

Sourcery G++ Lite

ARM SymbianOS

Sourcery G++ Lite 2010.09-54

Getting Started



Sourcery G++ Lite: ARM SymbianOS: Sourcery G++ Lite 2010.09-54: Getting Started

CodeSourcery, Inc.

Copyright © 2005, 2006, 2007, 2008, 2009, 2010 CodeSourcery, Inc.

All rights reserved.

Abstract

This guide explains how to install and build applications with Sourcery G++ Lite, CodeSourcery's customized and validated version of the GNU Toolchain. Sourcery G++ Lite includes everything you need for application development, including C and C++ compilers, assemblers, linkers, and libraries.

When you have finished reading this guide, you will know how to use Sourcery G++ from the command line.

Table of Contents

Preface	iv
1. Intended Audience	v
2. Organization	v
3. Typographical Conventions	v
1. Quick Start	1
1.1. Installation and Set-Up	2
1.2. Building Your Program	2
1.3. Running and Debugging Your Program	2
2. Installation and Configuration	3
2.1. Terminology	4
2.2. System Requirements	4
2.3. Downloading an Installer	5
2.4. Installing Sourcery G++ Lite	5
2.5. Installing Sourcery G++ Lite Updates	8
2.6. Setting up the Environment	8
2.7. Uninstalling Sourcery G++ Lite	10
3. Sourcery G++ Lite for ARM SymbianOS	12
3.1. Included Components and Features	13
3.2. Library Configurations	13
3.3. Building SymbianOS Programs	13
3.4. SymbianOS Runtime Libraries	16
3.5. NEON SIMD Code	16
3.6. Half-Precision Floating Point	16
3.7. ABI Compatibility	16
4. Using Sourcery G++ from the Command Line	18
4.1. Building an Application	19
4.2. Running Applications on the Target System	19
5. Next Steps with Sourcery G++	20
5.1. Sourcery G++ Knowledge Base	21
5.2. Example Programs	21
5.3. Manuals for GNU Toolchain Components	21
A. Sourcery G++ Lite Release Notes	22
A.1. Changes in Sourcery G++ Lite for ARM SymbianOS	23
B. Sourcery G++ Lite Licenses	32
B.1. Licenses for Sourcery G++ Lite Components	33
B.2. Sourcery G++ Software License Agreement	33
B.3. Attribution	37

Preface

This preface introduces the Sourcery G++ Lite Getting Started guide. It explains the structure of this guide and describes the documentation conventions used.

1. Intended Audience

This guide is written for people who will install and/or use Sourcery G++ Lite. This guide provides a step-by-step guide to installing Sourcery G++ Lite and to building simple applications. Parts of this document assume that you have some familiarity with using the command-line interface.

2. Organization

This document is organized into the following chapters and appendices:

Chapter 1, “Quick Start”	This chapter includes a brief checklist to follow when installing and using Sourcery G++ Lite for the first time. You may use this chapter as an abbreviated guide to the rest of this manual.
Chapter 2, “Installation and Configuration”	This chapter describes how to download, install and configure Sourcery G++ Lite. This section describes the available installation options and explains how to set up your environment so that you can build applications.
Chapter 3, “Sourcery G++ Lite for ARM SymbianOS”	This chapter contains information about using Sourcery G++ Lite that is specific to ARM SymbianOS targets. You should read this chapter to learn how to best use Sourcery G++ Lite on your target system.
Chapter 4, “Using Sourcery G++ from the Command Line”	This chapter explains how to build applications with Sourcery G++ Lite using the command line. In the process of reading this chapter, you will build a simple application that you can use as a model for your own programs.
Chapter 5, “Next Steps with Sourcery G++”	This chapter describes where you can find additional documentation and information about using Sourcery G++ Lite and its components. It also provides information about Sourcery G++ subscriptions. CodeSourcery customers with Sourcery G++ subscriptions receive comprehensive support for Sourcery G++.
Appendix A, “Sourcery G++ Lite Release Notes”	This appendix contains information about changes in this release of Sourcery G++ Lite for ARM SymbianOS. You should read through these notes to learn about new features and bug fixes.
Appendix B, “Sourcery G++ Lite Licenses”	This appendix provides information about the software licenses that apply to Sourcery G++ Lite. Read this appendix to understand your legal rights and obligations as a user of Sourcery G++ Lite.

3. Typographical Conventions

The following typographical conventions are used in this guide:

> `command arg ...` A command, typed by the user, and its output. The “>” character is the command prompt.

<code>command</code>	The name of a program, when used in a sentence, rather than in literal input or output.
<code>literal</code>	Text provided to or received from a computer program.
<i>placeholder</i>	Text that should be replaced with an appropriate value when typing a command.
<code>\</code>	At the end of a line in command or program examples, indicates that a long line of literal input or output continues onto the next line in the document.

Chapter 1

Quick Start

This chapter includes a brief checklist to follow when installing and using Sourcery G++ Lite for the first time. You may use this chapter as an abbreviated guide to the rest of this manual.

Follow the steps given in this chapter to install Sourcery G++ Lite and build and run your first application program. The checklist given here is not a tutorial and does not include detailed instructions for each step; however, it will help guide you to find the instructions and reference information you need to accomplish each step.

You can find additional details about the components, libraries, and other features included in this version of Sourcery G++ Lite in Chapter 3, “Sourcery G++ Lite for ARM SymbianOS”.

1.1. Installation and Set-Up

Install Sourcery G++ Lite on your host computer. You may download an installer package from the Sourcery G++ web site¹, or you may have received an installer on CD. The installer is an executable program that pops up a window on your computer and leads you through a series of dialogs to configure your installation. If the installation is successful, it will offer to launch the Getting Started guide. For more information about installing Sourcery G++ Lite, including host system requirements and tips to set up your environment after installation, refer to Chapter 2, “Installation and Configuration”.

1.2. Building Your Program

Build your program with Sourcery G++ command-line tools. Create a simple test program, and follow the directions in Chapter 4, “Using Sourcery G++ from the Command Line” to compile and link it using Sourcery G++ Lite.

1.3. Running and Debugging Your Program

The steps to run or debug your program depend on your target system and how it is configured. Choose the appropriate method for your target.

¹ http://www.codesourcery.com/gnu_toolchains/

Chapter 2

Installation and Configuration

This chapter explains how to install Sourcery G++ Lite. You will learn how to:

1. Verify that you can install Sourcery G++ Lite on your system.
2. Download the appropriate Sourcery G++ Lite installer.
3. Install Sourcery G++ Lite.
4. Configure your environment so that you can use Sourcery G++ Lite.

2.1. Terminology

Throughout this document, the term *host system* refers to the system on which you run Sourcery G++ while the term *target system* refers to the system on which the code produced by Sourcery G++ runs. The target system for this version of Sourcery G++ is `arm-none-symbianelf`.

If you are developing a workstation or server application to run on the same system that you are using to run Sourcery G++, then the host and target systems are the same. On the other hand, if you are developing an application for an embedded system, then the host and target systems are probably different.

2.2. System Requirements

2.2.1. Host Operating System Requirements

This version of Sourcery G++ supports the following host operating systems and architectures:

- Microsoft Windows 2000, Windows XP, Windows Vista, and Windows 7 systems using IA32, AMD64, and Intel 64 processors.
- GNU/Linux systems using IA32, AMD64, or Intel 64 processors, including Debian 3.1 (and later), Red Hat Enterprise Linux 3 (and later), and SuSE Enterprise Linux 8 (and later).

Sourcery G++ is built as a 32-bit application. Therefore, even when running on a 64-bit host system, Sourcery G++ requires 32-bit host libraries. If these libraries are not already installed on your system, you must install them before installing and using Sourcery G++ Lite. Consult your operating system documentation for more information about obtaining these libraries.

Installing on Ubuntu and Debian GNU/Linux Hosts

The Sourcery G++ graphical installer is incompatible with the `dash` shell, which is the default `/bin/sh` for recent releases of the Ubuntu and Debian GNU/Linux distributions. To install Sourcery G++ Lite on these systems, you must make `/bin/sh` a symbolic link to one of the supported shells: `bash`, `csh`, `tcsh`, `zsh`, or `ksh`.

For example, on Ubuntu systems, the recommended way to do this is:

```
> sudo dpkg-reconfigure -plow dash
Install as /bin/sh? No
```

This is a limitation of the installer and uninstaller only, not of the installed Sourcery G++ Lite toolchain.

2.2.2. Host Hardware Requirements

In order to install and use Sourcery G++ Lite, you must have at least 512MB of available memory.

The amount of disk space required for a complete Sourcery G++ Lite installation directory depends on the host operating system and the number of target libraries included. When you start the graphical installer, it checks whether there is sufficient disk space before beginning to install. Note that the graphical installer also requires additional temporary disk space during the installation process. On Microsoft Windows hosts, the installer uses the location specified by the `TEMP` environment variable for these temporary files. If there is not enough free space on that volume, the installer

prompts for an alternate location. On Linux hosts, the installer puts temporary files in the directory specified by the `IATEMPDIR` environment variable, or `/tmp` if that is not set.

2.2.3. Target System Requirements

See Chapter 3, “Sourcery G++ Lite for ARM SymbianOS” for requirements that apply to the target system.

2.3. Downloading an Installer

If you have received Sourcery G++ Lite on a CD, or other physical media, then you do not need to download an installer. You may skip ahead to Section 2.4, “Installing Sourcery G++ Lite”.

You can download Sourcery G++ Lite from the Sourcery G++ web site¹. This free version of Sourcery G++, which is made available to the general public, does not include all the functionality of CodeSourcery's product releases. If you prefer, you may instead purchase or register for an evaluation of CodeSourcery's product toolchains at the Sourcery G++ Portal².

Once you have navigated to the appropriate web site, download the installer that corresponds to your host operating system. For Microsoft Windows systems, the Sourcery G++ installer is provided as an executable with the `.exe` extension. For GNU/Linux systems Sourcery G++ Lite is provided as an executable installer package with the `.bin` extension. You may also install from a compressed archive with the `.tar.bz2` extension.

On Microsoft Windows systems, save the installer to the desktop. On GNU/Linux systems, save the download package in your home directory.

2.4. Installing Sourcery G++ Lite

The method used to install Sourcery G++ Lite depends on your host system and the kind of installation package you have downloaded.

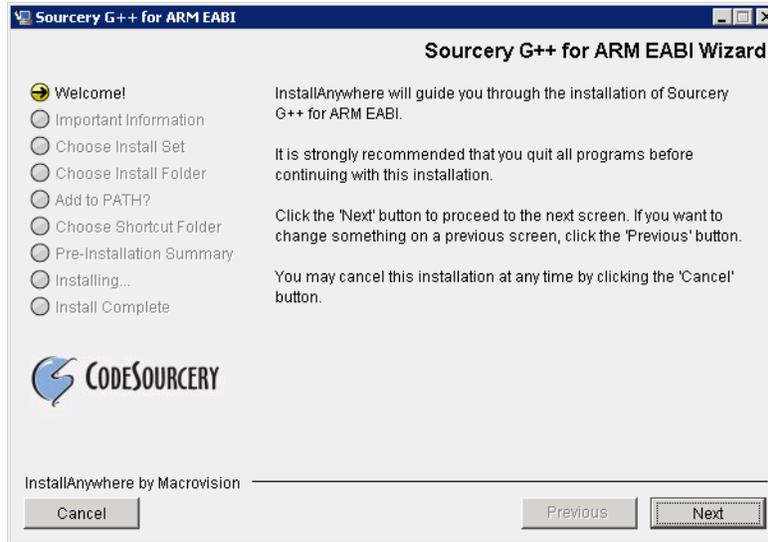
2.4.1. Using the Sourcery G++ Lite Installer on Microsoft Windows

If you have received Sourcery G++ Lite on CD, insert the CD in your computer. On most computers, the installer then starts automatically. If your computer has been configured not to automatically run CDs, open *My Computer*, and double click on the CD. If you downloaded Sourcery G++ Lite, double-click on the installer.

After the installer starts, follow the on-screen dialogs to install Sourcery G++ Lite. The installer is intended to be self-explanatory and on most pages the defaults are appropriate.

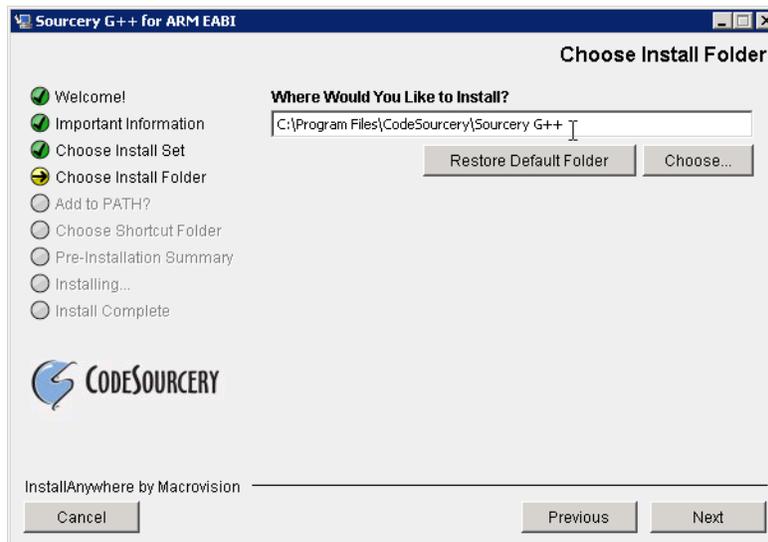
¹ http://www.codesourcery.com/gnu_toolchains/

² <https://support.codesourcery.com/GNUToolchain/>

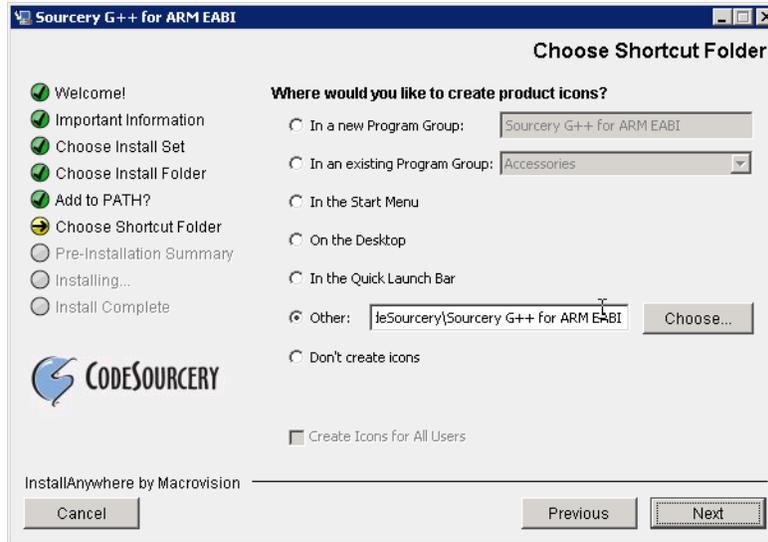


Running the Installer. The graphical installer guides you through the steps to install Sourcery G++ Lite.

You may want to change the install directory pathname and customize the shortcut installation.

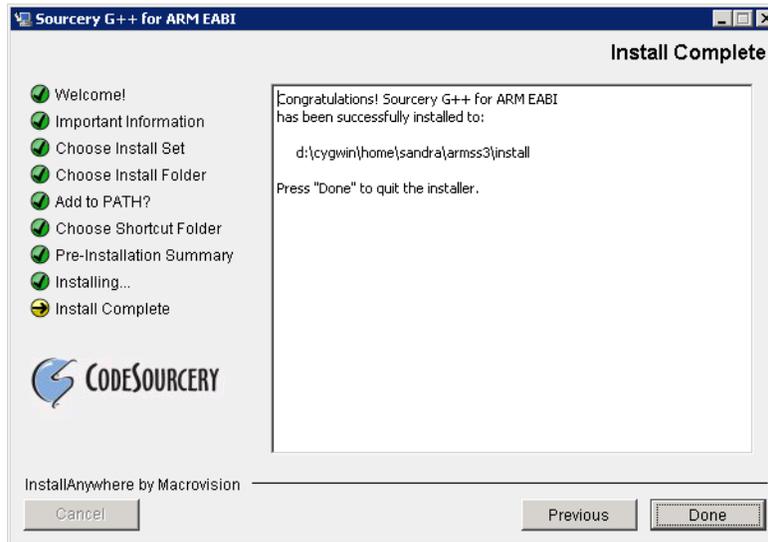


Choose Install Folder. Select the pathname to your install directory.



Choose Shortcut Folder. You can customize where the installer creates shortcuts for quick access to Sourcery G++ Lite.

When the installer has finished, it asks if you want to launch a viewer for the Getting Started guide. Finally, the installer displays a summary screen to confirm a successful install before it exits.



Install Complete. You should see a screen similar to this after a successful install.

If you prefer, you can run the installer in console mode rather than using the graphical interface. To do this, invoke the installer with the `-i console` command-line option. For example:

```
> /path/to/package.exe -i console
```

2.4.2. Using the Sourcery G++ Lite Installer on GNU/Linux Hosts

Start the graphical installer by invoking the executable shell script:

```
> /bin/sh ./path/to/package.bin
```

After the installer starts, follow the on-screen dialogs to install Sourcery G++ Lite. For additional details on running the installer, see the discussion and screen shots in the Microsoft Windows section above.

If you prefer, or if your host system does not run the X Window System, you can run the installer in console mode rather than using the graphical interface. To do this, invoke the installer with the `-i console` command-line option. For example:

```
> /bin/sh ./path/to/package.bin -i console
```

2.4.3. Installing Sourcery G++ Lite from a Compressed Archive

You do not need to be a system administrator to install Sourcery G++ Lite from a compressed archive. You may install Sourcery G++ Lite using any user account and in any directory to which you have write access. This guide assumes that you have decided to install Sourcery G++ Lite in the `$HOME/CodeSourcery` subdirectory of your home directory and that the filename of the package you have downloaded is `/path/to/package.tar.bz2`. After installation the toolchain will be in `$HOME/CodeSourcery/sourceryg++-2010.09`.

First, uncompress the package file:

```
> bunzip2 /path/to/package.tar.bz2
```

Next, create the directory in which you wish to install the package:

```
> mkdir -p $HOME/CodeSourcery
```

Change to the installation directory:

```
> cd $HOME/CodeSourcery
```

Unpack the package:

```
> tar xf /path/to/package.tar
```

2.5. Installing Sourcery G++ Lite Updates

If you have already installed an earlier version of Sourcery G++ Lite for ARM SymbianOS on your system, it is not necessary to uninstall it before using the installer to unpack a new version in the same location. The installer detects that it is performing an update in that case.

If you are installing an update from a compressed archive, it is recommended that you remove any previous installation in the same location, or install in a different directory.

Note that the names of the Sourcery G++ commands for the ARM SymbianOS target all begin with `arm-none-symbianelf`. This means that you can install Sourcery G++ for multiple target systems in the same directory without conflicts.

2.6. Setting up the Environment

As with the installation process itself, the steps required to set up your environment depend on your host operating system.

2.6.1. Setting up the Environment on Microsoft Windows Hosts

2.6.1.1. Setting the PATH

In order to use the Sourcery G++ tools from the command line, you should add them to your PATH. You may skip this step if you used the graphical installer, since the installer automatically adds Sourcery G++ to your PATH.

To set the PATH on a Microsoft Windows Vista system, use the following command in a `cmd.exe` shell:

```
> setx PATH "%PATH%;C:\Program Files\Sourcery G++\bin"
```

where `C:\Program Files\Sourcery G++` should be changed to the path of your Sourcery G++ Lite installation.

To set the PATH on a system running Microsoft Windows 7, from the desktop bring up the Start menu and right click on Computer. Select Properties and click on Advanced system settings. Go to the Advanced tab, then click on the Environment Variables button. Select the PATH variable and click the Edit. Add the string `;C:\Program Files\Sourcery G++\bin` to the end, and click OK. Be sure to adjust the pathname to reflect your actual installation directory.

To set the PATH on older versions of Microsoft Windows, from the desktop bring up the Start menu and right click on My Computer. Select Properties, go to the Advanced tab, then click on the Environment Variables button. Select the PATH variable and click the Edit. Add the string `;C:\Program Files\Sourcery G++\bin` to the end, and click OK. Again, you must adjust the pathname to reflect your installation directory.

You can verify that your PATH is set up correctly by starting a new `cmd.exe` shell and running:

```
> arm-none-symbianelf-g++ -v
```

Verify that the last line of the output contains: `Sourcery G++ Lite 2010.09-54`.

2.6.1.2. Working with Cygwin

Sourcery G++ Lite does not require Cygwin or any other UNIX emulation environment. You can use Sourcery G++ directly from the Windows command shell. You can also use Sourcery G++ from within the Cygwin environment, if you prefer.

The Cygwin emulation environment translates Windows path names into UNIX path names. For example, the Cygwin path `/home/user/hello.c` corresponds to the Windows path `c:\cygwin\home\user\hello.c`. Because Sourcery G++ is not a Cygwin application, it does not, by default, recognize Cygwin paths.

If you are using Sourcery G++ from Cygwin, you should set the `CYGPATH` environment variable. If this environment variable is set, Sourcery G++ Lite automatically translates Cygwin path names into Windows path names. To set this environment variable, type the following command in a Cygwin shell:

```
> export CYGPATH=cygpath
```

To resolve Cygwin path names, Sourcery G++ relies on the `cygpath` utility provided with Cygwin. You must provide Sourcery G++ with the full path to `cygpath` if `cygpath` is not in your PATH. For example:

```
> export CYGPATH=c:/cygwin/bin/cygpath
```

directs Sourcery G++ Lite to use `c:/cygwin/bin/cygpath` as the path conversion utility. The value of `CYGPATH` must be an ordinary Windows path, not a Cygwin path.

2.6.2. Setting up the Environment on GNU/Linux Hosts

If you installed Sourcery G++ Lite using the graphical installer then you may skip this step. The installer does this setup for you.

Before using Sourcery G++ Lite you should add it to your `PATH`. The command you must use varies with the particular command shell that you are using. If you are using the C Shell (`csh` or `tcsh`), use the command:

```
> setenv PATH $HOME/CodeSourcery/Sourcery_G++/bin:$PATH
```

If you are using Bourne Shell (`sh`), the Korn Shell (`ksh`), or another shell, use:

```
> PATH=$HOME/CodeSourcery/Sourcery_G++/bin:$PATH
> export PATH
```

If you are not sure which shell you are using, try both commands. In both cases, if you have installed Sourcery G++ Lite in an alternate location, you must replace the directory above with `bin` subdirectory of the directory in which you installed Sourcery G++ Lite.

You may also wish to set the `MANPATH` environment variable so that you can access the Sourcery G++ manual pages, which provide additional information about using Sourcery G++. To set the `MANPATH` environment variable, follow the same steps shown above, replacing `PATH` with `MANPATH`, and `bin` with `share/doc/sourceryg++-arm-none-symbianelf/man`.

You can test that your `PATH` is set up correctly by running the following command:

```
> arm-none-symbianelf-g++ -v
```

Verify that the last line of the output contains: `Sourcery G++ Lite 2010.09-54`.

2.7. Uninstalling Sourcery G++ Lite

The method used to uninstall Sourcery G++ Lite depends on the method you originally used to install it. If you have modified any files in the installation it is recommended that you back up these changes. The uninstall procedure may remove the files you have altered. In particular, the `arm-none-symbianelf` directory located in the install directory will be removed entirely by the uninstaller.

2.7.1. Using the Sourcery G++ Lite Uninstaller on Microsoft Windows

You should use the provided uninstaller to remove a Sourcery G++ Lite installation originally created by the graphical installer. Start the graphical uninstaller by invoking the Uninstall executable located in your installation directory, or use the uninstall shortcut created during installation. After the uninstaller starts, follow the on-screen dialogs to uninstall Sourcery G++ Lite.

You can run the uninstaller in console mode, rather than using the graphical interface, by invoking the Uninstall executable found in your Sourcery G++ Lite installation directory with the `-i console` command-line option.

To uninstall third-party drivers bundled with Sourcery G++ Lite, first disconnect the associated hardware device. Then use `Uninstall a program` (Vista and newer) or `Add or Remove Programs` (older versions of Windows) to remove the drivers separately. Depending on the device, you may need to reboot your computer to complete the driver uninstall.

2.7.2. Using the Sourcery G++ Lite Uninstaller on GNU/Linux

You should use the provided uninstaller to remove a Sourcery G++ Lite installation originally created by the executable installer script. Start the graphical uninstaller by invoking the executable `Uninstall` shell script located in your installation directory. After the uninstaller starts, follow the on-screen dialogs to uninstall Sourcery G++ Lite.

You can run the uninstaller in console mode, rather than using the graphical interface, by invoking the `Uninstall` script with the `-i console` command-line option.

2.7.3. Uninstalling a Compressed Archive Installation

If you installed Sourcery G++ Lite from a `.tar.bz2` file, you can uninstall it by manually deleting the installation directory created in the install procedure.

Chapter 3

Sourcery G++ Lite for ARM

SymbianOS

This chapter contains information about features of Sourcery G++ Lite that are specific to ARM SymbianOS targets. You should read this chapter to learn how to best use Sourcery G++ Lite on your target system.

3.1. Included Components and Features

This section briefly lists the important components and features included in Sourcery G++ Lite for ARM SymbianOS, and tells you where you may find further information about these features.

Component	Version	Notes
GNU programming tools		
GNU Compiler Collection	4.5.1	Separate manual included.
GNU Binary Utilities	2.20.51	Includes assembler, linker, and other utilities. Separate manuals included.
Debugging support and simulators		
Target libraries		
Other utilities		
GNU Make	N/A	Build support on Windows hosts.
GNU Core Utilities	N/A	Build support on Windows hosts.

3.2. Library Configurations

Sourcery G++ Lite for ARM SymbianOS includes the following library configuration.

ARMv5 - Little-Endian, Soft-Float	
Command-line option(s):	default
ARMv5 - Little-Endian, VFP	
Command-line option(s):	-mfloat-abi=softfp

Sourcery G++ includes copies of run-time libraries that have been built with optimizations for different target architecture variants or other sets of build options. Each such set of libraries is referred to as a *multilib*. When you link a target application, Sourcery G++ selects the multilib matching the build options you have selected.

3.3. Building SymbianOS Programs

Building programs for SymbianOS requires you install additional software and follow the SymbianOS build procedure.

You must install the Symbian SDK¹. For Linux hosts, you must install the SDK on a Windows machine and then make the file system visible on your Linux host. Alternatively, for Linux hosts, the GnuPoc² project provides patches. Set the environment variable `EPOCROOT` to the directory containing the `epoc32` directory of your Symbian SDK installation, and also ensure your `PATH` variable includes the `$EPOCROOT/epoc32/tools` directory. The following commands also make use of `epoclib` and `epocarch` variables for convenience. For instance, if you have installed the SDK at `/opt/symbian-sdk`, enter the following commands:

```
> export EPOCROOT=/opt/symbian-sdk/s60
> PATH=$EPOCROOT/epoc32/tools:$PATH
```

¹ http://developer.symbian.org/wiki/index.php/Symbian_C%2B%2B_Quick_Start

² <http://gnupoc.sourceforge.net/>

```
> epocinc=$EPOCROOT/epoc32/include
> epocarch=$EPOCROOT/epoc32/release/armv5
```

SymbianOS programs do not start at main, but at E32Main. Using an editor (such as notepad on Microsoft Windows or vi on UNIX-like systems), create a file named main.cc containing the following console program:

```
#include <e32base.h>
#include <e32cons.h>

_LIT (KTxtEPOC32EX, "EXAMPLES");
_LIT (KTxtExampleCode, "Symbian OS Example Code");
_LIT (KTxtOK, "ok [press any key]");

LOCAL_D CConsoleBase* console;

LOCAL_C int factorial(int n) {
    if (n == 0)
        return 1;
    return n * factorial (n - 1);
}

LOCAL_C void callExampleL () {
    console = Console::NewL
        (KTxtExampleCode,
         TSize (KConsFullScreen, KConsFullScreen));
    CleanupStack::PushL (console);

    _LIT (KHelloWorldText, "Hello world!\n");
    console->Printf (KHelloWorldText);
    for (int i = 0; i < 10; ++i) {
        int n = factorial (i);
        _LIT (KFactorialText, "factorial(%d) = %d\n");
        console->Printf (KFactorialText, i, n);
    }

    console->Printf (KTxtOK);
    console->Getch ();
    CleanupStack::PopAndDestroy ();
}

GLDEF_C TInt E32Main () {
    __UHEAP_MARK;
    CTrapCleanup *cleanup = CTrapCleanup::New ();
    TRAPD (error, callExampleL ());
    __ASSERT_ALWAYS (!error, User::Panic (KTxtEPOC32EX, error));
    delete cleanup;
    __UHEAP_MARKEND;
    return 0;
}
```

To compile a program in main.c use the following command:

```
> arm-none-symbianelf-g++ -march=armv5t -mthumb -mapcs -nostdinc \
-D__MARM__ -D__MARM_ARMV5__ -D__MARM_THUMB__ \
-D__MARM_INTERWORK__ -D__EABI__ -D__EXE__ \
-D__DEBUG__ -D__UNICODE__ -D__SUPPORT_CPP_EXCEPTIONS__ \
-D__GCCE__ -D__SYMBIAN32__ -D__EPOC32__ \
-D__S60_50__ -D__S60_3X__ -D__SERIES60_3X__ \
-D__PRODUCT_INCLUDE__=\"\$epocinc/variant/symbian_os.hrh\" \
-include $epocinc/gcce/gcce.h \
-I $epocinc/libc -I $epocinc -I $epocinc/variant \
-c -g -o main.o main.cc
```

You may see some warnings. These are from Symbian SDK header files, not Sourcery G++ files.

You can link your application with:

```
> arm-none-symbianelf-g++ -march=armv5t -mthumb -mapcs -nostdlib \
-Wl,--target1-abs -Wl,--no-undefined \
-Wl,-Ttext,0x8000 -Wl,-Tdata,0x400000 \
-Wl,--default-symver -Wl,-soname,"factorial{000a0000}.exe" \
-Wl,--entry,_E32Startup -Wl,-u,_E32Startup \
$epocarch/udeb/eexe.lib \
-shared -g -o factorial.sym main.o \
-Wl,"-" -Wl,$epocarch/udeb/usrt2_2.lib \
-Wl,$epocarch/udeb/ecrt0.lib -Wl,"-)" \
-Wl,$epocarch/lib/estlib.dso \
-Wl,$epocarch/lib/euser.dso \
-Wl,$epocarch/lib/dfpaeabi.dso \
-Wl,$epocarch/lib/dfprvct2_2.dso \
-Wl,$epocarch/lib/drtaeabi.dso \
-Wl,$epocarch/lib/scppnwdl.dso \
-Wl,$epocarch/lib/drtrvct2_2.dso \
-lsupc++ -lgcc
```

This produces a `factorial.sym` file that can be used by `arm-none-symbianelf-gdb`.

To run the program on SymbianOS, you must convert this file to EPOC32 format using the `elf2e32` command. The `elf2e32` command is part of the Symbian SDK and not part of Sourcery G++. If you are using a Linux host, and did not install GnuPoc, you must install Wine³ and invoke `elf2e32` as:

```
> wine $EPOCROOT/epoc32/tools/elf2e32.exe other options
```

The following command creates `factorial.exe`:

```
> elf2e32 --sid=0x00000000 --version=10.0 --uid1=0x1000007a \
--uid2=0xe8000075 --uid3=0x00000000 --vid=0x70000001 \
--capability=none --fpu=softvfp --targettype=EXE \
--output="factorial.exe" --elfinput="factorial.sym" \
--linkas="factorial{000a0000}.exe" \
--libpath="$epocarch/lib"
```

³ <http://www.winehq.org/>

3.4. SymbianOS Runtime Libraries

Sourcery G++ Lite does not include C or C++ runtime libraries for SymbianOS. These are provided separately by Symbian.

3.5. NEON SIMD Code

Sourcery G++ includes support for automatic generation of NEON SIMD vector code. Autovectorization is a compiler optimization in which loops involving normal integer or floating-point code are transformed to use NEON SIMD instructions to process several data elements at once.

To enable generation of NEON vector code, use the command-line options `-ftree-vectorize -mfpu=neon -mfloat-abi=softfp`. The `-mfpu=neon` option also enables generation of VFPv3 scalar floating-point code.

Sourcery G++ also includes support for manual generation of NEON SIMD code using C intrinsic functions. These intrinsics, the same as those supported by the ARM RealView® compiler, are defined in the `arm_neon.h` header and are documented in the 'ARM NEON Intrinsics' section of the GCC manual. The command-line options `-mfpu=neon -mfloat-abi=softfp` must be specified to use these intrinsics; `-ftree-vectorize` is not required.

3.6. Half-Precision Floating Point

Sourcery G++ for ARM SymbianOS includes support for half-precision (16-bit) floating point, including the new `__fp16` data type in C and C++, support for generating conversion instructions when compiling for processors that support them, and library functions for use in other cases.

To use half-precision floating point, you must explicitly enable it via the `-mfp16-format` command-line option to the compiler. For more information about `__fp16` representations and usage from C and C++, refer to the GCC manual.

3.7. ABI Compatibility

The Application Binary Interface (ABI) for the ARM Architecture is a collection of standards, published by ARM Ltd. and other organizations. The ABI makes it possible to combine tools from different vendors, including Sourcery G++ and ARM RealView®.

Sourcery G++ implements the ABI as described in these documents, which are available from the ARM Information Center⁴:

- BSABI - ARM IHI 0036B (28 October 2009)
- BPABI - ARM IHI 0037B (28 October 2009)
- EHABI - ARM IHI 0038A (28 October 2009)
- CLIBABI - ARM IHI 0039B (4 November 2009)
- AADWARF - ARM IHI 0040A (28 October 2009)
- CPPABI - ARM IHI 0041C (5 October 2009)

⁴ <http://infocenter.arm.com>

- AAPCS - ARM IHI 0042D (16 October 2009)
- RTABI - ARM IHI 0043C (19 October 2009)
- AAELF - ARM IHI 0044D (28 October 2009)
- ABI Addenda - ARM IHI 0045C (4 November 2009)

Sourcery G++ currently produces DWARF version 2, rather than DWARF version 3 as specified in AADWARF.

Chapter 4

Using Sourcery G++ from the Command Line

This chapter demonstrates the use of Sourcery G++ Lite from the command line.

4.1. Building an Application

This chapter explains how to build an application with Sourcery G++ Lite using the command line. As elsewhere in this manual, this section assumes that your target system is `arm-none-symbianelf`, as indicated by the `arm-none-symbianelf` command prefix.

Building programs for SymbianOS requires unique command-line arguments and build steps to integrate with the Symbian SDK; refer to Chapter 3, “Sourcery G++ Lite for ARM SymbianOS” for details.

4.2. Running Applications on the Target System

Consult your target board documentation for instructions on loading programs onto the target, and running them.

Chapter 5

Next Steps with Sourcery G++

This chapter describes where you can find additional documentation and information about using Sourcery G++ Lite and its components.

5.1. Sourcery G++ Knowledge Base

The Sourcery G++ Knowledge Base is available to registered users at the Sourcery G++ Portal¹. Here you can find solutions to common problems including installing Sourcery G++, making it work with specific targets, and interoperability with third-party libraries. There are also additional example programs and tips for making the most effective use of the toolchain and for solving problems commonly encountered during debugging. The Knowledge Base is updated frequently with additional entries based on inquiries and feedback from customers.

5.2. Example Programs

Sourcery G++ Lite includes some bundled example programs. You can find the source code for these examples in the `share/sourceryg++-arm-none-sybianelf-examples` directory of your Sourcery G++ installation.

The subdirectories contain a number of small, target-independent test programs. You may find these programs useful as self-contained test cases when experimenting with configuring the correct compiler and debugger settings for your target, or when learning how to use the debugger or other features of the Sourcery G++ toolchain.

5.3. Manuals for GNU Toolchain Components

Sourcery G++ Lite includes the full user manuals for each of the GNU toolchain components, such as the compiler, linker, assembler, and debugger. Most of the manuals include tutorial material for new users as well as serving as a complete reference for command-line options, supported extensions, and the like.

When you install Sourcery G++ Lite, links to both the PDF and HTML versions of the manuals are created in the `shortcuts` folder you select. If you elected not to create shortcuts when installing Sourcery G++ Lite, the documentation can be found in the `share/doc/sourceryg++-arm-none-sybianelf/` subdirectory of your installation directory.

In addition to the detailed reference manuals, Sourcery G++ Lite includes a Unix-style manual page for each toolchain component. You can view these by invoking the `man` command with the pathname of the file you want to view. For example, you can first go to the directory containing the man pages:

```
> cd $INSTALL/share/doc/sourceryg++-arm-none-sybianelf/man/man1
```

Then you can invoke `man` as:

```
> man ./arm-none-sybianelf-gcc.1
```

Alternatively, if you use `man` regularly, you'll probably find it more convenient to add the directory containing the Sourcery G++ man pages to your `MANPATH` environment variable. This should go in your `.profile` or equivalent shell startup file; see Section 2.6, "Setting up the Environment" for instructions. Then you can invoke `man` with just the command name rather than a pathname.

Finally, note that every command-line utility program included with Sourcery G++ Lite can be invoked with a `--help` option. This prints a brief description of the arguments and options to the program and exits without doing further processing.

¹ <https://support.codesourcery.com/GNUToolchain/>

Appendix A

Sourcery G++ Lite Release Notes

This appendix contains information about changes in this release of Sourcery G++ Lite for ARM SymbianOS. You should read through these notes to learn about new features and bug fixes.

A.1. Changes in Sourcery G++ Lite for ARM SymbianOS

This section documents Sourcery G++ Lite changes for each released revision.

A.1.1. Changes in Sourcery G++ Lite 2010.09-54

GCC fix for duplicated symbols. A GCC optimizer bug that caused multiple definitions of local symbols has been fixed. Code affected by the bug was rejected by the assembler.

NEON code generation fix. A GCC bug has been fixed that resulted in an assembler error `VFP/Neon double precision register expected`.

Static data size improvement at `-Os`. When optimizing for size, the compiler no longer implicitly adds padding bytes to align static and local arrays on word boundaries. This fixes static data size regressions introduced since GCC 4.4. The additional alignment is still used when optimizing for speed.

New `-fstrict-volatile-bitfields`. The compiler has a new option, `-fstrict-volatile-bitfields`, which forces access to a volatile structure member using the width that conforms to its type. This option is enabled by default to conform to the ARM EABI. Refer to the GCC manual for details.

Internal compiler error fixes. A bug has been fixed that caused the compiler to crash on code containing a typedef alias for `__builtin_va_list` with option `-femit-struct-debug-baseonly`. A second bug has been fixed that caused a crash when compiling code using C99 variable-length arrays. Additionally, a compiler crash on code using 64-bit integer multiplications with NEON vectorization enabled has also been fixed.

NEON narrowing-move instructions. The compiler now supports narrowing-move instructions when auto-vectorizing for NEON. Loops accessing arrays of `char` or `short` values are now more likely to be vectorized.

Improved support for atomic memory builtins. The compiler support for built-in atomic memory access operations on ARMv7 targets has been improved. These builtins are documented in the GCC manual.

Linker debug information fix. A bug in linker processing of debug information has been fixed. The bug sometimes prevented the Sourcery G++ debugger from displaying source code if the executable was linked with the `--gc-sections` option.

Absolute branch bug fixes. A bug that caused the assembler to crash on a branch to an absolute address has been fixed. Linker handling of the resulting relocations has also been improved. Previously this caused an invalid switch to ARM mode on ARMv7-M devices.

VMOV instruction bug fix. A bug that caused the assembler to incorrectly reject certain valid immediate operands for the `VMOV` instruction has been fixed.

A.1.2. Changes in Sourcery G++ Lite 2010.09-20

Changes to Sourcery G++ version numbering. Sourcery G++ product and Lite toolchains now uniformly use a version numbering scheme of the form 2010.09-54. The major and minor parts of the version number, in this case 2010.09, identify the release branch, while the final component is a build number within the branch. There are also new preprocessor macros defined by the compiler

for the version number components so that you may conditionalize code for Sourcery G++ or particular Sourcery G++ versions. Details are available in the [Sourcery G++ Knowledge Base](#)¹.

GCC fix for reference to undefined label. A bug in the optimizer that caused GCC to emit references to undefined labels has been fixed.

Precision improvement with vectorization enabled. The GCC auto-vectorizer no longer uses NEON floating-point instructions unless the `-funsafe-math-optimizations` option (implied by `-ffast-math`) is specified. This is because NEON hardware does not fully support the IEEE 754 standard for floating-point arithmetic. In particular, very small quantities may be flushed to zero.

Alignment attributes. A bug has been fixed that caused the compiler to ignore alignment attributes of C++ static member variables where the attribute was present on the definition, but not the declaration.

naked attribute semantics. The `naked` function attribute now also implies the `noinline` and `noclone` attributes. This fixes bugs resulting from invalid optimizations of functions with this attribute.

Stack corruption bug fix. A bug in GCC has been fixed that caused stack corruption in functions with the `interrupt` attribute.

GCC bug fix for push multiple instruction generation. A bug has been fixed that caused GCC to generate incorrect push multiple instructions, causing an assembler warning `register range not in ascending order`.

Thumb-2 internal compiler error fix. A bug has been fixed that caused the compiler to crash when compiling Thumb-2 code using 64-bit integer arithmetic.

Compiler optimization improvements. The compiler has been enhanced with a number of optimization improvements, including:

- More efficient assignment for structures containing bitfields.
- Better code for initializing C++ arrays with explicit element initializers.
- Improved logic for eliminating/combining redundant comparisons in code with nested conditionals.
- Better selection of loop variables, resulting in fewer temporaries and more efficient register usage.
- More optimization of references to globals in position-independent code.
- Various Thumb code generation improvements.
- Better code when constant addresses are used as arguments to inline assembly statements.
- Better code for copying small constant strings.
- Improved tuning for Cortex-M4 processors.
- Cortex-A9 specific tuning for VFP and NEON instructions.
- Use of more NEON features.

¹ <https://support.codesourcery.com/GNUToolchain/kbentry1>

Preprocessor symbols for floating-point calling convention. Built-in preprocessor symbols `__ARM_PCS` and `__ARM_PCS_VFP` are now defined to indicate the current floating-point calling convention.

GCC version 4.5.1. Sourcery G++ Lite for ARM SymbianOS is now based on GCC version 4.5.1. For more information about changes from GCC version 4.4 that was included in previous releases, see <http://gcc.gnu.org/gcc-4.5/changes.html>.

New `-Wdouble-promotion` warning option. The compiler has a new option, `-Wdouble-promotion`, which enables warnings about implicit promotions of `float` values to `double`. This option is useful when compiling code for processors (such as ARM Cortex-M4) that have hardware support for single-precision floating-point arithmetic only, where unintentional use of double precision results in dramatically slower code.

C++ runtime symbol visibility. A bug has been fixed that caused some symbols in the C++ runtime library (`libsupc++.a`) to have incorrect visibility attributes.

Linker bug fix. A bug that caused the linker error relocation truncated to fit: `R_ARM_THM_JUMP24` when linking some Thumb-2 applications has been fixed.

Assembler PC-relative store fix. A bug that caused the assembler to reject some valid PC-relative store instructions has been fixed. It now issues a warning instead for architectures where these instructions are deprecated.

ARMv7-A linker bug fix. A bug in the linker support for `--fix-cortex-a8`, which is enabled by default when linking ARMv7-A objects, has been fixed. Programs affected by the bug sometimes crashed with segmentation fault or illegal instruction errors.

Smaller C++ programs with `-g`. An assembler bug has been fixed that caused unnecessary references to exception-handling routines from C++ programs when debug information is enabled. For programs that do not otherwise use exceptions, this change results in smaller code size.

Additional validation in the assembler. The assembler now diagnoses an error, instead of producing an invalid object file, when directives such as `.hidden` are missing operands.

Assembler PC-relative load fix. An assembler bug that caused the assembler to reject some references to global symbols has been fixed. This bug affected Thumb instructions of the form `ldr r0, symbol`.

Strip bug fix. A bug in the `strip` and `objcopy` utilities, which resulted in stripped object files that the linker could not recognize, has been fixed.

Binutils update. The binutils package has been updated to version 2.20.51.20100809 from the FSF trunk. This update includes numerous bug fixes.

A.1.3. Changes in Sourcery G++ Lite 2010q1-190

Improved NEON code generation for 0.0 constants. The compiler now generates better code for loading double float 0.0 constants on processors supporting NEON instructions.

Incorrect linker-generated functions. A bug that caused some linker-generated functions (including stubs to support interworking from ARM mode to Thumb mode and stubs to implement long branches) to jump to invalid offsets has been fixed.

Improved code generation for `if` statements. The compiler can now generate better code for `if` statements when the `then` and `else` clauses contain similar code.

Assembler encoding bug fixes. Several bugs in the assembler have been fixed that caused selection of incorrect encodings for some instructions that have multiple encodings. The incorrect encodings are not believed to have affected runtime behavior but were not in conformance with the canonical encodings specified by the ARM ARM. The `objdump` command has also been fixed to decode such instructions correctly.

ARMv7-A performance improvements. The compiler has been enhanced to produce faster code for the ARM architecture, particularly for ARMv7-A cores, when compiling using the `-O2` option. This results in a significant improvement in performance relative to CodeSourcery's 2009q3 releases.

Linker performance improvement. A bug in the linker that caused applications with many input files to link slowly has been fixed.

Weak symbols. An assembler bug has been fixed that caused incorrect code to be generated for references to weak symbols when a default definition is also provided in the same file.

Optimization of ARM NEON `vdupq_n*` intrinsics. The compiler now generates better code for `vdupq_n*` intrinsics to load particular constants.

Linker bug fix for `--section-start`. A linker bug that caused `--section-start` to fail to work as documented if the section is defined in multiple object files has been fixed.

GCC inline assembly bug fixes. A bug that caused NEON/VFP registers specified in the clobber list of inline assembly statements to be saved and restored incorrectly has been fixed. Another bug that caused incorrect code when double-precision or quad-precision registers were specified in the clobber list has also been fixed.

Assembler segmentation fault fix. A bug has been fixed that caused the assembler to crash when processing some data filling directives, such as `.fill 0, 0, 0`.

Linker bug with Cortex-A8 erratum fix. A bug in the `--fix-cortex-a8` linker option, which is enabled by default when linking ARMv7-A objects, has been fixed. The bug could cause the linker to generate incorrect shared libraries.

Improved code generation for Cortex-A5. The compiler has been enhanced to provide instruction scheduling for Cortex-A5 cores. To take advantage of this, use the `-mcpu=cortex-a5` command-line option.

Better use of NEON instructions on Cortex-A8. The compiler now generates better code when optimizing for the Cortex-A8 by being less eager to use NEON instructions.

Assembler segmentation fault fix. A bug has been fixed that caused the assembler to crash when assembling some Thumb-only instructions in ARM mode. The assembler now gives an error on all incorrect uses of Thumb-only instructions in ARM mode.

GCC internal compiler error. A bug has been fixed that caused GCC to crash when compiling some C++ code using templates at `-O2` or `-O3`.

GCC internal compiler error with `optimize` attribute. A bug has been fixed that caused the compiler to crash when invoked with the `-O0` or `-O1` option on code using the `optimize` attribute to specify higher optimization levels for individual functions.

C++ array initializer optimization. The compiler now generates better code for some non-constant array initializations in C++.

A.1.4. Changes in Sourcery G++ Lite 2010q1-153

Debugging preprocessed source code. A compiler bug has been fixed that caused debug output to erroneously contain the name of the intermediate preprocessed file.

Thumb-2 size optimization improvements. The compiler has been enhanced to produce smaller code for the ARM architecture, particularly for Thumb-2 mode, when compiling using the `-Os` option. This results in a significant improvement in code size relative to CodeSourcery's 2009q3 releases.

Incorrect symbol addresses bug fix. A bug in the linker that caused it to assign incorrect addresses to symbols has been fixed. The bug occurred when the input objects contained sections not explicitly mentioned in the linker script.

C++ name-mangling of `va_list`. The compiler no longer issues the mangling of `'va_list'` has changed warnings for references to `std::va_list` within system header files.

Static constructor and destructor ordering fixes. The linker now correctly ensures that static destructors with priorities are executed after destructors without priorities. Another linker bug that caused incorrect static constructor and destructor ordering with partial linking involved has been fixed.

Backtracing through noreturn functions. A compiler bug that made it impossible to obtain a backtrace through functions declared with the `noreturn` attribute has been fixed. This fix makes it possible for the debugger to present a useful stack backtrace for applications that call `abort`.

Linker fix for data-only sections. A bug has been fixed that caused the linker to incorrectly mark parts of the output as containing code, rather than data, when linking data-only sections not explicitly tagged as such. The bug resulted in incorrect disassembly.

vcvt assembly bug fix. A bug that caused `vcvt.s32.f64` instructions to be misassembled as `vcvtr.s32.f64` has been fixed.

Improved code generation for Cortex-A9. The compiler has been enhanced to provide better instruction scheduling for Cortex-A9 cores. To take advantage of this, use the `-mcpu=cortex-a9` command-line option.

Improved NEON code generation. GCC's code generation for NEON targets (e.g., when compiling with `-mfpu=neon`) has been improved. In particular, the compiler can now make use of NEON instructions for many 64-bit integer operations.

Branches between ARM and Thumb fix. An assembler bug that caused incorrect branches between ARM and Thumb code in different sections has been fixed.

Assembler segmentation fault fix. A bug has been fixed that caused the assembler to crash when processing code containing invalid Thumb-mode instructions such as `ldr r0, 0`. The assembler now produces an error message in such cases.

Assembler fix for Thumb-2. A bug that caused the assembler to reject some valid Thumb-2 `strex` instructions has been fixed.

Disassembler bug fix. A bug in the disassembler has been fixed that caused incorrect output for data objects, including literal pools and the interrupt vector.

NEON assembler fix. The assembler now correctly handles the three-operand form of NEON logic instructions, such as `vorr.i32 q0, q0, #0xff`

Warning for deprecated instructions. The assembler now issues warnings about uses of `swp` or `swpb` instructions on architectures where they have been deprecated.

Indirect function call optimization. The instruction sequence used to implement calls via a function pointer has been improved to give better branch-prediction performance on some processors.

Optimizer bug fix. A bug in GCC that caused internal compiler errors at `-O2` or above has been fixed. The bug also occurred at other optimization levels when the `-fpromote-loop-indices` command-line option was used.

Additional error checks in the assembler. The assembler has been improved to perform a number of additional checks for invalid inputs. In particular, it now diagnoses additional invalid uses of the PC and SP registers, as specified in the ARM documentation. The assembler now also rejects invalid NEON alignment qualifiers, such as `vld1.8 {d0}, [r0, :128]` and `vld1.8 {q0}, [r0, :256]`.

Thumb-2 function call optimization. The compiler has been enhanced to generate improved code on Thumb-2 targets for functions that return via calls to other functions.

Out-of-range branch error. A compiler bug has been fixed that caused out-of-range branch errors from the assembler. The bug only affected code compiled in Thumb-2 mode.

Linker relocation diagnostics. A bug that caused the linker to incorrectly diagnose overflows for some valid relocations has been fixed.

Thumb-2 internal compiler error fix. A bug that caused an internal compiler error when building the QT library for Thumb-2 has been fixed.

Thumb-2 multiply fix. A bug that caused an invalid `muls` instruction to be generated in certain circumstances has been fixed. This affected code compiled for Thumb-2, and resulted in an error from the assembler.

Internal compiler error fix. A bug that caused an internal compiler error when using `-fno-omit-frame-pointer` to compile code for Thumb-2 has been fixed.

A.1.5. Changes in Sourcery G++ Lite 2009q3-63

@FILE fix. A bug has been fixed in the processing of `@FILE` command-line options by GCC, GDB, and other tools. The bug caused any options in `FILE` following a blank line to be ignored.

Preprocessor error handling. The preprocessor now treats failing to find a file referenced via `#include` as a fatal error.

NEON improvements. The compiler now generates improved NEON vector code when copying memory or storing constants to memory using the NEON coprocessor. The compiler also generates better code for accessing data arrays that are not known to have 64-bit alignment. In addition, a bug that caused internal compiler errors when compiling for Thumb-2 with NEON enabled has been fixed, as has another bug that caused some vector shift NEON operations to be wrongly rejected.

ELF file corruption with strip. A bug that caused `strip` to corrupt unusual ELF files has been fixed.

Compiler errors with float32_t. A bug has been fixed that caused compiler errors when using the `float32_t` type from `arm_neon.h`.

Support for ARM Cortex-A5 cores. Sourcery G++ now includes basic support for ARM Cortex-A5 cores. Use the `-mcpu=cortex-a5` command-line option.

Static variables and `asm` statements bug fix. A bug in GCC that caused functions containing static variables and `asm` statements to be miscompiled at `-O2` or above has been fixed. The bug also occurred at other optimization levels when the `-fremove-local-statics` command-line option was used.

Warnings for naked functions. A compiler bug that resulted in incorrect warnings about missing return statements in non-void functions declared with the `naked` attribute has been fixed.

Optimizer bug fix. A bug in GCC that caused functions with complex loop nests to be miscompiled at `-O2` or above has been fixed. The bug also occurred at other optimization levels when the `-fpromote-loop-indices` command-line option was used.

VFPv4 support. Sourcery G++ now includes support for VFPv4, VFPv4-D16 and NEON-VFPv4 coprocessors. Use the `-mfpu=vfpv4`, `-mfpu=vfpv4-d16` or `-mfpu=neon-vfpv4` options, respectively.

GCC internal compiler error. A bug has been fixed that caused the compiler to crash when optimizing code that casts between structure types and the type of the first field.

ELF Program Headers. The linker now better diagnoses errors in the usage of `FILEHDR` and `PHDRS` keywords in `PHDRS` command of linker scripts. Refer to the linker manual for more information.

A.1.6. Changes in Sourcery G++ Lite 2009q3-35

Improved optimization for ARM. GCC now automatically enables loop unrolling and `-fpromote-loop-indices` when `-O2` or `-O3` is specified. Loop unrolling is limited at `-O2` to control code growth. These changes improve performance by more than 5%.

VFP assembly mnemonics. The assembler now accepts unified assembly mnemonics for VFP instructions (e.g. `VADD.f32 s0, s0`) in legacy syntax mode.

VFP half-precision extensions. Sourcery G++ now includes support for VFP coprocessors with half-precision floating-point extensions. This can be enabled with the `-mfpu=vfpv3-d16-fp16` or `-mfpu=vfpv3-fp16` command-line options.

Optimizer improvements. When optimizing for speed, the compiler now uses improved heuristics to limit certain types of optimizations that may adversely affect both code size and speed. This change also makes it possible to produce better code when optimizing for space rather than speed.

Improved optimization for Thumb-2. GCC now supports instruction scheduling for Thumb-2 code. This optimization is enabled when compiling with `-O2`, `-O3`, or `-Os`, and can improve performance substantially.

ARM VFP assembler bug fix. The assembler now correctly assembles the `vmls`, `vnmla` and `vnmls` mnemonics. Previously these were incorrectly assembled to different instructions.

New assembler directive `.inst`. The assembler now accepts the new `.inst` directive to generate an instruction from its integer encoding.

Internal error in assembler. An assembler bug that caused an internal error when `.thumb` or `.arm` appears after an invalid instruction has been fixed.

Improved bit counting operation. The `__builtin_ctz` built-in function, which returns the number of trailing zero bits in a value, has been improved to use a shorter instruction sequence for ARMv6T2 and later.

Out-of-range branch errors. A Thumb-2 code generation defect in the compiler that caused branch out of range errors from the assembler has been eliminated.

Binutils update. The binutils package has been updated to version 2.19.51.20090709 from the FSF trunk. This update includes numerous bug fixes.

Linker fix. The linker now correctly processes references to undefined local symbols. Such references are treated the same as references to undefined global symbols. Usually object files contain no such references, as they can never be satisfied.

Assembler validation improvements. The assembler now issues a warning when a section finishes with an unclosed IT instruction block at the end of the input file. It also now rejects unwinding directives that appear outside of a `.fnstart/.fnend` pair. Additionally, 32-bit Thumb instructions are now correctly rejected when assembling for cores that do not support these instructions.

Assembler validations fix. A bug in the assembler that caused some `addw` and `subw` instructions with `SP` or `PC` as operand to be wrongly rejected has been fixed.

-mauto-it assembler option replaced with -mimplicit-it. The `-mauto-it` command-line option to the assembler has been replaced with a more general `-mimplicit-it` option to control the behavior of the assembler when conditional instructions appear outside an IT instruction block. If you were previously using `-mauto-it`, you should now use `-mimplicit-it=always`. Other `-mimplicit-it` modes allow you to separately control implicit IT instruction insertion behavior in ARM and Thumb-2 code. For more information, refer to the assembler manual. In addition to renaming the option, a number of bugs in the implicit IT generation have been fixed.

Linker failure with Cortex-A8 erratum fix. A bug in the `--fix-cortex-a8` linker option has been fixed. The bug caused the linker either to produce a `bad value` error, or to silently generate an incorrect executable.

Debug information for variadic functions. A compiler bug that resulted in incorrect debug information for functions with variable arguments has been fixed.

Overlay sections. `arm-none-symbianelf-readelf` now correctly recognizes section headers for `ARM_DEBUGOVERLAY` and `ARM_OVERLAYSECTION` sections.

Code generation improvements. The compiler has been changed to make better use of VFP registers in mixed integer and floating-point code, resulting in faster code.

Register variable corruption. A compiler bug has been fixed that caused incorrect code to be generated when the frame pointer or other special-use registers are used as explicit local register variables, introduced via the `asm` keyword on their declarations.

Assembler fix for mixed Thumb and ARM mode. A bug in the assembler has been fixed where mapping symbols were sometimes incorrectly placed at section boundaries. This could lead to incorrect disassembly in some cases.

-fremove-local-statics optimization. The `-fremove-local-statics` optimization is now enabled by default at `-O2` and higher optimization levels.

Elimination of spurious warnings about NULL. The C++ compiler no longer issues spurious warnings about comparisons between pointers to members and `NULL`.

Vectorizer improvements. The compiler now generates improved code for accesses to static nested array variables (e.g. `static int foo[8][8];`).

Linker bug fix. A bug that caused the linker to crash when `.ARM.exidx` sections were discarded by a linker script has been fixed.

GCC version 4.4.1. Sourcery G++ Lite for ARM SymbianOS is now based on GCC version 4.4.1. For more information about changes from GCC version 4.3 that was included in previous releases, see <http://gcc.gnu.org/gcc-4.4/changes.html>.

Linker map address sorting. The map generated by the linker `-Map` option now lists symbols sorted by address.

Assembler fix. The assembler now correctly diagnoses a missing operand to `b1` and `b1x` instructions. Previously, incorrect code was silently generated.

A.1.7. Changes in Older Releases

For information about changes in older releases of Sourcery G++ Lite for ARM SymbianOS, please refer to the Getting Started guide packaged with those releases.

Appendix B

Sourcery G++ Lite Licenses

Sourcery G++ Lite contains software provided under a variety of licenses. Some components are “free” or “open source” software, while other components are proprietary. This appendix explains what licenses apply to your use of Sourcery G++ Lite. You should read this appendix to understand your legal rights and obligations as a user of Sourcery G++ Lite.

B.1. Licenses for Sourcery G++ Lite Components

The table below lists the major components of Sourcery G++ Lite for ARM SymbianOS and the license terms which apply to each of these components.

Some free or open-source components provide documentation or other files under terms different from those shown below. For definitive information about the license that applies to each component, consult the source package corresponding to this release of Sourcery G++ Lite. Sourcery G++ Lite may contain free or open-source components not included in the list below; for a definitive list, consult the source package corresponding to this release of Sourcery G++ Lite.

Component	License
GNU Compiler Collection	GNU General Public License 3.0 http://www.gnu.org/licenses/gpl.html
GNU Binary Utilities	GNU General Public License 3.0 http://www.gnu.org/licenses/gpl.html
GNU Make	GNU General Public License 2.0 http://www.gnu.org/licenses/old-licenses/gpl-2.0.html
GNU Core Utilities	GNU General Public License 2.0 http://www.gnu.org/licenses/old-licenses/gpl-2.0.html

The CodeSourcery License is available in Section B.2, “Sourcery G++ Software License Agreement”.

Important

Although some of the licenses that apply to Sourcery G++ Lite are “free software” or “open source software” licenses, none of these licenses impose any obligation on you to reveal the source code of applications you build with Sourcery G++ Lite. You can develop proprietary applications and libraries with Sourcery G++ Lite.

Sourcery G++ Lite may include some third party example programs and libraries in the `share/sourceryg++-arm-none-symbianelf-examples` subdirectory. These examples are not covered by the Sourcery G++ Software License Agreement. To the extent permitted by law, these examples are provided by CodeSourcery as is with no warranty of any kind, including implied warranties of merchantability or fitness for a particular purpose. Your use of each example is governed by the license notice (if any) it contains.

B.2. Sourcery G++™ Software License Agreement

1. **Parties.** The parties to this Agreement are you, the licensee (“You” or “Licensee”) and CodeSourcery. If You are not acting on behalf of Yourself as an individual, then “You” means Your company or organization.
2. **The Software.** The Software licensed under this Agreement consists of computer programs and documentation referred to as Sourcery G++™ Lite Edition (the “Software”).
3. **Definitions.**

- 3.1. **CodeSourcery Proprietary Components.** The components of the Software that are owned and/or licensed by CodeSourcery and are not subject to a “free software” or “open source” license, such as the GNU Public License. The CodeSourcery Proprietary Components of the Software include, without limitation, the Sourcery G++ Installer, any Sourcery G++ Eclipse plug-ins, the CodeSourcery C Library (CSLIBC), and any Sourcery G++ Debug Sprite. For a complete list, refer to the *Getting Started Guide* included with the distribution.
- 3.2. **Open Source Software Components.** The components of the Software that are subject to a “free software” or “open source” license, such as the GNU Public License.
- 3.3. **Proprietary Rights.** All rights in and to copyrights, rights to register copyrights, trade secrets, inventions, patents, patent rights, trademarks, trademark rights, confidential and proprietary information protected under contract or otherwise under law, and other similar rights or interests in intellectual or industrial property.
- 3.4. **Redistributable Components.** The CodeSourcery Proprietary Components that are intended to be incorporated or linked into Licensee object code developed with the Software. The Redistributable Components of the Software include, without limitation, CSLIBC and the CodeSourcery Common Startup Code Sequence (CS3). For a complete list, refer to the *Getting Started Guide* included with the distribution.
4. **License Grant to Proprietary Components of the Software.** You are granted a non-exclusive, royalty-free license (a) to install and use the CodeSourcery Proprietary Components of the Software, (b) to transmit the CodeSourcery Proprietary Components over an internal computer network, (c) to copy the CodeSourcery Proprietary Components for Your internal use only, and (d) to distribute the Redistributable Component(s) in binary form only and only as part of Licensee object code developed with the Software that provides substantially different functionality than the Redistributable Component(s).
5. **Restrictions.** You may not: (i) copy or permit others to use the CodeSourcery Proprietary Components of the Software, except as expressly provided above; (ii) distribute the CodeSourcery Proprietary Components of the Software to any third party, except as expressly provided above; or (iii) reverse engineer, decompile, or disassemble the CodeSourcery Proprietary Components of the Software, except to the extent this restriction is expressly prohibited by applicable law.
6. **“Free Software” or “Open Source” License to Certain Components of the Software.** This Agreement does not limit Your rights under, or grant You rights that supersede, the license terms of any Open Source Software Component delivered to You by CodeSourcery. Sourcery G++ includes components provided under various different licenses. The *Getting Started Guide* provides an overview of which license applies to different components, and, for components subject to the Eclipse Public License, contains information on how to obtain the source code. Definitive licensing information for each “free software” or “open source” component is available in the relevant source file.
7. **CodeSourcery Trademarks.** Notwithstanding any provision in a “free software” or “open source” license agreement applicable to a component of the Software that permits You to distribute such component to a third party in source or binary form, You may not use any CodeSourcery trademark, whether registered or unregistered, including without limitation, CodeSourcery™, Sourcery G++™, the CodeSourcery crystal ball logo, or the Sourcery G++ splash screen, or any confusingly similar mark, in connection with such distribution, and You may not recompile the Open Source Software Components with the `--with-pkgversion` or `--with-bugurl` configuration options that embed CodeSourcery trademarks in the resulting binary.

8. **Term and Termination.** This Agreement shall remain in effect unless terminated pursuant to this provision. CodeSourcery may terminate this Agreement upon seven (7) days written notice of a material breach of this Agreement if such breach is not cured; provided that the unauthorized use, copying, or distribution of the CodeSourcery Proprietary Components of the Software will be deemed a material breach that cannot be cured.
9. **Transfers.** You may not transfer any rights under this Agreement without the prior written consent of CodeSourcery, which consent shall not be unreasonably withheld. A condition to any transfer or assignment shall be that the recipient agrees to the terms of this Agreement. Any attempted transfer or assignment in violation of this provision shall be null and void.
10. **Ownership.** CodeSourcery owns and/or has licensed the CodeSourcery Proprietary Components of the Software and all intellectual property rights embodied therein, including copyrights and valuable trade secrets embodied in its design and coding methodology. The CodeSourcery Proprietary Components of the Software are protected by United States copyright laws and international treaty provisions. CodeSourcery also owns all rights, title and interest in and with respect to its trade names, domain names, trade dress, logos, trademarks, service marks, and other similar rights or interests in intellectual property. This Agreement provides You only a limited use license, and no ownership of any intellectual property.
11. **Warranty Disclaimer; Limitation of Liability.** CODESOURCERY AND ITS LICENSORS PROVIDE THE SOFTWARE “AS-IS” AND PROVIDED WITH ALL FAULTS. CODESOURCERY DOES NOT MAKE ANY WARRANTY OF ANY KIND, EXPRESS OR IMPLIED. CODESOURCERY SPECIFICALLY DISCLAIMS THE IMPLIED WARRANTIES OF TITLE, NON-INFRINGEMENT, MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, SYSTEM INTEGRATION, AND DATA ACCURACY. THERE IS NO WARRANTY OR GUARANTEE THAT THE OPERATION OF THE SOFTWARE WILL BE UNINTERRUPTED, ERROR-FREE, OR VIRUS-FREE, OR THAT THE SOFTWARE WILL MEET ANY PARTICULAR CRITERIA OF PERFORMANCE, QUALITY, ACCURACY, PURPOSE, OR NEED. YOU ASSUME THE ENTIRE RISK OF SELECTION, INSTALLATION, AND USE OF THE SOFTWARE. THIS DISCLAIMER OF WARRANTY CONSTITUTES AN ESSENTIAL PART OF THIS AGREEMENT. NO USE OF THE SOFTWARE IS AUTHORIZED HEREUNDER EXCEPT UNDER THIS DISCLAIMER.
12. **Local Law.** If implied warranties may not be disclaimed under applicable law, then ANY IMPLIED WARRANTIES ARE LIMITED IN DURATION TO THE PERIOD REQUIRED BY APPLICABLE LAW.
13. **Limitation of Liability.** INDEPENDENT OF THE FORGOING PROVISIONS, IN NO EVENT AND UNDER NO LEGAL THEORY, INCLUDING WITHOUT LIMITATION, TORT, CONTRACT, OR STRICT PRODUCTS LIABILITY, SHALL CODESOURCERY BE LIABLE TO YOU OR ANY OTHER PERSON FOR ANY INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES OF ANY KIND, INCLUDING WITHOUT LIMITATION, DAMAGES FOR LOSS OF GOODWILL, WORK STOPPAGE, COMPUTER MALFUNCTION, OR ANY OTHER KIND OF COMMERCIAL DAMAGE, EVEN IF CODESOURCERY HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES. THIS LIMITATION SHALL NOT APPLY TO LIABILITY FOR DEATH OR PERSONAL INJURY TO THE EXTENT PROHIBITED BY APPLICABLE LAW. IN NO EVENT SHALL CODESOURCERY'S LIABILITY FOR ACTUAL DAMAGES FOR ANY CAUSE WHATSOEVER, AND REGARDLESS OF THE FORM OF ACTION, EXCEED THE AMOUNT PAID BY YOU IN FEES UNDER THIS AGREEMENT DURING THE PREVIOUS ONE YEAR PERIOD.
14. **Export Controls.** You agree to comply with all export laws and restrictions and regulations of the United States or foreign agencies or authorities, and not to export or re-export the Software

or any direct product thereof in violation of any such restrictions, laws or regulations, or without all necessary approvals. As applicable, each party shall obtain and bear all expenses relating to any necessary licenses and/or exemptions with respect to its own export of the Software from the U.S. Neither the Software nor the underlying information or technology may be electronically transmitted or otherwise exported or re-exported (i) into Cuba, Iran, Iraq, Libya, North Korea, Sudan, Syria or any other country subject to U.S. trade sanctions covering the Software, to individuals or entities controlled by such countries, or to nationals or residents of such countries other than nationals who are lawfully admitted permanent residents of countries not subject to such sanctions; or (ii) to anyone on the U.S. Treasury Department's list of Specially Designated Nationals and Blocked Persons or the U.S. Commerce Department's Table of Denial Orders. By downloading or using the Software, Licensee agrees to the foregoing and represents and warrants that it complies with these conditions.

15. **U.S. Government End-Users.** The Software is a “commercial item,” as that term is defined in 48 C.F.R. 2.101 (Oct. 1995), consisting of “commercial computer software” and “commercial computer software documentation,” as such terms are used in 48 C.F.R. 12.212 (Sept. 1995). Consistent with 48 C.F.R. 12.212 and 48 C.F.R. 227.7202-1 through 227.7202-4 (June 1995), all U.S. Government End Users acquire the Software with only those rights set forth herein.
16. **Licensee Outside The U.S.** If You are located outside the U.S., then the following provisions shall apply: (i) Les parties aux presentes confirment leur volonte que cette convention de meme que tous les documents y compris tout avis qui siy rattache, soient rediges en langue anglaise (translation: “The parties confirm that this Agreement and all related documentation is and will be in the English language.”); and (ii) You are responsible for complying with any local laws in your jurisdiction which might impact your right to import, export or use the Software, and You represent that You have complied with any regulations or registration procedures required by applicable law to make this license enforceable.
17. **Severability.** If any provision of this Agreement is declared invalid or unenforceable, such provision shall be deemed modified to the extent necessary and possible to render it valid and enforceable. In any event, the unenforceability or invalidity of any provision shall not affect any other provision of this Agreement, and this Agreement shall continue in full force and effect, and be construed and enforced, as if such provision had not been included, or had been modified as above provided, as the case may be.
18. **Arbitration.** Except for actions to protect intellectual property rights and to enforce an arbitrator's decision hereunder, all disputes, controversies, or claims arising out of or relating to this Agreement or a breach thereof shall be submitted to and finally resolved by arbitration under the rules of the American Arbitration Association (“AAA”) then in effect. There shall be one arbitrator, and such arbitrator shall be chosen by mutual agreement of the parties in accordance with AAA rules. The arbitration shall take place in Granite Bay, California, and may be conducted by telephone or online. The arbitrator shall apply the laws of the State of California, USA to all issues in dispute. The controversy or claim shall be arbitrated on an individual basis, and shall not be consolidated in any arbitration with any claim or controversy of any other party. The findings of the arbitrator shall be final and binding on the parties, and may be entered in any court of competent jurisdiction for enforcement. Enforcements of any award or judgment shall be governed by the United Nations Convention on the Recognition and Enforcement of Foreign Arbitral Awards. Should either party file an action contrary to this provision, the other party may recover attorney's fees and costs up to \$1000.00.
19. **Jurisdiction And Venue.** The courts of Placer County in the State of California, USA and the nearest U.S. District Court shall be the exclusive jurisdiction and venue for all legal proceedings that are not arbitrated under this Agreement.

20. **Independent Contractors.** The relationship of the parties is that of independent contractor, and nothing herein shall be construed to create a partnership, joint venture, franchise, employment, or agency relationship between the parties. Licensee shall have no authority to enter into agreements of any kind on behalf of CodeSourcery and shall not have the power or authority to bind or obligate CodeSourcery in any manner to any third party.
21. **Force Majeure.** Neither CodeSourcery nor Licensee shall be liable for damages for any delay or failure of delivery arising out of causes beyond their reasonable control and without their fault or negligence, including, but not limited to, Acts of God, acts of civil or military authority, fires, riots, wars, embargoes, or communications failure.
22. **Miscellaneous.** This Agreement constitutes the entire understanding of the parties with respect to the subject matter of this Agreement and merges all prior communications, representations, and agreements. This Agreement may be modified only by a written agreement signed by the parties. If any provision of this Agreement is held to be unenforceable for any reason, such provision shall be reformed only to the extent necessary to make it enforceable. This Agreement shall be construed under the laws of the State of California, USA, excluding rules regarding conflicts of law. The application of the United Nations Convention of Contracts for the International Sale of Goods is expressly excluded. This license is written in English, and English is its controlling language.

B.3. Attribution

This version of Sourcery G++ Lite may include code based on work under the following copyright and permission notices:

B.3.1. Android Open Source Project

```
/*
 * Copyright (C) 2008 The Android Open Source Project
 * All rights reserved.
 *
 * Redistribution and use in source and binary forms, with or without
 * modification, are permitted provided that the following conditions
 * are met:
 * * Redistributions of source code must retain the above copyright
 *   notice, this list of conditions and the following disclaimer.
 * * Redistributions in binary form must reproduce the above copyright
 *   notice, this list of conditions and the following disclaimer in
 *   the documentation and/or other materials provided with the
 *   distribution.
 *
 * THIS SOFTWARE IS PROVIDED BY THE COPYRIGHT HOLDERS AND CONTRIBUTORS
 * "AS IS" AND ANY EXPRESS OR IMPLIED WARRANTIES, INCLUDING, BUT NOT
 * LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS
 * FOR A PARTICULAR PURPOSE ARE DISCLAIMED. IN NO EVENT SHALL THE
 * COPYRIGHT OWNER OR CONTRIBUTORS BE LIABLE FOR ANY DIRECT, INDIRECT,
 * INCIDENTAL, SPECIAL, EXEMPLARY, OR CONSEQUENTIAL DAMAGES (INCLUDING,
 * BUT NOT LIMITED TO, PROCUREMENT OF SUBSTITUTE GOODS OR SERVICES; LOSS
 * OF USE, DATA, OR PROFITS; OR BUSINESS INTERRUPTION) HOWEVER CAUSED
 * AND ON ANY THEORY OF LIABILITY, WHETHER IN CONTRACT, STRICT LIABILITY,
 * OR TORT (INCLUDING NEGLIGENCE OR OTHERWISE) ARISING IN ANY WAY OUT
 * OF THE USE OF THIS SOFTWARE, EVEN IF ADVISED OF THE POSSIBILITY OF
 * SUCH DAMAGE.
 */
```