Sourcery VSIPL++

Getting Started

Version 2.3-22

Sourcery VSIPL++: Getting Started: Version 2.3-22

CodeSourcery, Inc.

Table of Contents

Preface

Abstract

This preface introduces *Getting Started With Sourcery VSIPL++*. It explains the structure of this book and lists other sources of information that relate to Sourcery VSIPL++.

1. Intended Audience

This book is written for users and system administrators who will install Sourcery VSIPL++. Parts of this document assume that you have some familiarity with the UNIX Borne Shell and with compiling C++ programs from the command line.

2. Organization

This document is organized into the following chapters and appendices:

Chapter 1, "Licensing"	This chapter describes the terms under which Sourcery VSIPL++ is licensed. Read this chapter to find out what rules apply to you as a user of Sourcery VSIPL++.
Chapter 2, "Installation"	This chapter explains how to install Sourcery VSIPL++ binary packages.
Chapter 3, "Installation from Source"	This chapter explains how to configure, install, and build Sourcery VSIPL++ from a source package.
Chapter 4, "Building Applications"	This chapter explains how to build and run applications with Sourcery VSIPL++. Read this chapter to find out how to build a simple application. You can use the simple application as a template for building more complex applications.
Appendix A, "Build Variants"	This appendix contains a listing of all build variants contained in this package.
Appendix C, "GNU General Public License"	This appendix contains the full text of the GNU General Public License. If you have not purchased a Sourcery VSIPL++ subscription from CodeSourcery, then this license applies to Sourcery VSIPL++.

3. Typographical Conventions

The following typographical conventions are used in this book:

`> command arg ...`	A command, typed by the user, and its output. The ">" character is the command prompt.
`command`	The name of a program, when used in a sentence, rather than in literal input or output.
`literal`	Text provided to or received from a computer program.
`placeholder`	Text that should be replaced with an appropriate value when typing a command.

4. Further Reading

Sourcery VSIPL++ Website	http://www.codesourcery.com/vsiplplusplus/
Sourcery VSIPL++ User's Guide	http://www.codesourcery.com/vsiplplusplus/users_guide.pdf

Sourcery VSIPL++ Reference Manual	http://www.codesourcery.com/vsiplplusplus/reference_manual.pdf
Sourcery VSIPL++ Frequently Asked Questions	http://www.codesourcery.com/vsiplplusplus/faq.html
VSIPL++ API Specification	http://www.codesourcery.com/public/vsiplplusplus/specification-1.0.pdf

Chapter 1
Licensing

Abstract

Sourcery VSIPL++ is available under three licenses. CodeSourcery customers may use the entire library under terms suitable for use in proprietary software, including software designed for use in classified systems. Other users may either use the entire library under the GNU General Public License, which requires that source code for Sourcery VSIPL++ applications be provided to their users, or they may use the core parts of the library that make up the reference implementation under the BSD license.

1.1. Proprietary Software

If you have a Sourcery VSIPL++ license from CodeSourcery, you may use Sourcery VSIPL++ under the terms of that agreement. The full text of the license is included in Appendix B, “Sourcery VSIPL++ Software License Agreement”.

If you are planning to use Sourcery VSIPL++ to develop proprietary applications, please contact `<sales@codesourcery.com>` or visit the Sourcery VSIPL++ web site[1] to find out more about obtaining a Sourcery VSIPL++ software license and support agreement.

1.2. Free and Open-Source Software

If you are planning to use Sourcery VSIPL++ to develop a free or open-source software application and are willing to share the source code for your application, you may use Sourcery VSIPL++ at no charge under the terms of the GNU General Public License 2.0. The full text of the license is included in Appendix C, “GNU General Public License”. The GPL requires that you share the source code for your application with everyone to whom you distribute your application. You have certain other rights and obligations under the GPL, as described in the appendix.

1.3. Reference Implementation

If you are planning to use the VSIPL++ reference implementation, you may use the core library parts of Sourcery VSIPL++ under the terms of the BSD license. The full text of the license is included in Appendix D, “ BSD License”. The exact files available under the BSD license are documented in the file `LICENSE` located in the top level directory of the source package.

[1] http://www.codesourcery.com/vsiplplusplus/

Chapter 2
Installation

Abstract

This chapter explains how to install Sourcery VSIPL++ from a precompiled binary package. Installing Sourcery VSIPL++ requires three steps:

1. Ensure that your system can run Sourcery VSIPL++.
2. Download a Sourcery VSIPL++ binary package for your system.
3. Install Sourcery VSIPL++.

Alternatively, if an appropriate pre-built binary package is not available, Sourcery VSIPL++ may be compiled and installed from a source package. Instructions for this option may be found in Chapter 3, “Installation from Source”.

2.1. System Requirements

This section explains what requirements your system must meet in order to run Sourcery VSIPL++. You must have software labeled as "Required" installed on your system. You can use Sourcery VSIPL++ without installing software labeled as "Optional." However, if you install these packages, Sourcery VSIPL++ may provide extra functionality or enhanced performance.

2.1.1. Operating System

Sourcery VSIPL++ binary packages are available for the following distribution / architectures / compiler sets (The C++ ABI is not standardized between compilers, and thus a C++ library compiled with one compiler may not reliably work with a different compiler):

- x86 / RHEL 4 (32 and 64-bit) / GCC 3.4.6
- Cell/B.E. Fedora 9 (32 and 64-bit) / GCC 4.1.1
- PowerPC / Fedora 9 (32 and 64-bit) / GCC 4.3

2.1.2. General Required Software

This section describes software that you must have installed in order to install and use a Sourcery VSIPL++ binary package on any system.

2.1.2.1. RPM

For GNU/Linux systems, Sourcery VSIPL++ binary packages are available as Redhat Package Manager (RPM) files and as compressed Tape Archive (Tar) files. When using Sourcery VSIPL++ RPM files, it is necessary to have RPM installed. RPM is installed by default on RHEL and Fedora.

2.1.2.2. GNU Tar

When using Sourcery VSIPL++ Tar files, CodeSourcery strongly recommends that you use GNU Tar to unpack the binary package due to incompatibilities between various versions of Tar. You can download GNU Tar as source code from http://ftp.gnu.org/pub/gnu/tar. Pre-compiled GNU Tar binaries are available for all popular operating systems.

2.1.3. Specific Software for x86 / RHEL 4

Both 32-bit and 64-bit applications can be built with Sourcery VSIPL++. To build 32-bit applications, 32-bit versions of the RPMs listed below must be installed. Likewise, to build 64-bit applications, 64-bit versions of the RPMs listed below must be installed.

2.1.3.1. x86 GNU Toolchain (Required)

In order to compile application programs using Sourcery VSIPL++ it is necessary to have the x86 GNU 3.4.6 toolchain installed.

The x86 GNU toolchain is part of the RHEL v4 distribution. The following RPM packages are required:

- gcc
- gcc-c++

2.1.3.2. Intel IPP and MKL (Optional)

The Intel Performance Primitives (IPP) and Intel Math Kernel Library (MKL) can be used by Sourcery VSIPL++ to accelerate some functions, including FFTs. Sourcery VSIPL++ for RHEL v4 requires that both libraries be used together.

Sourcery VSIPL++ expects IPP to be installed in `/opt/intel/ipp` and MKL to be installed in `/opt/intel/mkl`.

To find out more about IPP and MKL visit

- http://software.intel.com/intel-ipp/
- http://software.intel.com/intel-mkl/

2.1.3.3. LAM/MPI (Optional)

LAM/MPI is an optional library that provides MPI bindings for message passing. Sourcery VSIPL++ can use multiple cores, processors, or compute nodes simultaneously when LAM/MPI is installed.

LAM/MPI is available as an RPM package in the RHEL v4 distribution. The following RPM packages are required:

- lam-7.1.2
- lam-libs-7.1.2
- lam-devel-7.1.2

You can find out more information on LAM/MPI at http://www.lam-mpi.org/.

2.1.4. Specific Software for Cell/B.E. / Fedora 9

Both 32-bit and 64-bit applications can be built with Sourcery VSIPL++. To build-32-bit applications, 32-bit versions of the RPMs listed below must be installed. Likewise, to build 64-bit applications, 64-bit versions of the RPMs listed below must be installed.

2.1.4.1. Cell/B.E. GNU Toolchain (Required)

In order to compile application programs using Sourcery VSIPL++ it is necessary to have the Cell/B.E. GNU 4.1.1 toolchain installed. This toolchain is freely available and may be downloaded from the Barcelona Supercomputing website at http://www.bsc.es/plantillaH.php?cat_id=579.

The following RPM packages are required:

- ppu-gcc-4.1.1
- ppu-gcc-c++-4.1.1
- ppu-binutils

The following RPM packages are required only if you plan to write user-defined kernels:

- spu-gcc-4.1.1
- spu-gcc-c++-4.1.1

- spu-binutils
- spu-newlib

2.1.4.2. Cell/B.E. SPE Runtime Management Library 2 (Required)

In order for Sourcery VSIPL++ application programs to use the SPEs, it is necessary to have the Cell/B.E. SPE Runtime Management Library 2 (libspe2) installed.

This library is freely available and may be downloaded from the Barcelona Supercomputing Website at http://www.bsc.es/plantillaH.php?cat_id=581.

The following RPM packages are required:

- libspe2
- libspe2-devel

2.1.4.3. NUMACTL (Optional)

NUMACTL provides mechanisms for Sourcery VSIPL++ to control the PPEs and SPEs used by a process and its threads. By controlling locality, Sourcery VSIPL++ can improve application performance in some cases.

NUMACTL is available in RPM packages provided by the Fedora 9 distribution. The following RPM packages are required:

- numactl
- numactl-devel

2.1.4.4. OpenMPI (Optional)

OpenMPI is an optional library that provides MPI bindings for message passing. Sourcery VSIPL++ can use multiple compute nodes simultaneously when OpenMPI is installed. Note that OpenMPI is not necessary for Sourcery VSIPL++ to use multiple SPEs on a single Cell/B.E., or to use multiple PPEs and SPEs with a coherent interconnect such as on an IBM BladeCenter(R) QS20, QS21, or QS22 blade. It is only necessary if Sourcery VSIPL++ will be used on multiple blades connected via ethernet or similar network fabric.

OpenMPI is available in RPM packages provided by the Fedora 9 distribution. The following RPM packages are required:

- openmpi
- openmpi-devel
- openmpi-libs

2.2. Installing a Binary Package

This section explains how to install and run Sourcery VSIPL++ from a pre-built package. Pre-built Sourcery VSIPL++ packages are available from CodeSourcery's customer support portal. Visit your account http://www.codesourcery.com/VSIPLXX to download packages.

2.2.1. Unpacking the Distribution RPM

Sourcery VSIPL++ binary packages are available as RPM packages. The following commands use RPM to unpack the binary distribution into the location `/opt/codesourcery/sourceryvsipl++-2.3`:

```
> rpm -i sourceryvsipl++-i686-pc-linux-gnu-2.3-22.noarch.rpm
```

The exact package name will vary depending on the target platform.

2.2.2. Unpacking the Distribution Tarball

Sourcery VSIPL++ binary packages are distributed as compressed Tape Archive (Tar) files that are intended to be installed in the `/opt/codesourcery` directory. The following commands use GNU Tar to unpack the binary distribution into the location `/opt/codesourcery/sourceryvsipl++-2.3`:

```
> mkdir -p /opt/codesourcery
> cd /opt/codesourcery
> tar -xjf /path/to/sourceryvsipl++-2.3-22-i686-pc-linux-gnu.tar.bz2
```

Replace *`/path/to/sourceryvsipl++-2.3-22-i686-pc-linux-gnu.tar.bz2`* with the location and name of the particular Sourcery VSIPL++ package you are installing.

If you will be using pkg-config to determine compile and link time options, you should include the directory `/opt/codesourcery/sourceryvsipl++-2.3/lib/pkgconfig` in your `PKG_CONFIG_PATH` environment variable:

```
> export \
PKG_CONFIG_PATH=/opt/codesourcery/sourceryvsipl++-2.3/lib/pkgconfig
```

The directory layout of the installed package is as follows:

```
`- opt
   `- codesourcery
      `- sourceryvsipl++-2.3
         |- bin                  // General executables and scripts
         |  |- [arch]            // Arch-specific binary files
         |  |  `- [variant]      // Variant-specific binary files
         |  |     `- benchmarks // Benchmark executables
         |- include
         |  |- vsip              // Sourcery VSIPL++ Headers
         |  |- vsip_csl          // CodeSourcery extensions
         |  `- ...               // Other non-SV++ headers as \
necessary
         |- lib
         |  |- [arch]            // Arch-specific library files
         |  |  `- [variant]      // Variant-specific library files
         |  |     `- pkgconfig   // Variant-specific pkg-config
        |  `- pkgconfig       // Pkg-config links for all variants
         |- sbin                 // Installation scripts
         `- share                // Documentation and user files
            |- doc
```

```
            |  `- sourceryvsipl++ // PDF and HTML documentation
            `- sourceryvsipl++    // Example programs
```

Sourcery VSIPL++ binary packages contain a single set of shared library headers, and contain multiple library archives that are specialized by processor architecture they support and external libraries they use. These libraries are organized into lib/[arch]/[variant] directories, where [arch] is the processor architecture, and [variant] is the variant. For example, the GNU/Linux x86 binary package supports the ia32 and em64t architectures.

The [variant] subdirectory indicates which external libraries the VSIPL++ library is configured to use, and what level of optimization the library has been built with. Consult Appendix A, “Build Variants” to find out what build variants your binary package contains.

2.2.3. Other Install Locations

If you install Sourcery VSIPL++ into a directory other than `opt/sourceryvsipl++-2.3`, you must run the `set-prefix.sh` script to update the installation prefixes stored in the library's pkg-config `.pc` files.

The `set-prefix.sh` is located in the `sbin` subdirectory of the tarball.

For example, to install a binary package in `$HOME/sourceryvsipl++-2.3`:

Example 2.1. Installing a binary package in $HOME

```
> cd $HOME
> tar xfj sourceryvsipl++-2.3-22-i686-pc-linux-gnu.tar.bz2
> $HOME/sourceryvsipl++-2.3/sbin/set-prefix.sh
> export PKG_CONFIG_PATH=$HOME/sourceryvsipl++-2.3/lib/pkgconfig
```

2.2.4. Paths for External Libraries

Sourcery VSIPL++ binary packages that use the following external libraries have the library installation paths hard-coded in their pkg-config files (install path in parenthesis):

- Intel IPP (`/opt/intel/ipp`).
- Intel MKL (`/opt/intel/mkl`).

If these libraries are not installed in these locations, it is necessary to do one of the following:

- Update the pkg-config file paths using `set-prefix.sh`.
- Create a symbolic link from the default install location to the actual install location.
- Manually specify the paths to the libraries on each invocation of pkg-config.

Each of the options is described in more detail below.

The `set-prefix.sh` script in the `sourceryvsipl++-2.3/sbin` will update the pkg-config files with the correct installation prefixes for external libraries. `set-prefix.sh` takes arguments of the form `ipp:/prefix/to/ipp`, `mkl:/prefix/to/mkl`, and `mpi:/prefix/to/mpi`, to specify prefixes for IPP, MKL, and MPICH respectively.

For example, if the library has been installed into `/opt/codesourcery/sourceryvsipl++-2.3` and IPP is installed in `/opt/intel/ipp41`:

Example 2.2. Using `set-prefix.sh` to use IPP from different prefix

```
> /opt/codesourcery/sourceryvsipl++-2.3/sbin/set-prefix.sh \
ipp:/opt/intel/ipp41
```

If multiple prefixes need to be changed, `set-prefix.sh` can either be called once with multiple prefixes:

```
> /opt/codesourcery/sourceryvsipl++-2.3/sbin/set-prefix.sh \
        ipp:/opt/intel/ipp41 mkl:/opt/intel/mkl821
```

Or multiple times, once for each prefix:

```
> /opt/codesourcery/sourceryvsipl++-2.3/sbin/set-prefix.sh \
ipp:/opt/intel/ipp41
> /opt/codesourcery/sourceryvsipl++-2.3/sbin/set-prefix.sh \
mkl:/opt/intel/mkl821
```

Using symbolic links, it is possible to direct Sourcery VSIPL++'s expected directory to the actual installation libraries.

For example, if IPP is installed in `/opt/intel/ipp41`:

Example 2.3. Using a symbolic link to use IPP from different prefix

```
> ln -s /opt/intel/ipp41 /opt/intel/ipp
```

Finally, it is possible to manually pass the prefixes for external libraries to pkg-config program on each invocation.

For example, if IPP is installed in `/opt/intel/ipp41` and that MKL is installed in `/opt/intel/mkl821`, to query `--libs` from `pkg-config`:

Example 2.4. Overriding library prefixes from the command line

```
LIBS = `pkg-config \
        --define-variable=ipp_prefix=/usr/local/ipp41  \
        --define-variable=mkl_prefix=/usr/local/mkl821 \
        --libs vsipl++`
```

Chapter 3
Installation from Source

Abstract

This chapter explains how to configure and install Sourcery VSIPL++ from source for use on your system. Installing Sourcery VSIPL++ from source requires three steps:

1. Ensure that your system can run Sourcery VSIPL++.
2. Download the Sourcery VSIPL++ source package.
3. Configure, build, and install Sourcery VSIPL++.

If an appropriate pre-built binary package is available for your architecture, operating system, and compiler, using that is preferrable to building from source. Instructions for this installing pre-built binary packages can be found in Chapter 2, “Installation”.

3.1. System Requirements

This section explains what requirements your system must meet in order to run Sourcery VSIPL++.

3.1.1. Operating System

Sourcery VSIPL++ can be built and installed on any UNIX-like system that has a satisfactory C++ compiler. CodeSourcery's reference GNU/Linux platform is Red Hat Enterprise Linux 4.0. CodeSourcery's reference MCOE platform is 6.3.0.

The following compilers have been tested by CodeSourcery to work with Sourcery VSIPL++ for the noted OS and architecture: OS, architecture, and compiler combinations have been tested by CodeSourcery to work with Sourcery VSIPL++:

- GCC 3.4 (IA32 GNU/Linux)
- GCC 3.4 (EM64t GNU/Linux)
- GCC 4.1 (Cell/B.E. GNU/Linux)
- GCC 4.2 (IA32 GNU/Linux)
- GCC 4.2 (EM64t GNU/Linux)
- Intel C++ 9.1 (IA32 GNU/Linux)
- Intel C++ 9.1 (EM64t GNU/Linux)
- Intel C++ 9.1 (IA32 Windows)
- GreenHills C++ 4.0.6 (PowerPC MCOE 6.3.0)

The following compilers are known not to work at this time with Sourcery VSIPL++:

- GCC 3.3
- Intel C++ 8.1
- Intel C++ 9.0

3.1.2. Required Software

This section describes software that you must have installed in order to build and install VSIPL++. Although the instructions below refer to obtaining this software in source form, you will be able to find pre-compiled binary distributions for most popular operating systems. Consult your operating system manuals for information about obtaining and installing pre-compiled versions of these packages.

3.1.2.1. GNU Make

You must use the GNU version of `make` to build Sourcery VSIPL++. You can download GNU Make as source code from http://ftp.gnu.org/pub/gnu/make. Pre-compiled GNU Make binaries are available for all popular operating systems.

3.1.2.2. GNU Tar

The Sourcery VSIPL++ source code is distributed as a compressed Tape Archive (Tar) file. Due to incompatibilities between various versions of Tar, CodeSourcery strongly recommends that you use GNU Tar to unpack the source code. You can download GNU Tar as source code from http://ftp.gnu.org/pub/gnu/tar. Pre-compiled GNU Tar binaries are available for all popular operating systems.

3.1.3. Optional Software

You can build and use Sourcery VSIPL++ without installing any other software packages. However, if you install the additional packages described in this section, Sourcery VSIPL++ will provide additional functionality and better performance. This section explains what software you might wish to install and how to obtain it. Although some the instructions below refer to obtaining this optional software in source form, you will be able to find pre-compiled binary distributions for most popular operating systems. Consult your operating system manuals for information about obtaining and installing pre-compiled versions of these packages.

3.1.3.1. Numerical Libraries

Sourcery VSIPL++ can take advantage of high-performance numerical libraries to improve performance. This section describes the supported libraries. In general, Sourcery VSIPL++ will automatically make use of these libraries are they are installed on your system.

3.1.3.1.1. ATLAS

Automatically Tuned Linear Algebra Software can be used to accelerate some linear-algebra functions in Sourcery VSIPL++. Sourcery VSIPL++ source packages come with the ATLAS sources. Alternatively, if ATLAS is already installed on your system, Sourcery VSIPL++ can be configured to use it.

Visit http://math-atlas.sourceforge.net for more information about ATLAS.

3.1.3.1.2. FFTW3

The Fastest Fourier Transform in the West can be used to accelerate Sourcery VSIPL++ FFT performance. Sourcery VSIPL++ source packages include the FFTW3 sources. Alternatively, if FFTW3 is already installed on your system, Sourcery VSIPL++ can be configured to use it.

Visit http://www.fftw.org for more information about FFTW.

3.1.3.1.3. Intel IPP and MKL

The Intel Performance Primitives and Intel Math Kernel Library can be used by Sourcery VSIPL++ to accelerate some functions, including FFTs. IPP and MKL are proprietary libraries, so you cannot distribute a Sourcery VSIPL++ application using IPP or MKL under the terms of the GPL.

To find out more about IPP and MKL visit

- http://www.intel.com/cd/software/products/asmo-na/eng/perflib/ipp/index.htm
- http://www.intel.com/cd/software/products/asmo-na/eng/perflib/mkl/index.htm

3.1.3.1.4. AMD Core Math Library (ACML)

The AMD Core Math Library (ACML) can be used by Sourcery VSIPL++ to accelerate some linear-algebra functions.

Visit http://developer.amd.com/acml.aspx for more information about ACML.

3.1.3.1.5. Mercury SAL

The Mercury Scientific Algorithm Library (SAL) can be used by Sourcery VSIPL++ to accelerate many functions, including elementwise view operations, linear algebra, solvers, and signal processing objects (including FFT). SAL is a proprietary library, so you cannot distribute a Sourcery VSIPL++ application using SAL under the terms of the GPL.

Visit http://www.mc.com/products/software.aspx for more information about SAL.

3.1.3.1.6. VSIPL Back End

An implementation of the C VSIPL API can be used by Sourcery VSIPL++ to implement many functions, including linear algebra, solvers, and signal processing objects (such as FFT).

Visit the http://www.vsipl.org/ for more information about the VSIPL API and a list of implementations.

3.1.3.1.7. CML Back End

The Cell Math Library (CML) is used by Sourcery VSIPL++ to accelerate performance on Cell processors by offloading many computations to the SPUs. *CML is required to build any version of Sourcery VSIPL++ from source.* CML is available from CodeSourcery and included in the binary installation packages for the full version of Sourcery VSIPL++.

Contact `<sales@codesourcery.com>` for more information about CML.

3.1.3.2. Communications Libraries

If you install a communication library such as Mercury PAS (Parallel Acceleration System) or MPI (Message Passing Interface), you can run Sourcery VSIPL++ programs on multiple compute nodes simultaneously. On GNU/Linux platforms, Sourcery VSIPL++ works with both the LAM and MPICH implementations of MPI, and will likely work with other MPI implementations as well. On MCOE platforms, Sourcery VSIPL++ works with both Mercury PAS and Verari MPI/Pro.

3.1.3.2.1. Mercury PAS

Mercury Parallel Acceleration System (PAS) is a library for high-performance communication on Mercury PowerPC embedded computer and Cell blade systems. PAS is a propreitary library, so you cannot distribute a Sourcery VSIPL++ application using PAS under the terms of the GPL.

For more information on PAS, visit http://www.mc.com/products/software.aspx.

The following releases of Mercury PAS have been tested by CodeSourcery to work with Sourcery VSIPL++:

- MCOE PAS 4.3.0
- PAS for Linux Clusters

3.1.3.2.2. LAM/MPI

You can download LAM/MPI as source code from http://www.lam-mpi.org/.

Recommended configuration options when building LAM/MPI for use with Sourcery VSIPL++:

`--without-mpi2cpp` Do not build MPI/C++ interface. Although Sourcery VSIPL++ does not use this interface, building it may create link-time warnings when using different compiler versions.

The following releases of LAM/MPI have been tested by CodeSourcery to work with Sourcery VSIPL++:

- LAM/MPI 7.0.6
- LAM/MPI 7.1.1

> **RHEL Users**
>
> The RHEL LAM 6.5.9-1 package available for RHEL 3 is not suitable for use with Sourcery VSIPL++. This package does not support compilation with a C++ compiler.

3.1.3.2.3. MPICH

You can download MPICH as source code from http://www-unix.mcs.anl.gov/mpi/mpich/, but pre-built binaries for most popular operating systems are available from the system distributors. If MPICH is not already installed on your system, see the documentation for your operating system for information about obtaining MPICH.

3.1.3.2.4. OpenMPI

You can download OpenMPI as source code from http://www.open-mpi.org/, but pre-built binaries for most popular operating systems are available from the system distributors. If OpenMPI is not already installed on your system, see the documentation for your operating system for information about obtaining OpenMPI.

3.1.3.2.5. Verari MPI/Pro

The following release of Verari MPI/Pro has been tested by CodeSourcery to work with Sourcery VSIPL++:

- Verari MPI/Pro 2.1.0

3.2. Obtaining the Source Code

The Sourcery VSIPL++ Source Code is available from CodeSourcery's web site. Visit http://www.codesourcery.com/vsiplplusplus/download.html for instructions on downloading VSIPL++.

Sourcery VSIPL++ source packages are distributed as compressed Tape Archive (Tar) files. Use GNU Tar to unpack the source code with the following command:

```
> tar xjf sourceryvsipl++-2.3-22-source.tar.bz2
```

This command will create a subdirectory of the current directory called `sourceryvsipl++-2.3`.

3.3. Configuration

Before building Sourcery VSIPL++, you must run a configuration script to tell Sourcery VSIPL++ what C++ compiler you are using and what optional software you wish to use. After running the configuration script, you will build and install the Sourcery VSIPL++ library.

These instructions assume that your shell's current directory is the `sourceryvsipl++-2.3` directory created when you unpacked the VSIPL++ distribution. If you want to allow Sourcery VSIPL++ to automatically configure itself, run:

```
> ./configure
```

You will see output explaining the configuration decisions that Sourcery VSIPL++ is making.

There are several options that you can use to tell Sourcery VSIPL++ about your particular environment.

`CXX=`*`path`*
: Use *`path`* as the C++ compiler. If you do not provide this option, Sourcery VSIPL++ will search for a C++ compiler in your `PATH`.

`CXXFLAGS=`*`flags`*
: Use *`flags`* as flags to pass to the C++ compiler. The default value depends on your compiler. If you are using multiple flags (like `-O2 -ffast-math`), you must enclose the *`flags`* in quotes so that the shell will consider all of the flags as a single argument.

`--prefix=`*`directory`*
: Install the library in *`directory`*. Header files will be placed in a subdirectory of *`directory`* named `include`; the library itself will be placed in `lib`. You will need to have sufficient permissions to write to the installation directory. The default installation directory is `/usr/local`, which is usually not writable by non-administrators; therefore, you may want to use your home directory as an installation directory.

`--host=`*`architecture`*
: Specify the host-architecture that Sourcery VSIPL++ will be built for. The default is to build Sourcery VSIPL++ to run native on build machine. This option is useful when cross-compiling Sourcery VSIPL++.

`--disable-parallel`
: Do not use a parallel communications library, even if an appropriate MPI library is detected. This option is useful if you want to build a uniprocessor version of Sourcery VSIPL++. By default, MPI support will be included if it is available.

`--enable-parallel`
: Search for and use a communications library for support of multi-processor systems for parallel computation.

`--enable-parallel=`*`lib`*
: Search for and use the parallel communications library indicated by *`lib`*. Available options are `lam`, `mpich2`, `intelmpi`, `openmpi`, `mpipro`, and `pas`.

  `lam` selects the LAM/MPI library.

  `mpich2` selects the MPICH2 library.

`intelmpi` selects the Intel MPI Library.

`openmpi` selects then Open MPI library.

`mpipro` selects Verari's MPI/Pro. This option is necessary when using MPI/Pro on the Mercury platform.

`pas` enables the use of Mercury Parallel Acceleration System (PAS) for parallel services if found. This option is necessary to use PAS on the Mercury platform, and when using PAS for Linux clusters.

`--with-mpi-prefix=`*`directory`*
: Search for MPI installation in *`directory`* first. MPI headers should be in *`directory/include`*, MPI libraries in *`directory/lib`*, and MPI compilation commands (either `mpicxx` or `mpiCC`) should be in *`directory/bin`*. This option is useful if MPI is installed in a non-standard location, or if multiple MPI versions are installed.

`--with-mpi-cxxflags=`*`flags`*
`--with-mpi-libs=`*`flags`*
: In some cases, Sourcery VSIPL++ is unable to automatically detect the required compiler and linker options to enable MPI. In these cases, the required C++ compiler flags can be specified using the `--with-mpi-cxxflags` option, and the required linker (library) flags can be specified using the `--with-mpi-libs`. These options must be used together, and when they are used, the specific type of the MPI library in use must be specified with the `--enable-parallel=`*`type`* option.

`--disable-exceptions`
: Do not use C++ exceptions. Errors that would previously have generated an exception now cause an abort(). This option is useful if you want to build Sourcery VSIPL++ with a compiler that does not implement exceptions. By default, exceptions are used.

`--with-ipp`
: Enable the use of the Intel Performance Primitives (IPP) if found. Enabling IPP will accelerate the performance of signal processing and view element-wise operations.

`--with-ipp=win`
: Enable the use of the Intel Performance Primitives (IPP) for Windows if found. This option is useful when configuring Sourcery VSIPL++ on a Windows system.

`--with-ipp-prefix=`*`directory`*
: Search for IPP installation in *`directory`* first. IPP headers should be in the `include` subdirectory of *`directory`* and IPP libraries should be in the `lib` subdirectory. This option has the effect of enabling IPP (i.e. `--with-ipp`). This option is useful if IPP is installed in a non-standard location, or if multiple IPP versions are installed.

`--with-ipp-suffix=`*`suffix`*
: Use a processor specific version of the IPP libraries, as indicated by *`suffix`*. For example, the suffix em64t will select IPP libraries specific to em64t processors. By default, non-suffix IPP libraries are used, which determine the architecture at run-time and dynamically load the appropriate processor-

specific libraries. This option is useful if the automatic dispatcher is not able to determine the correct architecture.

`--with-sal`
: Enable the use of the Mercury Scientific Algorithm Library (SAL) if found. Enabling SAL will accelerate the performance of view element-wise operations, linear algebra, solvers, and signal processing operations.

`--with-sal-include=`*`directory`*
: Search for SAL header files in *`directory`* first. This option has the effect of enabling SAL (i.e. `--with-sal`). This option is useful if SAL headers is installed in a non-standard location, such as when using the CSAL library. However, it should not be necessary when building native on Mercury system.

`--with-sal-lib=`*`directory`*
: Search for SAL library files in *`directory`* first. This option has the effect of enabling SAL (i.e. `--with-sal`). This option is useful if SAL libraries is installed in a non-standard location, such as when using the CSAL library. However, it should not be necessary when building native on Mercury system.

`--with-cuda`
: Enable the use of NVidia's Compute Unified Device Architecture (CUDA). This enables the use of certain graphics processing units (GPUs) as computational accelerators (see NVidia's website for a list of compatible cards). For FFT support, use `--enable-fft=cuda` in addition to this option.

`--enable-fft=`*`lib`*
: Search for and use the FFT library indicated by *`lib`* to perform FFTs. Valid choices for *`lib`* include `fftw3`, `cuda`, `ipp`, `sal`, and `cvsip` which select FFTW3, CUDA, IPP, SAL, and C VSIPL libraries respectively. A fourth option, `builtin`, selects the FFTW3 library that comes with Sourcery VSIPL++ (default). This option should be used if an existing FFTW3 library is not available. If no FFT library is to be used (disabling Sourcery VSIPL++'s FFT functionality), `no_fft` should be chosen for *`lib`*. Multiple libraries may be given as a comma separated list. When performing an FFT, VSIPL++ will use the first library in the list that can support the FFT parameters. For example, on Mercury systems `--enable-fft=sal,builtin` would use SAL's FFT when possible, falling back to VSIPL++'s builtin FFTW3 otherwise.

`--with-fftw3-prefix=`*`directory`*
: Search for FFTW3 installation in *`directory`* first. FFTW3 headers should be in the `include` subdirectory of *`directory`* and FFTW3 libraries should be in the `lib` subdirectory. This option has the effect of enabling FFTW3 for FFTs (i.e. `--with-fft=fftw3`). This option is useful if FFTW3 is installed in a non-standard location, or if multiple FFTW3 versions are installed.

`--disable-fftw3-simd`
: Disable builtin FFTW3 from using SIMD ISA extensions (such as AltiVec or SSE2). By default, FFTW3 uses SIMD

	ISA extensions because they improve performance. However, this option is useful when building for a platform that does not support the ISA extensions.
`--with-lapack`	Enable Sourcery VSIPL++ to search for an appropriate LAPACK implementation on the platform. If found, it will be used to perform linear algebra (matrix-vector products and solvers).
`--with-lapack=`*`lib`*	Search for and use the LAPACK library indicated by *`lib`* to perform linear algebra (matrix-vector products and solvers). Valid choices for *`lib`* include `mkl`, `acml`, `atlas`, `generic`, `builtin`, and `no`. `mkl` selects the Intel Math Kernel Library (MKL) to perform linear algebra if found. `mkl_win` selects the Intel Math Kernel Library (MKL) on Windows systems to perform linear algebra if found. `acml` selects the AMD Core Math Library (ACML) to perform linear algebra if found. `atlas` selects the ATLAS library to perform linear algebra if found. `generic` selects a generic LAPACK library (-llapack) to perform linear algebra if found. `builtin` selects a version of LAPACK that doesn't require ATLAS. `no` is used to disable searching for a LAPACK library.
`--with-acml-prefix=`*`directory`*	Search for ACML installation in *`directory`* first. ACML headers should be in the `include` subdirectory of the install directory, whose path depends on the exact version of the library you have. Similarly, ACML libraries should be in the `lib` subdirectory. This option has the effect of enabling ACML for lapack (i.e. `--with-lapack=acml`). This option is useful if the ACML is installed in a non-standard location, or if multiple ACML versions are installed.
`--with-atlas-prefix=`*`directory`*	Search for ATLAS installation in *`directory`* first. ATLAS headers should be in the `include` subdirectory of *`directory`* and ATLAS libraries should be in the `lib` subdirectory, unless otherwise specified by `--with-atlas-include` and `--with-atlas-libdir`, respectively. This option has the effect of enabling ATLAS for lapack (i.e. `--with-lapack=atlas`). This option is useful if ATLAS is installed in a non-standard location, or if multiple ATLAS versions are installed.
`--with-atlas-include=`*`directory`*	Search for ATLAS include headers in *`directory`* first. This option has the effect of enabling ATLAS for lapack (i.e.

`--with-lapack=atlas`). This option is useful if ATLAS is installed in a location that does not fit the pattern assumed by `--with-atlas-prefix`.

`--with-atlas-libdir=`*`directory`*
: Search for ATLAS library files in *`directory`* first. This option has the effect of enabling ATLAS for lapack (i.e. `--with-lapack=atlas`). This option is useful if ATLAS is installed in a location that does not fit the pattern assumed by `--with-atlas-prefix`.

`--with-mkl-prefix=`*`directory`*
: Search for MKL installation in *`directory`* first. MKL headers should be in the `include` subdirectory of *`directory`* and MKL libraries should be in the `lib/(arch)` subdirectory. This option has the effect of enabling MKL for lapack (i.e. `--with-lapack=mkl`). This option is useful if MKL is installed in a non-standard location, or if multiple MKL versions are installed.

`--with-mkl-arch=`*`architecture`*
: Used in conjunction with `--with-mkl-prefix` to specify which library subdirectory of MKL to use. If `--with-mkl-prefix=`*`directory`* is used to specify the MKL prefix, libraries are searched for in `directory/architecture`. By default *`architecture`* is deduced based on the platform. This option is useful if this deduction is incorrect.

`--without-cblas`
: Disables the use of the C BLAS API, forcing the use of the Fortran BLAS API. This option is useful if building on a platform that does not provide the C BLAS API.

`--with-cbe-sdk`
: Enable the use of the IBM Cell/B.E. Software Development Kit (SDK) version 3.0 or 3.1 if found. Enabling the Cell/B.E. SDK will accelerate the performance of FFTs, vector-multiplication, vector-matrix multiplication, and fast convolution.

`--with-cbe-sdk-sysroot=`*`directory`*
: Search for Cell/B.E. SDK libraries and headers in a sysroot at *`directory`*, rather than in the system root directory (or the default sysroot location, in the case of SDK version 2.1). This option has the effect of enabling use of the Cell/B.E. SDK (i.e. `--with-cbe-sdk`). This option is used for cross-compilation.

`--with-numa`
: Enable the use of libnuma. This is useful on Cell/B.E. systems to insure that SPE resources allocated for accelertion are local to the PPE running VSIPL++.

`--with-cvsip`
: Enable Sourcery VSIPL++ to search for an appropriate C VSIPL implementation on the platform. If found, it will be used to perform linear algebra (matrix-vector products and solvers) and some signal processing (convolution, correlation, and FIR). If the `--enable-fft=cvsip` option is also given, the VSIPL implementation will be used to perform FFTs.

`--with-cvsip-prefix=`*`directory`* Search for a C VSIPL installation in *`directory`* first. Headers should be in the `include` subdirectory of *`directory`* and libraries should be in the `lib` subdirectory. This option has the effect of enabling the use of a VSIPL back end as if the option `--with-cvsip` had been given. This option is useful if VSIPL is installed in a non-standard location, or if multiple VSIPL versions are installed.

`--enable-only-ref-impl` Configure Sourcery VSIPL++ to be used as the VSIPL++ reference implementation. When the BSD licensed files are configured with this option, the result is the VSIPL++ reference implementation. This option implies the `--enable-fft=cvsip` and `--with-cvsip` options. Refer to Section 3.3.4, "Configuration Notes for the Reference Implementation" for more information on configuring the reference implementation.

`--with-png` Enables PNG I/O support, using libpng. By default, PNG support is enabled if libpng is found during configuration.

`--enable-simd-loop-fusion` Enable VSIPL++ to generate SIMD instructions for loop-fusion expressions (containing data that is SIMD aligned). This option is useful for increasing performance of many VSIPL++ expressions on platforms with SIMD instruction set extensions (such as Intel SSE, or Power VMX/AltiVec). The default is not to generate SIMD instructions.

`--enable-simd-unaligned-loop-fusion` Enable VSIPL++ to generate SIMD instructions for loop-fusion expressions, possibly containing data that is SIMD unaligned. This option is useful for increasing performance of VSIPL++ expressions that work with unaligned data on platforms with SIMD instruction set extensions (such as Intel SSE, or Power VMX/AltiVec). The default is to follow the setting of `--enable-simd-loop-fusion`.

`--with-complex=`*`format`* Specify the *`format`* for storing complex numbers. Valid choices for *`format`* are `inter` and `split`, which select interleaved and split storage respectively. This option is useful when a platform has better performance using a particular complex storage format. The default complex storage format is `inter`.

`--enable-timer=`*`timer`* Use *`timer`* type of timer for profiling. Valid choices for *`timer`* include `none`, `posix`, `realtime`, `pentiumtsc`, and `x86_64_tsc`, and `power_tb`. By default no timer is used (*`timer`*`=none` This option is necessary when you intent to use the libary's profiling or performance API features.

`none` disables profile timing.

`posix` selects the POSIX timer if present on the system.

`realtime` selects the POSIX realtime timer if present on the system.

	`pentiumtsc` selects the Pentium time-stamp counter (TSC) timer if present on the system.
	`x86_64_tsc` selects the x86-64 (or em64t) time-stamp counter (TSC) timer if present on the system.
	`power_tb` selects the Power architecture timebase counter timer if present on the system.
`--enable-cpu-mhz=`*`speed`*	Use *`speed`* MHz as the counter frequency for the Pentium and x86-64 timestamp counters. By default, the counter frequency is queried from the operating system at runtime. This option is useful if the correct counter frequency cannot be determined.
`--with-obj-ext=`*`EXT`*	Specify *`EXT`* as the file extension to be used for object files. Object files will be named `file.`*`EXT`*. Default value is determined heuristically by configure.
`--with-lib-ext=`*`EXT`*	Specify *`EXT`* as the file extension to be used for library archive files. Library archive files will be named `file.`*`EXT`*. Default value is determined heuristically by configure.
`--with-exe-ext=`*`EXT`*	Specify *`EXT`* as the file extension to be used for executable files. Executable files will be named `file`*`EXT`*. Unlike `--with-obj-ext` and `--with-lib-ext`, no "." is implied. Default value is determined heuristically by configure.
`--enable-shared-acconfig`	Generate an acconfig.hpp that can be shared by different configurations by putting macros on the compiler command line. This is useful when building binary packages. Normally an acconfig.hpp file is generated that can only be used by one configuration.
`--enable-shared-libs`	Build shared libraries as well as static libraries. This requires that position-independent code be generated, which may reduce performance.

Example 3.1, “Configuring Sourcery VSIPL++” shows how to use the configure script to use particular optimization options for the C++ compiler on a system where MPI support is not required. The exact output will vary from system to system, but the output shown here is representative.

Example 3.1. Configuring Sourcery VSIPL++

```
> ./configure CXXFLAGS="-O2 -ffast-math" --disable-mpi
checking build system type... i686-pc-linux-gnu
checking host system type... i686-pc-linux-gnu
checking for g++... g++
checking for C++ compiler default output file name... a.out
checking whether the C++ compiler works... yes
checking whether we are cross compiling... no
checking for suffix of executables...
checking for suffix of object files... o
checking whether we are using the GNU C++ compiler... yes
checking whether g++ accepts -g... yes
checking for bugs in g++ and its runtime... no bugs found
checking for openjade... openjade
checking for pdfjadetex... pdfjadetex
checking for a BSD-compatible install... /usr/bin/install -c
configure: creating ./config.status
config.status: creating src/vsip/impl/acconfig.hpp
config.status: creating src/vsip/GNUmakefile.inc
config.status: creating tests/context
config.status: creating tests/QMTest/configuration
config.status: creating doc/GNUmakefile.inc
config.status: creating GNUmakefile
config.status: creating src/vsip/impl/acconfig.hpp
```

3.3.1. Configuration Notes for Mercury Systems

When configuring Sourcery VSIPL++ for a Mercury PowerPC system, the following environment variables and configuration flags are recommended:

- `CXX=ccmc++`

  This selects the `ccmc++` cross compiler as the C++ compiler.

- `CC=ccmc`

  This selects the `ccmc` cross compiler as the C compiler.

- `AR=armc`

  This selects the `armc` archiver.

- `AR_FLAGS=cr`

  This selects the `c` (create archive if it does not exist) and `r` (replace files in archive) flags for the `armc` archiver. `armc` does not support the `u` flag (only replace files if they are an update).

- `CXXFLAGS="--no_implicit_include -Onotailrecursion -t` *`architecture`* `--no_exceptions -Ospeed --max_inlining -DNDEBUG --diag_suppress 177,550"`

  These are the recommended flags for compiling Sourcery VSIPL++ with the GreenHills C++ compiler on the Mercury platform. These flags fall into two categories: those necessary for a correct build, and those optional for good performance. The following are necessary to correctly build the library:

- `--no_implicit_include`

  GreenHills enables implicit inclusion by default. This permits the compiler to assume that if it needs to instantiate a template entity defined in a .hpp file it can implicitly include the corresponding .cpp file to get the source code for the definition.

  Sourcery VSIPL++ does not use this capability. Leaving this feature enabled will result in multiple symbol definition errors at link-time.

  Note: it is only necessary to disable implicit includes when building the library. After the library has been installed, applications using it may enable implicit includes.

- `-Onotailrecursion`

  This disables optimization of tail-recursive functions. This optimization has a defect which is triggered by some of Sourcery VSIPL++'s algorithms.

The following flags will improve the performance of the library and applications. These should be used for production.

- `-t` *`architecture`*

  This flag directs the compiler to generate code optimized for processor variant and endian-ness specified by *`architecture`*. Valid choices are listed in the `ccmc++` documentation and include `ppc7400`, `ppc7400_le`, `ppc7445`, and `ppc7445_le`.

- `--no_exceptions`

  Disable exception handling, which can have a large performance overhead with the GreenHills compiler. This should be used in conjunction with the configure flag `--disable-exceptions`.

- `-Ospeed`

  This option instructs the compiler to enable all optimizations which improve speed.

- `--max_inlining`

  By default, GreenHills will only consider functions composed entirely of straightline code (no control flow) for inlining. `--max_inlining` instructs the compiler to consider all functions (whether containing control flow statements or not) for inlining, subject to the usual restraints in the case of excessively large or complicated functions.

- `-DNDEBUG`

  Disable assertions. This option should be used when configuring the library for performance.

- `--diag_suppress 177,550`

  This option suppresses compiler diagnostics warning about unused variables. When compiling with `-DNDEBUG` assertions are removed that may be the only reference to a variable.

When compiling a development or debug version of the library, replace `-Ospeed -DNDEBUG` with `-g`.

- `--host=powerpc`

  Cross compile for the PowerPC processor.

- `--with-sal`

  Enable the SAL library.

- `--enable-fft=sal,builtin`

  Use SAL and Sourcery VSIPL++ builtin FFTW3 to perform FFT operations. SAL FFT will be used for FFTs with power-of-two sizes, FFTW3 will be used otherwise.

- `--with-fftw3-cflags="-O2"`

  Compile Sourcery VSIPL++'s builtin FFTW3 library with optimization level `-O2`. (Compiling FFTW3 with optimization level `-O3` produces link-errors with GreenHills C related to the handling of static functions. CodeSourcery is currently developing a work-around for this.)

- `--with-complex=split`

  Store complex data in split format by default.

- `--disable-exceptions`

  Disable the use of exceptions from within the library.

- `--enable-parallel=mpipro`

  Enable the use of Verari MPI/Pro for communications.

- `--enable-timer=realtime`

  Use the POSIX-realtime timer for profiling.

The file `examples/mercury/mcoe-setup.sh` is an example of how to configure Sourcery VSIPL++ for the Mercury with these options.

3.3.2. Configuration Notes for Windows Systems

Before configuring Sourcery VSIPL++ for a Microsoft Windows systems, the follow prerequisites are recommended:

- The Cygwin environment for Windows, including the GNU make and sed packages. Sourcery VSIPL++ uses this as development environment for configuring and building the Sourcery VSIPL++ library. Cygwin is not necessary to build and run Sourcery VSIPL++ applications. For more information on the Cygwin environment, visit http://www.cygwin.com/

- Intel C++ for Windows, version 9.1 or later. This may require installation of a Microsoft C++ compiler and Microsoft SDK for windows. For more information on Intel C++ and its requirements: http://www.intel.com/cd/software/products/asmo-na/eng/compilers/279578.htm

- Intel IPP and MKL for Windows.

When configuring Sourcery VSIPL++ for a Microsoft Windows system, the following environment variables and configuration flags are recommended:

- `CXX=icl`

  This selects the Intel C/C++ compiler `icl` as the C++ compiler.

- `CC=icl`

  This selects the Intel C/C++ compiler `icl` at the C compiler.

- `CXXFLAGS="/Qcxx-features /Qvc8"`

  These are the recommended flags for compiling Sourcery VSIPL++ with the Intel C++ compiler on Microsoft Windows platforms. The following are necessary to correctly build the library:

  - `/Qcxx-features`

    This enables standard C++ features for exception handling and RTTI.

  - `/Qvc8`

    This enables Microsoft Visual Studio 2005 compatibility. If using another version of Visual Studio, please consult the Intel C++ documentation for the correct option.

- `--build=i686-cygwin`

  Configure to build library in the cygwin environment.

- `--host=i686-mingw32`

  Target the resulting library to run on Microsoft Windows systems with the Win32 API.

- `--with-ipp=win`

  Enable the IPP library for Windows. This requires that the IPP header, library, and DLL directories be present in your `INCLUDE`, `LIB`, and `PATH` directories, respectively. Manually passing these paths to `configure` in Windows is not recommended.

- `--enable-fft=ipp`

  Use the IPP FFT functions to perform FFT operations.

- `--with-lapack=mkl_win`

  Use the MKL library for Windows to implement linear-algebra operations. This requires that the MKL header and library directories be present in your `INCLUDE` and `LIB`, directories, respectively. Manually passing these paths to `configure` in Windows is not recommended.

- `--disable-parallel`

  Disable parallel service. Sourcery VSIPL++ does not support MPI on Windows at this time.

3.3.3. Configuration Notes for Cell/B.E. Systems

When configuring Sourcery VSIPL++ for a Cell/B.E. host system, the following environment variables and configuration flags are recommended:

- `--with-cbe-sdk`

Enable use of the Cell/B.E. SDK and the Cell Math Library (CML). This is necessary to use the Cell/B.E.'s SPE processors to accelerate VSIPL++ functionality. If the SDK is not installed in the standard location, the `--with-cbe-sdk-prefix` should be used to specify the location.

- `--with-cml-prefix=PATH`

  Specify the installation path of CML. Headers are installed in a subdirectory named include; libraries in one named lib.

  To install headers and libraries in other places, use instead the options `--with-cml-include` and `--with-cml-libdir`.

- `--with-cml-include=PATH`

  Specify the directory containing CML header files. Use this option in conjunction with `--with-cml-libdir`. Do not use with `--with-cml-prefix`.

- `--with-cml-libdir=PATH`

  Specify the directory containing CML libraries. Use this option in conjunction with `--with-cml-include`. Do not use with `--with-cml-prefix`.

- `--with-numa`

  Enable use of libnuma for SPE/PPE affinity control. This may improve program performance by allocating SPEs close to the PPEs running VSIPL++.

- `--enable-timer=power_tb`

  Enable the Power Timebase high-resolution timer. This option is useful when using profiling or running library benchmarks.

Two additional options must be specified when using a non-Cell/B.E. build system to cross-compile Sourcery VSIPL++ for a Cell/B.E. host system.

- `--host=powerpc-cell-linux-gnu`

  Define the host system type.

- `--with-cbe-sdk-sysroot=`*`directory`*

  Specify the Cell/B.E. sysroot location. Typically, this will be `/opt/cell/sysroot` on a standard SDK 3.0 cross-compiler installation.

3.3.4. Configuration Notes for the Reference Implementation

If you wish to use the BSD-licensed reference-implementation subset of Sourcery VSIPL++, you must configure with the following option:

- `--enable-only-ref-impl`

  Build only the reference-implementation subset of Sourcery VSIPL++. If you do not use this option, the complete, optimized implementation of Sourcery VSIPL++ will be built.

3.4. Compilation and Installation

After you have configured Sourcery VSIPL++, build the library by running the following command:

```
> make
```

The command shown above assumes that GNU make is in your `PATH` and has been installed as `make`. On some systems, GNU make may be installed as `gmake`; if so, you will have to adjust the command shown above appropriately. After building the library, use the following command to install Sourcery VSIPL++:

```
> make install
```

Chapter 4 Building Applications

Abstract

Sourcery VSIPL++ comes with example programs, installed in the `share/sourceryvsipl++` subdirectory. This chapter explains how to compile, link, and run these programs. You can modify these programs to develop your own Sourcery VSIPL++ applications.

This chapter assumes that you have installed Sourcery VSIPL++ in `/opt/codesourcery/sourceryvsipl++-2.3`. If you have used a different path, you will have to adjust the filenames below accordingly. It is also assumed that the current directory is writable by you. For example, you can use your home directory or `/tmp` as the current directory. Finally, the examples in this chapter assume that you are using the GNU C++ compiler. If you are using another C++ compiler, you may have to make minor changes to the commands shown.

4.1. Using a Sourcery VSIPL++ Example Workspace

Sourcery VSIPL++ provides a set of examples that may be used as a starting point for user projects. To use them, you may want to set up a *workspace*, preconfigured to be used with a particular build variant:

```
> vsip-create-workspace --variant=VARIANT DESTINATION
```

where `VARIANT` is one of the available build variants (see Appendix A, “Build Variants” for a complete listing), and `DESTINATION` is the workspace directory you want to create.

(The vsip-create-workspace script is part of the Sourcery VSIPL++ installation, and can be found in `/opt/sourceryvsipl++-2.3-22/bin`.

This newly created workspace will contain a number of directories with some example applets. Within each directory, you may compile the examples by simply invoking

```
> make
```

or, if you want to override the variant value,

```
> make variant=VARIANT
```

This build system uses the pkg-config command to extract the information needed to correctly compile an application with the Sourcery VSIPL++ library.

Please refer to Appendix A, “Examples” for a detailed listing of available examples.

4.2. Building Manually

The file `/opt/codesourcery/sourceryvsipl++-2.3/share/sourceryvsipl++/example1.cpp` contains a very simple VSIPL++ program. You can use this file as a template for developing much more complex programs.

When building Sourcery VSIPL++ applications, you must ensure that your compiler can find the necessary header and library files. Since Sourcery VSIPL++ may depend on other libraries, the easiest way to determine the necessary compiler directives is with the `pkg-config` command.

Before `pkg-config` can find information about Sourcery VSIPL++, it is necessary to make sure that Sourcery VSIPL++'s `lib/pkgconfig` subdirectory is in `pkg-config`'s search path. You can check the search path by examining the `PKG_CONFIG_PATH` environment variable. To set the path:

```
> export \
PKG_CONFIG_PATH=/opt/codesourcery/sourceryvsipl++-2.3/lib/pkgconfig
```

First, determine what compiler is recommended:

```
> CXX=`pkg-config vsipl++ --variable=cxx`
```

Second, to compile the program, use the following command:

```
> $CXX -c `pkg-config vsipl++ --cflags` \
                        `pkg-config vsipl++ --variable=cxxflags` \
      \
/opt/codesourcery/sourceryvsipl++-2.3/share/sourceryvsipl++/example1.cpp
```

Finally, to link the program, use the following command:

```
> $CXX -o example1 example1.o `pkg-config --libs vsipl++`
```

Now that you have built the example program, you can run it like any other program, with:

```
> ./example1
```

4.2.1. Using `pkg-config`

When building applications, it is important to use the same C++ compiler that was used to build the Sourcery VSIPL++ library. Different C++ compilers, even different versions of the same compiler, may have incompatible linking conventions or different standard library implementations. However, it is possible to determine the compiler used to build Sourcery VSIPL++ via pkg-config:

```
> pkg-config --variable=cxx vsipl++
```

Using this, the previous commands to compile and link the example program become:

```
> `pkg-config --variable=cxx vsipl++` \
          -c `pkg-config --cflags vsipl++`
   \
/opt/codesourcery/sourceryvsipl++-2.3/share/sourceryvsipl++/example1.cpp
> `pkg-config --variable=cxx vsipl++` \
          -o example1 example1.o `pkg-config --libs vsipl++`
```

If pkg-config is not available on your system, you can specify the search paths manually. With most compilers, the `-I` switch can be used to specify directories containing header files. Use the following command to compile the program:

```
> g++ -c -I /opt/vsip/include \
      \
/opt/codesourcery/sourceryvsipl++-2.3/share/sourceryvsipl++/example1.cpp
```

To link the program manually, you must tell the compiler where to find the libraries when linking. For most compilers, the `-L` switch is used to specify directories to search for libraries, while the `-l` switch is used to specify the names of libraries to use. Use the following command to link the program:

```
> g++ -o example1 -L /opt/codesourcery/sourceryvsipl++-2.3/lib \
example1.o -l vsip
```

If Sourcery VSIPL++ was configured to use other libraries, such as MPI, it will be necessary to manually specify `-L` and `-l` options accordingly. These necessary options can be determined by looking in the `/opt/codesourcery/sourceryvsipl++-2.3/lib/pkgconfig/`

`vsipl++.pc` file. It contains a line prefixed with "Libs:" which indicates the libraries necessary to link a Sourcery VSIPL++ program.

4.3. Building with Microsoft Visual Studio

An example solution is provided in the `vcproj` sub-directory of the directory containing the example source files (`/opt/vsip/share/sourceryvsipl++`). It uses the Intel C++ compiler.

The Windows binary package uses Intel's IPP and MKL libraries, so you need to make sure their headers and libraries can be found by Microsoft Visual Studio, either by adding the appropriate search paths to the project files, or by adding them as global options to your Microsoft Visual Studio configuration (`Tools` → `Options` → `Projects and Solutions` → `VC++ Directories`).

4.4. Running Serial Applications

Serial VSIPL++ applications are run like other serial programs on your system. No special command-line arguments are required.

On Cell/B.E. it is necessary to set the ALF_LIBRARY_PATH environment variable before running Sourcery VSIPL++ aplications. This variable should contain the name of the library directory containing the files 'cml_kernels.so' and 'svpp_kernels.so.' This can be queried from pkg-config:

```
> export ALF_LIBRARY_PATH=`pkg-config vsipl++ \
--variable=libdir`:`pkg-config vsipl++ --variable=builtin_libdir`
```

On most GNU/Linux systems, serial applications are run by typing their name at the command prompt:

```
> ./example1
```

On most Mercury MCOE systems, serial applications are run using the `sysmc` and `runmc` commands:

```
> sysmc -ce CE -bcs=0 init
> runmc -ce CE ./example1.ppc
> sysmc -ce CE reset
```

For more details, refer to your system documentation.

4.5. Running Parallel Applications

How parallel VSIPL++ applications are run depends on the particular communication library used.

For most MPI libraries, parallel applications are run with the `mpirun` command. For example, to run a VSIPL++ application on two processors:

```
> mpirun -np 2 ./example1
```

This may require that your MPI library has been first initialized on the system by starting a daemon process. Please consult your MPI library documentation for more details.

For PAS, it is necessary to pass extra command line options to VSIPL++. `-pas_size` *`nproc`*`>` indicates the total number of processors in the PAS set. `-pas_rank` *`rank`* indicates the rank of the particular process in the set.

For example, to run a parallel VSIPL++ application with MCOE PAS with four CEs, 2, 3, 4 and 5:

```
> sysmc -ce 2 -bcs=0 init 3-5
> runmc -ce 3 ./example1.ppc -pas_size 4 -pas_rank 1 &
> runmc -ce 4 ./example1.ppc -pas_size 4 -pas_rank 2 &
> runmc -ce 5 ./example1.ppc -pas_size 4 -pas_rank 3 &
> runmc -ce 2 ./example1.ppc -pas_size 4 -pas_rank 0
> sysmc -ce 2 reset
```

For example, to run a parallel VSIPL++ application with PAS for Linux Clusters on compute nodes c1, c2, c3, c4:

```
> rsh -n c1 example1 -pas_size 4 -pas_rank 0 &
> rsh -n c2 example1 -pas_size 4 -pas_rank 1 &
> rsh -n c3 example1 -pas_size 4 -pas_rank 2 &
> rsh -n c4 example1 -pas_size 4 -pas_rank 3 &
> wait
```

Please consult your PAS library documentation for more details on starting PAS and running PAS programs.

4.6. Building Applications with the VSIPL API

Building applications with Sourcery VSIPL works very much as described in Section 4.2, “Building Manually”. Start by setting the `PKG_CONFIG_PATH` variable, then use pkg-config to determine the relevant build parameters. The notable difference is that the `packagename` here is *vsipl*, not *vsipl++*:

```

> export \
PKG_CONFIG_PATH=/opt/codesourcery/sourceryvsipl++-2.3/lib/pkgconfig
> `pkg-config --variable=cc vsipl` -c `pkg-config --cflags vsipl` \
      \
/opt/codesourcery/sourceryvsipl++-2.3/share/sourceryvsipl++/cvsip/fft.cpp
> `pkg-config --variable=cxx vsipl` -o fft fft.o `pkg-config --libs \
vsipl`
    \
```

Please note that, while the compilation itself can be carried out with a C compiler, the link step has to be done with a C++ compiler to make sure all the C++ system libraries are properly linked in.

And, similar to Section 4.1, “Using a Sourcery VSIPL++ Example Workspace”, a Makefile is provided with a demo application, which you may use as a starting point for writing VSIPL application:

```
> cd \
/opt/codesourcery/sourceryvsipl++-2.3/share/sourceryvsipl++/cvsip
> make
g++ -I/opt/codesourcery/sourceryvsipl++-2.3/include -o fft fft.c \
-L/opt/codesourcery/sourceryvsipl++-2.3/lib
  -lsvsip -lsvpp
```

Appendix A
Build Variants

Most Sourcery VSIPL++ packages contain multiple variants of the compiled binary portions of the library. These divide up along the following axes:

Target Platform
: Sourcery VSIPL++ supports a number of target platforms and platform variants, with separate libraries for each variant. For example, on many platforms there are 32-bit and 64-bit variants; there may also be multiple variants that use different back-end libraries.

Serial/Parallel
: In packages which support MPI-based parallelism across multiple processors or machines, there are "Parallel" versions of the library in which this parallelism is enabled, and "Serial" versions in which it is not.

Debug/Release
: "Debug" versions of the library are compiled without optimization and with all error-checking enabled in order to facilitate development and debugging of applications. "Release" versions are compiled with optimization enabled and with limited error-checking in order to obtain best performance.

The following table lists the library variants that have been installed as part of this Sourcery VSIPL++ package. The variant name can be used as the `VARIANT` option parameter to the `vsip-create-workspace` command (see Section 4.1, "Using a Sourcery VSIPL++ Example Workspace"), or to identify the appropriate `.pc` file to use with `pkg-config` (see Section 4.2, "Building Manually").

Table A.1. Installed Sourcery VSIPL++ Variants

Variant name	Configuration
`ia32-ser-intel`	Intel x86 (SSE2) with Intel IPP/MKL, Serial, Release
`ia32-ser-intel-debug`	Intel x86 (SSE2) with Intel IPP/MKL, Serial, Debug
`ia32-ser-builtin`	Intel x86 (SSE2), Serial, Release
`ia32-ser-builtin-debug`	Intel x86 (SSE2), Serial, Debug
`em64t-ser-intel`	Intel x86-64 with Intel IPP/MKL, Serial, Release
`em64t-par-intel`	Intel x86-64 with Intel IPP/MKL, Parallel (LAM MPI), Release
`em64t-ser-intel-debug`	Intel x86-64 with Intel IPP/MKL, Serial, Debug
`em64t-par-intel-debug`	Intel x86-64 with Intel IPP/MKL, Parallel (LAM MPI), Debug
`em64t-ser-builtin`	Intel x86-64, Serial, Release
`em64t-par-builtin`	Intel x86-64, Parallel (LAM MPI), Release
`em64t-ser-builtin-debug`	Intel x86-64, Serial, Debug
`em64t-par-builtin-debug`	Intel x86-64, Parallel (LAM MPI), Debug

Appendix B
Sourcery VSIPL++ Software License Agreement

December 2008

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Version 2, June 1991

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