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## Chapter 1. Target Devices

The target devices supported by the CC-RX are listed on the Website.

Please see the URL below.

CS+ Product Page:

<http://www.renesas.com/cs+>

## Chapter 2. Keywords When Uninstalling the Product

There are two ways to uninstall this product.

- Use the integrated uninstaller (uninstalls all CS+ components)
- Use the Windows uninstaller (only uninstalls this product)

To use the Windows uninstaller, select the following from the Control Panel:

- Programs and Features

Then select "CS+ CC-RX V2.05.00".

## Chapter 3. Changes

This section describes changes on CC-RX from V2.04.01 to V2.05.00.

The features indicated as **[Professional edition]** can only be used if the compiler is registered under the professional license.

### 3.1 Improvements to the feature for checking source code against MISRA-C:2012 rules **[Professional edition]**

The following rule numbers have been added to the arguments for `-misra2012` option, which allows the compiler to check the source code against MISRA-C:2012 rules.

2.6 2.7 9.2 9.3 12.1 12.3 12.4 14.4 15.1 15.2 15.3 15.4 15.5 15.6 15.7  
16.1 16.2 16.3 16.4 16.5 16.6 16.7 17.1 17.7 18.4 18.5 19.2 20.1 20.2  
20.3 20.4 20.5 20.6 20.7 20.8 20.9 20.10 20.11 20.12 20.13 20.14

### 3.2 Enhancing the security of dynamic memory management **[Professional edition]**

A feature for the detection of illegal operations in the releasing of heap space has been added. To create a standard library with this feature enabled, specify the `-secure_malloc` option and run the library generator.

When this feature is enabled, the standard library functions will work as follows.

- (1) As well as the actual areas allocated for users in the heap by the `calloc`, `malloc`, and `realloc` functions, four extra bytes are added before and after each area for the detection of illicit operations.
- (2) When called, the `free` and `realloc` functions determine if the argument is a pointer to an actual area allocated by `calloc`, `malloc`, or `realloc`, the pointer is to an area that has already been released, or the four-byte area for detecting illicit operations has been overwritten.
- (3) If any of the above is the case, an illicit operation is assumed to have proceeded, and `_heap_chk_fail` will be called.

The `__heap_chk_fail` function needs to be defined by the user. Write the processing which should be executed when any illicit operation has been detected in the heap space. For example, in the following program, if the string "ABCDEF" is copied from `str` to the buffer for four letters in the 6th line, the heap space will be corrupted since "EF" and a null character (`'\0'`) overflows from the buffer. In this case, `_heap_chk_fail` will be executed when the heap space is released at the 8th line.

```
1: #include <string.h>
2: #include <stdlib.h>
3: void func(char *str) {
4:   char *buf;
5:   buf = (*char)malloc(4);
6:   strcpy(buf, str); // Copy "ABCDEF" from str
7:   ...
8:   free(buf);
9: }
```

By using this feature, you can easily counter security problems through measures against the dual release of memory and against buffers overflowing.

### 3.3 Added intrinsic functions

#### 3.3.1 New intrinsic functions

We have added the following intrinsic functions for generating bit-manipulation instructions.

- `__bclr()`  
Generates a BCLR instruction.
- `__bset()`  
Generates a BSET instruction.
- `__bnot()`  
Generates a BNOT instruction.

#### 3.3.2 Aliases for existing intrinsic functions

We have added aliases for each of the intrinsic function that have been available on V2.04.01 or earlier versions of CC-RX. Each alias takes the form of "`__`" (two underscores) preceding the name of the corresponding intrinsic functions\*. The alias for the `max()` function, for example, is `__max()`. The interface for calling the aliases and the result of expansion is the same as for the corresponding intrinsic functions. In the above example, expanding `max(a, b)` and `__max(a, b)` will have the same results. The aliases are usable even when the header file (`machine.h`) is not included.

\* Identifiers with "`__`" appended are reserved for the compiler and thus should not be used in user programs.

### 3.4 Eliminated point for caution

Scope of optimization(RXC#038)

### 3.5 Other improvements

Other improvements are listed below.

(a) Reading and writing of temporary files

The problem of the compiler generating errors when attempting to read from or write to temporary files has been resolved.

(b) Precision of operations by `pow()` and `powf()`

The margin of error in the results of operations by `pow()` and `powf()` has been reduced.

(c) Internal errors

The problem of the compiler generating internal errors when compiling has been improved.

### 3.6 Enhanced optimization

For V2.05.00, optimization has been further enhanced on points (a) to (e), listed and described below.

(a) Merging of stack areas allocated for auto arrays in different local scopes (reducing the stack size)

The compiler merges stack areas allocated for auto arrays that belong to different blocks ({} ) whose lifetimes do not overlap.

< Example of source code >

```
int *g;
void func01(void){
    {
        int array01[10];
        g = array01;
        func();
    }
    {
        int array02[10];    // Lifetimes of array01[10] and
                           // array02[10] do not overlap.

        g = array02;
    }
}
```

< Code generated by V2.04.01>

```
_func01:
        .STACK _func01=88      ; Size of allocated
                                ; stack = 88 bytes

        PUSH.L R6
        MOV.L #_g, R6
        ADD #0FFFFFFB0H, R0
        MOV.L R0, R14
        MOV.L R14, [R6]
        BSR _foo
        ADD #28H, R0, R14
        MOV.L R14, [R6]
        RTSD #54H, R6-R6
```

< Code generated by V2.05.00>

```
_func01:
        .STACK _func01=52      ; Size of allocated
                                ; stack = 52 bytes

        PUSHM R6-R7
        ADD #0FFFFFFD8H, R0
        MOV.L #_g, R6
        MOV.L R0, R7
        MOV.L R7, [R6]
        BSR _foo
        MOV.L R7, [R6]
        RTSD #30H, R6-R7
```

### (b) Optimization of constant propagation

Obviously recognizable calculations of constants within loops are omitted.

< Example of source code >

```
j = 1;
k = 2;
l = 3;

for (ix=0; ix<xtra; ix++) {
    for (i=0; i<n4; i++) {
        j = j*(k-j)*(l-k);    // j is always 1
        k = l*k-(l-j)*k;      // k is always 2
        l = (l-k)*(k+j);      // l is always 3
        e1[l-2] = j+k+l;      // l-2 is always 1, j+k+l is always 6.
        e1[k-2] = j*k*l;      // k-2 is always 0, j+k*l is always 6.
    }
}
x = e1[0]+e1[1];
```

< Code generated by V2.04.01>

```
:
L13: ; bb47
    CMP R2, R6
    BGE L15
L14: ; bb3
    SUB R5, R15, R7
        ; j*(k-j)*(l-k),
        ; l*k-(l-j)*k, (l-k)*(k+j),
        ; ; are calculated each time.
    SUB R14, R5, R8
    MUL R7, R14
    MUL R8, R14
    MUL R5, R15, R8
    SUB R14, R15, R7
    MUL R5, R7
    ADD #01H, R6
    SUB R7, R8
    SUB R8, R15
    ADD R14, R8, R5
    MUL R5, R15
    ADD R15, R5
    SHLL #02H, R15, R7
:
```

< Code generated by V2.05.00>

```
:
L13: ; bb46
    CMP R2, R15
    BGE L15
L14: ; bb2
    ADD #01H, R15
    MOV.L #00000006H, 04H[R3]
        ; 6 is always assigned to e1[1].
    MOV.L #00000006H, [R3]
        ; 6 is always assigned to e1[0].
    BRA L13
:
```



### (c) Optimization of induction variables

The compiler does not generate code for redundantly updating loop induction variables.

< Example of source code >

```
void callee(unsigned i);
void caller(void){
    unsigned i;
    for(i=128; i != 0; --i){
        callee(i);
    }
}
```

< Code generated by V2.04.01>

```
      :
      MOV.L #00000080H, R6
      MOV.L R6, R7          ; Loop induction variable
                              ; is redundantly initialized.
L11:  ; bb
      MOV.L R7, R1
      BSR _callee
      SUB #01H, R7          ; Loop induction variable
                              ; is redundantly updated.
      SUB #01H, R6
      BNE L11
      :
```

< Code generated by V2.05.00>

```
      :
      MOV.L #00000080H, R6
L11:  ; bb
      MOV.L R6, R1
      BSR _callee
      SUB #01H, R6
      BNE L11
      :
```

(d) Using min, max, and abs instructions in optimization

The compiler uses min, max, and abs instructions more frequently.

< Example of source code >

```
int min_test(int a) {  
    if (a >= 17) {  
        a = 17;  
    }  
    return a;  
}
```

< Code generated by V2.04.01>

```
_min_test:  
    .STACK _min_test=4  
    CMP #10H, R1  
    MOV.L #00000011H, R14  
    BGT L12  
L11:    ; entry  
    MOV.L R1, R14  
L12:    ; entry  
    MOV.L R14, R1  
    RTS
```

< Code generated by V2.05.00>

```
_min_test:  
    .STACK _min_test=4  
    MIN #11H, R1    ; A min instruction is used.  
    RTS
```

### (e) Deleting unused code

The ability to delete unused code has been further enhanced.

< Example of source code >

```
unsigned long test(unsigned long long variable, int var){  
    if (var){  
        variable &= 0x012345678abcdefULL;  
    }  
    return (variable >> 32);  
}
```

< Code generated by V2.04.01>

```
_test:  
    .STACK _test=4  
    CMP #00H, R3  
    BEQ L12  
L11:    ; if_then_bb  
        AND #78ABCDEFH, R1    ; R1 is not referenced  
                                ; in the subsequent lines.  
        AND #00123456H, R2  
L12:    ; if_break_bb  
        MOV.L R2, R1  
        RTS
```

< Code generated by V2.05.00>

```
_test:  
    .STACK _test=4  
    CMP #00H, R3  
    BEQ L12  
L11:    ; if_then_bb  
        AND #00123456H, R2  
L12:    ; if_break_bb  
        MOV.L R2, R1  
        RTS
```

## Chapter 4. Points for Caution

This section describes points for caution regarding CC-RX.

### 4.1 Note on a case of the W0523041 message [C/C++ compiler]

When the `int_to_short` option is specified and a file including a C standard header is compiled as C++ or EC++, the compiler may show the W0523041 message. In this case, simply ignore the message because there are no problems.

[NOTE]

In compilation of C++ or EC++, the `int_to_short` option will be invalid.

Data that are shared between C and C++ (EC++) program must be declared as the long or short type rather than as the int type.

### 4.2 Note on using MVTC or POPC instructions [Assembler]

In the assembly language, the program counter (PC) cannot be specified for MVTC or POPC instructions.

### 4.3 Note on the delete option for linkage [Optimizing linkage editor]

When a function symbol is removed by the delete option, its following function in the source program is not allowed to have a breakpoint at its function name on the editor in your debugging. If you would like to set a breakpoint via the Label window at the function entrance, set the breakpoint via the Label window or at the program code of the function.

## Chapter 5. Restrictions

This chapter describes restrictions on CC-RX.

### 5.1 Options for compilers and other subsystems in the help system for the CS+ integrated environment

In the CS+ help system, refer to “Compiler” for the RX (the CC-RX environment) rather than “Build” for details of the command line options for the CC-RX (ccrx) C/C++ compiler, the assembler (asrx), the optimizing linkage editor (rlink) and the library generator (lbgrx). The descriptions under “Build” are very similar to those under “Compiler”, but are for V2.02.00.

### 5.2 Restriction on usage of math.h functions (frexp, ldexp, scalbn and remquo) in C++ language (including EC++)

An object is generated which will be an infinit-loop at execution when the actual argument of some function (frexp, ldexp, scalbn or remquo) of math.h is int-type, at compiling C++ or EC++ program.

Conditions:

This problem occurs when both (1) and (2) are satisfied.

(1) This program is in C++ or the lang=cpp option is effective.

(2) math.h is included and any of the following functions is called.

- (a) frexp(double, long\*) with 'int \*' type second argument (except when the first argument is float-type and the dbl\_size=8 option is effective).
- (b) ldexp(double, long) with 'int \*' type second argument (except when the first argument is float-type and the dbl\_size=8 option is effective).
- (c) scalbn(double, long) with 'int \*' type second argument (except when the first argument is float-type and the dbl\_size=8 option is effective).
- (d) remquo(double, double, long\*) with 'int \*' type third argument (except when the both the first and second arguments are float-type and the dbl\_size=8 option is effective).

Examples:

file.cpp:

```
// Example of compiling C++ source that generates an infinity-loop
#include <math.h>
double d1,d2;
```

```
int i;
void func(void)
{
    d2 = frexp(d1, &i);
}
```

### Command Line:

```
ccrx -cpu=rx600 -output=src file.cpp
```

### file.src: Example of the generated assembly program

```
_func:
    ; ...(Omitted)
    ; Calling substitute function of frexp
    BSR __$frexp__tm__2_f__FZlZPi_Q2_2l_Real_type__tm__4_ZlZ5_Type
    ; ...(Omitted)

__$frexp__tm__2_f__FZlZPi_Q2_2l_Real_type__tm__4_ZlZ5_Type:
L11:
    BRA L11 ; Calls itself ==> infinity-loop
```

### Countermeasures:

Select one of the following ways to avoid the problem.

- (1) Compile the program with the lang=c or lang=c99 option.
- (2) Change int or int \* into long or long \*.
- (3) Append the following declarations to each function that is being used.

```
/* For the frexp function */
static inline double frexp(double x, int *y)
{ long v = *y; double d = frexp(x,&v); *y = v; return (d); }
/* For the ldexp function */
static inline double ldexp(double x, int y)
{ long v = y; double d = ldexp(x,v); return (d); }
/* For the scalbn function */
static inline double scalbn(double x, int y)
{ long v = y; double d = scalbn(x,v); return (d); }
/* For the remquo function */
static inline double remquo(double x, double y, int *z)
{ long v = *z; double d = remquo(x,y,&v); *z = v; return (d); }
```

### Example of (2):

Change in file.cpp:

```
#include <math.h>
```

```
double d1,d2;
int i;
void func(void)
{
    long x = i; /* Accept as long type temporary */
    d2 = frexp(d1, &x); /* Call with long type argument */
    i = x; /* Set the result for variable 'i' */
}
```

Example of (3):

Change in file.cpp:

```
#include <math.h>
/* Append declaration */
static inline double frexp(double x, int *y)
{ long v = *y; double d = frexp(x,&v); *y = v; return (d); }
double d1,d2;
int i;
void func(void)
{
    d2 = frexp(d1, &i);
}
```

### 5.3 Restriction of PIC/PID function (pic and pid options)

When a standard library is created by the library generator (lbgrx) with the pic or pid option specified, the following warning may appear once or more.

```
W0591301:"-pic" option ignored (When the pic option has been specified)
```

```
W0591301:"-pid" option ignored (When the pid option has been specified)
```

Despite the warning, the created standard library has no problems.

### 5.4 Eliminated options (for the C/C++ compiler)

(a) -file\_inline, -file\_inline\_path

Specifying these options has no effect and the compiler will output a warning. Instead of **-file\_inline** or **-file\_inline\_path**, write **#include** in the source code.

(b) -enable\_register

This option is simply ignored and does not affect the generated code.

### 5.5 Notes on C/C++ source-level debugging (for the C/C++ compiler)

(1) Even when **-debug** is specified, you may not be able to set a breakpoint or stop stepped execution on lines that

- contain a dynamic initialization expression for a global variable (in C++),
  - are the first lines of functions that begin with a loop statement (e.g. **do** or **while**) and do not have an **auto** variable or of functions for which **#pragma inline\_asm** has been specified, or
  - contain the control section and body of a loop statement (e.g. **for**, **while**, or **do**) written as a single line.
- (2) The values of members of union type and of dummy variables that are to be passed via registers may be displayed incorrectly (e.g. in the [Watch] window).

### 5.6 Note on using sections that include the address 0xffffffff (in assembler)

If two or more **.section** directives in the assembly source code contain **.org** directives, the sections have the same name, and the sections overlap at 0xffffffff, the assembler outputs an internal error message (C0554098).

Example)

```
.section SS,ROMDATA
.org 0fffffffh
.byte 1
.byte 2 ; 0xffffffff
.section SS,ROMDATA
.org 0fffffffh
.byte 3; ; 0xffffffff
.end
```

### 5.7 Note on using **-form** and **-output** at the same time (in the linkage editor)

When **-form=rel** and **-output=<filename>** are specified for the linkage editor (**rlink**) at the same time, the filename extension given as **<filename>** is ignored and replaced with **.rel**.

Example)

```
rlink -form=relocate -output=DefaultBuild\lib_test.lib
```

The filename specified for output, **test.lib**, is changed to **test.rel**.

### 5.8 Note on using function names that begin with **\_builtin** (for the C/C++ compiler)

Declaration of a function with a name that begins with **\_builtin** and for which the definition is in **machine.h** in the **include** directory may lead to an internal error. In general, do not use any names that begin with an underscore (**\_**) in your source code, since such names are reserved.

### 5.9 Note on using **#pragma interrupt** with functions for which **save\_acc** is



enabled and that have dummy arguments (for the C/C++ compiler)

When **#pragma interrupt** is specified for a function and the **save\_acc** flag is enabled (including where this is done by using the **-save\_acc** compiler option), the compiler may not output code that reflects the correct values of dummy arguments which are passed via R4. Note: In general, we do not recommend defining arguments for functions with the **#pragma interrupt** specification.

## Chapter 6. Standard Libraries Included

This chapter describes restrictions on standard libraries included in RX Family C/C++ Compiler.

This compiler package includes four library files (\*.lib) for the RX600. You can use any of the library files if they correspond to the options that you wish to specify. Using these files shortens the time required for building.

### 6.1 Library files

Table 6.1 shows the standard library files and compiler options.

**Note:**

The compiler options you specify should be the same as the microcontroller options defined for each of the library files listed in table 6.1. Otherwise these library files are not usable, so specify your compiler options in the library generator to generate your own library file.

Library File	Purposes	Optimize <sup>*2</sup> Options	Microcontroller Options <sup>*1 *2</sup>		
			-endian	-cpu -rtti -exception -noexception	Others <sup>*3</sup>
<b>rx600lq.lib</b>	For the RX600 Optimization type:Speed  Little endian	-speed  -goptimize	-endian=little	-cpu=rx600   -rtti=on -exception	-round=nearest
<b>rx600ls.lib</b>	For the RX600 Optimization type:Size  Little endian	-size  -goptimize			-denormalize=off -dbl_size=4 -unsigned_char
<b>rx600bq.lib</b>	For the RX600 Optimization type: Speed Big endian	-speed  -goptimize	-endian=big		-unsigned_bitfield -bit_order=right -unpack -fint_register=0 -branch=24
<b>rx600bs.lib</b>	For the RX600 Optimization type: Size Big endian	-size  -goptimize			

**Table 6.1 Library Files**

\*Notes:

\*1 For details on microcontroller options, please see the “Microcontroller Options” columns of the “(1) Compile Options” of “section B.1.3 Options”, in the Integrated Development Environment User’s Manual: RX Build.

\*2 These option selections are same from the each default of them.

## 6.2 Using the library files

Copy the library file(s) included in the package from "lib" directory into a desired directory.

Then specify one of the copied library files for the Library option and start the linkage processing.

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