

C/C++ V3.2A

POSIX Commands of the C/C++ Compiler

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1 Preface

1.1 Brief product description

The BS2000 C/C++ Compiler V3.2A can be called from and controlled with options from the BS2000 (SDF) or POSIX (POSIX shell) environment.

This manual describes controlling the compiler from the POSIX environment, where the following POSIX commands are available:

<code>cc, c89</code>	Calls the compiler as a C compiler
<code>CC</code>	Calls the compiler as a C++ compiler
<code>cclistgen</code>	Calls the global listing generator

The options and operands of the above calling commands cover most of the services and functions available for controlling the compiler via the SDF interface (see the "C/C++ User Guide" [4]). The syntax of the POSIX commands is based on the definition in the XPG4 Standard or on the normal UNIX shell commands.

The `cc`, `c89` and `CC` calling commands also include linking the compiled objects together to form an executable program.

The software products CRTE V2.6A and POSIX-HEADER V1.6A are required for creating and running C and C++ programs in the POSIX environment. CRTE also contains the standard header files and modules of the C and C++ library functions. The headers of CRTE and also the POSIX headers are required for using the POSIX library functions.

1.2 Summary of contents

This manual describes how C and C++ programs are compiled, linked and executed with the C/C++ compiler and additional development tools in the POSIX environment.

Chapter 2 summarizes the C/C++ program development in the POSIX environment.

The compiler is called with the `cc`, `c89` and `CC` commands, which are described in detail with their options and the effects of these in chapter 3.

Chapter 4 describes the `cc1istgen` command, which is used to call and control the global listing generator.

All compiler options are listed alphabetically in chapter 5 (appendix) together with page references.

In order to work effectively with this manual, you will need to be familiar with the C and C++ programming languages and the POSIX shell.

This manual is primarily intended for use as a reference manual for the POSIX commands of the C/C++ compiler.

Detailed information on the services and functions of the C/C++ compiler beyond the POSIX control can be found in the following manual:

“C/C++ BS2000/OSD, C/C++ Compiler”, User Guide

In addition to SDF control of the C/C++ compiler, the above manual contains further information on topics not dealt with in this manual. These topics include:

- process and effects of optimization
- structure of the compiler listings and messages
- compiler C language support (a summary of the C language modes, implementation-dependent behavior, `#pragma` directives, extensions to the ANSI/ISO C standard)
- compiler C++ language support (a summary of the C++ language modes, implementation-dependent behavior, extensions to the ANSI C++ standard)
- links between functions and language
- brief description of the C++ libraries supplied with CRTE

1.3 Changes since the previous manual

The changes in this User Guide compared to C/C++ V3.1A are due to the following major innovations:

- Runtime options

- K environment_encoding_std
 - K environment_encoding_ebcdic

These options enable the encoding of external strings, such as arguments of *main* and environment variables, to be controlled.

- Link editor options

- z dup_ignore
 - z dup_warning
 - z dup_error

These options enable the behavior of duplicated entry names to be controlled during linking.

- RISC code generation is no longer supported in C/C++V3.2 and higher. All the information on it has therefore been removed.

1.4 Notational conventions

The following notational conventions are used to depict commands, options and program directives described in this User Guide:

*STD	Uppercase letters, digits and special characters which do not belong to the metalanguage characters designate keyword or constants which must be entered exactly as shown.
-R msg_id	Uppercase and lowercase letters, digits and special characters in typewritten text are constants and must be entered exactly as shown, except for the -K option arguments, which are shown in the manual in lowercase letters, but may be entered in both uppercase and lowercase (see page 42).
<i>name</i>	Lowercase letters in <i>italics</i> denote variables, which must be replaced by current values at the time of input.
{cc c89}	Braces enclose alternatives from which one must be selected. The separator character must not be specified.
[]	Square brackets enclose options that may be omitted.
()	Parentheses are constants and must be specified.
_	This symbol indicates that at least one white space character is necessary for the syntax.
...	Ellipses signify repetition, i.e. the preceding unit can be repeated several times in succession.

2 Basics

2.1 Delivery structure and software environment

The files required for controlling the BS2000 C/C++ compiler from the POSIX shell are stored as follows in the POSIX file system:

<code>/opt/C/bin/c89</code>	Links to the compiler and listing generator installed in BS2000
<code> cclistgen</code>	(PLAM library)
<code> cc</code>	Links to <code>opt/C/bin/c89</code>
<code> CC</code>	
<code>/usr/bin/cc</code>	Link to <code>/opt/C/bin/cc</code>
<code> c89</code>	Link to <code>/opt/C/bin/c89</code>
<code> CC</code>	Link to <code>/opt/C/bin/CC</code>
<code>/usr/bin/cclistgen</code>	Link to <code>/opt/C/bin/cclistgen</code>

Installation of the above POSIX files is described in the Release Notice for C/C++ (BS2000/OSD) V3.2A.

C/C++ uses the C and C++ library function header (or include) files and modules supplied with CRTE and the header files supplied with POSIX-HEADER for all POSIX library functions. The libraries for programs `lex` and `yacc` are part of the software product POSIX-SH.

The C and C++ library function modules are installed in BS2000 as PLAM libraries and not in the POSIX file system. When linking with the `cc/c89/CC` commands, the link options are issued to the relevant PLAM libraries as `RESOLVE` directives (of the LINK EDITOR). See also the link option `-l x` ([page 86](#)).

The header files for the C and C++ library functions are stored as POSIX files in the standard `/usr/include`, `/usr/include/sys` and `/usr/include/CC` directories. Installation of these header files is described in the CRTE Release Notice or in the manual "POSIX Basics" [1].

2.2 From source code to program execution

This section provides you with an overview of the following program creation stages in the POSIX subsystem:

- Providing the source code and header files
- Compiling
- Linking
- Testing
- Using the POSIX library functions

2.2.1 Providing the source code and header files

The source code and header files may be provided in EBCDIC or ASCII code. The default is EBCDIC in the POSIX file system and ASCII in the file systems of remote UNIX hosts. All files in a file system (POSIX file system or merged in, remote file system) must be available in the same codeset. The compiler does not query the codeset of individual files, it only queries the codeset of a file system. The files of ASCII file systems are converted automatically to EBCDIC, as long as the POSIX variable `IO_CONVERSION` is set to YES.

The the source code file names must contain one of the following standard suffixes:

<code>c, C</code>	C source code (<code>cc, c89</code>) or C++ source code (<code>CC</code>) before the preprocessor run
<code>cpp, CPP, cxx, CXX, cc, CC, c++, C++</code>	C++ source code before the preprocessor run (<code>CC</code>)
<code>i</code>	C source code (<code>cc, c89</code>) after the preprocessor run
<code>I</code>	C++ source code after the preprocessor run (<code>CC</code>)

In addition to the above suffixes, the `-Y F` option (see [page 47](#)) can be used to define additional input file suffixes which are then also accepted by the compiler.

Source code and include members stored in BS2000 files or PLAM libraries cannot be processed with the compiler in the POSIX file system.

The POSIX `bs2cp` command is provided for transferring BS2000 files and PLAM library members into the POSIX file system and vice versa. The POSIX `edt` command is provided for editing POSIX files in the POSIX shell. If the POSIX shell is accessed via `rlogin`, the `vi` editor may also be used. See the manual “POSIX Commands” [2].

The standard header files for the C and C++ library functions available with CRTE are in the standard `/usr/include`, `/usr/include/sys` and `/usr/include/CC` directories. These directories are searched automatically by the compiler (or preprocessor).

2.2.2 Compiling

C sources are compiled with the `cc` and `c89` commands and C++ sources with the `CC` command.

These commands are described in detail in chapter 3.

C and C++ language modes

The C and C++ sources can be compiled in various language modes via the following options:

C language modes (`cc/c89` commands):

- extended ANSI C (`-X a`), default
- strict ANSI C (`-X c`)
- Kernighan&Ritchie C (`-X t`)

C++ language modes (`CC` command):

- extended ANSI C++ (`-X w`), default
- strict ANSI C++ (`-X e`)
- Cfront V3.0.3 compatible C++ (`-X d`)

See [page 52ff](#) for the language mode options.

Creating an object file (“`.o`” file)

If the compilation run is not terminated after the preprocessor phase (see the `-E` and `-P` options on [page 49](#)), the compiler creates an LLM for each compiled source file and stores it by default in a POSIX object file named `basename.o` in the current directory. `basename` is the name of the source file without the directory part or the standard suffixes (`.c`, `.C` etc.).

A different directory and/or file name may be defined for the object file with the `-o` option (see [page 46](#)).

By default, a link run is started after compilation. If only one source file is compiled and linked in one step, the object file is stored temporarily and then deleted. If at least two source files or one source and one object file (`.o` file) are specified, the object files are not deleted.

Linking can be prevented by specifying the `-c` option (see [page 49](#)).

Creating an expanded, recompilable source program (“.i” file)

If the `-P` option is specified, only the preprocessor run is executed and one expanded, recompilable source program is generated for each compiled source file. The result is written by default into a POSIX source file named *basename.i* (cc, c89) or *basename.I* (CC) in the current directory.

The `-o` option can be used to specify a different destination directory and/or file name for the expanded source program (see [page 46](#)).

Creating compilation listings

The `-N listing` option can be used to request various compiler listings (e.g. source/error listing, cross-reference listing, etc.). The compiler either writes the requested listings separately for each compiled source file into a list file named *basename.lst* or collectively for all compiled source files into a list file *file* specified with the `-N output` option (see [page 92](#)).

You can also create CIFs (Compilation Information Files) for the output of compilation listings, which are subsequently processed with the global listing generator `cclistgen`. See the `-N cif` option ([page 92](#)) and [chapter “Global listing generator \(cclistgen\)” on page 99](#).

List files can be printed out with the POSIX `bs21p` command (see the manual “POSIX Commands” [32]).

Output destinations and codeset

The compiler saves the output files by default in the current directory, i.e. in the directory from which the compiler run was started.

The `-o` option (see [page 46](#)) can be used to specify a different directory and/or file name as the output destination. This can be a directory in the local POSIX file system or in a merged in file system on a remote host. However, it must be noted that it is only meaningful to further process text files on SINIX/UNIX hosts or PCs, i.e. only expanded source programs (“.i” files) and list files (“.lst” files).

The codeset of the destination file system determines the output codeset used for the files (ASCII or EBCDIC).

How characters and strings are stored is controlled by the `-K literal_encoding_...` option (see [page 58](#)).

2.2.3 Linking

A C or C++ program can only be linked in the POSIX shell to form an executable program with the `cc`, `c89` and `CC` calling commands. A “standalone” link editor, normally found in UNIX systems, does not exist. From the technical viewpoint, linking in the POSIX shell calls the BS2000 link editor and supplies it with the appropriate directives (`INCLUDE-MODULES`, `RESOLVE-BY-AUTOLINK` etc.).

A link run is started if none of the `-c`, `-E`, `-M`, `-P` or `-y` options are specified (see [page 49](#)), as long as no errors occurred during a prior compilation. By default, the linked program is written as an LLM into an executable POSIX file with the standard name `a.out`, in the current directory. The `-o` option can be used to specify a different directory and/or file name (see [page 46](#)).

No link listings can be generated when linking in the POSIX shell. If errors occur, appropriate error messages are output to `stderr`.

The `-N binder` option can be used to generate the standard listings of BINDER (see [page 92](#)).

Linking user modules

User modules can only be linked in statically and not dynamically (i.e. at runtime). Programs containing “unresolved externals” to user modules cannot be loaded in the POSIX shell.

The following can be input sources to the link editor:

- Object files generated by the compiler (“`.o`” files)
- Libraries created with the `ar` utility (“`.a`” files)
- LLMs that were copied from PLAM libraries into POSIX object files with the POSIX `bs2cp` command (see “Introductory examples” on [page 37](#)). These may be LLMs that were generated directly by a compiler in the BS2000 environment (SDF) or object modules which were written into an LLM with the link editor.
- LLMs and object modules in BS2000 PLAM libraries. The PLAM libraries must be assigned with the `BLSLIB m` environment variable (see the `-l BLSLIB` option on [page 87](#)).

The modules from the PLAM libraries may be modules generated by any BS2000 compiler with ILCS capabilities (e.g. C/C++, COBOL85, COBOL2000, ASSEMBH).

You must observe language-specific requirements with the above (parameter passing, required runtime systems, etc.).

Internal `INCLUDE-MODULES` directives are issued during linking with POSIX object files and `RESOLVE-BY-AUTOLINK` directives are issued for `ar` libraries and PLAM libraries.

Linking the CRTE runtime libraries

The link editor resolves the unresolved external references to the C and C++ runtime systems via autolink (RESOLVE-BY-AUTOLINK) from the CRTE PLAM libraries.

C runtime system

When code is generated, the C runtime system modules can be linked or loaded with the `cc`, `c89` and `CC` commands as follows:

1. Loading the C runtime system dynamically (partial bind). There are two variants of the partial bind linkage method:

- Standard partial bind (`-d y`)

Linking is carried out by default from the SYSLNK.CRTE.PARTIAL-BIND library if no special linker options are specified. This library contains link modules that resolve all unresolved external references to the C and COBOL runtime systems. Only the connection modules required are linked. If a module loaded by the application to be linked requires entries of the runtime system, this can result in unresolved external references because the link modules to the runtime system's entries need not necessarily already be linked. In this case the complete partial bind method should be used for linking (see also CRTE-BHB).

The C and COBOL runtime systems themselves are loaded dynamically at runtime, either from class 4 memory, if it has been preloaded, or from the SYSLNK.CRTE library.

The linked program requires considerably less disk storage space than if the C runtime system is linked statically from the SYSLNK.CRTE library (see 2.). The load time is also faster. The appropriate CRTE must be available when the program is called.

- Complete partial bind (`-d compl`)

In this case, linking is done from the SYSLNK.CRTE.COMPL library. Basically, the procedure for the complete partial bind is the same as that for the standard partial bind method. With complete partial bind, the link modules provided in SYSLNK.CRTE.COMPL contain all the entries and the external data of the complete C and COBOL runtime systems. This means that the unresolved external references which may occur when modules of an application which was linked in a standard partial bind are loaded cannot occur in complete partial bind.

When you use shared libraries in POSIX, successful linking is only guaranteed with a complete partial bind.

For more information on the partial bind linking method, see the manual "CRTE" [5].

2. Linking the complete C runtime system statically (`-d n`)

If the `-d n` link option is specified (see [page 84](#)), all required C runtime system modules are linked in from the SYSLNK.CRTE library.

3. Leaving the external references to the C runtime system unresolved (`-z nodefs`)

If the `-z nodefs` link option is specified (see [page 89](#)), the program is linked without a RESOLVE to the C runtime library. The unresolved external references are then resolved at runtime from the C runtime system preloaded in class 4 memory.

`-z nodefs` is not supported when linking C++ programs (`CC` command).

Cfront C++ library

The modules of the Cfront C++ library (SYSLNK.CRTE.CPP) and of the Cfront C++ runtime system (SYSLNK.CRTE.CFCPP) can only be linked in statically. If the Cfront C++ mode (`-X d` option) is specified in the `CC` command, these libraries are linked in automatically in addition to the C runtime system.

See also the `-l` link option on [page 86](#).

Standard C++ library

The modules of the standard C++ library (SYSLNK.CRTE.STDCPP) and of the ANSI C++ runtime stem ((SYSLNK.CRTE.RTSCPP) can only be linked in statically. These libraries are linked in automatically in addition to the C runtime system if the extended or strict ANSI C++ mode is specified in the `CC` command (`-X w` or `-X e` option or no option `-X . .`).

See also the `-l` link option on [page 86](#).

C++ Tools.h++ library

The modules of the Tools.h++ library (SYSLNK.CRTE.TOOLS) can only be linked in statically. The library is available in the ANSI C++ modes (`-X w` or `-X e` option) and is only linked in if the `-l RWtools` link option is also specified.

See also the `-l` link option on [page 86](#).

POSIX link switch

The `posix.o` link switch available with CRTE (corresponds to the CRTE SYSLNK.CRTE.POSIX library in the BS2000 environment) is linked in automatically. The time, signal handling and `clock` functions, which are duplicated in the C runtime system, are therefore generally executed with POSIX functions. Mixed processing of POSIX and BS2000 is generally possible. Please refer to the manual “C Library Functions for POSIX Applications” [3] for further details.

2.2.4 Debugging

Linked programs can be debugged with the dialog debugger AID, provided the required debugging information (LSD) has been generated by the compiler by specifying the `-g` option (see [page 80](#)).

Note

When the `-g` option is used, the objects created may be much larger under some circumstances due to the LSD information!

The AID debugger is activated with the POSIX `debug programname` command. When this command is input, the BS2000 environment becomes the current environment. This is indicated by the `%xxxxyyyy/` prompt, where `xxxxyyyy` stands for the PID of the process started using `debug`. The debugging commands as described in the manual “AID Debugging of C/C++ Programs” [7] can then be input. Once the program is terminated, the POSIX shell then becomes the current environment again.

The `debug` command is described with all operands in the manual “POSIX Commands” [2].

2.2.5 Using the POSIX library functions

In contrast to developing programs in the BS2000 environment (SDF), no special provisions are required for using the POSIX library functions in the POSIX environment. The following actions are executed automatically:

- setting the preprocessor defines `_OSD_POSIX`
- merging in the standard header files supplied with CRTE and POSIX-HEADER from the standard `/usr/include` or `/usr/include/sys` directories
- linking in the POSIX `posix.o` link switch (corresponds to the PLAM SYSLNK.CRTE.POSIX library in the BS2000 environment)

The PROGRAM-ENVIRONMENT variable is set to “Shell” when the program is started.

Please refer to the manual “C Library Functions for POSIX Applications” [3] for further details.

2.3 C++ template instantiation under POSIX

2.3.1 Basic aspects

The C++ language includes the concept of templates. A template is a description of a class or function that serves as a model for a family of derived classes or functions. For example, one can write a template for a `Stack` class, and then use a stack of integers, a stack of floats, or a stack of any user-defined type. These stacks could then be typically written in the source as `Stack<int>`, `Stack<float>` and `Stack<X>`. The compiler can create instantiations of the template for each of the types required from a single source description of the template for a stack.

The instantiation of a class template is always created as soon as it is required during compilation.

The instantiations of template functions and member functions or static data members of a class template (referred to as **template entities** below), by contrast, need not be created immediately. This is mainly due to the following reasons:

- In the case of template entities with external linkage (functions and static data members), it is important to have only one copy of the instantiated template entity throughout the program.
- The ANSI C++ language allows one to write a specialization for a template entity, which means that the user can supply a specific version to be used instead of the instantiation generated from the template for a specific data type. Since the compiler cannot know, when compiling a reference to a template entity, if a specialization for that entity is available in another compilation unit, it cannot create the instantiation immediately.
- The ANSI C++ language dictates that template functions which are not referenced should not be compiled and should be checked for errors. Consequently, a reference to a template class should not automatically instantiate all the member functions of that class.

Note that some template entities such as inline functions are always instantiated when used.

From the requirements listed above, it is evident that if the compiler is responsible for the entire instantiation (“automatic” instantiation), these instantiations can only be performed meaningfully on a program-wide basis. In other words, the compiler cannot make decisions about the instantiation of template entities until it has seen the source code of all compilation units in the program.

The C/C++ compiler provides an instantiation mechanism by which automatic instantiation is carried out at link time (with the aid of a “prelinker”). Refer to [section “Automatic instantiation” on page 19](#) for further details.

Explicit control over the instantiation process is available to the programmer via selectable instantiation modes and `#pragma` directives:

- The instantiation mode selection options are `-T auto`, `-T none`, `-T local` and `-T all`. They are described in detail in section “Template options” (page 65f).
- The following `#pragma` directives can be used to control instantiation of single templates or a group of templates:
 - The `instantiate` pragma creates the template instance specified as the argument. This pragma can be used in analogy to the ANSI C++ language convention *template declaration* for explicit instantiation requests. See also the example on page 32.
 - The `do_not_instantiate` pragma suppresses instantiation of the template instance specified as the argument. Typical candidates for this pragma are template entities for which specific definitions have been provided (specializations).
 - The `can_instantiate` pragma informs the compiler that the template instance specified as the argument can be, but does not have to be created in the compilation unit. This pragma is required in conjunction with libraries and is only evaluated in automatic instantiation mode. See also the example on page 34.

The exact syntax and general rules regarding these pragmas can be found in the C/C++ User Guide [4], in the section “Pragmas for controlling template Instantiation”.

- It is possible to implement explicit control using the “explicit instantiation statements” specified (in the source). These “explicit instantiation statements” can be generated using `-T etr_file_all` or `-T etr_file_assigned` (see the section “Generating explicit template instantiation statements (ETR files)” on page 24) and can then be incorporated into the sources by the user.

Important information

The method of template instantiation preset for this compiler (automatic instantiation by the prelinker and implicit inclusion) is also the method we recommend. There are options allowing you to change the settings for this method, but you should do this only in exceptional cases and only when you are very familiar with the entire application, including all the templates which are defined and used.

Implicit inclusion: implicit inclusion must not be disabled (with `-K no_implicit_include`) when templates from the standard C++ library (SYSLNK.CRTE.STDCPP) are used, since otherwise no definitions are found.

Instantiation modes \neq `-T auto`: there is a danger here that unsatisfied external references (`-T none`), duplicates (`-T all`) or runtime errors (`-T local`) may occur.

2.3.2 Automatic instantiation

Automatic instantiation (`-T auto` option) is supported by the compiler by default. This allows you to compile your source code and link the generated objects without having to worry about how the necessary instantiations are done.

Note that the discussion which follows refers to the automatic instantiation of template entities for which there is no explicit instantiation request (*template declaration*) and no `instantiate` pragma.

Requirements

For each instantiation, the compiler expects a source file that contains both a reference to the required instantiation and the definition of the template entity as well as all types required for the instantiation of that template entity. The last two requirements can be satisfied by the following methods:

- Each `.h` file that declares a template entity also contains either the definition of the entity or includes another file containing the definition.
- Implicit inclusion
When the compiler sees a template declaration in a `.h` file and discovers a need to instantiate that entity, it looks for a source file with the same base name as the `.h` file and a suffix that satisfies the conventions for C++ source file names (see the rules for input file names on [page 42ff](#)). This file is then implicitly included by the compiler on instantiation at the end of each compilation unit without a message being issued. See also [section “Implicit inclusion” on page 31](#) for details.
- The programmer makes sure that the files that define template entities also contain the definitions of all required types and adds C++ code or instantiation pragmas in those files to request the instantiation of the template entities therein.

First instantiation without a definition list

The definition list method can also be used as an alternative to the following procedure (see below).

The following steps are performed internally during automatic instantiation:

1. Create instantiation information files
No template entities are instantiated the first time that one or more source files are compiled. For each source file that makes use of a template, an associated instantiation information file is created if no such file already exists. An instantiation information file has the suffix `.o.i.i`. For example, the compilation of `abc.C` would result in the creation of the file `abc.o.i.i`. The instantiation information file must not be modified by the user.
2. Create object files
The created objects contain information on which instantiations could have been and were created when compiling a source file.
3. Assign template instantiations
When the object files are linked, the prelinker is called before the actual linking takes place. The prelinker examines the object files, looking for references and definitions of template entities and for added information about entities that could be instantiated. If it does not find a definition for a required template entity, it searches for an object file which can instantiate the template entity. When it finds such a file, it assigns the instantiation to it.
4. Update the instantiation information file
All instantiations that were assigned to a given file are recorded by name in the associated instantiation information file.
5. Recompile
The compiler is internally called again to recompile each file for which the instantiation information file was changed.
6. Create new object file
When the compiler compiles a file, it reads the instantiation information file for that compilation unit and creates a new object file with the required instantiations.
7. Repetition
Steps 3 to 6 are repeated until all instantiations that are required and can be generated have been created.
8. Linkage
The object files are linked together.

First instantiation using the definition list (temporary repository)

Since the procedure above (see [page 20](#)) recompiles some files more than once, an option was added that is intended to accelerate the overall process.

Generally the files are only recompiled once. The majority of instantiations are associated with the first files to be recompiled in the method. This has disadvantages in some cases since their object sizes increase due to this (although the sizes of other objects decrease to compensate for this).

Increasing the size of individual modules can be a disadvantage in user applications when, for example, precisely this module needs to be loaded often. The user must therefore decide if the method that more evenly distributes the instances (default) is desired or if this method is desired (due to improved response during prelinking).

This schema can be enabled by specifying the `-T definition_list` option.

Steps 3-5 above are modified. The resulting algorithm appears as follows then:

1. Create instantiation information files
When one or more source files are compiled for the first time, no template entities are instantiated. One instantiation information file is created (if not already present) for every source file that uses a template. An instantiation information file has the file suffix `.o.i.i`. When compiling `abc.C`, for example, the file `abc.o.i.i` would be created. The instantiation information file may not be modified by the user.
2. Create object files
The objects created contain information on which instances could be created and may be needed when compiling a source file.
3. Assign template instances to a source file
If there are references for template entities for which there are no definitions in the set of object files, then a file is selected that could instantiate one of the template entities. All template entities that can be instantiated in this file are assigned to it.
4. Update instantiation information
The set of instances that this file is assigned to is recorded in the associated instantiation file.
5. Save the definition list
A definition list is maintained internally in memory. It contains a list of all definitions relating to templates that were found in all object files. This list can be read in and changed during recompilation.

Note

This list is not stored in a file.

6. Recompilation
The compiler is called again internally to recompile the corresponding source file.

7. Create new object file

When the compiler recompiles a file, it reads the instantiation information file for this compilation unit and creates a new object file with the required instances.

If the compiler gets the chance during compilation to instantiate additional referenced template entities that are not mentioned in the definition list or were not found in the libraries resolved, then it also instantiates these template entities (e.g. for templates that are contained in templates). It passes a list of instantiations received to the prelinker so that the prelinker can assign them to the file.

This process permits faster instantiation. It also reduces the necessity of recompiling and existing file more than once during the prelink process.

8. Repeat

Steps 3 - 7 are repeated until all necessary and generatable instances have been created.

9. Link

The object files are linked.

Further development

Once a program has been linked correctly, the associated instantiation information files contain all the names of the required instantiations. From then on, whenever source files are compiled, the compiler will consult the instantiation information file and do the instantiations therein as in a normal compilation run. In other words, except in cases where the set of required instantiations changes, the prelinker will find all required instantiations stored in the object files, so no further instantiation adjustments are needed. This applies even if the entire program is recompiled.

If a specialization of a template entity has been provided somewhere in the program, the prelinker will treat it as a definition. Since this definition will satisfy any references to the template entity, the prelinker will see no need to request an instantiation for that template entity. If a specialization is added to a program that has already been compiled, the prelinker will remove the assignment of the instantiation from the corresponding instantiation information file.

The instantiation information file must not be modified (e.g. renamed or deleted) by the user, except in the following case: if a source file in which a definition was changed and another source file in which a specialization was added are being compiled in sequence in the same compiler run, and the compilation of the first file (with the changed definition) has aborted with an error, the associated instantiation information file must be deleted manually to allow the prelinker to regenerate it.

Automatic instantiation, libraries and prelinked object files

When an executable file is generated with the `CC` command in automatic instantiation mode, the prelinker will do the automatic instantiation only in individual object files (`.o` files), but not in objects that are part of a library (`.a` library) or an object file that was prelinked with the `-r` option.

When generating the executable file, libraries or prelinked object files that require instances of template entities must either

- already contain these instances (which may be achieved by explicit instantiation and/or the preinstantiation of objects using the `-y` option; see [page 50](#))
- or provide appropriate header files with `can_instantiate` pragmas.

More details can be found in [section “Libraries and templates” on page 32](#).

The option `-T add_prelink_files` provides a further method of controlling automatic instantiation in connection with libraries (see [page 66ff](#)).

2.3.3 Generating explicit template instantiation statements (ETR files)

In some cases, for example, when automatic instantiation cannot be used effectively, the programmer has the option of using explicit (manual) instantiation in order to extend the sources as required.

To make this process easier, it is possible to create an ETR file (ETR - Explicit Template Request) which contains the instantiation statements for the templates used and which can be incorporated into a source.

The options for creating this ETR file are described in the section "Template options" on [page 65](#).

The option has three possibilities: `-T etr_file_none` (default) `/_all` `/_assigned`. If `_none` is specified, the file will not be generated, if `_all` is specified, all relevant information is output, if `_assigned` is specified, then only the specified information is output.

The templates taken into account during the ETR analysis can be divided into the following classes:

- Templates that are instantiated explicitly in the compilation unit. These are output using `_all`.
- Templates that are assigned by the prelinker to the compilation unit and then instantiated within the compilation unit. These can be output using both `_all` and `_assigned`.
- Templates that are used in the compilation unit and that can be instantiated here. These are output using `_all`.
- Templates that are used in the compilation unit, but cannot be instantiated here. These are output using `_all`.

The contents of an ETR file have the following format:

- Comments in the header will indicate that the file is a generated file.
- Four logical lines are created for each template (see the example below):
 - a comment line containing the text 'The following template was'
 - a comment line containing the type of the instance (for example, 'explicitly instantiated')
 - a comment line containing the external name of the instance. This name is the same as the entry in the `ii` file and can also be obtained from the binder listing or the binder error listing
 - a line which describes the explicit instantiation for this instance

Notes

- If the lines described above are too long, they will be wrapped in the usual C++ fashion using “*Backslash newline*”.
- The sequence of the output templates is not defined. If recompilation takes place or a source is modified, the sequence may change.
- The fourth logical line is particularly interesting when copying to a source.
- The comments are always in English.

The following scenarios describe two possible uses of an ETR file:

1. The compiler is called during development using the `-T auto` and `-T etr_file_assigned` options.
The instantiation statements output to the ETR files are incorporated into the appropriate sources. Productive operation is then activated using the `-T none` or `-T auto` option the next time the compiler is called.
The advantage of this method is the considerable reduction in the time it takes to complete prelinking during productive operation.
2. The compiler is called during development using the `-T none` and `-T etr_file_all` options.
After binding the developer checks each unresolved external reference to see whether it is a template, and if it is a template, when it can be instantiated. Particularly helpful in this case are the output external names. Then, the developer selects a source for the instantiation and inserts the instantiation statements there. In addition, the correct header files must also be included.
This method requires a considerable amount of manual work. But you do not subsequently need to call the prelinker (`-T none`).
This procedure offers you precise control over the placing of instances (which is important when using components with high performance requirements).

Example 1

For a single ETR file compiled using two files, **x.c** and **y.c** (when using “**etr_file_all**”).

The following command sequence is used for compilation:

```
CC -c -T etr_file_all x.c y.c
```

Source x.c

```
template <class T> void f(T) {}
template <class T> void g(T);

template void f(long);

void foo()
{
    f(5);
    f('a');
    g(5);
}
```

Source y.c

```
template <class T> void f(T){}
void bar()
{
    f(5);
}
```

ETR-file x.o.etr

```
// This file is generated and will be changed when the module is compiled
// The following template was
// explicitly instantiated
// __Of__F1&_
template void f(long);

// The following template was
//used in this module and can be instantiated here
// __Of__Fi&_
template void f(int);

// The following template was
// instantiated automatically by the compiler
// __Of__Fc&_
template void f(char);

// The following template was
// used in this module
// __Og__Fi&_
template void g(int);
```

ETR-file y.o.etr

```
// This file is generated and will be changed when the module is compiled
// The following template was
// used in this module and can be instantiated here
// __Of__Fi&_
template void f(int);
```

The user can now decide in which source they wish to make explicit instantiations (this decision must always be made for entries with “used in this module and can be instantiated here”), for example, insertion of `template void f(int)` and `template void f(char)` in `x.c` (see the source in [Example 2 page 28](#)). Then you will subsequently not need to use automatic template instantiation.

Example 2

Example of the use of “`etr_file_assigned`”.

Two files are specified `x.c` and `y.c`:

Source `x.c`

```
template <class T> void f(T) {}
template <class T> void g(T);

template void f(long);

void foo()
{
    f(5);
    f('a');
    g(5);
}
```

Source `y.c`

```
template <class T> void f(T){}
void bar()
{
    f(5);
}
```

These programs are first compiled using the following commands and then prelinked:

```
CC -c -T auto -T etr_file_assigned x.c
CC -c -T auto -T etr_file_assigned y.c
CC -y -T auto -T etr_file_assigned x.o y.o
```

Then a file is created `x.o.etr` (since only `x` template instantiations are assigned) which looks like this:

```
// This file is generated and will be changed when the module is compiled

// The following template was
// instantiated automatically by the compiler
// __Of__Fi&_
template void f(int);
```

```
// The following template was
// instantiated automatically by the compiler
// __Of__Fc&_
template void f(char);
```

The important lines are inserted in the file **x.c**, thus creating the file **x1.c**:

```
template <class T> void f(T){}
template <class T> void g(T);

template void f(long);

void foo()
{
    f(5);
    f('a');
    g(5);
}
template void f(int);
template void f(char);
```

Then production can be carried out using the following commands:

```
CC -c -T none x1.c
CC -c -T none y.c
```

Example 3

The following example shows the four classes of template that can be output. The assumptions are as in Example 1

The following commands are entered:

```
CC -c -T auto y.c
CC -y -T auto y.o (this assigns f(int) y)
CC -c -T auto -T etr_file_all x.c
CC -y -T auto -T etr_file_all x.o y.o
```

Thus creates the following ETR file, **x.o.etr**:

```
// This file is generated and will be changed when the module is compiled

// The following template was
// explicitly instantiated
// __Of__F1&
template void f(long(;

// The following template was
// used in this module and can be instantiated here
// __Of__Fi&
template void f(int);

// The following template was
// instantiated automatically by the compiler
// __Of__Fc&
template void f(char);

// The following template was
// used in this module
// __Og__Fi&
template void g(int);
```

2.3.4 Implicit inclusion

The implicit inclusion of source files is a method of finding definitions of template entities. This method is enabled for the compiler by default (see also the `-K implicit_include` option on [page 68](#)) and can be disabled with `-K no_implicit_include`. Please refer to the notes on [page 18](#) with regard to disabling implicit inclusion.

If implicit inclusion is enabled, the compiler looks for the definition of a template entity in accordance with the following principle: if a template entity is declared in a header file named *basename.h* and no definition for it is available in the compiled source code, the compiler will assume that the definition for that template entity is in a source file with the same base name as the header file and with a suffix that is valid for C++ source files (e.g. *basename.C*).

Let us assume, for example, that a template entity `ABC::f` is declared in the header file `xyz.h`. If the instantiation of `ABC::f` is requested on compilation, but no definition of `ABC::f` exists in the compiled source code, the compiler will search the directory containing the header file for a source file with the base name `xyz` and a suffix that applies to C++ source files (e.g. `xyz.C`). If such a file exists, it will be treated as if it were included at the end of the source file containing the `#include` directive for `xyz.h`.

To ensure that the file containing the definition of a particular template entity can be found during instantiation, the complete path name of the file with the declaration of the template must be known. This information is not available in files containing `#line` directives. Consequently, implicit inclusion is not possible in such cases.

Implicit inclusion and the make utility

When working with the `make` utility, implicit inclusions must be taken into account when generating file dependency lines. In other words, the object file depends on explicitly included headers as well as implicitly included files with template definitions.

When using the `-M` option, implicit inclusions will be taken into account in automatic instantiation mode only if the instantiation information files have been correctly built.

The following steps are required for this purpose:

1. Compile all source files.
2. Link the program together so that all instantiations are assigned.
3. Generate file dependency lines with the `make` program using the `-M` option (see also [page 49](#)).
4. Repeat steps 2 and 3 if the generated template instances have changed.

Controlling instantiation assignments

The assignment of instantiations to local object files can be enabled and disabled with the `-K assign_local_only` and `-K no_assign_local_only` options (see [page 68](#)).

2.3.5 Libraries and templates

Instantiations for template entities (template functions, member functions and static data members of template classes) can be generated in automatic instantiation mode only if the object meets the following conditions:

- It is not part of a `.a` library,
- it contains a reference to the template entity or the `can_instantiate` pragma for that template entity,
- and it contains all definitions needed for the instantiation.

A library that requires instances for its implementation must either contain these instances or provide special headers with `can_instantiate` pragmas. These two options are explained individually below.

1. The library contains all required instances

The main point to be observed here is to ensure that no duplicates are created when using multiple libraries.

The instantiation of template entities in libraries can be achieved by the following methods:

- a) automatic instantiation of the template unit using the prelinker with the option `-y` (see [page 50](#)).

Caution

If multiple libraries that require the same entity are used, there is a potential risk of duplicates being created, since a separate object is not created per entity. This can be avoided by using the `-T add_prelink_files` option (see [page 66](#)).

- b) by explicitly instantiating all template entities with the instantiation directive `template declaration` or the `instantiate` pragma.

The main point to be observed here is to ensure that a separate object is created per entity.

Example

Given:

- a library `l.a` with references to the instances `t_list(Foo1)` and `t_list(Foo2)`,
- a header file `listFoo.h` with the declarations of `t_list`, `Foo1` and `Foo2`
- and a source file `listFoo.C` with the definitions of `t_list`, `Foo1` and `Foo2`


```
// l.h
#ifndef L_H
#define L_H
#include "listFoo.h"
void g();
#endif

// l.C (l.o is element of l.a)
#include "l.h"
void g()
{
    Foo1 f1;
    Foo2 f2;
    //...
    t_list(f1);
    t_list(f2);
    //...
}

//listFoo.h
#ifndef LIST_F00_H
#define LIST_F00_H
template <class T> void t_list (T t);
class Foo1;
class Foo2;
#endif

//listFoo.C
template <class T> class t_list (T t) {...};
class Foo1 {...};
class Foo2 {...};
```

Each of the referenced instances are contained in separate objects in the library l.a.

```
// lf1.C (lf1.o is element of l.a)
// lf1.C contains an explicit instantiation for t_list(Foo1)
#include "listFoo.h"
template void t_list(Foo1);

// lf2.C (lf2.o is element of l.a)
// lf2.C contains a pragma to instantiate t_list(Foo2)
#include "listFoo.h"
template void t_list(Foo1);
#pragma instantiate void t_list(Foo2)
```

2. The header files contain `can_instantiate` pragmas for all required instances.

Example

Given:

- a library `l.a` with a reference to the instance `t_list(Foo)`,
- a header file `listFoo.h` with the declarations of `t_list` and `Foo`
- and a source file `listFoo.C` with the definitions of `t_list` and `Foo`.

```
// l.h
#ifndef L_H
#define L_H
#include "listFoo.h"
void g();
#endif

// l.C (l.o is element of l.a)
#include "l.h"
void g()
{
    Foo f;
    //...
    t_list(f);
    //...
}

//listFoo.h
#ifndef LIST_F00_H
#define LIST_F00_H
template <class T> void t_list (T t);
class Foo;
#pragma can_instantiate t_list(Foo)
#endif

//listFoo.C
template <class T> void t_list (T t) {...};
class Foo {...};
```

The object `user.o` and the library `l.a` are linked together (`CC user.o l.a`).

```
// user.C
#include "l.h"
int f ()
{
    g();
}
```

`user.C` includes `l.h`, which in turn includes `listFoo.h`. Consequently, `user.C` contains notification that `list(Foo)` can be instantiated.

Automatic instantiation by the prelinker produces only one instance `t_list(Foo)`.

Note

In order to generate the needed instances, the `can_instantiate` pragma must be contained in a header file of the library that will be included by the user programs.

2.4 Porting software

When porting C source programs from UNIX/SINIX systems into POSIX BS2000, note must be made of the different, implementation-dependent handling of externally visible names by the compiler.

The BS2000 C/C++ compiler uses the external name of the source program (e.g. function name) to create a corresponding external name for the link editor (entry name). As default, lowercase letters are converted to uppercase and the underscore character (`_`) is converted to a dollar sign (`$`) (see also “Generating entry names” on [page 74](#)). These conversions ensure that the objects created by the compiler can be linked to other objects (e.g. objects created by BS2000 compilers in other languages or objects in object module format).

When selecting the externally visible name for C source programs, it is therefore imperative that two names not only differ in uppercase/lowercase. For example, the function names `getc` and `getC` will be mapped to the same external name `GETC`. Provided no names of BS2000 compilers in other languages are affected, this behavior can be prevented using the `-K llm_case_lower` option (see [page 75](#)).

2.5 Introductory examples

Compiling and linking with the `c89` command

```
c89 hello.c
```

Compiles `hello.c` and creates the executable file `a.out`

```
c89 -o hello hello.c
```

Compiles `hello.c` and creates the executable file `hello`

```
c89 -c hello.c upro.c
```

Compiles `hello.c` and `upro.c` and creates the object files `hello.o` and `upro.o`

```
c89 -o hello hello.o upro.o
```

Links `hello.o` and `upro.o` to the executable file `hello`

Copying with the `bs2cp` command

```
bs2cp bs2:hello hello.c
```

Copies the cataloged BS2000 file `HELLO` to the POSIX file `hello.c`

```
bs2cp 'bs2:plam.bsp(hello.1,1)' hello.o
```

Copies the LLM `HELLO.L` from the PLAM library `PLAM.BSP` to the POSIX object file `hello.o`

3 The cc, c89 and CC commands

The C/C++ compiler can be called and supplied with options from the POSIX shell. The options cover most of the services and functions available for controlling the compiler via the SDF interface.

The syntax of the options, names of the processed or created objects and other conventions are based on the definition in the XPG4 Standard. POSIX shell interface extensions not covered by the XPG4 standard are based on the normal compiler or utility interface in UNIX systems.

The compiler includes an integrated link phase which converts the normal shell link options into corresponding link editor directives. A “standalone” link editor which is independent of the calling command is not available in the POSIX shell.

Only POSIX files can be read and written when compiling with the C/C++ compiler in the POSIX shell. BS 2000 files are not supported.

The source and header files may exist in either EBCDIC or ASCII code. It is assumed that all files (from a remote, merged in or a POSIX file system) are in the same codeset.

3.1 Calling syntax and general rules

`{cc | c89 | CC} [option] ... operand ...`

When you invoke the `c89` command, you must specify all options (see [page 41](#)) before entering operands (see [page 42](#)).

This "options before operands" sequence is not mandatory for the `cc` and `CC` commands. Other differences between the `cc`, `c89` and `CC` commands are summarized below.

The cc, c89 and CC commands

`cc`

If the compiler is called with `cc`, it works as a C compiler, and the default language mode is set to extended ANSI C (see the `-X a` option on [page 52](#)).

Options and operands may be specified in any order on the command line.

In contrast to the `c89` command, `-L dir` is interpreted as an operand (see `-L` on [page 43](#) and the `--` option on [page 48](#)).

`c89`

If the compiler is called with `c89`, it works as a C compiler, and the default language mode is set to extended ANSI C (see the `-X c` option on [page 52](#)).

In this case, options and operands cannot be mixed on the command line, i.e. the "options before operands" sequence must be maintained.

In contrast to the `cc/CC` commands, `-L dir` is interpreted here as an option (see `-L` on [page 43](#) and the `--` option on [page 48](#)).

`CC`

If the compiler is called with `CC`, it works as a C++ compiler, and the default language mode is set to extended ANSI C++ (see the `-X w` option on [page 53](#)).

Options and operands may be specified on the command line in any order.

In contrast to the `c89` command, `-L dir` is interpreted as an operand (see `-L` on [page 43](#) and the `--` option on [page 48](#)).

Options

No *option* specified

If the source code contains no syntax errors, and all unresolved references are resolved, the compiler generates an executable file `a.out`, which contains the executable program.

The compiler only stores the object code of the separate source files in `.o` files with the same names if at least two source files or one source file and one `(.o)` object file are specified.

If only a source file `file.c` is specified, no object file `file.o` is available after compilation as it is a temporary file and is subsequently deleted. If an object file `file.o` exists before compilation, this is also deleted.

option

You can specify options in the compiler call to control the compilation process and to determine which arguments are passed to the programs for the individual compilation phases.

Options can also be used to instruct the compiler to perform only some of the compilation phases (see [page 49ff](#)). If the compilation process is not completed fully, all options that refer to the skipped compilation phases are ignored by the compiler. If multiple options are used to select the compilation phases to be performed, the compiler will stop after the earliest specified phase.

An option always consists of a single letter that is identified by a leading hyphen ("-").

Multiple options may be grouped, i.e. specified in succession after a single hyphen without any delimiting whitespace, only if none of the listed options take any arguments (e.g. `-V -c` could also be entered as `-Vc`).

Options that take arguments must be specified in accordance with the XPG4 Standard by separating the option and its argument with a space. This XPG4-compliant notation is strongly recommended, but is not enforced by the compiler for compatibility reasons (e.g. the compiler will accept `-ohello` instead of `-o hello`).

Arguments that contain delimiters (`:` or `,`) or the equals sign (`=`) must not be specified with any whitespace before or after these characters.

Examples

```
-D MAKRO = 1      illegal
-D MAKRO=1       legal
-R limit, 20     illegal
-R limit,20      legal
```

If the same option is specified more than once with conflicting arguments (e.g. `-K at` and `-K no_at`), the last option specified on the command line applies.

Options that are not known to the compiler, i.e. options that begin with an unrecognized letter after the leading hyphen ("-"), are passed through to the link editor. If the unknown option and the argument are separated by whitespace, the option is interpreted and passed as an option without an argument.

Options with unrecognized arguments are ignored, and a corresponding warning is issued.

Special input rules for the -K option

`-K arg1[,arg2...]`

The `-K` option can be used to specify one or more arguments in succession, with a delimiting comma between each such argument. The delimiter between the arguments (i.e. the comma) must not be preceded or followed by any whitespace. Multiple `-K` options with one argument each have the same effect as a single `-K` option with multiple arguments delimited by commas. The arguments specified with the `-K` option may be entered in uppercase and/or lowercase letters (e.g. the arguments `PIC`, `pic`, `Pic`, etc. are equivalent). In the case of conflicting specifications (e.g. `-K uchar` and `-K schar`), the last entry is taken without issuing a warning.

Operands

The "operands" category includes the following entries:

- the names of input files, i.e.: *file.suffix*
- the link editor options `-l x` and `-lBLSLIB`
- only for the `cc/CC` commands: also the link editor option `-L dir`

The compiler processes all options first, and then the operands, in the order in which they are specified on the command line.

All arguments that follow the `--` option (which ends the input of options) on the command line are interpreted as operands, even if they begin with a "-" character (see the `--` option on [page 48](#)).

file.suffix

The name of an input file.

The compiler determines the contents of a file, and thus the compilation steps to be performed in each case, from the file name extension. The file name must therefore have a suffix (or extension) that matches its contents. The possible suffixes that can be used to identify source files will depend on the mode in which the compiler is invoked and whether the compiler was called with the `cc/c89` command (C mode) or with `CC` (C++ mode).

The following suffixes are interpreted in individual cases as listed below:

- c, C C source code (cc, c89) or C++ source code (CC) before the preprocessor run
- cpp, CPP, cxx, CXX, cc, CC, c++, C++
C++ source code before the preprocessor run (CC)
- i C source code (cc, c89) after the preprocessor run
- I C++ source code after the preprocessor run (CC)
- o Object file
- a Static library with object modules created with the ar utility

In addition to the suffixes above, the `-Y F` option may be used to specify other user-defined suffixes, which are then recognized by the individual compiler components (see [page 47](#)).

File names with no suffix or an unrecognized suffix are passed through to the link editor without issuing a warning.

At least one input file (*file.suffix*) or one library in the form `-l x` is required for each compiler call.

If more than one input file is specified, these files need not be of the same type, i.e. source files and object files may all be specified in the same compiler call. In the case of object files and libraries, the order and position in which they are entered on the command line are significant for linking.

`-L dir`

`-L dir` is only interpreted as an operand when the compiler is called with the `cc` and `CC` commands. *dir* can be used to specify an additional directory that is to be searched by the link editor for the libraries specified with the `-l` option (see [page 88](#) for more details).

`-l x`

This operand instructs the link editor to search for libraries named `libx.a` (see “Link editor options” on [page 83ff](#) for more details).

`-l BLSLIB`

This operand instructs the link editor to search through PLAM libraries which were assigned with the `BLSLIB $_{nm}$` shell environment variable ($00 \geq nm \leq 99$) (see “Link editor options” on [page 83ff](#) for more details).

Exit status

- 0 Normal termination of the compiler run; no errors, but possibly with notes and warnings
- 1 Normal termination of the compiler run; with errors
- 2 Abnormal termination of the compiler run; with the occurrence of a fatal error

3.2 Description of options

The following sections describe the possible options for the `cc`, `c89` and `CC` commands in groups, depending on the context in which they are used. The options are classified as follows:

- General options ([page 46](#))
- Options for selecting compilation phases ([page 49](#))
- Options for selecting the language mode ([page 52](#))
- Preprocessor options ([page 55](#))
- Common frontend options in C and C++ ([page 58](#))
- C++-specific frontend options ([page 62](#))
- Optimization options ([page 69](#))
- Options for controlling object generation ([page 73](#))
- Runtime options ([page 80](#))
- Link editor options ([page 83](#))
- Options for controlling message output ([page 90](#))
- Options for outputting listings and CIF information ([page 92](#))

The general aspects to be observed when entering options are discussed in [section “Calling syntax and general rules” on page 40](#)).

A list of all options in alphabetic order with references to the pages on which they appear can be found in the appendix ([page 105ff](#)).

3.2.1 General options

`-K arg1[,arg2...]`

General input rules for the `-K` option can be found on [page 42](#).

The following entries are possible as *arg* arguments for general control of the compilation run:

`verbose`

`no_verbose`

Note that the `-K verbose` specification, which causes additional information on template instantiation to be written to the standard error output `stderr`, is presently only meaningful with the `CC` command.

`-K no_verbose` is the default setting.

`-o output_destination`

If this option is omitted, the compiler generates output files with default names and places them in the current directory.

The `-o` option can be used to rename the various output files of a compiler run and/or have them written to a different directory.

output_destination can be any of the following: only the name of a directory, only a file name, or a file name including directory components. The specified directories must already exist.

output_destination = directory name *dir*

The output files are created with default names and placed in the specified directory *dir* as follows:

- When an executable file is generated, the file is assigned the name *dir/a.out*.
- If the `-c` option is specified, the object file is named *dir/sourcefile.o*.
- If the `-E` option is specified, the preprocessor output is written to the file *dir/sourcefile.i* (`cc/c89` command) or *dir/sourcefile.I* (`CC` command) instead of the standard output `stdout`.
- If the `-M` option is specified, the preprocessor output (dependency lines for further processing with `make`) is written to the file *dir/sourcefile.mk* instead of the standard output `stdout`.
- If the `-P` option is specified, the preprocessor output is written to the file *dir/sourcefile.i* (`cc/c89` command) or *dir/sourcefile.I* (`CC` command).

With the exception of the executable file generated by the link editor, independent output files are created for each compiled source file in cases where multiple source files are specified for compilation.

output_destination = a specified *file_name* or

output_destination = a specified directory and file name: *dir/file_name*

If an executable file is being generated or if the `-o` option is specified in combination with option `-c`, `-E`, `-M` or `-P`, the compiler writes the result to a file named *file_name* and places it in the current directory or in the directory specified with *dir*. Apart from the executable file generated by the link editor, a different file name may be specified for all other output files, but only if a single source file is listed for compilation in each compiler call.

If more than one input file is specified but only **one** output file is specified, then a warning is output and *output_destination* is reset to the default value.

If an executable file is created, the file name specified with `-o` must differ from an object file generated by the compiler or specified explicitly in the command line. For example, the following commands are rejected with errors:

```
cc -o hello.o hello.o
cc -o hello.o hello.c
```

`-V`

For each compiler component that is implicitly called during the execution of `cc/c89/CC`, the version and possibly a copyright note are written in a separate line. In the linking procedure the version of the CRTE being used and a list of the libraries used are also output.

`-Y F,file-type,user_suffix`

This option can be used to define user-specific suffixes in the form *user_suffix* for input files of type *file-type* in addition to the standard suffixes (see [page 42](#)).

The following entries are possible for *file-type*:

<code>c++</code>	C++ source file
<code>c</code>	C source file
<code>prec++</code>	C++ preprocessor output file
<code>prec</code>	C preprocessor output file
<code>obj</code>	Object file
<code>lib</code>	Static library

Example

```
-Y F,obj,lib
```

An input file named *file.lib* is recognized by the compiler as an object file.

--

This option ends the input of options, i.e. causes all following arguments (except for the link editor options that fall under the "operands" category) to be interpreted as file names, even if they begin with a hyphen. This makes it possible to specify file names that start with a hyphen (e.g. `-hello.c`).

The following link editor options are permitted after the `--` option:

`-l x`

`-l BSLIB`

`-L dir` (only with the `cc` and `CC` commands; in the `c89` command, this entry would be interpreted as a file name!)

3.2.2 Options for selecting compilation phases

All of the options listed below always suppress the linkage run and cause any link editor options and operands that may have been specified to be ignored.

-C

Terminates the compiler run after an LLM has been created and placed into an object file *file.o* for each compiled source file. The object is written by default into the current directory. The `-o` option (see [page 46](#)) can be used to define a different file name and/or directory.

-E

The compiler run is terminated after the preprocessor phase and the result is written to the standard output `stdout`. Any blank lines present in the file are combined in the process, and the corresponding `#line` directives are generated. By default, C and C++ comments are removed from the preprocessor output (see the `-C` option on [page 55](#)). If the `-o` option is specified (see [page 46](#)), the result of the preprocessor run is written to a file instead of the standard output `stdout`.

-M

The compiler run is terminated after the preprocessor phase; however, instead of the normal preprocessor output (cf. `-E`, `-P`), a list of dependency lines that is suitable for further processing with the POSIX `make` program is generated and written to the standard output `stdout`. If the `-o` option is specified (see [page 46](#)), the file dependency list is written to a file instead of the standard output `stdout`.

Note

Templates in ANSI-C++ sources are not included explicitly.

-P

The compiler run is terminated after the preprocessor phase, and the result is written to a file named *file.i* (`cc/c89` command) or *file.I* (`CC` command) and placed in the current directory instead of the standard output `stdout` as in the `-E` option. The output does not contain any additional `#line` directives. By default, C or C++ comments are removed from the preprocessor output (see the `-C` option on [page 55](#)). *file.i* can be subsequently compiled further with the `cc/c89/CC` commands, whereas *file.I* can only be compiled with the `CC` command. If desired, the `-o` option (see [page 46](#)) may be used to specify another file name and/or directory.

-y

This option can only be specified with the `CC` command in the ANSI C++ modes. The compiler run is terminated after the prelinker phase (automatic template instantiation), and an object file named `sourcefile.o` containing the instantiated templates is generated for each compiled source file. This is meaningful for objects that are to be subsequently incorporated in a library (`.a` library) or in a prelinked object file (`-r`); no automatic instantiation is performed for templates within libraries or prelinked object files. Note that the `-y` option can only be meaningfully used in the default automatic instantiation mode (`-T auto`).

Example

Contents of the source files (extracts):

```
// a.h:
class A {int i;};

// f.h:
template <class T> void f(T)
{
    /* any code */
}

// b.c:
#include "a.h"
#include "f.h"

void foo() {
    A a;
    f(a);
}

// main.c:
void main(void)
{
    foo();
}
```

Commands:

```
CC -c b.c
```

The first compilation produces an object file `b.o` and a template information file `b.o.i1`, where each contains an entry that the function `f(A)` is not instantiated.

```
CC -y b.o
```

The `b.o` and `b.o.i1` files generated in the first compilation run are updated, and the function `f(A)` is instantiated.

```
ar -r x.a b.o
```

The module in `b.o` is added to the library `x.a`.

```
CC main.c x.a
```

An executable file named `a.out` is generated.

The following command sequence, by contrast, would not produce the desired result:

```
rm *.o *.i1 *.a a.out /* Cleanup the current directory */
CC -c b.c
ar -r x.a b.o
CC main.c x.a
```

This command sequence results in an error message. This is because the function `f(A)` cannot be found, since no automatic instantiation is performed for the templates in the library `x.a`.

3.2.3 Options for selecting the language mode

-X a

-X c

-X t

These options are used to select the C language mode and can only be specified when calling the compiler with `cc` and `c89`.

-X a

Extended ANSI C mode (the default setting when calling the compiler with `cc` and `c89`)
The compiler supports C code, as defined in the ANSI/ISO C standard, including the ISO C Amendment 1). In addition, various other language extensions are also supported (see the chapter “C language support” in the C/C++ User Guide [4]). Note that the name space is not restricted to names specified by the standard. All C library functions of the system (ANSI functions, POSIX and X/OPEN functions, and UNIX extensions) may be used.

`__STDC__` has a value of 0 and `__STDC_VERSION__` the value 199409L.

-X c

Strict ANSI C mode

This mode can be used to test a program for ANSI/ISO compliance.

As in the extended ANSI C mode (-X a), the compiler supports C code in accordance with the ANSI/ISO C standard.

However, in contrast to the extended ANSI C mode, the name space is restricted to the names defined in the standard, and only the C library functions that are defined in the ANSI/ISO standard are available. This is achieved as follows: specifying the `-X c` option internally sets the `_STRICT_STDC` define. If this define is set, prototype declarations for all C library functions not defined in standard headers in the ANSI/ISO C standard (`stdio.h`, `stdlib.h`, etc.) are disabled or bypassed. However, the `_STRICT_STDC` define only affects the prototype declarations in the standard headers defined in ANSI/ISO. The BS2000 and POSIX-specific include headers do not use this define.

Deviations from the standard result in compiler messages (mostly warnings). If desired, the output of errors can be forced in such cases by specifying the `-R strict_errors` option.

`__STDC__` has a value of 1 and `__STDC_VERSION__` the value 199409L.

-X t

K&R C mode

This mode should not be used for new developments. It is typically intended for porting "old" K&R C sources and/or systematic conversions to ANSI C.

The compiler accepts C code, as defined by Kernighan&Ritchie in the reference manual ("The C Programming Language", First Edition). It also supports C language elements of the ANSI C standard that are semantically identical to the Kernighan&Ritchie "definition" of the C language (e.g. function prototypes, `const`, `volatile`). This simplifies the conversion of a K&R C source to ANSI C. All C library functions of the system (i.e. ANSI functions, POSIX and X/OPEN functions, UNIX extensions) are available for use.

As far as the preprocessor behavior is concerned, ANSI/ISO C is the default. If desired, the option `-K kr_cpp` can be specified to convert the preprocessor behavior to K&R C (as required when porting old C sources, for example).

`__STDC__` has a value of 0 and `__STDC_VERSION__` is undefined.

-X w

-X e

-X d

These options are used to select the C++ language mode and can be specified when calling the compiler with `CC`.

-X w

Extended ANSI C++ mode (the default when calling the compiler with `CC`).

The compiler supports C++ code in accordance with the definition proposed in the ANSI C++ draft for the ANSI/ISO C++ standard. In this case, the name space is not restricted to names specified in the standard.

The following C++ libraries are available:

- the standard C++ library (strings, containers, iterators, algorithms, and numerics), including the Cfront-compatible I/O classes
- the Tools.h++ library

For more information on C++ libraries, see also the C++ User Guide [4]

As in the extended ANSI C mode (`-X a`), various language extensions as well as all C library functions of the system are available for use.

`__STDC__` has a value of 0, `__cplusplus` the value 2 and `__STDC_VERSION__` the value 199409L.

-X e

Strict ANSI C++ mode

In terms of the C++ language support (based on the ANSI/ISO C++) and the available C++ libraries, this mode corresponds to the extended ANSI C++ mode (-X w).

However, in contrast to the extended ANSI C++ mode, only the C library functions defined in the ANSI/ISO standard are available (analogous to the strict ANSI C mode -X c).

Deviations from the standard result in compiler messages (mostly warnings), but the output of errors can be forced in such cases by specifying the -R strict_errors option.

__STDC__ has a value of 1, __cplusplus the value 199612L (which will be increased in future versions) and __STDC_VERSION the value 199409L.

-X d

Cfront-C++ mode

This mode is only offered for compatibility reasons and should not be used for new developments. It supports the C++ language elements of Cfront V3.0.3, which was first released with the C++ V2.1 compiler.

The Cfront-compatible C++ library for complex mathematics and stream-oriented I/O is available.

More information on the Cfront C++ library can be found in the C++ User Guide [4].

C++ sources must be compiled and linked with -X d if their objects are to be linkable with C++ V2.1/V2.2 objects.

__STDC__ has a value of 0, __cplusplus the value 1 and __STDC_VERSION the value 199409L.

3.2.4 Preprocessor options

-A "*name*(*tokens*)"

This option can be used to define an assertion, as if by a preprocessor `#assert` directive (see the section "Extensions over ANSI/ISO C" in the C/C++ User Guide [4]). The quotes are required because of the special significance of parentheses in the POSIX shell. The parentheses can alternatively be nullified with the backslash:

-A *name*\(*tokens*\)

-C

This option is evaluated only if the `-E` or `-P` option is also specified (see [page 49](#)). It causes C or C++ comments to be retained in the preprocessor output. Such comments are removed by default.

-D *name*[=*value*]

This option can be used to define names, symbolic constants and macros (as if by a preprocessor `#define` directive).

-D *name* corresponds to the `#define` directive for defining names, i.e. `#define name`;

-D *name=**value* corresponds to the `#define` directive for text substitutions, i.e. `#define name value`.

-H

Causes a list of all header files used during the compilation run to be written to the standard error output `stderr`.

-i *header*

This option specifies an include file *header* which is inserted before the source program text (pre-include).

You can specify the *header* as follows:

- by giving the fully qualified path name of the include file
- by giving the relative path name of the include file on the basis of the option `-I` (see [page 56](#))

The include file specified as the *header* will be handled in exactly the same way as any include file where an `#include` statement is specified at the beginning of the source program file. If several header files are to be pre-included, the corresponding `#include` instructions must be collected together in a single include file which is then specified using the option `-i`.

-I *dir*

dir is added to the list of directories that are searched by the preprocessor for header files. If this option is entered more than once, the order of entry determines the search order for header files.

If the relative pathname of the header file (which does not begin with a slash /) is specified in the `#include` directive enclosed within quotes "...", the preprocessor searches the directories in the following order:

1. the directory of the source or header file containing the `#include` directive
2. the directories that were specified with the preprocessor `-I` option
3. either the directories specified with the `-Y I` option (see [page 57](#)) or the standard directories listed below.

Last-searched standard-directories:

- a) Only with the `CC` command in ANSI-C++ modes (`-X w` and `-X e`) the `/usr/include/CC` directory
- b) In all cases the standard `/usr/include` and `/usr/include/sys` directories

If the relative pathname of the header file is specified in the `#include` directive enclosed within angular brackets `<...>`, the preprocessor will only search the directories listed under points 2 and 3 above.

If you want the preprocessor to search some other directories last instead of the standard directories listed above, you can specify such directories by using the `-Y I` option (see below).

-K *arg1[,arg2...]*

General input rules for the `-K` option can be found on [page 42](#).

The following entries are possible as *arg* arguments to control preprocessor behavior:

`ansi_cpp`

`kr_cpp`

`-K ansi_cpp` is the default setting in all C and C++ language modes of the compiler. This means that preprocessor behavior in accordance with the ANSI/ISO C standard is also supported in the K&R C mode.

The obsolete preprocessor behavior based on Reiser `cpp` and Johnson `pcc` can be turned on with `-K kr_cpp`, but only in K&R C mode. The `-K kr_cpp` specification is ignored in all other C and C++ language modes.

-U *name*

Undefines a macro or a symbolic constant *name* (as when using the preprocessor directive `#undef`), where *name* is a predefined preprocessor name (see [page 97](#)) or a name that was defined with the `-D` option in the command line before or after option `-U`. This option has no effect on `#define` directives in the source program.

-Y *I,dir[:dir...]*

Instructs the preprocessor which directory or directories are to be searched for header files last. *dir* specifies the directory.

Without this option, the last directories to be searched are the standard directories (see the `-I` option, points a) and b)).

3.2.5 Common frontend options in C and C++

`-K arg1[,arg2...]`

General input rules for the `-K` option can be found on [page 42](#).

The following entries are possible as *arg* arguments to control the compiler frontend in the C and C++ modes:

`uchar`

`schar`

The default data type `char` is unsigned. If `-K schar` is specified, `char` is treated as a signed `char` in expressions and conversions.

Note that the use of this option may result in portability problems!

`at`

`no_at`

If `-K no_at` is specified, the “at” sign ‘@’ is not allowed in identifiers.

The default is `-K at`. The ‘@’ sign in identifiers is an extension to the ANSI standard and using it causes a warning to be output in strict ANSI modes.



If you are using a Cfront C++ library, you cannot use the option `-K no_at`.

`dollar`

`no_dollar`

If `-K no_dollar` is specified, the dollar sign ‘\$’ is not allowed in identifiers.

The default is `-K dollar`. The ‘\$’ sign in identifiers is an extension to the ANSI standard and using it causes a warning to be output in strict ANSI modes.

`literal_encoding_native`

`literal_encoding_ascii`

`literal_encoding_ascii_full`

`literal_encoding_ebcdic`

`literal_encoding_ebcdic_full`

This option determines whether the C/C++ compiler creates the code for characters or for strings in EBCDIC or ASCII format (ISO 8859-1).

In C/C++, literal strings can contain binary coded characters as octal or hexadecimal escape sequences with the following syntax:

- octal escape sequences: `‘\ [0-7] [0-7][0-7]’`
- hexadecimal escape sequences: `‘\x [0-9A-F] [0-9A-F]’`

Whether or not the C/C++ compiler escape sequences are converted into ASCII format depends on the value specified for the option `literal_encoding_...`.

`literal_encoding_native`

The C/C++ compiler leaves the character and literal string code in the EBCDIC format, i.e. it transfers the characters and strings into the object code without converting them.

`literal_encoding_native` is the default setting.

`literal_encoding_ascii`

The C/C++ compiler encodes the characters and literal strings in ASCII format. Strings containing escape sequences *will not be* converted into ASCII format.

`literal_encoding_ascii_full`

The C/C++ compiler encodes the characters and literal strings in ASCII format. Strings containing escape sequences *will be* converted into ASCII format.

`literal_encoding_ebcdic`

The C/C++ compiler leaves the character and literal string code in the EBCDIC format, i.e. it transfers the characters and strings into the object code without converting them.

`literal_encoding_ebcdic` has the same effect as

`literal_encoding_ebcdic_full` or `literal_encoding_native`.

`literal_encoding_ebcdic_full`

The C/C++ compiler leaves the character and literal string code in the EBCDIC format, it transfers the characters and strings into the object code without converting them.

`literal_encoding_ebcdic_full` has the same effect as

`literal_encoding_ebcdic` or `literal_encoding_native`.

Prerequisites for using the ASCII Format:

- For *each and every* CRTE function (C library function) in your program that works with characters or strings, you must use the corresponding or matching include file. If you do not do this, the CRTE functions will not be able to process the character strings correctly. You should ensure that you include the include file `<stdio.h>` for the function `printf()` with `#include <stdio.h>`.
- If you are using CRTE functions you must also specify the following options:
 - `K 11m_keep`
 - `K 11m_case_lower`

signed_fields_signed
signed_fields_unsigned

If `-K signed_fields_unsigned` is specified, signed bit fields are always interpreted as unsigned. This option is only offered for compatibility with older C versions and is only meaningful in K&R C mode.

The default is `-K signed_fields_signed`.

plain_fields_signed
plain_fields_unsigned

These arguments control whether integer bit fields (short, int, long) are treated as signed or unsigned types by default.

The default is `-K plain_fields_signed`.

long_preserving
unsigned_preserving

These arguments control whether arithmetic operations with operands of type long and unsigned int return a result of type long (long_preserving) in accordance with K&R mode (first edition; appendix 6.6) or of type unsigned long (unsigned_preserving) in accordance with ANSI/ISO C.

The default is `-K unsigned_preserving`.

alternative_tokens
no_alternative_tokens

These arguments control whether alternative tokens are to be recognized by the compiler:

- Digraph sequences in the C and C++ language modes (e.g. `<: for []`),
- Additional keyword operators which are only valid in the C++ language modes (e.g. `and for &&`, `bitand for &`).

`-K alternative_tokens` is the default in the ANSI C++ modes, and

`-K no_alternative_tokens` is the default for all other modes.

longlong
no_longlong

These arguments control whether the data type long long is recognized by the compiler.

`-K longlong` is the default. In this case, the preprocessor define `_LONGLONG` is set.

The data type long long is an extension to the ANSI C and C++ Standard.

If `-K no_longlong` is set, the use of the data type long long will result in an error.

`end_of_line_comments`

`no_end_of_line_comments`

These arguments control whether the compiler accepts C++-style comments (`//...`) in C programs as well. The `-K end_of_line_comments` option can only be enabled in the extended ANSI C mode (`-X a`).

`-K no_end_of_line_comments` is the default.

3.2.6 C++-specific frontend options

The options described in the following sections on "General C++ options" and "Template options" are only applicable to the `CC` command.

General C++ options

General C++ options can be used to control the following C++ features:

- how tables are defined for virtual class functions
- whether the keywords `wchar_t` and `bool` are recognized
- the scope of initialization directives in `for` and `while` loops
- whether the old specialization syntax is accepted

Apart from the definition of tables for virtual functions, none of the language features listed above are supported in Cfront C++ mode.

–K *arg1* [, *arg2* . . .]

General input rules for the –K option can be found on [page 42](#). The following entries are possible as *arg* arguments to control the C++ frontend:

`normal_vtbl`
`force_vtbl`
`suppress_vtbl`

These arguments allow you to specify how the virtual function table is to be generated by the compiler.

–K `normal_vtbl` (default)

The virtual function table is declared as `static` by default, i.e. one copy of the table is generated for each module.

–K `force_vtbl`

This option causes the table in the module concerned to be defined and initialized globally. The option may only be specified for one compilation unit.

–K `suppress_vtbl`

This option causes the table in the module concerned to be declared as `external`.

Note

These options only affect classes in which the normal heuristics is still effective for positioning the table of virtual functions. They therefore only affect classes which contain no “non-inline non-pure virtual function”.

`using_std`
`no_using_std`

These arguments determine the use of ANSI C++ library functions for which names have been defined in the standard name space `std`.

If `-K using_std` is specified, the compiler behaves as if the following lines were entered at the start of a compilation unit:

```
namespace std{}  
using namespace std;
```

`-K using_std` is the default in extended ANSI C++ mode (`-X w`).

`-K no_using_std` is the default in strict ANSI C++ mode (`-X e`) and the only possible behavior in Cfront C++ mode (`-X d`).

If `-K no_using_std` is set in the extended or strict ANSI C++ mode, the source program must contain the directive `using namespace std;` otherwise, the names must be qualified appropriately before the first call to an ANSI C++ library function.

`wchar_t_keyword`
`no_wchar_t_keyword`

These arguments can be used to define whether `wchar_t` is recognized as a keyword.

`-K wchar_t_keyword` is the default in the ANSI C++ modes. In this case, the preprocessor macro `_WCHAR_T` is defined.

`-K no_wchar_t_keyword` is the default and the only possible behavior in the Cfront C++ mode.

`bool`
`no_bool`

These arguments can be used to define whether `bool` is recognized as a keyword.

`-K bool` is the default in the ANSI C++ modes. In this case, the preprocessor macro `_BOOL` is defined.

`-K no_bool` is the default and the only possible behavior in the Cfront C++ mode.

old_for_init

new_for_init

These arguments define how an initialization directive in `for` and `while` loops is to be handled.

`-K old_for_init`

Specifies that an initialization directive has the same scope as the entire loop. This is the default setting in the Cfront C++ mode.

`-K new_for_init`

Specifies the new ANSI C++-compliant scope rule, which surrounds the entire loop in its own implicitly generated scope.

This is the default setting in the ANSI C++ modes.

no_old_specialization

old_specialization

These arguments are used to enable or disable acceptance of new template specializations `template<>` syntax.

`-K no_old_specialization` is the default setting in the Cfront C++ mode. In this case, the compiler implicitly defines the macro `__OLD_SPECIALIZATION_SYNTAX` with the value 0.

If `-K old_specialization` is specified, the compiler implicitly defines the macro `__OLD_SPECIALIZATION_SYNTAX` with the value 1.

Template options

The following options are only relevant in the ANSI-C++ modes as templates are not supported in the Cfront C++ mode.

-T none
-T auto
-T local
-T all

These options control how templates with external linkage are instantiated. This includes function templates as well as (non-static and non-inline) functions and static variables that are members of class templates. These template types are combined under the generic term "template entity" below.

In all instantiation modes, the compiler generates all instances per compilation unit that are requested with the explicit instantiation directive `template declaration` or with the instantiation pragma `#pragma instantiate template entity`.

The remaining template entities are instantiated as follows:

-T none

No instances are generated unless explicitly requested.

-T auto (default)

Instantiation is carried out globally for all compilation units by a prelinker. The prelinker is activated when an executable file is generated with the `CC` command or if the `-y` option (see [page 50](#)) is specified. No instantiations are performed by the prelinker when generating a prelinked object file (`-r` option). The principle of automatic instantiation is described in detail in [section "Automatic instantiation" on page 19](#).

-T local

Instantiation is carried out per compilation unit.

All template entities used in a compilation unit are instantiated, with internal linkage for the functions generated in the process. This provides a very simple mechanism for starting template programming. The compiler instantiates the functions required in each compilation unit as local functions. The program links them and then terminates correctly. However, this method produces a large number of copies of the instantiated functions and is therefore not recommended for production. And for the same reasons this mode is not suitable if one of the templates contains `static` variables.

Warning:

The `basic_string` template contains a static variable which is used to represent an empty string. If you use the `-T local` option and select the `string` type from the library the empty string is no longer recognized. Try to avoid using this combination as it can lead to serious problems.

`-T all`

Instantiation is carried out per compilation unit.

All template entities that are used or declared in a compilation unit are instantiated. All member functions and static variables of a class template are instantiated regardless of whether they are used or not. Function templates are also instantiated if they are just declared.

`-T add_prelink_files,pl_file1[,pl_file2...]`

This option can be used to specify objects and libraries that are taken into account as described below when the prelinker determines the instances to be generated:

pl_filei is the name of an object file (`.o` file) or a static library (`.a` file).

- If an object file or library *pl_filei* contains the definition of a function or static data member, no instance of a template entity that is a duplicate this is generated.
- If an object file or library *pl_filei* needs instances for template entities, these instances are not generated.

Problem

The `libX.a` and `libY.a` libraries contain references to the same template instances. Duplicates occur if the objects of the two libraries were each preinstantiated with the `-y` option.

In such cases, the prelinker must be informed that symbols are defined elsewhere and it should therefore not generate any instances. The `-T add_prelink_files` option is provided for this purpose.

Solution

The objects of the `libX.a` library are initially preinstantiated with the `-y` option. Then the objects of the `libY.a` library are preinstantiated, using the `-T add_prelink_files,libX.a` option to inform the prelinker to consider `libX.a` and ensure that no duplicate of this is generated.

-T `max_iterations,n`

In automatic instantiation mode (-T `auto`), this option specifies the maximum number *n* of prelinker runs. The default is *n* = 30. The number of prelinker runs is unlimited if *n* is set to the value 0.

-T `etr_file_none`

-T `etr_file_all`

-T `etr_file_assigned`

These three options are used to control the creation of an ETR file `file.etr` (ETR=Explicit Template Request) for the application of explicit template instantiation (see section 2.3.3 on [page 24](#)).

Warning:

The `etr_file_all` and `etr_file_assigned` options are ignored if they are used in conjunction with the preprocessor options `-P` / `-E` / `-M`.

-T `etr_file_none`

This is the default setting and suppresses the output of instantiation information.

-T `etr_file_all`

This option outputs all the possible template information.

-T `etr_file_assigned`

This option ensures that only those instantiation templates assigned by the prelinker are output.

-T `[no_]definition_list` or -T `[no_]d`

This options allows for internal communication between the front end and the prelinker during the recompilation phase of the automatic template instantiation. You will find more information in the section "[First instantiation using the definition list \(temporary repository\)](#)" on [page 21](#).

-K `arg1[,arg2...]`

General input rules for the `-K` option can be found on [page 42](#). The following entries are possible as *arg* arguments to control template instantiation:

assign_local_only
no_assign_local_only

These arguments determine whether or not instantiation assignments are only supported locally. If `-K assign_local_only` is set, the following applies:

- Instantiations can only be assigned to object files that are located in the current directory (local files).
- Instantiations can only be assigned to an object file if the current directory at the time of the instantiation matches the current directory at compile time.

Example

```
cd dir1          # The current directory when
CC -c test1.c   # compiling test1.c is dir1

cd ../dir2      # The current directory when
CC -c test2.c   # compiling test2.c is dir2

cd ../dir1      # The current directory for the
                # prelinker is dir1
CC -K assign_local_only -o test test1.c ../dir2/test2.o
```

In this example, the assignment of instantiations is restricted to the local object file `test1.o`.

`-K no_assign_local_only` is the default setting.

implicit_include
no_implicit_include

These arguments determine whether the definition of a template is implicitly included (see "Implicit inclusion" on [page 31](#)).

`-K implicit_include` is the default setting.

instantiation_flags
no_instantiation_flags

`-K instantiation_flags` is the default setting and causes special symbols to be generated for use by the prelinker during automatic instantiation.

If `-K no_instantiation_flags` is set, no such symbols are generated, so the object size is reduced. Consequently, no automatic instantiation with `-T auto` is possible in this case.

3.2.7 Optimization options

If none of the following optimization options are specified, the compiler does not carry out any optimization. This corresponds to the SDF `LEVEL=*LOW` option.

The separate optimization options and their effects are described in detail in the C/C++ User Guide [4] in the section “Optimization”.

`-O`

`-F O2`

These options enable the standard optimization of the compiler. The only difference between the two options is that every optimization strategy is internally executed only once for `-O`, but several times for `-F O2`. Consequently, the overall compile time at the `-O` optimization level is significantly less than the compile time required for the “highly-optimized” `-F O2` level.

The following standard optimizations are performed by the compiler:

- calculates constant expressions at compilation time
- optimizes the indexing in loops
- eliminates unnecessary assignments
- propagates constant expressions
- eliminates redundant expressions
- optimizes jumps and unconditional jump commands

In addition, registers are also optimized, but this can be disabled with the `-F r` option.

In contrast to the SDF option (where the optimization level can be set as `*HIGH` or `*VERY-HIGH` without parameters), loop unrolling is disabled here.

If the standard optimization has not been explicitly enabled with `-O` or `-F O2`, it is automatically activated at level `-O` if the `-F loopunroll` (loop expansion) or `-F i`, `-F inline_by_source` (inline substitution of user-defined functions) options are specified.

`-F I[name]`

This option allows you to specify the C library functions for which the implementation in CRTE can be assumed. This permits better optimization of the program.

When `-F I` is specified without *name*, all calls for known C library functions are handled separately.

When the `-F I` option is not specified, no call is handled separately.

When `-F I name` is specified (without a separating blank), only the *name* function is handled separately.

If several functions are to be handled separately, the `-F I name` option must be specified several times.

The `-F I` option can be specified independently of normal optimization.

The compiler achieves the greatest effect by means of inline generation of a function. In this case the function code is inserted directly in place of the function call. This eliminates time-consuming management activities required of the runtime system (e.g. saving and restoring registers or returning from the function), thus shortening program runtime.

The following C library functions can be generated inline:

abs	strcat
fabs	strlen
labs	strcmp
memcmp	strncmp
memcpy	strcpy
memset	

Functions which are generated inline cannot be replaced by other functions at linkage time, nor can they be used as test points when debugging with AID.

The default compiler optimization does not have to be activated for generating C library functions inline.

The compiler knows the semantics of the CRTE library functions. With the `-F Iname` option you command the compiler to generate optimized functions that observe the CRTE library function semantics. If no name is specified, then the compiler should use all its knowledge of the CRTE functions (the compiler knows of about 150 functions).

Functions which are not generated inline are retained as calls. However, optimizations are possible which are not feasible with the user functions. For example, the compiler can use the information that the `isdigit()` function has no side effects.

Some functions are highly specialized since they are generated to be completely inline. For these functions the compiler creates the code directly without passing it to CRTE. These functions are listed in the table above.

In some cases this optimization may not be desired. If the program is to be debugged, you may need to set a breakpoint in such a function. This is not possible for functions generated to be completely inline, or more precisely, you can set a breakpoint, but it will not be reached. The code generated by the compiler is used and not the function where the breakpoint was set.

Another case is when a function is defined with a name that is already known to the compiler. In most cases this function will use semantics different from the CRTE semantics. If a conflict between such a function and this option arises, then all calls assume the CRTE semantics. Warning CFE2067 is output in this case.

Note that the CRTE semantics are used in every compilation unit. The warning is only output in the compilation unit that contains the private definition.

`-F i[name]`
`-F inline_by_source`

These alternative options control the inline substitution of user-defined functions. As in the case of some C library functions from the standard library (see `-F I`, [page 69](#)), each call to an inline function is replaced by the corresponding function code. This saves the code sequence for the call and return and thus results in faster execution times. Specifying the `-F i`, `-F iname` or `-F inline_by_source` options automatically activates the standard optimization (`-O`) as well, unless `-F O2` was explicitly set.

`-F i` and `-F iname`

When `-F i` is specified with or without *name*, the compiler selects functions for inline substitution in accordance with its own criteria. Any existing inline pragmas and C++-specific inline functions in the source program are automatically considered by the compiler in the search for suitable candidates (see also `-F inline_by_source`).

If *name* is specified (without a leading blank!), the function *name* will also be inlined. If multiple user-selected functions are to be considered by the compiler for inline substitution, the `-F iname` option must be specified more than once. The `-F iname` option is ignored for C++ compilations, i.e. by the `CC` command.

`-F inline_by_source`

If this option is specified, only the following user-defined functions are inlined:

- For C compilations (`cc`, `c89`): C functions declared with the `#pragma inline name` directive (see also the section “inline pragma” in the C/C++ User Guide [4]). The inline pragma is not supported in C++.
- For C++ compilations (`CC`): the C++-specific inline functions. These are the functions defined within classes and functions with the `inline` attribute.

Note on inline functions in C++

The inline substitution of C++-specific inline functions is also performed when optimization is not enabled or if the `-F i` or `-F inline_by_source` options are not set. This can be suppressed with the `-F no_inlining` option.

`-F loopunroll[,n]`

This option controls loop unrolling. Multiple unrolling of the loop body speeds up loop execution. This optimization option is not used by default. If it is specified, it automatically activates the standard optimization (`-O`), unless `-O2` was explicitly set.

If `-F loopunroll` is specified without `n`, the compiler unrolls loop bodies four times. You can use `n` to specify your own unroll factor, where `n` can be set to a value between 1 and 100.

Specifying `-F loopunroll[,n]` does not guarantee that the optimizer will always carry out the loop expansion. The optimizer decides whether or not to run the loop expansion on the basis of the loop structure and specified factor `n`.

`-F no_inlining`

This option suppresses the inline substitution of C++-specific inline functions, which is performed by default even if the `-f i` or `-f inline_by_source` options have not been specified.

If the `-F no_inlining` option in combination with the `-f i` or `-f inline_by_source` option, the last specification on the command line applies.

If `-F no_inlining` is the last specified option, even the originally requested inlining of user-defined C functions is suppressed (however, the implicitly set `-O` optimization remains enabled).

The inlining of C library functions set with the `-f I` option (see page [page 69](#)) is not affected by `-F no_inlining`.

3.2.8 Options for controlling object generation

-K *arg1* [,*arg2*...]

General input rules for the -K option can be found on [page 42](#).

The following entries are possible as *arg* arguments to control object generation:

Assembler commands for subroutine entries

subcall_basr

subcall_lab

-K subcall_basr (default)

The BASR command is generated by default.

-K subcall_lab

The processor-independent LA and B assembler commands are generated.

Programs using these commands will run on all 7500 systems.

Warning: This option is not allowed in the ANSI-C++ mode.

Generating the ETPND area

The following options are used to delete the #pragma directive for generating an ETPND area (see the section “ETPND pragma” in the C/C++ User Guide [4]) or to define the date format of the ETPND area.

no_etpnd

calendar_etpnd

julian_etpnd

-K no_etpnd (default)

By default, no ETPND area is generated.

-K calendar_etpnd

The date format in the ETPND area is defined as follows:

8 bytes calendar date - 4 bytes load address.

-K julian_etpnd

The date format in the ETPND area is defined as follows:

6 bytes calendar date - 3 bytes Julian date - 4 bytes load address.

Generating the entry code for function calls`ilcs_opt``ilcs_out``-K ilcs_opt (default)`

The ILCS entry code is generated inline. This speeds up the runtime of the created object.

`-K ilcs_out`

A jump is made to the ILCS entry code for function calls in the runtime system. This reduces the module code volume. The compatibility to C-V1.0 objects is ensured.

Handling enum data`enum_value``enum_long``-K enum_value (default)`

By default, the enum data is handled as char, short or long, depending on the value range.

`-K enum_long`

enum data is always handled as type long objects.

Generating the entry names with LLMs`llm_convert``llm_keep``-K llm_convert (default)`

By default, underscore characters are converted to dollar signs when entry names are generated.

`-K llm_keep`

The underscore characters are retained when generating entry names.

The underscore character conversion applies to all external symbols in the C language modes and only the symbols declared with `external "C"` in the C++ language modes (not the entry names of the C library functions). The underscore character is always retained when coding external C++ symbols.

`no_llm_case_lower`

`llm_case_lower`

`-K no_llm_case_lower` (default)

By default, lowercase letters are converted to uppercase when entry names are generated.

`-K llm_case_lower`

The lowercase letters are retained when entry names are generated.

The lowercase to uppercase conversion applies to all external symbols in the C language modes and the Cfront C++ mode, and only the symbols declared with `external "C"` in the ANSI C++ language modes. Lowercase letters are always retained when coding external C++ symbols in the ANSI C++ modes.

Warning:

The C library functions are only available in full if one of the following combinations of options has been specified:

- `-K dollar` and `-K no_llm_case_lower`
- `-K llm_keep` and `-K llm_case_lower`

`csect_suffix=`*suffix*

`csect_hashpath`

These options specify how CSECT names are formed. By default the CSECT name is derived from the module name, and the module name is derived from the source name as long as it is not explicitly specified.

The options can be sued to generate different CSECT names when the object names are the same.

With the help of these two options, a 30 character long string is created as the basis for the real CSECT names. This basis can be output using `'-K verbose / -v'`.

The basis is changed in the usual manner by:

- converting all lower case letters to upper case letters ,
- converting all special characters such as `'_'` or `'.'` to `'$'` and
- adding `'&@'` or `'&#'` to generate real CSECT names.

With the help of these options you select different suffixes that are appended to the object names. If an object name is longer than 30 characters (not including the length of the suffix), then it is truncated.

-K csect_suffix=

With this option you specify a user-defined suffix. A maximum of 10 characters are used.

-K csect_hashpath

With this option you generate a 7 character long string from the full object path (including '..'; links are not expanded). This character string is used as the suffix.

Storing const objects

roconst

no_roconst

-K no_roconst (default)

By default, type `const` objects are stored in the data module. (WRITEABLE).

-K roconst

Type `const` objects are stored in the code module (READ-ONLY). The constants cannot be overwritten even if the `const` attribute is removed with a `cast` operator.

Caution: only global or local static constants are affected. Local auto variables with the `const` type attribute cannot be stored in the READ-ONLY area.

Storing string constants

no_rostr

rostr

-K no_rostr (default)

By default, string constants are stored in the data module (WRITEABLE). This allows the values to be overwritten if the `const` attribute is removed with a `cast` operator.

-K rostr

String constants and aggregate initialization constants are stored in the code module (READ-ONLY).

Floating-arithmetics in /390 and IEEE formats

no_ieee_floats

ieee_floats

-K no_ieee_floats (default setting)

By default, floating point data types and operations in /390 format are used.

-K ieee_floats

The IEEE format is used for floating-point data types and operations. This applies to all variables and constants of the `float`, `double` and `long double` data types inside the C/C++ programmes.

Important:

- The same C/C++ program can produce different results depending on whether the IEEE format or the /390 format is used for floating-point data types and operations. The reasons for this are as follows:
 - IEEE floating-point numbers use a different internal notation from /390 floating-point numbers.
 - IEEE floating-point operations use different semantics from /390 floating-point operations even on the same type of operation. This is the case, for example, in rounding. IEEE format uses "Round to Nearest" as default whereas /390 format uses "Round to Zero" as default.
- C++ library functions do not support the IEEE format and must therefore be replaced with C functions where necessary (see the example below).

Prerequisites for using the IEEE-Format:

- For each and every CRTE function that works with floating-point numbers in your program, you must use the corresponding or matching include file. If you do not do this, the CRTE functions will not be able to process the floating-point numbers correctly. You should ensure that you include the include file `<stdio.h>` for the function `printf()` with `#include <stdio.h>`.
- CRTE contains some C library functions which use the IEEE format for floating-point arithmetics. To ensure that the IEEE function names are correctly used, you should specify the following two options for the option `ieee_floats`:

```
-K llm_keep
-K llm_case_lower
```

Generating shareable code

```
no_share
```

```
share
```

```
-K no_share (default)
```

By default, the compiler does not generate any shareable code.

```
-K share
```

The compiler generates shareable code comprising a shared code CSECT and a non-shared data CSECT.

Modules containing shareable code can only be meaningfully further processed in a BS2000 environment (SDF).

Storing workspace variables`workspace_static``workspace_stack``-K workspace_static (default)`

By default, workspace variables are stored in the static data area.

`-K workspace_stack`

The data required for workspace variables is stored on the stack.

Multiple definition of externally visible variables`external_multiple``external_unique``-K external_multiple`

An externally visible variable that is defined in several modules is only assigned one memory area.

In order to achieve this, the variable may not be statically initialized in any of the definitions. The compiler places the memory for this variable in the COMMON area. If the variable is statically initialized during definition, the memory is placed in the data area. It is then not possible to assign it just one memory area.

This behavior is the default in K&R C mode.

`-K external_unique`

Externally visible variables may only be defined in just one module and must be declared as `external` in all other modules. The memory space for such variables is placed in the data module of the object in which the variable was defined.

This behavior is the default in the ANSI C and all C++ language modes. The default may not be changed in the C++ language modes.

Length of external C names

The following options define the length of external C names and affect all external symbols in the C language modes, but only the symbols declared with `extern "C"` in the C++ modes (not the entry names of C library functions).

`c_names_std``c_names_unlimited``c_names_short``-K c_names_std (default)`

By default, external C names may be a maximum of 32 characters long. Longer names are truncated by the compiler to 32 characters. Only 30 characters are allowed when generating shareable code (`-K share`).

`-K c_names_unlimited`

Names are not truncated. In this case, the compiler generates entry names in EEN format. EENs can have a length of up to 32000 characters. Modules containing EENs are saved by the compiler in LLM Format 4. More detailed information on how LLMs in Format 4 are processed further can be found on [page 83](#)

(`-B extended_external_names`).

EENs are not supported in the Cfront C++ mode.

`-K c_names_short`

External C names are truncated to 8 characters.

Note

Options which affect the length of external names also affect the names of static functions as the compiler handles the names of static functions like the names of external functions.

3.2.9 Debug option

-g

The compiler generates additional information (LSD) for the AID debugger. By default, no debugging information is generated.

A program, i.e. an executable file generated by the link editor, can be debugged in the POSIX shell with the `debug` command. Once this command is input, the user is in BS2000 mode (indicated by `%DEBUG/`). The AID commands are then input as described in the manual “AID Debugging of C/C++ Programs” [10]. The POSIX shell is the current environment after the program is terminated.

A description of the `debug` command can be found in the manual “POSIX Commands” [2].

3.2.10 Runtime options

The following options can be used during compilation of programs containing the `main` function, to influence their behavior at runtime

-K *arg1[,arg2...]*

General input rules for the -K option can be found on [page 42](#).

The following entries are possible as *arg* arguments to control the runtime behavior:

`integer_overflow`

`no_integer_overflow`

-K `integer_overflow` (default)

By default, the program mask is set to `X'0C'` in compliance with the ILCS convention.

-K `no_integer_overflow`

The program mask is set to `X'00'`.

The two program masks have the following effect:

	<code>X'0C'</code>	<code>X'00'</code>
Fixed point overflow	allowed	suppressed
Decimal overflow	allowed	suppressed
Exponent underflow	suppressed	suppressed
Mantissa null	suppressed	suppressed

Notes

The ILCS program mask may not be changed with mixed code!

The `-K integer_overflow` option does not affect the selection of generated commands. The result is that permitting INTEGER-OVERFLOWS does not necessarily mean that an overflow is triggered in all cases.

prompting

no_prompting

`-K prompting` (default)

If the program is called from the BS2000 environment (SDF), a prompt line is output in which parameters can be specified for the `main` function or for redirecting the standard I/O stream.

`-K no_prompting`

No prompt line is output.

This option has no effect if the program is started from the POSIX shell as the parameters are always specified in the command line in this case.

statistics

no_statistics

`-K statistics` (default)

The used CPU time is output when a program generated with this option is terminated. However, this only occurs when the program is transferred to BS2000 and is started there.

`-K no_statistics`

The used CPU time is not output.

stacksize=*n*

The `-K stacksize` option can be used to input a number *n* (8 to 99999) which defines the number of KB to be reserved for the first segment of the C runtime stack. The default is 64 KB.

`-K environment_encoding_std`

`-K environment_encoding_ebcdic`

These options enable the encoding of external strings, such as arguments of `main` and environment variables, to be controlled.

These options are only effective with sources which contain the `main` function.

-K environment_encoding_std (default).

The external strings are encoded in the way specified in the options

-K literal_encoding_ascii, -K literal_encoding_ascii_full,

-K literal_encoding_ebcdic or -K literal_encoding_ebcdic_full

-K environment_encoding_ebcdic

This option is offered for reasons of compatibility. Despite

-K literal_encoding_ascii or -K literal_encoding_ascii_full

being specified, external strings are encoded in EBCDIC.

The table below explains the option combinations and the encoding of the external strings:

	environment_encoding_std	environment_encoding_ebcdic
literal_encoding_ebcdic*	EBCDIC	EBCDIC
literal_encoding_ascii*	ASCII	EBCDIC

3.2.11 Link editor options

The following link editor options are not evaluated if one of the `-c`, `-E`, `-M` or `-P` options are specified (terminate the compiler run after compilation or after the preprocessor run, see [page 49](#)).

All options in the `cc/c89/CC` command that are not known to the compiler, i.e. options which begin with an unrecognized letter after the hyphen "-", are passed through to the link editor.

`-B extended_external_names`

`-B short_external_names`

This option controls the handling of symbol names in Extended External Name (EEN) format by the link editor.

EENs, i.e. untruncated external C++ symbols are generally contained in modules that were generated with the compiler in the ANSI C++ mode.

Untruncated external C symbols are generated only if the `-K c_names_unlimited` option is specified at compilation (see [page 78](#)).

If this is the case, even external C symbols are not truncated to 32 bytes by the compiler.

Modules with EENs are stored by the compiler in LLM Format 4. The modules of the C++ libraries and of the CRTE runtime systems used in ANSI C++ mode are also provided in LLM Format 4.

Note, however, that BLSSERV V2.0 or later (which can be currently used as of BS2000/OSD V3.0) is required in order to load LLMs in Format 4 with the dynamic binder-loader DBL.

If the modules generated by the compiler do not include any EENs, i.e. are in LLM Format 1, this option has no effect, since the link editor always generates LLM Format 1 in accordance with the input format in this case.

By default, i.e. if the `-B` option is not specified, the LLM format generated by the link editor depends on the BS2000/OSD version under which the `cc/c89/CC` command is executed:

BS2000/OSD Versions 1 to 3:

From the original LLM Format 4, the link editor generates a format that is compatible with DBL (< BLSSERV V2.0), i.e. LLM Format 1. The result module will then no longer contain any EENs. LLMs in Format 1 cannot be linked partially, i.e. first linked with unresolved external references to EENs and then linked further on an incremental basis.

BS2000/OSD Version 4 or higher:

The link editor generates LLM Format 4. The EENs remain in the result module without being truncated. LLMs in Format 4 can be partially linked, i.e. first linked with unresolved external references to EENs and then processed further as desired by means of the link editor (as of BLSSERV V2.0).

-B extended_external_names

This entry is needed if the link editor is running in BS2000/OSD Versions 1 to 3 and is to generate LLM Format 4. By default, LLM Format 1 is generated in BS2000/OSD Versions 1 to 3.

-B short_external_names

This entry is needed if the link editor is running in BS2000/OSD Version 4 and is to generate LLM Format 1. By default, LLM Format 4 is generated in BS2000/OSD Version 4 and higher.

Summary of generated LLM formats

Input format	Option -B	Output format	
		OSD V1-3	OSD V4
LLM 1	no entry extended_external_names / short_external_names	LLM 1	LLM 1
LLM 4 (EEN)	no entry	LLM 1	LLM 4
	short_external_names	LLM 1	LLM 1
	extended_external_names	LLM 4	LLM 4

-d y

-d n

-d compl

This option affects linking the C runtime system.

By default, i.e. if the option is either not specified or -d y is specified, a RESOLVE for the standard C libc.a library is issued to the SYSLNK.CRTE.PARTIAL-BIND library. Instead of the complete C runtime system being linked in, only a connection module is linked that satisfies all unresolved external references to the C runtime system. The C runtime system itself is loaded dynamically at runtime, either from class 4 memory if the C runtime system has been preloaded, or from the SYSLNK.CRTE.

If -d n is specified, the C runtime system is linked in completely from the SYSLNK.CRTE.

The complete partial bind method of the CRTE is supported with the `-d compl` option. To accomplish this the SYSLNK.CRTE.COMPL library is linked in. You will find a detailed description of the complete partial bind method in the "CRTE" [5] manual.

In the ANSI-C++ mode the special library SYSLNK.CRTE.CPP-COMPL is linked instead of the standard libraries SYSLNK.CRTE.STDCPP and SYSLNK.CRTE.RTSCPP. This library is also used instead of SYSLNK.CRTE.TOOLS.

Note

The complete partial bind method is not supported in the CFRONT-C++ mode. The option `-d compl` is reset to `-dy` in this case.

`-K arg1[,arg2...]`

General input rules for the `-K`-option can be found on [page 42](#).

The following entries are possible as *arg* arguments to control the link editor:

`link_stdlibs`

`no_link_stdlibs`

`-K link_stdlibs` is the default setting and causes certain standard libraries to be automatically linked in (see also the `-l` option, [page 86](#)). This means that the corresponding `-l` options are automatically set for these libraries:

1. Only with the CC command

`-l Cstd` in the ANSI C++ modes

`-l C` and in Cfront C++ mode

2. Always

`-l c`

If `-K no_link_stdlibs` is specified, the above libraries are not linked in automatically. This is, for example, meaningful if the `-y` option is used to terminate compilation after prelinking (see [page 50](#)) or if a prelinked object file is generated with the `-r` option (see [page 88](#)).

-l *x*

This option instructs the link editor to search the library named `libx.a` for resolving external references via autolink. By default the link editor searches for the library in the following directories in the order given below:

1. The directories specified with `-L`
2. Either the directories specified with the `-Y P` option (see [page 89](#)) or the standard `/usr/lib` directory.

`-l x` falls into the category of operands and can also be specified with `--` after options have been input (see also “Operands” on [page 42](#)).

The standard libraries of the C and C++ runtime system are not installed in the POSIX file system `/usr/lib` directory, they are stored as PLAM libraries in BS2000.

Assignment of standard code *x* to the BS2000 PLAM libraries:

<i>x</i>	Library name	Contents
c	SYSLNK.CRTE.PARTIAL-BIND	Connection module for loading the C runtime system dynamically (default)
	SYSLNK.CRTE	Separate modules for completely linking the C runtime system (with <code>-d n</code>)
m	see c	
C	see c	
	SYSLNK.CRTE.CFCPP	Cfront C++ runtime system
	SYSLNK.CRTE.CPP	Cfront C++ library for input/output and complex mathematics
Cstd	see c	
	SYSLNK.CRTE.RTSCPP	ANSI C++ runtime system
	SYSLNK.CRTE.STDCPP	Standard C++ library
RWtools	SYSLNK.CRTE.TOOLS	C++ library Tools.h++

The link editor only resolves the unresolved external references from these PLAM libraries if the `-l x` option is used and not if the path name is specified explicitly (e.g. `/usr/lib/libRwtools.a`) using the *file.suffix* operand (see [page 42](#))!

`-l c` is implicitly added as the last `-l` option for the `cc` and `c89` commands, `-l C` for the `CC` command in the Cfront C++ mode, and `-l Cstd` for the `CC` command in the ANSI C++ modes (does not apply for `-K no_link_stdlibs`).

The order and position in which the `-l` options and any object files (or source files from which the compiler generates object files) are specified in the command line is significant to the link process.

For example, the program would be linked correctly with the `CC test.c -l Rwtools` command, but the `CC -l Rwtools test.c` command would lead to an error.

`-l BLSLIB`

This option instructs the link editor to search PLAM libraries which were assigned with the `BLSLIB nn` ($00 \leq nn \leq 99$) shell environment variable.

The environment variables must be supplied with the library names and exported with the POSIX `export` command before the compiler is called. The libraries are searched in ascending order nn .

The number assignment nn must be sequential, without gaps and start with 00!

A separate RESOLVE directive to the link editor is generated internally for each BLSLIB environment variable. It may be necessary to assign the environment variables several times to libraries with cyclic dependencies (e.g. with forward and reverse references), and not just once.

`-l BLSLIB` falls into the category of operands and can also be specified with `--` after options have been input (see also “Operands” on [page 42](#)).

Example

The library assigned with BLSLIB00 contains unresolved external references to the library assigned with BLSLIB01 and this in turn contains unresolved external references to the BLSLIB00 library (reverse references).

```
BLSLIB00='RZ99.SYSLNK.CCC.999'
BLSLIB01='MYTEST.LIB'
BLSLIB02='RZ99.SYSLNK.CCC.999'
export BLSLIB00 BLSLIB01 BLSLIB02
c89 mytest.o -l BLSLIB
```

-L *dir*

The *dir* option can be used to specify an additional directory in which the link editor is to search for libraries specified with `-l` options. By default, only the `/usr/lib` directory is searched for the libraries. A directory specified with `-L` is searched before the standard `/usr/lib` directory or before the directories specified with the `-Y P` option. The order in which the `-L` options are specified in the command line determines the link editor search order.

This option only falls into the category of operands for the `cc` and `CC` commands and can therefore only be specified with `--` after the options have been input (see also “Operands” on [page 42](#)).

-r

Several object files can be prelinked to form a single object file with this option. A prelinked object file is not executable, but contains the relocation information required to repeat a linkage run.

The following options are set implicitly when prelinking with `-r`:

`-K no_link_stdlibs` (see [page 85](#)) and `-B extended_external_names` (see [page 83](#)). This means that the C/C++ standard libraries are not linked and that LLM Format 4 is generated in the case of long C and C++ names (EENs). The `-K link_stdlibs` and `-B short_external_names` options, if specified, are ignored. Note that BLSSERV V2.0 must always be available in the ANSI C++ modes and also in the C modes whenever long C names (EENs) are used so that the prelinked object files can be processed further (i.e. linked). No instantiations by the prelinker are performed when generating a prelinked object file.

Unresolved references do not cause error messages to be output.

The prelinked object file is given the name `a.out` or the name specified with the `-o` option. The object file can only be meaningfully further processed (linked) if the name of the prelinked object file is suffixed with `.o` or with a suffix which can be defined with the `-Y F` option (see [page 47](#)).

-S

Symbol table information is stripped from the output file. The sections with additional information for troubleshooting and with line numbers and associated offset information are also removed.

The option is ignored if debugging information for AID is simultaneously requested (`-g` options). It is also ignored in all C++ modes as the symbol tables are required at runtime for global initialization. The option corresponds to the link editor `SAVE-LLM SYMBOL-DICTIONARY=*NO` directive.

-Y *P, dir1[:dir2...]*

Instructs the link editor to search for libraries in the directories specified with *dir* last. Without this option, the last directory to be searched is the standard `/usr/lib` directory.

-z `nodefs`

This option is only supported when linking C programs (`cc`, `c89`). Specifying this option allows a C program to be linked in which all external references to the standard C library `libc.a` remain unresolved, i.e. no `RESOLVE` is issued to the library `SYSLNK.CRTE.PARTIAL-BIND` or `SYSLNK.CRTE`. The unresolved external references are resolved dynamically at runtime from the C runtime system which is preloaded into class 4 memory.

If this option is used, unresolved externals to user modules are ignored and not reported. Information on unresolved external references is only output when the program is loaded.

-z `dup_ignore`

-z `dup_warning`

-z `dup_error`

These options control the behavior of duplicates during linking.

-z `dup_ignore`

Duplicates are ignored during linking.

This is the default.

-z `dup_warning`

Duplicates during linking result in a warning being issued.

-z `dup_error`

Duplicates during linking result in an error.

Programs which contain duplicates cannot be executed in POSIX.

The compiler cannot specify any duplicates which are found by name, but they are output when an attempt is made to start the program.

The modules which contain the duplicates can be found using the `BINDER` listing (see `-N binder`, [page 92](#)) and possibly also with the name mangler `nm`.

3.2.12 Options for controlling message output

More detailed information on the compiler message output can be found in the C/C++ User Guide [4] in the section “Structure of the compiler messages”.

`-R diagnose_to_listing`

This option allows you to sort diagnostic information (normally sent to `stderr`) as a special “result listing” and to copy this to the end of the listing file. Note: the messages are sorted according to their message weighting.

`-R limit,n`

This option defines the maximum number of errors tolerated by the compiler before it aborts the compilation run. Notes and warnings are counted separately. The default value is $n = 50$. If $n = 0$, the compiler will attempt to continue compiling as long as possible, regardless of the number of errors that have occurred.

`-R min_weight,min_weight`

This option defines the minimum error weight (i.e. severity code) as of which diagnostic messages from the compiler are to be output to the standard error output `stderr`.

`-R min_weight,warning` is the default setting. The following entries are possible for *min_weight*:

<code>notes</code>	All messages are output, i.e. even the notes.
<code>warnings</code>	The output of notes is suppressed (default).
<code>errors</code>	The output of notes and warnings is suppressed.
<code>fatals</code>	The output of notes, warnings and errors is suppressed.

`-R note,msgid,[msgid...]`

`-R warning,msgid,[msgid...]`

`-R error,msgid,[msgid...]`

These options can be used to change the default severity code of diagnostic messages. *msgid* is the corresponding message number. The severity code for fatal errors cannot be changed. This also applies to errors, unless they have been explicitly marked in the original message with an asterisk: [`*error`]. Depending on the language mode or the position in the code, the same message ID *msgid* can have a different severity code (warning or error).

-R show_column

-R no_show_column

This option determines whether the diagnostic messages of the compiler are generated in short or long form.

-R show_column is the default setting, which means that the original source program line is shown with the error location marked (with ^) in addition to the diagnostic message itself.

If -R no_show_column is specified, the marked source program line is not output.

-R strict_errors

-R strict_warnings

This option can only be used meaningfully in the strict ANSI C/C++ modes (-X c, -X e).

-K strict_warnings is the default, which means that warnings are issued for language constructs that deviate from the ANSI/ISO standard, but do not represent a serious violation of the semantic rules defined therein (e.g. implementation-dependent language extensions; see the C/C++ User Guide [4]).

If -K strict_errors is specified, such cases are treated as errors with corresponding messages.

More serious violations automatically lead to errors.

-R suppress ,msgid,[msgid...]

Suppresses the output of the message with the message ID *msgid*. Some messages (e.g. fatal errors) cannot be suppressed.

-R use_before_set

-R no_use_before_set

-R use_before_set is the default setting and causes warnings to be issued if local auto variables are used in the program before being assigned a value.

If -R no_use_before_set is specified, the output of such warnings is suppressed.

-v

The output of messages with this option is the same as for the option combination

-R min_weight,notes and -K verbose.

-w

This option is a synonym for -R min_weight,errors.

3.2.13 Options for outputting listings and CIF information

`-N binder[,file]`

This option, which is analogous to the MAP operand of the BINDER statement SAVE-LLM, can be used to request the standard listings of BINDER. These listings are created only when an executable file or a prelinked object file (`-r`) is generated. If *file* is not specified, the BINDER listings are written to an output file *file.lst*, where *file* is the name of the executable or the prelinked object file (`a.out` or the name defined with the `-o` option). *file* can be used to specify some other output file name. The `-N binder` option is ignored if specified in combination with any of the options `-c`, `-E`, `-M`, `-P` or `-y`.

`-N cif,[output-spec],consumer1[,consumer2 ...]`

(*output-spec* is a file or a directory).

The compiler generates a CIF (Compilation Information File) containing information for the specified *consumers*. If *output-spec* is not specified, the CIF is written into a separate file named *sourcefile.cif* for each compiled source file. A different output file name can be defined with *output-spec*. In this case, only one source file can be compiled. The global listing generator `cclistgen` is provided to further process the generated CIF information (see [page 99](#)).

The following entries can be made for *consumer*:

```
option
prepro
source_error
data_allocation_map
cross_reference
object
project (only with the CC command)
summary
ALL
```

If ALL is specified, all possible CIF information is generated, e.g. when the compiler run is terminated after the preprocessor phase (`-E`, `-P` options), CIF information for an options, preprocessor and statistics listing. The CIF may be very large if ALL is specified!

`-N listing1[,listing2...]`

The compiler writes the listings requested with this option either into a separate *sourcefile.lst* file for each compiled source file or for all compiled source files into the listing file *file* specified with the `-N output` option.

When the maximum number of errors is reached (controlled by `-R limit`), no source program information will be output to the source/error list. At this point the source/error list can no longer taken as a reliable guide to real error status.

The following entries are possible for *listing*:

`option` or `lo` (options listing)

`prepro` or `lp` (preprocessor listing)

`source_error` or `ls` (source program/error listing)

`data_allocation_map` or `lm` (map listing)

`cross_reference` or `lx` (cross-reference listing, see also the `-N xref` option)

`object` or `la` (object listing)

`project` or `lP` (project listing, only with the `CC` command)

`summary` or `lS` (statistics listing)

`ALL`

If `ALL` is specified, all possible CIF information is generated, e.g. when the compiler run is terminated after the preprocessor phase (`-E`, `-P` options), an options, preprocessor and statistics listing.

Examples for the structure of compiler listings can be found in the section “Description of listings” of the C/C++ User Guide [4].

`-N output[, [output-spec][, layout][, [lpp][, cpl]]]`

This option can be used to specify the name of the output file (*output-spec*) or output directory in which the compiler listings for all source files are to be written.

If *output-spec* is not specified, a separate listing file *sourcefile.lst* is generated for each compiled source file.

If *output-spec* specifies an existing output directory, the name *output-spec/sourcefile.lst* is assigned by default. If this is not the case, the name *output-spec* is interpreted as the file name.

The following entries can be made for *layout*:

`normal` or `for_normal_print` (default)

The default page length is 64 lines and the line width 132 characters.

`rotation` or `for_rotation_print`

The page length for the compiler listing is defined as 84 lines and the line width as 120 characters.

lpp can be used to define a page length of from 11 to 255 lines per page.

cpl can be used to define a line width of from 120 to 255 characters per line.

Note

Since the output file is prepared for printing under POSIX, there are up to 3 control characters at the beginning of some lines in the file. In addition, every line is terminated with the printer control character for a carriage return. If the output file is printed out, then the line length is `cp1 - 1`.

`-N title, text`

This operand can be used to specify if an additional line is to appear in the header of the listing and the text that is to be entered in it. In contrast to pragmas, which only apply to source and preprocessor listings, the `-N title` option applies to all compiler listings. In order to ensure that the desired text is transferred correctly, it is advisable to enter it within quotes ("*text*"). In the case of source and preprocessor listings, `TITLE` and `PAGE` pragmas (if any) override the `-N title` specification. See also the section on "Pragmas to control the layout of listings" in the C/C++ User Guide [4].

`-N xref, xrefopt1[, xrefopt2...]`

The sections contained in the cross-reference listing requested with `-N cross_reference` can be controlled with this option.

If the `-N xref` option is not specified, the cross-reference listing contains a list of the variables, functions and labels (equivalent to `-N xref, v, f, l`).

The cross-reference listing always contains a `FILETABLE` section containing the names of all files, libraries and members that the compiler used as sources.

If the `-N xref` option is specified, the cross-reference listing only contains the `FILETABLE` section and the sections requested with the `xrefopt` argument:

- `p` List of the names processed by the preprocessor in `#include` and `#define` statements
- `y` List of the user-defined types (typedefs, structure, union, classes and counter types)
- `v` List of variables
- `f` List of functions
- `l` List of labels
- `t` List of templates (only with C++ compilations)
- `o=str` The order in which the separate sections are listed in the cross-reference listing. *str* is a string of up to 6 characters (letters for the lists shown above). The default is the order as shown above (i.e., `o=pyvflt`). If the order specified with `o=str` does not include all letters for the listings requested with `-N xref`, the omitted letters are implicitly appended to the end of *str* in the default order shown above.

-K *arg1[,arg2...]*

General input rules for the -K option can be found on [page 42](#).

The following entries are possible as *arg* arguments to control the listing output:

include_user
include_all
include_none

These arguments control whether and which header files are mapped to the source program, preprocessor and cross-reference listings.

-K include_user is the default and only maps the user header files.

If -K include_all is specified, all header files are mapped, i.e. the standard header files and those of the user.

If -K include_none is specified, no header files are mapped.

cif_include_user
cif_include_all
cif_include_none

These arguments control whether and from which header files (also called include files) the CIF information for source/error, preprocessor and cross-reference listings is to be generated.

-K cif_include_user is the default and causes only the user-defined header files to be considered in the CIF.

If -K cif_include_all is specified, all header files, i.e., the standard headers and the user-defined headers, are considered in the CIF.

If -K cif_include_none is specified, none of the header files are considered in the CIF.

pragmas_interpreted
pragmas_ignored

These arguments control whether `#pragma` directives for controlling the layout of listings are evaluated (see also the section “Pragmas to control the layout of listings” in the *C/C++ User Guide* [4]).

-K pragmas_interpreted is the default.

3.3 Files

<i>file.c/.C</i>	C source file (cc, c89) or C++ source file (CC) before the preprocessor run
<i>file.cpp/.CPP/.cxx/.CXX/.cc/.CC/.c++/.C++</i>	C++ source file before the preprocessor run
<i>file.i</i>	C source file (cc, c89) after the preprocessor run
<i>file.I</i>	C++ source file) after the preprocessor run
<i>file.o</i>	LLM object file
<i>file.a</i>	Static library containing object files created with the <code>ar</code> utility
<i>file.lst</i>	File containing compilation listings
<i>file.cif</i>	File containing CIF information for further processing with the global listing generator <code>cc1istgen</code>
<i>file.etr</i>	File containing explicit instantiation statements
<i>file.o.i.i</i>	Information file for automatic template instantiation (used internally)
<i>a.out</i>	Executable file
<i>file.mk</i>	Preprocessor output file for further processing with <code>make</code>
<i>/var/tmp/...</i>	Temporary files used during compilation

3.4 Environment variables

The `cc/c89/CC` commands can be influenced with the following environment variables:

<code>LANG, LC_MESSAGES</code>	Message output language
<code>NLSPATH</code>	Search path for the message catalog (currently not used)
<code>TMPDIR</code>	Name of the directory in which temporary files are stored
<code>BLSLIBmn</code>	Assignment of PLAM libraries which the link editor is to search with <code>autolink</code>
<code>IO_CONVERSION</code>	Automatic conversion (<code>IO_CONVERSION=YES</code>) from ASCII to EBCDIC.

3.5 Predefined preprocessor names

When the compiler is called with `cc`, `c89` or `CC`, specific options, preprocessor macros and predicates are predefined, dependent on the command.

Predefined preprocessor macros (defines)

<code>_BOOL</code>	In the ANSI C++ modes (<code>-X wle</code>) with the <code>-K bool</code> option (default)
<code>__CGLOBALS_PRAGMA</code>	Always set
<code>__cplusplus</code>	In all C++ language modes: == 1 in Cfront C++ mode (<code>-X d</code>) == 2 in extended ANSI C++ mode (<code>-X w</code>) == 199612L in strict ANSI C++ mode (<code>-X e</code>)
<code>cplusplus</code>	In all C++ language modes (<code>-X dlwle</code>)
<code>__CFRONT_V3</code>	In Cfront C++ mode (<code>-X d</code>)
<code>__EDG_NO_IMPLICIT_INCLUSION</code>	In the ANSI C++ modes (<code>-X wle</code>) if implicit inclusion was disabled during template instantiation (<code>-K no_implicit_include</code>)
<code>__EXISTCGLOB</code>	Always set
<code>LANGUAGE_C</code>	Input file is a C or C++ source file
<code>_LANGUAGE_C</code>	Input file is a C or C++ source file
<code>_LONGLONG</code>	<code>-K longlong</code> option
<code>__OLD_SPECIALIZATION_SYNTAX</code>	In the ANSI C++ modes (<code>-X wle</code>) == 1 with the <code>-K old_specialization</code> option == 0 with the <code>-K no_old_specialization</code> option (default)
<code>_OSD_POSIX</code>	Always set
<code>__OSD_POSIX</code>	Always set
<code>__SIGNED_CHARS__</code>	<code>-K schar</code> option
<code>__SNI</code>	In all C modes (<code>-X tlalc</code>) and in Cfront C++ mode (<code>-X d</code>)
<code>__SNI_HOST_BS2000_POSIX</code>	Always set

<code>__SNI__STDCplusplus</code>	In all C++ language modes: == 0 in Cfront and in extended ANSI C++ mode (-X dlw) == 1 in strict ANSI C++ mode (-X e)
<code>__SNI_TARG_BS2000_POSIX</code>	Always set
<code>__STDC__</code>	Always set: == 0 in the K&R C (-X t), extended ANSI C (-X a), Cfront C++ (-X d) and extended ANSI C++ (-X w) language modes == 1 in the strict ANSI C (-X c) and strict ANSI-C++ (-X e) language modes
<code>__STDC_VERSION__</code>	Undefined in K&R C mode (-X t) == 199409L in the ANSI C language modes in all C++ modes
<code>_STRICT_STDC</code>	In the strict ANSI C and C++ language modes (-X c, -X e)
<code>_WCHAR_T</code>	In the ANSI C++ modes (-X wle) with the -K wchar_t_keyword option (default) If this option is not set (e.g. in the C modes or in Cfront C++ mode), <code>_WCHAR_T</code> is defined in several standard includes to issue a typedef for <code>wchar_t</code>
<code>_WCHAR_T_KEYWORD</code>	In the ANSI C++ modes (-X wle) with the -K wchar_t_keyword option (default)
<code>_XPG_IV</code>	With the c89 calling command

Predefined preprocessor predicates (#assert)

<code>data_model(bit32)</code>	Always set
<code>cpu(7500)</code>	With /390 code generation
<code>machine(7500)</code>	With /390 code generation
<code>system(bs2000)</code>	Always set

4 Global listing generator (cclistgen)

The global listing generator is called with the `cclistgen` command. The input sources for the listing generator are the CIFs (Compilation Information Files) generated by the compiler and written into a file `sourcefile.cif` or into an explicitly specified file `file` (see the `-N cif` option on [page 92](#)). The generated listings are written by default to `stdout` or into an output file specified in the `-o` option. The listing generator creates global module cross-reference and project listings from the local module cross-reference and project listing CIF information. The remaining listings are generated per source file.

4.1 Calling syntax

```
cclistgen [option] ... operand ...
```

Mixing options and operands is not allowed. The “options first, operands last” order must be adhered to.

Options

No *option* specified

A source/error listing is generated and output to `stdout`.

option

Options can be used to control the type and scope of the listings to be generated. The options are described in the next section (on [page 101ff](#)).

If `cclistgen` is called with illegal options, the program outputs an error message and terminates with an exit status `>0`.

Operands*cif file*

Name of the CIF file from which a listing is to be generated. An unlimited number of CIF files can be specified, but at least one must be. The syntax of the `.cif` extension is not checked, i.e. other file names are accepted (see also the `-N cif` compiler option on [page 92](#)).

Exit status

The exit value 0 is returned if the listing was generated successfully; an exit value >0 is returned if an error occurred.

4.2 Options

`-o` *outputfile*

The global listing is written to the file *outputfile*. If *outputfile* contains a directory path section, the file is written into it, otherwise into the current directory. The listing is output to `stdout` by default. If the `-o` option is used, the output codeset (ASCII or EBCDIC) is determined by the destination system codeset. However, BS2000 print control characters are always generated.

`-V`

The version and a copyright message are output to `stderr`.

`-N` *listing1*[, *listing2*...]

The listing generator writes the listings requested with this option either to `stdout` or into the file specified with the `-o` *outputfile* option.

The following can be specified for *listing*:

`option` or `lo` (options listing)

`prepro` or `lp` (preprocessor listing)

`source_error` or `ls` (source/error listing)

`data_allocation_map` or `lm` (map listing)

`cross_reference` or `lx` (cross-reference listing)

`object` or `la` (object listing)

`project` or `lP` (project listing, only with the `CC` command)

`summary` or `lS` (statistics listing)

`ALL`

If `ALL` is specified, all possible listings are generated, e.g. when the compilation run is terminated after the preprocessor phase (`-E`, `-P` option), an options, preprocessor and statistics listing.

`-N` `output` [, *layout*][, [*lpp*][, *cpl*]]

The layout of the global listing can be influenced with this option.

Four specifications are possible for *layout*:

`normal` or `for_normal_print` (default)

The default for the page length is 64 lines and for the line width 132 characters.

`rotation` or `for_rotation_print`

Defines the page length as 84 lines and the line width as 120 characters.

A page length of from 11 to 255 lines can be defined with `lpp`.

A line width of from 120 to 255 characters can be defined with `cpl`.

Note

Since the output file is prepared for printing under POSIX, there are up to 3 control characters at the beginning of some lines in the file. In addition, every line is terminated with the printer control character for a carriage return. If the output file is printed out, then the line length is `cpl - 1`.

`-N title, text`

This operand can be used to specify if an additional line is to appear in the header of the listing and the text that is to be entered in it. In contrast to pragmas, which only apply to source and preprocessor listings, the `-N title` option applies to all compiler listings. In order to ensure that the desired text is transferred correctly, it is advisable to enter it within quotes ("`text`"). In the case of source and preprocessor listings, `TITLE` and `PAGE` pragmas (if any) override the `-N title` specification. See also the section on "Pragmas to control the layout of listings" in the C/C++ User Guide [4].

`-N xref, xrefopt1[, xrefopt2...]`

This option can be used to control which sections are included in the cross-reference listing requested with the `-N cross_reference` option. If the `-N xref` option is not specified, the cross-reference listing contains a list of the variables, functions and labels (equivalent to `-N xref, v, f, l`).

The cross-reference listing always contains a `FILETABLE` section with the names of all files, libraries and members that the compiler used as sources.

If the `-N xref` option is specified, the cross-reference listing contains the `FILETABLE` section and only the sections requested with the `xrefopt` argument. The following can be specified for `xrefopt`:

- `p` List of the names in `#include` and `#define` directives processed by the preprocessor.
- `y` List of the user-defined types (typedefs, structure, union, classes and counter types)
- `v` List of variables
- `f` List of functions
- `l` List of labels
- `t` List of templates (only with C++ compilations)

`o=str` The order in which the separate sections are listed in the cross-reference listing. *str* is a string of 6 characters maximum (letters for the listings shown above). The default is the order shown above (i.e. `o=pyvflt`). If the order specified with `o=str` does not include all letters for the listings requested with `-N xref`, the omitted letters are implicitly appended to the end of *str* in the default order shown above.

`-K arg1[,arg2...]`

General input rules for the `-K` option can be found on [page 42](#).

The following entries are possible as *arg* arguments to control the listing output:

`include_user`

`include_all`

`include_none`

These options control whether and which header files are mapped to the source program, preprocessor and cross-reference listing.

`-K include_user` is the default and causes only the user header files to be mapped.

If `-K include_all` is specified, all header files, i.e. the standard and the user header files, are mapped.

No header files are mapped if `-K include_none` is specified.

`pragmas_interpreted`

`pragmas_ignored`

These arguments control whether `#pragma` directives are evaluated to control the layout of the listing (see also the section “Pragmas to control the layout of listings” in the C/C++ User Guide [4]).

`-K pragmas_interpreted` is the default.

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The manuals are available as online manuals, see <http://manuals.fujitsu-siemens.com>, or in printed form which must be paid and ordered separately at <http://FSC-manualshop.com>.

- [1] **POSIX** (BS2000/OSD)
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- [2] **POSIX** (BS2000/OSD)
Commands
User Guide
- [3] **C Library Functions** (BS2000/OSD)
for POSIX Applications
Reference Manual
- [4] **C/C++ V3.2A** (BS2000/OSD)
C/C++ Compiler
User Guide
- [5] **CRTE** (BS2000/OSD)
Common RunTime Environment
User Guide
- [6] **C++** (BS2000)
C++ Library Functions
- [7] **AID V2.3B** (BS2000/OSD)
Debugging of C/C++ Programs
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- [8] **Tools.h++ V7.0**
User Guide
- [9] **Tools.h++ V7.0**
Class Reference

- [10] **C++ Library Functions** (BS2000)
Reference Manual
- [11] **AID** (BS2000/OSD)
Advanced Interactive Debugger
Debugging of C/C++ Programs
User Guide

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- [12] The C Programming Language
3rd. Edition - ANSI-C
by Brian W. Kernighan und Dennis M. Ritchie
- [13] The C++ Programming Language
(2nd. Edition)
by Bjarne Stroustrup
- [14] The C++ Programming Language
(Third Edition)
by Bjarne Stroustrup
- [15] „American National Standard for Information Systems - Programming Language C“,
Doc.No. X3J11/90-013, February 14, 1990 bzw.
„International Standard ISO/IEC 9899 : 1990, Programming languages - C“
- [16] „International Standard ISO/IEC 9899 : 1990, Programming languages - C /
Amendment 1 : 1994“
- [17] „Working Paper for Draft Proposed International Standard for Information Systems -
Programming Language C++“,
Doc.No. X3J16/96-0219R1, WG21/N0137, Dec 2 1996

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10772 Berlin

- [18] „International Standard ISO/IEC 14882 : 1998, Programming languages - C++“

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