

# MKL

## Category: Math & Scientific Libraries

The Intel Math Kernel Library (MKL) is composed of highly optimized mathematical functions for engineering and scientific applications requiring high performance on Intel platforms. The functional areas of the library include linear algebra consisting of LAPACK and BLAS, fast Fourier transform (FFT), and vector transcendental functions.

MKL release 10.x is part of the Intel compiler 11.0 and 11.1 releases. Once you load in a 11.x compiler module, the path to the MKL library is automatically included in your default path. If you choose to use Intel compiler 10.x or earlier versions, you have to load an MKL module separately.

## A Layered Model for MKL

Starting with MKL release 10.0, Intel employs a layered model for the MKL library. The layers are the interface layer, the threading layer, and the computational layer.

### Interface Layer

LP64 interface (uses 32-bit integer type) or ILP64 interface (uses 64-bit integer type).

SP2DP interface supports Cray-style naming in applications targeted for the Intel 64 or IA-64 architecture and using the ILP64 interface. SP2DP interface provides a mapping between single-precision names (for both real and complex types) in the application and double-precision names in Intel MKL BLAS and LAPACK.

### Threading Layer

#### Sequential

The sequential (non-threaded) mode requires no Compatibility OpenMP\* or Legacy OpenMP\* run-time library, and does not respond to the environment variable OMP\_NUM\_THREADS or its Intel MKL equivalents. In this mode, Intel MKL runs unthreaded code. However, it is thread-safe, which means that you can use it in a parallel region from your own OpenMP code. You should use the library in the sequential mode only if you have a particular reason not to use Intel MKL threading. The sequential mode may be helpful when using Intel MKL with programs threaded with some non-Intel compilers or in other situations where you may, for various reasons, need a non-threaded

version of the library (for instance, in some MPI cases).

Note that the "sequential" library depends on the POSIX threads library (`pthread`), which is used to make the Intel MKL software thread-safe and should be listed on the link line.

## Threaded

The "threaded" library in MKL version 10.x supports the implementation of OpenMP that many compilers (Intel, PGI, GNU) provide.

## Computational Layer

For any given processor architecture (IA-32, IA-64, or Intel 64) and OS, this layer has only one computational library to link with, regardless of the Interface and Threading layer.

## Compiler Support Run-time Libraries

`libiomp`  
IntelCompatibility OpenMP run-time library  
`libguide`  
Intel Legacy OpenMP run-time library

For example, to do a dynamic linking of `myprog.f` and parallel Intel MKL supporting LP64 interface, use:

```
ifort myprog.f -Wl,--start-group -lmkl_intel_lp64 \  
-lmkl_intel_thread -lmkl_core -Wl,--end-group -openmp
```

If you are unsure of what MKL libraries to link with, use the suggestion provided in this [Intel web site](#) by providing the proper OS (for example, Linux), processor architecture (such as, Intel 64), compiler (Intel or Intel Compatible), dynamic or static linking, integer length, sequential or multi-threaded, OpenMP library, cluster library (for example, BLACS, ScaLAPACK), MPI library (Intel MPI, MPICH2, SGIMPT, etc.).

## The -mkl Switch of Intel Compiler Version 11.1 and Above

Starting from Intel compiler version 11.1, an `-mkl` switch is provided to link to certain parts of the MKL library.

```
-mkl[=  
    link to the Intel(R) Math Kernel Library (Intel(R) MKL) and  
    bring in the associated headers  
    parallel - link using the threaded Intel(R) MKL libraries.
```

```

        This is the default when -mkl is specified
sequential - link using the non-threaded Intel(R) MKL libraries
cluster    - link using the Intel(R) MKL Cluster libraries plus
            the sequential Intel(R) MKL libraries

```

The libraries that are linked in for:

```

* -mkl=parallel

    --start-group \
    -lmkl_solver_lp64 \
    -lmkl_intel_lp64 \
    -lmkl_intel_thread \
    -lmkl_core \
    -liomp5 \
    --end-group \

* -mkl=sequential

    --start-group \
    -lmkl_solver_lp64_sequential \
    -lmkl_intel_lp64 \
    -lmkl_sequential \
    -lmkl_core \
    --end-group \

* -mkl=cluster

    --start-group \
    -lmkl_solver_lp64 \
    -lmkl_intel_lp64 \
    -lmkl_cdft_core \
    -lmkl_scalapack_lp64 \
    -lmkl_blacs_lp64 \
    -lmkl_sequential \
    -lmkl_core \
    -liomp5 \
    --end-group \

```

Note that the use of **--start-group** and **--end-group** allows cycling through these 4 libraries until all their inter-references (if any) have been resolved.

## Where to find more information about MKL

Man pages and two PDF files from Intel are available for each version of MKL.

## Man Pages of Intel MKL

A collection of man pages of Intel MKL functions are available under the **man3** subdirectory (for example, **/nasa/intel/Compiler/11.1/072/man/en\_US/man3**) of the MKL

installation. You will have to load an MKL module or an Intel compiler 11.x module before you can see the man pages. For example:

```
% module load comp-intel/11.1.072
% man gemm
```

provides information about [*s, d, c, z, sc, dz*] `gemm` routines.

Unfortunately, there is not a "man mkl" page.

## Intel MKL Reference Manual (mklman.pdf)

Contains detailed descriptions of the functions and interfaces for all library domains:

- BLAS
- LAPACK
- ScaLAPACK
- Sparse Solver
- Interval Linear Solvers
- Vector Math Library (VML)
- Vector Statistical Library (VSL)
- Conventional DFTs and Cluster DFTs
- Partial Differential Equations support
- Optimization Solvers

## Intel MKL User's Guide (userguide.pdf)

Provides Intel MKL usage information in greater detail:

- Getting started information
- Application compiling and linking depending on a particular platform and function domain
- Building custom DLLs
- Configuring the development environment
- Coding mixed-language calls
- Threading
- Memory management
- Ways to obtain best performance

The two PDF files can be found in the `doc` or `Documentation` directory of the MKL installation. For example, on Pleiades:

- MKL version 10.0.011

/nasa/intel/mkl/10.0.011/doc

- The version included in the Intel compiler module 11.1.072

/nasa/intel/Compiler/11.1/072/Documentation/en\_US/mkl

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<http://www.nas.nasa.gov/hecc/support/kb/entry/90/?ajax=1>