

# CC-RL

C++

User's Manual

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## 1. OUTLINE

This user's manual describes the specifications and notes when using the option `-lang=cpp14`, which allows the compiler to compile the source program with C++14 standard and is a part of the C compiler package for RL78 family CC-RL V1.14.00.

Please also refer to the CC-RL User's Manual as well.

### 1.1 Feedback on the option `-lang=cpp14`

Please send your feedback on this feature from the URL below:

<https://forms.office.com/r/wSGqp6BKic>

### 1.2 Copyrights

This software uses the following softwares.

- LLVM and Clang are copyrights of University of Illinois at Urbana-Champaign.
- Protocol Buffers is copyright of Google Inc.

The libraries for C++ use the following softwares. Please refer to the license files included in the compiler package for detail.

- `compiler_rt`
- `libc++`
- `libc++abi`
- `newlib`

Other software components are copyright of Renesas Electronics Corporation.

## 2. OPTIONS

Specify the following option for compiling a source program with C++14 standard.

```
-lang=cpp14
```

[Detailed description]

This option allows the compiler to compile a source program with C++14 standard (ISO/IEC 14882:2014).

- A compile error will occur when C source files are specified as input with this option. For details of the kind of input/output files, please refer to "2.2 I/O Files" in CC-RL User's Manual.
- Please refer to the following section for the existing options that can be used with this option.

### 2.1 Existing options available under the C++14 specification

#### 2.1.1 Compile options

This section shows the existing compile options allowed to combine with `-lang=cpp14`. "X" in the "Combinable" column indicates that the option is just ignored, or an error message will be output.

Table 1 Compiler options available under the C++14 standard

| Category                           | Option                  | Combinable | Note  |
|------------------------------------|-------------------------|------------|---|
| Version display specification      | <code>-V</code>         | ✓          |   |
| Help display specification         | <code>-help</code>      | ✓          |   |
| Output file specification          | <code>-o</code>         | ✓          |   |
|                                    | <code>-obj_path</code>  | ✓          |   |
|                                    | <code>-asm_path</code>  | ✓          |   |
|                                    | <code>-prep_path</code> | ✓          |   |
| Source debugging control           | <code>-g</code>         | ✓          | Some debug information of C++ standard specifications will be discarded. Please refer to the section "NOTES" below. |
|                                    | <code>-g_line</code>    | ✓          |   |
| Device specification relation      | <code>-cpu</code>       | ✓          |   |
|                                    | <code>-use_mda</code>   | ✓          |   |
| Processing interrupt specification | <code>-P</code>         | ✓          |   |
|                                    | <code>-S</code>         | ✓          |   |
|                                    | <code>-c</code>         | ✓          |   |

Table 1 Compiler options available under the C++14 standard (2)

| Category                      | Option  | Combinable | Note  |
|-------------------------------|---|------------|---|
| Preprocessor control          | -D  | ✓          |   |
|                               | -U  | ✓          |   |
|                               | -I  | ✓          |   |
|                               | -preinclude                                   | ✓          |   |
|                               | -preprocess                                   | X          |   |
| Memory model                  | -memory_model={small   medium}                | ✓          |   |
|                               | -far_rom                                      | ✓          | Internal error may occur in some programs.  |
| Optimization                  | -O{ size   speed   default   lite   nothing } | ✓          |   |
|                               | -goptimize                                    | ✓          |   |
| Optimization (detailed)       | -Oinline_level[= <i>value</i> ]               | ✓          |   |
|                               | -Oinline_size[= <i>value</i> ]                | ✓          |   |
|                               | -Opipeline[={on off}]                         | ✓          |   |
|                               | -Ounroll[= <i>value</i> ]                     | ✓          |   |
|                               | -Otail_call[={on off}]                        | ✓          |   |
|                               | -Odelete_static_func[={on off}]               | ✓          |   |
|                               | -Omerge_files                                 | X          |   |
|                               | -Ointermodule                                 | X          |   |
|                               | -Owhile_program                               | X          |   |
|                               | -Oalias={ansi noansi}                         | X          |   |
|                               | -Osame_code={on off}                          | ✓          |   |
| Additional information output | -cref   | X          |   |
|                               | -pass_source                                  | ✓          |   |
| Error output control          | -no_warning_num                               | ✓          | Applicable to the messages ranged for W0510000-W0519999 and W0530000-W0559999 (W0520000-W0529999 are not output when -lang=cpp14 is specified). |
|                               | -change_message                               | ✓          | Applicable to the messages ranged for W0510000-W0519999 and W0530000-W0549999 (W0520000-W0529999 are not output when -lang=cpp14 is specified)  |
|                               | -error_file                                   | ✓          |   |

Table 1 Compiler options available under the C++14 standard (3)

| Category                      | Option  | Combinable | Note  |
|-------------------------------|---|------------|---|
| Code generation changing      | -dbl_size={4 8}                                   | ✓          |   |
|                               | -signed_char                                      | ✓          |   |
|                               | -signed_bitfield                                  | X          | This option has no effect when -lang=cpp14 is specified: The bitfield type for which neither "signed" nor "unsigned" is specified as "signed". This is different from the interpretation when -lang=c or -lang=c99 is specified: those options handle the bitfield type for which neither "signed" nor "unsigned" is specified as "unsigned". |
|                               | -switch   | ✓          |   |
|                               | -volatile   | X          |   |
|                               | -merge_string                                     | X          |   |
|                               | -pack   | ✓          |   |
|                               | -stuff  | X          |   |
|                               | -stack_protector<br>-stack_protector_all          | X          |   |
|                               | -insert_nop_with_label<br>-control_flow_integrity | X          |   |
| Extensions                    | -strict_std                                       | X          |   |
|                               | -refs_without_declaration                         | X          |   |
|                               | -large_variable                                   | X          |   |
|                               | -nest_comment                                     | X          |   |
|                               | -character_set                                    | X          | This option has no effect when -lang=cpp14 is specified: The encoding in the source file is always interpreted as UTF-8.  |
| MISRA check                   | -misra2004  | X          |   |
|                               | -misra2012  | X          |   |
|                               | -ignore_files_misra                               | X          |   |
|                               | -check_language_extension                         | X          |   |
|                               | -misra_intermodule                                | X          |   |
| Subcommand file specification | -subcommand                                       | ✓          |   |
| Assembler and linker control  | -asmopt= <i>arg</i>                               | ✓          |   |
|                               | -lnkopt= <i>arg</i>                               | ✓          |   |
|                               | -asmcmd= <i>filename</i>                          | ✓          |   |
|                               | -lnkcmd= <i>filename</i>                          | ✓          |   |
|                               | -dev= <i>filename</i>                             | ✓          |   |
| Compiler transition support   | -convert_cc={ca78k0r nc30 iar}                    | X          |   |
|                               | -unaligned_pointer_for_ca78k0r                    | X          |   |

### 2.1.2 Assemble options

All existing assemble options are allowed to combine with `-lang=cpp14`.

### 2.1.3 Link options

The existing link option below is not allowed to combine with `-lang=cpp14`. The other options are allowed to combine with `-lang=cpp14`.

Table 2 Link options available under the C++14 standard

| Category       | Option               | Combinable | Note |
|----------------|----------------------|------------|------|
| Output control | <code>-VFINFO</code> | X          |      |



## 3. COMPILER LANGUAGE SPECIFICATIONS

### 3.1 Basic language specifications

#### 3.1.1 Unsupported C++ language specifications

The following language specifications are not supported.

- Exception handling
- Runtime type identification
- Threads
- Atomic operations

#### 3.1.2 Implementation-defined behavior of C++14

This section covers the implementation-defined behavior.

Table 3 Implementation-defined behavior

| Section No. | Item   | Description  |
|-------------|--|--|
| 1.3.6       | diagnostic message   | Refer to "7. Message".   |
| 1.4         | required libraries for freestanding implementation   | Refer to "5. Library Specifications".                                  |
| 1.7         | bits in a byte   | 8 bits.  |
| 1.9         | interactive device   | What constitutes an interactive device is not specified.               |
| 1.10        | number of threads in a program under a freestanding implementation                             | Multi-threaded execution is not supported.                             |
| 2.2         | mapping physical source file characters to basic source character set                          | Map as UTF-8 as-is.  |
| 2.2         | physical source file characters  | UTF-8.   |
| 2.2         | converting characters from source character set to execution character set                     | The source character set and the execution character set are the same. |
| 2.2         | whether source of translation units must be available to locate template definitions           | The source is not required.  |
| 2.9         | mapping header name to header or external source file  | Interpreted as described and mapped to a file name.                    |
| 2.14.3      | value of multicharacter literal  | the lower 4 bytes of the execution character set.                      |
| 2.14.3      | value of wide-character literal containing multiple characters                                 | the last character in the execution character set.                     |
| 2.14.3      | value of wide-character literal with single c-char that is not in execution wide-character set | the value of the character.  |
| 2.14.3      | encoding of universal character name not in execution character set                            | the value of the character.  |
| 2.14.3      | semantics of non-standard escape sequences   | ¥e and ¥E are valid. Both values are 0x1b.                             |
| 2.14.3      | value of character literal outside range of corresponding type                                 | An error occurs.   |
| 2.14.5      | concatenation of some types of string literals   | An error occurs.   |

Table 3 Implementation-defined behavior

| Section No. | Item  | Description  |
|-------------|---|--|
| 3.6.1       | defining main in freestanding environment   | Not defined.   |
| 3.6.1       | parameters to main  | Not defined.   |
| 3.6.1       | start-up and termination in freestanding environment  | Not defined. Depends on the startup routine.   |
| 3.6.1       | linkage of main   | C linkage.   |
| 3.6.2       | dynamic initialization of static objects before main  | Depends on the startup routine.  |
| 3.6.2       | dynamic initialization of thread-local objects before entry                                 | Threads are not supported.   |
| 3.9.1       | extended signed integer types   | Extended signed integer types are not supported.   |
| 3.9.1       | representation of char  | 1 byte.  |
| 3.9.1       | signedness of char  | Unsigned char type. However, it can be switched to signed char type by <code>-signed_char</code> option. |
| 3.9.1       | value representation of floating-point types  | Compliant with IEEE754.  |
| 3.9.2       | value representation of pointer types   | Refer to "3.1.3 Internal representation and value area of data".   |
| 3.11        | alignment   | Refer to "3.1.3 Internal representation and value area of data".   |
| 4.13        | rank of extended signed integer type  | Extended signed integer type is not supported.   |
| 5.3.3       | sizeof applied to fundamental types other than char, signed char, and unsigned char         | Refer to "3.1.3 Internal representation and value area of data".   |
| 5.3.4       | support for over-aligned types  | Over-aligned types are not supported.  |
| 5.8         | result of right shift of negative value   | Arithmetic shift is performed.   |
| 7.2         | underlying type for enumeration   | Refer to "3.1.3 Internal representation and value area of data".   |
| 7.4         | meaning of asm declaration  | The asm declaration is not supported.  |
| 8.4.1       | string resulting from <code>__func__</code>   | A function name is returned.   |
| 16.2        | nesting limit for <code>#include</code> directives  | The nesting limit depends on the memory available.   |
| 16.6        | <code>#pragma</code>  | Refer to "Pragma directive".   |
| 16.8        | text of <code>__DATE__</code> when date of translation is not available                     | The date is always available.  |
| 16.8        | text of <code>__TIME__</code> when time of translation is not available                     | The time is always available.  |
| 16.8        | definition and meaning of <code>__STDC__</code>   | Defined as 1.  |
| 16.8        | definition and meaning of <code>__STDC_VERSION__</code>                                     | Not defined.   |
| 17.6.5.12   | exceptions thrown by standard library functions that do not have an exception specification | Exceptions are not supported.  |
| 18.2        | type of <code>size_t</code>   | unsigned int.  |
| 18.5        | exit status   | Not defined.   |

### 3.1.3 Internal representation and allocation of data

This section describes the internal representation and value range for each data type in CC-RL.

#### (1) Basic type

Table 4 Basic types

| Data Type          | Size (byte) | Alignment (byte) | Signed/Unsigned | Data range           |                       | Note   |
|--------------------|-------------|------------------|-----------------|----------------------|-----------------------|--|
|                    |             |                  |                 | Minimum Value        | Maximum Value         |  |
| char               | 1           | 1                | Unsigned        | 0                    | +255                  | The value range is the same as that of signed char when -signed_char is specified. |
| signed char        | 1           | 1                | Signed          | -128                 | +127                  |  |
| unsigned char      | 1           | 1                | Unsigned        | 0                    | +255                  |  |
| short              | 2           | 2                | Signed          | -32768               | +32767                |  |
| signed short       | 2           | 2                | Signed          | -32768               | +32767                |  |
| unsigned short     | 2           | 2                | Unsigned        | 0                    | +65535                |  |
| int                | 2           | 2                | Signed          | -32768               | +32767                |  |
| signed int         | 2           | 2                | Signed          | -32768               | +32767                |  |
| unsigned int       | 2           | 2                | Unsigned        | 0                    | +65535                |  |
| long               | 4           | 2                | Signed          | -2147483648          | +2147483647           |  |
| singed long        | 4           | 2                | Signed          | -2147483648          | +2147483647           |  |
| unsigned long      | 4           | 2                | Unsigned        | 0                    | +4294967295           |  |
| long long          | 8           | 2                | Signed          | -9223372036854775808 | +9223372036854775807  |  |
| signed long long   | 8           | 2                | Signed          | -9223372036854775808 | +9223372036854775807  |  |
| unsigned long long | 8           | 2                | Unsigned        | 0                    | +18446744073709551615 |  |

Table 4 Basic types (2)

| Data Type                    | Size (byte) | Alignment (byte) | Signed/ Unsigned | Data range              |                         | Note  |
|------------------------------|-------------|------------------|------------------|-------------------------|-------------------------|---|
|                              |             |                  |                  | Minimum Value           | Maximum Value           |   |
| wchar_t                      | 2           | 2                | Unsigned         | 0                       | +65535                  |   |
| char16_t                     | 2           | 2                | Unsigned         | 0                       | +65535                  |   |
| char32_t                     | 4           | 2                | Unsigned         | 0                       | +4294967295             |   |
| bool                         | 1           | 1                | Unsigned         | -                       | -                       | Only the bit 0 is meaningful. The bits from 1 to 7 are undefined. |
| float                        | 4           | 2                | Signed           | 1.17549435E-38F         | 3.40282347E+38F         |   |
| double (-double_size=4)      | 4           | 2                | Signed           | 1.17549435E-38F         | 3.40282347E+38F         |   |
| double (-double_size=8)      | 8           | 2                | Signed           | 2.2250738585072014E-308 | 1.7976931348623158E+308 |   |
| long double (-double_size=4) | 4           | 2                | Signed           | 1.17549435E-38F         | 3.40282347E+38F         |   |
| long double (-double_size=8) | 8           | 2                | Signed           | 2.2250738585072014E-308 | 1.7976931348623158E+308 |   |

## (2) Derived types

- Pointer and array types

Table 5 Pointer and array types

| Data Type                       | Size(byte)  | Alignment(byte)                   |
|---------------------------------|---|-----------------------------------|
| Pointer type                    | near pointer  | 2                                 |
|                                 | far pointer   | 4                                 |
| Lvalue reference type           | near reference  | 2                                 |
| Rvalue reference type           | far reference   | 4                                 |
| Pointer to data member type     | 2   | 2                                 |
| Pointer to member function type | 4   | 2                                 |
| Array type                      | The size of the element type * The number of the elements | The alignment of the element type |

- Enumeration type

Table 6 Enumeration type

| The minimum value for enumerator | The maximum value for enumerator | Underlying type    | Note   |
|----------------------------------|----------------------------------|--------------------|--|
| -128                             | 127                              | signed char        | -  |
| 0                                | 255                              | unsigned char      | If all enumerators are in the range 0-255, this representation applies.                  |
| -32768                           | 32767                            | signed short       | -  |
| 0                                | 65535                            | unsigned short     | If all enumerators are in the range 0-65535, this representation applies.                |
| -2147483647                      | 2147483647                       | signed long        | -  |
| 0                                | 4294967295                       | unsigned long      | If all enumerators are in the range 0-4294967295, this representation applies.           |
| -9223372036854775808             | 9223372036854775807              | signed long long   | -  |
| 0                                | 18446744073709551615             | unsigned long long | If all enumerators are in the range 0-18446744073709551615, this representation applies. |
| Otherwise                        |                                  | signed long long   | A warning will be output.  |

## 3.2 Language extension specifications

### 3.2.1 Reserved words

Please refer to “4.2.1 Reserved words” in the CC-RL User’s Manual for detail of the keywords reserved by CC-RL.

However, the following reserved words are not supported.

- `__saddr`
- `__callt`
- `__sectop`
- `__secend`

Some of the specifications for the following reserved word differ from those when the `-lang=c99` option is specified.

- `__inline`

When the `-lang=cpp14` option is specified, the keyword `__inline` is an alias for the keyword `inline`; this is for compliance with the specification of `inline` for C++.

### 3.2.2 Macros

The Table 6 shows the macros whose definitions differ along with the parameter given for the option `-lang`. Please also refer to “4.2.2 Macros” in the CC-RL User's Manual as well for detail of the other macros.

Note that the values in the table are in decimal.

Table 7 Macros

| Name                          | Definition when<br><code>-lang=cpp14</code> is specified | Definition when <code>-lang=c</code> or <code>-lang=c99</code> is specified   |
|-------------------------------|--|---|
| <code>__cplusplus</code>      | 201402L  | Undefined   |
| <code>__clang__</code>        | 1  | Undefined   |
| <code>__STDC_HOSTED__</code>  | 0  | 0 (when <code>-lang=c99</code> is specified)  |
| <code>__STDC__</code>         | 1  | 1 (when <code>-strict_std</code> is specified)  |
| <code>__STDC_VERSION__</code> | Undefined  | 199409L (when both <code>-lang=c</code> and <code>-strict_std</code> are specified)<br>199901L (when <code>-lang=c99</code> is specified) |
| <code>__STDC_IEC_559__</code> | 1  | 1 (when <code>-lang=c99</code> is specified)  |

### 3.2.3 `#pragma` directives

`#pragma` directives described in “4.2.4 `#pragma` directives” in the CC-RL User's Manual are not supported.

### 3.2.4 Intrinsic functions

Intrinsic functions described in “4.2.7 Intrinsic functions” in the CC-RL User's Manual are supported. Please refer to the CC-RL User's Manual for details.

## 4. SECTION SPECIFICATIONS

This section describes the names and the relocation attributes of the reserved sections when compiling under C++14 language specifications. Please refer to the CC-RL User's Manual for the other sections.

### 4.1 Section name

Table 8 Reserved section names

| Default Section Name        | Relocation Attribute | Description   |
|-----------------------------|----------------------|---|
| .init_array                 | CONSTF               | Section for the global constructors   |
| .callt0                     | CALLT0               | Section for the table used when callt functions called  |
| .text                       | TEXT                 | Section for code (allocated to the near area)   |
| .textf                      | TEXTF                | Section for code (allocated to the far area)  |
| .textf_unit64kp             | TEXTF_UNIT64KP       | Section for code (section is allocated so that the start address is an even address and the section does not exceed the (64 Kbytes - 1) boundary)                                       |
| .const                      | CONST                | ROM data (allocated to the near area) (within the mirror area)  |
| .constf                     | CONSTF               | ROM data (allocated to the far area)  |
| .data                       | DATA                 | Section for near initialized data (with initial value)  |
| .dataf                      | DATAF                | Section for far initialized data (with initial value)   |
| .sdata                      | SDATA                | Section for initialized data (with initial value, allocated to saddr)   |
| .bss                        | BSS                  | Section for data area (without initial value, allocated to near area)   |
| .bssf                       | BSSF                 | Section for data area (without initial value, allocated to far area)  |
| .sbss                       | SBSS                 | Section for data area (without initial value, allocated to saddr)   |
| .option_byte                | OPT_BYTE             | Section specific for user option byte and on-chip debugging specification   |
| .security_id                | SECUR_ID             | Section specific for security ID specification  |
| .flash_security_id          | FLASH_SECUR_ID       | Section specific for flash programmer security ID specification   |
| .vect<vector table address> | AT                   | Interrupt vector table<br>If the -split_vect option is specified, a section is generated based on ".vect<vector table address>".<br>The vector table address is in hexadecimal notation |

## 5. LIBRARY SPECIFICATIONS

### 5.1 Outline

The CC-RL provides the dedicated libraries for compiling C++ source programs based on the software below. Please refer to the source program included in the compiler package for detail.

- compiler\_rt
- libc++
- libc++abi
- newlib

### 5.2 Supplied Libraries

The following 6 libraries are provided for each of the CPU core types S1, S2, and S3 specified by the option `-cpu`. All these libraries are dedicated for uses with `-lang=cpp14` specified, and does not supported uses with `-lang=c` or `-lang=c99`.

Table 9 Supplied libraries

| Library Name         | Outline                                     |
|----------------------|---|
| rl78_libc.lib        | The standard library (C99)                  |
| rl78_libm.lib        | The standard math library (C99)             |
| rl78_libgloss.lib    | The low-level library                       |
| rl78_libcxx.lib      | The standard library (C++14)                |
| rl78_libcxxabi.lib   | The runtime library for ABI support (C++14) |
| rl78_compiler-rt.lib | The runtime library for the compiler        |

\* The libraries corresponding for the S2 core are built with multiplier and divider/multiply-accumulator enabled (`-use_mda=mda`).

\* All the libraries assume single precision for the "double" and "long double" floating point type (`-dbl_size=4`).

### 5.3 Header Files

The header files required for using the C++ libraries are listed below.

Table 10 Header Files

| Category                   | File Name   | Description   |
|----------------------------|-------------|---|
| The standard library (C99) | <assert.h>  | Header file for program diagnostics                     |
|                            | <complex.h> | Header file for complex number                          |
|                            | <ctype.h>   | Header file for character conversion and classification |
|                            | <errno.h>   | Header file for reporting error condition               |



Table 10 Header Files (2)

| Category                     | File Name            | Description  |
|------------------------------|----------------------|--|
| The standard library (C99)   | <float.h>            | Header file for floating-point representation and operation            |
|                              | <inttypes.h>         | Header file for the maximum-width integer type                         |
|                              | <iso646.h>           | Header file for alternative spellings of macro names                   |
|                              | <limits.h>           | Header file for quantitative limiting of integers                      |
|                              | <locale.h>           | Header file for localization   |
|                              | <math.h>             | Header file for mathematical calculation                               |
|                              | <setjmp.h>           | Header file for non-local jump   |
|                              | <signal.h>           | Header file for signal handling  |
|                              | <stdarg.h>           | Header file for supporting functions having variable arguments         |
|                              | <stdbool.h>          | Header file for logical types and values                               |
|                              | <stddef.h>           | Header file for common definitions                                     |
|                              | <stdint.h>           | Header file for integer type of the specified width                    |
|                              | <stdio.h>            | Header file for standard I/O   |
|                              | <stdlib.h>           | Header file for general utilities                                      |
|                              | <string.h>           | Header file for manipulation of sequential memory and character string |
|                              | <tgmath.h>           | Header file for type generic mathematical calculation                  |
|                              | <wchar.h>            | Header file for utilities related to multibyte/wide character          |
|                              | <wctype.h>           | Header file for wide character conversion and classification           |
| The standard library (C++14) | <algorithm>          | Header file for algorithmic operations                                 |
|                              | <array>              | Header file for fixed sized sequential container                       |
|                              | <bitset>             | Header file for fixed sized sequential bit container                   |
|                              | <chrono>             | Header file for date and time  |
|                              | <codecvt>            | Header file for character code conversion                              |
|                              | <complex>            | Header file for complex number   |
|                              | <condition_variable> | Header file for synchronization among the threads                      |

Table 10 Header Files (3)

| Category                     | File Name          | Description  |
|------------------------------|--------------------|--|
| The standard library (C++14) | <deque>            | Header file for double ended queue   |
|                              | <forward_list>     | Header file for singly-linked list   |
|                              | <fstream>          | Header file for file stream  |
|                              | <functional>       | Header file for function object  |
|                              | <future>           | Header file for providing "future" pattern   |
|                              | <initializer_list> | Header file for initializer list   |
|                              | <iomanip>          | Header file for I/O manipulator and formatting   |
|                              | <ios>              | Header file for base classes of iostream   |
|                              | <iosfwd>           | Header file for forward declaration of iostream  |
|                              | <iostream>         | Header file for standard iostream objects  |
|                              | <istream>          | Header file for input streams  |
|                              | <iterator>         | Header file for iterators  |
|                              | <limits>           | Header file for properties of the implementation's representation of the arithmetic type |
|                              | <list>             | Header file for doubly-linked list   |
|                              | <locale>           | Header file for the information peculiar to a locale                                     |
|                              | <map>              | Header file for associative container of unique keys and values                          |
|                              | <memory>           | Header file for memory management  |
|                              | <mutex>            | Header file for mechanisms for mutual exclusion  |
|                              | <new>              | Header file for dynamic storage allocation   |
|                              | <numeric>          | Header file for generalized numeric operations   |
|                              | <ostream>          | Header file for output streams   |
|                              | <queue>            | Header file for queue  |
|                              | <random>           | Header file for random number generation   |
|                              | <ratio>            | Header file for compile time rational arithmetic   |
|                              | <regex>            | Header file for regular expression template  |
|                              | <scoped_allocator> | Header file for scoped allocator   |
|                              | <set>              | Header file for associative container of unique keys                                     |

Table 10 Header Files (4)

| Category                            | File Name                            | Description  |
|-------------------------------------|--------------------------------------|--|
| The standard library (C++14)        | <sstream>                            | Header file for string stream  |
|                                     | <stack>                              | Header file for stack  |
|                                     | <streambuf>                          | Header file for stream buffers   |
|                                     | <string>                             | Header file for string classes   |
|                                     | <system_error>                       | Header file for system error support                                       |
|                                     | <tuple>                              | Header file for tuples   |
|                                     | <type_traits>                        | Header file for type traits  |
|                                     | <typeindex>                          | Header file for type indexes   |
|                                     | <unordered_map>                      | Header file for unordered associative containers of unique keys and values |
|                                     | <unordered_set>                      | Header file for unordered associative containers of unique keys            |
|                                     | <utility>                            | Header file for utility components   |
|                                     | <valarray>                           | Header file for numeric arrays   |
|                                     | <vector>                             | Header file for vector   |
| The C compatible standard libraries | <cassert>                            | Header file compatible with assert.h                                       |
|                                     | <ccomplex>                           | Header file compatible with complex.h                                      |
|                                     | <cctype>                             | Header file compatible with ctype.h  |
|                                     | <cerrno>                             | Header file compatible with errno.h  |
|                                     | <cfloat>                             | Header file compatible with float.h  |
|                                     | <cinttypes>                          | Header file compatible with inttypes.h                                     |
|                                     | <ciso646>                            | Header file compatible with iso646.h                                       |
|                                     | <climits>                            | Header file compatible with limits.h                                       |
|                                     | <locale>                             | Header file compatible with locale.h                                       |
|                                     | <cmath>                              | Header file compatible with math.h   |
|                                     | <csetjmp>                            | Header file compatible with setjmp.h                                       |
|                                     | <csignal>                            | Header file compatible with signal.h                                       |
|                                     | <cstdlib>                            | Header file compatible with stdarg.h                                       |
|                                     | <stdbool>                            | Header file compatible with stdbool.h                                      |
|                                     | <stddef>                             | Header file compatible with stddef.h                                       |
|                                     | <stdint>                             | Header file compatible with stdint.h                                       |
|                                     | <stdio>                              | Header file compatible with stdio.h  |
|                                     | <stdlib>                             | Header file compatible with stdlib.h                                       |
|                                     | <string>                             | Header file compatible with string.h                                       |
|                                     | <tgmath>                             | Header file compatible with tgmath.h                                       |
| <wchar>                             | Header file compatible with wchar.h  |  |
| <wctype>                            | Header file compatible with wctype.h |  |

## 6. STARTUP

### 6.1 Startup Routine

Before entering the main function, execute the following processes in addition to those described in 8.2 Startup Routine in CC-RL User's Manual.

#### 6.1.1 Initialization of global objects of class type

Call the constructor for each object of class type declared with static storage duration.

The addresses of those constructors are stored in the section named `.init_array`. Put the following description in the startup routine for calling all of them.

```
MOVW    BC, #LOWW(SIZEOF(.init_array))
BR      $.L2_INIT
.L1_INIT:
DECW    BC
DECW    BC
MOV     ES, #HIGHW(STARTOF(.init_array))
MOVW    AX, ES:LOWW(STARTOF(.init_array))[BC]
MOV     CS, #0x00
PUSH    BC
CALL    AX
POP     BC
.L2_INIT:
CLRW    AX
CMPW    AX, BC
BNZ     $.L1_INIT
```

## 7. MESSAGE

### 7.1 Message Formats

There are two formats of message when `-lang=cpp14` is specified.

#### 7.1.1 Format 1

This kind of format contains a message number as explained in “10 MESSAGE” in CC-RL User's Manual. Please refer to the manual for detail.

Those messages are numbered as:

0510000-0519999, 0530000-0539999, 0540000-0549999, 0550000-0559999, and  
0560000-0569999.

(1) When the file name and line number are included

```
file-name (line-number) : message-type 05 message-number : message
```

(2) When the file name and line number aren't included

```
message-type 05 message-number : message
```

#### 7.1.2 Format 2

This kind of format is output as below.

(1) When the file name, line number, and column number are included

```
file-name : line-number : column-number : message-type : message
```

(2) When neither the file name, line number, nor column number are included

```
message-type : message
```

### 7.2 Message Types

The message types are as follows.

Table 11 Message Types

| Message Type |          | Description   |
|--------------|----------|---|
| Format 1     | Format 2 |   |
| C            | -        | Internal error : Processing is aborted.<br>No object codes are generated.                                 |
| E            | error    | Error : Processing is aborted if a set number of errors occur.<br>No object codes are generated.          |
| F            | fatal    | Fatal error : Processing is aborted.<br>No object codes are generated.                                    |
| M            | remark   | Information : Processing continues.<br>Object codes are generated.  |
| W            | warning  | Warning : Processing continues.<br>Object codes are generated (They might not be what the user intended). |
| -            | note     | Additional information for the other types of messages.   |

## 8. NOTES

### 8.1 Missing information for source level debugging

Information for source level debugging for the language specification listed below is not supported.

- Anonymous unions
- Namespaces
- Derived classes
  - Virtual base classes
  - Virtual functions
- Templates

### 8.2 sbrk

The standard library calls the function `sbrk` in processing such as dynamic memory management. The function is included in low level support library `rl78_libgloss.lib` and defined as below. If you prefer `sbrk` to work differently, please implement your own `sbrk` and link it to your application.

```
#define HEAPSIZE 0x400
union HEAP_TYPE {
    signed long dummy;
    signed char heap[HEAPSIZE];
};

static union HEAP_TYPE heap_area ;
static signed char *brk=(void *)&heap_area;
void *sbrk(int size)
{
    void *p = 0;
    if (brk + size > heap_area.heap + HEAPSIZE) {
        return (void *)-1;
    }
    p = brk;
    brk += size;
    return p;
}
```

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| Rev. | Date      | Description |   |
|------|-----------|-------------|---|
|      |           | Page        | Summary   |
| 1.00 | Jan.20.23 | —           | First Edition issued  |
| 1.01 | Jul.20.23 | 4           | Feedback on the Technical Preview Edition is added.   |
|      |           | 13          | Table 6 is changed.   |
|      |           | 13          | Unsupported reserved words are added.   |
|      |           | 14          | Value of <code>__STDC_IEC_559__</code> is changed.  |
| 1.02 | Apr.20.24 | —           | Removed the descriptions "Technical Preview Edition" from the entire document as we update it for CC-RL V1.14.00.                   |
|      |           | 16          | Unsupported header files( <code>time.h</code> , <code>ctime</code> , <code>exception</code> , <code>stdexcept</code> ) are deleted. |
|      |           | 22          | "8.2 sbrk" is added.  |



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