User's Manual

RENESAS

RI600PX

Real-Time Operating System

User's Manual: Coding

Target Device

RX Family with MPU (Memory Protection Unit)

Renesas Electronics
www.renesas.com

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How to Use This Manual

Readers

This manual is intended for users who design and develop application system using RX MCU family.

Purpose

This manual is intended for users to understand the functions of real-time OS “RI600PX” manufactured by Renesas Electronics, described the organaization listed below.

Organization

This manual can be broadly divided into the following units.

CHAPTER 1 OVERVIEW
CHAPTER 2 SYSTEM BUILDING
CHAPTER 3 MEMORY PROTECTION FUNCTIONS
CHAPTER 4 TASK MANAGEMENT FUNCTIONS
CHAPTER 5 TASK DEPENDENT SYNCHRONIZATION FUNCTIONS
CHAPTER 6 TASK EXCEPTION HANDLING FUNCTIONS
CHAPTER 7 SYNCHRONIZATION AND COMMUNICATION FUNCTIONS
CHAPTER 8 EXTENDED SYNCHRONIZATION AND COMMUNICATION FUNCTIONS
CHAPTER 9 MEMORY POOL MANAGEMENT FUNCTIONS
CHAPTER 10 TIME MANAGEMENT FUNCTIONS
CHAPTER 11 SYSTEM STATE MANAGEMENT FUNCTIONS
CHAPTER 12 INTERRUPT MANAGEMENT FUNCTIONS
CHAPTER 13 SYSTEM CONFIGURATION MANAGEMENT FUNCTIONS
CHAPTER 14 OBJECT RESET FUNCTIONS
CHAPTER 15 SYSTEM DOWN
CHAPTER 16 SCHEDULING FUNCTION
CHAPTER 17 SYSTEM INITIALIZATION
CHAPTER 18 DATA TYPES AND MACROS
CHAPTER 19 SERVICE CALLS
CHAPTER 20 SYSTEM CONFIGURATION FILE
CHAPTER 21 CONFIGURATOR cfg600px
CHAPTER 22 TABLE GENARATION UTILITY mkritblpx
APPENDIX A WINDOW REFERENCE
APPENDIX B FLOATING-POINT OPERATION FUNCTION
APPENDIX C DSP FUNCTION
APPENDIX D STACK SIZE ESTIMATION

How to Read This Manual

It is assumed that the readers of this manual have general knowledge in the fields of electrical engineering, logic circuits, microcomputers, C language, and assemblers.

To understand the hardware functions of the RX MCU
-> Refer to the User's Manual of each product.

Conventions

Data significance:	Higher digits on the left and lower digits on the right
Note:	Footnote for item marked with Note in the text
Caution:	Information requiring particular attention
Remark:	Supplementary information
Numeric representation:	Decimal ... XXXX
	Hexadecimal ... 0xXXXX

Prefixes indicating power of 2 (address space and memory capacity):

K (kilo)	2^{10}- = 1024
M (mega)	$2^{20} = 1024^2$

up4(*data*):	A value in which *data* is rounded up to the multiple of 4.
down(*data*):	A integer part of *data*.

Related Documents

The related documents indicated in this publication may include preliminary versions. However, preliminary versions are not marked as such.

Document Name		Document No.
RI Series	Start	R20UT0751E
	Message	R20UT0756E
RI600PX	Coding	This document
	Debug	R20UT0950E

Caution **The related documents listed above are subject to change without notice. Be sure to use the latest edition of each document when designing.**

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CHAPTER 1 OVERVIEW

1.1 Outline

The RI600PX is a built-in real-time, multi-task OS that provides a highly efficient real-time, multi-task environment to increases the application range of processor control units.
The RI600PX is a high-speed, compact OS capable of being stored in and run from the ROM of a target system.
The RI600PX is based on the μITRON4.0 specification. Furthermore, the RI600PX supports the memory protection function specified by μITRON4.0 protection extension.

1.1.1 Real-time OS

Control equipment demands systems that can rapidly respond to events occurring both internal and external to the equipment. Conventional systems have utilized simple interrupt handling as a means of satisfying this demand. As control equipment has become more powerful, however, it has proved difficult for systems to satisfy these requirements by means of simple interrupt handling alone.
In other words, the task of managing the order in which internal and external events are processed has become increasingly difficult as systems have increased in complexity and programs have become larger.
Real-time OS has been designed to overcome this problem.
The main purpose of a real-time OS is to respond to internal and external events rapidly and execute programs in the optimum order.

1.1.2 Multi-task OS

A “task” is the minimum unit in which a program can be executed by an OS. “Multi-task” is the name given to the mode of operation in which a single processor processes multiple tasks concurrently.
Actually, the processor can handle no more than one program (instruction) at a time. But, by switching the processor’s attention to individual tasks on a regular basis (at a certain timing) it appears that the tasks are being processed simultaneously.
A multi-task OS enables the parallel processing of tasks by switching the tasks to be executed as determined by the system.
One important purpose of a multi-task OS is to improve the throughput of the overall system through the parallel processing of multiple tasks.

1.1.3 Memory protection function

1) High-reliability system
To reduce a possibility of being unable to detect program glitches when debugging the program and causing a trouble in the market after the system has been shipped from the factory, this OS assures the system of high reliability.
If memory data destruction occurs especially in a memory area in which the OS, etc. are stored, the system may produce a dangerous condition by, for example, operating erratically. However, since this OS is free of memory data corruptions, the system can continue operating normally, and is therefore assured of high system reliability.

2) Debug assistance
In systems without memory protection, a corruption of memory content by an illegal pointer behavior, etc. generally is not noticed until it actually comes to the surface as a trouble symptom. The cause of the trouble can only be identified by analyzing emulator's trace data, which requires a large amount of time. The RI600PX can detect a bug when an illegal memory access is committed, enabling the debugging efficiency to be greatly increased.

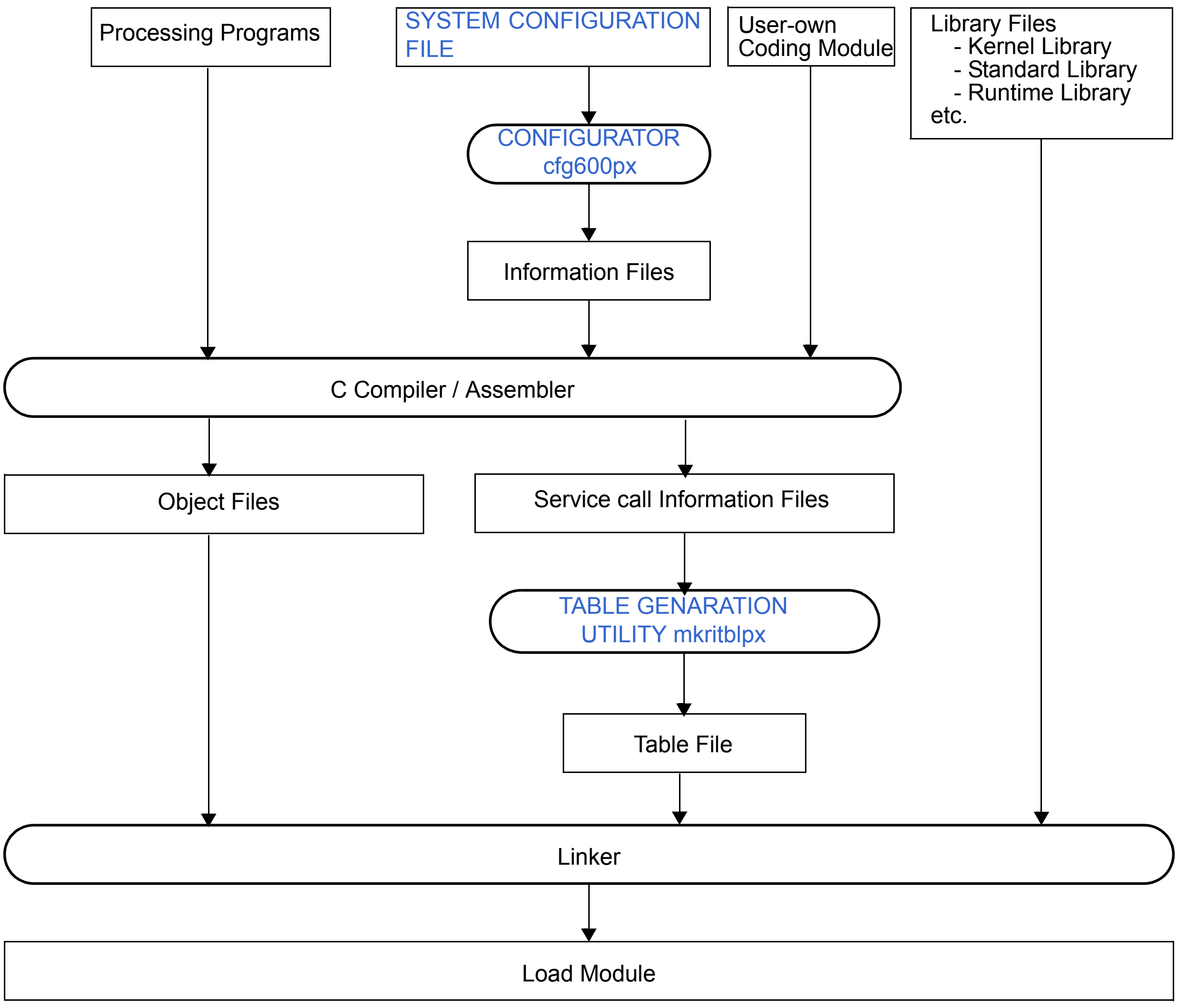
CHAPTER 2 SYSTEM BUILDING

This chapter describes how to build a system (load module) that uses the functions provided by the RI600PX.

2.1 Outline

System building consists in the creation of a load module using the files (kernel library, etc.) installed on the user development environment (host machine) from the RI600PX's supply media.
Figure 2-1 shows the procedure of system building.

Figure 2-1 Example of System Building


Processing Programs
SYSTEM CONFIGURATION FILE
User-own Coding Module
Library Files - Kernel Library - Standard Library - Runtime Library etc.
CONFIGURATOR cfg600px
Information Files
C Compiler / Assembler
Object Files
Service call Information Files
TABLE GENARATION UTILITY mkritblpx
Table File
Linker
Load Module

The RI600PX provides a sample program with the files necessary for generating a load module.
The sample programs are stored in the following folder. The source files are stored in “appli” sub-folder.

<ri_sample> = <CubeSuite+_root>\SampleProjects\RX\device_name_RI600PX

- <CubeSuite+_root>

  Indicates the installation folder of CubeSuite+.
  The default folder is “C:\Program Files\Renesas Electronics\CubeSuite+\”.

- SampleProjects
  Indicates the sample project folder of CubeSuite+.

- RX
  Indicates the sample project folder of RX MCU.

- *device_name*_RI600PX
  Indicates the sample project folder of the RI600PX. The project file is stored in this folder.

  device_name: Indicates the device name which the sample is provided.

2.2 Coding Processing Programs

Code the processing that should be implemented in the system.
In the RI600PX, the processing program is classified into the following five types, in accordance with the types and purposes of the processing that should be implemented.

- Tasks
  A task is processing program that is not executed unless it is explicitly manipulated via service calls provided by the RI600PX, unlike other processing programs (interrupt handler, cyclic handler and alarm handler).

- Task Exception Handling Routines
  When task exception is requested to a task, the task exception handling routine defined for the task is invoked. The requested exception code is passed to the task exception handling routine.

- Cyclic Handlers
  The cyclic handler is a routine started for every specified cycle time.
  The RI600PX handles the cyclic handler as a “non-task (module independent from tasks)”. Therefore, even if a task with the highest priority in the system is being executed, the processing is suspended when a specified activation cycle has come, and the control is passed to the cyclic handler.

- Alarm Handlers
  The alarm handler is a routine started only once after the specified time.
  The RI600PX handles the alarm handler as a “non-task (module independent from tasks)”. Therefore, even if a task with the highest priority in the system is being executed, the processing is suspended when a specified activation cycle has come, and the control is passed to the cyclic handler.

- Interrupt Handlers
  The interrupt handler is a routine started when an interrupt occurs.
  The RI600PX handles the interrupt handler as a “non-task (module independent from tasks)”. Therefore, even if a task with the highest priority in the system is being executed, the processing is suspended when an interrupt occurs, and the control is passed to the interrupt handler.

Note For details about the processing programs, refer to “CHAPTER 4 TASK MANAGEMENT FUNCTIONS”, “CHAPTER 6 TASK EXCEPTION HANDLING FUNCTIONS”, “CHAPTER 10 TIME MANAGEMENT FUNCTIONS”, “CHAPTER 12 INTERRUPT MANAGEMENT FUNCTIONS”.

2.3 Coding System Configuration File

Code the SYSTEM CONFIGURATION FILE required for creating information files that contain data to be provided for the RI600PX.

Note For details about the system configuration file, refer to “CHAPTER 20 SYSTEM CONFIGURATION FILE”.

2.4 Coding User-Own Coding Module

- MEMORY PROTECTION FUNCTIONS
  - Access Exception Handler (_RI_sys_access_exception( ))
    The access exception handler will be invoked when a task or task exception handling routine accesses the memory that has not been permitted.
- TIME MANAGEMENT FUNCTIONS
  - Base Clock Timer Initialization Routine (_RI_init_cmt_knl( ))
    The base clock timer initialization routine is called at starting the RI600PX.
- SYSTEM DOWN
  - System down routine (_RI_sys_dwn__( ))
    The system down routine is called when the system down occurs.
- SYSTEM INITIALIZATION
  - Boot processing file
    For details, refer to “17.2 Boot Processing File (User-Own Coding Module)”.
  - Section information file (User-Own Coding Module)
    Informations for uninitialized data sections and initialized data sections are defined in the section information file.

2.5 Creating Load Module

Run a build on CubeSuite+ for files created in sections from “2.2 Coding Processing Programs” to “2.4 Coding User-Own Coding Module”, and library files provided by the RI600PX and C compiler package, to create a load module.

1) Create or load a project

Create a new project, or load an existing one.

Note See “RI Series Real-Time Operating System User's Manual: Start”, “CubeSuite+ Integrated Development Environment User's Manual: Start” and the Release Notes of this product for details about creating a new project or loading an existing one.

2) Set a build target project

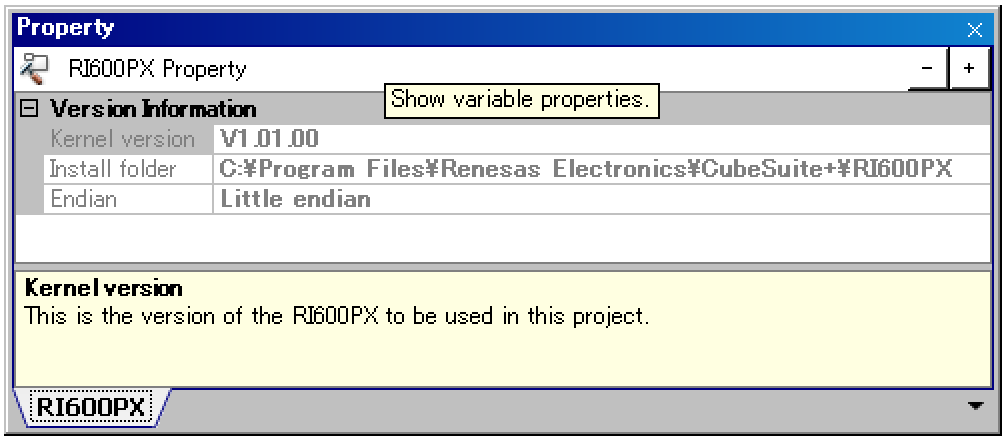
When making settings for or running a build, set the active project.
If there is no subproject, the project is always active.

Note See “CubeSuite+ Integrated Development Environment User's Manual: RX Build” for details about setting the active project.

3) Confirm the version

Select the Realtime OS node on the project tree to open the Property panel.
Confirm the version of RI600PX to be used in the [Kernel version] property on the [RI600PX] tab.

Figure 2-2 Property Panel: [RI600PX] Tab



Version Information

Kernel version	V1.01.00
Install folder	C:¥Program Files¥Renesas Electronics¥CubeSuite+¥RI600PX
Endian	Little endian

Kernel version
This is the version of the RI600PX to be used in this project.

4) Set build target files

For the project, add or remove build target files and update the dependencies.

Note See “CubeSuite+ Integrated Development Environment User's Manual: RX Build” for details about adding or removing build target files for the project and updating the dependencies.

The following lists the files required for creating a load module.

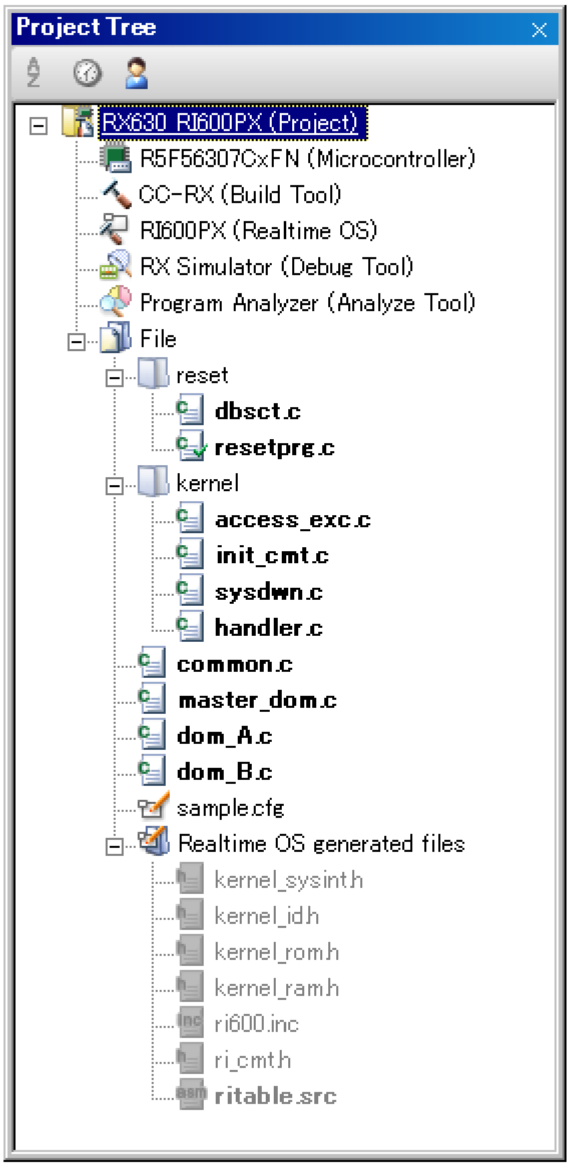
- Source files created in “2.2 Coding Processing Programs”
  - Processing programs (tasks, cyclic handlers, alarm handlers, interrupt handlers)
- System configuration file created in “2.3 Coding System Configuration File”
  - SYSTEM CONFIGURATION FILE

  Note Specify “cfg” as the extension of the system configuration file name. If the extension is different, “cfg” is automatically added (for example, if you designate “aaa.c” as a file name, the file is named as “aaa.c.cfg”).
- Source files created in “2.4 Coding User-Own Coding Module”
  - User-own coding module (system down routine, boot processing)
- Library files provided by the RI600PX
  - Kernel library (refer to “2.6.3 Kernel library”)
- Library files provided by the C compiler package
  - Standard library, runtime library, etc.

Note 1 If the system configuration file is added to the Project Tree panel, the Realtime OS generated files node is appeared.
The following information files are appeared under the Realtime OS generated files node. However, these files are not generated at this point in time.

- System information header file (kernel_id.h)
- Service call definition file (kernel_sysint.h)
- ROM definition file (kernel_rom.h)
- RAM definition file (kernel_ram.h)
- System definition file (ri600.inc)
- CMT timer definition file (ri_cmt.h)
- Table file (ritable.src)

Figure 2-3 Project Tree Panel



```
Project Tree
RX630_RI600PX (Project)
    R5F56307CxFN (Microcontroller)
    CC-RX (Build Tool)
    RI600PX (Realtime OS)
    RX Simulator (Debug Tool)
    Program Analyzer (Analyze Tool)
    File
        reset
            dbsct.c
            resetprg.c
        kernel
            access_exc.c
            init_cmt.c
            sysdwn.c
            handler.c
        common.c
        master_dom.c
        dom_A.c
        dom_B.c
        sample.cfg
        Realtime OS generated files
            kernel_sysint.h
            kernel_id.h
            kernel_rom.h
            kernel_ram.h
            ri600.inc
            ri_cmt.h
            ritable.src
```

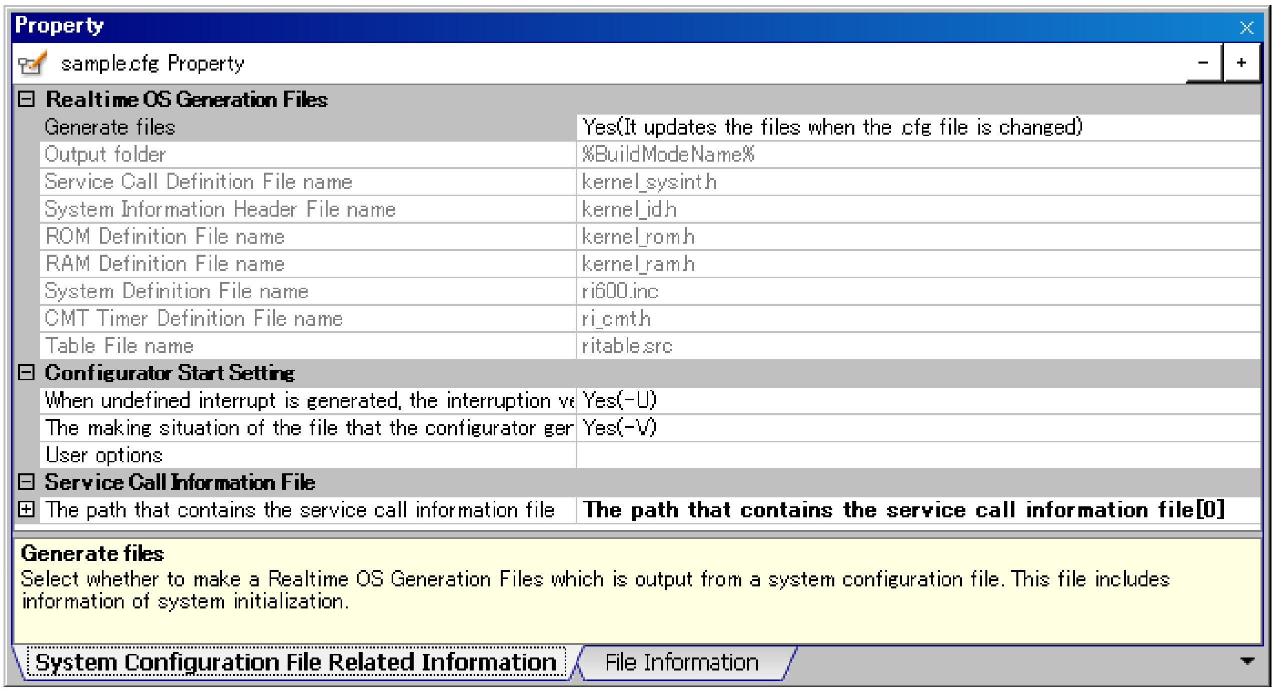
Note 2 When replacing the system configuration file, first remove the added system configuration file from the project, then add another one again.

Note 3 Although it is possible to add more than one system configuration files to a project, only the first file added is enabled. Note that if you remove the enabled file from the project, the remaining additional files will not be enabled; you must therefore add them again.

5) Set the output of Realtime OS generation files

Select the system configuration file on the project tree to open the Property panel.
On the [System Configuration File Related Information] tab, set the output of realtime OS generation files, etc.

Figure 2-4 Property Panel: [System Configuration File Related Information] Tab



Realtime OS Generation Files	
Generate files	Yes(It updates the files when the .cfg file is changed)
Output folder	%BuildModeName%
Service Call Definition File name	kernel_sysint.h
System Information Header File name	kernel_id.h
ROM Definition File name	kernel_rom.h
RAM Definition File name	kernel_ram.h
System Definition File name	ri600.inc
CMT Timer Definition File name	ri_cmt.h
Table File name	ritable.src
Configurator Start Setting	
When undefined interrupt is generated, the interruption ve	Yes(-U)
The making situation of the file that the configurator ger	Yes(-V)
User options	
Service Call Information File	
The path that contains the service call information file	**The path that contains the service call information file[0]**

Generate files
Select whether to make a Realtime OS Generation Files which is output from a system configuration file. This file includes information of system initialization.

6) Specify the output of a load module file

Set the output of a load module file as the product of the build.

Note See “CubeSuite+ Integrated Development Environment User's Manual: RX Build” for details about specifying the output of a load module file.

7) Set build options

Set the options for the compiler, assembler, linker, and the like.
Please be sure to refer to “2.6 Build Options”.

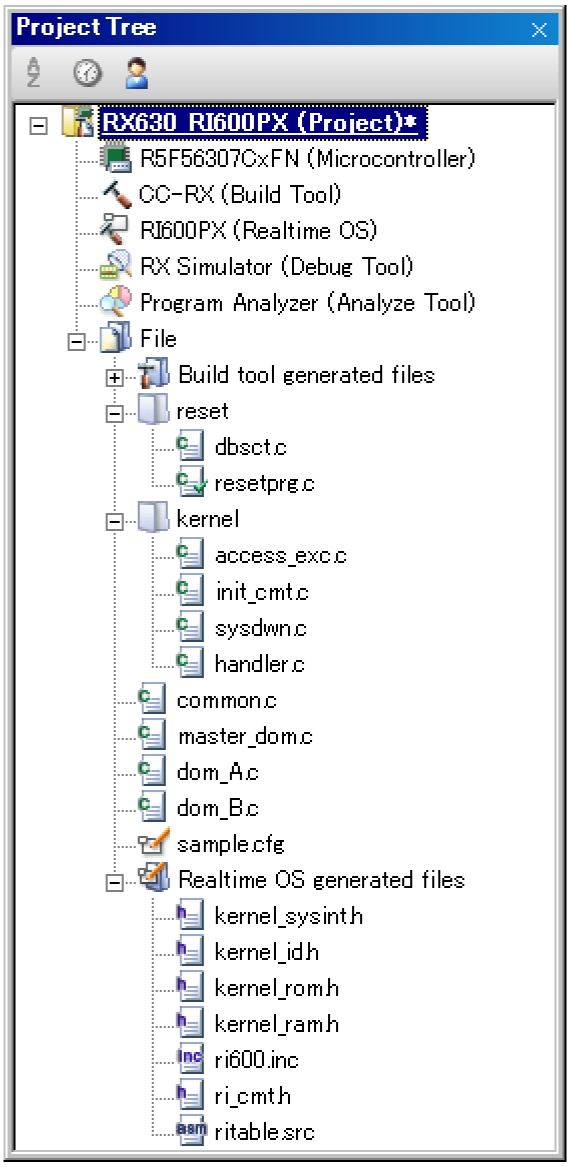
Note See “CubeSuite+ Integrated Development Environment User's Manual: RX Build” for details about setting build options.

8) Run a build

Run a build to create a load module.

Note See “CubeSuite+ Integrated Development Environment User's Manual: RX Build” for details about running a build.

Figure 2-5 Project Tree Panel (After Running Build)



9) Save the project

Save the setting information of the project to the project file.

Note See “CubeSuite+ Integrated Development Environment User's Manual: Start” for details about saving the project.

2.6 Build Options

This section explains the build options that should be especially noted.

2.6.1 Service call information files and “-ri600_preinit_mrc” compiler option

The service call information file (mrc files) are generated to the same folder as object files at compilation of the source files that includes kernel.h file.
The name of service calls used in the source files are outputted in the mrc files. It is necessary to input all files to the table generation utility mkritblpx. If there is a leaking in the input file, service call modules that application uses might not be linked. In this case, the system down will occur when the service call is issued.
On the other hand, if the mrc files which are generated in the past and which is invalid in now are input to the mkritblpx, the service call modules that are not used in the application may be linked. In this case, there is no problem in the operation of the RI600PX but the module size uselessly grows.
Specify “-ri600_preinit_mrc” compiler option for the source file that includes kernel.h file even if this option is not specified, there is no problem in the operation of the RI600PX but the service call module that is not used in the application may be linked.
When application libraries are used, the mrc files that is generated at compilation of the library source should be inputted to the mkritblpx. If this way is difficult for you, make mrc file where name of using service calls is described (see belows), and input the mrc file to the mkritblpx.
Note, the system down will occur when the service call that is not linked is called.

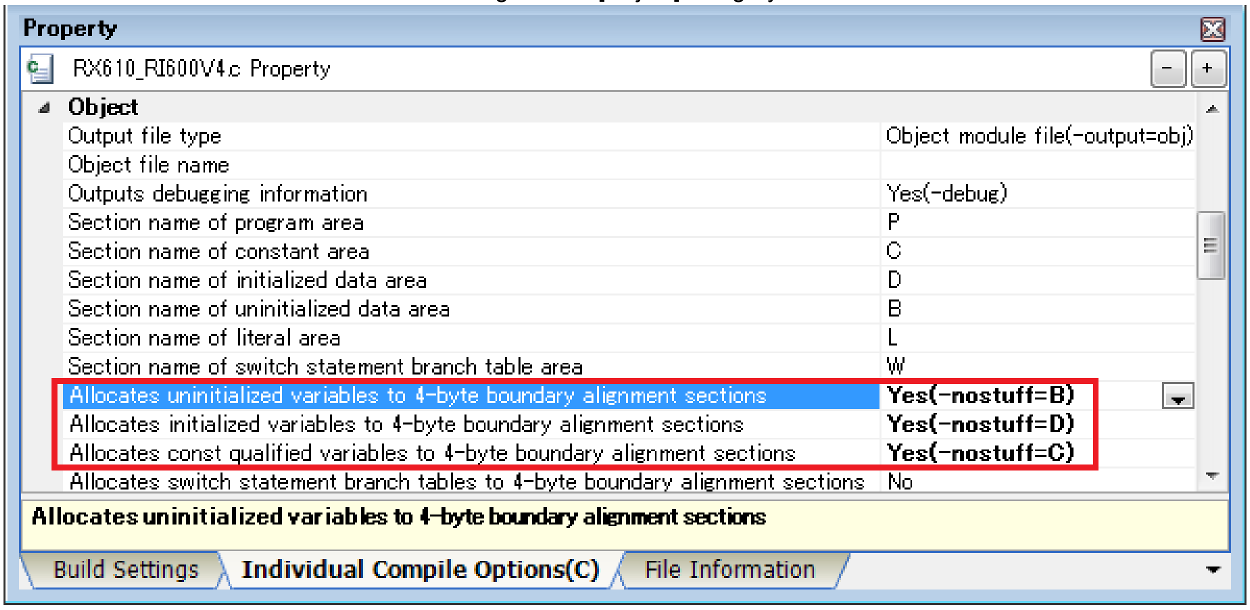
```
sta_tsk
snd_mbx
rcv_mbx
prcv_mbx
```

2.6.2 Compiler option for the boot processing file

It is necessary to set “-nostuff” option for the boot processing file (“resetprg.c” in the sample project) like a mention in “17.2.3 Compiler option for boot processing file”. If not, the RI600PX does not work correctly.
To set “-nostuff” option only for the boot processing file, please set any of the following in the [Individual Compile Options] tab of [Property] panel for the boot processing file. To set “-nostuff” option for all, please set any of the following in the [Compiler Options] tab of [Property] panel for [CC-RX (Build Tool)].

1) Set in the [Object] category
Like Figure 2-6, set “Yes” in [Allocates uninitialized variables to 4-byte boundary alignment sections], [Allocates initialized variables to 4-byte boundary alignment sections] and [Allocates const qualified variables to 4-byte boundary alignment sections].

Figure 2-6 [Object] category

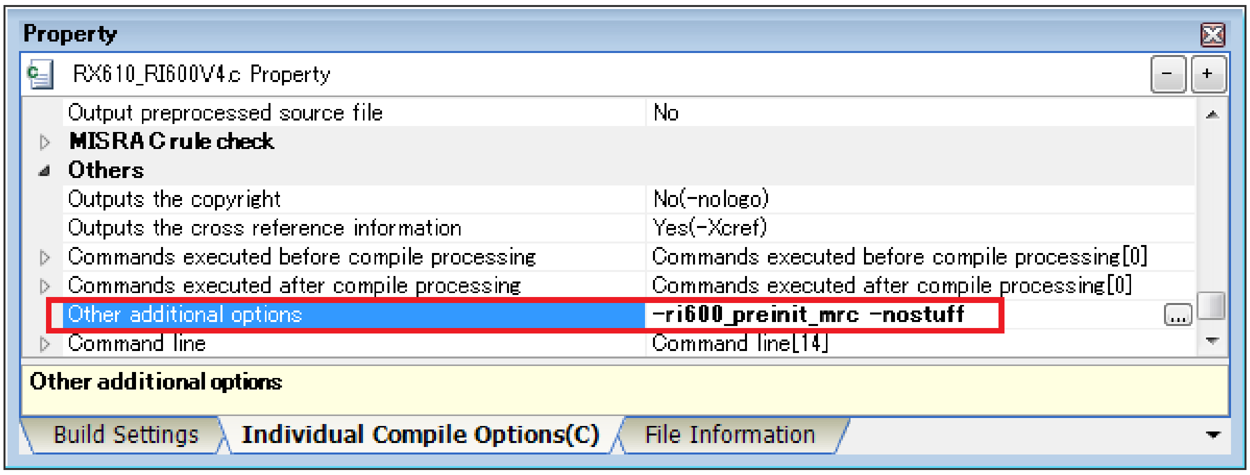

Property
RX610_RI600V4.c Property

Object	
Output file type	Object module file(-output=obj)
Object file name	
Outputs debugging information	Yes(-debug)
Section name of program area	P
Section name of constant area	C
Section name of initialized data area	D
Section name of uninitialized data area	B
Section name of literal area	L
Section name of switch statement branch table area	W
Allocates uninitialized variables to 4-byte boundary alignment sections	**Yes(-nostuff=B)**
Allocates initialized variables to 4-byte boundary alignment sections	**Yes(-nostuff=D)**
Allocates const qualified variables to 4-byte boundary alignment sections	**Yes(-nostuff=C)**
Allocates switch statement branch tables to 4-byte boundary alignment sections	No

Allocates uninitialized variables to 4-byte boundary alignment sections

2) Set in the [Others] category
Like Figure 2-7, add “-nostuff” to [Other additional options].

Figure 2-7 [Others] category


Property
RX610_RI600V4.c Property

Output preprocessed source file	No
MISRA C rule check	
Others	
Outputs the copyright	No(-nologo)
Outputs the cross reference information	Yes(-Xcref)
Commands executed before compile processing	Commands executed before compile processing[0]
Commands executed after compile processing	Commands executed after compile processing[0]
Other additional options	**-ri600_preinit_mrc -nostuff**
Command line	Command line[14]

Other additional options

2.6.3 Kernel library

The kernel libraries are stored in the folders described in Table 2-1. Note, CubeSuite+ links the appropriate kernel library automatically, you need not consider the kernel libraries.

Table 2-1 Kernel libraries

	Folder	Compiler version corresponding to the library	Corresponding CPU core	File name	Description
1	<ri_root>\library\rxv1	V1.02.01 or later	RXv1 architecture	ri600lit.lib	For little endian
				ri600big.lib	For big endian
2	<ri_root>\library\rxv2	V2.01.00 or later	RXv1 architecture and RXv2 architecture	ri600lit.lib	For little endian
				ri600big.lib	For big endian

Note 1 <ri_root> indicates the installation folder of RI600PX.
The default folder is "C:\Program Files\Renesas Electronics\CubeSuite+\RI600PX".

Note 2 The kernel described in item-2 of Table 2-1 is linked when compiler V2.01.00 or later is used. In the case of others, the kernel library described in item-1 of Table 2-1 is linked.

2.6.4 Arrangement of section

1) Naming convention of sections
In order to arrange sections to suitable memory objects, defining the naming convention of sections like the following examples is recommended.

- The 1st character : Section type
  - P : Program area
  - C : Constant area
  - B : Uninitialized data area
  - D : Initialized data area (ROM)
  - R : Variables area for initialized data (RAM) (generated by linker)
  - W : Switch statement branch table area (generated by compiler)
  - L : Literal area (generated by compiler)
- The 2nd character or subsequent ones
  - RI* : Reserved by the RI600PX
    This area is never accessed from user mode (= task context).
  - U* : Memory object or user stack
    This area is accessed from user mode (= task context).
  - S* : Excluding the above-mentioned
    This area is never accessed from user mode (= task context).

2) RI600PX sections
Table 2-2 shows RI600PX sections.
The application must not use the RI600PX except SURI_STACK and BURI_HEAP.

Table 2-2 RI600PX sections

Section name	Attribute	Boundary alignment	ROM/RAM	Description
PRI_KERNEL	CODE	1	ROM/RAM	RI600PX program
CRI_ROM	ROMDATA	4	ROM/RAM	RI600PX constant
DRI_ROM	ROMDATA	4	ROM/RAM	RI600PX initialized data (ROM)
FIX_INTERRUPT_VECTOR	ROMDATA	4	ROM	Fixed vector table/Exception vector table Refer to "FIX_INTERRUPT_VECTOR section"
INTERRUPT_VECTOR	ROMDATA	4	ROM/RAM	Relocatable vector table (1kB)
SI	DATA	4	RAM	System stack
SURI_STACK	DATA	4	RAM	Default section for user stack area
BRI_RAM	DATA	4	RAM	- RI600PX variable - Data queue area created by the system configuration file - Message buffer area created by the system configuration file (when the section is omitted)
RRI_RAM	DATA	4	RAM	RI600PX initialized data (RAM)
BURI_HEAP	DATA	4	RAM	- Fixed-sized memory pool area created by the system configuration file (when the section is omitted) - variable-sized memory pool area created by the system configuration file (when the section is omitted) Usually, this section should be arranged to memory object.

3) FIX_INTERRUPT_VECTOR section

The configurator cfg600px generates fixed vector table/exception vector table as FIX_INTERRUPT_VECTOR section according to the contents of definitions of “interrupt_fvector[]” in the system configuration file.

- At the time of RXv1 architecture use
  In the RXv1 architecture, fixed vector table is being fixed to address 0xFFFFFF80. It is necessary to arrange the FIX_INTERRUPT_VECTOR section at address 0xFFFFFF80.
  When the FIX_INTERRUPT_VECTOR section is not arranged to address 0xFFFFFF80, RI600PX does not operate correctly.
- At the time of RXv2 architecture use
  In the RXv2 architecture, the name of fixed vector table is changed into exception vector table, and can set up the start address by EXTB register. The initial value of EXTB register at the time of reset is 0xFFFFFF80, it is same as fixed interrupt vector table in RXv1 architecture.
  Usually, please arrange the FIX_INTERRUPT_VECTOR section to address 0xFFFFFF80.
  When the FIX_INTERRUPT_VECTOR section is not arranged to address 0xFFFFFF80, “interrupt_fvector[31]” (reset vector) in the system configuration file is ignored. Please generate the reset vector (address 0xFFFFFFFC) by the user side. And initialize EXTB register to the start address of FIX_INTERRUPT_VECTOR section in Boot processing function (PowerON_Reset_PC( ))

4) “aligned_section” linker option
The “aligned_section” linker option must be specified for following sections.

- The section specified as “memory_object[].start_address” in the system configuration file
- The section specified as “task[].stack_section” in the system configuration file
- SURI_STACK section

5) Attention concerning L and W section
The L section is literal area, and the W section is switch statement branch table area. These section are generated by the compiler.
The name of these section cannot be changed by using “#pragma section” directive.
Please note it as follows when a function executes as a task and the L and W section may be generated by compiling the source file.

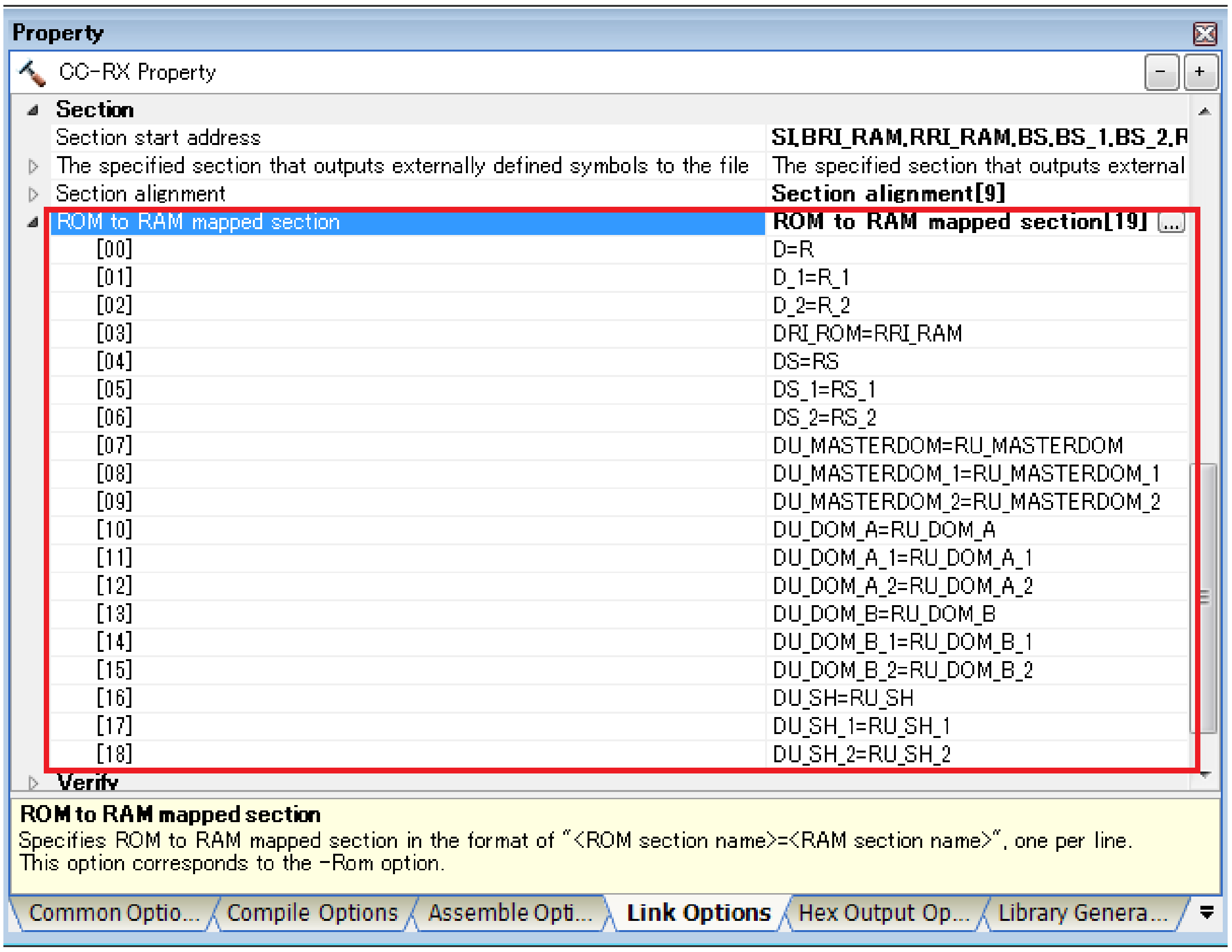
A) All functions in the source file executes only as tasks which belong to same domain
Especially, there are no points of concern. The L and W section should be a memory object to be able to read from the domain.

B) Functions in the source file executes as tasks which belong to separate domains
Because a different name cannot be given to literal area and switch table area of each function, it is impossible to divide these area to separate memory object. Therefore, separate functions in order to the domain at running to individual source file and apply (A), or the L and W section should be a memory object to be able to read from all domain.

2.6.5 Initialized data section

About sections described in DTBL of the Section information file (User-Own Coding Module), it is necessary to perform setting to map sections placed on ROM to sections placed on RAM by using "-rom" linker option. Set [Link Options] tab of [Property] panel for [CC-RX (Build Tool)] like Figure 2-8.

Figure 2-8 ROM to RAM mapped section



Section	
Section start address	SI,BRI_RAM,RRI_RAM,BS,BS_1,BS_2,R
The specified section that outputs externally defined symbols to the file	The specified section that outputs external
Section alignment	Section alignment[9]
ROM to RAM mapped section	ROM to RAM mapped section[19]
[00]	D=R
[01]	D_1=R_1
[02]	D_2=R_2
[03]	DRI_ROM=RRI_RAM
[04]	DS=RS
[05]	DS_1=RS_1
[06]	DS_2=RS_2
[07]	DU_MASTERDOM=RU_MASTERDOM
[08]	DU_MASTERDOM_1=RU_MASTERDOM_1
[09]	DU_MASTERDOM_2=RU_MASTERDOM_2
[10]	DU_DOM_A=RU_DOM_A
[11]	DU_DOM_A_1=RU_DOM_A_1
[12]	DU_DOM_A_2=RU_DOM_A_2
[13]	DU_DOM_B=RU_DOM_B
[14]	DU_DOM_B_1=RU_DOM_B_1
[15]	DU_DOM_B_2=RU_DOM_B_2
[16]	DU_SH=RU_SH
[17]	DU_SH_1=RU_SH_1
[18]	DU_SH_2=RU_SH_2
Verify	

ROM to RAM mapped section
Specifies ROM to RAM mapped section in the format of "<ROM section name>=<RAM section name>", one per line.
This option corresponds to the -Rom option.

Note In sample projects provided by RI600PX, it is already set up that the "DRI_ROM" section of RI600PX is mapped to "RRI_RAM" section.

CHAPTER 3 MEMORY PROTECTION FUNCTIONS

This chapter describes the memory protection functions performed by the RI600PX.

3.1 Outline

The RI600PX achieves following memory access protection function by using MPU (Memory Protection Unit) found in MCU. Note, handlers can access all address space.

1) Detection of illegal access by tasks and task exception handling routines
Tasks and task exception handling routines can access only permitted memory objects. The access exception handler will be invoked if a task or task exception handling routine access the area that has not been permitted.

2) Protection of user stack area
The user stack area of each task is inaccessible from other tasks. The access exception handler will be invoked if an user stack overflows or a task accesses an user stack for another task.

3) Detection of illegal access by the RI600PX
Some service calls receives pointers as argument. The RI600PX inspects whether the invoking task can access to the area indicated by the pointer. The service call returns E_MACV error when the invoking task does not have the access permission to the area.
And some service calls saves the context registers of the invoking task. If the user stack will overflow at the time, the service call returns E_MACV error.
This feature is available only for service calls issued from task context.

3.2 Domain, Memory object, Access permission vector

The memory protection function is achieved by controlling the following.

- Who
- To where
- What access is permitted

The one that corresponds to “Who” is domain. Tasks and task exception handling routines belong to either of domain without fail. Domains are distinguished by domain ID with the value from 1 to 15. Domains is generated statically by the system configuration file.
The one that corresponds to “To where” is memory object, and the one that corresponds to “What access is permitted” is access permission vector.
Usually, memory objects are registered statically by the system configuration file. Memory objects can be registered dynamically by using ata_mem service call and unregistered by using det_mem service call. The start address of a memory object must be 16-bytes boundary, and the size must be multiple of 16.
Access permission vector represents whether tasks that belong to each domain can access (operand-read, operand-write, execution access) to the memory object.
The access exception handler will be invoked if a task accesses to the memory object that has not been permitted, or a task accesses other than memory objects and user stack for itself.
On the other hand, in handlers (interrupt handlers, cyclic handlers, alarm handlers and access exception handler), there is no concept of belonging domain. Handlers can access all address space.

Figure 3-1 Summary of Memory Protection

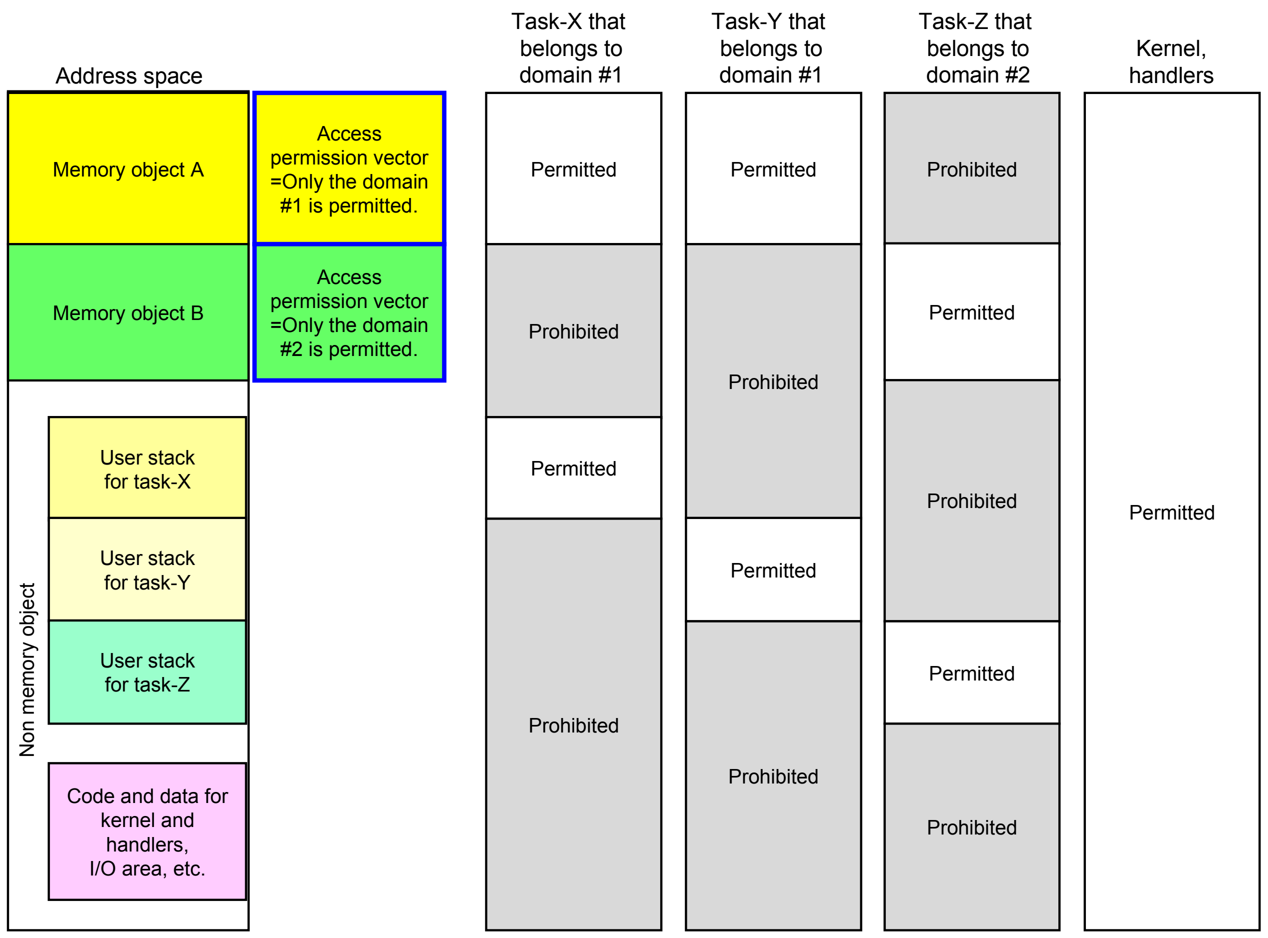


Table 3-1 shows the operation concerning memory objects.

Table 3-1 The operation concerning memory objects

Operation	Static (system configuration file)	Dynamic (service call)
Registration	memory_object[]	ata_mem
Unregistration	-	det_mem
Change access permission	-	sac_mem
Check access permission (Other than memory object can be checked.)	-	vprb_mem
Refer to state	-	ref_mem

3.3 Restriction in the Number of Memory Objects

The number of memory objects to which either of access (operand-read, operand-write and execution access) has been permitted by a certain domain is seven or less. Please design memory map with careful attention to this. The E_OACV error is detected when this restriction are no longer filled by ata_mem or sac_mem.

3.4 Trusted Domain

In the system which does not support protection mechanism other than memory protection, for example, the possibility of the following illegal accesses can be considered.

1) The task-A with malice does not have access permission for the memory object-M.

2) The coder wrote the source code for Task-A to create and start the task-B that belongs to the domain which has access permission for the memory object-M.

3) The illegal access is not detected if the task-B accesses the memory object-M.

To prevent such illegal access, the RI600PX supports “trusted domain”. The following service calls that gives the change to the composition of software can be called only from tasks that belongs to trusted domain. The E_OACV error is detected when a tasks that does not belong to trusted domain calls either of these service calls.

- cre_???, acre_???, del_???, def_tex, ata_mem, det_mem, sac_mem

3.5 Change Access Permission

The access permission for a memory object can be changed dynamically by using sac_mem.
For instance, the following example showcases the requirement to change the access permission.

In this example, it is required download application into memory that belongs to another domain and execute the application as a task .

1) Register the area for downloading as a memory object (ata_mem). At this time, specify to permit access the memory object from the domain-A that the task to download belongs to. Afterwards, download to the memory object area.

2) After downloading, set to be able to access the memory object from the domain-B (sac_mem). And create and start the downloaded code as the task that belongs to the domain-B.

3.6 Protection of User Stack

The user stack of each task can be accessed only by the task. The access exception handler will be invoked if the user stack overflows or a task accesses the user stack for another task.
When service call invoked from task uses user stack, the RI600PX inspects whether stack pointer points in the range of the user stack for invoking task. If not, the error E_MACV is returned.

3.7 Check Access Permission

In the program called from two or more domains, there is a scene that the program wants to judge whether the program can access the memory. In such a case, vprb_mem service call is useful. The vprb_mem inspects whether the specified task can do the specified access to the specified memory area.

3.8 Processor Mode

The memory protection by MPU (Memory Protection Unit) is effective only at user mode.
In the RI600PX system, task context executes in user mode, and non-task context executes in supervisor mode.

3.9 Enable MPU (Memory Protection Unit)

The RI600PX enables MPU at initiation (vsta_knl, ivsta_knl). Do not disable MPU after the RI600PX has been initialized. If the MPU is disabled, the system operation cannot be guaranteed.

3.10 Access Exception Handler (_RI_sys_access_exception( ))

The access exception handler will be invoked when a task or task exception handling routine accesses the memory that has not been permitted. For such situation, the access exception handler can either remove the factor of illegal access and return to normal program execution or be used for debug purposes.

3.10.1 User-Own Coding Module

The access exception handler must be implemented as user-own coding module.

Note The source file for the access exception handler provided by the RI600PX as a sample file is “access_exc.c”.

- Basic form of access exception handler
  The following shows the basic form of access exception handler.

```
#include    "kernel.h"                    // Provided by RI600PX
#include    "kernel_id.h"                 // Generated by cfg600px

////////////////////////////////////////////////////////////
// Access exception handler
////////////////////////////////////////////////////////////
void _RI_sys_access_exception(UW pc ,UW psw, UW sts, UW addr);
void _RI_sys_access_exception(UW pc ,UW psw, UW sts, UW addr)
{
        ............
        ............
}
```

Note The function name of access exception handler is “_RI_sys_access_exception”.

- Parameters

I/O	Parameters	Register	Description
I	UW *pc*;	R1	The instruction address that causes access exception
I	UW *psw*;	R2	The PSW value at access exception
I	UW *sts*;	R3	Factor of access exception Value of MPESTS register in the MPU (Memory Protection Unit)) is passed.
I	UW *addr*;	R4	In the case of operand access error, the accessed address (= Value of MPDEA register in the MPU) is passed. In the case of execution access error, the *addr* is indeterminate.

- Stack
  The access exception handler uses the system stack.

- Service call
  The access exception handler can issue service calls whose “Useful range” is “Non-task”.

- PSW register when processing is started

Table 3-2 PSW Register When Access Exception Handler is Started

Bit	Value	Note
I	0	All interrupts are masked.
IPL	Same before exception	Do not lower IPL more than the start of processing.
PM	0	Supervisor mode
U	0	System stack
C, Z, S, O	Undefined	
Others	0	

3.11 Design of Memory Map

This section explains information required for a design of memory map.

3.11.1 The Restrictions regarding the Address of Memory Objects

The start address of memory objects must be 16-bytes boundary, and the size must be multiple of 16.
When a memory object is registered by the static API “memory_object[]” in the system configuration file, the start address can be specified by absolute address value or section name.
To specify I/O register area, absolute address value should be used.
When specifying section name, the start section and end section of the memory object should be specified. In this case, the sections must be arranged as assumption at linking. For example, specify “aligned_section” linker-option for the section specified for “start of memory object” (memory_object[].start_address) because the start address of memory object must be 16-bytes boundary.
And the size of memory objects must be multiple of 16. In other words, the termination address of memory object must be multiple of 16 + 15. But, the end section (specified for memory_object[].end_address) does not necessary become just like that. When the termination address of the end section is not multiple of 16 + 15, the area from the termination address + 1 to next multiple of 16 + 15 is also treated with a part of the memory object. Therefore, don’t arrange any sections in the range from the termination address + 1 to next multiple of 16 + 15.

- Example
  When specifying “CU_DOM1” for “memory_object[].end_address” and the termination address of CU_DOM1 section is 0xFFFF1003, do not arrange any sections from 0xFFFF1004 to 0xFFFF100F. To achieve this requirement, specify “aligned_section” linker option to the section which follows “CU_DOM1”.

3.11.2 Area That Should Be the Inside of Memory Objects

1) Area that is accessed by tasks
Tasks can access only memory objects to which the permission is appropriately set except it's own user stack. Therefore, it is necessary that program sections, constant sections, uninitialized data sections and initialized data sections accessed by tasks should be allocated to the inside of memory objects. Moreover, when the task accesses I/O area, the I/O area should be the inside of memory objects.

2) Message area handled by mailbox
The message must be generated in the memory objects that both transmitting task and receiving task can access. However, the management table exists in the top of message area. The system operation cannot be guaranteed if the management table is destroyed. For this reason, data queue or message buffer is recommended for message communication.

3) Fixed-sized and variable-sized memory pool area
The memory pool area should be the inside of memory object which can be accessed by tasks that use memory blocks.
However, the RI600PX generates management tables in the memory pool area. The system operation cannot be guaranteed if the management table is destroyed.

- A fixed-sized memory pool is created by the system configuration file
  The fixed-sized memory pool area is generated in the section indicated by “memorypool[].section”. When “memorypool[].section” is omitted, the fixed-sized memory pool area is generated in the “BURI_HEAP” section.

- A fixed-sized memory pool is created by cre_mpf or acre_mpf
  Application should acquire the fixed-sized memory pool area, and specify the start address for cre_mpf or acre_mpf.

- A variable-sized memory pool is created by the system configuration file
  The variable-sized memory pool area is generated in the section indicated by “variable_memorypool[].mpl_section”. When “variable_memorypool[].mpl_section” is omitted, the variable-sized memory pool area is generated in the “BURI_HEAP” section.

- A variable-sized memory pool is created by cre_mpl or acre_mpl
  Application should acquire the variable-sized memory pool area, and specify the start address for cre_mpl or acre_mpl.

3.11.3 Area That Should Be the Outside of Memory Objects

1) All the RI600PX sections except BURI_HEAP
The RI600PX sections except BURI_HEAP should be allocated to the outside of memory objects because these sections are accessed only by the RI600PX. Refer to "2.6.4 Arrangement of section" for the RI600PX sections.

2) User stack area for tasks
The user stack area for tasks should be outside of memory objects. The correct system operation cannot be guaranteed if the user stack area overwraps with either all user stacks and memory objects.

- A task is created by the system configuration file
The user stack area is generated in the section indicated by "task[].stack_section". When "task[].stack_section" is omitted, the user stack area is generated in the "SURI_STACK" section.

- A task is created by cre_tsk or acre_tsk
Application should acquire the user stack area, and specify the start address for cre_tsk or acre_tsk.

3) Data queue area
The data queue area should be outside of memory objects. The correct system operation cannot be guaranteed if the data queue area overwraps with either all user stacks and memory objects.

- A data queue is created by the system configuration file
The data queue area is generated in the "BRI_RAM" section of the RI600PX.

- A data queue is created by cre_dtq or acre_dtq
Application should acquire the data queue area, and specify the start address for cre_dtq or acre_dtq.

4) Message buffer area
The message buffer area should be outside of memory objects. The correct system operation cannot be guaranteed if the message buffer area overwraps with either all user stacks and memory objects.

- A message buffer is created by the system configuration file
The message buffer area is generated in the "BRI_RAM" section of the RI600PX.

- A message buffer is created by cre_mbf or acre_mbf
Application should acquire the message buffer area, and specify the start address for cre_mbf or acre_mbf.

5) Fixed-sized memory pool management area
The fixed-sized memory pool management area should be outside of memory objects. The correct system operation cannot be guaranteed if the fixed-sized memory pool management area overwraps with either all user stacks and memory objects.

- A fixed-sized memory pool is created by the system configuration file
The data queue area is generated in the "BRI_RAM" section of the RI600PX.

- A fixed-sized memory pool is created by cre_mpf or acre_mpf
Application should acquire the fixed-sized memory pool management area, and specify the start address for cre_mpf or acre_mpf.

CHAPTER 4 TASK MANAGEMENT FUNCTIONS

This chapter describes the task management functions performed by the RI600PX.

4.1 Outline

The task management functions provided by the RI600PX include a function to reference task statuses such as priorities and detailed task information, in addition to a function to manipulate task statuses such as generation, activation and termination of tasks.

4.2 Tasks

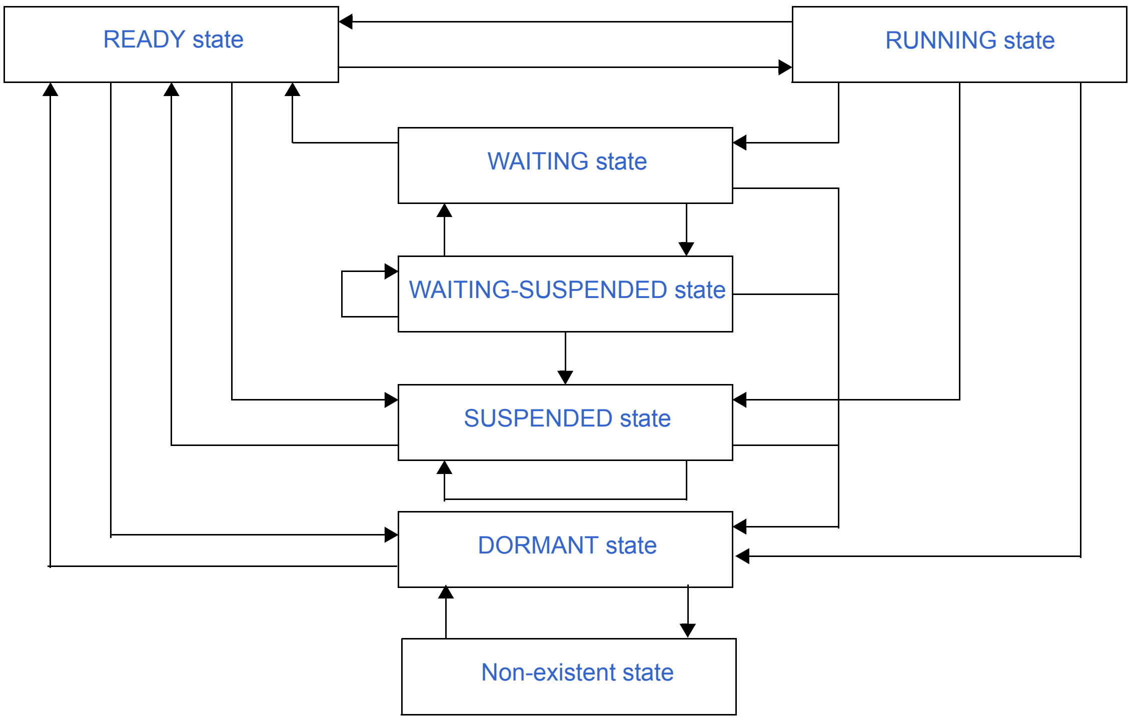
A task is processing program that is not executed unless it is explicitly manipulated via service calls provided by the RI600PX, unlike other processing programs (interrupt handler, cyclic handler and alarm handler), and is called from the scheduler.

Note The execution environment information required for a task's execution is called “task context”. During task execution switching, the task context of the task currently under execution by the RI600PX is saved and the task context of the next task to be executed is loaded.

4.2.1 Task state

Tasks enter various states according to the acquisition status for the OS resources required for task execution and the occurrence/non-occurrence of various events. In this process, the current state of each task must be checked and managed by the RI600PX.
The RI600PX classifies task states into the following seven types.

Figure 4-1 Task State



1) Non-existent state

The task has not been registered in the RI600PX. This is a virtual state.

2) DORMANT state

State of a task that is not active, or the state entered by a task whose processing has ended.
A task in the DORMANT state, while being under management of the RI600PX, is not subject to RI600PX scheduling.

3) READY state

State of a task for which the preparations required for processing execution have been completed, but since another task with a higher priority level or a task with the same priority level is currently being processed, the task is waiting to be given the CPU's use right.

4) RUNNING state

State of a task that has acquired the CPU use right and is currently being processed.
Only one task can be in the running state at one time in the entire system.

5) WAITING state

State in which processing execution has been suspended because conditions required for execution are not satisfied.
Resumption of processing from the WAITING state starts from the point where the processing execution was suspended. The value of information required for resumption (such as task context) immediately before suspension is therefore restored.
In the RI600PX, the WAITING state is classified into the following 12 types according to their required conditions and managed.

Table 4-1 WAITING State

WAITING State	Service Calls
Sleeping state	slp_tsk or tslp_tsk
Delayed state	dly_tsk.
WAITING state for a semaphore resource	wai_sem or twai_sem
WAITING state for an eventflag	wai_flg or twai_flg
Sending WAITING state for a data queue	snd_dtq or tsnd_dtq
Receiving WAITING state for a data queue	rcv_dtq or trcv_dtq.
Receiving WAITING state for a mailbox	rcv_mbx or trcv_mbx.
WAITING state for a mutex	loc_mtx or tloc_mtx.
Sending WAITING state for a message buffer	snd_mbf or tsnd_mbf
Receiving WAITING state for a message buffer	rcv_mbf or trcv_mbf
WAITING state for a fixed-sized memory block	get_mpf or tget_mpf.
WAITING state for a variable-sized memory block	get_mpl or tget_mpl.

6) SUSPENDED state

State in which processing execution has been suspended forcibly.
Resumption of processing from the SUSPENDED state starts from the point where the processing execution was suspended. The value of information required for resumption (such as task context) immediately before suspension is therefore restored.

7) WAITING-SUSPENDED state

State in which the WAITING and SUSPENDED states are combined.
A task enters the SUSPENDED state when the WAITING state is cancelled, or enters the WAITING state when the SUSPENDED state is cancelled.

4.2.2 Task priority

A priority level that determines the order in which that task will be processed in relation to the other tasks is assigned to each task.
As a result, in the RI600PX, the task that has the highest priority level of all the tasks that have entered an executable state (RUNNING state or READY state) is selected and given the CPU use right.
In the RI600PX, the following two types of priorities are used for management purposes.

- Current priority
  The RI600PX performs the following processing according to current priority.
  - Task scheduling (Refer to "16.4 Task Scheduling Method")
  - Queuing tasks to a wait queue in the order of priority

  Note The current priority immediately after it moves from the DORMANT state to the READY state is specified at creating the task.

- Base priority
  Unless mutex is used, the base priority is the same as the current priority. When using mutex, refer to "8.2.2 Current priority and base priority".

Note 1 In the RI600PX, a task having a smaller priority number is given a higher priority.

Note 2 The priority range that can be specified in a system can be defined by Maximum task priority (priority) in System Information (system)) when creating a system configuration file.

4.2.3 Basic form of tasks

The following shows the basic form of tasks.

```
#include    "kernel.h"                   /*Standard header file definition*/
#include    "kernel_id.h"                /*Header file generated by cfg600px*/
#pragma task Task1                       /*Refer to note 4*/
void Task1 (VP_INT exinf);               /*Refer to note 4*/
void Task1 (VP_INT exinf)
{
    /* ......... */

    ext_tsk ();                          /*Terminate invoking task*/
}
```

Note 1 The following information is passed to *exinf*.

How to activate	*exinf*
TA_ACT attribute is specified at the task creation	Extended information specified at the task creation.
act_tsk or iact_tsk	
sta_tsk or ista_tsk	Start code (*stacd*) specified by sta_tsk or ista_tsk

Note 2 When the return instruction is issued in a task, the same processing as ext_tsk is performed.

Note 3 For details about the extended information, refer to “4.5 Activate Task”.

Note 4 These statements are unnecessary for the task which is created by the system configuration file because the cfg600px generates these statement into the “kernel_id.h”.

4.2.4 Internal processing of task

In the RI600PX, original dispatch processing (task scheduling) is executed during task switching.
Therefore, note the following points when coding tasks.

- Stack
  Tasks use user stacks that are defined in Task Information (task[]), cre_tsk or acre_tsk.

- Service call
  Tasks can issue service calls whose “Useful range” is “Task”.

- PSW register when processing is started

Table 4-2 PSW Register When Task Processing is Started

Bit	Value	Note
I	1	All interrupts are acceptable.
IPL	0	
PM	1	User mode
U	1	User stack
C, Z, S, O	Undefined	
Others	0	

- FPSW register when processing is started
  When setting of Task context register (context) in System Information (system) includes “FPSW”, the FPSW when processing is started is shown in Table 4-3. The FPSW when processing is undefined in other cases.

Table 4-3 FPSW Register When Task Processing is Started

Compiler options		Value
-round	-denormalize	
nearest (default)	off (default)	0x00000100 (Only DN bit is 1.)
	on	0
zero	off (default)	0x00000101 (Only DN bit and RM bit are 1.)
	on	1 (Only RM bit is 1.)

4.2.5 Processor mode of task

The processor mode at the time of task execution is always user mode. It is impossible to execute a task in the supervisor mode.
Processing to execute in the supervisor mode should be implemented as an interrupt handler for INT instruction.
For example, the WAIT instruction, that changes the CPU to the power saving mode, is privilege instruction. The WAIT instruction should execute in the supervisor mode.
Note, INT #1 to #8 are reserved by the RI600PX, application cannot use INT #1 to #8.

4.3 Create Task

Tasks are created by one of the following methods.

1) Creation by the system configuration file
The static API “task[]” described in the system configuration file creates a task.
Refer to “20.10 Task Information (task[])” for the details of “task[]”.

2) Creation by cre_tsk or acre_tsk
The cre_tsk creates a task with task ID indicated by parameter *tskid* according to the content of parameter *pk_ctsk*.
The acre_tsk creates a task according to the content of parameter *pk_ctsk*, and returns the created task ID.
The information specified is shown below.

- Task attribute (*tskatr*)
  The following informations are specified as *tskatr*.
  - The domain to which the task belongs
    Refer to “3.2 Domain, Memory object, Access permission vector” for the details of the domain.
  - Specification started after creation (TA_ACT attribute)
    When the TA_ACT attribute is specified, the created task makes a transition to the READY state. When the TA_ACT attribute is not specified, the created task makes a transition to the DORMANT state.
- Extended information (*exinf*)
- Task start address (*task*)
- Task initial priority (*itskpri*)
- User stack size (*stksz*), Start address of user stack (*stk*)
  The user stack area must satisfy the following.
  - The start address must be 16-bytes boundary.
  - The size must be multiple of 16.
  - The user stack area must not overwrap with either all user stacks and all memory objects.

These service calls can be called from tasks that belong to Trusted Domain.
The following describes an example for coding acre_tsk as a representative.

```
#include    "kernel.h"               /*Standard header file definition*/
#include    "kernel_id.h"            /*Header file generated by cfg600px*/

extern void Task2 (VP_INT exinf);
#pragma section B SU_STACK2          /*Section for user stack area*/
                                     /*It is necessary to locate 16-byte boundary*/
                                     /*address at linking.*/
#define STKSZ2 256                   /*The user stack size must be multiple of 16.*/
static UW Stack2[STKSZ2/sizeof(UW)]; /*User stack area*/
#pragma section

#pragma task Task1                   /*Refer to note*/
void Task1 (VP_INT exinf);           /*Refer to note*/
void Task1 (VP_INT exinf)
{
    ER_ID  tskid;                    /*Declares variable*/
    T_CTSK pk_ctsk = {               /*Declares and initializes variable*/
        TA_DOM(1)|TA_ACT,                /*Task attribute (tskatr)*/
        0,                               /*Extended information (exinf)*/
        (FP)Task2,                       /*Task start address (task)*/
        1,                               /*Task initial priority (itskpri)*/
        STKSZ2,                          /*User stack size (stksz)*/
        (VP)Stack2                       /*Start address of user stack (stk)*/
    };
    /* ......... */

    tskid = acre_tsk ( &pk_ctsk );   /*Creates task*/

    /* ......... */
}
```

Note These statements are unnecessary for the task which is created by the system configuration file because the cfg600px generates these statement into the “kernel_id.h”.

4.4 Delete Task

Tasks are deleted by one of the following methods.

1) Delete invoking task by exd_tsk
The exd_tsk terminates the invoking task normally and deletes the task.
The following describes an example for coding this service call.

.

```
#include    "kernel.h"                /*Standard header file definition*/
#include    "kernel_id.h"             /*Header file generated by cfg600px*/
#pragma task Task1                    /*Refer to note*/
void Task1 (VP_INT exinf);            /*Refer to note*/
void Task1 (VP_INT exinf)
{
    /* ......... */

    exd_tsk ();                       /*Terminate and delete invoking task*/
}
```

Note 1 When the invoking task has locked mutexes, the locked state are released at the same time (processing equivalent to unl_mtx).

Note 2 These statements are unnecessary for the task which is created by the system configuration file because the cfg600px generates these statement into the “kernel_id.h”.

2) Delete another task by del_tsk
The del_tsk deletes the task in the DORMANT state indicated by parameter *tskid*.
This service call can be called from tasks that belong to Trusted Domain.
The following describes an example for coding this service call.

.

```
#include    "kernel.h"                /*Standard header file definition*/
#include    "kernel_id.h"             /*Header file generated by cfg600px*/
#pragma task Task1                    /*Refer to note*/
void Task1 (VP_INT exinf);            /*Refer to note*/
void Task1 (VP_INT exinf)
{
    ID      tskid = 8;                /*Declares and initializes variable*/
    /* ......... */

    del_tsk ( tskid );                /*Delete other task*/
}
```

Note These statements are unnecessary for the task which is created by the system configuration file because the cfg600px generates these statement into the “kernel_id.h”.

4.5 Activate Task

The RI600PX provides two types of interfaces for task activation: queuing an activation request queuing and not queuing an activation request.

4.5.1 Activate task with queuing

A task (queuing an activation request) is activated by issuing the following service call from the processing program.

- act_tsk, iact_tsk
  These service calls move the task specified by parameter *tskid* from the DORMANT state to the READY state.
  As a result, the target task is queued at the end on the ready queue corresponding to the initial priority and becomes subject to scheduling by the RI600PX.
  If the target task has been moved to a state other than the DORMANT state when this service call is issued, this service call does not move the state but increments the activation request counter (by added 1 to the activation request counter).
  The following describes an example for coding these service calls.

```
#include    "kernel.h"          /*Standard header file definition*/
#include    "kernel_id.h"       /*Header file generated by cfg600px*/
#pragma task Task1                  /*Refer to note 3*/
void Task1 (VP_INT exinf);          /*Refer to note 3*/
void Task1 (VP_INT exinf)
{
    ID      tskid = 8;          /*Declares and initializes variable*/

    /* ......... */

    act_tsk (tskid);            /*Activate task (queues an activation request)*/

    /* ......... */
}
```

Note 1 The activation request counter managed by the RI600PX is configured in 8-bit widths. If the number of activation requests exceeds the maximum count value 255 as a result of issuing this service call, the counter manipulation processing is therefore not performed but “E_QOVR” is returned.

Note 2 Extended information specified at creating the task is passed to the task activated by issuing these service calls.

Note 3 These statements are unnecessary for the task which is created by the system configuration file because the cfg600px generates these statement into the “kernel_id.h”.

4.5.2 Activate task without queuing

A task (not queuing an activation request) is activated by issuing the following service call from the processing program.

- sta_tsk, ista_tsk
  These service calls move the task specified by parameter *tskid* from the DORMANT state to the READY state.
  As a result, the target task is queued at the end on the ready queue corresponding to the initial priority and becomes subject to scheduling by the RI600PX.
  This service call does not perform queuing of activation requests. If the target task is in a state other than the DORMANT state, the status manipulation processing for the target task is therefore not performed but “E_OBJ” is returned.
  Specify for parameter *stacd* the extended information transferred to the target task.
  The following describes an example for coding these service calls.

```
#include    "kernel.h"              /*Standard header file definition*/
#include    "kernel_id.h"           /*Header file generated by cfg600px*/
#pragma task Task1                  /*Refer to note*/
void Task1 (VP_INT exinf);          /*Refer to note*/
void Task1 (VP_INT exinf)
{
    ID      tskid = 8;          /*Declares and initializes variable*/
    VP_INT  stacd = 123;        /*Declares and initializes variable*/

    /* ......... */

    sta_tsk (tskid, stacd);     /*Activate task (does not queue an activation */
                                /*request)*/

    /* ......... */
}
```

Note These statements are unnecessary for the task which is created by the system configuration file because the cfg600px generates these statement into the “kernel_id.h”.

4.6 Cancel Task Activation Requests

An activation request is cancelled by issuing the following service call from the processing program.

- can_act, ican_act
  This service call cancels all of the activation requests queued to the task specified by parameter *tskid* (sets the activation request counter to 0).
  When this service call is terminated normally, the number of cancelled activation requests is returned.
  The following describes an example for coding these service calls.

```
#include    "kernel.h"              /*Standard header file definition*/
#include    "kernel_id.h"           /*Header file generated by cfg600px*/
#pragma task Task1                  /*Refer to note 2*/
void Task1 (VP_INT exinf);          /*Refer to note 2*/
void Task1 (VP_INT exinf)
{
    ER_UINT ercd;                   /*Declares variable*/
    ID      tskid = 8;              /*Declares and initializes variable*/

    /* ......... */

    ercd = can_act (tskid);         /*Cancel task activation requests*/

    if (ercd >= 0) {
        /* ......... */             /*Normal termination processing*/
    }

    /* ......... */
}
```

Note 1 This service call does not perform status manipulation processing but performs the setting of activation request counter. Therefore, the task does not move from a state such as the READY state to the DORMANT state.

Note 2 These statements are unnecessary for the task which is created by the system configuration file because the cfg600px generates these statement into the “kernel_id.h”.

4.7 Terminate Task

4.7.1 Terminate invoking task

The invoking task is terminated by issuing the following service call from the processing program.

- ext_tsk
  This service call moves the invoking task from the RUNNING state to the DORMANT state.
  As a result, the invoking task is unlinked from the ready queue and excluded from the RI600PX scheduling subject.
  If an activation request has been queued to the invoking task (the activation request counter > 0) when this service call is issued, this service call moves the task from the RUNNING state to the DORMANT state, decrements the wake-up request counter (by subtracting 1 from the activation request counter), and then moves the task from the DORMANT state to the READY state.
  The following describes an example for coding this service call.

```
#include    "kernel.h"              /*Standard header file definition*/
#include    "kernel_id.h"           /*Header file generated by cfg600px*/
#pragma task Task1                  /*Refer to note 3*/
void Task1 (VP_INT exinf);          /*Refer to note 3*/
void Task1 (VP_INT exinf)
{
    /* ......... */

    ext_tsk ();                     /*Terminate invoking task*/
}
```

Note 1 When the invoking task has locked mutexes, the locked state are released at the same time (processing equivalent to unl_mtx).

Note 2 When the return instruction is issued in a task, the same processing as ext_tsk is performed.

Note 3 These statements are unnecessary for the task which is created by the system configuration file because the cfg600px generates these statement into the “kernel_id.h”.

4.7.2 Terminate Another task

- ter_tsk
  This service call forcibly moves the task specified by parameter *tskid* to the DORMANT state.
  As a result, the target task is excluded from the RI600PX scheduling subject.
  If an activation request has been queued to the target task (the activation request counter > 0) when this service call is issued, this service call moves the task to the DORMANT state, decrements the activation request counter (by subtracting 1 from the wake-up request counter), and then moves the task from the DORMANT state to the READY state.
  The following describes an example for coding this service call.

```
#include    "kernel.h"              /*Standard header file definition*/
#include    "kernel_id.h"           /*Header file generated by cfg600px*/
#pragma task Task1                  /*Refer to note 2*/
void Task1 (VP_INT exinf);          /*Refer to note 2*/
void Task1 (VP_INT exinf)
{
    ID      tskid = 8;              /*Declares and initializes variable*/

    /* ......... */

    ter_tsk (tskid);                /*Terminate task*/

    /* ......... */
}
```

Note 1 When the target task has locked mutexes, the locked state are released at the same time (processing equivalent to unl_mtx).

Note 2 These statements are unnecessary for the task which is created by the system configuration file because the cfg600px generates these statement into the “kernel_id.h”.

4.8 Change Task Priority

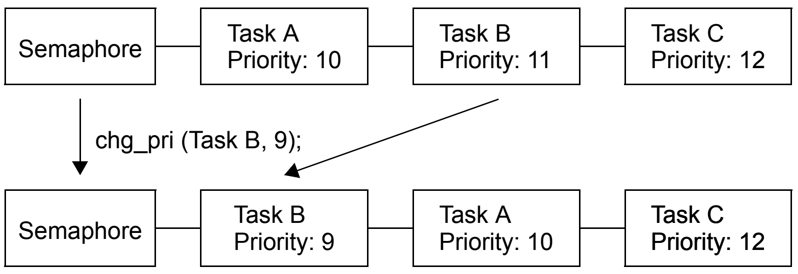
The priority is changed by issuing the following service call from the processing program.

- chg_pri, ichg_pri
  This service call changes the base priority of the task specified by parameter *tskid* to a value specified by parameter *tskpri*.
  The changed base priority is effective until the task terminates or this servie call is issued. When next the task is activated, the base priority is the initial priority which is specified at the task creation.
  This service call also changes the current priority of the target task to a value specified by parameter *tskpri*. However, the current priority is not changed when the target task has locked mutexes.
  If the target task has locked mutexes or is waiting for mutex to be locked and if *tskpri* is higher than the ceiling priority of either of the mutexes, this service call returns “E_ILUSE”.
  When the current priority is changed, the following state variations are generated.

1) When the target task is in the RUNNING or READY state.
This service call re-queues the task at the end of the ready queue corresponding to the priority specified by parameter *tskpri*.

2) When the target task is queued to a wait queue of the object with TA_TPRI or TA_CEILING attribute.
This service call re-queues the task to the wait queue corresponding to the priority specified by parameter *tskpri*. When two or more tasks of same current priority as this service call re-queues the target task at the end among their tasks.

Example When three tasks (task A: priority level 10, task B: priority level 11, task C: priority level 12) are queued to the semaphore wait queue in the order of priority, and the priority level of task B is changed from 11 to 9, the wait order will be changed as follows.



The following describes an example for coding these service calls.

```
#include    "kernel.h"              /*Standard header file definition*/
#include    "kernel_id.h"           /*Header file generated by cfg600px*/
#pragma task Task1                  /*Refer to note 2*/
void Task1 (VP_INT exinf);          /*Refer to note 2*/
void Task1 (VP_INT exinf)
{
    ID      tskid = 8;              /*Declares and initializes variable*/
    PRI     tskpri = 9;             /*Declares and initializes variable*/

    /* ......... */

    chg_pri (tskid, tskpri);        /*Change task priority*/

    /* ......... */
}
```

Note 1 For current priority and base priority, refer to “8.2.2 Current priority and base priority”.

Note 2 These statements are unnecessary for the task which is created by the system configuration file because the cfg600px generates these statement into the “kernel_id.h”.

4.9 Reference Task Priority

A task priority is referenced by issuing the following service call from the processing program.

- get_pri, iget_pri
  Stores current priority of the task specified by parameter *tskid* in the area specified by parameter *p_tskpri*.
  The following describes an example for coding these service calls.

```
#include    "kernel.h"              /*Standard header file definition*/
#include    "kernel_id.h"           /*Header file generated by cfg600px*/
#pragma task Task1                  /*Refer to note 2*/
void Task1 (VP_INT exinf);          /*Refer to note 2*/
void Task1 (VP_INT exinf)
{
    ID      tskid = 8;              /*Declares and initializes variable*/
    PRI     p_tskpri;               /*Declares variable*/

    /* ......... */

    get_pri (tskid, &p_tskpri);     /*Reference task priority*/

    /* ......... */
}
```

Note 1 For current priority and base priority, refer to "8.2.2 Current priority and base priority".

Note 2 These statements are unnecessary for the task which is created by the system configuration file because the cfg600px generates these statement into the "kernel_id.h".

4.10 Reference Task State

4.10.1 Reference task state

A task status is referenced by issuing the following service call from the processing program.

- ref_tsk, iref_tsk
  Stores task state packet (current state, current priority, etc.) of the task specified by parameter *tskid* in the area specified by parameter *pk_rtsk*.
  The following describes an example for coding these service calls.

```
#include    "kernel.h"              /*Standard header file definition*/
#include    "kernel_id.h"           /*Header file generated by cfg600px*/
#pragma task Task1                  /*Refer to note 2*/
void Task1 (VP_INT exinf);          /*Refer to note 2*/
void Task1 (VP_INT exinf)
{
    ID      tskid = 8;              /*Declares and initializes variable*/
    T_RTSK  pk_rtsk;                /*Declares data structure*/
    STAT    tskstat;                /*Declares variable*/
    PRI     tskpri;                 /*Declares variable*/
    PRI     tskbpri;                /*Declares variable*/
    STAT    tskwait;                /*Declares variable*/
    ID      wobjid;                 /*Declares variable*/
    TMO     lefttmo;                /*Declares variable*/
    UINT    actcnt;                 /*Declares variable*/
    UINT    wupcnt;                 /*Declares variable*/
    UINT    suscnt;                 /*Declares variable*/

    /* ......... */

    ref_tsk (tskid, &pk_rtsk);      /*Reference task state*/

    tskstat = pk_rtsk.tskstat;      /*Reference current state*/
    tskpri = pk_rtsk.tskpri;        /*Reference current priority*/
    tskbpri = pk_rtsk.tskbpri;      /*Reference base priority*/
    tskwait = pk_rtsk.tskwait;      /*Reference reason for waiting*/
    wobjid = pk_rtsk.wobjid;        /*Reference object ID number for which the */
                                    /*task is waiting*/
    lefttmo = pk_rtsk.lefttmo;      /*Reference remaining time until time-out*/
    actcnt = pk_rtsk.actcnt;        /*Reference activation request count*/
    wupcnt = pk_rtsk.wupcnt;        /*Reference wake-up request count*/
    suscnt = pk_rtsk.suscnt;        /*Reference suspension count*/

    /* ......... */
}
```

Note 1 For details about the task state packet, refer to "[Task state packet: T_RTSK]".

Note 2 These statements are unnecessary for the task which is created by the system configuration file because the cfg600px generates these statement into the "kernel_id.h".

4.10.2 Reference task state (simplified version)

A task status (simplified version) is referenced by issuing the following service call from the processing program.

- ref_tst, iref_tst
  Stores task state packet (current state, reason for waiting) of the task specified by parameter *tskid* in the area specified by parameter *pk_rtst*.
  Used for referencing only the current state and reason for wait among task information.
  Response becomes faster than using ref_tsk or iref_tsk because only a few information items are acquired.
  The following describes an example for coding these service calls.

```
#include    "kernel.h"              /*Standard header file definition*/
#include    "kernel_id.h"           /*Header file generated by cfg600px*/
#pragma task Task1                  /*Refer to note 2*/
void Task1 (VP_INT exinf);          /*Refer to note 2*/
void Task1 (VP_INT exinf)
{
    ID      tskid = 8;              /*Declares and initializes variable*/
    T_RTST  pk_rtst;                /*Declares data structure*/
    STAT    tskstat;                /*Declares variable*/
    STAT    tskwait;                /*Declares variable*/

    /* ......... */

    ref_tst (tskid, &pk_rtst);      /*Reference task state (simplified version)*/

    tskstat = pk_rtst.tskstat;      /*Reference current state*/
    tskwait = pk_rtst.tskwait;      /*Reference reason for waiting*/

    /* ......... */
}
```

Note 1 For details about the task state packet (simplified version), refer to " [Task state packet (simplified version): T_RTST]".

Note 2 These statements are unnecessary for the task which is created by the system configuration file because the cfg600px generates these statement into the "kernel_id.h".

CHAPTER 5 TASK DEPENDENT SYNCHRONIZATION FUNCTIONS

This chapter describes the task dependent synchronization functions performed by the RI600PX.

5.1 Outline

The RI600PX provides several task-dependent synchronization functions.

5.2 Put Task to Sleep

5.2.1 Waiting forever

A task is moved to the sleeping state (waiting forever) by issuing the following service call from the processing program.

- slp_tsk
  This service call moves the invoking task from the RUNNING state to the WAITING state (sleeping state).
  If a wake-up request has been queued to the target task (the wake-up request counter > 0) when this service call is issued, this service call does not move the state but decrements the wake-up request counter (by subtracting 1 from the wake-up request counter).
  The sleeping state is cancelled in the following cases.

Sleeping State Cancel Operation	Return Value
A wake-up request was issued as a result of issuing wup_tsk.	E_OK
A wake-up request was issued as a result of issuing iwup_tsk.	E_OK
Forced release from waiting (accept rel_wai while waiting).	E_RLWAI
Forced release from waiting (accept irel_wai while waiting).	E_RLWAI

The following describes an example for coding this service call.

```
#include    "kernel.h"              /*Standard header file definition*/
#include    "kernel_id.h"           /*Header file generated by cfg600px*/
#pragma task Task1                  /*Refer to note*/
void Task1 (VP_INT exinf);          /*Refer to note*/
void Task1 (VP_INT exinf)
{
    ER      ercd;                   /*Declares variable*/

    /* ......... */
    ercd = slp_tsk ();              /*Put task to sleep*/
    if (ercd == E_OK) {
        /* ......... */             /*Normal termination processing*/
    } else if (ercd == E_RLWAI) {
        /* ......... */             /*Forced termination processing*/
    }
    /* ......... */
}
```

Note These statements are unnecessary for the task which is created by the system configuration file because the cfg600px generates these statement into the “kernel_id.h”.

5.2.2 With time-out

A task is moved to the sleeping state (with time-out) by issuing the following service call from the processing program.

- tslp_tsk
  This service call moves the invoking task from the RUNNING state to the WAITING state with time-out(sleeping state).
  As a result, the invoking task is unlinked from the ready queue and excluded from the RI600PX scheduling subject.
  If a wake-up request has been queued to the target task (the wake-up request counter > 0) when this service call is issued, this service call does not move the state but decrements the wake-up request counter (by subtracting 1 from the wake-up request counter).
  The sleeping state is cancelled in the following cases.

Sleeping State Cancel Operation	Return Value
A wake-up request was issued as a result of issuing wup_tsk.	E_OK
A wake-up request was issued as a result of issuing iwup_tsk.	E_OK
Forced release from waiting (accept rel_wai while waiting).	E_RLWAI
Forced release from waiting (accept irel_wai while waiting).	E_RLWAI
The time specified by *tmout* has elapsed.	E_TMOUT

The following describes an example for coding this service call.

```
#include    "kernel.h"              /*Standard header file definition*/
#include    "kernel_id.h"           /*Header file generated by cfg600px*/
#pragma task Task1                  /*Refer to note 2*/
void Task1 (VP_INT exinf);          /*Refer to note 2*/
void Task1 (VP_INT exinf)
{
    ER      ercd;               /*Declares variable*/
    TMO     tmout = 3600;       /*Declares and initializes variable*/

    /* ......... */

    ercd = tslp_tsk (tmout);    /*Put task to sleep*/

    if (ercd == E_OK) {
        /* ......... */         /*Normal termination processing*/
    } else if (ercd == E_RLWAI) {
        /* ......... */         /*Forced termination processing*/
    } else if (ercd == E_TMOUT) {
        /* ......... */         /*Time-out processing*/
    }

    /* ......... */
}
```

Note 1 When TMO_FEVR is specified for wait time *tmout*, processing equivalent to slp_tsk will be executed.

Note 2 These statements are unnecessary for the task which is created by the system configuration file because the cfg600px generates these statement into the “kernel_id.h”.

5.3 Wake-up Task

A task is woken up by issuing the following service call from the processing program.

- wup_tsk, iwup_tsk
  These service calls cancel the WAITING state (sleeping state) of the task specified by parameter *tskid*.
  As a result, the target task is moved from the sleeping state to the READY state, or from the WAITING-SUSPENDED state to the SUSPENDED state.
  If the target task is in a state other than the sleeping state when this service call is issued, this service call does not move the state but increments the wake-up request counter (by added 1 to the wake-up request counter).
  The following describes an example for coding these service calls.

```
#include    "kernel.h"              /*Standard header file definition*/
#include    "kernel_id.h"           /*Header file generated by cfg600px*/
#pragma task Task1                  /*Refer to note 2*/
void Task1 (VP_INT exinf);          /*Refer to note 2*/
void Task1 (VP_INT exinf)
{
    ID      tskid = 8;              /*Declares and initializes variable*/

    /* ......... */

    wup_tsk (tskid);                /*Wake-up task*/

    /* ......... */
}
```

Note 1 The wake-up request counter managed by the RI600PX is configured in 8-bit widths. If the number of wake-up requests exceeds the maximum count value 255 as a result of issuing this service call, the counter manipulation processing is therefore not performed but “E_QOVR” is returned.

Note 2 These statements are unnecessary for the task which is created by the system configuration file because the cfg600px generates these statement into the “kernel_id.h”.

5.4 Cancel Task Wake-up Requests

A wake-up request is cancelled by issuing the following service call from the processing program.

- can_wup, ican_wup
  These service calls cancel all of the wake-up requests queued to the task specified by parameter *tskid* (the wake-up request counter is set to 0).
  When this service call is terminated normally, the number of cancelled wake-up requests is returned.
  The following describes an example for coding these service calls.

```
#include    "kernel.h"                  /*Standard header file definition*/
#include    "kernel_id.h"               /*Header file generated by cfg600px*/
#pragma task Task1                      /*Refer to note*/
void Task1 (VP_INT exinf);              /*Refer to note*/
void Task1 (VP_INT exinf)
{
    ER_UINT ercd;                       /*Declares variable*/
    ID      tskid = 8;                  /*Declares and initializes variable*/

    /* ......... */

    ercd = can_wup (tskid);             /*Cancel task wake-up requests*/

    if (ercd >= 0) {
        /* ......... */                 /*Normal termination processing*/
    }

    /* ......... */
}
```

Note These statements are unnecessary for the task which is created by the system configuration file because the cfg600px generates these statement into the “kernel_id.h”.

5.5 Forcibly Release Task from Waiting

The WAITING state is forcibly cancelled by issuing the following service call from the processing program.

- rel_wai, irel_wai
  These service calls forcibly cancel the WAITING state of the task specified by parameter *tskid*.
  As a result, the target task unlinked from the wait queue and is moved from the WAITING state to the READY state, or from the WAITING-SUSPENDED state to the SUSPENDED state.
  “E_RLWAI” is returned from the service call that triggered the move to the WAITING state (slp_tsk, wai_sem, or the like) to the task whose WAITING state is cancelled by this service call.
  The following describes an example for coding these service calls.

```
#include    "kernel.h"              /*Standard header file definition*/
#include    "kernel_id.h"           /*Header file generated by cfg600px*/
#pragma task Task1                  /*Refer to note 3*/
void Task1 (VP_INT exinf);          /*Refer to note 3*/
void Task1 (VP_INT exinf)
{
    ID      tskid = 8;              /*Declares and initializes variable*/

    /* ......... */

    rel_wai (tskid);                /*Release task from waiting*/

    /* ......... */
}
```

Note 1 This service call does not perform queuing of forced cancellation requests. If the target task is in a state other than the WAITING or WAITING-SUSPENDED state, “E_OBJ” is returned.

Note 2 The SUSPENDED state is not cancelled by these service calls.

Note 3 These statements are unnecessary for the task which is created by the system configuration file because the cfg600px generates these statement into the “kernel_id.h”.

5.6 Suspend Task

A task is moved to the SUSPENDED state by issuing the following service call from the processing program.

- sus_tsk, isus_tsk
  These service calls move the target task specified by parameter *tskid* from the RUNNING state to the SUSPENDED state, from the READY state to the SUSPENDED state, or from the WAITING state to the WAITING-SUSPENDED state.
  If the target task has moved to the SUSPENDED or WAITING-SUSPENDED state when this service call is issued, these service calls return E_QOVR.
  The following describes an example for coding these service calls.

```
#include    "kernel.h"                /*Standard header file definition*/
#include    "kernel_id.h"             /*Header file generated by cfg600px*/
#pragma task Task1                    /*Refer to note*/
void Task1 (VP_INT exinf);            /*Refer to note*/
void Task1 (VP_INT exinf)
{
    ID      tskid = 8;                /*Declares and initializes variable*/

    /* ......... */

    sus_tsk (tskid);                  /*Suspend task*/

    /* ......... */
}
```

Note These statements are unnecessary for the task which is created by the system configuration file because the cfg600px generates these statement into the “kernel_id.h”.

5.7 Resume Suspended Task

5.7.1 Resume suspended task

The SUSPENDED state is cancelled by issuing the following service call from the processing program.

- rsm_tsk, irsm_tsk
  These service calls move the target task specified by parameter *tskid* from the SUSPENDED state to the READY state, or from the WAITING-SUSPENDED state to the WAITING state.
  The following describes an example for coding these service calls.

```
#include    "kernel.h"              /*Standard header file definition*/
#include    "kernel_id.h"           /*Header file generated by cfg600px*/
#pragma task Task1                  /*Refer to note 3*/
void Task1 (VP_INT exinf);          /*Refer to note 3*/
void Task1 (VP_INT exinf)
{
    ID      tskid = 8;              /*Declares and initializes variable*/

    /* ......... */

    rsm_tsk (tskid);                /*Resume suspended task*/

    /* ......... */
}
```

Note 1 This service call does not perform queuing of cancellation requests. If the target task is in a state other than the SUSPENDED or WAITING-SUSPENDED state, “E_OBJ” is therefore returned.

Note 2 The RI600PX does not support queing of suspend request. The behavior of the frsm_tsk and ifrsm_tsk, that can release from the SUSPENDED state even if suspend request has been queued, are same as rsm_tsk and irsm_tsk.

Note 3 These statements are unnecessary for the task which is created by the system configuration file because the cfg600px generates these statement into the “kernel_id.h”.

5.7.2 Forcibly resume suspended task

The SUSPENDED state is forcibly cancelled by issuing the following service calls from the processing program.

- frsm_tsk, ifrsm_tsk
  These service calls move the target task specified by parameter *tskid* from the SUSPENDED state to the READY state, or from the WAITING-SUSPENDED state to the WAITING state.
  The following describes an example for coding these service calls.

```
#include    "kernel.h"              /*Standard header file definition*/
#include    "kernel_id.h"           /*Header file generated by cfg600px*/
#pragma task Task1                  /*Refer to note 3*/
void Task1 (VP_INT exinf);          /*Refer to note 3*/
void Task1 (VP_INT exinf)
{
    ID      tskid = 8;              /*Declares and initializes variable*/

    /* ......... */

    frsm_tsk (tskid);                /*Forcibly resume suspended task*/

    /* ......... */
}
```

Note 1 This service call does not perform queuing of cancellation requests. If the target task is in a state other than the SUSPENDED or WAITING-SUSPENDED state, “E_OBJ” is returned.

Note 2 The RI600PX does not support queing of suspend request. Therefore, the behavior of these service calls are same as rsm_tsk and irsm_tsk.

Note 3 These statements are unnecessary for the task which is created by the system configuration file because the cfg600px generates these statement into the “kernel_id.h”.

5.8 Delay Task

A task is moved to the delayed state by issuing the following service call from the processing program.

- dly_tsk
  This service call moves the invoking task from the RUNNING state to the WAITING state (delayed state).
  As a result, the invoking task is unlinked from the ready queue and excluded from the RI600PX scheduling subject.
  The delayed state is cancelled in the following cases.

Delayed State Cancel Operation	Return Value
Delay time specified by parameter *dlytim* has elapsed.	E_OK
Forced release from waiting (accept rel_wai while waiting).	E_RLWAI
Forced release from waiting (accept irel_wai while waiting).	E_RLWAI

The following describes an example for coding this service call.

```
#include    "kernel.h"              /*Standard header file definition*/
#include    "kernel_id.h"           /*Header file generated by cfg600px*/
#pragma task Task1                  /*Refer to note 2*/
void Task1 (VP_INT exinf);          /*Refer to note 2*/
void Task1 (VP_INT exinf)
{
    ER      ercd;                   /*Declares variable*/
    RELTIM  dlytim = 3600;          /*Declares and initializes variable*/

    /* ......... */

    ercd = dly_tsk (dlytim);        /*Delay task*/

    if (ercd == E_OK) {
        /* ......... */             /*Normal termination processing*/
    } else if (ercd == E_RLWAI) {
        /* ......... */             /*Forced termination processing*/
    }

    /* ......... */
}
```

Note 1 When 0 is specified as *dlytim*, the delay time is up to next base clock interrupt generation.

Note 2 These statements are unnecessary for the task which is created by the system configuration file because the cfg600px generates these statement into the “kernel_id.h”.

5.9 Differences Between Sleep with Time-out and Delay

There are diffrences between “Sleep with time-out (5.2.2 With time-out)” and “Delay (5.8 Delay Task)” as shown in Table 5-1.

Table 5-1 Differences Between “Sleep with time-out” and “Delay”

	Sleep with time-out	Delay
Service call that causes status change	tslp_tsk	dly_tsk
Return value when time has elapsed	E_TMOUT	E_OK
Operation when wup_tsk or iwup_tsk is issued	Wake-up	Queues the wake-up request (time elapse wait is not cancelled).

CHAPTER 6 TASK EXCEPTION HANDLING FUNCTIONS

This chapter describes the task exception handling functions performed by the RI600PX.

6.1 Outline

When task exception is requested to a task, the task exception handling routine defined for the task is invoked. The requested exception code is passed to the task exception handling routine.
By this function, exception handling in a task can be implemented easily.
The following shows the service calls as the task exception handling functions.

Table 6-1 Task Exception Handling Functions

Service Call	Function	Useful Range
def_tex	Define task exception handling routine	Task
ras_tex	Raise task exception	Task
iras_tex	Raise task exception	Non-task
dis_tex	Disable task exception	Task
ena_tex	Enable task exception	Task
sns_tex	Reference task exception disabled state	Task, Non-task
ref_tex	Reference task exception state	Task
iref_tex	Reference task exception state	Non-task

6.2 Task Exception Handling Routines

Exception handling according to the requested exception code should be implemented in a task exception handling routine.

6.2.1 Basic form of task exception handling routines

The following shows the basic form of ask exception handling routines.

```
#include    "kernel.h"              /*Standard header file definition*/
#include    "kernel_id.h"           /*Header file generated by cfg600px*/
#pragma taskexception Texrtn1                   /*Refer to note 3*/
void Texrtn1 ( TEXPTN texptn, VP_INT exinf );   /*Refer to note 3*/
void Texrtn1 ( TEXPTN texptn, VP_INT exinf )
{
    /* ......... */
}
```

Note 1 The accepted exception code is passed to *texptn*.

Note 2 The extend information defined at creating the task is passed to *exinf*.

Note 3 These statements are unnecessary for the task exception handling routine which is created by the system configuration file because the cfg600px generates these statement into the “kernel_id.h”.

6.2.2 Internal processing of task exception handling routine

- Stack
  Task exception handling routines use user stacks for the task.

- Service call
  Tasks can issue service calls whose “Useful range” is “task”.

- PSW register when processing is started

Table 6-2 PSW Register When Task Exception Handling Routine Processing is Started

Bit	Value	Note
I	1	
IPL	Same as IPL in the task just before the task exception handling routine starts.	
PM	1	User mode
U	1	User stack
C, Z, S, O	Undefined	
Others	0	

- FPSW register when processing is started
  When setting of Task context register (context) in System Information (system) includes “FPSW”, the FPSW when processing is started is shown in Table 6-3. The FPSW when processing is undefined in other cases.

Table 6-3 FPSW Register When Task Processing is Started

Compiler options		Value
-round	-denormalize	
nearest (default)	off (default)	0x00000100 (Only DN bit is 1.)
	on	0
zero	off (default)	0x00000101 (Only DN bit and RM bit are 1.)
	on	1 (Only RM bit is 1.)

6.2.3 The starting conditions of task exception handling routines

When all the following conditions are fulfilled about a task which is scheduled according to "16.4 Task Scheduling Method", the RI600PX starts the task exception handling routine in stead of the task itself. When the task exception handling routine is finished, execution of the task itself is resumed.

Table 6-4 The Starting Conditions of Task Exception Handling Routines

No.	Value
1	The task is in the task exception enabled state.
2	The pending exception code of the task is not 0.

The exception code is represented by TEXPTN type bit pattern.
When task exception is requested by ras_tex or iras_tex, the pending exception code for the corresponded task is renewed to the logical add with specified exception code.
Tasks are in one of the state of task exception disabled state or task exception enabled state. Immediately after starting tasks, the task is in task exception disabled state. And the task is in task exception disabled state while the task exception handling routine is not defined. When ena_tex is called, the invoking task enters in task exception enabled state. When dis_tex is called, the invoking task enters in task exception disabled state.
When the task exception handling routine is started, the task enters in task exception disabled state. When the task exception handling routine is finished, the task enters in task exception enabled state.

Table 6-5 Operations to Disable Task Exception

No.	Operating	Target task
1	Activate Task	Activated task
2	dis_tex	Invoking task
3	Starting of task exception handling routine	Concerned task
4	Cancel a Definition of Task Exception Handling Routine	Concerned task

Table 6-6 Operations to Enable Task Exception

No.	Operating	Target task
1	ena_tex	Invoking task
2	Finishing of task exception handling routine	Concerned task

6.3 Define Task Exception Handling Routine

Task exception handling routines are defined by one of the following methods.

1) Definition by the system configuration file
The task exception handling routine can be defined by the static API “task[]”, which creates a task, described in the system configuration file.
Refer to “20.10 Task Information (task[])” for the details of “task[]”.

2) Definition by def_tex
The def_tex defines a task exception handling routine for the task indicated by parameter *tskid* according to the content of parameter *pk_dtex*.
The information specified is shown below.

- Task exception handling routine attribute (*texatr*)
  Only TA_HLNG can be specified as *texatr*.

- Task exception handling routine start address (*texrtn*)

This service call can be called from tasks that belong to Trusted Domain.
The following describes an example for coding def_tex.

```
#include    "kernel.h"                /*Standard header file definition*/
#include    "kernel_id.h"             /*Header file generated by cfg600px*/

extern void Texrtn1 ( TEXPTN texptn, VP_INT exinf );

#pragma task Task1                    /*Refer to note*/
void Task1 (VP_INT exinf);            /*Refer to note*/
void Task1 (VP_INT exinf)
{
    ER      ercd;                     /*Declares variable*/
    ID      tskid = TSK_SELF;         /*Declares and initializes variable*/
    T_DTEX pk_dtex = {                /*Declares and initializes variable*/
        TA_HLNG,                /*Task exception handling routine attribute (texatr)*/
         (FP)Texrtn1            /*Start address (texrtn)*/
    };
    /* ......... */

    ercd = def_tex ( tskid, &pk_dtex ); /*Define task exception handling routine*/

    /* ......... */
}
```

Note These statements are unnecessary for the task which is created by the system configuration file because the cfg600px generates these statement into the “kernel_id.h”.

6.4 Cancel a Definition of Task Exception Handling Routine

When NULL is specified as parameter *pk_dtex* in the def_tex, the def_tex cancels a definition of the task exception handling routine for the task indicated by parameter *tskid*.
The def_tex can be called from tasks that belong to Trusted Domain.
The following describes an example for coding to cancel the a definition of the task exception handling routine by using def_tex.
.

```
#include    "kernel.h"              /*Standard header file definition*/
#include    "kernel_id.h"           /*Header file generated by cfg600px*/
#pragma task Task1                  /*Refer to note*/
void Task1 (VP_INT exinf);          /*Refer to note*/
void Task1 (VP_INT exinf)
{
    ER      ercd;                   /*Declares variable*/
    ID      tskid = TSK_SELF;       /*Declares and initializes variable*/
    /* ......... */

    ercd = def_tex ( tskid, (T_DTEX *)NULL ); /*Cancel a definition*/

    /* ......... */
}
```

Note These statements are unnecessary for the task which is created by the system configuration file because the cfg600px generates these statement into the “kernel_id.h”.

6.5 Request Task Exception

- ras_tex, iras_tex
  These service calls requests task exception handling for the task indicated by parameter *tskid*. The task pending exception code for the task is ORed with the value indicated by parameter *rasptn*.
  When all the conditions described in "6.2.3 The starting conditions of task exception handling routines" are fulfilled by this service call, the RI600PX starts the task exception handling routine.
  The following describes an example for coding this service call.

```
#include    "kernel.h"          /*Standard header file definition*/
#include    "kernel_id.h"       /*Header file generated by cfg600px*/
#pragma task Task1                  /*Refer to note*/
void Task1 (VP_INT exinf);          /*Refer to note*/
void Task1 (VP_INT exinf)
{
    ID      tskid = 8;              /*Declares and initializes variable*/
    TEXPTN  rasptn = 0x00000001UL;  /*Declares and initializes variable*/

    /* ......... */

    ras_tex ( tskid, rasptn );      /*Request task exception*/

    /* ......... */
}
```

Note These statements are unnecessary for the task which is created by the system configuration file because the cfg600px generates these statement into the "kernel_id.h".

6.6 Disable and Enable Task Exception

The dis_tex disables task exception for the invoking task, and the ena_tex enables task exception for the invoking task.
The following describes an example for coding this service call.

```
#include    "kernel.h"                  /*Standard header file definition*/
#include    "kernel_id.h"               /*Header file generated by cfg600px*/
#pragma task Task1                      /*Refer to note*/
void Task1 (VP_INT exinf);              /*Refer to note*/
void Task1 (VP_INT exinf)
{
    /* ......... */

    ena_tex ();                         /*Disable task exception*/

    /* ......... */                     /*Task exception enabled state*/

    dis_tex ();                         /*Enable task exception*/

    /* ......... */
}
```

Note These statements are unnecessary for the task which is created by the system configuration file because the cfg600px generates these statement into the “kernel_id.h”.

6.7 Reference Task Exception Disabled State

It may be necessary to refer to task exception disabled state for the task of a calling agency in functions that are called from two or more tasks and handlers. In this case, sns_tex is useful.

- sns_tex
  This service call returns TRUE when the task in the RUNNING state is in the task exception disabled state, and when other, this service call returns FALSE.
  The following describes an example for coding this service call.

```
#include    "kernel.h"              /*Standard header file definition*/
#include    "kernel_id.h"           /*Header file generated by cfg600px*/

void CommonFunc ( void );
void CommonFunc ( void )
{
    BOOL ctx;                       /*Declares variable*/
    BOOL tex;                       /*Declares variable*/

    /* ......... */

    ctx = sns_ctx ( );              /*Reference context type*/

    if (ctx == TRUE ) {
        /* ......... */             /*Processing for non-task context*/
        /* ......... */
    } else if ( ctx == FALSE ) {
        /* ......... */             /*Processing for task context*/
        /* ......... */

        tex = sns_tex ();           /*Reference task exception disabled state*/

        if ( tex == TRUE) {
            /* ......... */         /*The invoking task is in the task*/
            /* ......... */         /*exception disabled state.*/
        } else if ( tex == FALSE) {
            /* ......... */         /*The invoking task is in the task*/
            /* ......... */         /*exception enabled state.*/
        }
    }

    /* ......... */
}
```

6.8 Reference Task Exception State

- ref_tex, iref_tex
  Stores task exception state packet of the task specified by parameter *tskid* in the area specified by parameter *pk_rtex*.
  The following describes an example for coding these service calls.

```
#include    "kernel.h"                 /*Standard header file definition*/
#include    "kernel_id.h"              /*Header file generated by cfg600px*/
#pragma task Task1                     /*Refer to note 2*/
void Task1 (VP_INT exinf);             /*Refer to note 2*/
void Task1 (VP_INT exinf)
{
    ID      tskid = 8;                 /*Declares and initializes variable*/
    T_RTEX  pk_rtex;                   /*Declares data structure*/
    STAT    texstat;                   /*Declares variable*/
    TEXPTN  texptn;                    /*Declares variable*/

    /* ......... */

    ref_tex (tskid, &pk_rtex);         /*Reference task exception state*/

    texstat = pk_rtex.texstat;         /*Reference task exception handling state*/
    texptn = pk_rtex.texptn;           /*Reference pending exception code*/

    /* ......... */
}
```

Note 1 For details about the task exception state packet, refer to "[Task exception state packet: T_RTEX]".

Note 2 These statements are unnecessary for the task which is created by the system configuration file because the cfg600px generates these statement into the "kernel_id.h".

CHAPTER 7 SYNCHRONIZATION AND COMMUNICATION FUNCTIONS

This chapter describes the synchronization and communication functions performed by the RI600PX.

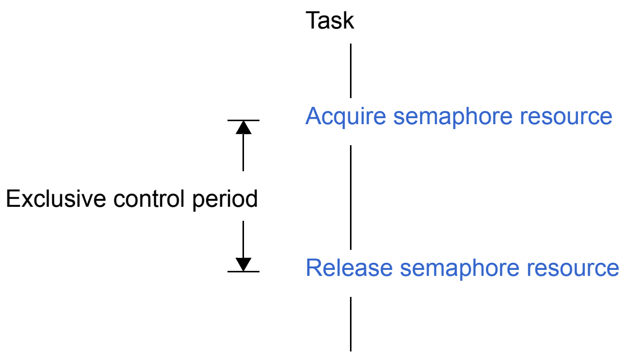
7.1 Outline

The synchronization and communication functions of the RI600PX consist of Semaphores, Eventflags, Data Queues, and Mailboxes that are provided as means for realizing exclusive control, queuing, and communication among tasks.

7.2 Semaphores

In the RI600PX, non-negative number counting semaphores are provided as a means (exclusive control function) for preventing contention for limited resources (hardware devices, library function, etc.) arising from the required conditions of simultaneously running tasks.
The following shows a processing flow when using a semaphore.

Figure 7-1 Processing Flow (Semaphore)



7.2.1 Create semaphore

Semaphores are created by one of the following methods.

1) Creation by the system configuration file
The static API “semaphore[]” described in the system configuration file creates a semaphore.
Refer to “20.11 Semaphore Information (semaphore[])” for the details of “semaphore[]”.

2) Creation by cre_sem or acre_sem
The cre_sem creates a semaphore with semaphore ID indicated by parameter *semid* according to the content of parameter *pk_csem*.
The acre_sem creates a semaphore according to the content of parameter *pk_csem*, and returns the created semaphore ID.
The information specified is shown below.

- Semaphore attribute (*sematr*)
  The following informations are specified as *sematr*.
    - The order of task wait queue (FIFO order or task current priority order)
- Initial semaphore count (*isemcnt*)
- Maximum semaphore count (*maxsem*)

These service calls can be called from tasks that belong to Trusted Domain.
The following describes an example for coding acre_sem as a representative.

```
#include    "kernel.h"              /*Standard header file definition*/
#include    "kernel_id.h"           /*Header file generated by cfg600px*/
#pragma task Task1                  /*Refer to note*/
void Task1 (VP_INT exinf);          /*Refer to note*/
void Task1 (VP_INT exinf)
{
    ER      semid;              /*Declares variable*/
    T_CSEM  pk_csem = {         /*Declares and initializes variable*/
        TA_TFIFO,                   /*Semaphore attribute (sematr)*/
        1,                          /*Initial semaphore count (isemcnt)*/
        0                           /*Maximum semaphore count (maxsem)*/
    };

    /* ......... */

    semid = acre_sem ( &pk_csem );  /*Create semaphore/

    /* ......... */
}
```

Note These statements are unnecessary for the task which is created by the system configuration file because the cfg600px generates these statement into the “kernel_id.h”.

7.2.2 Delete semaphore

- del_sem
  This service call deletes the semaphore specified by parameter *semid*.
  When there are waiting tasks for the target semaphore by using wai_sem or twai_sem, this service call cancels the WAITING state of the tasks and returns E_DLT as a return value of the wai_sem or twai_sem.
  This service call can be called from tasks that belong to Trusted Domain.
  The following describes an example for coding this service call.

```
#include    "kernel.h"              /*Standard header file definition*/
#include    "kernel_id.h"           /*Header file generated by cfg600px*/
#pragma task Task1                  /*Refer to note*/
void Task1 (VP_INT exinf);          /*Refer to note*/
void Task1 (VP_INT exinf)
{
    ID      semid = 8;          /*Declares and initializes variable*/

    /* ......... */

    ercd = del_sem ( semid );   /*Delete semaphore*/

    /* ......... */
}
```

Note These statements are unnecessary for the task which is created by the system configuration file because the cfg600px generates these statement into the “kernel_id.h”.

7.2.3 Acquire semaphore resource

A resource is acquired (waiting forever, polling, or with time-out) by issuing the following service call from the processing program.

- wai_sem (Wait)
- pol_sem, ipol_sem (Polling)
- twai_sem (Wait with time-out)

- wai_sem (Wait)
  This service call acquires a resource from the semaphore specified by parameter *semid* (subtracts 1 from the semaphore counter).
  When no resources are acquired from the target semaphore when this service call is issued (no available resources exist), this service call does not acquire resources but queues the invoking task to the target semaphore wait queue and moves it from the RUNNING state to the WAITING state (resource acquisition wait state).
  The WAITING state for a semaphore resource is cancelled in the following cases.

WAITING State for a Semaphore Resource Cancel Operation	Return Value
The resource was released to the target semaphore as a result of issuing sig_sem.	E_OK
The resource was released to the target semaphore as a result of issuing isig_sem.	E_OK
Forced release from waiting (accept rel_wai while waiting).	E_RLWAI
Forced release from waiting (accept irel_wai while waiting).	E_RLWAI
Forced release from waiting (accept del_sem while waiting).	E_DLT

The following describes an example for coding this service call.

```
#include    "kernel.h"              /*Standard header file definition*/
#include    "kernel_id.h"           /*Header file generated by cfg600px*/
#pragma task Task1                  /*Refer to note 2*/
void Task1 (VP_INT exinf);          /*Refer to note 2*/
void Task1 (VP_INT exinf)
{
    ER      ercd;               /*Declares variable*/
    ID      semid = 1;          /*Declares and initializes variable*/

    /* ......... */

    ercd = wai_sem (semid );    /*Acquire semaphore resource*/

    if (ercd == E_OK) {
        /* ......... */         /*Normal termination processing*/

        sig_sem ( semid );      /*Release semaphore resource*/
    } else if (ercd == E_RLWAI) {
        /* ......... */         /*Forced termination processing*/
    }

    /* ......... */
}
```

Note 1 Invoking tasks are queued to the target semaphore wait queue in the order defined at creating the semaphore (FIFO order or current priority order).

Note 2 These statements are unnecessary for the task which is created by the system configuration file because the cfg600px generates these statement into the “kernel_id.h”.

- pol_sem, ipol_sem (Polling)
  These service calls acquire a resource from the semaphore specified by parameter *semid* (subtracts 1 from the semaphore counter).
  If a resource could not be acquired from the target semaphore (semaphore counter is set to 0) when these service calls are issued, the counter manipulation processing is not performed but “E_TMOUT” is returned.
  The following describes an example for coding these service calls.

```
#include    "kernel.h"              /*Standard header file definition*/
#include    "kernel_id.h"           /*Header file generated by cfg600px*/
#pragma task Task1                  /*Refer to note*/
void Task1 (VP_INT exinf);          /*Refer to note*/
void Task1 (VP_INT exinf)
{
    ER      ercd;                   /*Declares variable*/
    ID      semid = 1;              /*Declares and initializes variable*/

    /* ......... */

    ercd = pol_sem (semid);         /*Acquire semaphore resource*/

    if (ercd == E_OK) {
        /* ......... */             /*Polling success processing*/

        sig_sem ( semid );          /*Release semaphore resource*/
    } else if (ercd == E_TMOUT) {
        /* ......... */             /*Polling failure processing*/
    }

    /* ......... */
}
```

Note These statements are unnecessary for the task which is created by the system configuration file because the cfg600px generates these statement into the “kernel_id.h”.

- twai_sem (Wait with time-out)
  This service call acquires a resource from the semaphore specified by parameter *semid* (subtracts 1 from the semaphore counter).
  If no resources are acquired from the target semaphore when service call is issued this (no available resources exist), this service call does not acquire resources but queues the invoking task to the target semaphore wait queue and moves it from the RUNNING state to the WAITING state with time-out (resource acquisition wait state).
  The WAITING state for a semaphore resource is cancelled in the following cases.

WAITING State for a Semaphore Resource Cancel Operation	Return Value
The resource was released to the target semaphore as a result of issuing sig_sem.	E_OK
The resource was released to the target semaphore as a result of issuing isig_sem.	E_OK
Forced release from waiting (accept rel_wai while waiting).	E_RLWAI
Forced release from waiting (accept irel_wai while waiting).	E_RLWAI
The time specified by *tmout* has elapsed.	E_TMOUT
Forced release from waiting (accept del_sem while waiting).	E_DLT

The following describes an example for coding this service call.

```
#include    "kernel.h"              /*Standard header file definition*/
#include    "kernel_id.h"           /*Header file generated by cfg600px*/
#pragma task Task1                  /*Refer to note 3*/
void Task1 (VP_INT exinf);          /*Refer to note 3*/
void Task1 (VP_INT exinf)
{
    ER      ercd;                   /*Declares variable*/
    ID      semid = 1;              /*Declares and initializes variable*/
    TMO     tmout = 3600;           /*Declares and initializes variable*/

    /* ......... */

    ercd = twai_sem (semid, tmout); /*Acquire semaphore resource*/

    if (ercd == E_OK) {
        /* ......... */             /*Normal termination processing*/

        sig_sem ( semid );          /*Release semaphore resource*/
    } else if (ercd == E_RLWAI) {
        /* ......... */             /*Forced termination processing*/
    } else if (ercd == E_TMOUT) {
        /* ......... */             /*Time-out processing*/
    }

    /* ......... */
}
```

Note 1 Invoking tasks are queued to the target semaphore wait queue in the order defined at creating the semaphore (FIFO order or current priority order).

Note 2 TMO_FEVR is specified for wait time *tmout*, processing equivalent to wai_sem will be executed. When TMO_POL is specified, processing equivalent to pol_sem will be executed.

Note 3 These statements are unnecessary for the task which is created by the system configuration file because the cfg600px generates these statement into the “kernel_id.h”.

7.2.4 Release semaphore resource

A resource is released by issuing the following service call from the processing program.

- sig_sem, isig_sem
  These service calls releases the resource to the semaphore specified by parameter *semid* (adds 1 to the semaphore counter).
  If a task is queued in the wait queue of the target semaphore when this service call is issued, the counter manipulation processing is not performed but the resource is passed to the relevant task (first task of wait queue).
  As a result, the relevant task is unlinked from the wait queue and is moved from the WAITING state (WAITING state for a semaphore resource) to the READY state, or from the WAITING-SUSPENDED state to the SUSPENDED state.
  The following describes an example for coding these service calls.

```
#include    "kernel.h"           /*Standard header file definition*/
#include    "kernel_id.h"        /*Header file generated by cfg600px*/
#pragma task Task1               /*Refer to note 2*/
void Task1 (VP_INT exinf);       /*Refer to note 2*/
void Task1 (VP_INT exinf)
{
    ER      ercd;                /*Declares variable*/
    ID      semid = 1;           /*Declares and initializes variable*/

    /* ......... */

    ercd = wai_sem (semid );     /*Acquire semaphore resource*/

    if (ercd == E_OK) {
        /* ......... */          /*Normal termination processing*/

        sig_sem ( semid );       /*Release semaphore resource*/
    } else if (ercd == E_RLWAI) {
        /* ......... */          /*Forced termination processing*/
    }

    /* ......... */
}
```

Note 1 With the RI600PX, the maximum possible number of semaphore resources (maximum resource count) is defined during configuration. If the number of resources exceeds the specified maximum resource count, this service call therefore does not release the acquired resources (addition to the semaphore counter value) but returns E_QOVR.

Note 2 These statements are unnecessary for the task which is created by the system configuration file because the cfg600px generates these statement into the “kernel_id.h”.

7.2.5 Reference semaphore state

A semaphore status is referenced by issuing the following service call from the processing program.

- ref_sem, iref_sem
  Stores semaphore state packet (ID number of the task at the head of the wait queue, current resource count, etc.) of the semaphore specified by parameter *semid* in the area specified by parameter *pk_rsem*.
  The following describes an example for coding these service calls.

```
#include    "kernel.h"              /*Standard header file definition*/
#include    "kernel_id.h"           /*Header file generated by cfg600px*/
#pragma task Task1                  /*Refer to note 2*/
void Task1 (VP_INT exinf);          /*Refer to note 2*/
void Task1 (VP_INT exinf)
{
    ID      semid = 1;              /*Declares and initializes variable*/
    T_RSEM  pk_rsem;                /*Declares variable*/
    ID      wtskid;                 /*Declares variable*/
    UINT    semcnt;                 /*Declares variable*/

    /* ......... */

    ref_sem ( semid, &pk_rsem );    /*Reference semaphore state*/

    wtskid = pk_rsem.wtskid;        /*Reference ID number of the task at the */
                                    /*head of the wait queue*/
    semcnt = pk_rsem.semcnt;        /*Reference current resource count*/

    /* ......... */
}
```

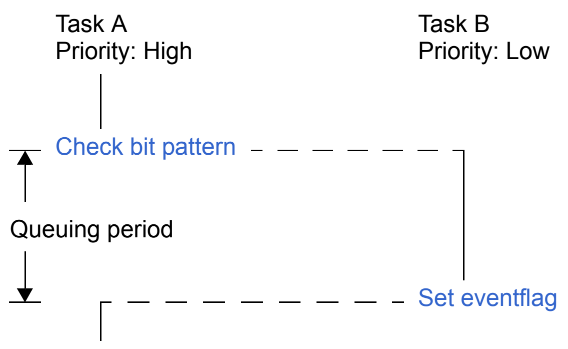
Note 1 For details about the semaphore state packet, refer to “[Semaphore state packet: T_RSEM]”.

Note 2 These statements are unnecessary for the task which is created by the system configuration file because the cfg600px generates these statement into the “kernel_id.h”.

7.3 Eventflags

The RI600PX provides 32-bit eventflags as a queuing function for tasks, such as keeping the tasks waiting for execution, until the results of the execution of a given processing program are output.
The following shows a processing flow when using an eventflag.

Figure 7-2 Processing Flow (Eventflag)



7.3.1 Create eventflag

Eventflags are created by one of the following methods.

1) Creation by the system configuration file
The static API "flag[]" described in the system configuration file creates a eventflag.
Refer to "20.12 Eventflag Information (flag[])" for the details of "flag[]".

2) Creation by cre_flg or acre_flg
The cre_flg creates a eventflag with eventflag ID indicated by parameter *flgid* according to the content of parameter *pk_cflg*.
The acre_flg creates a eventflag according to the content of parameter *pk_cflg*, and returns the created eventflag ID.
The information specified is shown below.

- Eventflag attribute (*flgatr*)
  The following informations are specified as *flgatr*.
  - The order of task wait queue (FIFO order or task current priority order)
  - Whether multiple task can wait on the event flag.
  - Whether the bit pattern of the event flag is cleared to 0 when a task is released from the WAITING state,
- Initial bit pattern (*iflgptn*)

These service calls can be called from tasks that belong to Trusted Domain.
The following describes an example for coding acre_flg as a representative.

```
#include    "kernel.h"                /*Standard header file definition*/
#include    "kernel_id.h"             /*Header file generated by cfg600px*/
#pragma task Task1                    /*Refer to note*/
void Task1 (VP_INT exinf);            /*Refer to note*/
void Task1 (VP_INT exinf)
{
    ER       flgid;               /*Declares variable*/
    T_CFLG   pk_cflg = {          /*Declares and initializes variable*/
        TA_TFIFO|TA_WSGL|TA_CLR,      /*Eventflag attribute (flgatr)*/
        0UL                           /*Initial bit pattern (iflgptn)*/
    };

    /* ......... */

    flgid = acre_flg ( &pk_cflg ); /*Create eventflag/

    /* ......... */
}
```

Note These statements are unnecessary for the task which is created by the system configuration file because the cfg600px generates these statement into the "kernel_id.h".

7.3.2 Delete Eventflag

- del_flg
  This service call deletes the eventflag specified by parameter *flgid*.
  When there are waiting tasks for the target eventflag by using wai_flg or twai_flg, this service call cancels the WAIT-ING state of the tasks and returns E_DLT as a return value of the wai_flg or twai_flg.
  This service call can be called from tasks that belong to Trusted Domain.
  The following describes an example for coding this service call.

```
#include    "kernel.h"                /*Standard header file definition*/
#include    "kernel_id.h"             /*Header file generated by cfg600px*/
#pragma task Task1                    /*Refer to note*/
void Task1 (VP_INT exinf);            /*Refer to note*/
void Task1 (VP_INT exinf)
{
    ID      flgid = 8;          /*Declares and initializes variable*/

    /* ......... */

    ercd = del_flg ( flgid );   /*Delete semaphore*/

    /* ......... */
}
```

Note These statements are unnecessary for the task which is created by the system configuration file because the cfg600px generates these statement into the “kernel_id.h”.

7.3.3 Set eventflag

A bit pattern is set by issuing the following service call from the processing program.

- set_flg, iset_flg
  These service calls set the result of ORing the bit pattern of the eventflag specified by parameter flgid and the bit pattern specified by parameter setptn as the bit pattern of the target eventflag.
  After that, these service calls evaluate whether the wait condition of the tasks in the wait queue is satisfied. This evaluation is done in order of the wait queue. If the wait condition is satisfied, the relevant task is unlinked from the wait queue at the same time as bit pattern setting processing. As a result, the relevant task is moved from the WAITING state (WAITING state for an eventflag) to the READY state, or from the WAITING-SUSPENDED state to the SUSPENDED state. At this time, the bit pattern of the target event flag is cleared to 0 and this service call finishes processing if the TA_CLR attribute is specified for the target eventflag.

```
#include    "kernel.h"              /*Standard header file definition*/
#include    "kernel_id.h"           /*Header file generated by cfg600px*/
#pragma task Task1                  /*Refer to note*/
void Task1 (VP_INT exinf);          /*Refer to note*/
void Task1 (VP_INT exinf)
{
    ID      flgid = 1;              /*Declares and initializes variable*/
    FLGPTN  setptn = 0x00000001UL;  /*Declares and initializes variable*/

    /* ......... */

    set_flg (flgid, setptn);        /*Set eventflag*/

    /* ......... */
}
```

Note These statements are unnecessary for the task which is created by the system configuration file because the cfg600px generates these statement into the “kernel_id.h”.

7.3.4 Clear eventflag

A bit pattern is cleared by issuing the following service call from the processing program.

- clr_flg, iclr_flg
  This service call sets the result of ANDing the bit pattern set to the eventflag specified by parameter *flgid* and the bit pattern specified by parameter *clrptn* as the bit pattern of the target eventflag.
  The following describes an example for coding these service calls.

```
#include    "kernel.h"              /*Standard header file definition*/
#include    "kernel_id.h"           /*Header file generated by cfg600px*/
#pragma task Task1                  /*Refer to note*/
void Task1 (VP_INT exinf);          /*Refer to note*/
void Task1 (VP_INT exinf)
{
    ID      flgid = 1;              /*Declares and initializes variable*/
    FLGPTN  clrptn = 0xFFFFFFFEUL;  /*Declares and initializes variable*/

    /* ......... */

    clr_flg (flgid, clrptn);        /*Clear eventflag*/

    /* ......... */
}
```

Note These statements are unnecessary for the task which is created by the system configuration file because the cfg600px generates these statement into the “kernel_id.h”.

7.3.5 Check bit pattern

A bit pattern is checked (waiting forever, polling, or with time-out) by issuing the following service call from the processing program.

- wai_flg (Wait)
- pol_flg, ipol_flg (Polling)
- twai_flg (Wait with time-out)

- wai_flg (Wait)
  This service call checks whether the bit pattern specified by parameter *waiptn* and the bit pattern that satisfies the required condition specified by parameter *wfmode* are set to the eventflag specified by parameter *flgid*.
  If a bit pattern that satisfies the required condition has been set for the target eventflag, the bit pattern of the target eventflag is stored in the area specified by parameter *p_flgptn*.
  If the bit pattern of the target eventflag does not satisfy the required condition when this service call is issued, the invoking task is queued to the target eventflag wait queue.
  As a result, the invoking task is unlinked from the ready queue and is moved from the RUNNING state to the WAITING state (WAITING state for an eventflag).
  The WAITING state for an eventflag is cancelled in the following cases.

WAITING State for an Eventflag Cancel Operation	Return Value
A bit pattern that satisfies the required condition was set to the target eventflag as a result of issuing set_flg.	E_OK
A bit pattern that satisfies the required condition was set to the target eventflag as a result of issuing iset_flg.	E_OK
Forced release from waiting (accept rel_wai while waiting).	E_RLWAI
Forced release from waiting (accept irel_wai while waiting).	E_RLWAI
Forced release from waiting (accept del_flg while waiting).	E_DLT

The following shows the specification format of required condition *wfmode*.

- *wfmode* = TWF_ANDW
  Checks whether all of the bits to which 1 is set by parameter *waiptn* are set as the target eventflag.
- *wfmode* = TWF_ORW
  Checks which bit, among bits to which 1 is set by parameter *waiptn*, is set as the target eventflag.

The following describes an example for coding this service call.

```
#include    "kernel.h"               /*Standard header file definition*/
#include    "kernel_id.h"            /*Header file generated by cfg600px*/
#pragma task Task1                   /*Refer to note 4*/
void Task1 (VP_INT exinf);           /*Refer to note 4*/
void Task1 (VP_INT exinf)
{
    ER      ercd;                    /*Declares variable*/
    ID      flgid = 1;               /*Declares and initializes variable*/
    FLGPTN  waiptn = 14;             /*Declares and initializes variable*/
    MODE    wfmode = TWF_ANDW;       /*Declares and initializes variable*/
    FLGPTN  p_flgptn;                /*Declares variable*/

    /* ......... */

                                     /*Wait for eventflag*/
    ercd = wai_flg (flgid, waiptn, wfmode, &p_flgptn);

    if (ercd == E_OK) {
        /* ......... */              /*Normal termination processing*/
    } else if (ercd == E_RLWAI) {
        /* ......... */              /*Forced termination processing*/
    }

    /* ......... */
}
```

Note 1 When a task has already waited on the eventflag which has been created with TA_WSGL attribute (only one task is allowed to be in the WAITING state for the eventflag), this service call returns E_ILUSE error.

Note 2 Invoking tasks are queued to the target event flag (TA_WMUL attribute) wait queue in the order defined at creating the eventflag (FIFO order or current priority order).
However, when the TA_CLR attribute is not specified, the wait queue is managed in the FIFO order even if the priority order is specified. This behavior falls outside μITRON4.0 specification.

Note 3 The RI600PX performs bit pattern clear processing (0 setting) when the required condition of the target eventflag (TA_CLR attribute) is satisfied.

Note 4 These statements are unnecessary for the task which is created by the system configuration file because the cfg600px generates these statement into the “kernel_id.h”.

- pol_flg, ipol_flg (Polling)
  This service call checks whether the bit pattern specified by parameter *waiptn* and the bit pattern that satisfies the required condition specified by parameter *wfmode* are set to the eventflag specified by parameter *flgid*.
  If the bit pattern that satisfies the required condition has been set to the target eventflag, the bit pattern of the target eventflag is stored in the area specified by parameter *p_flgptn*.
  If the bit pattern of the target eventflag does not satisfy the required condition when this service call is issued, "E_TMOUT" is returned.
  The following shows the specification format of required condition *wfmode*.

  - *wfmode* = TWF_ANDW
    Checks whether all of the bits to which 1 is set by parameter *waiptn* are set as the target eventflag.

  - *wfmode* = TWF_ORW
    Checks which bit, among bits to which 1 is set by parameter *waiptn*, is set as the target eventflag.

  The following describes an example for coding these service calls.

```
#include    "kernel.h"                /*Standard header file definition*/
#include    "kernel_id.h"             /*Header file generated by cfg600px*/
#pragma task Task1                    /*Refer to note 3*/
void Task1 (VP_INT exinf);            /*Refer to note 3*/
void Task1 (VP_INT exinf)
{
    ER      ercd;                     /*Declares variable*/
    ID      flgid = 1;                /*Declares and initializes variable*/
    FLGPTN  waiptn = 14;              /*Declares and initializes variable*/
    MODE    wfmode = TWF_ANDW;        /*Declares and initializes variable*/
    FLGPTN  p_flgptn;                 /*Declares variable*/

    /* ......... */

                                      /*Wait for eventflag*/
    ercd = pol_flg (flgid, waiptn, wfmode, &p_flgptn);

    if (ercd == E_OK) {
        /* ......... */               /*Polling success processing*/
    } else if (ercd == E_TMOUT) {
        /* ......... */               /*Polling failure processing*/
    }

    /* ......... */
}
```

Note 1 When a task has already waited on the eventflag which has been created with TA_WSGL attribute (only one task is allowed to be in the WAITING state for the eventflag), this service call returns E_ILUSE error.

Note 2 The RI600PX performs bit pattern clear processing (0 setting) when the required condition of the target eventflag (TA_CLR attribute) is satisfied.

Note 3 These statements are unnecessary for the task which is created by the system configuration file because the cfg600px generates these statement into the "kernel_id.h".

- twai_flg (Wait with time-out)
  This service call checks whether the bit pattern specified by parameter *waiptn* and the bit pattern that satisfies the required condition specified by parameter *wfmode* are set to the eventflag specified by parameter *flgid*.
  If a bit pattern that satisfies the required condition has been set for the target eventflag, the bit pattern of the target eventflag is stored in the area specified by parameter *p_flgptn*.
  If the bit pattern of the target eventflag does not satisfy the required condition when this service call is issued, the invoking task is queued to the target eventflag wait queue.
  As a result, the invoking task is unlinked from the ready queue and is moved from the RUNNING state to the WAITING state (WAITING state for an eventflag).
  The WAITING state for an eventflag is cancelled in the following cases.

WAITING State for an Eventflag Cancel Operation	Return Value
A bit pattern that satisfies the required condition was set to the target eventflag as a result of issuing set_flg.	E_OK
A bit pattern that satisfies the required condition was set to the target eventflag as a result of issuing iset_flg.	E_OK
Forced release from waiting (accept rel_wai while waiting).	E_RLWAI
Forced release from waiting (accept irel_wai while waiting).	E_RLWAI
The time specified by *tmout* has elapsed.	E_TMOUT
Forced release from waiting (accept del_flg while waiting).	E_DLT

The following shows the specification format of required condition *wfmode*.

- *wfmode* = TWF_ANDW
  Checks whether all of the bits to which 1 is set by parameter *waiptn* are set as the target eventflag.

- *wfmode* = TWF_ORW
  Checks which bit, among bits to which 1 is set by parameter *waiptn*, is set as the target eventflag.

The following describes an example for coding this service call.

```
#include    "kernel.h"              /*Standard header file definition*/
#include    "kernel_id.h"           /*Header file generated by cfg600px*/
#pragma task Task1                  /*Refer to note 5*/
void Task1 (VP_INT exinf);          /*Refer to note 5*/
void Task1 (VP_INT exinf)
{
    ER      ercd;                   /*Declares variable*/
    ID      flgid = 1;              /*Declares and initializes variable*/
    FLGPTN  waiptn = 14;            /*Declares and initializes variable*/
    MODE    wfmode = TWF_ANDW;      /*Declares and initializes variable*/
    FLGPTN  p_flgptn;               /*Declares variable*/
    TMO     tmout = 3600;           /*Declares and initializes variable*/

    /* ......... */

                                    /*Wait for eventflag*/
    ercd = twai_flg (flgid, waiptn, wfmode, &p_flgptn, tmout);

    if (ercd == E_OK) {
        /* ......... */             /*Normal termination processing*/
    } else if (ercd == E_RLWAI) {
        /* ......... */             /*Forced termination processing*/
    } else if (ercd == E_TMOUT) {
        /* ......... */             /*Time-out processing*/
    }

    /* ......... */
}
```

Note 1 When a task has already waited on the eventflag which has been created with TA_WSGL attribute (only one task is allowed to be in the WAITING state for the eventflag), this service call returns E_ILUSE error.

Note 2 Invoking tasks are queued to the target event flag (TA_WMUL attribute) wait queue in the order defined at creating the eventflag (FIFO order or current priority order).
However, when the TA_CLR attribute is not specified, the wait queue is managed in the FIFO order even if the priority order is specified. This behavior falls outside μITRON4.0 specification.

Note 3 The RI600PX performs bit pattern clear processing (0 setting) when the required condition of the target eventflag (TA_CLR attribute) is satisfied.

Note 4 TMO_FEVR is specified for wait time *tmout*, processing equivalent to wai_flg will be executed. When TMO_POL is specified, processing equivalent to pol_flg will be executed.

Note 5 These statements are unnecessary for the task which is created by the system configuration file because the cfg600px generates these statement into the “kernel_id.h”.

7.3.6 Reference eventflag state

An eventflag status is referenced by issuing the following service call from the processing program.

- ref_flg, iref_flg
  Stores eventflag state packet (ID number of the task at the head of the wait queue, current bit pattern, etc.) of the eventflag specified by parameter *flgid* in the area specified by parameter *pk_rflg*.
  The following describes an example for coding these service calls.

```
#include    "kernel.h"              /*Standard header file definition*/
#include    "kernel_id.h"           /*Header file generated by cfg600px*/
#pragma task Task1                  /*Refer to note 2*/
void Task1 (VP_INT exinf);          /*Refer to note 2*/
void Task1 (VP_INT exinf)
{
    ID      flgid = 1;              /*Declares and initializes variable*/
    T_RFLG  pk_rflg;                /*Declares data structure*/
    ID      wtskid;                 /*Declares variable*/
    FLGPTN  flgptn;                 /*Declares variable*/

    /* ......... */

    ref_flg (flgid, &pk_rflg);      /*Reference eventflag state*/

    wtskid = pk_rflg.wtskid;        /*Reference ID number of the task at the */
                                    /*head of the wait queue*/
    flgptn = pk_rflg.flgptn;        /*Reference current bit pattern*/

    /* ......... */
}
```

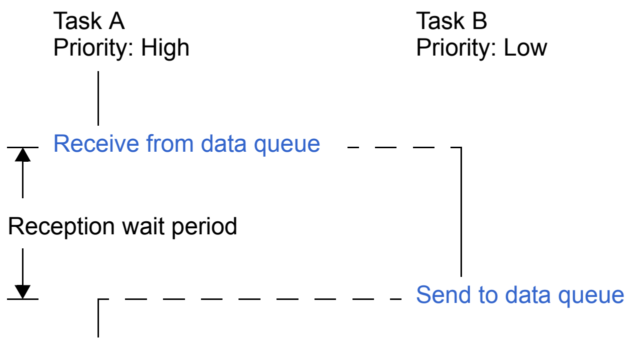
Note 1 For details about the eventflag state packet, refer to “[Eventflag state packet: T_RFLG]”.

Note 2 These statements are unnecessary for the task which is created by the system configuration file because the cfg600px generates these statement into the “kernel_id.h”.

7.4 Data Queues

Multitask processing requires the inter-task communication function (data transfer function) that reports the processing result of a task to another task. The RI600PX therefore provides the data queues for transferring the prescribed size of data.
The following shows a processing flow when using a data queue.

Figure 7-3 Processing Flow (Data Queue)



Note Data units of 4 bytes are transmitted or received at a time.

7.4.1 Create data queue

Data queues are created by one of the following methods.

1) Creation by the system configuration file
The static API “data_queue[]” described in the system configuration file creates a data queue.
Refer to “20.13 Data Queue Information (dataqueue[])” for the details of “data_queue[]”.

2) Creation by cre_dtq or acre_dtq
The cre_dtq creates a data queue with data queue ID indicated by parameter *dtqid* according to the content of parameter *pk_cdtq*.
The acre_dtq creates a data queue according to the content of parameter *pk_cdtq*, and returns the created data queue ID.
The information specified is shown below.

- Data queue attribute (*dtqatr*)
  The following informations are specified as *dtqatr*.
  - The order of task wait queue for sending (FIFO order or task current priority order)
- Capacity of the data queue area (*dtqcnt*), Start address of the data queue area (*dtq*)
  The TSZ_DTQ(*dtqcnt*) bytes area from the address indicated by parameter *dtq* is used for the data queue area. Refer to “18.3.2 Macros for Data Queue” for details of TSZ_DTQ macro.
  The data queue area should be generated to the area other than memory objects and user stacks.

These service calls can be called from tasks that belong to Trusted Domain.
The following describes an example for coding acre_dtq as a representative.

```
#include    "kernel.h"                /*Standard header file definition*/
#include    "kernel_id.h"             /*Header file generated by cfg600px*/

#define DTQCNT 10                     /*Capacity of the data queue area*/
                                      /*(the number of data elements)*/

#pragma section B BRI_RAM             /*Section for the data queue area*/
static UW dtq_area[ TSZ_DTQ(dtqcnt)/sizeof(UW)]; /*Data queue area*/
#pragma section

#pragma task Task1                    /*Refer to note*/
void Task1 (VP_INT exinf);            /*Refer to note*/
void Task1 (VP_INT exinf)
{
    ER      dtqid;                /*Declares variable*/
    T_CDTQ  pk_cdtq = {           /*Declares and initializes variable*/
        TA_TFIFO,                     /*Data queue attribute (dtqatr)*/
        DTQCNT,                       /*Capacity of the data queue area (dtqcnt)*/
        (VP)dtq_area                  /*Start address of the data queue area (dtq)*/
    };

    /* ......... */

    dtqid = acre_dtq ( &pk_cdtq );    /*Create data queue/

    /* ......... */
}
```

Note These statements are unnecessary for the task which is created by the system configuration file because the cfg600px generates these statement into the “kernel_id.h”.

7.4.2 Delete data queue

- del_dtq
  This service call deletes the data queue specified by parameter *dtqid*.
  When there are waiting tasks for the target data queue by using snd_dtq, tsnd_dtq, rcv_dtq or trcv_dtq, this service call cancels the WAITING state of the tasks and returns E_DLT as a return value of the snd_dtq, tsnd_dtq, rcv_dtq or trcv_dtq.
  This service call can be called from tasks that belong to Trusted Domain.
  The following describes an example for coding this service call.

```
#include    "kernel.h"              /*Standard header file definition*/
#include    "kernel_id.h"           /*Header file generated by cfg600px*/
#pragma task Task1                  /*Refer to note*/
void Task1 (VP_INT exinf);          /*Refer to note*/
void Task1 (VP_INT exinf)
{
    ID      dtqid = 8;          /*Declares and initializes variable*/

    /* ......... */

    ercd = del_dtq ( dtqid );   /*Delete data queue*/

    /* ......... */
}
```

Note These statements are unnecessary for the task which is created by the system configuration file because the cfg600px generates these statement into the “kernel_id.h”.

7.4.3 Send to data queue

A data is transmitted by issuing the following service call from the processing program.

- snd_dtq (Wait)
- psnd_dtq, ipsnd_dtq (Polling)
- tsnd_dtq (Wait with time-out)

- snd_dtq (Wait)
  This service call processes as follows according to the situation of the data queue specified by the parameter *dtqid*.
  - There is a task in the reception wait queue.
    This service call transfers the data specified by parameter *data* to the task in the top of the reception wait queue. As a result, the task is unlinked from the reception wait queue and moves from the WAITING state (data reception wait state) to the READY state, or from the WAITING-SUSPENDED state to the SUSPENDED state.
  - There is no task neither in the reception wait queue and transmission wait queue and there is available space in the data queue.
    This service call stores the data specified by parameter *data* to the data queue.
  - There is no task neither in the reception wait queue and transmission wait queue and there is no available space in the data queue, or there is a task in the transmission wait queue.
    This service call queues the invoking task to the transmission wait queue of the target data queue and moves it from the RUNNING state to the WAITING state (data transmission wait state).
    The sending WAITING state for a data queue is cancelled in the following cases.

Sending WAITING State for a Data Queue Cancel Operation	Return Value
Available space was secured in the data queue area as a result of issuing rcv_dtq.	E_OK
Available space was secured in the data queue area as a result of issuing prcv_dtq.	E_OK
Available space was secured in the data queue area as a result of issuing iprcv_dtq.	E_OK
Available space was secured in the data queue area as a result of issuing trcv_dtq.	E_OK
Forced release from waiting (accept rel_wai while waiting).	E_RLWAI
Forced release from waiting (accept irel_wai while waiting).	E_RLWAI
The data queue is reset as a result of issuing vrst_dtq.	EV_RST
Forced release from waiting (accept del_dtq while waiting).	E_DLT

The following describes an example for coding this service call.

```
#include    "kernel.h"                  /*Standard header file definition*/
#include    "kernel_id.h"               /*Header file generated by cfg600px*/
#pragma task Task1                      /*Refer to note 3*/
void Task1 (VP_INT exinf);              /*Refer to note 3*/
void Task1 (VP_INT exinf)
{
    ER      ercd;                       /*Declares variable*/
    ID      dtqid = 1;                  /*Declares and initializes variable*/
    VP_INT  data = 123;                 /*Declares and initializes variable*/

    /* ......... */

    ercd = snd_dtq (dtqid, data);       /*Send to data queue*/

    if (ercd == E_OK) {
        /* ......... */                 /*Normal termination processing*/
    } else if (ercd == E_RLWAI) {
        /* ......... */                 /*Forced termination processing*/
    }

    /* ......... */
}
```

Note 1 Data is written to the data queue area in the order of the data transmission request.

Note 2 Invoking tasks are queued to the transmission wait queue of the target data queue in the order defined at creating the data queue (FIFO order or current priority order).

Note 3 These statements are unnecessary for the task which is created by the system configuration file because the cfg600px generates these statement into the “kernel_id.h”.

- psnd_dtq, ipsnd_dtq (Polling)
  These service calls process as follows according to the situation of the data queue specified by the parameter *dtqid*.
  - There is a task in the reception wait queue.
    These service calls transfer the data specified by parameter *data* to the task in the top of the reception wait queue. As a result, the task is unlinked from the reception wait queue and moves from the WAITING state (data reception wait state) to the READY state, or from the WAITING-SUSPENDED state to the SUSPENDED state.
  - There is no task neither in the reception wait queue and transmission wait queue and there is available space in the data queue.
    These service calls store the data specified by parameter *data* to the data queue.
  - There is no task neither in the reception wait queue and transmission wait queue and there is no available space in the data queue, or there is a task in the transmission wait queue.
    These service calls return "E_TMOUT".

The following describes an example for coding these service calls.

```
#include    "kernel.h"              /*Standard header file definition*/
#include    "kernel_id.h"           /*Header file generated by cfg600px*/
#pragma task Task1                  /*Refer to note 2*/
void Task1 (VP_INT exinf);          /*Refer to note 2*/
void Task1 (VP_INT exinf)
{
    ER      ercd;                   /*Declares variable*/
    ID      dtqid = 1;              /*Declares and initializes variable*/
    VP_INT  data = 123;             /*Declares and initializes variable*/

    /* ......... */

    ercd = psnd_dtq (dtqid, data);  /*Send to data queue*

    if (ercd == E_OK) {
        /* ......... */             /*Polling success processing*/
    } else if (ercd == E_TMOUT) {
        /* ......... */             /*Polling failure processing*/
    }

    /* ......... */
}
```

Note 1 Data is written to the data queue area in the order of the data transmission request.

Note 2 These statements are unnecessary for the task which is created by the system configuration file because the cfg600px generates these statement into the "kernel_id.h".

- tsnd_dtq (Wait with time-out)
  This service call processes as follows according to the situation of the data queue specified by the parameter *dtqid*.
  - There is a task in the reception wait queue.
    This service call transfers the data specified by parameter *data* to the task in the top of the reception wait queue. As a result, the task is unlinked from the reception wait queue and moves from the WAITING state (data reception wait state) to the READY state, or from the WAITING-SUSPENDED state to the SUSPENDED state.
  - There is no task neither in the reception wait queue and transmission wait queue and there is available space in the data queue.
    This service call stores the data specified by parameter *data* to the data queue.
  - There is no task neither in the reception wait queue and transmission wait queue and there is no available space in the data queue, or there is a task in the transmission wait queue.
    This service call queues the invoking task to the transmission wait queue of the target data queue and moves it from the RUNNING state to the WAITING state with time (data transmission wait state).
    The sending WAITING state for a data queue is cancelled in the following cases.

Sending WAITING State for a Data Queue Cancel Operation	Return Value
Available space was secured in the data queue area as a result of issuing rcv_dtq.	E_OK
Available space was secured in the data queue area as a result of issuing prcv_dtq.	E_OK
Available space was secured in the data queue area as a result of issuing iprcv_dtq.	E_OK
Available space was secured in the data queue area as a result of issuing trcv_dtq.	E_OK
Forced release from waiting (accept rel_wai while waiting).	E_RLWAI
Forced release from waiting (accept irel_wai while waiting).	E_RLWAI
The data queue is reset as a result of issuing vrst_dtq.	EV_RST
The time specified by *tmout* has elapsed.	E_TMOUT
Forced release from waiting (accept del_dtq while waiting).	E_DLT

The following describes an example for coding this service call.

```
#include    "kernel.h"              /*Standard header file definition*/
#include    "kernel_id.h"           /*Header file generated by cfg600px*/
#pragma task Task1                  /*Refer to note 4*/
void Task1 (VP_INT exinf);          /*Refer to note 4*/
void Task1 (VP_INT exinf)
{
    ER      ercd;                   /*Declares variable*/
    ID      dtqid = 1;              /*Declares and initializes variable*/
    VP_INT  data = 123;             /*Declares and initializes variable*/
    TMO     tmout = 3600;           /*Declares and initializes variable*/

    /* ......... */

                                    /*Send to data queue*/
    ercd = tsnd_dtq (dtqid, data, tmout);

    if (ercd == E_OK) {
        /* ......... */             /*Normal termination processing*/
    } else if (ercd == E_RLWAI) {
        /* ......... */             /*Forced termination processing*/
    } else if (ercd == E_TMOUT) {
        /* ......... */             /*Time-out processing*/
    }

    /* ......... */
}
```

Note 1 Data is written to the data queue area in the order of the data transmission request.

Note 2 Invoking tasks are queued to the transmission wait queue of the target data queue in the order defined at creating the data queue (FIFO order or current priority order).

Note 3 TMO_FEVR is specified for wait time *tmout*, processing equivalent to snd_dtq will be executed. When TMO_POL is specified, processing equivalent to psnd_dtq will be executed.

Note 4 These statements are unnecessary for the task which is created by the system configuration file because the cfg600px generates these statement into the “kernel_id.h”.

7.4.4 Forced send to data queue

Data is forcibly transmitted by issuing the following service call from the processing program.

- fsnd_dtq, ifsnd_dtq
  This service call processes as follows according to the situation of the data queue specified by the parameter *dtqid*.

  - There is a task in the reception wait queue.
    This service call transfers the data specified by parameter *data* to the task in the top of the reception wait queue. As a result, the task is unlinked from the reception wait queue and moves from the WAITING state (data reception wait state) to the READY state, or from the WAITING-SUSPENDED state to the SUSPENDED state.

  - There is no task neither in the reception wait queue and transmission wait queue.
    This service call stores the data specified by parameter *data* to the data queue.
    If there is no available space in the data queue, this service call deletes the oldest data in the data queue before storing the data specified by *data* to the data queue.

The following describes an example for coding these service calls.

```
#include    "kernel.h"              /*Standard header file definition*/
#include    "kernel_id.h"           /*Header file generated by cfg600px*/
#pragma task Task1                  /*Refer to note 2*/
void Task1 (VP_INT exinf);          /*Refer to note 2*/
void Task1 (VP_INT exinf)
{
    ID      dtqid = 1;              /*Declares and initializes variable*/
    VP_INT  data = 123;             /*Declares and initializes variable*/

    /* ......... */

    fsnd_dtq (dtqid, data);         /*Forced send to data queue*/

    /* ......... */
}
```

Note 1 Data is written to the data queue area in the order of the data transmission request.

Note 2 These statements are unnecessary for the task which is created by the system configuration file because the cfg600px generates these statement into the “kernel_id.h”.

7.4.5 Receive from data queue

A data is received (waiting forever, polling, or with time-out) by issuing the following service call from the processing program.

- rcv_dtq (Wait)
- prcv_dtq, iprcv_dtq (Polling)
- trcv_dtq (Wait with time-out)

- rcv_dtq (Wait)
  This service call processes as follows according to the situation of the data queue specified by the parameter *dtqid*.
  - There is a data in the data queue.
    This service call takes out the oldest data from the data queue and stores the data to the area specified by *p_data*.
    When there is a task in the transmission wait queue, this service call stores the data sent by the task in the top of the transmission wait queue and moves it from the WAITING state (data transmission wait state) to the READY state.
  - There is no data in the data queue and there is a task in the transmission wait queue.
    This service call stores the data specified by the task in the top of the transmission wait queue to the area specified by *p_data*. As a result, the task is unlinked from the transmission wait queue and moves from the WAITING state (data transmission wait state) to the READY state, or from the WAITING-SUSPENDED state to the SUSPENDED state.
    Note, this situation is caused only when the capacity of the data queue is 0.
  - There is no data in the data queue and there is no task in the transmission wait queue.
    This service call queues the invoking task to the reception wait queue of the target data queue and moves it from the RUNNING state to the WAITING state (data reception wait state).
    The receiving WAITING state for a data queue is cancelled in the following cases.

Receiving WAITING State for a Data Queue Cancel Operation	Return Value
Data was sent to the data queue area as a result of issuing snd_dtq.	E_OK
Data was sent to the data queue area as a result of issuing psnd_dtq.	E_OK
Data was sent to the data queue area as a result of issuing ipsnd_dtq.	E_OK
Data was sent to the data queue area as a result of issuing tsnd_dtq.	E_OK
Data was sent to the data queue area as a result of issuing fsnd_dtq.	E_OK
Data was sent to the data queue area as a result of issuing ifsnd_dtq.	E_OK
Forced release from waiting (accept rel_wai while waiting).	E_RLWAI
Forced release from waiting (accept irel_wai while waiting).	E_RLWAI
Forced release from waiting (accept del_dtq while waiting).	E_DLT

The following describes an example for coding this service call.

```
#include    "kernel.h"              /*Standard header file definition*/
#include    "kernel_id.h"           /*Header file generated by cfg600px*/
#pragma task Task1                  /*Refer to note 2*/
void Task1 (VP_INT exinf);          /*Refer to note 2*/
void Task1 (VP_INT exinf)
{
    ER      ercd;                   /*Declares variable*/
    ID      dtqid = 1;              /*Declares and initializes variable*/
    VP_INT  p_data;                 /*Declares variable*/

    /* ......... */

                                    /*Receive from data queue*/
    ercd = rcv_dtq (dtqid, &p_data);

    if (ercd == E_OK) {
        /* ......... */             /*Normal termination processing*/
    } else if (ercd == E_RLWAI) {
        /* ......... */             /*Forced termination processing*/
    }

    /* ......... */
}
```

Note 1 Invoking tasks are queued to the reception wait queue of the target data queue in the order of the data reception request.

Note 2 These statements are unnecessary for the task which is created by the system configuration file because the cfg600px generates these statement into the “kernel_id.h”.

- prcv_dtq, iprcv_dtq (Polling)
  These service calls process as follows according to the situation of the data queue specified by the parameter *dtqid*.

  - There is a data in the data queue.
    This service call takes out the oldest data from the data queue and stores the data to the area specified by *p_data*.
    When there is a task in the transmission wait queue, this service call stores the data sent by the task in the top of the transmission wait queue and moves it from the WAITING state (data transmission wait state) to the READY state.

  - There is no data in the data queue and there is a task in the transmission wait queue.
    These service calls store the data specified by the task in the top of the transmission wait queue to the area specified by *p_data*. As a result, the task is unlinked from the transmission wait queue and moves from the WAITING state (data transmission wait state) to the READY state, or from the WAITING-SUSPENDED state to the SUSPENDED state.
    Note, this situation is caused only when the capacity of the data queue is 0.

  - There is no data in the data queue and there is no task in the transmission wait queue.
    These service calls return "E_TMOUT".

The following describes an example for coding these service calls.

```
#include    "kernel.h"               /*Standard header file definition*/
#include    "kernel_id.h"            /*Header file generated by cfg600px*/
#pragma task Task1                   /*Refer to note*/
void Task1 (VP_INT exinf);           /*Refer to note*/
void Task1 (VP_INT exinf)
{
    ER      ercd;                    /*Declares variable*/
    ID      dtqid = 1;               /*Declares and initializes variable*/
    VP_INT  p_data;                  /*Declares variable*/

    /* ......... */

                                     /*Receive from data queue*/
    ercd = prcv_dtq (dtqid, &p_data);

    if (ercd == E_OK) {
        /* ......... */              /*Polling success processing*/
    } else if (ercd == E_TMOUT) {
        /* ......... */              /*Polling failure processing*/
    }

    /* ......... */
}
```

Note These statements are unnecessary for the task which is created by the system configuration file because the cfg600px generates these statement into the "kernel_id.h".

- trcv_dtq (Wait with time-out)
  This service call processes as follows according to the situation of the data queue specified by the parameter *dtqid*.

  - There is a data in the data queue.
    This service call takes out the oldest data from the data queue and stores the data to the area specified by *p_data*.
    When there is a task in the transmission wait queue, this service call stores the data sent by the task in the top of the transmission wait queue and moves it from the WAITING state (data transmission wait state) to the READY state.

  - There is no data in the data queue and there is a task in the transmission wait queue.
    This service call stores the data specified by the task in the top of the transmission wait queue to the area specified by *p_data*. As a result, the task is unlinked from the transmission wait queue and moves from the WAITING state (data transmission wait state) to the READY state, or from the WAITING-SUSPENDED state to the SUSPENDED state.
    Note, this situation is caused only when the capacity of the data queue is 0.

  - There is no data in the data queue and there is no task in the transmission wait queue.
    This service call queues the invoking task to the reception wait queue of the target data queue and moves it from the RUNNING state to the WAITING state with time (data reception wait state).
    The receiving WAITING state for a data queue is cancelled in the following cases.

Receiving WAITING State for a Data Queue Cancel Operation	Return Value
Data was sent to the data queue area as a result of issuing snd_dtq.	E_OK
Data was sent to the data queue area as a result of issuing psnd_dtq.	E_OK
Data was sent to the data queue area as a result of issuing ipsnd_dtq.	E_OK
Data was sent to the data queue area as a result of issuing tsnd_dtq.	E_OK
Data was sent to the data queue area as a result of issuing fsnd_dtq.	E_OK
Data was sent to the data queue area as a result of issuing ifsnd_dtq.	E_OK
Forced release from waiting (accept rel_wai while waiting).	E_RLWAI
Forced release from waiting (accept irel_wai while waiting).	E_RLWAI
The time specified by *tmout* has elapsed.	E_TMOUT
Forced release from waiting (accept del_dtq while waiting).	E_DLT

The following describes an example for coding this service call.

```
#include    "kernel.h"              /*Standard header file definition*/
#include    "kernel_id.h"           /*Header file generated by cfg600px*/
#pragma task Task1                  /*Refer to note 3*/
void Task1 (VP_INT exinf);          /*Refer to note 3*/
void Task1 (VP_INT exinf)
{
    ER      ercd;                   /*Declares variable*/
    ID      dtqid = 1;              /*Declares and initializes variable*/
    VP_INT  p_data;                 /*Declares variable*/
    TMO     tmout = 3600;           /*Declares and initializes variable*/

    /* ......... */

                                    /*Receive from data queue*/
    ercd = trcv_dtq (dtqid, &p_data, tmout);

    if (ercd == E_OK) {
            /* ......... */         /*Normal termination processing*/
    } else if (ercd == E_RLWAI) {
            /* ......... */         /*Forced termination processing*/
    } else if (ercd == E_TMOUT) {
            /* ......... */         /*Time-out processing*/
    }

    /* ......... */
}
```

Note 1 Invoking tasks are queued to the reception wait queue of the target data queue in the order of the data reception request.

Note 2 TMO_FEVR is specified for wait time *tmout*, processing equivalent to rcv_dtq will be executed. When TMO_POL is specified, processing equivalent to prcv_dtq will be executed.

Note 3 These statements are unnecessary for the task which is created by the system configuration file because the cfg600px generates these statement into the “kernel_id.h”.

7.4.6 Reference data queue state

A data queue status is referenced by issuing the following service call from the processing program.

- ref_dtq, iref_dtq
  These service calls store the detailed information of the data queue (existence of waiting tasks, number of data elements in the data queue, etc.) specified by parameter *dtqid* into the area specified by parameter *pk_rdtq*.
  The following describes an example for coding these service calls.

```
#include    "kernel.h"              /*Standard header file definition*/
#include    "kernel_id.h"           /*Header file generated by cfg600px*/
#pragma task Task1                  /*Refer to note 2*/
void Task1 (VP_INT exinf);          /*Refer to note 2*/
void Task1 (VP_INT exinf)
{
    ID      dtqid = 1;              /*Declares and initializes variable*/
    T_RDTQ  pk_rdtq;                /*Declares data structure*/
    ID      stskid;                 /*Declares variable*/
    ID      rtskid;                 /*Declares variable*/
    UINT    sdtqcnt;                /*Declares variable*/

    /* ......... */

    ref_dtq (dtqid, &pk_rdtq);      /*Reference data queue state*/

    stskid = pk_rdtq.stskid;        /*Acquires existence of tasks waiting for */
                                    /*data transmission*/
    rtskid = pk_rdtq.rtskid;        /*Acquires existence of tasks waiting for */
                                    /*data reception*/
    sdtqcnt = pk_rdtq.sdtqcnt;      /*Reference the number of data elements in */
                                    /*data queue*/

    /* ......... */
}
```

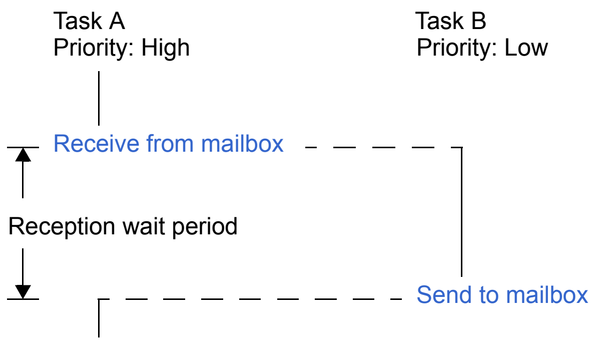
Note 1 For details about the data queue state packet, refer to "[Data queue state packet: T_RDTQ]".

Note 2 These statements are unnecessary for the task which is created by the system configuration file because the cfg600px generates these statement into the "kernel_id.h".

7.5 Mailboxes

Multitask processing requires the inter-task communication function (message transfer function) that reports the processing result of a task to another task. The RI600PX therefore provides the mailbox for transferring the start address of a message written in the shared memory area.
The following shows a processing flow when using a mailbox.

Figure 7-4 Processing Flow (Mailbox)



7.5.1 Messages

The information exchanged among processing programs via the mailbox is called “messages”.
Messages can be transmitted to any processing program via the mailbox, but it should be noted that, in the case of the synchronization and communication functions of the RI600PX, only the start address of the message is handed over to the receiving processing program, but the message contents are not copied to a separate area.

- Message area
  The message must be generated in the memory objects that both transmitting task and receiving task can access. However, the management table exists in the top of message area. The system operation cannot be guaranteed if the management table is destroyed. For this reason, data queue or message buffer is recommended for message communication.

- Basic form of messages
  In the RI600PX, the message contents and length are prescribed as follows, according to the attributes of the mailbox to be used.
  - When using a mailbox with the TA_MFIFO attribute
    The message must be started from the T_MSG structure. This area is used by the kernel. The use message should be arranged following the T_MSG structure.
    The length of the message is prescribed among the processing programs that exchange data using the mailbox.
    The following shows the basic form of coding TA_MFIFO attribute messages.

    [Message packet for TA_MFIFO attribute]

```
/* T_MSG structure, which is defined in the kernel.h*/
typedef struct {
    VP      msghead;       /*RI600PX management area*/
} T_MSG;

/* Message structure defined by user*/
typedef struct {
    T_MSG   t_msg;         /*T_MSG structure*/
    B       data[8];       /*User message*/
} USER_MSG;
```

  - When using a mailbox with the TA_MPRI attribute
    The message must be started from the T_MSG_PRI structure. The T_MSG_PRI.msgque is used by the kernel.
    The message priority should be set to T_MSG_PRI.msgpri.
    The length of the message is prescribed among the processing programs that exchange data using the mailbox.
    The following shows the basic form of coding TA_MPRI attribute messages.

    [Message packet for TA_MPRI attribute]

```
/* T_MSG structure, which is defined in the kernel.h*/
typedef struct {
    VP      msghead;       /*RI600PX management area*/
} T_MSG;

/* T_MSG_PRI structure, which is defined in the kernel.h*/
typedef struct {
    T_MSG   msgque;        /*Message header*/
    PRI     msgpri;        /*Message priority*/
} T_MSG_PRI;

/* Message structure defined by user*/
typedef struct {
    T_MSG_PRI t_msg;       /*T_MSG_PRI structure*/
    B         data[8];     /*User message*/
} USER_MSG;
```

Note 1 In the RI600PX, a message having a smaller priority number is given a higher priority.

Note 2 Values that can be specified as the message priority level are limited to the range defined by Maximum message priority (max_pri) in Mailbox Information (mailbox[])) when the system configuration file is created.

7.5.2 Create mailbox

Mailboxes are created by one of the following methods.

1) Creation by the system configuration file
The static API “mailbox[]” described in the system configuration file creates a mailbox.
Refer to “20.14 Mailbox Information (mailbox[])” for the details of “mailbox[]”.

2) Creation by cre_mbx or acre_mbx
The cre_mbx creates a mailbox with mailbox ID indicated by parameter *mbxid* according to the content of parameter *pk_cmbx*.
The acre_mbx creates a mailbox according to the content of parameter *pk_cmbx*, and returns the created mailbox ID.
The information specified is shown below.

- Mailbox attribute (*mbxatr*)
  The following informations are specified as *mbxatr*.
    - The order of task wait queue (FIFO order or task current priority order)
    - The order of message queue (FIFO order or message priority order)
- Maximum message priority (*maxmpri*)

These service calls can be called from tasks that belong to Trusted Domain.
The following describes an example for coding acre_mbx as a representative.

```
#include    "kernel.h"              /*Standard header file definition*/
#include    "kernel_id.h"           /*Header file generated by cfg600px*/
#pragma task Task1                  /*Refer to note*/
void Task1 (VP_INT exinf);          /*Refer to note*/
void Task1 (VP_INT exinf)
{
    ER      mbxid;              /*Declares variable*/
    T_CMBX  pk_cmbx = {         /*Declares and initializes variable*/
        TA_TFIFO|TA_MFIFO,          /*Mailbox attribute (mbxatr)*/
        1,                          /*Maximum message priority (maxmpri)*/
        0                           /*Reserved (mprihd)*/
    };

    /* ......... */

    mbxid = acre_mbx ( &pk_cmbx );  /*Create mailbox/

    /* ......... */
}
```

Note These statements are unnecessary for the task which is created by the system configuration file because the cfg600px generates these statement into the “kernel_id.h”.

7.5.3 Delete mailbox

- del_mbx
  This service call deletes the mailbox specified by parameter *mbxid*.
  When there are waiting tasks for the target mailbox by using rcv_mbx or trcv_mbx, this service call cancels the WAIT-ING state of the tasks and returns E_DLT as a return value of the rcv_mbx or trcv_mbx.
  This service call can be called from tasks that belong to Trusted Domain.
  The following describes an example for coding this service call.

```
#include    "kernel.h"                /*Standard header file definition*/
#include    "kernel_id.h"             /*Header file generated by cfg600px*/
#pragma task Task1                    /*Refer to note*/
void Task1 (VP_INT exinf);            /*Refer to note*/
void Task1 (VP_INT exinf)
{
    ID      mbxid = 8;            /*Declares and initializes variable*/

    /* ......... */

    ercd = del_mbx ( mbxid );    /*Delete semaphore*/

    /* ......... */
}
```

Note These statements are unnecessary for the task which is created by the system configuration file because the cfg600px generates these statement into the “kernel_id.h”.

7.5.4 Send to mailbox

A message is transmitted by issuing the following service call from the processing program.

- snd_mbx, isnd_mbx
  This service call transmits the message specified by parameter *pk_msg* to the mailbox specified by parameter *mbxid* (queues the message in the wait queue).
  If a task is queued to the target mailbox wait queue when this service call is issued, the message is not queued but handed over to the relevant task (first task of the wait queue).
  As a result, the relevant task is unlinked from the wait queue and is moved from the WAITING state (receiving WAITING state for a mailbox) to the READY state, or from the WAITING-SUSPENDED state to the SUSPENDED state.
  The following describes an example for coding these service calls.

```
#include    "kernel.h"              /*Standard header file definition*/
#include    "kernel_id.h"           /*Header file generated by cfg600px*/
#pragma task Task1                  /*Refer to note 3*/
void Task1 (VP_INT exinf);          /*Refer to note 3*/
void Task1 (VP_INT exinf)
{
    ID      mbxid = 1;              /*Declares and initializes variable*/
    T_MSG_PRI       *pk_msg;        /*Declares data structure*/

    /* ......... */

    /* ......... */                 /*Secures memory area (for message)*/
    pk_msg = ...                    /* and set the pointer to pk_msg*/
    /* ......... */                 /*Creates message (contents)*/

    pk_msg->msgpri = 8;             /*Initializes data structure*/

                                    /*Send to mailbox*/
    snd_mbx (mbxid, (T_MSG *) pk_msg);

    /* ......... */
}
```

Note 1 Messages are queued to the target mailbox in the order defined by queuing method during configuration (FIFO order or message priority order).

Note 2 For details about the message packet T_MSG and T_MSG_PRI, refer to “7.5.1 Messages”.

Note 3 These statements are unnecessary for the task which is created by the system configuration file because the cfg600px generates these statement into the “kernel_id.h”.

7.5.5 Receive from mailbox

A message is received (infinite wait, polling, or with time-out) by issuing the following service call from the processing program.

- rcv_mbx (Wait)
- prcv_mbx, iprcv_mbx (Polling)
- trcv_mbx (Wait with time-out)

- rcv_mbx (Wait)
  This service call receives a message from the mailbox specified by parameter *mbxid*, and stores its start address in the area specified by parameter *ppk_msg*.
  If no message could be received from the target mailbox (no messages were queued to the wait queue) when this service call is issued, this service call does not receive messages but queues the invoking task to the target mailbox wait queue and moves it from the RUNNING state to the WAITING state (message reception wait state).
  The receiving WAITING state for a mailbox is cancelled in the following cases.

Receiving WAITING State for a Mailbox Cancel Operation	Return Value
A message was transmitted to the target mailbox as a result of issuing snd_mbx.	E_OK
A message was transmitted to the target mailbox as a result of issuing isnd_mbx.	E_OK
Forced release from waiting (accept rel_wai while waiting).	E_RLWAI
Forced release from waiting (accept irel_wai while waiting).	E_RLWAI
Forced release from waiting (accept del_mbx while waiting).	E_DLT

The following describes an example for coding this service call.

```
#include    "kernel.h"              /*Standard header file definition*/
#include    "kernel_id.h"           /*Header file generated by cfg600px*/
#pragma task Task1                  /*Refer to note 3*/
void Task1 (VP_INT exinf);          /*Refer to note 3*/
void Task1 (VP_INT exinf)
{
    ER      ercd;                   /*Declares variable*/
    ID      mbxid = 1;              /*Declares and initializes variable*/
    T_MSG   *ppk_msg;               /*Declares data structure*/

    /* ......... */

                                    /*Receive from mailbox*/
    ercd = rcv_mbx (mbxid, &ppk_msg);

    if (ercd == E_OK) {
        /* ......... */             /*Normal termination processing*/
    } else if (ercd == E_RLWAI) {
        /* ......... */             /*Forced termination processing*/
    }

    /* ......... */
}
```

Note 1 Invoking tasks are queued to the target mailbox wait queue in the order defined at creating the mailbox (FIFO order or current priority order).

Note 2 For details about the message packet T_MSG and T_MSG_PRI, refer to "7.5.1 Messages".

Note 3 These statements are unnecessary for the task which is created by the system configuration file because the cfg600px generates these statement into the "kernel_id.h".

- prcv_mbx, iprcv_mbx (Polling)
  This service call receives a message from the mailbox specified by parameter *mbxid*, and stores its start address in the area specified by parameter *ppk_msg*.
  If the message could not be received from the target mailbox (no messages were queued in the wait queue) when this service call is issued, message reception processing is not executed but “E_TMOUT” is returned.
  The following describes an example for coding these service calls.

```
#include    "kernel.h"              /*Standard header file definition*/
#include    "kernel_id.h"           /*Header file generated by cfg600px*/
#pragma task Task1                  /*Refer to note 2*/
void Task1 (VP_INT exinf);          /*Refer to note 2*/
void Task1 (VP_INT exinf)
{
    ER      ercd;                   /*Declares variable*/
    ID      mbxid = 1;              /*Declares and initializes variable*/
    T_MSG   *ppk_msg;               /*Declares data structure*/

    /* ......... */

                                    /*Receive from mailbox*/
    ercd = prcv_mbx (mbxid, &ppk_msg);

    if (ercd == E_OK) {
        /* ......... */             /*Polling success processing*/
    } else if (ercd == E_TMOUT) {
        /* ......... */             /*Polling failure processing*/
    }

    /* ......... */
}
```

Note 1 For details about the message packet T_MSG and T_MSG_PRI, refer to “7.5.1 Messages”.

Note 2 These statements are unnecessary for the task which is created by the system configuration file because the cfg600px generates these statement into the “kernel_id.h”.

- trcv_mbx (Wait with time-out)
  This service call receives a message from the mailbox specified by parameter *mbxid*, and stores its start address in the area specified by parameter *ppk_msg*.
  If no message could be received from the target mailbox (no messages were queued to the wait queue) when this service call is issued, this service call does not receive messages but queues the invoking task to the target mailbox wait queue and moves it from the RUNNING state to the WAITING state with time-out (message reception wait state).
  The receiving WAITING state for a mailbox is cancelled in the following cases.

Receiving WAITING State for a Mailbox Cancel Operation	Return Value
A message was transmitted to the target mailbox as a result of issuing snd_mbx.	E_OK
A message was transmitted to the target mailbox as a result of issuing isnd_mbx.	E_OK
Forced release from waiting (accept rel_wai while waiting).	E_RLWAI
Forced release from waiting (accept irel_wai while waiting).	E_RLWAI
The time specified by *tmout* has elapsed.	E_TMOUT
Forced release from waiting (accept del_mbx while waiting).	E_DLT

The following describes an example for coding this service call.

```
#include    "kernel.h"                /*Standard header file definition*/
#include    "kernel_id.h"             /*Header file generated by cfg600px*/
#pragma task Task1                    /*Refer to note 4*/
void Task1 (VP_INT exinf);            /*Refer to note 4*/
void Task1 (VP_INT exinf)
{
    ER      ercd;                     /*Declares variable*/
    ID      mbxid = 1;                /*Declares and initializes variable*/
    T_MSG   *ppk_msg;                 /*Declares data structure*/
    TMO     tmout = 3600;             /*Declares and initializes variable*/

    /* ......... */

                                      /*Receive from mailbox*/
    ercd = trcv_mbx (mbxid, &ppk_msg, tmout);

    if (ercd == E_OK) {
        /* ......... */               /*Normal termination processing*/
    } else if (ercd == E_RLWAI) {
        /* ......... */               /*Forced termination processing*/
    } else if (ercd == E_TMOUT) {
        /* ......... */               /*Time-out processing*/
    }

    /* ......... */
}
```

Note 1 Invoking tasks are queued to the target mailbox wait queue in the order defined at creating the mailbox (FIFO order or current priority order).

Note 2 TMO_FEVR is specified for wait time *tmout*, processing equivalent to rcv_mbx will be executed. When TMO_POL is specified, processing equivalent to prcv_mbx will be executed.

Note 3 For details about the message packet T_MSG and T_MSG_PRI, refer to "7.5.1 Messages".

Note 4 These statements are unnecessary for the task which is created by the system configuration file because the cfg600px generates these statement into the "kernel_id.h".

7.5.6 Reference mailbox state

A mailbox status is referenced by issuing the following service call from the processing program.

- ref_mbx, iref_mbx
  Stores mailbox state packet (ID number of the task at the head of the wait queue, start address of the message packet at the head of the wait queue) of the mailbox specified by parameter *mbxid* in the area specified by parameter *pk_rmbx*.
  The following describes an example for coding these service calls.

```
#include    "kernel.h"                  /*Standard header file definition*/
#include    "kernel_id.h"               /*Header file generated by cfg600px*/
#pragma task Task1                      /*Refer to note 2*/
void Task1 (VP_INT exinf);              /*Refer to note 2*/
void Task1 (VP_INT exinf)
{
    ID      mbxid = 1;                  /*Declares and initializes variable*/
    T_RMBX  pk_rmbx;                    /*Declares data structure*/
    ID      wtskid;                     /*Declares variable*/
    T_MSG   *pk_msg;                    /*Declares data structure*/

    /* ......... */

    ref_mbx (mbxid, &pk_rmbx);          /*Reference mailbox state*/

    wtskid = pk_rmbx.wtskid;            /*Reference ID number of the task at the */
                                        /*head of the wait queue*/
    pk_msg = pk_rmbx.pk_msg;            /*Reference start address of the message */
                                        /*packet at the head of the wait queue*/

    /* ......... */
}
```

Note 1 For details about the mailbox state packet, refer to "[Mailbox state packet: T_RMBX]".

Note 2 These statements are unnecessary for the task which is created by the system configuration file because the cfg600px generates these statement into the "kernel_id.h".

CHAPTER 8 EXTENDED SYNCHRONIZATION AND COMMUNICATION FUNCTIONS

This chapter describes the extended synchronization and communication functions performed by the RI600PX.

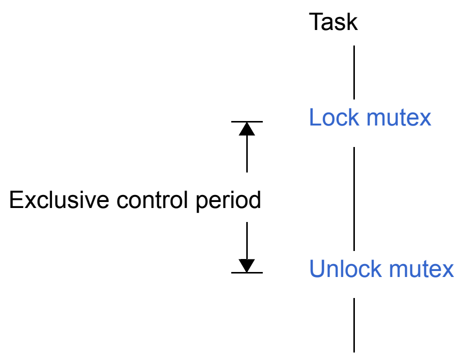
8.1 Outline

The extended synchronization and communication function of the RI600PX provides Mutexes for implementing exclusive control between tasks, and Message Buffers for transferring messages of he arbitrary size by copying the message.

8.2 Mutexes

Multitask processing requires the function to prevent contentions on using the limited number of resources (A/D converter, coprocessor, files, or the like) simultaneously by tasks operating in parallel (exclusive control function). To resolve such problems, the RI600PX therefore provides "mutexes".
The following shows a processing flow when using a mutex.
The mutexes provided in the RI600PX supports the priority ceiling protocol.

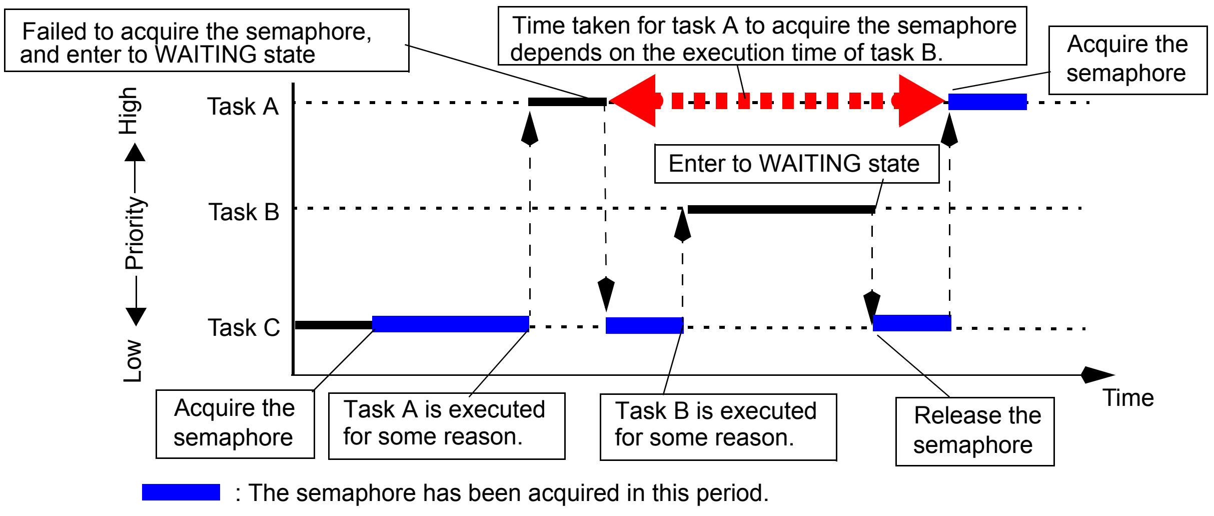
Figure 8-1 Processing Flow (Mutex)



8.2.1 Priority inversion problem

When a semaphore is used for exclusive control of a resource, a problem called priority inversion may arise. This refers to the situation where a task that is not using a resource delays the execution of a task requesting the resource.
Figure 8-2 illustrates this problem. In this figure, tasks A and C are using the same resource, which task B does not use. Task A attempts to acquire a semaphore so that it can use the resource but enters the WAITING state because task C is already using the resource. Task B has a priority higher than task C and lower than task A. Thus, if task B is executed before task C has released the semaphore, release of the semaphore is delayed by the execution of task B. This also delays acquisition of the semaphore by task A. From the viewpoint of task A, a lower-priority task that is not even competing for the resource gets priority over task A.
To avoid this problem, use a mutex instead of a semaphore.

Figure 8-2 Priority Inversion Problem


Failed to acquire the semaphore, and enter to WAITING state
Time taken for task A to acquire the semaphore depends on the execution time of task B.
Acquire the semaphore
High
Priority
Low
Task A
Task B
Task C
Enter to WAITING state
Time
Acquire the semaphore
Task A is executed for some reason.
Task B is executed for some reason.
Release the semaphore
: The semaphore has been acquired in this period.

8.2.2 Current priority and base priority

A task has two priority levels: base priority and current priority. Tasks are scheduled according to current priority.
While a task does not have a mutex locked, its current priority is always the same as its base priority.
When a task locks a mutex, only its current priority is raised to the ceiling priority of the mutex.
When priority-changing service call chg_pri or ichg_pri is issued, both the base priority and current priority are changed if the specified task does not have a mutex locked. When the specified task locks a mutex, only the base priority is changed.
When the specified task has a mutex locked or is waiting to lock a mutex, these service calls returns “E_ILUSE” if a priority higher than the ceiling priority of the mutex is specified.
The current priority can be checked through service call get_pri or iget_pri. And both the current priority and base priority can be referred by ref_tsk or iref_tsk.

8.2.3 Simplified priority ceiling protocol

Original behavior of the priority ceiling protocol is to make the current priority of the task to the highest ceiling priority of mutexes which are locked by the task. This behavior is achieved by controlling the current priority of the task as follows.

- When a task locks a mutex, changes the current priority of the task to the highest ceiling priority of mutexes which are locked by the task.
- When a task unlocks a mutex, changes the current priority of the task to the highest ceiling priority of mutexes which continues to be locked by the task. When there is no mutex locked by the task after unlock, returns the current priority of the task to the base priority.

However, the RI600PX adopts simplified priority ceiling protocol because of reducing overhead. Therefore, the underlined part is not processed.

8.2.4 Differences from semaphores

The mutex operates similarly to semaphores (binary semaphore) whose the maximum resource count is 1, but they differ in the following points.

- The current priority of the task which locks a mutex raises to the ceiling priority of the mutex until the task unlocks the mutex. As a result, the priority inversion problem is evaded.
  --> The current priority is not changed by using semaphore.

- A locked mutex can be unlocked (equivalent to returning of resources) only by the task that locked the mutex
  --> Semaphores can return resources via any task and handler.

- Unlocking is automatically performed when a task that locked the mutex is terminated (ext_tsk or ter_tsk)
  --> Semaphores do not return resources automatically, so they end with resources acquired.

- Semaphores can manage multiple resources (the maximum resource count can be assigned), but the maximum number of resources assigned to a mutex is fixed to 1.

8.2.5 Create mutex

Mutexes are created by one of the following methods.

1) Creation by the system configuration file
The static API “mutex[]” described in the system configuration file creates a mutex.
Refer to “20.15 Mutex Information (mutex[])” for the details of “mutex[]”.

2) Creation by cre_mtx or acre_mtx
The cre_mtx creates a mutex with mutex ID indicated by parameter *mtxid* according to the content of parameter *pk_cmtx*.
The acre_mtx creates a mutex according to the content of parameter *pk_cmtx*, and returns the created mutex ID.
The information specified is shown below.

- Mutex attribute (*mtxatr*)
  Only TA_CEILING (Priority ceiling protocol) can be specified for *mtxatr.*
  Note, task wait queue is managed in task current priority order.

- Ceiling priority (*ceilpri*)

These service calls can be called from tasks that belong to Trusted Domain.
The following describes an example for coding acre_mtx as a representative.

```
#include    "kernel.h"              /*Standard header file definition*/
#include    "kernel_id.h"           /*Header file generated by cfg600px*/
#pragma task Task1                  /*Refer to note*/
void Task1 (VP_INT exinf);          /*Refer to note*/
void Task1 (VP_INT exinf)
{
    ER      mtxid;              /*Declares variable*/
    T_CMTX  pk_cmtx = {         /*Declares and initializes variable*/
        TA_CEILING,                 /*Mutex attribute (mtxatr)*/
        1                           /*Ceiling priority (ceilpri)*/
    };

    /* ......... */

    mtxid = acre_mtx ( &pk_cmtx );  /*Create mutex/

    /* ......... */
}
```

Note These statements are unnecessary for the task which is created by the system configuration file because the cfg600px generates these statement into the “kernel_id.h”.

8.2.6 Delete mutex

- del_mtx
  This service call deletes the mutex specified by parameter *mtxid*.
  When either of task locks the target mutex, the lock by the task is cancelled. As a result, the current task priority of the task is returned to the base priority when there is no mutex being locked by the task. The task is not notified that the mutex has been deleted. If an attempt is later made to unlock the mutex by using unl_mtx, an error E_NOEXS is returned.
  When there are waiting tasks for the target mutex by using loc_mtx or tloc_mtx, this service call cancels the WAITING state of the tasks and returns E_DLT as a return value of the loc_mtx or tloc_mtx.
  This service call can be called from tasks that belong to Trusted Domain.
  The following describes an example for coding this service call.

```
#include    "kernel.h"              /*Standard header file definition*/
#include    "kernel_id.h"           /*Header file generated by cfg600px*/
#pragma task Task1                  /*Refer to note*/
void Task1 (VP_INT exinf);          /*Refer to note*/
void Task1 (VP_INT exinf)
{
    ID      mtxid = 8;          /*Declares and initializes variable*/

    /* ......... */

    ercd = del_mtx ( mtxid );   /*Delete semaphore*/

    /* ......... */
}
```

Note These statements are unnecessary for the task which is created by the system configuration file because the cfg600px generates these statement into the “kernel_id.h”.

8.2.7 Lock mutex

Mutexes can be locked by issuing the following service call from the processing program.

- loc_mtx (Wait)
- ploc_mtx (Polling)
- tloc_mtx (Wait with time-out)

- loc_mtx (Wait)
  This service call locks the mutex specified by parameter *mtxid*.
  If the target mutex could not be locked (another task has been locked) when this service call is issued, this service call queues the invoking task to the target mutex wait queue and moves it from the RUNNING state to the WAITING state (mutex wait state).
  The WAITING state for a mutex is cancelled in the following cases.

WAITING State for a Mutex Cancel Operation	Return Value
The locked state of the target mutex was cancelled as a result of issuing unl_mtx.	E_OK
The locked state of the target mutex was cancelled as a result of issuing ext_tsk.	E_OK
The locked state of the target mutex was cancelled as a result of issuing exd_tsk.	E_OK
The locked state of the target mutex was cancelled as a result of issuing ter_tsk.	E_OK
Forced release from waiting (accept rel_wai while waiting).	E_RLWAI
Forced release from waiting (accept irel_wai while waiting).	E_RLWAI
Forced release from waiting (accept del_mtx while waiting).	E_DLT

When the mutex is locked, this service call changes the current priority of the invoking task to the ceiling priority of the target mutex. However, this service call does not change the current priority when the invoking task has locked other mutexes and the ceiling priority of the target mutex is lower than or equal to the ceiling priority of the locked mutexes.
The following describes an example for coding this service call.

```
#include    "kernel.h"              /*Standard header file definition*/
#include    "kernel_id.h"           /*Header file generated by cfg600px*/
#pragma task Task1                  /*Refer to note 3*/
void Task1 (VP_INT exinf);          /*Refer to note 3*/
void Task1 (VP_INT exinf)
{
    ER      ercd;                   /*Declares variable*/
    ID      mtxid = 8;              /*Declares and initializes variable*/

    /* ......... */

    ercd = loc_mtx (mtxid);         /*Lock mutex*/

    if (ercd == E_OK) {
        /* ......... */             /*Locked state*/

        unl_mtx (mtxid);            /*Unlock mutex*/
    } else if (ercd == E_RLWAI) {
        /* ......... */             /*Forced termination processing*/
    }

    /* ......... */
}
```

Note 1 Invoking tasks are queued to the target mutex wait queue in the priority order. Among tasks with the same priority, they are queued in FIFO order.

Note 2 This service call returns “E_ILUSE” if this service call is re-issued for the mutex that has been locked by the invoking task (multiple-locking of mutex).

Note 3 These statements are unnecessary for the task which is created by the system configuration file because the cfg600px generates these statement into the “kernel_id.h”.

- ploc_mtx (Polling)
  This service call locks the mutex specified by parameter *mtxid*.
  If the target mutex could not be locked (another task has been locked) when this service call is issued but "E_TMOUT" is returned.
  When the mutex is locked, this service call changes the current priority of the invoking task to the ceiling priority of the target mutex. However, the this service call does not change the current priority when the invoking task has locked other mutexes and the ceiling priority of the target mutex is lower than or equal to the ceiling priority of the locked mutexes.
  The following describes an example for coding this service call.

```
#include    "kernel.h"                  /*Standard header file definition*/
#include    "kernel_id.h"               /*Header file generated by cfg600px*/
#pragma task Task1                      /*Refer to note 2*/
void Task1 (VP_INT exinf);              /*Refer to note 2*/
void Task1 (VP_INT exinf)
{
    ER      ercd;                       /*Declares variable*/
    ID      mtxid = 8;                  /*Declares and initializes variable*/

    /* ......... */

    ercd = ploc_mtx (mtxid);            /*Lock mutex*/

    if (ercd == E_OK) {
        /* ......... */                 /*Polling success processing*/

        unl_mtx (mtxid);                /*Unlock mutex*/
    } else if (ercd == E_TMOUT) {
        /* ......... */                 /*Polling failure processing*/
    }

    /* ......... */
}
```

Note 1 This service call returns "E_ILUSE" if this service call is re-issued for the mutex that has been locked by the invoking task (multiple-locking of mutex).

Note 2 These statements are unnecessary for the task which is created by the system configuration file because the cfg600px generates these statement into the "kernel_id.h".

- tloc_mtx (Wait with time-out)
  This service call locks the mutex specified by parameter *mtxid*.
  If the target mutex could not be locked (another task has been locked) when this service call is issued, this service call queues the invoking task to the target mutex wait queue and moves it from the RUNNING state to the WAITING state with time-out (mutex wait state).
  The WAITING state for a mutex is cancelled in the following cases.

WAITING State for a Mutex Cancel Operation	Return Value
The locked state of the target mutex was cancelled as a result of issuing unl_mtx.	E_OK
The locked state of the target mutex was cancelled as a result of issuing ext_tsk.	E_OK
The locked state of the target mutex was cancelled as a result of issuing exd_tsk.	E_OK
The locked state of the target mutex was cancelled as a result of issuing ter_tsk.	E_OK
Forced release from waiting (accept rel_wai while waiting).	E_RLWAI
Forced release from waiting (accept irel_wai while waiting).	E_RLWAI
The time specified by *tmout* has elapsed.	E_TMOUT
Forced release from waiting (accept del_mtx while waiting).	E_DLT

When the mutex is locked, this service call changes the current priority of the invoking task to the ceiling priority of the target mutex. However, the this service call does not change the current priority when the invoking task has locked other mutexes and the ceiling priority of the target mutex is lower than or equal to the ceiling priority of the locked mutexes.
The following describes an example for coding this service call.

```
#include    "kernel.h"              /*Standard header file definition*/
#include    "kernel_id.h"           /*Header file generated by cfg600px*/
#pragma task Task1                  /*Refer to note 4*/
void Task1 (VP_INT exinf);          /*Refer to note 4*/
void Task1 (VP_INT exinf)
{
    ER      ercd;                   /*Declares variable*/
    ID      mtxid = 8;              /*Declares and initializes variable*/
    TMO     tmout = 3600;           /*Declares and initializes variable*/

    /* ......... */
    ercd = tloc_mtx (mtxid, tmout); /*Lock mutex*/
    if (ercd == E_OK) {
        /* ......... */             /*Locked state*/
        unl_mtx (mtxid);            /*Unlock mutex*/
    } else if (ercd == E_RLWAI) {
        /* ......... */             /*Forced termination processing*/
    } else if (ercd == E_TMOUT) {
        /* ......... */             /*Time-out processing*/
    }
    /* ......... */
}
```

Note 1 Invoking tasks are queued to the target mutex wait queue in the priority order. Among tasks with the same priority, they are queued in FIFO order.

Note 2 This service call returns “E_ILUSE” if this service call is re-issued for the mutex that has been locked by the invoking task (multiple-locking of mutex).

Note 3 TMO_FEVR is specified for wait time *tmout*, processing equivalent to loc_mtx will be executed. When TMO_POL is specified, processing equivalent to ploc_mtx will be executed.

Note 4 These statements are unnecessary for the task which is created by the system configuration file because the cfg600px generates these statement into the “kernel_id.h”.

8.2.8 Unlock mutex

The mutex locked state can be cancelled by issuing the following service call from the processing program.

- unl_mtx
  This service call unlocks the locked mutex specified by parameter *mtxid*.
  If a task has been queued to the target mutex wait queue when this service call is issued, mutex lock processing is performed by the task (the first task in the wait queue) immediately after mutex unlock processing.
  As a result, the task is unlinked from the wait queue and moves from the WAITING state (mutex wait state) to the READY state, or from the WAITING-SUSPENDED state to the SUSPENDED state. And this service call changes the current priority of the task to the ceiling priority of the target mutex. However, this service call does not change the current priority when the task has locked other mutexes and the ceiling priority of the target mutex is lower than or equal to the ceiling priority of the locked mutexes.
  The following describes an example for coding this service call.

```
#include    "kernel.h"                  /*Standard header file definition*/
#include    "kernel_id.h"               /*Header file generated by cfg600px*/
#pragma task Task1                      /*Refer to note 3*/
void Task1 (VP_INT exinf);              /*Refer to note 3*/
void Task1 (VP_INT exinf)
{
    ER      ercd;                       /*Declares variable*/
    ID      mtxid = 8;                  /*Declares and initializes variable*/

    /* ......... */

    ercd = loc_mtx (mtxid);             /*Lock mutex*/

    if (ercd == E_OK) {
        /* ......... */                 /*Locked state*/

        unl_mtx (mtxid);                /*Unlock mutex*/
    } else if (ercd == E_RLWAI) {
        /* ......... */                 /*Forced termination processing*/
    }

    /* ......... */
}
```

Note 1 A locked mutex can be unlocked only by the task that locked the mutex.
If this service call is issued for a mutex that was not locked by the invoking task, no processing is performed but “E_ILUSE” is returned.

Note 2 When terminating a task, the mutexes which are locked by the terminated task are unlocked.

Note 3 These statements are unnecessary for the task which is created by the system configuration file because the cfg600px generates these statement into the “kernel_id.h”.

8.2.9 Reference mutex state

A mutex status is referenced by issuing the following service call from the processing program.

- ref_mtx,
  This service call stores the detailed information of the mutex specified by parameter *mtxid* (existence of locked mutexes, waiting tasks, etc.) into the area specified by parameter *pk_rmtx*.
  The following describes an example for coding this service call.

```
#include    "kernel.h"              /*Standard header file definition*/
#include    "kernel_id.h"           /*Header file generated by cfg600px*/
#pragma task Task1                  /*Refer to note 2*/
void Task1 (VP_INT exinf);          /*Refer to note 2*/
void Task1 (VP_INT exinf)
{
    ID      mtxid = 1;              /*Declares and initializes variable*/
    T_RMTX  pk_rmtx;                /*Declares data structure*/
    ID      htskid;                 /*Declares variable*/
    ID      wtskid;                 /*Declares variable*/

    /* ......... */

    ref_mtx (mbxid, &pk_rmtx);      /*Reference mutex state*/

    htskid = pk_rmtx.htskid;        /*Acquires existence of locked mutexes*/
    wtskid = pk_rmtx.wtskid;        /*Reference ID number of the task at the */
                                    /*head of the wait queue*/

    /* ......... */
}
```

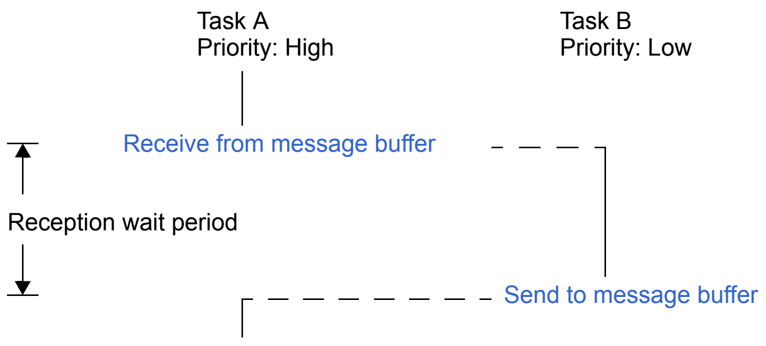
Note 1 For details about the mutex state packet, refer to “[Mutex state packet: T_RMTX]”.

Note 2 These statements are unnecessary for the task which is created by the system configuration file because the cfg600px generates these statement into the “kernel_id.h”.

8.3 Message Buffers

Multitask processing requires the inter-task communication function (message transfer function) that reports the processing result of a task to another task. The RI600PX therefore provides the message buffers for copying and transferring the arbitrary size of message.
The following shows a processing flow when using a message buffer.

Figure 8-3 Processing Flow (Message buffer)



8.3.1 Create message buffer

Message buffers are created by one of the following methods.

1) Creation by the system configuration file
The static API “message_buffer[]” described in the system configuration file creates a message buffer.
Refer to “20.16 Message Buffer Information (message_buffer[])” for the details of “message_buffer[]”.

2) Creation by cre_mbf or acre_mbf
The cre_mbf creates a message buffer with message buffer ID indicated by parameter *mbfid* according to the content of parameter *pk_cmbf*.
The acre_mbf creates a message buffer according to the content of parameter *pk_cmbf*, and returns the created message buffer ID.
The information specified is shown below.

- Message buffer attribute (*mbfatr*)
  Only TA_TFIFO (the order of task wait queue for sending is managed by FIFO order.) can be specified for *mbfatr*.

- Maximum message size (*maxmsz*)

- Size of the message buffer area (*mbfsz*), Start address of the message buffer area (*mbf*)
  The message buffer area should be generated to the area other than memory objects and user stacks.

These service calls can be called from tasks that belong to Trusted Domain.
The following describes an example for coding acre_mbf as a representative.

```
#include    "kernel.h"              /*Standard header file definition*/
#include    "kernel_id.h"           /*Header file generated by cfg600px*/

#define MAX_MSGSZ 64                /*Maximum message size (in bytes)*/
#define MBFSZ     256               /*Size of the message buffer area (in bytes)*/

#pragma section B BRI_RAM           /*Section for the message buffer area*/
static UW mbf_area[MBFSZ/sizeof(UW)]; /*Message buffer area*/
#pragma section

#pragma task Task1                  /*Refer to note*/
void Task1 (VP_INT exinf);          /*Refer to note*/
void Task1 (VP_INT exinf)
{
    ER      mbfid;         /*Declares variable*/
    T_CMBF  pk_cmbf = {    /*Declares and initializes variable*/
        TA_TFIFO,             /*Message buffer attribute (mbfatr)*/
        MAX_MSGSZ,            /*Maximum message size (in bytes)(maxmsz)*/
        MBFSZ,                /*Size of the message buffer area (in bytes) (mbfsz)*/
        (VP)mbf_area          /*Start address of the message buffer area (mbf)*/
    };

    /* ......... */

    mbfid = acre_mbf ( &pk_cmbf );  /*Create message buffer/

    /* ......... */
}
```

Note These statements are unnecessary for the task which is created by the system configuration file because the cfg600px generates these statement into the “kernel_id.h”.

8.3.2 Delete message buffer

- del_mbf
  This service call deletes the message buffer specified by parameter *mbfid*.
  When there are waiting tasks for the target message buffer by using snd_mbf, tsnd_mbf, rcv_mbf or trcv_mbf, this service call cancels the WAITING state of the tasks and returns E_DLT as a return value of the snd_mbf, tsnd_mbf, rcv_mbf or trcv_mbf.
  This service call can be called from tasks that belong to Trusted Domain.
  The following describes an example for coding this service call.

```
#include    "kernel.h"              /*Standard header file definition*/
#include    "kernel_id.h"           /*Header file generated by cfg600px*/
#pragma task Task1                  /*Refer to note*/
void Task1 (VP_INT exinf);          /*Refer to note*/
void Task1 (VP_INT exinf)
{
    ID      mbfid = 8;          /*Declares and initializes variable*/

    /* ......... */

    ercd = del_mbf ( mbfid );   /*Delete data queue*/

    /* ......... */
}
```

Note These statements are unnecessary for the task which is created by the system configuration file because the cfg600px generates these statement into the “kernel_id.h”.

8.3.3 Send to message buffer

A message is transmitted by issuing the following service call from the processing program.

- snd_mbf (Wait)
- psnd_mbf, ipsnd_mbf (Polling)
- tsnd_mbf (Wait with time-out)

- snd_mbf (Wait)
  This service call processes as follows according to the situation of the message buffer specified by the parameter *mbfid*.

  - There is a task in the reception wait queue.
    This service call transfers the message specified by parameter *msg* to the task in the top of the reception wait queue. As a result, the task is unlinked from the reception wait queue and moves from the WAITING state (message reception wait state) to the READY state, or from the WAITING-SUSPENDED state to the SUSPENDED state.

  - There is no task neither in the reception wait queue and transmission wait queue and there is available space in the message buffer.
    This service call stores the message specified by parameter *msg* to the message buffer. As a result, the size of available space in the target message buffer decreases by the amount calculated by the following expression.

    The amount of decrease = up4(*msgsz*) + VTSZ_MBFTBL

  - There is no task neither in the reception wait queue and transmission wait queue and there is no available space in the message buffer, or there is a task in the transmission wait queue.
    This service call queues the invoking task to the transmission wait queue of the target message buffer and moves it from the RUNNING state to the WAITING state (message transmission wait state).
    The sending WAITING state for a message buffer is cancelled in the following cases.

Sending WAITING State for a Message Buffer Cancel Operation	Return Value
Available space was secured in the message buffer area as a result of issuing rcv_mbf.	E_OK
Available space was secured in the message buffer area as a result of issuing prcv_mbf.	E_OK
Available space was secured in the message buffer area as a result of issuing trcv_mbf.	E_OK
The task at the top of the transmission wait queue was forcedly released from waiting by following either. - Forced release from waiting (accept rel_wai while waiting). - Forced release from waiting (accept irel_wai while waiting). - Forced release from waiting (accept ter_tsk while waiting). - The time specified by *tmout* for tsnd_mbf has elapsed.	E_OK
Forced release from waiting (accept rel_wai while waiting).	E_RLWAI
Forced release from waiting (accept irel_wai while waiting).	E_RLWAI
The message buffer is reset as a result of issuing vrst_mbf.	EV_RST
Forced release from waiting (accept del_mbf while waiting).	E_DLT

The following describes an example for coding this service call.

```
#include    "kernel.h"              /*Standard header file definition*/
#include    "kernel_id.h"           /*Header file generated by cfg600px*/
#pragma task Task1                  /*Refer to note 3*/
void Task1 (VP_INT exinf);          /*Refer to note 3*/
void Task1 (VP_INT exinf)
{
    ER      ercd;                   /*Declares variable*/
    ID      mbfid = 1;              /*Declares and initializes variable*/
    B       msg[] = {1,2,3};        /*Declares and initializes variable*/
    UINT    msgsz = sizeof( msg );  /*Declares and initializes variable*/

    /* ......... */

    ercd = snd_mbf (mbfid, (VP)msg, msgsz);   /*Send to message buffer*/

    if (ercd == E_OK) {
        /* ......... */             /*Normal termination processing*/
    } else if (ercd == E_RLWAI) {
        /* ......... */             /*Forced termination processing*/
    }

    /* ......... */
}
```

Note 1 Message is written to the message buffer area in the order of the message transmission request.

Note 2 Invoking tasks are queued to the transmission wait queue of the target message buffer in the FIFO order.

Note 3 These statements are unnecessary for the task which is created by the system configuration file because the cfg600px generates these statement into the “kernel_id.h”.

- psnd_mbf, ipsnd_mbf (Polling)
  This service call processes as follows according to the situation of the message buffer specified by the parameter *mbfid*.
  - There is a task in the reception wait queue.
    This service call transfers the message specified by parameter *msg* to the task in the top of the reception wait queue. As a result, the task is unlinked from the reception wait queue and moves from the WAITING state (message reception wait state) to the READY state, or from the WAITING-SUSPENDED state to the SUSPENDED state.
  - There is no task neither in the reception wait queue and transmission wait queue and there is available space in the message buffer.
    This service call stores the message specified by parameter *msg* to the message buffer. As a result, the size of available space in the target message buffer decreases by the amount calculated by the following expression.

    The amount of decrease = up4(*msgsz*) + VTSZ_MBFTBL
  - There is no task neither in the reception wait queue and transmission wait queue and there is no available space in the message buffer, or there is a task in the transmission wait queue.
    This service call returns “E_TMOUT”.

The following describes an example for coding these service calls.

```
#include    "kernel.h"              /*Standard header file definition*/
#include    "kernel_id.h"           /*Header file generated by cfg600px*/
#pragma task Task1                  /*Refer to note 2*/
void Task1 (VP_INT exinf);          /*Refer to note 2*/
void Task1 (VP_INT exinf)
{
    ER      ercd;                   /*Declares variable*/
    ID      mbfid = 1;              /*Declares and initializes variable*/
    B       msg[] = {1,2,3};        /*Declares and initializes variable*/
    UINT    msgsz = sizeof( msg );  /*Declares and initializes variable*/

    /* ......... */

    ercd = psnd_mbf (mbfid, (VP)msg, msgsz); /*Send to message buffer*/

    if (ercd == E_OK) {
        /* ......... */             /*Polling success processing*/
    } else if (ercd == E_TMOUT) {
        /* ......... */             /*Polling failure processing*/
    }

    /* ......... */
}
```

Note 1 Message is written to the message buffer area in the order of the message transmission request.

Note 2 These statements are unnecessary for the task which is created by the system configuration file because the cfg600px generates these statement into the “kernel_id.h”.

- tsnd_mbf (Wait with time-out)
  This service call processes as follows according to the situation of the message buffer specified by the parameter *mbfid*.
  - There is a task in the reception wait queue.
    This service call transfers the message specified by parameter *msg* to the task in the top of the reception wait queue. As a result, the task is unlinked from the reception wait queue and moves from the WAITING state (message reception wait state) to the READY state, or from the WAITING-SUSPENDED state to the SUSPENDED state.
  - There is no task neither in the reception wait queue and transmission wait queue and there is available space in the message buffer.
    This service call stores the message specified by parameter *msg* to the message buffer. As a result, the size of available space in the target message buffer decreases by the amount calculated by the following expression.

    The amount of decrease = up4(*msgsz*) + VTSZ_MBFTBL
  - There is no task neither in the reception wait queue and transmission wait queue and there is no available space in the message buffer, or there is a task in the transmission wait queue.
    This service call queues the invoking task to the transmission wait queue of the target message buffer and moves it from the RUNNING state to the WAITING state with time (message transmission wait state).
    The sending WAITING state for a message buffer is cancelled in the following cases.

Sending WAITING State for a Message Buffer Cancel Operation	Return Value
Available space was secured in the message buffer area as a result of issuing rcv_mbf.	E_OK
Available space was secured in the message buffer area as a result of issuing prcv_mbf.	E_OK
Available space was secured in the message buffer area as a result of issuing trcv_mbf.	E_OK
The task at the top of the transmission wait queue was forcedly released from waiting by following either. - Forced release from waiting (accept rel_wai while waiting). - Forced release from waiting (accept irel_wai while waiting). - Forced release from waiting (accept ter_tsk while waiting). - The time specified by *tmout* for tsnd_mbf has elapsed.	E_OK
Forced release from waiting (accept rel_wai while waiting).	E_RLWAI
Forced release from waiting (accept irel_wai while waiting).	E_RLWAI
The message buffer is reset as a result of issuing vrst_mbf.	EV_RST
The time specified by *tmout* has elapsed.	E_TMOUT
Forced release from waiting (accept del_mbf while waiting).	E_DLT

The following describes an example for coding this service call.

```
#include    "kernel.h"              /*Standard header file definition*/
#include    "kernel_id.h"           /*Header file generated by cfg600px*/
#pragma task Task1                  /*Refer to note 4*/
void Task1 (VP_INT exinf);          /*Refer to note 4*/
void Task1 (VP_INT exinf)
{
    ER      ercd;                   /*Declares variable*/
    ID      mbfid = 1;              /*Declares and initializes variable*/
    B       msg[] = {1,2,3};        /*Declares and initializes variable*/
    TMO     tmout = 3600;           /*Declares and initializes variable*/

    /* ......... */

    ercd = tsnd_mbf (mbfid, (VP)msg, msgsz, tmout); /*Send to message buffer*/

    if (ercd == E_OK) {
        /* ......... */             /*Normal termination processing*/
    } else if (ercd == E_RLWAI) {
        /* ......... */             /*Forced termination processing*/
    } else if (ercd == E_TMOUT) {
        /* ......... */             /*Time-out processing*/
    }

    /* ......... */
}
```

Note 1 Message is written to the message buffer area in the order of the message transmission request.

Note 2 Invoking tasks are queued to the transmission wait queue of the target message buffer in the FIFO order.

Note 3 TMO_FEVR is specified for wait time *tmout*, processing equivalent to snd_mbf will be executed. When TMO_POL is specified, processing equivalent to psnd_mbf will be executed.

Note 4 These statements are unnecessary for the task which is created by the system configuration file because the cfg600px generates these statement into the “kernel_id.h”.

8.3.4 Receive from message buffer

A message is received (waiting forever, polling, or with time-out) by issuing the following service call from the processing program.

- rcv_mbf (Wait)
- prcv_mbf (Polling)
- trcv_mbf (Wait with time-out)

- rcv_mbf (Wait)
  This service call processes as follows according to the situation of the message buffer specified by the parameter *mbfid*.
  - There is a message in the message buffer.
    This service call takes out the oldest message from the message buffer and stores the message to the area specified by *msg* and return the size of the message. As a result, the size of available space in the target message buffer increases by the amount calculated by the following expression.

    The amount of increase = up4(Return value) + VTSZ_MBFTBL

    In addition, this service call repeats the following processing until task in the transmission wait queue is lost or it becomes impossible to store the message in the message buffer.
    - When there is a task in the transmission wait queue and there is available space in the message buffer for the message specified by the task in the top of the transmission wait queue, the task is unlinked from the transmission wait queue and moves from the WAITING state (message transmission wait state) to the READY state, or from the WAITING-SUSPENDED state to the SUSPENDED state. As a result, the size of available space in the target message buffer decreases by the amount calculated by the following expression.

      The amount of decrease =up4(The message size sent by the task) + VTSZ_MBFTBL
  - There is no message in the message buffer and there is a task in the transmission wait queue.
    This service call stores the message specified by the task in the top of the transmission wait queue to the area pointed by the parameter *msg*. As a result, the task is unlinked from the transmission wait queue and moves from the WAITING state (message transmission wait state) to the READY state, or from the WAITING-SUSPENDED state to the SUSPENDED state.
    Note, this situation is caused only when the size of the message buffer is 0.
  - There is no message in the message buffer and there is no task in the transmission wait queue.
    This service call queues the invoking task to the reception wait queue of the target message buffer and moves it from the RUNNING state to the WAITING state (message reception wait state).
    The receiving WAITING state for a message buffer is cancelled in the following cases.

Receiving WAITING State for a Message Buffer Cancel Operation	Return Value
Message was sent to the message buffer area as a result of issuing snd_mbf.	E_OK
Message was sent to the message buffer area as a result of issuing psnd_mbf.	E_OK
Message was sent to the message buffer area as a result of issuing ipsnd_mbf.	E_OK
Message was sent to the message buffer area as a result of issuing tsnd_mbf.	E_OK
Forced release from waiting (accept rel_wai while waiting).	E_RLWAI
Forced release from waiting (accept irel_wai while waiting).	E_RLWAI
Forced release from waiting (accept del_mbf while waiting).	E_DLT

The following describes an example for coding this service call.

```
#include    "kernel.h"              /*Standard header file definition*/
#include    "kernel_id.h"           /*Header file generated by cfg600px*/
#pragma task Task1                  /*Refer to note 3*/
void Task1 (VP_INT exinf);          /*Refer to note 3*/
void Task1 (VP_INT exinf)
{
    ER      ercd;                   /*Declares variable*/
    ID      mbfid = 1;              /*Declares and initializes variable*/
    B       msg[16];                /*Declares variable (maximum message size)*/

    /* ......... */

    ercd = rcv_mbf (mbfid, (VP)msg); /*Receive from message buffer */

    if (ercd == E_OK) {
        /* ......... */             /*Normal termination processing*/
    } else if (ercd == E_RLWAI) {
        /* ......... */             /*Forced termination processing*/
    }

    /* ......... */
}
```

Note 1 The maximum message size is defined at creating the message buffer. The size of the area pointed by *msg* requires at least the maximum message size.

Note 2 Invoking tasks are queued to the reception wait queue of the target message buffer in the order of the message reception request.

Note 3 These statements are unnecessary for the task which is created by the system configuration file because the cfg600px generates these statement into the “kernel_id.h”.

- prcv_mbf (Polling)
  This service call processes as follows according to the situation of the message buffer specified by the parameter *mbfid*.
  - There is a message in the message buffer.
    This service call takes out the oldest message from the message buffer and stores the message to the area specified by *msg* and return the size of the message. As a result, the size of available space in the target message buffer increases by the amount calculated by the following expression.

    The amount of increase = up4(Return value) + VTSZ_MBFTBL

    In addition, this service call repeats the following processing until task in the transmission wait queue is lost or it becomes impossible to store the message in the message buffer.
    - When there is a task in the transmission wait queue and there is available space in the message buffer for the message specified by the task in the top of the transmission wait queue, the task is unlinked from the transmission wait queue and moves from the WAITING state (message transmission wait state) to the READY state, or from the WAITING-SUSPENDED state to the SUSPENDED state. As a result, the size of available space in the target message buffer decreases by the amount calculated by the following expression.

      The amount of decrease =up4(The message size sent by the task) + VTSZ_MBFTBL
  - There is no message in the message buffer and there is a task in the transmission wait queue.
    This service call stores the message specified by the task in the top of the transmission wait queue to the area pointed by the parameter *msg*. As a result, the task is unlinked from the transmission wait queue and moves from the WAITING state (message transmission wait state) to the READY state, or from the WAITING-SUSPENDED state to the SUSPENDED state.
    Note, this situation is caused only when the size of the message buffer is 0.
  - There is no message in the message buffer and there is no task in the transmission wait queue.
    This service call returns "E_TMOUT".

The following describes an example for coding these service calls.

```
#include    "kernel.h"              /*Standard header file definition*/
#include    "kernel_id.h"           /*Header file generated by cfg600px*/
#pragma task Task1                  /*Refer to note 2*/
void Task1 (VP_INT exinf);          /*Refer to note 2*/
void Task1 (VP_INT exinf)
{
    ER      ercd;                   /*Declares variable*/
    ID      mbfid = 1;              /*Declares and initializes variable*/
    B       msg[16];                /*Declares variable (maximum message size)*/

    /* ......... */

    ercd = prcv_mbf (mbfid, (VP)msg); /*Receive from message buffer */

    if (ercd == E_OK) {
        /* ......... */             /*Polling success processing*/
    } else if (ercd == E_TMOUT) {
        /* ......... */             /*Polling failure processing*/
    }

    /* ......... */
}
```

Note 1 The maximum message size is defined at creating the message buffer. The size of the area pointed by *msg* requires at least the maximum message size.

Note 2 These statements are unnecessary for the task which is created by the system configuration file because the cfg600px generates these statement into the "kernel_id.h".

- trcv_mbf (Wait with time-out)
  This service call processes as follows according to the situation of the message buffer specified by the parameter *mbfid*.
  - There is a message in the message buffer.
    This service call takes out the oldest message from the message buffer and stores the message to the area specified by *msg* and return the size of the message. As a result, the size of available space in the target message buffer increases by the amount calculated by the following expression.

    The amount of increase = up4(Return value) + VTSZ_MBFTBL

    In addition, this service call repeats the following processing until task in the transmission wait queue is lost or it becomes impossible to store the message in the message buffer.
    - When there is a task in the transmission wait queue and there is available space in the message buffer for the message specified by the task in the top of the transmission wait queue, the task is unlinked from the transmission wait queue and moves from the WAITING state (message transmission wait state) to the READY state, or from the WAITING-SUSPENDED state to the SUSPENDED state. As a result, the size of available space in the target message buffer decreases by the amount calculated by the following expression.

      The amount of decrease =up4(The message size sent by the task) + VTSZ_MBFTBL
  - There is no message in the message buffer and there is a task in the transmission wait queue.
    This service call stores the message specified by the task in the top of the transmission wait queue to the area pointed by the parameter *msg*. As a result, the task is unlinked from the transmission wait queue and moves from the WAITING state (message transmission wait state) to the READY state, or from the WAITING-SUSPENDED state to the SUSPENDED state.
    Note, this situation is caused only when the size of the message buffer is 0.
  - There is no message in the message buffer and there is no task in the transmission wait queue.
    This service call queues the invoking task to the reception wait queue of the target message buffer and moves it from the RUNNING state to the WAITING state with time (message reception wait state).
    The receiving WAITING state for a message buffer is cancelled in the following cases.

Receiving WAITING State for a Message Buffer Cancel Operation	Return Value
Message was sent to the message buffer area as a result of issuing snd_mbf.	E_OK
Message was sent to the message buffer area as a result of issuing psnd_mbf.	E_OK
Message was sent to the message buffer area as a result of issuing ipsnd_mbf.	E_OK
Message was sent to the message buffer area as a result of issuing tsnd_mbf.	E_OK
Forced release from waiting (accept rel_wai while waiting).	E_RLWAI
Forced release from waiting (accept irel_wai while waiting).	E_RLWAI
The time specified by *tmout* has elapsed.	E_TMOUT
Forced release from waiting (accept del_mbf while waiting).	E_DLT

The following describes an example for coding this service call.

```
#include    "kernel.h"              /*Standard header file definition*/
#include    "kernel_id.h"           /*Header file generated by cfg600px*/
#pragma task Task1                  /*Refer to note 4*/
void Task1 (VP_INT exinf);          /*Refer to note 4*/
void Task1 (VP_INT exinf)
{
    ER      ercd;                   /*Declares variable*/
    ID      mbfid = 1;              /*Declares and initializes variable*/
    B       msg[16];                /*Declares variable (maximum message size)*/
    TMO     tmout = 3600;           /*Declares and initializes variable*/

    /* ......... */

    ercd = trcv_mbf (mbfid, (VP)msg, tmout ); /*Receive from message buffer */

    if (ercd == E_OK) {
            /* ......... */         /*Normal termination processing*/
    } else if (ercd == E_RLWAI) {
            /* ......... */         /*Forced termination processing*/
    } else if (ercd == E_TMOUT) {
            /* ......... */         /*Time-out processing*/
    }

    /* ......... */
}
```

Note 1 The maximum message size is defined at creating the message buffer. The size of the area pointed by *msg* requires at least the maximum message size.

Note 2 Invoking tasks are queued to the reception wait queue of the target message buffer in the order of the message reception request.

Note 3 TMO_FEVR is specified for wait time *tmout*, processing equivalent to rcv_mbf will be executed. When TMO_POL is specified, processing equivalent to prcv_mbf will be executed.

Note 4 These statements are unnecessary for the task which is created by the system configuration file because the cfg600px generates these statement into the “kernel_id.h”.

8.3.5 Reference message buffer state

A message buffer status is referenced by issuing the following service call from the processing program.

- ref_mbf, iref_mbf
  These service calls store the detailed information of the message buffer (existence of waiting tasks, available buffer size, etc.) specified by parameter *mbfid* into the area specified by parameter *pk_rmbf*.
  The following describes an example for coding this service call.

```
#include    "kernel.h"              /*Standard header file definition*/
#include    "kernel_id.h"           /*Header file generated by cfg600px*/
#pragma task Task1                  /*Refer to note 2*/
void Task1 (VP_INT exinf);          /*Refer to note 2*/
void Task1 (VP_INT exinf)
{
    ID      mbfid = 1;              /*Declares and initializes variable*/
    T_RMBF  pk_rmbf;                /*Declares message structure*/
    ID      stskid;                 /*Declares variable*/
    ID      rtskid;                 /*Declares variable*/
    UINT    smsgcnt;                /*Declares variable*/
    SIZE    fmbfsz;                 /*Declares variable*/

    /* ......... */

    ref_mbf (mbfid, &pk_rmbf);       /*Reference message buffer state*/

    stskid = pk_rmbf.stskid;        /*Acquires existence of tasks waiting for */
                                    /*message transmission*/
    rtskid = pk_rmbf.rtskid;        /*Acquires existence of tasks waiting for */
                                    /*message reception*/
    smsgcnt = pk_rmbf.smsgcnt;      /*Acquires the number of message in */
                                    /*message buffer*/
    fmbfsz = pk_rmbf.fmbfsz;        /*Acquires the available buffer size */

    /* ......... */
}
```

Note 1 For details about the message buffer state packet, refer to "[Message buffer state packet: T_RMBF]".

Note 2 These statements are unnecessary for the task which is created by the system configuration file because the cfg600px generates these statement into the "kernel_id.h".

CHAPTER 9 MEMORY POOL MANAGEMENT FUNCTIONS

This chapter describes the memory pool management functions performed by the RI600PX.

9.1 Outline

The RI600PX provides “Fixed-Sized Memory Pools” and “Variable-Sized Memory Pools” as dynamic memory allocation function.
In the fixed-sized memory pool, the size of memory that can use is fixation, but the over-head to acquire/release memory is short.
On the other hand, in the variable-sized memory pool, memory of the arbitrary size can be used, but the over-head to acquire/release memory is longer than the fixed-sized memory pool. And fragmentation of the memory pool area may occur.

9.2 Fixed-Sized Memory Pools

When a dynamic memory manipulation request is issued from a processing program in the RI600PX, the fixed-sized memory pool is provided as a usable memory area.
Dynamic memory manipulation of the fixed-size memory pool is executed in fixed size memory block units.

9.2.1 Create fixed-sized memory pool

Fixed-sized memory pools are created by one of the following methods.

1) Creation by the system configuration file
The static API “memorypool[]” described in the system configuration file creates a fixed-sized memory pool.
Refer to “20.17 Fixed-sized Memory Pool Information (memorypool[])” for the details of “memorypool[]”.

2) Creation by cre_mpf or acre_mpf
The cre_mpf creates a fixed-sized memory pool with fixed-sized memory pool ID indicated by parameter *mpfid* according to the content of parameter *pk_cmpf*.
The acre_mpf creates a fixed-sized memory pool according to the content of parameter *pk_cmpf*, and returns the created fixed-sized memory pool ID.
The information specified is shown below.

- Fixed-sized memory pool attribute (*mpfatr*)
  The following informations are specified as *mpfatr*.
  - The order of task wait queue (FIFO order or task current priority order)
- Total number of memory blocks (*blkcnt*), memory block size (*blksz*), Start address of the fixed-sized memory pool area (*mpf*)
  The TSZ_MPF(*blkcnt*, *blksz*) bytes area from the address indicated by parameter *mpf* is used for the fixed-sized memory pool area. Refer to “18.3.3 Macros for Fixed-sized Memory Pool” for details of TSZ_MPF macro.
  The fixed-sized memory pool area should be in the memory object to be able to access by tasks which uses memory blocks.
- Start address of the fixed-sized memory pool management area (*mpfmb*)
  The TSZ_MPFMB(*blkcnt*, *blksz*) bytes area from the address indicated by parameter *mpfmb* is used for the fixed-sized memory pool management area. Refer to “18.3.3 Macros for Fixed-sized Memory Pool” for details of TVSZ_MPFMB macro.
  The fixed-sized memory pool management area should be generated to the area other than memory objects and user stacks.

These service calls can be called from tasks that belong to Trusted Domain.
The following describes an example for coding acre_mpf as a representative.

```
#include    "kernel.h"              /*Standard header file definition*/
#include    "kernel_id.h"           /*Header file generated by cfg600px*/

#define BLKCNT    32                /*Total number of memory blocks*/
#define BLKSZ     16                /*Memory block size (in bytes)*/

#pragma section B BU_SH           /*Section for the fixed-sized memory pool area*/
                                      /*Fixed-sized memory pool area*/
static UW mpf_area[ TSZ_MPF(BLKCNT, BLKSZ)/sizeof(UW) ];

                       /* Section for the fixed-sized memory pool management area*/
#pragma section B BRI_RAM
                                   /*Fixed-sized memory pool management area*/
static UW mpfmb_area[ TSZ_MPFMB(BLKCNT, BLKSZ)/sizeof(UW) ];
#pragma section

#pragma task Task1                  /*Refer to note*/
void Task1 (VP_INT exinf);          /*Refer to note*/
void Task1 (VP_INT exinf)
{
    ER      mpfid;        /*Declares variable*/
    T_CMPF  pk_cmpf = {   /*Declares and initializes variable*/
        TA_TFIFO,       /*Fixed-sized memory pool attribute (mpfatr)*/
        BLKCNT,         /*Total number of memory blocks (blkcnt)*/
        BLKSZ,          /*Memory block size (in bytes) (blksz)*/
       (VP)mpf_area,    /*Start address of the fixed-sized memory pool area (mpf)*/
           /*Start address of the fixed-sized memory pool management area (mpfmb)*/
        (VP)mpfmb_area
    };

    /* ......... */

    mpfid = acre_mpf ( &pk_cmpf );  /*Create fixed-sized memory pool/

    /* ......... */
}
```

Note These statements are unnecessary for the task which is created by the system configuration file because the cfg600px generates these statement into the “kernel_id.h”.

9.2.2 Delete fixed-sized memory pool

- del_mpf
  This service call deletes the fixed-sized memory pool specified by parameter *mpfid*.
  When there are waiting tasks for the target fixed-sized memory pool by using get_mpf or tget_mpf, this service call cancels the WAITING state of the tasks and returns E_DLT as a return value of the get_mpf or tget_mpf.
  This service call can be called from tasks that belong to Trusted Domain.
  The following describes an example for coding this service call.

```
#include    "kernel.h"                /*Standard header file definition*/
#include    "kernel_id.h"             /*Header file generated by cfg600px*/
#pragma task Task1                    /*Refer to note*/
void Task1 (VP_INT exinf);            /*Refer to note*/
void Task1 (VP_INT exinf)
{
    ID      mpfid = 8;            /*Declares and initializes variable*/

    /* ......... */

    ercd = del_mpf ( mpfid );    /*Delete fixed-sized memory pool*/

    /* ......... */
}
```

Note These statements are unnecessary for the task which is created by the system configuration file because the cfg600px generates these statement into the “kernel_id.h”.

9.2.3 Acquire fixed-sized memory block

A fixed-sized memory block is acquired (waiting forever, polling, or with time-out) by issuing the following service call from the processing program.

- get_mpf (Wait)
- pget_mpf, ipget_mpf (Polling)
- tget_mpf (Wait with time-out)

The RI600PX does not perform memory clear processing when a fixed-sized memory block is acquired. The contents of the acquired fixed-size memory block are therefore undefined.

- get_mpf (Wait)
  This service call acquires the fixed-sized memory block from the fixed-sized memory pool specified by parameter *mpfid* and stores the start address in the area specified by parameter *p_blk*.
  If no fixed-size memory blocks could be acquired from the target fixed-size memory pool (no available fixed-size memory blocks exist) when this service call is issued, this service call does not acquire the fixed-size memory block but queues the invoking task to the target fixed-size memory pool wait queue and moves it from the RUNNING state to the WAITING state (fixed-size memory block acquisition wait state).
  The WAITING state for a fixed-sized memory block is cancelled in the following cases.

WAITING State for a Fixed-sized Memory Block Cancel Operation	Return Value
A fixed-sized memory block was returned to the target fixed-sized memory pool as a result of issuing rel_mpf.	E_OK
A fixed-sized memory block was returned to the target fixed-sized memory pool as a result of issuing irel_mpf.	E_OK
Forced release from waiting (accept rel_wai while waiting).	E_RLWAI
Forced release from waiting (accept irel_wai while waiting).	E_RLWAI
The fixed-sized memory pool is reset as a result of issuing vrst_mpf.	EV_RST
Forced release from waiting (accept del_mpf while waiting).	E_DLT

The following describes an example for coding this service call.

```
#include    "kernel.h"              /*Standard header file definition*/
#include    "kernel_id.h"           /*Header file generated by cfg600px*/
#pragma task Task1                  /*Refer to note 4*/
void Task1 (VP_INT exinf);          /*Refer to note 4*/
void Task1 (VP_INT exinf)
{
    ER      ercd;                   /*Declares variable*/
    ID      mpfid = 1;              /*Declares and initializes variable*/
    VP      p_blk;                  /*Declares variable*/

    /* ......... */

    ercd = get_mpf (mpfid, &p_blk); /*Acquire fixed-sized memory block */

    if (ercd == E_OK) {
        /* ......... */             /*Normal termination processing*/

        rel_mpf (mpfid, p_blk);     /*Release fixed-sized memory block*/
    } else if (ercd == E_RLWAI) {
        /* ......... */             /*Forced termination processing*/
    }

    /* ......... */
}
```

Note 1 Invoking tasks are queued to the target fixed-size memory pool wait queue in the order defined at creating the fixed-sized memory pool (FIFO order or current priority order).

Note 2 The contents of the block are undefined.

Note 3 The alignment number of memory block is 1. Please perform the following, in order to enlarge the alignment number of memory blocks.

- Specify the memory block size to a multiple of the desired alignment number at creating the fixed-sized memory pool.
- Make the start address of the fixed-sized memory pool area into the address of the desired alignment number.

Note 4 These statements are unnecessary for the task which is created by the system configuration file because the cfg600px generates these statement into the “kernel_id.h”.

- pget_mpf, ipget_mpf (Polling)
  This service call acquires the fixed-sized memory block from the fixed-sized memory pool specified by parameter *mpfid* and stores the start address in the area specified by parameter *p_blk*.
  If a fixed-sized memory block could not be acquired from the target fixed-sized memory pool (no available fixed-sized memory blocks exist) when this service call is issued, fixed-sized memory block acquisition processing is not performed but “E_TMOUT” is returned.
  The following describes an example for coding these service calls.

```
#include    "kernel.h"              /*Standard header file definition*/
#include    "kernel_id.h"           /*Header file generated by cfg600px*/
#pragma task Task1                  /*Refer to note 3*/
void Task1 (VP_INT exinf);          /*Refer to note 3*/
void Task1 (VP_INT exinf)
{
    ER      ercd;                   /*Declares variable*/
    ID      mpfid = 1;              /*Declares and initializes variable*/
    VP      p_blk;                  /*Declares variable*/

    /* ......... */

                                    /*Acquire fixed-sized memory block */
    ercd = pget_mpf (mpfid, &p_blk);

    if (ercd == E_OK) {
        /* ......... */             /*Polling success processing*/

        rel_mpf (mpfid, p_blk);     /*Release fixed-sized memory block*/
    } else if (ercd == E_TMOUT) {
        /* ......... */             /*Polling failure processing*/
    }

    /* ......... */
}
```

Note 1 The contents of the block are undefined.

Note 2 The alignment number of memory block is 1. Please perform the following, in order to enlarge the alignment number of memory blocks.

- Specify the memory block size to a multiple of the desired alignment number at creating the fixed-sized memory pool.
- Make the start address of the fixed-sized memory pool area into the address of the desired alignment number.

Note 3 These statements are unnecessary for the task which is created by the system configuration file because the cfg600px generates these statement into the “kernel_id.h”.

- tget_mpf (Wait with time-out)
  This service call acquires the fixed-sized memory block from the fixed-sized memory pool specified by parameter *mpfid* and stores the start address in the area specified by parameter *p_blk*.
  If no fixed-size memory blocks could be acquired from the target fixed-size memory pool (no available fixed-size memory blocks exist) when this service call is issued, this service call does not acquire the fixed-size memory block but queues the invoking task to the target fixed-size memory pool wait queue and moves it from the RUNNING state to the WAITING state with time-out (fixed-size memory block acquisition wait state).
  The WAITING state for a fixed-sized memory block is cancelled in the following cases.

WAITING State for a Fixed-sized Memory Block Cancel Operation	Return Value
A fixed-sized memory block was returned to the target fixed-sized memory pool as a result of issuing rel_mpf.	E_OK
A fixed-sized memory block was returned to the target fixed-sized memory pool as a result of issuing irel_mpf.	E_OK
Forced release from waiting (accept rel_wai while waiting).	E_RLWAI
Forced release from waiting (accept irel_wai while waiting).	E_RLWAI
The fixed-sized memory pool is reset as a result of issuing vrst_mpf.	EV_RST
The time specified by *tmout* has elapsed.	E_TMOUT
Forced release from waiting (accept del_mpf while waiting).	E_DLT

The following describes an example for coding this service call.

```
#include    "kernel.h"              /*Standard header file definition*/
#include    "kernel_id.h"           /*Header file generated by cfg600px*/
#pragma task Task1                  /*Refer to note 5*/
void Task1 (VP_INT exinf);          /*Refer to note 5*/
void Task1 (VP_INT exinf)
{
    ER      ercd;                   /*Declares variable*/
    ID      mpfid = 1;              /*Declares and initializes variable*/
    VP      p_blk;                  /*Declares variable*/
    TMO     tmout = 3600;           /*Declares and initializes variable*/

    /* ......... */
                                    /*Acquire fixed-sized memory block*/
    ercd = tget_mpf (mpfid, &p_blk, tmout);

    if (ercd == E_OK) {
        /* ......... */             /*Normal termination processing*/

        rel_mpf (mpfid, p_blk);     /*Release fixed-sized memory block*/
    } else if (ercd == E_RLWAI) {
        /* ......... */             /*Forced termination processing*/
    } else if (ercd == E_TMOUT) {
        /* ......... */             /*Time-out processing*/
    }

    /* ......... */
}
```

Note 1 Invoking tasks are queued to the target fixed-size memory pool wait queue in the order defined at creating the fixed-sized memory pool (FIFO order or current priority order).

Note 2 The contents of the block are undefined.

Note 3 The alignment number of memory block is 1. Please perform the following, in order to enlarge the alignment number of memory blocks.

- Specify the memory block size to a multiple of the desired alignment number at creating the fixed-sized memory pool.
- Make the start address of the fixed-sized memory pool area into the address of the desired alignment number.

Note 4 TMO_FEVR is specified for wait time *tmout*, processing equivalent to get_mpf will be executed. When TMO_POL is specified, processing equivalent to pget_mpf will be executed.

Note 5 These statements are unnecessary for the task which is created by the system configuration file because the cfg600px generates these statement into the “kernel_id.h”.

9.2.4 Release fixed-sized memory block

A fixed-sized memory block is returned by issuing the following service call from the processing program.

- rel_mpf, irel_mpf
  This service call returns the fixed-sized memory block specified by parameter *blk* to the fixed-sized memory pool specified by parameter *mpfid*.
  If a task is queued to the target fixed-sized memory pool wait queue when this service call is issued, fixed-sized memory block return processing is not performed but fixed-sized memory blocks are returned to the relevant task (first task of wait queue).
  As a result, the relevant task is unlinked from the wait queue and is moved from the WAITING state (WAITING state for a fixed-sized memory block) to the READY state, or from the WAITING-SUSPENDED state to the SUSPENDED state.
  The following describes an example for coding these service calls.

```
#include    "kernel.h"              /*Standard header file definition*/
#include    "kernel_id.h"           /*Header file generated by cfg600px*/
#pragma task Task1                  /*Refer to note*/
void Task1 (VP_INT exinf);          /*Refer to note*/
void Task1 (VP_INT exinf)
{
    ER      ercd;                   /*Declares variable*/
    ID      mpfid = 1;              /*Declares and initializes variable*/
    VP      blk;                    /*Declares variable*/

    /* ......... */

    ercd = get_mpf (mpfid, &blk);   /*Acquire fixed-sized memory block */
                                    /*(waiting forever)*/

    if (ercd == E_OK) {
        /* ......... */             /*Normal termination processing*/

        rel_mpf (mpfid, blk);       /*Release fixed-sized memory block*/
    } else if (ercd == E_RLWAI) {
        /* ......... */             /*Forced termination processing*/
    }

    /* ......... */
}
```

Note These statements are unnecessary for the task which is created by the system configuration file because the cfg600px generates these statement into the “kernel_id.h”.

9.2.5 Reference fixed-sized memory pool state

A fixed-sized memory pool status is referenced by issuing the following service call from the processing program.

- ref_mpf, iref_mpf
  Stores fixed-sized memory pool state packet (ID number of the task at the head of the wait queue, number of free memory blocks, etc.) of the fixed-sized memory pool specified by parameter *mpfid* in the area specified by parameter *pk_rmpf*.
  The following describes an example for coding these service calls.

```
#include    "kernel.h"                  /*Standard header file definition*/
#include    "kernel_id.h"               /*Header file generated by cfg600px*/
#pragma task Task1                      /*Refer to note 2*/
void Task1 (VP_INT exinf);              /*Refer to note 2*/
void Task1 (VP_INT exinf)
{
    ID      mpfid = 1;                  /*Declares and initializes variable*/
    T_RMPF  pk_rmpf;                    /*Declares data structure*/
    ID      wtskid;                     /*Declares variable*/
    UINT    fblkcnt;                    /*Declares variable*/

    /* ......... */

    ref_mpf (mpfid, &pk_rmpf);          /*Reference fixed-sized memory pool state*/

    wtskid = pk_rmpf.wtskid;            /*Reference ID number of the task at the */
                                        /*head of the wait queue*/
    fblkcnt = pk_rmpf.fblkcnt;          /*Reference number of free memory blocks*/

    /* ......... */
}
```

Note 1 For details about the fixed-sized memory pool state packet, refer to "[Fixed-sized memory pool state packet: T_RMPF]".

Note 2 These statements are unnecessary for the task which is created by the system configuration file because the cfg600px generates these statement into the "kernel_id.h".

9.3 Variable-Sized Memory Pools

When a dynamic memory manipulation request is issued from a processing program in the RI600PX, the variable-sized memory pool is provided as a usable memory area.
Dynamic memory manipulation for variable-size memory pools is performed in the units of the specified variable-size memory block size.

9.3.1 Size of Variable-sized memory block

In the current implementation of the RI600PX, the size of the variable-sized memory block to be acquired is selected from 12 (in maximum) kinds of variations. This variations are selected from 24 kinds of inside decided beforehand according to the maximum memory block size that is defined at creating the variable-sized memory pool. Table 9-1 shows variation of memory block size. Note, this behavior may be changed in the future version.

Table 9-1 Variation of memory block size

No,	Size of memory block (Hexadecimal)	Example-1 max_memsize = 0x100	Example-1 max_memsize = 0x20000
1	12 (0xC)	Used	-
2	36 (0x24)	Used	-
3	84 (0x54)	Used	Used
4	180 (0xB4)	Used	Used
5	372 (0x174)	-	Used
6	756 (0x2F4)	-	Used
7	1524 (0x5F4)	-	Used
8	3060 (0xBF4)	-	Used
9	6132 (0x17F4)	-	Used
10	12276 (0x2FF4)	-	Used
11	24564 (0x5FF4)	-	Used
12	49140 (0xBFF4)	-	Used
13	98292 (0x17FF4)	-	Used
14	196596 (0x2FFF4)	-	Used
15	393204 (0x5FFF4)	-	-
16	786420 (0xBFFF4)	-	-
17	1572852 (0x17FFF4)	-	-
18	3145716 (0x2FFFF4)	-	-
19	6291444 (0x5FFFF4)	-	-
20	12582900 (0xBFFFF4)	-	-
21	25165812 (0x17FFFF4)	-	-
22	50331636 (0x2FFFFF4)	-	-
23	100663284 (0x5FFFFF4)	-	-
24	201326580 (0xBFFFFF4)	-	-

9.3.2 Create variable-sized memory pool

Variable-sized memory pools are created by one of the following methods.

1) Creation by the system configuration file
The static API “variable_memorypool[]” described in the system configuration file creates a variable-sized memory pool.
Refer to “20.18 Variable-sized Memory Pool Information (variable_memorypool[])” for the details of “variable_memorypool[]”.

2) Creation by cre_mpl or acre_mpl
The cre_mpl creates a variable-sized memory pool with variable-sized memory pool ID indicated by parameter *mplid* according to the content of parameter *pk_cmpl*.
The acre_mpl creates a variable-sized memory pool according to the content of parameter *pk_cmpl*, and returns the created variable-sized memory pool ID.
The information specified is shown below.

- Variable-sized memory pool attribute (*mplatr*)
  Only TA_TFIFO (the order of task wait queue is managed by FIFO order.) can be specified for *mplatr*.
- Size of variable-sized memory pool area (*mplsz*), Start address of the variable-sized memory pool area (*mpl*)
  The start adderess of the variable-sized memory pool area must be 4-bytes boundary.
  The variable-sized memory pool area should be in the memory object to be able to access by tasks which uses memory blocks.
- Maximum memory block size (*maxblksz*)
  Specify the maximum memory block size for *maxblksz*. For details, refer to “9.3.1 Size of Variable-sized memory block”.

These service calls can be called from tasks that belong to Trusted Domain.
The following describes an example for coding acre_mpl as a representative.

```
#include    "kernel.h"               /*Standard header file definition*/
#include    "kernel_id.h"            /*Header file generated by cfg600px*/

#define MPLSZ     1024      /*Size of variable-sized memory pool area (in bytes)*/
#define MAXBLKSZ  128       /*Maximum memory block size (in bytes)*/

#pragma section B BU_SH     /*Section for the variable-sized memory pool area*/
static UW mpl_area[ MPLSZ/sizeof(UW) ]; /*Variable-sized memory pool area*/
#pragma section

#pragma task Task1                   /*Refer to note*/
void Task1 (VP_INT exinf);           /*Refer to note*/
void Task1 (VP_INT exinf)
{
    ER      mplid;        /*Declares variable*/
    T_CMPF  pk_cmpl = {   /*Declares and initializes variable*/
        TA_TFIFO,   /*Variable-sized memory pool attribute (mplatr)*/
        MPLSZ,      /*Size of variable-sized memory pool area (in bytes) (mplsz)*/
        (VP)mpl_area,/*Start address of the variable-sized memory pool area (mpl)*/
        MAXBLKLSZ   /*Maximum memory block size (in bytes) (maxblksz)*/
    };

    /* ......... */
    mplid = acre_mpl ( &pk_cmpf );  /*Create variable-sized memory pool/
    /* ......... */
}
```

Note These statements are unnecessary for the task which is created by the system configuration file because the cfg600px generates these statement into the “kernel_id.h”.

9.3.3 Delete variable-sized memory pool

- del_mpl
  This service call deletes the variable-sized memory pool specified by parameter *mplid*.
  When there are waiting tasks for the target variable-sized memory pool by using get_mpl or tget_mpl, this service call cancels the WAITING state of the tasks and returns E_DLT as a return value of the get_mpl or tget_mpl.
  This service call can be called from tasks that belong to Trusted Domain.
  The following describes an example for coding this service call.

```
#include    "kernel.h"              /*Standard header file definition*/
#include    "kernel_id.h"           /*Header file generated by cfg600px*/
#pragma task Task1                  /*Refer to note*/
void Task1 (VP_INT exinf);          /*Refer to note*/
void Task1 (VP_INT exinf)
{
    ID      mplid = 8;          /*Declares and initializes variable*/

    /* ......... */

    ercd = del_mpl ( mplid );   /*Delete variable-sized memory pool*/

    /* ......... */
}
```

Note These statements are unnecessary for the task which is created by the system configuration file because the cfg600px generates these statement into the “kernel_id.h”.

9.3.4 Acquire variable-sized memory block

A variable-sized memory block is acquired (waiting forever, polling, or with time-out) by issuing the following service call from the processing program.

- get_mpl (Wait)
- pget_mpl, ipget_mpl (Polling)
- tget_mpl (Wait with time-out)

The RI600PX does not perform memory clear processing when a variable-sized memory block is acquired. The contents of the acquired variable-size memory block are therefore undefined.

- get_mpl (Wait)
  This service call acquires a variable-size memory block of the size specified by parameter blksz from the variable-size memory pool specified by parameter *mplid*, and stores its start address into the area specified by parameter *p_blk*.
  If no variable-size memory blocks could be acquired from the target variable-size memory pool (no successive areas equivalent to the requested size were available) when this service call is issued, this service call does not acquire variable-size memory blocks but queues the invoking task to the target variable-size memory pool wait queue and moves it from the RUNNING state to the WAITING state (variable-size memory block acquisition wait state).
  The WAITING state for a variable-sized memory block is cancelled in the following cases.

WAITING State for a Variable-sized Memory Block Cancel Operation	Return Value
The variable-size memory block that satisfies the requested size was returned to the target variable-size memory pool as a result of issuing rel_mpl.	E_OK
The task at the top of the transmission wait queue was forcedly released from waiting by following either. - Forced release from waiting (accept rel_wai while waiting). - Forced release from waiting (accept irel_wai while waiting). - Forced release from waiting (accept ter_tsk while waiting). - The time specified by *tmout* for tget_mpl has elapsed.	E_OK
Forced release from waiting (accept rel_wai while waiting).	E_RLWAI
Forced release from waiting (accept irel_wai while waiting).	E_RLWAI
The variable-sized memory pool is reset as a result of issuing vrst_mpl.	EV_RST
Forced release from waiting (accept del_mpl while waiting).	E_DLT

The following describes an example for coding this service call.

```
#include    "kernel.h"              /*Standard header file definition*/
#include    "kernel_id.h"           /*Header file generated by cfg600px*/
#pragma task Task1                  /*Refer to note 5*/
void Task1 (VP_INT exinf);          /*Refer to note 5*/
void Task1 (VP_INT exinf)
{
    ER      ercd;                   /*Declares variable*/
    ID      mplid = 1;              /*Declares and initializes variable*/
    UINT    blksz = 256;            /*Declares and initializes variable*/
    VP      p_blk;                  /*Declares variable*/

    /* ......... */
                                    /*Acquire variable-sized memory block */
    ercd = get_mpl (mplid, blksz, &p_blk);

    if (ercd == E_OK) {
        /* ......... */             /*Normal termination processing*/

        rel_mpl (mplid, p_blk);     /*Release variable-sized memory block*/
    } else if (ercd == E_RLWAI) {
        /* ......... */             /*Forced termination processing*/
    }

    /* ......... */
}
```

Note 1 For the size of the memory block, refer to “9.3.1 Size of Variable-sized memory block”.

Note 2 Invoking tasks are queued to the target variable-size memory pool wait queue in the FIFO order.

Note 3 The contents of the block are undefined.

Note 4 The alignment number of memory blocks changes with creation method of the variable-sized memory pool.

- Created by system configuration file
  The alignment number is 1. To enlarge the alignment number to 4, specify unique section to Section name assigned to the memory pool area (mpl_section) in Variable-sized Memory Pool Information (variable_memorypool[]) and locate the section to 4-bytes boundary address when linking.
- Created by cre_mpl or acre_mpl
  The alignment number is 4.

Note 5 These statements are unnecessary for the task which is created by the system configuration file because the cfg600px generates these statement into the “kernel_id.h”.

- pget_mpl, ipget_mpl (Polling)
  This service call acquires a variable-size memory block of the size specified by parameter *blksz* from the variable-size memory pool specified by parameter *mplid*, and stores its start address into the area specified by parameter *p_blk*.
  If no variable-size memory blocks could be acquired from the target variable-size memory pool (no successive areas equivalent to the requested size were available) when this service call is issued, this service call does not acquire variable-size memory block but returns “E_TMOUT”.
  The following describes an example for coding these service calls.

```
#include    "kernel.h"              /*Standard header file definition*/
#include    "kernel_id.h"           /*Header file generated by cfg600px*/
#pragma task Task1                  /*Refer to note 4*/
void Task1 (VP_INT exinf);          /*Refer to note 4*/
void Task1 (VP_INT exinf)
{
    ER      ercd;                   /*Declares variable*/
    ID      mplid = 1;              /*Declares and initializes variable*/
    UINT    blksz = 256;            /*Declares and initializes variable*/
    VP      p_blk;                  /*Declares variable*/

    /* ......... */

                                    /*Acquire variable-sized memory block*/
    ercd = pget_mpl (mplid, blksz, &p_blk);

    if (ercd == E_OK) {
        /* ......... */             /*Polling success processing*/

        rel_mpl (mplid, p_blk);     /*Release variable-sized memory block*/
    } else if (ercd == E_TMOUT) {
        /* ......... */             /*Polling failure processing*/
    }

    /* ......... */
}
```

Note 1 For the size of the memory block, refer to “9.3.1 Size of Variable-sized memory block”.

Note 2 The contents of the block are undefined.

Note 3 The alignment number of memory blocks changes with creation method of the variable-sized memory pool.

- Created by system configuration file
  The alignment number is 1. To enlarge the alignment number to 4, specify unique section to Section name assigned to the memory pool area (mpl_section) in Variable-sized Memory Pool Information (variable_memorypool[]) and locate the section to 4-bytes boundary address when linking.
- Created by cre_mpl or acre_mpl
  The alignment number is 4.

Note 4 These statements are unnecessary for the task which is created by the system configuration file because the cfg600px generates these statement into the “kernel_id.h”.

- tget_mpl (Wait with time-out)
  This service call acquires a variable-size memory block of the size specified by parameter *blksz* from the variable-size memory pool specified by parameter *mplid*, and stores its start address into the area specified by parameter *p_blk*.
  If no variable-size memory blocks could be acquired from the target variable-size memory pool (no successive areas equivalent to the requested size were available) when this service call is issued, this service call does not acquire variable-size memory blocks but queues the invoking task to the target variable-size memory pool wait queue and moves it from the RUNNING state to the WAITING state with time-out (variable-size memory block acquisition wait state).
  The WAITING state for a variable-sized memory block is cancelled in the following cases.

WAITING State for a Variable-sized Memory Block Cancel Operation	Return Value
The variable-size memory block that satisfies the requested size was returned to the target variable-size memory pool as a result of issuing rel_mpl.	E_OK
The task at the top of the transmission wait queue was forcedly released from waiting by following either. - Forced release from waiting (accept rel_wai while waiting). - Forced release from waiting (accept irel_wai while waiting). - Forced release from waiting (accept ter_tsk while waiting). - The time specified by *tmout* for tget_mpl has elapsed.	E_OK
Forced release from waiting (accept rel_wai while waiting).	E_RLWAI
Forced release from waiting (accept irel_wai while waiting).	E_RLWAI
The variable-sized memory pool is reset as a result of issuing vrst_mpl.	EV_RST
The time specified by *tmout* has elapsed.	E_TMOUT
Forced release from waiting (accept del_mpl while waiting).	E_DLT

The following describes an example for coding this service call.

```
#include    "kernel.h"              /*Standard header file definition*/
#include    "kernel_id.h"           /*Header file generated by cfg600px*/
#pragma task Task1                  /*Refer to note 4*/
void Task1 (VP_INT exinf);          /*Refer to note 4*/
void Task1 (VP_INT exinf)
{
    ER      ercd;                   /*Declares variable*/
    ID      mplid = 1;              /*Declares and initializes variable*/
    UINT    blksz = 256;            /*Declares and initializes variable*/
    VP      p_blk;                  /*Declares variable*/
    TMO     tmout = 3600;           /*Declares and initializes variable*/

    /* ......... */

                                    /*Acquire variable-sized memory block*/
    ercd = tget_mpl (mplid, blksz, &p_blk, tmout);

    if (ercd == E_OK) {
        /* ......... */             /*Normal termination processing*/

        rel_mpl (mplid, p_blk ;     /*Release variable-sized memory block*/
    } else if (ercd == E_RLWAI) {
        /* ......... */             /*Forced termination processing*/
    } else if (ercd == E_TMOUT) {
        /* ......... */             /*Time-out processing*/
    }

    /* ......... */
}
```

Note 1 For the size of the memory block, refer to "9.3.1 Size of Variable-sized memory block".

Note 2 Invoking tasks are queued to the target variable-size memory pool wait queue in the FIFO order.

Note 3 The contents of the block are undefined.

Note 4 The alignment number of memory blocks changes with creation method of the variable-sized memory pool.

- Created by system configuration file
  The alignment number is 1. To enlarge the alignment number to 4, specify unique section to Section name assigned to the memory pool area (mpl_section) in Variable-sized Memory Pool Information (variable_memorypool[]) and locate the section to 4-bytes boundary address when linking.
- Created by cre_mpl or acre_mpl
  The alignment number is 4.

Note 5 TMO_FEVR is specified for wait time *tmout*, processing equivalent to get_mpl will be executed. When TMO_POL is specified, processing equivalent to pget_mpl will be executed.

Note 6 These statements are unnecessary for the task which is created by the system configuration file because the cfg600px generates these statement into the "kernel_id.h".

9.3.5 Release variable-sized memory block

A variable-sized memory block is returned by issuing the following service call from the processing program.

- rel_mpl
  This service call returns the variable-sized memory block specified by parameter *blk* to the variable-sized memory pool specified by parameter *mplid*.
  After returning the variable-size memory blocks, these service calls check the tasks queued to the target variable-size memory pool wait queue from the top, and assigns the memory if the size of memory requested by the wait queue is available. This operation continues until no tasks queued to the wait queue remain or no memory space is available. As a result, the task that acquired the memory is unlinked from the queue and moved from the WAITING state (variable-size memory block acquisition wait state) to the READY state, or from the WAITING-SUSPENDED state to the SUSPENDED state.
  The following describes an example for coding these service calls.

```
#include    "kernel.h"              /*Standard header file definition*/
#include    "kernel_id.h"           /*Header file generated by cfg600px*/
#pragma task Task1                  /*Refer to note 2*/
void Task1 (VP_INT exinf);          /*Refer to note 2*/
void Task1 (VP_INT exinf)
{
    ER      ercd;                   /*Declares variable*/
    ID      mplid = 1;              /*Declares and initializes variable*/
    UINT    blksz = 256;            /*Declares and initializes variable*/
    VP      blk;                    /*Declares variable*/

    /* ......... */

                                    /*Acquire variable-sized memory block*/
    ercd = get_mpl (mplid, blksz, &blk);

    if (ercd == E_OK) {
        /* ......... */             /*Normal termination processing*/

        rel_mpl (mplid, blk);       /*Release variable-sized memory block*/
    } else if (ercd == E_RLWAI) {
        /* ......... */             /*Forced termination processing*/
    }

    /* ......... */
}
```

Note 1 The RI600PX do only simple error detection for *blk*. If *blk* is illegal and the error is not detected, the operation is not guaranteed after that.

Note 2 These statements are unnecessary for the task which is created by the system configuration file because the cfg600px generates these statement into the “kernel_id.h”.

9.3.6 Reference variable-sized memory pool state

A variable-sized memory pool status is referenced by issuing the following service call from the processing program.

- ref_mpl, iref_mpl
  These service calls store the detailed information (ID number of the task at the head of the wait queue, total size of free memory blocks, etc.) of the variable-size memory pool specified by parameter *mplid* into the area specified by parameter *pk_rmpl*.
  The following describes an example for coding these service calls.

```
#include    "kernel.h"              /*Standard header file definition*/
#include    "kernel_id.h"           /*Header file generated by cfg600px*/
#pragma task Task1                  /*Refer to note 2*/
void Task1 (VP_INT exinf);          /*Refer to note 2*/
void Task1 (VP_INT exinf)
{
    ID      mplid = 1;              /*Declares and initializes variable*/
    T_RMPL  pk_rmpl;                /*Declares data structure*/
    ID      wtskid;                 /*Declares variable*/
    SIZE    fmplsz;                 /*Declares variable*/
    UINT    fblksz;                 /*Declares variable*/

    /* ......... */

    ref_mpl (mplid, &pk_rmpl);      /*Reference variable-sized memory pool state*/

    wtskid = pk_rmpl.wtskid;        /*Reference ID number of the task at the */
                                    /*head of the wait queue*/
    fmplsz = pk_rmpl.fmplsz;        /*Reference total size of free memory blocks*/
    fblksz = pk_rmpl.fblksz;        /*Reference maximum memory block size*/

    /* ......... */
}
```

Note 1 For details about the variable-sized memory pool state packet, refer to “[Variable-sized memory pool state packet: T_RMPL]”.

Note 2 These statements are unnecessary for the task which is created by the system configuration file because the cfg600px generates these statement into the “kernel_id.h”.

CHAPTER 10 TIME MANAGEMENT FUNCTIONS

This chapter describes the time management functions performed by the RI600PX.

10.1 Outline

The RI600PX's time management function provides methods to implement time-related processing (Timer Operations: Delay Task, Time-out, Cyclic Handlers, Alarm Handlers and System Time) by using base clock timer interrupts that occur at constant intervals, as well as a function to manipulate and reference the system time.

10.2 System Time

The system time is a time used by the RI600PX for performing time management (in millisecond).
After initialization to 0 by the Kernel Initialization Module (vsta_knl, ivsta_knl), the system time is updated based on the base clock interval defined by Denominator of base clock interval time (tic_deno) and Denominator of base clock interval time (tic_deno) in System Information (system) when creating a system configuration file.

10.2.1 Base clock timer interrupt

To realize the time management function, the RI600PX uses interrupts that occur at constant intervals (base clock timer interrupts).
When a base clock timer interrupt occurs, processing related to the RI600PX time (system time update, task time-out/ delay, cyclic handler activation, alarm handler activation, etc.) is executed.
Basically, either of channel 0-3 of the compare match timer (CMT) implemented in the MCU is used for base clock time. The channel number is specified by Selection of timer channel for base clock (timer)in Base Clock Interrupt Information (clock). in the system configuration file.
The hardware initialization to generate base clock timer interrupt is separated as user-own coding module. For details, refer to "10.9 Base Clock Timer Initialization Routine (_RI_init_cmt_knl( ))"

10.2.2 Base clock interval

In the RI600PX, service call parameters for time specification are specified in msec units.
It is desirable to set 1 msec for the occurrence interval of base clock timer interrupts, but it may be difficult depending on the target system performance (processing capability, required time resolution, or the like).
In such a case, the occurrence interval of base clock timer interrupt can be specified by Denominator of base clock interval time (tic_deno) and Denominator of base clock interval time (tic_deno) in System Information (system) when creating a system configuration file.
By specifying the base clock interval, processing regards that the time equivalent to the base clock interval elapses during a base clock timer interrupt.

10.3 Timer Operations

The RI600PX's timer operation function provides Delay Task, Time-out, Cyclic Handlers, Alarm Handlers and System Time,as the method for realizing time-dependent processing.

10.4 Delay Task

Delayed task that makes the invoking task transit from the RUNNING state to the WAITING state during the interval until a given length of time has elapsed, and makes that task move from the WAITING state to the READY state once the given length of time has elapsed.
Delayed wake-up is implemented by issuing the following service call from the processing program.

dly_tsk

10.5 Time-out

Time-out is the operation that makes the target task move from the RUNNING state to the WAITING state during the interval until a given length of time has elapsed if the required condition issued from a task is not immediately satisfied, and makes that task move from the WAITING state to the READY state regardless of whether the required condition is satisfied once the given length of time has elapsed.
A time-out is implemented by issuing the following service call from the processing program.

tslp_tsk, twai_sem, twai_flg, tsnd_dtq, trcv_dtq, trcv_mbx, tloc_mtx, tsnd_mbf, trcv_mbf, tget_mpf, tget_mpl

10.6 Cyclic Handlers

The cyclic handler is a routine dedicated to cycle processing that is activated periodically at a constant interval (activation cycle).
The RI600PX handles the cyclic handler as a “non-task (module independent from tasks)”. Therefore, even if a task with the highest priority in the system is being executed, the processing is suspended when a specified activation cycle has come, and the control is passed to the cyclic handler.

10.6.1 Basic form of cyclic handler

The following shows the basic form of cyclic handlers. The extended information defined at creating the cyclic handler is passed to the *exinf*.

```
#include    "kernel.h"                  /*Standard header file definition*/
#include    "kernel_id.h"               /*Header file generated by cfg600px*/
#pragma cychandler Cychdr1              /*Refer to note*/
void Cychdr1 (VP_INT exinf);
void Cychdr1 (VP_INT exinf)
{
    /* ......... */

    return;                             /*Terminate cyclic handler*/
}
```

Note These statements are unnecessary for the cyclic handler which is created by the system configuration file because the cfg600px generates these statement into the “kernel_id.h”.

10.6.2 Processing in cyclic handler

- Stack
  A cyclic handler uses the system stack.

- Service call
  The RI600PX handles the cyclic handler as a “non-task”.
  The cyclic handler can issue service calls whose “Useful range” is “Non-task”.

  Note If a service call (isig_sem, iset_flg, etc.) which causes dispatch processing (task scheduling processing) is issued in order to quickly complete the processing in the cyclic handler during the interval until the processing in the cyclic handler ends, the RI600PX executes only processing such as queue manipulation, counter manipulation, etc., and the actual dispatch processing is delayed until a return instruction is issued by the cyclic handler, upon which the actual dispatch processing is performed in batch.

- PSW register when processing is started

Table 10-1 PSW Register When Cyclic Handler is Started

Bit	Value	Note
I	1	
IPL	Base clock interrupt priority level (IPL)	Do not lower IPL more than the start of processing.
PM	0	Supervisor mode
U	0	System stack
C, Z, S, O	Undefined	
Others	0	

10.6.3 Create cyclic handler

Cyclic handlers are created by one of the following methods.

1) Creation by the system configuration file
The static API “cyclic_hand[]” described in the system configuration file creates a cyclic handler.
Refer to “20.19 Cyclic Handler Information (cyclic_hand[])” for the details of “cyclic_hand[]”.

2) Creation by cre_cyc or acre_cyc
The cre_cyc creates a cyclic handler with cyclic handler ID indicated by parameter *cycid* according to the content of parameter *pk_ccyc*.
The acre_cyc creates a cyclic handler according to the content of parameter *pk_ccyc*, and returns the created cyclic handler ID.
The information specified is shown below.

- Cyclic handler attribute (*cycatr*)
  The following informations are specified as *cycatr*.
  - Whether the cyclic handler is in the operational state. (TA_STA attribute)
  - Whether the activation phase is saved. (TA_PHS attribute)
- Extended information (*exinf*)
- Cyclic handler start address (*cychdr*)
- Activation cycle (*cyctim*)
- Activation phase (*cycphs*)

These service calls can be called from tasks that belong to Trusted Domain.
The following describes an example for coding acre_cyc as a representative.

```
#include    "kernel.h"               /*Standard header file definition*/
#include    "kernel_id.h"            /*Header file generated by cfg600px*/

extern void Cychdr1(VP_INT exinf);

#pragma task Task1                   /*Refer to note*/
void Task1 (VP_INT exinf);           /*Refer to note*/
void Task1 (VP_INT exinf)
{
    ER      cycid;               /*Declares variable*/
    T_CCYC  pk_ccyc = {          /*Declares and initializes variable*/
        TA_STA,                      /*Cyclic handler attribute (cycatr)*/
        0,                           /*Extended information (exinf)*/
        (FP)Cychdr1,                 /*Start address (cychdr)*/
        10,                          /*Activation cycle (cyctim)*/
        2                            /*Activation phase (cycphs)*/
    };

    /* ......... */

    cycid = acre_cyc ( &pk_ccyc );   /*Create cyclic handler/

    /* ......... */
}
```

Note These statements are unnecessary for the task which is created by the system configuration file because the cfg600px generates these statement into the “kernel_id.h”.

10.6.4 Delete cyclic handler

- del_cyc
  This service call deletes the cyclic handler specified by parameter *cycid*.
  This service call can be called from tasks that belong to Trusted Domain.
  The following describes an example for coding this service call.

```
#include    "kernel.h"                /*Standard header file definition*/
#include    "kernel_id.h"             /*Header file generated by cfg600px*/
#pragma task Task1                    /*Refer to note*/
void Task1 (VP_INT exinf);            /*Refer to note*/
void Task1 (VP_INT exinf)
{
    ID      cycid = 8;          /*Declares and initializes variable*/

    /* ......... */

    ercd = del_cyc ( cycid );   /*Delete cyclic handler*/

    /* ......... */
}
```

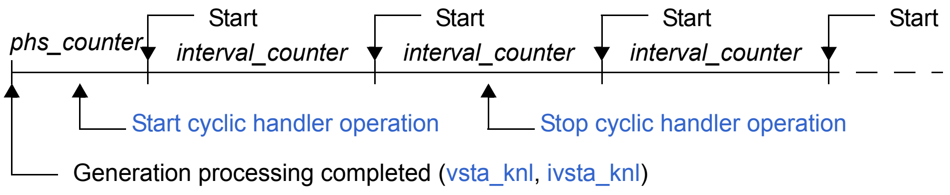
Note These statements are unnecessary for the task which is created by the system configuration file because the cfg600px generates these statement into the “kernel_id.h”.

10.6.5 Start cyclic handler operation

Moving to the operational state (STA state) is implemented by issuing the following service call from the processing program.

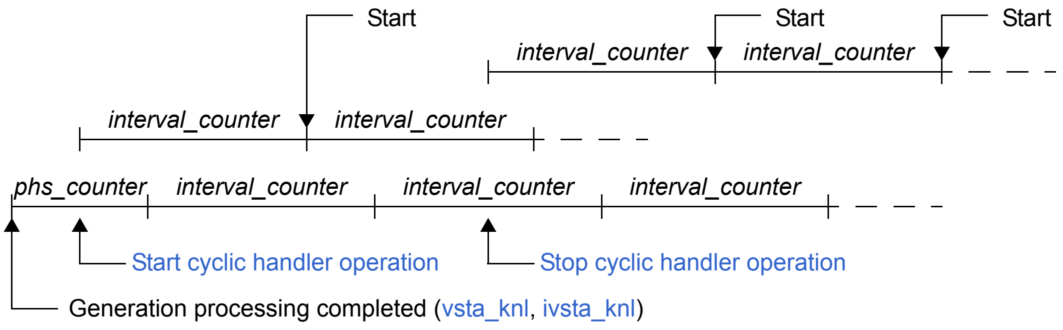
- sta_cyc, ista_cyc
  This service call moves the cyclic handler specified by parameter *cycid* from the non-operational state (STP state) to operational state (STA state).
  As a result, the target cyclic handler is handled as an activation target of the RI600PX.
  The relative interval from when either of this service call is issued until the first activation request is issued varies depending on whether the TA_PHS attribute (phsatr) is specified for the target cyclic handler during configuration.
  - If the TA_PHS attribute is specified
    The target cyclic handler activation timing is set up based on the activation phases and activation cycle.
    If the target cyclic handler has already been in operational state, however, no processing is performed even if this service call is issued, but it is not handled as an error.
    The following shows a cyclic handler activation timing image.

Figure 10-1 TA_PHS Attribute: Specified


Start
Start
Start
Start
phs_counter
interval_counter
interval_counter
interval_counter
Start cyclic handler operation
Stop cyclic handler operation
Generation processing completed (vsta_knl, ivsta_knl)

  - If the TA_PHS attribute is not specified
    The target cyclic handler activation timing is set up according to the activation cycle on the basis of the call time of this service call.
    This setting is performed regardless of the operating status of the target cyclic handler.
    The following shows a cyclic handler activation timing image.

Figure 10-2 TA_PHS Attribute: Not Specified



The following describes an example for coding these service calls.

```
#include    "kernel.h"              /*Standard header file definition*/
#include    "kernel_id.h"           /*Header file generated by cfg600px*/
#pragma task Task1                  /*Refer to note*/
void Task1 (VP_INT exinf);          /*Refer to note*/
void Task1 (VP_INT exinf)
{
    ID      cycid = 1;              /*Declares and initializes variable*/

    /* ......... */

    sta_cyc (cycid);                /*Start cyclic handler operation*/

    /* ......... */
}
```

Note These statements are unnecessary for the task which is created by the system configuration file because the cfg600px generates these statement into the “kernel_id.h”.

10.6.6 Stop cyclic handler operation

Moving to the non-operational state (STP state) is implemented by issuing the following service call from the processing program.

- stp_cyc, istp_cyc
  This service call moves the cyclic handler specified by parameter *cycid* from the operational state (STA state) to non-operational state (STP state).
  As a result, the target cyclic handler is excluded from activation targets of the RI600PX until issuance of sta_cyc or ista_cyc.
  The following describes an example for coding these service calls.

```
#include    "kernel.h"                  /*Standard header file definition*/
#include    "kernel_id.h"               /*Header file generated by cfg600px*/
#pragma task Task1                      /*Refer to note 2*/
void Task1 (VP_INT exinf);              /*Refer to note 2*/
void Task1 (VP_INT exinf)
{
    ID      cycid = 1;                  /*Declares and initializes variable*/

    /* ......... */

    stp_cyc (cycid);                    /*Stop cyclic handler operation*/

    /* ......... */
}
```

Note 1 This service call does not perform queuing of stop requests. If the target cyclic handler has been moved to the non-operational state (STP state), therefore, no processing is performed but it is not handled as an error.

Note 2 These statements are unnecessary for the task which is created by the system configuration file because the cfg600px generates these statement into the “kernel_id.h”.

10.6.7 Reference cyclic handler state

A cyclic handler status by issuing the following service call from the processing program.

- ref_cyc, iref_cyc
  Stores cyclic handler state packet (current state, time until the next activation, etc.) of the cyclic handler specified by parameter *cycid* in the area specified by parameter *pk_rcyc*.
  The following describes an example for coding these service calls.

```
#include    "kernel.h"              /*Standard header file definition*/
#include    "kernel_id.h"           /*Header file generated by cfg600px*/
#pragma task Task1                  /*Refer to note 2*/
void Task1 (VP_INT exinf);          /*Refer to note 2*/
void Task1 (VP_INT exinf)
{
    ID      cycid = 1;              /*Declares and initializes variable*/
    T_RCYC  pk_rcyc;                /*Declares data structure*/
    STAT    cycstat;                /*Declares variable*/
    RELTIM  lefttim;                /*Declares variable*/

    /* ......... */

    ref_cyc (cycid, &pk_rcyc);      /*Reference cyclic handler state*/

    cycstat = pk_rcyc.cycstat;      /*Reference current state*/
    lefttim = pk_rcyc.lefttim;      /*Reference time left before the next */
                                    /*activation*/

    /* ......... */
}
```

Note 1 For details about the cyclic handler state packet, refer to “[Cyclic handler state packet: T_RCYC]”.

Note 2 These statements are unnecessary for the task which is created by the system configuration file because the cfg600px generates these statement into the “kernel_id.h”.

10.7 Alarm Handlers

The alarm handler is a routine started when the specified time passes.
The RI600PX handles the alarm handler as a “non-task (module independent from tasks)”. Therefore, even if a task with the highest priority in the system is being executed, the processing is suspended when a specified time has elapsed, and the control is passed to the alarm handler.

10.7.1 Basic form of alarm handler

The following shows the basic form of alarm handlers. The extended information defined at creating the alarm handler is passed to the *exinf*.

```
#include    "kernel.h"              /*Standard header file definition*/
#include    "kernel_id.h"           /*Header file generated by cfg600px*/
#pragma alarmhand Almhdr1           /*Refer to note*/
void Almhdr1 (VP_INT exinf);        /*Refer to note*/
void Almhdr1 (VP_INT exinf)
{
    /* ......... */

    return;                         /*Terminate alarm handler*/
}
```

Note These statements are unnecessary for the alarm handler which is created by the system configuration file because the cfg600px generates these statement into the “kernel_id.h”.

10.7.2 Processing in alarm handler

- Stack
  A alarm handler uses the system stack.

- Service call
  The RI600PX handles the alarm handler as a “non-task”.
  The alarm handler can issue service calls whose “Useful range” is “Non-task”.

  Note If a service call (isig_sem, iset_flg, etc.) which causes dispatch processing (task scheduling processing) is issued in order to quickly complete the processing in the alarm handler during the interval until the processing in the alarm handler ends, the RI600PX executes only processing such as queue manipulation, counter manipulation, etc., and the actual dispatch processing is delayed until a return instruction is issued by the alarm handler, upon which the actual dispatch processing is performed in batch.

- PSW register when processing is started

Table 10-2 PSW Register When Alarm Handler is Started)

Bit	Value	Note
I	1	
IPL	Base clock interrupt priority level (IPL)	Do not lower IPL more than the start of processing.
PM	0	Supervisor mode
U	0	System stack
C, Z, S, O	Undefined	
Others	0	

10.7.3 Create alarm handler

Cyclic handlers are created by one of the following methods.

1) Creation by the system configuration file
The static API "alarm_hand[]" described in the system configuration file creates a cyclic handler.
Refer to "20.20 Alarm Handler Information (alarm_handl[])" for the details of "alarm_hand[]".

2) Creation by cre_alm or acre_alm
The cre_alm creates a cyclic handler with alarm handler ID indicated by parameter *almid* according to the content of parameter *pk_calm*.
The acre_cyc creates a alarm handler according to the content of parameter *pk_calm*, and returns the created alarm handler ID.
The information specified is shown below.

- Alarm handler attribute (*almatr*)
  Only TA_HLNG can be specified for *almatr*.
- Extended information (*exinf*)
- Alarm handler start address (*almhdr*)

These service calls can be called from tasks that belong to Trusted Domain.
The following describes an example for coding acre_alm as a representative.

```
#include    "kernel.h"              /*Standard header file definition*/
#include    "kernel_id.h"           /*Header file generated by cfg600px*/

extern void Almhdr1(VP_INT exinf);

#pragma task Task1                  /*Refer to note*/
void Task1 (VP_INT exinf);          /*Refer to note*/
void Task1 (VP_INT exinf)
{
    ER      almid;              /*Declares variable*/
    T_CALM  pk_calm = {         /*Declares and initializes variable*/
        TA_HLNG,                    /*Alarm handler attribute (cycatr)*/
        0,                          /*Extended information (exinf)*/
        (FP)Almhdr1                 /*Start address (almhdr)*/
    };

    /* ......... */

    almid = acre_alm ( &pk_calm );  /*Create alarm handler/

    /* ......... */
}
```

Note These statements are unnecessary for the task which is created by the system configuration file because the cfg600px generates these statement into the "kernel_id.h".

10.7.4 Delete alarm handler

- del_alm
  This service call deletes the alarm handler specified by parameter *almid*.
  This service call can be called from tasks that belong to Trusted Domain.
  The following describes an example for coding this service call.

```
#include    "kernel.h"               /*Standard header file definition*/
#include    "kernel_id.h"            /*Header file generated by cfg600px*/
#pragma task Task1                   /*Refer to note*/
void Task1 (VP_INT exinf);           /*Refer to note*/
void Task1 (VP_INT exinf)
{
    ID      almid = 8;           /*Declares and initializes variable*/

    /* ......... */

    ercd = del_alm ( almid );    /*Delete alarm handler*/

    /* ......... */
}
```

Note These statements are unnecessary for the task which is created by the system configuration file because the cfg600px generates these statement into the “kernel_id.h”.

10.7.5 Start alarm handler operation

Moving to the operational state (STA state) is implemented by issuing the following service call from the processing program.

- sta_alm, ista_alm
  This service call sets the activation time of the alarm handler specified by *almid* in *almtim* (msec), and moves the alarm handler from the non-operational state (STP state) to operational state (STA state).
  As a result, the target alarm handler is handled as an activation target of the RI600PX.
  The following describes an example for coding these service calls.

```
#include    "kernel.h"             /*Standard header file definition*/
#include    "kernel_id.h"          /*Header file generated by cfg600px*/
#pragma task Task1                 /*Refer to note 3*/
void Task1 (VP_INT exinf);         /*Refer to note 3*/
void Task1 (VP_INT exinf)
{
    ID      almid = 1;             /*Declares and initializes variable*/

    /* ......... */

    sta_alm (almid);               /*Start alarm handler operation*/

    /* ......... */
}
```

Note 1 When 0 is specified for *almtim*, the alarm handler will start at the next base clock interruption.

Note 2 When the target alarm handler has already started (STA state), this service call sets the activation time of the target alarm handler in *almtim* (msec) after canceling the activation time.

Note 3 These statements are unnecessary for the task which is created by the system configuration file because the cfg600px generates these statement into the “kernel_id.h”.

10.7.6 Stop alarm handler operation

Moving to the non-operational state (STP state) is implemented by issuing the following service call from the processing program.

- stp_alm, istp_alm
  This service call moves the alarm handler specified by parameter *cycid* from the operational state (STA state) to non-operational state (STP state).
  As a result, the target alarm handler is excluded from activation targets of the RI600PX until issuance of sta_alm or ista_alm.
  The following describes an example for coding these service calls.

```
#include    "kernel.h"                  /*Standard header file definition*/
#include    "kernel_id.h"               /*Header file generated by cfg600px*/
#pragma task Task1                      /*Refer to note 2*/
void Task1 (VP_INT exinf);              /*Refer to note 2*/
void Task1 (VP_INT exinf)
{
    ID      almid = 1;                  /*Declares and initializes variable*/

    /* ......... */

    stp_alm (almid);                    /*Stop alarm handler operation*/

    /* ......... */
}
```

Note 1 This service call does not perform queuing of stop requests. If the target alarm handler has been moved to the non-operational state (STP state), therefore, no processing is performed but it is not handled as an error.

Note 2 These statements are unnecessary for the task which is created by the system configuration file because the cfg600px generates these statement into the “kernel_id.h”.

10.7.7 Reference Alarm Handler State

A alarm handler status by issuing the following service call from the processing program.

- ref_alm, iref_alm
  Stores alarm handler state packet (current state, time until the next activation, etc.) of the alarm handler specified by parameter *cycid* in the area specified by parameter *pk_rcyc*.
  The following describes an example for coding these service calls.

```
#include    "kernel.h"              /*Standard header file definition*/
#include    "kernel_id.h"           /*Header file generated by cfg600px*/
#pragma task Task1                  /*Refer to note 2*/
void Task1 (VP_INT exinf);          /*Refer to note 2*/
void Task1 (VP_INT exinf)
{
    ID      almid = 1;              /*Declares and initializes variable*/
    T_RALM  pk_ralm;                /*Declares data structure*/
    STAT    almstat;                /*Declares variable*/
    RELTIM  lefttim;                /*Declares variable*/

    /* ......... */

    ref_alm (almid, &pk_ralm);      /*Reference alarm handler state*/

    almstat = pk_ralm.almstat;      /*Reference current state*/
    lefttim = pk_ralm.lefttim;      /*Reference time left */

    /* ......... */
}
```

Note 1 For details about the alarm handler state packet, refer to “[Alarm handler state packet: T_RALM]”.

Note 2 These statements are unnecessary for the task which is created by the system configuration file because the cfg600px generates these statement into the “kernel_id.h”.

10.8 System Time

10.8.1 Set system time

The system time can be set by issuing the following service call from the processing program.
Note that even if the system time is changed, the actual time at which the time management requests made before that (e.g., task time-outs, task delay by dly_tsk, cyclic handlers, and alarm handlers) are generated will not change.

- set_tim, iset_tim
  These service calls change the system time (unit: msec) to the time specified by parameter *p_systim*.
  The following describes an example for coding these service calls.

```
#include    "kernel.h"                  /*Standard header file definition*/
#include    "kernel_id.h"               /*Header file generated by cfg600px*/
#pragma task Task1                      /*Refer to note 2*/
void Task1 (VP_INT exinf);              /*Refer to note 2*/
void Task1 (VP_INT exinf)
{
    SYSTIM  p_systim;                   /*Declares data structure*/

    p_systim.ltime = 3600;              /*Initializes data structure*/
    p_systim.utime = 0;                 /*Initializes data structure*/

    /* ......... */

    set_tim (&p_systim);                /*Set system time*/

    /* ......... */
}
```

Note 1 For details about the system time packet SYSTIM, refer to "[System time packet: SYSTIM]".

Note 2 These statements are unnecessary for the task which is created by the system configuration file because the cfg600px generates these statement into the "kernel_id.h".

10.8.2 Reference system time

The system time can be referenced by issuing the following service call from the processing program.

- get_tim, iget_tim
  These service calls store the system time (unit: msec) into the area specified by parameter *p_systim*.
  The following describes an example for coding these service calls.

```
#include    "kernel.h"               /*Standard header file definition*/
#include    "kernel_id.h"            /*Header file generated by cfg600px*/
#pragma task Task1                   /*Refer to note 2*/
void Task1 (VP_INT exinf);           /*Refer to note 2*/
void Task1 (VP_INT exinf)
{
    SYSTIM  p_systim;                /*Declares data structure*/
    UW      ltime;                   /*Declares variable*/
    UH      utime;                   /*Declares variable*/

    /* ......... */

    get_tim (&p_systim);             /*Reference System Time*/

    ltime = p_systim.ltime;          /*Acquirer system time (lower 32 bits)*/
    utime = p_systim.utime;          /*Acquirer system time (higher 16 bits)*/

    /* ......... */
}
```

Note 1 For details about the system time packet SYSTIM, refer to “[System time packet: SYSTIM]”.

Note 2 These statements are unnecessary for the task which is created by the system configuration file because the cfg600px generates these statement into the “kernel_id.h”.

10.9 Base Clock Timer Initialization Routine (_RI_init_cmt_knl( ))

10.9.1 User-own cording module

The base clock timer initialization routine must be implemented as user-own coding module.

Note The source file for the base clock timer initialization routine provided by the RI600PX as a sample file is "init_cmt.c".

- Basic form of base clock timer initialization routine
  The following shows the basic form of base clock timer initialization routine.

```
#include    "kernel.h"                    // Provided by RI600PX
#include    "kernel_id.h"                 // Generated by cfg600px

#if (((_RI_CLOCK_TIMER) >=0) && ((_RI_CLOCK_TIMER) <= 3))
#include    "ri_cmt.h"
#endif

////////////////////////////////////////////////////////////
// Timer initialize call-back
////////////////////////////////////////////////////////////
void _RI_init_cmt_knl(void);
void _RI_init_cmt_knl(void)
{
#if (((_RI_CLOCK_TIMER) >=0) && ((_RI_CLOCK_TIMER) <= 3))
    _RI_init_cmt();
#endif
}
```

Note The function name of the base clock timer initialization routine is "_RI_init_cmt_knl".

- Description
  The base clock timer initialization routine is called by vsta_knl and ivsta_knl.
  The "_RI_CLOCK_TIMER" is macro generated in "kernel_id.h" by the cfg600px. The definition value for "_RI_CLOCK_TIMER" is depend on Selection of timer channel for base clock (timer) in the system configuration file. Details are shown below.

clock.timer	"_RI_CLOCK_TIMER" definition value
"CMT0"	0
"CMT1"	1
"CMT2"	2
"CMT3"	3
"OTHER"	0x7FFFFFFF
"NOTIMER"	-1

When "CMT0", "CMT1", "CMT2" or "CMT3" is specified for "clock.timer", the cfg600px generates the inline-function "void _RI_init_cmt(void)" for initializing the base clock timer. The _RI_init_cmt_knl() should be implemented only to call _RI_init_cmt().
When "OTHER" is specified for "clock.timer", the application must implement _RI_init_cmt_knl().

When “NOTIMER” is specified for “clock.timer”, the _RI_init_cmt_knl() should be implemented so that nothing may be processed.

- Stack
  The base clock timer initialization routine uses the system stack.

- Service call
  The base clock timer initialization routine can issue service calls whose “Useful range” is “Non-task”.

- PSW register when processing is started

Table 10-3 PSW Register When Base Clock Timer Initialization Routine is Started

Bit	Value	Note
I	1	
IPL	Kernel interrupt mask level (system_IPL)	Do not lower IPL more than the start of processing.
PM	0	Supervisor mode
U	0	System stack
C, Z, S, O	Undefined	
Others	0	

CHAPTER 11 SYSTEM STATE MANAGEMENT FUNCTIONS

This chapter describes the system management functions performed by the RI600PX.

11.1 Outline

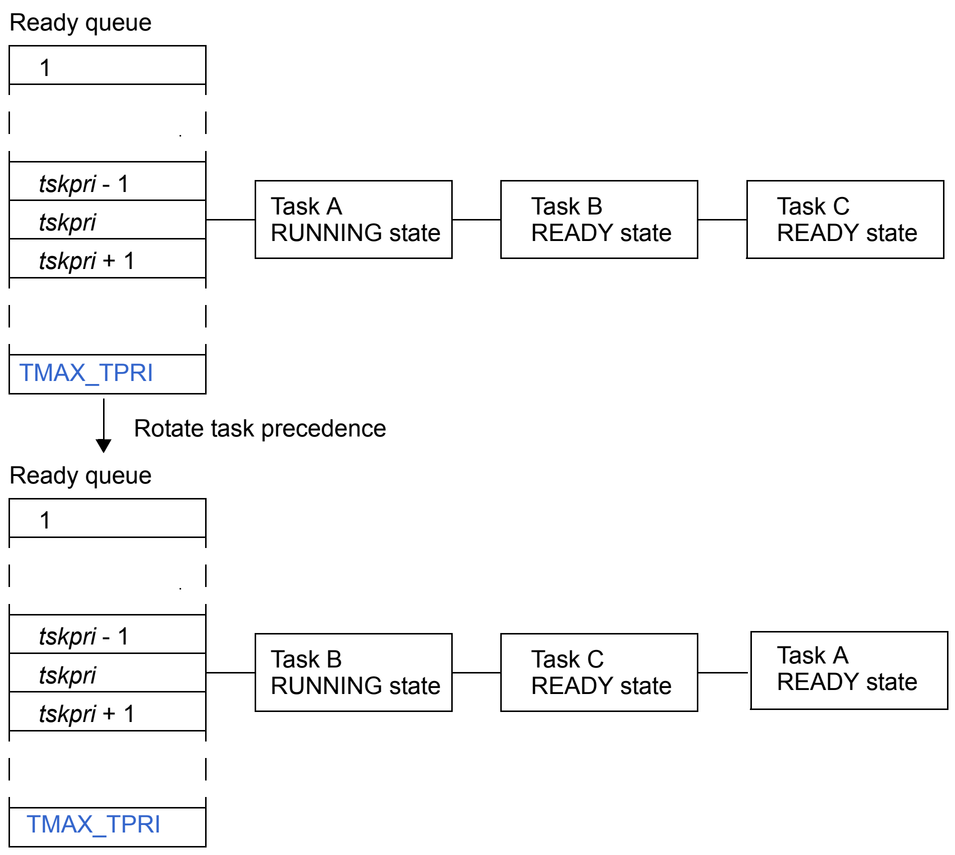
The RI600PX's system status management function provides functions for referencing the system status such as the context type and CPU lock status, as well as functions for manipulating the system status such as ready queue rotation, scheduler activation, or the like.
Note, refer to "CHAPTER 15 SYSTEM DOWN" for system down (vsys_dwn, ivsys_dwn) and refer to "CHAPTER 17 SYSTEM INITIALIZATION" for starting of the RI600PX (vsta_knl, ivsta_knl).

11.2 Rotate Task Precedence

Task precedence is rotated by issuing the following service call from the processing program.

- rot_rdq, irot_rdq
  This service call re-queues the first task of the ready queue corresponding to the priority specified by parameter *tskpri* to the end of the queue to change the task execution order explicitly.
  The following shows the status transition when this service call is used.

Figure 11-1 Rotate Task Precedence



The following describes an example for coding these service calls.

```
#include    "kernel.h"              /*Standard header file definition*/
#include    "kernel_id.h"           /*Header file generated by cfg600px*/
#pragma cychandler Cychdr1          /*refer to note 5*/
void Cychdr1 (VP_INT exinf);        /*refer to note 5*/
void Cychdr1 (VP_INT exinf)         /*Cyclic handler*/
{
    PRI     tskpri = 8;             /*Declares and initializes variable*/

    /* ......... */

    irot_rdq (tskpri);              /*Rotate task precedence*/

    /* ......... */

    return;                         /*Terminate cyclic handler*/
}
```

Note 1 This service call does not perform queuing of rotation requests. If no task is queued to the ready queue corresponding to the relevant priority, therefore, no processing is performed but it is not handled as an error.

Note 2 Round-robin scheduling can be implemented by issuing this service call via a cyclic handler in a constant cycle.

Note 3 The ready queue is a hash table that uses priority as the key, and tasks that have entered an executable state (READY state or RUNNING state) are queued in FIFO order.
Therefore, the scheduler realizes the RI600PX's scheduling system by executing task detection processing from the highest priority level of the ready queue upon activation, and upon detection of queued tasks, giving the CPU use right to the first task of the proper priority level.

Note 4 When TPRI_SELF is specified as *tskpri*, the base priority of the invoking task is applied as the target priority of this service call.
As for a task which has locked mutexes, the current priority might be different from the base priority. In this case, even if the task issues this servie call specifying TPRI_SELF as parameter *tskpri*, the ready queue of the current priority that the invoking task belongs cannot be changed.

Note 5 These statements are unnecessary for the cyclic handler which is created by the system configuration file because the cfg600px generates these statement into the “kernel_id.h”.

11.3 Reference Task ID in the RUNNING State

A RUNNING-state task is referenced by issuing the following service call from the processing program.

- get_tid, iget_tid
  These service calls store the ID of a task in the RUNNING state in the area specified by parameter *p_tskid*.
  The following describes an example for coding these service calls.

```
#include    "kernel.h"              /*Standard header file definition*/
#include    "kernel_id.h"           /*Header file generated by cfg600px*/

void Inthdr (void)                  /*Interrupt handler*/
{
    ID      p_tskid;                /*Declares variable*/

    /* ......... */

    iget_tid (&p_tskid);            /*Reference task ID in the RUNNING state*/

    /* ......... */

    return;                         /*Terminate interrupt handler*/
}
```

Note This service call stores TSK_NONE in the area specified by parameter *p_tskid* if no tasks that have entered the RUNNING state exist.

11.4 Lock and Unlock the CPU

In the CPU locked state, the task scheduling is prohibited, and kernel interrupts are masked. Therefore, exclusive processing can be achieved for all processing programs except non-kernel interrupt handlers.
The following service calls moves to the CPU locked state.

- loc_cpu, iloc_cpu
  These service calls transit the system to the CPU locked state.
  The service calls that can be issued in the CPU locked state are limited to the one listed below.

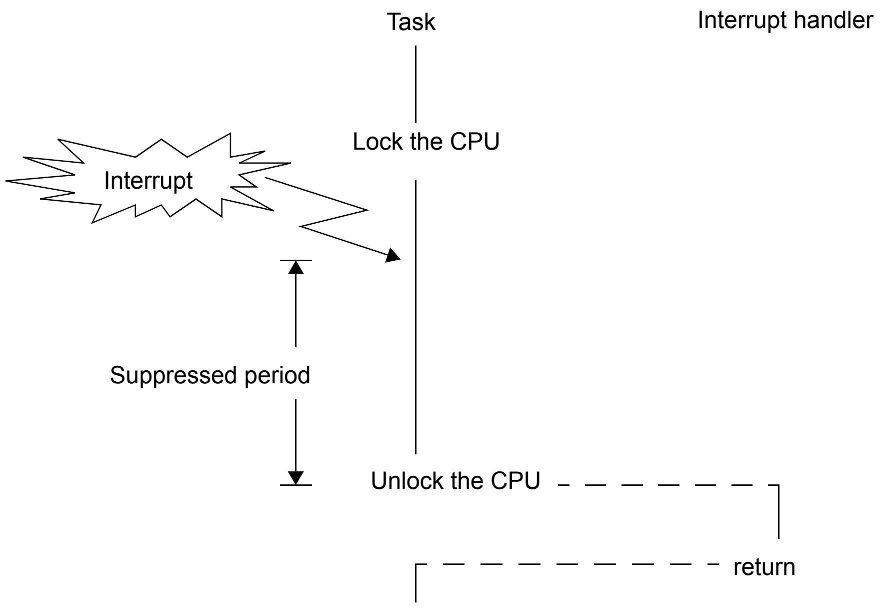
Service Call that can be issued	Function
ext_tsk	Terminate invoking task. (This service call transit the system to the CPU unlocked state.)
exd_tsk	Terminate and delete invoking task. (This service call transit the system to the CPU unlocked state.)
sns_tex	Reference task exception disabled state
loc_cpu, iloc_cpu	Lock the CPU.
unl_cpu, iunl_cpu	Unlock the CPU.
sns_loc	Reference CPU state.
sns_dsp	Reference dispatching state.
sns_ctx	Reference contexts.
sns_dpn	Reference dispatch pending state.
vsys_dwn, ivsys_dwn	System down

The following service calls and ext_tsk and exd_tsk release from the CPU locked state.

- unl_cpu, iunl_cpu
  These service calls transit the system to the CPU unlocked state.

The following shows a processing flow when using the CPU locked state.

Figure 11-2 Lock the CPU



The following describes an example for coding “lock the CPU” and “unlock the CPU”.

```
#include    "kernel.h"                  /*Standard header file definition*/
#include    "kernel_id.h"               /*Header file generated by cfg600px*/
#pragma task Task1                      /*Refer to note 7*/
void Task1 (VP_INT exinf);              /*Refer to note 7*/
void Task1 (VP_INT exinf)
{
    /* ......... */

    loc_cpu ();                         /*Lock the CPU*/

    /* ......... */                     /*CPU locked state*/

    unl_cpu ();                         /*Unlock the CPU*/

    /* ......... */
}
```

Note 1 The CPU locked state changed by issuing loc_cpu or iloc_cpu must be cancelled before the processing program that issued this service call ends.

Note 2 The loc_cpu and iloc_cpu do not perform queuing of lock requests. If the system is in the CPU locked state, therefore, no processing is performed but it is not handled as an error.

Note 3 The unl_cpu and iunl_cpu do not perform queuing of unlock requests. If the system is in the CPU unlocked state, therefore, no processing is performed but it is not handled as an error

Note 4 The unl_cpu and iunl_cpu do not cancel the dispatching disabled state that was set by issuing dis_dsp.

Note 5 The base clock interrupt is masked during the CPU locked state. Therefore, time handled by the TIME MANAGEMENT FUNCTIONS may be delayed if the period of the CPU locked state becomes long.

Note 6 For kernel interrupts, refer to “12.1 Interrupt Type”.

Note 7 These statements are unnecessary for the task which is created by the system configuration file because the cfg600px generates these statement into the “kernel_id.h”.

11.5 Reference CPU Locked State

It may be necessary to refer to current CPU locked state in functions that are called from two or more tasks and handlers. In this case, sns_loc is useful.

- sns_loc
  This service call examines whether the system is in the CPU locked state or not. This service call returns TRUE when the system is in the CPU locked state, and return FALSE when the system is in the CPU unlocked state.
  The following describes an example for coding this service call.

```
#include    "kernel.h"              /*Standard header file definition*/
#include    "kernel_id.h"           /*Header file generated by cfg600px*/

void CommonFunc ( void );
void CommonFunc ( void )
{
    BOOL ercd;                      /*Declares variable*/

    /* ......... */

    ercd = sns_loc ();              /*Reference CPU state*/

    if (ercd == TRUE) {
        /* ......... */             /*CPU locked state*/
    } else if (ercd == FALSE) {
        /* ......... */             /*CPU unlocked state*/
    }

    /* ......... */
}
```

11.6 Disable and Enable Dispatching

In the dispatching disabled state, the task scheduling is prohibited. Therefore, exclusive processing can be achieved for all tasks.
The following service call moves to the dispatching disabled state. And also when PSW.IPL is changed to other than 0 by using chg_ims, the system shifts to the dispatching disabled state.

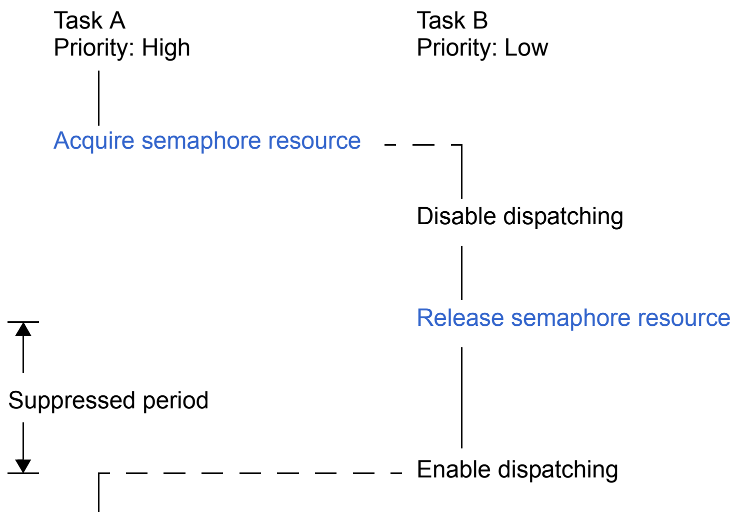
- dis_dsp
  This service call transits the system to the dispatching disabled state.

The dispatching disabled state is cancelled by the following service call, ext_tsk, exd_tsk and chg_ims that changes PSW.IPL to 0.

- ena_dsp
  This service call transits the system to the dispatching enabled state.

The following shows a processing flow when using the dispatching disabled state.

Figure 11-3 Disable Dispatching



The following describes an example for coding this service call.

```
#include    "kernel.h"                /*Standard header file definition*/
#include    "kernel_id.h"             /*Header file generated by cfg600px*/
#pragma task Task1                    /*Refer to note 5*/
void Task1 (VP_INT exinf);            /*Refer to note 5*/
void Task1 (VP_INT exinf)
{
    /* ......... */

    dis_dsp ();                       /*Disable dispatching*/

    /* ......... */                   /*Dispatching disabled state*/

    ena_dsp ();                       /*Enable dispatching*/

    /* ......... */
}
```

Note 1 The dispatching disabled state must be cancelled before the task that issued dis_dsp moves to the DORMANT state.

Note 2 The dis_dsp does not perform queuing of lock requests. If the system is in the dispatching disabled state, therefore, no processing is performed but it is not handled as an error.

Note 3 The ena_dsp does not perform queuing of unlock requests. If the system is in the dispatching enabled state, therefore, no processing is performed but it is not handled as an error

Note 4 If a service call (such as wai_sem, wai_flg) that may move the status of the invoking task is issued while the dispatching disabled state, that service call returns E_CTX regardless of whether the required condition is immediately satisfied.

Note 5 These statements are unnecessary for the task which is created by the system configuration file because the cfg600px generates these statement into the “kernel_id.h”.

11.7 Reference Dispatching Disabled State

It may be necessary to refer to current dispatching disabled state in functions that are called from two or more tasks . In this case, sns_dsp is useful.

- sns_dsp
  This service call examines whether the system is in the dispatching disabled state or not. This service call returns TRUE when the system is in the dispatching disabled state, and return FALSE when the system is in the dispatching enabled state.
  The following describes an example for coding this service call.

```
#include    "kernel.h"              /*Standard header file definition*/
#include    "kernel_id.h"           /*Header file generated by cfg600px*/

void CommonFunc ( void );
void CommonFunc ( void )
{
    BOOL ercd;                      /*Declares variable*/

    /* ......... */

    ercd = sns_dsp ();              /*Reference dispatching state*/

    if (ercd == TRUE) {
        /* ......... */             /*Dispatching disabled state*/
    } else if (ercd == FALSE) {
        /* ......... */             /*Dispatching enabled state*/
    }

    /* ......... */
}
```

11.8 Reference Context Type

It may be necessary to refer to current context type in functions that are called from two or more tasks and handlers. In this case, sns_ctx is useful.

- sns_ctx
  This service call examines the context type of the processing program that issues this service call. This service call returns TRUE when the processing program is non-task context, and return FALSE when the processing program is task context.
  The following describes an example for coding this service call.

```
#include    "kernel.h"              /*Standard header file definition*/
#include    "kernel_id.h"           /*Header file generated by cfg600px*/

void CommonFunc ( void );
void CommonFunc ( void )
{
    BOOL ercd;                      /*Declares variable*/

    /* ......... */

    ercd = sns_ctx ( );             /*Reference context type*/

    if (ercd == TRUE) {
        /* ......... */             /*Non-task contexts*/
    } else if (ercd == FALSE) {
        /* ......... */             /*Task contexts*/
    }

    /* ......... */
}
```

11.9 Reference Dispatch Pending State

The state to fill either the following is called dispatch pending state.

- Dispatching disabled state
- CPU locked state
- PSW.IPL > 0, such as handlers

It may be necessary to refer to current dispatch pending state in functions that are called from two or more tasks and handlers. In this case, sns_dpn is useful.

- sns_dpn
  This service call examines whether the system is in the dispatch pending state or not. This service call returns TRUE when the system is in the dispatch pending state, and return FALSE when the system is not in the dispatch pending state.
  The following describes an example for coding this service call.

```
#include    "kernel.h"              /*Standard header file definition*/
#include    "kernel_id.h"           /*Header file generated by cfg600px*/

void CommonFunc ( void );
void CommonFunc ( void )
{
    BOOL ercd;                      /*Declares variable*/

    /* ......... */

    ercd = sns_dpn ();              /*Reference dispatch pending state*/

    if (ercd == TRUE) {
        /* ......... */             /*Dispatch pending state*/
    } else if (ercd == FALSE) {
        /* ......... */             /*Other state*/
    }

    /* ......... */
}
```

CHAPTER 12 INTERRUPT MANAGEMENT FUNCTIONS

This chapter describes the interrupt management functions performed by the RI600PX.

12.1 Interrupt Type

Interrupts are classified into kernel interrupt and non-kernel interrupt.

- Kernel interrupt
  An interrupt whose interrupt priority level is lower than or equal to the kernel interrupt mask level is called the kernel interrupt.
  A kernel interrupt handler can issue service calls.
  Note, however, that handling of kernel interrupts generated during kernel processing may be delayed until the interrupts become acceptable.

- Non-kernel interrupt
  An interrupt whose interrupt priority level is higher than the kernel interrupt mask level is called the non-kernel interrupt. The non-maskable interrupt is classified into non-kernel interrupt.
  A non-kernel interrupt handler must not issue service calls.
  Non-kernel interrupts generated during service-call processing are immediately accepted whether or not kernel processing is in progress.

Note The kernel interrupt mask level id defined by Kernel interrupt mask level (system_IPL) in System Information (system).

12.2 Fast Interrupt of the RX-MCU

The RX-MCU supports the “fast interrupt” function. Only one interrupt source can be made the fast interrupt. The fast interrupt is handled as the one that has interrupt priority level 15. To use the fast interrupt function, make sure there is only one interrupt source that is assigned interrupt priority level 15.
For the fast interrupt function to be used in the RI600PX, it is necessary that the interrupt concerned be handled as an non-kernel interrupt. In other words, the kernel interrupt mask level must be set to 14 or below.
And “os_int = NO;” and “pragma_switch = F;” are required for interrupt_vector[] definition.
And the FINTV register of the RX-MCU must be initialized to the start address of the handler in the Boot processing function (PowerON_Reset_PC( )).

12.3 CPU Exception

The following CPU exceptions are handled as non-kernel interrupt.

- Unconditional trap (INT, BRK instruction)
  Note, INT #1 to #8 are reserved by the RI600PX.
- Undefined instruction exception
- Privileged instruction exception
- Floating-point exception

On the other hand, the access exception handler is handled as kernel interrupt.

12.4 Base Clock Timer Interrupt

The TIME MANAGEMENT FUNCTIONS is realized by using base clock timer interrupts that occur at constant intervals. When the base clock timer interrupt occurs, The RI600PX's time management interrupt handler is activated and executes time-related processing (system time update, delayed wake-up/time-out of task, cyclic handler activation, etc.).

12.5 Multiple Interrupts

In the RI600PX, occurrence of an interrupt in an interrupt handler is called “multiple interrupts”.
It can be set whether each interrupt handler for relocatable vector permits multiple interrupts. For details, refer to “20.21 Relocatable Vector Information (interrupt_vector[])”.

12.6 Interrupt Handlers

The interrupt handler is a routine dedicated to interrupt servicing that is activated when an interrupt occurs.
The RI600PX handles the interrupt handler as a non-task (module independent from tasks). Therefore, even if a task with the highest priority in the system is being executed, the processing is suspended when an interrupt occurs, and the control is passed to the interrupt handler.

12.6.1 Basic form of interrupt handlers

The following shows the basic form of interrupt handlers.

```
#include    "kernel.h"              /*Standard header file definition*/
#include    "kernel_id.h"           /*Header file generated by cfg600px*/

void Inthdr1 (void)
{
    /* ......... */

    return;                         /*Terminate interrupt handler*/
}
```

Note The cfg600px outputs the prototype declaration and #pragma interrupt directive for the handler function to kernel_id.h.

- Stack
  A interrupt handler uses the system stack.

- Service call
  The RI600PX handles the interrupt handler as a “non-task”.
  The kernel interrupt handler can issue service calls whose “Useful range” is “Non-task”.
  No service call can be issued in non-kernel interrupt handler.

  Note If a service call (isig_sem, iset_flg, etc.) which causes dispatch processing (task scheduling processing) is issued in order to quickly complete the processing in the interrupt handler during the interval until the processing in the interrupt handler ends, the RI600PX executes only processing such as queue manipulation, counter manipulation, etc., and the actual dispatch processing is delayed until a return instruction is issued by the interrupt handler, upon which the actual dispatch processing is performed in batch.

- PSW register when processing is started

Table 12-1 PSW Register When Interrupt Handler is Started

Bit	Value	Note
I	- “pragma_switch = E”: 1 - Other cases: 0	
IPL	- Interrupt: Interrupt priority level - CPU exception: Same before exception	Do not lower IPL more than the start of processing.
PM	0	Supervisor mode
U	0	System stack
C, Z, S, O	Undefined	
Others	0	

12.6.2 Register interrupt handler

The RI600PX supports the static registration of interrupt handlers only. They cannot be registered dynamically by issuing a service call from the processing program.
Static interrupt handler registration means defining of interrupt handlers using static API “interrupt_vector[]” (relocatable vector) and “interrupt_fvector[]” (fixed vector/exception vector) in the system configuration file.
For details about the static API “interrupt_vector[]”, refer to “20.21 Relocatable Vector Information (interrupt_vector[])”, and for details about the static API “interrupt_fvector[]”, refer to “20.22 Fixed Vector/Exception Vector Information (interrupt_fvector[])”.

12.7 Maskable Interrupt Acknowledgement Status in Processing Programs

The maskable interrupt acknowledgement status of RX-MCU depends on the values of PSW.I and PSW.IPL. See the hardware manual for details.
The initial status is determined separately for each processing program. See Table 12-2 for details.

Table 12-2 Maskable Interrupt Acknowledgement Status upon Processing Program Startup

Processing Program	PSW.I	PSW.IPL
Task	1	0
Task exception handling routine	1	Same as IPL in the task just before the task exception handling routine starts.
Cyclic handler, Alarm handler	1	Base clock interrupt priority level (IPL)
Interrupt Handler	- “pragma_switch = E”: 1 - Other cases: 0	- Interrupt: Interrupt priority level - CPU exception: Same before exception

12.8 Prohibit Maskable Interrupts

There is the following as a method of prohibiting maskable interrupts.

- Move to the CPU locked state by using loc_cpu, iloc_cpu
- Change PSW.IPL by using chg_ims, ichg_ims
- Change PSW.I and PSW.IPL directly (only for handlers)

12.8.1 Move to the CPU locked state by using loc_cpu, iloc_cpu

In the CPU locked state, PSW.IPL is changed to the Kernel interrupt mask level (system_IPL). Therefore, only kernel interrupts are prohibited in the CPU locked state.
Note, in the CPU locked state, service call issuance is restricted. For details, refer to "11.4 Lock and Unlock the CPU".

12.8.2 Change PSW.IPL by using chg_ims, ichg_ims

The PSW.IPL can be changed to arbitrary value by using chg_ims, ichg_ims.
When a task changes PSW.IPL to other than 0 by using chg_ims, the system is moved to the dispatching disabled state. When a task returns PSW.IPL to 0, the system returns to the dispatching enabled state.
Do not issue ena_dsp while a task changes PSW.IPL to other than 0 by using chg_ims. If issuing ena_dsp, the system moves to the dispatching enabled state. If task dispatching occurs, PSW is changed for the dispatched task. Therefore PSW.IPL may be lowered without intending it.
The handlers must not lower PSW.IPL more than it starts.

12.8.3 Change PSW.I and PSW.IPL directly (only for handlers)

The handlers can change PSW.I and PSW.IPL directly. This method is faster than ichg_ims.
The handlers must not lower PSW.IPL more than it starts.
Note, the compiler provides following intrinsic functions for operating PSW. See CubeSuite+ RX Build User's Manual for details about intrinsic functions.

- set_ipl(): Change PSW.IPL
- get_ipl(): Refer to PSW.IPL
- set_psw(): Change PSW
- get_psw(): Refer to PSW

CHAPTER 13 SYSTEM CONFIGURATION MANAGEMENT FUNCTIONS

This chapter describes the system configuration management functions performed by the RI600PX.

13.1 Outline

The RI600PX's system configuration management function provides the function to reference the version information.

13.2 Reference Version Information

The version information can be referenced by issuing the following service call from the processing program.

- ref_ver, iref_ver
  These service calls store the version information into the area specified by parameter *pk_rver*.
  The following describes an example for coding these service calls.

```
#include    "kernel.h"              /*Standard header file definition*/
#include    "kernel_id.h"           /*Header file generated by cfg600px*/
#pragma task Task1                  /*Refer to note 2*/
void Task1 (VP_INT exinf);          /*Refer to note 2*/
void Task1 (VP_INT exinf)
{
    T_RVER  pk_rver;                /*Declares data structure*/
    UH      maker;                  /*Declares variable*/
    UH      prid;                   /*Declares variable*/

    /* ......... */

    ref_ver (&pk_rver);             /*Reference version information/

    maker = pk_rver.maker;          /*Acquirer system time (lower 32 bits)*/
    prid = pk_rver.prid;            /*Acquirer system time (higher 16 bits)*/

    /* ......... */
}
```

Note 1 For details about the version information packet T_RVER, refer to “[Version information packet: T_RVER]”.

Note 2 These statements are unnecessary for the task which is created by the system configuration file because the cfg600px generates these statement into the “kernel_id.h”.

CHAPTER 14 OBJECT RESET FUNCTIONS

This chapter describes the object reset functions performed by the RI600PX.

14.1 Outline

The object reset function returns Data Queues, Mailboxes, Message Buffers, Fixed-Sized Memory Pools and Variable-Sized Memory Pools to the initial state. The object reset function falls outside μITRON4.0 specification.

14.2 Reset Data Queue

A data queue is reset by issuing the following service call from the processing program.

- vrst_dtq
  This service call reset the data queue specified by parameter *dtqid*.
  The data having been accumulated by the data queue area are annulled. The tasks to wait to send data to the target data queue are released from the WAITING state, and EV_RST is returned as a return value for the tasks.
  The following describes an example for coding this service call.

```
#include    "kernel.h"              /*Standard header file definition*/
#include    "kernel_id.h"           /*Header file generated by cfg600px*/
#pragma task Task1                  /*Refer to note 2*/
void Task1 (VP_INT exinf);          /*Refer to note 2*/
void Task1 (VP_INT exinf)
{
    ER      ercd;               /*Declares variable*/
    ID      dtqid = 1;          /*Declares and initializes variable*/

    /* ......... */

    ercd = vrst_dtq ( dtqid );  /*Reset data queue*/

    /* ......... */
}
```

Note 1 In this service call, the tasks to wait to receive data do not released from the WAITING state.

Note 2 These statements are unnecessary for the task which is created by the system configuration file because the cfg600px generates these statement into the “kernel_id.h”.

14.3 Reset Mailbox

A mailbox is reset by issuing the following service call from the processing program.

- vrst_mbx
  This service call reset the mailbox specified by parameter *mbxid*.
  The messages having been accumulated by the mailbox come off from the management of the RI600PX.
  The following describes an example for coding this service call.

```
#include    "kernel.h"                  /*Standard header file definition*/
#include    "kernel_id.h"               /*Header file generated by cfg600px*/
#pragma task Task1                      /*Refer to note 2*/
void Task1 (VP_INT exinf);              /*Refer to note 2*/
void Task1 (VP_INT exinf)
{
    ER      ercd;                   /*Declares variable*/
    ID      mbxid = 1;              /*Declares and initializes variable*/

    /* ......... */

    ercd = vrst_mbx ( mbxid) ;      /*Reset mailbox*/

   /* ......... */
}
```

Note 1 In this service call, the tasks to wait to receive message do not released from the WAITING state.

Note 2 These statements are unnecessary for the task which is created by the system configuration file because the cfg600px generates these statement into the “kernel_id.h”.

14.4 Reset Message Buffer

A message buffer is reset by issuing the following service call from the processing program.

- vrst_mbf
  This service call reset the message buffer specified by parameter *mbfid*.
  The messages having been accumulated by the message buffer area are annulled. The tasks to wait to send message to the target message buffer are released from the WAITING state, and EV_RST is returned as a return value for the tasks.
  The following describes an example for coding this service call.

```
#include    "kernel.h"                /*Standard header file definition*/
#include    "kernel_id.h"             /*Header file generated by cfg600px*/
#pragma task Task1                    /*Refer to note 2*/
void Task1 (VP_INT exinf);            /*Refer to note 2*/
void Task1 (VP_INT exinf)
{
    ER      ercd;                 /*Declares variable*/
    ID      mbfid = 1;            /*Declares and initializes variable*/

    /* ......... */

    ercd = vrst_mbf ( mbfid );    /*Reset message buffer*/

    /* ......... */
}
```

Note 1 In this service call, the tasks to wait to receive message do not released from the WAITING state.

Note 2 These statements are unnecessary for the task which is created by the system configuration file because the cfg600px generates these statement into the “kernel_id.h”.

14.5 Reset Fixed-sized Memory Pool

A fixed-sized memory pool is reset by issuing the following service call from the processing program.

- vrst_mpf
  This service call reset the fixed-sized memory pool specified by parameter *mpfid*.
  The tasks to wait to get memory block from the target fixed-sized memory pool are released from the WAITING state, and EV_RST is returned as a return value for the tasks.
  All fixed-sized memory blocks that had already been acquired are returned to the target fixed-sized memory pool. Therefore, do not access those fixed-sized memory blocks after issuing this service call.
  The following describes an example for coding this service call.

```
#include    "kernel.h"              /*Standard header file definition*/
#include    "kernel_id.h"           /*Header file generated by cfg600px*/
#pragma task Task1                  /*Refer to note*/
void Task1 (VP_INT exinf);          /*Refer to note*/
void Task1 (VP_INT exinf)
{
    ER      ercd;               /*Declares variable*/
    ID      mpfid = 1;          /*Declares and initializes variable*/

    /* ......... */

    ercd = vrst_mpf ( mpfid );  /*Reset fixed-sized memory pool*/

    /* ......... */
}
```

Note These statements are unnecessary for the task which is created by the system configuration file because the cfg600px generates these statement into the “kernel_id.h”.

14.6 Reset Variable-sized Memory Pool

A variable-sized memory pool is reset by issuing the following service call from the processing program.

- vrst_mpl
  This service call reset the variable-sized memory pool specified by parameter *mpfid*. The tasks to wait to get memory block from the target variable-sized memory pool are released from the WAITING state, and EV_RST is returned as a return value for the tasks.
  All variable-sized memory blocks that had already been acquired are returned to the target variable-sized memory pool. Therefore, do not access those variable-sized memory blocks after issuing this service call.
  The following describes an example for coding this service call.

```
#include    "kernel.h"               /*Standard header file definition*/
#include    "kernel_id.h"            /*Header file generated by cfg600px*/
#pragma task Task1                   /*Refer to note*/
void Task1 (VP_INT exinf);           /*Refer to note*/
void Task1 (VP_INT exinf)
{
    ER      ercd;                /*Declares variable*/
    ID      mplid = 1;           /*Declares and initializes variable*/

    /* ......... */

    ercd = vrst_mpl ( mplid );   /*Reset variable-sized memory pool*/

    if (ercd == E_OK) {

    /* ......... */
}
```

Note These statements are unnecessary for the task which is created by the system configuration file because the cfg600px generates these statement into the "kernel_id.h".

CHAPTER 15 SYSTEM DOWN

This chapter describes the system down functions performed by the RI600PX.

15.1 Outline

When the event that cannot be recovered while the RI600PX is operating occurs, the system down is caused and the system down routine is invoked.

15.2 User-Own Coding Module

The system down routine must be implemented as user-own coding module.

Note The source file for the system down routine provided by the RI600PX as a sample file is “sysdwn.c”.

15.2.1 System down routine (_RI_sys_dwn__( ))

The following shows the basic form of the system down routine. The system down routine must not return.

```
#include    "kernel.h"                /*Standard header file definition*/
#include    "kernel_id.h"             /*Header file generated by cfg600px*/

void  _RI_sys_dwn__ ( W type, VW inf1, VW inf2, VW inf3 ); /*Prototype declaration*/

void  _RI_sys_dwn__ ( W type, VW inf1, VW inf2, VW inf3 )
{
    /* ......... */

        while(1);
}
```

Note The function name of the system down routine is “_RI_sys_dwn__”.

- Stack
  The system down routine uses the system stack.

- Service call
  The system down routine must not issue service calls.

- PSW register when processing is started

Table 15-1 PSW Register When System Down Routine is Started

Bit	Value	Note
I	0	
IPL	- *type* < 0 : Undefined - *type* >= 0 : Same before system down	Do not lower IPL more than the start of processing.
PM	0	Supervisor mode
U	0	System stack
C, Z, S, O	undefined	
Others	0	

15.2.2 Parameters of system down routine

- *type* == -1 (Error when a kernel interrupt handler ends)

Table 15-2 Parameters of System Down Routine (*type* == -1)

inf1	inf2	inf3	Description
E_CTX (-25)	2	undefined	PSW.PM == 1 (user mode) when a kernel interrupt handler ends.
	3	undefined	PSW.IPL > kernel interrupt mask level when a kernel interrupt handler ends.
	5	undefined	The system is in the CPU locked state when a kernel interrupt handler ends.
E_MACV (-26)	12	undefined	Stack pointer points for the interrupted task points out of user stack for the task.

- *type* == -2 (Error in ext_tsk)

Table 15-3 Parameters of System Down Routine (*type* == -2)

inf1	inf2	inf3	Description
E_CTX (-25)	1	undefined	The ext_tsk is called in the non-task context.
	4	undefined	The ext_tsk is called in the state “PSW.IPL > Kernel interrupt mask level”.

- *type* == -3 (Unlinked service call issued)

Table 15-4 Parameters of System Down Routine (*type* == -3)

inf1	inf2	inf3	Description
E_NOSPT (-9)	undefined	undefined	Unlinked service call is issued.

Note Refer to “2.6.1 Service call information files and “-ri600_preinit_mrc” compiler option”.

- *type* == -4 (Error at returning from task exception handling routine)

Table 15-5 Parameters of System Down Routine (*type* == -4)

inf1	inf2	inf3	Description
E_CTX (-25)	7	undefined	A task exception handling routine returns in the state “PSW.IPL > Kernel interrupt mask level”.
	8	undefined	A task exception handling routine returns in the CPU locked state.
	9	undefined	A task exception handling routine returns in the non-task context.

- *type* == -5 (Error in exd_tsk)

Table 15-6 Parameters of System Down Routine (*type* == -5)

inf1	inf2	inf3	Description
E_CTX (-25)	10	undefined	The exd_tsk is called in the state “PSW.IPL > Kernel interrupt mask level”.
	11	undefined	The exd_tsk is called in the non-task context.

- *type* == -6 (Error in vsta_knl and ivsta_knl)

Table 15-7 Parameters of System Down Routine (*type* == -6)

inf1	inf2	inf3	Description	
E_PAR (-17)	15	undefined	Error regarding to registration of memory object (memory_object[])	1) Start address is not 16-bytes boundary. 2) Bit15 of either acptn1, acptn2 or acptn3 is 1. 3) acptn1 == acptn2 == acptn3 == 0 4) Bits corresponded to the domain ID that is larger than the maximum domain ID (VTMAX_DOMAIN) of either acptn1, acptn2 or acptn3 is 1. 5) Start address > termination address
E_OBJ (-41)		undefined		Multiple memory object with the same address are registered.
E_OACV (-27)		undefined		The number of memory objects from which the access is permitted to one domain exceeds 7.
E_PAR (-17)	16	undefined	Error regarding to task creation (task[])	The “termination address of user stack + 1” is not 16-bytes boundary.

- *type* == -16 (Undefined relocatable vector interrupt)

Table 15-8 Parameters of System Down Routine (*type* == -16)

inf1	inf2	inf3
- “-U” option is not specified for cfg600px Undefined - “-U” option is specified for cfg600px Vector number	PC, which is pushed to the stack by CPU’s interrupt operation	PSW, which is pushed to the stack by CPU’s interrupt operation

- *type* == -17 (Undefined fixed vector/exception vector interrupt)

Table 15-9 Parameters of System Down Routine (type == -17)

inf1	inf2	inf3
- “-U” option is not specified for cfg600px Undefined - “-U” option is specified for cfg600px Vector number	PC, which is pushed to the stack by CPU’s interrupt operation	PSW, which is pushed to the stack by CPU’s interrupt operation

- *type* > 0 (Issuing vsys_dwn, ivsys_dwn from application))
  0 and a negative *type* value is reserved by the RI600PX. When calling vsys_dwn, ivsys_dwn from application, use positive *type* value.

Table 15-10 Parameters of System Down Routine (type > 0)

inf1	inf2	inf3
Value specified for vsys_dwn, ivsys_dwn		

CHAPTER 16 SCHEDULING FUNCTION

This chapter describes the scheduler of the RI600PX.

16.1 Outline

The scheduling functions provided by the RI600PX consist of functions manage/decide the order in which tasks are executed by monitoring the transition states of dynamically changing tasks, so that the CPU use right is given to the optimum task.

16.2 Processing Unit and Precedence

An application program is executed in the following processing units.

- Task (including task exception handling routine)
- Interrupt handler
- Cyclic handler
- Alarm handler
- Access exception handler

The various processing units are processed in the following order of precedence.

1) Interrupt handlers, cyclic handlers, alarm handlers

2) Access exception handler

3) Scheduler

4) Tasks (including task exception handling routines)

The “scheduler” is the RI600PX’s processing that schedules running task and dispatches to the task.
Since interrupt handler, cyclic handlers, alarm handlers and access exception handler have higher precedence than the scheduler, no tasks and no task exception handling routines are executed while these handlers are executing. (Refer to “16.7 Task Scheduling in Non-Tasks”).
The precedence of an interrupt handler becomes higher when the interrupt level is higher.
The precedence of a cyclic handler and alarm handler is the same as the interrupt handler which interrupt level is same as the base clock timer interrupt.
The order of precedence for tasks depends on the current priority of the tasks.

16.3 Task Drive Method

The RI600PX employs the Event-driven system in which the scheduler is activated when an event (trigger) occurs.

- Event-driven system
  Under the event-driven system of the RI600PX, the scheduler is activated upon occurrence of the events listed below and dispatch processing (task scheduling processing) is executed.
  - Issuance of service call that may cause task state transition
  - Issuance of instruction for returning from non-task (cyclic handler, interrupt handler, etc.)
  - Occurrence of base clock interrupt used when achieving TIME MANAGEMENT FUNCTIONS

16.4 Task Scheduling Method

As task scheduling methods, the RI600PX employs the Priority level method, which uses the priority level defined for each task, and the FCFS method, which uses the time elapsed from the point when a task becomes target to RI600PX scheduling.

- Priority level method

  A task with the highest current priority is selected from among all the tasks that have entered an executable state (RUNNING state or READY state), and given the CPU use right.

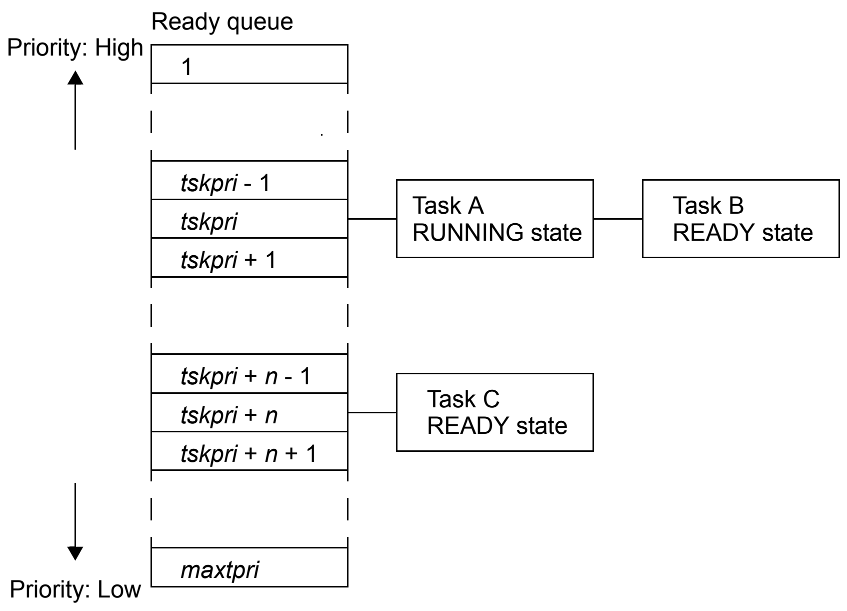
- FCFS method

  When two or more “task with the highest priority level” exist, the scheduling target task can not be decided only by the Priority level method. In this case, the RI600PX decides the scheduling target task by first come first served (FCFS) method. Concretely, the task that enters to executable state (READY state) earliest among them, and given the CPU use right.

16.4.1 Ready queue

The RI600PX uses a “ready queue” to implement task scheduling.
The ready queue is a hash table that uses priority as the key, and tasks that have entered an executable state (READY state or RUNNING state) are queued in FIFO order. Therefore, the scheduler realizes the RI600PX's scheduling method (priority level or FCFS) by executing task detection processing from the highest priority level of the ready queue upon activation, and upon detection of queued tasks, giving the CPU use right to the first task of the proper priority level.
The following shows the case where multiple tasks are queued to a ready queue.

Figure 16-1 Implementation of Scheduling Method (Priority Level Method or FCFS Method)

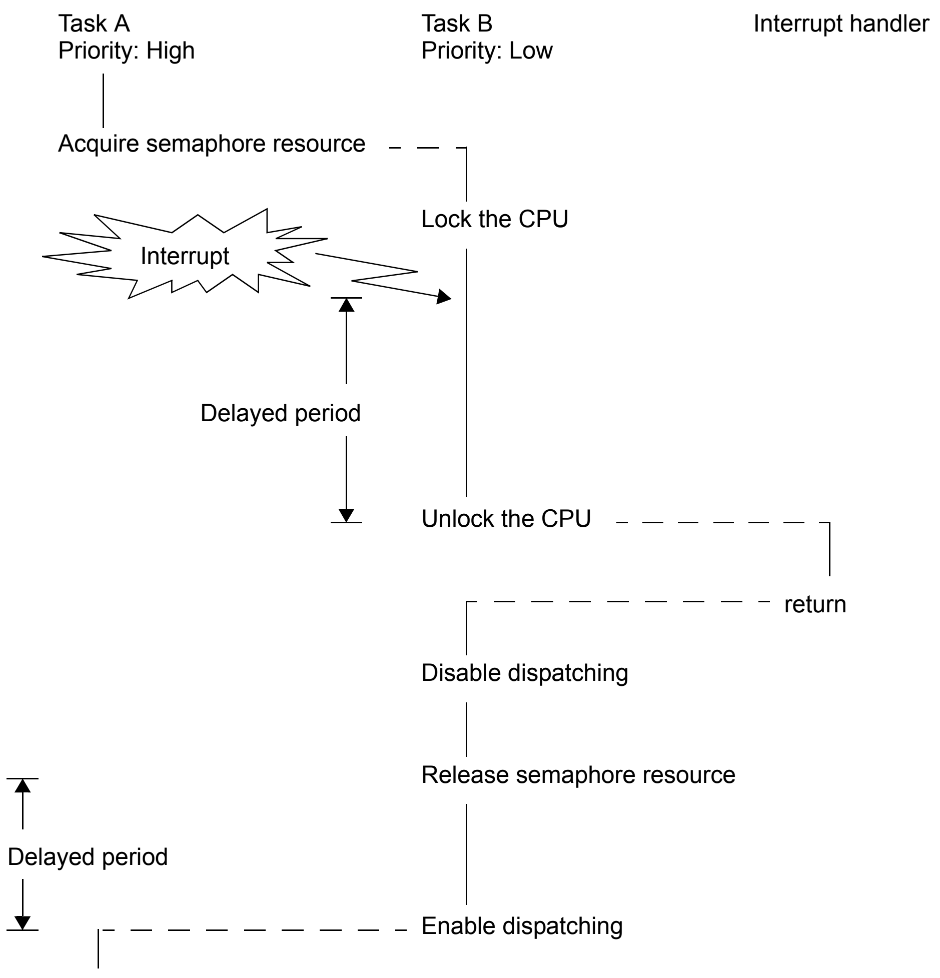


- Create ready queue
  In the RI600PX, the method of creating a ready queue is limited to “static creation”.
  Ready queues therefore cannot be created dynamically using a method such as issuing a service call from a processing program.
  Static ready queue creation means defining of Maximum task priority (priority) in System Information (system) in the system configuration file.

16.5 Task Scheduling Lock Function

The RI600PX provides the scheduling lock function for manipulating the scheduler status explicitly from the processing program and disabling/enabling dispatch processing.
The following shows a processing flow when using the scheduling lock function.

Figure 16-2 Scheduling Lock Function



For details, refer to “11.4 Lock and Unlock the CPU” and “11.6 Disable and Enable Dispatching”.

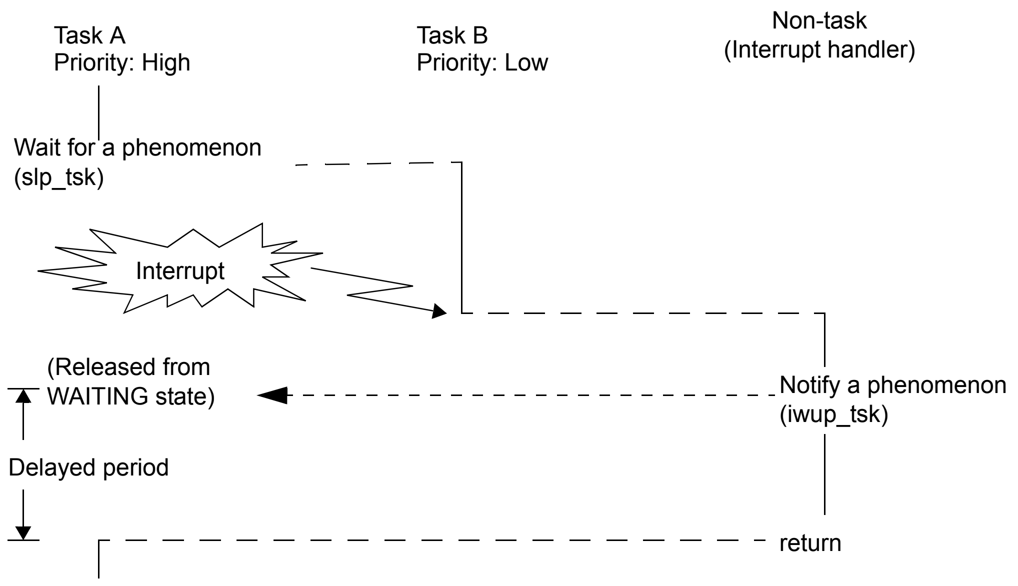
16.6 Idling

When there is no RUNNING or READY task, the RI600PX enters an endless loop and waits for interrupts.

16.7 Task Scheduling in Non-Tasks

If processing of non-tasks starts, any tasks will not be performed until non-task processing is completed, since the precedence of non-task (interrupt handler, cyclic handler, alarm handler and access exception handler) is higher than task as shown in "16.2 Processing Unit and Precedence".
The following shows a example when a service call accompanying dispatch processing is issued in non-tasks. In this example, when the interrupt handler issues iwup_tsk, the Task A whose priority is higher than the task B is released from the WAITING state, but processing of the interrupt handler is continued at this time, without performing the task A yet. When processing of the interrupt handler is completed, the scheduler is started, and as a result, the task A is performed.

Figure 16-3 Scheduling in Non-Tasks



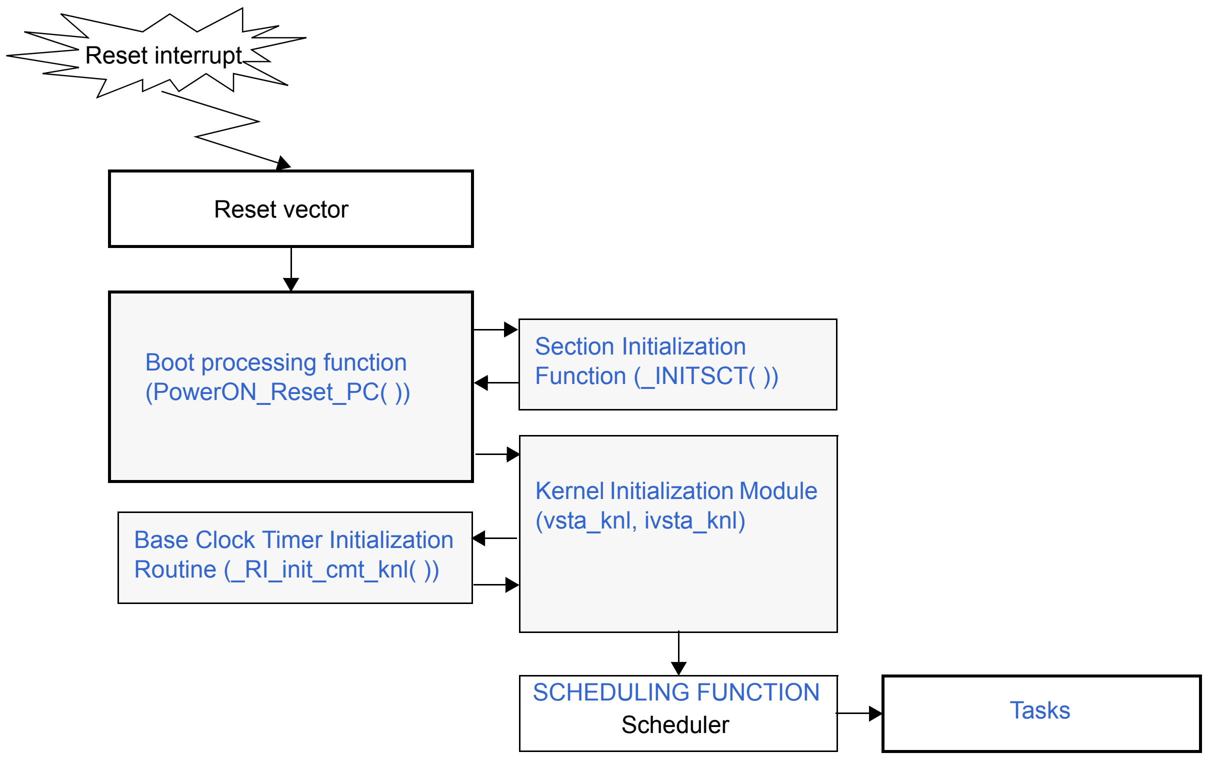
CHAPTER 17 SYSTEM INITIALIZATION

This chapter describes the system initialization routine performed by the RI600PX.

17.1 Outline

The following shows a processing flow from when a reset interrupt occurs until the control is passed to the task.

Figure 17-1 Processing Flow (System Initialization)


Reset interrupt
Reset vector
Boot processing function (PowerON_Reset_PC( ))
Section Initialization Function (_INITSCT( ))
Kernel Initialization Module (vsta_knl, ivsta_knl)
Base Clock Timer Initialization Routine (_RI_init_cmt_knl( ))
SCHEDULING FUNCTION
Scheduler
Tasks

17.2 Boot Processing File (User-Own Coding Module)

The following should be described in the boot processing file.

1) Boot processing function (PowerON_Reset_PC( ))

2) Include kernel_ram.h and kernel_rom.h

Note The boot processing file which is provided by the RI600PX as a sample file is “resetprg.c”.

17.2.1 Boot processing function (PowerON_Reset_PC( ))

The boot processing function is the program registered in the reset vector, and is executed in supervisor mode. Generally, following processing are required in the boot processing function.

- Initialize the processor and hardwares
  If using Fast Interrupt of the RX-MCU, initialize the FINTV register to the start address of the fast interrupt handler.
- Initialize C/C++ runtime environment (Initialize sections, etc.)
- Start the RI600PX (call vsta_knl or ivsta_knl)

- Basic form of boot processing function
  The boot processing function should be implemented as “void PowerON_Reset_PC(void)”. When the name of the boot processing function is other, it is necessary to define the function name to “interrupt_fvector[31]” in the system configuration file.

Note For the details of the details of the static API “interrupt_fvector[]”, refer to “20.22 Fixed Vector/Exception Vector Information (interrupt_fvector[])”.

- The points of concern about the boot processing function
  - Stack
    Describe #pragma entry directive to be shown below. Thereby, the object code which sets the stack pointer (ISP) as the system stack at the head of the boot processing function is generated.

```
#pragma entry PowerON_Reset_PC
```

  - PSW register
    Keep the status that all interrupts are prohibited and in the supervisor mode until calling the Kernel Initialization Module (vsta_knl, ivsta_knl). This status is satisfied just behind CPU reset (PSW.I=0, PSW.PM=0). Generally, the boot processing function should not change the PSW.
  - EXTB register (RXv2 architecture)
    Initialize EXTB register to the start address of FIX_INTERRUPT_VECTOR section if needed. Please refer to “FIX_INTERRUPT_VECTOR section” in section 2.6.4.
  - Service call
    Since the boot processing function is executed before executing of Kernel Initialization Module (vsta_knl, ivsta_knl), service calls except vsta_knl and ivsta_knl must not be called from the boot processing function.

17.2.2 Include kernel_ram.h and kernel_rom.h

The boot processing file must include “kernel_ram.h” and “kernel_rom.h”, which are generated by the cfg600px, in this order.

17.2.3 Compiler option for boot processing file

The following compiler options are required for the boot processing file.

- “-lang=c” or “-lang=c99”
- “-nostuff”
- Suitable “-isa” or “-cpu”

Note Compiler option "-isa" is supported by the compiler CC-RX V2.01 or later.

17.2.4 Example of the boot processing file

```
#include    <machine.h>
#include    <_h_c_lib.h>
//#include  <stddef.h>                    // Remove the comment when you use errno
//#include  <stdlib.h>                    // Remove the comment when you use rand()
#include    "typedefine.h"                // Define Types
#include    "kernel.h"                    // Provided by RI600PX
#include    "kernel_id.h"                 // Generated by cfg600px

#ifdef __cplusplus
extern "C" {
#endif
void PowerON_Reset_PC(void);
#ifdef __cplusplus
}
#endif

// #ifdef __cplusplus                  // Use SIM I/O
// extern "C" {
// #endif
// extern void _INIT_IOLIB(void);
// extern void _CLOSEALL(void);
// #ifdef __cplusplus
// }
// #endif


#define FPSW_init 0x00000000  // FPSW bit base pattern

// extern void srand(_UINT);      // Remove the comment when you use rand()
// extern _SBYTE *_s1ptr;         // Remove the comment when you use strtok()

// #ifdef __cplusplus                  // Use Hardware Setup
// extern "C" {
// #endif
// extern void HardwareSetup(void);
// #ifdef __cplusplus
// }

// #endif

// #ifdef __cplusplus    // Remove the comment when you use global class object
// extern "C" {                   // Sections C$INIT and C$END will be generated
// #endif
// extern void _CALL_INIT(void);
// extern void _CALL_END(void);
// #ifdef __cplusplus
// }
// #endif
```

```
////////////////////////////////////////////////////////////
// Section definition
////////////////////////////////////////////////////////////
#pragma section P PS
#pragma section B BS
#pragma section C CS
#pragma section D DS

#pragma entry PowerON_Reset_PC

////////////////////////////////////////////////////////////
// Boot processing
////////////////////////////////////////////////////////////
void PowerON_Reset_PC(void)
{
#ifdef __ROZ                           // Initialize FPSW
#define _ROUND 0x00000001              // Let FPSW RMbits=01 (round to zero)
#else
#define _ROUND 0x00000000              // Let FPSW RMbits=00 (round to nearest)
#endif
#ifdef __DOFF
#define _DENOM 0x00000100              // Let FPSW DNbit=1 (denormal as zero)
#else
#define _DENOM 0x00000000              // Let FPSW DNbit=0 (denormal as is)
#endif

//     set_extb(__sectop("FIX_INTERRUPT_VECTOR"));// Initialize EXTB register
                                                //   (only for RXv2 arch.)
    set_fpsw(FPSW_init | _ROUND | _DENOM);

    _INITSCT();                        // Initialize Sections

//  _INIT_IOLIB();                     // Use SIM I/O

//  errno=0;                           // Remove the comment when you use errno
//  srand((_UINT)1);                   // Remove the comment when you use rand()
//  _s1ptr=NULL;                       // Remove the comment when you use strtok()

//  HardwareSetup();                   // Use Hardware Setup
    nop();

//  set_fintv(<handler address>);      // Initialize FINTV register

//  _CALL_INIT();              // Remove the comment when you use global class object

    vsta_knl();                        // Start RI600PX
                                       // Never return from vsta_knl

//  _CLOSEALL();                       // Use SIM I/O

//  _CALL_END();               // Remove the comment when you use global class object

    brk();

}
//////////////////////////////////////////////////////////////////////////////
// RI600PX system data
//////////////////////////////////////////////////////////////////////////////
#include "kernel_ram.h"      // generated by cfg600px
#include "kernel_rom.h"      // generated by cfg600px
```

17.3 Kernel Initialization Module (vsta_knl, ivsta_knl)

The kernel initialization module is executed by calling vsta_knl, ivsta_knl. Generally, vsta_knl, ivsta_knl is called from the Boot processing function (PowerON_Reset_PC( )).
The following processing is executed in the kernel initialization module.

1) Initialize ISP register to the end address of SI section + 1

2) Initialize INTB register to the start address of the relocatable vector table (INTERRUPT_VECTOR section). The relocatable vector table is generated by the cfg600px.

3) Initialize the system time to 0.

4) Create various object which are defined in the system configuration file. If an error is detected in this process, the system will be down.

5) Initialize MPU (Memory Protection Unit).

6) Initialize base clock timer (call Base Clock Timer Initialization Routine (_RI_init_cmt_knl( )))

7) Pass control to scheduler

17.4 Section Initialization Function (_INITSCT( ))

The section initialization function "_INITSCT()" called from Boot processing function (PowerON_Reset_PC( )) is provided by the compiler. The _INITSCT() clears the uninitialized data section to 0 and initializes the initialized data section in order to the tables described in the Section information file (User-Own Coding Module).
The user needs to write the sections to be initialized to the tables for section initialization (DTBL and BTBL) in the section information file. The section address operator is used to set the start and end addresses of the sections used by the _INITSCT(). Section names in the section initialization tables are declared, using C$BSEC for uninitialized data areas, and C$DSEC for initialized data areas.
Initialized sections written in DTBL must be mapped from ROM to RAM by using "-rom" linker option. For details, refer to "2.6.5 Initialized data section".

Note See "CubeSuite+ Integrated Development Environment User's Manual: RX Coding" for details of the _INITSCT().

17.4.1 Section information file (User-Own Coding Module)

The section information file should be implemented as user-own coding module.
The example of the section information file is shown below.

Note The section information file which is provided by the RI600PX as a sample file is “dbsct.c”.

```
#include "typedefine.h"

#pragma unpack

#pragma section C C$DSEC
extern const struct {
    _UBYTE *rom_s;       /* Start address of the initialized data section in ROM */
    _UBYTE *rom_e;       /* End address of the initialized data section in ROM   */
    _UBYTE *ram_s;       /* Start address of the initialized data section in RAM */
}   _DTBL[] = {
    { __sectop("D"), __secend("D"), __sectop("R") },
    { __sectop("D_2"), __secend("D_2"), __sectop("R_2") },
    { __sectop("D_1"), __secend("D_1"), __sectop("R_1") },
    { __sectop("DS"), __secend("DS"), __sectop("RS") },
    { __sectop("DS_2"), __secend("DS_2"), __sectop("RS_2") },
    { __sectop("DS_1"), __secend("DS_1"), __sectop("RS_1") },
    { __sectop("DU_SH"), __secend("DU_SH"), __sectop("RU_SH") },
    { __sectop("DU_SH_2"), __secend("DU_SH_2"), __sectop("RU_SH_2") },
    { __sectop("DU_SH_1"), __secend("DU_SH_1"), __sectop("RU_SH_1") },
    { __sectop("DU_MASTERDOM"), __secend("DU_MASTERDOM"),
                                          __sectop("RU_MASTERDOM") },
    { __sectop("DU_MASTERDOM_2"), __secend("DU_MASTERDOM_2"),
                                          __sectop("RU_MASTERDOM_2") },
    { __sectop("DU_MASTERDOM_1"), __secend("DU_MASTERDOM_1"),
                                          __sectop("RU_MASTERDOM_1") },
    { __sectop("DU_DOM_A"), __secend("DU_DOM_A"), __sectop("RU_DOM_A") },
    { __sectop("DU_DOM_A_2"), __secend("DU_DOM_A_2"), __sectop("RU_DOM_A_2") },
    { __sectop("DU_DOM_A_1"), __secend("DU_DOM_A_1"), __sectop("RU_DOM_A_1") },
    { __sectop("DU_DOM_B"), __secend("DU_DOM_B"), __sectop("RU_DOM_B") },
    { __sectop("DU_DOM_B_2"), __secend("DU_DOM_B_2"), __sectop("RU_DOM_B_2") },
    { __sectop("DU_DOM_B_1"), __secend("DU_DOM_B_1"), __sectop("RU_DOM_B_1") }
};

#pragma section C C$BSEC
extern const struct {
    _UBYTE *b_s;          /* Start address of non-initialized data section */
    _UBYTE *b_e;          /* End address of non-initialized data section */
}   _BTBL[] = {
    { __sectop("B"), __secend("B") },
    { __sectop("B_2"), __secend("B_2") },
    { __sectop("B_1"), __secend("B_1") },
    { __sectop("BS"), __secend("BS") },
    { __sectop("BS_2"), __secend("BS_2") },
    { __sectop("BS_1"), __secend("BS_1") },
    { __sectop("BU_SH"), __secend("BU_SH") },
    { __sectop("BU_SH_2"), __secend("BU_SH_2") },
    { __sectop("BU_SH_1"), __secend("BU_SH_1") },
    { __sectop("DU_MASTERDOM"), __secend("DU_MASTERDOM"),
                                            __sectop("RU_MASTERDOM") },
    { __sectop("DU_MASTERDOM_2"), __secend("DU_MASTERDOM_2"),
                                            __sectop("RU_MASTERDOM_2") },
    { __sectop("DU_MASTERDOM_1"), __secend("DU_MASTERDOM_1"),
                                            __sectop("RU_MASTERDOM_1") },
    { __sectop("DU_DOM_A"), __secend("DU_DOM_A"), __sectop("RU_DOM_A") },
    { __sectop("DU_DOM_A_2"), __secend("DU_DOM_A_2"), __sectop("RU_DOM_A_2") },
    { __sectop("DU_DOM_A_1"), __secend("DU_DOM_A_1"), __sectop("RU_DOM_A_1") },
    { __sectop("DU_DOM_B"), __secend("DU_DOM_B"), __sectop("RU_DOM_B") },
    { __sectop("DU_DOM_B_2"), __secend("DU_DOM_B_2"), __sectop("RU_DOM_B_2") },
    { __sectop("DU_DOM_B_1"), __secend("DU_DOM_B_1"), __sectop("RU_DOM_B_1") }
};

#pragma section C C$BSEC
extern const struct {
    _UBYTE *b_s;         /* Start address of non-initialized data section */
    _UBYTE *b_e;         /* End address of non-initialized data section */
}   _BTBL[] = {
    { __sectop("B"), __secend("B") },
    { __sectop("B_2"), __secend("B_2") },
    { __sectop("B_1"), __secend("B_1") },
    { __sectop("BS"), __secend("BS") },
    { __sectop("BS_2"), __secend("BS_2") },
    { __sectop("BS_1"), __secend("BS_1") },
    { __sectop("BU_SH"), __secend("BU_SH") },
    { __sectop("BU_SH_2"), __secend("BU_SH_2") },
    { __sectop("BU_SH_1"), __secend("BU_SH_1") },
    { __sectop("BU_MASTERDOM"), __secend("BU_MASTERDOM") },
    { __sectop("BU_MASTERDOM_2"), __secend("BU_MASTERDOM_2") },
    { __sectop("BU_MASTERDOM_1"), __secend("BU_MASTERDOM_1") },
    { __sectop("BU_DOM_A"), __secend("BU_DOM_A") },
    { __sectop("BU_DOM_A_2"), __secend("BU_DOM_A_2") },
    { __sectop("BU_DOM_A_1"), __secend("BU_DOM_A_1") },
    { __sectop("BU_DOM_B"), __secend("BU_DOM_B") },
    { __sectop("BU_DOM_B_2"), __secend("BU_DOM_B_2") },
    { __sectop("BU_DOM_B_1"), __secend("BU_DOM_B_1") }
};
#pragma section

/*
** CTBL prevents excessive output of L1100 messages when linking.
** Even if CTBL is deleted, the operation of the program does not change.
*/
_UBYTE * const _CTBL[] = {
    __sectop("C_1"), __sectop("C_2"), __sectop("C"),
    __sectop("W_1"), __sectop("W_2"), __sectop("W"),
    __sectop("CU_MASTERDOM_1"), __sectop("CU_MASTERDOM_2"),
    __sectop("CU_MASTERDOM"),
    __sectop("CU_DOM_A_1"), __sectop("CU_DOM_A_2"), __sectop("CU_DOM_A"),
    __sectop("CU_DOM_B_1"), __sectop("CU_DOM_B_2"), __sectop("CU_DOM_B"),
    __sectop("WU_SH_1"), __sectop("WU_SH_2"), __sectop("WU_SH"),
    __sectop("LU_SH"),
    __sectop("CU_SH_1"), __sectop("CU_SH_2"), __sectop("CU_SH"),
    __sectop("CS_1"), __sectop("CS_2"), __sectop("CS"), __sectop("P")
};

#pragma packoption
```

17.5 Registers in Fixed Vector Table / Exception Vector Table

For some MCUs, the endian select register, ID code protection on connection of the on-chip debugger, etc. are assigned in the address from 0xFFFFFF80 to 0xFFFFFFBF in fixed vector table (RXv1 architecture) / exception vector table (RXv2 architecture). To set up such registers, describe “interrupt_fvector[]” in the system configuration file. For details, refer to “20.22 Fixed Vector/Exception Vector Information (interrupt_fvector[])”.

CHAPTER 18 DATA TYPES AND MACROS

This chapter describes the data types and macros, which are used when issuing service calls provided by the RI600PX.

Note <ri_root> indicates the installation folder of RI600PX.
The default folder is “C:\Program Files\Renesas Electronics\CubeSuite+\RI600PX”.

18.1 Data Types

The Following lists the data types of parameters specified when issuing a service call.
Macro definition of the data type is performed by <ri_root>\in600\kernel.h, or <ri_root>\inc600\itron.h that is included by kernel.h.

Table 18-1 Data Types

Macro	Data Type	Description
B	signed char	Signed 8-bit integer
H	signed short	Signed 16-bit integer
W	signed long	Signed 32-bit integer
D	signed long long	Signed 64-bit integer
UB	unsigned char	Unsigned 8-bit integer
UH	unsigned short	Unsigned 16-bit integer
UW	unsigned long	Unsigned 32-bit integer
UD	unsigned long long	Unsigned 64-bit integer
VB	signed char	8-bit value with unknown data type
VH	signed short	16-bit value with unknown data type
VW	signed long	32-bit value with unknown data type
VD	signed long long	64-bit value with unknown data type
VP	void *	Pointer to unknown data type
FP	void (*)	Processing unit start address (pointer to a function)
INT	signed long	Signed 32-bit integer
UINT	unsigned long	Unsigned 32-bit integer
BOOL	signed long	Boolean value (TRUE or FALSE)
ER	signed long	Error code
ID	signed short	Object ID
ATR	unsigned short	Object attribute
STAT	unsigned short	Object state
MODE	unsigned short	Service call operational mode
PRI	signed short	Priority for tasks or messages
SIZE	unsigned long	Memory area size (in bytes)
TMO	signed long	Time-out (in millisecond)
RELTIM	unsigned long	Relative time (in millisecond)

Macro	Data Type	Description
VP_INT	signed long	Pointer to unknown data type, or signed 32-bit integer
ER_ID	signed long	Error code, or object ID
ER_UINT	signed long	Error code, or signed 32-bit integer
ER_BOOL	signed long	Error code, or signed 32-bit integer
ACPTN	unsigned short	Access permission pattern
FLGPTN	unsigned long	Bit pattern of eventflag
IMASK	unsigned short	Interrupt mask level
TEXPTN	unsigned long	Task exception code

18.2 Constant macros

The following lists the constant macros.
The constant macros are defined by either of following header files.

- <ri_root>\inc600\kernel.h
- <ri_root>\inc600\itron.h, which s included by kernel.h
- System information header file kernel_id.h, which is generated by the cfg600px.
  The contents of this file is changed according to the system configuration file.

Table 18-2 Constant Macros

Classifica-tion	Macro	Definition	Where	Description
General	NULL	0	itron.h	Null pointer
	TRUE	1	itron.h	True
	FALSE	0	itron.h	False
	E_OK	0	itron.h	Normal completion

Classification	Macro	Definition	Where	Description
Attribute	TA_NULL	0	itron.h	Object attribute unspecified
	TA_HLNG	0x0000	kernel.h	High-level language interface
	TA_TFIFO	0x0000	kernel.h	Task wait queue in FIFO order
	TA_TPRI	0x0001	kernel.h	Task wait queue is managed in task current priority order. Among tasks with the same priority, they are queued in FIFO order.
	TA_MFIFO	0x0000	kernel.h	Message queue in FIFO order
	TA_MPRI	0x0002	kernel.h	Message queue is managed in message priority order. Among messages with the same priority, they are queued in FIFO order.
	TA_ACT	0x0002	kernel.h	Task is activated after creation
	TA_WSGL	0x0000	kernel.h	Do not allow multiple tasks to wait for eventflag
	TA_WMUL	0x0002	kernel.h	Allow multiple tasks to wait for eventflag
	TA_CLR	0x0004	kernel.h	Clear eventflag when freed from WAITING state
	TA_CEILING	0x0003	kernel.h	Priority ceiling protocol
	TA_STA	0x0002	kernel.h	Create cyclic hander in operational state
	TA_PHS	0x0004	kernel.h	Save cyclic hander phase
Time-out	TMO_POL	0	itron.h	Polling
	TMO_FEVR	-1	itron.h	Waiting forever
Operation mode	TWF_ANDW	0x0000	kernel.h	Eventflag AND wait
	TWF_ORW	0x0001	kernel.h	Eventflag OR wait
Task exception	TTEX_ENA	0x0000	kernel.h	Task exception enabled state
	TTEX_DIS	0x0001	kernel.h	Task exception disabled state

Classifica-tion	Macro	Definition	Where	Description
Object state	TTS_RUN	0x0001	kernel.h	RUNNING state
	TTS_RDY	0x0002	kernel.h	READY state
	TTS_WAI	0x0004	kernel.h	WAITING state
	TTS_SUS	0x0008	kernel.h	SUSPENDED state
	TTS_WAS	0x000C	kernel.h	WAITING-SUSPENDED state
	TTS_DMT	0x0010	kernel.h	DORMANT state
	TTW_SLP	0x0001	kernel.h	Sleeping state
	TTW_DLY	0x0002	kernel.h	Delayed state
	TTW_SEM	0x0004	kernel.h	Waiting state for a semaphore resource
	TTW_FLG	0x0008	kernel.h	Waiting state for an eventflag
	TTW_SDTQ	0x0010	kernel.h	Sending waiting state for a data queue
	TTW_RDTQ	0x0020	kernel.h	Receiving waiting state for a data queue
	TTW_MBX	0x0040	kernel.h	Receiving waiting state for a mailbox
	TTW_MTX	0x0080	kernel.h	Waiting state for a mutex
	TTW_SMBF	0x0100	kernel.h	Sending waiting state for a message buffer
	TTW_RMBF	0x0200	kernel.h	Receiving waiting state for a message buffer
	TTW_MPF	0x2000	kernel.h	Waiting state for a fixed-sized memory block
	TTW_MPL	0x4000	kernel.h	Waiting state for a variable-sized memory block
	TCYC_STP	0x0000	kernel.h	Cyclic handler in non-operational state
	TCYC_STA	0x0001	kernel.h	Cyclic handler in operational state
	TALM_STP	0x0000	kernel.h	Alarm handler in non-operational state
	TALM_STA	0x0001	kernel.h	Alarm handler in operational state
Others	TSK_SELF	0	kernel.h	Specify invoking task
	TSK_NONE	0	kernel.h	No relevant task
	TPRI_SELF	0	kernel.h	Specify base priority of invoking task
	TPRI_INI	0	kernel.h	Specify initial priority

Classification	Macro	Definition	Where	Description
Kernel configuration	TMIN_TPRI	1	kernel.h	Minimum task priority
	TMAX_TPRI	system.priority	kernel_id.h	Maximum task priority
	TMIN_MPRI	1	kernel.h	Minimum message priority
	TMAX_MPRI	system.message_pri	kernel_id.h	Maximum message priority
	TKERNEL_MAKER	0x011B	kernel.h	Kernel maker code
	TKERNEL_PRID	0x0004	kernel.h	Identification number of the kernel
	TKERNEL_SPVER	0x5403	kernel.h	Version number of the ITRON specification
	TKERNEL_PRVER	0x0120	kernel.h	Version number of the kernel
	TMAX_ACTCNT	255	kernel.h	Maximum number of queued task activation requests
	TMAX_WUPCNT	255	kernel.h	Maximum number of queued task wake-up requests
	TMAX_SUSCNT	1	kernel.h	Maximum number of nested task suspension requests
	TBIT_FLGPTN	32	kernel.h	Number of bits in an eventflag
	TBIT_TEXPTN	32	kernel.h	Number of bits in task exception code
	TIC_NUME	system.tic_nume	kernel_id.h	Numerator of base clock interval
	TIC_DENO	system.tic_deno	kernel_id.h	Denominator of base clock interval
	TMAX_MAXSEM	65535	kernel.h	Maximum value the maximum semaphore resource count
	VTMAX_DOMAIN	Refer to Note 1	kernel_id.h	Maximum domain ID
	VTMAX_TSK	Refer to Note 1	kernel_id.h	Maximum task ID
	VTMAX_SEM	Refer to Note 1	kernel_id.h	Maximum semaphore ID
	VTMAX_FLG	Refer to Note 1	kernel_id.h	Maximum eventflag ID
	VTMAX_DTQ	Refer to Note 1	kernel_id.h	Maximum data queue ID
	VTMAX_MBX	Refer to Note 1	kernel_id.h	Maximum mailbox ID
	VTMAX_MTX	Refer to Note 1	kernel_id.h	Maximum mutex ID
	VTMAX_MBF	Refer to Note 1	kernel_id.h	Maximum message buffer ID
	VTMAX_MPF	Refer to Note 1	kernel_id.h	Maximum fixed-sized memory pool ID
	VTMAX_MPL	Refer to Note 1	kernel_id.h	Maximum variable-sized memory pool ID
	VTMAX_CYH	Refer to Note 1	kernel_id.h	Maximum cyclic handler ID
	VTMAX_ALH	Refer to Note 1	kernel_id.h	Maximum alarm handler ID
	VTSZ_MBFTBL	4	kernel.h	Size of message buffer's message management table (in bytes)
	VTMAX_AREASIZE	0x10000000	kernel.h	Maximum size of various areas (in bytes)
	VTKNL_LVL	system.system_IPL	kernel_id.h	Kernel interrupt mask level
	VTIM_LVL	clock.IPL	kernel_id.h	Base clock interrupt level

Classifica-tion	Macro	Definition	Where	Description
Error code	E_SYS	-5	itron.h	System error
	E_NOSPT	-9	itron.h	Unsupported function
	E_RSFN	-10	itron.h	Reserved function code
	E_RSATR	-11	itron.h	Reserved attribute
	E_PAR	-17	itron.h	Parameter error
	E_ID	-18	itron.h	Invalid ID number
	E_CTX	-25	itron.h	Context error
	E_MACV	-26	itron.h	Memory access violation
	E_OACV	-27	itron.h	Object access violation
	E_ILUSE	-28	itron.h	Illegal use of service call
	E_NOMEM	-33	itron.h	Insufficient memory
	E_NOID	-34	itron.h	No ID number available
	E_OBJ	-41	itron.h	Object state error
	E_NOEXS	-42	itron.h	Non-existent object
	E_QOVR	-43	itron.h	Queuing overflow
	E_RLWAI	-49	itron.h	Forced release from WAITING state
	E_TMOUT	-50	itron.h	Polling failure of time-out
	E_DLT	-51	itron.h	Waiting object deleted
	E_CLS	-52	itron.h	Waiting object state changed
	EV_RST	-127	itron.h	Released from WAITING state by the object reset
Protection extension	TDOM_SELF	0	kernel.h	Domain that invoking task belongs
	TACP_SHARED	((1u << (VTMAX_DOMAIN)) -1)	kernel.h	Access permission pattern that represents “all domain can access”
	TACT_SRW	{TACP_SHARED, TACP_SHARED, TACP_SHARED}	kernel.h	Access permission vector that represents “all types of access (operand-read, operand-write, execution) are permitted for all domains” Refer to Note 2.
	TACT_SRO	{TACP_SHARED, 0, TACP_SHARED}	kernel.h	Access permission vector that represents “operand-read access is permitted for all domains, and operand-write access and execution access are not permitted for all domains” Refer to Note 2.
	TPM_READ	1	kernel.h	Operand-read access
	TPM_WRITE	2	kernel.h	Operand-write access
	TPM_EXEC	4	kernel.h	Execution access

Note 1 Refer to “20.7 Maximum ID (maxdefine)”.

Note 2 These macros can be describe only at the right of an initial assignment statement.

18.3 Function Macros

The following lists the function macros.
The function macros are defined by either of following header files.

- <ri_root>\inc600\kernel.h
- <ri_root>\inc600\itron.h, which s included by kernel.h

18.3.1 Macros for Error Code

1) ER MERCD (ER *ercd*)
Return the main error code of *ercd*.

2) ER SERCD (ER *ercd*)
Return sub error code of *ercd*.

3) ER ERCD (ER *mercd*, ER *sercd*)
Return the error code from the main error code indicated by *mercd* and sub error code indicated by *sercd*.

Note In the error code returned from the RI600PX, all sub error code is -1, and all main error code is same as the value described in Table 18-2.

18.3.2 Macros for Data Queue

1) SIZE TSZ_DTQ (UINT *dtqcnt*)
Returns the size of a data queue area in which the *dtqcnt* number of data items can be stored. (in bytes)

18.3.3 Macros for Fixed-sized Memory Pool

1) SIZE TSZ_MPF (UINT *blkcnt*, UINT *blksz*)
Returns the size of a fixed-sized memory pool from which *blkcnt* number of *blksz*-byte memory blocks can be acquired. (in bytes)

2) SIZE TSZ_MPFMB (UINT *blkcnt*, UINT *blksz*)
Returns the size of the management area required for a fixed-sized memory pool from which *blkcnt* number of *blksz*-byte memory blocks can be acquired. (in bytes)

18.3.4 Macros for Domain

1) ATR TA_DOM (ID *domid*)
Returns attribute which represents to belong to the domain indicated by *domid*. This macro is used for bit7-4 of *tskatr* (task attribute) at task creation.

18.3.5 Access permission

1) ACPTN TACP (ID *domid*)

Returns access permission pattern that represents “only the domain indicated by *domid* can access”.

2) ACVCT TACT_PRW (ID *domid*)

Returns access permission vector that represents “all types of access (operand-read, operand-write, execution) are permitted only for the domain indicated by *domid*”.

3) ACVCT TACT_PRO (ID *domid*)

Returns access permission vector that represents “operand-wirte access is not permitted for all domain, operand-read and execution access are permitted only for the domain indicated by *domid*”.

4) ACVCT TACT_SRPW (ID *domid*)

Returns access permission vector that represents “operand-read and execution access are permitted for all domain, operand-write access is permitted only for the domain indicated by *domid*”.

CHAPTER 19 SERVICE CALLS

This chapter describes the service calls supported by the RI600PX.

19.1 Outline

The service calls provided by the RI600PX are service routines provided for indirectly manipulating the resources (tasks, semaphores, etc.) managed by the RI600PX from a processing program.
The service calls provided by the RI600PX are listed below by management module.

- Task management functions

cre_tsk	acre_tsk	del_tsk	act_tsk
iact_tsk	can_act	ican_act	sta_tsk
ista_tsk	ext_tsk	exd_tsk	ter_tsk
chg_pri	ichg_pri	get_pri	iget_pri
ref_tsk	iref_tsk	ref_tst	iref_tst

- Task dependent synchronization functions

slp_tsk	tslp_tsk	wup_tsk	iwup_tsk
can_wup	ican_wup	rel_wai	irel_wai
sus_tsk	isus_tsk	rsm_tsk	irsm_tsk
frsm_tsk	ifrsm_tsk	dly_tsk	

- Task exception handling functions

def_tex	ras_tex	iras_tex	dis_tex
ena_tex	sns_tex	ref_tex	iref_tex

- Synchronization and communication functions (semaphores)

cre_sem	acre_sem	del_sem	wai_sem
pol_sem	ipol_sem	twai_sem	sig_sem
isig_sem	ref_sem	iref_sem	

- Synchronization and communication functions (eventflags)

cre_flg	acre_flg	del_flg	set_flg
iset_flg	clr_flg	iclr_flg	wai_flg
pol_flg	ipol_flg	twai_flg	ref_flg
iref_flg			

- Synchronization and communication functions (data queues)

cre_dtq	acre_dtq	del_dtq	snd_dtq
psnd_dtq	ipsnd_dtq	tsnd_dtq	fsnd_dtq
ifsnd_dtq	rcv_dtq	prcv_dtq	iprcv_dtq
trcv_dtq	ref_dtq	iref_dtq	

- Synchronization and communication functions (mailboxes)

cre_mbx	acre_mbx	del_mbx	snd_mbx
isnd_mbx	rcv_mbx	prcv_mbx	iprcv_mbx
trcv_mbx	ref_mbx	iref_mbx	

- Extended synchronization and communication functions (mutexes)

cre_mtx	acre_mtx	del_mtx	loc_mtx
ploc_mtx	tloc_mtx	unl_mtx	ref_mtx

- Extended synchronization and communication functions (message buffers)

cre_mbf	acre_mbf	del_mbf	snd_mbf
psnd_mbf	ipsnd_mbf	tsnd_mbf	rcv_mbf
prcv_mbf	trcv_mbf	ref_mbf	iref_mbf

- Memory pool management functions (fixed-sized memory pools)

cre_mpf	acre_mpf	del_mpf	get_mpf
pget_mpf	ipget_mpf	tget_mpf	rel_mpf
irel_mpf	ref_mpf	iref_mpf	

- Memory pool management functions (variable-sized memory pools)

cre_mpl	acre_mpl	del_mpl	get_mpl
pget_mpl	ipget_mpl	tget_mpl	rel_mpl
ref_mpl	iref_mpl		

- Time management functions

set_tim	iset_tim	get_tim	iget_tim
cre_cyc	acre_cyc	del_cyc	sta_cyc
ista_cyc	stp_cyc	istp_cyc	ref_cyc
iref_cyc	cre_alm	acre_alm	del_alm
sta_alm	ista_alm	stp_alm	istp_alm
ref_alm	iref_alm		

- System state management functions

rot_rdq	irot_rdq	get_tid	iget_tid
loc_cpu	iloc_cpu	unl_cpu	iunl_cpu
dis_dsp	ena_dsp	sns_ctx	sns_loc
sns_dsp	sns_dpn	vsys_dwn	ivsys_dwn
vsta_knl	ivsta_knl		

- Interrupt management functions

chg_ims	ichg_ims	get_ims	iget_ims

- System configuration management functions

ref_ver	iref_ver

- Object reset functions

vrst_dtq	vrst_mbx	vrst_mbf	vrst_mpf
vrst_mpl			

- Memory object management functions

ata_mem	det_mem	sac_mem	vprb_mem
ref_mem			

19.1.1 Method for calling service calls

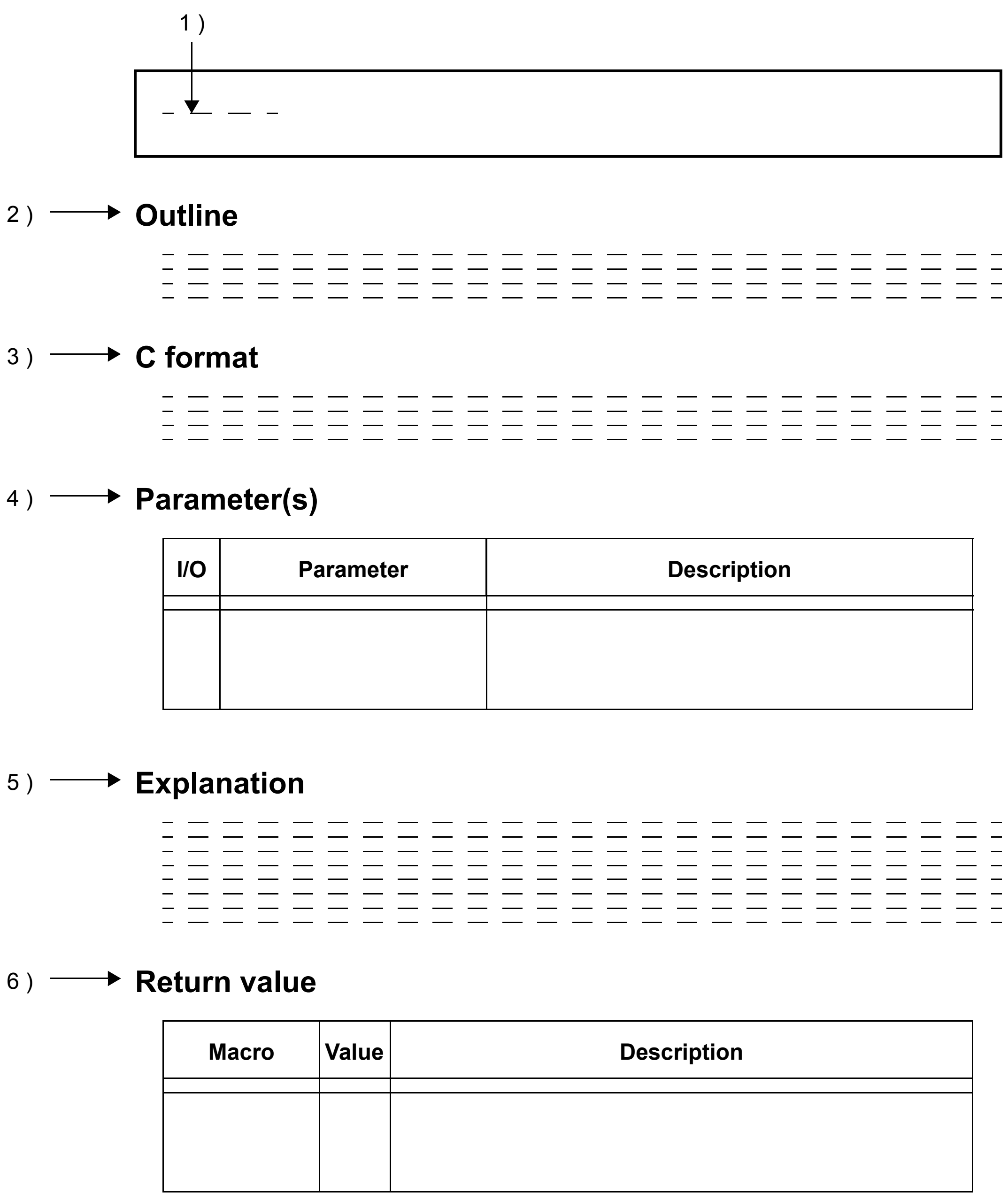
The service calls can be calls by the same way as normal C-language function.

Note To call the service calls provided by the RI600PX from a processing program, the header files listed below must be coded (include processing).

kernel.h:	Standard header file
kernel_id.h	System information header file, which is generated by the cfg600px

19.2 Explanation of Service Call

The following explains the service calls supported by the RI600PX, in the format shown below.



1) Name
Indicates the name of the service call.

2) Outline
Outlines the functions of the service call.

3) C format
Indicates the format to be used when describing a service call to be issued in C language.

4) Parameter(s)
Service call parameters are explained in the following format.

I/O	Parameter	Description
A	B	C

A) Parameter classification

I:	Parameter input to RI600PX.
O:	Parameter output from RI600PX.

B) Parameter data type

C) Description of parameter

5) Explanation
Explains the function of a service call.

6) Return value
Indicates a service call's return value using a macro and value.

Macro	Value	Description
A	B	C

A) Macro of return value

B) Value of return value

C) Description of return value

19.2.1 Task management functions

The following shows the service calls provided by the RI600PX as the task management functions.

Table 19-1 Task Management Functions

Service Call	Function	Useful Range
cre_tsk	Create task	Task
acre_tsk	Create task (automatic ID assignment)	Task
del_tsk	Delete task	Task
act_tsk	Activate task (queues an activation request)	Task
iact_tsk	Activate task (queues an activation request)	Non-task
can_act	Cancel task activation requests	Task
ican_act	Cancel task activation requests	Non-task
sta_tsk	Activate task (does not queue an activation request)	Task
ista_tsk	Activate task (does not queue an activation request)	Non-task
ext_tsk	Terminate invoking task	Task
exd_tsk	Terminate and delete invoking task	Task
ter_tsk	Terminate task	Task
chg_pri	Change task priority	Task
ichg_pri	Change task priority	Non-task
get_pri	Reference task current priority	Task
iget_pri	Reference task current priority	Non-task
ref_tsk	Reference task state	Task
iref_tsk	Reference task state	Non-task
ref_tst	Reference task state (simplified version)	Task
iref_tst	Reference task state (simplified version)	Non-task

cre_tsk
acre_tsk

Outline

Create task.

C format

```
ER      cre_tsk (ID tskid, T_CTSK *pk_ctsk );
ER_ID   acre_tsk ( T_CTSK *pk_ctsk );
```

Parameter(s)

I/O	Parameter	Description
I	`ID tskid;`	ID number of the task.
I	`T_CTSK *pk_ctsk;`	Pointer to the packet containing the task creation information.

[Task creation information packet : T_CTSK]

```
typedef struct  t_ctsk {
    ATR     tskatr;         /*Task attribute*/
    VP_INT  exinf;          /*Extended information*/
    FP      task;           /*Task start address*/
    PRI     itskpri;        /*Task initial priority*/
    SIZE    stksz;          /*User stack size (in bytes)*/
    VP      stk;            /*Start address of user stack*/
} T_CTSK;
```

Explanation

This service call can be called from tasks that belong to Trusted Domain.
The cre_tsk creates a task with task ID indicated by *tskid* according to the content of *pk_ctsk*. The acre_tsk creates a task according to the content of *pk_ctsk*, and returns the created task ID.
The processing performed at task creation is shown in Table 19-2.

Table 19-2 Processing Performed at Task Creation

No.	Content of processing
1	Clears the number of queued activation requests.
2	Resets the task state so that the task exception handling routine is not defined.

1) Task attribute (*tskatr*)
The following are specified for *tskatr*.

```
tskatr := ( TA_HLNG   | [TA_ACT] | [TA_DOM (domid) ] )
```

The bit position of tskatr is shown as follows.

bit15 ～ bit8	bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0
0	Domain ID （TA_DOM(*domid*)）				0	0	TA_ACT :1	TA_HLNG : 0

- TA_HLNG (= 0x0000)
  Only C-language is supported for task description language.
- TA_ACT (= 0x0002)
  When the TA_ACT attribute is specified, the created task makes a transition to the READY state. The processing performed at task activation is shown in Table 19-3. When the TA_ACT attribute is not specified, the created task makes a transition to the DORMANT state.
- TA_DOM(*domid*)
  The created task belong to the domain indicated by *domid*. When 0 is specified for *domid* or TA_DOM(domid) is not specified, the created task belongs to the domain that the invoking task belong to.

  Note For detail of TA_DOM macro, refer to “18.3.4 Macros for Domain”.

2) Extended information (*exinf*)
When the task is activated by TA_ACT attribute, act_tsk or iact_tsk, *exinf* is passed to the task as argument. And *exinf* is passed to the task exception handling routine. The *exinf* can be widely used by the user, for example, to set information concerning the task.

3) Task start address (*task*)
Specify the task start address for *task*.

4) Task initial priority (*itskpri*)
Specify initial priority of the task for *itskpri*. Ranges of the value that can be specified are from 1 to TMAX_TPRI.

5) User stack size (*stksz*), Start address of user stack (*stk*)
The application acquires user stack area, and specifies the start address for *stk* and the size for *stksz*.
The user stack area must satisfy the following.

A) The *stk* must be 16-bytes boundary. If not, error E_PAR is returned.

B) The *stksz* must be multiple of 16. If not, error E_PAR is returned.

C) The user stack area must not overwrap with either all user stacks and all memory objects. If not, an error is not detected and correct system operation cannot be guaranteed.

Note The μITRON4.0 specification defines the function that the kernel allocates user stack area when NULL is specified for *stk*. But RI600PX does not support this function.

Return value

Macro	Value	Description
-	Positive value	Normal completion of acre_tsk. (Created task ID)
E_OK	0	Normal completion of cre_tsk.

Macro	Value	Description
E_RSATR	-11	Reserved attribute - Either bit0, bit2, bit3 or bit8-15 in *tskatr* is 1. - VTMAX_DOMAIN < (Value of bit4-7 of *tskatr*)
E_PAR	-17	Parameter error. - *pk_ctsk* == NULL - *task* == NULL - *itskpri* < 0 - TMAX_TPRI < *itskpri* - *stk* is not 16-bytes boundary. - *stksz* is not multiple of 16. - *stksz* < (lower bound value described in Table 20-8 - VTMAX_AREASIZE < *stksz* - *stk* + *stksz* > 0x100000000
E_ID	-18	Invalid ID number. (only for cre_tsk) - *tskid* < 0 - *tskid* > VTMAX_TSK
E_CTX	-25	Context error. - This service call was issued in the CPU locked state. - This service call was issued from non-task. - This service call was issued in the status “PSW.IPL > kernel interrupt mask level”.
E_MACV	-26	Memory access violation. - Stack pointer points out of user stack for invoking task. - The operand-read access to the area indicated by *pk_ctsk* has not been permitted to the invoking task.
E_OACV	-27	Object access violation. - The invoking task does not belong to trusted domain.
E_NOMEM	-33	Insufficient memory. - *stk* == NULL
E_NOID	-34	No ID number available.(only for acre_tsk)
E_OBJ	-41	Object state error. (only for cre_tsk) - The task specified by *tskid* exists.

del_tsk

Outline

Delete task.

C format

```
ER      del_tsk (ID tskid);
```

Parameter(s)

I/O	Parameter	Description
I	`ID        tskid;`	ID number of the task.

Explanation

This service call can be called from tasks that belong to Trusted Domain.
This service call deletes the task indicated by *tskid*.

Return value

Macro	Value	Description
E_OK	0	Normal completion.
E_ID	-18	Invalid ID number. - *tskid* $\leq$ 0 - *tskid* > VTMAX_TSK
E_CTX	-25	Context error. - This service call was issued in the CPU locked state. - This service call was issued from non-task. - This service call was issued in the status “PSW.IPL > kernel interrupt mask level”.
E_MACV	-26	Memory access violation. - Stack pointer points out of user stack for invoking task.
E_OACV	-27	Object access violation. - The invoking task does not belong to trusted domain.
E_OBJ	-41	Object state error. - Specified task is not in the DORMANT state.
E_NOEXS	-42	Non-existent object. - The task specified by *tskid* does not exist.

act_tsk
iact_tsk

Outline

Activate task (queues an activation request).

C format

```
ER      act_tsk (ID tskid);
ER      iact_tsk (ID tskid);
```

Parameter(s)

I/O	Parameter	Description
I	`ID tskid;`	ID number of the task. TSK_SELF: Invoking task. Value: ID number of the task.

Explanation

These service calls move the task specified by parameter *tskid* from the DORMANT state to the READY state.
As a result, the target task is queued at the end on the ready queue corresponding to the initial priority and becomes subject to scheduling by the RI600PX.
At this time, the following processing is done.

Table 19-3 Processing Performed at Task Activation

No.	Content of processing
1	Initializes the task's base priority and current priority.
2	Clears the number of queued wake-up requests.
3	Clears the number of nested suspension count.
4	Clears pending exception code.
5	Disables task exception

If the target task has been moved to a state other than the DORMANT state when this service call is issued, this service call does not move the state but increments the activation request counter (by added 1 to the activation request counter).

Note 1 The activation request counter managed by the RI600PX is configured in 8-bit widths. If the number of activation requests exceeds the maximum count value 255 as a result of issuing this service call, the counter manipulation processing is therefore not performed but “E_QOVR” is returned.

Note 2 Extended information specified at creating the task is passed to the task activated by issuing these service calls.

Return value

Macro	Value	Description
E_OK	0	Normal completion.
E_ID	-18	Invalid ID number. - *tskid* < 0 - *tskid* > VTMAX_TSK - When iact_tsk was issued from a non-task, TSK_SELF was specified for *tskid*.
E_CTX	-25	Context error. - This service call was issued in the CPU locked state. - The iact_tsk was issued from task. - The act_tsk was issued from non-task. - This service call was issued in the status “PSW.IPL > kernel interrupt mask level”.
E_MACV	-26	Memory access violation. (only for act_tsk) - Stack pointer points out of user stack for invoking task.
E_NOEXS	-42	Non-existent object. - The task specified by *tskid* does not exist.
E_QOVR	-43	Queuing overflow. - Activation request count exceeded 255.

can_act
ican_act

Outline

Cancel task activation requests.

C format

```
ER_UINT can_act (ID tskid);
ER_UINT ican_act (ID tskid);
```

Parameter(s)

I/O	Parameter	Description
I	`ID tskid;`	ID number of the task. TSK_SELF: Invoking task. Value: ID number of the task.

Explanation

This service call cancels all of the activation requests queued to the task specified by parameter *tskid* (sets the activation request counter to 0).
When this service call is terminated normally, the number of cancelled activation requests is returned.

Note This service call does not perform status manipulation processing but performs the setting of activation request counter. Therefore, the task does not move from a state such as the READY state to the DORMANT state.

Return value

Macro	Value	Description
-	Positive value	Normal completion (activation request count).
-	0	Normal completion. - Activation request count is 0. - Specified task is in the DORMANT state.
E_ID	-18	Invalid ID number. - *tskid* < 0 - *tskid* > VTMAX_TSK - When the iact_tsk was issued from a non-task, TSK_SELF was specified for *tskid*.

Macro	Value	Description
E_CTX	-25	Context error. - This service call was issued in the CPU locked state. - This service call was issued in the status “PSW.IPL > kernel interrupt mask level”. Note When the ican_act is issued from task or the can_act is issued from non-task, the context error is not detected and normal operation of the system is not guaranteed.
E_NOEXS	-42	Non-existent object. - The task specified by *tskid* does not exist.

sta_tsk
ista_tsk

Outline

Activate task (does not queue an activation request).

C format

```
ER      sta_tsk (ID tskid, VP_INT stacd);
ER      ista_tsk (ID tskid, VP_INT stacd);
```

Parameter(s)

I/O	Parameter	Description
I	`ID tskid;`	ID number of the task.
I	`VP_INT stacd;`	Start code of the task.

Explanation

These service calls move the task specified by parameter *tskid* from the DORMANT state to the READY state.
As a result, the target task is queued at the end on the ready queue corresponding to the initial priority and becomes subject to scheduling by the RI600PX.
At this time, processing described in Table 19-3 is done.
These service calls do not perform queuing of activation requests. If the target task is in a state other than the DORMANT state, the status manipulation processing for the target task is therefore not performed but “E_OBJ” is returned.
The *stacd* is passed to the target task.

Return value

Macro	Value	Description
E_OK	0	Normal completion.
E_ID	-18	Invalid ID number. - *tskid* ≤ 0 - *tskid* > VTMAX_TSK
E_CTX	-25	Context error. - This service call was issued in the CPU locked state. - The ista_tsk was issued from task. - The sta_tsk was issued from non-task. - This service call was issued in the status “PSW.IPL > kernel interrupt mask level”.

Macro	Value	Description
E_MACV	-26	Memory access violation. (only for sta_tsk) - Stack pointer points out of user stack for invoking task.
E_OBJ	-41	Object state error - Specified task is not in the DORMANT state.
E_NOEXS	-42	Non-existent object. - The task specified by *tskid* does not exist.

ext_tsk

Outline

Terminate invoking task.

C format

```
  void    ext_tsk (void);
```

Parameter(s)

None.

Explanation

This service call moves the invoking task from the RUNNING state to the DORMANT state.
As a result, the invoking task is unlinked from the ready queue and excluded from the RI600PX scheduling subject.
At this time, the following processing is done.

Table 19-4 Processing Performed at Task Termination

No.	Content of processing
1	Unlocks the mutexes which are locked by the terminated task. (processing equivalent to unl_mtx will be executed)

The CPU locked state and dispatching disabled state is cancelled.
If an activation request has been queued to the invoking task (the activation request counter > 0) when this service call is issued, this service call moves the task from the RUNNING state to the DORMANT state, decrements the activation request counter (by subtracting 1 from the activation request counter), and then moves the task from the DORMANT state to the READY state. At this time, processing described in Table 19-3 is done.
This service call does not return. In the following cases, this service call causes SYSTEM DOWN.

- This service call was issued from non-task.
- This service call was issued in the status “PSW.IPL > kernel interrupt mask level”

Note 1 When the return instruction is issued in the task entry function, the same processing as ext_tsk is performed.

Note 2 This service call does not have the function to automatically free the resources except the mutex hitherto occupied by the task (e.g., semaphores and memory blocks). Make sure the task frees these resources before it terminates

Return value

None.

exd_tsk

Outline

Terminate and delete invoking task.

C format

```
void    exd_tsk (void);
```

Parameter(s)

None.

Explanation

This service call terminates the invoking task normally and deletes the task.
The processing performed at task termination is shown in Table 19-4.
The CPU locked state and dispatching disabled state is cancelled.
This service call does not return. In the following cases, this service call causes SYSTEM DOWN.

- This service call was issued from non-task.
- This service call was issued in the status “PSW.IPL > kernel interrupt mask level”

Note This service call does not have the function to automatically free the resources except the mutex hitherto occupied by the task (e.g., semaphores and memory blocks). Make sure the task frees these resources before it terminates

Return value

None.

ter_tsk

Outline

Terminate task.

C format

```
ER        ter_tsk (ID tskid);
```

Parameter(s)

I/O	Parameter	Description
I	`ID        tskid;`	ID number of the task.

Explanation

This service call forcibly moves the task specified by parameter *tskid* to the DORMANT state.
As a result, the target task is excluded from the RI600PX scheduling subject.
At this time, processing described in Table 19-4 is done.
If an activation request has been queued to the target task (the activation request counter > 0) when this service call is issued, this service call moves the task to the DORMANT state, decrements the activation request counter (by subtracting 1 from the activation request counter), and then moves the task from the DORMANT state to the READY state. At this time, processing described in Table 19-3 is done.

Note This service call does not have the function to automatically free the resources except the mutex hitherto occupied by the task (e.g., semaphores and memory blocks). Make sure the task frees these resources before it terminates

Return value

Macro	Value	Description
E_OK	0	Normal completion.
E_ID	-18	Invalid ID number. - *tskid* ≤ 0 - *tskid* > VTMAX_TSK
E_CTX	-25	Context error. - This service call was issued in the CPU locked state. - This service call was issued from non-task. - This service call was issued in the status “PSW.IPL > kernel interrupt mask level”.
E_MACV	-26	Memory access violation. - Stack pointer points out of user stack for invoking task.

Macro	Value	Description
E_ILUSE	-28	Illegal service call use. - Specified task is the invoking task.
E_OBJ	-41	Object state error. - Specified task is in the DORMANT state.
E_NOEXS	-42	Non-existent object. - The task specified by *tskid* does not exist.

chg_pri
ichg_pri

Outline

Change task priority.

C format

```
ER      chg_pri (ID tskid, PRI tskpri);
ER      ichg_pri (ID tskid, PRI tskpri);
```

Parameter(s)

I/O	Parameter	Description
I	`ID tskid;`	ID number of the task. TSK_SELF: Invoking task. Value: ID number of the task.
I	`PRI tskpri;`	New base priority of the task. TPRI_INI: Initial priority. Value: New base priority of the task.

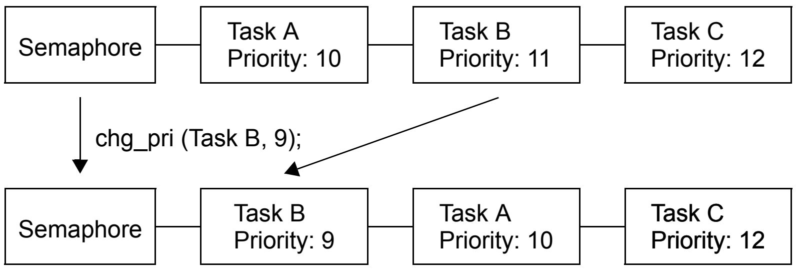
Explanation

This service call changes the base priority of the task specified by parameter *tskid* to a value specified by parameter *tskpri*.
The changed base priority is effective until the task terminates or this service call is issued. When next the task is activated, the base priority is the initial priority which is specified at the task creation.
This service call also changes the current priority of the target task to a value specified by parameter *tskpri*. However, the current priority is not changed when the target task has locked mutexes.
If the target task has locked mutexes or is waiting for mutex to be locked and if *tskpri* is higher than the ceiling priority of either of the mutexes, this service call returns “E_ILUSE”.
When the current priority is changed, the following state variations are generated.

1) When the target task is in the RUNNING or READY state.
This service call re-queues the task at the end of the ready queue corresponding to the priority specified by parameter *tskpri*.

2) When the target task is queued to a wait queue of the object with TA_TPRI or TA_CEILING attribute.
This service call re-queues the task to the wait queue corresponding to the priority specified by parameter *tskpri*. When two or more tasks of same current priority as *tskpri*, this service call re-queues the target task at the end among their tasks.

Example When three tasks (task A: priority level 10, task B: priority level 11, task C: priority level 12) are queued to the semaphore wait queue in the order of priority, and the priority level of task B is changed from 11 to 9, the wait order will be changed as follows.



Note For current priority and base priority, refer to "8.2.2 Current priority and base priority".

Return value

Macro	Value	Description
E_OK	0	Normal completion.
E_PAR	-17	Parameter error. - *tskpri* < 0 - *tskpri* > TMAX_TPRI
E_ID	-18	Invalid ID number. - *tskid* < 0 - *tskid* > VTMAX_TSK - When ichg_pri was issued from a non-task, TSK_SELF was specified for *tskid*.
E_CTX	-25	Context error. - This service call was issued in the CPU locked state. - The ichg_pri was issued from task. - The chg_pri was issued from non-task. - This service call was issued in the status "PSW.IPL > kernel interrupt mask level".
E_MACV	-26	Memory access violation. (only for chg_pri) - Stack pointer points out of user stack for invoking task.
E_ILUSE	-28	Illegal use of service call. - *tskpri* < The ceiling priority of the mutex locked by the target task. - *tskpri* < The ceiling priority of the mutex by which the target task waits for lock.
E_OBJ	-41	Object state error. - Specified task is in the DORMANT state.
E_NOEXS	-42	Non-existent object. - The task specified by *tskid* does not exist.

get_pri
iget_pri

Outline

Reference task current priority.

C format

```
ER      get_pri (ID tskid, PRI *p_tskpri);
ER      iget_pri (ID tskid, PRI *p_tskpri);
```

Parameter(s)

I/O	Parameter	Description
I	`ID       tskid;`	ID number of the task. TSK_SELF: Invoking task. Value: ID number of the task.
O	`PRI      *p_tskpri;`	Pointer to the area returning the current priority of the task.

Explanation

This service call stores the current priority of the task specified by parameter *tskid* in the area specified by parameter *p_tskpri*.

Note For current priority and base priority, refer to "8.2.2 Current priority and base priority".

Return value

Macro	Value	Description
E_OK	0	Normal completion.
E_PAR	-17	Parameter error. - *p_tskpri* == NULL
E_ID	-18	Invalid ID number. - *tskid* < 0 - *tskid* > VTMAX_TSK - When this service call was issued from a non-task, TSK_SELF was specified for *tskid*.

Macro	Value	Description
E_CTX	-25	Context error. - This service call was issued in the CPU locked state. - This service call was issued in the status "PSW.IPL > kernel interrupt mask level". Note When the iget_pri is issued from task or the get_pri is issued from non-task, the context error is not detected and normal operation of the system is not guaranteed.
E_MACV	-26	Memory access violation. (only for get_pri) - The operand-write access to the area indicated by *p_tskpri* has not been permitted to the invoking task.
E_OBJ	-41	Object state error. - Specified task is in the DORMANT state.
E_NOEXS	-42	Non-existent object. - The task specified by *tskid* does not exist.

ref_tsk
iref_tsk

Outline

Reference task state.

C format

```
ER      ref_tsk (ID tskid, T_RTSK *pk_rtsk);
ER      iref_tsk (ID tskid, T_RTSK *pk_rtsk);
```

Parameter(s)

I/O	Parameter	Description
I	`ID       tskid;`	ID number of the task. TSK_SELF: Invoking task. Value: ID number of the task.
O	`T_RTSK   *pk_rtsk;`	Pointer to the packet returning the task state.

[Task state packet: T_RTSK]

```
typedef struct  t_rtsk {
    STAT    tskstat;        /*Current state*/
    PRI     tskpri;         /*Current priority*/
    PRI     tskbpri;        /*Base priority*/
    STAT    tskwait;        /*Reason for waiting*/
    ID      wobjid;         /*Object ID number for which the task is waiting*/
    TMO     lefttmo;        /*Remaining time until time-out*/
    UINT    actcnt;         /*Activation request count*/
    UINT    wupcnt;         /*Wake-up request count*/
    UINT    suscnt;         /*Suspension count*/
} T_RTSK;
```

Explanation

Stores task state packet (current state, current priority, etc.) of the task specified by parameter *tskid* in the area specified by parameter *pk_rtsk*.

- *tskstat*
  Stores the current state.

TTS_RUN:	RUNNING state
TTS_RDY:	READY state
TTS_WAI:	WAITING state
TTS_SUS:	SUSPENDED state
TTS_WAS:	WAITING-SUSPENDED state
TTS_DMT:	DORMANT state

- *tskpri*
  Stores the current priority.
  The *tskpri* is effective only when the *tskstat* is other than TTS_DMT.

- *tskbpri*
  Stores the base priority.
  The *tskbpri* is effective only when the *tskstat* is other than TTS_DMT.

- *tskwait*
  Stores the reason for waiting.
  The *tskwait* is effective only when the *tskstat* is TTS_WAI or TTS_WAS.

TTW_SLP:	Sleeping state caused by slp_tsk or tslp_tsk
TTW_DLY:	Delayed state caused by dly_tsk
TTW_SEM:	WAITING state for a semaphore resource caused by wai_sem or twai_sem
TTW_FLG:	WAITING state for an eventflag caused by wai_flg or twai_flg
TTW_SDTQ:	Sending WAITING state for a data queue caused by snd_dtq or tsnd_dtq
TTW_RDTQ:	Receiving WAITING state for a data queue caused by rcv_dtq or trcv_dtq
TTW_MBX:	Receiving WAITING state for a mailbox caused by rcv_mbx or trcv_mbx
TTW_MTX:	WAITING state for a mutex caused by loc_mtx or tloc_mtx
TTW_SMBF:	Sending WAITING state for a message buffer caused by snd_mbf or tsnd_mbf
TTW_RMBF:	Receiving WAITING state for a message buffer caused by rcv_mbf or trcv_mbf
TTW_MPF:	WAITING state for a fixed-sized memory block caused by get_mpf or tget_mpf
TTW_MPL:	WAITING state for a variable-sized memory block caused by get_mpl or tget_mpl

- *wobjid*
  Stores the object (such as semaphore, eventflag, etc.) ID number for which the task waiting.
  The *wobjid* is effective only when the *tskwait* is TTW_SEM or TTW_FLG or TTW_SDTQ or TTW_RDTQ or TTW_MBX or TTW_MTX or TTW_SMBF or TTW_RMBF or TTW_MPF or TTW_MPL.

- *lefttmo*
  Stores the remaining time until time-out (in millisecond).
  The TMO_FEVR is stored for waiting forever.
  The *lefttmo* is effective only when the *tskstat* is TTS_WAI or TTS_WAS, and the *tskwait* is other than TTW_DLY.

  Note The *lefttmo* is undefined when the *tskwait* is TTW_DLY.

- *actcnt*
  Stores the activation request count.

- *wupcnt*
  Stores the wake-up request count.
  The *wupcnt* is effective only when the *tskstat* is other than TTS_DMT.

- *suscnt*
  Stores the suspension count.
  The *suscnt* is effective only when the *tskstat* is other than TTS_DMT.

Return value

Macro	Value	Description
E_OK	0	Normal completion.
E_PAR	-17	Parameter error. - *pk_rtsk* == NULL
E_ID	-18	Invalid ID number. - *tskid* < 0 - *tskid* > VTMAX_TSK - When this service call was issued from a non-task, TSK_SELF was specified for *tskid*.
E_CTX	-25	Context error. - This service call was issued in the CPU locked state. - This service call was issued in the status “PSW.IPL > kernel interrupt mask level”. Note When the iref_tsk is issued from task or the ref_tsk is issued from non-task, the context error is not detected and normal operation of the system is not guaranteed.
E_MACV	-26	Memory access violation. (only for ref_tsk) - The operand-write access to the area indicated by *pk_rtsk* has not been permitted to the invoking task.
E_NOEXS	-42	Non-existent object. - The task specified by *tskid* does not exist.

ref_tst
iref_tst

Outline

Reference task state (simplified version).

C format

```
ER      ref_tst (ID tskid, T_RTST *pk_rtst);
ER      iref_tst (ID tskid, T_RTST *pk_rtst);
```

Parameter(s)

I/O	Parameter	Description
I	`ID tskid;`	ID number of the task. TSK_SELF: Invoking task. Value: ID number of the task.
O	`T_RTST *pk_rtst;`	Pointer to the packet returning the task state.

[Task state packet (simplified version): T_RTST]

```
typedef struct  t_rtst {
    STAT    tskstat;        /*Current state*/
    STAT    tskwait;        /*Reason for waiting*/
} T_RTST;
```

Explanation

Stores task state packet (current state, reason for waiting) of the task specified by parameter *tskid* in the area specified by parameter *pk_rtst*.
Used for referencing only the current state and reason for wait among task information.
Response becomes faster than using ref_tsk or iref_tsk because only a few information items are acquired.

- *tskstat*
  Stores the current state.

TTS_RUN:	RUNNING state
TTS_RDY:	READY state
TTS_WAI:	WAITING state
TTS_SUS:	SUSPENDED state
TTS_WAS:	WAITING-SUSPENDED state
TTS_DMT:	DORMANT state

- *tskwait*
  Stores the reason for waiting.
  The *tskwait* is effective only when the *tskstat* is TTS_WAI or TTS_WAS.

TTW_SLP:	Sleeping state caused by slp_tsk or tslp_tsk
TTW_DLY:	Delayed state caused by dly_tsk

TTW_SEM:	WAITING state for a semaphore resource caused by wai_sem or twai_sem
TTW_FLG:	WAITING state for an eventflag caused by wai_flg or twai_flg
TTW_SDTQ:	Sending WAITING state for a data queue caused by snd_dtq or tsnd_dtq
TTW_RDTQ:	Receiving WAITING state for a data queue caused by rcv_dtq or trcv_dtq
TTW_MBX:	Receiving WAITING state for a mailbox caused by rcv_mbx or trcv_mbx
TTW_MTX:	WAITING state for a mutex caused by loc_mtx or tloc_mtx
TTW_SMBF:	Sending WAITING state for a message buffer caused by snd_mbf or tsnd_mbf
TTW_RMBF:	Receiving WAITING state for a message buffer caused by rcv_mbf or trcv_mbf
TTW_MPF:	WAITING state for a fixed-sized memory block caused by get_mpf or tget_mpf
TTW_MPL:	WAITING state for a variable-sized memory block caused by get_mpl or tget_mpl

Return value

Macro	Value	Description
E_OK	0	Normal completion.
E_PAR	-17	Parameter error. - *pk_rtst* == NULL
E_ID	-18	Invalid ID number. - *tskid* < 0 - *tskid* > VTMAX_TSK - When this service call was issued from a non-task, TSK_SELF was specified for *tskid*.
E_CTX	-25	Context error. - This service call was issued in the CPU locked state. - This service call was issued in the status “PSW.IPL > kernel interrupt mask level”. Note When the iref_tst is issued from task or the ref_tst is issued from non-task, the context error is not detected and normal operation of the system is not guaranteed.
E_MACV	-26	Memory access violation. (only for ref_tst) - The operand-write access to the area indicated by *pk_rtst* has not been permitted to the invoking task.
E_NOEXS	-42	Non-existent object. - The task specified by *tskid* does not exist.

19.2.2 Task dependent synchronization functions

The following shows the service calls provided by the RI600PX as the task dependent synchronization functions.

Table 19-5 Task Dependent Synchronization Functions

Service Call	Function	Useful Range
slp_tsk	Put task to sleep (waiting forever)	Task
tslp_tsk	Put task to sleep (with time-out)	Task
wup_tsk	Wake-up task	Task
iwup_tsk	Wake-up task	Non-task
can_wup	Cancel task wake-up requests	Task
ican_wup	Cancel task wake-up requests	Non-task
rel_wai	Release task from waiting	Task
irel_wai	Release task from waiting	Non-task
sus_tsk	Suspend task	Task
isus_tsk	Suspend task	Non-task
rsm_tsk	Resume suspended task	Task
irsm_tsk	Resume suspended task	Non-task
frsm_tsk	Forcibly resume suspended task	Task
ifrsm_tsk	Forcibly resume suspended task	Non-task
dly_tsk	Delay task	Task

slp_tsk

Outline

Put task to sleep (waiting forever).

C format

```
  ER      slp_tsk (void);
```

Parameter(s)

None.

Explanation

As a result, the invoking task is unlinked from the ready queue and excluded from the RI600PX scheduling subject.
If a wake-up request has been queued to the target task (the wake-up request counter > 0) when this service call is issued, this service call does not move the state but decrements the wake-up request counter (by subtracting 1 from the wake-up request counter).
The sleeping state is cancelled in the following cases.

Sleeping State Cancel Operation	Return Value
A wake-up request was issued as a result of issuing wup_tsk.	E_OK
A wake-up request was issued as a result of issuing iwup_tsk.	E_OK
Forced release from waiting (accept rel_wai while waiting).	E_RLWAI
Forced release from waiting (accept irel_wai while waiting).	E_RLWAI

Return value

Macro	Value	Description
E_OK	0	Normal completion.
E_CTX	-25	Context error. - This service call was issued from a non-task. - This service call was issued in the CPU locked state. - This service call was issued in the dispatching disabled state. - This service call was issued in the status “PSW.IPL > kernel interrupt mask level”.
E_MACV	-26	Memory access violation. - Stack pointer points out of user stack for invoking task.
E_RLWAI	-49	Forced release from the WAITING state. - Accept rel_wai/irel_wai while waiting.

tslp_tsk

Outline

Put task to sleep (with time-out).

C format

```
ER      tslp_tsk (TMO tmout);
```

Parameter(s)

I/O	Parameter	Description
I	`TMO      tmout;`	Specified time-out (in millisecond). TMO_FEVR: Waiting forever. TMO_POL: Polling. Value: Specified time-out.

Explanation

This service call moves the invoking task from the RUNNING state to the WAITING state (sleeping state).
As a result, the invoking task is unlinked from the ready queue and excluded from the RI600PX scheduling subject.
If a wake-up request has been queued to the target task (the wake-up request counter > 0) when this service call is issued, this service call does not move the state but decrements the wake-up request counter (by subtracting 1 from the wake-up request counter).
The sleeping state is cancelled in the following cases.

Sleeping State Cancel Operation	Return Value
A wake-up request was issued as a result of issuing wup_tsk.	E_OK
A wake-up request was issued as a result of issuing iwup_tsk.	E_OK
Forced release from waiting (accept rel_wai while waiting).	E_RLWAI
Forced release from waiting (accept irel_wai while waiting).	E_RLWAI
The time specified by *tmout* has elapsed.	E_TMOUT

Note When TMO_FEVR is specified for wait time *tmout*, processing equivalent to slp_tsk will be executed.

Return value

Macro	Value	Description
E_OK	0	Normal completion.

Macro	Value	Description
E_PAR	-17	Parameter error. - *tmout* < -1 - *tmout* > (0x7FFFFFFF - TIC_NUME) / TIC_DENO
E_CTX	-25	Context error. - This service call was issued from a non-task. - This service call was issued in the CPU locked state. - This service call was issued in the dispatching disabled state. - This service call was issued in the status “PSW.IPL > kernel interrupt mask level”.
E_MACV	-26	Memory access violation. - Stack pointer points out of user stack for invoking task.
E_RLWAI	-49	Forced release from the WAITING state. - Accept rel_wai/irel_wai while waiting.
E_TMOUT	-50	Polling failure or specified time has elapsed.

wup_tsk
iwup_tsk

Outline

Wake-up task.

C format

```
ER      wup_tsk (ID tskid);
ER      iwup_tsk (ID tskid);
```

Parameter(s)

I/O	Parameter	Description
I	`ID tskid;`	ID number of the task. TSK_SELF: Invoking task. Value: ID number of the task.

Explanation

These service calls cancel the WAITING state (sleeping state) of the task specified by parameter *tskid*.
As a result, the target task is moved from the sleeping state to the READY state, or from the WAITING-SUSPENDED state to the SUSPENDED state.
If the target task is in a state other than the sleeping state when this service call is issued, this service call does not move the state but increments the wake-up request counter (by added 1 to the wake-up request counter).

Note The wake-up request counter managed by the RI600PX is configured in 8-bit widths. If the number of wake-up requests exceeds the maximum count value 255 as a result of issuing this service call, the counter manipulation processing is therefore not performed but “E_QOVR” is returned.

Return value

Macro	Value	Description
E_OK	0	Normal completion.
E_ID	-18	Invalid ID number. - *tskid* < 0 - *tskid* > VTMAX_TSK - When iwup_tsk was issued from a non-task, TSK_SELF was specified for *tskid*.

Macro	Value	Description
E_CTX	-25	Context error. - This service call was issued in the CPU locked state. - The iwup_tsk was issued from task. - The wup_tsk was issued from non-task. - This service call was issued in the status "PSW.IPL > kernel interrupt mask level".
E_MACV	-26	Memory access violation. (only for wup_tsk) - Stack pointer points out of user stack for invoking task.
E_OBJ	-41	Object state error. - Specified task is in the DORMANT state.
E_NOEXS	-42	Non-existent object. - The task specified by *tskid* does not exist.
E_QOVR	-43	Queuing overflow. - Wake-up request count exceeded 255.

can_wup
ican_wup

Outline

Cancel task wake-up requests.

C format

```
ER_UINT can_wup (ID tskid);
ER_UINT ican_wup (ID tskid);
```

Parameter(s)

I/O	Parameter	Description
I	`ID tskid;`	ID number of the task. TSK_SELF: Invoking task. Value: ID number of the task.

Explanation

These service calls cancel all of the wake-up requests queued to the task specified by parameter *tskid* (the wake-up request counter is set to 0), and return the number of cancelled wake-up requests.

Return value

Macro	Value	Description
-	0 or more	Normal completion (wake-up request count).
E_ID	-18	Invalid ID number. - *tskid* < 0 - *tskid* > VTMAX_TSK - When this service call was issued from a non-task, TSK_SELF was specified for *tskid*.
E_CTX	-25	Context error. - This service call was issued in the CPU locked state. - This service call was issued in the status "PSW.IPL > kernel interrupt mask level". Note When the ican_wup is issued from task or the can_wup is issued from non-task, the context error is not detected and normal operation of the system is not guaranteed.
E_OBJ	-41	Object state error. - Specified task is in the DORMANT state.

Macro	Value	Description
E_NOEXS	-42	Non-existent object. - The task specified by *tskid* does not exist.

rel_wai
irel_wai

Outline

Release task from waiting.

C format

```
ER      rel_wai (ID tskid);
ER      irel_wai (ID tskid);
```

Parameter(s)

I/O	Parameter	Description
I	`ID tskid;`	ID number of the task.

Explanation

These service calls forcibly cancel the WAITING state of the task specified by parameter *tskid*.
As a result, the target task unlinked from the wait queue and is moved from the WAITING state to the READY state, or from the WAITING-SUSPENDED state to the SUSPENDED state.
"E_RLWAI" is returned from the service call that triggered the move to the WAITING state (slp_tsk, wai_sem, or the like) to the task whose WAITING state is cancelled by this service call.

Note 1 These service calls do not perform queuing of forced cancelation requests. If the target task is neither in the WAITING state nor WAITING-SUSPENDED state, "E_OBJ" is returned.

Note 2 The SUSPENDED state is not cancelled by these service calls.

Return value

Macro	Value	Description
E_OK	0	Normal completion.
E_ID	-18	Invalid ID number. - *tskid* ≤ 0 - *tskid* > VTMAX_TSK
E_CTX	-25	Context error. - This service call was issued in the CPU locked state. - The irel_wai was issued from task. - The rel_wai was issued from non-task. - This service call was issued in the status "PSW.IPL > kernel interrupt mask level".

Macro	Value	Description
E_MACV	-26	Memory access violation. (only for rel_wai) - Stack pointer points out of user stack for invoking task.
E_OBJ	-41	Object state error. - Specified task is neither in the WAITING state nor WAITING-SUSPENDED state.
E_NOEXS	-42	Non-existent object. - The task specified by *tskid* does not exist.

sus_tsk
isus_tsk

Outline

Suspend task.

C format

```
ER      sus_tsk (ID tskid);
ER      isus_tsk (ID tskid);
```

Parameter(s)

I/O	Parameter	Description
I	`ID tskid;`	ID number of the task. TSK_SELF: Invoking task. Value: ID number of the task.

Explanation

These service calls move the task specified by parameter *tskid* from the RUNNING state to the SUSPENDED state, from the READY state to the SUSPENDED state, or from the WAITING state to the WAITING-SUSPENDED state.
If the target task has moved to the SUSPENDED or WAITING-SUSPENDED state when this service call is issued, these service calls return “E_QOVR”.

Note In the RI600PX, the suspend request can not be nested.

Return value

Macro	Value	Description
E_OK	0	Normal completion.
E_ID	-18	Invalid ID number. - *tskid* < 0 - *tskid* > VTMAX_TSK - When this service call was issued from a non-task, TSK_SELF was specified for *tskid*.
E_CTX	-25	Context error. - This service call was issued in the CPU locked state. - The isus_tsk was issued from task. - The sus_tsk was issued from non-task. - This service call was issued in the status “PSW.IPL > kernel interrupt mask level”. - The invoking task is specified in the dispatching disabled state.

Macro	Value	Description
E_MACV	-26	Memory access violation. (only for sus_tsk) - Stack pointer points out of user stack for invoking task.
E_OBJ	-41	Object state error. - Specified task is in the DORMANT state. - Specified task is in the RUNNING state when isus_tsk is issued in the dispatching disabled state.
E_NOEXS	-42	Non-existent object. - The task specified by *tskid* does not exist.
E_QOVR	-43	Queuing overflow. - Specified task is neither in the SUSPENDED state nor WAITING-SUSPENDED state.

rsm_tsk
irsm_tsk

Outline

Resume suspended task.

C format

```
ER      rsm_tsk (ID tskid);
ER      irsm_tsk (ID tskid);
```

Parameter(s)

I/O	Parameter	Description
I	`ID tskid;`	ID number of the task.

Explanation

These service calls move the task specified by parameter *tskid* from the SUSPENDED state to the READY state, or from the WAITING-SUSPENDED state to the WAITING state.

Note 1 These service calls do not perform queuing of forced cancelation requests. If the target task is neither in the SUSPENDED state nor WAITING-SUSPENDED state, “E_OBJ” is returned.

Note 2 The RI600PX does not support queuing of suspend request. The behavior of the frsm_tsk and ifrsm_tsk, that can release from the SUSPENDED state even if suspend request has been queued, are same as rsm_tsk and irsm_tsk.

Return value

Macro	Value	Description
E_OK	0	Normal completion.
E_ID	-18	Invalid ID number. - *tskid* ≤ 0 - *tskid* > VTMAX_TSK
E_CTX	-25	Context error. - This service call was issued in the CPU locked state. - The irsm_tsk was issued from task. - The rsm_tsk was issued from non-task. - This service call was issued in the status “PSW.IPL > kernel interrupt mask level”.
E_MACV	-26	Memory access violation. (only for rsm_tsk) - Stack pointer points out of user stack for invoking task.

Macro	Value	Description
E_OBJ	-41	Object state error. - Specified task is neither in the SUSPENDED state nor WAITING-SUSPENDED state.
E_NOEXS	-42	Non-existent object. - The task specified by *tskid* does not exist.

frsm_tsk
ifrsm_tsk

Outline

Forcibly resume suspended task.

C format

```
ER      frsm_tsk (ID tskid);
ER      ifrsm_tsk (ID tskid);
```

Parameter(s)

I/O	Parameter	Description
I	`ID tskid;`	ID number of the task.

Explanation

These service calls cancel all of the suspend requests issued for the task specified by parameter *tskid* (by setting the suspend request counter to 0). As a result, the target task moves from the SUSPENDED state to the READY state, or from the WAITING-SUSPENDED state to the WAITING state.

Note 1 These service calls do not perform queuing of forced cancelation requests. If the target task is neither in the SUSPENDED state nor WAITING-SUSPENDED state, “E_OBJ” is returned.

Note 2 The RI600PX does not support queuing of suspend request. Therefore, the behavior of these service calls are same as rsm_tsk and irsm_tsk.

Return value

Macro	Value	Description
E_OK	0	Normal completion.
E_ID	-18	Invalid ID number. - *tskid* ≤ 0 - *tskid* > VTMAX_TSK
E_CTX	-25	Context error. - This service call was issued in the CPU locked state. - The ifrsm_tsk was issued from task. - The frsm_tsk was issued from non-task. - This service call was issued in the status “PSW.IPL > kernel interrupt mask level”.
E_MACV	-26	Memory access violation. (only for frsm_tsk) - Stack pointer points out of user stack for invoking task.

Macro	Value	Description
E_OBJ	-41	Object state error. - Specified task is neither in the SUSPENDED state nor WAITING-SUSPENDED state.
E_NOEXS	-42	Non-existent object. - The task specified by *tskid* does not exist.

dly_tsk

Outline

Delay task.

C format

```
ER      dly_tsk (RELTIM dlytim);
```

Parameter(s)

I/O	Parameter	Description
I	`RELTIM dlytim;`	Amount of time to delay the invoking task (in millisecond).

Explanation

This service call moves the invoking task from the RUNNING state to the WAITING state (delayed state).
As a result, the invoking task is unlinked from the ready queue and excluded from the RI600PX scheduling subject.
The delayed state is cancelled in the following cases.

Delayed State Cancel Operation	Return Value
Delay time specified by parameter *dlytim* has elapsed.	E_OK
Forced release from waiting (accept rel_wai while waiting).	E_RLWAI
Forced release from waiting (accept irel_wai while waiting).	E_RLWAI

Note When 0 is specified as *dlytim*, the delay time is up to next base clock interrupt generation.

Return value

Macro	Value	Description
E_OK	0	Normal completion.
E_PAR	-17	Parameter error. - *dlytim* > (0x7FFFFFFF - TIC_NUME) / TIC_DENO
E_CTX	-25	Context error. - This service call was issued from a non-task. - This service call was issued in the CPU locked state. - This service call was issued in the dispatching disabled state. - This service call was issued in the status "PSW.IPL > kernel interrupt mask level".

Macro	Value	Description
E_MACV	-26	Memory access violation. - Stack pointer points out of user stack for invoking task.
E_RLWAI	-49	Forced release from the WAITING state. - Accept rel_wai/irel_wai while waiting.

19.2.3 Task exception handling functions

The following shows the service calls provided by the RI600PX as the task exception handling functions.

Table 19-6 Task Exception Handling Functions

Service Call	Function	Useful Range
def_tex	Define task exception handling routine	Task
ras_tex	Raise task exception	Task
iras_tex	Raise task exception	Non-task
dis_tex	Disable task exception	Task
ena_tex	Enable task exception	Task
sns_tex	Reference task exception disabled state	Task, Non-task
ref_tex	Reference task exception state	Task
iref_tex	Reference task exception state	Non-task

def_tex

Outline

Define task exception handling routine.

C format

```
ER      def_tex (ID tskid, T_DTEX *pk_dtex );
```

Parameter(s)

I/O	Parameter	Description
I	`ID tskid;`	ID number of the task. TSK_SELF: Invoking task. Value: ID number of the task.
I	`T_DTEX *pk_dtex;`	NULL: Cancel the definition of task exception handling routine. Other than NULL: Pointer to the packet containing the task exception handling routine definition information.

[Task exception handling routine definition information packet : T_DTEX]

```
typedef struct  t_dtex {
    ATR     texatr;         /*Task exception handling routine attribute*/
    FP      texrtn;         /*Task exception handling routine start address*/
} T_DTEX;
```

Explanation

This service call can be called from tasks that belong to Trusted Domain.
This service call defines a task exception handling routine for the task indicated by *tskid* according to the content of *pk_dtex*. If a task exception handling routine has already been defined for the task, this service call updates the definition contents.
When NULL is specified for *pk_dtex*, the definition of the task exception handling routine for the task is cancelled. At this time, the task pending exception code is cleared to 0, and the task exception handling is disabled.

1) Task ID (*tskid*)
Specify the task ID to define a task exception handling routine for *tskid*. Specifying *tskid* = TSK_SELF (= 0) means that the invoking task itself is specified.

2) Task exception handling routine attribute (*texatr*)
Only TA_HLNG can be specified for *texatr.*

- TA_HLNG (= 0x0000)
  Only C-language is supported for task exception handling routine description language.

3) Task exception handling routine start address (*texrtn*)
Specify the task exception handling routine start address for *texrtn*.

Return value

Macro	Value	Description
E_OK	0	Normal completion.
E_RSATR	-11	Reserved attribute - *texatr* != TA_HLNG
E_PAR	-17	Parameter error. - *pk_dtex* != NULL and *texrtn* == NULL
E_ID	-18	Invalid ID number. - *tskid* < 0 - *tskid* > VTMAX_TSK
E_CTX	-25	Context error. - This service call was issued in the CPU locked state. - This service call was issued from non-task. - This service call was issued in the status “PSW.IPL > kernel interrupt mask level”.
E_MACV	-26	Memory access violation. - Stack pointer points out of user stack for invoking task. - *pk_dtex* != NULL and the operand-read access to the area indicated by *pk_ctsk* has not been permitted to the invoking task.
E_OACV	-27	Object access violation. - The invoking task does not belong to trusted domain.
E_NOEXS	-42	Non-existent object. - The task specified by *tskid* does not exist.

ras_tex
iras_tex

Outline

Raise task exception.

C format

```
ER      ras_tex ( ID tskid, TEXPTN rasptn );
ER      iras_tex ( ID tskid, TEXPTN rasptn );
```

Parameter(s)

I/O	Parameter	Description
I	`ID        tskid;`	ID number of the task. TSK_SELF: Invoking task. Value: ID number of the task.
I	`TEXPTN   rasptn;`	Task exception code to be requested.

Explanation

This service call requests task exception handling for the task indicated by *tskid*. The task pending exception code for the task is ORed with the value indicated by *rasptn*.
When the conditions for starting task exception handling routine are satisfied, the task exception handling routine is invoked. Please refer to "6.2.3 The starting conditions of task exception handling routines" for the conditions for starting task exception handling routine.
When a task exception handling routine is invoked, the task pending exception code is cleared to 0, and the task exception handling is disabled. The pending exception code before clear and extended information for the task are passed to the task exception handling routine.
At the return from a task exception handling routine, the task exception is enabled, and the task restarts execution from the point immediately before the start of the task exception handling routine.
When a task exception handling routine returns, the RI600PX saves context registers for the task to the user stack. If the user stack is overflow, system goes down.
It is necessary to release from CPU locked state by the end of a task exception handling routine when shifting to the CPU locked state in a task exception handling routine. If CPU is locked at the end of a task exception handling routine, system goes down.
The interrupt priority level (PSW.IPL) before and after the start of a task exception handling routine is not changed. And the interrupt priority level before and after the return from a task exception handling routine is not changed. When the interrupt priority level at the end of a task exception handling routine is higher than the kernel interrupt mask level, system goes down.

Return value

Macro	Value	Description
E_OK	0	Normal completion.

Macro	Value	Description
E_PAR	-17	Parameter error. - *rasptn* == 0
E_ID	-18	Invalid ID number. - *tskid* < 0 - *tskid* > VTMAX_TSK - When iras_tex was issued from a non-task, TSK_SELF was specified for *tskid*.
E_CTX	-25	Context error. - This service call was issued in the CPU locked state. - The iras_tex was issued from task. - The ras_tex was issued from non-task. - This service call was issued in the status “PSW.IPL > kernel interrupt mask level”.
E_MACV	-26	Memory access violation. (only for ras_tex) - Stack pointer points out of user stack for invoking task.
E_OBJ	-41	Object state error. - Specified task is neither in the WAITING state nor WAITING-SUSPENDED state.
E_NOEXS	-42	Non-existent object. - The task specified by *tskid* does not exist.

dis_tex

Outline

Disable task exception.

C format

```
ER      dis_tex (void);
```

Parameter(s)

None.

Explanation

This service call disables task exception handling for the invoking task.

Return value

Macro	Value	Description
E_OK	0	Normal completion.
E_CTX	-25	Context error. - This service call was issued from a non-task. - This service call was issued in the CPU locked state. - This service call was issued in the status “PSW.IPL > kernel interrupt mask level”.
E_OBJ	-41	Object state error. - A task exception handling routine is not defined for the invoking task.

ena_tex

Outline

Enable task exception.

C format

```
ER      ena_tex (void);
```

Parameter(s)

None.

Explanation

This service call enables task exception handling for the invoking task.

Return value

Macro	Value	Description
E_OK	0	Normal completion.
E_CTX	-25	Context error. - This service call was issued from a non-task. - This service call was issued in the CPU locked state. - This service call was issued in the status "PSW.IPL > kernel interrupt mask level".
E_MACV	-26	Memory access violation. - Stack pointer points out of user stack for invoking task.
E_OBJ	-41	Object state error. - A task exception handling routine is not defined for the invoking task.

sns_tex

Outline

Reference task exception disabled state.

C format

```
BOOL    sns_tex (void);
```

Parameter(s)

None.

Explanation

This service call returns TRUE if the task in the RUNNING state is in the task exception disabled state, and otherwise returns FALSE. Table 19-7 shows the details.

Table 19-7 Return value of sns_tex

Task in the RUNNING state	Task exception handling routine for the task in the RUNNING state	Task exception disabled state for the task in the RUNNING state	Return value	Note
Exist	Defined	Enabled state	FALSE	
		Disabled state	TRUE	
	Not defined	Disabled state	TRUE	When task exception handling routine is not defined, task exception handling is disabled.
Not exist	-	-	TRUE	

Return value

Macro	Value	Description
TRUE	1	Normal completion (task exception disabled state).
FALSE	0	Normal completion (task exception enabled state).
E_CTX	-25	Context error. - This service call was issued in the status “PSW.IPL > kernel interrupt mask level”.

ref_tex
iref_tex

Outline

Reference task exception state.

C format

```
ER      ref_tex (ID tskid, T_RTEX *pk_rtex);
ER      iref_tex (ID tskid, T_RTEX *pk_rtex);
```

Parameter(s)

I/O	Parameter	Description
I	`ID tskid;`	ID number of the task. TSK_SELF: Invoking task. Value: ID number of the task.
O	`T_RTEX *pk_rtex;`	Pointer to the packet returning the task exception state.

[Task exception state packet: T_RTEX]

```
typedef struct  t_rtex {
    STAT    texstat;        /*Task exception handling state*/
    UINT    pndptn;         /*Pending exception code*/
} T_RTEX;
```

Explanation

Stores task exception state of the task specified by parameter *tskid* in the area specified by parameter *pk_rtex*.

- *tskstat*
  Stores task exception handling state.

TTEX_ENA:	Task exception enabled state
TTEX_DIS:	Task exception disabled state

- *pndptn*
  Stores the pending exception code.

Return value

Macro	Value	Description
E_OK	0	Normal completion.

Macro	Value	Description
E_PAR	-17	Parameter error. - *pk_rtex* == NULL
E_ID	-18	Invalid ID number. - *tskid* < 0 - *tskid* > VTMAX_TSK - When this service call was issued from a non-task, TSK_SELF was specified for *tskid*.
E_CTX	-25	Context error. - This service call was issued in the CPU locked state. - This service call was issued in the status “PSW.IPL > kernel interrupt mask level”. Note When the iref_tex is issued from task or the ref_tex is issued from non-task, the context error is not detected and normal operation of the system is not guaranteed.
E_MACV	-26	Memory access violation. (only for ref_tex) - The operand-write access to the area indicated by *pk_rtex* has not been permitted to the invoking task.
E_NOEXS	-42	Non-existent object. - The task specified by *tskid* does not exist.

19.2.4 Synchronization and communication functions (semaphores)

The following shows the service calls provided by the RI600PX as the synchronization and communication functions (semaphores).

Table 19-8 Synchronization and Communication Functions (Semaphores)

Service Call	Function	Useful Range
cre_sem	Create semaphore	Task
acre_sem	Create semaphore (automatic ID assignment)	Task
del_sem	Delete semaphore	Task
wai_sem	Acquire semaphore resource (waiting forever)	Task
pol_sem	Acquire semaphore resource (polling)	Task
ipol_sem	Acquire semaphore resource (polling)	Non-task
twai_sem	Acquire semaphore resource (with time-out)	Task
sig_sem	Release semaphore resource	Task
isig_sem	Release semaphore resource	Non-task
ref_sem	Reference semaphore state	Task
iref_sem	Reference semaphore state	Non-task

cre_sem
acre_sem

Outline

Create semaphore.

C format

```
ER       cre_sem (ID semid, T_CSEM *pk_csem );
ER_ID    acre_sem ( T_CSEM *pk_csem );
```

Parameter(s)

I/O	Parameter	Description
I	`ID        semid;`	ID number of the semaphore.
I	`T_CSEM   *pk_csem;`	Pointer to the packet containing the semaphore creation information.

[Semaphore creation information packet : T_CSEM]

```
typedef struct  t_csem {
    ATR     sematr;          /*Semaphore attribute*/
    UINT    isemcnt;         /*Initial semaphore count*/
    UINT    maxsem;          /*Maximum semaphore count*/
} T_CSEM;
```

Explanation

This service call can be called from tasks that belong to Trusted Domain.
The cre_sem creates a semaphore with semaphore ID indicated by *semid* according to the content of *pk_csem*. The acre_sem creates a semaphore according to the content of *pk_csem*, and returns the created semaphore ID.

1) Semaphore attribute (*sematr*)
The following are specified for *sematr*.

```
sematr := ( TA_TFIFO | TA_TPRI )
```

- TA_TFIFO (= 0x0000)
  Task wait queue is managed in FIFO order.

- TA_TPRI (= 0x0001)
  Task wait queue is managed in task current priority order. Among tasks with the same priority, they are queued in FIFO order.

2) Initial semaphore count (*isemcnt*)
Specify initial semaphore count within the range from 0 to *maxsem*.

3) Maximum semaphore count (*maxsem*)
Specify maximum semaphore count within the range from 1 to TMAX_MAXSEM (= 65535).

Return value

Macro	Value	Description
-	Positive value	Normal completion of acre_sem. (Created semaphore ID)
E_OK	0	Normal completion of cre_sem.
E_RSATR	-11	Reserved attribute - Either of bits in *sematr* except bit0 is 1.
E_PAR	-17	Parameter error. - *pk_csem* == NULL - *maxsem* == 0 - *maxsem* > TMAX_MAXSEM - *maxsem* < *isemcnt*
E_ID	-18	Invalid ID number. (only for cre_sem) - *semid* < 0 - *semid* > VTMAX_SEM
E_CTX	-25	Context error. - This service call was issued in the CPU locked state. - This service call was issued from non-task. - This service call was issued in the status “PSW.IPL > kernel interrupt mask level”.
E_MACV	-26	Memory access violation. - Stack pointer points out of user stack for invoking task. - The operand-read access to the area indicated by *pk_csem* has not been permitted to the invoking task.
E_OACV	-27	Object access violation. - The invoking task does not belong to trusted domain.
E_NOID	-34	No ID number available.(only for acre_sem)
E_OBJ	-41	Object state error. (only for cre_sem) - The semaphore specified by *semid* exists.

del_sem

Outline

Delete semaphore.

C format

```
ER      del_sem (ID semid);
```

Parameter(s)

I/O	Parameter	Description
I	`ID        semid;`	ID number of the semaphore.

Explanation

This service call can be called from tasks that belong to Trusted Domain.
This service call deletes the semaphore indicated by *semid*.
When there are waiting tasks for the target semaphore by using wai_sem or twai_sem, this service call cancels the WAIT-ING state of the tasks and returns E_DLT as a return value of the wai_sem or twai_sem.

Return value

Macro	Value	Description
E_OK	0	Normal completion.
E_ID	-18	Invalid ID number. - *semid* ≤ 0 - *semid* > VTMAX_SEM
E_CTX	-25	Context error. - This service call was issued in the CPU locked state. - This service call was issued from non-task. - This service call was issued in the status “PSW.IPL > kernel interrupt mask level”.
E_MACV	-26	Memory access violation. - Stack pointer points out of user stack for invoking task.
E_OACV	-27	Object access violation. - The invoking task does not belong to trusted domain.
E_NOEXS	-42	Non-existent object. - The semaphore specified by *semid* does not exist.

wai_sem

Outline

Acquire semaphore resource (waiting forever).

C format

```
ER      wai_sem (ID semid);
```

Parameter(s)

I/O	Parameter	Description
I	`ID       semid;`	ID number of the semaphore.

Explanation

This service call acquires a resource from the semaphore specified by parameter *semid* (subtracts 1 from the semaphore counter).
If no resources are acquired from the target semaphore when this service call is issued (no available resources exist), this service call does not acquire resources but queues the invoking task to the target semaphore wait queue and moves it from the RUNNING state to the WAITING state (resource acquisition wait state).
The WAITING state for a semaphore resource is cancelled in the following cases.

WAITING State for a Semaphore Resource Cancel Operation	Return Value
The resource was released to the target semaphore as a result of issuing sig_sem.	E_OK
The resource was released to the target semaphore as a result of issuing isig_sem.	E_OK
Forced release from waiting (accept rel_wai while waiting).	E_RLWAI
Forced release from waiting (accept irel_wai while waiting).	E_RLWAI
Forced release from waiting (accept del_sem while waiting).	E_DLT

Note Invoking tasks are queued to the target semaphore wait queue in the order specified at creating the semaphore (FIFO order or current priority order).

Return value

Macro	Value	Description
E_OK	0	Normal completion.
E_ID	-18	Invalid ID number. - *semid* ≤ 0 - *semid* > VTMAX_SEM

Macro	Value	Description
E_CTX	-25	Context error. - This service call was issued from a non-task. - This service call was issued in the CPU locked state. - This service call was issued in the dispatching disabled state. - This service call was issued in the status “PSW.IPL > kernel interrupt mask level”.
E_MACV	-26	Memory access violation. - Stack pointer points out of user stack for invoking task.
E_NOEXS	-42	Non-existent object. - The semaphore specified by *semid* does not exist.
E_RLWAI	-49	Forced release from the WAITING state. - Accept rel_wai/irel_wai while waiting.
E_DLT	-51	Waiting object deleted. - Accept del_sem while waiting.

pol_sem
ipol_sem

Outline

Acquire semaphore resource (polling).

C format

```
ER      pol_sem (ID semid);
ER      isem_sem (ID semid);
```

Parameter(s)

I/O	Parameter	Description
I	`ID semid;`	ID number of the semaphore.

Explanation

This service call acquires a resource from the semaphore specified by parameter *semid* (subtracts 1 from the semaphore counter).
If a resource could not be acquired from the target semaphore (semaphore counter is set to 0) when this service call is issued, the counter manipulation processing is not performed but "E_TMOUT" is returned.

Return value

Macro	Value	Description
E_OK	0	Normal completion.
E_ID	-18	Invalid ID number. - *semid* ≤ 0 - *semid* > VTMAX_SEM
E_CTX	-25	Context error. - This service call was issued in the CPU locked state. - This service call was issued in the status "PSW.IPL > kernel interrupt mask level". Note When the ipol_sem is issued from task or the pol_sem is issued from non-task, the context error is not detected and normal operation of the system is not guaranteed.
E_NOEXS	-42	Non-existent object. - The semaphore specified by *semid* does not exist.
E_TMOUT	-50	Polling failure.

twai_sem

Outline

Acquire semaphore resource (with time-out).

C format

```
ER      twai_sem (ID semid, TMO tmout);
```

Parameter(s)

I/O	Parameter	Description
I	`ID        semid;`	ID number of the semaphore.
I	`TMO       tmout;`	Specified time-out (in millisecond). TMO_FEVR: Waiting forever. TMO_POL: Polling. Value: Specified time-out.

Explanation

This service call acquires a resource from the semaphore specified by parameter *semid* (subtracts 1 from the semaphore counter).
If no resources are acquired from the target semaphore when service call is issued this (no available resources exist), this service call does not acquire resources but queues the invoking task to the target semaphore wait queue and moves it from the RUNNING state to the WAITING state with time-out (resource acquisition wait state).
The WAITING state for a semaphore resource is cancelled in the following cases.

WAITING State for a Semaphore Resource Cancel Operation	Return Value
The resource was released to the target semaphore as a result of issuing sig_sem.	E_OK
The resource was released to the target semaphore as a result of issuing isig_sem.	E_OK
Forced release from waiting (accept rel_wai while waiting).	E_RLWAI
Forced release from waiting (accept irel_wai while waiting).	E_RLWAI
The time specified by *tmout* has elapsed.	E_TMOUT
Forced release from waiting (accept del_sem while waiting).	E_DLT

Note 1 Invoking tasks are queued to the target semaphore wait queue in the order specified at creating the semaphore (FIFO order or current priority order).

Note 2 TMO_FEVR is specified for wait time *tmout*, processing equivalent to wai_sem will be executed. When TMO_POL is specified, processing equivalent to pol_sem will be executed.

Return value

Macro	Value	Description
E_OK	0	Normal completion.
E_PAR	-17	Parameter error. - *tmout* < -1 - *tmout* > (0x7FFFFFFF - TIC_NUME) / TIC_DENO
E_ID	-18	Invalid ID number. - *semid* ≤ 0 - *semid* > VTMAX_SEM
E_CTX	-25	Context error. - This service call was issued from a non-task. - This service call was issued in the CPU locked state. - This service call was issued in the dispatching disabled state. - This service call was issued in the status “PSW.IPL > kernel interrupt mask level”.
E_MACV	-26	Memory access violation. - Stack pointer points out of user stack for invoking task.
E_NOEXS	-42	Non-existent object. - The semaphore specified by *semid* does not exist.
E_RLWAI	-49	Forced release from the WAITING state. - Accept rel_wai/irel_wai while waiting.
E_TMOUT	-50	Polling failure or specified time has elapsed.
E_DLT	-51	Waiting object deleted. - Accept del_sem while waiting.

sig_sem
isig_sem

Outline

Release semaphore resource.

C format

```
ER      sig_sem (ID semid);
ER      isig_sem (ID semid);
```

Parameter(s)

I/O	Parameter	Description
I	`ID semid;`	ID number of the semaphore.

Explanation

These service calls releases the resource to the semaphore specified by parameter *semid* (adds 1 to the semaphore counter).
If a task is queued in the wait queue of the target semaphore when this service call is issued, the counter manipulation processing is not performed but the resource is passed to the relevant task (first task of wait queue).
As a result, the relevant task is unlinked from the wait queue and is moved from the WAITING state (WAITING state for a semaphore resource) to the READY state, or from the WAITING-SUSPENDED state to the SUSPENDED state.

Note With the RI600PX, the maximum possible number of semaphore resources is defined at semaphore creation. If the number of resources exceeds the maximum resource count, this service call therefore does not release the acquired resources (addition to the semaphore counter value) but returns E_QOVR.

Return value

Macro	Value	Description
E_OK	0	Normal completion.
E_ID	-18	Invalid ID number. - *semid* ≤ 0 - *semid* > VTMAX_SEM
E_CTX	-25	Context error. - This service call was issued in the CPU locked state. - The isig_sem was issued from task. - The sig_sem was issued from non-task. - This service call was issued in the status “PSW.IPL > kernel interrupt mask level”.

Macro	Value	Description
E_MACV	-26	Memory access violation. (only for sig_sem) - Stack pointer points out of user stack for invoking task.
E_NOEXS	-42	Non-existent object. - The semaphore specified by *semid* does not exist.
E_QOVR	-43	Queuing overflow. - Resource count exceeded the maximum resource count.

ref_sem
iref_sem

Outline

Reference semaphore state.

C format

```
ER      ref_sem (ID semid, T_RSEM *pk_rsem);
ER      iref_sem (ID semid, T_RSEM *pk_rsem);
```

Parameter(s)

I/O	Parameter	Description
I	`ID       semid;`	ID number of the semaphore.
O	`T_RSEM   *pk_rsem;`	Pointer to the packet returning the semaphore state.

[Semaphore state packet: T_RSEM]

```
typedef struct  t_rsem {
    ID      wtskid;         /*Existence of waiting task*/
    UINT    semcnt;         /*Current resource count*/
} T_RSEM;
```

Explanation

Stores semaphore state packet (ID number of the task at the head of the wait queue, current resource count, etc.) of the semaphore specified by parameter *semid* in the area specified by parameter *pk_rsem*.

- *wtskid*
  Stores whether a task is queued to the semaphore wait queue.

TSK_NONE:	No applicable task
Value:	ID number of the task at the head of the wait queue

- *semcnt*
  Stores the current resource count.

Return value

Macro	Value	Description
E_OK	0	Normal completion.
E_PAR	-17	Parameter error. - *pk_rsem* == NULL

Macro	Value	Description
E_ID	-18	Invalid ID number. - *semid* ≤ 0 - *semid* > VTMAX_SEM
E_CTX	-25	Context error. - This service call was issued in the CPU locked state. - This service call was issued in the status “PSW.IPL > kernel interrupt mask level”. Note When the iref_sem is issued from task or the ref_sem is issued from non-task, the context error is not detected and normal operation of the system is not guaranteed.
E_MACV	-26	Memory access violation. (only for ref_sem) - The operand-write access to the area indicated by *pk_rsem* has not been permitted to the invoking task.
E_NOEXS	-42	Non-existent object. - The semaphore specified by *semid* does not exist.

19.2.5 Synchronization and communication functions (eventflags)

The following shows the service calls provided by the RI600PX as the synchronization and communication functions (eventflags).

Table 19-9 Synchronization and Communication Functions (Eventflags)

Service Call	Function	Useful Range
cre_flg	Create eventflag	Task
acre_flg	Create eventflag (automatic ID assignment)	Task
del_flg	Delete eventflag	Task
set_flg	Set eventflag	Task
iset_flg	Set eventflag	Non-task
clr_flg	Clear eventflag	Task
iclr_flg	Clear eventflag	Non-task
wai_flg	Wait for eventflag (waiting forever)	Task
pol_flg	Wait for eventflag (polling)	Task
ipol_flg	Wait for eventflag (polling)	Non-task
twai_flg	Wait for eventflag (with time-out)	Task
ref_flg	Reference eventflag state	Task
iref_flg	Reference eventflag state	Non-task

cre_flg
acre_flg

Outline

Create eventflag.

C format

```
ER      cre_flg (ID flgid, T_CFLG *pk_cflg );
ER_ID   acre_flg ( T_CFLG *pk_cflg );
```

Parameter(s)

I/O	Parameter	Description
I	`ID       flgid;`	ID number of the eventflag.
I	`T_CFLG   *pk_cflg;`	Pointer to the packet containing the eventflag creation information.

[Eventflag creation information packet : T_CFLG]

```
typedef struct  t_cflg {
    ATR     flgatr;         /*Eventflag attribute*/
    FLGPTN  iflgptn;        /*Initial bit pattern*/
} T_CFLG;
```

Explanation

This service call can be called from tasks that belong to Trusted Domain.
The cre_flg creates a eventflag with eventflag ID indicated by *flgid* according to the content of *pk_cflg*. The acre_flg creates a eventflag according to the content of *pk_cflg*, and returns the created eventflag ID.

1) Eventflag attribute (*flgatr*)
The following are specified for *flgatr*.

```
flgatr := ( ( TA_TFIFO || TA_TPRI ) | ( TA_WSGL || TA_WMUL ) | [TA_CLR] )
```

- TA_TFIFO (= 0x0000)
  Task wait queue is managed in FIFO order.

- TA_TPRI (= 0x0001)
  Task wait queue is managed in task current priority order. Among tasks with the same priority, they are queued in FIFO order.
  When TA_CLR attribute is not specified, even if there is the TA_TPRI attribute specified, the queue is managed in the same way as for the TA_TFIFO attribute. This behavior falls outside µITRON4.0 specification.

- TA_WSGL (= 0x0000)
  Does not permit multiple tasks to wait for the eventflag.

- TA_WMUL (= 0x0002)
  Permit multiple tasks to wait for the eventflag.

- TA_CLR (= 0x0004)
  All the bits of the eventflag are cleared when wai_flg, pol_flg, ipol_flg or twai_flg ends normally.

2) Initial bit pattern (*iflgptn*)
Specify initial eventflag bit pattern.

Return value

Macro	Value	Description
-	Positive value	Normal completion of acre_flg. (Created eventflag ID)
E_OK	0	Normal completion of cre_flg.
E_RSATR	-11	Reserved attribute - Either of bits in *flgatr* except bit0, bit1 and bit2 is 1.
E_PAR	-17	Parameter error. - *pk_cflg* == NULL
E_ID	-18	Invalid ID number. (only for cre_flg) - *flgid* < 0 - *flgid* > VTMAX_FLG
E_CTX	-25	Context error. - This service call was issued in the CPU locked state. - This service call was issued from non-task. - This service call was issued in the status “PSW.IPL > kernel interrupt mask level”.
E_MACV	-26	Memory access violation. - Stack pointer points out of user stack for invoking task. - The operand-read access to the area indicated by *pk_cflg* has not been permitted to the invoking task.
E_OACV	-27	Object access violation. - The invoking task does not belong to trusted domain.
E_NOID	-34	No ID number available.(only for acre_flg)
E_OBJ	-41	Object state error. (only for cre_flg) - The eventflag specified by *flgid* exists.

del_flg

Outline

Delete eventflag.

C format

```
ER      del_flg (ID flgid);
```

Parameter(s)

I/O	Parameter	Description
I	`ID        flgid;`	ID number of the eventflag.

Explanation

This service call can be called from tasks that belong to Trusted Domain.
This service call deletes the eventflag indicated by *flgid*.
When there are waiting tasks for the target eventflag by using wai_flg or twai_flg, this service call cancels the WAITING state of the tasks and returns E_DLT as a return value of the wai_flg or twai_flg.

Return value

Macro	Value	Description
E_OK	0	Normal completion.
E_ID	-18	Invalid ID number. - *flgid* $\leq$ 0 - *flgid* > VTMAX_FLG
E_CTX	-25	Context error. - This service call was issued in the CPU locked state. - This service call was issued from non-task. - This service call was issued in the status “PSW.IPL > kernel interrupt mask level”.
E_MACV	-26	Memory access violation. - Stack pointer points out of user stack for invoking task.
E_OACV	-27	Object access violation. - The invoking task does not belong to trusted domain.
E_NOEXS	-42	Non-existent object. - The eventflag specified by *flgid* does not exist.

set_flg
iset_flg

Outline

Set eventflag.

C format

```
ER      set_flg (ID flgid, FLGPTN setptn);
ER      iset_flg (ID flgid, FLGPTN setptn);
```

Parameter(s)

I/O	Parameter	Description
I	`ID` *`flgid;`*	ID number of the eventflag.
I	`FLGPTN` *`setptn;`*	Bit pattern to set.

Explanation

These service calls set the result of ORing the bit pattern of the eventflag specified by parameter *flgid* and the bit pattern specified by parameter *setptn* as the bit pattern of the target eventflag.
After that, these service calls evaluate whether the wait condition of the tasks in the wait queue is satisfied. This evaluation is done in order of the wait queue. If the wait condition is satisfied, the relevant task is unlinked from the wait queue at the same time as bit pattern setting processing. As a result, the relevant task is moved from the WAITING state (WAITING state for an eventflag) to the READY state, or from the WAITING-SUSPENDED state to the SUSPENDED state. At this time, the bit pattern of the target event flag is cleared to 0 and this service call finishes processing if the TA_CLR attribute is specified for the target eventflag.

Return value

Macro	Value	Description
E_OK	0	Normal completion.
E_ID	-18	Invalid ID number. - *flgid* ≤ 0 - *flgid* > VTMAX_FLG
E_CTX	-25	Context error. - This service call was issued in the CPU locked state. - The iset_flg was issued from task. - The set_flg was issued from non-task. - This service call was issued in the status "PSW.IPL > kernel interrupt mask level".

Macro	Value	Description
E_MACV	-26	Memory access violation. (only for set_flg) - Stack pointer points out of user stack for invoking task.
E_NOEXS	-42	Non-existent object. - The eventflag specified by *flgid* does not exist.

clr_flg
iclr_flg

Outline

Clear eventflag.

C format

```
ER      clr_flg (ID flgid, FLGPTN clrptn);
ER      iclr_flg (ID flgid, FLGPTN clrptn);
```

Parameter(s)

I/O	Parameter	Description
I	`ID        flgid;`	ID number of the eventflag.
I	`FLGPTN    clrptn;`	Bit pattern to clear.

Explanation

This service call sets the result of ANDing the bit pattern set to the eventflag specified by parameter *flgid* and the bit pattern specified by parameter *clrptn* as the bit pattern of the target eventflag.

Return value

Macro	Value	Description
E_OK	0	Normal completion.
E_ID	-18	Invalid ID number. - *flgid* ≤ 0 - *flgid* > VTMAX_FLG
E_CTX	-25	Context error. - This service call was issued in the CPU locked state. - This service call was issued in the status “PSW.IPL > kernel interrupt mask level”. Note When the iclr_flg is issued from task or the clr_flg is issued from non-task, the context error is not detected and normal operation of the system is not guaranteed.
E_NOEXS	-42	Non-existent object. - The eventflag specified by *flgid* does not exist.

wai_flg

Outline

Wait for eventflag (waiting forever).

C format

```
ER      wai_flg (ID flgid, FLGPTN waiptn, MODE wfmode, FLGPTN *p_flgptn);
```

Parameter(s)

I/O	Parameter	Description
I	`ID flgid;`	ID number of the eventflag.
I	`FLGPTN waiptn;`	Wait bit pattern.
I	`MODE wfmode;`	Wait mode. TWF_ANDW: AND waiting condition. TWF_ORW: OR waiting condition.
O	`FLGPTN *p_flgptn;`	Bit pattern causing a task to be released from waiting.

Explanation

This service call checks whether the bit pattern specified by parameter waiptn and the bit pattern that satisfies the required condition specified by parameter wfmode are set to the eventflag specified by parameter flgid.
If a bit pattern that satisfies the required condition has been set for the target eventflag, the bit pattern of the target eventflag is stored in the area specified by parameter p_flgptn.
If the bit pattern of the target eventflag does not satisfy the required condition when this service call is issued, the invoking task is queued to the target eventflag wait queue.
As a result, the invoking task is unlinked from the ready queue and is moved from the RUNNING state to the WAITING state (WAITING state for an eventflag).
The WAITING state for an eventflag is cancelled in the following cases.

WAITING State for an Eventflag Cancel Operation	Return Value
A bit pattern that satisfies the required condition was set to the target eventflag as a result of issuing set_flg.	E_OK
A bit pattern that satisfies the required condition was set to the target eventflag as a result of issuing iset_flg.	E_OK
Forced release from waiting (accept rel_wai while waiting).	E_RLWAI
Forced release from waiting (accept irel_wai while waiting).	E_RLWAI
Forced release from waiting (accept del_flg while waiting).	E_DLT

The following shows the specification format of required condition *wfmode*.

- *wfmode* == TWF_ANDW
  Checks whether all of the bits to which 1 is set by parameter *waiptn* are set as the target eventflag.

- *wfmode* == TWF_ORW
  Checks which bit, among bits to which 1 is set by parameter *waiptn*, is set as the target eventflag.

Note 1 With the RI600PX, whether to enable queuing of multiple tasks to the event flag wait queue is defined at eventflag creation. If this service call is issued for the event flag (TA_WSGL attribute) to which a wait task is queued, therefore, “E_ILUSE” is returned regardless of whether the required condition is immediately satisfied.

TA_WSGL:	Only one task is allowed to be in the WAITING state for the eventflag.
TA_WMUL:	Multiple tasks are allowed to be in the WAITING state for the eventflag.

Note 2 Invoking tasks are queued to the target event flag (TA_WMUL attribute) wait queue in the order specified at creating the eventflag (FIFO order or current priority order).
However, when the TA_CLR attribute is not specified, the wait queue is managed in the FIFO order even if the priority order is specified. This behavior falls outside μITRON4.0 specification.

Note 3 The RI600PX performs bit pattern clear processing (0 setting) when the required condition of the target eventflag (TA_CLR attribute) is satisfied.

Return value

Macro	Value	Description
E_OK	0	Normal completion.
E_PAR	-17	Parameter error. - *waiptn* == 0 - *wfmode* is invalid. - *p_flgptn* == NULL
E_ID	-18	Invalid ID number. - *flgid* $\leq$ 0 - *flgid* > VTMAX_FLG
E_CTX	-25	Context error. - This service call was issued from a non-task. - This service call was issued in the CPU locked state. - This service call was issued in the dispatching disabled state. - This service call was issued in the status “PSW.IPL > kernel interrupt mask level”.
E_MACV	-26	Memory access violation. - Stack pointer points out of user stack for invoking task. - The operand-write access to the area indicated by *p_flgptn* has not been permitted to the invoking task.
E_ILUSE	-28	Illegal use of service call. - There is already a task waiting for an eventflag with the TA_WSGL attribute.
E_NOEXS	-42	Non-existent object. - The eventflag specified by *flgid* does not exist.
E_RLWAI	-49	Forced release from the WAITING state. - Accept rel_wai/irel_wai while waiting.
E_DLT	-51	Waiting object deleted. - Accept del_flg while waiting.

pol_flg
ipol_flg

Outline

Wait for eventflag (polling).

C format

```
ER      pol_flg (ID flgid, FLGPTN waiptn, MODE wfmode, FLGPTN *p_flgptn);
ER      ipol_flg (ID flgid, FLGPTN waiptn, MODE wfmode, FLGPTN *p_flgptn);
```

Parameter(s)

I/O	Parameter	Description
I	`ID flgid;`	ID number of the eventflag.
I	`FLGPTN waiptn;`	Wait bit pattern.
I	`MODE wfmode;`	Wait mode. TWF_ANDW: AND waiting condition. TWF_ORW: OR waiting condition.
O	`FLGPTN *p_flgptn;`	Bit pattern causing a task to be released from waiting.

Explanation

This service call checks whether the bit pattern specified by parameter *waiptn* and the bit pattern that satisfies the required condition specified by parameter *wfmode* are set to the eventflag specified by parameter *flgid*.
If the bit pattern that satisfies the required condition has been set to the target eventflag, the bit pattern of the target eventflag is stored in the area specified by parameter *p_flgptn*.
If the bit pattern of the target eventflag does not satisfy the required condition when this service call is issued, “E_TMOUT” is returned.
The following shows the specification format of required condition *wfmode*.

- *wfmode* == TWF_ANDW
  Checks whether all of the bits to which 1 is set by parameter *waiptn* are set as the target eventflag.

- *wfmode* == TWF_ORW
  Checks which bit, among bits to which 1 is set by parameter *waiptn*, is set as the target eventflag.

Note 1 With the RI600PX, whether to enable queuing of multiple tasks to the event flag wait queue is defined during configuration. If this service call is issued for the event flag (TA_WSGL attribute) to which a wait task is queued, therefore, “E_ILUSE” is returned regardless of whether the required condition is immediately satisfied.

TA_WSGL:	Only one task is allowed to be in the WAITING state for the eventflag.
TA_WMUL:	Multiple tasks are allowed to be in the WAITING state for the eventflag.

Note 2 The RI600PX performs bit pattern clear processing (0 setting) when the required condition of the target eventflag (TA_CLR attribute) is satisfied.

Return value

Macro	Value	Description
E_OK	0	Normal completion.
E_PAR	-17	Parameter error. - *waiptn* == 0 - *wfmode* is invalid. - *p_flgptn* == NULL
E_ID	-18	Invalid ID number. - *flgid* $\leq$ 0 - *flgid* > VTMAX_FLG
E_CTX	-25	Context error. - This service call was issued in the CPU locked state. - This service call was issued in the status “PSW.IPL > kernel interrupt mask level”. Note When the ipol_flg is issued from task or the pol_flg is issued from non-task, the context error is not detected and normal operation of the system is not guaranteed.
E_MACV	-26	Memory access violation. (only for pol_flg) - The operand-write access to the area indicated by *p_flgptn* has not been permitted to the invoking task.
E_ILUSE	-28	Illegal use of service call. - There is already a task waiting for an eventflag with the TA_WSGL attribute.
E_NOEXS	-42	Non-existent object. - The eventflag specified by *flgid* does not exist.
E_TMOUT	-50	Polling failure

twai_flg

Outline

Wait for eventflag (with time-out).

C format

```
ER      twai_flg (ID flgid, FLGPTN waiptn, MODE wfmode, FLGPTN *p_flgptn, TMO tmout);
```

Parameter(s)

I/O	Parameter	Description
I	`ID flgid;`	ID number of the eventflag.
I	`FLGPTN waiptn;`	Wait bit pattern.
I	`MODE wfmode;`	Wait mode. TWF_ANDW: AND waiting condition. TWF_ORW: OR waiting condition.
O	`FLGPTN *p_flgptn;`	Bit pattern causing a task to be released from waiting.
I	`TMO tmout;`	Specified time-out (in millisecond). TMO_FEVR: Waiting forever. TMO_POL: Polling. Value: Specified time-out.

Explanation

This service call checks whether the bit pattern specified by parameter *waiptn* and the bit pattern that satisfies the required condition specified by parameter *wfmode* are set to the eventflag specified by parameter *flgid*.
If a bit pattern that satisfies the required condition has been set for the target eventflag, the bit pattern of the target eventflag is stored in the area specified by parameter *p_flgptn*.
If the bit pattern of the target eventflag does not satisfy the required condition when this service call is issued, the invoking task is queued to the target eventflag wait queue.
As a result, the invoking task is unlinked from the ready queue and is moved from the RUNNING state to the WAITING state (WAITING state for an eventflag).
The WAITING state for an eventflag is cancelled in the following cases.

WAITING State for an Eventflag Cancel Operation	Return Value
A bit pattern that satisfies the required condition was set to the target eventflag as a result of issuing set_flg.	E_OK
A bit pattern that satisfies the required condition was set to the target eventflag as a result of issuing iset_flg.	E_OK
Forced release from waiting (accept rel_wai while waiting).	E_RLWAI
Forced release from waiting (accept irel_wai while waiting).	E_RLWAI
The time specified by *tmout* has elapsed.	E_TMOUT

WAITING State for an Eventflag Cancel Operation	Return Value
Forced release from waiting (accept del_flg while waiting).	E_DLT

The following shows the specification format of required condition *wfmode*.

- *wfmode* == TWF_ANDW
  Checks whether all of the bits to which 1 is set by parameter *waiptn* are set as the target eventflag.

- *wfmode* == TWF_ORW
  Checks which bit, among bits to which 1 is set by parameter *waiptn*, is set as the target eventflag.

Note 1 With the RI600PX, whether to enable queuing of multiple tasks to the event flag wait queue is defined at eventflag creation. If this service call is issued for the event flag (TA_WSGL attribute) to which a wait task is queued, therefore, “E_ILUSE” is returned regardless of whether the required condition is immediately satisfied.

TA_WSGL:	Only one task is allowed to be in the WAITING state for the eventflag.
TA_WMUL:	Multiple tasks are allowed to be in the WAITING state for the eventflag.

Note 2 Invoking tasks are queued to the target event flag (TA_WMUL attribute) wait queue in the order specified at creating the eventflag (FIFO order or current priority order).
However, when the TA_CLR attribute is not specified, the wait queue is managed in the FIFO order even if the priority order is specified. This behavior falls outside μITRON4.0 specification.

Note 3 The RI600PX performs bit pattern clear processing (0 setting) when the required condition of the target eventflag (TA_CLR attribute) is satisfied.

Note 4 TMO_FEVR is specified for wait time *tmout*, processing equivalent to wai_flg will be executed. When TMO_POL is specified, processing equivalent to pol_flg will be executed.

Return value

Macro	Value	Description
E_OK	0	Normal completion.
E_PAR	-17	Parameter error. - *waiptn* == 0 - *wfmode* is invalid. - *p_flgptn* == NULL - *tmout* < -1 - *tmout* > (0x7FFFFFFF - TIC_NUME) / TIC_DENO
E_ID	-18	Invalid ID number. - *flgid* ≤ 0 - *flgid* > VTMAX_FLG
E_CTX	-25	Context error. - This service call was issued from a non-task. - This service call was issued in the CPU locked state. - This service call was issued in the dispatching disabled state. - This service call was issued in the status “PSW.IPL > kernel interrupt mask level”.

Macro	Value	Description
E_MACV	-26	Memory access violation. - Stack pointer points out of user stack for invoking task. - The operand-write access to the area indicated by *p_flgptn* has not been permitted to the invoking task.
E_ILUSE	-28	Illegal use of service call. - There is already a task waiting for an eventflag with the TA_WSGL attribute.
E_NOEXS	-42	Non-existent object. - The eventflag specified by *flgid* does not exist.
E_RLWAI	-49	Forced release from the WAITING state. - Accept rel_wai/irel_wai while waiting.
E_TMOUT	-50	Polling failure or specified time has elapsed.
E_DLT	-51	Waiting object deleted. - Accept del_flg while waiting.

ref_flg
iref_flg

Outline

Reference eventflag state.

C format

```
ER      ref_flg (ID flgid, T_RFLG *pk_rflg);
ER      iref_flg (ID flgid, T_RFLG *pk_rflg);
```

Parameter(s)

I/O	Parameter	Description
I	`ID       flgid;`	ID number of the eventflag.
O	`T_RFLG   *pk_rflg;`	Pointer to the packet returning the eventflag state.

[Eventflag state packet: T_RFLG]

```
typedef struct  t_rflg {
    ID      wtskid;         /*Existence of waiting task*/
    FLGPTN  flgptn;         /*Current bit pattern*/
} T_RFLG;
```

Explanation

Stores eventflag state packet (ID number of the task at the head of the wait queue, current bit pattern, etc.) of the eventflag specified by parameter *flgid* in the area specified by parameter *pk_rflg*.

- *wtskid*
  Stores whether a task is queued to the event flag wait queue.

TSK_NONE:	No applicable task
Value:	ID number of the task at the head of the wait queue

- *flgptn*
  Stores the current bit pattern.

Return value

Macro	Value	Description
E_OK	0	Normal completion.
E_PAR	-17	Parameter error. - *pk_rflg* == NULL

Macro	Value	Description
E_ID	-18	Invalid ID number. - *flgid* ≤ 0 - *flgid* > VTMAX_FLG
E_CTX	-25	Context error. - This service call was issued in the CPU locked state. - This service call was issued in the status “PSW.IPL > kernel interrupt mask level”. Note When the iref_flg is issued from task or the ref_flg is issued from non-task, the context error is not detected and normal operation of the system is not guaranteed.
E_MACV	-26	Memory access violation. (only for ref_flg) - The operand-write access to the area indicated by *pk_rflg* has not been permitted to the invoking task.
E_NOEXS	-42	Non-existent object. - The eventflag specified by *flgid* does not exist.

19.2.6 Synchronization and communication functions (data queues)

The following shows the service calls provided by the RI600PX as the synchronization and communication functions (data queues).

Table 19-10 Synchronization and Communication Functions (Data Queues)

Service Call	Function	Useful Range
cre_dtq	Create data queue	Task
acre_dtq	Create data queue (automatic ID assignment)	Task
del_dtq	Delete data queue	Task
snd_dtq	Send to data queue (waiting forever)	Task
psnd_dtq	Send to data queue (polling)	Task
ipsnd_dtq	Send to data queue (polling)	Non-task
tsnd_dtq	Send to data queue (with time-out)	Task
fsnd_dtq	Forced send to data queue	Task
ifsnd_dtq	Forced send to data queue	Non-task
rcv_dtq	Receive from data queue (waiting forever)	Task
prcv_dtq	Receive from data queue (polling)	Task
iprcv_dtq	Receive from data queue (polling)	Non-task
trcv_dtq	Receive from data queue (with time-out)	Task
ref_dtq	Reference data queue state	Task
iref_dtq	Reference data queue state	Non-task

cre_dtq
acre_dtq

Outline

Create data queue.

C format

```
ER       cre_dtq (ID dtqid, T_CDTQ *pk_cdtq );
ER_ID    acre_dtq ( T_CDTQ *pk_cdtq );
```

Parameter(s)

I/O	Parameter	Description
I	`ID       dtqid;`	ID number of the data queue.
I	`T_CDTQ   *pk_cdtq;`	Pointer to the packet containing the data queue creation information.

[Data queue creation information packet : T_CDTQ]

```
typedef struct  t_cdtq {
    ATR     dtqatr; /*Data queue attribute*/
    UINT    dtqcnt; /*Capacity of the data queue area (the number of data elements)*/
    VP      dtq;    /*Start address of the data queue area*/
} T_CDTQ;
```

Explanation

This service call can be called from tasks that belong to Trusted Domain.
The cre_dtq creates a data queue with data queue ID indicated by *dtqid* according to the content of *pk_cdtq*. The acre_dtq creates a data queue according to the content of *pk_cdtq*, and returns the created data queue ID.

1) Data queue attribute (*dtqatr*)
The following are specified for *dtqatr*.

```
dtqatr := ( TA_TFIFO || TA_TPRI )
```

- TA_TFIFO (= 0x0000)
  Task wait queue for sending is managed in FIFO order.

- TA_TPRI (= 0x0001)
  Task wait queue for sending is managed in task current priority order. Among tasks with the same priority, they are queued in FIFO order.

  Note Task wait queue for receiving is managed in FIFO order.

2) Capacity of the data queue area (*dtqcnt*), Start address of the data queue area (*dtq*)
The application acquires TSZ_DTQ(*dtqcnt*) bytes of data queue area and specifies the start address for *dtq*.
It is also possible to specify 0 as *dtqcnt*. In this case, since data cannot be stored in the data queue, the data sending task or data receiving task that has performed its operation first will enter the WAITING state. The WAITING

state of that task is canceled when the task of another side has performed its operation. Thus, data sending tasks and data receiving tasks are completely synchronized. Note, *dtq* is disregarded when *dtqcnt* is 0.

Note 1 For details of TSZ_DTQ macro, refer to “18.3.2 Macros for Data Queue”.

Note 2 The RI600PX is not concerned of anything of the access permission to the data queue area. Usually, the data queue area should be generated to the area other than memory objects and user stacks. When the data queue area is generated in the memory object, a task with the operand-write access permission to the memory object might rewrite data queue area by mistake.

Note 3 The μITRON4.0 specification defines the function that the kernel allocates data queue area when NULL is specified for *dtq*. But RI600PX does not support this function.

Return value

Macro	Value	Description
-	Positive value	Normal completion of acre_dtq. (Created data queue ID)
E_OK	0	Normal completion of cre_dtq.
E_RSATR	-11	Reserved attribute - Either of bits in *dtqatr* except bit0 is 1.
E_PAR	-17	Parameter error. - *pk_cdtq* == NULL - *dtqcnt* > 65535 - *dtqcnt* != 0 and *dtq* + TSZ_DTQ(*dtqcnt*) > 0x100000000
E_ID	-18	Invalid ID number. (only for cre_dtq) - *dtqid* < 0 - *dtqid* > VTMAX_DTQ
E_CTX	-25	Context error. - This service call was issued in the CPU locked state. - This service call was issued from non-task. - This service call was issued in the status “PSW.IPL > kernel interrupt mask level”.
E_MACV	-26	Memory access violation. - Stack pointer points out of user stack for invoking task. - The operand-read access to the area indicated by *pk_cdtq* has not been permitted to the invoking task.
E_OACV	-27	Object access violation. - The invoking task does not belong to trusted domain.
E_NOMEM	-33	Insufficient memory. - *dtqcnt* != 0 and *dtq* == NULL
E_NOID	-34	No ID number available.(only for acre_dtq)
E_OBJ	-41	Object state error. (only for cre_dtq) - The data queue specified by *dtqid* exists.

del_dtq

Outline

Delete data queue.

C format

```
ER      del_dtq (ID dtqid);
```

Parameter(s)

I/O	Parameter	Description
I	`ID` *`dtqid;`*	ID number of the data queue.

Explanation

This service call can be called from tasks that belong to Trusted Domain.
This service call deletes the data queue indicated by *dtqid*.
When there are waiting tasks for the target data queue by using snd_dtq, tsnd_dtq, rcv_dtq or trcv_dtq, this service call cancels the WAITING state of the tasks and returns E_DLT as a return value of the snd_dtq, tsnd_dtq, rcv_dtq or trcv_dtq.

Return value

Macro	Value	Description
E_OK	0	Normal completion.
E_ID	-18	Invalid ID number. - *dtqid* ≤ 0 - *dtqid* > VTMAX_DTQ
E_CTX	-25	Context error. - This service call was issued in the CPU locked state. - This service call was issued from non-task. - This service call was issued in the status “PSW.IPL > kernel interrupt mask level”.
E_MACV	-26	Memory access violation. - Stack pointer points out of user stack for invoking task.
E_OACV	-27	Object access violation. - The invoking task does not belong to trusted domain.
E_NOEXS	-42	Non-existent object. - The data queue specified by *dtqid* does not exist.

snd_dtq

Outline

Send to data queue (waiting forever).

C format

```
ER      snd_dtq (ID dtqid, VP_INT data);
```

Parameter(s)

I/O	Parameter	Description
I	`ID dtqid;`	ID number of the data queue.
I	`VP_INT data;`	Data element to be sent to the data queue.

Explanation

This service call processes as follows according to the situation of the data queue specified by the parameter *dtqid*.

- There is a task in the reception wait queue.
  This service call transfers the data specified by parameter *data* to the task in the top of the reception wait queue. As a result, the task is unlinked from the reception wait queue and moves from the WAITING state (data reception wait state) to the READY state, or from the WAITING-SUSPENDED state to the SUSPENDED state.
- There is no task neither in the reception wait queue and transmission wait queue and there is available space in the data queue.
  This service call stores the data specified by parameter *data* to the data queue.
- There is no task neither in the reception wait queue and transmission wait queue and there is no available space in the data queue, or there is a task in the transmission wait queue.
  This service call queues the invoking task to the transmission wait queue of the target data queue and moves it from the RUNNING state to the WAITING state (data transmission wait state).
  The sending WAITING state for a data queue is cancelled in the following cases.

Sending WAITING State for a Data Queue Cancel Operation	Return Value
Available space was secured in the data queue area as a result of issuing rcv_dtq.	E_OK
Available space was secured in the data queue area as a result of issuing prcv_dtq.	E_OK
Available space was secured in the data queue area as a result of issuing iprcv_dtq.	E_OK
Available space was secured in the data queue area as a result of issuing trcv_dtq.	E_OK
Forced release from waiting (accept rel_wai while waiting).	E_RLWAI
Forced release from waiting (accept irel_wai while waiting).	E_RLWAI
The data queue is reset as a result of issuingissuing vrst_dtq.	EV_RST
Forced release from waiting (accept del_dtq while waiting).	E_DLT

Note 1 Data is written to the data queue area in the order of the data transmission request.

Note 2 Invoking tasks are queued to the transmission wait queue of the target data queue in the order specified at creating the data queue (FIFO order or current priority order).

Return value

Macro	Value	Description
E_OK	0	Normal completion.
E_ID	-18	Invalid ID number. - *dtqid* ≤ 0 - *dtqid* > VTMAX_DTQ
E_CTX	-25	Context error. - This service call was issued from a non-task. - This service call was issued in the CPU locked state. - This service call was issued in the dispatching disabled state. - This service call was issued in the status “PSW.IPL > kernel interrupt mask level”.
E_MACV	-26	Memory access violation. - Stack pointer points out of user stack for invoking task.
E_NOEXS	-42	Non-existent object. - The data queue specified by *dtqid* does not exist.
E_RLWAI	-49	Forced release from the WAITING state. - Accept rel_wai/irel_wai while waiting.
E_DLT	-51	Waiting object deleted. - Accept del_dtq while waiting.
EV_RST	-127	Released from WAITING state by the object reset (vrst_dtq)

psnd_dtq
ipsnd_dtq

Outline

Send to data queue (polling).

C format

```
ER      psnd_dtq (ID dtqid, VP_INT data);
ER      ipsnd_dtq (ID dtqid, VP_INT data);
```

Parameter(s)

I/O	Parameter	Description
I	`ID      dtqid;`	ID number of the data queue.
I	`VP_INT  data;`	Data element to be sent to the data queue.

Explanation

These service calls process as follows according to the situation of the data queue specified by the parameter *dtqid*.

- There is a task in the reception wait queue.
  These service calls transfer the data specified by parameter *data* to the task in the top of the reception wait queue. As a result, the task is unlinked from the reception wait queue and moves from the WAITING state (data reception wait state) to the READY state, or from the WAITING-SUSPENDED state to the SUSPENDED state.
- There is no task neither in the reception wait queue and transmission wait queue and there is available space in the data queue.
  These service calls store the data specified by parameter *data* to the data queue.
- There is no task neither in the reception wait queue and transmission wait queue and there is no available space in the data queue, or there is a task in the transmission wait queue.
  These service calls return “E_TMOUT”.

Note Data is written to the data queue area of the target data queue in the order of the data transmission request.

Return value

Macro	Value	Description
E_OK	0	Normal completion.
E_ID	-18	Invalid ID number. - *dtqid* $\leq$ 0 - *dtqid* > VTMAX_DTQ

Macro	Value	Description
E_CTX	-25	Context error. - This service call was issued in the CPU locked state. - The ipsnd_dtq was issued from task. - The psnd_dtq was issued from non-task. - This service call was issued in the status “PSW.IPL > kernel interrupt mask level”.
E_MACV	-26	Memory access violation. (only for psnd_dtq) - Stack pointer points out of user stack for invoking task.
E_NOEXS	-42	Non-existent object. - The data queue specified by *dtqid* does not exist.
E_TMOUT	-50	Polling failure.

tsnd_dtq

Outline

Send to data queue (with time-out).

C format

```
ER      tsnd_dtq (ID dtqid, VP_INT data, TMO tmout);
```

Parameter(s)

I/O	Parameter	Description
I	`ID dtqid;`	ID number of the data queue.
I	`VP_INT data;`	Data element to be sent to the data queue.
I	`TMO tmout;`	Specified time-out (in millisecond). TMO_FEVR: Waiting forever. TMO_POL: Polling. Value: Specified time-out.

Explanation

This service call processes as follows according to the situation of the data queue specified by the parameter *dtqid*.

- There is a task in the reception wait queue.
  This service call transfers the data specified by parameter *data* to the task in the top of the reception wait queue. As a result, the task is unlinked from the reception wait queue and moves from the WAITING state (data reception wait state) to the READY state, or from the WAITING-SUSPENDED state to the SUSPENDED state.
- There is no task neither in the reception wait queue and transmission wait queue and there is available space in the data queue.
  This service call stores the data specified by parameter *data* to the data queue.
- There is no task neither in the reception wait queue and transmission wait queue and there is no available space in the data queue, or there is a task in the transmission wait queue.
  This service call queues the invoking task to the transmission wait queue of the target data queue and moves it from the RUNNING state to the WAITING state with time (data transmission wait state).
  The sending WAITING state for a data queue is cancelled in the following cases.

Sending WAITING State for a Data Queue Cancel Operation	Return Value
Available space was secured in the data queue area as a result of issuing rcv_dtq.	E_OK
Available space was secured in the data queue area as a result of issuing prcv_dtq.	E_OK
Available space was secured in the data queue area as a result of issuing iprcv_dtq.	E_OK
Available space was secured in the data queue area as a result of issuing trcv_dtq.	E_OK
Forced release from waiting (accept rel_wai while waiting).	E_RLWAI
Forced release from waiting (accept irel_wai while waiting).	E_RLWAI
The data queue is reset as a result of issuing vrst_dtq.	EV_RST

Sending WAITING State for a Data Queue Cancel Operation	Return Value
The time specified by *tmout* has elapsed.	E_TMOUT
Forced release from waiting (accept del_dtq while waiting).	E_DLT

Note 1 Data is written to the data queue area of the target data queue in the order of the data transmission request.

Note 2 Invoking tasks are queued to the transmission wait queue of the target data queue in the order specified at creating the data queue (FIFO order or current priority order).

Note 3 TMO_FEVR is specified for wait time *tmout*, processing equivalent to snd_dtq will be executed. When TMO_POL is specified, processing equivalent to psnd_dtq will be executed.

Return value

Macro	Value	Description
E_OK	0	Normal completion.
E_PAR	-17	Parameter error. - *tmout* < -1 - *tmout* > (0x7FFFFFFF - TIC_NUME) / TIC_DENO
E_ID	-18	Invalid ID number. - *dtqid* ≤ 0 - *dtqid* > VTMAX_DTQ
E_CTX	-25	Context error. - This service call was issued from a non-task. - This service call was issued in the CPU locked state. - This service call was issued in the dispatching disabled state. - This service call was issued in the status “PSW.IPL > kernel interrupt mask level”.
E_MACV	-26	Memory access violation. - Stack pointer points out of user stack for invoking task.
E_NOEXS	-42	Non-existent object. - The data queue specified by *dtqid* does not exist.
E_RLWAI	-49	Forced release from the WAITING state. - Accept rel_wai/irel_wai while waiting.
E_TMOUT	-50	Polling failure or specified time has elapsed.
E_DLT	-51	Waiting object deleted. - Accept del_dtq while waiting.
EV_RST	-127	Released from WAITING state by the object reset (vrst_dtq)

fsnd_dtq
ifsnd_dtq

Outline

Forced send to data queue.

C format

```
ER      fsnd_dtq (ID dtqid, VP_INT data);
ER      ifsnd_dtq (ID dtqid, VP_INT data);
```

Parameter(s)

I/O	Parameter	Description
I	`ID` *`dtqid;`*	ID number of the data queue.
I	`VP_INT` *`data;`*	Data element to be sent to the data queue.

Explanation

These service calls process as follows according to the situation of the data queue specified by the parameter *dtqid*.

- There is a task in the reception wait queue.
  This service call transfers the data specified by parameter *data* to the task in the top of the reception wait queue. As a result, the task is unlinked from the reception wait queue and moves from the WAITING state (data reception wait state) to the READY state, or from the WAITING-SUSPENDED state to the SUSPENDED state.
- There is no task neither in the reception wait queue and transmission wait queue.
  This service call stores the data specified by parameter *data* to the data queue.
  If there is no available space in the data queue, this service call deletes the oldest data in the data queue before storing the data specified by *data* to the data queue.

Return value

Macro	Value	Description
E_OK	0	Normal completion.
E_ID	-18	Invalid ID number. - *dtqid* ≤ 0 - *dtqid* > VTMAX_DTQ

Macro	Value	Description
E_CTX	-25	Context error. - This service call was issued in the CPU locked state. - The ifsnd_dtq was issued from task. - The fsnd_dtq was issued from non-task. - This service call was issued in the status “PSW.IPL > kernel interrupt mask level”.
E_MACV	-26	Memory access violation. (only for fsnd_dtq) - Stack pointer points out of user stack for invoking task.
E_ILUSE	-28	Illegal use of service call. - The capacity of the data queue area is 0.
E_NOEXS	-42	Non-existent object. - The data queue specified by *dtqid* does not exist.

rcv_dtq

Outline

Receive from data queue (waiting forever).

C format

```
ER      rcv_dtq (ID dtqid, VP_INT *p_data);
```

Parameter(s)

I/O	Parameter	Description
I	`ID dtqid;`	ID number of the data queue.
O	`VP_INT *p_data;`	Data element received from the data queue.

Explanation

This service call processes as follows according to the situation of the data queue specified by the parameter *dtqid*.

- There is a data in the data queue.
  This service call takes out the oldest data from the data queue and stores the data to the area specified by *p_data*.
  When there is a task in the transmission wait queue, this service call stores the data sent by the task in the top of the transmission wait queue and moves it from the WAITING state (data transmission wait state) to the READY state.
- There is no data in the data queue and there is a task in the transmission wait queue.
  This service call stores the data specified by the task in the top of the transmission wait queue to the area specified by *p_data*. As a result, the task is unlinked from the transmission wait queue and moves from the WAITING state (data transmission wait state) to the READY state, or from the WAITING-SUSPENDED state to the SUSPENDED state.
  Note, this situation is caused only when the capacity of the data queue is 0.
- There is no data in the data queue and there is no task in the transmission wait queue.
  This service call queues the invoking task to the reception wait queue of the target data queue and moves it from the RUNNING state to the WAITING state (data reception wait state).
  The receiving WAITING state for a data queue is cancelled in the following cases.

Receiving WAITING State for a Data Queue Cancel Operation	Return Value
Data was sent to the data queue area as a result of issuing snd_dtq.	E_OK
Data was sent to the data queue area as a result of issuing psnd_dtq.	E_OK
Data was sent to the data queue area as a result of issuing ipsnd_dtq.	E_OK
Data was sent to the data queue area as a result of issuing tsnd_dtq.	E_OK
Data was sent to the data queue area as a result of issuing fsnd_dtq.	E_OK
Data was sent to the data queue area as a result of issuing ifsnd_dtq.	E_OK
Forced release from waiting (accept rel_wai while waiting).	E_RLWAI
Forced release from waiting (accept irel_wai while waiting).	E_RLWAI
Forced release from waiting (accept del_dtq while waiting).	E_DLT

Note Invoking tasks are queued to the reception wait queue of the target data queue in the order of the data reception request.

Return value

Macro	Value	Description
E_OK	0	Normal completion.
E_PAR	-17	Parameter error. - *p_data* == NULL
E_ID	-18	Invalid ID number. - *dtqid* ≤ 0 - *dtqid* > VTMAX_DTQ
E_CTX	-25	Context error. - This service call was issued from a non-task. - This service call was issued in the CPU locked state. - This service call was issued in the dispatching disabled state. - This service call was issued in the status “PSW.IPL > kernel interrupt mask level”.
E_MACV	-26	Memory access violation. - Stack pointer points out of user stack for invoking task. - The operand-write access to the area indicated by *p_data* has not been permitted to the invoking task.
E_NOEXS	-42	Non-existent object. - The data queue specified by *dtqid* does not exist.
E_RLWAI	-49	Forced release from the WAITING state. - Accept rel_wai/irel_wai while waiting.
E_DLT	-51	Waiting object deleted. - Accept del_dtq while waiting.

prcv_dtq
iprcv_dtq

Outline

Receive from data queue (polling).

C format

```
ER      prcv_dtq (ID dtqid, VP_INT *p_data);
ER      iprcv_dtq (ID dtqid, VP_INT *p_data);
```

Parameter(s)

I/O	Parameter	Description
I	`ID dtqid;`	ID number of the data queue.
O	`VP_INT *p_data;`	Data element received from the data queue.

Explanation

These service calls process as follows according to the situation of the data queue specified by the parameter *dtqid*.

- There is a data in the data queue.
  This service call takes out the oldest data from the data queue and stores the data to the area specified by *p_data*. When there is a task in the transmission wait queue, this service call stores the data sent by the task in the top of the transmission wait queue and moves it from the WAITING state (data transmission wait state) to the READY state.
- There is no data in the data queue and there is a task in the transmission wait queue.
  These service calls store the data specified by the task in the top of the transmission wait queue to the area specified by *p_data*. As a result, the task is unlinked from the transmission wait queue and moves from the WAITING state (data transmission wait state) to the READY state, or from the WAITING-SUSPENDED state to the SUSPENDED state.
  Note, this situation is caused only when the capacity of the data queue is 0.
- There is no data in the data queue and there is no task in the transmission wait queue.
  These service calls return “E_TMOUT”.

Return value

Macro	Value	Description
E_OK	0	Normal completion.
E_PAR	-17	Parameter error. - *p_data* == NULL

Macro	Value	Description
E_ID	-18	Invalid ID number. - *dtqid* ≤ 0 - *dtqid* > VTMAX_DTQ
E_CTX	-25	Context error. - This service call was issued in the CPU locked state. - The iprcv_dtq was issued from task. - The prcv_dtq was issued from non-task. - This service call was issued in the status “PSW.IPL > kernel interrupt mask level”.
E_MACV	-26	Memory access violation. (only for prcv_dtq) - Stack pointer points out of user stack for invoking task. - The operand-write access to the area indicated by *p_data* has not been permitted to the invoking task.
E_NOEXS	-42	Non-existent object. - The data queue specified by *dtqid* does not exist.
E_TMOUT	-50	Polling failure.

trcv_dtq

Outline

Receive from data queue (with time-out).

C format

```
ER      trcv_dtq (ID dtqid, VP_INT *p_data, TMO tmout);
```

Parameter(s)

I/O	Parameter	Description
I	`ID dtqid;`	ID number of the data queue.
O	`VP_INT *p_data;`	Data element received from the data queue.
I	`TMO tmout;`	Specified time-out (in millisecond). TMO_FEVR: Waiting forever. TMO_POL: Polling. Value: Specified time-out.

Explanation

This service call processes as follows according to the situation of the data queue specified by the parameter *dtqid*.

- There is a data in the data queue.
  This service call takes out the oldest data from the data queue and stores the data to the area specified by *p_data*.
  When there is a task in the transmission wait queue, this service call stores the data sent by the task in the top of the transmission wait queue and moves it from the WAITING state (data transmission wait state) to the READY state.
- There is no data in the data queue and there is a task in the transmission wait queue.
  This service call stores the data specified by the task in the top of the transmission wait queue to the area specified by *p_data*. As a result, the task is unlinked from the transmission wait queue and moves from the WAITING state (data transmission wait state) to the READY state, or from the WAITING-SUSPENDED state to the SUSPENDED state.
  Note, this situation is caused only when the capacity of the data queue is 0.
- There is no data in the data queue and there is no task in the transmission wait queue.
  This service call queues the invoking task to the reception wait queue of the target data queue and moves it from the RUNNING state to the WAITING state with time (data reception wait state).
  The receiving WAITING state for a data queue is cancelled in the following cases.

Receiving WAITING State for a Data Queue Cancel Operation	Return Value
Data was sent to the data queue area as a result of issuing snd_dtq.	E_OK
Data was sent to the data queue area as a result of issuing psnd_dtq.	E_OK
Data was sent to the data queue area as a result of issuing ipsnd_dtq.	E_OK
Data was sent to the data queue area as a result of issuing tsnd_dtq.	E_OK
Data was sent to the data queue area as a result of issuing fsnd_dtq.	E_OK
Data was sent to the data queue area as a result of issuing ifsnd_dtq.	E_OK

Receiving WAITING State for a Data Queue Cancel Operation	Return Value
Forced release from waiting (accept rel_wai while waiting).	E_RLWAI
Forced release from waiting (accept irel_wai while waiting).	E_RLWAI
The time specified by *tmout* has elapsed.	E_TMOUT
Forced release from waiting (accept del_dtq while waiting).	E_DLT

Note 1 Invoking tasks are queued to the reception wait queue of the target data queue in the order of the data reception request.

Note 2 TMO_FEVR is specified for wait time *tmout*, processing equivalent to rcv_dtq will be executed. When TMO_POL is specified, processing equivalent to prcv_dtq will be executed.

Return value

Macro	Value	Description
E_OK	0	Normal completion.
E_PAR	-17	Parameter error. - *p_data* == NULL - *tmout* < -1 - *tmout* > (0x7FFFFFFF - TIC_NUME) / TIC_DENO
E_ID	-18	Invalid ID number. - *dtqid* ≤ 0 - *dtqid* > VTMAX_DTQ
E_CTX	-25	Context error. - This service call was issued from a non-task. - This service call was issued in the CPU locked state. - This service call was issued in the dispatching disabled state. - This service call was issued in the status “PSW.IPL > kernel interrupt mask level”.
E_MACV	-26	Memory access violation. - Stack pointer points out of user stack for invoking task. - The operand-write access to the area indicated by *p_data* has not been permitted to the invoking task.
E_NOEXS	-42	Non-existent object. - The data queue specified by *dtqid* does not exist.
E_RLWAI	-49	Forced release from the WAITING state. - Accept rel_wai/irel_wai while waiting.
E_TMOUT	-50	Polling failure or specified time has elapsed.
E_DLT	-51	Waiting object deleted. - Accept del_dtq while waiting.

ref_dtq
iref_dtq

Outline

Reference data queue state.

C format

```
ER      ref_dtq (ID dtqid, T_RDTQ *pk_rdtq);
ER      iref_dtq (ID dtqid, T_RDTQ *pk_rdtq);
```

Parameter(s)

I/O	Parameter	Description
I	`ID dtqid;`	ID number of the data queue.
O	`T_RDTQ *pk_rdtq;`	Pointer to the packet returning the data queue state.

[Data queue state packet: T_RDTQ]

```
typedef struct  t_rdtq {
    ID      stskid;         /*Existence of tasks waiting for data transmission*/
    ID      rtskid;         /*Existence of tasks waiting for data reception*/
    UINT    sdtqcnt;        /*Number of data elements in data queue*/
} T_RDTQ;
```

Explanation

These service calls store the detailed information of the data queue (existence of waiting tasks, number of data elements in the data queue, etc.) specified by parameter *dtqid* into the area specified by parameter *pk_rdtq*.

- *stskid*
  Stores whether a task is queued to the transmission wait queue of the data queue.

TSK_NONE:	No applicable task
Value:	ID number of the task at the head of the transmission wait queue

- *rtskid*
  Stores whether a task is queued to the reception wait queue of the data queue.

TSK_NONE:	No applicable task
Value:	ID number of the task at the head of the reception wait queue

- *sdtqcnt*
  Stores the number of data elements in data queue.

Return value

Macro	Value	Description
E_OK	0	Normal completion.
E_PAR	-17	Parameter error. - *pk_rdtq* == NULL
E_ID	-18	Invalid ID number. - *dtqid* ≤ 0 - *dtqid* > VTMAX_DTQ
E_CTX	-25	Context error. - This service call was issued in the CPU locked state. - This service call was issued in the status "PSW.IPL > kernel interrupt mask level". Note When the iref_dtq is issued from task or the ref_dtq is issued from non-task, the context error is not detected and normal operation of the system is not guaranteed.
E_MACV	-26	Memory access violation. (only for ref_dtq) - The operand-write access to the area indicated by *pk_rdtq* has not been permitted to the invoking task.
E_NOEXS	-42	Non-existent object. - The data queue specified by *dtqid* does not exist.

19.2.7 Synchronization and communication functions (mailboxes)

The following shows the service calls provided by the RI600PX as the synchronization and communication functions (mailboxes).

Table 19-11 Synchronization and Communication Functions (Mailboxes)

Service Call	Function	Useful Range
cre_mbx	Create mailbox	Task
acre_mbx	Create mailbox (automatic ID assignment)	Task
del_mbx	Delete mailbox	Task
snd_mbx	Send to mailbox	Task
isnd_mbx	Send to mailbox	Non-task
rcv_mbx	Receive from mailbox (waiting forever)	Task
prcv_mbx	Receive from mailbox (polling)	Task
iprcv_mbx	Receive from mailbox (polling)	Non-task
trcv_mbx	Receive from mailbox (with time-out)	Task
ref_mbx	Reference mailbox state	Task
iref_mbx	Reference mailbox state	Non-task

cre_mbx
acre_mbx

Outline

Create mailbox.

C format

```
ER      cre_mbx (ID mbxid, T_CMBX *pk_cmbx );
ER_ID   acre_mbx ( T_CMBX *pk_cmbx );
```

Parameter(s)

I/O	Parameter	Description
I	`ID       mbxid;`	ID number of the mailbox.
I	`T_CMBX   *pk_cmbx;`	Pointer to the packet containing the mailbox creation information.

[Mailbox creation information packet : T_CMBX]

```
typedef struct  t_cmbx {
    ATR    mbxatr;          /*Mailbox attribute*/
    PRI    maxmpri;         /*Maximum message priority*/
    VP     mprihd;          /*For future expansion*/
} T_CMBX;
```

Explanation

This service call can be called from tasks that belong to Trusted Domain.
The cre_mbx creates a mailbox with mailbox ID indicated by *mbxid* according to the content of *pk_cmbx*. The acre_mbx creates a mailbox according to the content of *pk_cmbx*, and returns the created mailbox ID.

1) Mailbox attribute (*mbxatr*)
The following are specified for *mbxatr*.

```
mbxatr := ( ( TA_TFIFO || TA_TPRI ) | ( TA_MFIFO || TA_MPRI ) )
```

- TA_TFIFO (= 0x0000)
  Task wait queue is managed in FIFO order.

- TA_TPRI (= 0x0001)
  Task wait queue is managed in task current priority order. Among tasks with the same priority, they are queued in FIFO order.

- TA_MFIFO (= 0x0000)
  Message queue is managed in FIFO order.

- TA_MPRI (= 0x0002)
  Message queue is managed in message priority order. Among messages with the same priority, they are queued in FIFO order.

2) Maximum message priority (*maxmpri*)
When TA_MPRI is specified for *mbxatr*, the range of message priority which can be used is from 1 to *maxmpri*. Ranges of the value that can be specified are from 1 to TMAX_MPRI.

3) *mpdihd*
The *mprihd* is for future expansion, and is only disregarded.

Return value

Macro	Value	Description
-	Positive value	Normal completion of acre_mbx. (Created mailbox ID)
E_OK	0	Normal completion of cre_mbx.
E_RSATR	-11	Reserved attribute - Either of bits in *mbxatr* except bit0 and bit1 is 1.
E_PAR	-17	Parameter error. - *pk_cmbx* == NULL - When TA_MPRI is specified - *maxmpri* <= 0 - *maxmpri* > TMAX_MPRI
E_ID	-18	Invalid ID number. (only for cre_mbx) - *mbxid* < 0 - *mbxid* > VTMAX_MBX
E_CTX	-25	Context error. - This service call was issued in the CPU locked state. - This service call was issued from non-task. - This service call was issued in the status “PSW.IPL > kernel interrupt mask level”.
E_MACV	-26	Memory access violation. - Stack pointer points out of user stack for invoking task. - The operand-read access to the area indicated by *pk_cmbx* has not been permitted to the invoking task.
E_OACV	-27	Object access violation. - The invoking task does not belong to trusted domain.
E_NOID	-34	No ID number available.(only for acre_mbx)
E_OBJ	-41	Object state error. (only for cre_mbx) - The mailbox specified by *mbxid* exists.

del_mbx

Outline

Delete mailbox.

C format

```
ER      del_mbx (ID mbxid);
```

Parameter(s)

I/O	Parameter	Description
I	`ID mbxid;`	ID number of the mailbox.

Explanation

This service call can be called from tasks that belong to Trusted Domain.
This service call deletes the mailbox indicated by *mbxid*.
When there are waiting tasks for the target mailbox by using rcv_mbx or trcv_mbx, this service call cancels the WAITING state of the tasks and returns E_DLT as a return value of the rcv_mbx or trcv_mbx.

Return value

Macro	Value	Description
E_OK	0	Normal completion.
E_ID	-18	Invalid ID number. - *mbxid* ≤ 0 - *mbxid* > VTMAX_MBX
E_CTX	-25	Context error. - This service call was issued in the CPU locked state. - This service call was issued from non-task. - This service call was issued in the status “PSW.IPL > kernel interrupt mask level”.
E_MACV	-26	Memory access violation. - Stack pointer points out of user stack for invoking task.
E_OACV	-27	Object access violation. - The invoking task does not belong to trusted domain.
E_NOEXS	-42	Non-existent object. - The mailbox specified by *mbxid* does not exist.

snd_mbx
isnd_mbx

Outline

Send to mailbox.

C format

```
ER      snd_mbx (ID mbxid, T_MSG *pk_msg);
ER      isnd_mbx (ID mbxid, T_MSG *pk_msg);
```

Parameter(s)

I/O	Parameter	Description
I	`ID mbxid;`	ID number of the mailbox.
I	`T_MSG *pk_msg;`	Start address of the message packet to be sent to the mailbox.

[Message packet T_MSG for TA_MFIFO attribute]

```
typedef struct {
    VP      msghead;        /*RI600PX management area*/
} T_MSG;
```

[Message packet for T_MSG_PRI for TA_MPRI attribute]

```
typedef struct {
    T_MSG   msgque;         /*Message header*/
    PRI     msgpri;         /*Message priority*/
} T_MSG_PRI;
```

Explanation

This service call transmits the message specified by parameter *pk_msg* to the mailbox specified by parameter *mbxid* (queues the message in the wait queue).
If a task is queued to the target mailbox wait queue when this service call is issued, the message is not queued but handed over to the relevant task (first task of the wait queue).
As a result, the relevant task is unlinked from the wait queue and is moved from the WAITING state (receiving WAITING state for a mailbox) to the READY state, or from the WAITING-SUSPENDED state to the SUSPENDED state.

Note 1 Messages are queued to the target mailbox message queue in the order specified at creating the mailbox (FIFO order or message priority order).

Note 2 Do not modify transmitted message (the area indicated by *pk_msg*) until the message is received.

Return value

Macro	Value	Description
E_OK	0	Normal completion.
E_PAR	-17	Parameter error. - *pk_msg* == NULL - When the target mailbox has TA_MPRI attribute: - *msgpri* ≤ 0 - *msgpri* > TMAX_MPRI
E_ID	-18	Invalid ID number. - *mbxid* ≤ 0 - *mbxid* > VTMAX_MBX
E_CTX	-25	Context error. - This service call was issued in the CPU locked state. - The isnd_mbx was issued from task. - The snd_mbx was issued from non-task. - This service call was issued in the status “PSW.IPL > kernel interrupt mask level”.
E_MACV	-26	Memory access violation. (only for snd_mbx) - Stack pointer points out of user stack for invoking task. - The operand-read and operand-write access to the message header area has not been permitted to the invoking task. Message header area: - TA_MFIFO attribute : The T_MSG structure started from the address indicated by pk_msg - TA_MPRI attribute : The T_MSG_PRI structure started from the address indicated by pk_msg
E_NOEXS	-42	Non-existent object. - The mailbox specified by *mbxid* does not exist.

rcv_mbx

Outline

Receive from mailbox (waiting forever).

C format

```
ER      rcv_mbx (ID mbxid, T_MSG **ppk_msg);
```

Parameter(s)

I/O	Parameter	Description
I	`ID       mbxid;`	ID number of the mailbox.
O	`T_MSG    **ppk_msg;`	Start address of the message packet received from the mailbox.

[Message packet T_MSG for TA_MFIFO attribute]

```
typedef struct {
    VP      msghead;        /*RI600PX management area*/
} T_MSG;
```

[Message packet T_MSG_PRI for TA_MPRI attribute]

```
typedef struct {
    T_MSG   msgque;         /*Message header*/
    PRI     msgpri;         /*Message priority*/
} T_MSG_PRI;
```

Explanation

This service call receives a message from the mailbox specified by parameter *mbxid*, and stores its start address in the area specified by parameter *ppk_msg*.
If no message could be received from the target mailbox (no messages were queued to the wait queue) when this service call is issued, this service call does not receive messages but queues the invoking task to the target mailbox wait queue and moves it from the RUNNING state to the WAITING state (message reception wait state).
The receiving WAITING state for a mailbox is cancelled in the following cases.

Receiving WAITING State for a Mailbox Cancel Operation	Return Value
A message was transmitted to the target mailbox as a result of issuing snd_mbx.	E_OK
A message was transmitted to the target mailbox as a result of issuing isnd_mbx.	E_OK
Forced release from waiting (accept rel_wai while waiting).	E_RLWAI
Forced release from waiting (accept irel_wai while waiting).	E_RLWAI
Forced release from waiting (accept del_mbx while waiting).	E_DLT

Note Invoking tasks are queued to the target mailbox wait queue in the order specified at creating the mailbox (FIFO order or current priority order).

Return value

Macro	Value	Description
E_OK	0	Normal completion.
E_PAR	-17	parameter error. - *ppk_msg* == NULL
E_ID	-18	Invalid ID number. - *mbxid* $\leq$ 0 - *mbxid* > VTMAX_MBX
E_CTX	-25	Context error. - This service call was issued from a non-task. - This service call was issued in the CPU locked state. - This service call was issued in the dispatching disabled state. - This service call was issued in the status “PSW.IPL > kernel interrupt mask level”.
E_MACV	-26	Memory access violation. - Stack pointer points out of user stack for invoking task. - The operand-write access to the area indicated by *ppk_msg* has not been permitted to the invoking task.
E_NOEXS	-42	Non-existent object. - The mailbox specified by *mbxid* does not exist.
E_RLWAI	-49	Forced release from the WAITING state. - Accept rel_wai/irel_wai while waiting.
E_DLT	-51	Waiting object deleted. - Accept del_mbx while waiting.

prcv_mbx
iprcv_mbx

Outline

Receive from mailbox (polling).

C format

```
ER      prcv_mbx (ID mbxid, T_MSG **ppk_msg);
ER      iprcv_mbx (ID mbxid, T_MSG **ppk_msg);
```

Parameter(s)

I/O	Parameter	Description
I	`ID mbxid;`	ID number of the mailbox.
O	`T_MSG **ppk_msg;`	Start address of the message packet received from the mailbox.

[M[Message packet T_MSG for TA_MFIFO attribute]

```
typedef struct {
    VP      msghead;        /*RI600PX management area*/
} T_MSG;
```

[Message packet T_MSG_PRI for TA_MPRI attribute]

```
typedef struct {
    T_MSG   msgque;         /*Message header*/
    PRI     msgpri;         /*Message priority*/
} T_MSG_PRI;
```

Explanation

This service call receives a message from the mailbox specified by parameter *mbxid*, and stores its start address in the area specified by parameter *ppk_msg*.
If the message could not be received from the target mailbox (no messages were queued in the wait queue) when this service call is issued, message reception processing is not executed but “E_TMOUT” is returned.

Return value

Macro	Value	Description
E_OK	0	Normal completion.

Macro	Value	Description
E_PAR	-17	parameter error. - *ppk_msg* == NULL
E_ID	-18	Invalid ID number. - *mbxid* ≤ 0 - *mbxid* > VTMAX_MBX
E_CTX	-25	Context error. - This service call was issued in the CPU locked state. - This service call was issued in the status "PSW.IPL > kernel interrupt mask level". Note When the iprcv_mbx is issued from task or the prcv_mbx is issued from non-task, the context error is not detected and normal operation of the system is not guaranteed.
E_MACV	-26	Memory access violation. (only for prcv_mbx) - The operand-write access to the area indicated by *ppk_msg* has not been permitted to the invoking task.
E_NOEXS	-42	Non-existent object. - The mailbox specified by *mbxid* does not exist.
E_TMOUT	-50	Polling failure.

trcv_mbx

Outline

Receive from mailbox (with time-out).

C format

```
ER      trcv_mbx (ID mbxid, T_MSG **ppk_msg, TMO tmout);
```

Parameter(s)

I/O	Parameter	Description
I	`ID mbxid;`	ID number of the mailbox.
O	`T_MSG **ppk_msg;`	Start address of the message packet received from the mailbox.
I	`TMO tmout;`	Specified time-out (in millisecond). TMO_FEVR: Waiting forever. TMO_POL: Polling. Value: Specified time-out.

[Message packet: T_MSG]

```
typedef struct  t_msg {
    struct  t_msg   *msgnext;   /*Reserved for future use*/
} T_MSG;
```

[Message packet: T_MSG_PRI]

```
typedef struct  t_msg_pri {
    struct  t_msg   msgque;     /*Reserved for future use*/
    PRI     msgpri;             /*Message priority*/
} T_MSG_PRI;
```

Explanation

This service call receives a message from the mailbox specified by parameter *mbxid*, and stores its start address in the area specified by parameter *ppk_msg*.
If no message could be received from the target mailbox (no messages were queued to the wait queue) when this service call is issued, this service call does not receive messages but queues the invoking task to the target mailbox wait queue and moves it from the RUNNING state to the WAITING state with time-out (message reception wait state).
The receiving WAITING state for a mailbox is cancelled in the following cases.

Receiving WAITING State for a Mailbox Cancel Operation	Return Value
A message was transmitted to the target mailbox as a result of issuing snd_mbx.	E_OK
A message was transmitted to the target mailbox as a result of issuing isnd_mbx.	E_OK

Receiving WAITING State for a Mailbox Cancel Operation	Return Value
Forced release from waiting (accept rel_wai while waiting).	E_RLWAI
Forced release from waiting (accept irel_wai while waiting).	E_RLWAI
The time specified by *tmout* has elapsed.	E_TMOUT
Forced release from waiting (accept del_mbx while waiting).	E_DLT

Note 1 Invoking tasks are queued to the target mailbox wait queue in the order specified at creating the mailbox (FIFO order or current priority order).

Note 2 TMO_FEVR is specified for wait time *tmout*, processing equivalent to rcv_mbx will be executed. When TMO_POL is specified, processing equivalent to prcv_mbx will be executed.

Return value

Macro	Value	Description
E_OK	0	Normal completion.
E_PAR	-17	Parameter error. - *ppk_msg* == NULL - *tmout* < -1 - *tmout* > (0x7FFFFFFF - TIC_NUME) / TIC_DENO
E_ID	-18	Invalid ID number. - *mbxid* ≤ 0 - *mbxid* > VTMAX_MBX
E_CTX	-25	Context error. - This service call was issued from a non-task. - This service call was issued in the CPU locked state. - This service call was issued in the dispatching disabled state. - This service call was issued in the status “PSW.IPL > kernel interrupt mask level”.
E_MACV	-26	Memory access violation. - Stack pointer points out of user stack for invoking task. - The operand-write access to the area indicated by *ppk_msg* has not been permitted to the invoking task.
E_NOEXS	-42	Non-existent object. - The mailbox specified by *mbxid* does not exist.
E_RLWAI	-49	Forced release from the WAITING state. - Accept rel_wai/irel_wai while waiting.
E_TMOUT	-50	Polling failure or specified time has elapsed.
E_DLT	-51	Waiting object deleted. - Accept del_mbx while waiting.

ref_mbx
iref_mbx

Outline

Reference mailbox state.

C format

```
ER      ref_mbx (ID mbxid, T_RMBX *pk_rmbx);
ER      iref_mbx (ID mbxid, T_RMBX *pk_rmbx);
```

Parameter(s)

I/O	Parameter	Description
I	`ID mbxid;`	ID number of the mailbox.
O	`T_RMBX *pk_rmbx;`	Pointer to the packet returning the mailbox state.

[Mailbox state packet: T_RMBX]

```
typedef struct  t_rmbx {
    ID      wtskid;         /*Existence of waiting task*/
    T_MSG   *pk_msg;        /*Existence of waiting message*/
} T_RMBX;
```

Explanation

Stores mailbox state packet (ID number of the task at the head of the wait queue, start address of the message packet at the head of the wait queue) of the mailbox specified by parameter *mbxid* in the area specified by parameter *pk_rmbx*.

- *wtskid*
  Stores whether a task is queued to the mailbox wait queue.

TSK_NONE:	No applicable task
Value:	ID number of the task at the head of the wait queue

- *pk_msg*
  Stores whether a message is queued to the mailbox wait queue.

NULL:	No applicable message
Value:	Start address of the message packet at the head of the wait queue

Return value

Macro	Value	Description
E_OK	0	Normal completion.

Macro	Value	Description
E_PAR	-17	parameter error. - *pk_rmbx* == NULL
E_ID	-18	Invalid ID number. - *mbxid* ≤ 0 - *mbxid* > VTMAX_MBX
E_CTX	-25	Context error. - This service call was issued in the CPU locked state. - This service call was issued in the status “PSW.IPL > kernel interrupt mask level”. Note When the iref_mbx is issued from task or the ref_mbx is issued from non-task, the context error is not detected and normal operation of the system is not guaranteed.
E_MACV	-26	Memory access violation. (only for ref_mbx) - The operand-write access to the area indicated by *pk_rmbx* has not been permitted to the invoking task.
E_NOEXS	-42	Non-existent object. - The mailbox specified by *mbxid* does not exist.

19.2.8 Extended synchronization and communication functions (mutexes)

The following shows the service calls provided by the RI600PX as the extended synchronization and communication functions (mutexes).

Table 19-12 Extended Synchronization and Communication Functions (Mutexes)

Service Call	Function	Useful Range
cre_mtx	Create mutex	Task
acre_mtx	Create mutex (automatic ID assignment)	Task
del_mtx	Delete mutex	Task
loc_mtx	Lock mutex (waiting forever)	Task
ploc_mtx	Lock mutex (polling)	Task
tloc_mtx	Lock mutex (with time-out)	Task
unl_mtx	Unlock mutex	Task
ref_mtx	Reference mutex state	Task

cre_mtx
acre_mtx

Outline

Create mutex.

C format

```
ER        cre_mtx (ID mtxid, T_CMTX *pk_cmtx );
ER_ID     acre_mtx ( T_CMTX *pk_cmtx );
```

Parameter(s)

I/O	Parameter	Description
I	`ID      mtxid;`	ID number of the mutex.
I	`T_CMTX  *pk_cmtx;`	Pointer to the packet containing the mutex creation information.

[Mutex creation information packet : T_CMTX]

```
typedef struct  t_cmtx {
    ATR     mtxatr;          /*Mutex attribute*/
    PRI     ceilpri;         /*Ceiling priority*/
} T_CMTX;
```

Explanation

This service call can be called from tasks that belong to Trusted Domain.
The cre_mtx creates a mutex with mutex ID indicated by *mtxid* according to the content of *pk_cmtx*. The acre_mtx creates a mutex according to the content of *pk_cmtx*, and returns the created mutex ID.

1) Mutex attribute (*mtxatr*)
Only TA_CEILING can be specified for *mtxatr*.

- TA_CEILING (= 0x0003)
  Priority ceiling protocol
  For details, refer to “8.2.3 Simplified priority ceiling protocol”.

Note Task wait queue is managed in task current priority order. Note, tasks of the same current priority are managed in FIFO order.

2) Ceiling priority (*ceilpri*)
The current task priority of the task which locks a mutex rises to the *ceilpri*.
Ranges of the value that can be specified are from 1 to TMAX_TPRI.

Return value

Macro	Value	Description
-	Positive value	Normal completion of acre_mtx. (Created mutex ID)
E_OK	0	Normal completion of cre_mtx.
E_RSATR	-11	Reserved attribute - *mtxatr* != TA_CEILING.
E_PAR	-17	Parameter error. - *pk_cmtx* == NULL - ceilpri <= 0 - ceilpri > TMAX_TPRI
E_ID	-18	Invalid ID number. (only for cre_mtx) - *mtxid* < 0 - *mtxid* > VTMAX_MTX
E_CTX	-25	Context error. - This service call was issued in the CPU locked state. - This service call was issued from non-task. - This service call was issued in the status “PSW.IPL > kernel interrupt mask level”.
E_MACV	-26	Memory access violation. - Stack pointer points out of user stack for invoking task. - The operand-read access to the area indicated by *pk_cmtx* has not been permitted to the invoking task.
E_OACV	-27	Object access violation. - The invoking task does not belong to trusted domain.
E_NOID	-34	No ID number available.(only for acre_mtx)
E_OBJ	-41	Object state error. (only for cre_mtx) - The mutex specified by *mtxid* exists.

del_mtx

Outline

Delete mutex.

C format

```
ER      del_mtx (ID mtxid);
```

Parameter(s)

I/O	Parameter	Description
I	`ID` *`mtxid;`*	ID number of the mutex.

Explanation

This service call can be called from tasks that belong to Trusted Domain.
This service call deletes the mutex indicated by *mtxid*.
When either of task locks the target mutex, the lock by the task is cancelled. As a result, the current task priority of the task is returned to the base priority when there is no mutex being locked by the task. The task is not notified that the mutex has been deleted. If an attempt is later made to unlock the mutex by using unl_mtx, an error E_NOEXS is returned.
When there are waiting tasks for the target mutex by using loc_mtx or tloc_mtx, this service call cancels the WAITING state of the tasks and returns E_DLT as a return value of the loc_mtx or tloc_mtx.

Return value

Macro	Value	Description
E_OK	0	Normal completion.
E_ID	-18	Invalid ID number. - *mtxid* ≤ 0 - *mtxid* > VTMAX_MTX
E_CTX	-25	Context error. - This service call was issued in the CPU locked state. - This service call was issued from non-task. - This service call was issued in the status “PSW.IPL > kernel interrupt mask level”.
E_MACV	-26	Memory access violation. - Stack pointer points out of user stack for invoking task.
E_OACV	-27	Object access violation. - The invoking task does not belong to trusted domain.

Macro	Value	Description
E_NOEXS	-42	Non-existent object. - The mutex specified by *mtxid* does not exist.

loc_mtx

Outline

Lock mutex (waiting forever).

C format

```
ER        loc_mtx (ID mtxid);
```

Parameter(s)

I/O	Parameter	Description
I	`ID        mtxid;`	ID number of the mutex.

Explanation

This service call locks the mutex specified by parameter *mtxid*.
If the target mutex could not be locked (another task has been locked) when this service call is issued, this service call queues the invoking task to the target mutex wait queue and moves it from the RUNNING state to the WAITING state (mutex wait state).
The WAITING state for a mutex is cancelled in the following cases.

WAITING State for a Mutex Cancel Operation	Return Value
The locked state of the target mutex was cancelled as a result of issuing unl_mtx.	E_OK
The locked state of the target mutex was cancelled as a result of issuing ext_tsk.	E_OK
The locked state of the target mutex was cancelled as a result of issuing exd_tsk.	E_OK
The locked state of the target mutex was cancelled as a result of issuing ter_tsk.	E_OK
Forced release from waiting (accept rel_wai while waiting).	E_RLWAI
Forced release from waiting (accept irel_wai while waiting).	E_RLWAI
Forced release from waiting (accept del_mtx while waiting).	E_DLT

When the mutex is locked, this service call changes the current priority of the invoking task to the ceiling priority of the target mutex. However, this service call does not change the current priority when the invoking task has locked other mutexes and the ceiling priority of the target mutex is lower than or equal to the ceiling priority of the locked mutexes.

Note 1 Invoking tasks are queued to the target mutex wait queue in task current priority order. Among tasks with the same priority, they are queued in FIFO order.

Note 2 This service call returns “E_ILUSE” if this service call is re-issued for the mutex that has been locked by the invoking task (multiple-locking of mutex).

Return value

Macro	Value	Description
E_OK	0	Normal completion.
E_ID	-18	InvalidID number. - *mtxid* $\leq$ 0 - *mtxid* > VTMAX_MTX
E_CTX	-25	Context error. - This service call was issued from a non-task. - This service call was issued in the CPU locked state. - This service call was issued in the dispatching disabled state. - This service call was issued in the status “PSW.IPL > kernel interrupt mask level”.
E_MACV	-26	Memory access violation. - Stack pointer points out of user stack for invoking task.
E_ILUSE	-28	Illegal use of service call. - The invoking task has already locked the target mutex. - Ceiling priority violation (the base priority of the invoking task < the ceiling priority of the target mutex)
E_NOEXS	-42	Non-existent object. - The mutex specified by *mtxid* does not exist.
E_RLWAI	-49	Forced release from the WAITING state. - Accept rel_wai/irel_wai while waiting.
E_DLT	-51	Waiting object deleted. - Accept del_mtx while waiting.

ploc_mtx

Outline

Lock mutex (polling).

C format

```
ER      ploc_mtx (ID mtxid);
```

Parameter(s)

I/O	Parameter	Description
I	`ID mtxid;`	ID number of the mutex.

Explanation

This service call locks the mutex specified by parameter *mtxid*.
If the target mutex could not be locked (another task has been locked) when this service call is issued but “E_TMOUT” is returned.
When the mutex is locked, this service call changes the current priority of the invoking task to the ceiling priority of the target mutex. However, this service call does not change the current priority when the invoking task has locked other mutexes and the ceiling priority of the target mutex is lower than or equal to the ceiling priority of the locked mutexes.

Note This service call returns “E_ILUSE” if this service call is re-issued for the mutex that has been locked by the invoking task (multiple-locking of mutex).

Return value

Macro	Value	Description
E_OK	0	Normal completion.
E_ID	-18	Invalid ID number. - *mtxid* ≤ 0 - *mtxid* > VTMAX_MTX
E_CTX	-25	Context error. - This service call was issued from a non-task. - This service call was issued in the dispatching disabled state. - This service call was issued in the status “PSW.IPL > kernel interrupt mask level”.
E_MACV	-26	Memory access violation. - Stack pointer points out of user stack for invoking task.

Macro	Value	Description
E_ILUSE	-28	Illegal use of service call. - The invoking task has already locked the target mutex. - Ceiling priority violation (the base priority of the invoking task < the ceiling priority of the target mutex)
E_NOEXS	-42	Non-existent object. - The mutex specified by *mtxid* does not exist.
E_TMOUT	-50	Polling failure.

tloc_mtx

Outline

Lock mutex (with time-out).

C format

```
ER      tloc_mtx (ID mtxid, TMO tmout);
```

Parameter(s)

I/O	Parameter	Description
I	`ID      mtxid;`	ID number of the mutex.
I	`TMO     tmout;`	Specified time-out (in millisecond). TMO_FEVR: Waiting forever. TMO_POL: Polling. Value: Specified time-out.

Explanation

This service call locks the mutex specified by parameter *mtxid*.
If the target mutex could not be locked (another task has been locked) when this service call is issued, this service call queues the invoking task to the target mutex wait queue and moves it from the RUNNING state to the WAITING state with time-out (mutex wait state).
The WAITING state for a mutex is cancelled in the following cases.

WAITING State for a Mutex Cancel Operation	Return Value
The locked state of the target mutex was cancelled as a result of issuing unl_mtx.	E_OK
The locked state of the target mutex was cancelled as a result of issuing ext_tsk.	E_OK
The locked state of the target mutex was cancelled as a result of issuing exd_tsk.	E_OK
The locked state of the target mutex was cancelled as a result of issuing ter_tsk.	E_OK
Forced release from waiting (accept rel_wai while waiting).	E_RLWAI
Forced release from waiting (accept irel_wai while waiting).	E_RLWAI
The time specified by *tmout* has elapsed.	E_TMOUT
Forced release from waiting (accept del_mtx while waiting).	E_DLT

When the mutex is locked, this service call changes the current priority of the invoking task to the ceiling priority of the target mutex. However, this service call does not change the current priority when the invoking task has locked other mutexes and the ceiling priority of the target mutex is lower than or equal to the ceiling priority of the locked mutexes.

Note 1 Invoking tasks are queued to the target mutex wait queue in task current priority order. Among tasks with the same priority, they are queued in FIFO order.

Note 2 This service call returns “E_ILUSE” if this service call is re-issued for the mutex that has been locked by the invoking task (multiple-locking of mutex).

Note 3 TMO_FEVR is specified for wait time *tmout*, processing equivalent to loc_mtx will be executed. When TMO_POL is specified, processing equivalent to ploc_mtx will be executed.

Return value

Macro	Value	Description
E_OK	0	Normal completion.
E_PAR	-17	Parameter error. - *tmout* < -1 - *tmout* > (0x7FFFFFFF - TIC_NUME) / TIC_DENO
E_ID	-18	Invalid ID number. - *mtxid* ≤ 0 - *mtxid* > VTMAX_MTX
E_CTX	-25	Context error. - This service call was issued from a non-task. - This service call was issued in the CPU locked state. - This service call was issued in the dispatching disabled state. - This service call was issued in the status “PSW.IPL > kernel interrupt mask level”.
E_MACV	-26	Memory access violation. - Stack pointer points out of user stack for invoking task.
E_ILUSE	-28	Illegal use of service call. - The invoking task has already locked the target mutex. - Ceiling priority violation (the base priority of the invoking task < the ceiling priority of the target mutex)
E_NOEXS	-42	Non-existent object. - The mutex specified by *mtxid* does not exist.
E_RLWAI	-49	Forced release from the WAITING state. - Accept rel_wai/irel_wai while waiting.
E_TMOUT	-50	Polling failure or specified time has elapsed.
E_DLT	-51	Waiting object deleted. - Accept del_mtx while waiting.

unl_mtx

Outline

Unlock mutex.

C format

```
ER       unl_mtx (ID mtxid);
```

Parameter(s)

I/O	Parameter	Description
I	`ID mtxid;`	ID number of the mutex.

Explanation

This service call unlocks the locked mutex specified by parameter *mtxid*.
If a task has been queued to the target mutex wait queue when this service call is issued, mutex lock processing is performed by the task (the first task in the wait queue) immediately after mutex unlock processing.
As a result, the task is unlinked from the wait queue and moves from the WAITING state (mutex wait state) to the READY state, or from the WAITING-SUSPENDED state to the SUSPENDED state. And this service call changes the current priority of the task to the ceiling priority of the target mutex. However, this service call does not change the current priority when the task has locked other mutexes and the ceiling priority of the target mutex is lower than or equal to the ceiling priority of the locked mutexes.

Note 1 A locked mutex can be unlocked only by the task that locked the mutex.
If this service call is issued for a mutex that was not locked by the invoking task, "E_ILUSE" is returned.

Note 2 When a task terminates, mutexes locked by the task are unlocked.

Return value

Macro	Value	Description
E_OK	0	Normal completion.
E_ID	-18	Invalid ID number. - *mtxid* ≤ 0 - *mtxid* > VTMAX_MTX
E_CTX	-25	Context error. - This service call was issued from a non-task. - This service call was issued in the CPU locked state. - This service call was issued in the status "PSW.IPL > kernel interrupt mask level".
E_MACV	-26	Memory access violation. - Stack pointer points out of user stack for invoking task.

Macro	Value	Description
E_ILUSE	-28	Illegal use of service call. - The invoking task have not locked the target mutex.
E_NOEXS	-42	Non-existent object. - The mutex specified by *mtxid* does not exist.

ref_mtx

Outline

Reference mutex state.

C format

```
ER      ref_mtx (ID mtxid, T_RMTX *pk_rmtx);
```

Parameter(s)

I/O	Parameter	Description
I	`ID      mtxid;`	ID number of the mutex.
O	`T_RMTX  *pk_rmtx;`	Pointer to the packet returning the mutex state.

[Mutex state packet: T_RMTX]

```
typedef struct  t_rmtx {
    ID      htskid;         /*Existence of locked mutex*/
    ID      wtskid;         /*Existence of waiting task*/
} T_RMTX;
```

Explanation

This service call stores the detailed information of the mutex specified by parameter *mtxid* (existence of locked mutexes, waiting tasks, etc.) into the area specified by parameter *pk_rmtx*.

- *htskid*
  Stores whether a task that is locking a mutex exists.

TSK_NONE:	No applicable task
Value:	ID number of the task locking the mutex

- *wtskid*
  Stores whether a task is queued to the mutex wait queue.

TSK_NONE:	No applicable task
Value:	ID number of the task at the head of the wait queue

Return value

Macro	Value	Description
E_OK	0	Normal completion.
E_PAR	-17	parameter error. - *pk_rmtx* == NULL

Macro	Value	Description
E_ID	-18	Invalid ID number. - *mtxid* ≤ 0 - *mtxid* > VTMAX_MTX
E_CTX	-25	Context error. - This service call was issued from a non-task. - This service call was issued in the CPU locked state. - This service call was issued in the status “PSW.IPL > kernel interrupt mask level”.
E_MACV	-26	Memory access violation. - The operand-write access to the area indicated by *pk_rmtx* has not been permitted to the invoking task
E_NOEXS	-42	Non-existent object. - The mutex specified by *mtxid* does not exist.

19.2.9 Extended synchronization and communication functions (message buffers)

The following shows the service calls provided by the RI600PX as the extended synchronization and communication functions (message buffers).

Table 19-13 Extended Synchronization and Communication Functions (Message Buffers)

Service Call	Function	Useful Range
cre_mbf	Create message buffer	Task
acre_mbf	Create message buffer (automatic ID assignment)	Task
del_mbf	Delete message buffer	Task
snd_mbf	Send to message buffer (waiting forever)	Task
psnd_mbf	Send to message buffer (polling)	Task
ipsnd_mbf	Send to message buffer (polling)	Non-task
tsnd_mbf	Send to message buffer (with time-out)	Task
rcv_mbf	Receive from message buffer (waiting forever)	Task
prcv_mbf	Receive from message buffer (polling)	Task
trcv_mbf	Receive from message buffer (with time-out)	Task
ref_mbf	Reference message buffer state	Task
iref_mbf	Reference message buffer state	Non-task

cre_mbf
acre_mbf

Outline

Create message buffer.

C format

```
ER      cre_mbf (ID mbfid, T_CMBF *pk_cmbf );
ER_ID   acre_mbf ( T_CMBF *pk_cmbf );
```

Parameter(s)

I/O	Parameter	Description
I	`ID mbfid;`	ID number of the message buffer.
I	`T_CMBF *pk_cmbf;`	Pointer to the packet containing the message buffer creation information.

[Message buffer creation information packet : T_CMBF]

```
typedef struct  t_cmbf {
    ATR     mbfatr;   /*Message buffer attribute*/
    UINT    maxmsz;   /*Maximum message size (in bytes)*/
    UINT    mbfsz;    /*Size of the message buffer area (in bytes)*/
    VP      mbf;      /*Start address of the message buffer area*/
} T_CMBF;
```

Explanation

This service call can be called from tasks that belong to Trusted Domain.
The cre_mbf creates a message buffer with message buffer ID indicated by *mbfid* according to the content of *pk_cmbf*.
The acre_mbf creates a message buffer according to the content of *pk_cmbf*, and returns the created message buffer ID.

1) Message buffer attribute (*mbfatr*)
Only TA_TFIFO can be specified for *mbfatr*.

- TA_TFIFO (= 0x0000)
  Task wait queue for sending is managed in FIFO order.

  Note Task wait queue for receiving is managed in FIFO order.

2) Maximum message size (*maxmsz*)
Specify the maximum size of message which can be sent to this message buffer. The size of the reception area specified by rcv_mbf, prcv_mbf and trcv_mbf must be not less than *maxmsz*.

3) Size of the message buffer area (*mbfsz*), Start address of the message buffer area (*mbf*)
The application acquires *mbfsz* bytes of message buffer area and specifies the start address for *mbf*.
It is also possible to specify 0 as *mbfsz*. In this case, since message cannot be stored in the message buffer, the

message sending task or message receiving task that has performed its operation first will enter the WAITING state. The WAITING state of that task is canceled when the task of another side has performed its operation. Thus, message sending tasks and message receiving tasks are completely synchronized. Note, *mbf* is disregarded when *mbfsz* is 0.

Note 1 The RI600PX is not concerned of anything of the access permission to the message buffer area. Usually, the message buffer area should be generated to the area other than memory objects and user stacks. When the message buffer area is generated in the memory object, a task with the operand-writie access permission to the memory object might rewrite message buffer area by mistake.

Note 2 The µITRON4.0 specification defines the function that the kernel allocates message buffer area when NULL is specified for *mbf*. But RI600PX does not support this function.

Return value

Macro	Value	Description
-	Positive value	Normal completion of acre_mbf. (Created message buffer ID)
E_OK	0	Normal completion of cre_mbf.
E_RSATR	-11	Reserved attribute - *mbfatr* != TA_TFIFO
E_PAR	-17	Parameter error. - *pk_cmbf* == NULL - *maxmsz* == 0, *maxmsz* > 65528 - 0 < *mbfsz* < 8, *mbfsz* > 65532 - *mbfsz* == 0 and *mbf* + *mbfsz* > 0x100000000 - *mbfsz* == 0 and *mbfsz* < *maxmsz* + VTSZ_MBFTBL
E_ID	-18	Invalid ID number. (only for cre_mbf) - *mbfid* < 0 - *mbfid* > VTMAX_MBF
E_CTX	-25	Context error. - This service call was issued in the CPU locked state. - This service call was issued from non-task. - This service call was issued in the status “PSW.IPL > kernel interrupt mask level”.
E_MACV	-26	Memory access violation. - Stack pointer points out of user stack for invoking task. - The operand-read access to the area indicated by *pk_cmbf* has not been permitted to the invoking task.
E_OACV	-27	Object access violation. - The invoking task does not belong to trusted domain.
E_NOMEM	-33	Insufficient memory. - *mbfsz* != 0 and *mbf* == NULL
E_NOID	-34	No ID number available.(only for acre_mbf)
E_OBJ	-41	Object state error. (only for cre_mbf) - The message buffer specified by *mbfid* exists.

del_mbf

Outline

Delete message buffer.

C format

```
ER      del_mbf (ID mbfid);
```

Parameter(s)

I/O	Parameter	Description
I	`ID mbfid;`	ID number of the message buffer.

Explanation

This service call can be called from tasks that belong to Trusted Domain.
This service call deletes the message buffer indicated by *mbfid*.
When there are waiting tasks for the target message buffer by using snd_mbf, tsnd_mbf, rcv_mbf or trcv_mbf, this service call cancels the WAITING state of the tasks and returns E_DLT as a return value of the snd_mbf, tsnd_mbf, rcv_mbf or trcv_mbf.

Return value

Macro	Value	Description
E_OK	0	Normal completion.
E_ID	-18	Invalid ID number. - *mbfid* $\leq$ 0 - *mbfid* > VTMAX_MBF
E_CTX	-25	Context error. - This service call was issued in the CPU locked state. - This service call was issued from non-task. - This service call was issued in the status “PSW.IPL > kernel interrupt mask level”.
E_MACV	-26	Memory access violation. - Stack pointer points out of user stack for invoking task.
E_OACV	-27	Object access violation. - The invoking task does not belong to trusted domain.
E_NOEXS	-42	Non-existent object. - The message buffer specified by *mbfid* does not exist.

snd_mbf

Outline

Send to message buffer (waiting forever).

C format

```
ER      tsnd_mbf (ID mbfid, VP msg, UINT msgsz);
```

Parameter(s)

I/O	Parameter	Description
I	`ID` *`mbfid;`*	ID number of the message buffer.
I	`VP` *`msg;`*	Pointer to the message to be sent.
I	`UINT` *`msgsz;`*	Message size to be sent (in bytes).

Explanation

This service call processes as follows according to the situation of the message buffer specified by the parameter *mbfid*.

- There is a task in the reception wait queue.
  This service call transfers the message specified by parameter *msg* to the task in the top of the reception wait queue. As a result, the task is unlinked from the reception wait queue and moves from the WAITING state (message reception wait state) to the READY state, or from the WAITING-SUSPENDED state to the SUSPENDED state.

- There is no task neither in the reception wait queue and transmission wait queue and there is available space in the message buffer.
  This service call stores the message specified by parameter *msg* to the message buffer. As a result, the size of available space in the target message buffer decreases by the amount calculated by the following expression.

  The amount of decrease = up4(*msgsz*) + VTSZ_MBFTBL

- There is no task neither in the reception wait queue and transmission wait queue and there is no available space in the message buffer, or there is a task in the transmission wait queue.
  This service call queues the invoking task to the transmission wait queue of the target message buffer and moves it from the RUNNING state to the WAITING state (message transmission wait state).
  The sending WAITING state for a message buffer is cancelled in the following cases.

Sending WAITING State for a Message Buffer Cancel Operation	Return Value
Available space was secured in the message buffer area as a result of issuing rcv_mbf.	E_OK
Available space was secured in the message buffer area as a result of issuing prcv_mbf.	E_OK
Available space was secured in the message buffer area as a result of issuing trcv_mbf.	E_OK

Sending WAITING State for a Message Buffer Cancel Operation	Return Value
The task at the top of the transmission wait queue was forcedly released from waiting by following either. - Forced release from waiting (accept rel_wai while waiting). - Forced release from waiting (accept irel_wai while waiting). - Forced release from waiting (accept ter_tsk while waiting). - The time specified by *tmout* for tsnd_mbf has elapsed.	E_OK
Forced release from waiting (accept rel_wai while waiting).	E_RLWAI
Forced release from waiting (accept irel_wai while waiting).	E_RLWAI
The message buffer is reset as a result of issuing vrst_mbf.	EV_RST
Forced release from waiting (accept del_mbf while waiting).	E_DLT

Note 1 Message is written to the message buffer area in the order of the message transmission request.

Note 2 Invoking tasks are queued to the transmission wait queue of the target message buffer in the FIFO order.

Return value

Macro	Value	Description
E_OK	0	Normal completion.
E_PAR	-17	Parameter error. - *msgsz* == 0 - *msgsz* > (Maximum message size specified at creation) - *msg* == NULL
E_ID	-18	Invalid ID number. - *mbfid* ≤ 0 - *mbfid* > VTMAX_MBF
E_CTX	-25	Context error. - This service call was issued from a non-task. - This service call was issued in the CPU locked state. - This service call was issued in the dispatching disabled state. - This service call was issued in the status “PSW.IPL > kernel interrupt mask level”.
E_MACV	-26	Memory access violation. - Stack pointer points out of user stack for invoking task. - The operand-read access to the area indicated by *msg* (start : *msg*, size : *msgsz*) has not been permitted to the invoking task.
E_NOEXS	-42	Non-existent object. - The message buffer specified by *mbfid* does not exist.
E_RLWAI	-49	Forced release from the WAITING state. - Accept rel_wai/irel_wai while waiting.
E_DLT	-51	Waiting object deleted. - Accept del_mbf while waiting.

Macro	Value	Description
EV_RST	-127	Released from WAITING state by the object reset (vrst_mbf)

psnd_mbf
ipsnd_mbf

Outline

Send to message buffer (polling).

C format

```
ER      psnd_mbf (ID mbfid, VP msg, UINT msgsz);
ER      ipsnd_mbf (ID mbfid, VP msg, UINT msgsz);
```

Parameter(s)

I/O	Parameter	Description
I	`ID` *`mbfid;`*	ID number of the message buffer.
I	`VP` *`msg;`*	Pointer to the message to be sent.
I	`UINT` *`msgsz;`*	Message size to be sent (in bytes).

Explanation

These service calls process as follows according to the situation of the message buffer specified by the parameter *mbfid*.

- There is a task in the reception wait queue.
  This service call transfers the message specified by parameter *msg* to the task in the top of the reception wait queue. As a result, the task is unlinked from the reception wait queue and moves from the WAITING state (message reception wait state) to the READY state, or from the WAITING-SUSPENDED state to the SUSPENDED state.

- There is no task neither in the reception wait queue and transmission wait queue and there is available space in the message buffer.
  This service call stores the message specified by parameter *msg* to the message buffer. As a result, the size of available space in the target message buffer decreases by the amount calculated by the following expression.
  The amount of decrease = up4(*msgsz*) + VTSZ_MBFTBL

- There is no task neither in the reception wait queue and transmission wait queue and there is no available space in the message buffer, or there is a task in the transmission wait queue.
  These service calls return “E_TMOUT”.

Note Message is written to the message buffer area in the order of the message transmission request.

Return value

Macro	Value	Description
E_OK	0	Normal completion.

Macro	Value	Description
E_PAR	-17	Parameter error. - *msgsz* == 0 - *msgsz* > (Maximum message size specified at creation) - *msg* == NULL
E_ID	-18	Invalid ID number. - *mbfid* ≤ 0 - *mbfid* > VTMAX_MBF
E_CTX	-25	Context error. - This service call was issued in the CPU locked state. - The ipsnd_mbf was issued from task. - The psnd_mbf was issued from non-task. - This service call was issued in the status “PSW.IPL > kernel interrupt mask level”.
E_MACV	-26	Memory access violation. (only for psnd_mbf) - Stack pointer points out of user stack for invoking task. - The operand-read access to the area indicated by *msg* (start : *msg*, size : *msgsz*) has not been permitted to the invoking task.
E_NOEXS	-42	Non-existent object. - The message buffer specified by *mbfid* does not exist.
E_TMOUT	-50	Polling failure.

tsnd_mbf

Outline

Send to message buffer (with time-out).

C format

```
ER      tsnd_mbf (ID mbfid, VP msg, UINT msgsz, TMO tmout);
```

Parameter(s)

I/O	Parameter	Description
I	`ID` *mbfid;*	ID number of the message buffer.
I	`VP` *msg;*	Pointer to the message to be sent.
I	`UINT` *msgsz;*	Message size to be sent (in bytes).
I	`TMO` *tmout;*	Specified time-out (in millisecond). TMO_FEVR: Waiting forever. TMO_POL: Polling. Value: Specified time-out.

Explanation

This service call processes as follows according to the situation of the message buffer specified by the parameter *mbfid*.

- There is a task in the reception wait queue.
  This service call transfers the message specified by parameter *msg* to the task in the top of the reception wait queue. As a result, the task is unlinked from the reception wait queue and moves from the WAITING state (message reception wait state) to the READY state, or from the WAITING-SUSPENDED state to the SUSPENDED state.

- There is no task neither in the reception wait queue and transmission wait queue and there is available space in the message buffer.
  This service call stores the message specified by parameter *msg* to the message buffer. As a result, the size of available space in the target message buffer decreases by the amount calculated by the following expression.

  The amount of decrease = up4(*msgsz*) + VTSZ_MBFTBL

- There is no task neither in the reception wait queue and transmission wait queue and there is no available space in the message buffer, or there is a task in the transmission wait queue.
  This service call queues the invoking task to the transmission wait queue of the target message buffer and moves it from the RUNNING state to the WAITING state with time (message transmission wait state).
  The sending WAITING state for a message buffer is cancelled in the following cases.

Sending WAITING State for a Message Buffer Cancel Operation	Return Value
Available space was secured in the message buffer area as a result of issuing rcv_mbf.	E_OK
Available space was secured in the message buffer area as a result of issuing prcv_mbf.	E_OK
Available space was secured in the message buffer area as a result of issuing trcv_mbf.	E_OK

Sending WAITING State for a Message Buffer Cancel Operation	Return Value
The task at the top of the transmission wait queue was forcedly released from waiting by following either. - Forced release from waiting (accept rel_wai while waiting). - Forced release from waiting (accept irel_wai while waiting). - Forced release from waiting (accept ter_tsk while waiting). - The time specified by *tmout* for tsnd_mbf has elapsed.	E_OK
Forced release from waiting (accept rel_wai while waiting).	E_RLWAI
Forced release from waiting (accept irel_wai while waiting).	E_RLWAI
The message buffer is reset as a result of issuing vrst_mbf.	EV_RST
The time specified by *tmout* has elapsed.	E_TMOUT
Forced release from waiting (accept del_mbf while waiting).	E_DLT

Note 1 Message is written to the message buffer area in the order of the message transmission request.

Note 2 Invoking tasks are queued to the transmission wait queue of the target message buffer in the FIFO order.

Note 3 TMO_FEVR is specified for wait time *tmout*, processing equivalent to snd_mbf will be executed. When TMO_POL is specified, processing equivalent to psnd_mbf will be executed.

Return value

Macro	Value	Description
E_OK	0	Normal completion.
E_PAR	-17	Parameter error. - *msgsz* == 0 - *msgsz* > (Maximum message size specified at creation) - *msg* == NULL - *tmout* < -1 - *tmout* > (0x7FFFFFFF - TIC_NUME) / TIC_DENO
E_ID	-18	Invalid ID number. - *mbfid* ≤ 0 - *mbfid* > VTMAX_MBF
E_CTX	-25	Context error. - This service call was issued from a non-task. - This service call was issued in the CPU locked state. - This service call was issued in the dispatching disabled state. - This service call was issued in the status “PSW.IPL > kernel interrupt mask level”.
E_MACV	-26	Memory access violation. - Stack pointer points out of user stack for invoking task. - The operand-read access to the area indicated by *msg* (start : *msg*, size : *msgsz*) has not been permitted to the invoking task.

Macro	Value	Description
E_NOEXS	-42	Non-existent object. - The message buffer specified by *mbfid* does not exist.
E_RLWAI	-49	Forced release from the WAITING state. - Accept rel_wai/irel_wai while waiting.
E_TMOUT	-50	Polling failure or specified time has elapsed.
E_DLT	-51	Waiting object deleted. - Accept del_mbf while waiting.
EV_RST	-127	Released from WAITING state by the object reset (vrst_mbf)

rcv_mbf

Outline

Receive from message buffer (waiting forever).

C format

```
ER_UINT  rcv_mbf (ID mbfid, VP msg);
```

Parameter(s)

I/O	Parameter	Description
I	ID mbfid;	ID number of the message buffer.
O	VP msg;	Pointer to store the message.

Explanation

This service call processes as follows according to the situation of the message buffer specified by the parameter *mbfid*.

- There is a message in the message buffer.
  This service call takes out the oldest message from the message buffer and stores the message to the area specified by *msg* and return the size of the message. As a result, the size of available space in the target message buffer increases by the amount calculated by the following expression.

  The amount of increase = up4(Return value) + VTSZ_MBFTBL

  In addition, this service call repeats the following processing until task in the transmission wait queue is lost or it becomes impossible to store the message in the message buffer.

  - When there is a task in the transmission wait queue and there is available space in the message buffer for the message specified by the task in the top of the transmission wait queue, the task is unlinked from the transmission wait queue and moves from the WAITING state (message transmission wait state) to the READY state, or from the WAITING-SUSPENDED state to the SUSPENDED state. As a result, the size of available space in the target message buffer decreases by the amount calculated by the following expression.

    The amount of decrease =up4(The message size sent by the task) + VTSZ_MBFTBL

- There is no message in the message buffer and there is a task in the transmission wait queue.
  This service call stores the message specified by the task in the top of the transmission wait queue to the area pointed by the parameter *msg*. As a result, the task is unlinked from the transmission wait queue and moves from the WAITING state (message transmission wait state) to the READY state, or from the WAITING-SUSPENDED state to the SUSPENDED state.
  Note, this situation is caused only when the size of the message buffer is 0.

- There is no message in the message buffer and there is no task in the transmission wait queue.
  This service call queues the invoking task to the reception wait queue of the target message buffer and moves it from the RUNNING state to the WAITING state (message reception wait state).
  The receiving WAITING state for a message buffer is cancelled in the following cases.

Receiving WAITING State for a Message Buffer Cancel Operation	Return Value
Message was sent to the message buffer area as a result of issuing snd_mbf.	E_OK

Receiving WAITING State for a Message Buffer Cancel Operation	Return Value
Message was sent to the message buffer area as a result of issuing psnd_mbf.	E_OK
Message was sent to the message buffer area as a result of issuing ipsnd_mbf.	E_OK
Message was sent to the message buffer area as a result of issuing tsnd_mbf.	E_OK
Forced release from waiting (accept rel_wai while waiting).	E_RLWAI
Forced release from waiting (accept irel_wai while waiting).	E_RLWAI
Forced release from waiting (accept del_mbf while waiting).	E_DLT

Note 1 The maximum message size is defined at creating the message buffer. The size of the area pointed by *msg* must be not less than the maximum message size.

Note 2 Invoking tasks are queued to the reception wait queue of the target message buffer in the order of the message reception request.

Return value

Macro	Value	Description
-	Positive value	Normal completion (the size of the received message).
E_PAR	-17	Parameter error. - *msg* == NULL
E_ID	-18	Invalid ID number. - *mbfid* ≤ 0 - *mbfid* > VTMAX_MBF
E_CTX	-25	Context error. - This service call was issued from a non-task. - This service call was issued in the CPU locked state. - This service call was issued in the dispatching disabled state. - This service call was issued in the status “PSW.IPL > kernel interrupt mask level”.
E_MACV	-26	Memory access violation. - Stack pointer points out of user stack for invoking task. - The operand-write access to the area indicated by *msg* (start : *msg*, size : maximum message size specified at creation) has not been permitted to the invoking task.
E_NOEXS	-42	Non-existent object. - The message buffer specified by *mbfid* does not exist.
E_RLWAI	-49	Forced release from the WAITING state. - Accept rel_wai/irel_wai while waiting.
E_DLT	-51	Waiting object deleted. - Accept del_mbf while waiting.

prcv_mbf

Outline

Receive from message buffer (polling).

C format

```
ER_UINT  prcv_mbf (ID mbfid, VP msg);
```

Parameter(s)

I/O	Parameter	Description
I	`ID` *`mbfid;`*	ID number of the message buffer.
O	`VP` *`msg;`*	Pointer to store the message.

Explanation

- There is a message in the message buffer.
  This service call takes out the oldest message from the message buffer and stores the message to the area specified by *msg* and return the size of the message. As a result, the size of available space in the target message buffer increases by the amount calculated by the following expression.

  The amount of increase = up4(Return value) + VTSZ_MBFTBL

  In addition, this service call repeats the following processing until task in the transmission wait queue is lost or it becomes impossible to store the message in the message buffer.

  - When there is a task in the transmission wait queue and there is available space in the message buffer for the message specified by the task in the top of the transmission wait queue, the task is unlinked from the transmission wait queue and moves from the WAITING state (message transmission wait state) to the READY state, or from the WAITING-SUSPENDED state to the SUSPENDED state. As a result, the size of available space in the target message buffer decreases by the amount calculated by the following expression.

    The amount of decrease =up4(The message size sent by the task) + VTSZ_MBFTBL

- There is no message in the message buffer and there is a task in the transmission wait queue.
  This service call stores the message specified by the task in the top of the transmission wait queue to the area pointed by the parameter *msg*. As a result, the task is unlinked from the transmission wait queue and moves from the WAITING state (message transmission wait state) to the READY state, or from the WAITING-SUSPENDED state to the SUSPENDED state.
  Note, this situation is caused only when the size of the message buffer is 0.

- There is no message in the message buffer and there is no task in the transmission wait queue.
  This service call returns “E_TMOUT”.

Note The maximum message size is defined at creating the message buffer. The size of the area pointed by *msg* must be not less than the maximum message size.

Return value

Macro	Value	Description
-	Positive value	Normal completion (the size of the received message).
E_PAR	-17	Parameter error. - *msg* == NULL
E_ID	-18	Invalid ID number. - *mbfid* ≤ 0 - *mbfid* > VTMAX_MBF
E_CTX	-25	Context error. - This service call was issued from a non-task. - This service call was issued in the CPU locked state. - This service call was issued in the status “PSW.IPL > kernel interrupt mask level”.
E_MACV	-26	Memory access violation. - Stack pointer points out of user stack for invoking task. - The operand-write access to the area indicated by *msg* (start : *msg*, size : maximum message size specified at creation) has not been permitted to the invoking task.
E_NOEXS	-42	Non-existent object. - The message buffer specified by *mbfid* does not exist.
E_TMOUT	-50	Polling failure.

trcv_mbf

Outline

Receive from message buffer (with time-out).

C format

```
ER_UINT  trcv_mbf (ID mbfid, VP msg, TMO tmout);
```

Parameter(s)

I/O	Parameter	Description
I	`ID` *`mbfid;`*	ID number of the message buffer.
O	`VP` *`msg;`*	Pointer to store the message.
I	`TMO` *`tmout;`*	Specified time-out (in millisecond). TMO_FEVR: Waiting forever. TMO_POL: Polling. Value: Specified time-out.

Explanation

This service call processes as follows according to the situation of the message buffer specified by the parameter *mbfid*.

- There is a message in the message buffer.
  This service call takes out the oldest message from the message buffer and stores the message to the area specified by *msg* and return the size of the message. As a result, the size of available space in the target message buffer increases by the amount calculated by the following expression.

  The amount of increase = up4(Return value) + VTSZ_MBFTBL

  In addition, this service call repeats the following processing until task in the transmission wait queue is lost or it becomes impossible to store the message in the message buffer.

  - When there is a task in the transmission wait queue and there is available space in the message buffer for the message specified by the task in the top of the transmission wait queue, the task is unlinked from the transmission wait queue and moves from the WAITING state (message transmission wait state) to the READY state, or from the WAITING-SUSPENDED state to the SUSPENDED state. As a result, the size of available space in the target message buffer decreases by the amount calculated by the following expression.

    The amount of decrease =up4(The message size sent by the task) + VTSZ_MBFTBL

- There is no message in the message buffer and there is a task in the transmission wait queue.
  This service call stores the message specified by the task in the top of the transmission wait queue to the area pointed by the parameter *msg*. As a result, the task is unlinked from the transmission wait queue and moves from the WAITING state (message transmission wait state) to the READY state, or from the WAITING-SUSPENDED state to the SUSPENDED state.
  Note, this situation is caused only when the size of the message buffer is 0.

- There is no message in the message buffer and there is no task in the transmission wait queue.
  This service call queues the invoking task to the reception wait queue of the target message buffer and moves it from the RUNNING state to the WAITING state with time (message reception wait state).
  The receiving WAITING state for a message buffer is cancelled in the following cases.

Receiving WAITING State for a Message Buffer Cancel Operation	Return Value
Message was sent to the message buffer area as a result of issuing snd_mbf.	E_OK
Message was sent to the message buffer area as a result of issuing psnd_mbf.	E_OK
Message was sent to the message buffer area as a result of issuing ipsnd_mbf.	E_OK
Message was sent to the message buffer area as a result of issuing tsnd_mbf.	E_OK
Forced release from waiting (accept rel_wai while waiting).	E_RLWAI
Forced release from waiting (accept irel_wai while waiting).	E_RLWAI
The time specified by *tmout* has elapsed.	E_TMOUT
Forced release from waiting (accept del_mbf while waiting).	E_DLT

Note 1 The maximum message size is defined at creating the message buffer. The size of the area pointed by *msg* must be not less than the maximum message size.

Note 2 Invoking tasks are queued to the reception wait queue of the target message buffer in the order of the message reception request.

Note 3 TMO_FEVR is specified for wait time *tmout*, processing equivalent to rcv_mbf will be executed. When TMO_POL is specified, processing equivalent to prcv_mbf will be executed.

Return value

Macro	Value	Description
-	Positive value	Normal completion (the size of the received message).
E_PAR	-17	Parameter error. - *msg* == NULL - *tmout* < -1 - *tmout* > (0x7FFFFFFF - TIC_NUME) / TIC_DENO
E_ID	-18	Invalid ID number. - *mbfid* ≤ 0 - *mbfid* > VTMAX_MBF
E_CTX	-25	Context error. - This service call was issued from a non-task. - This service call was issued in the CPU locked state. - This service call was issued in the dispatching disabled state. - This service call was issued in the status “PSW.IPL > kernel interrupt mask level”.
E_MACV	-26	Memory access violation. - Stack pointer points out of user stack for invoking task. - The operand-write access to the area indicated by *msg* (start : *msg*, size : maximum message size specified at creation) has not been permitted to the invoking task.
E_NOEXS	-42	Non-existent object. - The message buffer specified by *mbfid* does not exist.

Macro	Value	Description
E_RLWAI	-49	Forced release from the WAITING state. - Accept rel_wai/irel_wai while waiting.
E_TMOUT	-50	Polling failure or specified time has elapsed.
E_DLT	-51	Waiting object deleted. - Accept del_mbf while waiting.

ref_mbf
iref_mbf

Outline

Reference message buffer state.

C format

```
ER      ref_mbf (ID mbfid, T_RMBF *pk_rmbf);
ER      iref_mbf (ID mbfid, T_RMBF *pk_rmbf);
```

Parameter(s)

I/O	Parameter	Description
I	`ID        mbfid;`	ID number of the message.
O	`T_RMBF   *pk_rmbf;`	Pointer to the packet returning the message buffer state.

[Message buffer state packet: T_RMBF]

```
typedef struct  t_rmbf {
    ID      stskid;         /*Existence of tasks waiting for message transmission*/
    ID      rtskid;         /*Existence of tasks waiting for message reception*/
    UINT    smsgcnt;        /*Number of message elements in message buffer*/
    SIZE    fmbfsz;         /*Available buffer size*/
} T_RMBF;
```

Explanation

These service calls store the detailed information of the message buffer (existence of waiting tasks, number of data elements in the message buffer, etc.) specified by parameter *mbfid* into the area specified by parameter *pk_rmbf*.

- *stskid*
  Stores whether a task is queued to the transmission wait queue of the message buffer.

TSK_NONE:	No applicable task
Value:	ID number of the task at the head of the transmission wait queue

- *rtskid*
  Stores whether a task is queued to the reception wait queue of the message buffer.

TSK_NONE:	No applicable task
Value:	ID number of the task at the head of the reception wait queue

- *smsgcnt*
  Stores the number of message elements in message buffer.

- *fmbfsz*
  Stores available size of the message buffer (in bytes).

Return value

Macro	Value	Description
E_OK	0	Normal completion.
E_PAR	-17	Parameter error. - *pk_rmbf* == NULL
E_ID	-18	Invalid ID number. - *mbfid* ≤ 0 - *mbfid* > VTMAX_MBF
E_CTX	-25	Context error. - This service call was issued in the CPU locked state. - This service call was issued in the status "PSW.IPL > kernel interrupt mask level". Note When the iref_mbf is issued from task or the ref_mbf is issued from non-task, the context error is not detected and normal operation of the system is not guaranteed.
E_MACV	-26	Memory access violation. (only for ref_mbf) - The operand-write access to the area indicated by *pk_rmbf* has not been permitted to the invoking task.
E_NOEXS	-42	Non-existent object. - The message buffer specified by *mbfid* does not exist.

19.2.10 Memory pool management functions (fixed-sized memory pools)

The following shows the service calls provided by the RI600PX as the memory pool management functions (fixed-sized memory pools).

Table 19-14 Memory Pool Management Functions (Fixed-Sized Memory Pools)

Service Call	Function	Useful Range
cre_mpf	Create fixed-sized memory pool	Task
acre_mpf	Create fixed-sized memory pool (automatic ID assignment)	Task
del_mpf	Delete fixed-sized memory pool	Task
get_mpf	Acquire fixed-sized memory block (waiting forever)	Task
pget_mpf	Acquire fixed-sized memory block (polling)	Task
ipget_mpf	Acquire fixed-sized memory block (polling)	Non-task
tget_mpf	Acquire fixed-sized memory block (with time-out)	Task
rel_mpf	Release fixed-sized memory block	Task
irel_mpf	Release fixed-sized memory block	Non-task
ref_mpf	Reference fixed-sized memory pool state	Task
iref_mpf	Reference fixed-sized memory pool state	Non-task

cre_mpf
acre_mpf

Outline

Create fixed-sized memory pool.

C format

```
ER      cre_mpf (ID mpfid, T_CMPF *pk_cmpf );
ER_ID   acre_mpf ( T_CMPF *pk_cmpf );
```

Parameter(s)

I/O	Parameter	Description
I	`ID       mpfid;`	ID number of the fixed-sized memory pool.
I	`T_CMPF  *pk_cmpf;`	Pointer to the packet containing the fixed-sized memory pool creation information.

[Fixed-sized memory pool creation information packet : T_CMPF]

```
typedef struct  t_cmpf {
    ATR    mpfatr;  /*fixed-sized memory pool attribute*/
    UINT   blkcnt;  /*Total number of memory blocks*/
    UINT   blksz;   /*Memory block size (in bytes)*/
    VP     mpf;     /*Start address of the fixed-sized memory pool area*/
    VP     mpfmb;   /*Start address of the fixed-sized memory pool management area*/
} T_CMPF;
```

Explanation

This service call can be called from tasks that belong to Trusted Domain.
The cre_mpf creates a fixed-sized memory pool with fixed-sized memory pool ID indicated by *mpfid* according to the content of *pk_cmpf*. The acre_mpf creates a fixed-sized memory pool according to the content of *pk_cmpf*, and returns the created fixed-sized memory pool ID.

1) Fixed-sized memory pool attribute (*mpfatr*)
The following are specified for *mpfatr*.

```
mpfatr := ( TA_TFIFO | TA_TPRI )
```

- TA_TFIFO (= 0x0000)
  Task wait queue is managed in FIFO order.

- TA_TPRI (= 0x0001)
  Task wait queue is managed in task current priority order. Among tasks with the same priority, they are queued in FIFO order.

2) Total number of memory blocks (*blkcnt*), memory block size (*blksz*), Start address of the fixed-sized memory pool area (*mpf*)

The application acquires TSZ_MPF(*blkcnt*, *blksz*) bytes of fixed-sized memory pool area and specifies the start address for *mpf*.

Note 1 For details of TSZ_MPF macro, refer to "18.3.3 Macros for Fixed-sized Memory Pool".

Note 2 The RI600PX is not concerned of anything of the access permission to the fixed-sized memory pool area. To access to the memory block from task, the memory pool area must be in the memory object with appropriate permission.
Note, the RI600PX generates management tables in the memory pool area. If the management table is rewritten by allocation, correct system operation cannot be guaranteed.

Note 3 The μITRON4.0 specification defines the function that the kernel allocates fixed-sized memory pool area when NULL is specified for *mpf*. But RI600PX does not support this function.

Note 4 The alignment number of memory block is 1. Please perform the following, in order to enlarge the alignment number of memory blocks.

- Specify the memory block size to a multiple of the desired alignment number at fixed-sized memory pool creation.
- Make the start address of the fixed-sized memory pool area into the address of the desired alignment number.

3) Start address of the fixed-sized memory pool management area (*mpfmb*)
The application acquires TSZ_MPFMB(*blkcnt*, *blksz*) bytes of fixed-sized memory pool management area and specifies the start address for *mpfmb*.

Note 1 For details of TSZ_MPFMB macro, refer to "18.3.3 Macros for Fixed-sized Memory Pool".

Note 2 The RI600PX is not concerned of anything of the access permission to the fixed-sized memory pool management area. Usually, the fixed-sized memory pool management area should be generated to the area other than memory objects and user stacks. When the fixed-sized memory pool management area is generated in the memory object, a task with the operand-write access permission to the memory object might rewrite the fixed-sized memory pool management area by mistake.

Return value

Macro	Value	Description
-	Positive value	Normal completion of acre_mpf. (Created fixed-sized memory pool ID)
E_OK	0	Normal completion of cre_mpf.
E_RSATR	-11	Reserved attribute - Either of bits in *mpfatr* except bit0 is 1.
E_PAR	-17	Parameter error. - *pk_cmpf* == NULL - *blkcnt* == 0, *blkcnt* > 65535 - *blksz* == 0, *blksz* > 65535 - TSZ_MPF(*blkcnt*, *blksz*) > VTMAX_AREASIZE - *mpf* + TSZ_MPF(*blkcnt*, *blksz*) > 0x100000000
E_ID	-18	Invalid ID number. (only for cre_mpf) - *mpfid* < 0 - *mpfid* > VTMAX_MPF

Macro	Value	Description
E_CTX	-25	Context error. - This service call was issued in the CPU locked state. - This service call was issued from non-task. - This service call was issued in the status “PSW.IPL > kernel interrupt mask level”.
E_MACV	-26	Memory access violation. - Stack pointer points out of user stack for invoking task. - The operand-read access to the area indicated by *pk_cmpf* has not been permitted to the invoking task.
E_OACV	-27	Object access violation. - The invoking task does not belong to trusted domain.
E_NOMEM	-33	Insufficient memory. - *mpf* == NULL - *mpfmb* == NULL
E_NOID	-34	No ID number available.(only for acre_mpf)
E_OBJ	-41	Object state error. (only for cre_mpf) - The fixed-sized memory pool specified by *mpfid* exists.

del_mpf

Outline

Delete fixed-sized memory pool.

C format

```
ER      del_mpf (ID mpfid);
```

Parameter(s)

I/O	Parameter	Description
I	`ID      mpfid;`	ID number of the fixed-sized memory pool.

Explanation

This service call can be called from tasks that belong to Trusted Domain.
This service call deletes the fixed-sized memory pool indicated by *mpfid*.
When there are waiting tasks for the target fixed-sized memory pool by using get_mpf or tget_mpf, this service call cancels the WAITING state of the tasks and returns E_DLT as a return value of the get_mpf or tget_mpf.

Return value

Macro	Value	Description
E_OK	0	Normal completion.
E_ID	-18	Invalid ID number. - *mpfid* ≤ 0 - *mpfid* > VTMAX_MPF
E_CTX	-25	Context error. - This service call was issued in the CPU locked state. - This service call was issued from non-task. - This service call was issued in the status “PSW.IPL > kernel interrupt mask level”.
E_MACV	-26	Memory access violation. - Stack pointer points out of user stack for invoking task.
E_OACV	-27	Object access violation. - The invoking task does not belong to trusted domain.
E_NOEXS	-42	Non-existent object. - The fixed-sized memory pool specified by *mpfid* does not exist.

get_mpf

Outline

Acquire fixed-sized memory block (waiting forever).

C format

```
ER      get_mpf (ID mpfid, VP *p_blk);
```

Parameter(s)

I/O	Parameter	Description
I	`ID` *mpfid;*	ID number of the fixed-sized memory pool.
O	`VP` **p_blk;*	Start address of the acquired memory block.

Explanation

This service call acquires the fixed-sized memory block from the fixed-sized memory pool specified by parameter *mpfid* and stores the start address in the area specified by parameter *p_blk*.
If no fixed-size memory blocks could be acquired from the target fixed-size memory pool (no available fixed-size memory blocks exist) when this service call is issued, this service call does not acquire the fixed-size memory block but queues the invoking task to the target fixed-size memory pool wait queue and moves it from the RUNNING state to the WAITING state (fixed-size memory block acquisition wait state).
The WAITING state for a fixed-sized memory block is cancelled in the following cases.

WAITING State for a Fixed-sized Memory Block Cancel Operation	Return Value
A fixed-sized memory block was returned to the target fixed-sized memory pool as a result of issuing rel_mpf.	E_OK
A fixed-sized memory block was returned to the target fixed-sized memory pool as a result of issuing irel_mpf.	E_OK
Forced release from waiting (accept rel_wai while waiting).	E_RLWAI
Forced release from waiting (accept irel_wai while waiting).	E_RLWAI
The fixed-sized memory pool is reset as a result of issuing vrst_mpf.	EV_RST
Forced release from waiting (accept del_mpf while waiting).	E_DLT

Note 1 Invoking tasks are queued to the target fixed-size memory pool wait queue in the order defined at creating the fixed-sized memory pool. (FIFO order or current priority order).

Note 2 The contents of the block are undefined.

Note 3 The alignment number of memory block is 1. Please perform the following, in order to enlarge the alignment number of memory blocks.

- Specify the memory block size to a multiple of the desired alignment number at creating the fixed-sized memory pool.
- Make the start address of the fixed-sized memory pool area into the address of the desired alignment number.

Return value

Macro	Value	Description
E_OK	0	Normal completion.
E_PAR	-17	Parameter error. - *p_blk* == NULL
E_ID	-18	Invalid ID number. - *mpfid* ≤ 0 - *mpfid* > VTMAX_MPF
E_CTX	-25	Context error. - This service call was issued from a non-task. - This service call was issued in the CPU locked state. - This service call was issued in the dispatching disabled state. - This service call was issued in the status “PSW.IPL > kernel interrupt mask level”.
E_MACV	-26	Memory access violation. - Stack pointer points out of user stack for invoking task. - The operand-write access to the area indicated by *p_blk* has not been permitted to the invoking task.
E_NOEXS	-42	Non-existent object. - The fixed-sized memory pool specified by *mpfid* does not exist.
E_RLWAI	-49	Forced release from the WAITING state. - Accept rel_wai/irel_wai while waiting.
E_DLT	-51	Waiting object deleted. - Accept del_mpf while waiting.
EV_RST	-127	Released from WAITING state by the object reset (vrst_mpf)

pget_mpf
ipget_mpf

Outline

Acquire fixed-sized memory block (polling).

C format

```
ER      pget_mpf (ID mpfid, VP *p_blk);
ER      ipget_mpf (ID mpfid, VP *p_blk);
```

Parameter(s)

I/O	Parameter	Description
I	`ID` *mpfid;*	ID number of the fixed-sized memory pool.
O	`VP` **p_blk;*	Start address of the acquired memory block.

Explanation

This service call acquires the fixed-sized memory block from the fixed-sized memory pool specified by parameter *mpfid* and stores the start address in the area specified by parameter *p_blk*.
If a fixed-sized memory block could not be acquired from the target fixed-sized memory pool (no available fixed-sized memory blocks exist) when this service call is issued, fixed-sized memory block acquisition processing is not performed but "E_TMOUT" is returned.

Note 1 The contents of the block are undefined.

Note 2 The alignment number of memory block is 1. Please perform the following, in order to enlarge the alignment number of memory blocks.

- Specify the memory block size to a multiple of the desired alignment number at creating the fixed-sized memory pool.
- Make the start address of the fixed-sized memory pool area into the address of the desired alignment number.

Return value

Macro	Value	Description
E_OK	0	Normal completion.
E_PAR	-17	Parameter error. - *p_blk* == NULL
E_ID	-18	Invalid ID number. - *mpfid* ≤ 0 - *mpfid* > VTMAX_MPF

Macro	Value	Description
E_CTX	-25	Context error. - This service call was issued in the CPU locked state. - This service call was issued in the status "PSW.IPL > kernel interrupt mask level". Note When the ipget_mpf is issued from task or the pget_mpf is issued from non-task, the context error is not detected and normal operation of the system is not guaranteed.
E_MACV	-26	Memory access violation. (only for pget_mpf) - Stack pointer points out of user stack for invoking task. - The operand-write access to the area indicated by *p_blk* has not been permitted to the invoking task.
E_NOEXS	-42	Non-existent object. - The fixed-sized memory pool specified by *mpfid* does not exist.
E_TMOUT	-50	Polling failure.

tget_mpf

Outline

Acquire fixed-sized memory block (with time-out).

C format

```
ER      tget_mpf (ID mpfid, VP *p_blk, TMO tmout);
```

Parameter(s)

I/O	Parameter	Description
I	`ID mpfid;`	ID number of the fixed-sized memory pool.
O	`VP *p_blk;`	Start address of the acquired memory block.
I	`TMO tmout;`	Specified time-out (in millisecond). TMO_FEVR: Waiting forever. TMO_POL: Polling. Value: Specified time-out.

Explanation

This service call acquires the fixed-sized memory block from the fixed-sized memory pool specified by parameter *mpfid* and stores the start address in the area specified by parameter *p_blk*.
If no fixed-size memory blocks could be acquired from the target fixed-size memory pool (no available fixed-size memory blocks exist) when this service call is issued, this service call does not acquire the fixed-size memory block but queues the invoking task to the target fixed-size memory pool wait queue and moves it from the RUNNING state to the WAITING state with time-out (fixed-size memory block acquisition wait state).
The WAITING state for a fixed-sized memory block is cancelled in the following cases.

WAITING State for a Fixed-sized Memory Block Cancel Operation	Return Value
A fixed-sized memory block was returned to the target fixed-sized memory pool as a result of issuing rel_mpf.	E_OK
A fixed-sized memory block was returned to the target fixed-sized memory pool as a result of issuing irel_mpf.	E_OK
Forced release from waiting (accept rel_wai while waiting).	E_RLWAI
Forced release from waiting (accept irel_wai while waiting).	E_RLWAI
The fixed-sized memory pool is reset as a result of issuing vrst_mpf.	EV_RST
The time specified by *tmout* has elapsed.	E_TMOUT
Forced release from waiting (accept del_mpf while waiting).	E_DLT

Note 1 Invoking tasks are queued to the target fixed-size memory pool wait queue in the order defined at creating the fixed-sized memory pool. (FIFO order or current priority order).

Note 2 The contents of the block are undefined.

Note 3 The alignment number of memory block is 1. Please perform the following, in order to enlarge the alignment number of memory blocks.

- Specify the memory block size to a multiple of the desired alignment number at creating the fixed-sized memory pool.
- Make the start address of the fixed-sized memory pool area into the address of the desired alignment number.

Note 4 TMO_FEVR is specified for wait time *tmout*, processing equivalent to get_mpf will be executed. When TMO_POL is specified, processing equivalent to pget_mpf will be executed.

Return value

Macro	Value	Description
E_OK	0	Normal completion.
E_PAR	-17	Parameter error. - *p_blk* == NULL - *tmout* < -1 - *tmout* > (0x7FFFFFFF - TIC_NUME) / TIC_DENO
E_ID	-18	Invalid ID number. - *mpfid* ≤ 0 - *mpfid* > VTMAX_MPF
E_CTX	-25	Context error. - This service call was issued from a non-task. - This service call was issued in the CPU locked state. - This service call was issued in the dispatching disabled state. - This service call was issued in the status “PSW.IPL > kernel interrupt mask level”.
E_MACV	-26	Memory access violation. - Stack pointer points out of user stack for invoking task. - The operand-write access to the area indicated by *p_blk* has not been permitted to the invoking task.
E_NOEXS	-42	Non-existent object. - The fixed-sized memory pool specified by *mpfid* does not exist.
E_RLWAI	-49	Forced release from the WAITING state. - Accept rel_wai/irel_wai while waiting.
E_TMOUT	-50	Polling failure or specified time has elapsed.
E_DLT	-51	Waiting object deleted. - Accept del_mpf while waiting.
EV_RST	-127	Released from WAITING state by the object reset (vrst_mpf)

rel_mpf
irel_mpf

Outline

Release fixed-sized memory block.

C format

```
ER      rel_mpf (ID mpfid, VP blk);
ER      irel_mpf (ID mpfid, VP blk);
```

Parameter(s)

I/O	Parameter	Description
I	`ID        mpfid;`	ID number of the fixed-sized memory pool.
I	`VP        blk;`	Start address of the memory block to be released.

Explanation

This service call returns the fixed-sized memory block specified by parameter *blk* to the fixed-sized memory pool specified by parameter *mpfid*.
If a task is queued to the target fixed-sized memory pool wait queue when this service call is issued, fixed-sized memory block return processing is not performed but fixed-sized memory blocks are returned to the relevant task (first task of wait queue).
As a result, the relevant task is unlinked from the wait queue and is moved from the WAITING state (WAITING state for a fixed-sized memory block) to the READY state, or from the WAITING-SUSPENDED state to the SUSPENDED state.

Return value

Macro	Value	Description
E_OK	0	Normal completion.
E_PAR	-17	Parameter error. - *blk* == NULL - *blk* is illegal.
E_ID	-18	Invalid ID number. - *mpfid* ≤ 0 - *mpfid* > VTMAX_MPF

Macro	Value	Description
E_CTX	-25	Context error. - This service call was issued in the CPU locked state. - The irel_mpf was issued from task. - The rel_mpf was issued from non-task. - This service call was issued in the status “PSW.IPL > kernel interrupt mask level”.
E_MACV	-26	Memory access violation. (only for rel_mpf) - Stack pointer points out of user stack for invoking task.
E_NOEXS	-42	Non-existent object. - The fixed-sized memory pool specified by *mpfid* does not exist.

ref_mpf
iref_mpf

Outline

Reference fixed-sized memory pool state.

C format

```
ER      ref_mpf (ID mpfid, T_RMPF *pk_rmpf);
ER      iref_mpf (ID mpfid, T_RMPF *pk_rmpf);
```

Parameter(s)

I/O	Parameter	Description
I	`ID       mpfid;`	ID number of the fixed-sized memory pool.
O	`T_RMPF   *pk_rmpf;`	Pointer to the packet returning the fixed-sized memory pool state.

[Fixed-sized memory pool state packet: T_RMPF]

```
typedef struct  t_rmpf {
    ID      wtskid;         /*Existence of waiting task*/
    UINT    fblkcnt;        /*Number of free memory blocks*/
} T_RMPF;
```

Explanation

Stores fixed-sized memory pool state packet (ID number of the task at the head of the wait queue, number of free memory blocks, etc.) of the fixed-sized memory pool specified by parameter *mpfid* in the area specified by parameter *pk_rmpf*.

- *wtskid*
  Stores whether a task is queued to the fixed-size memory pool.

TSK_NONE:	No applicable task
Value:	ID number of the task at the head of the wait queue

- *fblkcnt*
  Stores the number of free memory blocks.

Return value

Macro	Value	Description
E_OK	0	Normal completion.
E_PAR	-17	Parameter error. - *pk_rmpf* == NULL

Macro	Value	Description
E_ID	-18	Invalid ID number. - *mpfid* ≤ 0 - *mpfid* > VTMAX_MPF
E_CTX	-25	Context error. - This service call was issued in the CPU locked state. - This service call was issued in the status “PSW.IPL > kernel interrupt mask level”. Note When the iref_mpf is issued from task or the ref_mpf is issued from non-task, the context error is not detected and normal operation of the system is not guaranteed.
E_MACV	-26	Memory access violation. (only for ref_mpf) - The operand-write access to the area indicated by *pk_rmpf* has not been permitted to the invoking task.
E_NOEXS	-42	Non-existent object. - The fixed-sized memory pool specified by *mpfid* does not exist.

19.2.11 Memory pool management functions (variable-sized memory pools)

The following shows the service calls provided by the RI600PX as the memory pool management functions (variable-sized memory pools).

Table 19-15 Memory Pool Management Functions (Variable-Sized Memory Pools)

Service Call	Function	Useful Range
cre_mpl	Create variable-sized memory pool	Task
acre_mpl	Create variable-sized memory pool (automatic ID assignment)	Task
del_mpl	Delete variable-sized memory pool	Task
get_mpl	Acquire variable-sized memory block (waiting forever)	Task
pget_mpl	Acquire variable-sized memory block (polling)	Task
ipget_mpl	Acquire variable-sized memory block (polling)	Non-task
tget_mpl	Acquire variable-sized memory block (with time-out)	Task
rel_mpl	Release variable-sized memory block	Task
ref_mpl	Reference variable-sized memory pool state	Task
iref_mpl	Reference variable-sized memory pool state	Non-task

cre_mpl
acre_mpl

Outline

Create variable-sized memory pool.

C format

```
ER      cre_mpl (ID mplid, T_CMPL *pk_cmpl );
ER_ID   acre_mpl ( T_CMPL *pk_cmpl );
```

Parameter(s)

I/O	Parameter	Description
I	`ID       mplid;`	ID number of the variable-sized memory pool.
I	`T_CMPL   *pk_cmpl;`	Pointer to the packet containing the variable-sized memory pool creation information.

[Variable-sized memory pool creation information packet : T_CMPL]

```
typedef struct  t_cmpl {
    ATR    mplatr;   /*variable-sized memory pool attribute*/
    SIZE   mplsz;    /*Size of variable-sized memory pool area (in bytes)*/
    VP     mpl;      /*Start address of the variable-sized memory pool area*/
    UINT   maxblksz; /*maximum memory block size (in bytes)*/
} T_CMPL;
```

Explanation

This service call can be called from tasks that belong to Trusted Domain.
The cre_mpl creates a variable-sized memory pool with variable-sized memory pool ID indicated by *mplid* according to the content of *pk_cmpl*. The acre_mpl creates a variable-sized memory pool according to the content of *pk_cmpl*, and returns the created variable-sized memory pool ID.

1) Variable-sized memory pool attribute (*mplatr*)
Only TA_TFIFO can be specified for *mplatr*.

- TA_TFIFO (= 0x0000)
  Task wait queue is managed in FIFO order.

2) Size of variable-sized memory pool area (*mplsz*), Start address of the variable-sized memory pool area (*mpl*)
The application acquires *mplsz* bytes of variable-sized memory pool area and specifies the start address for *mpl*.
The *mpl* must be 4-bytes boundary.

Note 1 The RI600PX is not concerned of anything of the access permission to the variable-sized memory pool area. To access to the memory block from task, the memory pool area must be in the memory object with appropriate permission.

Note, the RI600PX generates management tables in the memory pool area. If the management table is rewritten by allocation, correct system operation cannot be guaranteed.

Note 2 The µITRON4.0 specification defines the function that the kernel allocates variable-sized memory pool area when NULL is specified for *mpl*. But RI600PX does not support this function.

Note 3 The alignment number of memory block is 4.

3) Maximum memory block size (*maxblksz*)
Specify the maximum memory block size for *maxblksz*. Note, the maximum size of memory block that can be actually acquired might be larger than *maxblksz*. For details, refer to “9.3.1 Size of Variable-sized memory block”.

Return value

Macro	Value	Description
-	Positive value	Normal completion of acre_mpl. (Created variable-sized memory pool ID)
E_OK	0	Normal completion of cre_mpl.
E_RSATR	-11	Reserved attribute - *mplatr* != TA_TFIFO
E_PAR	-17	Parameter error. - *pk_cmpl* == NULL - *mplsz* < 24, *mplsz* > VTMAX_AREASIZE - *maxblksz* == 0, *maxblksz* > 0x0BFFFFF4 - *mplsz* is too small to *maxblksz*. - *mpl* + *mplsz* > 0x100000000 - *mpl* is not 4-bytes boundary.
E_ID	-18	Invalid ID number. (only for cre_mpl) - *mplid* < 0 - *mplid* > VTMAX_MPL
E_CTX	-25	Context error. - This service call was issued in the CPU locked state. - This service call was issued from non-task. - This service call was issued in the status “PSW.IPL > kernel interrupt mask level”.
E_MACV	-26	Memory access violation. - Stack pointer points out of user stack for invoking task. - The operand-read access to the area indicated by *pk_cmpl* has not been permitted to the invoking task.
E_OACV	-27	Object access violation. - The invoking task does not belong to trusted domain.
E_NOMEM	-33	Insufficient memory. - *mpl* == NULL
E_NOID	-34	No ID number available.(only for acre_mpl)
E_OBJ	-41	Object state error. (only for cre_mpl) - The variable-sized memory pool specified by *mplid* exists.

del_mpl

Outline

Delete variable-sized memory pool.

C format

```
ER      del_mpl (ID mplid);
```

Parameter(s)

I/O	Parameter	Description
I	`ID      mplid;`	ID number of the variable-sized memory pool.

Explanation

This service call can be called from tasks that belong to Trusted Domain.
This service call deletes the variable-sized memory pool indicated by *mplid*.
When there are waiting tasks for the target variable-sized memory pool by using get_mpl or tget_mpl, this service call cancels the WAITING state of the tasks and returns E_DLT as a return value of the get_mpl or tget_mpl.

Return value

Macro	Value	Description
E_OK	0	Normal completion.
E_ID	-18	Invalid ID number. - *mplid* ≤ 0 - *mplid* > VTMAX_MPL
E_CTX	-25	Context error. - This service call was issued in the CPU locked state. - This service call was issued from non-task. - This service call was issued in the status “PSW.IPL > kernel interrupt mask level”.
E_MACV	-26	Memory access violation. - Stack pointer points out of user stack for invoking task.
E_OACV	-27	Object access violation. - The invoking task does not belong to trusted domain.
E_NOEXS	-42	Non-existent object. - The variable-sized memory pool specified by *mplid* does not exist.

get_mpl

Outline

Acquire variable-sized memory block (waiting forever).

C format

```
ER      get_mpl (ID mplid, UINT blksz, VP *p_blk);
```

Parameter(s)

I/O	Parameter	Description
I	`ID mplid;`	ID number of the variable-sized memory pool.
I	`UINT blksz;`	Memory block size to be acquired (in bytes).
O	`VP *p_blk;`	Start address of the acquired memory block.

Explanation

This service call acquires a variable-size memory block of the size specified by parameter blksz from the variable-size memory pool specified by parameter *mplid*, and stores its start address into the area specified by parameter *p_blk*.
If no variable-size memory blocks could be acquired from the target variable-size memory pool (no successive areas equivalent to the requested size were available) when this service call is issued, this service call does not acquire variable-size memory blocks but queues the invoking task to the target variable-size memory pool wait queue and moves it from the RUNNING state to the WAITING state (variable-size memory block acquisition wait state).
The WAITING state for a variable-sized memory block is cancelled in the following cases.

WAITING State for a Variable-sized Memory Block Cancel Operation	Return Value
The variable-size memory block that satisfies the requested size was returned to the target variable-size memory pool as a result of issuing rel_mpl.	E_OK
The task at the top of the transmission wait queue was forcedly released from waiting by following either. - Forced release from waiting (accept rel_wai while waiting). - Forced release from waiting (accept irel_wai while waiting). - Forced release from waiting (accept ter_tsk while waiting). - The time specified by *tmout* for tget_mpl has elapsed.	E_OK
Forced release from waiting (accept rel_wai while waiting).	E_RLWAI
Forced release from waiting (accept irel_wai while waiting).	E_RLWAI
The variable-sized memory pool is reset as a result of issuing vrst_mpl.	EV_RST
Forced release from waiting (accept del_mpl while waiting).	E_DLT

Note 1 For the size of the memory block, refer to "9.3.1 Size of Variable-sized memory block".

Note 2 Invoking tasks are queued to the target variable-size memory pool wait queue in the FIFO order.

Note 3 The contents of the block are undefined.

Note 4 The alignment number of memory blocks changes with creation method of the variable-sized memory pool.

- Created by system configuration file
  The alignment number is 1. To enlarge the alignment number to 4, specify unique section to Section name assigned to the memory pool area (mpl_section) in Variable-sized Memory Pool Information (variable_memorypool[]) and locate the section to 4-bytes boundary address when linking.
- Created by cre_mpl or acre_mpl
  The alignment number is 4.

Return value

Macro	Value	Description
E_OK	0	Normal completion.
E_PAR	-17	Parameter error. - *blksz* == 0 - *blksz* exceeds the maximum size that can be acquired. - *p_blk* == NULL
E_ID	-18	Invalid ID number. - *mplid* ≤ 0 - *mplid* > VTMAX_MPL
E_CTX	-25	Context error. - This service call was issued from a non-task. - This service call was issued in the CPU locked state. - This service call was issued in the dispatching disabled state. - This service call was issued in the status “PSW.IPL > kernel interrupt mask level”.
E_MACV	-26	Memory access violation. - Stack pointer points out of user stack for invoking task. - The operand-write access to the area indicated by *p_blk* has not been permitted to the invoking task.
E_NOEXS	-42	Non-existent object. - The variable-sized memory pool specified by *mplid* does not exist.
E_RLWAI	-49	Forced release from the WAITING state. - Accept rel_wai/irel_wai while waiting.
E_DLT	-51	Waiting object deleted. - Accept del_mpl while waiting.
EV_RST	-127	Released from WAITING state by the object reset (vrst_mpl)

pget_mpl
ipget_mpl

Outline

Acquire variable-sized memory block (polling).

C format

```
ER      pget_mpl (ID mplid, UINT blksz, VP *p_blk);
ER      ipget_mpl (ID mplid, UINT blksz, VP *p_blk);
```

Parameter(s)

I/O	Parameter	Description
I	`ID mplid;`	ID number of the variable-sized memory pool.
I	`UINT blksz;`	Memory block size to be acquired (in bytes).
O	`VP *p_blk;`	Start address of the acquired memory block.

Explanation

This service call acquires a variable-size memory block of the size specified by parameter *blksz* from the variable-size memory pool specified by parameter *mplid*, and stores its start address into the area specified by parameter *p_blk*.
If no variable-size memory blocks could be acquired from the target variable-size memory pool (no successive areas equivalent to the requested size were available) when this service call is issued, this service call does not acquire variable-size memory block but returns “E_TMOUT”.

Note 1 For the size of the memory block, refer to “9.3.1 Size of Variable-sized memory block”.

Note 2 The contents of the block are undefined.

Note 3 The alignment number of memory blocks changes with creation method of the variable-sized memory pool.

- Created by system configuration file
  The alignment number is 1. To enlarge the alignment number to 4, specify unique section to Section name assigned to the memory pool area (mpl_section) in Variable-sized Memory Pool Information (variable_memorypool[]) and locate the section to 4-bytes boundary address when linking.
- Created by cre_mpl or acre_mpl
  The alignment number is 4.

Return value

Macro	Value	Description
E_OK	0	Normal completion.

Macro	Value	Description
E_PAR	-17	Parameter error. - *blksz* == 0 - *blksz* exceeds the maximum size that can be acquired. - *p_blk* == NULL
E_ID	-18	Invalid ID number. - *mplid* ≤ 0 - *mplid* > VTMAX_MPL
E_CTX	-25	Context error. - This service call was issued in the CPU locked state. - This service call was issued in the status "PSW.IPL > kernel interrupt mask level". Note When the ipget_mpl is issued from task or the pget_mpl is issued from non-task, the context error is not detected and normal operation of the system is not guaranteed.
E_MACV	-26	Memory access violation. (only for pget_mpl) - Stack pointer points out of user stack for invoking task. - The operand-write access to the area indicated by *p_blk* has not been permitted to the invoking task.
E_NOEXS	-42	Non-existent object. - The variable-sized memory pool specified by *mplid* does not exist.
E_TMOUT	-50	Polling failure.

tget_mpl

Outline

Acquire variable-sized memory block (with time-out).

C format

```
ER      tget_mpl (ID mplid, UINT blksz, VP *p_blk, TMO tmout);
```

Parameter(s)

I/O	Parameter	Description
I	`ID mplid;`	ID number of the variable-sized memory pool.
I	`UINT blksz;`	Memory block size to be acquired (in bytes).
O	`VP *p_blk;`	Start address of the acquired memory block.
I	`TMO tmout;`	Specified time-out (in millisecond). TMO_FEVR: Waiting forever. TMO_POL: Polling. Value: Specified time-out.

Explanation

This service call acquires a variable-size memory block of the size specified by parameter *blksz* from the variable-size memory pool specified by parameter *mplid*, and stores its start address into the area specified by parameter *p_blk*.
If no variable-size memory blocks could be acquired from the target variable-size memory pool (no successive areas equivalent to the requested size were available) when this service call is issued, this service call does not acquire variable-size memory blocks but queues the invoking task to the target variable-size memory pool wait queue and moves it from the RUNNING state to the WAITING state with time-out (variable-size memory block acquisition wait state).
The WAITING state for a variable-sized memory block is cancelled in the following cases.

WAITING State for a Variable-sized Memory Block Cancel Operation	Return Value
The variable-size memory block that satisfies the requested size was returned to the target variable-size memory pool as a result of issuing rel_mpl.	E_OK
The task at the top of the transmission wait queue was forcedly released from waiting by following either. - Forced release from waiting (accept rel_wai while waiting). - Forced release from waiting (accept irel_wai while waiting). - Forced release from waiting (accept ter_tsk while waiting). - The time specified by *tmout* for tget_mpl has elapsed.	E_OK
Forced release from waiting (accept rel_wai while waiting).	E_RLWAI
Forced release from waiting (accept irel_wai while waiting).	E_RLWAI
The variable-sized memory pool is reset as a result of issuing vrst_mpl.	EV_RST
The time specified by *tmout* has elapsed.	E_TMOUT

WAITING State for a Variable-sized Memory Block Cancel Operation	Return Value
Forced release from waiting (accept del_mpl while waiting).	E_DLT

Note 1 For the size of the memory block, refer to "9.3.1 Size of Variable-sized memory block".

Note 2 Invoking tasks are queued to the target variable-size memory pool wait queue in the FIFO order.

Note 3 The contents of the block are undefined.

Note 4 The alignment number of memory blocks changes with creation method of the variable-sized memory pool.

- Created by system configuration file
  The alignment number is 1. To enlarge the alignment number to 4, specify unique section to Section name assigned to the memory pool area (mpl_section) in Variable-sized Memory Pool Information (variable_memorypool[]) and locate the section to 4-bytes boundary address when linking.
- Created by cre_mpl or acre_mpl
  The alignment number is 4.

Note 5 TMO_FEVR is specified for wait time *tmout*, processing equivalent to get_mpl will be executed. When TMO_POL is specified, processing equivalent to pget_mpl will be executed.

Return value

Macro	Value	Description
E_OK	0	Normal completion.
E_PAR	-17	Parameter error. - *blksz* == 0 - *blksz* exceeds the maximum size that can be acquired. - *p_blk* == NULL - *tmout* < -1 - *tmout* > (0x7FFFFFFF - TIC_NUME) / TIC_DENO
E_ID	-18	Invalid ID number. - *mplid* ≤ 0 - *mplid* > VTMAX_MPL
E_CTX	-25	Context error. - This service call was issued from a non-task. - This service call was issued in the CPU locked state. - This service call was issued in the dispatching disabled state. - This service call was issued in the status "PSW.IPL > kernel interrupt mask level".
E_MACV	-26	Memory access violation. - Stack pointer points out of user stack for invoking task. - The operand-write access to the area indicated by *p_blk* has not been permitted to the invoking task.
E_NOEXS	-42	Non-existent object. - The variable-sized memory pool specified by *mplid* does not exist.
E_RLWAI	-49	Forced release from the WAITING state. - Accept rel_wai/irel_wai while waiting.

Macro	Value	Description
E_TMOUT	-50	Polling failure or specified time has elapsed.
E_DLT	-51	Waiting object deleted. - Accept del_mpl while waiting.
EV_RST	-127	Released from WAITING state by the object reset (vrst_mpl)

rel_mpl

Outline

Release variable-sized memory block.

C format

```
ER      rel_mpl (ID mplid, VP blk);
```

Parameter(s)

I/O	Parameter	Description
I	`ID mplid;`	ID number of the variable-sized memory pool.
I	`VP blk;`	Start address of memory block to be released.

Explanation

This service call returns the variable-sized memory block specified by parameter *blk* to the variable-sized memory pool specified by parameter *mplid*.
After returning the variable-size memory blocks, these service calls check the tasks queued to the target variable-size memory pool wait queue from the top, and assigns the memory if the size of memory requested by the wait queue is available. This operation continues until no tasks queued to the wait queue remain or no memory space is available. As a result, the task that acquired the memory is unlinked from the queue and moved from the WAITING state (variable-size memory block acquisition wait state) to the READY state, or from the WAITING-SUSPENDED state to the SUSPENDED state.

Note The RI600PX do only simple error detection for *blk*. If *blk* is illegal and the error is not detected, the operation is not guaranteed after that.

Return value

Macro	Value	Description
E_OK	0	Normal completion.
E_PAR	-17	Parameter error. - *blk* == NULL - *blk* is illegal.
E_ID	-18	Invalid ID number. - *mplid* ≤ 0 - *mplid* > VTMAX_MPL

Macro	Value	Description
E_CTX	-25	Context error. - This service call was issued in the CPU locked state. - This service call was issued from non-task. - This service call was issued in the status “PSW.IPL > kernel interrupt mask level”.
E_MACV	-26	Memory access violation. - Stack pointer points out of user stack for invoking task.
E_NOEXS	-42	Non-existent object. - The variable-sized memory pool specified by *mplid* does not exist.

ref_mpl
iref_mpl

Outline

Reference variable-sized memory pool state.

C format

```
ER      ref_mpl (ID mplid, T_RMPL *pk_rmpl);
ER      iref_mpl (ID mplid, T_RMPL *pk_rmpl);
```

Parameter(s)

I/O	Parameter	Description
I	`ID        mplid;`	ID number of the variable-sized memory pool.
O	`T_RMPL   *pk_rmpl;`	Pointer to the packet returning the variable-sized memory pool state.

[Variable-sized memory pool state packet: T_RMPL]

```
typedef struct  t_rmpl {
    ID      wtskid;         /*Existence of waiting task*/
    SIZE    fmplsz;         /*Total size of free memory blocks*/
    UINT    fblksz;         /*Maximum memory block size available*/
} T_RMPL;
```

Explanation

These service calls store the detailed information (ID number of the task at the head of the wait queue, total size of free memory blocks, etc.) of the variable-size memory pool specified by parameter *mplid* into the area specified by parameter *pk_rmpl*.

- *wtskid*
  Stores whether a task is queued to the variable-size memory pool wait queue.

TSK_NONE:	No applicable task
Value:	ID number of the task at the head of the wait queue

- *fmplsz*
  Stores the total size of free memory blocks (in bytes).

- *fblksz*
  Stores the maximum memory block size available (in bytes).

Return value

Macro	Value	Description
E_OK	0	Normal completion.
E_PAR	-17	Parameter error. - *pk_rmpl* == NULL
E_ID	-18	Invalid ID number. - *mplid* ≤ 0 - *mplid* > VTMAX_MPL
E_CTX	-25	Context error. - This service call was issued in the CPU locked state. - This service call was issued in the status "PSW.IPL > kernel interrupt mask level". Note When the iref_mpl is issued from task or the ref_mpl is issued from non-task, the context error is not detected and normal operation of the system is not guaranteed.
E_MACV	-26	Memory access violation. (only for ref_mpl) - The operand-write access to the area indicated by *pk_rmpl* has not been permitted to the invoking task.
E_NOEXS	-42	Non-existent object. - The variable-sized memory pool specified by *mplid* does not exist.

19.2.12 Time management functions

The following shows the service calls provided by the RI600PX as the time management functions.

Table 19-16 Time Management Functions

Service Call	Function	Useful Range
set_tim	Set system time	Task
iset_tim	Set system time	Non-task
get_tim	Reference system time	Task
iget_tim	Reference system time	Non-task
cre_cyc	Create cyclic handler	Task
acre_cyc	Create cyclic handler (automatic ID assignment)	Task
del_cyc	Delete cyclic handler	Task
sta_cyc	Start cyclic handler operation	Task
ista_cyc	Start cyclic handler operation	Non-task
stp_cyc	Stop cyclic handler operation	Task
istp_cyc	Stop cyclic handler operation	Non-task
ref_cyc	Reference cyclic handler state	Task
iref_cyc	Reference cyclic handler state	Non-task
cre_alm	Create alarm handler	Task
acre_alm	Create alarm handler (automatic ID assignment)	Task
del_alm	Delete alarm handler	Task
sta_alm	Start alarm handler operation	Task
ista_alm	Start alarm handler operation	Non-task
stp_alm	Stop alarm handler operation	Task
istp_alm	Stop alarm handler operation	Non-task
ref_alm	Reference alarm handler state	Task
iref_alm	Reference alarm handler state	Non-task

set_tim
iset_tim

Outline

Set system time.

C format

```
ER      set_tim (SYSTIM *p_systim);
ER      iset_tim (SYSTIM *p_systim);
```

Parameter(s)

I/O	Parameter	Description
I	`SYSTIM   *p_systim;`	Time to set as system time.

[System time packet: SYSTIM]

```
typedef struct  systim {
    UH      utime;          /*System time (higher 16 bits)*/
    UW      ltime;          /*System time (lower 32 bits)*/
} SYSTIM;
```

Explanation

These service calls change the RI600PX system time (unit: msec) to the time specified by parameter *p_systim*.

Note Even if the system time is changed, the actual time at which the time management requests made before that (e.g., task time-outs, task delay by dly_tsk, cyclic handlers, and alarm handlers) are generated will not change.

Return value

Macro	Value	Description
E_OK	0	Normal completion.
E_PAR	-17	Parameter error. - *p_systim* == NULL

Macro	Value	Description
E_CTX	-25	Context error. - This service call was issued in the CPU locked state. - This service call was issued in the status “PSW.IPL > kernel interrupt mask level”. Note When the iset_tim is issued from task or the set_tim is issued from non-task, the context error is not detected and normal operation of the system is not guaranteed.
E_MACV	-26	Memory access violation. (only for set_tim) - The operand-read access to the area indicated by *p_systim* has not been permitted to the invoking task.

get_tim
iget_tim

Outline

Reference system time.

C format

```
ER      get_tim (SYSTIM *p_systim);
ER      iget_tim (SYSTIM *p_systim);
```

Parameter(s)

I/O	Parameter	Description
O	`SYSTIM *p_systim;`	Current system time.

[System time packet: SYSTIM]

```
typedef struct  systim {
    UH      utime;          /*System time (higher 16 bits)*/
    UW      ltime;          /*System time (lower 32 bits)*/
} SYSTIM;
```

Explanation

These service calls store the RI600PX system time (unit: msec) into the area specified by parameter *p_systim*.

Return value

Macro	Value	Description
E_OK	0	Normal completion.
E_PAR	-17	Parameter error. - *p_systim* == NULL
E_CTX	-25	Context error. - This service call was issued in the CPU locked state. - This service call was issued in the status “PSW.IPL > kernel interrupt mask level”. Note When the iget_tim is issued from task or the get_tim is issued from non-task, the context error is not detected and normal operation of the system is not guaranteed.

Macro	Value	Description
E_MACV	-26	Memory access violation. (only for get_tim) - The operand-write access to the area indicated by *p_systim* has not been permitted to the invoking task.

cre_cyc
acre_cyc

Outline

Create cyclic handler.

C format

```
ER      cre_cyc (ID cycid, T_CCYC *pk_ccyc );
ER_ID   acre_cyc ( T_CCYC *pk_ccyc );
```

Parameter(s)

I/O	Parameter	Description
I	`ID       cycid;`	ID number of the cyclic handler.
I	`T_CCYC   *pk_ccyc;`	Pointer to the packet containing the cyclic handler creation information.

[Cyclic handler creation information packet : T_CCYC]

```
typedef struct  t_ccyc {
    ATR     cycatr;         /*Cyclic handler attribute*/
    VP_INT  exinf;          /*Extended information*/
    FP      cychdr;         /*Cyclic handler start address*/
    RELTIM  cyctim;         /*Activation cycle (in milli-second)*/
    UINT    cycphs;         /*Activation phase (in milli-second)*/
} T_CCYC;
```

Explanation

This service call can be called from tasks that belong to Trusted Domain.
The cre_cyc creates a cyclic handler with cyclic handler ID indicated by *cycid* according to the content of *pk_ccyc*. The acre_cyc creates a cyclic handler according to the content of *pk_ccyc*, and returns the created cyclic handler ID.

1) Cyclic handler attribute (*cycatr*)
The following are specified for *cycatr*.

```
cycatr := ( TA_HLMG | [ TA_STA ] | [ TA_PHS ] )
```

- TA_HLNG (= 0x0000)
  Only C-language is supported for cyclic handler description language.
- TA_STA (= 0x0002)
  When TA_STA is specified, the cyclic handler is in operational state (STA state). When TA_STA is not specified, the cyclic handler is in non-operational state (STP state).
- TA_PHS (= 0x0004)
  When TA_PHS is specified, the next activation time is determined preserving the activation phase when the cyclic handler is moved to operational state. When TA_PHS is not specified, the cyclic handler is activated cyctim

milliseconds after issuing sta_cyc or ista_cyc.
Please refer to "10.6.5 Start cyclic handler operation".

2) Extended information (*exinf*)
The *exinf* is passed to the cyclic handler as argument. The *exinf* can be widely used by the user, for example, to set information concerning the cyclic handler.

3) Cyclic handler start address (*cychdr*)
Specify the cyclic handler start address for *cychdr*.

4) Activation cycle (*cyctim*), activation phase (*cycphs*)
Specify activation cycle (in milli-second) for *cyctim*.
And specify the time to the first staring from this service call (in milli-second) for *cycphs*. When both TA_STA and TA_PHS are not specified, the *cycphs* is ignored.

Return value

Macro	Value	Description
-	Positive value	Normal completion of acre_cyc. (Created cyclic handler ID)
E_OK	0	Normal completion of cre_cyc.
E_RSATR	-11	Reserved attribute - Either of bits in *cycatr* except bit1 and bit2 is 1.
E_PAR	-17	Parameter error. - *pk_ccyc* == NULL - *cychdr* == NULL - *cyctim* == 0, *cyctim* > (0x7FFFFFFF - TIC_NUME) / TIC_DENO - *cyctim* < *cycphs*
E_ID	-18	Invalid ID number. (only for cre_cyc) - *cycid* < 0 - *cycid* > VTMAX_CYH
E_CTX	-25	Context error. - This service call was issued in the CPU locked state. - This service call was issued from non-task. - This service call was issued in the status "PSW.IPL > kernel interrupt mask level".
E_MACV	-26	Memory access violation. - Stack pointer points out of user stack for invoking task. - The operand-read access to the area indicated by *pk_ccyc* has not been permitted to the invoking task.
E_OACV	-27	Object access violation. - The invoking task does not belong to trusted domain.
E_NOID	-34	No ID number available.(only for acre_cyc)
E_OBJ	-41	Object state error. (only for cre_cyc) - The cyclic handler specified by *cycid* exists.

del_cyc

Outline

Delete cyclic handler.

C format

```
ER      del_cyc (ID cycid);
```

Parameter(s)

I/O	Parameter	Description
I	`ID cycid;`	ID number of the cyclic handler.

Explanation

This service call can be called from tasks that belong to Trusted Domain.
This service call deletes the cyclic handler indicated by *cycid*.

Return value

Macro	Value	Description
E_OK	0	Normal completion.
E_ID	-18	Invalid ID number. - *cycid* ≤ 0 - *cycid* > VTMAX_CYH
E_CTX	-25	Context error. - This service call was issued in the CPU locked state. - This service call was issued from non-task. - This service call was issued in the status “PSW.IPL > kernel interrupt mask level”.
E_MACV	-26	Memory access violation. - Stack pointer points out of user stack for invoking task.
E_OACV	-27	Object access violation. - The invoking task does not belong to trusted domain.
E_NOEXS	-42	Non-existent object. - The cyclic handler specified by *cycid* does not exist.

sta_cyc
ista_cyc

Outline

Start cyclic handler operation.

C format

```
ER      sta_cyc (ID cycid);
ER      ista_cyc (ID cycid);
```

Parameter(s)

I/O	Parameter	Description
I	`ID        cycid;`	ID number of the cyclic handler.

Explanation

This service call moves the cyclic handler specified by parameter *cycid* from the non-operational state (STP state) to operational state (STA state).
As a result, the target cyclic handler is handled as an activation target of the RI600PX.
The relative interval from when either of this service call is issued until the first activation request is issued varies depending on whether the TA_PHS attribute is specified for the target cyclic handler at creation. For details, refer to "10.6.5 Start cyclic handler operation".

- When the TA_PHS attribute is specified
  The target cyclic handler activation timing is set up based on the activation phases and activation cycle.
  If the target cyclic handler has already been in operational state, however, no processing is performed even if this service call is issued, but it is not handled as an error.

- When the TA_PHS attribute is not specified
  The target cyclic handler activation timing is set up according to the activation cycle on the basis of the call time of this service call.
  This setting is performed regardless of the operating status of the target cyclic handler.

Return value

Macro	Value	Description
E_OK	0	Normal completion.
E_ID	-18	Invalid ID number. - *cycid* ≤ 0 - *cycid* > VTMAX_CYH

Macro	Value	Description
E_CTX	-25	Context error. - This service call was issued in the CPU locked state. - This service call was issued in the status "PSW.IPL > kernel interrupt mask level". Note When the ista_cyc is issued from task or the sta_cyc is issued from non-task, the context error is not detected and normal operation of the system is not guaranteed.
E_NOEXS	-42	Non-existent object. - The cyclic handler specified by *cycid* does not exist.

stp_cyc
istp_cyc

Outline

Stop cyclic handler operation.

C format

```
ER      stp_cyc (ID cycid);
ER      istp_cyc (ID cycid);
```

Parameter(s)

I/O	Parameter	Description
I	`ID        cycid;`	ID number of the cyclic handler.

Explanation

This service call moves the cyclic handler specified by parameter *cycid* from the operational state (STA state) to non-operational state (STP state).
As a result, the target cyclic handler is excluded from activation targets of the RI600PX until issuance of sta_cyc or ista_cyc.

Note This service call does not perform queuing of stop requests. If the target cyclic handler has been moved to the non-operational state (STP state), therefore, no processing is performed but it is not handled as an error.

Return value

Macro	Value	Description
E_OK	0	Normal completion.
E_ID	-18	Invalid ID number. - *cycid* ≤ 0 - *cycid* > VTMAX_CYH
E_CTX	-25	Context error. - This service call was issued in the CPU locked state. - This service call was issued in the status “PSW.IPL > kernel interrupt mask level”. Note When the istp_cyc is issued from task or the stp_cyc is issued from non-task, the context error is not detected and normal operation of the system is not guaranteed.
E_NOEXS	-42	Non-existent object. - The cyclic handler specified by *cycid* does not exist.

ref_cyc
iref_cyc

Outline

Reference cyclic handler state.

C format

```
ER      ref_cyc (ID cycid, T_RCYC *pk_rcyc);
ER      iref_cyc (ID cycid, T_RCYC *pk_rcyc);
```

Parameter(s)

I/O	Parameter	Description
I	`ID       cycid;`	ID number of the cyclic handler.
O	`T_RCYC   *pk_rcyc;`	Pointer to the packet returning the cyclic handler state.

[Cyclic handler state packet: T_RCYC]

```
typedef struct  t_rcyc {
    STAT    cycstat;        /*Current state*/
    RELTIM  lefttim;        /*Time left before the next activation*/
} T_RCYC;
```

Explanation

Stores cyclic handler state packet (current state, time until the next activation, etc.) of the cyclic handler specified by parameter *cycid* in the area specified by parameter *pk_rcyc*.

- *cycstat*
  Store the current state.

TCYC_STP:	Non-operational state
TCYC_STA:	Operational state

- *lefttim*
  Stores the time until the next activation (in millisecond). When the target cyclic handler is in the non-operational state, lefttim is undefined.

Return value

Macro	Value	Description
E_OK	0	Normal completion.

Macro	Value	Description
E_PAR	-17	Parameter error. - *pk_rcyc* == NULL
E_ID	-18	Invalid ID number. - *cycid* ≤ 0 - *cycid* > VTMAX_CYH
E_CTX	-25	Context error. - This service call was issued in the CPU locked state. - This service call was issued in the status “PSW.IPL > kernel interrupt mask level”. Note When the iref_cyc is issued from task or the ref_cyc is issued from non-task, the context error is not detected and normal operation of the system is not guaranteed.
E_MACV	-26	Memory access violation. (only for ref_cyc) - The operand-write access to the area indicated by *pk_rcyc* has not been permitted to the invoking task.
E_NOEXS	-42	Non-existent object. - The cyclic handler specified by *cycid* does not exist.

cre_alm
acre_alm

Outline

Create alarm handler.

C format

```
ER      cre_alm (ID almid, T_CALM *pk_calm );
ER_ID   acre_alm ( T_CALM *pk_calm );
```

Parameter(s)

I/O	Parameter	Description
I	`ID        almid;`	ID number of the alarm handler.
I	`T_CALM   *pk_calm;`	Pointer to the packet containing the alarm handler creation information.

[Alarm handler creation information packet : T_CALM]

```
typedef struct  t_calm {
    ATR     almatr;         /*Alarm handler attribute*/
    VP_INT  exinf;          /*Extended information*/
    FP      almhdr;         /*Alarm handler start address*/
} T_CALM;
```

Explanation

This service call can be called from tasks that belong to Trusted Domain.
The cre_alm creates a alarm handler with alarm handler ID indicated by *almid* according to the content of *pk_calm*. The acre_alm creates a alarm handler according to the content of *pk_calm*, and returns the created alarm handler ID.

1) Alarm handler attribute (*almatr*)
Only TA_HLNG can be specified for *almatr*.

- TA_HLNG (= 0x0000)
Only C-language is supported for alarm handler description language.

2) Extended information (*exinf*)
The *exinf* is passed to the alarm handler as argument. The *exinf* can be widely used by the user, for example, to set information concerning the alarm handler.

3) Alarm handler start address (*almhdr*)
Specify the alarm handler start address for *almhdr*.

Return value

Macro	Value	Description
-	Positive value	Normal completion of acre_alm. (Created alarm handler ID)
E_OK	0	Normal completion of cre_alm.
E_RSATR	-11	Reserved attribute - *almatr* != TA_HLNG
E_PAR	-17	Parameter error. - *pk_calm* == NULL - *almhdr* == NULL
E_ID	-18	Invalid ID number. (only for cre_alm) - *almid* < 0 - *almid* > VTMAX_ALH
E_CTX	-25	Context error. - This service call was issued in the CPU locked state. - This service call was issued from non-task. - This service call was issued in the status “PSW.IPL > kernel interrupt mask level”.
E_MACV	-26	Memory access violation. - Stack pointer points out of user stack for invoking task. - The operand-read access to the area indicated by *pk_calm* has not been permitted to the invoking task.
E_OACV	-27	Object access violation. - The invoking task does not belong to trusted domain.
E_NOID	-34	No ID number available.(only for acre_alm)
E_OBJ	-41	Object state error. (only for cre_alm) - The alarm handler specified by *almid* exists.

del_alm

Outline

Delete alarm handler.

C format

```
ER        del_alm (ID almid);
```

Parameter(s)

I/O	Parameter	Description
I	`ID        almid;`	ID number of the alarm handler.

Explanation

This service call can be called from tasks that belong to Trusted Domain.
This service call deletes the alarm handler indicated by *almid*.

Return value

Macro	Value	Description
E_OK	0	Normal completion.
E_ID	-18	Invalid ID number. - *almid* $\le$ 0 - *almid* > VTMAX_ALH
E_CTX	-25	Context error. - This service call was issued in the CPU locked state. - This service call was issued from non-task. - This service call was issued in the status “PSW.IPL > kernel interrupt mask level”.
E_MACV	-26	Memory access violation. - Stack pointer points out of user stack for invoking task.
E_OACV	-27	Object access violation. - The invoking task does not belong to trusted domain.
E_NOEXS	-42	Non-existent object. - The alarm handler specified by *almid* does not exist.

sta_alm
ista_alm

Outline

Start alarm handler operation.

C format

```
ER      sta_alm (ID almid, RELTIM almtim);
ER      ista_alm (ID almid, RELTIM almtim);
```

Parameter(s)

I/O	Parameter	Description
I	`ID      almid;`	ID number of the alarm handler.
I	`RELTIM  almtim;`	Activation time (unit: msec)

Explanation

This service call sets to start the alarm handler specified by parameter *almid* in *almtim* msec and moves the target alarm handler from the non-operational state (STP state) to operational state (STA state).
As a result, the target alarm handler is handled as an activation target of the RI600PX.

Note 1 When 0 is specified for almtim, the alarm handler will start at next base clock interrupt.

Note 2 This service call sets the activation time even if the target alarm handler has already been in the operational state. The previous activation time becomes invalid.

Return value

Macro	Value	Description
E_OK	0	Normal completion.
E_PAR	-17	Parameter error. - *almtim* > (0x7FFFFFFF - TIC_NUME) / TIC_DENO
E_ID	-18	Invalid ID number. - *almid* ≤ 0 - *almid* > VTMAX_ALH

Macro	Value	Description
E_CTX	-25	Context error. - This service call was issued in the CPU locked state. - This service call was issued in the status "PSW.IPL > kernel interrupt mask level". Note When the ista_alm is issued from task or the sta_alm is issued from non-task, the context error is not detected and normal operation of the system is not guaranteed.
E_NOEXS	-42	Non-existent object. - The alarm handler specified by *almid* does not exist.

stp_alm
istp_alm

Outline

Stop alarm handler operation.

C format

```
ER        stp_alm (ID almid);
ER        istp_alm (ID almid);
```

Parameter(s)

I/O	Parameter	Description
I	`ID        almid;`	ID number of the alarm handler.

Explanation

This service call moves the alarm handler specified by parameter *almid* from the operational state (STA state) to non-operational state (STP state).
As a result, the target alarm handler is excluded from activation targets of the RI600PX until issuance of sta_alm or ista_alm.

Note This service call does not perform queuing of stop requests. If the target alarm handler has been moved to the non-operational state (STP state), therefore, no processing is performed but it is not handled as an error.

Return value

Macro	Value	Description
E_OK	0	Normal completion.
E_ID	-18	Invalid ID number. - *almid* ≤ 0 - *almid* > VTMAX_ALH
E_CTX	-25	Context error. - This service call was issued in the CPU locked state. - This service call was issued in the status “PSW.IPL > kernel interrupt mask level”. Note When the istp_alm is issued from task or the stp_alm is issued from non-task, the context error is not detected and normal operation of the system is not guaranteed.
E_NOEXS	-42	Non-existent object. - The alarm handler specified by *almid* does not exist.

ref_alm
iref_alm

Outline

Reference alarm handler state.

C format

```
ER      ref_alm (ID almid, T_RALM *pk_ralm);
ER      iref_alm (ID almid, T_RALM *pk_ralm);
```

Parameter(s)

I/O	Parameter	Description
I	`ID       almid;`	ID number of the alarm handler.
O	`T_RALM   *pk_ralm;`	Pointer to the packet returning the alarm handler state.

[Alarm handler state packet: T_RALM]

```
typedef struct  t_ralm {
    STAT    almstat;        /*Current state*/
    RELTIM  lefttim;        /*Time left before the next activation*/
} T_RALM;
```

Explanation

Stores alarm handler state packet (current state, time until the next activation, etc.) of the alarm handler specified by parameter *almid* in the area specified by parameter *pk_ralm*.

- *almstat*
  Store the current state.

TALM_STP:	Non-operational state
TALM_STA:	Operational state

- *lefttim*
  Stores the time until the next activation (in millisecond). When the target alarm handler is in the non-operational state, lefttim is undefined.

Return value

Macro	Value	Description
E_OK	0	Normal completion.

Macro	Value	Description
E_PAR	-17	Parameter error. - *pk_ralm* == NULL
E_ID	-18	Invalid ID number. - *almid* ≤ 0 - *almid* > VTMAX_ALH
E_CTX	-25	Context error. - This service call was issued in the CPU locked state. - This service call was issued in the status “PSW.IPL > kernel interrupt mask level”. Note When the iref_alm is issued from task or the ref_alm is issued from non-task, the context error is not detected and normal operation of the system is not guaranteed.
E_MACV	-26	Memory access violation. (only for ref_alm) - The operand-write access to the area indicated by *pk_ralm* has not been permitted to the invoking task.
E_NOEXS	-42	Non-existent object. - The alarm handler specified by *almid* does not exist.

19.2.13 System state management functions

The following shows the service calls provided by the RI600PX as the system state management functions.

Table 19-17 System State Management Functions

Service Call	Function	Useful Range
rot_rdq	Rotate task precedence	Task
irot_rdq	Rotate task precedence	Non-task
get_tid	Reference task ID in the RUNNING state	Task
iget_tid	Reference task ID in the RUNNING state	Non-task
loc_cpu	Lock the CPU	Task
iloc_cpu	Lock the CPU	Non-task
unl_cpu	Unlock the CPU	Task
iunl_cpu	Unlock the CPU	Non-task
dis_dsp	Disable dispatching	Task
ena_dsp	Enable dispatching	Task
sns_ctx	Reference contexts	Task, Non-task
sns_loc	Reference CPU locked state	Task, Non-task
sns_dsp	Reference dispatching disabled state	Task, Non-task
sns_dpn	Reference dispatch pending state	Task, Non-task
vsys_dwn	System down	Task, Non-task
ivsys_dwn	System down	Task, Non-task
vsta_knl	Start RI600PX	Task, Non-task
ivsta_knl	Start RI600PX	Task, Non-task

rot_rdq
irot_rdq

Outline

Rotate task precedence.

C format

```
ER      rot_rdq (PRI tskpri);
ER      irot_rdq (PRI tskpri);
```

Parameter(s)

I/O	Parameter	Description
I	`PRI tskpri;`	Priority of the tasks. TPRI_SELF: Current priority of the invoking task. Value: Priority of the tasks.

Explanation

This service call re-queues the first task of the ready queue corresponding to the priority specified by parameter *tskpri* to the end of the queue to change the task execution order explicitly.

Note 1 This service call does not perform queuing of rotation requests. If no task is queued to the ready queue corresponding to the relevant priority, therefore, no processing is performed but it is not handled as an error.

Note 2 Round-robin scheduling can be implemented by issuing this service call via a cyclic handler in a constant cycle.

Note 3 The ready queue is a hash table that uses priority as the key, and tasks that have entered an executable state (READY state or RUNNING state) are queued in FIFO order.
Therefore, the scheduler realizes the RI600PX's scheduling system by executing task detection processing from the highest priority level of the ready queue upon activation, and upon detection of queued tasks, giving the CPU use right to the first task of the proper priority level.

Note 4 As for a task which has locked mutexes, the current priority might be different from the base priority. In this case, even if the task issues this servie call specifying TPRI_SELF for parameter *tskpri*, the ready queue of the current priority that the invoking task belongs cannot be changed.

Note 5 For current priority and base priority, refer to "8.2.2 Current priority and base priority".

Return value

Macro	Value	Description
E_OK	0	Normal completion.

Macro	Value	Description
E_PAR	-17	Parameter error. - *tskpri* < 0 - *tskpri* > TMAX_TPRI - When this service call was issued from a non-task, TPRI_SELF was specified *tskpri*.
E_CTX	-25	Context error. - This service call was issued in the CPU locked state. - The irot_rdq was issued from task. - The rot_rdq was issued from non-task. - This service call was issued in the status “PSW.IPL > kernel interrupt mask level”.
E_MACV	-26	Memory access violation. (only for rot_rdq) - Stack pointer points out of user stack for invoking task.

get_tid
iget_tid

Outline

Reference task ID in the RUNNING state.

C format

```
ER      get_tid (ID *p_tskid);
ER      iget_tid (ID *p_tskid);
```

Parameter(s)

I/O	Parameter	Description
O	`ID        *p_tskid;`	Pointer to the area returning the task ID number.

Explanation

These service calls store the ID of a task in the RUNNING state in the area specified by parameter *p_tskid*.
This service call stores TSK_NONE in the area specified by parameter *p_tskid* if no tasks that have entered the RUNNING state exist.

Return value

Macro	Value	Description
E_OK	0	Normal completion.
E_PAR	-17	Parameter error. - *p_tskid* == NULL
E_CTX	-25	Context error. - This service call was issued in the CPU locked state. - This service call was issued in the status “PSW.IPL > kernel interrupt mask level”. Note When the iget_tid is issued from task or the get_tid is issued from non-task, the context error is not detected and normal operation of the system is not guaranteed.
E_MACV	-26	Memory access violation. (only for get_tid) - The operand-write access to the area indicated by *p_tskid* has not been permitted to the invoking task.

loc_cpu
iloc_cpu

Outline

Lock the CPU.

C format

```
ER      loc_cpu (void);
ER      iloc_cpu (void);
```

Parameter(s)

None.

Explanation

These service calls transit the system to the CPU locked state.
In the CPU locked state, the task scheduling is prohibited, and kernel interrupts are masked. Therefore, exclusive processing can be achieved for all processing programs except non-kernel interrupt handlers.
The service calls that can be issued in the CPU locked state are limited to the one listed below.

Service Call that can be issued	Function
ext_tsk	Terminate invoking task. (This service call transit the system to the CPU unlocked state.)
exd_tsk	Terminate and delete invoking task. (This service call transit the system to the CPU unlocked state.)
sns_tex	Reference task exception disabled state
loc_cpu, iloc_cpu	Lock the CPU.
unl_cpu, iunl_cpu	Unlock the CPU.
sns_loc	Reference CPU state.
sns_dsp	Reference dispatching state.
sns_ctx	Reference contexts.
sns_dpn	Reference dispatch pending state.
vsys_dwn, ivsys_dwn	System down

The unl_cpu, iunl_cpu ext_tsk and exd_tsk releases from the CPU locked state,

Note 1 The CPU locked state changed by issuing these service calls must be cancelled before the processing program that issued this service call ends.

Note 2 These service calls do not perform queuing of lock requests. If the system is in the CPU locked state, therefore, no processing is performed but it is not handled as an error.

Note 3 The RI600PX realizes the TIME MANAGEMENT FUNCTIONS by using base clock timer interrupts that occurs at constant intervals. If acknowledgment of the relevant base clock timer interrupt is disabled by issuing this service call, the TIME MANAGEMENT FUNCTIONS may no longer operate normally.

Note 4 For kernel interrupts, refer to “12.1 Interrupt Type”.

Note 5 The loc_cpu returns E_ILUSE error while interrupt mask has changed to other than 0 by chg_ims.

Return value

Macro	Value	Description
E_OK	0	Normal completion.
E_CTX	-25	Context error. - This service call was issued in the status “PSW.IPL > kernel interrupt mask level”. Note When the iloc_cpu is issued from task or the loc_cpu is issued from non-task, the context error is not detected and normal operation of the system is not guaranteed.
E_ILUSE	-28	Illegal use of service call. - This service call is issued in the status that the invoking task changes the PSW.IPL to other than 0 by using chg_ims.

unl_cpu
iunl_cpu

Outline

Unlock the CPU.

C format

```
ER      unl_cpu (void);
ER      iunl_cpu (void);
```

Parameter(s)

None.

Explanation

These service calls transit the system to the CPU unlocked state.

Note 1 These service calls do not perform queuing of cancellation requests. If the system is in the CPU unlocked state, therefore, no processing is performed but it is not handled as an error.

Note 2 These service calls do not cancel the dispatching disabled state that was set by issuing dis_dsp.

Note 3 The CPU locked state is also cancelled by ext_tsk or exd_tsk.

Return value

Macro	Value	Description
E_OK	0	Normal completion.
E_CTX	-25	Context error. - The iunl_cpu was issued from task. - The unl_cpu was issued from task. - This service call was issued in the status “PSW.IPL > kernel interrupt mask level”.
E_MACV	-26	Memory access violation. (only for unl_cpu) - Stack pointer points out of user stack for invoking task.

dis_dsp

Outline

Disable dispatching.

C format

```
ER      dis_dsp (void);
```

Parameter(s)

None.

Explanation

This service call transits the system to the dispatching disabled state.
In the dispatching disabled state, the task scheduling is prohibited. Therefore, exclusive processing can be achieved for all tasks.
The operation that transit the system to the dispatching disabled state is as follows.

- dis_dsp
- chg_ims that changes PSW.IPL to other than 0.

The operation that transit the system to the dispatching enabled state is as follows.

- ena_dsp
- ext_tsk
- exd_tsk
- chg_ims that changes PSW.IPL to 0.

Note 1 The dispatching disabled state changed by issuing this service call must be cancelled before the task that issued this service call moves to the DORMANT state.

Note 2 This service call does not perform queuing of disable requests. If the system is in the dispatching disabled state, therefore, no processing is performed but it is not handled as an error.

Note 3 If a service call (such as wai_sem, wai_flg) that may move the status of the invoking task is issued while the dispatching disabled state, that service call returns E_CTX regardless of whether the required condition is immediately satisfied.

Return value

Macro	Value	Description
E_OK	0	Normal completion.
E_CTX	-25	Context error. - This service call was issued from a non-task. - This service call was issued in the CPU locked state. - This service call was issued in the status “PSW.IPL > kernel interrupt mask level”.

ena_dsp

Outline

Enable dispatching.

C format

```
ER      ena_dsp (void);
```

Parameter(s)

None.

Explanation

This service call transits the system to the dispatching enabled state.
The operation that changes in the dispatching disabled state is as follows.

- dis_dsp
- chg_ims that changes PSW.IPL to other than 0.

The operation that changes in the dispatching enabled state is as follows.

- ena_dsp
- ext_tsk
- exd_tsk
- chg_ims that changes PSW.IPL to 0.

Note 1 This service call does not perform queuing of enable requests. If the system is in the dispatch enabled state, therefore, no processing is performed but it is not handled as an error.

Note 2 If a service call (such as wai_sem, wai_flg) that may move the status of the invoking task is issued from when dis_dsp is issued until this service call is issued, the RI600PX returns E_CTX regardless of whether the required condition is immediately satisfied.

Return value

Macro	Value	Description
E_OK	0	Normal completion.
E_CTX	-25	Context error. - This service call was issued from a non-task. - This service call was issued in the CPU locked state. - This service call was issued in the status “PSW.IPL > kernel interrupt mask level”.

Macro	Value	Description
E_MACV	-26	Memory access violation. - Stack pointer points out of user stack for invoking task.

sns_ctx

Outline

Reference contexts.

C format

```
BOOL    sns_ctx (void);
```

Parameter(s)

None.

Explanation

This service call examines the context type of the processing program that issues this service call. This service call returns TRUE when the processing program is non-task context, and return FALSE when the processing program is task context.

Return value

Macro	Value	Description
TRUE	1	Normal completion (non-task context).
FALSE	0	Normal completion (task context).
E_CTX	-25	Context error. - This service call was issued in the status “PSW.IPL > kernel interrupt mask level”.

sns_loc

Outline

Reference CPU locked state.

C format

```
BOOL    sns_loc (void);
```

Parameter(s)

None.

Explanation

This service call examines whether the system is in the CPU locked state or not. This service call returns TRUE when the system is in the CPU locked state, and return FALSE when the system is in the CPU unlocked state.

Return value

Macro	Value	Description
TRUE	1	Normal completion (CPU locked state).
FALSE	0	Normal completion (CPU unlocked state).
E_CTX	-25	Context error. - This service call was issued in the status “PSW.IPL > kernel interrupt mask level”.

sns_dsp

Outline

Reference dispatching disabled state.

C format

```
BOOL      sns_dsp (void);
```

Parameter(s)

None.

Explanation

This service call examines whether the system is in the dispatching disabled state or not. This service call returns TRUE when the system is in the dispatching disabled state, and return FALSE when the system is in the dispatching enabled state.

Return value

Macro	Value	Description
TRUE	1	Normal completion (dispatching disabled state).
FALSE	0	Normal completion (dispatching enabled state).
E_CTX	-25	Context error. - This service call was issued in the status “PSW.IPL > kernel interrupt mask level”.

sns_dpn

Outline

Reference dispatch pending state.

C format

```
BOOL     sns_dpn (void);
```

Parameter(s)

None.

Explanation

This service call examines whether the system is in the dispatch pending state or not. This service call returns TRUE when the system is in the dispatch pending state, and return FALSE when the system is not in the dispatch pending state.
The state to fill either the following is called dispatch pending state.

- Dispatching disabled state
- CPU locked state
- PSW.IPL > 0, such as handlers

Return value

Macro	Value	Description
TRUE	1	Normal completion. (dispatch pending state)
FALSE	0	Normal completion. (any other states)
E_CTX	-25	Context error. - This service call was issued in the status “PSW.IPL > kernel interrupt mask level”.

vsys_dwn
ivsys_dwn

Outline

System down.

C format

```
void    vsys_dwn(W type, VW inf1, VW inf2, VW inf3);
void    vsys_dwn(W type, VW inf1, VW inf2, VW inf3);
```

Parameter(s)

I/O	Parameter	Description
I	`W    type;`	Error type.
I	`VW   inf1;`	System down information 1
I	`VW   inf2;`	System down information 2
I	`VW   inf3;`	System down information 3

Explanation

These service calls pass the control to the System down routine (_RI_sys_dwn__( )).
Specify the value (from 1 to 0x7FFFFFFF) typed to the occurring error for *type*. Note the value of 0 or less is reserved by the RI600PX.
These service calls never return.
For details of the parameter specification, refer to "15.2.2 Parameters of system down routine".
These service calls are the function outside the range of μITRON4.0 specifications.

Note The system down routine is also called when abnormality is detected in the RI600PX.

Return value

None.

vsta_knl
ivsta_knl

Outline

Start RI600PX.

C format

```
void     vsta_knl( void );
void     vsta_knl( void );
```

Parameter(s)

None.

Explanation

These service start the RI600PX.
These service calls never return.
When these service call is issued, it is necessary to fill the following.

- All interrupts can not be accepted. (For example, PSW.I == 0)
- The CPU is in the supervisor mode (PSW.PM == 0).

The outline of processing of these service calls is shown as follows.

1) Initialize ISP register to the end address of SI section + 1
2) Initialize INTB register to the start address of the relocatable vector table (INTERRUPT_VECTOR section). The relocatable vector table is generated by the cfg600px.
3) Initialize the system time to 0.
4) Create various object which are defined in the system configuration file. If an error is detected in this process, the system will be down.
5) Initialize MPU (Memory Protection Unit).
6) Initialize base clock timer (call Base Clock Timer Initialization Routine (_RI_init_cmt_knl( )))
7) Pass control to scheduler

These service calls are the function outside the range of μITRON4.0 specifications.

Return value

None.

19.2.14 Interrupt management functions

The following shows the service calls provided by the RI600PX as the interrupt management functions.

Table 19-18 Interrupt Management Functions

Service Call	Function	Useful Range
chg_ims	Change interrupt mask	Task
ichg_ims	Change interrupt mask	Non-task
get_ims	Reference interrupt mask	Task
iget_ims	Reference interrupt mask	Non-task

chg_ims
ichg_ims

Outline

Change interrupt mask.

C format

```
ER      chg_ims (IMASK imask);
ER      ichg_ims (IMASK imask);
```

Parameter(s)

I/O	Parameter	Description
I	`IMASK imask;`	Interrupt mask desired.

Explanation

These service calls change PSW.IPL to the value specified by *imask*. Ranges of the value that can be specified for *imask* are from 0 to 15.
In the chg_ims, the system shifts to the dispatching disabled state when other than 0 is specified for *imask*, (it is equivalent to dis_dsp.) and shifts to the dispatching enabled state when 0 is specified for *imask* (it is equivalent to ena_dsp.).
On the other hand, the ichg_ims does not change the dispatching disabled / enabled state.
The service calls that can be issued while PSW.IPL is larger than the Kernel interrupt mask level (system_IPL) are limited to the one listed below.

Service Call that can be issued	Function
chg_ims, ichg_ims	Change interrupt mask.
get_ims, iget_ims	Reference interrupt mask
vsys_dwn, ivsys_dwn	System down
vsta_knl, ivsta_knl	Start RI600PX.

Note 1 In the non-task, the interrupt mask must not lower PSW.IPL more than it starts.

Note 2 The dispatching disabled state changed by issuing the chg_ims must be cancelled before the task that issued this service call moves to the DORMANT state.

Note 3 If a service call (such as wai_sem, wai_flg) that may move the status of the invoking task is issued while the dispatching disabled state, that service call returns E_CTX regardless of whether the required condition is immediately satisfied.

Note 4 The RI600PX realizes the TIME MANAGEMENT FUNCTIONS by using base clock timer interrupts that occurs at constant intervals. If acknowledgment of the relevant base clock timer interrupt is disabled by issuing this service call, the TIME MANAGEMENT FUNCTIONS may no longer operate normally.

Note 5 Do not issue ena_dsp while a task changes PSW.IPL to other than 0 by using chg_ims. If issuing ena_dsp, the system moves to the dispatching enabled state. If task dispatching occurs, PSW is changed for the dispatched task. Therefore PSW.IPL may be lowered without intending it

Note 6 Refer to “12.8 Prohibit Maskable Interrupts”.

Return value

Macro	Value	Description
E_OK	0	Normal completion.
E_PAR	-17	Parameter error. - *imask* > 15
E_CTX	-25	Context error. - This service call was issued in the CPU locked state. - The ichg_ims was issued from task. - The chg_ims was issued from non-task.
E_MACV	-26	Memory access violation. (only for chg_ims) - Stack pointer points out of user stack for invoking task.

get_ims
iget_ims

Outline

Reference interrupt mask.

C format

```
ER      get_ims (IMASK *p_imask);
ER      iget_ims (IMASK *p_imask);
```

Parameter(s)

I/O	Parameter	Description
O	IMASK *p_imask;	Pointer to the area returning the interrupt mask.

Explanation

These service calls store PSW.IPL into the area specified by parameter *p_imask*.

Note 1 These service call do not detect the context error.

Note 2 The following intrinsic functions provided by compiler are higher-speed than this service call. See “CubeSuite+ Integrated Development Environment User's Manual: RX Coding” for details about intrinsic functions.

- get_ipl() : Refers to the interrupt priority level.
- get_psw() : Refers to PSW value.

Return value

Macro	Value	Description
E_OK	0	Normal completion.
E_PAR	-17	Parameter error. - *p_imask* == NULL
E_MACV	-26	Memory access violation. (only for get_ims) - The operand-write access to the area indicated by *p_imask* has not been permitted to the invoking task.

19.2.15 System configuration management functions

The following shows the service calls provided by the RI600PX as the system configuration management functions.

Table 19-19 System Configuration Management Functions

Service Call	Function	Useful Range
ref_ver	Reference version information	Task
iref_ver	Reference version information	Non-task

ref_ver
iref_ver

Outline

Reference version information.

C format

```
ER      ref_ver (T_RVER *pk_rver);
ER      iref_ver (T_RVER *pk_rver;
```

Parameter(s)

I/O	Parameter	Description
O	`T_RVER   *pk_rver;`	Pointer to the packet returning the version information.

[Version information packet: T_RVER]

```
typedef struct  t_rver {
    UH      maker;          /*Kernel maker code*/
    UH      prid;           /*Identification number of the kernel*/
    UH      spver;          /*Version number of the ITRON specification*/
    UH      prver;          /*Version number of the kernel*/
    UH      prno[4];        /*Management information of the kernel*/
} T_RVER;
```

Explanation

These service calls store the RI600PX version information into the area specified by parameter pk_rver.

- *maker*
  The *maker* represents the manufacturer who created this kernel. In the RI600PX, 0x011B, which is the maker code assigned for Renesas Electronics Corporation, is returned for *maker*.
  Note, the value defined in the kernel configuration macro TKERNEL_MAKER is same as *maker*.

- *prid*
  The *prid* represents the number that identifies the kernel and VLSI. In the RI600PX, 0x0004 is returned for *prid*.
  Note, the value defined in the kernel configuration macro TKERNEL_PRID is same as *prid*.

- *spver*
  The *spver* represents the specification to which this kernel conforms. In the RI600PX, 0x5403 is returned for *spver*.
  Note, the value defined in the kernel configuration macro TKERNEL_SPVER is same as *spver*.

- *prver*
  The *prver* represents the version number of this kernel.
  For example, 0x0123 is returned for *prver* when the kernel version is “V1.02.03”.
  Note, the value defined in the kernel configuration macro TKERNEL_PRVER is same as *prver*.

- *prno*
  The *prno* represents product management information and product number, etc. In the RI600PX, 0x0000 is returned for all *prnos*.

Return value

Macro	Value	Description
E_OK	0	Normal completion.
E_PAR	-17	Parameter error. - *pk_rver* == NULL
E_CTX	-25	Context error. - This service call was issued in the CPU locked state. - This service call was issued in the status "PSW.IPL > kernel interrupt mask level". Note When the iref_ver is issued from task or the ref_ver is issued from non-task, the context error is not detected and normal operation of the system is not guaranteed.
E_MACV	-26	Memory access violation. (only for ref_ver) - The operand-write access to the area indicated by *pk_rver* has not been permitted to the invoking task.

19.2.16 Object reset functions

The following shows the service calls provided by the RI600PX as the object reset functions.

Table 19-20 Object Reset Functions

Service Call	Function	Useful Range
vrst_dtq	Reset data queue	Task
vrst_mbx	Reset mailbox	Task
vrst_mbf	Reset message buffer	Task
vrst_mpf	Reset fixed-sized memory pool	Task
vrst_mpl	Reset variable-sized memory pool	Task

vrst_dtq

Outline

Reset data queue.

C format

```
ER      vrst_dtq (ID dtqid);
```

Parameter(s)

I/O	Parameter	Description
I	`ID` *`dtqid;`*	ID number of the data queue.

Explanation

This service call reset the data queue specified by parameter *dtqid*.
The data having been accumulated by the data queue area are annulled. The tasks to wait to send data to the target data queue are released from the WAITING state, and EV_RST is returned as a return value for the tasks.

Note 1 In this service call, the tasks to wait to receive data do not released from the WAITING state.

Note 2 This service call is the function outside μITRON4.0 specification.

Return value

Macro	Value	Description
E_OK	0	Normal completion.
E_ID	-18	Invalid ID number. - *dtqid* ≤ 0 - *dtqid* > VTMAX_DTQ
E_CTX	-25	Context error. - This service call was issued from a non-task. - This service call was issued in the CPU locked state. - This service call was issued in the status “PSW.IPL > kernel interrupt mask level”.
E_MACV	-26	Memory access violation. - Stack pointer points out of user stack for invoking task.
E_NOEXS	-42	Non-existent object. - The data queue specified by *dtqid* does not exist.

vrst_mbx

Outline

Reset mailbox.

C format

```
ER      vrst_mbx (ID mbxid);
```

Parameter(s)

I/O	Parameter	Description
I	`ID        mbxid;`	ID number of the mailbox.

Explanation

This service call reset the mailbox specified by parameter *mbxid*.
The messages having been accumulated by the mailbox come off from the management of the RI600PX.

Note 1 In this service call, the tasks to wait to receive message do not released from the WAITING state.

Note 2 This service call is the function outside μITRON4.0 specification.

Return value

Macro	Value	Description
E_OK	0	Normal completion.
E_ID	-18	Invalid ID number. - *mbxid* $\leq$ 0 - *mbxid* > VTMAX_MBX
E_CTX	-25	Context error. - This service call was issued from a non-task. - This service call was issued in the CPU locked state. - This service call was issued in the status “PSW.IPL > kernel interrupt mask level”.
E_MACV	-26	Memory access violation. - Stack pointer points out of user stack for invoking task.
E_NOEXS	-42	Non-existent object. - The mailbox specified by *mbxid* does not exist.

vrst_mbf

Outline

Reset message buffer.

C format

```
ER      vrst_mbf (ID mbfid);
```

Parameter(s)

I/O	Parameter	Description
I	`ID mbfid;`	ID number of the message buffer.

Explanation

This service call reset the message buffer specified by parameter *mbfid*.
The messages having been accumulated by the message buffer area are annulled. The tasks to wait to send message to the target message buffer are released from the WAITING state, and EV_RST is returned as a return value for the tasks.

Note 1 In this service call, the tasks to wait to receive message do not released from the WAITING state.

Note 2 This service call is the function outside μITRON4.0 specification.

Return value

Macro	Value	Description
E_OK	0	Normal completion.
E_ID	-18	Invalid ID number. - *mbfid* ≤ 0 - *mbfid* > VTMAX_MBF
E_CTX	-25	Context error. - This service call was issued from a non-task. - This service call was issued in the CPU locked state. - This service call was issued in the status “PSW.IPL > kernel interrupt mask level”.
E_MACV	-26	Memory access violation. - Stack pointer points out of user stack for invoking task.
E_NOEXS	-42	Non-existent object. - The message buffer specified by *mbfid* does not exist.

vrst_mpf

Outline

Reset fixed-sized memory pool.

C format

```
ER      vrst_mpf (ID mpfid);
```

Parameter(s)

I/O	Parameter	Description
I	`ID        mpfid;`	ID number of the fixed-sized memory pool.

Explanation

This service call reset the fixed-sized memory pool specified by parameter *mpfid*.
The tasks to wait to get memory block from the target fixed-sized memory pool are released from the WAITING state, and EV_RST is returned as a return value for the tasks.

Note 1 All fixed-sized memory blocks that had already been acquired are returned to the target fixed-sized memory pool. Therefore, do not access those fixed-sized memory blocks after issuing this service call.

Note 2 This service call is the function outside μITRON4.0 specification.

Return value

Macro	Value	Description
E_OK	0	Normal completion.
E_ID	-18	Invalid ID number. - *mpfid* ≤ 0 - *mpfid* > VTMAX_MPF
E_CTX	-25	Context error. - This service call was issued from a non-task. - This service call was issued in the CPU locked state. - This service call was issued in the status “PSW.IPL > kernel interrupt mask level”.
E_MACV	-26	Memory access violation. - Stack pointer points out of user stack for invoking task.
E_NOEXS	-42	Non-existent object. - The fixed-sized memory pool specified by *mpfid* does not exist.

vrst_mpl

Outline

Reset variable-sized memory pool.

C format

```
ER      vrst_mpl (ID mplid);
```

Parameter(s)

I/O	Parameter	Description
I	`ID` *`mplid;`*	ID number of the variable-sized memory pool.

Explanation

This service call reset the variable-sized memory pool specified by parameter *mplid*.
The tasks to wait to get memory block from the target variable-sized memory pool are released from the WAITING state, and EV_RST is returned as a return value for the tasks.

Note 1 All variable-sized memory blocks that had already been acquired are returned to the target variable-sized memory pool. Therefore, do not access those variable-sized memory blocks after issuing this service call.

Note 2 This service call is the function outside μITRON4.0 specification.

Return value

Macro	Value	Description
E_OK	0	Normal completion.
E_ID	-18	Invalid ID number. - *mplid* ≤ 0 - *mplid* > VTMAX_MPL
E_CTX	-25	Context error. - This service call was issued from a non-task. - This service call was issued in the CPU locked state. - This service call was issued in the status “PSW.IPL > kernel interrupt mask level”.
E_MACV	-26	Memory access violation. - Stack pointer points out of user stack for invoking task.
E_NOEXS	-42	Non-existent object. - The fixed-sized memory pool specified by *mpfid* does not exist.

19.2.17 Memory object management functions

The following shows the service calls provided by the RI600PX as the memory object management functions.

Table 19-21 Memory Object Management Functions

Service Call	Function	Useful Range
ata_mem	Register memory object	Task
det_mem	Unregister memory object	Task
sac_mem	Change access permission vector for memory object	Task
vprb_mem	Check access permission	Task
ref_mem	Reference memory object state	Task

ata_mem

Outline

Register memory object.

C format

```
ER      ata_mem ( T_AMEM *pk_amem, ACVCT *p_acvct );
```

Parameter(s)

I/O	Parameter	Description
I	`T_AMEM   *pk_amemm;`	Pointer to the packet containing the memory object registration information.
I	`ACVCT    *p_acvct;`	Pointer to the packet containing the access permission vector.

[Memory object registration information packet : T_AMEM]

```
typedef struct  t_amem {
    ATR     mematr;         /*Memory object attribute*/
    VP      base;           /*Memory object start address*/
    SIZE    size;           /Size of memory object (in bytes)*/
} T_AMEM;
```

[Access permission vector : ACVCT]

```
typedef struct  acvct {
    ACPTN   acptn1;         /*Access permission pattern for operand-read*/
    ACPTN   acptn2;         /*Access permission pattern for operand-write*/
    ACPTN   acptn3;         /*Access permission pattern for execution*/
} ACVCT;
```

Explanation

This service call can be called from tasks that belong to Trusted Domain.
This service call registers the area started from the address specified by *base* with the *size* [bytes] as the memory object with the access permission vector specified by *p_acvct*.
The bit N-1 in the access permission pattern shows whether tasks belonging to the domain ID #N can access the memory object. The bit value 1 means "permitted" and 0 means "not permitted".
The specified memory object area must satisfy the following.

A) The start address (*base*) must be 16-bytes boundary. If not, this service call returns E_PAR error.

B) The size (*size*) must be multiple of 16. If not, this service call returns E_PAR error.

C) The memory object area must not either with all user stacks and all other memory objects. If not, this service call does not detect an error, and correct system operation cannot be guaranteed.

Note 1 The following macros are prepared to specify access permission vector.

- TACT_SRW
  Returns access permission vector that represents "all types of access (operand-read, operand-write, execution) are permitted for all domains". This macro can be describe only at the right of an initial assignment statement.

- TACT_SRO
  Returns access permission vector that represents "operand-read access is permitted for all domains, and operand-write access and execution access are not permitted for all domains". This macro can be describe only at the right of an initial assignment statement.

- ACVCT TACT_PRW (ID domid)
  Returns access permission vector that represents "all types of access (operand-read, operand-write, execution) are permitted only for the domain indicated by *domid*". This macro can be describe only at the right of an initial assignment statement.

- ACVCT TACT_PRO (ID domid)
  Returns access permission vector that represents "operand-write access is not permitted for all domain, operand-read and execution access are permitted only for the domain indicated by *domid*". This macro can be describe only at the right of an initial assignment statement.

- ACVCT TACT_SRPW (ID domid)
  Returns access permission vector that represents "operand-read and execution access are permitted for all domain, operand-write access is permitted only for the domain indicated by *domid*". This macro can be describe only at the right of an initial assignment statement.

Note 2 The following macros are prepared to specify access permission pattern.

- TACP_SHARED
  Returns access permission pattern that represents "all domain can access".

- ACPTN TACP (ID domid)
  Returns access permission pattern that represents "only the domain indicated by *domid* can access".

Note 3 The memory object attribute (mematr) is merely ignored.

Return value

Macro	Value	Description
E_OK	0	Normal completion.
E_PAR	-17	parameter error. - *pk_amem* == NULL - *base* is not 16-bytes boundary. - *size* is not multiple of 16. - *p_acvct* == NULL - *acptn1* == *acptn2* == *acptn3* == 0 - Either of bits corresponding to the domain ID that is larger than the maximum domain ID (VTMAX_DOMAIN) of either *acptn1*, *acptn2* or *acptn3* is 1. - *size* == 0 - *base* + *size* > 0x100000000
E_CTX	-25	Context error. - This service call was issued in the CPU locked state. - This service call was issued from non-task. - This service call was issued in the status "PSW.IPL > kernel interrupt mask level".

Macro	Value	Description
E_MACV	-26	Memory access violation. - Stack pointer points out of user stack for invoking task. - The operand-read access to the area indicated by *pk_amem* has not been permitted to the invoking task. - The operand-read access to the area indicated by *p_acvct* has not been permitted to the invoking task.
E_OACV	-27	Object access violation. - The invoking task does not belong to trusted domain. - The number of memory objects from which the access is permitted to one domain exceeds 7.
E_OBJ	-41	Object state error. - The memory object started from the address specified by *base* has already been registered.

det_mem

Outline

Unregister memory object.

C format

```
ER      det_mem (VP base);
```

Parameter(s)

I/O	Parameter	Description
I	`VP` *`base;`*	Memory object start address.

Explanation

This service call can be called from tasks that belong to Trusted Domain.
This service call unregisters the memory object started from the address specified by *base*.

Return value

Macro	Value	Description
E_OK	0	Normal completion.
E_CTX	-25	Context error. - This service call was issued in the CPU locked state. - This service call was issued from non-task. - This service call was issued in the status “PSW.IPL > kernel interrupt mask level”.
E_MACV	-26	Memory access violation. - Stack pointer points out of user stack for invoking task.
E_OACV	-27	Object access violation. - The invoking task does not belong to trusted domain.
E_NOEXS	-42	Non-existent object. - The memory object started from the address specified by *base* has already been registered.

sac_mem

Outline

Change access permission vector for memory object.

C format

```
ER      sac_mem ( VP base, ACVCT *p_acvct );
```

Parameter(s)

I/O	Parameter	Description
I	`VP base;`	Memory object start address.
I	`ACVCT *p_acvct;`	Pointer to the packet containing the access permission vector.

[Access permission vector : ACVCT]

```
typedef struct  acvct {
    ACPTN   acptn1;         /*Access permission pattern for operand-read*/
    ACPTN   acptn2;         /*Access permission pattern for operand-write*/
    ACPTN   acptn3;         /*Access permission pattern for execution*/
} ACVCT;
```

Explanation

This service call can be called from tasks that belong to Trusted Domain.
This service call changes the access permission vector for the memory object started from the address specified by *base* to the content indicated by *p_acvct*.

Return value

Macro	Value	Description
E_OK	0	Normal completion.
E_PAR	-17	Parameter error. - *p_acvct* == NULL - *acptn1* == *acptn2* == *acptn3* == 0 - Either of bits corresponding to the domain ID that is larger than the maximum domain ID (VTMAX_DOMAIN) of either *acptn1*, *acptn2* or *acptn3* is 1.

Macro	Value	Description
E_CTX	-25	Context error. - This service call was issued in the CPU locked state. - This service call was issued from non-task. - This service call was issued in the status “PSW.IPL > kernel interrupt mask level”.
E_MACV	-26	Memory access violation. - Stack pointer points out of user stack for invoking task. - The operand-read access to the area indicated by *p_acvct* has not been permitted to the invoking task.
E_OACV	-27	Object access violation. - The invoking task does not belong to trusted domain. - The number of memory objects from which the access is permitted to one domain exceeds 7.
E_NOEXS	-42	Non-existent object. - The memory object started from the address specified by *base* has already been registered.

vprb_mem

Outline

Check access permission.

C format

```
ER_BOOL  vprb_mem ( VP base, SIZE size, ID tskid, MODE pmmode );
```

Parameter(s)

I/O	Parameter	Description
I	`VP` *`base;`*	Start address for checking
I	`SIZE` *`size;`*	Size of checking area (in bytes).
I	`ID` *`tskid;`*	ID number of the task. TSK_SELF: Invoking task. Value: ID number of the task.
I	`PMMODE` *`pmmode;`*	Access mode.

Explanation

This service call checks whether the task indicated by *tskid* has the access permission indicated by *pmmode* for the memory area of *size* bytes from the address specified by *base*. This service call returns TRUE when the access is permitted and returns FALSE when the access is not permitted.
The following are specified for pmmode.

```
pmmode := ( TPM_READ | TPM_WRITE | TPM_EXEC )
```

- TPM_READ (= 0x0001)
  Checks whether operand-read access is permitted.
- TPM_WRITE (= 0x0002)
  Checks whether operand-write access is permitted.
- TPM_EXEC (= 0x0004)
  Checks whether execution access is permitted.

Note This service call is the function outside μITRON4.0 specification.

Return value

Macro	Value	Description
TRUE	0	Normal completion. (The access is permitted.)
FALSE	0	Normal completion.(The access is not permitted.)

Macro	Value	Description
E_PAR	-17	Parameter error. - *size* == 0 - *pmmode* == *0*, One of bits except bit0, bit1 and bit2 of *pmmode* is 1.
E_ID	-18	Invalid ID number. - *tskid* < 0 - *tskid* > VTMAX_TSK
E_CTX	-25	Context error. - This service call was issued in the CPU locked state. - This service call was issued from non-task. - This service call was issued in the status “PSW.IPL > kernel interrupt mask level”.
E_MACV	-26	Memory access violation. - Stack pointer points out of user stack for invoking task.
E_NOEXS	-42	Non-existent object. - The task specified by *tskid* does not exist.

ref_mem

Outline

Reference memory object state.

C format

```
ER      ref_mem (VP base, T_RMEM *pk_rmem);
```

Parameter(s)

I/O	Parameter	Description
I	`VP base;`	Memory object start address.
O	`T_RMEM *pk_rmem;`	Pointer to the packet returning the mutex state.

[Access permission vector : ACVCT]

```
typedef struct  acvct {
    ACPTN   acptn1;         /*Access permission pattern for operand-read*/
    ACPTN   acptn2;         /*Access permission pattern for operand-write*/
    ACPTN   acptn3;         /*Access permission pattern for execution*/
} ACVCT;
```

[Memory object state packet: T_RMEM]

```
typedef struct  t_rmem {
    ACVCT   acvct;          /*Access permission vector*/
} T_RMEM;
```

Explanation

This service call stores the information of the memory object started from the address specified by parameter *base* into the area specified by parameter *pk_rmem*.
The bit N-1 in the access permission pattern shows whether tasks belonging to the domain ID #N can access the memory object. The bit value 1 means "permitted" and 0 means "not permitted".

Return value

Macro	Value	Description
E_OK	0	Normal completion.
E_PAR	-17	parameter error. - *pk_rmem* == NULL

Macro	Value	Description
E_CTX	-25	Context error. - This service call was issued in the CPU locked state. - This service call was issued from non-task. - This service call was issued in the status “PSW.IPL > kernel interrupt mask level”.
E_MACV	-26	Memory access violation. - Stack pointer points out of user stack for invoking task. - The operand-write access to the area indicated by *pk_rmem* has not been permitted to the invoking task
E_NOEXS	-42	Non-existent object. - The memory object started from the address specified by *base* has already been registered.

CHAPTER 20 SYSTEM CONFIGURATION FILE

This chapter explains the coding method of the system configuration file required to output information files that contain data to be provided for the RI600PX.

20.1 Outline

The following shows the notation method of system configuration files.

- Comment
  Parts from two successive slashes (//) to the line end are regarded as comments.

- Numeric
  A numeric value can be written in one of the following formats. Note, do not specify the value exceeding 0xFFFFFFFF.

Hexadecimal:	Add "0x" or "0X" at the beginning of a numeric value or add "h" or "H" at the end. In the latter format, be sure to add "0" at the beginning when the value begins with an alphabetic letter from A to F or a to f. Note that the configurator does not distinguish between uppercase and lowercase letters for alphabetic letters (A to F or a to f) used in numeric value representation.
Decimal:	Simply write an integer value as is usually done (23, for example). Note that a decimal value must not begin with "0".
Octal:	Add "0" at the beginning of a numeric value or add "O" or "o" at the end.
Binary:	Add "B" or "b" at the end of a numeric value. Note that a binary value must not begin with "0".

- Operator
  The following operator can be used for numeric value.

Table 20-1 Operator

Operator	Precedence	Direction of Computation
( )	High	Left to right
- (unary minus)		Right to left
* / %		Left to right
+ - (binary minus)	Low	Left to right

- Symbol
  A symbol is a string of numeric characters, uppercase alphabetic letters, lowercase alphabetic letters, and underscores (_). It must not begin with a numeric character.

- Function name
  A function name consists of numeric characters, uppercase alphabetic letters, lowercase alphabetic letters, underscores (_), and dollar signs ($). It must not begin with a numeric character and must end with "()".
  To specify module name written by assembly language, name the module starting in '_', and specify the name that excludes '_' for function name.

- Frequency
  The frequency is indicated by a character string that consist of numerals and . (period), and ends with "MHz". The numerical values are significant up to six decimal places. Also note that the frequency can be entered using

20.2 Default System Configuration File

For most definition items, if the user omits settings, the settings in the default system configuration file are used. The default system configuration file is stored in the folder indicated by environment variable “LIB600”. Be sure not to edit this file.

20.3 Configuration Information (static API)

The configuration information that is described in a system configuration file is shown as follows.

- System Information (system)
- Base Clock Interrupt Information (clock)
- Maximum ID (maxdefine)
- Domain Definition (domain[])
- Memory Object Definition (memory_object[])
- Task Information (task[])
- Semaphore Information (semaphore[])
- Eventflag Information (flag[])
- Data Queue Information (dataqueue[])
- Mailbox Information (mailbox[])
- Mutex Information (mutex[])
- Message Buffer Information (message_buffer[])
- Fixed-sized Memory Pool Information (memorypool[])
- Variable-sized Memory Pool Information (variable_memorypool[])
- Cyclic Handler Information (cyclic_hand[])
- Alarm Handler Information (alarm_handl[])
- Relocatable Vector Information (interrupt_vector[])
- Fixed Vector/Exception Vector Information (interrupt_fvector[])

20.4 System Information (system)

Here, information on the system whole is defined.
Only one “system” can be defined. And the “system” can not be omitted.

Format

Parentheses < >show the user input part.

```
system {
    stack_size  = <1. System stack size (stack_size)>;
    priority    = <2. Maximum task priority (priority)>;
    system_IPL  = <3. Kernel interrupt mask level (system_IPL)>;
    message_pri = <4. Maximum message priority (message_pri)>;
    tic_deno    = <5. Denominator of base clock interval time (tic_deno)>;
    tic_nume    = <6. Numerator of base clock interval time (tic_nume)>;
    context     = <7. Task context register (context)>;
};
```

1) System stack size (*stack_size*)

- Description
  Define the total stack size used in service call processing and interrupt processing.
- Definition format
  Numeric value
- Definition range
  More than 8, and multiple of 4.
- When omitting
  The set value in the default system configuration file (factory setting: 0x800) applied.

2) Maximum task priority (*priority*)

- Description
  Define the maximum task priority.
- Definition format
  Numeric value
- Definition range
  1 - 255
- When omitting
  The set value in the default system configuration file (factory setting: 32) applied.
- TMAX_TPRI
  The cfg600px outputs the macro TMAX_TPRI which defines this setting to the system information header file “kernel_id.h”.

3) Kernel interrupt mask level (*system_IPL*)

- Description
  Define the interrupt mask level when the kernel's critical section is executed (PSW register's IPL value). Interrupts with higher priority levels than that are handled as “non-kernel interrupts”.
  For details of “non-kernel interrupts” and “kernel interrupts”, refer to “12.1 Interrupt Type”.
- Definition format
  Numeric value
- Definition range
  1 - 15
- When omitting
  The set value in the default system configuration file (factory setting: 7) applied.

- VTKNL_LVL
  The cfg600px outputs the macro VTKNL_LVL which defines this setting to the system information header file "kernel_id.h".

4) Maximum message priority (*message_pri*)

- Description
  Define the maximum message priority used in the mailbox function. Note that if the mailbox function is not used, this definition item has no effect.
- Definition format
  Numeric value
- Definition range
  1 - 255
- When omitting
  The set value in the default system configuration file (factory setting: 255) applied.
- TMAX_MPRI
  The cfg600px outputs the macro TMAX_MPRI which defines this setting to the system information header file "kernel_id.h".

5) Denominator of base clock interval time (*tic_deno*)

- Description
  The base clock interval time is calculated by the following expression. Either *tic_deno* or *tic_nume* should be 1.

  The base clock interval time (in millisecond) = *tic_nume* / *tic_deno*
- Definition format
  Numeric value
- Definition range
  1 - 100
- When omitting
  The set value in the default system configuration file (factory setting: 1) applied.
- TIC_DENO
  The cfg600px outputs the macro TIC_DENO which defines this setting to the system information header file "kernel_id.h".

6) Numerator of base clock interval time (*tic_nume*)

- Description
  See above.
- Definition format
  Numeric value
- Definition range
  1 - 65535
- When omitting
  The set value in the default system configuration file (factory setting: 1) applied.
- TIC_NUME
  The cfg600px outputs the macro TIC_NUME which defines this setting to the system information header file "kernel_id.h".

7) Task context register (*context*)

- Description
  Define the register set used by tasks. The settings made here apply to all tasks.

- Definition format
  Symbol

- Definition range
  Select one from item of "Setting" in Table 20-2.

Table 20-2 system.context

Setting	CPU		FPU	DSP
	PSW, PC, R0 - R7, R14, R15	R8 - R13	FPSW	Accumulator [a]
NO	Guaranteed	Guaranteed	Not guaranteed	Not guaranteed
FPSW	Guaranteed	Guaranteed	Guaranteed	Not guaranteed
ACC	Guaranteed	Guaranteed	Not guaranteed	Guaranteed
FPSW,ACC	Guaranteed	Guaranteed	Guaranteed	Guaranteed
MIN	Guaranteed	Not guaranteed	Not guaranteed	Not guaranteed
MIN,FPSW	Guaranteed	Not guaranteed	Guaranteed	Not guaranteed
MIN,ACC	Guaranteed	Not guaranteed	Not guaranteed	Guaranteed
MON,FPSW,ACC	Guaranteed	Not guaranteed	Guaranteed	Guaranteed

a. When compiler option "-isa=rxv2" is specified, the "Accumulator" means ACC0 register and ACC1 register. In the case of others, the "Accumulator" means ACC0 register (in RXv2 architecture) or ACC register (in RXV1 architecture).

Note Compiler option "-isa" is supported by the compiler CC-RX V2.01 or later.

- When omitting
  The set value in the default system configuration file (factory setting: NO) applied.

- Note
  Be sure to refer to "20.5 Note Concerning system.context".

20.5 Note Concerning system.context

This sections explains note concerning system.context.

20.5.1 Note concerning FPU and DSP

The setting for system.context differs depending on how FPU and DSP are handled.
The recommendation setting of system.context is indicated from now on. If other than recommended setting is specified, the RI600PX performance may be slightly deteriorated, compared to the recommended settings case.

1) When using MCU that incorporates FPU and DSP (accumulator)
Corresponding MCUs: RX600 series, etc.

2) When using MCU that does not incorporate FPU, but incorporates DSP (accumulator)
Corresponding MCUs: RX200 series, etc.

3) When using MCU that incorporates FPU, but does not incorporate DSP (accumulator)
Corresponding MCUs: MCUs that corresponds to this doesn't exist at the time of making of this manual.

4) When using MCU that incorporate neither FPU nor DSP (accumulator)
Corresponding MCUs: MCUs that corresponds to this doesn't exist at the time of making of this manual.

Note The compiler outputs floating-point arithmetic instructions only when the -fpu option is specified. If the -chkfpu option is specified in the assembler, the floating-point arithmetic instructions written in a program are detected as warning.
In no case does the compiler output the DSP function instructions. If the -chkdsp option is specified in the assembler, the DSP function instructions written in a program are detected as warning.

1) When using MCU that incorporates FPU and DSP (accumulator)

Table 20-3 When using MCU that incorporates FPU and DSP (accumulator)

Usage condition of instruction in tasks		Recommendation setting of system.context
Floating point arithmetic instructions	DSP function instructions	
YES	YES	“FPSW” and “ACC” included settings essential
	NO	“FPSW” included setting essential and “ACC” excluded setting recommended
NO	YES	“ACC” included setting essential and “FPSW” excluded setting recommended
	NO	“FPSW” and “ACC” excluded settings recommended

2) When using MCU that does not incorporate FPU, but incorporates DSP (accumulator)

Table 20-4 When using MCU that does not incorporate FPU, but incorporates DSP (accumulator)

Usage condition of instruction in tasks		Recommendation setting of system.context
Floating point arithmetic instructions	DSP function instructions	
YES	YES	Since the MCU does not incorporate FPU, floating-point arithmetic instructions cannot be used.
	NO	
NO	YES	“FPSW” excluded and “ACC” included settings essential
	NO	“FPSW” excluded setting essential and “ACC” excluded settings recommended

3) When using MCU that incorporates FPU, but does not incorporate DSP (accumulator)

Table 20-5 When using MCU that incorporates FPU, but does not incorporate DSP (accumulator)

Usage condition of instruction in tasks		Recommendation setting of system.context
Floating point arithmetic instructions	DSP function instructions	
YES	YES	Since the MCU does not incorporate DSP, DSP function instructions cannot be used.
	NO	“FPSW” included and “ACC” excluded settings essential
NO	YES	Since the MCU does not incorporate DSP, DSP function instructions cannot be used.
	NO	“ACC” excluded setting essential and “FPSW” excluded settings recommended

4) When using MCU that incorporate neither FPU nor DSP (accumulator)

Table 20-6 When using MCU that incorporate neither FPU nor DSP (accumulator)

Usage condition of instruction in tasks		Recommendation setting of system.context
Floating point arithmetic instructions	DSP function instructions	
YES	YES	Since the MCU incorporate neither FPU nor DSP, floating-point arithmetic instructions and DSP function instructions cannot be used.
	NO	
NO	YES	
	NO	“FPSW” and “ACC” excluded settings essential

20.5.2 Relationship with the compiler options “fint_register”, “base” and “pid”

n system.context, by selecting one of choices “MIN,” “MIN, ACC”, “MIN, FPSW,” or “MIN, ACC, FPSW,” it is possible to configure the registers so that R8- R13 registers will not be saved as task context. This results in an increased processing speed.
Note, however, that such a setting of system.context is permitted in only the case where all of R8 - R13 registers are specified to be used by the compiler options “-fint_register”, “-base” and “-pid”.
If, in any other case, the above setting is made for system.context, the kernel will not operate normally.

- Good example:

  1) -fint_register=4 -base=rom=R8 -base=ram=R9

  2) -fint_register=3 -base=rom=R8 -base=ram=R9 -base=0x80000=R10

- Bad example:

  3) No “-fint_register”, “-base” and “-pid” options

  4) -fint_register=4

  5) -base=rom=R8 -base=ram=R9

  6) -fint_register=3 -base=rom=R8 -base=ram=R9

20.6 Base Clock Interrupt Information (clock)

Here, information on the base clock interrupt is defined. The cfg600px outputs the file “ri_cmt.h” where the base clock timer initialization function (__RI_init_cmt()) is described.
Only one “clock” can be defined.

Format

Parentheses < >show the user input part.

```
clock {
    timer       = <1. Selection of timer channel for base clock (timer)>;
    template    = <2. Template file (template)>;
    timer_clock = <3. CMT frequency (timer_clock)>;
    IPL         = <4. Base clock interrupt priority level (IPL)>;
};
```

1) Selection of timer channel for base clock (*timer*)

- Description
  Define the timer channel for the base clock.
- Definition format
  Symbol
- Definition range
  Select one from Table 20-7.

Table 20-7 clock.timer

Setting	Description
CMT0	Use CMT channel 0 assigned to relocatable vector 28.
CMT1	Use CMT channel 1 assigned to relocatable vector 29.
CMT2	Use CMT channel 2 assigned to relocatable vector 30.
CMT3	Use CMT channel 3 assigned to relocatable vector 31.
OTHER	Use a timer other than the above. In this case, the user needs to create a timer initialize routine.
NOTIMER	Do not use the base clock interrupt.

Note 1 The CMT (Compare Match Timer) is the timer that is mounted on RX MCU typically.

Note 2 Do not select “CMT2” and “CMT3” when CMT channel 2 and channel 3 are not mounted with RX MCU to use, and when relocatable vector assigned to CMT channel 2 and channel 3 is different from Table 20-7 with RX MCU to use.
For example, RX111 does not support CMT channel 2 and channel 3. And in RX64M, relocatable vector assigned to CMT channel 2 and channel 3 is not 30 and 31.

- When omitting
  The set value in the default system configuration file (factory setting: “CMT0”) applied.

2) Template file (*template*)

- Description
  Specify template file where hardware information and initialization function of CMT is described.
  This definition is ignored when either “NOTIMER” or “OTHER” is specified for *timer*.
  The template files are provided by the RI600PX. The template files may be added in the future version.
  Refer to the release notes for MCUs supported by each template file.
  Either CMT1, CMT2 or CMT3 might be unsupported according to template file. When the unsupported CMT channel is specified for *timer*, the cfg600px does not detect error but the error is detected at compilation of the file which includes “ri_cmt.h”.
- Definition format
  Symbol
- Definition range
  -
- When omitting
  The set value in the default system configuration file (factory setting: “rx630.tpl”) applied.

3) CMT frequency (*timer_clock*)

- Description
  Define frequency of the clock supplied to CMT. Please specify the frequency of PCLK (peripheral clock).
- Definition format
  Frequency
- Definition range
  -
- When omitting
  The set value in the default system configuration file (factory setting: “25MHz”) applied.

4) Base clock interrupt priority level (*IPL*)

- Description
  Define the interrupt priority level of the base clock interrupt.
- Definition format
  Numeric value
- Definition range
  From 1 to Kernel interrupt mask level (system_IPL) in System Information (system)
- When omitting
  The set value in the default system configuration file (factory setting: 4) applied.
- VTIM_LVL
  The cfg600px outputs the macro VTIM_LVL which defines this setting to the system information header file “kernel_id.h”.

20.7 Maximum ID (maxdefine)

The definition item maxdefine is provided for the definition of the maximum ID for each object. And this definition is required to use service calls to create an object dynamically.
The macros in which the maximum ID of each object are defined is output to the system information header file "kernel_id.h". (Refer to "18.2 Constant macros")

Format

Parentheses < >show the user input part.

```
maxdefine {
    max_task     = <1. Maximum task ID (max_task)>;
    max_sem      = <2. Maximum semaphore ID (max_sem)>;
    max_flag     = <3. Maximum eventflag ID (max_flag)>;
    max_dtq      = <4. Maximum data queue ID (max_dtq)>;
    max_mbx      = <5. Maximum mailbox ID (max_mbx)>;
    max_mtx      = <6. Maximum mutex ID (max_mtx)>;
    max_mbf      = <7. Maximum message buffer ID (max_mbf)>;
    max_mpf      = <8. Maximum fixed-sized memory pool ID (max_mpf)>;
    max_mpl      = <9. Maximum variable-sized memory pool ID (max_mpl)>;
    max_cyh      = <10. Maximum cyclic handler ID (max_cyh)>;
    max_alh      = <11. Maximum alarm handler ID (max_alh)>;
    max_domain   = <12. Maximum domain ID (max_domain)>;
};
```

1) Maximum task ID (*max_task*)

- Description
  The cre_tsk, acre_tsk, del_tsk, exd_tsk and def_tex can be used by this definition. Ranges of task ID that can be used are is as follows.
  - Minimum value : 1
  - Maximum value : The largest one among *max_task*, the ID number defined in "task[]" and the number of "task[]" definitions
- Definition format
  Numeric value
- Definition range
  From 1 to 255
- When omitting
  The cre_tsk, acre_tsk, del_tsk and def_tex returns E_NOSPT error. And exd_tsk causes system down.
  Ranges of task ID that can be used are is as follows.
  - Minimum value : 1
  - Maximum value : The largest one among the ID number defined in "task[]" and the number of "task[]" definitions
- VTMAX_TSK
  The cfg600px outputs the macro VTMAX_TSK which defines the maximum value to the system information header file "kernel_id.h".

2) Maximum semaphore ID (*max_sem*)

- Description
  The cre_sem, acre_sem and del_sem can be used by this definition.
  Ranges of semaphore ID that can be used are is as follows.
  - Minimum value : 1

    - Maximum value : The largest one among *max_sem*, the ID number defined in “semaphore[]” and the number of “semaphore[]” definitions

- Definition format
  Numeric value

- Definition range
  From 1 to 255

- When omitting
  The cre_sem, acre_sem and del_sem returns E_NOSPT error.
  Ranges of semaphore ID that can be used are is as follows.

    - Minimum value : 1

    - Maximum value : The largest one among the ID number defined in “semaphore[]” and the number of “semaphore[]” definitions

- VTMAX_SEM
  The cfg600px outputs the macro VTMAX_SEM which defines the maximum value to the system information header file “kernel_id.h”.

3) Maximum eventflag ID (*max_flag*)

- Description
  The cre_flg, acre_flg and del_flg can be used by this definition.
  Ranges of eventflag ID that can be used are is as follows.

    - Minimum value : 1

    - Maximum value : The largest one among *max_flag*, the ID number defined in “flag[]” and the number of “flag[]” definitions

- Definition format
  Numeric value

- Definition range
  From 1 to 255

- When omitting
  The cre_flg, acre_flg and del_flg returns E_NOSPT error.
  Ranges of eventflag ID that can be used are is as follows.

    - Minimum value : 1

    - Maximum value : The largest one among the ID number defined in “flag[]” and the number of “flag[]” definitions

- VTMAX_FLG
  The cfg600px outputs the macro VTMAX_FLG which defines the maximum value to the system information header file “kernel_id.h”.

4) Maximum data queue ID (*max_dtq*)

- Description
  The cre_dtq, acre_dtq and del_dtq can be used by this definition.
  Ranges of data queue ID that can be used are is as follows.

    - Minimum value : 1

    - Maximum value : The largest one among *max_dtq*, the ID number defined in “data_queue[]” and the number of “data_queue[]” definitions

- Definition format
  Numeric value

- Definition range
  From 1 to 255

- When omitting
  The cre_dtq, acre_dtq and del_dtq returns E_NOSPT error.
  Ranges of data queue ID that can be used are is as follows.

  - Minimum value : 1
  - Maximum value : The largest one among the ID number defined in “data_queue[]” and the number of “data_queue[]” definitions

- VTMAX_DTQ
  The cfg600px outputs the macro VTMAX_DTQ which defines the maximum value to the system information header file “kernel_id.h”.

5) Maximum mailbox ID (*max_mbx*)

- Description
  The cre_mbx, acre_mbx and del_mbx can be used by this definition.
  Ranges of mailbox ID that can be used are is as follows.

  - Minimum value : 1
  - Maximum value : The largest one among *max_mbx*, the ID number defined in “mailbox[]” and the number of “mailbox[]” definitions

- Definition format
  Numeric value

- Definition range
  From 1 to 255

- When omitting
  The cre_mbx, acre_mbx and del_mbx returns E_NOSPT error.
  Ranges of mailbox ID that can be used are is as follows.

  - Minimum value : 1
  - Maximum value : The largest one among the ID number defined in “mailbox[]” and the number of “mailbox[]” definitions

- VTMAX_MBX
  The cfg600px outputs the macro VTMAX_MBX which defines the maximum value to the system information header file “kernel_id.h”.

6) Maximum mutex ID (*max_mtx*)

- Description
  The cre_mtx, acre_mtx and del_mtx can be used by this definition.
  Ranges of mutex ID that can be used are is as follows.

  - Minimum value : 1
  - Maximum value : The largest one among *max_mtx*, the ID number defined in “mutex[]” and the number of “mutex[]” definitions

- Definition format
  Numeric value

- Definition range
  From 1 to 255

- When omitting
  The cre_mtx, acre_mtx and del_mtx returns E_NOSPT error.
  Ranges of mutex ID that can be used are is as follows.

  - Minimum value : 1
  - Maximum value : The largest one among the ID number defined in “mutex[]” and the number of “mutex[]” definitions

- VTMAX_MTX
  The cfg600px outputs the macro VTMAX_MTX which defines the maximum value to the system information

7) Maximum message buffer ID (*max_mbf*)

- Description
  The cre_mbf, acre_mbf and del_mbf can be used by this definition.
  Ranges of message buffer ID that can be used are is as follows.
  - Minimum value : 1
  - Maximum value : The largest one among *max_mbf*, the ID number defined in “message_buffer[]” and the number of “message_buffer[]” definitions
- Definition format
  Numeric value
- Definition range
  From 1 to 255
- When omitting
  The cre_mbf, acre_mbf and del_mbf returns E_NOSPT error.
  Ranges of message buffer ID that can be used are is as follows.
  - Minimum value : 1
  - Maximum value : The largest one among the ID number defined in “message_buffer[]” and the number of “message_buffer[]” definitions
- VTMAX_MBF
  The cfg600px outputs the macro VTMAX_MBF which defines the maximum value to the system information

8) Maximum fixed-sized memory pool ID (*max_mpf*)

- Description
  The cre_mpf, acre_mpf and del_mpf can be used by this definition.
  Ranges of fixed-sized memory pool ID that can be used are is as follows.
  - Minimum value : 1
  - Maximum value : The largest one among *max_mpf*, the ID number defined in “memorypool[]” and the number of “memorypool[]” definitions
- Definition format
  Numeric value
- Definition range
  From 1 to 255
- When omitting
  The cre_mpf, acre_mpf and del_mpf returns E_NOSPT error.
  Ranges of fixed-sized memory pool ID that can be used are is as follows.
  - Minimum value : 1
  - Maximum value : The largest one among the ID number defined in “memorypool[]” and the number of “memorypool[]” definitions
- VTMAX_MPF
  The cfg600px outputs the macro VTMAX_MPF which defines the maximum value to the system information

9) Maximum variable-sized memory pool ID (*max_mpl*)

- Description
  The cre_mpl, acre_mpl and del_mpl can be used by this definition.
  Ranges of variable-sized memory pool ID that can be used are is as follows.
  - Minimum value : 1
  - Maximum value : The largest one among *max_mpl*, the ID number defined in “variable_memorypool[]” and the number of “variable_memorypool[]” definitions
- Definition format
  Numeric value

- Definition range
  From 1 to 255
- When omitting
  The cre_mpl, acre_mpl and del_mpl returns E_NOSPT error.
  Ranges of variable-sized memory pool ID that can be used are is as follows.
  - Minimum value : 1
  - Maximum value : The largest one among the ID number defined in “variable_memorypool[]” and the number of “variable_memorypool[]” definitions
- VTMAX_MPL
  The cfg600px outputs the macro VTMAX_MPL which defines the maximum value to the system information

10) Maximum cyclic handler ID (*max_cyh*)

- Description
  The cre_cyc, acre_cyc and del_cyc can be used by this definition.
  Ranges of cyclic handler ID that can be used are is as follows.
  - Minimum value : 1
  - Maximum value : The largest one among *max_cyh*, the ID number defined in “cyclic_hand[]” and the number of “cyclic_hand[]” definitions
- Definition format
  Numeric value
- Definition range
  From 1 to 255
- When omitting
  The cre_cyc, acre_cyc and del_cyc returns E_NOSPT error.
  Ranges of cyclic handler ID that can be used are is as follows.
  - Minimum value : 1
  - Maximum value : The largest one among the ID number defined in “cyclic_hand[]” and the number of “cyclic_hand[]” definitions
- VTMAX_CYH
  The cfg600px outputs the macro VTMAX_CYH which defines the maximum value to the system information

11) Maximum alarm handler ID (*max_alh*)

- Description
  The cre_alm, acre_alm and del_alm can be used by this definition.
  Ranges of alarm handler ID that can be used are is as follows.
  - Minimum value : 1
  - Maximum value : The largest one among *max_alh*, the ID number defined in “alarm_hand[]” and the number of “alarm_hand[]” definitions
- Definition format
  Numeric value
- Definition range
  From 1 to 255
- When omitting
  The cre_alm, acre_alm and del_alm returns E_NOSPT error.
  Ranges of alarm handler ID that can be used are is as follows.
  - Minimum value : 1
  - Maximum value : The largest one among the ID number defined in “alarm_hand[]” and the number of “alarm_hand[]” definitions

- VTMAX_ALH
  The cfg600px outputs the macro VTMAX_ALH which defines the maximum value to the system information

12) Maximum domain ID (*max_domain*)

- Description
  Ranges of domain ID that can be used are is as follows.
  - Minimum value : 1
  - Maximum value : The largest one among *max_domain*, the ID number defined in “domain[]”
- Definition format
  Numeric value
- Definition range
  From 1 to 15
- When omitting
  Ranges of mutex ID that can be used are is as follows.
  - Minimum value : 1
  - Maximum value : The largest one among the ID number defined in “domain[]”
- VTMAX_DOMAIN
  The cfg600px outputs the macro VTMAX_DOMAIN which defines the maximum value to the system information

20.8 Domain Definition (domain[])

Here, each domain is defined. The domain that is not defined by this static API is handled as “trust = NO”.

Format

Parentheses < >show the user input part.

```
domain[ <1. ID number> ] {
    trust          = <2. Trusted domain (trust)>;
};
```

1) ID number

- Description
  Define the domain ID number.
- Definition format
  Numeric value
- Definition range
  From 1 to 15
- When omitting
  Cannot be omitted.

2) Trusted domain (*trust*)

- Description
  Define whether the domain is Trusted Domain.
- Definition format
  Symbol
- Definition range
  Select either of the following:

YES:	The domain is trusted domain.
OFF:	The domain is not trusted domain.

- When omitting
  The set value in the default system configuration file (factory setting: “NO”) applied.

20.9 Memory Object Definition (memory_object[])

Here, each memory object is defined.
Please be sure to refer to "3.11 Design of Memory Map".

Format

Parentheses < >show the user input part.

```
memory_object[ ] {
    start_address  = <1. Start address of memory object (start_addreess)>;
    end_address    = <2. Termination address of memory object (end_addreess)>;
    acptn1         = <3. Access permission pattern (acptn1, acptn2, acptn2)>;
    acptn2         = <3. Access permission pattern (acptn1, acptn2, acptn2)>;
    acptn3         = <3. Access permission pattern (acptn1, acptn2, acptn2)>;
};
```

1) Start address of memory object (*start_addreess*)

- Description
  Define start address of the memory object by numeric value or section name.
  When section name is specified, since the section should be started from 16-bytes boundary address, specify "aligned_section" linker option at linking.
  When numeric value is specified, the value must be multiple of 16.

- Definition format
  Symbol or numeric value

- Definition range
  Numeric value : From 0 to 0xFFFFFFF0, and multiple of 16

- When omitting
  Cannot be omitted.

2) Termination address of memory object (*end_addreess*)

- Description
  Define termination address of the memory object by numeric value or section name.
  When section name is specified, the address in which termination address of this section is rounded up to "multiple of 16 + 15" is treated with the termination address of the memory object. If the termination address of this section is not "multiple of 16 + 15", you must not allocate any section in the range from "the termination address of this section + 1" to next " multiple of 16 + 15" address. The above-mentioned conditions are fulfilled by specifying "aligned_section" linker option as the section which follows this section at linking.

-
  When numeric value is specified, the value must be multiple of 16 + 15.

- Definition format
  Symbol or numeric value

- Definition range
  Numeric value : From 0x0000000F to 0xFFFFFFFF, and multiple of 16 + 15

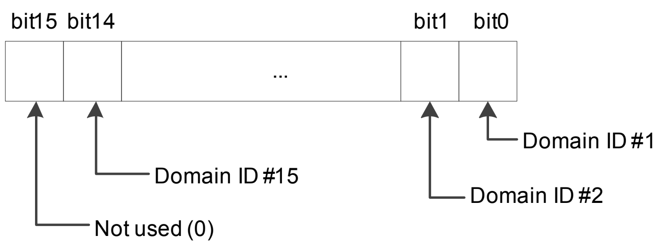
- When omitting
  Cannot be omitted.

3) Access permission pattern (*acptn1*, *acptn2*, *acptn2*)

- Description
  Define access permission pattern for operand-read access (acptn1), operand-write access (acptn2) and execution access (acptn3) by symbol or numeric value.
  Only the "TACP_SHARED" (permit access to all the domains) can be specified as symbol.
  Use numeric value to specify permission for each domain according to Figure 20-1.

When either of the bits corresponding to domains exceeding the maximum domain ID is set, the cfg600px does not detect an error and t becomes a SYSTEM DOWNat staring the RI600PX.

Figure 20-1 Access Permission Pattern



- Definition format
  Symbol or numeric value
- Definition range
  Symbol : TACP_SHARED : Permits access to all the domains.
  Numeric value : From 0 to 0x7FFF
- When omitting
  The set value in the default system configuration file (factory setting: “TACP_SHARED”) applied.

20.10 Task Information (task[])

Here, each task is defined.

Format

Parentheses < >show the user input part.

```
task[ <1. ID number> ] {
    name          = <2. ID name (name)>;
    entry_address = <3. Task entry address (entry_addreess)>;
    stack_size    = <4. User stack size (stack_size)>;
    stack_section = <5. Section name assigned to the stack area (stack_section)>;
    priority      = <6. Task initial priority (priority)>;
    initial_start = <7. TA_ACT attribute (initial_start)>;
    exinf         = <8. Extended information (exinf)>;
    texrtn        = <9. Task exception handling routine entry address (texrtn)>;
    domain_num    = <10. Belonging domain ID (domain_num)>;
};
```

1) ID number

- Description
  Define the task ID number.
- Definition format
  Numeric value
- Definition range
  From 1 to 255
- When omitting
  The cfg600px assigns the ID number automatically.

2) ID name (*name*)

- Description
  Define the ID name. The specified ID name is output to the system information header file (kernel_id.h) in the form of the following.

```
      #define    <ID name>    <ID number>
```

- Definition format
  Symbol
- Definition range
  -
- When omitting
  Cannot be omitted.

3) Task entry address (*entry_addreess*)

- Description
  Define the starting function of the task.
- Definition format
  Symbol
- Definition range
  -
- When omitting
  Cannot be omitted.

4) User stack size (*stack_size*)

- Description
  Define the user stack size.
- Definition format
  Numeric value
- Definition range
  More than the following values, and multiple of 16.

Table 20-8 Lower Bound Value of User Stack Size

Setting of system.context	Compiler option “-isa”	Lower bound value
NO	-	68
FPSW	-	72
ACC	“-isa=rxv2”	92
	“-isa=rxv1” or not specify “-isa”	76
FPSW,ACC	“-isa=rxv2”	96
	“-isa=rxv1” or not specify “-isa”	80
MIN	-	44
MIN,FPSW	-	48
MIN,ACC	“-isa=rxv2”	68
	“-isa=rxv1” or not specify “-isa”	52
MON,FPSW,ACC	“-isa=rxv2”	72
	“-isa=rxv1” or not specify “-isa”	56

Note Compiler option “-isa” is supported by the compiler CC-RX V2.01 or later.

- When omitting
  The set value in the default system configuration file (factory setting: 256) applied.

5) Section name assigned to the stack area (*stack_section*)

- Description
  Define the section name to be assigned to the user stack area.
  The cfg600px generates the user stack area with the size specified by *stack_size* to the section specified by *stack_section*. The section attribute is “DATA”, and the alignment number is 4.
  When linking, be sure to locate this section in the RAM area. Note, this section must not be located to address 0.
  Since this section should be started from 16-bytes boundary address, specify “aligned_section” linker option at linking.
- Definition format
  Symbol
- Definition range
  -
- When omitting
  The set value in the default system configuration file (factory setting: “SURI_STACK”) applied.

6) Task initial priority (*priority*)

- Description
  Define the task initial priority.
- Definition format
  Numeric value
- Definition range
  From 1 to Maximum task priority (priority) in System Information (system)
- When omitting
  The set value in the default system configuration file (factory setting: 1) applied.

7) TA_ACT attribute (*initial_start*)

- Description
  Define the initial state of the task.
- Definition format
  Symbol
- Definition range
  Select either of the following:

ON:	Specify the TA_ACT attribute. (The initial state is READY state.)
OFF:	Not Specify the TA_ACT attribute. (The initial state is DORMANGT state.)

- When omitting
  The set value in the default system configuration file (factory setting: “OFF”) applied.

8) Extended information (*exinf*)

- Description
  Define the extended information of the task.
- Definition format
  Numeric value
- Definition range
  From 0 to 0xFFFFFFFF
- When omitting
  The set value in the default system configuration file (factory setting: 0) applied.
- Note
  When the task is activated by the TA_ACT attribute, act_tsk or iact_tsk, the extended information is passed to the task.

9) Task exception handling routine entry address (*texrtn*)

- Description
  Define the starting function of the task exception handling routine. To not define task exception handling routine, do not define *texrtn*.
- Definition format
  Symbol
- Definition range
  -
- When omitting
  The task exception handling routine is not defined.

10) Belonging domain ID (*domain_num*)

- Description
  Define the ID number of the domain by which the task belongs.

- Definition format
  Numeric value
- Definition range
  From 1 to 15
- When omitting
  The set value in the default system configuration file (factory setting: 1) applied.

20.11 Semaphore Information (semaphore[])

Here, each semaphore is defined.

Format

Parentheses < >show the user input part.

```
semaphore[ <1. ID number> ] {
    name          = <2. ID name (name)>;
    max_count     = <3. Maximum resource count (max_count)>;
    initial_count = <4. Initial resource count (initial_count)>;
    wait_queue    = <5. Wait queue attribute (wait_queue)>;
};
```

1) ID number

- Description
  Define the semaphore ID number.

- Definition format
  Numeric value

- Definition range
  From 1 to 255

- When omitting
  The cfg600px assigns the ID number automatically.

2) ID name (*name*)

- Description
  Define the ID name. The specified ID name is output to the system information header file (kernel_id.h) in the form of the following.

```
        #define   <ID name>   <ID number>
```

- Definition format
  Symbol

- Definition range
  -

- When omitting
  Cannot be omitted.

3) Maximum resource count (*max_count*)

- Description
  Define the maximum resource count

- Definition format
  Numeric value

- Definition range
  From 1 to 65535

- When omitting
  The set value in the default system configuration file (factory setting: 1) applied.

4) Initial resource count (*initial_count*)

- Description
  Define the initial resource count.
- Definition format
  Numeric value
- Definition range
  From 0 to *max_count*
- When omitting
  The set value in the default system configuration file (factory setting: 1) applied.

5) Wait queue attribute (*wait_queue*)

- Description
  Define the wait queue attribute.
- Definition format
  Symbol
- Definition range
  Select either of the following:

TA_TFIFO:	FIFO order
TA_TPRI:	Task current priority order Among tasks with the same current priority, they are queued in FIFO order.

- When omitting
  The set value in the default system configuration file (factory setting: “TA_TFIFO”) applied.

20.12 Eventflag Information (flag[])

Here, each semaphore is defined.

Format

Parentheses < >show the user input part.

```
flag[ <1. ID number> ] {
    name            = <2. ID name (name)>;
    initial_pattern = <3. Initial bit pattern (initial_pattern)>;
    wait_multi      = <4. Multiple wait permission attribute (wait_multi)>;
    clear_attribute = <5. Clear attribute (clear_attribute)>;
    wait_queue      = <6. Wait queue attribute (wait_queue)>;
};
```

1) ID number

- Description
  Define the eventflag ID number.

- Definition format
  Numeric value

- Definition range
  From 1 to 255

- When omitting
  The cfg600px assigns the ID number automatically.

2) ID name (*name*)

- Description
  Define the ID name. The specified ID name is output to the system information header file (kernel_id.h) in the form of the following.

```
        #define    <ID name>    <ID number>
```

- Definition format
  Symbol

- Definition range
  -

- When omitting
  Cannot be omitted.

3) Initial bit pattern (*initial_pattern*)

- Description
  Define the initial bit pattern

- Definition format
  Numeric value

- Definition range
  From 0 to 0xFFFFFFFF

- When omitting
  The set value in the default system configuration file (factory setting: 0) applied.

4) Multiple wait permission attribute (*wait_multi*)

- Description
  Define the attribute regarding whether multiple tasks are permitted to wait for the eventflag.
- Definition format
  Symbol
- Definition range
  Select either of the following:

TA_WSGL:	Not permit multiple tasks to wait for the eventflag.
TA_WMUL:	Permit multiple tasks to wait for the eventflag.

- When omitting
  The set value in the default system configuration file (factory setting: “TA_WSGL”) applied.

5) Clear attribute (*clear_attribute*)

- Description
  Define the clear attribute (TA_CLR).
- Definition format
  Symbol
- Definition range
  Select either of the following:

NO:	Not specify the TA_CLR attribute.
YES:	Specify the TA_CLR attribute.

- When omitting
  The set value in the default system configuration file (factory setting: “NO”) applied.

6) Wait queue attribute (*wait_queue*)

- Description
  Define the wait queue attribute.
- Definition format
  Symbol
- Definition range
  Select either of the following: However, when the TA_CLR attribute is not specified, the wait queue is managed in the FIFO order even if TA_TPRI is specified for *wait_queue*. This behavior falls outside μITRON4.0 specification.

TA_TFIFO:	FIFO order
TA_TPRI:	Task current priority order Among tasks with the same current priority, they are queued in FIFO order.

- When omitting
  The set value in the default system configuration file (factory setting: “TA_TFIFO”) applied.

20.13 Data Queue Information (dataqueue[])

Here, each data queue is defined.

Format

Parentheses < >show the user input part.

```
dataqueue[ <1. ID number> ] {
    name            = <2. ID name (name)>;
    buffer_size     = <3. Data count (buffer_size)>;
    wait_queue      = <4. Wait queue attribute (wait_queue)>;
};
```

1) ID number

- Description
  Define the data queue ID number.
- Definition format
  Numeric value
- Definition range
  From 1 to 255
- When omitting
  The cfg600px assigns the ID number automatically.

2) ID name (*name*)

- Description
  Define the ID name. The specified ID name is output to the system information header file (kernel_id.h) in the form of the following.

  ```
  #define   <ID name>   <ID number>
  ```
- Definition format
  Symbol
- Definition range
  -
- When omitting
  Cannot be omitted.

3) Data count (*buffer_size*)

- Description
  Define the number of data that the data queue can be stored.
- Definition format
  Numeric value
- Definition range
  From 0 to 65535
- When omitting
  The set value in the default system configuration file (factory setting: 0) applied.

4) Wait queue attribute (*wait_queue*)

- Description
  Define the wait queue attribute for sending.
  Note, task wait queue for receiving is managed in FIFO order.
- Definition format
  Symbol
- Definition range
  Select either of the following:

TA_TFIFO:	FIFO order
TA_TPRI:	Task current priority order Among tasks with the same current priority, they are queued in FIFO order.

- When omitting
  The set value in the default system configuration file (factory setting: “TA_TFIFO”) applied.

20.14 Mailbox Information (mailbox[])

Here, each mailbox is defined.

Format

Parentheses < >show the user input part.

```
mailbox[ <1. ID number> ] {
    name          = <2. ID name (name)>;
    wait_queue    = <3. Wait queue attribute (wait_queue)>;
    message_queue = <4. Message queue attribute (message_queue)>;
    max_pri       = <5. Maximum message priority (max_pri)>;
};
```

1) ID number

- Description
  Define the mailbox ID number.
- Definition format
  Numeric value
- Definition range
  From 1 to 255
- When omitting
  The cfg600px assigns the ID number automatically.

2) ID name (*name*)

- Description
  Define the ID name. The specified ID name is output to the system information header file (kernel_id.h) in the form of the following.

```
        #define   <ID name>   <ID number>
```

- Definition format
  Symbol
- Definition range
  -
- When omitting
  Cannot be omitted.

3) Wait queue attribute (*wait_queue*)

- Description
  Define the wait queue attribute.
- Definition format
  Symbol
- Definition range
  Select either of the following:

TA_TFIFO:	FIFO order
TA_TPRI:	Task current priority order Among tasks with the same current priority, they are queued in FIFO order.

- When omitting
  The set value in the default system configuration file (factory setting: “TA_TFIFO”) applied.

4) Message queue attribute (*message_queue*)

- Description
  Define the message queue attribute.

- Definition format
  Symbol

- Definition range
  Select either of the following:

TA_MFIFO:	The order of the message transmission request.
TA_MPRI:	Message priority order

- When omitting
  The set value in the default system configuration file (factory setting: “TA_MFIFO”) applied.

5) Maximum message priority (*max_pri*)

- Description
  When TA_MPRI is specified for *message_queue*, the message priority from 1 to *max_pri* can be used.
  When TA_MFIFO is specified for *message_queue*, this item is only disregarded.

- Definition format
  Numeric value

- Definition range
  From 1 to Maximum message priority (message_pri) in System Information (system)

- When omitting
  The set value in the default system configuration file (factory setting: 1) applied.

20.15 Mutex Information (mutex[])

Here, each mutex is defined.

Format

Parentheses < >show the user input part.

```
mutex[ <1. ID number> ] {
    name          = <2. ID name (name)>;
    ceilpri       = <3. Ceiling priority (ceilpri)>;
};
```

1) ID number

- Description
  Define the mutex ID number.
- Definition format
  Numeric value
- Definition range
  From 1 to 255
- When omitting
  The cfg600px assigns the ID number automatically.

2) ID name (*name*)

- Description
  Define the ID name. The specified ID name is output to the system information header file (kernel_id.h) in the form of the following.

```
        #define    <ID name>    <ID number>
```

- Definition format
  Symbol
- Definition range
  -
- When omitting
  Cannot be omitted.

3) Ceiling priority (*ceilpri*)

- Description
  The RI600PX adopts Simplified priority ceiling protocol. The ceiling priority should be defined in *ceilpri*.
- Definition format
  Numeric value
- Definition range
  From 1 to Maximum task priority (priority) in System Information (system)
- When omitting
  The set value in the default system configuration file (factory setting: 1) applied.

20.16 Message Buffer Information (message_buffer[])

Here, each message buffer is defined.

Format

Parentheses < >show the user input part.

```
message_buffer[ <1. ID number> ] {
   name         = <2. ID name (name)>;
   mbf_size     = <3. Buffer size (mbf_size)>;
   mbf_section = <4. Section name assigned to the message buffer area (mbf_section)>;
   max_msgsz    = <5. Maximum message size (max_msgsz)>
};
```

1) ID number

- Description
  Define the message buffer ID number.
- Definition format
  Numeric value
- Definition range
  From 1 to 255
- When omitting
  The cfg600px assigns the ID number automatically.

2) ID name (*name*)

- Description
  Define the ID name. The specified ID name is output to the system information header file (kernel_id.h) in the form of the following.

  ```
  #define   <ID name>   <ID number>
  ```
- Definition format
  Symbol
- Definition range
  -
- When omitting
  Cannot be omitted.

3) Buffer size (*mbf_size*)

- Description
  Define the size of the message buffer in bytes.
- Definition format
  Numeric value
- Definition range
  0, or multiple of 4 in the range from 8 to 65532
- When omitting
  The set value in the default system configuration file (factory setting: 0) applied.

4) Section name assigned to the message buffer area (*mbf_section*)

- Description
  Define the section name to be assigned to the message buffer area.
  When *mbf_size* > 0, the cfg600px generates the message buffer area with the size specified by *buffer_size* to the section specified by *mbf_section*. The section attribute is “DATA”, and the alignment number is 4.
  When linking, be sure to locate this section in the RAM area. Note, this section must not be located to address 0.
- Definition format
  Symbol
- Definition range
  -
- When omitting
  The set value in the default system configuration file (factory setting: “BURI_HEAP”) applied.

5) Maximum message size (*max_msgsz*)

- Description
  Define the maximum message size of the message buffer in bytes.
  When *mbf_size* > 0, *max_msgsz* must be less than or equal to “*mbf_size* - 4”.
- Definition format
  Numeric value
- Definition range
  From 1 to 65528
- When omitting
  The set value in the default system configuration file (factory setting: 4) applied.

20.17 Fixed-sized Memory Pool Information (memorypool[])

Here, each fixed-sized memory pool is defined.

Format

Parentheses < >show the user input part.

```
memorypool[ <1. ID number> ] {
    name       = <2. ID name (name)>;
    siz_block  = <3. The size of the fixed-sized memory block (siz_block)>;
    num_block  = <4. The number of the fixed-sized memory block (num_block)>;
    section    = <5. Section name assigned to the memory pool area (section)>
    wait_queue = <6. Wait queue attribute (wait_queue)>;
};
```

1) ID number

- Description
  Define the fixed-sized memory pool ID number.
- Definition format
  Numeric value
- Definition range
  From 1 to 255
- When omitting
  The cfg600px assigns the ID number automatically.

2) ID name (*name*)

- Description
  Define the ID name. The specified ID name is output to the system information header file (kernel_id.h) in the form of the following.

```
        #define    <ID name>    <ID number>
```

- Definition format
  Symbol
- Definition range
  -
- When omitting
  Cannot be omitted.

3) The size of the fixed-sized memory block (*siz_block*)

- Description
  Define the size of the fixed-sized memory block in bytes.
- Definition format
  Numeric value
- Definition range
  From 1 to 65535
- When omitting
  The set value in the default system configuration file (factory setting: 256) applied.

4) The number of the fixed-sized memory block (*num_block*)

- Description
  Define the number of the fixed-sized memory block.
- Definition format
  Numeric value
- Definition range
  From 1 to 65535
- When omitting
  The set value in the default system configuration file (factory setting: 1) applied.

5) Section name assigned to the memory pool area (*section*)

- Description
  Define the section name to be assigned to the fixed-sized memory pool area.
  The cfg600px generates the fixed-sized memory pool area with the size calculated by “*siz_block* * *num_block*” to the section specified by *section*. The section attribute is “DATA”, and the alignment number is 4.
  When linking, be sure to locate this section in the RAM area. Note, this section must not be located to address 0.
- Definition format
  Symbol
- Definition range
  -
- When omitting
  The set value in the default system configuration file (factory setting: “BRI_HEAP”) applied.

6) Wait queue attribute (*wait_queue*)

- Description
  Define the wait queue attribute.
- Definition format
  Symbol
- Definition range
  Select either of the following:

TA_TFIFO:	FIFO order
TA_TPRI:	Task current priority order Among tasks with the same current priority, they are queued in FIFO order.

- When omitting
  The set value in the default system configuration file (factory setting: “TA_TFIFO”) applied.

20.18 Variable-sized Memory Pool Information (variable_memorypool[])

Here, each variable-sized memory pool is defined.

Format

Parentheses < >show the user input part.

```
variable_memorypool[ <1. ID number> ] {
    name        = <2. ID name (name)>;
    heap_size   = <3. The size of the variable-sized memory pool (heap_size)>;
    num_block   = <4. Upper limit of the variable-sized memory block (max_memsize)>;
    section     = <5. Section name assigned to the memory pool area (mpl_section)>
};
```

1) ID number

- Description
  Define the variable-sized memory pool ID number.
- Definition format
  Numeric value
- Definition range
  From 1 to 255
- When omitting
  The cfg600px assigns the ID number automatically.

2) ID name (*name*)

- Description
  Define the ID name. The specified ID name is output to the system information header file (kernel_id.h) in the form of the following.

  ```
  #define    <ID name>    <ID number>
  ```
- Definition format
  Symbol
- Definition range
  -
- When omitting
  Cannot be omitted.

3) The size of the variable-sized memory pool (*heap_size*)

- Description
  Define the size of the variable-sized memory pool area in bytes.
- Definition format
  Numeric value
- Definition range
  From 24 to 0x10000000
- When omitting
  The set value in the default system configuration file (factory setting: 1024) applied.

4) Upper limit of the variable-sized memory block (*max_memsize*)

- Description
  Define the upper limit of an acquirable memory block size in bytes.
- Definition format
  Numeric value
- Definition range
  From 1 to 0xBFFFFF4
- When omitting
  The set value in the default system configuration file (factory setting: 36) applied.
- Note
  Refer to "9.3.1 Size of Variable-sized memory block" for the size of the variable-sized memory blocks.

5) Section name assigned to the memory pool area (*mpl_section*)

- Description
  Define the section name to be assigned to the variable-sized memory pool area.
  The cfg600px generates the variable-sized memory pool area with the size specified by *heap_size* to the section specified by *mpl_section*. The section attribute is "DATA", and the alignment number is 4.
  When linking, be sure to locate this section in the RAM area. Note, this section must not be located to address 0.
- Definition format
  Symbol
- Definition range
  -
- When omitting
  The set value in the default system configuration file (factory setting: "BRI_HEAP") applied.

20.19 Cyclic Handler Information (cyclic_hand[])

Here, each cyclic handler is defined.

Format

Parentheses < >show the user input part.

```
cyclic_hand[ <1. ID number> ] {
    name             = <2. ID name (name)>;
    entry_address    = <3. Cyclic handler entry address (entry_address)>;
    interval_counter = <4. Activation cycle (interval_counter)>;
    start            = <5. Initial state (start)>;
    phs_counter      = <6. Activation phase (phs_counter)>;
    phsatr           = <7. TA_PHS attribute (phsatr)>;
    exinf            = <8. Extended information (exinf)>;
};
```

1) ID number

- Description
  Define the cyclic handler ID number.
- Definition format
  Numeric value
- Definition range
  From 1 to 255
- When omitting
  The cfg600px assigns the ID number automatically.

2) ID name (*name*)

- Description
  Define the ID name. The specified ID name is output to the system information header file (kernel_id.h) in the form of the following.

  ```
  #define    <ID name>    <ID number>
  ```
- Definition format
  Symbol
- Definition range
  -
- When omitting
  Cannot be omitted.

3) Cyclic handler entry address (*entry_address*)

- Description
  Define the starting function of the cyclic handler.
- Definition format
  Symbol
- Definition range
  -
- When omitting
  Cannot be omitted.

4) Activation cycle (*interval_counter*)

- Description
  Define the activation cycle in millisecond.
- Definition format
  Numeric value
- Definition range
  From 1 to (0x7FFFFFFF - system.tic_nume) / system.tic_deno
- When omitting
  The set value in the default system configuration file (factory setting: 1) applied.

5) Initial state (*start*)

- Description
  Define the initial state of the cyclic handler.
- Definition format
  Symbol
- Definition range
  Select either of the following:

OFF:	Non operational stat (The TA_STA attribute is not specified.)
ON:	Operational state (The TA_STA attribute is specified.)

- When omitting
  The set value in the default system configuration file (factory setting: “OFF”) applied.

6) Activation phase (*phs_counter*)

- Description
  Define the activation phase in millisecond
- Definition format
  Numeric value
- Definition range
  From 0 to *interval_counter*
- When omitting
  The set value in the default system configuration file (factory setting: 0) applied.

7) TA_PHS attribute (*phsatr*)

- Description
  Define the attribute concerning the activation phase.
- Definition format
  Symbol
- Definition range
  Select either of the following:

OFF:	Not preserve the activation phase. (The TA_PHS attribute is not specified.)
ON:	Preserve the activation phase. (The TA_PHS attribute is specified.)

- When omitting
  The set value in the default system configuration file (factory setting: “OFF”) applied.

8) Extended information (*exinf*)

- Description
  Define the extended information of the cyclic handler.
- Definition format
  Numeric value
- Definition range
  From 0 to 0xFFFFFFFF

- When omitting
  The set value in the default system configuration file (factory setting: 0) applied.
- Note
  The extended information is passed to the cyclic handler.

20.20 Alarm Handler Information (alarm_handl[])

Here, each alarm handler is defined.

Format

Parentheses < >show the user input part.

```
alarm_hand[ <1. ID number> ] {
    name            = <2. ID name (name)>;
    entry_address   = <3. Alarm handler entry address (entry_address)>;
    exinf           = <4. Extended information (exinf)>;
};
```

1) ID number

- Description
  Define the alarm handler ID number.
- Definition format
  Numeric value
- Definition range
  From 1 to 255
- When omitting
  The cfg600px assigns the ID number automatically.

2) ID name (*name*)

- Description
  Define the ID name. The specified ID name is output to the system information header file (kernel_id.h) in the form of the following.

```
        #define   <ID name>   <ID number>
```

- Definition format
  Symbol
- Definition range
  -
- When omitting
  Cannot be omitted.

3) Alarm handler entry address (*entry_address*)

- Description
  Define the starting function of the alarm handler.
- Definition format
  Symbol
- Definition range
  -
- When omitting
  Cannot be omitted.

4) Extended information (*exinf*)

- Description
  Define the extended information of the alarm handler.
- Definition format
  Numeric value
- Definition range
  From 0 to 0xFFFFFFFF
- When omitting
  The set value in the default system configuration file (factory setting: 0) applied.
- Note
  The extended information is passed to the alarm handler.

20.21 Relocatable Vector Information (interrupt_vector[])

Here, each interrupt handler for relocatable vector of the RX MCU is defined.
If any interrupt occurs whose vector number is not defined here, the system goes down.
Note, the cfg600px does not generate code to initialize the interrupt control registers, the causes of interrupts, etc. for the interrupts defined here. These initialization need to be implemented in the application.

Note Since the vector number from 1 to 8 are reserved by the RI600PX, do not define these vectors. And do not define the vectors which are reserved by the MCU specification.

Format

Parentheses < >show the user input part.

```
interrupt_vector[ <1. Vector number> ] {
    entry_address = <2. Interrupt handler entry address (entry_addreess)>;
    os_int        = <3. Kernel interrupt specification (os_int)>;
    pragma_switch = <4. Switch passed to pragma directive (pragma_switch)>;
};
```

1) Vector number

- Description
  Define the vector number.
- Definition format
  Numeric value
- Definition range
  From 0 to 255
- When omitting
  Cannot be omitted.

2) Interrupt handler entry address (*entry_addreess*)

- Description
  Define the starting function of the interrupt handler.
- Definition format
  Symbol
- Definition range
  -
- When omitting
  Cannot be omitted.

3) Kernel interrupt specification (*os_int*)

- Description
  Interrupts whose interrupt priority level is lower than or equal to the Kernel interrupt mask level (system_IPL) must be defined as the kernel interrupt, and the other interrupts must be defined as the non-kernel interrupt.
  Note, when the Kernel interrupt mask level (system_IPL) is 15, all interrupts for relocatable vector must be defined as the kernel interrupt.
- Definition format
  Symbol
- Definition range
  Select either of the following:

YES:	Kernel interrupt
NO:	Non-kernel interrupt

- When omitting
  Cannot be omitted.

4) Switch passed to pragma directive (*pragma_switch*)

- Description
  The cfg600px outputs "#pragma interrupt" directive to handle the function specified by *entry_address* as a interrupt function to the system information header file kernel_id.h.
  The switches passed to this pragma directive should be specified for *pragma_switch*.
- Definition format
  Symbol
- Definition range
  The following can be specified. To specify multiple choices, separate each with a comma. However, "ACC" and "NOACC" cannot be specified at the same time.

E:	The "enable" switch that permits a multiple interrupt is passed.
F:	The "fint" switch that specifies a fast interrupt is passed. Note, a fast interrupt must be handled as non-kernel interrupt (os_int = NO).
S:	The "save" switch that limits the number of registers used in the interrupt handler is passed.
ACC:	The "acc" switch that guarantees the ACC register in the interrupt handler is passed.
NOACC:	The "no_acc" switch that does not guarantee the ACC register in the interrupt handler is passed

- When omitting
  No switches are passed.

Note 1 Refer to Table 20-9 for the guarantee of the ACC register.

Table 20-9 Guarantee of the ACC Register

Setting of pragma_switch	"-save_acc" compiler option	
	Not specified	Specified
Neither "ACC" nor "NOACC" is not specified.	Neither "acc" nor "no_acc" switch is not passed. The ACC register is not guaranteed.	Neither "acc" nor "no_acc" switch is not passed. The ACC register is guaranteed.
"ACC" is specified.	The "acc" switch is passed. The ACC register is guaranteed.	
"NOACC" is specified.	The "no_acc" switch is passed. The ACC register is not guaranteed.	

Note 2 When either "CMT0", "CMT1", "CMT2" or "CMT3" is defined as Selection of timer channel for base clock (timer), it is treated that "interrupt_vector[]" is implicitly defined by the following specification.

- Vector number
  - CMT0 : 28
  - CMT1 : 29
  - CMT2 : 30
  - CMT3 : 31
- *entry_address* : The entry address of the base clock interrupt processing routine in the RI600PX
- *os_int* : YES

- *pragma_switch* : E,ACC

20.22 Fixed Vector/Exception Vector Information (interrupt_fvector[])

Here, fixed vector table of the RXv1 architecture (address from 0xFFFFFF80 to 0xFFFFFFFF) / exception vector table of RXv2 architecture is defined.
Not only interrupt handler address but also the endian select register, etc., are included in fixed vector table/exception vector table.
All interrupt in fixed vector/exception vector is non-kernel interrupt.
In the RI600PX, the vector number is allocated according to the vector address as shown in Table 20-10. The Table 20-10 also shows the setting of the vector to which the definition is omitted.
Note, the content of fixed vector table/exception vector table is different in each MCU. For details, refer to the hardware manual of the MCU used.
Note, the cfg600px does not generate code to initialize the interrupt control registers, the causes of interrupts, etc. for the interrupts defined here. These initialization need to be implemented in the application.

Table 20-10 Fixed Vector Table/Exception Vector table

Vector address [a]	Vector number	Example of factor (different in each MCU)	When omitting
0xFFFFFF80	0	Endian select register	The following are set according to "-endian" compiler option. - "-endian=little" 0xFFFFFFFF - "-endian=big" 0xFFFFFFF8
0xFFFFFF84	1	(Reserved area)	0xFFFFFFFF
0xFFFFFF88	2	Option function select register 1	
0xFFFFFF8C	3	Option function select register 0	
0xFFFFFF90	4	(Reserved area)	
0xFFFFFF94	5	(Reserved area)	
0xFFFFFF98	6	(Reserved area)	
0xFFFFFF9C	7	ROM code protection (flash memory)	
0xFFFFFFA0	8	ID code protection on connection of the on-chip debugger (flash memory)	
0xFFFFFFA4	9		
0xFFFFFFA8	10		
0xFFFFFFAC	11		
0xFFFFFFB0	12	(Reserved area)	
0xFFFFFFB4	13	(Reserved area)	
0xFFFFFFB8	14	(Reserved area)	
0xFFFFFFBC	15	(Reserved area)	

Vector address [a]	Vector number	Example of factor (different in each MCU)	When omitting
0xFFFFFFC0	16	(Reserved area)	System down
0xFFFFFFC4	17	(Reserved area)	
0xFFFFFFC8	18	(Reserved area)	
0xFFFFFFCC	19	(Reserved area)	
0xFFFFFFD0	20	Privileged instruction exception	
0xFFFFFFD4	21	Access exception	Access exception handler [b]
0xFFFFFFD8	22	(Reserved area)	
0xFFFFFFDC	23	Undefined instruction exception	
0xFFFFFFE0	24	(Reserved area)	
0xFFFFFFE4	25	Floating-point exception	
0xFFFFFFE8	26	(Reserved area)	
0xFFFFFFEC	27	(Reserved area)	
0xFFFFFFF0	28	(Reserved area)	
0xFFFFFFF4	29	(Reserved area)	
0xFFFFFFF8	30	Non-maskable interrupt	
0xFFFFFFFC	31	Reset	PowerON_Reset_PC()

a. The vector address in Table 20-10 is the address of fixed vector table in RXv1 architecture.
The address of exception vector table in RXv2 architecture is decided by EXTB register. The initial value of EXTB register at the time of reset is same as fixed vector table in RXv1 architecture. Refer to "FIX_INTERRUPT_VECTOR section" in section 2.6.4.

b. Do not define a handler to the vector-21. If defined, the access exception handler never be initiated.

Format

Parentheses < >show the user input part.

```
interrupt_fvector[ <1. Vector number> ] {
    entry_address = <2. Interrupt handler entry address (entry_addreess)>;
    pragma_switch = <3. Switch passed to pragma directive (pragma_switch)>;
};
```

1) Vector number

- Description
  Define the vector number.

- Definition format
  Numeric value

- Definition range
  From 0 to 31

- When omitting
  Cannot be omitted.

2) Interrupt handler entry address (*entry_addreess*)

- Description
  Define the starting function of the interrupt handler or the set value to fixed vector/exception vector.
- Definition format
  Symbol or numeric value
- Definition range
  From 0 to 0xFFFFFFFF when a numeric value is specified.
- When omitting
  Cannot be omitted.

3) Switch passed to pragma directive (*pragma_switch*)

- Description
  The cfg600px outputs “#pragma interrupt” directive to handle the function specified by *entry_address* as a interrupt function to the system information header file kernel_id.h.
  The switches passed to this pragma directive should be specified for *pragma_switch*.
- Definition format
  Symbol
- Definition range
  The following can be specified. To specify multiple choices, separate each with a comma. However, “ACC” and “NOACC” cannot be specified at the same time.

S:	The “save” switch that limits the number of registers used in the interrupt handler is passed.
ACC:	The “acc” switch that guarantees the ACC register in the interrupt handler is passed.
NOACC:	The “no_acc” switch that does not guarantee the ACC register in the interrupt handler is passed

- When omitting
  No switches are passed.
- Note
  Refer to Table 20-9 for the guarantee of the ACC register.

20.23 RAM Capacity Estimation

Memory areas used and managed by the RI600PX are broadly classified into four types of sections.

- BRI_RAM section: The RI600PX's management data, data queue area created by the system configuration file, message buffer area created by the system configuration file without specifying section
- RRI_RAM section: The RI600PX's management data (when dynamic creation function is used)
- BURI_HEAP section: Fixed-sized memory pool area and variable-sized memory pool area created by the system configuration file without specifying section
- SURI_STACK section: User stack area of tasks created by the system configuration file without specifying section
- SI section: System stack area

20.23.1 BRI_RAM and RRI_RAM section

The RI600PX's management data is located in the BRI_RAM and RRI_RAM section.
The Table 20-11 shows the size calculation method for the BRI_RAM and RRI_RAM section (unit: bytes). In addition, actual size may become larger than the value computed by Table 20-11 for boundary adjustment.

Table 20-11 BRI_RAM and RRI_RAM Section Size Calculation Method

Object Name	Section	Size Calculation Method (in bytes)
System control block	BRI_RAM	28 + 4 × down((*TMAX_TPRI* - 1) / 32 + 1) + *TMAX_TPRI* + *VTMAX_SEM* + 2 × *VTMAX_DTQ* + *VTMAX_FLG* + *VTMAX_MBX* + *VTMAX_MTX* + 2 × *VTMAX_MBF* + *VTMAX_MPF* + *VTMAX_MPL* + 57 × *VTMAX_DOMAIN*
	RRI_RAM[a]	4 + *VTMAX_SEM* + 2 × *VTMAX_DTQ* + *VTMAX_FLG* + *VTMAX_MBX* + *VTMAX_MTX* + 2 × *VTMAX_MBF* + *VTMAX_MPF* + *VTMAX_MPL*
Task control block	BRI_RAM	28 × *VTMAX_TSK*
	RRI_RAM[b]	24 × *VTMAX_TSK*
Semaphore control block[c]	BRI_RAM	4 × *VTMAX_SEM* + down (*VTMAX_SEM* / 8 + 1)
	RRI_RAM[d]	4 × *VTMAX_SEM*
Eventflag control block[e]	BRI_RAM	8 × *VTMAX_FLG* + 2 × down (*VTMAX_FLG* / 8 + 1)
	RRI_RAM[f]	4 × *VTMAX_FLG*
Data queue control block[g]	BRI_RAM	6 × *VTMAX_DTQ*+ down (*VTMAX_DTQ* / 8 + 1) + *DTQ_ALLSIZE*
	RRI_RAM[h]	8 × *VTMAX_DTQ*
Mailbox control block[i]	BRI_RAM	8 × *VTMAX_MBX* + 2 × down (*VTMAX_MBX* / 8 + 1)
	RRI_RAM[j]	*VTMAX_MBX*
Mutex control block[k]	BRI_RAM	*VTMAX_MTX* + down (*VTMAX_MTX* / 8 + 1)
	RRI_RAM[l]	*VTMAX_MTX*
Message buffer control block[m]	BRI_RAM	16 × *VTMAX_MBF* + *MBF_ALLSIZE*
	RRI_RAM[n]	8 × *VTMAX_MBF*
Fixed-sized memory pool control block[o]	BRI_RAM	8 × *VTMAX_MPF* + down (*VTMAX_MPF* / 8 + 1) + Σ *(*memorypool[].num_block / 8 + 1)
	RRI_RAM[p]	12 × *VTMAX_MPF*

Object Name	Section	Size Calculation Method (in bytes)
Variable-sized memory pool control block[q]	BRI_RAM	36 × *VTMAX_MPL*
	RRI_RAM[r]	20 × *VTMAX_MPL*
Cyclic handler control block[s]	BRI_RAM	8 × *VTMAX_CYH*
	RRI_RAM[t]	20 × *VTMAX_CYH*
Alarm handler control block[u]	BRI_RAM	8 × *VTMAX_ALH*
	RRI_RAM[v]	8 × *VTMAX_ALH*

a. When all Maximum task ID (max_task), Maximum semaphore ID (max_sem), Maximum eventflag ID (max_flag), Maximum data queue ID (max_dtq), Maximum mailbox ID (max_mbx), Maximum mutex ID (max_mtx), Maximum message buffer ID (max_mbf), Maximum fixed-sized memory pool ID (max_mpf) and Maximum variable-sized memory pool ID (max_mpl) are 0 or undefined, the size of this area is 4 bytes.
b. This area is generated only when Maximum task ID (max_task) is defined.
c. This area is not generated when *VTMAX_SEM* is 0.
d. This area is generated only when Maximum semaphore ID (max_sem) is defined.
e. This area is not generated when *VTMAX_FLG* is 0.
f. This area is generated only when Maximum eventflag ID (max_flag) is defined.
g. This area is not generated when *VTMAX_DTQ* is 0.
h. This area is generated only when Maximum data queue ID (max_dtq) is defined.
i. This area is not generated when *VTMAX_MBX* is 0.
j. This area is generated only when Maximum mailbox ID (max_mbx) is defined.
k. This area is not generated when *VTMAX_MTX* is 0.
l. This area is generated only when Maximum mutex ID (max_mtx) is defined.
m. This area is not generated when *VTMAX_MBF* is 0.
n. This area is generated only when Maximum message buffer ID (max_mbf) is defined.
o. This area is not generated when *VTMAX_MPF* is 0.
p. This area is generated only when Maximum fixed-sized memory pool ID (max_mpf) is defined.
q. This area is not generated when *VTMAX_MPL* is 0.
r. This area is generated only when Maximum variable-sized memory pool ID (max_mpl) is defined.
s. This area is not generated when *VTMAX_CYH* is 0.
t. This area is generated only when Maximum cyclic handler ID (max_cyh) is defined.
u. This area is not generated when *VTMAX_ALH* is 0.
v. This area is generated only when Maximum alarm handler ID (max_alh) is defined.

Note Each keyword in the size calculation methods has the following meaning.

TMAX_TPRI:	The *TMAX_TPRI* represents maximum task priority. The cfg600px outputs the macro *TMAX_TPRI* which defines the value set as Maximum task priority (priority) in System Information (system) to the system information header file kernel_id.h.
VTMAX_TSK:	The *VTMAX_TSK* represents the maximum task ID. The cfg600px outputs the macro of *VTMAX_TSK* to the system information header file kernel_id.h. For details, refer to “Maximum task ID (max_task)”.
VTMAX_SEM:	The *VTMAX_SEM* represents the maximum semaphore ID. The cfg600px outputs the macro of *VTMAX_SEM* to the system information header file kernel_id.h. For details, refer to “Maximum semaphore ID (max_sem)”.
VTMAX_FLG:	The *VTMAX_FLG* represents the maximum eventflag ID. The cfg600px outputs the macro of *VTMAX_FLG* to the system information header file kernel_id.h. For details, refer to “Maximum eventflag ID (max_flag)”.
VTMAX_DTQ:	The *VTMAX_DTQ* represents the maximum data queue ID. The cfg600px outputs the macro of *VTMAX_DTQ* to the system information header file kernel_id.h. For details, refer to “Maximum data queue ID (max_dtq)”.
DTQ_ALLSIZE:	Total of size of data queue area created in the system configuration file. Concretely, it is calculated by the following expressions. Σ dataqueue[].buffer_size * 4 Note, *DTQ_ALLSIZE* is 4 when this calculation result is 0.
VTMAX_MBX:	The *VTMAX_MBX* represents the maximum mailbox ID. The cfg600px outputs the macro of *VTMAX_MBX* to the system information header file kernel_id.h. For details, refer to “Maximum mailbox ID (max_mbx)”.
VTMAX_MTX:	The *VTMAX_MTX* represents the maximum mutex ID. The cfg600px outputs the macro of *VTMAX_MTX* to the system information header file kernel_id.h. For details, refer to “Maximum mutex ID (max_mtx)”.
VTMAX_MBF:	The *VTMAX_MBF* represents the maximum message buffer ID. The cfg600px outputs the macro of *VTMAX_MBF* to the system information header file kernel_id.h. For details, refer to “Maximum message buffer ID (max_mbf)”.
MBF_ALLSIZE:	Total of size of message buffer area created in the system configuration file without specifying “mbf_section”. Concretely, it is calculated by the following expressions. Σ message_buffer[].mbf_size * 4
VTMAX_MPF:	The *VTMAX_MPF* represents the maximum fixed-sized memory pool ID. The cfg600px outputs the macro of *VTMAX_MPF* to the system information header file kernel_id.h. For details, refer to “Maximum fixed-sized memory pool ID (max_mpf)”.
VTMAX_MPL:	The *VTMAX_MPL* represents the maximum variable-sized memory pool ID. The cfg600px outputs the macro of *VTMAX_MPL* to the system information header file kernel_id.h. For details, refer to “Maximum variable-sized memory pool ID (max_mpl)”.
VTMAX_CYH:	The *VTMAX_CYH* represents the maximum cyclic handler ID. The cfg600px outputs the macro of *VTMAX_CYH* to the system information header file kernel_id.h. For details, refer to “Maximum cyclic handler ID (max_cyh)”.
VTMAX_ALH:	The *VTMAX_ALH* represents the maximum alarm handler ID. The cfg600px outputs the macro of *VTMAX_ALH* to the system information header file kernel_id.h. For details, refer to “Maximum alarm handler ID (max_alh)”.
VTMAX_DOMAIN:	The *VTMAX_DOMAIN* represents the maximum domain ID. The cfg600px outputs the macro of *VTMAX_DOMAIN* to the system information header file kernel_id.h. For details, refer to “Maximum domain ID (max_domain)”.

20.23.2 BURI_HEAP section

The fixed-sized memory pool area and variable-sized memory pool area are located in the BURI_HEAP section. Note, when a fixed-sized memory pool and variable-sized memory pool are defined, the area can be located into the user-specific section.
The size of the BURI_HEAP section is calculated by the total of following. In addition, when user specific data is generated in the BURI_HEAP section, the size should be added.

- Total size of fixed-sized memory pool area
  This is calculated about the definition of Fixed-sized Memory Pool Information (memorypool[]) that omits to specify "section" by the following expressions.

  Σ (memorypool[].siz_block * memorypool[].num_block)

- Total size of variable-sized memory pool area
  This is calculated about the definition of Variable-sized Memory Pool Information (variable_memorypool[]) that omits to specify "mpl_section" by the following expressions.

  Σ variable_memorypool[].heap_size

20.23.3 SURI_STACK section

The user stack area is located in the SURI_STACK section. Note, when a task is defined, the user stack area can be located into the user-specific section.
The size of the SURI_STACK section is calculated about the definition of Task Information (task[]) that omits to specify "stack_section" by the following expressions. In addition, when user specific data is generated in the SURI_STACK section, the size should be added.

Σ task[].stack_size

Note For estimation of stack size, refer to "APPENDIX D STACK SIZE ESTIMATION".

20.23.4 SI section

The system stack area is located in the SI section.
The system stack size is the same as a set value for System stack size (stack_size) in System Information (system).

Note For estimation of stack size, refer to "APPENDIX D STACK SIZE ESTIMATION".

20.24 Description Examples

The following describes an example for coding the system configuration file.

Note The RI600PX provides sample source files for the system configuration file.

```
// System Definition
system{
    stack_size  = 1024;
    priority    = 10;
    system_IPL  = 14;
    message_pri = 1;
    tic_deno    = 1;
    tic_nume    = 1;
    context     = FPSW,ACC;
};

// System Clock Definition ----------------------------------------
clock{
    timer       = CMT0;
    template    = rx630.tpl;
    timer_clock = 25MHz;
    IPL         = 13;
};

// Number of object ----------------------------------------
    max_task    = 10;
    max_sem     = 1;
//  max_flag    = ;
    max_dtq     = 1;
//  max_mbx     = ;
//  max_mtx     = ;
//  max_mbf     = ;
//  max_mpf     = ;
    max_mpl     = 1;
//  max_cyh     = ;
//  max_alh     = ;
    max_domain  = 3;
};

// Trusted domain
domain[1] {
    trust   = YES;
};

// Memory Object Definition : Master domain data
memory_object[1]{
    start_address = BU_MASTERDOM;
    end_address   = RU_MASTERDOM_2;
    acptn1        = 0x0001;
    acptn2        = 0x0001;
    acptn3        = 0;
};
// Memory Object Definition : App-domain A data
memory_object[2]{
    start_address = BU_DOM_A;
    end_address   = RU_DOM_A_2;
    acptn1        = 0x0002;
    acptn2        = 0x0002;
    acptn3        = 0;
};
```

```
// Memory Object Definition : App-domain B data
memory_object[3]{
    start_address = BU_DOM_B;
    end_address   = RU_DOM_B_2;
    acptn1        = 0x0004;
    acptn2        = 0x0004;
    acptn3        = 0;
};

// Memory Object Definition : Shared data
memory_object[4]{
    start_address = BURI_HEAP;
    end_address   = RU_SH_2;
    acptn1        = TACP_SHARED;
    acptn2        = TACP_SHARED;
    acptn3        = 0;
};

// Memory Object Definition : Master domain code and const
memory_object[5]{
    start_address = PU_MASTERDOM;
    end_address   = DU_MASTERDOM_2;
    acptn1        = 0x0001;
    acptn2        = 0;
    acptn3        = 0x0001;
};

// Memory Object Definition : App-domain A code and const
memory_object[6]{
    start_address = PU_DOM_A;
    end_address   = DU_DOM_A_2;
    acptn1        = 0x0002;
    acptn2        = 0;
    acptn3        = 0x0002;
};

// Memory Object Definition : App-domain B code and const
memory_object[7]{
    start_address = PU_DOM_B;
    end_address   = DU_DOM_B_2;
    acptn1        = 0x0004;
    acptn2        = 0;
    acptn3        = 0x0004;
};

// Memory Object Definition : Shared code and const
memory_object[8]{
    start_address = PU_SH;
    end_address   = DU_SH_2;
    acptn1        = TACP_SHARED;
    acptn2        = 0;
    acptn3        = TACP_SHARED;
};
```

```
// Task Definition ----------------------------------------
task[]{
    name             = ID_MASTERDOMTASK;
    entry_address    = MasterDom_Task();
    initial_start    = ON;
    stack_size       = 256;
    priority         = 1;
//  stack_section    = SURI_STACK;
    exinf            = 1;
//  texrtn           = ;
    domain_num       = 1;
};

// Semaphore Definition ----------------------------------------
//  semaphore[]{
//      name             = ID_SEM1;
//      wait_queue       = TA_TFIFO;
//      max_count        = 1;
//      initial_count    = 1;
//  };

// Eventflag Definition ----------------------------------------
//  flag[]{
//      name             = ID_FLG1;
//      initial_pattern = 0;
//      wait_queue       = TA_TFIFO;
//      wait_multi       = TA_WSGL;
//      clear_attribute = NO;
//  };

// Data Queue Definition ----------------------------------------
//  dataqueue[]{
//      name             = ID_DTQ1;
//      buffer_size      = 4;
//      wait_queue       = TA_TFIFO;
//  };

// Mailbox Definition ----------------------------------------
//  mailbox[]{
//      name             = ID_MBX1;
//      wait_queue       = TA_TFIFO;
//      message_queue    = TA_MFIFO;
//      max_pri          = 1;
//  };

// Mutex definition ----------------------------------------
//  mutex[]{
//      name             = ID_MTX1;
//      ceilpri          = 1;
//  };

// Message Buffer Definition ----------------------------------------
//  message_buffer[]{
//      name             = ID_MBF1;
//      mbf_size         = 128;
//      mbf_section      = BRI_RAM;
//      max_msgsz        = 16;
//      wait_queue       = TA_TFIFO;
//  };
// Fixed-sized Memory Pool Definition ----------------------------------------
//  memorypool[]{
//      name            = ID_MPF1;
//      section         = BURI_HEAP;
//      num_block       = 1;
//      siz_block       = 0x100;
//      wait_queue      = TA_TFIFO;
//  };
// Variable-sized Memory Pool Definition ----------------------------------------
//  variable_memorypool[]{
//      name            = ID_MPL1;
//      mpl_section     = BURI_HEAP;
//      heap_size       = 1024;
//      max_memsize     = 36;
//  };

// Cyclic Handler Definition ----------------------------------------
cyclic_hand[] {
    name             = ID_CYC1;
    entry_address    = cyh1();
    interval_counter = 10;
    start            = ON;
    phsatr           = OFF;
    phs_counter      = 10;
    exinf            = 1;
};

// Alarm Handler Definition ----------------------------------------
alarm_hand[] {
    name             = ID_ALM1;
    entry_address    = alh1();
    exinf            = 1;
};

// Relocatable Vector Definition ----------------------------------------
//  interrupt_vector[64]{
//      os_int          = YES;
//      entry_address   = inh64();
//      pragma_switch   = E;
//  };

// Fixed Vector Definition ----------------------------------------
//  interrupt_fvector[0]{// MDES register (address : 0xFFFFFF80)
//      entry_address   = AUTO_ENDIAN;
//  };

//  interrupt_fvector[1]{// Reserved (address : 0xFFFFFF84)
//      entry_address   = 0xFFFFFFFF;
//  };

//  interrupt_fvector[2]{// OFS1 register (address : 0xFFFFFF88)
//      entry_address   = 0xFFFFFFFF;
//  };

//  interrupt_fvector[3]{// OFS0 register (address : 0xFFFFFF8C)
//      entry_address   = 0xFFFFFFFF;
//  };

//  interrupt_fvector[4]{// Reserved (address : 0xFFFFFF90)
//      entry_address   = 0xFFFFFFFF;
//  };
//  interrupt_fvector[5]{// Reserved (address : 0xFFFFFF96)
//      entry_address   = 0xFFFFFFFF;
//  };

//  interrupt_fvector[6]{// Reserved (address : 0xFFFFFF98)
//      entry_address   = 0xFFFFFFFF;
//  };

//  interrupt_fvector[7]{// ROM code protect (address : 0xFFFFFF9C)
//      entry_address   = 0xFFFFFFFF;
//  };

//  interrupt_fvector[8]{// ID coce protect (address : 0xFFFFFFA0)
//      entry_address   = 0xFFFFFFFF;
//  };

//  interrupt_fvector[9]{// ID coce protect (address : 0xFFFFFFA4)
//      entry_address   = 0xFFFFFFFF;
//  };

//  interrupt_fvector[10]{// ID coce protect (address : 0xFFFFFFA8)
//      entry_address   = 0xFFFFFFFF;
//  };

//  interrupt_fvector[11]{// ID coce protect (address : 0xFFFFFFAC)
//      entry_address   = 0xFFFFFFFF;
//  };

//  interrupt_fvector[12]{// Reserved (address : 0xFFFFFFA0)
//      entry_address   = 0xFFFFFFFF;
//  };

//  interrupt_fvector[13]{// Reserved (address : 0xFFFFFFA4)
//      entry_address   = 0xFFFFFFFF;
//  };

//  interrupt_fvector[14]{// Reserved (address : 0xFFFFFFA8)
//      entry_address   = 0xFFFFFFFF;
//  };

//  interrupt_fvector[15]{// Reserved (address : 0xFFFFFFAC)
//      entry_address   = 0xFFFFFFFF;
//  };

//  interrupt_fvector[30]{// NMI (address : 0xFFFFFFF8)
//      entry_address   = NMI_handler();
//      pragma_switch   = ;
//  };

//  interrupt_fvector[31]{// Reset (address : 0xFFFFFFFC)
//      entry_address   = PowerON_Reset_PC();
//  };
```

CHAPTER 21 CONFIGURATOR cfg600px

This chapter explains configurator cfg600px.

21.1 Outline

To build systems (load module) that use functions provided by the RI600PX, the information storing data to be provided for the RI600PX is required.
Since information files are basically enumerations of data, it is possible to describe them with various editors.
Information files, however, do not excel in descriptiveness and readability; therefore substantial time and effort are required when they are described.
To solve this problem, the RI600PX provides a utility tool (configurator "cfg600px") that converts a system configuration file which excels in descriptiveness and readability into information files.
The cfg600px reads the system configuration file as a input file, and then outputs information files.
The information files output from the cfg600px are explained below.

- System information header file (kernel_id.h)
  An information file that contains the correspondence between object names (task names, semaphore names, or the like) described in the system configuration file and IDs.

- Service call definition file (kernel_sysint.h)
  The declaration for issuing service calls by using INT instruction is described in this file. This file is included by kernel.h.

- ROM definition file (kernel_rom.h), RAM definition file (kernel_ram.h)
  These files contain the RI600PX management data. These files must be included only by the boot processing file. For details, refer to "17.2 Boot Processing File (User-Own Coding Module)".

- System definition file (ri600.inc)
  The system definition file is included by the table file (ritable.src) which is generated by the mktitbl.

- Vector table template file (vector.tpl)
  The vector table template file is input to the mkritblpx.

- CMT timer definition file (ri_cmt.h)
  When either of CMT0, CMT1, CMT or CMT3 is specified for Selection of timer channel for base clock (timer) for in Base Clock Interrupt Information (clock), the Template file (template) is retrieved from the folder indicated by the environment variable "LIB600", and the retrieved file is output after it is renamed to "ri_cmt.h". The CMT timer definition file is used for the base clock timer initialization routine. For details, refer to "10.9 Base Clock Timer Initialization Routine (_RI_init_cmt_knl( ))".

21.2 Start cfg600px

21.2.1 Start cfg600px from command line

ıIt is necessary to set the environment variable “LIB600” to “<ri_root>\lib600” beforehand.
The following is how to activate the cfg600px from the command line.
Note that, in the examples below, “C>” indicates the command prompt, “Δ” indicates pressing of the space key, and “<Enter>” indicates pressing of the enter key.
The options enclosed in “[ ]” can be omitted.

```
C>  cfg600px.exe Δ [-U]  Δ [-v] Δ [-V] Δ file <Enter>
```

The output files are generated to the current folder.

The details of each option are explained below:

- -U
  When an undefined interrupt occurs, the system down is caused. When -U option is specified, the vector number will be transferred to the system down routine (refer to “CHAPTER 15 SYSTEM DOWN”). This is useful for debugging. However, the kernel code size increases by about 1.5 kB.

- -v
  Show a description of the command option and details of its version.

- -V
  Show the creation status of files generated by the cfg600px.

- *file*
  Specifies the system configuration file name to be input. If the filename extension is omitted, the extension “.cfg” is assumed.

Note <ri_root> indicates the installation folder of RI600PX.
The default folder is “C:\Program Files\Renesas Electronics\CubeSuite+\RI600PX”.

21.2.2 Start cfg600px from CubeSuite+

This is started when CubeSuite+ performs a build, in accordance with the setting on the Property panel, on the [System Configuration File Related Information] tab.

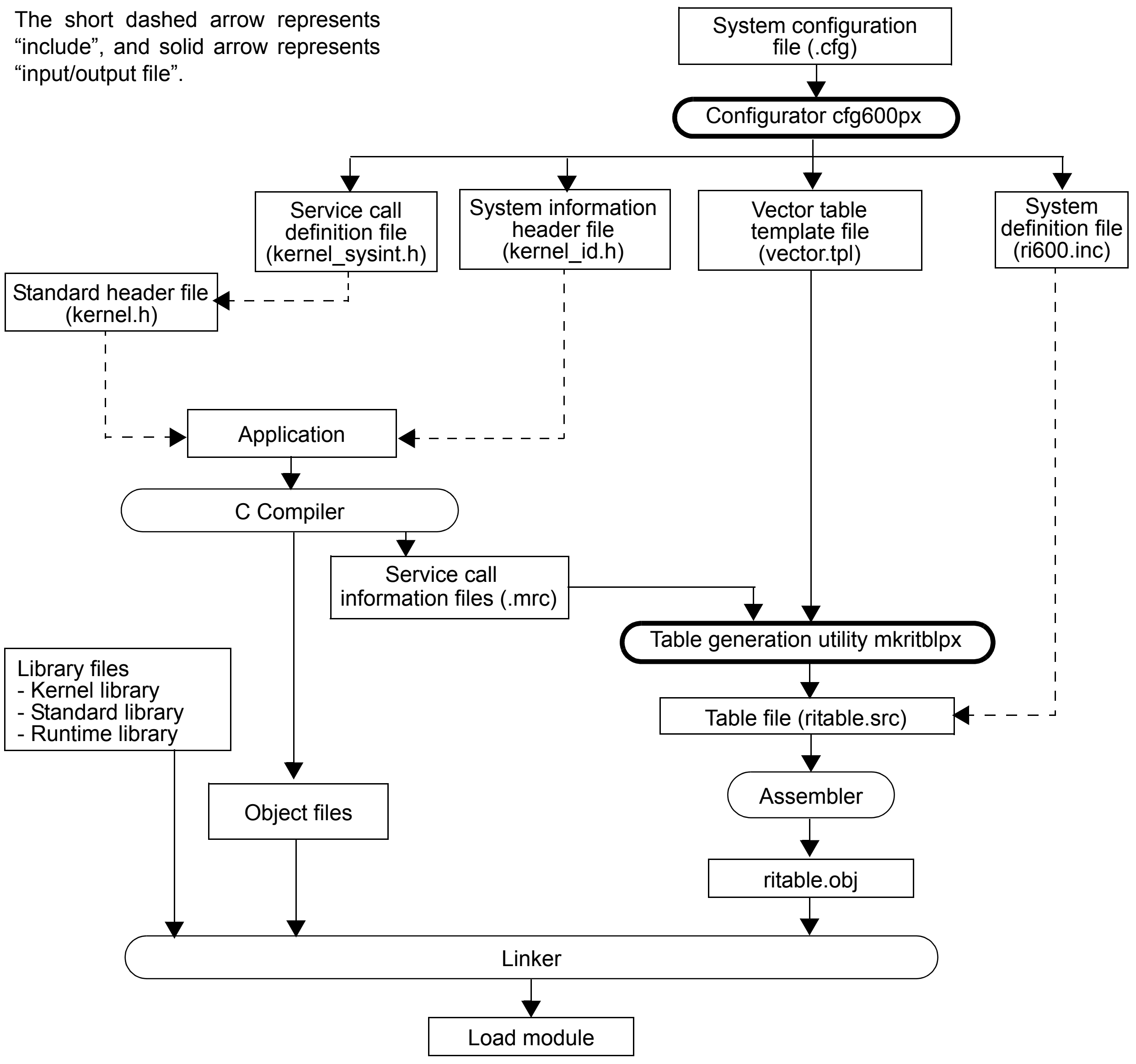
CHAPTER 22 TABLE GENARATION UTILITY mkritblpx

This chapter explains the table generation utility mkritblpx.

22.1 Outline

The utility mkritblpx is a command line tool that after collecting service call information used in the application, generates service call tables and interrupt vector tables.
When compiling applications, the service call information files (.mrc) that contains the service call information to be used are generated. The mkribl reads the service call information files, and generates the service call table to be linked only the service calls used in the system.
Furthermore, the mkritblpx generates an interrupt vector table based on the vector table template files generated by the cfg600px and the service call information files.

Figure 22-1 Outline of mkritblpx


The short dashed arrow represents "include", and solid arrow represents "input/output file".
System configuration file (.cfg)
Configurator cfg600px
Service call definition file (kernel_sysint.h)
System information header file (kernel_id.h)
Vector table template file (vector.tpl)
System definition file (ri600.inc)
Standard header file (kernel.h)
Application
C Compiler
Service call information files (.mrc)
Table generation utility mkritblpx
Library files
- Kernel library
- Standard library
- Runtime library
Table file (ritable.src)
Assembler
Object files
ritable.obj
Linker
Load module

22.2 Start mkritblpx

22.2.1 Start mkritblpx from command line

It is necessary to set the environment variable “LIB600” to “<ri_root>\lib600” beforehand.
The following is how to activate the mkritblpx from the command line.
Note that, in the examples below, “C>” indicates the command prompt, “Δ” indicates pressing of the space key, and “<Enter>” indicates pressing of the enter key.
The options enclosed in “[ ]” can be omitted.

```
C>  mkritblpx.exe Δ [path] <Enter>
```

The output files are generated to the current folder.

The details of each option are explained below:

- *path*
  Specifies the service call information file or the path to the folder where the service call information files are retrieved. Note, when a folder path is specified, the sub folder is not retrieved.
  The mkritblpx makes the current folder a retrieval path regardless of this specification.

Note <ri_root> indicates the installation folder of RI600PX.
The default folder is “C:\Program Files\Renesas Electronics\CubeSuite+\RI600PX”.

22.2.2 Start mkritblpx from CubeSuite+

This is started when CubeSuite+ performs a build, in accordance with the setting on the Property panel, on the [System Configuration File Related Information] tab.

22.3 Notes

Refer to “2.6.1 Service call information files and “-ri600_preinit_mrc” compiler option”.

APPENDIX A WINDOW REFERENCE

This appendix explains the window/panels that are used when the activation option for the configurator cfg600px and the table generation utility mkritblpx is specified from the integrated development environment CubeSuite+.

A.1 Description

The following shows the list of window/panels.

Table A-1 List of Window/Panels

Window/Panel Name	Function Description
Main window	This is the first window to be open when CubeSuite+ is launched.
Project Tree panel	This panel is used to display the project components in tree view.
Property panel	This panel is used to display the detailed information on the Realtime OS node, system configuration file, or the like that is selected on the Project Tree panel and change the settings of the information.

Main window

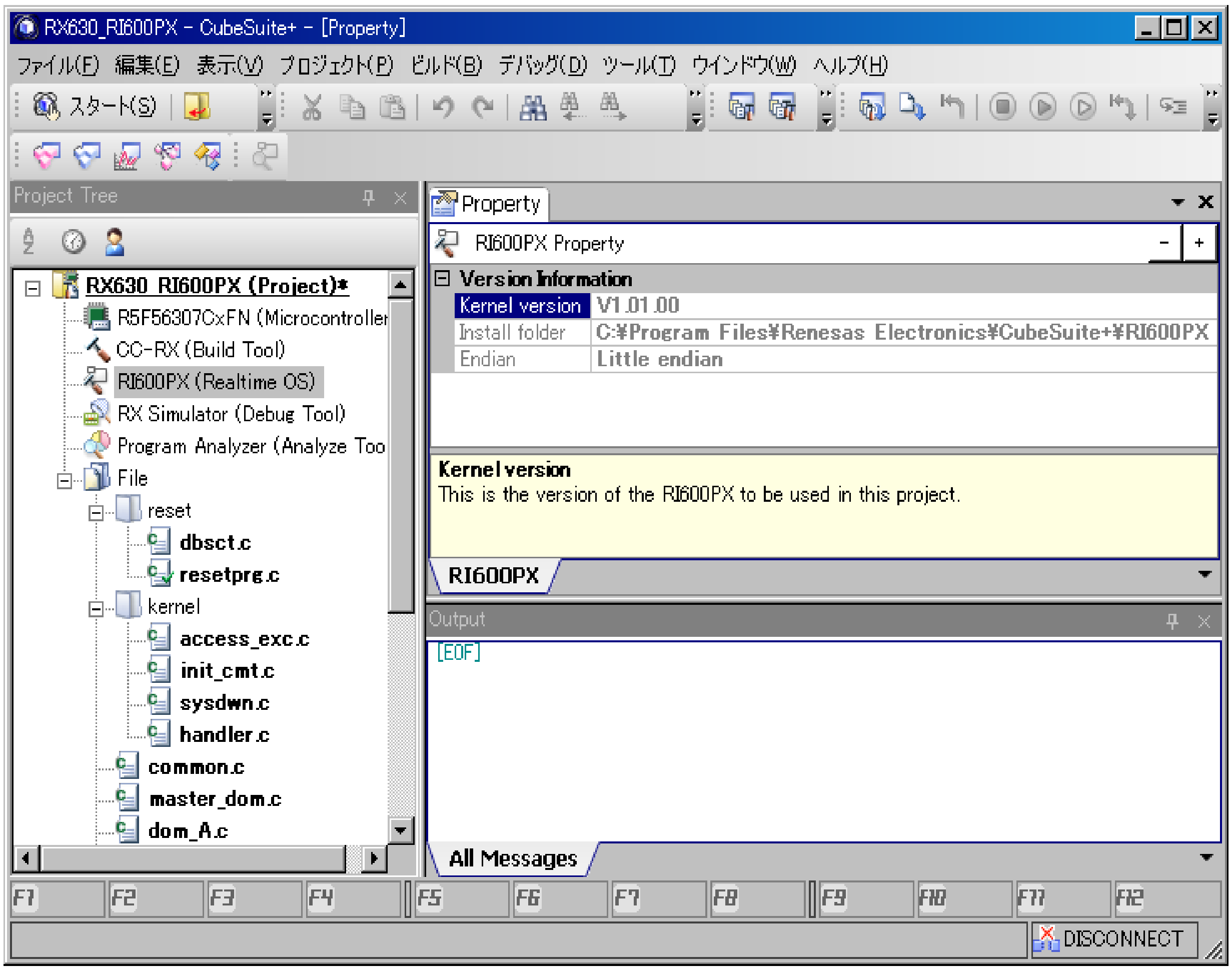
Outline

This is the first window to be open when CubeSuite+ is launched.
This window is used to control the user program execution and open panels for the build process.

This window can be opened as follows:

- Select Windows [start] -> [All programs] -> [Renesas Electronics CubeSuite+] -> [CubeSuite+]

Display image



Version Information

Kernel version	V1.01.00
Install folder	C:¥Program Files¥Renesas Electronics¥CubeSuite+¥RI600PX
Endian	Little endian

Kernel version
This is the version of the RI600PX to be used in this project.

```
[EOF]
```

Explanation of each area

1) Menu bar

Displays the menus relate to realtime OS.
Contents of each menu can be customized in the User Setting dialog box.

- [View]

Realtime OS	The [View] menu shows the cascading menu to start the tools of realtime OS.
Resource Information	Opens the Realtime OS Resource Information panel. Note that this menu is disabled when the debug tool is not connected.

2) Toolbar

Displays the buttons relate to realtime OS.
Buttons on the toolbar can be customized in the User Setting dialog box. You can also create a new toolbar in the same dialog box.

- Realtime OS toolbar

🔍	Opens the Realtime OS Resource Information panel. Note that this button is disabled when the debug tool is not connected.

3) Panel display area

The following panels are displayed in this area.

- Project Tree panel
- Property panel
- Output panel

See the each panel section for details of the contents of the display.

Note See "CubeSuite+ Integrated Development Environment User's Manual: RX Build" for details about the Output panel.

Project Tree panel

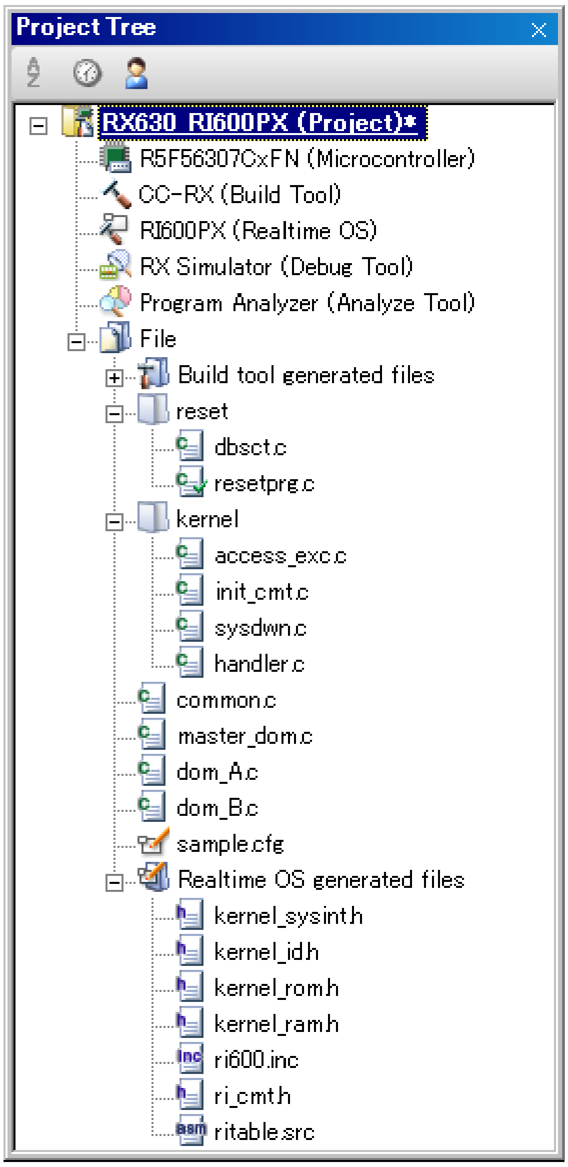
Outline

This panel is used to display the project components such as Realtime OS node, system configuration file, etc. in tree view.

This panel can be opened as follows:

- From the [View] menu, select [Project Tree].

Display image



Project Tree

```
RX630_RI600PX (Project)*
  R5F56307CxFN (Microcontroller)
  CC-RX (Build Tool)
  RI600PX (Realtime OS)
  RX Simulator (Debug Tool)
  Program Analyzer (Analyze Tool)
  File
    Build tool generated files
    reset
      dbsct.c
      resetprg.c
    kernel
      access_exc.c
      init_cmt.c
      sysdwn.c
      handler.c
    common.c
    master_dom.c
    dom_A.c
    dom_B.c
    sample.cfg
    Realtime OS generated files
      kernel_sysint.h
      kernel_id.h
      kernel_rom.h
      kernel_ram.h
      ri600.inc
      ri_cmt.h
      ritable.src
```

Explanation of each area

1) Project tree area

Project components are displayed in tree view with the following given node.

Node	Description
RI600PX (Realtime OS) (referred to as “Realtime OS node”)	Realtime OS to be used.
xxx.cfg	System configuration file.
Realtime OS generated files (referred to as “Realtime OS generated files node”)	The following information files appear directly below the node created when a system configuration file is added. - System information header file (kernel_id.h) - Service call definition file (kernel_sysint.h - ROM definition file (kernel_rom.h) - RAM definition file (kernel_ram.h) - System definition file (ri600.inc) - vector table template file (vector.tpl) - CMT timer definition file (ri_cmt.h) This node and files displayed under this node cannot be deleted directly. This node and files displayed under this node will no longer appear if you remove the system configuration file from the project.

Context menu

1) When the Realtime OS node or Realtime OS generated files node is selected

Property	Displays the selected node's property on the Property panel.

2) When the system configuration file or an information file is selected

Assemble	Assembles the selected assembler source file. Note that this menu is only displayed when a system information table file or an entry file is selected. Note that this menu is disabled when the build tool is in operation.
Open	Opens the selected file with the application corresponds to the file extension. Note that this menu is disabled when multiple files are selected.
Open with Internal Editor...	Opens the selected file with the Editor panel. Note that this menu is disabled when multiple files are selected.
Open with Selected Application...	Opens the Open with Program dialog box to open the selected file with the designated application. Note that this menu is disabled when multiple files are selected.
Open Folder with Explorer	Opens the folder that contains the selected file with Explorer.
Add	Shows the cascading menu to add files and category nodes to the project.

	Add File...	Opens the Add Existing File dialog box to add the selected file to the project.
	Add New File...	Opens the Add File dialog box to create a file with the selected file type and add to the project.
	Add New Category	Adds a new category node at the same level as the selected file. You can rename the category. This menu is disabled while the build tool is running, and if categories are nested 20 levels.
Remove from Project		Removes the selected file from the project. The file itself is not deleted from the file system. Note that this menu is disabled when the build tool is in operation.
Copy		Copies the selected file to the clipboard. When the file name is in editing, the characters of the selection are copied to the clipboard.
Paste		This menu is always disabled.
Rename		You can rename the selected file. The actual file is also renamed.
Property		Displays the selected file's property on the Property panel.

Property panel

Outline

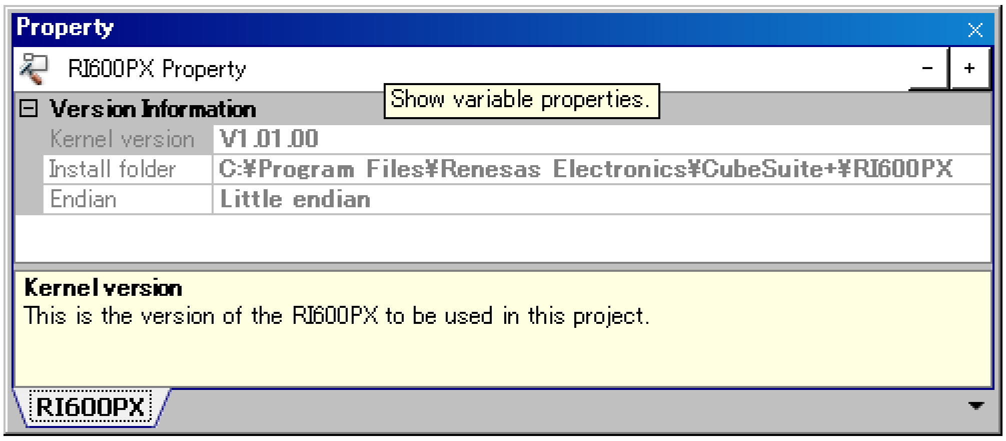
This panel is used to display the detailed information on the Realtime OS node, system configuration file, or the like that is selected on the Project Tree panel by every category and change the settings of the information.

This panel can be opened as follows:

- On the Project Tree panel, select the Realtime OS node, system configuration file, or the like, and then select the [View] menu -> [Property] or the [Property] from the context menu.

Note When either one of the Realtime OS node, system configuration file, or the like on the Project Tree panel while the Property panel is opened, the detailed information of the selected node is displayed.

Display image



Version Information

Kernel version	V1.01.00
Install folder	C:¥Program Files¥Renesas Electronics¥CubeSuite+¥RI600PX
Endian	Little endian

Kernel version
This is the version of the RI600PX to be used in this project.

Explanation of each area

1) Selected node area

Display the name of the selected node on the Project Tree panel.
When multiple nodes are selected, this area is blank.

2) Detailed information display/change area

In this area, the detailed information on the Realtime OS node, system configuration file, or the like that is selected on the Project Tree panel is displayed by every category in the list. And the settings of the information can be changed directly.
Mark ⊟ indicates that all the items in the category are expanded. Mark ⊞ indicates that all the items are collapsed.
You can expand/collapse the items by clicking these marks or double clicking the category name.
See the section on each tab for the details of the display/setting in the category and its contents.

3) Property description area

Display the brief description of the categories and their contents selected in the detailed information display/change area.

4) Tab selection area

Categories for the display of the detailed information are changed by selecting a tab.
In this panel, the following tabs are contained (see the section on each tab for the details of the display/setting on the tab).

- When the Realtime OS node is selected on the Project Tree panel
    - [RI600PX] tab
- When the system configuration file is selected on the Project Tree panel
    - [System Configuration File Related Information] tab
    - [File Information] tab
- When the Realtime OS generated files node is selected on the Project Tree panel
    - [Category Information] tab
- When the system information table file or entry file is selected on the Project Tree panel
    - [Build Settings] tab
    - [Individual Assemble Options] tab
    - [File Information] tab
- When the system information header file is selected on the Project Tree panel
    - [File Information] tab

Note1 See “CubeSuite+ Integrated Development Environment User's Manual: RX Build” for details about the [File Information] tab, [Category Information] tab, [Build Settings] tab, and [Individual Assemble Options] tab.

Note2 When multiple components are selected on the Project Tree panel, only the tab that is common to all the components is displayed. If the value of the property is modified, that is taken effect to the selected components all of which are common to all.

[Edit] menu (only available for the Project Tree panel)

Undo	Cancels the previous edit operation of the value of the property.
Cut	While editing the value of the property, cuts the selected characters and copies them to the clip board.
Copy	Copies the selected characters of the property to the clip board.
Paste	While editing the value of the property, inserts the contents of the clip board.
Delete	While editing the value of the property, deletes the selected character string.
Select All	While editing the value of the property, selects all the characters of the selected property.

Context menu

Undo	Cancels the previous edit operation of the value of the property.
Cut	While editing the value of the property, cuts the selected characters and copies them to the clip board.
Copy	Copies the selected characters of the property to the clip board.

Paste	While editing the value of the property, inserts the contents of the clip board.
Delete	While editing the value of the property, deletes the selected character string.
Select All	While editing the value of the property, selects all the characters of the selected property.
Reset to Default	Restores the configuration of the selected item to the default configuration of the project. For the [Individual Assemble Options] tab, restores to the configuration of the general option.
Reset All to Default	Restores all the configuration of the current tab to the default configuration of the project. For the [Individual Assemble Options] tab, restores to the configuration of the general option.

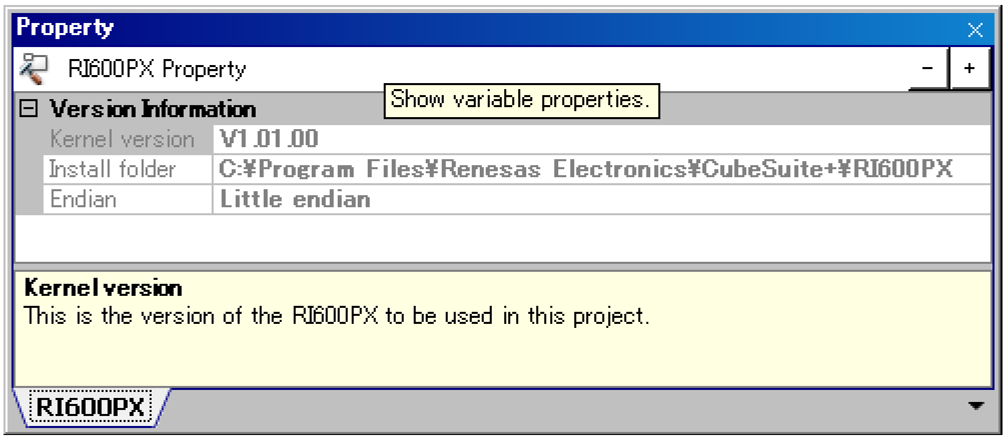
[RI600PX] tab

Outline

This tab shows the detailed information on RI600PX to be used categorized by the following.

- Version Information

Display image



Kernel version	V1.01.00
Install folder	C:¥Program Files¥Renesas Electronics¥CubeSuite+¥RI600PX
Endian	Little endian

Kernel version
This is the version of the RI600PX to be used in this project.

Explanation of each area

1) [Version Information]
The detailed information on the version of the RI600PX are displayed.

Kernel version	Display the version of RI600PX to be used.	
	Default	The version of the installed RI600PX
	How to change	Changes not allowed
Install folder	Display the folder in which RI600PX to be used is installed with the absolute path.	
	Default	The folder in which RI600PX to be used is installed
	How to change	Changes not allowed
Endian	Display the endian set in the project. Display the same value as the value of the [Select endian] property of the build tool.	
	Default	The endian in the property of the build tool
	How to change	Changes not allowed

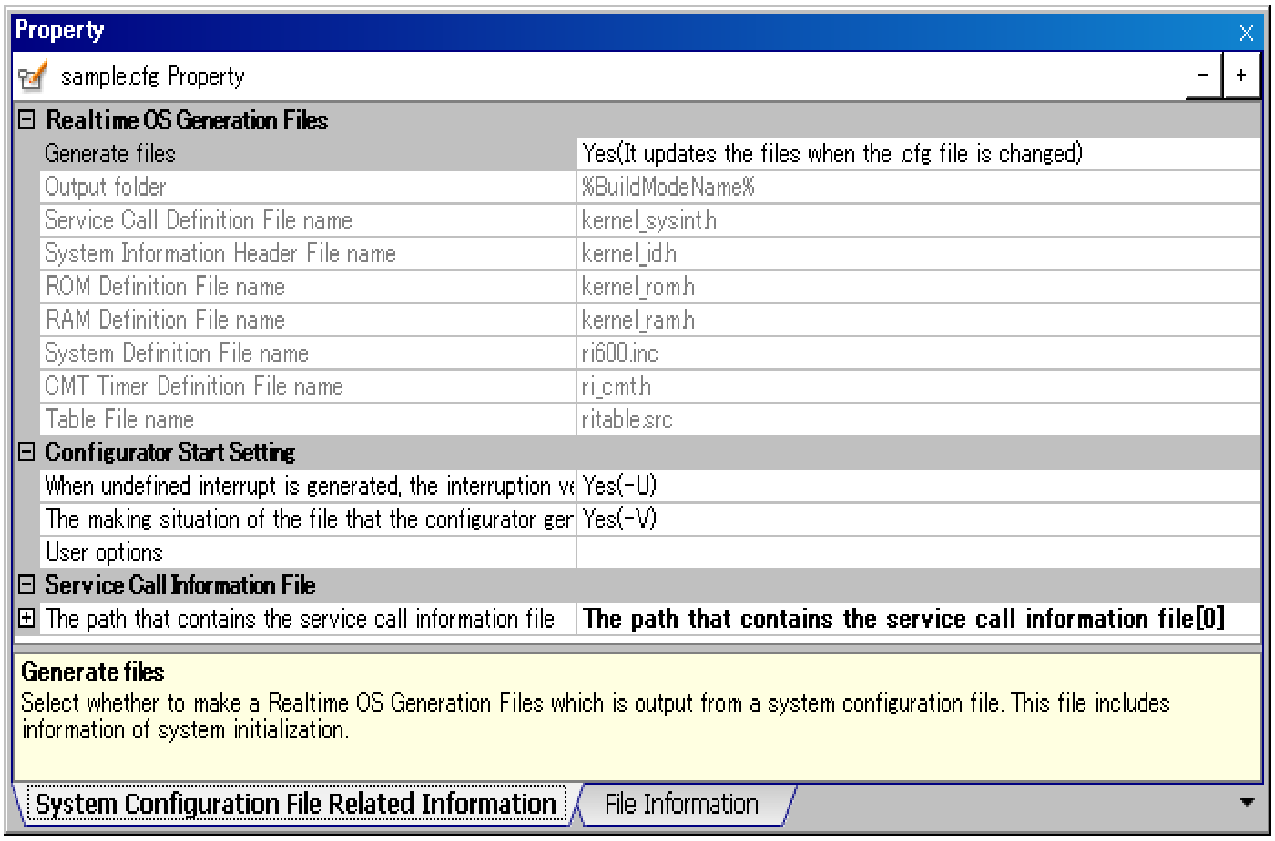
[System Configuration File Related Information] tab

Outline

This tab shows the detailed information on the using system configuration file categorized by the following and the configuration can be changed.

- Realtime OS Generation Files
- Configurator Start Setting
- Service Call Information File

Display image



Property

sample.cfg Property

⊟ Realtime OS Generation Files	
Generate files	Yes(It updates the files when the .cfg file is changed)
Output folder	%BuildModeName%
Service Call Definition File name	kernel_sysint.h
System Information Header File name	kernel_id.h
ROM Definition File name	kernel_rom.h
RAM Definition File name	kernel_ram.h
System Definition File name	ri600.inc
CMT Timer Definition File name	ri_cmt.h
Table File name	ritable.src
⊟ Configurator Start Setting	
When undefined interrupt is generated, the interruption ve	Yes(-U)
The making situation of the file that the configurator ger	Yes(-V)
User options	
⊟ Service Call Information File	
⊞ The path that contains the service call information file	**The path that contains the service call information file[0]**

Generate files
Select whether to make a Realtime OS Generation Files which is output from a system configuration file. This file includes information of system initialization.

Explanation of each area

1) [Realtime OS Generation Files]
The detailed information on the RI600PX generation files are displayed and the configuration can be changed.

Generate files	Select whether to generate realtime OS generation files and whether to update the realtime OS generation files when the system configuration file is changed.		
	Default	Yes(It updates the file when the .cfg file is changed)	
	How to change	Select from the drop-down list.	
	Restriction	Yes(It updates the file when the .cfg file is changed)	Generates new realtime OS generation files and displays them on the project tree. If the system configuration file is changed when there are already realtime OS generation files, then realtime OS generation files are updated.
		No(It does not register the file to the project)	Does not generate realtime OS generation files and does not display them on the project tree. If this item is selected when there are already realtime OS generation files, then the files themselves are not deleted.
Output folder	Display the folder for outputting realtime OS generation files.		
	Default	%BuildModeName%	
	How to change	Changes not allowed	
Service Call Definition File Name	Display the name of the service call definition file that the cfg600px outputs.		
	Default	kernel_sysint.h	
	How to change	Changes not allowed	
System Information Header File Name	Display the name of the system information header file that the cfg600px outputs.		
	Default	kernel_id.h	
	How to change	Changes not allowed	
ROM Definition FIle Name	Display the name of the ROM definition file that the cfg600px outputs.		
	Default	kernel_rom.h	
	How to change	Changes not allowed	
RAM Definition FIle Name	Display the name of the RAM definition file that the cfg600px outputs.		
	Default	kernel_ram.h	
	How to change	Changes not allowed	
System Definition FIle Name	Display the name of the system definition file that the cfg600px outputs.		
	Default	ri600.inc	
	How to change	Changes not allowed	
CMT Timer Definition File Name	Display the name of the CMT timer definition file which is generated by the cfg600px.		
	Default	ri_cmt.h	
	How to change	Changes not allowed	

Table File Name	Display the name of the table file that the mkritblpx outputs..	
	Default	ritable.src
	How to change	Changes not allowed

2) [Configurator Start Setting]

The start option of the configurator cfg600px can be specified.

When undefined interrupt is generated, the interruption vector number is passed to system down routine.	When an undefined interrupt occurs, the system down is caused. When -U option is specified, the vector number will be transferred to the system down routine (refer to "CAHPTER 15 SYSTEM DOWN"). This is useful for debugging. However, the kernel code size increases by about 1.5 kB.		
	Default	Yes(-U)	
	How to change	Select from the drop-down list.	
	Restriction	Yes(-U)	When undefined interrupt is generated, the interruption vector number is passed to system down routine.
		No	When undefined interrupt is generated, the interruption vector number is not passed to system down routine.
The making situation of the file that the configurator generates is displayed.	Select whether to display the creation status of files generated by the cfg600px.		
	Default	Yes(-U)	
	How to change	Select from the drop-down list.	
	Restriction	Yes(-U)	Display the creation status of files generated by the cfg600px.
		No	Do not display the creation status of files generated by the cfg600px.
User options.	Input the command line option directly.		
	Default	-	
	How to change	Directly enter to the text box.	
	Restriction	Up to 259 characters	

3) [Service Call Information File]

Specify the path where the table generation utility mkritblpx retrieves the service call information files.

The path that contains the service call information file.	Specifies the service call information file (.mrc) or the path to the folder where the service call information files are retrieved. Note, when a folder path is specified, the sub folder is not retrieved. When relative path is specified, the project folder is the base folder. When absolute path is specified, the specified path is converted into the relative path which is based from the project folder. However, if the drive of the specified path is different from the drive of the project folder, this conversion is not done. Note, the project folder is passed to the mkritblpx regardless this setting. The following place holder can be specified. %BuildModeName% : Convert to the build mode name.	
	How to change	Edit by the Path Edit dialog box which appears when clicking the [...] button.
	Restriction	Up to 259 characters Note, when extension is not specified or the specified extension is not ".mrc", the specified path is interpreted as folder.

Note 1 Refer to "2.6.1 Service call information files and "-ri600_preinit_mrc" compiler option" for the service call information file.

Note 2 When using the "optimization for accesses to external variables" compiler option, the CubeSuite+ generates the folder to store object files and service call information files for 1st build, and specifies this folder path for [Service Call Information File] tacit.

Note 3 The service call information files are generated to the same folder as object files at compilation. Please change this item appropriately when you do the operation to which the output folder of object files is changed.

APPENDIX B FLOATING-POINT OPERATION FUNCTION

It is only when the -fpu option is specified that the compiler outputs floating-point arithmetic instructions.
If the -chkfpu option is specified in the assembler, the floating-point arithmetic instructions written in a program are detected as warning.

B.1 When Using Floating-point Arithmetic Instructions in Tasks and Task Exception Handling Routines

Make settings that include "FPSW" for Task context register (context) in System Information (system). As a result, the FPSW register is managed independently in each task.
The initial FPSW value for tasks and task exception handling routines is initialized by the value according to compiler options to be used. For details, refer to "4.2.4 Internal processing of task" and "6.2.2 Internal processing of task exception handling routine".

B.2 When Using Floating-point Arithmetic Instructions in Handlers

It is necessary that the handler explicitly guarantee the FPSW register.
The initial FPSW value of handlers is undefined.
To guarantee and initialize the FPSW register, write a program as follows.

```
#include <machine.h>    // To use the intrinsic function get_fpsw() and set_fpsw(),
                        // include machine.h.
#include "kernel.h"
#include "kernel_id.h"
void handler (void)
{
    unsigned long old_fpsw;    // Declare variable for saving the FPSW register
    old_fpsw = get_fpsw () ;    // Save the FPSW register
    set_fpsw (0x00000100) ;     // Initialize the FPSW register if necessary
    /* Floating-point arithmetic operation */
    set_fpsw (old_fpsw) ;       // Restore the FPSW register
}
```

APPENDIX C DSP FUNCTION

When a MCU which support the DSP function is used, it is necessary to note the treatment of the ACC register (accumulator). Concretely, please note it as follows when you use the following DSP instructions which update ACC register.

- RXv1/RXv2 architecture common instruction
  MACHI, MACLO, MULHI, MULLO, RACW, MVTACHI, MVTACLO
- RXv2 architecture instructions
  EMACA, EMSBA, EMULA, MACLH, MSBHI, MSBLH, MSBLO, MULLH, MVTACGU, RACL,RDACL, RDACW

In no case does the compiler generate these instructions.
Note also that if the -chkdsp option is specified in the assembler, the DSP function instructions written in a program are detected as warning.

C.1 When Using DSP Instructions in Tasks and Task Exception Handling Routines

Make settings that include “ACC” for Task context register (context) in System Information (system). As a result, the ACC register is managed independently in each task.

C.2 When Using DSP Instructions in Handlers

If the application contains any tasks or interrupt handlers that use the above-mentioned DSP instructions, it is necessary that all of the interrupt handlers guarantee the ACC register. There are the following two method.

1) Use “-save_acc” compiler option

2) Specify “ACC” for “pragma_switch” in all interrupt handler definition (Relocatable Vector Information (interrupt_vector[]) and Fixed Vector/Exception Vector Information (interrupt_fvector[])).

APPENDIX D STACK SIZE ESTIMATION

If a stack overflows, the behavior of the system becomes irregular. Therefore, a stack must not overflow referring to this chapter.

D.1 Types of Stack

There are two types of stacks: the user stack and system stack. The method for calculating stack sizes differs between the user stack and system stack.

- User stack
  The stack used by tasks is called “User stack”.
  When a task is created by Task Information (task[]) in the system configuration file, the size and the name of the section where the stack is allocated are specified.
  When a task is created by cre_tsk or acre_tsk, the size and the start address of the user stack area are specified.

- System stack
  The system stack is used by handlers and the kernel. The system has only one system stack. The size is specified by System stack size (stack_size) in System Information (system). The section name of the system stack is “SI”.

D.2 Call Walker

The CubeSuite+ package includes “Call Walker” which is a utility tool to calculate stack size.
The Call Walker can display stack size used by each function tree.

D.3 User Stack Size Estimation

The quantity consumed of user stack for each task is a value in which the value calculated by the following expressions was rounded up to the multiple of 16.

Quantity consumed of user stack = *treesz_task* + *ctxsz _task* + *treesz_tex* + *ctxsz_tex*

- *treesz_task*
  Size consumed by function tree that makes the task entry function starting point. (the size displayed by Call Walker).

- *treesz_tex*
  Size consumed by function tree that makes the task exception handling routine entry function starting point. (the size displayed by Call Walker).

- *ctxsz _task*, *ctxsz _tex*
  Size for task context registers. The *ctxsz _task* is for task, and *ctxsz _tex* is for task exception handling routine.
  The size for task context registers is different according to the setting of Task context register (context) in System Information (system). Refer to Table D-1.

Table D-1 Size of Task Context Register

Setting of system.context	Compiler option “-isa”	Size of Task Contest Register
NO	-	68
FPSW	-	72
ACC	“-isa=rxv2”	92
	“-isa=rxv1” or not specify “-isa”	76
FPSW,ACC	“-isa=rxv2”	96
	“-isa=rxv1” or not specify “-isa”	80
MIN	-	44
MIN,FPSW	-	48
MIN,ACC	“-isa=rxv2”	68
	“-isa=rxv1” or not specify “-isa”	52
MON,FPSW,ACC	“-isa=rxv2”	72
	“-isa=rxv1” or not specify “-isa”	56

Note Compiler option “-isa” is supported by the compiler CC-RX V2.01 or later.

D.4 System Stack Size Estimation

The system stack is most consumed when an interrupt occurs during service call processing followed by the occurrence of multiple interrupts. The quantity consumed of system stack is calculated by the following expressions.

$$\text{Quantity consumed of system stack} = svcsz + \sum_{k=1}^{15} inthdrsz_{k} + sysdwnsz$$

- *svcsz*
  The maximum size among the service calls to be used in the all processing program. The value *svcsz* depends on the RI600PX version. For details, refer to release notes.

- *inthdrsz*
  Size consumed by function tree that makes the interrupt handler entry function starting point. (the size displayed by Call Walker).
  The "k" means interrupt priority level. If there are multiple interrupts in the same priority level, the $inthdrsz_{k}$ should select the maximum size among the handlers.
  The size used by the base clock interrupt handler (the interrupt priority level is specified by Base clock interrupt priority level (IPL) in Base Clock Interrupt Information (clock)) is the maximum value in the following Please refer to the release notes for *clocksz1*, *clocksz2* and *clocksz3*.
  Don't have to add the size used by the base clock interrupt handler when base clock timer is not used (clock.timer = NOTIMER).

  - *clocksz1* + *cycsz*
  - *clocksz2* + *almsz*
  - *clocksz3*

    - *cycsz*
      Size consumed by function tree that makes the cyclic handler entry function starting point. (the size displayed by Call Walker).
      If there are multiple cyclic handlers, the *cycsz* should select the maximum size among the handlers.

    - *almsz*
      Size consumed by function tree that makes the alarm handler entry function starting point. the size displayed by Call Walker).
      If there are multiple alarm handlers, the *cycsz* should select the maximum size among the handlers.

- *sysdwnsz*
  Size consumed by function tree that makes the system down routine entry function starting point. (the size displayed by Call Walker) + 40. When the system down routine has never been executed, *sysdwnsz* is assumed to be 0.

Revision Record

Rev.	Date	Description	
		Page	Summary
1.00	Apr 01, 2012	-	First Edition issued
1.01	Sep 20, 2013 (RI600PX V1.02.00)	24	“2.6.2 Compiler option for the boot processing file” has been detailed.
		25	With support of RXv2 architecture, the composition of kernel libraries have been changed.
		28, 217, 225, 527, etc.	With support of RXv2 architecture, the explanation about FIX_INTERRUPT_VECTOR section and EXTB register have been added or changed. Moreover, “fixed vector” has been replaced by “fixed vector/exception vector”.
		29	“2.6.5 Initialized data section” has been added.
		42, 67, 557	The specification of FPSW register when task and task exception handling routine processing is started has been changed.
		217	With support of RXv2 architecture, the explanation about compiler option “-isa” and “-cpu” have been added.
		221, 456	The explanation about starting of RI600PX has been improved.
		222	Expression of section “17.4 Section Initialization Function (_INITSCT( ))” has been improved.
		230	With revision to V1.02.00, the definition value of TKERNEL_PRVER has been changed into 0x0120.
		485	With support of RXv2 architecture, Table 20-2 has been changed.
		489	The explanation of Table 20-7 has been improved.
		501	With support of RXv2 architecture, Table 20-8 has been changed.
		558	The RXv2 instructions have been added to DSP instructions which update ACC register.
		558	The description “All interrupt handlers explicitly guarantee the ACC register” has been deleted.
		560	With support of RXv2 architecture, Table D-1 has been changed.

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User's Manual: Coding

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Renesas Electronics America Inc.
2880 Scott Boulevard Santa Clara, CA 95050-2554, U.S.A.
Tel: +1-408-588-6000, Fax: +1-408-588-6130

Renesas Electronics Canada Limited
1101 Nicholson Road, Newmarket, Ontario L3Y 9C3, Canada
Tel: +1-905-898-5441, Fax: +1-905-898-3220

Renesas Electronics Europe Limited
Dukes Meadow, Millboard Road, Bourne End, Buckinghamshire, SL8 5FH, U.K
Tel: +44-1628-651-700, Fax: +44-1628-651-804

Renesas Electronics Europe GmbH
Arcadiastrasse 10, 40472 Düsseldorf, Germany
Tel: +49-211-65030, Fax: +49-211-6503-1327

Renesas Electronics (China) Co., Ltd.
7th Floor, Quantum Plaza, No.27 ZhiChunLu Haidian District, Beijing 100083, P.R.China
Tel: +86-10-8235-1155, Fax: +86-10-8235-7679

Renesas Electronics (Shanghai) Co., Ltd.
Unit 204, 205, AZIA Center, No.1233 Lujiazui Ring Rd., Pudong District, Shanghai 200120, China
Tel: +86-21-5877-1818, Fax: +86-21-6887-7858 / -7898

Renesas Electronics Hong Kong Limited
Unit 1601-1613, 16/F., Tower 2, Grand Century Place, 193 Prince Edward Road West, Mongkok, Kowloon, Hong Kong
Tel: +852-2886-9318, Fax: +852 2886-9022/9044

Renesas Electronics Taiwan Co., Ltd.
13F, No. 363, Fu Shing North Road, Taipei, Taiwan
Tel: +886-2-8175-9600, Fax: +886 2-8175-9670

Renesas Electronics Singapore Pte. Ltd.
80 Bendemeer Road, Unit #06-02 Hyflux Innovation Centre Singapore 339949
Tel: +65-6213-0200, Fax: +65-6213-0300

Renesas Electronics Malaysia Sdn.Bhd.
Unit 906, Block B, Menara Amcorp, Amcorp Trade Centre, No. 18, Jln Persiaran Barat, 46050 Petaling Jaya, Selangor Darul Ehsan, Malaysia
Tel: +60-3-7955-9390, Fax: +60-3-7955-9510

Renesas Electronics Korea Co., Ltd.
11F., Samik Lavied' or Bldg., 720-2 Yeoksam-Dong, Kangnam-Ku, Seoul 135-080, Korea
Tel: +82-2-558-3737, Fax: +82-2-558-5141

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Renesas Electronics Corporation

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