified locations and conditions.
- Examine the internal state of your program when execution has stopped.
- Change the values in your program so that you can experiment with corrections and continue debugging without re-invoking the program.

This chapter provides the following information:

- A list of features and benefits of the gdb960 software debugger.
- A description of the new features in gdb960.
- Information about this manual including chapter and appendix descriptions and notational conventions.
- Instructions on how to access the online help systems that are provided with gdb960.

gdb960 Features and Benefits

- Graphical and command line user interfaces. With gdb960v provides a windowed environment where you can access almost all of gdb960's command line features (listed below).

- Source-level debugging. You can set and display breakpoints directly in source code, browse through program modules, and examine the procedure call chain.
- Watch expressions. You can select specific program variables to display, and you can watch the values of these variables change as you step through your program.
- Breakpoints. You can define a breakpoint at a function name, source-code line, an assembly instruction, an execution address, or (on the i960® Cx, Jx, Hx, and Rx processors) a data address.
- Stepping. You can execute your program as single assembly-language steps, high-level-language statement steps, or high-level-language procedure call or return steps.
- Register access. You can examine and modify the processor registers.
- Memory access. You can display and modify memory and system tables. You can also display and assemble code in memory as assembler mnemonics.
- Symbolic support. You can use symbols to debug all programs written in the C language. You can also display and modify program memory using program symbols.
- Downloading. You can download i960 processor ELF/DWARF, Common Object File Format (COFF) files, or b.out files.
- Release 6.0 includes support for source-level debugging of C++ code. This feature is available in both the command line and GUI versions of the debugger. Debugging is supported only with ELF/DWARF Common Object File Format.

What's New in gdb960?

- 64-bit Integer Support: The debugger now dispalys long long int types and dispalys long long values in all standard formats including signed and unsigned decimal, octal, and hex.
- JTAG Emulation Support: This version of gdb960 adds JTAG interface support. The debugger connects to the Spectrum Digital Incorporated's SPI610* JTAG scanner. The SPI610 is also known as a scan path interface adapter or pod.

About this Manual

Contents

This guide includes the following chapters and appendices:

Table 1-1 Chapter Summaries

Chapter	Description
1. The gdb960 Debugger	This chapter.
2. Running gdb960	Provides setup instructions and invocation procedures for all three gdb960 interfaces.
3. Using the gdb960v Windows Graphical User Interface	Tells you how to use all features of the Windows 95/NT GUI.
4. Using the gdb960 UNIX Graphical User Interface	Tells you how to use all features of the UNIX GUI.
5. Configuring the gdb960 Environment	Describes the basic commands for configuring the gdb960 environment, including commands for specifying files and directories.
6. Example gdb960 Session	Provides an example session of the gdb960 Software Debugger.
7. Running Your Program with gdb960	Describes how to run programs from the gdb960 debugger, including: • specifying arguments for your program • setting the working directory for gdb960 • setting the environment for gdb960
8. Program Execution Control	Describes the features of gdb960 that let you halt, examine, and restart your program.

continued ☛

Table 1-1 Chapter Summaries (continued)

Chapter	Description
9. Examining the Program Stack	Provides information about manipulating stack frames, selecting frames, creating traces, and extracting information from selected frames.
10. Examining Source Files	Describes commands and techniques that allow you to display specified pieces of source files.
11. Displaying Program Data and Symbols	Contains information about examining data through expressions, variables, and artificial arrays. This chapter also presents information about accessing the value history, using convenience variables, and accessing registers.
12. gdb960 Command and Option Reference	Provides a list of the gdb960 command line options and commands, along with common HDIL invocation options.
13. Storing Commands	Tells you how to define custom commands, create command files to execute commands sequences automatically, and control gdb960's output.

Table 1-2 Appendix Summaries

Appendix	Description
A. Using gdb960 Under GNU Emacs	Describes setting up gdb960 in Emacs and using Emacs commands with gdb960.
B. Command Line Editing	Describes GNU's command line editing and provides some examples of its use.
C. GNU History Library	Describes the GNU history library, a programming tool that provides a consistent user interface for recalling lines of typed input.
D. Using gdb960 with ApLink	Tells you how to use the debugger with the ApLink debug probe.

Audience

To use this product, you must be familiar with your host operating system, the i960 processor architecture, and the i960 processor program development tools (CTOOLS). See the list of related publications listed in *Getting Started with the i960® Processor Development Tools* for more information on the i960 processor. This manual assumes that you know techniques for writing and debugging software.

Notational Conventions

The following notational and terminology conventions are used throughout this manual:

debugger, debug tool	refers to the gdb960 software debugger.
i960 Cx processor	refers generically to the i960 CA and CF processors.
i960 Hx processor	refers to the i960 HA, HD, and HT processors.
i960 Jx processor	refers to the i960 JA, JF, JD, and JT processors.
i960 Kx processor	refers generically to the i960 KA, KB, SA, and SB processors.
i960 Rx processor	refers generically to the i960 RD, RP, RM and RN processors.
target processor	refers to the i960 processor on the target board. This processor can be an i960 Sx, Kx, Cx, Jx, Hx, or Rx processor.
`This type style`	indicates an element of syntax, a reserved word, a keyword, a filename, computer output, or part of a program example. The text appears in lowercase unless uppercase is significant. `l` is lowercase letter L in examples. `1` is the number 1 in examples.

	`O` is the uppercase O in examples. `0` is the number 0 in examples.
`This type style`	indicates the exact characters you type as input in examples.
`This type style`	indicates a place holder for an identifier, an expression, a string, a symbol, or a value. Substitute one of these items for the place holder.
`[]`	means the syntactic symbols enclosed by the braces are optional.
`{}`	means you must select one, and only one, of the syntactic symbols enclosed in the braces.
`|`	means exclusive or. Select only one of the syntactic items on opposite sides of the bar.
`&`	means and. In syntax specification (except when used in a C/C++ expression as a unary operator), shows that symbols on both sides of the `&` must appear together.

UNIX and Windows Command Line Differences

Most examples in this manual show a UNIX command line. Unless otherwise specified, examples work in both UNIX and Windows 95/NT environments. In Windows you can precede optional arguments with either a `-` or `/`; however, you must use a backslash (\) in directory pathnames.

Related Publications

This manual contains the information needed to use the debugger. The publications list in *Getting Started with the i960® Processor Development Tools* provides the order numbers and brief descriptions of related manuals and books. For information on ordering these and other Intel publications, contact your local Intel sales office or write to the Intel Corporation

Literature Sales, P.O. Box 5937, Denver, CO 80217-9808 or call 1-800-548-4725.

Online Help

All three gdb960 interfaces (Windows GUI, UNIX GUI, and Windows/UNIX command line) provide online help.

In Windows 95/NT, reference information is available to you anytime by pressing **F1** in any window, or by opening the Help menu and choosing any of the help options listed there. Using the **F1** key provides you with context-sensitive information about the current active window.

The UNIX help system is HTML-based and can be viewed with any web browser such as Mosaic* or Netscape*. To view the file, simply open the file `wingdb960.htm` with your web browser. At installation this file is placed the in directory `[$G960BASE/$i960BASE]/html/tools/`.

When running gdb960 from the command line, use the `help` command as described in Chapter 5. This allows you to access reference information about specific gdb960 commands.

Contacting Intel Support Services

If you need service or assistance with the debugger, refer to *Getting Started with the i960® Processor Development Tools.*

Getting Started 2

This chapter provides information on setting up your target platform and host PC to use with gdb960. In this chapter you:

- Set up your target board
- Learn about MON960, the onboard monitor software that gdb960 uses to communicate with your evaluation board.
- Learn about recompiling your software for debugging.
- Learn how to start gdb960's Windows, UNIX, and command line interfaces

For some operations, you may need to refer to your target board manual, the *MON960 Debug Monitor User's Guide,* and the *i960® Processor Compiler User's Guide*.

Setting Up Your Target Board

To run your software, you must have a target board connected to the host computer. Target boards such as the Cyclone evaluation platform support communications via serial port, parallel port, or PCI bus. Using mondb and gdb960, you can create a TCP/IP link to a target board connected to another computer. The table below shows the host requirements for using each type of communication:

Communication Media	Resource(s) Required
Serial Communication	• One available serial port
Serial Communication /Parallel Download	• One available serial port • One available parallel port
PCI Communication/ Download (fastest)	• One available full length PCI slot
TCP/IP Connection	• Target board connected to host PC (server) via serial, serial/parallel, or PCI link. • Server running mondb using the `-srv` *`host_name port`* option. • Client running gdb960 using the `-tcp` *`host_name port`* option. • Network connection. • TCP/IP software running on both server and client.

If your PC host and target support PCI communication, you will probably want to take advantage of the superior host-to-target transfer speeds that PCI communication provides. See the *MON960 Debug Monitor User's Guide* for a list of i960 evaluation boards that support PCI communication. For information on setting up the TCP/IP link see "TCI/IP Communication" on page 2-3.

Refer to your target board documentation for steps on connecting the board to your host system.

Using the MON960 Debug Monitor with gdb960

The MON960 debug monitor software is resident in ROM or Flash on all evaluation boards provided by Intel. This software allows a debugger such as gdb960 to communicate with the evaluation board, and view and modify memory. If you are using a Cyclone evaluation board, you probably do not

need to install the files from the MON960 installation media, since the software in your evaluation board is sufficient for all gdb960 debugging features.

If, however, you need to update the version of MON960 in your evaluation board or want to retarget MON960 for a custom board, you must install the MON960 software to the host. The MON960 installation media includes ROM images (hex files) for all currently supported target boards and source code. MON960 also ships with its source code, so you can modify MON960 to support custom boards. For more information, refer to the *MON960 Debug Monitor User's Guide*.

Because MON960 is a separate product from CTOOLS, versions of MON960 may be released between releases of CTOOLS. Dependencies between versions of MON960 and versions of the tools are described in the release notes. For details on versions and dependencies, refer to the release notes and the *MON960 Debug Monitor User's Guide*.

Updated versions of MON960 are available free on the Intel World-Wide Web server at:

`http://www.intel.com`

TCP/IP Communication

gdb960 supports a operation client mode using the TCP Internet Protocols (AF_INET, SOCK_STREAM) to establish the connection. The operation of gdb960 in client mode is completely transparent to the user with the exception of the command line options required. The server must have a target i960 board installed and be ready for communication via serial or PCI connection prior to starting the client.

The gdb960 TCP/IP client communication software is implemented as a standard driver that is part of the HDILCOMM library. Both client and server systems must have standard TCP/IP communication software installed in order for gdb960 to function in TCP/IP mode.

The client HDILCOMM packets, which are normally sent directly to the target board via SERIAL or PCI connection, are encapsulated into standard TCP/IP packets and sent to the server where they are extracted and forwarded to the target board via serial or PCI connection. Response HDILCOMM packets from the target board are received by the server, encapsulated into standard TCP/IP packets, and sent to the client for processing.

Hardware Requirements

- PC or UNIX workstation for client operation.
- PC or UNIX workstation for server operation.
- i960 processor evaluation board installed on the server machine.
- Network connection between client and server.

Software Requirements

- TCP/IP software installed on both client and server.

Server Semantics

Invoke the mondb executable with the `-srv` option and one of the standard target board communication options (serial or PCI). The `-srv` option must be immediately followed by two arguments. The first argument is the name of the server machine that directly corresponds to that machine's IP address. The second argument is the server port number that is used to establish the client/server connection. Note that selecting a port number is left to the operator, there is no standard port reserved for this type of connection. For example:

```
mondb -pci -srv  computerXYZ.company.com  1234
```

Client Semantics

Invoke gdb960 executable with the `-tcp` option. Place the same two arguments that were used to invoke the server immediately after the `-tcp` option. The first argument being the machine name of the server and the

second being the port number to be used for establishing the connection. For example:

```
gdb960 -tcp  computerXYZ.company.com  1234
```

JTAG Emulation Support

This version of gdb960 adds JTAG interface support. The debugger connects to the Spectrum Digital Incorporated's SPI610* JTAG scanner. The SPI610 is also known as a scan path interface adapter or pod. The JTAG interface is supported on Windows 95, NT4.0, IBM RS6000*, Sun Solaris*, and Hewlett Packard HP700*. The JTAG interface requires:

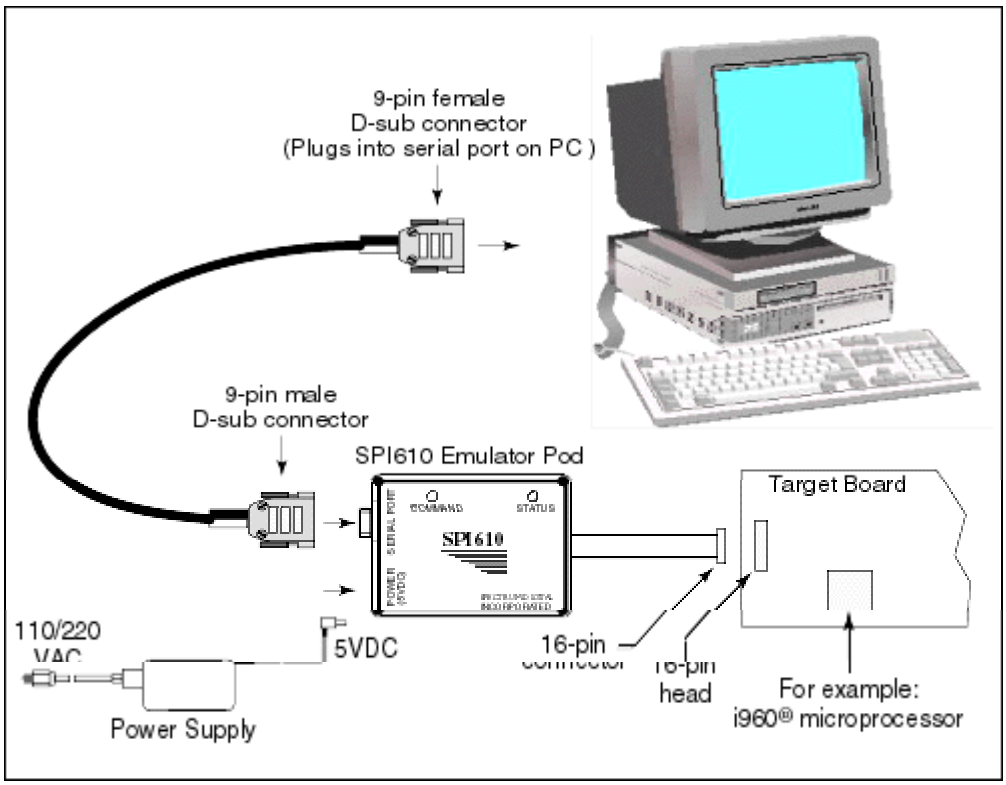
- Spectrum Digitals Incorporated SPI610 JTAG scanner. Spectrum Digital, Inc. web site is http://www.spectrumdigital.com/
- Control code file, spi610.gdb for the scanner. This file is provided by Spectrum Digital Incorporated. Their installation program will install the file in the same directory as gdb960 (i.e. $G960BASE/bin or $I960BASE/bin). Alternatively, the file can be saved in the current working directory as from which gdb960 was invoked.
- mon960 version 3.3.0 or later. hdil and hdilcomm libraries have considerable modifications and new files to allow the JTAG extension.
- IQ80960JT100(little endian mode only), IQ80960RP, IQ80960RPLV, IQ80960RD, IQ80960RM, IQ80960RN evaluation platforms, or your own platform with one of the equvalent processors, a JTAG connector, and a JTAG minimum version of mon960 ported to your system.

Connecting the SPI610 to Your Target System

Figure 1 shows how you connect the SPI610 Emulator Pod and 16 conductor ribbon cable (tail) to your target system. In most cases, the target system will be a 'CYCLONE' PCI board in another chassis, or a target board of your own design. The target system must have a mating 16 pin (8x2 double row header) connector.

Target Cable Connectors

Figure 1: Connecting the SP1610 to your Target System



NOTE. *Be very careful with the target cable connectors. Connect them gently. Do not force them into position or you may damage the connectors. Do not connect or disconnect the 16-pin cable while the target system is powered up. Prior to connecting the emulator pod to the target, remove power from the target or turn the target system off.*

Connect one end of the supplied cable to the serial port that you intend to use. Connect the other end of the cable to the 9 pin connector on the SPI610 emulator pod.

The SPI610 should be powered by the power supply provided with the SPI610.

JTAG Header Pin Definitions

The SPI610 JTAG Emulator interfaces to a 2x8 double row header on the target board. The signals of this connector are defined in Table 1.

Table 1: JTAG Pin Definitions

Pin #	Signal	Pin #	Signal
1	TRST#	9	GND
2	TDI	10	GND
3	TDO	11	GND
4	TMS	12	GND
5	TCK	13	GND
6	LCDINIT#	14	GND
7	I_RST#	15	GND
8	PWRVLD	16	GND

Signal descriptions can be found in the i960® RM/RN I/O Processor Developer's Manual, 80960RM I/O Processor Data Sheet and the 80960RN I/O Processor Data Sheet.

Running gdb960 with JTAG

gdb960

To invoke the JTAG interface from the command line, use the following syntax:

```
gdb960 -jtag port [myfile] [-b baud]
```

where port is the rs232 *port myfile* is the application to be debugged, and *baud* is a specific baud rate. For example on NT4.0:

```
gdb960 -jtag com1 myapp -b 57600
```

and on a RS6000:

```
gdb960 -jtag tty0 myapp
```

The JTAG interface can also be invoked while running gdb960 using the *target* command. On Windows 95 the command would be:

```
target mon960 -jtag com1
```

Once connected through JTAG, the *info target* command can be used to obtain additional connection information and JTAG version numbers.

gdb960v

The GUI version of gdb960 has the same requirements as gdb960. gdb960w and the crosswind.tcl file must be updated to version 6.1.0 or later. Inside the GUI, the Target dialog box adds a new JTAG selection. Choosing JTAG, will invoke a JTAG communication port selection dialog box. This dialog box will allow selecting the JTAG serial port and the baud rate to use. Giving the *ok* to this dialog box will begin the JTAG connection process. If connection is completed, then a connection status will be displayed, otherwise, a error message box will be posted. From the command line window, the *info target* command provides additional connection information.

Compiling for Debugging

To debug a program effectively, you need to recompile your code to include debug information. This information is stored in the object file, and describes the data type of each variable or function and the correlation between source line numbers and addresses in the executable code.

To include debugging information, specify the `-g` option when you invoke the compiler (gcc960 or ic960). For example, the commands:

```
gcc960 -g -ACA t1.c
ic960 -g -ACA t1.c
```

tell the compiler to compile the file `t1.c` for use with the i960 CA architecture and to include debugging information.

You can use the `-g` option with or without `-O`*n* (capital "Oh"), where *n* is an optimization level, making it possible to debug optimized code. Note, however, that some debugging operations do not work as well with `-g -O`*n* as with just `-g`. Many optimizations can make debugging optimized code more difficult. In particular, source line information in the program may be incorrect, which can cause confusion while debugging. Also, variables that exist in your source programs may not exist at run-time, or their values may not be current. These difficulties appear most often at higher levels of optimization.

You can reduce problems caused by compiler optimizations greatly by compiling with ELF/DWARF object module format whenever possible. (Use the `-Felf` compiler option.) The ELF/DWARF debug data is specifically enriched to aide debugging of highly optimized code. If problems persist, disable optimization features and compile with `-g` only.

For more information on compiler options, refer to the *i960® Processor Compiler User's Guide*.

Starting gdb960

Starting the gdb960 Windows Graphical User Interface

You can start the debugging session by double-clicking the icon that was installed into your gdb960 program group during CTOOLS installation. The installation also sets the proper environment variables for you.

When the debugger is running, you can interact with it through the editor window, through the Debugger command window, and through the Debug menu and toolbar. See Chapter 3 for details.

Starting the gdb960 UNIX Graphical User Interface

To start the gdb960 UNIX GUI, use the syntax:

```
gdb960v [options]
```

where `options` is any of the options allowed by the gdb960 command line interface (see Chapter 12 for more information). For example, in Bourne shell you might enter:

```
$G960BASE/bin/gdb960v -r /dev/tty0 myprogram
```

You can also use `-d` display option, which allows you to explicitly set the X terminal type used for the display. For example:

```
gdb960v -r /dev/tty0 -d system.company.com:0.0 myprogram
```

selects the X DISPLAY as the console of `system.company.com`. If no `-d` option is given, the debugger uses the current setting of the DISPLAY environment variable. If it is not set, the debugger issues a fatal error.

When the debugger is running, you are ready to load an executable's symbols and begin debugging. See Chapter 4 for details.

Starting the Command Line Interface

You can invoke gdb960's command line interface from a Windows command prompt box, a UNIX command line, an Emacs command line, or with a batch command file executed from a Windows or UNIX command line. Once started, gdb960 interactively reads commands from standard input until you exit the debugger by entering the `quit` command.

NOTE. *Unless otherwise specified, command line options in examples are presented using the UNIX* `-x` *option specification syntax. Either the* `-x` *syntax or the* `/x` *syntax is allowable on Windows systems. Command line options apply to both the GUI and the command line versions of gdb960.*

The command name for invoking the debugger is `gdb960`. Enter `gdb960` along with associated options to start an interactive debugging session.

The following invocation example starts the gdb960 software debugger and establishes communication with a MON960 debug monitor connected to `tty` *`X`* running at the default baud rate (38400 bps). The debugger reads symbols from the file *`program`*, then downloads *`program`* to the MON960 debug monitor:

`gdb960 -r` *`port`* [*`program`*]

- for example, to specify a serial port on a host and load the program with symbols for the executable `myprogram`, you would enter the command in Windows and UNIX:

  `gdb960 -r com2 myprogram` (Windows Host)

  `gdb960 -r /dev/tty0 myprogram` (UNIX Host)

- To specify serial communication and parallel download

  `gdb960 -r com2 -par lpt1 myprogram` (Windows Host)

  `gdb960 -r /dev/tty0 -par /dev/bpp0 myprogram` (UNIX Host)

- For PCI communication:

gdb960 -pci myprogram (Windows Host)

- For TCP/IP communication on the server:

  mondb -pci -srv computerXYZ.company.com 1234 (Windows/UNIX)

  For TCP/IP communication on the client:

  gdb960 -tcp computerXYZ.company.com 1234 (Windows/UNIX)

Changing Your Target Settings After Starting gdb960

After you have run gdb960, you can change your target communications settings using the `target` command at the gdb960 prompt:

```
gdb960 executable
(gdb960) target mon960 port [ hdil arguments ]
```

The following is a list of command line options and their descriptions:

`r` *`port`*
: Specify the serial port name of a serial interface to use to connect to the target system. If no target type is set using the `-t` option or `target` command, the debugger assumes that MON960 is the target monitor.

  You can specify *`port`* as any of:

  - a full pathname (e.g., `-r /dev/ttya`)
  - a device name in `/dev` (e.g., `-r ttya`)
  - the unique suffix for a specific `tty` (e.g., `-r a`)

`t mon960`
: Use MON960 as the target type. This is the default target type.

`b` *`bps`*
: Set the line speed, baud rate or bps of the serial interface to the target system. MON960 supports baud rates of 1200, 2400, 9600, 19200, and 38400 bps (the default) on UNIX hosts; some of these may not be available on every host. The

	additional, unsupported, baud rates 57600 and 115200 may work on some hosts.
`brk`	Send a break (of about 1/4 second in duration) to the target system after opening the connection but before trying to communicate. If the target board is equipped with a break-triggered reset circuit, this allows you to connect to a running system.
`par` *`device`*	Use parallel download instead of serial download. Use parallel device, *`device`*, for downloading (typically LPT1 or LPT2 on Windows, varies on UNIX). The parallel device is used only for downloading. Other host/target communications use the serial port specified with `-r` or the PCI target specified with `-pci`. For more information about UNIX parallel download from gdb960, refer to Appendix F in this guide.
`pci`	Selects a target connected to the host's PCI bus (if available).
`pcib` *`bus_no dev_no func_no`*	Selects a target connected to the host's PCI bus (if available). This option selects the target using an absolute PCI bus address. All arguments are specified in hex.
`pciv` *`vendor_id device_id`*	Selects a target connected to the host's PCI bus (if available). This option selects the target using using an algorithm that searches for the first available PCI device that matches the specified PCI vendor and device ID. All arguments are specified in hex.

`pcic {io | mmap}` Configures PCI communications. By default, gdb960 always attempts to communicate with a PCI device via I/O space. This option permits the user to explicitly specify the interface.

- `io` Communicate via I/O space (i.e., use in/out instructions to access the PCI device).
- `mmap` Communicate via memory-mapped access.

`-tcp` *`hostname port`* Connect via TCP/IP link to target board connected to server *`hostname`*. *`port`* specifies the port where the board is connected to the server.

HDIL Arguments

The MON960 Host Debugger Interface Library (HDIL) routines allow interaction with the target monitor. Several optional HDIL arguments may be specified on the `target mon960` command line. These options affect the communication between the host and target. For more information on the HDIL routines, refer to the *MON960 Debug Monitor User's Guide*.

Combining Serial Communication and PCI Downloading

If your PC host and target support PCI communication, but application requirements make it undesirable for the monitor to tie up the PCI bus with I/O and various service requests (e.g., register dumps), then use PCI download to augment serial communication.

Examples

```
> gdb960 -r com1 -pci myprog
```

This example connects to the target via serial port COM1 and downloads the program *`myprog`* via the PCI bus. The PCI bus is used only for downloading; all other host/target communication use the serial port.

```
> gdb960 -r com1 -pcib 0 c 0 myprog
```

This example is similar to the previous one, except that the PCI device is explicitly specified by bus (`0`), device (`0xc`), and function number (`0`).

Emacs Invocation

On UNIX hosts, if you are a GNU Emacs user, you can set up gdb960 to run in an Emacs window. This has many advantages over the normal, single line gdb960 command line, notably the source code buffer that Emacs keeps updated for you as you debug your application. For more information on running gdb960 under Emacs, refer to Appendix B, *Using gdb960 Under GNU Emacs*.

Batch Mode Invocation

You can also start gdb960 in batch mode. You can get more detailed control over how gdb960 starts by using the command-line options listed in Appendix E of this manual.

All the options and command line arguments listed in a batch file are processed in sequential order. Sometimes order is important. For example, when the `x` option is used, you need to load an object before you can manipulate it.

Mode Options

Mode options specified in the gdb960 invocation line determine how the software debugger accepts input, produce output, and processes debugging commands. The following is a list of the available mode options along with brief descriptions of their effects on gdb960's operation:

`batch` — Run in batch mode. Terminate gdb960 with exit code `0` after processing the commands in the file specified with `-x` and in `.gdbinit`, if not inhibited. Terminate with non-zero status if an error occurs in executing the gdb960 commands in the command file. On Windows hosts, the initiation batch file is named `init.gdb` instead of `.gdbinit`. Only one command file can be specified on the command line. Execution of gdb960 terminates when the command file ends.

	Batch mode allows you to run gdb960 as a filter. For example, you can download and run a series of programs and capture their output.
`G`	Informs gdb960 that the target has big-endian memory.
`help`	gdb960 briefly describes usage details.
`nx`	Suppress execution of commands in the `.gdbinit` initialization file. Normally, the commands in `.gdbinit` execute after the command line options and arguments have been processed. For more information on command files, refer to Chapter 13.
`pc` *`picoffset`*	Debug position-independent code. Download code sections to link-time-address + *`picoffset`* instead of the usual link-time-address. When gdb960 reads the symbol table from your program, code section labels and symbols will have *`picoffset`* added to their link-time addresses to account for this relocation.
`pd` *`pidoffset`*	Debug position-independent data. Download data and bss sections to link-time-address + *`pidoffset`* instead of to link-time-address. When gdb960 reads the symbol table from your program, data and bss symbols will have *`pidoffset`* added to their link-time addresses to account for this relocation.
`px` *`offset`*	Enter the same offset for both `-pc` and `-pd`. Download all sections to link-time-address + *`offset`* instead of to link-time-address. When gdb960 reads the symbol table from the program to debug, all labels and symbols have *`offset`* added to their link-time addresses to account for this relocation.

q	"Quiet." Do not display the introductory and copyright messages. These messages are automatically suppressed in batch mode.

Using the gdb960 Windows Graphical User Interface

3

This chapter provides information on running gdb960 using its Graphical User Interface (gdb960v) in Windows 95 and Windows NT. Topics include:

- Overview
- Online Help (page 3-2)
- Starting and Stopping the Debugger (page 3-3)
- A Sketch of the Debugger (page 3-4)
- Connecting to a Target (page 3-6)
- Setting the Search Path (page 3-9)
- Opening a File (page 3-10)
- Listing Code (page 3-11)
- Debugging with gdb960v (page 3-12)
- Using the dgb960v Text Editor (page 3-34)
- The Debugger Command Line Window (page 3-40)

See Chapter 4 for information on running the UNIX version.

Overview

The design of the gdb960v GUI debugger combines the best features of graphical and command-line debugging interfaces. The most common debugging activities, such as setting breakpoints and controlling program execution, are available through convenient point-and-click interfaces. Similarly, program listings and data-inspection windows provide an immediate visual context for the crucial portions of your application.

For more complex or unpredictable debugging needs, a command-line interface gives you full access to a wealth of specialized debugging commands. For instructions on running gdb960 from the command line, see Chapters 5 through 13.

Online Help

Reference information is available to you anytime you are running the debugger simply by pressing **F1** in any window, or by pulling down the Help menu and choosing any of the help options listed there. Using the **F1** key provides you with context-sensitive information about the current active window. The Help menu provides you with options that let you start your search in the more general areas of the online help system and then move to the more specific topics.

Starting and Stopping the Debugger

Starting the Debugger

You can start the debugging session by double clicking the icon that was installed into your gdb960v program group during installation of the toolset. The installation also sets the proper environment variables for you. You can modify the Windows start up properties to include any command line options you want used, such as the specifying the baud rate for the communications port.

When the debugger is running, you can interact with it through the editor window, through the Debugger command window, and through the Debug menu and toolbar. The section titled "A Sketch of the Debugger" provides an outline of these interaction modes.

Stopping the Debugger

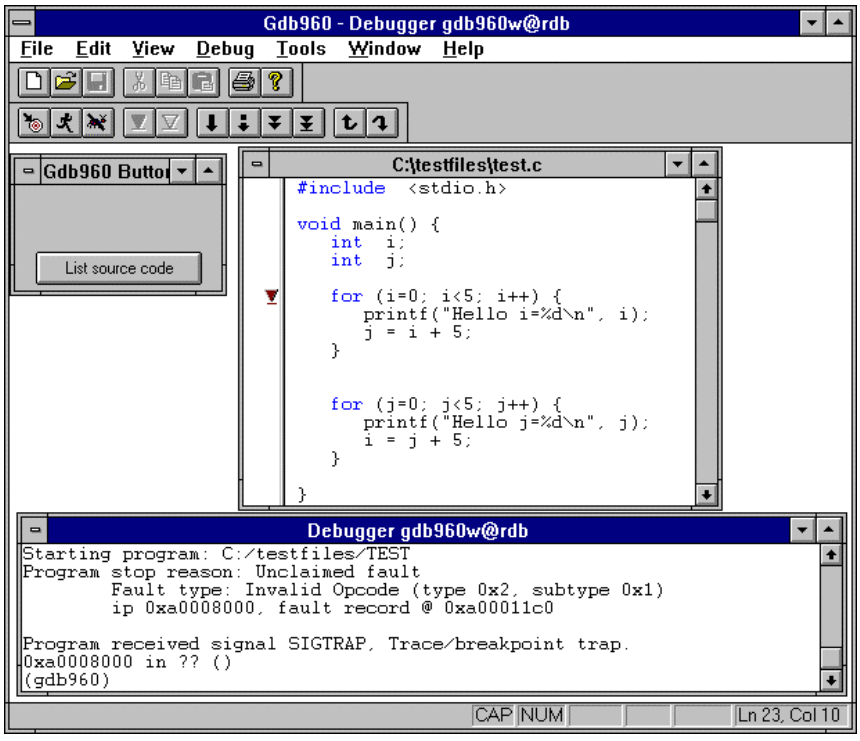
You can end the debugging session in any of the following ways:

- In the debug toolbar, press the button.
- Click on the Stop Debugging command in the Debug menu.
- Close the Debugger command window.
- Close the debugger.

A Sketch of the Debugger

Figure 3-1 illustrates the windows and buttons you can use to interact with the debugger.

Figure 3-1 Debugging Windows



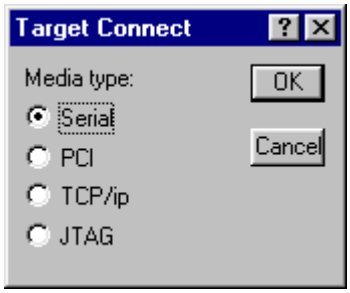
The editor window (in the background) keeps track of the code you are debugging. You can click in this window to specify information for debugger commands (such as symbol names, or lines of code). The debugger in turn uses the attribute panel, in the left margin of the editor window, to show breakpoints and the execution context.

Connecting to a Target

Now that you are more familiar with the parts of the debugger window, you are ready to connect to a target board.

1. If you have not already done so, physically connect the target board to the host. For details, see Chapter 2.
2. Press the Target Connect button in the gdb960v buttons pane. You can also open File pull down menu, select the Target Connect option and from the submenu select the type of media used for communication between the host and the target. You can then skip step 3 below. The Target Connect window appears.

Figure 3-3 The Target Connect Window



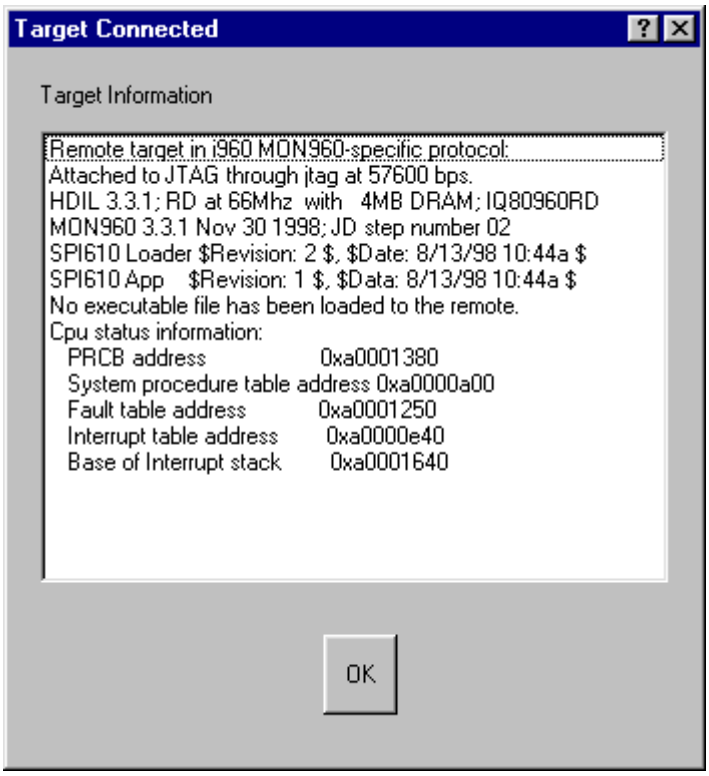
1. Select the type of media you are using for communication between the target and host. Select the fastest media your hardware supports. For details, see Chapter 2.
   — If you select PCI, a window appears displaying the PCI devices that are currently installed in your system. Select the desired PCI device and choose OK. For example, the Cyclone i960 IQ80960RP evaluation board has vendor and device identification numbers 8086 and 0960 respectively. For more information on

PCI, see the *PCI Local Bus Specification* from the PCI Special Interest Group (1-800-433-5177).

- If you select Serial, you are prompted to select the port parameters. You also have the option of using a parallel port to download code to the target. Once you have set the correct parameters, choose OK.
- If you select TCP/IP, you are prompted to enter the name of the server sharing the evaluation board and the port where the board is connected. Once you have set the correct parameters, choose OK. (See "TCP/IP Communication" in Chapter 2 for more information on setting up a TCP/IP connection.)
- If you select JTAG, you are prompted to select the port parameters. Once you have set the correct parameters, choose OK.

If you have not successfully connected to your target, a dialog displaying an error message is presented to you. When you successfully connect, a window displays target information.

Figure 3-4 Target Connected Window



When you have successfully connected to your target, the following changes appear in the main window:

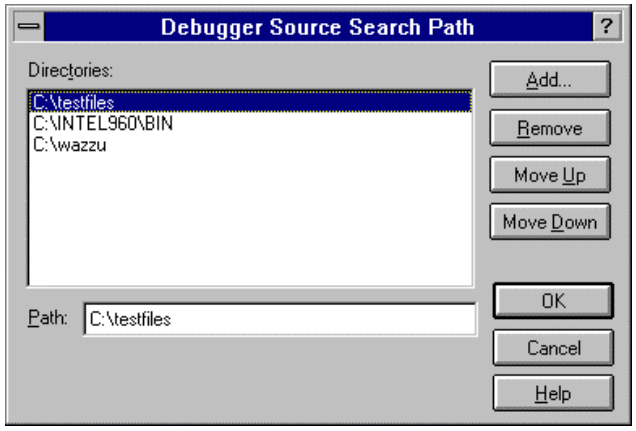
- The Target Connect button in the gdb960v buttons pane disappears.
- The status line at the lower left corner indicates that you have connected to a host running MON960.

Setting the Search Path

The debugger maintains a list of directories where it searches for source code. This list is called the source search path. To edit this list:

1. Open the Debug pull down menu, and then select Source Search Path. This window shown in Figure 3-5 appears.

Figure 3-5 Source Search Path Window



2. Use the following buttons to maintain the Search list:

Add	Brings up a window where you can select a new directory to add to the current search directory list.
Remove	Removes a search directory from the list.
Move Up	Moves the selected directory up one place higher in the list.
Move Down	Moves the selected directory down one place lower in the list.

Note that the order of the directories is significant. Generally, you should place the directories that you will be accessing most often first. Also, if the

same filename exists in multiple directories, make sure the directory with the desired file is listed above any other directories that contain files with the same name. (To reduce confusion while debugging your application, we recommend you consider using unique filenames across directory boundaries.)

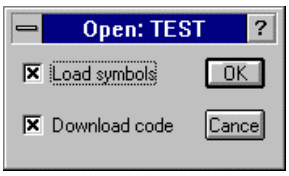
You can set the debugger source paths prior to starting the debugging session. The directories you enter here persist to the next debugger invocation.

Opening a File

You are now ready to open a program file, load its symbols, and/or Download code from it to the target. (You can edit a file using the Open file menu item in the File menu. See "Source Views" on page 3-31 for more information.)

1. Press the Open Binary button located in the gdb960v buttons pane. Alternatively, you can pull down the File menu and choose Open Binary.
2. In the File select dialog, select the desired program file and choose OK. This window shown in Figure 3-5 appears.

Figure 3-6 Open Window



3. You can now load the symbols and/or download the code to the target. For the purposes of this chapter, select Load symbols and download code and choose OK.
   The status line in the lower left corner of the window tells you when the debugger has finished loading the symbols and/or downloading the

file. Also, the List source code button replaces the Open Binary button in the gdb960v buttons pane.

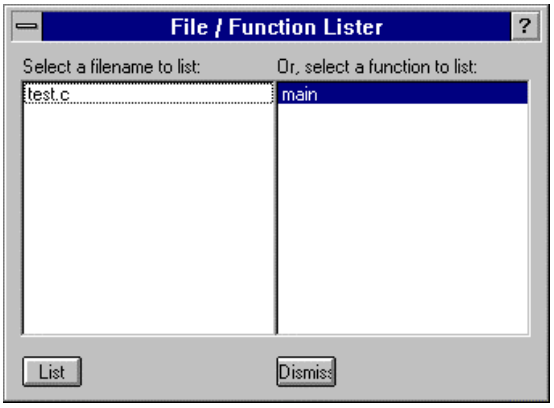
You are now ready to use the debugger's options for listing code, as described in the next section.

Listing Code

The debugger lets you display any of the files or modules that comprise a program in an edit window. You can also have multiple edit windows open, which lets you move between source files and modules as needed.

1. Press the List source code button in the gdb960v buttons window. The window shown in Figure 3-7 appears.

Figure 3-7 File/Function Lister Window



You can also access this window by pulling down the View menu and choosing List Code.

The left field lists the names of the files (or modules) that comprise the program. To the right is a list with the names of the functions found in the program.

2. Select the file and function that you want displayed, then press the List button. An edit window appears displaying the selected file or

module. By default it appears in C/C++ code. The two other file viewing options are described in "Source Views" on page 3-31.

NOTE. *If the debugger cannot find the file or function you specify, it displays an error message in a message box. In most cases, the error is due to the directory with the desired module or file not being in the list of search directories. To fix this problem, use the Source Search Path option from the Debug menu to add the directory where the file or function resides to the list of search directories. For more information, see "The Debug Menu" on page 3-17.*

So far, you have:

- Connected to the target
- Opened a binary file reading its symbols and downloading its code to the target
- Listed a source module or two.

You are now ready to debug your software as described in the next section.

Debugging With gdb960

Programs executing under debugger control execute normally and the debugger maintains control until:

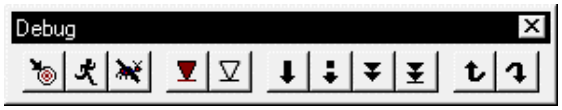
- The program terminates.
- The program encounters a breakpoint.
- You interrupt the executing program via the debugger.
- An event such as a fatal error occurs. (Note that an interrupt for the executing program by itself will not cause the debugger to regain control.)

CAUTION. *You must compile your application using debugging symbols (*`-g`*) to use many of the features of the debugger. Highly optimized code is best debugged with ELF/DWARF file format (*`-Felf`*).*

You can interrupt program execution with Interrupt Debugger in the Debug menu, by pressing CTRL+BREAK in the Debugger command window, or by using the keyboard shortcut ALT+SHIFT+F5.

Debugger Buttons

Figure 3-8 Debug Toolbar



The Debug toolbar (shown as a floating palette in Figure 3-8) has buttons for the most common debugging commands. Table 3-1 summarizes each button.

Table 3-1 Summary of Debug Buttons

Button	Description	Button	Description
	Download		Next
	Run program		Continue
	Stop debugging		Finish
	Toggle breakpoint		Up stack
	Toggle Temporary breakpoint		Down stack
	Step		

You can get the same help using the "tool tip feature". Place the mouse over the button and pause. A bubble pops up, letting you know what the button does.

The following paragraphs describe each button.

Download an object module to the connected target. This button is equivalent to the Download command in the Debug menu; it opens a file browser to find the module. See "Downloading a Module" on page 3-17.

Run a program on the target under debugger control. A Run dialog box allows you to specify initial arguments for the program. This button is equivalent to the Run command in the Debug menu. See "Navigating through a Program" on page 3-19 for more information.

Stop the debugger. This button is equivalent to the Stop Debugging command in the Debug menu.

Set or remove a breakpoint or temporary breakpoint on the current line of the editor window. To insert a breakpoint, place the mouse cursor on the desire line, press the left mouse button to select the line, then press to insert a breakpoint or to insert a temporary breakpoint. The breakpoint is inserted at the next valid stopping point.

To delete a breakpoint, place the mouse cursor on a line that is already marked with the breakpoint icon, press the left button, and then press or .

This button is equivalent to the Toggle Breakpoint command in the Debug menu; see “Setting Breakpoints” on page 3-17.

Step to the next line of code. This button is equivalent to Step in the Debug menu; see “Navigating through a Program” on page 3-19. This button causes the debugger to step one machine instruction when the edit window contains assembly language?

Step over a function call: instead of stepping to the next statement executed, this button steps to the next line on the screen. If there is a function call on the current line, the button executes that function in its entirety, then stops at the line after the function call. This button is equivalent to the Next command in the Debug menu; see “Navigating through a Program” on page 3-19.

The next button behaves analogously to the step button when assembly language is displayed in

the edit window.

Continue program execution. This button allows the program to continue execution from its current IP location until the debugger regains control. The debugger regains control when:

- The program terminates.
- The program encounters a breakpoint.
- You interrupt the program.
- An event such as an interrupt or a fatal error occurs.

This button is equivalent to Continue in the Debug menu; see "Navigating through a Program" on page 3-19.

Finish the current execution continues until the current function completes, then the debugger regains control in the calling statement. This button is equivalent to the Finish command in the Debug menu; see "Navigating through a Program" on page 3-19.

Move one level up the function stack. This button is equivalent to the Up Stack Frame command in the Debug menu; see "Viewing Alternate Stack Levels" on page 3-23. The change is reflected in the Backtrace and Register windows.

Move one level down the stack. This is the converse of the up button. This button is equivalent to the Down Stack Frame command in the Debug menu; see "Viewing Alternate Stack Levels" on page 3-23. The change is reflected in the Backtrace and Register windows.

The Debug Menu

The Debug menu provides an alternate method from debugger buttons to invoke commands, and also presents supplementary debugger commands. Refer to the online help for detailed descriptions of each option.

Downloading a Module

Once the debugger is running and you have connected to a target, you can download code to the target board.

1. Click on the Download button. Alternatively, you can pull down the Debug menu and choose Download, or press Shift+F6.
2. Select a program to download to the target for debugging. You can also do this operation while opening a binary file. (See "Opening a File" on page 3-10 for details). This brings up the Download objects dialog box, where you can select one or more object modules.

3. Click the Download button to download the selected object modules to the target. Debugging information for these modules is contained in each object module.

Setting Breakpoints

To set a breakpoint:

1. Place the text cursor in the line where you want the program to stop.
2. Choose Toggle Breakpoint or Toggle Temporary Breakpoint.

Table 3-2 Breakpoint Buttons

Button	Shortcut	Debug Menu Command	Description
	F9	Toggle Breakpoint	Places a breakpoint that stops execution at that point each time you run the program.
	F8	Toggle Temporary Breakpoint	Places a breakpoint that stops execution at the selected point only once. The debugger disables it automatically as soon as the program stops there.

The same breakpoint symbols used on the buttons for these commands mark breakpoints in the editor's left margin, so that you can readily distinguish the two kinds of breakpoints.

If you try to create a breakpoint on a line that has no corresponding object code (such as a comment line or a declaration), the breakpoint appears on the next line that does have corresponding object code.

To remove either type of breakpoint, select the breakpoint line, then click the appropriate breakpoint command.

NOTE. *If your application was compiled without debugging information, the debugger displays an error when you try to set a breakpoint using these commands. If you are forced to work on an object module without debugging information, you can still break at the start of any function in the following ways:*

- *Check the Break at main check box in the Run dialog box when you start the program (See "Navigating through a Program").*
- *Use the break command in the debugger command window (see Chapter 13 for usage of the break command).*

In either case, when the debugger stops, it displays a Disassembly window, as it does whenever no debugging information is available for the program context.

Navigating through a Program

To run a program under debugger control:

1. Press the Run button, or pull down the Debug menu and choose Run. The Run dialog box (see Figure 3-9) appears.

Figure 3-9 The Run Window

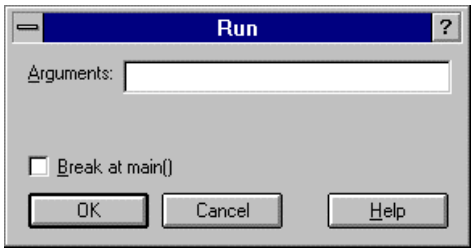


Figure 3-9 shows the Run dialog box with an argument list (optional). The default for required arguments that you do not supply is zero. To set a temporary breakpoint program function main, check the Break at main() box.

2. Specify the arguments (if any) used by the program.
3. Click OK to start the program execution on the target.

Once a program stops under debugger control (most often, at a breakpoint), you can single-step through the code, jump over function calls, or resume execution. Figure 3-10 shows the debugger stopped at the routine graphInit( ). The context pointer ▶ indicates what statement executes if you allow the program to resume.

Figure 3-10 The Context Pointer

```
/*******************************************************************************
*
* graphInit - coloring graph initialization
*
*/

void graphInit (void)
    {

    /* set initial node number to 0 */

    dB.nNum = 0;

    /*
     * enabling round robin: necessary to give each node of the
     * graph (which have all the same priority) some CPU access
     */
```

When the program is stopped, you can use any of the following options from the Debug menu:

Table 3-3 Buttons for Stepping Through a Program

Button	Shortcut	Debug Menu Command	Description
	F5	Continue	Restarts program execution. If there are no remaining breakpoints, interrupts, or signals, the program runs to completion. A common example of using Continue is to set a breakpoint at the end of a loop, then use Continue repeatedly to stop once in each loop iteration, while monitoring a loop variable.
	F10	Step	Steps through the code one line at a time. If you have auxiliary debugger windows open (See “Using the Auxiliary Debugger Windows” on page 3-24), they are updated with current values as you step through the code. If there is a function call in the current line, Step takes you to the first line of that function, not to the next line currently displayed on your screen. The only exception is for functions that are compiled without debugging information; Step cannot step into these functions.

continued ☛

Table 3-3 Buttons for Stepping Through a Program (continued)

Button	Shortcut	Debug Menu Command	Description
	CTRL+F5	Next	Single-steps without going into other functions. The Next command is similar to Step, but instead of stepping to the very next statement executed (which, in the case of a function call, is typically not the next statement displayed), Next steps to the next line on the screen. The command allows you to run through a function call without considering its details. If there is no intervening function call, this is the same thing as Step. When there is an intervening function call, Next executes that function in its entirety, then stops at the line after the function call.
	SHIFT+F5	Finish	Continues execution until the current function completes, then the debugger regains control in the calling statement. This option is useful if, after stepping through a program, you conclude that the problem you are interested in lies in the current function's caller, rather than at the stack level where your program is suspended.

The effect of Step is somewhat different if the current view in the editor shows assembly instructions (when either Disassembly or Mixed is selected from the View menu, or the current routine has no debugging symbols). In this case, Step advances execution to the next machine instruction rather than to the next source line. The display style has the same effect on Next as on Step: thus, Next causes the program to run through a call instruction and stop on the next source line.

Viewing Alternate Stack Levels

Each function call creates a new stack frame. A stack frame contains auto variables, local variables, and register values for the called function. The Backtrace window displays all active stack frames. The Backtrace window can be opened with the menu command Debug: Back Trace or Alt+6. The deepest frame, #0, is where program execution stopped. The debugger displays data, symbols and source code from the current stack frame. This also means that which variable definitions are visible depends on the selected stack frame. The data for that frame is related to the function which created the frame. The Up Stack Frame command in the Debug menu selects the context to the current function's caller. You can then click it again to get to function's caller stack frame, and so on.

This command does not change the location of the program counter; it only affects what data, symbols, and source code are visible. If you continue or step the program, execution still takes up where it left off, regardless of whether you have used this command.

Use the Down Stack Frame command to retrace your steps through the stack. Like Up Stack Frame, it changes only your view of the program, not the program's state.

As you move up and down the stack frames, the Backtrace window changes the highlight to the currently selected stack frame and the Register window contents change to reflect the register values associated with the selected stack frame.

Table 3-4 lists displays the toolbar button, keyboard shortcut, and Debug menu commands for using the Up and Down Stack Frame features.

Table 3-4 Buttons for Navigating Up and Down the Stack

Button	Shortcut	Debug Menu Command
	CTRL+U	Up Stack Frame
	CTRL+D	Down Stack Frame

Using the Auxiliary Debugger Windows

When a program stops under debugger control, you can examine local and global program variables, arguments, registers, target memory, and the execution stack. Table 3-5 provides you with a summary of these window types.

Table 3-5 Buttons for Bringing Up Auxiliary Debugger Windows

Button	Shortcut	Debug Menu Command
n/a	ALT+2	Inspect
n/a	ALT+3	Locals
n/a	ALT+4	Registers
n/a	ALT+5	Memory
n/a	ALT+6	Back Trace

The sections below describe the Debug menu commands that open auxiliary windows for these purposes.

NOTE. *The sub-windows described in this section update each time your program stops in the debugger. Each update highlights values that changed since the previous display.*

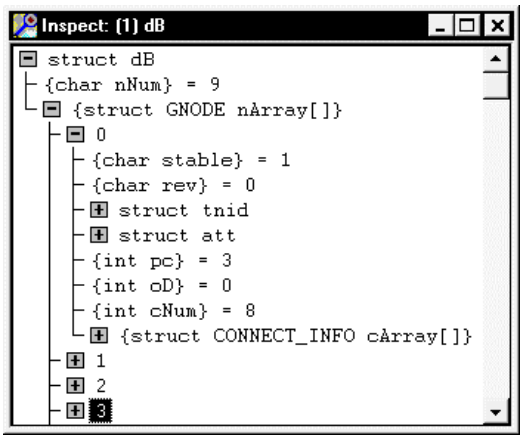
Inspect

To monitor an expression or a symbol's current value:

1. Select an expression or symbol name in the editor,
2. Pull down the Debug menu and choose Inspect, or press Alt+2. This opens a sub-window for the selected symbol; the window is updated automatically each time the program stops. Alternatively, if you choose Inspect with nothing selected and specify the symbol name in the dialog provided.

Several different kinds of data-inspection windows are available, depending on the data structure. The debugger chooses the right one automatically.

Figure 3-12 Inspect: Partly Hidden Structure Hierarchy

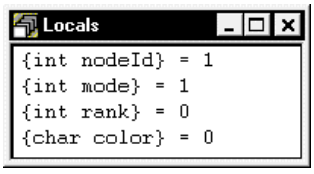


You can also click on pointers (marked with a small asterisk) to open a new Inspect window that shows the pointer value. This feature provides a convenient way of exploring list values interactively

Locals

To view the value of local variables, open the Debug menu and choose Locals. Alternatively, use the Alt+3 keyboard command. A window appears, showing the values of local variables. For example:

Figure 3-13 Locals Window

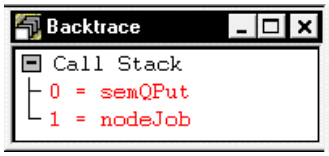


You can use the same controls as for Inspect windows (see the previous section) to hide or reveal levels of structures. The contents of the Locals window always reflect the routine that is currently executing; when you step into a different routine, the new routine's local variables replace those in the previous display.

Back Trace

To inspect the calling sequence leading to the current routine, pull down the Debug menu and choose Back Trace, or press Alt+6. A window opens to monitor the stack.

Figure 3-14 Backtrace Window

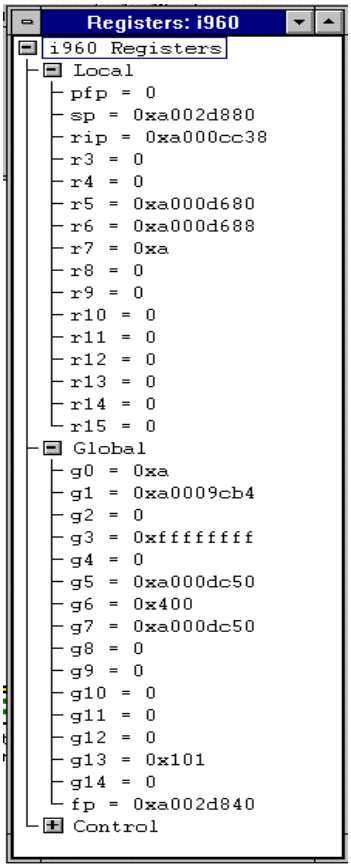


In the Backtrace window, you can double-click on any routine to make the corresponding editor window the active window.

Registers

To view the values of the target registers, pull down the Debug menu and choose Registers, or press Alt+4. Figure 3-15 illustrates the Registers window.

Figure 3-15 Registers Window



You can use the same hierarchy controls described in "Inspect" to hide or reveal groups of registers.

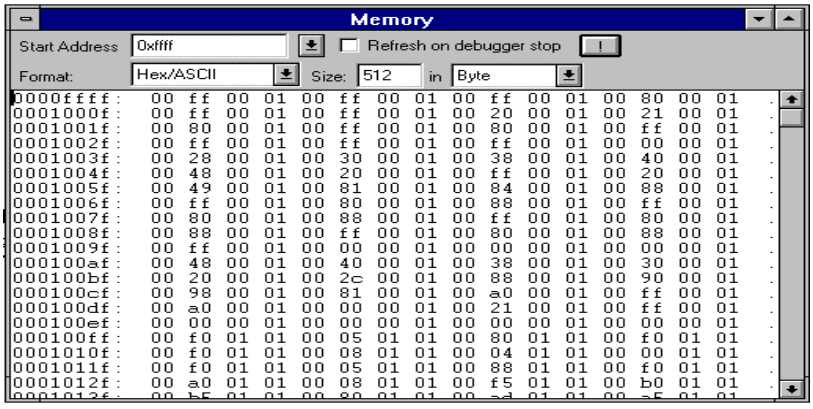
Memory

Table 3-6 Options for Bringing Up the Memory Window

Button	Shortcut	Debug Menu Command
n/a	ALT+5	Memory

Click the Memory item in the debug menu to open a window that displays a range of target memory starting at a specified address. Figure 3-15 shows a maximized Memory window, displaying memory in Hex/ASCII format. The numbers in the left margin of Figure 3-16 identify the control fields described below.

Figure 3-16 Memory Window



NOTE. *You can choose whether to update the Memory window only on demand, or automatically. Check the box labeled Refresh on debugger stop to update the Memory window each time the debugger takes control.*

To update the memory display immediately, press the ! *button.*

The following controls specify what memory range to display, and in what format:

Start Address Enter the beginning address for the range of memory. The debugger saves each address you type here. You can select a previously displayed address from the drop-down list associated with this box.

Format Select a display format from this drop-down list box.

Size Type the amount of memory to display here. The units are specified in the adjacent in field. For example, if the in field has the value Word, the Memory window displays 4 × Size bytes of data.

in Select the unit of memory to display.

Table 3-7 Memory-display Formats and Units

Format Values	Unit Values (in)
Hex/ASCII	Byte
Octal	Halfword
Hex	Word
Decimal	Giant (8 bytes)
Unsigned decimal	
Binary	
Float	
Address	
Instruction	
Char	
String	

See the description of the x ("examine") command in Chapter 13 for a discussion of the memory-display formats.

Source Views

While the debugger is running, you have control how your program is displayed. By default the debugger displays your code in C/C++ style. You also have the option of displaying the source as disassembly or a combination of C/C++ and disassembly. To change the view, simply pull down the View menu and choose one of these options:

Source Displays the C/C++ source code. This is the default style of program display. To choose this option, you can also press the F7 key.

Disassembly Displays a symbolic disassembly of your program's object code. This style of display is the default for routines compiled without debugging information (such as the C/C++ runtime library routines supplied as object code only). To choose this option, you can also press Alt+F7.

Mixed Source and Disassembly

Displays both high-level source and a symbolic disassembly, with the assembly-level code shown as close as possible to the source code that generates the corresponding object code. To choose this option, you can also press Shift+F7. Figure 3-17 shows a mixed-mode code display.

The debugger is fully operational no matter what view you select. For example, you can set breakpoints in a line of assembly code, and you can use the Step and Next commands in either assembly or source. In views that show assembly, these commands step by instructions rather than by source lines; see "Navigating through a Program" on page 3-19.

The editor, however, works only on source code. Thus, when you display a view with disassembled instructions, the editor display goes into read-only mode until you either stop debugging or switch to the Source view.

NOTE. *Disassembly takes a long time the first time you switch to a view that requires it. Subsequently, in the same debugging session, you can switch views quickly. The disassembly information is not persistent; the debugger discards it when you stop debugging (or if you close the source file with the Close command in the File menu).*

Note also that if you have a relatively slow PC, (e.g., has slower than a 100 MHz Pentium® processor, and/or your modules are larger than 500 lines of C/C++ code, the time to disassemble will be quite slow. The status line shows progress as it disassembles as percentages of the modules.

Using the gdb960v Text Editor

gdb960v provides an integrated text editor to manage, edit, and print source files. Most of the procedures involved in using the editor, such as file and text handling and moving around in a file, should seem familiar if you have used other Windows-based text editors. The Text Editor window displays C/C++ source files as well as all header files used in gdb960. With the editor, you can:

- Perform advanced find and replace operations.
- Specify syntax coloring.
- Customize tab stops.
- Use toolbar shortcuts for various commands.
- Use multiple levels of undo and redo.
- Open multiple windows for debugging, monitoring variables, disassembling code, and displaying source files.
- Open multiple views of the same file.
- Take advantage of other ease-of-use features, such as a list of recently opened files at the bottom of the File menu, parsing text around the insertion point as the initial search string in a Find operation, and keyboard shortcuts.

Editing a File

Opening a File

1. From the File menu, choose Open (CTRL+O).
   or
   Click on the Standard Toolbar.
   The Open dialog box appears.
2. Select the drive and directory where the file is stored. The default is the current drive and directory.

3. Set the types of files to display in the Files of Type box. Files with the chosen extension are displayed in the File name box.

   This box serves as a filter to display all files with a given extension. The drop-down box initially lists commonly-used file extensions. The default shows the `.TXT`, `.C`, `.CPP`, `.H`, `.HPP`, and `.TCL` extensions.

   Alternatively, you can specify wildcard patterns in the File name box to display file types. The new wildcard pattern is retained until the dialog box is closed. You can also use any combination of wildcard patterns, delimited by semicolons. For example, entering `"*.` displays all files with these extensions.

4. In the File name box, click a filename, then click Open.
   or
   Double-click on a filename.

You are now ready to edit the file.

Creating a New Text File

1. From the File menu, choose New (CTRL+N). The New dialog box appears.
2. Select C/C++ Source File, then click OK.
   or
   Click on the Standard toolbar.
3. From the File menu, choose Save (CTRL+S).
   or
   Click on the Standard toolbar.
   The Save As dialog box appears.
4. Double-click a directory where you want to store the source file (or move down a path to the appropriate directory).
5. Type a filename in the File name box, then choose OK. The default extension given to a file is the last extension used when you saved a file. You can type another extension or select one from the Save as Type box.

You are now ready to enter text into the file you created.

Cutting, Copying and Pasting Text

1. Select the text you want to paste.
2. From the Edit menu, choose the Cut (CTRL+X or SHIFT+DEL) or Copy (CTRL+C or CTRL+INS).
3. Place the insertion point in any source window where you want to insert the text.
4. From the Edit menu, choose the Paste (CTRL+V or SHIFT+INS).

Moving to a Line

1. From the Edit menu, choose Go To.
   The Go To dialog box appears.
2. In the Line box, type a line number.
3. Click OK.

If you type a line number greater than the last line in your source file, the editor moves to the end of the file.

Finding a Text String

1. Position the insertion point where you want to start your search.
   If you select some text, the editor uses that text as the default search string.
2. From the Edit menu, choose Find (ALT+F3).
   The Find dialog box appears.
3. Type the search text in the Find What box.
4. Select any of the Find options.
5. To begin your search, choose Find Next.
   The find dialog box disappears when the search begins. To repeat a find operation, you can use the F3 shortcut key.
   To begin a find without bringing up the Find dialog box, select a text string in a source file, then press ALT+F3.

Finding and Replacing Text

1. Position the insertion point where you want to start your search.

If you select some text, the editor uses that text as the default search string.

2. From the Edit menu, choose Replace.
   The Replace dialog box appears.
3. Type the search text in the Find What box.
4. Type the replacement text in the Replace With box.
5. Select any of the Replace options.
   Begin replacing text by choosing Find Next or Replace All.

Printing the Contents of an Active Window

1. From the File menu, choose Print.
   The Print dialog box appears.
2. Under Print Range, select the All option button.
3. Click OK.

Customizing a Print Job

1. From the File menu, choose Page Setup.
2. Type the header or footer text, codes (see Table 3-6), or both.
3. Click OK.

Table 3-9 Print Options

To Print	Use
Filename	&f
Page # of current page	&p
Current system time	&t
Current system date	&d
Left aligned	&l
Centered	&c
Right aligned	&r

Saving a File

1. From the File menu, choose Save (CTRL+S).
   or

Click on the Standard Toolbar.

2. If your file is unnamed, the environment displays the Save As dialog box. In the File name box, type the filename.
3. Select the drive and directory where you want the file saved. The default is the current drive and directory.
4. Specify the type of file you're saving in the Save as type box.
5. Click Save.

Saving A New File or Renaming an Existing One

1. Make the file active by clicking the editor window.
2. From the File menu, choose Save As.
   The Save As dialog box appears.
3. Type a filename and extension in the File name box.
4. Choose the drive and the directory where you want to save the file.
5. Click Save.

Setting the Save Options

1. From the Tools menu, choose Options>Editor.
   The Editor Preferences dialog box appears.
2. To save open files before running any tool, select the Save Before Running Tools/Builds check box.
3. Click OK.

Customizing the Text Editor

Setting the Attribute Pane

1. From the Tools menu, choose Options>Editor.
   The Editor Preferences dialog is displayed.
2. Select the Attribute Pane check box (this box is checked by default).
   When the mouse is moved into the Attribute Pane, the cursor changes to an up-and-right-pointing select cursor (a mirror image of the standard select arrow).
   — Clicking the left mouse button in the margin selects the entire line to the right of the click. Dragging the mouse cursor in the selection margin selects multiple consecutive lines.

— Clicking the left mouse button or dragging the mouse cursor with the Shift key held down extends the selection.

Changing the Tab Settings

1. From the Tools menu, choose Options>Editor.
   The Editor Preferences dialog box appears.
2. Under Tab Settings, in the Tab Stops box, type the number of spaces to be used as a tab stop. The default is four spaces.
3. Click OK.

Changing Font Type and Font Size

1. From the Tools menu, choose Options>Font.
   The Font dialog box appears.
2. Select the font from the Font box. The text sample in the Sample box will change to the font you selected.
3. Select the size in points from the Size box. The text sample in the Sample box will change to the font size you selected.

Changing Syntax Coloring in a Source File

1. Click the editor window or use the Window menu to make the source window active.
   If there are multiple windows open on the source file, select one of them. Syntax coloring changes will appear in all windows opened on the source file.
2. From the Tools menu, choose Options>Color.
   The Color Preferences dialog box is displayed. The Items list box displays the current setting for syntax coloring.
3. Select a window or text element for which you want to specify a color.
4. Click a color from both the Foreground and Background color areas.
5. Click OK.
   Note that syntax coloring must be enabled before you can set the syntax coloring properties for any specific file. To enable global syntax coloring, select the Syntax Coloring check box in the Color Preferences dialog box.

The Debugger Command Line Window

The gdb960v graphical interface is usually the most convenient way to run the debugger. However, you can also use the command-line interface, which in some cases is the best way to perform a particular action (and in some cases, the only way to perform an action). The Debugger window provides full access to the command language described in Chapters 5-13.

Using the gdb960 UNIX Graphical User Interface

4

This chapter provides step-by-step instructions for running gdb960 using its UNIX Graphical User Interface (gdb960v). Topics include:

- Overview
- Online Help
- Running the Debugger
- Setting the Working Directory
- Connecting to a Target
- Opening a File
- Using the Debugger
- Editing Source Code
- Creating a New File
- Setting the Search Directories
- Exiting the Debugger
- Customizing the GUI
- See Chapter 3 for information on running the Windows 95/NT version.

Overview

gdb960v provides users with a Graphical User Interface to access many of the features of its line-oriented interface. The most common debugging activities, such as setting breakpoints and controlling program execution, are available through convenient point-and-click interfaces. Similarly, program listings and data-inspection windows provide an immediate visual context for the crucial portions of your application.

For more complex or unpredictable debugging needs, a command-line interface gives you full access to a wealth of specialized debugging commands. For instructions on running gdb960 from the command line, see Chapters 5 through 13.

Online Help

The UNIX help system is HTML-based and can be viewed with any web browser such as Mosaic or Netscape. To view the file, simply open the file `wingdb960.htm` with your web browser. At installation this file is placed the in directory `[$G960BASE/$i960BASE]/html/tools/`.

Running the GUI Debugger

To start the gdb960v UNIX GUI, use the syntax:

```
gdb960v [options]
```

where `options` is any of the options allowed by the gdb960 command line interface (see chapter 12 for more information). For example, in borne shell you might enter:

```
$G960BASE/bin/gdb960v -r /dev/tty0 myprogram
```

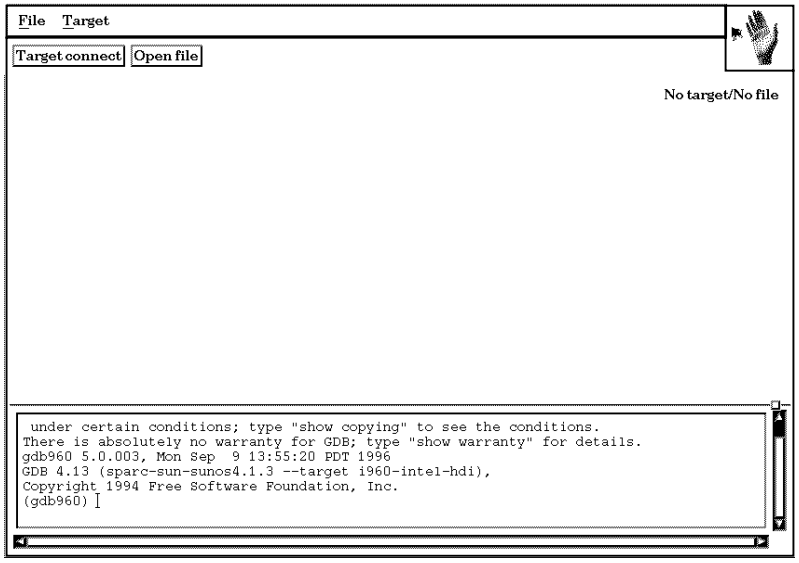
You can also use `-d` display option, which allows you to explicitly set the X terminal type used for the display. For example:

```
gdb960v -r /dev/tty0 -d system.company.com:0.0 myprogram
```

selects the X DISPLAY as the console of `system.company.com`.
If no `-d` option is given, the debugger uses the current setting of the DISPLAY environment variable. If it is not set, the debugger issues a fatal error.

A Sketch of the Debugger

Here is the initial gdb960v screen:



The initial screen includes:

- A menu bar with pull down menus for File and Target.
- A toolbar with buttons that vary depending on the state of the debugger. For example, the Target connect button disappears after you have connected to a target board. In the above figure, the toolbar contains the Target connect and Open file buttons.
- A target status line near the upper right corner. This area shows the state of the target connection, the name of the program that is loaded (if any), and whether the program is running or stopped.
- A source pane, where the debugger displays source code and disassembly to you.
- A debug margin along the left side of the source pane, where the debugger shows which line it is executing, and where breakpoints are set.

- A command line window at the bottom of the screen, where you can enter gdb960 commands.. All gdb960 commands can be used in this window. This is where debugger error messages are displayed, and other feedback such as printing the values of variables.
- An animation area (above showing the debugging hand). When the debugger is busy, this area flashes and animate.

To start debugging a program, you need to:

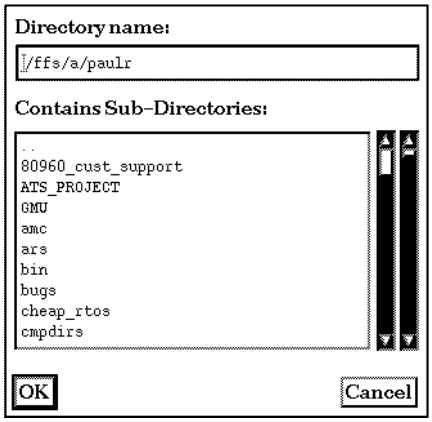
1. Set your working directory (optional).
2. Connect to a target.
3. Open a file, load the symbols from a program, and optionally download code to the target.
4. Start running the application.

The sections that follow describe how to complete these tasks.

Setting the Working Directory

Before you get started debugging, you can optionally change your working directory. This can be done anytime you are in the debugger.

1. Open the File menu and choose Change Directory. This window appears:



2. Enter the desired path in the directory name textbox. You can also set this textbox using the mouse by selecting one of the directory names listed in the Contains Sub-Directories listbox . A dialog box appears, confirming that the directory has been changed.

   You can also change the working directory in the command window by using the `cd <dirname>` command.

Connecting to a Target

Now that you have set the working directory, you are ready to connect to a target board.

1. Physically connect the target board to the host via a serial cable. For more information see Chapter 2.
2. Make sure the target board has the MON960 debug monitor running. For more information, see Chapter 2.
3. Press the Target Connect button from the toolbar. You can also use the Connect option in the Target pull down menu.
4. You are prompted to select either serial or TCP/IP connection.
   - — If you select serial, Enter the serial port name in the top text box of the dialog.

     Typically in a UNIX system, there is a file named `/dev/tty??` used for serial communication. In the Serial port field, you can enter either the entire name (`/dev/tty??`), or just the `??` portion.

     You can set this value by including the `-r` command line option when you initiate gdb960v as you would using the line oriented debugger. (see your system administrator for the specific name of the serial port on your system).

     You can also set this option in the command window using the `target mon960 <portname> ...` command.
   - — If you select TCP/IP, you are prompted to enter the name of the server sharing the evaluation board and the port where the board is connected. Once you have set the correct parameters, choose

OK. (See "TCP/IP Communication" in Chapter 2 for more information on setting up a TCP/IP connection.)

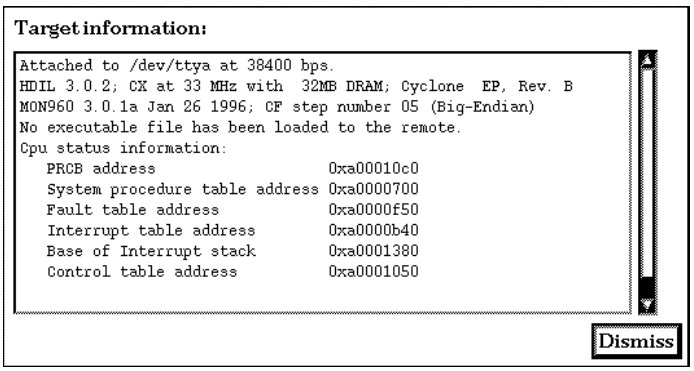
5. If needed, specify the baud rate used to communicate with the target board. The default setting is 38,400 BPS, and is the maximum rate (on UNIX). You need only use this option to specify a slower baud rate than the default.
6. If you wish to use a parallel port for code downloading, make sure the parallel cable is connected from target to host, and enter the port name in the field provided.
7. To connect to the target, press the connect button.

NOTE. *You can set variables so that the proper communication parameters are set automatically whenever you run gdb960. These variables are stored in the TCL configuration files. For more information, see "Customizing the GUI" on page 4-18.*

If you have not successfully connected to your target, an error message appears in the command window.

When you have successfully connected to your target, the following changes appear in the main window:

- The Target Connect button on the toolbar disappears.
- The No target portion of the status line becomes MON960.
- The Windows pull down menu appears, which gives you options for viewing the contents of registers.
- A dialog box appears indicating various information about the target to which you have connected.

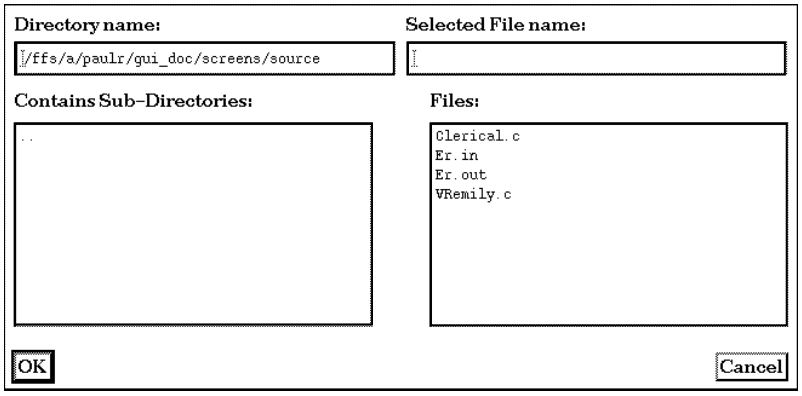


Note also that if you have previously opened a file and read the symbols from it, the Download button appears on the toolbar.

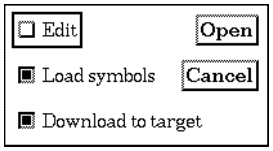
Opening a File

You are now ready to open a program file and then load its symbols and or download code from it to the target. You can also edit the file in a text editor as described in "Editing Source Code" on page 4-17.

1. Press the Open File button. This window appears:



   You can also access this window by opening the File menu and choosing Open.
2. Select the desired file by entering the directory and filename in the text boxes provided, or by selecting one of the directory or file items in the two list boxes provided.
3. Choose OK.
4. A window appears, giving you the option to edit the source file or load its symbols. If you choose to load the symbols you can also download the file to the target. In this section, you load the symbols and download to the target. See "Editing Source Code" on page 4-18 for more information on using gdb960v to run your favorite text editor.

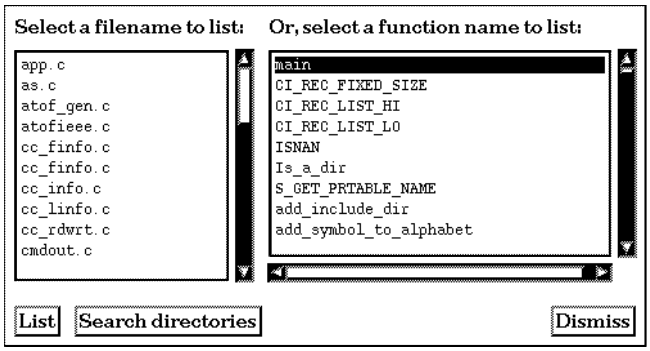


5. Select the Load symbols and Download to target options and choose Open. Notice the following changes to the Debugger window:
   - The Open file button from the toolbar disappears.
   - The List Code button appears on the toolbar.
   - The status line indicates the basename of the file from which you have loaded symbols/downloaded code.
   - The Source list menu appears. The options in this menu allow you to set the search directories for source files, and also to bring up the list code dialog.

Listing Code

The debugger lets you display any of the files or modules that comprise a program. You can also have multiple windows open, which lets you move between source files and modules as needed.

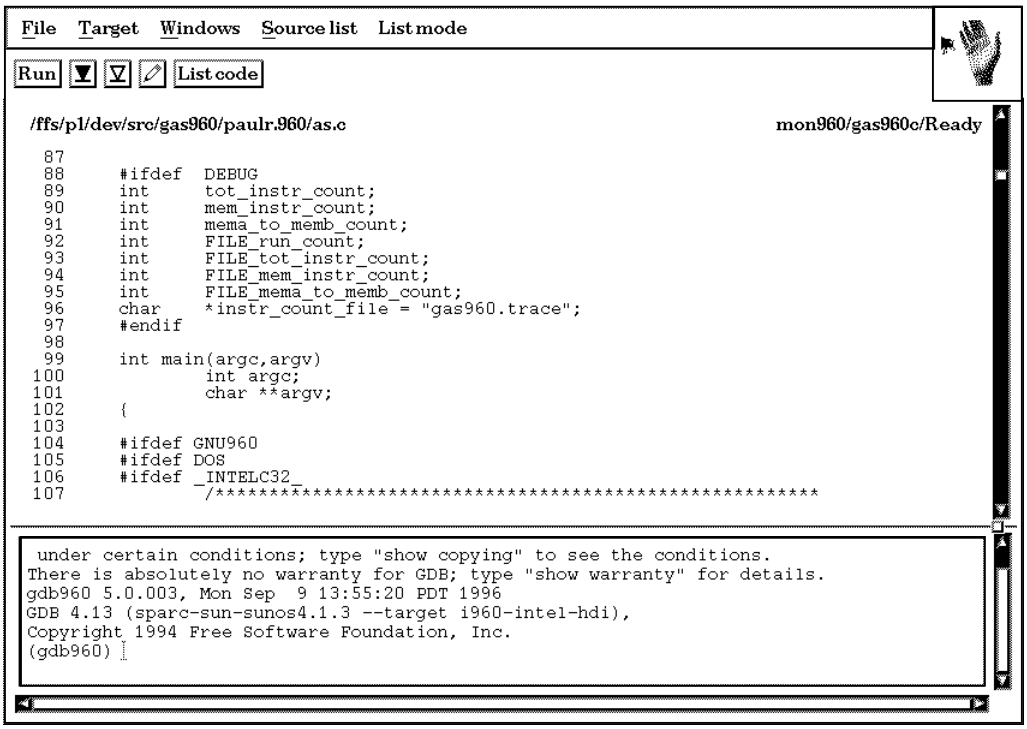
1. Choose List Code from the toolbar. This window appears:



   The left field displays the names of the files or modules that comprise the program. To the right are the names of the functions found in the program

2. Select the file or function that you want displayed.

3. Choose List. Notice the following changes to the debugger main window:
   - Two buttons for setting permanent or temporary breakpoints appear on the toolbar.
   - If the target is connected, the Run button appears on the toolbar.
   - The List mode menu appears. The options in this menu let you specify whether you want to display C/C++ code, assembly code or both.



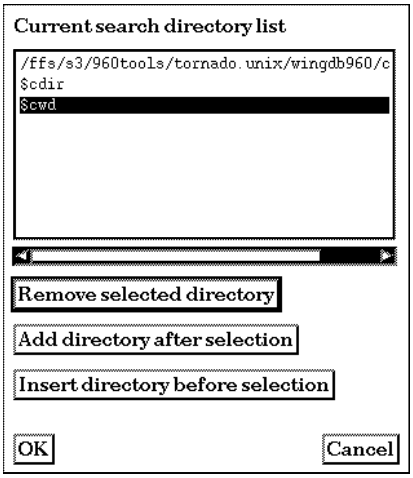
NOTE. *If the debugger cannot find the file or function you specify, it displays an error message in the command window. In most cases, the error is due to the directory with the desired module or file not being in the list of search directories. To fix this problem, use the Search Directories option from the Windows directory to add the directory where the file or function resides to the list of search directories. For more information, see "Setting the Search Directories" on page 4-11.*

You are now ready to debug your software as described in the next section.

Setting the Search Directories

The Search Directories option lets you maintain a list of directories that gdb960v uses when searching for files or modules for listing. Also, if the same filename exists in multiple directories, make sure the directory with the desired file is listed above any other directories that contain files with the same name.

1. Open the Source list menu and choose Search directories. This window appears:



2. Use these options to set up the search directories list:

Remove selected directory	Removes the selected directory from the search list.
Add directory after selection	Adds a new entry to the search directory list after the selection.
Pressing Insert directory before	Adds a new entry to the search directory list before the selection.

Both the Add directory after selection and the Insert directory before selection options present you with a dialog where you select a directory name.

When you are finished modifying the search list press the OK button.

Using the Debugger

Once you have connected to the target, loaded the file, and downloaded your program, you are ready to use gdb960's debugging features. In this section you learn how to

- List the code in C/C++, assembly language, or mixed code.
- Set permanent or temporary breakpoints.
- Run the program.
- Step through your code.

Code Display Options

After you have loaded symbols from a file, you have the option of displaying them in C/C++, assembly language, or mixed code.

1. Select the List mode menu. The List mode menu appears.
2. Choose the desired mode:

C	Displays C/C++ source code.
Assembly	Displays assembly language code.
Mixed	Displays a combination of C/C++ and assembly language code.

Setting Breakpoints

The debugger lets you set two kinds of breakpoints:

	Breakpoints, which stop execution at the indicated line of code each time the code is run.
	Temporary breakpoints, which stop execution at the indicated line of code the first time you run the program, but then are deleted.

There are two methods for setting and removing breakpoints:

Point and Click

Using the mouse, select the line where you wish to insert or remove a breakpoint, then press the right mouse button to set a breakpoint.

Drag and Drop

Drag a breakpoint or a temporary breakpoint icon to a location in the source pane. The breakpoint or temporary breakpoint icon appears in the debug margin at the file line number where you dropped the icon.

Running Your Program

Now that you have set your breakpoints, you are ready to run your program.

1. Press the Run button. The Target Run dialog appears.
2. In the Target Run, enter any program command line options.

For example, you might enter "`-debug`" in the box, and then your initial program module (`main() ?`) can parse these using the usual techniques of parsing argc, argv. This assumes you are using Intel's standard `crt960.o` startup routine.

3. Press Run.

NOTE. *You can set the default invocation arguments by assigning them to the targetRunArgs variable in your tcl configuration file See "Customizing the GUI" on page 4-18 for more information.*

When your program starts executing, the debugger changes the appearance of the screen in a number of ways. In the main window, the Run button changes to the re-Run button and the following new buttons appear:

Target interrupt: Lets you interrupt processing on the target board. Your board must have a break detect circuit to use this option (see xyz for more information on this). To resume execution from where it stopped, press the step, next, continue or finish buttons.

Step/next: Causes execution to resume for one line of C/C++ code, or assembly instruction (depending on which list mode is currently selected). The step button steps into calls, whereas the next button steps over calls.

Continue: Continues execution from where it stopped.

Finish: Continues execution until the current subroutine completes, then the debugger regains

	control in the calling statement.
Backtrace	Displays the backtrace window. See backtrace window below.
	Up stack frames: Causes the debugger to go to the scope of the caller of the current frame.
	Down stack frames: Causes the debugger to go down in stack frames closer to where the machine is actually executing.
`p p*`	**print/print star:** Lets you print (or, print with one level of indirection) what is currently selected in the source pane, and display it in the command window.
`i i*`	**Display/display *:** Display the value of the selection (or the selection with one level of indirection) in a separate window. The window updates whenever the variable changes values.

Once a program starts executing, the debugger regains control after:

- the program encounters one of the breakpoints you inserted, or
- the program encounter a fatal error, or
- you press the Target interrupt button.

When the debugger regains control, the source pane displays the C/C++ source code or assembly language corresponding to the location where execution halted, and the arrow icon (▶) appears in the debug margin adjacent to the C/C++ source statement or the assembly instruction where execution halted.

Using the Up and Down Stack Frames Feature

Pressing the up and down the stack frame buttons causes the debugger to display the contexts of the previous or next stack frames respectively. Two icons displayed in the debug margin help you in using this feature:

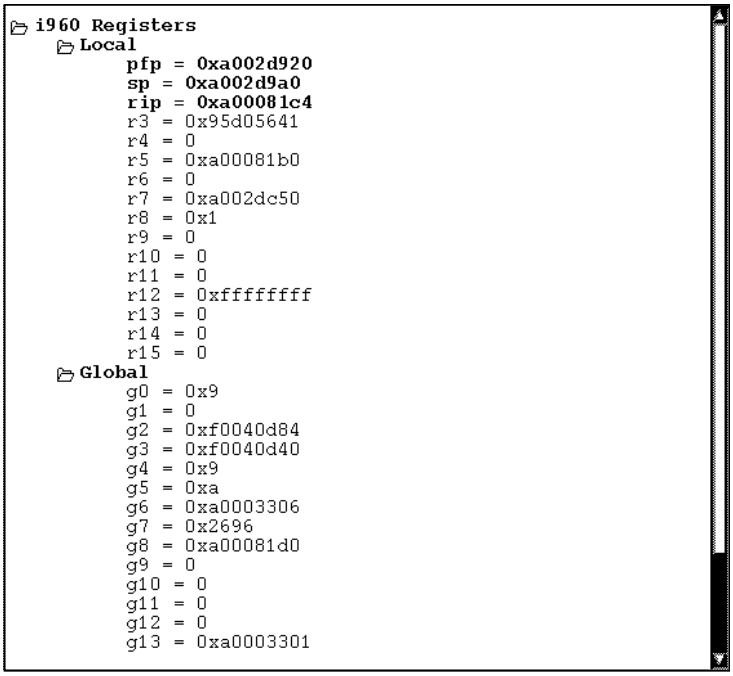
indicates the call site.

indicates the innermost frame.

Viewing the Contents of Registers

After you have run your program or stopped execution at a breakpoint, you may want to check the values of the i960 processor registers. To do so:

1. Open the Windows menu and choose Registers. This window appears:

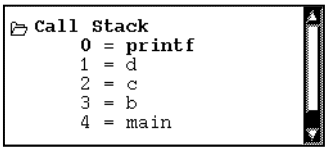


The window is updated each time the target halts, and if a value differs from the previous display, the value appears in bold. For example, in the register window above, the three registers pfp, sp, and rip have changed since the previous execution.

Using the Backtrace Window

When debugging software, it is often useful to step backwards through the calling sequence. gdb960v lets you do this any time after you have halted program execution. To use this feature:

1. Select the Windows menu and choose Backtrace, or press the Backtrace button on the toolbar. An interactive window displaying the program's call stack appears:



   The frame that corresponds to the source pane is set in bold. The Debug margin displays the current execution point going up and down in the backtrace. The register window changes to display the register values for the selected stack frame.
2. Click on any member of the call stack to display its contents in the source pane.

Using the Print/Print Star Options

The print and the print * buttons let you print (or, print with one level of indirection) what is currently selected in the source pane, and display it in the command window. For example, suppose in the source pane there is a line of source code that says:

```
foo(bar);
```

If you select the variable `bar` and press the print button, the command window displays the current value of the variable in the command window.

Editing Source Code

To edit your source code, drag the edit icon to the line that you want to change. If you drag the Edit icon, by default, the vi editor is brought up.

You can specify a different editor by setting the EDITOR environment variable. See "Customizing the GUI" on page 4-18 for more information.

Creating a New File

To create a new source file:

1. Open the File menu, and choose New.
2. In the dialog provided, enter the name of the file that you would like to create and the directory where it will reside.

The debugger brings up the text editor specified with the TCL EDITOR environment variable. See "Customizing the GUI" on page 4-18 for information on setting this option.

Exiting the Debugger

To exit the debugger:

1. Open the File menu and choose Exit.
   Alternatively, you can type **`quit`** in the command window.

Customizing the GUI

You can customize your configuration for many of the GUI's dialogs by editing the following TCL files. To set the options, you need to edit either of the following files:

```
$I960BASE$G960BASE/gui/host/resource/tcl/app-config/<host-type>.tcl
```

```
$HOME/.wind/crosswind.tcl
```

The second file is read in after the first one, and so can override values in the first file, which in turn overrides the default configuration. The first file is for customizations visible throughout the whole system, affecting all users, whereas the second file is for customizations specific to a user.

For example you may enter lines to set your target communication parameters:

```
set targetConnectSerialPort “01”
set targetConnectSerialBaud “9600”
set targetConnectSerialPPort “/dev/bpp0”
```

You may want to set the default invocation arguments by assigning them to the targetRunArgs. For example:

```
set targetRunArgs “-debug”
```

You may also want to specify the editor to use by setting the EDITOR environment variable, or by setting the textEditor TCL variable in the above .tcl files. For example:

```
set textEditor emacs
```

Configuring the gdb960 Environment 5

In this chapter, you learn some of the basic commands for configuring the gdb960 environment. Topics include:

- Rules for using gdb960 commands
- Commands for specifying files and directories
- gdb960 environment variables
- Using the `help` command, to access reference information on gdb960 commands
- Using the `show` command to determine the current gdb960 settings
- Using the `info` command to display register and breakpoint settings
- Setting the gdb960 command prompt
- Command line editing
- Using the History feature
- Shell and Make options
- Setting the gdb960 screen size
- Setting the radix (octal, decimal, hexadecimal)
- Message options
- Quitting gdb960

Rules for Using gdb960 Commands

Commands consist of a command name followed by arguments whose meaning depends on the command name. For example, the command `step` accepts an argument that is the number of times to step, as in `step 5`. You can also use the `step` command with no arguments. Some commands do not allow any arguments.

Command names may be truncated if the abbreviation is unambiguous. Some commands have pre-defined abbreviations. These are listed in the

description for individual commands. For example, `s` is specially defined as equivalent to `step` even though there are other commands whose names start with `s`. For more information on command line shortcuts, refer to Appendix B.

Entering a blank line at the gdb960 prompt repeats the previous command. Commands whose unintentional repetition might cause trouble are restricted from repeating in this way. Other commands (e.g., `list` and `x`) act differently when repeated. For example, `list` *n* shows the next *n* lines beyond those already listed rather than repeating the lines already displayed.

An input line starting with # is a comment; it does nothing. This is useful in command files. For additional information on command files, refer to Chapter 13.

File-specifying Options

When you invoke gdb960 from the command line, the debugger assumes that the first argument not preceded by one of the file-specifying command line options or by the option flags "`-`" or "`/`" specifies an executable file. For example, in this command line `program1` is the name of the executable from which symbolic information is read:

```
gdb960 -pci program1
```

This is equivalent to using the `-se` option described below. There are other options that let you perform such functions as changing the working directory, specifying additional search directories, and specifying whether the debugger loads a program's symbols before downloading and executing it.

`add-symbol-file` *`filename address`*
: The `add-symbol-file` command reads additional symbol table information from *`filename`*. Use this command when that file has been dynamically loaded (by some other means)

	into the running program. The *address* argument must be the memory address at which the file has been loaded. The symbol table of *filename* is added to the symbol table originally read with the `symbol-file` command. You can use the `add-syms` command any number of times; the new symbol data keeps adding to the old. In contrast, the `symbol-file` command loses all the symbol data gdb960 has read before loading new symbols.
`cd` *directory*	Set gdb960's working directory to *directory*.
`d` *directory*	Add *directory* to the search path for source files.
`e` *file*	Use *file* as the file to download and/or execute.
`exec-file` *filename*	Specify that the program to be run (but not the symbol table) is found in *filename*. The gdb960 debugger searches the environment variable `PATH`, when necessary, to locate the program. Use the `file` command to get both the symbol table and the program to run from the same file.
`file` *filename* `[ -p{c|d|x}` *offset* `]`	Use *filename* as the program to be debugged. It is read for its symbols and pure memory contents, and it is executed when you give the `run` command. If you do not specify a directory and the file is not found in gdb960's working directory, gdb960 uses the `PATH` environment variable as a list of directories to search. The `file` command with no argument leaves both the executable file and symbol table unspecified.

	If you specify `-pc`, `-pd`, or `-px`, symbols are relocated by adding *`offset`* to their values. These arguments act the same as their command-line counterparts. Refer to Chapter 12 for more information. After loading the debug data with the `file` command, you can download the code with the `load` command.
`info files`	Display the current target, including the names of the executable files currently in use by gdb960, and the files from which symbols were loaded.
`load [` *`filename`* `]`	This command downloads *`filename`* to the current target. If you have already specified an exec-file with the `file` or `exec-file` commands, then leaving out *`filename`* causes the current exec-file to be downloaded.
`readnow`	Read each symbol file's entire symbol table immediately, rather than the default, which is to read it incrementally as needed. This slows the symbol-file command, but speeds up other operations.
`s` *`file`*	Read symbol table from *`file`*.
`se` *`file`*	Read the symbol table from *`file`* and use it as the executable.
`symbol-file` *`filename`*	Read symbol table information from file *`filename`*. `PATH` is searched when necessary. Use the `file` command to get both the symbol table and the program to run from the same file. The `symbol-file` command with no argument clears out gdb960's information on your program's symbol table.

	The `symbol-file` command causes the gdb960 debugger to lose the contents of its convenience variables, the value history, and all breakpoints and auto-display expressions. This is because they may contain pointers to internal data recording symbols and data types that are part of the old symbol table data being discarded.
`x` *`file`*	Execute gdb960 commands from *`file`*. For more information on setting up a batch mode execution file, refer to Chapter 13. `-command` is a synonym for `-x`.

While all file-specifying commands allow both absolute and relative file names as arguments, gdb960 always converts the file name to an absolute.

gdb960 Environment Variables

The following is a list of environment variables recognized by the gdb960 debugger. Following each variable is a description of its use and its default value:

`COMSPEC`	Used by Windows systems only. Sets the shell to run for the shell command. Can be overridden with the SHELL variable.
`SHELL`	Sets the shell to run for the `shell` command. Defaults are: UNIX: `/bin/sh` Windows: Current setting of the `$COMSPEC` environment variable. If `$COMSPEC` is not set, the debugger then looks for `COMMAND.COM` in the current `PATH`.
`PATH`	Used by gdb960 to find executables when not found in the current directory.

`HOME`	Used by gdb960 to find `.gdbinit` and `.inputrc`. No defaults. The debugger always looks in the current directory for `.gdbinit` whether or not `$HOME/.gdbinit` is found. The debugger always takes `.inputrc` from the `$HOME` directory.
`HISTSIZE`	Sets number of gdb960 commands to save in history file. Default is 256.
`GDBHISTFILE`	Sets name of history file. Defaults are `.gdb_history` in the current directory for UNIX hosts; `hist.gdb` in the current directory in Windows.
`TERM`	Used to set up screen width and height from termcap database. Default is 80 x 24.
`I960ERR`	Windows only. If set, send `stdout` and `stderr` to different streams. Default is to mix `stdout` and `stderr`.
`G960BAUD`	Sets the default baud rate. Default is 38400 bps. Command line `-b` overrides `$G960BAUD`.

The help Command

The `help` command displays category- or command-specific help. The `help` command syntax is as follows:

`help [` *`option`* `]`	Displays information about gdb960 commands. When *`option`* is a command name, help displays a paragraph on how to use the command. With no arguments, `help` displays a short list of command categories; you can then enter the `help` command using one of the listed categories to replace *`option`*. The result is a list of the individual commands in the specified category.

The show Command

The `show` command displays the gdb960 software debugger's internal state. The following is the `show` command syntax:

`show` *`option`*	Where *`option`* is one of the `set` command options.

The following are some of the more commonly used `show` command options:

`version`	Displays version information for the currently running gdb960 software debugger.
`print`	Displays gdb960's print settings.
`editing`	Tells you whether command line editing is on or off.
`prompt`	Displays the current prompt string. For more information on the prompt string, see the `set prompt` command.

For a complete listing of the `show` options, refer to Chapter 12.

The info Command

The `info` command displays information about the program being debugged, for example, the program's registers or the status of the program's breakpoints. Following is the `info` command syntax and a description of the effects of two examples of the use of `info`:

`info` *`option`*	Where *`option`* is one of the `info` options listed in Chapter 12.

The following are examples of the `info` command:

`info registers`	Displays the registers of the program.
`info breakpoints`	Displays the current breakpoints.

For a complete listing of the possible arguments to `info`, refer to Appendix E.

The set prompt Command

The `set prompt` command changes the prompt string displayed by gdb960. The gdb960 software debugger indicates its readiness to read a command by printing a string called the prompt. This prompt string is normally `(gdb960)`.

`set prompt` *`newprompt`*	Directs gdb960 to use *`newprompt`* as its prompt string.

Command Line Editing

The gdb960 software debugger reads its input commands via the `readline` interface. This GNU library provides consistent behavior for programs that provide a command line interface to the user. Advantages are `Emacs`-style or `vi`-style in-line editing of commands, `csh`-like history substitution, as well as storage and recall of command history across debugging sessions. For detailed information on the command line editing capabilities of gdb960, refer to Appendix B, *Command Line Editing*.

The `set` command controls the behavior of command line editing in gdb960. The `show` command checks the status of command line editing. The following examples demonstrate the use of `set` and `show`. For a complete list of the options available for `set` and `show`, refer to Chapter 12.

`set editing` `set editing on`	Enable command line editing (enabled by default).
`set editing off`	Disable command line editing.
`show editing`	Show whether command line editing is enabled.

Using the History Feature

The `set history save` command causes each command entered at the gdb960 command line to be stored for later retrieval. You can store the commands to either a buffer or a file. History expansion commands allow retrieval of commands stored by `history`. Below is the `set history` command syntax followed by a list of and a description of the effects of the possible replacements for option in a `set history` command:

`set history [` *`option`* `]`

Where *`option`* may be any of the following:

`filename`	Set the gdb960 command history file to *`filename`*. The gdb960 debugger reads an initial command history list from this file and writes a history list to this file when you exit gdb960. The history list is accessed through history expansion or through the history command editing characters. By default, *`filename`* is `./.gdb_history` for UNIX hosts, and `./hist.gdb` for Windows hosts. However, when the `GDBHISTFILE` environment variable is set, the value of the `GDBHISTFILE` is used.
`save on`	Record the gdb960 command history in a file. By default, *`filename`* is `./.gdb_history` for UNIX hosts, and `./hist.gdb` for Windows hosts. However, when the `GDBHISTFILE` environment variable is set, the value of `GDBHISTFILE` is used. You can also specify a filename using the `set history file` command. By default, `set history save` is `off`.
`save off`	Stop recording command history in a file.

`size [`*`size`*`]`	Set the number of commands that gdb960 keeps in its history list. The default is the value of the `HISTSIZE` environment variable, or 256 when `HISTSIZE` is not set.

History Expansion

History expansion assigns special meaning to the exclamation point character (`!`). Since `!` is also the logical *`not`* operator in C/C++, history expansion is off by default.

NOTE. *When using `!` as a logical* `not` *in an expression while history expansion is enabled, you may sometimes need to follow `!` with a space or a tab to prevent it from being expanded. The `readline` history facilities do not attempt substitution on the strings `"!="` and `"!("` even when history expansion is enabled.*

The `set history` options to control history expansion are:

`expansion on`	Enable history expansion. History expansion is `off` by default.
`expansion off`	Disable history expansion.

The `show history` options to display the state of the gdb960 history parameters are:

`filename`	`show history` by itself displays all four states.
`save`	
`size`	
`expansion`	

For additional information about command line editing using `Emacs` or `vi`, refer to Appendix A. For additional options, refer to Chapter 12.

shell and make Commands

You can execute a shell command from within gdb960 in either Windows or UNIX systems by entering the `shell` command.

`shell`	Causes gdb960 to spawn a shell with a command prompt. Enter the `exit` command to the shell to return to gdb960.
`shell` *`command`*	Causes gdb960 to spawn a shell to execute *`command`*. The debugger uses the environment variable `SHELL` when it is set, otherwise gdb960 uses `/bin/sh`.

The utility `make` is often needed in development environments. The `shell` command is not needed to execute make. However, `make` must appear in the PATH:

`make …`	Causes gdb960 to spawn a shell run the `make` program with the arguments specified with the `make` command. This is equivalent to `shell make …`

Screen Size

Certain gdb960 commands may output large amounts of information to the screen. To help you read all of it, gdb960 pauses and asks you for input at the end of each page. Enter `RET` to continue. On UNIX, gdb960 sets the screen size based on settings from the termcap database, the value of the `TERM` environment variable, and the `stty rows` and `stty cols` settings. In Windows, gdb960 queries the host for the current screen dimensions. You can override the default settings with the `set height` and `set width` commands.

The gdb960 software debugger also uses the screen width setting to determine when to wrap lines of output. It tries to break the line at a readable place, rather than simply letting it overflow onto the following line.

`show height`
`show width`
`set height` *`lpp`*
`set width` *`cpl`*
	These set commands specify a screen height and a screen width, where *`lpp`* contains the number of lines on the screen, and *`cpl`* contains the number of columns on the screen. The associated show commands display the current setting. If you specify a height of zero lines, gdb960 does not pause during output, no matter how long the output is. This is useful if output is to a file or to an editor buffer.

Setting Radix

You can enter numbers in octal, decimal, or hexadecimal in gdb960 using the standard conventions: Octal numbers begin with "`0`" and hexadecimal numbers begin with "`0x`." Numbers that begin with none of these are, by default, entered in base ten; likewise, the default display for numbers when no particular format is specified is base ten. You can change the default base for both input and output with the `set radix` command.

`set radix` *`base`*	Set the default base for numeric input and display. Supported choices for *`base`* are decimal 8, 10, 16. *`base`* must be specified either unambiguously or using the current default radix.
`show radix`	Display the current default base for numeric input and display.
`set input-radix` *`base`*	Set the default base for numeric input that you provide.

`set output-radix` *`base`*	Set the default base for numeric output printed by gdb960.
`set radix` *`base`*	Set both input and output bases.

Messages, Complaints and Cautions

By default, gdb960 is silent about its inner workings. The `set verbose` command forces gdb960 to display messages during lengthy internal operations.

Currently, the messages controlled by `set verbose` announce that the symbol table for a source file is being read.

`set verbose on`	Enables gdb960's output of informational messages.
`set verbose off`	Disables gdb960's output of informational messages.
`show verbose`	Displays whether `set verbose` is on or off.

You can tell gdb960 to display a message when it encounters a bug in an object file's symbol table. By default, gdb960 does not display such messages.

`set complaints` *`limit`*	Permits gdb960 to output *`limit`* complaints about each type of unusual symbol before becoming silent about the problem. The default is zero, off. Set `limit` to a large number -- five is reasonable -- to prevent complaints from being suppressed.
`show complaints`	Displays how many symbol complaints gdb960 is permitted to produce.

By default, gdb960 provides cautions in its queries for information. For example, if you try to run a program that is already running, the debugger displays the message shown in the following example:

```
(gdb960) run
The program being debugged has been started already.
Start it from the beginning? (y or n)
```

You can use these options to enable or disable this feature:

`set confirm off`	Disables cautions.
`set confirm on`	Enables cautions (the default).
`show confirm`	Displays state of cautious questions.

Exiting gdb960

To exit the gdb960 software debugger, use the `quit` command (abbreviated `q`), or type an end-of-file character, usually `CTRL + d`. An interrupt, often `CTRL + c`, does not exit from gdb960, but terminates the action of any gdb960 command that is in progress and returns control to the gdb960 command line.

Example gdb960 Session

6

This chapter contains an example session of the gdb960 Software Debugger. The session provided here uses a variation on "hello, world." In the example, you perform the following tasks:

1. list the program
2. compile the program
3. invoke the debugger
4. load the program
5. set a breakpoint
6. list lines
7. set another breakpoint
8. execute to the breakpoints
9. examine data
10. exit from the program and the debugger

Example Session

This extended example demonstrates a minimal set of gdb960 commands. Follow the example sequence to familiarize yourself with the debugger and the command line interface. Experiment with the other commands described in this manual.

The following is a UNIX listing of the example program:

```
$ cat hello.c
char buf[20] = "hi there";

main(argc, argv)
int argc;
char *argv[];
{
    int i = 8;
    buf[i++] = ',';
    buf[i++] = '\0';
    strcat(buf, " ya'll");
    printf ("%s\n", buf);
}
```

The two compiler invocation lines below demonstrate a build of the example program using gcc960 and ic960, respectively. For more information on the two compilers, refer to your compiler user's guide. In the example compile lines, the test program is built for the Intel EV80960CA evaluation board:

```
$ gcc960 -g -Tmevca -o hello hello.c
$ ic960 -g -Tev960ca -o hello hello.c
```

The example assumes a UNIX system and a serial port, `/dev/tty01`. To familiarize yourself with a work session with the gdb960 software debugger, perform the following actions:

1. Invoke the gdb960 debugger by entering the following command:

   ```
   $ gdb960 -r 01
   ```

2. The following messages appear:

   ```
   GDB is free software and you are welcome to distribute
   copies of it under certain conditions; type "show
   copying" to see the conditions.

   There is absolutely no warranty for GDB; type "show
   warranty" for details.

   gdb960 2.4, Thu Mar 10 09:14:12 PST 1995
   GDB 5.0 (host --target i960-intel-mon960),
   ```

```
Copyright 1993 Free Software Foundation, Inc.
Connected to /dev/tty01 at 38400 bps.
```

3. Once the prompt returns, specify the file gdb960 is to read the symbol table from by entering the `file` command:

```
(gdb960) file hello
Reading symbols from hello...done.
```

4. Enter the load command to download the program and prepare for execution:

```
(gdb960) load
section 0, name .text, address 0xe0008000, size 0x4c9c, flags 0x20
        writing section at  0xe0008000
section 1, name .data, address 0xe000cca0, size 0x18, flags 0x40
        writing section at  0xe000cca0
section 2, name .bss, address 0xe000ccc0, size 0x68c, flags 0x80
-- noload
```

5. Set a breakpoint after the initialization code and at the first executable line in `main()`:

```
(gdb960) b main
Breakpoint 1 at 0xe0008100: file hello.c, line 8.
```

6. Run the program until it encounters the breakpoint at the first line of main:

```
(gdb960) run
Starting program: /ffs/a/peters/gdb960/tutorial/hello
Breakpoint 1, main (argc=1, argv=0xe000d0c0) at hello.c:8
8                       int i = 8;
```

7. List ten lines, centered around the encountered breakpoint:

```
(gdb960) list
1
2   char         buf[20] = "hi there";
3
4   main(argc, argv)
5   int argc;
6   char *argv[];
7   {
8               int i = 8;
9               buf[i++] = ',';
10              buf[i++] = '\0';
```

8. Set a breakpoint on line 10:

```
(gdb960) b 10
Breakpoint 2 at 0xe0008120: file hello.c, line 10.
```

9. Continue execution until the second breakpoint is encountered:

```
(gdb960) c
Continuing.
Breakpoint 2, main (argc=1, argv=0xe000d0c0) at hello.c:10
10                        buf[i++] = '\0';
```

10. Display the contents of the eighth element of the `buf` array:

```
(gdb960) p buf[8]
$1 = 44 ','
```

11. Step to the next line:

```
(gdb960) n
11                      strcat(buf, " ya'll");
```

12. Display the string held in `buf` after executing the eighth line:

```
(gdb960) p buf
$2 = "hi there,\000\000\000\000\000\000\000"
```

13. Step to the next line:

```
(gdb960) n
12                      printf("%s\n", buf);
```

14. Display the string held in `buf` after executing the eleventh line:

```
(gdb960) p buf
$3 = "hi there, ya'll\000\000\000\000"
```

15. Continue execution until the program terminates:

```
(gdb960) c
Continuing.
hi there, ya'll
Program exited with code 020.
```

16. Quit the debugger:

```
(gdb960) q
Terminating old session with dev/tty01
$
```

Running Your Program with gdb960 7

This chapter describes how to complete the following tasks:

- Run programs from the gdb960 debugger
- Specify arguments for your program
- Set the working directory for gdb960
- Set the environment for gdb960

Running Programs

Complete the following steps:

1. Make sure you recompile your software to include debugging information as described in Chapter 2.
2. Run gdb960 and specify the name of the file that you would like to execute, as described in Chapter 2. For example:

   ```
   gdb960 -pci myprogram
   ```

Note that you can use the file specification options (e.g., `file`, `exec-file`) described in Chapter 5 to specify a different file to execute after gdb960 has loaded.

3. Enter the `run` command, using the syntax:

   ```
   run [arguments]
   ```

   where *`arguments`* specifies any arguments that your program accepts on the `run` command. Alternately, use `set` *`args`* to set the program arguments.

Entering a `run` command begins program execution immediately. For a discussion of how to stop and restart a program by using breakpoints, refer to Chapter 8.

Setting Your Program's Arguments

The arguments to your program are specified as arguments to the `run` command. The run command passes them directly to the monitor target to be used during the invocation of your program.

NOTE. *Entering `run` with no arguments invokes your program with the same arguments used by the previous `run`.*

The following commands allow you to change or examine the arguments to be passed the next time your program is invoked by the `run` command:

`set args` [*`arguments`*]	The command `set args` can be used to specify the arguments to use the next time the program is run. If `set args` has no arguments, it means to use no arguments the next time the program is run. This way, you can run your program with arguments and set it to run again with no arguments.
`show args`	Show the arguments to be used by your program when it next starts.

Setting Your Program's Working Directory

Each program invocation with `run` inherits its working directory from gdb960's current working directory. The gdb960 debugger's working directory is initially inherited from its parent process (typically the shell). The `cd` command allows specifying a new working directory in gdb960.

The gdb960 working directory also serves as a default for the commands that specify files on which gdb960 operates.

`cd` *`directory`*	Set gdb960's working directory to *`directory`*.
`pwd`	Display gdb960's working directory.

Your Program's Environment

At startup, gdb960 inherits the environment from your current shell. This environment is then passed on to MON960, where it becomes available to your program.

Up to 20 environment variables can be passed to the program via MON960. The typical UNIX environment is larger than that. It may be necessary to start your UNIX shell with a stripped-down environment if you need to pass variables to your application. One common way to do this is to give the UNIX command:

```
env - /bin/ksh
```

where `/bin/ksh` is the shell that is used to start up gdb960.

The following commands allow you to change or examine the program environment:

`set environment` *`varname`* `[`*`value`*`]`	Set environment variable *`varname`* to *`value`*. The environment change is visible to your program, not to gdb960. If optional *`value`* is omitted, *`varname`* is set to NULL. `environment` can be abbreviated `env`.
`show environment` `[`*`varname`*`]`	Show the value of environment variable *`varname`*, or all variables if *`varname`* is omitted.
`unset environment` `[` *`varname`* `]`	Remove the variable *`varname`* from the environment. If *`varname`* is omitted, remove all environment variables.
`path` *`directory`*	Add *`directory`* to the front of the PATH environment variable. (the search path for

executables). You may specify several directory names, separated by ':' or white space (';' or white space on Windows).

Program Execution Control 8

This chapter describes the features of the gdb960 debugger that allow you to halt, examine, and restart your program.

A debugger allows you to interrupt program execution to inspect the internal state of the program. The gdb960 debugger provides breakpoints, conditional breakpoints, and watchpoints to monitor execution and halt execution at instructions you have identified, or when conditions you have defined develop.

Breakpoints

A breakpoint halts program execution when the execution point reaches a pre-selected instruction in the program. Set breakpoints explicitly with gdb960 commands, specifying by line number, function name, or exact address the line on which the program should halt execution. Conditions describing the internal state of the program can be added to breakpoints. When the breakpoint is encountered, the debugger interrupts the programs operation and evaluates the stop conditions. If the conditions evaluate to false, then the debugger silently continues program execution. If the conditions evaluate to true, then the debugger announces the interruption. The effects of momentary interruptions to a real-time system must be considered when setting conditional breakpoints.

When each breakpoint is created, the debugger assigns it a number. The numbers are successive integers starting with 1. In commands for controlling breakpoint features, the breakpoint number determines which breakpoint is affected. Each breakpoint can be enabled or disabled; if disabled, it cannot effect program execution until enabled.

Breakpoints are set with the `break` command (abbreviated `b`). The gdb960 software debugger allows any number of breakpoints on the same line in a program. When it resumes execution, the gdb960 debugger ignores breakpoints until at least one instruction has been executed. Otherwise, you could not proceed past a breakpoint without first disabling it.

Refer to Chapter 2 for more information on breakpoints and symbolic debugging of optimized code.

The following is a list of commands that create, examine, or manipulate breakpoints. Accompanying each command is a description of its use:

`break`	Set a breakpoint at the next instruction to be executed in the selected stack frame. A breakpoint set with `break` in the innermost frame halts execution the next time it reaches the current location. In any selected frame but the innermost, the breakpoint causes the program to halt as soon as control returns to that frame. For more detail on how stack frames are selected and moving from frame to frame, refer to Chapter 9.
`break *`*`address`*	Set a breakpoint at *`address`*. You can set breakpoints in parts of the program that do not have debugging information or source files. The asterisk allows the command line parser to identify *`address`* as an address rather than a number.
`break [` *`filename:`* `]` *`function`*	Set a breakpoint at entry to *`function`* in *`filename`*. Specifying a file name is unnecessary except when multiple files contain functions with the same name.
`break [` *`filename:`* `]`*`linenum`*	Set a breakpoint at line *`linenum`* in source file *`filename`*. If *`filename`* is

	not specified, it defaults to the current file.
`break ... if` *`cond`*	Set a breakpoint with condition *`cond`*; evaluate the expression *`cond`* each time the breakpoint is reached, and halt only if the value is non zero. An ellipsis, "`...`", stands for one of the possible arguments described above (or no argument) specifying where to break. See the *Break Conditions* section in this chapter for more information on breakpoint conditions.
`break +`*`offset`* `break -`*`offset`*	Set a breakpoint *`offset`* number of lines forward or back from the execution point in the currently selected frame.
`hbreak` *`args`*	For MON960, only. Set a hardware breakpoint, abbreviated `hb`. The arguments list, *`args`*, allows the same arguments that are listed in the `break` command, and the breakpoint is set the same way. Hardware breakpoints allow breakpoints in non-writeable code (e.g., code that resides in ROM or FLASH). Breakpoints set with the break command are silently ignored when set in code that resides in non-writeable memory. You may set any number of hardware breakpoints, but i960 processor architectures allow only two to be enabled at any one time. If more than

	two are enabled, the lowest two breakpoint numbers are honored and all others are automatically disabled.
`info break [ bnum ]`	The command `info break` displays a list of all breakpoints set and not deleted, showing their numbers, where in the program they are, and any special features related to them. Disabled breakpoints are included in the list and marked as disabled. Specifying a breakpoint number after the `info break` command lists only information about the breakpoint associated with the specified number. The `info break` command sets the convenience variable `$_` and the default examining-address for the `x` command to the address of the last breakpoint listed.
`info watch`	This is a synonym for `info break`.
`rbreak regex`	Set a breakpoint on all functions matching *regex*. This command sets an unconditional breakpoint on all matches, displaying a list of all breakpoints set. Once the breakpoints are set, they are treated just like the breakpoints set with `break`. They can be deleted, disabled, made conditional, etc., in the standard ways.

`tbreak` *`args`*	Set a breakpoint that only halts execution once. The arguments list, *`args`*, is the same as in the `break` command, and the breakpoint is set the same way, but the breakpoint is automatically disabled the first time it is encountered. For more information on disabling breakpoints, refer to the *Disabling Breakpoints and Watchpoints* section in this chapter.

Watchpoints

A watchpoint is a breakpoint that halts your program only when a specified expression's value changes. Watchpoints are set with the `watch` command. Watchpoints are managed like other breakpoints and are enabled, disabled, and deleted using the same commands used for other breakpoints.

There are two types of watchpoints:

1. Hardware-assisted watchpoints use i960 registers and evaluate at normal execution speed.
2. Software watchpoints depend on single-stepping and are slower.

Hardware watchpoints are available on i960 Cx, Jx, Rx, and Hx processors. A maximum of two hardware watchpoints can be set at any one time (six on the Hx processors).

When you specify a watchpoint with the watch command, gdb960 determines automatically if the target hardware supports hardware watchpoints. If so, and if there are sufficient hardware watchpoint registers available, they are allocated to your watchpoint. Otherwise, a software watchpoint is generated. The `awatch` and `wwatch` commands are available for setting only hardware-assisted watchpoints.

Watchpoints find bugs when the module, function or location causing the problem is unknown. For all types of watchpoints, provide a specifier for a memory location (*expr* below; i.e., not a register or machine address, but a variable like `arg[10]`). The gdb960 debugger converts the expression into an address.

`awatch` *expr*	Set a memory access hardware watchpoint. Memory access watchpoints halt program execution when any read or write is attempted at the address of *expr*.
`watch` *expr*	Set a watchpoint on *expr*. Use hardware resources if available.
`wwatch` *expr*	Set a memory write hardware watchpoint. Memory write watchpoints halt program execution when a write is attempted at the address of *expr*.

Deleting Breakpoints and Watchpoints

The `clear` command lets you delete breakpoints according to their placement in the program. The `delete` command lets you delete individual breakpoints by specifying their breakpoint numbers. A deleted breakpoint no longer exists in any sense; it is forgotten.

NOTE. *The gdb960 debugger automatically ignores breakpoints on the first instruction to be executed when you continue execution without changing the execution address. This prevents the debugger from stalling on a breakpoint.*

The following is a list of commands that remove breakpoints or watchpoints:

`clear`	Delete any breakpoints at the next instruction to be executed in the selected stack frame. When the innermost frame is selected, clear deletes the breakpoint at which the program halted.
`clear function` `clear` *`filename:function`*	Delete any breakpoints set at the entry to the function *`function`*.
`clear linenum` `clear` *`filename:linenum`*	Delete any breakpoints set at or within the code of the specified line.
`delete breakpoints` *`bnums...`* `delete` *`bnums...`* `delete`	Delete the breakpoints of the numbers specified as arguments. If no argument is specified, delete all breakpoints.

Disabling Breakpoints and Watchpoints

Once a breakpoint is created, it can be set to one of the four following states:

- Enabled. The breakpoint halts the program. A breakpoint made with the `break` command starts out in this state.
- Disabled. The breakpoint has no effect on the program.
- Enabled once. The breakpoint halts the program, but when it does so it is disabled. A breakpoint made with the `tbreak` command starts out in this state.
- Enabled for deletion. The breakpoint halts the program, but immediately after the breakpoint is deleted permanently.

Disabling renders a breakpoint inoperative. However, a disabled breakpoint can be enabled again.

Disable and enable breakpoints with the `disable` and `enable` commands, optionally specifying one or more breakpoint numbers as arguments.

NOTE. *Use* `info break` *to display a list of breakpoints if you don't know which breakpoint numbers to use.*

The following is a list of commands and descriptions for enabling or disabling breakpoints:

`disable breakpoints` *`bnums`*	Disable the breakpoints listed in `bnums`.
`disable` *`bnums`*	Any number of breakpoints may be listed by number. Separate each number from the next by a space. The `breakpoint` keyword is not necessary unless differentiating between disabling display and disabling breakpoints. The default is to disable breakpoints.
`disable`	If no list of breakpoints is specified, all breakpoints are disabled. A disabled breakpoint has no effect but is not forgotten. All options such as ignore-counts, conditions and commands are remembered in case the breakpoint is enabled again later.
`enable breakpoints` *`bnums`* `enable` *`bnums`* `enable`	Enable the breakpoints specified in `bnums`. If `bnums` is not specified, enable all defined breakpoints.
`enable once` *`bnums`*	Enable the specified breakpoints temporarily. Each is disabled the next time it halts your program.
`enable delete` *`bnums`*	Enable the specified breakpoints temporarily. Each is deleted the next time it halts your program.

Except for a breakpoint set with `tbreak`, breakpoints are enabled or disabled only when you use one of the above commands.

NOTE. *The command* `until` *can set and delete a breakpoint, but it does not change the state of your breakpoints. The* `until` *command is described later in this chapter.*

Break Conditions

Execution is halted every time an enabled breakpoint is encountered. To customize a breakpoint to halt execution only under special conditions, a conditional expression can be attached to the breakpoint. Conditional breakpoints cause momentary program interruption, which can affect real-time programs. Execution halts only if the expression evaluates to true.

Any valid C/C++ expression in scope when the breakpoint is reached can be used in a breakpoint condition.

Breakpoint conditions can have side effects, and may even call functions in your program. This can useful, for example, to activate functions that log program progress, or to use your own print functions to format special data structures. The effects are predictable unless there is another enabled breakpoint at the same address. In that case, gdb960 might encounter the unexpected breakpoint first and halt execution without checking the expected breakpoint. Note that breakpoint commands are usually more convenient and flexible for the purpose of performing side effects when a breakpoint is reached.

When a breakpoint is set, break conditions can be specified by using `if` in the arguments to the `break` command. Breakpoint conditions can also be changed at any time with the `condition` command. The following is a list of condition commands and their effects on the breakpoints to which they are applied:

`condition` *`bnum expression`* — Specify *`expression`* as the break condition for breakpoint number *`bnum`*. The breakpoint halts the program only if the value of *`expression`* is true (non zero, in C/C++). The *`expression`* is not

evaluated when the `condition` argument is given. When you enter the `condition` argument to the `break` command, the *`expression`* you specify is checked immediately for syntactic correctness and to determine whether symbols in it are defined in the scope of your breakpoint. For more information on examining data, refer to Chapter 11.

`condition` *`bnum`* — Remove the condition from breakpoint number *`bnum`* to make it an unconditional breakpoint.

Each breakpoint has an integer value called an `ignore` *`count`* associated with it. The integer is set to 0 for enabled, unconditional breakpoints. The `ignore` *`count`* command sets the integer to a positive value. Each time execution encounters the breakpoint, the ignore count value is decremented by 1. When the value reaches 0, the breakpoint halts execution and any set conditions are evaluated. The following is a list of commands that manipulate *`count`* and execution:

`ignore` *`bnum count`* — Set the count of breakpoint number *`bnum`* to *`count`*. The next *`count`* times the breakpoint is reached, your program's execution does not halt; other than to decrement the ignore count, gdb960 takes no action.

To make the breakpoint halt the next time it is reached, specify a count of zero.

`continue [` *`count`* `]`
`fg [` *`count`* `]` — Continue executing the program. If *`count`* is specified, ignore *`count`* of the breakpoint that halted execution to *`count`* minus one. The program does not halt at the breakpoint again until the breakpoint is encountered *`count`* times.

Except when halted at a breakpoint, the argument to `continue` is ignored.

The synonym `fg` is provided for convenience, and has exactly the same behavior as `continue`.

NOTE. *If a breakpoint has a positive ignore count and a condition, the condition is evaluated each time the breakpoint is hit, but execution does not stop until the ignore count reaches zero.*

Commands Executed on Breaking

You can give any breakpoint a series of commands to execute after execution halts at a breakpoint. For example, you might want to display the values of certain expressions, or enable other breakpoints. The following command allows creation of a list of commands that can be associated with breakpoints:

`commands` *`bnum`*

Specify a list of commands for breakpoint number *`bnum`*. Enter the commands one per line on separate lines following `commands`. Type a separate line containing the `end` command to terminate the commands.

To remove all commands from a breakpoint, follow `commands` immediately by `end`.

NOTE. *With no arguments, `commands` refers to the last breakpoint set, not to the breakpoint most recently encountered.*

Breakpoint commands can re-start execution. The `cont` or `step` commands begin execution again. However, any further commands in the same command list are ignored. When execution halts again, gdb960 executes any command list associated with the breakpoint that causes the halt.

If `silent` is the first command specified in a command list, the usual message about halting at a breakpoint is not displayed. This may be desirable for breakpoints that are to display a specific message and then continue. If the remaining commands also display nothing, you see no sign that the breakpoint was reached at all. The `silent` command is meaningful only at the beginning of the command list for a breakpoint. The following example displays the value of *x* at entry to `foo` when *x* is positive; then continues execution:

```
break foo if x>0
commands
silent              # Don't print normal bp stuff.
print x             # What is x's value?
cont                # Resume program.
end
```

NOTE. *The commands `echo` and `output` allow more precise display control of output and are often useful in silent breakpoints.*

The following example of a command list shows correction of one bug so another can be pursued without reinvoking the program. The example places a breakpoint just after an error in the code, gives the breakpoint a condition to detect the error case, and adds a command list that assigns

correct values to variables that need them. The command list starts with the `silent` command so no output is produced and ends with the `cont` command so the program does not halt:

```
break 403
commands
silent
set x = y + 4
cont
end
```

Continuing

The continue command allows you to re-start a halted program.

`continue cont`	Continue running the program where it halted.

If the program halted at a breakpoint, execution resumes at the address of the breakpoint, but the breakpoint is not taken.

Stepping

Stepping means executing a line of code, or set of lines, according to restrictions set by the `step` command. Control returns automatically to the debugger after one line of code. Breakpoints are active during stepping, and execution halts if a breakpoint is encountered on a machine instruction. The `step` command may be given when control is within a function that has no debugging information. Execution proceeds until control reaches another function, or is about to return from this function. The following is a list of stepping commands and their descriptions:

`finish`	Continue execution until after the selected stack frame returns (or until there is some other reason to halt, such as a fatal signal or a breakpoint). Display the value returned by the selected stack frame.

`next`	Similar to `step`, but function calls in a line are executed without halting or taking special actions inside them. Execution halts when control reaches a new line of code at the stack level that was executing when the `next` command was given or if another breakpoint is hit. `next` is abbreviated as `n`. A *`count`* argument is a repeat count, as in `step`.
`nexti` `nexti` *`count`*	Execute one machine instruction, but if it is a subroutine call, proceed until the subroutine returns. A *`count`* argument is a repeat count, as in `step`.
`step`	Execute one line of code then halt execution and return control to the debugger. This command is abbreviated as `s`.
`step` *`count`*	Execute *`count`* lines. If a breakpoint or a signal not related to stepping is encountered before *`count`* steps, execution halts.
`stepi` `stepi` *`count`*	Execute one machine instruction, then halt and return control to the debugger. It is often useful to do `display/i $ip` when stepping by machine instructions. This causes the next instruction executed to display automatically at each halt. For more information on examining data, refer to Chapter 11. A *`count`* argument is a repeat count, as in `step`.
`until`	The `until` command allows execution of all iterations of a loop as a single step. The `until` command with no arguments causes execution to continue until the program reaches a source line greater than the current source line. The `until` command always halts the program if it attempts to exit the current stack frame.

With no argument, `until` works like single instruction stepping, and hence is slower than `until` with an argument. The until command accepts all the same arguments as the `break` command.

`until` *`location`* Continue running the program until either the specified location is reached, or the current (innermost) stack frame returns. *`location`* can be any argument form acceptable to `break`. This form of the `until` command uses breakpoints, and hence is quicker than `until` without an argument because it need not break on every machine instruction.

A typical technique for using stepping is to put a breakpoint (see the *Breakpoints* section) at the beginning of the function or program section where a problem is believed to be, execute to the breakpoint, then step through the suspect area, examining the interesting variables until the problem occurs.

The `cont` command can be used after stepping to resume execution until the next breakpoint or signal.

Continuing at a Different Address

Ordinarily, when you continue the program, you do so from the place it stopped, with the `cont` command. You can instead continue from any address you choose using the following commands:

`jump` *`linenum`* Resume execution at line number *`linenum`*. Execution may stop immediately if there is a breakpoint there.

The `jump` command does not change the current stack frame, the stack pointer, the contents of any memory location, or any register other than the instruction pointer. If line *`linenum`* is in a

different function from the one currently executing, the results may be unpredictable if the two functions expect different patterns of arguments or of local variables. For this reason, the `jump` command requests confirmation if the specified line is not in the function currently executing. However, results are predictable based on careful study of the machine-language code of the program.

`jump *`*`address`*

Resume execution at the instruction at address *`address`*. The asterisk allows the command line parser to identify *`address`* as an address rather than a number.

You can get much the same effect as the `jump` command by storing a new value into the register `$ip`. The difference is that the program does not start running; only the address where it will run when it is continued changes. For example:

```
set $ip = 0x485
```

causes the next `cont` command or stepping command to execute at address 0x485, rather than at the address where the program stopped.

The most common use of the `jump` command is to back up, perhaps with more breakpoints set, over a portion of a program that has already executed.

gmu Commands

The gmu commands allow interactive control over the Guarded Memory Unit (GMU). They apply to the Hx processor only.

gmu protect and gmu detect specify the type of GMU register to control, either protection (protect) or detection (detect). Protection GMU registers are identified by number, ranging from 0 to NUMPREGS - 1. NUMPREGS is currently 2 on the Hx processors. Detection GMU registers are identified by number, ranging from 0 to NUMDREGS - 1. NUMDREGS is currently 6 on the Hx processors.

gdb960 records the gmu define commands in an internal data structure called the command cache. If you later invoke the file command, gdb960 reprograms the GMU using the commands in the command cache. This allows the same GMU definitions to be used repeatedly while only the file name changes. Since the gmu define commands accept expressions, as well as addresses, you can protect a section of memory without knowing its exact size. If the section's size changes due to recompilation, the GMU settings still work, regardless of the change.

gmu detect
gmu protect

Following is the gmu detect and gmu protect command syntax, a description of the effects of the possible options, and examples of use. Refer to Chapter 12 for further discussion of gmu syntax and arguments.

gmu detect | protect *subcommand*	Allows control over the Hx processor Guarded Memory Unit, and specifies the type of GMU register to control, either protection (protect) or detection (detect). *subcommand* specifies the action to perform on the register. Following are the *subcommand* options for the gmu protect and gmu detect commands.
define	Initialize and enable the specified register.

`disable`	Disable the previously-defined register.
`enable`	Enable the previously-defined register.

You may also use the `info gmu` command to print a table of all current GMU registers. Refer to Chapter 12 for more information on the `info` command.

Syntax

`gmu detect define` *`regnum access startaddress endaddress`*

Initializes and enables the specified GMU detection register.

`regnum`	Specifies a detection register number.
`access`	Specifies which types of memory access can cause a GMU fault. The string has the form *`modetype`*`[,`*`modetype`*`]` where *`mode`* is either `u` or `s`, for user mode access or supervisor mode access. *`type`* is a string of one or more letters from Table 8-1. An optional second *`modetype`* may be given to program both user and supervisor modes in the same command. An example of a valid *`access`* argument is `urw,sx`, which means *fault on a user mode read or user mode write or a supervisor mode execute*.
`startaddress`	Evaluates to the starting address of the desired detection range.
`endaddress`	Evaluates to one byte beyond the ending address of the desired detection range.

`gmu detect disable [`*`regnum`*`]`

Disables the specified GMU detection register. Clears the memory detection enable bit for this register in the GMU control register. If *`regnum`* is omitted, disable all GMU detection registers.

`gmu detect enable [`*`regnum`*`]`

Enables the specified GMU detection register. Sets the memory detection enable bit for this register in the GMU control register. If *`regnum`* is omitted, enable all GMU detection registers.

`gmu protect define` *`regnum access address mask`*

Initializes and enables the specified protection GMU register.

`regnum`	Specifies a protection register number.
`access`	Specifies which types of memory access can cause a GMU fault. The string has the form *`modetype`*`[,`*`modetype`*`]` where *`mode`* is either `u` or `s`, for user mode access or supervisor mode access. *`type`* is a string of one or more letters from Table 8-1. An optional second *`modetype`* may be given to program both user and supervisor modes in the same command. An example of a valid *`access`* argument is `urw,sx`, which means *fault on a user mode read or user mode write or a supervisor mode execute*.
`address`	Evaluates to the starting address of the desired protection range.
`mask`	Evaluates to a number describing the addressing constraints for this range. For more information, refer to the *i960 Hx Microprocessor User's Manual*.

Table 8-1 Access Types

Access Type	Access Type Symbolic Name
Read	r
Write	w
Execute	x
Data Cache Write	c
None (clears previous settings)	n

`gmu protect disable [`*`regnum`*`]`

Disables the specified GMU protection register. Specifies a GMU protection register number. Clears the memory protection enable bit for this register in the GMU control register. If *`regnum`* is omitted, disable all GMU protection registers.

`gmu protect enable [`*`regnum`*`]`

Enables the specified GMU protection register. Set the memory protection enable bit for this register in the GMU control register. If *`regnum`* is omitted, enable all GMU protection registers.

Examples

```
(gdb960) gmu protect define 0 urwxc 0 0xfffc0000
```

This example establishes 256 KB of illegal access protection beginning at address 0. Any user-mode access to this memory range triggers a fault. All supervisor-mode access is allowed without generating a fault. Protection register 0 is used.

```
(gdb960) gmu detect define 4 sw,uw 0xa0010000 0xa0020000
```

This example initializes detection register 4 as follows: 64 KB of illegal access detection beginning at address 0xa0010000. Either a user-mode write or a supervisor-mode write to this memory range triggers a fault.

Examining the Program Stack 9

The gdb960 debugger provides commands for examining the stack. It allows you to see information about where the call was made and the local variables of the called function. Each function call causes information to be saved in a block of data called a stack frame. The stack frame also contains the call's arguments. All stack frames are allocated from a region of memory called the call stack.

The gdb960 debugger selects one of the stack frames, and many gdb960 commands act on the selected frame. In particular, when you ask gdb960 for a variable's value, the value is sought in the selected frame. Commands are provided in gdb960 to allow selection of any stack frame.

When execution halts, gdb960 automatically selects the currently executing frame and describes it briefly. This chapter provides information about manipulating stack frames, selecting frames, creating traces, and extracting information from selected frames.

Stack Frames

The call stack is divided into contiguous pieces called stack frames, or frames. Each frame contains the data associated with a call to a function. A frame contains the function's arguments, its local variables, and its execution address.

When your program starts, the call stack contains a frame for all-purpose execution. You might call this the `start` frame, which is how gdb960 prints it for `backtrace`. The function `main` is actually in the second-to-the-outermost frame. The starting frame is called the initial frame or the outermost frame. Each time a function is called, a new frame is created. Each time a function returns, its frame is eliminated from the call stack. If

a function is recursive, there can be many frames for the same function. The frame for the function where execution is actually occurring is called the innermost frame. This is the most recently created of all the stack frames that still exist.

Stack frames are identified by addresses. A stack frame consists of many bytes, each of which has its own address; different hosts have different conventions for choosing a byte whose address serves as the frame address. On i960 processors, the address of the currently executing frame is kept in the frame pointer register.

The gdb960 debugger assigns numbers to all existing stack frames, starting with zero for the innermost frame, one for the frame that called it, and so on. These numbers are record keeping devices for gdb960. They do not really exist in your program; they provide a way of describing stack frames in gdb960 commands.

When program execution halts, gdb960 automatically selects the innermost stack frame. Many gdb960 commands refer implicitly to the selected stack frame. You can select any frame using gdb960 command frame. Once selected, gdb960 commands operate on the newly-selected frame.

Backtraces

A backtrace is a summary list of stack frames in the order in which they were called. The backtrace presents one line per frame, starting with the currently executing frame (frame zero), followed by its caller (frame one), and so on up the stack. The following is a list of commands for creating a backtrace; accompanying each command is a description of its use:

`backtrace`	Display a backtrace of the entire stack: one line per frame for all frames in the stack. You can stop the backtrace at any time by typing the system interrupt character, normally `CTRL + C`.
`backtrace` *n*	Display only the innermost *n* frames.
`backtrace -`*n*	Display only the outermost *n* frames.

The commands `where` and `info stack` are synonyms for `backtrace`.

Every line in the backtrace shows a frame number and function name. An instruction pointer value is also shown – unless you use `set print address off`.

If a function is in a source file whose symbol table data has been fully read, the backtrace shows the source file name and line number, as well as the function's arguments. When the line number is shown, the instruction pointer value for that line number is omitted if it is at the beginning of the code.

Here is an example of a backtrace. It was made with the command `bt 3`, so it shows the innermost three frames:

```
#0  rtx_equal_p (x=(rtx) 0x8e58c, y=(rtx) 0x1086c4) \
(/gp/rms/cc/rtlanal.c line 337)
#1  0x246b0 in expand_call (...) (...)
#2  0x21cfc in expand_expr (...) (...)
(More stack frames follow...)
```

The functions `expand_call` and `expand_expr` are in a file whose symbol details have not been fully read. Full detail is available for the function `rtx_equal_p`, which is in the file `rtlanal.c`. Its arguments, named `x` and `y`, are shown with their typed values.

Selecting a Frame

Most commands for examining the stack, and other data in a program, work on the currently selected stack frame. The following commands select a stack frame. Each finishes by displaying a brief description of the stack frame just selected:

`frame` *n* — Select frame number *n*, where frame zero is the innermost (currently executing) frame, frame one is the frame that called the innermost one, and so on. The highest-numbered frame is the `start` frame. The second highest is the frame for `main`.

`frame` *frame_addr* — Select the frame at address *frame_addr*. If the chaining of stack frames has been damaged by a bug, it is impossible for gdb960 to properly assign numbers to all frames. If the numbers are unavailable, addresses are still available for selecting frames.

`up [` *n* `]` — Select the frame *n* frames up from the previously selected frame. For positive numbers *n*, this advances toward the outermost frame, to higher frame numbers. Default is one.

`down [` *n* `]` — Select the frame *n* frames down from the previously selected frame. For positive numbers *n*, this advances toward the innermost frame, to lower frame numbers. Default is one.

Each of the above commands ends by displaying information about the selected frame: the frame number, the function name and its arguments, the source file and line number of execution in that frame, and the text of that source line. For example:

```
#3  main (argc=3, argv=??, env=??) at main.c:67
67        read_input_file (argv[i]);
```

After one of the above listed commands produces a printout, entering the `list` command without arguments displays ten source lines centered on the point of execution in the selected frame.

`up-silently` *n* `down-silently` *n*	These two commands are variants of `up` and `down`, respectively. They differ in that they do their work silently, without causing display of the new frame. They are intended primarily for use in gdb960 command scripts, where output might be unnecessary and distracting.

Frame Information

The following commands display information about the selected stack frame.

`frame`	With no argument, does not change which frame is selected, but does display information about the currently selected stack frame. The `frame` command can be abbreviated to `f`. The `frame` command can also be used as an argument to `info`.
`info frame`	Display a verbose description of the selected stack frame, including the frame's address, the address of the frame called by the selected frame, the frame that called the selected frame, the address of the selected frame's arguments, the instruction pointer saved in the selected frame (the address of execution in the caller frame), and which registers were saved in the frame. The description is useful when some problem has corrupted the stack format.
`info frame` *`frame_addr`*	Display a verbose description of the frame at address *`frame_addr`*, without selecting that frame. The selected frame remains unchanged.

`info args`	Display the selected frame's arguments, each on a separate line.
`info locals`	Display the selected frame's local variables, each on a separate line. These are all variables declared static or automatic within all program blocks that are executed within this frame.

Examining Source Files 10

The gdb960 debugger knows from which source files your program was compiled and can display parts of the source files' text. When execution halts, gdb960 displays the source line at which execution halted. When you select a stack frame, gdb960 displays the source line on which execution in that frame has halted.

This chapter describes commands and techniques that allow you to display specified pieces of source files. The chapter contains information on displaying specified source lines, identifying the directory in which source files are found, and searching source files for particular lines.

Displaying Source Lines

To display lines from a source file, use the `list` command (abbreviated as `l`). There are several ways to specify which part of the file you want to display.

The following is a list of the most common uses of the `list` command. Each command is followed by a description of its effect:

`list` *`linenum`*	Display `listsize` lines centered on *`linenum`* from the current source file. The command `set listsize` *`n`* changes the default of ten lines to `n` lines.
`list` *`function`*	Display `listsize` lines centered around the beginning of *`function`*.

`list`	Display `listsize` more lines. If the last lines displayed were displayed with a `list` command, display `listsize` lines following the last lines displayed; however, if the last line displayed was a solitary line displayed as part of displaying a stack frame, display `listsize` lines centered around that line.
`list -`	Display the `listsize` lines preceding the last lines displayed.

Repeating a `list` command with `RET` discards the argument, so it is equivalent to entering `list`. However, the '`-`' argument is preserved in repetition so that each repetition displays preceding lines in the file.

The `list` command expects a user supplied zero, one, or two *`linespecs`*. The `linespec` arguments specify source lines; there are several ways of writing the `linespec` argument but the effect is always to specify some source line. The following is a list of `list` commands with possible arguments and descriptions of their effects.

`list` *`linespec`*	Display `listsize` number of lines centered around the line specified by *`linespec`*.
`list` *`first`*`,`*`last`*	Display lines from *`first`* to *`last`*. Both arguments are `linespecs`.
`list ,`*`last`*	Display `listsize` lines, ending with *`last`*.
`list` *`first`*`,`	Display `listsize` lines, starting with *`first`*.
`list +`	Display the `listsize` lines following the last lines displayed.
`list -`	Display the `listsize` lines preceding the lines last displayed.

`list`	Display `listsize` lines. If the last lines displayed were displayed with a `list` command, the new lines follow them. If the last line displayed was part of a stack frame display, the new lines precede and follow it.

linespec Definition

The display command argument `linespec` can be composed of a single argument or a combination of arguments. The following is a list of possible `linespec` command arguments that modify the display of source lines:

`linenum`	Specifies line *`linenum`* of the current source file. The `linenum` argument is a `linespec`. When a `list` command has two `linespec` arguments, both refer to the same source file as the first `linespec`.
`+`*`offset`*	Specifies the line *`offset`* lines after the last line displayed. When used as the second `linespec` in a `list` command, `+offset` specifies the line *`offset`* lines after the first `linespec`.
`-`*`offset`*	Specifies the line *`offset`* lines before the last line displayed.
`filename:linenum`	Specifies line *`linenum`* in the source file *`filename`*.
`function`	Specifies the line of the first executable statement that begins the body of the function *`function`*.

filename:function	Specifies the line of the first executable statement in the *function* in *filename*. The file name is needed with a function name only if you have identically named functions in different source files. Otherwise, the function argument searches all specified source files for the first match.
**address*	Specifies the line containing the program's address, where *address* may be any expression. The asterisk is necessary to allow the command line parser to identify *address* as an address rather than a number.

The `info` command maps source lines to program addresses. The following is an example command line for the info command:

`info line` *linenum*	Displays the starting and ending addresses of the compiled code for source line *linenum*. The default examine address for the `x` command is changed to the starting address of the line, so that `x/i` is sufficient to begin examining the machine code. Also, this address is saved as the value of the convenience variable `$_`. For more information on the `x` command and convenience variables, refer to Chapter 11.

Searching Source Files

Two commands let you search the current source file for a regular expression. The following list shows the `forward` and `reverse` commands and describes their uses:

`forward-search` *`regexp`*	Checks each line, starting with the one following the last line listed, for a match for *`regexp`*. It lists the line that is found. The command abbreviation for `forward` is `fo`. The synonym `search` *`regexp`* is also supported.
`reverse-search` *`regexp`*	Checks each line, starting with the one before the last line listed and going backward, for a match for *`regexp`*. It lists the line that is found. The command abbreviation for `reverse` is `rev`.

Specifying Source Directories

Executable programs sometimes do not record the directories of the source files from which they were compiled, just the source file names. Additionally, directories can be moved between compilation and debugging. The gdb960 debugger remembers a list of directories to search for source files. That directory list is called the source path. Each time gdb960 wants a source file, it tries all directories in the list, in the order they appear, until it finds a file with the desired name. The source path is not the same as the executable search path unless you have specified them identically.

If gdb960 can't find a source file in the source path, and the object program records the directory the program was compiled in, gdb960 tries the recorded directory too. If the source path is empty, and there is no record of the compilation directory, gdb960 looks in the current directory.

Whenever you reset or rearrange the source path, gdb960 clears out any information it has cached about where source files are found, where each line is in the file, and so forth.

When you start gdb960, its source path is empty. The source path contains only the special directories "`$cdir`" (stands for the compilation directory, if available from the object file) and "`$cwd`" (stands for the current working directory). To add other directories, use the `directory` command.

`directory` *`dirname`*	Add directory *`dirname`* (abbreviated, `dir`) to the front of the source path. Multiple directory names may be given to this command, separated by white space or a colon (`:`), or a semi colon (`;`) on DOS.
`directory`	Reset the source path to empty. You are prompted for confirmation.
`show directories`	Display the source path; show which directories it contains.

Because the `directory` command, when used with arguments, adds to the front of the source path, it can affect files that gdb960 has already found. If the source path contains directories that you do not want, and those directories contain misleading files with names matching your source files, you can correct the situation using one of the following two methods:

1. using `directory` with no argument to reset the source path to empty.
2. using `directory` with suitable arguments to add any other directories you want in the source path. You can add all the directories in one command.

`list`	Display `listsize` more lines. If the last lines displayed were displayed with a `list` command, display `listsize` lines following the last lines displayed; however, if the last line displayed was a solitary line displayed as part of displaying a stack frame, display `listsize` lines centered around that line.
`list -`	Display the `listsize` lines preceding the last lines displayed.

Repeating a `list` command with `RET` discards the argument, so it is equivalent to entering `list`. However, the '`-`' argument is preserved in repetition so that each repetition displays preceding lines in the file.

The `list` command expects a user supplied zero, one, or two *`linespecs`*. The `linespec` arguments specify source lines; there are several ways of writing the `linespec` argument but the effect is always to specify some source line. The following is a list of `list` commands with possible arguments and descriptions of their effects.

`list` *`linespec`*	Display `listsize` number of lines centered around the line specified by *`linespec`*.
`list` *`first`*`,`*`last`*	Display lines from *`first`* to *`last`*. Both arguments are `linespecs`.
`list ,`*`last`*	Display `listsize` lines, ending with *`last`*.
`list` *`first`*`,`	Display `listsize` lines, starting with *`first`*.
`list +`	Display the `listsize` lines following the last lines displayed.
`list -`	Display the `listsize` lines preceding the lines last displayed.

`list`	Display `listsize` lines. If the last lines displayed were displayed with a `list` command, the new lines follow them. If the last line displayed was part of a stack frame display, the new lines precede and follow it.

linespec Definition

The display command argument `linespec` can be composed of a single argument or a combination of arguments. The following is a list of possible `linespec` command arguments that modify the display of source lines:

`linenum`	Specifies line *`linenum`* of the current source file. The `linenum` argument is a `linespec`. When a `list` command has two `linespec` arguments, both refer to the same source file as the first `linespec`.
`+`*`offset`*	Specifies the line *`offset`* lines after the last line displayed. When used as the second `linespec` in a `list` command, `+offset` specifies the line *`offset`* lines after the first `linespec`.
`-`*`offset`*	Specifies the line *`offset`* lines before the last line displayed.
`filename:linenum`	Specifies line *`linenum`* in the source file *`filename`*.
`function`	Specifies the line of the first executable statement that begins the body of the function *`function`*.

filename:function	Specifies the line of the first executable statement in the *function* in *filename*. The file name is needed with a function name only if you have identically named functions in different source files. Otherwise, the function argument searches all specified source files for the first match.
**address*	Specifies the line containing the program's address, where *address* may be any expression. The asterisk is necessary to allow the command line parser to identify *address* as an address rather than a number.

The `info` command maps source lines to program addresses. The following is an example command line for the info command:

`info line` *linenum*	Displays the starting and ending addresses of the compiled code for source line *linenum*. The default examine address for the `x` command is changed to the starting address of the line, so that `x/i` is sufficient to begin examining the machine code. Also, this address is saved as the value of the convenience variable `$_`. For more information on the `x` command and convenience variables, refer to Chapter 11.

Searching Source Files

Two commands let you search the current source file for a regular expression. The following list shows the `forward` and `reverse` commands and describes their uses:

`forward-search` *`regexp`*	Checks each line, starting with the one following the last line listed, for a match for *`regexp`*. It lists the line that is found. The command abbreviation for `forward` is `fo`. The synonym `search` *`regexp`* is also supported.
`reverse-search` *`regexp`*	Checks each line, starting with the one before the last line listed and going backward, for a match for *`regexp`*. It lists the line that is found. The command abbreviation for `reverse` is `rev`.

Specifying Source Directories

Executable programs sometimes do not record the directories of the source files from which they were compiled, just the source file names. Additionally, directories can be moved between compilation and debugging. The gdb960 debugger remembers a list of directories to search for source files. That directory list is called the source path. Each time gdb960 wants a source file, it tries all directories in the list, in the order they appear, until it finds a file with the desired name. The source path is not the same as the executable search path unless you have specified them identically.

If gdb960 can't find a source file in the source path, and the object program records the directory the program was compiled in, gdb960 tries the recorded directory too. If the source path is empty, and there is no record of the compilation directory, gdb960 looks in the current directory.

Whenever you reset or rearrange the source path, gdb960 clears out any information it has cached about where source files are found, where each line is in the file, and so forth.

When you start gdb960, its source path is empty. The source path contains only the special directories "`$cdir`" (stands for the compilation directory, if available from the object file) and "`$cwd`" (stands for the current working directory). To add other directories, use the `directory` command.

`directory` *`dirname`*	Add directory *`dirname`* (abbreviated, `dir`) to the front of the source path. Multiple directory names may be given to this command, separated by white space or a colon (`:`), or a semi colon (`;`) on DOS.
`directory`	Reset the source path to empty. You are prompted for confirmation.
`show directories`	Display the source path; show which directories it contains.

Because the `directory` command, when used with arguments, adds to the front of the source path, it can affect files that gdb960 has already found. If the source path contains directories that you do not want, and those directories contain misleading files with names matching your source files, you can correct the situation using one of the following two methods:

1. using `directory` with no argument to reset the source path to empty.
2. using `directory` with suitable arguments to add any other directories you want in the source path. You can add all the directories in one command.

Displaying Program Data and Symbols

11

This chapter contains information on examining data through expressions, variables, and artificial arrays. This chapter also presents information about accessing the value history, using convenience variables, and accessing registers.

To help in presentation of data, gdb960 allows use of format options and output format specifications. Use of the options and format specifications is also presented and demonstrated in this chapter.

The usual way to examine data in your program is with the `print` command (abbreviated `p`), or its synonym `inspect`. The `print` command evaluates and displays the value of any valid C/C++ expression, *exp*. The value of *exp* is displayed in a format appropriate to its data type. The following example shows the syntax of the `print` command:

`print` *exp*

A lower-level way of examining data is with the `x` command. It examines data in memory at a specified address and displays it in a specified format.

Expressions

Many different gdb960 commands accept an expression and evaluate its value. Any valid C/C++ operator, constant, or variable is legal in a gdb960 expression, including conditional expressions, and casts. Symbols defined by preprocessor `#define` commands do not evaluate.

In addition to C/C++ language operators, the gdb960 debugger supports the following three operators:

`@`	a binary operator for treating parts of memory as arrays. For more information on treating memory as arrays, refer to the *Artificial Arrays* section in this chapter.
`::`	allows specification of a variable in terms of the file or function in which the variable is defined.
`{`*`type`*`}` *`addr`*	Refers to an object of type *`type`* stored at memory address *`addr`*, where *`addr`* may be any expression whose value is an integer or pointer (but parentheses are required around non-unary operators, just as in a cast). The `type` construct is allowed regardless of what kind of data resides at *`addr`*.

Program Variables

The most common kind of expression used to examine data is a variable name. A reference to a variable by an expression assumes the reference is to an instance of the variable that is located in the selected stack frame; the variable must either be global (static) or be visible according to the C/C++ scope rules from the point of execution in that frame. For more information on the selected stack frame, refer to Chapter 9.

In the following example function, the variable `a` is usable whenever the program is executing within the function `foo`, but the variable `b` is visible only while the program is executing inside the block where `b` is declared:

```
foo (a)
     int a;
{
  bar (a);
  {
    int b = test ();
    bar (b);
  }
}
```

As a special exception, you can refer to a variable or function whose scope is a single source file even if the current execution point is not in the currently selected file. If there are two or more static file-scope variables with the same name in two or more different files, you can specify which one you want in the following manner:

`block``::`*`variable`*

In this example, *`block`* is the name of the source file in which the variable you want resides.

Assignment to Variables

To alter a variable's value, evaluate an assignment expression. In the following example, `print` stores the value 4 into the variable `x`, and then displays the value of the assignment expression (which is 4):

```
print x=4
```

All C/C++ assignment operators are supported, including the increment operators `++` and `--`, and combined assignments such as `+=` and `<<=`.

If you are not interested in seeing the assignment's value, use the `set` command instead of the `print` command. `set` does not display the expression's value and does not put it in the value history. The expression is evaluated only for side effects. For more information on the value history and examining data, refer to Chapter 11.

NOTE. *If the beginning of a* `set` *command's argument string appears identical to a* `set` *subcommand, you may need to use the* `set variable` *command. This command is identical to* `set` *except for its lack of subcommands.*

Artificial Arrays

It is often useful to display several successive objects of the same type in memory (e.g., a section of an array, or an array of dynamically determined size for which only a pointer exists in the program).

To display successive objects, construct an artificial array by using the binary operator `@`. The left operand of `@` is the first element of the desired array, as an individual object. The right operand is the number of objects in the array. The result is an array value whose elements are all of the type of the left argument. The first element is actually the left argument; the second element comes from bytes of memory immediately following those that hold the first element, and so on.

Given the following example source line, you might want to display the contents of `array`:

```
int *array = (int *) malloc (len * sizeof (int));
```

To display the contents of array, enter the following line:

```
p *array@len
```

The left operand of `@` must reside in memory. Array values made with `@` in this way behave just like other arrays in terms of subscripting, and are coerced to pointers when used in expressions.

Format Options

The gdb960 software debugger provides the following ways to control array, structure, and symbol printing. Each of the `set` commands shown has a corresponding `show` command that displays the current setting. For commands where the `on` or `off` arguments are used as toggles, the default is `on` when the argument is omitted.

`set print address on`	Display memory addresses showing the location of stack traces, structure values, pointer values, breakpoints, and so forth, even when it also displays the contents of those addresses.
`set print address off`	Do not display addresses when displaying their contents. The following is a `backtrace` command example:

```
(gdb960) set print address on
(gdb960) bt
#0  hithere (foo=0x55) at hi.c:11
#1  0xe00081b4 in main (argc=0x1, argv=0xe000e960)
at hello.c:43
#2  0xe00080d4 in start ()
(gdb960) set print addr off
```

```
(gdb960) set print address off
(gdb960) bt
#0  hiya (foo=0x55) at hi.c:11
#1  main (argc=0x1, argv=) at hello.c:43
#2  start ()
```

The `set print address off` command eliminates most machine dependent displays from the gdb960 interface. For example, with `print address off`, you should get the same text for backtraces on all machines, whether or not they involve pointer arguments. This is especially useful if you wish to compare the results of running the same program on different hosts, using gdb960 in batch mode as an execution vehicle.

When gdb960 displays a symbolic address, it normally displays the closest earlier symbol plus an offset. If that symbol does not uniquely identify the address (for example, it is a name whose scope is a single source file), you may need to disambiguate by entering the `info line` command, for example `info line *0x4537`. As an alternative, you can set gdb960 to display the source file and line number when it displays a symbolic address. The following list provides examples of the `set print` command and descriptions of the effect of each example:

`set print symbol-filename on`	Display the source file name and line number of a symbol in the symbolic form of an address.
`set print symbol-filename off`	Do not display the source file name and line number of a symbol. Omission of the `on` or `off` argument assumes `off`.
`set print symbolic-disassembly`	(can be abbreviated `set print symbolic`) When on, addresses in the disassembly show the machine address followed by <*`symbol`*`+1234>` where *`symbol`* is the closest preceding function name. Turning this off creates less clutter in the display. The `on` setting is the default.
`set print max-symbolic-offset MAX-OFFSET`	Display only the symbolic form of an address if the offset between the closest earlier symbol and the address is less than `MAX-OFFSET`. The default is zero, to always display the symbolic form of an address, if any symbol precedes it.
`set print autoderef`	When `on`, always dereference `char *` pointers (i.e., print the string that the `char *` points to). When turned `off`, `char *` is printed like a `void *` (i.e., just print the hex address that the `char *` points to). The `on` setting is the default.

`set print array on`	Pretty-print arrays. This format is more convenient to read, but uses more space. `off` is the default.
`set print array off`	Return to compressed format for arrays.
`set print elements` *`number-of-elements`*	When displaying a large array, stop displaying after printing the number of elements set by the `set print elements` command. The limit also applies to display of strings. Setting the number of elements to zero allows unlimited displaying.

`set print pretty on`	Display structures in an indented format with one member per line. The following is an example of a pretty printed structure:
	`$1 = {`
	` next = 0x0,`
	` flags = {`
	`  sweet = 1,`
	`  sour = 1`
	` },`
	` meat = 0x54 "Pork"`
	`}`

`set print pretty off`	`off` is the default format. Display structures in a compact format, as in the following example: `$1 = {next = 0x0, flags = {sweet = 1, sour = 1}, meat = 0x54 "Pork"}`

`set print repeats` *`repeats`*	Set threshold for printing repeated elements (e.g., printing an array that contains *`repeats`* or more zeroes prints a message `'\000' <repeats NN times>`, where NN is the number of elements). The default for *`repeats`* is 10.
`set print sevenbit-strings on`	Display using only seven-bit characters; if this option is set, gdb960 displays any eight-bit characters, in strings or character values, using the notation `\`*`NNN`*. For example, `M-a` is displayed as octal `\341`.
`set print sevenbit-strings off`	Display using either seven-bit or eight-bit characters, as required. `off` is the default.
`set print union on`	Display unions that are contained in structures. `on` is the default.
`set print union off`	Do not display unions contained in structures.

The following example demonstrates displaying structures containing unions. The structures are declared, initialized, and displayed with `union` both `on` and `off`:

```
typedef enum {Tree, Bug} Species;
typedef enum {Big_tree, Acorn, Seedling} Tree_forms;
typedef enum {Caterpillar, Cocoon, Butterfly} Bug_forms;

struct thing {
Species it;
union {
Tree_forms tree;
Bug_forms bug;
} form;
};
```

```
struct thing foo = {Tree, {Acorn}};

(gdb960) set print union on
(gdb960) print foo
$2 = {it = Tree, form = {tree = Acorn, bug = Cocoon}}
(gdb960) set print union off
$2 = {it = Tree, form = {...}}
```

Output Formats

The gdb960 software debugger normally displays all values according to their data types. Output formats allow you to view data as other types. Possible types are:

- integer in hexidecimal
- integer in signed decimal
- integer in unsigned decimal
- integer in octal
- integer in binary
- integer as character constant
- address as hexadecimal
- floating point

To display a value already computed, start the arguments of the `print` command with a slash and a format letter. The following is a list of the supported format letters:

`x` Regard the bits of the value as an integer, and display the integer in hexadecimal.

`d` Display as integer in signed decimal.

`u` Display as integer in unsigned decimal.

`o` Display as integer in octal.

`t` Display as integer in binary. The letter `t` stands for "two".

`a` Display as an address, both absolute in hex and as an offset of the nearest preceding symbol. This format can be used to discover in which function an unknown address is located:

```
(gdb) p/a 0x54320
$3 = 0x54320 <_initialize_vx+396>
```

`c` Regard as an integer and display as a character constant.

`f` Regard the bits of the value as a floating point number and display using floating point syntax.

The following example displays the instruction pointer in hexadecimal:

```
p/x $ip
```

No space is required before the slash because gdb960 command names cannot contain a slash.

To redisplay the last value in the value history with a different format, you can use the `print` command with a format and no expression. For example, `p/x` redisplays the last printed value in hex.

Examining Memory

This section contains information about manipulating and examining memory contents. The commands listed below provide access to the memory. Each command is followed by a description of its use:

`set caching [ on | off ]` The gdb960 debugger normally caches target memory reads and writes to reduce serial-line traffic. In some cases, this feature masks volatile memory changes. To prevent gdb960 from caching target memory, use `set caching off`, which flushes the memory cache prior to every target read or write. By default, caching is enabled, `set caching on`.

`disassemble { function | address } [ address ]`	Provides a dump of a range of memory as machine instructions. The range is the inclusive area bounded by the two machine addresses provided in the *address* arguments. If only one *address* argument is provided, gdb960 finds the first C/C++ function that starts at an address less than or equal to the given address; then it disassembles the entire function. If only a *function* argument is provided, then the function named in *function* is disassembled in its entirety. If the string in `function` is not a function name, then its address is calculated and acted on as though it were an *address* argument.
`x [ /NFU ] [ address ]`	You can use the command `x` to examine memory in any of several formats, independent of your program's data types. `N`, `F`, and `U` are all optional parameters that specify how much memory to display and how to format it; `address` is an expression giving the address where you want to start displaying memory. If you use defaults for `NFU`, you need not type the slash (`/`). Several commands set convenient defaults for `address`. `N` is the repeat count. The repeat count is a decimal integer; the default is 1. It specifies how much memory (counting by units `U`) to display.

`F` is the display format. It is one of the formats used by `print`, or `s` (null-terminated string) or `i` (machine instruction). The default is `x` (hexadecimal) initially, or the format specified the last time you used either the `x` command or `print`.

`U` is the unit size. The unit size is any of the size specifiers described in the lists on the following pages.

Each time you specify a unit size with `x`, that size becomes the default unit the next time you use `x`. For the `s` and `i` formats, the unit size is ignored and is normally not written.

Output format specifies how large a unit of memory to examine and how to display the contents of that unit. Format specification consists of one or two of the following letters:

The following letters specify the size of unit to examine:

`b` Examine individual bytes.

`h` Examine half words (two bytes each).

`w` Examine words (four bytes each).

`g` Examine giant words (eight bytes).

The following letters specify the display format:

`x` Display as integers in unsigned hexadecimal.

`d` Display as integers in signed decimal.

`u` Display as integers in unsigned decimal.

`t` Display as integers in binary. The letter `t` stands for "two".

`o` Display as integers in unsigned octal.

`a` Display as an address, both absolute in hex and then relative to a symbol defined as an address below it. Note that `p/a` and `x/a` are similar, but not exactly the same. The following example shows `p/a` displaying the result of an expression as if it were an address:

```
(gdb960) p/a main + 8
$9 = 0xe00080e8 <main+8>
```

The following example of the `x/a` command shows it displaying the contents of the result of the expression as if it were an address. There is an additional level of indirection here:

```
gdb960) x/a &main
0xe000880e0 <main>: 0x59084810
(gdb960) x/a 0xe000880e8
0xe000880e8 <main+8>:   0xe00080f0 <main+16>
```

`c` Display as character constants.

`f` Display as floating point. This works only with sizes `w` and `g`.

`s` Display a null-terminated string of characters. The specified unit size is ignored; instead, the unit is however many bytes it takes to reach a null character, including the null character.

`i` Display a machine instruction in assembler syntax. The specified unit size is ignored; the number of bytes in an instruction varies depending on the type of machine, the op code, and the addressing modes used. The command `disassemble` is an alternative for inspecting machine instructions.

If either the manner of displaying or the size of unit is unspecified, the default is to use the last used specification. If you do not use any letters after the slash, you can omit the slash as well.

If you omit the address to examine, the address following the last unit examined is used. String and instruction formats actually compute a unit-size based on the data. It ensures that the next string or instruction examined starts in the right place.

When the `print` command shows a value that resides in memory, `print` also sets the address for the `x` command. Similarly, the `info line` command also sets the address for `x` to the start of the machine code for the specified line, and `info breakpoints` sets the address for `x` to the address of the last breakpoint listed.

When you use `RET` to repeat an `x` command, any previously specified address is ignored, so the repeated command examines the successive locations in memory rather than the same ones.

You can use one command to examine several consecutive memory units by writing a repeat-count after the slash and before the format letters. The repeat count must be a decimal integer. It has the same effect as repeating the `x` command that many times, except that the output may be more compact, with several units per line. The following example displays `x` instructions, starting with the one to be executed next in the selected frame:

```
x/10i $ip
```

After displaying a set of instructions, you could display the seven following instructions by entering the following example, in which the format and address are allowed to default to the last address accessed by the previous `x` command:

```
x/7
```

The addresses and contents displayed by the `x` command are not put in the value history because there are often so many of them that they get in the way.

After an `x` command, the last address examined is available for use in expressions in the convenience variable `$_`. The contents of that address, as examined, are available in the convenience variable `$__`.

If the `x` command has a repeat count, the address and contents saved are from the last memory unit displayed, which is not the same as the last address displayed, if several units were displayed on the last line of output.

Storing to Memory

The gdb960 software debugger allows more implicit conversions in assignments than C/C++ do; you can freely store an integer value into a pointer variable or vice versa, and any structure can be converted to any other structure that is the same length or shorter.

To store values into arbitrary places in memory, use the `{...}` construct to generate a value of specified type at a specified address. For more information on the `{...}` construct, refer to Chapter 12.

In the following example `{int}0x83040` refers to memory location 0x83040 as an integer (which implies a certain size and representation in memory), and `set` stores the value 4 into that memory location:

```
set {int}0x83040 = 4
```

Automatic Display

To frequently display the value of an expression to see how it changes, add it to the automatic display list so that gdb960 displays its value each time the program stops. Each expression added to the list is given an identifying number. To remove an expression from the list, specify that number in a `disable display` or `delete display` command. The automatic display shows item numbers, expressions and their current values:

```
2: foo = 38
3: bar[5] = (struct hack *) 0x3804
```

If the expression refers to local variables, then it does not make sense outside the lexical context in which it was set up. Such an expression is disabled when execution enters a context where one of its variables is not defined.

For example, if you give the command `display name` while inside a function containing a variable `name`, then this argument displays while the program continues to stop inside that function. When it stops elsewhere -- where there is no variable `name` -- display is disabled. The next time your

program stops where `name` is meaningful, you can enable the display expression once again by entering the `enable display` command. The following is a list of `display` commands and their descriptions:

`display` *`exp`*	Add the expression *`exp`* to the list of expressions to display each time the program stops. For more detailed information on expressions, refer to the *Expressions* section in this chapter.
`display/`*`fmt exp`*	Add the expression *`exp`* to the auto-display list and display it each time in the specified format *`fmt`*. *`fmt`* specifies only a display format and not a size or count.
`display/`*`fmt addr`*	For *`fmt`* `i` or `s`, or when including a unit-size or a number of units, add the expression, a memory address, to be examined each time the program stops, `addr`. Examining means, in effect, entering `x/`*`fmt addr`*.
`undisplay` *`dnums`* `delete display` *`dnums`*	Remove item numbers *`dnums`* from the list of expressions to display.
`disable display` *`dnums`*	Disable the display of item numbers *`dnums`*. A disabled display item is not displayed automatically, but is not forgotten. It may be enabled again later.
`enable display` *`dnums`*	Enable the display of item numbers *`dnums`*. The items in `dnums` appear once again in auto display until you specify otherwise.
`display`	Display the current values of the expressions on the list, just as occurs when the program stops.

`info display`	Display the list of expressions set up to display automatically, each one with its item number. Do not display the values of the expressions. Include disabled expressions and mark them as such in the printout. Also include expressions that refer to automatic variables.

Examining the Symbol Table

The commands described in this section allow you to inquire about the symbols (names of variables, functions and types) defined in your program. This information is found by gdb960 in the symbol table loaded by the `symbol-file` command. The information is inherent in the text of your program and does not change as the program executes.

NOTE. `print &symbol` *does not work at all for a register variable, and, for a stack local variable, displays the exact address of the current instantiation of the variable.*

`whatis` *`exp`*	Display the data type of expression *`exp`*. The argument *`exp`* is not actually evaluated, and any side-effecting operations (such as assignments or function calls) inside it do not take place.
`whatis`	Display the data type of `$`, the last value in the value history.
`ptype` *`typename`*	Display a description of data type *`typename`*. *`typename`* may be the name of a type, or for C/C++ code, it may have the form `struct` *`struct-tag`*, `union` *`union-tag`* or `enum` *`enum-tag`*.

`ptype` *`exp`*	Display a description of the type of expression *`exp`*. This is like `whatis` except it displays a detailed description instead of just the name of the type. The following example shows the results of entering `whatis` and `ptype` if the type of a variable is `struct complex {double real; double imag;}`:
	
	`(gdb960) whatis foo`
	`struct complex`
	`(gdb960) ptype foo`
	`struct complex {double real; double imag;}`

`info address` *`symbol`*	Describe where the data for *`symbol`* is stored. For a register variable, this says which register it is kept in. For a non-register local variable, this displays the stack-frame offset at which the variable is always stored.
`info functions`	Display the names and data types of all defined functions.
`info functions` *`regexp`*	Display the names and data types of all defined functions whose names match the regular expression *`regexp`*. Thus, `info fun step` finds all functions whose names include `step`; `info fun ^step` finds those whose names start with `step`.
`info locals`	Display the names and data types of local variables from the current stack frame.
`info sources`	Display the names of all source files along with debugging information.
`info types`	Print a brief description of all types in the program. This includes typedefs, enums, structs and unions explicitly declared or included.

`info types` *`regexp`*	Print a brief description of all types whose name matches regular expression *`regexp`*.
`info variables`	Display the names and data types of all variables declared outside of functions (i.e., all variables except for local variables).
`info variables` *`regexp`*	Display the names and data types of all variables (except for local variables) whose names match the regular expression *`regexp`*.
`printsyms` *`filename`*	Write a complete dump of the debugger's symbol data into the file *`filename`*.

Command-Line Completion

When working with C++ syntax, you may need to quote some arguments for them to be properly parsed by gdb960 for command-line completion. For example, if you try to use command-line completion as follows:

```
(gdb960) b class_name::overloaded<TAB>
```

gdb960 is unable to find any completions. However, if you quote the argument with a single leading quote as shown:

```
(gdb960) b 'class_name::overload<TAB>
```

gdb960 finds the appropriate completion:

```
(gdb960) b 'class_name::overloaded_func(
```

Here, gdb960 is waiting for the user to fill in argument types to distinguish between multiple overloaded functions with the same function name and differing arguments. If you type two TAB characters and allow gdb960 to provide a list of possible completions, it gives the following:

```
my_class::ol_func(char)        my_class::ol_func(int, int)
my_class::ol_func(double, double)
```

Letting Readline Type For You

The following is a list of the command names, their original bindings, and short descriptions for automatic completions on the command line:

`complete (TAB)`	Attempt to do completion on the text before the cursor. This is implementation-defined. Generally, if you are typing a filename argument, you can do filename completion; if you are typing a command, you can do command completion; if you are typing in a symbol to gdb960, you can do symbol name completion; if you are typing in a variable to `Bash`, you can do variable name completion.
`possible-completions (TAB TAB) (or META + ?)`	List the possible completions of the text before the cursor.

Working with Overloaded Member Functions

When you specify an overloaded member function name to gdb960 without specifying the function's parameters, gdb960 displays a menu of options for selecting the function(s) you wish to reference. For example:

```
(gdb960) b my_class::ol_func
[0] cancel
[1] all
[2] my_class::ol_func(double, double) at ol.cc:27
[3] my_class::ol_func(char) at ol.cc:20
[4] my_class::ol_func(int, int) at ol.cc:13
>
```

Typing 0 terminates the operation without setting a breakpoint. Typing 1, or any combination of 2 through 4 sets breakpoints on the identified functions:

```
> 2 3
Breakpoint 1 at 0xa0008184: file ol.cc, line 27.
Breakpoint 2 at 0xa0008150: file ol.cc, line 20.
(gdb960)
```

Value History

Values displayed by `print` are saved in gdb960's value history so you can refer to them in other expressions. Values are kept until the symbol table is re-read or discarded. When the symbol table changes, the value history is discarded because values may contain pointers back to the types defined in the symbol table.

The values displayed are given history numbers for reference. The reference numbers are successive integers starting with 1. The `print` command displays the history number assigned to a value by displaying `$`*`num`*`=` before the value, where *`num`* is the history number.

To refer to a value previously displayed, use `$` and the value's history number. The output displayed by `print` reminds you of that. The `$` character, alone, refers to the most recent value in the history, and `$$` refers to the value before that. `$$`*`n`* refers to the nth value from the end; `$$2` is the value just before `$$`, `$$1` is equivalent to `$$`, and `$$0` is equivalent to `$`.

The following example displays the contents of a structure pointed to by a pointer that was just displayed:

```
p *$
```

If you have a chain of structures where the component `next` points to the next one, you can display the contents of the next one with the following example:

```
p *$.next
```

Repeat commands with RET.

The history records values, not expressions. In the following example, if the value of x is 4, then the value recorded in the value history by the print command remains 4 even though the value of x has changed:

```
print x
set x=5
```

The following is a list of show commands and descriptions of their effects:

show values	Display the last X values in the value history, with their item numbers. This is like p$$9 repeated X number of times, except that show values does not change the history.
show values *n*	Display X history values centered on history item number *n*.
show values +	Display X history values just after the values last printed.

Convenience Variables

You can use convenience variables within gdb960 to hold a value and refer to it later. These variables exist entirely within gdb960 and are not part of your program. Setting a convenience variable does not affect further execution of your program, so you may use them freely.

Convenience variables have names starting with $. Any name starting with $ can be used for a convenience variable, unless it is one of the pre-defined register names. For more information on registers and register names, refer to the *Registers* section in this chapter.

You can save a value in a convenience variable with an assignment expression, just as you would set a variable in your program. The following example saves the value contained in the object pointed to by object_ptr in the $foo convenience variable:

```
set $foo = *object_ptr
```

Using a convenience variable the first time creates it; but its value is `void` until you assign a new value. You can alter the value with another assignment at any time because convenience variables have no fixed types. You can assign a convenience variable any type of value, including structures and arrays, even if that variable already has a value of a different type. The convenience variable as an expression has its current value's type. Use the `show` command to display a list of convenience variables used:

`show convenience`	Display a list of convenience variables used so far, and their values. `show con` is the abbreviation.

One way to use a convenience variable is as a counter to be incremented or as a pointer to be advanced. In the following example, `$i` is set at 0 and used in the `print` command to control incrementing the `bar[]` array:

```
set $i = 0
print bar[$i++]->contents
...repeat that command by typing RET.
```

The following is a list of the convenience variables gdb960 automatically creates:

`$_`	Automatically set by the `x` command to the last address examined. Other commands that provide a default address for `x` to examine also set `$_` to that address. The commands include `info line` and `info breakpoint`.
`$__`	The variable `$__` is automatically set by the `x` command to the value found in the last address examined.

Registers

Machine register contents can be referred to in expressions as variables with names starting with `$`. The `info registers` command lists the names of all the registers.

The names `$ip` and `$sp` represent the instruction pointer register and the stack pointer, respectively. The name `$fp` represents a register that contains a pointer to the current stack frame.

The gdb960 debugger always views the contents of a register as an integer when the register is examined in this way. Some machines have special registers that can hold nothing but floating point values. There is no way to refer to the contents of an ordinary register as a floating point value. However, you can display the value in an ordinary register as a floating point value by entering the `print/f $`*`regname`* command.

Some registers have distinct raw and virtual data formats. Register contents are saved by the operating system in a different data format from the one your program normally sees. For example, the registers of the i960 KB floating point coprocessor are always saved in extended (raw) format, but most C/C++ programs expect to work with double (virtual) format.

The gdb960 debugger normally works with the virtual format only (the format that makes sense for your program), but the `info registers` command displays the data in both formats.

Except for `g0` through `g15`, register values are relative to the selected stack frame. For more information on the stack frame, refer to Chapter 9.

The result is the value the register would contain if all stack frames nearer to 0 were exited and their saved registers restored. To see the real contents of all registers, you must select the innermost frame by entering the command, `frame 0`.

The global registers `g0` through `g15` are never saved. For these registers, relativization makes no difference.

The following is a list of commands that display register information:

`regs`	Display non-floating registers as two columns of hexidecimal numbers. Output is suitable for a 24x80 display.
`info registers`	Display the names and relativized values of all non-floating-point registers.
`info all-registers`	Display the names and relativized values of all registers, including floating-point registers. For MON960, this is a synonym for `info registers` when the i960 processor architecture does not contain floating-point registers (e.g., the i960 CA processor family).
`info registers` *`regname`*	Display the relativized value of register *`regname`*. The *`regname`* argument may be any register name that is valid on the machine you are using, with or without the initial `$`.

Examples

The following example displays the instruction pointer in hexadecimal:

```
p/x $ip
```

The following example displays the instruction to be executed next:

```
x/i $ip
```

The following example adds four to the stack pointer:

```
set $sp -= 4
```

The set `$sp -= 4` command also removes one word from the stack on machines where stacks grow upward in memory. This assumes that the innermost stack frame is selected. Setting `$sp` is not allowed when other stack frames are selected. To pop entire frames off the stack, regardless of machine architecture, enter the `finish` command.

Profile Data File Manipulation

The `profile` command supports the two-pass compilation systems of the i960 compiler. (See your compiler user's guide for complete information on two-pass compilation.) The gdb960 software debugger provides the `profile` command to store and retrieve profiling counts, even if your target does not support file I/O.

As you run an instrumented application, the instrumented code generates information about the application and accumulates it in the application's memory space. It is then necessary to save the information into a file on the host system to make it available for the second compilation pass. This file is known as a profile file. You can save this information yourself at any time during the debugging session and then retrieve it at a later time. If your target system does not have a file system, the debugger is the only way to save this information in a file.

`profile clear`	Reset profile data area in target memory to all zeroes.
`profile get [` *`filename`* `]`	Get profile data from *`filename`* and put it into the profile data area in target memory (default file name is `./default.pf`).
`profile put [` *`filename`* `]`	Store profile data from the profile data area in target memory into *`filename`* (default file name is `./default.pf`).

gdb960 Command and Option Reference

12

This chapter contains two sections. The first is a list of possible command line arguments that you can use when invoking gdb960. The second section is a list of gdb960 commands and their options.

gdb960 Invocation Arguments

`-b` *`bps`*	Set the baud rate (bps), of the serial interface to the i960 processor target system.
`-batch`	Run in batch mode.
`-brk`	Send a break (of about 1/4 second in duration) through MON960 to the target system, after opening the connection, but before trying to talk. This allows you to connect to some running systems.
`-cd` *`directory`*	Set gdb960's working directory to *`directory`*.
`-command` *`cmdfile`*	Run gdb960 commands from *`cmdfile`*.
`-d` *`directory`*	Add *`directory`* to the path to search for source files.
`-e` *`file`*	Use *`file`* as the file to download and/or execute.
`-G`	Inform gdb960 that the target has big-endian memory.
`-nx`	Suppress execution of commands in the `.gdbinit` initialization file. For more

	information on command files, refer to Chapter 13.
`-par` *`device`*	Use parallel download instead of serial download. The parallel device (typically LPT1 or LPT2 in Windows) is used only for downloading. Other host/target communications use the serial port specified with `-r`.
`-pc` *`picoffset`*	Debug position-independent code. Download code sections to link-time-address + *`picoffset`* instead of the usual link-time-address.
`-pci`	Specify PCI communication. Refer to Chapter 2 for more information.
`-pd` *`pidoffset`*	Debug position-independent data. Download data and bss sections to link-time-address + *`pidoffset`*, instead of to link-time-address.
`-px` *`offset`*	Enter the same offset for both `-pc` and `-pd`.
`-q`	"Quiet." Do not display the introductory and copyright messages.
`-r` *`port`*	Specify the serial port name of a serial interface to be used to connect to the target system.
`-readnow`	Read each symbol file's entire symbol table immediately, rather than the default, which is to read it incrementally as needed.
`-s` *`file`*	Read symbol table from *`file`*.
`-se` *`file`*	Read the symbol table from *`file`* and use it as the executable.
`-t` *`target`*	Use *`target`* as the target monitor type. MON960 is currently the only supported target type.

`-tcp` *`hostname port`*	Connect via TCP/IP link to target board connected to server *`hostname`*. *`port`* specifies the port where the board is connected to the server.
`-x` *`file`*	Execute gdb960 commands from *`file`*. For more information on setting up a batch mode execution file, see Chapter 13. The `-command` option is a synonym for `-x`.

gdb960 Commands

This section contains an alphabetic listing of the gdb960 commands. Each command appears as a section header followed by a syntax description, a description of the command's purpose, and the arguments you can use with the command.

add-symbol-file

`add-symbol-file` *`filename`* `[` *`address`* `]`

Reads symbol table information.

`filename`	Read additional symbol table information from *`filename`*.
`address`	The memory address at which the files' .text section has been loaded.

aplink enable

`aplink enable` *`bit value`*

Changes bits in the ApLink mode register.

aplink reset

`aplink reset`

Executes the ApLink reset command.

aplink switch

`aplink switch region mode`

Changes ApLink modes. *region* is a hex constant; *mode* is a decimal constant.

aplink wait

`aplink wait`

Executes the ApLink `wait` command.

awatch

`awatch expr`

Sets a memory access hardware watchpoint. Memory access watchpoints halt program execution when any read or write is attempted at the address of *expr*.

backtrace

`backtrace [ n | -n ]`

Displays a backtrace of the entire stack, one line per frame for all frames in the stack. You can stop the backtrace at any time by typing the system interrupt character, normally `CTRL + C`.

n	Display only the innermost *n* frames.
-n	Display only the outermost *n* frames.

break

`break [ argument ] [ options ]`

Sets a breakpoint.

`*address`	Set a breakpoint at *address*.
`break filename:function`	Set a breakpoint at entry to *function* in *filename*.
`filename:linenum`	Set a breakpoint at line *linenum* in source file *filename*.
`function`	Set a breakpoint at entry to *function*.
`... if cond`	Set a breakpoint with condition *cond*; evaluate the expression *cond* each time the breakpoint is reached, and halt only if the value is non zero. An ellipsis, "`...`", stands for one of the possible arguments described above (or no argument) specifying where to break.
`linenum`	Set a breakpoint at *linenum* in the current source file (the source file corresponding to the currently selected frame).
`[ + | - ]offset`	Set a breakpoint *offset* number of lines forward (`+`) or back (`-`) from the execution point in the currently selected frame.

call

`call` *`function (args)`*

Calls a function in the program. The function *`function`* is called with argument *`args,`* and the return value is printed and saved in the value history, if it is not void.

cd

`cd` *`directory`*

Sets gdb960's working directory to *`directory`*.

clear

`clear [` *`argument`* `]`

Deletes any breakpoints at the next instruction to be executed in the selected stack frame. When the innermost frame is selected, `clear` deletes the breakpoint at which the program halted.

`[ breakpoints ]` *`bnums`*	Delete the breakpoints of the numbers specified in *`bnums`*.
`function filename:function`	Delete any breakpoints set at the entry to the function *`function`*.
`linenum`	Delete any breakpoints set at or within the code
`filename:linenum`	of the specified line.

commands

`commands` *`bnum`*

Specifies a list of commands for breakpoint number *`bnum`*. The commands appear one per line on separate lines following `commands`. Type a separate line containing the `end` command to terminate the commands.

To remove all commands from a breakpoint, follow `commands` immediately by `end`.

condition

`condition` *`bnum`* `[` *`expression`* `]`

Adds a condition to a breakpoint.

`bnums`	The breakpoint numbers of breakpoints to alter.
`expression`	The break condition for breakpoint number *`bnum`*. The breakpoint(s) halts the program only if the value of *`expression`* is true (non zero, in C/C++). If not specified, remove the condition from breakpoint number *`bnums`* to make it an unconditional breakpoint. For more information on examining data, refer to Chapter 11.

continue

`continue [` *`count`* `]`

Continues executing the program, setting the ignore count of the breakpoint that halted execution to *`count`* minus one. The program does not halt at the breakpoint again until the breakpoint is encountered *`count`* times.

If the program halts for any reason other than a breakpoint, the argument to `continue` is ignored.

The synonym `fg` is provided for convenience, and has exactly the same behavior as other forms of the command.

define

`define` *`commandname`*

Defines a command.

`commandname`	Define a command named *`commandname`*. The end of these commands is marked by a line containing `end`. You can include up to 10 arguments. This command is also useful to "hook" a command.

delete

`delete [` *`bnums`* `]`

If no argument is specified, deletes all breakpoints. Otherwise, deletes the breakpoints whose numbers appear in *`bnums`*.

delete display

`delete display [` *`dnums`* `]`

Removes item numbers *`dnums`* from the list of expressions to display. If *`dnums`* is omitted, removes all items from the list of expressions to display.

directory

`directory [` *`dirname`* `]`

With no argument, resets the source path to empty. You are then prompted for confirmation.

`dirname`	Add directory *`dirname`* to the front of the source path.

disable

`disable [ display ] | [ breakpoints ] [ bnums ]`

Disables the breakpoints listed in *bnums*. Any number of breakpoints may be listed by number. Separates each number from the next by a space. The `breakpoints` keyword is not necessary unless differentiating between disabling the display of breakpoints, `display`, and disabling breakpoints. If no list of breakpoints is specified, all breakpoints are disabled.

disassemble

`disassemble { function | address } [ address ]`

Provides a dump of a range of memory as machine instructions.

address	The range is the inclusive area bounded by the two machine addresses provided in the *address* arguments. If only one *address* argument is provided, gdb960 finds the first C/C++ function that starts at an address less than or equal to the given address, then disassembles the entire function.
function	If only a *function* argument is provided, then the function named in *function* is disassembled in its entirety. If the string in *function* is not a function name, then its address is calculated and acted on as though it were an *address* argument.

display

`display [ /format ] [ exp | addr ]`

Prints a list of expressions each time the program stops. Without arguments, displays the current values of the expressions on the list, just as when the program stops.

addr	For *fmt* `i` or `s`, or when including a unit-size or a number of units, add *addr* to the auto-display list.
exp	Add the expression *exp* to the auto-display list and display it each time in the specified format.
/formatspec	The format in which memory contents are to display.

document

`document` *commandname*

Documents a user-defined command.

commandname	Document the user-defined command *commandname*. The `document` command reads lines of documentation, ending with `end`. After the `document` command is finished, `help` on command *commandname* displays the documentation you specify.

down

`down [`*n*`]`

Selects the frame *n* frames down from the previously selected frame. For positive numbers *n*, this advances toward the innermost frame, to lower frame numbers. Default is one.

down-silently

`down-silently` *`n`*

Same as `down`, except produces no output. This is useful in command scripts.

echo

`echo` *`text`*

Displays *`text`*. C/C++ escape sequences may be used in *`text`*.

`text`	Display *`text`*. Non printing characters can be included in text using C/C++ escape sequences, such as `\n` to print a newline.

enable

`enable [ display ] | [ once | delete | breakpoints ] [` *`bnums`* `]`

Enables breakpoints.

`bnums`	Enable breakpoints specified in *`bnums`*. If *`bnums`* is not specified, enable all defined breakpoints.
`breakpoints`	The `breakpoints` keyword is not necessary unless differentiating between enabling the display of breakpoints, `display,` and enabling breakpoints. If no list of breakpoints is specified, all breakpoints are enabled.
`delete` *`bnums`*	Enable the specified breakpoints temporarily. Each is deleted the next time it halts your program.
`display`	Enable display of breakpoint information.
`once` *`bnums`*	Enable the specified breakpoints temporarily. Each is disabled the next time it halts your program.

exec-file

`exec-file [ filename ]`

Specifies the program to run. Omitting the argument specifies no executable.

filename	Specify that the program to be run (but not the symbol table) is found in *filename*. The gdb960 debugger searches the environment variable PATH, if necessary, to locate the program.

file

`file [ filename ][ -p{c|d|x} offset ]`

Specifies the program to debug.

no arguments	Leaves both the executable file and symbol table unspecified.
filename	The program to be debugged. It is read for its symbols and pure memory contents, and it is executed when you give the run command.
pc, pd, or px	Symbols are relocated by adding *offset* to their values. These arguments act the same as their command-line counterparts.

finish

`finish`

Continues execution until after the selected stack frame returns (or until there is some other reason to halt, such as a fatal signal or a breakpoint). Displays the value returned by the selected stack frame.

forward-search

`forward-search` *`regexp`*

Searches for a text match in each line.

`regexp`	Searches by line, starting with the one following the last line listed, for a match for the regular expression *`regexp`*.

frame

`frame [` *`n`* `|` *`addr`* `]`

When used with any of the arguments described with the `break` command, selects a stack frame; with no argument, it does not change which frame is selected, but still displays information about the currently selected stack frame. The `frame` command can be used as an argument to `info`.

`n`	Select frame number *`n`*, where frame zero is the innermost (currently executing) frame.
`frame_addr`	Select the frame at address *`addr`*.

gmu detect define

`gmu detect define` *`regnum access startaddress endaddress`*

Controls the Guarded Memory Unit (GMU) detection registers. Detection GMU registers are identified by number, ranging from `0` to `NUMDREGS - 1`. `NUMDREGS` is currently 6 on the Hx processors.

`regnum`	Specifies the protection register number.
`access`	Specifies which types of memory access cause a GMU fault. The string has the form `ModeType[,ModeType]` where *`Mode`* is either `u` (user mode access) or `s` (supervisor mode access); *`Type`* is a string of one or more letters from Table 12-1. An optional second *`modetype`* may be given to program both user mode and supervisor mode in the same command. An example of a valid *`access`* argument is `urw,sx`, which means *fault on a user mode read or user mode write or a supervisor mode execute*.
`startaddress`	Evaluates to the starting address of the detection range.
`endaddress`	Evaluates to one byte beyond the ending address of the desired detection range.

gmu detect disable

`gmu detect disable [`*`regnum`*`]`

Disables the specified GMU detection register. Clears the memory detection enable bit in the GMU control register. If *`regnum`* is omitted, disables all GMU detection registers.

gmu detect enable

`gmu detect enable [`*`regnum`*`]`

Enables the specified GMU detection register. Sets the memory detection enable bit for this register in the GMU control register. If *`regnum`* is omitted, enables all GMU detection registers.

gmu protect define

`gmu protect define` *`regnum access address mask`*

Controls the Guarded Memory Unit (GMU) protection registers. Protection GMU registers are identified by number, ranging from `0` to `NUMPREGS - 1`. `NUMPREGS` is currently 2 on the Hx processors.

`regnum`	Specifies the protection register number.
`access`	Specifies which types of memory access cause a GMU fault. The string has the form `ModeType[,ModeType]` where *`Mode`* is either `u` (user mode access) or `s` (supervisor mode access); *`Type`* is a string of one or more letters from Table 12-1. An optional second *`modetype`* may be given to program both user mode and supervisor mode in the same command. An example of a valid *`access`* argument is `urw,sx`, which means *fault on a user mode read or user mode write or a supervisor mode execute*.
`address`	Evaluates to the starting address of the protection range.
`mask`	Evaluates to a number describing the addressing constraints for this range. For more information, refer to the *i960 Hx Microprocessor User's Manual*.

Table 12-1 Access Types

Access Type	Access Type Symbolic Name
Read	r
Write	w
Execute	x
Data Cache Write	c
None (clears previous settings)	n

gmu protect disable

`gmu protect disable [`*`regnum`*`]`

Disables the specified GMU protection register. Specifies a GMU protection register number. Clears the memory protection enable bit for this register in the GMU control register. If *`regnum`* is omitted, disables all GMU protection registers.

gmu protect enable

`gmu protect enable [`*`regnum`*`]`

Enables the specified GMU protection register. Sets the memory protection enable bit for this register in the GMU control register. If *`regnum`* is omitted, enables all GMU protection registers.

hbreak

`hbreak` *`args`*

Sets a hardware breakpoint on a specified line or function. The arguments list allows the same arguments as are listed in the `break` command, and the breakpoint is set in the same way. Hardware breakpoints allow breakpoints in non-writeable code; e.g., code that resides in ROM or FLASH. Breakpoints set with the `break` command are silently ignored when set in code that resides in non-writeable memory. You can set any number of hardware breakpoints, but i960 processor architecture allows only two to be enabled at any one time.

help

`help [` *`option`* `]`

Displays information about gdb960 commands.

`option`	With no arguments, `help` displays a short list of command categories.

ignore

`ignore` *`bnum count`*

Sets the count of breakpoint number *`bnum`* to *`count`*. The next *`count`* times the breakpoint is reached, your program's execution does not halt; other than to decrement the ignore count, gdb960 takes no action.

To make the breakpoint halt the next time it is reached, specify a count of zero.

info

`info` *`option`* `[` *`option_modifier`* `]`

Displays requested information.

`address` *`symbol`*	Describes where the data for *`symbol`* is stored.
`all-registers`	Display the names and relativized values of all registers, including floating-point registers.
`args`	Display the selected frame's arguments, each on a separate line.
`break [` *`bnum`* `]`	The command `info break` displays a list of all breakpoints set and not deleted, showing their numbers, where in the program they are, and any special features related to them. *`bnum`* identifies breakpoints about which information should be displayed.
`display`	Display the list of expressions set up to display automatically, each one with its item number.
`files`	Display the current target, including the names of the executable files currently in use, and the files from which symbols were loaded.
`frame [` *`addr`* `]`	Without the *`addr`* argument, display a verbose description of the selected stack frame. With the *`addr`* argument, display a verbose description of the frame at address *`addr`*.
`functions [` *`regexp`* `]`	Without the *`regexp`* argument, display the names and data types of all defined functions. With the *`regexp`* argument, display the names and data types of all defined

	functions whose names match the regular expression *regexp*.
`gmu`	Display the current values of all Guarded Memory Unit (GMU) registers (Hx only).
`line` *linenum*	Display the starting and ending addresses of the compiled code for source line *linenum*.
`program`	Display the execution status of the program.
`locals`	Display the selected frame's local variables, each on a separate line.
`registers [` *regname* `]`	Without the *regname* argument, display the names and relativized values of all non-floating-point registers.
	With the *regname* argument, display the relativized value of register *regname*.
`set`	Display all gdb960 settings.
`sources`	Display the names of all source files with debugging information.
`stack`	Display a backtrace.
`target`	Display the execution status of the program.
`types [` *regexp* `]`	Display either all types, or all those matching the regular expression *regexp*.
`variables [` *regexp* `]`	Without the *regexp* argument, display the names and data types of all variables declared outside of functions.
	With the *regexp* argument, display the names and data types of all variables

	(except for local variables) whose names match regular expression *regexp*.
`watch`	This is a synonym for `info break`.

jump

`jump { `*`linenum`*` | *`*`address`*` }`

Resumes execution at a new location.

`linenum`	Resume execution at line number *`linenum`*.
`*address`	Resume execution at the instruction at address *`address`*. The asterisk is required so the command line parser can identify *`address`* as a location rather than a value. For more information on halting the program, refer to Chapter 8.

list

`list [ `*`listsize`*` ] [n]`

Without an argument, displays *`listsize`* more lines. If the last lines displayed were displayed with a `list` command, displays *`listsize`* lines following the last lines displayed; however, if the last line displayed was a solitary line displayed as part of displaying a stack frame, displays *`listsize`* lines centered around that line. The command `set listsize` *`n`* changes the default of ten lines to *`n`* lines.

`linenum`	Display *`listsize`* lines centered on *`linenum`* from the current source file.
`-`	Display the *`listsize`* lines preceding the last lines displayed.
`function`	Display *`listsize`* lines centered around the beginning of *`function`*.

first,*last*	Display lines from *first* to *last*. Both arguments are linespecs.
,*last*	Display *listsize* lines, ending with *last*.
first,	Display *listsize* lines, starting with *first*.
+	Display the *listsize* lines following the last lines displayed.
-	Display the *listsize* lines preceding the lines last displayed.

lmadr

`lmadr` *regno value*

Sets the contents of the specified logical memory address register to the designated value. Range of *regno* is `0-1`.

This command is valid only for i960 Jx/Hx/Rx processors. Both command arguments are assumed to be hex constants.

lmmr

`lmmr` *regno value*

Sets the contents of the specified logical memory mask register to the designated value. Range of `regno` is `0-1`.

This command is valid only for i960 Jx/Hx/Rx processors. Both command arguments are assumed to be hex constants.

load

`load [ filename ]`

Downloads file.

filename	Download *filename* to the current target. If you have already specified an exec-file with the `file` or `exec-file` command, then leaving out *filename* causes the current exec-file to be downloaded.

make

`make [ make-options ]`

Runs a `make` tool in the shell, using the options in *make-options* as arguments to the `make command`.

mcon

`mcon region value`

Sets the Memory Configuration register for *region* to the specified value. Range of *region* is `0-0xf`. This command is valid only for i960 Cx/Jx/Hx/Rx processors. For the i960 Jx and Rx processors, *region* is automatically divided by two to map to the supported range of that processor. Both command arguments are assumed to be hex constants.

next

`next [count]`

Similar to `step`, but steps over function calls. Execution halts when control reaches a new line of code at the stack level that was executing when the `next` command was given. `next` is abbreviated as `n`. A *count* argument is a repeat count, as in `step`.

See also `step`, `nexti`.

nexti

`nexti [ count ]`
`ni`

Executes one machine instruction, but if it is a subroutine call, proceeds until the subroutine returns.

count	A *count* argument is a repeat count, as in `next`.

See also `stepi`, `next`.

output

`output [ /fmt ] expression`

expression	Display the value of *expression* and nothing but that value: no newlines, no `$nn =`. The value is not entered in the value history. For more information on expressions, refer to Chapter 11.
/fmt expression	Display the value of *expression* in format *fmt*. For more information on format specifications (*fmt*), refer to Chapter 11.

path

`path [ directory ]`

Adds *directory* to the front of the current search path. If no *directory* argument is specified, displays the current search path.

print

`print /fmt expression`

Displays the evaluated value of *exp* and add *exp* to the value `history`, where *exp* is an expression.

`/fmt expression`	Display the value of *`expression`* in format *`fmt`*. For more information on format specifications (*`fmt`*), refer to Chapter 11.

printf

`printf` *`string`*`, `*`expression`*`...`

Prints formatted data.

`string, expression`	Display the value of *`expression`* in the format specified in *`string`*. Format specifications are the same as for C/C++ `printf`(). For more information on expressions, refer to Chapter 11.

printsyms

`printsyms` *`filename`*

Writes a complete dump of the debugger's symbol data into the file *`filename`*.

profile

`profile { put | get | clear } [ `*`filename`*` ]`

Manages profile data.

`clear`	Reset profile data area in target memory to all zeroes.
`get [ `*`filename`*` ]`	Get profile data from *`filename`* and put it into the profile data area in target memory (default file name is `./default.pf`).
`put [ `*`filename`*` ]`	Store profile data from the profile data area in target memory into *`filename`* (default file name is `./default.pf`).

ptype

`ptype [ typename | exp ]`

Displays a description of a type.

typename	Display a description of data type *typename*. *typename* can be the name of a type, or for C/C++ code it can have the form `struct` *struct-tag*, `union` *union-tag* or `enum` *enum-tag*.
exp	Display a description of the type of expression *exp*. This is like `whatis`, except it displays a detailed description instead of just the name of the type.

pwd

`pwd`

Displays gdb960's working directory.

quit

`quit [ -n ]`

The optional `-n` option tells `quit` not to reset the target system.

rbreak

`rbreak regexp`

Sets a breakpoint on all functions matching *regexp*. This command sets an unconditional breakpoint on all matches, displaying a list of all breakpoints set. Once the breakpoints are set, they are treated just like the breakpoints set with `break`. They can be deleted, disabled, made conditional, and so forth, in the standard ways.

The gdb960 debugger converts the expression to an address.

regs

`regs`

Displays non-floating registers as two columns of hexadecimal numbers. Output is suitable for a 24x80 display. This command is an Intel modification to GNU gdb.

reset

`reset`

Sends a break to the remote target board with MON960 attached through a serial line; useful only if the target board has a circuit to perform a hard reset, or some other action, when a break is detected.

reverse-search

`reverse-search` *`regexp`*

Searches backward for a text match on each line.

`regexp`	Check each line, starting with the one preceding the last line listed, for a match for *`regexp`*. Lists the line that is found. The command abbreviation for `reverse` is `rev`.

run

`run [`*`arguments`*`]`

Before executing the `run` command, you must use the `file` command, `exec-file` command, or an argument to gdb960 to specify the program. The `run` command initiates execution at the location it has recorded as the start of the program. Program arguments are specified in *`arguments`*.

search

`search` *`regexp`*

Searches forward for a text match on each line.

`regexp`	Check each line, starting with the one following the last line listed, for a match for *`regexp`*. Lists the line that is found.

select-frame

`select-frame [` *`n`* `|` *`addr`* `]`

When used with any of the arguments described with the `break` command, selects a stack frame; with no argument, does not change which frame is selected. The `select-frame` command does not display information. The `select-frame` command can be used as an argument to `info`.

`n`	Select frame number *n*, where frame zero is the innermost (currently executing) frame.
`addr`	Select the frame at address *`addr`*.

set

`set item [` *`setting`* `] [` *`filename`* `]`

Changes the setting of a debugger attribute.

`{`*`type`*`}` *`addr`* `=` *`value`*	Assigns a value to a memory location. For example: `set {int} 0x4321 = 5`
`args`	Specify the arguments to be used the next time the program is run. If `set args` has no arguments, it means use no arguments the next time the program is run.

`autoreset [ on | off ]`	When `on`, the default, `quit` resets the target.
`caching [ on | off ]`	Prevent gdb960 from caching target memory if `off` is set. By default, caching is enabled, `set caching on`.
`complaints` *`limit`*	Permit gdb960 to output *`limit`* complaints about each type of unusual symbol before becoming silent about the problem. The default is zero, `off`. Set `limit` to a large number -- five is reasonable -- so complaints are not suppressed.
`confirm [ off | on ]`	Disables or enables (the default) cautious questions.
`demangle-style`	Show the current C++ demangling style. Setting this variable determines how gdb960 determines which demangling style gdb960 uses for C++ mangled names. The following choices are available and can be selected using the `set demangle-style` command.

`auto`	Determines demangling style on a case-by-case basis (this is the default)
`gnu`	Uses gnu (g++) style demangling
`lucid`	Uses lucid (lcc) style demangling
`arm`	Uses ARM-style demangling

It is suggested that you use either the `auto` or `gnu` settings when working with CTOOLS files.

`editing [ on | off ]`	Enable or disable command line editing. `on` is the default.
`env` *`var value`*	Set the environment variable *`var`* to expression *`value`*.
`height` *`lpp`*	Set the number of horizontal output lines on the screen.
`history [` *`option`* `]`	The `set history` options to control history expansion are:
`expansion on`	Enable history expansion.
`expansion off`	Disable history expansion (default).
`filename`	Set the command history file to *`filename`*
`history save [ on | off ]`	Record the gdb960 command history in a file. By default, *`filename`* is `./.gdb_history` on UNIX, and `./hist.gdb` on DOS. However, when the `GDBHISTFILE` environment variable is set, its value is used. You can also specify a filename using the `set history` *`filename`* command. By default, `set history save` is off.
`history size [`*`size`*`]`	Set the number of commands that gdb960 keeps in its history list. The default is the value of the `HISTSIZE` environment variable, or 256 if `HISTSIZE` is not set.
`input-radix` *`base`*	Set the default base for numeric user input. Supported choices for *`base`* are decimal 8, 10, 16. *`base`* must be specified either unambiguously or using the current default radix.

`Language`	Sets the source language. This variable can be set to any of the following: `local` — Automatically sets the language based on the source file name and contents `auto` — Same as `local` `c` — C language `c++` — C++ language `asm` — Assembly language gdb960 defaults to `auto` when first loaded, but this can be changed by using the `set language` command. Setting the language affects how gdb960 parses command expressions and interprets information found in the source file.
`listsize` *`n`*	Set the number of lines to list to *`n`*.
`output-radix` *`base`*	Set the default base for numeric output. Supported choices for *`base`* are decimal 8, 10, 16. *`base`* must be specified either unambiguously or using the current default radix.
`print address [ on | off ]`	Enable or disable display of memory addresses showing the location of stack traces, structure values, pointer values, breakpoints, and so forth, even when it also displays the contents of those addresses. `on` is the default.
`print array [ on | off ]`	Display pretty-print arrays. This format is more convenient to read, but uses more space. `off` is the default.

`print asm-demangle`	Display demangled C++ names in disassembly listings. If `print asm-demangle` is enabled, gdb960 demangles C++ mangled names in assembly code text (e.g., function disassembly). If this option is disabled (the default), gdb960 does not demangle names in assembly text.
`print autoderef [ on | off ]`	Print `char *` variables as strings. `on` is the default.
`print demangle`	Display demangled encoded C++ names. When `print demangle` is enabled (the default), gdb960 demangles C++ symbol names in its output. When this option is disabled, gdb960 does not demangle C++ mangled symbol names.
`print elements` *`NUMBER-OF-ELEMENTS`*	When displaying a large array, stop displaying after printing the number of elements set by the `set print elements` command. The limit also applies to display of strings. Setting the number of elements to zero allows unlimited displaying.
`print hit-counts [ on | off ]`	Display the number of times a breakpoint or watchpoint was encountered in `info break` output. `off` is the default.
`print max-symbolic-offset` *`max-offset`*	Display only the symbolic form of an address if the offset between the closest earlier symbol and the address is less than *`max-offset`*. The default is zero, to always display the symbolic form of an address, if any symbol precedes it.

`print null-stop [ on | off ]`	Stop printing of char arrays on the first null character when `on`. The default is `off`.
`print pretty [ on | off ]`	Display structures in an indented format with one member per line. `off` is the default format
`print sevenbit-strings [ on | off ]`	Display using only seven-bit characters; if this option is set, gdb960 displays any eight-bit characters, in strings or character values, using the notation `\`*`NNN`*. For example, `M-a` is displayed as octal `\341`. `off` is the default.
`print static-members`	Enable printing of C++ static members. If `print static-members` is enabled (the default), gdb960 includes static data members when displaying a class instance. If this option is disabled, gdb960 does not include static data members in its output. This flag does not affect the printing of a type (e.g., "`p a_class`" is affected, but "`ptype a_class`" is not).
`print symbolic-disassembly`	Can be abbreviated *`set print symbolic`*. When on, addresses in the disassembly show the machine address followed by <*`symbol`*+1234> where *`symbol`* is the closest preceding function name. Turning this off reduces clutter in the display. The on setting is the default.
`print symbol-filename [ on | off ]`	Disable or enable displaying the source file name and line number of a symbol in the symbolic form of an address. `off` is the default.

`print union [ on | off ]`	Display unions contained in structures. `on` is the default.
`prompt` *`newprompt`*	Direct gdb960 to use *`newprompt`* as its prompt string.
`radix` *`base`*	Set the default base for numeric input and display. Supported choices for *`base`* are decimal 8, 10, 16. *`base`* must be specified either unambiguously or using the current default radix.
`variable` *`var = expr`*	Set the variable *`var`* to expression *`expr`*. The keyword `variable` is required when *`var`* conflicts with a `set print` keyword.
`verbose [ on | off ]`	Enable gdb960's output of certain informational messages. `off` is the default.
`width` *`cpl`*	Contain the number of lines on the screen, and *`cpl`* contains the number of columns on the screen.

shell

`shell [` *`command`* `]`

Directs gdb960 to invoke an inferior shell and give you a shell prompt.

`command`	Directs gdb960 to invoke an inferior shell to execute *`command`*. The environment variable `SHELL` is used if it exists, otherwise gdb960 uses `/bin/sh` on UNIX and `command.com` on DOS.

show

`show [` *`settings`* `]`

Displays the setting of a debugger attribute. If you include no arguments, gdb960 displays all current settings. For each of these commands, see the corresponding `set` command for more information.

`args`	Show start-up arguments to give program being debugged.
`autoreset`	Show resetting of the target automatically when quitting.
`caching`	Show target memory caching.
`check`	Show the status of the type/range checker.
`commands`	Show the history of commands you typed.
`complaints`	Show maximum number of complaints about incorrect symbols
`confirm`	Show whether to confirm potentially dangerous operations.
`convenience`	Show debugger convenience ("$foo") variables.
`copying`	Show conditions for redistributing copies of gdb960.
`demangle-style`	Show the current C++ demangling style. Setting this variable determines how gdb960 determines which demangling style gdb960 uses for C++ mangled names. The following choices are available and can be selected using the `set demangle-style` command.

`auto`	Determines demangling style on a case-by-case basis (this is the default)
`gnu`	Uses gnu (g++) style demangling
`lucid`	Uses lucid (lcc) style demangling
`arm`	Uses ARM style demangling

It is suggested that you use either the `auto` or

	`gnu` settings when working with CTOOLS files.
`directories`	Show current search path for finding source files.
`editing`	Show editing of command lines as they are typed.
`endian`	Show endianness of target.
`environment`	Show the environment settings.
`gnutarget`	Show the current BFD target.
`height`	Show number of lines in a page.
`history`	Show command history parameters.
`input-radix`	Show default input radix for entering numbers.
`language`	Show the current source language.
`listsize`	Show default number of source lines gdb960 lists.
`output-radix`	Show default output radix for printing of values.
`paths`	Show current search path for finding object files.
`print`	Generic command for showing print settings.
`print address`	Show whether printing of addresses is enabled or disabled.
`print array`	Show whether pretty printing of arrays is enabled or disabled.
`print asm-demangle`	Show whether demangling of C++ names in disassembly listings is enabled or disabled. When `print asm-demangle` is enabled, gdb960 demangles C++ mangled names in assembly code text (e.g., function disassembly). When this option is disabled (the default), gdb960 does not demangle names in assembly text.
`print autoderef`	Show whether to print char pointers as strings is enabled or disabled.

`print demangle`	Show whether demangling of encoded C++ names when displaying is enabled or disabled. When `print demangle` is enabled (the default), gdb960 demangles C++ symbol names in its output. When this option is disabled, gdb960 does not demangle C++ mangled symbol names.
`print elements`	Show the limit on string chars or array elements to print.
`print hit-counts`	Show whether the printing of breakpoint hit counts is enabled or disabled.
`print max-symbolic-offset`	Show the largest offset that will be printed in <symbol+1234> form.
`print null-stop`	Show whether printing of char arrays to stop at first null char is enabled or disabled.
`print pretty`	Show whether pretty printing of structures is enabled or disabled.
`print repeats`	Show threshold for repeated print elements.
`print sevenbit-strings`	Show whether printing of 8-bit characters in strings as \nnn is enabled or disabled.
`print static-members`	Show whether printing of C++ static members is enabled or disabled. If `print static-members` is enabled (the default), gdb960 includes static data members when displaying a class instance. If this option is disabled, gdb960 does not include static data members in its output. This flag does not affect the printing of a type (e.g., "`p a_class`" is affected, but "`ptype a_class`" is not).
`print symbol-filename`	Show whether printing of source filename and line number with <symbol> is enabled or

	disabled.
`print symbolic-disassembly`	Show whether printing of <symbol+1234> with disassembly is enabled or disabled.
`print union`	Show whether printing of unions interior to structures is enabled or disabled.
`prompt`	Show gdb960 command prompt.
`radix`	Show the default input and output number radices.
`remotebaud`	Show baud rate for remote serial I/O.
`remotedebug`	Show debugging of remote protocol.
`symbol-reloading`	Show dynamic symbol table reloading multiple times in one run.
`targetdebug`	Show target debugging.
`user`	Show definitions of user-defined commands
`values`	Elements of value history around item number IDX (or last ten).
`verbose`	Show verbose information.
`version`	Show gdb960 version.
`warranty`	Various kinds of warranty you do not have
`watchdog`	Show watchdog timer.
`width`	Show number of characters gdb960 thinks are in a line
`write`	Show writing into executable and core files.

source

`source` *`file`*

Reads gdb960 commands from *`file`*.

step

`step [ count ]`

Executes one line of code, then halts execution and returns control to the debugger. Steps into function calls. This command is abbreviated `s`.

`count`	Execute *`count`* lines. If a breakpoint or a signal not related to stepping is encountered before *`count`* steps, execution halts.

See also `stepi`.

stepi

`stepi [ count ]`
`si`

Executes one machine instruction, then halts and returns control to the debugger.

`count`	A *`count`* argument is a repeat count, as in `step`.

See also `next`, `nexti`.

symbol-file

`symbol-file [ filename ]`

Reads symbol table information. The `symbol-file` command with no argument clears out gdb960's information on your program's symbol table.

The `symbol-file` command causes the gdb960 debugger to forget the contents of its convenience variables, the value history, and all breakpoints and auto-display expressions. This is because they may contain pointers to the internal data recording symbols and data types, which are part of the old symbol table data being discarded.

`filename`	Read symbol table information from file *`filename`*. `PATH` is searched when necessary.

Use the `file` command to run both the symbol table and the program from the same file.

target

`target` *`type devicename`* [*`hdil_arguments`*]

[*`type`*] *`devicename`*	Connect to an i960 processor board controlled by a *`type MON960`*. The *`devicename`* is the name of the serial device to use for the connection, (e.g., `/dev/ttya`). On Windows hosts, this is the name of your serial port (e.g., `COM1`).
`hdil_arguments`	See the *MON960 Debug Monitor User's Guide*, for valid arguments to pass as *`hdil_arguments`*.

tbreak

`tbreak` *`args`*

Sets a breakpoint enabled to cause only one halt. The arguments list, *`args`* is the same as in the `break` command, and the breakpoint is set the same way, but the breakpoint is automatically disabled the first time it is encountered. For more information on disabling breakpoints, see the `disable` command in this chapter.

thbreak

`thbreak` *`args`*

Sets a hardware-assisted breakpoint enabled to cause only one halt. The arguments list *`args`* is the same as in the `hbreak` command, and the breakpoint is set the same way. However, the breakpoint is automatically disabled the first time it is encountered.

undisplay

`undisplay` *`dnums`*

Removes item numbers *`dnums`* from the list of expressions to display.

unset

`unset env [` *`var`* `]`

Unsets environment variable *`var`*. With no arguments, unsets all environment variables.

until

`until [` *`location`* `]`

Allows executing all iterations of a loop as a single step; without arguments, causes execution to continue until the program reaches a source line greater than the current source line.

The `until` command always halts the program if it attempts to exit from the current stack frame.

With no argument, `until` works like single instruction stepping, and hence is slower than `until` with an argument. The `until` command accepts the same arguments as the `break` command.

`location`	Continue running the program until either the specified location is reached, or the current (innermost) stack frame returns. *`location`* can be any argument form acceptable to `break` (see the `set` command in this chapter). This form of the `until` command uses breakpoints, and hence is quicker than `until` without an argument because it need not break on every machine instruction.

up

`up` *n*

Selects the frame *n* frames up from the previously selected frame. For positive numbers *n*, this advances toward the outermost frame, to higher frame numbers. Default is one.

up-silently

`up-silently` *n*

Same as up, except produces no output. This is useful in command scripts.

watch

`watch` *expr*

Sets a watchpoint on *expr*. Execution stops whenever the value of *expr* changes. If hardware-assisted watchpoints are available in the target hardware, they are assigned to the watchpoint; otherwise a software watchpoint is generated. Use `awatch` or `wwatch` for hardware-only watchpoints.

whatis

`whatis [` *exp* `]`

Without an argument, displays the data type of `$`, the last value in the value history.

exp — Briefly display the data type of expression *exp* like `ptype`, but do not expand type descriptions. The argument *exp* is not actually evaluated, and any side-effecting operations (such as assignments) inside it do not take place. For more information on examining data, refer to Chapter 11.

where

`where`

Synonym for `backtrace`.

wwatch

`wwatch` *`expr`*

Sets a memory write hardware watchpoint. Memory write watchpoints halt program execution when a write is attempted at the address of *`expr`*.

x

`x` */formatspec address*

Examines memory without reference to the program's data types. The format must be explicitly specified.

`address`	The beginning location in memory where examination is to begin.
/formatspec	The format in which memory contents are to be displayed. For more information on formatting output, refer to Chapter 11.

See also `print, set`

Storing Commands 13

The gdb960 debugger provides two ways to store sequences of commands for execution: user-defined commands and command files. This chapter lists commands for defining custom commands, a description of how to create command files that can execute sequences of commands automatically, and a list of commands for controlling output.

User-defined Commands

A user-defined command is a sequence of gdb960 commands that you assign a name which can then be used to invoke the sequence. The `define` command assigns the execution name to the sequence of commands.

As with breakpoint command lists, a user-defined command is a list of commands entered after the initial command is entered. Terminate the list with the `end` command.

The following is an example of creating a user-defined command list which, when invoked by entering the `foo` command, displays a name, a number, and sets the `$tmp` convenience variable to the next structure. In

this example, the convenience variable `$tmp` must be set to the first structure before the `foo` command is invoked. Once defined, this command allows examining each member of a list by repeatedly pressing `RETURN`:

```
(gdb960) define foo
print $tmp->sptr->name.str
print $tmp->sptr->number
set $tmp = $tmp->next
end

(gdb960)
```

The following is a list of commands used to create and manipulate user-defined commands. Each command is followed by a description of its use:

`define` *`commandname`*
: Define a command named *`commandname`*. If there is already a command by that name, you must confirm that you want to redefine it.

  The command definition is made up of other gdb960 command lines that follow the `define` command. The end of these commands is marked by a line containing `end`.

`document` *`commandname`*
: Document the user-defined command *`commandname`*. The command *`commandname`* must already be defined. The `document` command reads lines of documentation just as `define` reads lines of the command definition, ending with `end`. After the `document` command is finished, `help` on command *`commandname`* displays the documentation you have specified.

  You must use the `document` command to change a command's documentation. Redefining the command with `define` does not change its documentation.

User-defined commands can have up to 10 arguments. When they are executed, the commands of the definition do not display. An error in any

command stops execution of the user-defined command and displays an error.

Commands that ask for confirmation if used interactively proceed without confirmation when part of a user-defined command. Many gdb960 commands that normally display messages omit the messages when used in user-defined commands.

User-defined Command Hooks

You may define hooks, which are a special kind of user-defined command. Whenever you run the command `foo`, if the user-defined command `hook-foo` exists, it is executed before that command. Like other user-defined commands, hooks can have up to 10 arguments.

In addition, a pseudo-command, `stop`, exists. Defining `hook-stop` makes the associated commands execute every time execution stops in your program, before breakpoint commands are run, displays are printed, or the stack frame is printed.

For example, suppose you want to execute a troublesome loop over and over, but you do not wish to single-step through it. The following resets the loop counter before `continue`, and examines the registers each time execution stops:

```
(gdb960) define hook-continue
set var i = 12
end
(gdb960) define hook-stop
regs
end
(gdb960) continue
```

You can define a hook for any single-word command in gdb960, but not for command aliases; you should define a hook for the basic command name (e.g., `backtrace` rather than `bt`). If an error occurs during the execution of your hook, execution of gdb960 commands stops, and gdb960 issues a prompt (before the command that you actually typed had a chance to run).

To undefine a hook, redefine it with the word `end` only.

Command Files

A command file contains gdb960 command lines. Comments and lines starting with `#` can also be included. An empty line in a command file does nothing; it does not repeat the last command.

On invocation, gdb960 first executes commands from its `init files`. These are files named `.gdbinit` on UNIX hosts and `init.gdb` on DOS hosts. The gdb960 debugger reads any `init file` in your home directory, then any `init file` in the current working directory. The `init files` are not executed if the `-nx` invocation option is given.

You can also request the execution of a command file with the `source` command, as shown in the following line:

`(gdb960) source` *`filename`* Execute the command file *`filename`*.

Lines in a command file are executed sequentially. They do not display as they are executed. An error in any command terminates execution of the command file. Commands that normally ask for confirmation proceed without confirmation when used in a command file. Many gdb960 commands that normally display messages omit the messages when used in command files.

Commands for Controlled Output

During execution of a command file or user-defined command, only output explicitly displayed by the included commands appears. This section describes three commands for generating output from a command file or a user-defined command. The following is a list of commands and their effects when included in a command list:

`echo` *`text`*

Display *`text`*. Non-printing characters can be included in text using C/C++ escape sequences, such as `\n` to print a newline. No newline will be printed unless you specify one. In addition to the standard C/C++ escape sequences, a backslash followed by a space stands for a space. Unless escaped, leading and trailing spaces are trimmed from all arguments. Thus, to display " `and foo =` ", use the command:

```
echo \ and foo = \ .
```

A backslash at the end of *`text`* continues the command onto subsequent lines. For example:

```
echo This is some text\n\
which is continued\n\
onto several lines.\n
```

produces the same output as:

```
echo This is some text\n
echo which is continued\n
echo onto several lines.\n
```

`output` *`expression`*

Display the value of *`expression`* and nothing but that value: no newlines, and no `$nn =`. The value is not entered in the value history. For more information on expressions, refer to Chapter 11. The following example compares the printout of the `print` command to the printout of the `output` command:

```
(gdb960) print/d foo
$15=42
(gdb960) output/d foo
42
(gdb960)
```

`output/`*`fmt`* *`expression`*

Display the value of *`expression`* in format *`fmt`*. For more information on expressions, refer to Chapter 11.

`printf` *`string, expressions`*

Display the values of the *`expressions`* under the control of *`string`*. The *`expressions`* are separated by commas and may be either numbers or pointers. Their values are displayed as specified by *`string`*, exactly as if the program were to execute the following C/C++ output function:

```
printf(string,expressions...);
```

For example, you can display two values in hex by entering the following command:

```
printf "foo, bar-foo = 0x%x, 0x%x\n", foo, bar-foo
```

The only backslash-escape sequences allowed in the format string are backslash-letter combinations.

Using gdb960 Under GNU Emacs

A

Setting Up gdb960 in Emacs

If you have GNU Emacs version 19 or greater

1. Copy the file `gud960.el` from the source code tree (*`BaseOfTree`*`/src/gdb960/common/gud960.el`) into your home directory, or, if you already have a collection of `.el` files, into that directory. Your system administrator can tell you where *`BaseOfTree`* is.
2. Edit `~/.emacs` and add the line:

   ```
   (autoload 'gdb960 "~/gud960.el" nil t)
   ```

   Substitute the destination directory you used in step 1, if it is different from your home directory.
3. Make sure gdb960 can be found on your PATH.
4. The next time you start Emacs, run the command `gdb960`. It asks for a command line, in the same way that the Emacs command `gdb` does.
5. Enter the name of the i960 processor program you want to debug, followed by any other arguments you wish to pass to `gdb960`.

If you have an earlier version of GNU Emacs

1. Copy the file `gdb960.el` from the GNU/960 source code tree (*`BaseOfTree`*`/src/gdb960/common/gdb960.el`) into your home directory, or, if you already have a collection of `.el` files, into that directory. Your system administrator can tell you where *`BaseOfTree`* is.

2. Edit `~/.emacs` and add the line:

   ```
   (autoload 'gdb960 "~/gdb960.el" nil t)
   ```

   Substitute the destination directory you used in step 1, if it is different from your home directory.
3. Make sure gdb960 can be found on your PATH.
4. The next time you start Emacs, run the command `gdb960`. It asks for a symbol-file, in the same way that the Emacs command `gdb` does.
5. Enter the name of the i960 processor program you want to debug.
6. After you see the gdb960 prompt, use the gdb960 `target` command to connect to your target.

Either version

When the target stops running for the first time, due to a breakpoint or single-stepping, Emacs splits the current window vertically, showing you the text of the current source file in the second window. This new buffer is continually updated as you step through your source code.
A special interface allows you to use GNU Emacs to view and edit the source files for the program you are debugging with gdb960. Using gdb960 under Emacs is just like using gdb960 normally except in two aspects:

1. All terminal input and output goes through the Emacs buffer. This applies both to gdb960 commands and their output, and to the input and output produced by the program you are debugging. This is useful because it means you can copy the text of previous commands and input them again; you can even use parts of the output that way. All the facilities of Emacs' shell mode are available for interacting with your program. In particular, you can send signals the usual Emacs way: for example, `C-c C-c` for an interrupt, and `C-c C-z` for a stop.

2. gdb960 displays source code through Emacs.

   Each time gdb960 displays a stack frame, Emacs automatically finds the source file for that frame and puts an arrow (=>) at the left margin of the current line. Emacs uses a separate buffer for source display and splits the screen to show both your gdb960 session and the source.

Explicit gdb960 `list` or `search` commands still produce output as usual.

CAUTION. *If the directory where your program resides is not your current directory, it can be easy to confuse Emacs about the location of the source files, in which case the auxiliary display buffer does not appear to show your source. gdb960 can find programs by searching your environment's* `PATH`*, so the gdb960 input and output session proceed normally; but Emacs does not get enough information back from gdb960 to locate the source files in this situation. To avoid this problem, either start gdb960 mode from the directory where your program resides, or specify a full path name when prompted for the* `M-x gdb960` *argument.*

Confusion can also result if you use the gdb960 `file` *command to switch to debugging a program in some other location, from an existing gdb960 buffer in Emacs.*

Using Emacs Commands with gdb960

By default, `M-x gdb960` calls the program called `gdb960`. If you need to call `gdb960` by a different name (for example, if you keep several configurations around, with different names) you can set the Emacs variable `gdb960-command-name`. In the following example, the `setq` command (preceded by `ESC ESC`, or typed in the `*scratch*` buffer, or in your `.emacs` file) makes Emacs call the program named `mygdb` instead:

```
setq gdb960-command-name "mygdb"
```

In the gdb960 I/O buffer, you can use these special Emacs (version 18 or earlier) commands in addition to the standard Shell mode commands:

`C-h m`	Describe the features of Emacs' gdb960 Mode.
`M-s`	Execute to another source line, like the gdb960 `step` command; also update the display window to show the current file and location.
`M-n`	Execute to next source line in this function, skipping all function calls, like the gdb960 `next` command. Then update the display window to show the current file and location.
`M-i`	Execute one instruction, like the gdb960 `stepi` command; update display window accordingly.
`M-x gdb960-nexti`	Execute to the next instruction, using the gdb960 `nexti` command; update display window accordingly.
`C-c C-f`	Execute until you exit from the selected stack frame, like the gdb960 `finish` command.
`M-c`	Continue executing your program, like the gdb960 `continue` command.
`M-u`	Go up the number of frames indicated by the numeric argument.
`M-d`	Go down the number of frames indicated by the numeric argument, like the gdb960 `down` command.

`C-x &`

Read the number where the cursor is positioned, and insert it at the end of the gdb960 I/O buffer. For example, if you wish to disassemble code around an address that was displayed earlier, type `disassemble`; then move the cursor to the address display and pick up the argument for `disassemble` by typing `C-x &`.

You can customize this further by defining elements of the gdb960 `list print` command; once it is defined, you can format or otherwise process numbers picked up by `C-x &` before they are inserted. A numeric argument to `C-x &` indicates both that you want special formatting, and acts as an index to pick an element of the list. If the list element is a string, the number to be inserted is formatted using the Emacs function `format`; otherwise, the number is passed as an argument to the corresponding list element.

In any source file, the Emacs command `C-x SPC` (gdb960 `break`) tells gdb960 to set a breakpoint on the source line point is on. If you accidentally delete the source-display buffer, an easy way to get it back is to type the command `f` in the gdb960 buffer, to request a frame display; when you run under Emacs, this recreates the source buffer, if necessary, to show you the context of the current frame.

The source files displayed in Emacs are in ordinary Emacs buffers that are visiting the source files in the usual way. You can edit the files with these buffers if you wish.

CAUTION. *In Emacs v19 or later, most of the special commands shown above have been replaced by commands preceded with the* `C-c` *command prefix. Use* `C-h m` *to list the commands available in gdb960 mode.*

Command Line Editing

B

Command line editing allows fast modification of command lines. You can repeat often typed text, delete and replace text, record text to be inserted later, splice commands together, and repair mis-typed commands.

This appendix describes the command line editing interface and provides some examples of its use.

Introduction to Line Editing

In this appendix, the following notation is used to describe keystrokes.

The text `CTRL + k` is read as ‘Control k’ and describes the character produced when the Control key is depressed and held while the `k` key is pressed.

The text `META + k` is read as ‘Meta k’ and describes the character produced when the `META` key (if you have one) is depressed, and the `k` key is pressed. If you do not have a `META` key, identical effects can result from holding down the `ESC` key while typing `k`. Either process is known as metafying the `k` key.

The text `META + CTRL + k` is read as 'Meta Control k' and describes the character produced by metafying `CTRL + k`.

In addition, several keys have their own names. Specifically, DEL, ESC, LFD, SPC, RET, and TAB all stand for themselves when seen in this text, or in an init file. For more information on init files, refer to the *Readline Init File* section of this appendix.

Readline Interaction

The Readline library provides a set of commands for manipulating the text on the command line, allowing you to fix typos without retyping the line. These editing commands allow positioning the cursor and deleting or inserting text. When you are satisfied with a line, press RETURN. The cursor does not have to be at the end of the line to press RETURN and have the modifications accepted.

Readline Bare Essentials

To enter characters into the line, position the cursor and type. Characters appear at the cursor position, and the cursor moves to the right. If you mis-type a character, you can use DEL to back up, and delete the mis-typed character.

Typing CTRL + b moves the cursor to the left, and CTRL + f moves the cursor to the right.

When adding text in the middle of a line, notice that characters to the right of the cursor move right to make room for the text you are inserting. When deleting text to the left of the cursor, characters to the right of the cursor move left to fill in the blank space created. The following is a list of input line editing commands and descriptions of their effects:

CTRL + b	Move back one character.
CTRL + f	Move forward one character.
DEL	Delete the character to the left of the cursor.
CTRL + d	Delete the character underneath the cursor.

`CTRL + _`	Undo the last input line change made. You can repeat the undo command until only an empty line remains.

Readline Movement Commands

Commands in addition to `CTRL + b`, `CTRL + f`, `CTRL + d`, and `DEL` allow rapid movement within a line. Here are some commands for moving more rapidly about the line:

`CTRL + a`	Move to the start of the line.
`CTRL + e`	Move to the end of the line.
`META + f`	Move forward a word.
`META + b`	Move backward a word.
`CTRL + l`	Clear the screen, redisplaying the current line at the top.

Notice how `CTRL + f` moves forward a character, while `META + f` moves forward an entire word. It is a loose convention that control keystrokes operate on characters while meta keystrokes operate on words.

Readline Killing Commands

Killing text means to delete the text from the line, but to save it away for later use. If the description for a command says that it 'kills' text, then you can retrieve the text later.

The following is a list of commands for killing text:

`CTRL + k`	Kill the text from the current cursor position to the end of the line.
`META + d`	Kill from the cursor to the end of the current word, or if between words, to the end of the next word.

`META + DEL`	Kill from the cursor to the start of the previous word, or if between words, to the start of the previous word.
`CTRL + w`	Kill from the cursor to the previous white space. This is different than `META + DEL` because `CTRL + w` kills to first white space, rather than to first white space before a complete word.

Yanking text means retrieving the text from the kill buffer. If the description for a command says that it yanks text, then the command places previously-killed text at the cursor position.

The following commands yank the text back into the line:

`CTRL + y`	Yank the most recently killed text back into the command line at the cursor location.
`META + y`	Rotate the kill-ring (the list of previously killed text), and yank the new top. You can do this only if the prior command is `CTRL + y` or `META + y`.

When you use a kill command, the text is saved in a buffer called a kill-ring. Any number of consecutive kills save all the killed text together in one element of the kill-ring. When yanking, all text in one element of the kill-ring is retrieved. Elements in the kill-ring separate from one another only if kills are separated by other commands. The kill-ring is not changed by creation of a new command line. Text killed on a previously typed line is available to be yanked when you are typing another line.

Readline Arguments

You can pass numeric arguments to Readline commands. Sometimes, numeric arguments determine the number of times a command is to repeat. Sometimes the sign of the argument determines the action and the numeric provides an offset. If you pass a negative argument to a command that normally acts in a forward direction, that command acts in a backward direction. For example, to kill text back to the start of the line, you might type `META + - CTRL + k`.

Generally, pass numeric arguments to a command by typing `META` *`digits`* before the command. If the first `digit` you type is a minus sign (`-`), then the sign of the argument is negative. Once you have typed one meta digit to get the argument started, type the remaining digits, and then the command. For example, to give the `CTRL + d` command an argument of 10, type `META + 1 0 CTRL + d`.

Readline Init File

Although the Readline library comes with a set of Emacs-like key bindings, it is possible to set up your own key bindings and change the state of a few variables. You can customize programs that use Readline by putting commands in an init file in your home directory. The name of this file is `.inputrc` on UNIX hosts, and `inputrc` on Windows hosts. gdb960 looks for this file at startup in the directory specified by the `$HOME` environment variable. There is no default for `$HOME`. If `$HOME` is not set, then no init file is used.

When a program that uses the Readline library starts up, the `~/.inputrc` file is read, and the key bindings are set.

Readline Variables

There are four internal Readline variables. You can use them to change the initial state of Readline editing. A list of the Readline init variables and their descriptions follows:

`editing-mode`	Controls which editing mode you are using. By default, GNU Readline starts up in Emacs editing mode. Possible settings are: `emacs` and `vi`.
`horizontal-scroll-mode`	Controls whether the text of the lines you edit scroll horizontally on a single screen line when they are larger than the width of the screen, instead of wrapping onto a new screen line. There are two possible settings: `on` and `off`. `off` is the default.
`mark-modified-lines`	Controls whether an asterisk appears at the beginning of history lines that have been modified. There are two possible settings: `on` and `off`. `off`, no asterisk, is the default.
`prefer-visible-bell [ on | off ]`	If set to `on`, use the visible bell if one is available rather than using the terminal bell. There are two possible settings: `on` and `off`. `off` is the default.

Although the Readline library comes with a set of Emacs-like key bindings, it is possible to set up your own key bindings. You can customize programs that use Readline by putting commands in an init file in your home directory. The name of this file is `~/.inputrc`.

The following two examples set `editing-mode` to `vi` and `horizontal-scroll` mode to `on`, respectively:

```
set editing-mode vi

set horizontal-scroll-mode on
```

Readline Key Bindings

The syntax for controlling key bindings in the `~/.inputrc` or `C:\inputrc` requires that you know the name of the command you want to change. The following pages provide tables containing command names, their default key bindings, and a short description of what each command does.

Once you know the name of the command, place the name of the key you wish to bind the command to, a colon, and then the name of the command on a line in the `init` file.

In the following example, `CTRL` + `u` is bound to the function `universal-argument`, and `CTRL` + `o` is bound to the macro "`&>output`", which inserts the string `&>output` into the line:

```
# This is a comment line.
Control-o:          ">&output"
Control-u:          universal-argument
```

You need not spell out the key sequences. You can specify key sequences in shorthand by enclosing the sequence in double quotes and using Emacs-style escapes. In the following example, `CTRL` + `u` is bound to the function `universal-argument`, `CTRL` + `o` is bound to the macro "`>&output`", which inserts the string `&>output` into the line, and `CTRL` + `x` `CTRL` + `r` is bound to the function `re-read-init-file`:

```
# This is a comment line.
"\CTRL + o":               ">&output"
"\CTRL + u":               universal-argument
"\CTRL + x\CTRL + r":      re-read-init-file
```

Commands For Moving

The following is a list of the command names, their original bindings, and short descriptions for cursor movement commands:

`beginning-of-line` (`CTRL` + `a`)	Move to the start of the current line.
`end-of-line` (`CTRL` + `e`)	Move to the end of the line.

`forward-char (CTRL + f)`	Move forward a character.
`backward-char (CTRL + b)`	Move back a character.
`forward-word (META + f)`	Move forward to the end of the next word.
`backward-word (META + b)`	Move back to the first white space that precedes the cursor position.
`clear-screen (CTRL + l)`	Clear the screen, leaving the current line at the top of the screen.

Commands For Manipulating History

The following is a list of history manipulation command names, their original bindings, and short descriptions:

`accept-line (Newline, Return)`	Accept the line regardless of cursor position. If this line is non-empty, add it to the history list. If this line was a history line, restore the history line to its original state.
`previous-history (CTRL + p)`	Move up through the history list.
`next-history (CTRL + n)`	Move down through the history list.
`beginning-of-history (META + <)`	Move to the first line in the history.
`end-of-history (META + >)`	Move to the end of the input history (i.e., the line you are entering).
`reverse-search-history (CTRL + r)`	Search backward, starting at the current line, and moving up through the history as necessary. This is a character-by-character, incremental search.

`forward-search-history (CTRL + s)`	Search forward, starting at the current line, and moving down through the history.

Commands For Changing Text

The following is a list of the command names, their original bindings, and short descriptions for changing text on the command line:

`delete-char (CTRL + d)`	Delete the character under the cursor. If the cursor is at the beginning of the line, and there are no characters in the line, and the last character typed was not `CTRL + d`, then return EOF.
`backward-delete-char (Rubout)`	Delete the character behind the cursor. A numeric argument says to kill the characters instead of deleting them.
`quoted-insert (CTRL + q, CTRL + v)`	Add the next character that you type to the line verbatim. Use this command to insert characters like `CTRL + q`.
`tab-insert (META + TAB)`	Insert a tab character.
`self-insert (a,b,A,1,!,...)`	Insert the character of the key that is pressed.
`transpose-chars (CTRL + t)`	Drag the character before the cursor forward. The cursor insertion point moves forward as well. If the cursor is at the end of the line, then transpose the two characters preceding the cursor. Negative arguments do not work.
`transpose-words (META + t)`	Drag the word behind the cursor past the word in front of the cursor, moving the cursor over that word as well.

`upcase-word (META + u)`	Convert to uppercase the current (or following) word. With a negative argument, convert the previous word, but do not move the cursor.
`downcase-word (META + l)`	Convert to lowercase the current (or following) word. With a negative argument, convert the previous word, but do not move the cursor.
`capitalize-word (META + c)`	Convert to uppercase the current (or following) word. With a negative argument, convert the previous word, but do not move the cursor.

Killing And Yanking

The following is a list of the command names, their original bindings, and short descriptions for killing and yanking text on the command line:

`kill-line (CTRL + k)`	Kill the text from the current cursor position to the end of the line.
`backward-kill-line ()`	Kill backward to the beginning of the line. This is normally not bound to a key sequence.
`kill-word (META + d)`	Kill from the cursor to the end of the current word, or if between words, to the end of the next word.
`backward-kill-word (META + DEL)`	Kill the word behind the cursor.
`unix-line-discard (CTRL + u)`	Remove the line input (`backward-kill-line`). Save the killed text on the kill-ring.

`unix-word-rubout (CTRL + w)`	Remove a word from line input. Save the text on the kill-ring. This is the same as `backward-kill-word`.
`yank (CTRL + y)`	Yank the top of the kill-ring into the buffer at the cursor.
`yank-pop (META + y)`	Rotate the kill-ring, and yank the new top. You can only do this if the prior command is `yank` or `yank-pop`.

Specifying Numeric Arguments

The following is a list of the command names, their original bindings, and short descriptions for specifying numeric arguments on the command line:

`digit-argument (META + 0, META + 1, ...META + -)`	Add this digit to the argument already accumulating, or start a new argument. `META + -` starts a negative argument.
`universal-argument ()`	Do what `CTRL + u` does in Emacs. By default, this function is not bound to a key sequence.

Some Miscellaneous Commands

The following is a list of the command names, their original bindings, and short descriptions for miscellaneous actions on the command line:

`abort (CTRL + g)`	Stops execution and sounds the terminal bell.
`do-uppercase-version (META + a, META + b)`	Run the command that is bound to the uppercase character.
`prefix-meta (ESC)`	Make the next character typed metafied. This is for people without a meta key. `ESC-f` is equivalent to `META + f`.

`undo` (`CTRL` + `_`)	Character by character, incremental undo, separately remembered for each line.
`revert-line` (`META` + `r`)	Undo all changes made to this line. This is like typing the `undo` command enough times to get back to blank line.

Readline vi Mode

While the Readline library does not have a full set of `vi` editing functions, it does contain enough to allow simple editing of the command line.

To switch interactively between `Emacs` and `vi` editing modes, use the command `META` + `CTRL` + `j` (toggle-editing-mode).

When you enter a line in `vi` mode, you are already in insertion mode, as if you had typed an `i` after invoking `vi`. Pressing `ESC` switches to edit mode, and allows you to edit text with the standard `vi` movement keys: For example, you may move to previous history lines with `k`, follow lines with `j`, and so forth.

GNU History Library

C

This appendix describes the history library, a programming tool that provides a consistent user interface for recalling lines of previously typed input.

Many programs read input from the user one line at a time. The GNU history library keeps track of those lines, associates arbitrary data with each line, and uses information from previous lines to make up new ones.

The programmer using the History library has functions available for completing the following tasks:

- remembering lines on a history stack
- associating arbitrary data with a line
- removing lines from the stack
- searching through the stack for a line containing an arbitrary text string
- referencing any line on the stack directly.

In addition, a history expansion function is available that provides a consistent user interface across many different programs.

The end-user using programs written with the History library has the benefit of a consistent user interface, with a set of well-known commands for manipulating the text of previous lines and using that text in new commands. The basic history manipulation commands are similar to the history substitution used by `csh`.

History Interaction

The History library provides a history expansion feature similar to the history expansion in `csh`. The following text describes the available syntax features.

History expansion takes place in two parts. First, determine which line from the previous history should be used during substitution. Second, select portions of that line for inclusion in the current line. The line selected from the previous history is called the event, and the portions of that line that are acted upon are called words. The line is broken into words in `Bash` shell fashion. Words are delimited by white space, with the exception of quoted strings. So, several words surrounded by quotes are considered one word.

Event Designators

An event designator is a character or character sequence that refers to a command line entry in the history list. The following is a list of event designators and descriptions of their effects:

`!`	Start a history substitution, except when followed by a space, tab, `=`, `(`, or end-of-line.
`!!`	Refer to the previous command. This is a synonym for `!-1`.
`!`*`n`*	Refer to command line *n*.
`!-`*`n`*	Refer to the command line *n* lines back.
`!`*`string`*	Refer to the most recent command starting with *string*.
`!?`*`string`*`[?]`	Refer to the most recent command containing *string*.

Word Designators

A colon (`:`) separates event specifications from the word designators. The colon can be omitted if the word designator begins with `^`, `$`, `*` or `%`. Words are numbered from the beginning of the line, with the first word being denoted by a 0 (zero).

`0 (zero)`	The zero'th word. This is usually the command word.
`n`	The *n*'th word.
`^`	The first argument. That is, word 1.
`$`	The last argument.
`%`	The word matched by the most recent *`?string?`* search.
`x-y`	A range of words; `-y` is the abbreviation for `0-y`.
`*`	All of the words, excepting the zero'th. This is a synonym for `1-$`. It is not an error to use `*` if there is just one word in the event. The empty string is returned in that case.

Modifiers

Modifiers allow modification of designator-created commands. After the optional word designator, you can add a sequence of one or more of the following modifiers, each preceded by a colon (`:`):

`#`	The entire current command line typed so far.
`h`	Remove a trailing pathname component, leaving only the head.
`r`	Remove a trailing suffix of the form *`.suffix`*, leaving the basename.

`e`	Remove all but the suffix.
`t`	Remove all leading pathname components, leaving the tail.
`p`	Display the new command but do not execute it. This takes effect immediately, so it should be the last specifier on the line.

Using gdb960 with ApLink

D

gdb960 supports ApLink, a software and hardware debug probe for the i960 processors. Because ApLink includes the MON960 debug monitor on board, it makes i960 processor software development as simple as self-hosted development on a PC or workstation. By using ApLink, you avoid having to port software or design specialized hardware into the target system to use the monitor.

ApLink Commands

These commands are useful primarily for ApLink, but can be used by all i960 Cx, Jx, and Hx processor-based targets.

`mcon` *`region value`*	Set the Memory Configuration register for *`region`* to the specified value. Range of *`region`* is `0-0xf`. This command is valid only for i960 Cx/Jx/Hx processors. For the i960 Jx processor, *`region`* is automatically divided by two to map to the supported range of that processor. Both command arguments are assumed to be hex constants.
`lmadr` *`regno value`*	Set the contents of the specified logical memory address register to the designated value. Range of *`regno`* is `0-1`.

	This command is valid only for i960 Jx/Hx/Rx processors. The debugger assumes that both command arguments are hex constants.
`lmmr` *`regno value`*	Set the contents of the specified logical memory mask register to the designated value. Range of *`regno`* is `0-1`. This command is valid only for i960 Jx/Hx/Rx processors. The debugger assumes that both command arguments are hex constants.

NOTE. *Improper use of the `mcon`, `lmadr`, or `lmmr` commands causes MON960 to crash. See the next section for examples of using these commands.*

Using gdb960 With ApLink

The i960 Cx, Jx, and Hx ApLink-compatible versions of MON960 are not configured to enable the active memory regions on the target connected to ApLink. Consequently, debugger access to target memory and/or peripherals is, by default, impossible.

However, ApLink-aware debuggers, such as gdb960 R5.0 and later, support several new commands to dynamically enable processor memory regions following monitor boot.

Cx Configuration

To configure memory regions for a Cx-based target, you need only to modify the processor's memory region configuration registers. For more information on those registers, refer to the description of the processor's bus controller in Chapter 10 of the *i960 Cx Microprocessor User's Manual*. The following example shows gdb960 syntax that enables DRAM in memory regions C and D of an EP80960CX target connected to ApLink.

```
c:\> gdb960 -r com1 -b 57600
(gdb960) mcon c 0x900003
 /* d-cache on, 32-bit, little-endian, !ready set, burst set */
(gdb960) mcon d 0x900003
 /* d-cache on, 32-bit, little-endian, !ready set, burst set */
```

i960® Jx Memory Configuration

Configuring memory regions for an i960 Jx processor-based target is discussed in Chapter 12 of the *i960 Jx Microprocessor User's Manual*.

When the i960 Jx processor's `DLMCON.dcen` bit is not set, a region containing noncacheable, memory-mapped peripheral(s) may be enabled by simply using the previously described `mcon` commands to write an appropriate bus width setting into the applicable PMCON register. When enabling cacheable memory (i.e., DRAM), the processor's PMCON, LMADR, and LMMR registers must all be configured.

The effective address range for a logical data template is defined using the `A31:12` field in the `LMADRx` register and the `MA31:12` field in the `LMMRx` register. For each data access, the upper 20 bits of the effective address are compared against `A31:12` of the `LMADRx`.

Only address bits for which the corresponding mask bit is set (in the `LMMRx` register) are compared. Effective address bits with corresponding mask bits cleared are automatically considered a match. Logically, the operation is as follows:

`(EFA[31:12]` `xnor` `LMADRx[A31:12])` or `(not LMMRx[MA31:12])` where `EFA[31:12]` is the effective bus address. Only when all compared address bits match are the LMADRx be used for the current bus access.

The following example gdb960 commands enable 32-bit DRAM in memory region A of an EP80960JX target connected to ApLink.

```
c:\> gdb960 -r com1
(gdb960) mcon  a 0x800000
 /* 32-bit bus width */
(gdb960) lmadr 0 0xa0000002
 /*  data caching configured for region A */
(gdb960) lmmr  0 0xf0000001
 /* set mask register to appropriate value & enable
template */
```

gdb960 Scripts

gdb960 supports command scripts that automate enabling a target's DRAM and/or peripheral memory regions prior to downloading and debugging a program. The following example script and actual command line syntax demonstrate how to use this facility. The script downloads and executes a fictitious program called "hello". In this example, assume that an EP80960CX target is physically connected to a CA ApLink and that the EP80960CX has DRAM in region C.

Example Script

```
c:\> type gdb960.cmd
mcon c 0x900003
file hello
load hello
run
c:\> gdb960 -b 57600 -r com1 -parallel lpt1 -
command=gdb960.cmd
```

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