RX600 & RX200 Series

Simple Flash API for RX

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Introduction

A simple Application Program Interface (API) has been created to allow users of flash based RX600 & RX200 Series devices to easily integrate reprogramming abilities into their applications using User Mode programming. User Mode programming is the term used to describe a Renesas MCU's ability to reprogram its own internal flash memory while running in its normal operational mode. This application note focuses on using that API and integrating it with your application program.

The API source files comply with the Renesas RX compiler only.

Reading Erased Data Flash

The most common question that is received for this package is that the user has read erased data flash and the values were not 0xFF. If you wish to see why this is, please refer to Section 3.10.

Target Device

The following is a list of devices able to use this API:

- **RX610 Group**
- **RX621, RX62N, RX62T, RX62G Group**
- **RX630, RX631, RX63N, RX63T Group**
- **RX210 Group**

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1. Overview

The Simple Flash API is provided to customers to make the process of programming and erasing on-chip flash areas easier. Both ROM and data flash areas are supported. The API in its simplest form can be used to perform blocking erase and program operations. The term 'blocking' means that when a program or erase function is called, the function does not return until the operation has finished. When a flash operation is on-going, that flash area cannot be accessed by the user. If an attempt to access the flash area is made, the flash control unit will transition into an error state. For this reason 'blocking' operations are preferred by some users to prevent the possibility of a flash error. But there are other cases where blocking operations are not desired. If the user is writing data to the data flash for example, the ROM can still be read. In this case many users would like for the data flash write or erase to occur in the background (non-blocking) while their application continues to run in ROM. RX600 and RX200 Series MCUs support this feature and it is available in the Simple Flash API. The user can also perform non-blocking ROM operations as well, but application code will need to be located outside of ROM.

1.1 Features

Below is a list of the features supported by the Simple Flash API.

- Blocking erasing and programming of User ROM
- Non-blocking, background operation, erasing and programming of User ROM
- Blocking erasing, programming, and blank checking of data flash
- Non-blocking, background operation, erasing, programming, and blank checking of data flash
- Callback functions for when flash operation has finished (only with non-blocking)
- ROM to ROM transfers
- Data flash to data flash transfers
- Lock bit protection
- Lock bit set/read

2. API Information

This Middleware API follows the Renesas API naming standards.

2.1 Hardware Requirements

This middleware requires your MCU support the following features:

- Flash with background operation feature (all RX600 & RX200 Series MCUs feature this)
- Clock speed supplied to Flash Control Unit must be greater than or equal to 4MHz

2.2 Hardware Resource Requirements

This section details the hardware peripherals that this middleware requires. Unless explicitly stated, these resources must be reserved for the middleware and the user cannot use them.

2.2.1 Flash Control Unit (FCU)

The FCU takes care of programming and erasing internal memory. This middleware uses the FCU and therefore should not be used by the middleware user.

2.3 Software Requirements

This software is not dependent upon any other software packages.

2.4 Supported Toolchains

This middleware is tested and working with the following toolchains:

- Renesas RX Toolchain v1.02

2.5 Header Files

All API calls are accessed by including a single file *r_flash_api_rx_if.h* which is supplied with this middleware's project code.

2.6 Integer Types

This project uses ANSI C99 "Exact width integer types" in order to make the code clearer and more portable. These types are defined in *stdint.h*.

2.7 Configuration Overview

Configuring this middleware is done through the supplied *r_flash_api_rx_config.h* header file. Each configuration item is represented by a macro definition in this file. Each configurable item is detailed in the table below.

Configuration Options in *r_flash_api_rx_config.h*	
FLASH_API_RX_CFG_ ENABLE_ROM_PROGRAMMING	If defined then ROM programming is enabled and code required for this operation is copied to RAM. If undefined then only data flash operations are available and all code will be located in ROM.
FLASH_API_RX_CFG_FLASH_TO_FLASH	If defined then ROM to ROM and data flash to data flash operations will be enabled. When enabled the Flash API will require a RAM buffer to hold the data to be programmed. The size of the RAM buffer will be maximum number of bytes between the programming size of the data flash and ROM.
FLASH_API_RX_CFG_DATA_FLASH_BGO	Enables non-blocking data flash operations. When enabled, data flash operations will occur in the background and API functions will return before the operation has finished. When disabled API functions will not return until the data flash operation has completed.

FLASH_API_RX_CFG_ROM_BGO	Enables non-blocking ROM operations. When enabled, ROM operations will occur in the background and API functions will return before the operation has finished. When disabled API functions will not return until the ROM operation has completed.
FLASH_API_RX_CFG_FLASH_READY_IPL	This is the interrupt priority level that will be used for the flash ready interrupt when BGO operations are enabled.
FLASH_API_RX_CFG_ IGNORE_LOCK_BITS	If defined then lock bit protection will be ignored. If undefined then lock bit protection will be used and if a program/erase is attempted on a block with its lock bit set, the operation will fail.
FLASH_API_RX_CFG_ COPY_CODE_BY_API	After a reset parts of the Flash API must be copied to RAM before the API can be used. This originally was done by editing the dbsct.c file to copy the code over when other RAM sections are initialized. There is now the R_FlashCodeCopy() function which does the same thing. Uncomment this macro if you will be using the R_FlashCodeCopy() function. Comment out this macro if you are using the original dbsct.c method.

Table 1 : Flash API Configuration Items

2.7.1 What About Configuring the MCU Information?

In earlier versions of this middleware, information about the MCU was required to be input by the user. Examples of information that was needed included:

- Which MCU family (e.g. RX62N)
- ROM and Data Flash size
- Clock speed supplied to FCU

This is no longer defined in the Flash API middleware since this code now uses the r_bsp package. The r_bsp package includes startup code and MCU information for different RX boards. The Flash API gets the information it needs from the files in the r_bsp package. Users are encouraged to add their own boards to the r_bsp package. By having a clear foundation for middleware to be built on top of this should enable RX middleware to be more easily integrated.

2.7.2 What happened to DATA_FLASH_OPERATION_PIPL AND ROM_OPERATION_PIPL?

In v2.00 of the Simple Flash API for RX there were two extra #define's in the user configuration file that are not shown in the table above. These definitions were removed due to a bug that was found in the code. The way the definitions were meant to work was that when a flash operation was called, the API would set the MCU's IPL to a certain level. When the flash operation was finished, the API would set the IPL back to what it was before the flash operation was called. Using this method, the user could easily prevent certain interrupts from occurring during flash operation which could cause a ROM or data flash access violation. The problem occurred when trying to restore the MCU's IPL at the end of a flash operation. If the flash operation was done using BGO then it would finish inside of the flash ready ISR. The IPL could be changed inside of the ISR but since the IPL is restored from the stack when returning from an ISR, the change essentially had no effect. This means that after the flash operation was finished the MCU's IPL was not correctly restored. To fix this, the definitions were removed. This means the user must take extra care to make sure no interrupts occur during flash operations that may cause an access violation.

If the user would like to restore these features, two options are presented here. The first is to have code that alters the IPL value that is stored on the stack when an ISR is taken. This can be tricky since the location on the stack can change depending on how many stack variables are used and how many registers are saved. The other option is to make the flash ready interrupt the fast interrupt. This option is easier to code for and safer since the IPL will always be stored in the backup PSW register. The downside to this approach is that the user loses the ability to use the fast interrupt for another interrupt.

2.8 API Data Structures

This section details the data structures that are used with the middleware's API functions.

2.8.1 Flash Block Addresses

If needed, the user can use the *g_flash_BlockAddresses[]* array to get the addresses associated with a MCU's memory blocks. Note that these addresses are the program and erasing addresses rather than the read addresses. The only difference in these addresses is that when reading the high-order byte is always 0xFF (e.g. 0xFFFF4000) for ROM addresses and when programming or erasing the high-order byte is always 0x00 (e.g. 0x00FF4000). This means that the user can easily OR in 0xFF000000 to a ROM address from the array and have the appropriate read address. No change is needed when using data flash addresses. Also, when erasing ROM, make sure you do not erase this array since it is a constant array and is stored in ROM by default.

```
/* Data Structure #1 */
const uint32_t g_flash_BlockAddresses[86] = {
   0x00FFF000,  /* EB00 */
   0x00FFE000,  /* EB01 */
   0x00FFD000,  /* EB02 */
   0x00FFC000,  /* EB03 */
   ...
};
```

2.9 Return Values

This shows the different values API functions can return. These definitions are all found in *r_flash_api_rx_if.h*. Some of the return values have the same value to keep compatibility with older versions of the middleware. No function will use two return definitions from the list below with identical values.

```
/**** Function Return Values ****/
/* Operation was successful */
#define FLASH_SUCCESS           (0x00)
/* Flash area checked was blank, making this 0x00 as well to keep existing
   code checking compatibility */
#define FLASH_BLANK             (0x00)
/* The address that was supplied was not on aligned correctly for ROM or DF */
#define FLASH_ERROR_ALIGNED     (0x01)
/* Flash area checked was not blank, making this 0x01 as well to keep existing
   code checking compatibility */
#define FLASH_NOT_BLANK         (0x01)
/* The number of bytes supplied to write was incorrect */
#define FLASH_ERROR_BYTES       (0x02)
/* The address provided is not a valid ROM or DF address */
#define FLASH_ERROR_ADDRESS     (0x03)
/* Writes cannot cross the 1MB boundary on some parts */
#define FLASH_ERROR_BOUNDARY    (0x04)
/* Flash is busy with another operation */
#define FLASH_BUSY              (0x05)
/* Operation failed */
#define FLASH_FAILURE           (0x06)
/* Lock bit was set for the block in question */
#define FLASH_LOCK_BIT_SET      (0x07)
/* Lock bit was not set for the block in question */
#define FLASH_LOCK_BIT_NOT_SET  (0x08)
```

2.10 Adding Middleware to Your Project

Follow the steps below to add the middleware's code to your project.

1. Copy the 'r_flash_api_rx' directory (packaged with this application note) to your project directory.
2. Add src*r_flash_api_rx.c* to your project.
3. Add an include path to the 'r_flash_api_rx' directory.
4. Add an include path to the 'r_flash_api_rx\src' directory.
5. Copy the reference configuration file *'r_flash_api_rx_config_reference.h*' from the 'ref' folder to your project and rename it *r_flash_api_rx_config.h*.
6. Configure middleware for your system through just copied *r_flash_api_rx_config.h*.
7. Add a #include for *r_flash_api_rx_if.h* in any source files that need to use the Flash API.

The following steps are only required if you are programming or erasing ROM. If you are only operating on data flash, then these steps can be ignored. These steps are discussed with more detail in Section 2.12.

8. Make a ROM section named 'PFRAM'.
9. Make a RAM section named 'RPFRAM'.
10. Configure your linker such that code allocated in the 'FRAM' section will actually be executed in RAM.
11. After reset, make sure the Flash API code is copied from ROM to RAM. This can be done by calling the R_FlashCodeCopy() function.

2.11 Limitations

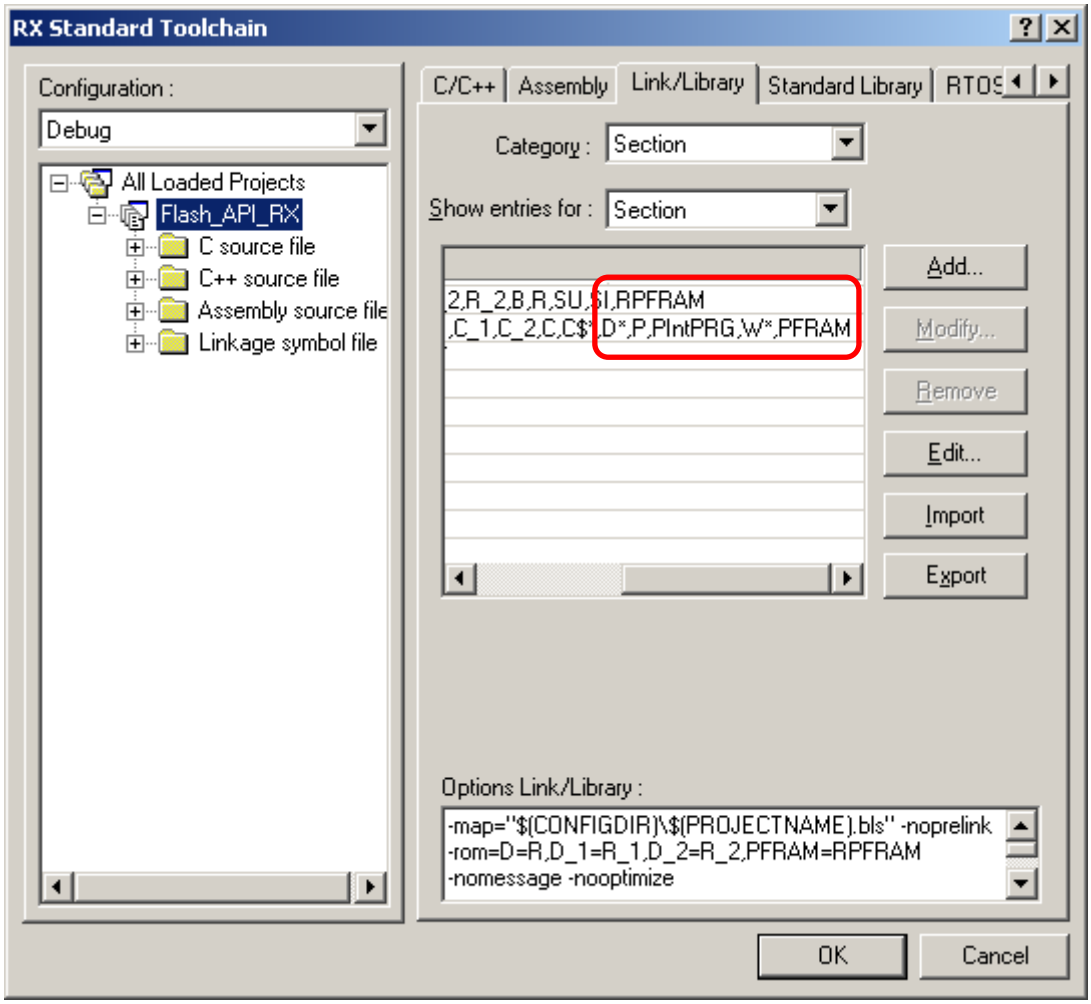
1. This code is not re-entrant but does protect against multiple concurrent function calls.
2. During ROM operations neither ROM nor DF can be accessed. If using ROM BGO then make sure code runs from RAM.
3. During DF operations the DF cannot be accessed but ROM can be accessed normally.

2.12 Putting Flash API Code in RAM

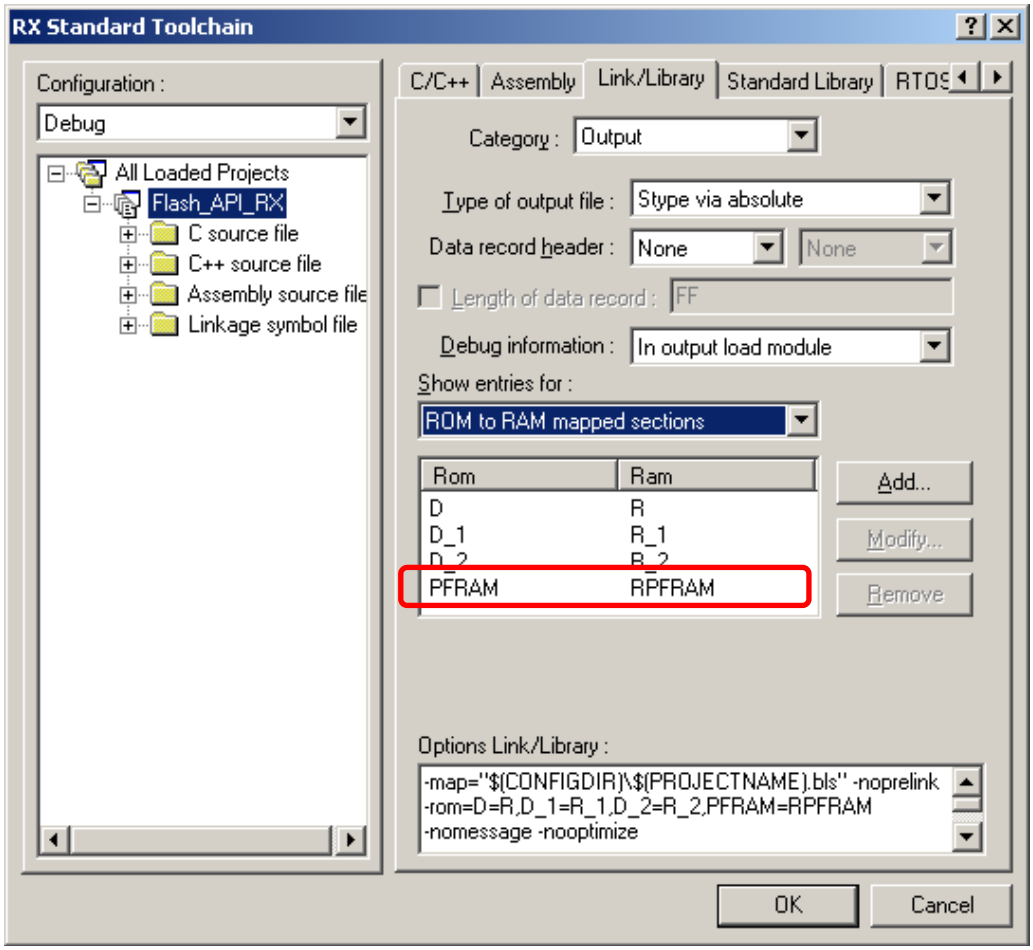
RX600 & RX200 Series MCUs require that sections in RAM and ROM be created to hold the API functions for reprogramming ROM. This is required because the FCU cannot program or erase ROM while executing or reading from ROM. Also, the RAM section will need to be initialized after reset. Note that this is only for ROM programming. If you are only programming the data flash area, you do not need these settings, but you should change the configuration setting 'FLASH_API_RX_CFG_ENABLE_ROM_PROGRAMMING' to undefined in the file *r_flash_api_rx_config.h*. Please follow the steps below if you are programming or erasing ROM:

In HEW:

1. Add a new section titled '**RPFRAM**' in a RAM area.
2. Add a new section titled '**PFRAM**' in a ROM area.



3. Add the linker option to map the ROM section (PFRAM) address to RAM section address (RPFRAM) as seen below.



4. The linker is now setup to correctly allocate the appropriate Flash API code to RAM. Now we need to make sure that the code gets copied from ROM to RAM after reset. If this is not done before a Flash API function is called then the MCU will jump to uninitialized RAM. Two ways to copy this code to RAM are presented below.

The first way is to edit the *dbsct.c*. This file contains an array that specifies which RAM areas need to be initialized after a reset. In *dbsct.*c add the initialization of this code for the RAM section as seen below in RED (note: don't forget to add the comma on the previous line)

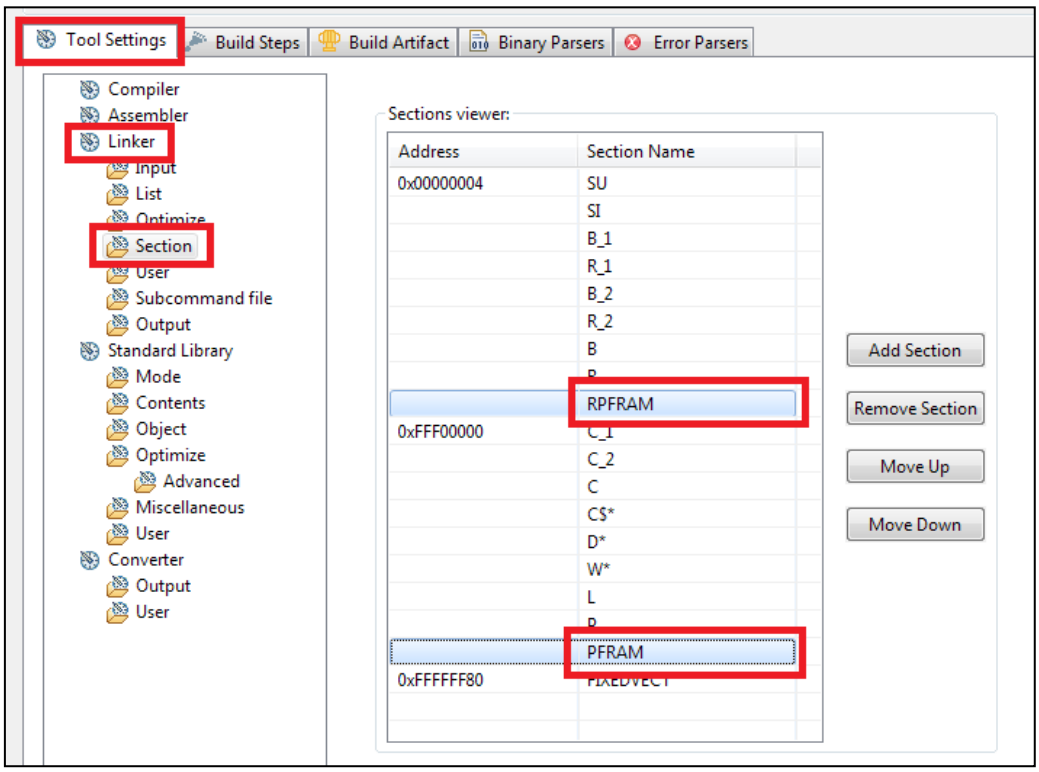
```
-- FILE [dbsct.c] --
#pragma section $DSEC
static const struct {
    _UBYTE *rom_s;  /* Initial address on ROM of initialization data section */
    _UBYTE *rom_e;  /* Final address on ROM of initialization data section */
    _UBYTE *ram_s;  /* Initial address on RAM of initialization data section */
}   DTBL[] = {
    { __sectop("D"), __secend("D"), __sectop("R") } ,
    { __sectop("PFRAM"), __secend("PFRAM"), __sectop("RPFRAM") }
};
```

Starting with v2.20 of the Simple Flash API for RX, there is now an API function that will copy the code to RAM. This is the R_FlashCodeCopy() function. Just call this function before making any other Flash API calls. If using this method the user will need to make sure and uncomment the macro for COPY_CODE_BY_API in *r_flash_api_rx_config.h*. If using the *dbsct.c* method then the user can comment out this macro which will lead to the R_FlashCodeCopy() function not being compiled.

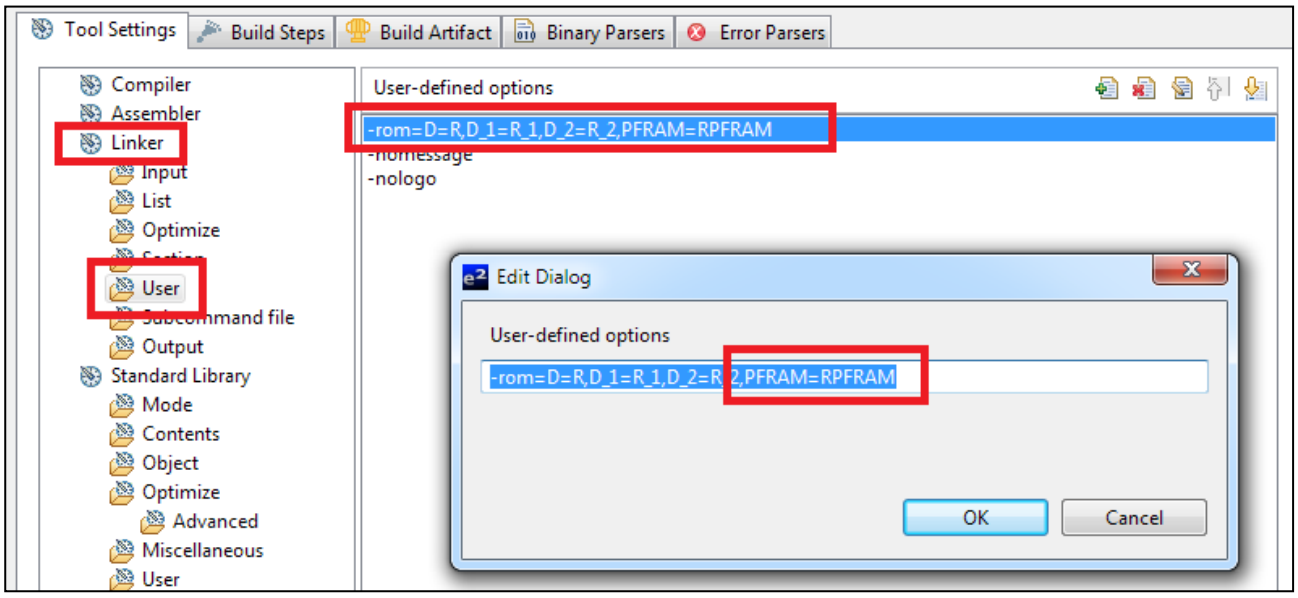
In E2Studio:

The same process of setting up the linker sections and mapping ROM to RAM needs to be done in E2Studio as well.

1. Add a new section titled '**RPFRAM**' in a RAM area.
2. Add a new section titled '**PFRAM**' in a ROM area.



3. Add the linker option to map the ROM section (PFRAM) address to RAM section address (RPFRAM) by appending ',PFRAM=RPFRAM' to the user defined option for '-rom' as seen below.. This is done using the Linker >> User section of the Tool Settings in E2Studio.



4. Follow the last step from the HEW instructions above to copy the Flash API to RAM.

2.13 Using Non-Blocking Background Operations

When background operations (BGO) for ROM or data flash are enabled, API function calls will not block and will return before the flash operation has finished. The user should take care in these instances that they do not try to access the flash area that is being operated on until the operation has finished. If the area is accessed during an operation then the FCU will go into an error state and the operation will fail.

The user will be alerted when a background flash operation has finished through a callback function. There are 3 callback functions that the Simple Flash API uses when an operation completes. The user should write these functions in their application code. For an example, look in the *flash_api_rx_demo_main.c* file that is included with this application note. The 3 callback functions are:

- **void FlashEraseDone(void)**
  - This function is called when a data flash or ROM erase has completed
- **void FlashWriteDone(void)**
  - This function is called when a data flash or ROM write has completed
- **void FlashBlankCheckDone(uint8_t result)**
  - This function is called when a data flash blank check has completed. The 'result' parameter will be 'FLASH_BLANK' in the event that the block was blank and 'FLASH_NOT_BLANK' in the event that the block was not blank.

There is also a callback function in the event that a flash error has occurred.

- **void FlashError(void)**

The Flash API will reset the FCU when an error is detected but this callback is included to alert the user that the flash operation did not complete successfully.

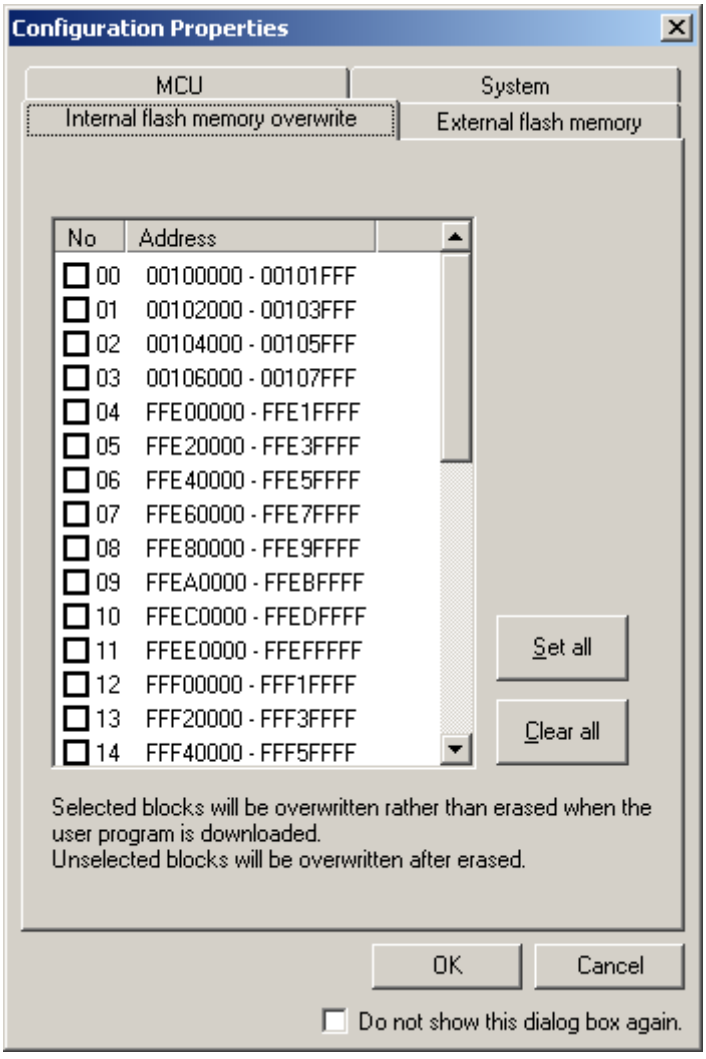
3. Usage Notes

3.1 Debugging within HEW

Using the E1 and E20, you are allowed to debug while erasing and programming the on board flash memory and data flash memory. Care should be taken to make sure that the flash block holding the user program is not erased unless the user has some way of programming new code while executing in RAM.

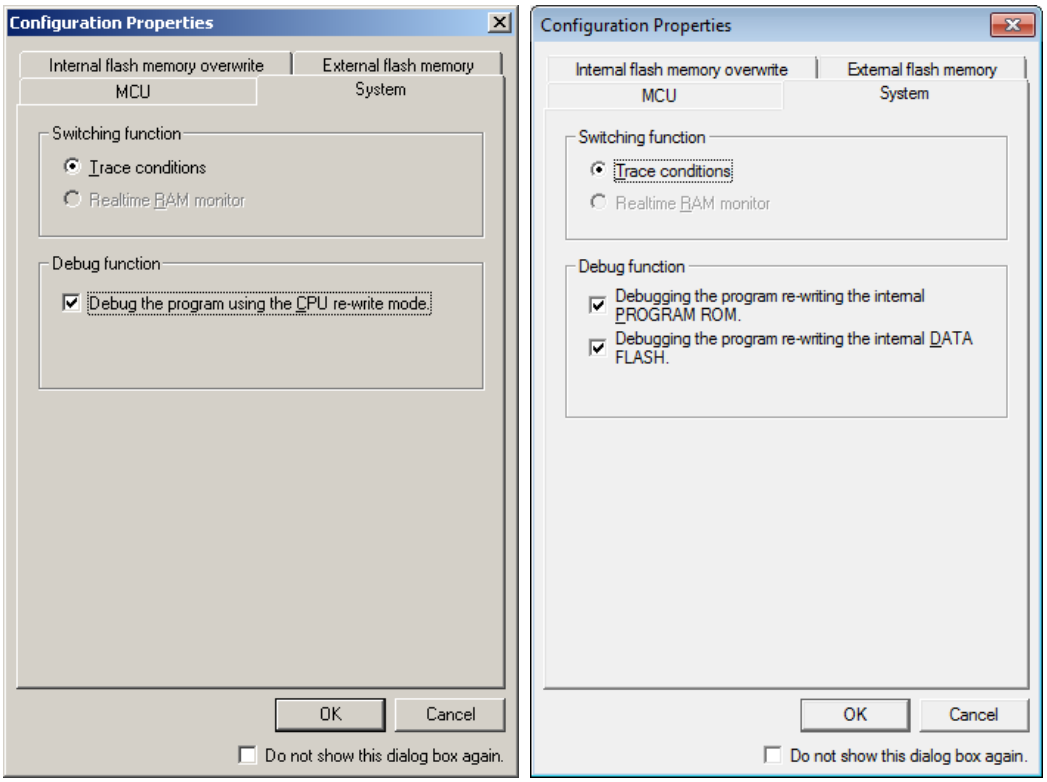
You cannot use the FDT programming software to view previously written data to the flash memory because an RX600 or RX200 Series device will automatically erase all flash memory when it enters boot mode as a built-in security feature.

If you attempt to disconnect and then re-connect to your system with HEW, the entire flash memory will be erased upon re-connecting with the E1/E20 under default debugger settings. In order to preserve the flash values you will need to specify which flash blocks you want to be overwritten, rather than erased. This is done in the 'Configuration Properties' window underneath the 'Internal flash memory overwrite' tab. Place a check in the boxes next to the flash blocks you desire to be overwritten instead of being erased. A screenshot of the window is below.



3.2 Viewing Programmed/Erased Flash Memory in HEW

Use of the Memory window inside HEW to view the flash memory contents after an erase or write will not work under the default debugger settings. The reason for this is that HEW will cache the flash memory contents when the debug session starts and will not refresh the values after the program/erase command finishes. There is an option when connecting though that specifies you are using CPU rewrite code and therefore to refresh the flash memory values. This option is in the 'Configuration Properties' window that will come up when connecting to the E1/E20/JLink. Depending on which version of the debugger software is installed, you may see different options. The screenshots below show the different screens that may be presented. First switch to the 'System' tab. If using an earlier version of the debugger software (as shown below on the left) then check the box next to 'Debug the program using the CPU re-write mode'. If using a newer version of the software then you will likely see the screenshot on the right. In this case check the boxes next to the memory areas you will be programming or erasing. If programming or erasing both, then check both boxes as shown below. Now when using the memory window the current flash memory values will be displayed.



3.3 ROM Area Boundaries

The RX600 and RX200 Series have some MCUs that have more than one ROM Area. For example, a RX63N with 2MB of ROM has 4 ROM Areas (Area 0, 1, 2, and 3). You are allowed to write over flash blocks that are inside the same ROM Area, but not over ROM Area boundaries. If you do try to write over a boundary, then the R_FlashWrite() function will return an error code before performing any write operations stating that this has occurred. In order to write over a boundary, the user will have to take precautions to make sure and split the write up where the first write programs up to the boundary and then the second write starts at the boundary.

Which ROM Area is currently selected for programming and erasure is controlled by the FENTRY bits located in the FENTRYR register. The reason programming cannot go across the boundary is because only one of these bits can be set at a time. Which bit is set is automatically taken care of when the user calls the R_FlashWrite() function.

3.4 Data Flash BGO Precautions

When using data flash BGO the User ROM, RAM, and external memory can still be accessed. This means that care should only be taken to make sure that the data flash is not accessed during a data flash operation. This includes interrupts that may access the data flash.

3.5 ROM BGO Precautions

When using ROM BGO external memory and RAM can still be accessed. Since most users will put their code in ROM, extra care should be taken compared to performing BGO data flash operations. Since the API code will return before the ROM operation has finished the code that calls the API function will need to be outside of the User ROM. Another important issue to be aware of is the relocatable vector table. The vector table by default resides in the User ROM. If an interrupt occurs during the ROM operation then ROM will be accessed to fetch the interrupt's starting address and an error will occur. To fix this situation the user will need to relocate the vector table and any interrupt service routines that may occur outside of ROM. The user will also need to change the variable vector table's pointer register (INTB). Examples of this are shown in the example workspace that comes with this application note.

3.6 Interrupts

ROM or data flash areas cannot be accessed while a flash operation is on-going for that particular memory area. This means that care will need to be taken when allowing interrupts to occur during flash operations. These precautions apply whether the user is using BGO operations or not.

3.7 Configure for Only Data Flash Use

The Flash API can be configured to only enable data flash operations. This can be very beneficial for users who do not need ROM operations because it saves code and RAM space. If ROM operations are disabled then the user does not need to have any of the Flash API code in RAM. This means the user does not need to setup the RPFRAM and PFRAM sections. In order to disable ROM operations the user should do the following:

1. Comment out the ENABLE_ROM_PROGRAMMING macro in the file *r_flash_api_rx_config.h*.
2. If you previously setup the RPFRAM and PFRAM sections then you can remove them. You can also remove the ROM to RAM mapping that was previously setup. See Section 2.12 for more info.
3. You do not need to call the R_FlashCodeCopy() function if ROM operations are disabled. If you do call it, it will just return without doing anything.

3.8 Erase Entire User Application Area (ROM)

There are multiple ways to erase the entire User Application Area. One way is to place the Flash API in the User Boot Area. This area is usually used for bootloaders and can only be erased in Serial Boot Mode. Since the user's application cannot run in Boot Mode, the user does not have to worry about accidentally erasing the User Boot Area. When using the User Boot Area the user will still need follow the steps to copy the appropriate Flash API functions to RAM. The user will also need to move the relocatable vector table to either the User Boot Area or RAM if they are using ROM or data flash BGO.

Another way to approach this is to copy everything to RAM and use RAM exclusively. When doing this the user will need to modify the Flash API code to put the array that holds flash addresses in RAM instead of ROM. Follow these steps to move the array to RAM:

1. Open up the header file for your MCU's Group in the *src/targets/* folder. For example, if you are using the RX62N MCU then you would open the file *src/targets/rx62n/r_flash_api_rx62n.h*.
2. In the file find the g_flash_BlockAddresses[] array. There will be two declarations of the array. One that actually defines the array's contents and the other that declares it as an extern. Remove the *const* keyword from both declarations. Removing the *const* keyword will move the array to RAM.

If using RAM only the user will also need to move the relocatable vector table to RAM if they are using ROM or data flash BGO since these features use FCU interrupts.

3.9 Reading from Data Flash After Reset

After reset the user cannot read, write, or erase the data flash. In order to enable these operations the user will need to call the R_FlashDataAreaAccess() function. See the API information page (Section 5.4) for more information.

3.10 Checking if a Data Flash Location is Blank (Erased)

Data flash locations on the RX cannot be checked for blank (i.e. erased) by comparing the read value to 0xFF. The reason for this is that RX data flash cells actually have 2 cells per bit (compared to 1 cell per bit for ROM). This means that there are 4 different states the bit can be in; though only 3 are used: undefined, 0, and 1. Erased data flash locations on the RX have a value of undefined (not 0 or 1) and therefore the read bit value cannot be used to determine if the bit is erased. When a data flash bit is programmed, one of the cells is always changed depending on whether a 0 or 1 is being written. If the user wishes to know if a data flash location is erased then they should use the R_FlashDataAreaBlankCheck() function (Section 5.5). This API function uses the Blank Check feature of the RX's Flash Control Unit (FCU) to determine if a data flash location has programmed data or not.

3.11 Putting Flash API in User Boot Area

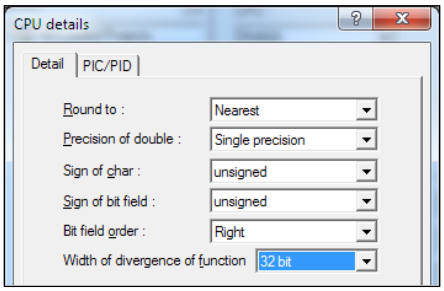
By default, the Renesas RX Toolchain will use 24 bits for the maximum distance that a branch instruction can jump to. The options are 16, 24, or 32 bits. The smaller the chosen value, the smaller the compiled code will be. The reason for this is that if you choose 16 or 24 bits then you are guaranteeing the Renesas RX Toolchain that the destination of all branches will be within the range specified and therefore the compiler does not need to reserve 32 bits for branches. With this guarantee the toolchain can save 1 byte per branch with 24 bit offsets or 2 bytes per branch with 16 bit offsets.

With regular applications, 24 bits will usually be fine. When using User Boot Mode with the Flash API though, 32 bit branches are required. The reason for this is that the Flash API has to put some code in RAM when programming or erasing ROM. Since the end of the User Boot Area is 0xFF800000 and the beginning of RAM is 0x00000000 this means there is a distance of 0x800000. This appears to be within 24 bits, but branches can have positive or negative offsets so the offset is a 2's complement number and therefore the range is half in each direction. This means that calls to Flash API routines in the User Boot Area cannot reach the functions in RAM with 24 bit branches. If the user does not change this setting in the Renesas RX Toolchain then the user will get a 'L2330 (E) Relocation size overflow' error.

To set the Renesas RX Toolchain to use 32 bit branches, follow these steps:

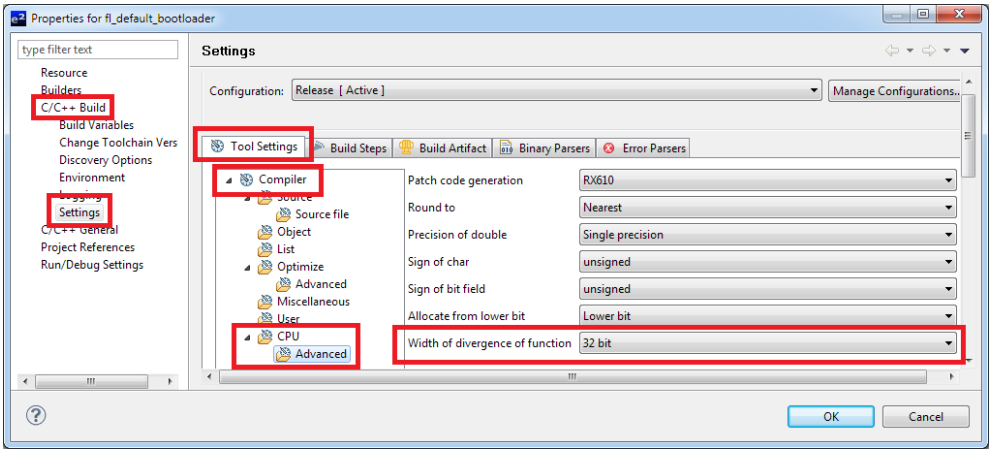
In HEW:

1. Open up your project in HEW.
2. Go to Build >> RX Standard Toolchain.
3. Click the right arrow at the top-right of the 'RX Standard Toolchain' window until you can see the 'CPU' tab.
4. Click the 'CPU' tab.
5. Click the 'Details…' button.
6. In the window that comes up ('CPU details') choose '32 bit' for 'Width of divergence of function'.



In E2Studio:

1. Right click on your project folder and select ‘Properties’.
2. Expand ‘C/C++ Build’ and click on ‘Settings’.
3. Click on the ‘Tool Settings’ tab and choose Compiler >> CPU >> Advanced.
4. Choose ’32 bit’ for ‘Width of divergence of function’..



4. Bootloader Implementations

If you wish to create a bootloader that will have the ability to erase/program the entire memory space of the device, then you will need to either put all of your code in the User Boot flash area or move your entire bootloader application to RAM. You cannot leave your code in the User flash area since you cannot erase a block of flash that you are currently running from.

4.1 Moving an entire application to the User Boot area

Some RX600 and RX200 Series devices have a separate flash area designated as the User Boot area. The MCU can be setup such that it boots into this area instead of using the user application reset vector. This flash area cannot be programmed or erased by a user program running on the MCU. These features make this flash area convenient for holding a bootloader application. Some steps and considerations for this implementation are below.

- Change the linker settings within HEW such that your application code and Interrupt Vector Table are placed in the User Boot area. If these settings are not changed then by default the code and IVT will be placed in the regular User flash area.
- In User Boot mode the reset vector is moved from 0xFFFFFFFC to 0xFF7FFFFC. Therefore make sure for your bootloader application you mark 0xFF7FFFFC as the reset vector. This can be done by doing the following:
    1. Setup a section at 0xFF7FFFFC in the linker settings. We'll call it 'BOOTVECT' for this example.
    2. Create a new C source file, add it your project, and add an array of function pointers. An example of this is shown below where the function we want run after reset is called 'BootLoader'.

```
#pragma section C BOOTVECT

void* const Boot_Vectors[] = {
    //0xFF7FFFFC is reset vector in User Boot Mode
    (void*) BootLoader,
}
```

4.2 Moving a bootloader application to RAM

If your RX device does not have a User Boot flash area, or if you do not wish to use the User Boot area for some other reason, you can move your bootloader application to RAM. Some steps and considerations for this implementation are detailed below.

- Allocate a section in RAM within HEW's linker settings where you want your program to execute from. Make sure when you name the section that the first letter is an 'F', which signifies a 'Fixed' area section. For example, if you want a section called MY_APP_RAM, you would name the section named 'FMY_APP_RAM' in the linker settings.
- Because your RAM executable code will need a ROM location to be loaded and stored, you must first allocate a section within HEW's linker settings. Make sure when you name the section that the first letter is a 'P' which is required by the toolchain to signify a 'Program' area. For example, if you want a section called MY_APP, you would name the section named 'PMY_APP' in the linker settings.
- The RX linker has a special option that will assign RAM memory addresses for functions (and data), but then physically place it in a ROM location. This is done with the assumption that the application program will copy the code or data from the ROM storage location to the RAM execution location before it is referenced. After your code is moved to RAM, all the absolute address references will match your RAM location. Also, whenever any other source module attempts to reference this code, it will be given its RAM address, not its ROM storage address. This is done by using the linker's ROM-to-RAM mapping option "-rom=xxxx=yyyy" where 'xxxx' would be the ROM section you have allocated and 'yyyy' would be the RAM section you have allocated. This can be configured in HEW following the directions shown in Step 3 of Section 2.12. In our example, it would look like:

    -rom=PMY_APP=FMY_APP_RAM

- When it is time to execute your RAM based program, you must first copy the executable binary from its ROM storage location to its RAM executable location. Below is an example of how you could do that. You could also add your sections to the code in *dbsct.c* file as shown in Step 4 of Section 2.12.

```
unsigned char *scr;
unsigned char *dst;

src = (unsigned char *)(__sectop("PMY_APP"));
dst = (unsigned char *)(__sectop("FMY_APP_RAM"));
for( ; src < (unsigned char *)(__secend("PMY_APP")); src++, dst++)
{
    *dst = *src;
}
```

- When writing your code, you will also need to tell the linker which functions should be part of this special ROM section that will be relocated to RAM. To do that, place "#pragma section MY_APP" before the function. Note that the 'P' before 'MY_APP' has been removed. This is because the compiler will automatically insert a 'P' at the beginning of each section that is intended to hold executable code. Please note that once the '#pragma section' is used in a source file, all function and data declarations following it will be placed in that section as well until the end of the file unless another '#pragma section' is encountered. If this next '#pragma section' has no section name, then the default sections will be used. You can also specify a section name and it will be used for the code and data after it. For more information, please refer to the Renesas RX Toolchain Manual. Below is an example of its usage.

```
#pragma section MY_APP
void function1( void )
{
    {THIS FUNCTION WILL BE PLACED IN 'PMY_APP'}
}
void function2( void )
{
    {THIS FUNCTION WILL BE PLACED IN 'PMY_APP'}
}
```

- One final consideration is to make sure that all reference functions be part of that section that will be relocated to RAM. It will be no good moving and executing your code from RAM if your code still accidentally calls a function in ROM (that you might have already erased). In some cases, compiler optimization may have your code call a common standard library function to increase code efficiency because calling a single library function will use less code than implementing the functionality multiple times throughout the code. An example of this would be doing 32-bit multiply operations in your application code. This sometimes may be tricky to spot unless you are examining the compiler's generated output. Since these libraries will be located in their default ROM based locations (not your special ROM-to-RAM section), your special reprogramming code may execute OK for erasing a few blocks, but then after erasing the block with the library function call in it, your application will terminally crash.

5. API Functions

5.1 Summary

The following functions are included in this API:

Function	Description
R_FlashErase()	Erases an entire flash block.
R_FlashEraseRange()	Erases a range of addresses. Erases at least 1 flash block.
R_FlashWrite()	Write data to ROM or data flash.
R_FlashDataAreaAccess()	Enable read, write, erase access to data flash.
R_FlashDataAreaBlankCheck()	Check if a data flash address (or block) is erased.
R_FlashProgramLockBit()	Set lock bit for a ROM block so it cannot be erased or written.
R_FlashReadLockBit()	Read lock bit for a ROM block.
R_FLashSetLockBitProtection()	Enable or disable ROM lock bit protection.
R_FlashGetStatus()	Get the current status of flash operations.
R_FlashCodeCopy()	Copy Flash API code from ROM section to RAM.
R_FlashGetVersion()	Get the current version of this API.

5.2 R_FlashErase

This function allows an entire flash block to be erased.

Format

```
uint8_t R_FlashErase(uint32_t block);
```

Parameters

block

Specifies the block to erase. This value is defined in the r_flash_api_rx_if.h file. The blocks are labeled in the same fashion as they are in the device's Hardware Manual. For example, on the RX610 the block located at address 0xFFFFE000 is called Block 0 in the hardware manual therefore "BLOCK_0" should be passed for this parameter.

Return Values

FLASH_SUCCESS:	*Operation successful (if BGO is enabled this means the operations was started successfully)*
FLASH_FAILURE:	*Operation failed.*
FLASH_BUSY:	*Other flash operation in progress, try again later*

Properties

Prototyped in file "r_flash_api_rx_if.h"
Implemented in file "r_flash_api_rx.c"

Description

Erases a single block of flash memory. Starting with RX63x MCUs some RX MCUs now have much smaller erase blocks for the data flash. For example, the RX630, RX631, and RX63N have 32 byte erase blocks. This means that that for a 32KB data flash there are 1024 blocks. Instead of having a definition for each block (e.g. BLOCK_DB0, BLOCK_DB1, …, BLOCK_DB1023) data flash blocks were grouped into 2KB virtual blocks. Each virtual block therefore consists of 64 real data flash blocks. This was done to make it easier on users to delete larger regions of data flash as has been done in the past. Users still have the option of deleting with 32 byte granularity using the R_FlashEraseRange() function.

Reentrant

No, but is protected by lock to prevent errors from concurrent function calls.

Example

```
uint32_t loop;
uint8_t ret;

/* Search for record */
for (loop = 0; loop < NUM_BLOCKS_TO_ERASE; loop++)
{
    /* Erase block */
    ret = R_FlashErase(loop);

    /* Check for errors. */
    if (FLASH_SUCCESS != ret)
    {
        . . .
    }
}
```

Special Notes:

Do not attempt to erase a flash block that you are currently executing from. If you are erasing a data flash block then make sure you have enabled modifications of the data flash block by calling the R_FlashDataAreaAccess() function.

5.3 R_FlashEraseRange (Not Available on RX610, RX62x)

The function starts erasing data flash blocks at a given address and stops when the number of bytes to erase has been reached.

Format

```
uint8_t R_FlashEraseRange(uint32_t start_addr, uint32_t bytes);
```

Parameters

start_addr

Specifies the address where the erase should begin. This must be on an erase boundary and the address must be in the data flash area.

bytes

Specifies the number of bytes to erase. This must be a multiple of the data flash erase size. For example, on the RX630 the data flash erase size is 32 bytes so 32, 64, 96, etc… could used for this parameter.

Return Values

FLASH_SUCCESS:	*Operation successful (if BGO is enabled this means the operations was started successfully)*
FLASH_FAILURE:	*Operation failed.*
FLASH_BUSY:	*Other flash operation in progress, try again later*
FLASH_ERROR_BYTES:	*Number of bytes did not match erase size*
FLASH_ERROR_ADDRESS:	*Invalid address, this is only for data flash*

Properties

Prototyped in file “r_flash_api_rx_if.h”
Implemented in file “r_flash_api_rx.c”

Description

Erases at least 1 data flash block. This function was first introduced for RX63x MCUs that had significantly smaller data flash erase sectors than previous RX600 MCUs. Instead of having the user deal with a large number of data flash block #defines, this function allows the user to send in an address and how many bytes they wish to erase.

Reentrant

No, but is protected by lock to prevent errors from concurrent function calls.

Example

```
uint8_t ret;

/* Erase 64 bytes. */
ret = R_FlashEraseRange(address, 64);

/* Check for errors. */
if (FLASH_SUCCESS != ret)
{
    . . .
}
```

Special Notes:

- This function is not available on RX610 or RX62x MCUs. The reason for this is that these MCUs have larger data flash erase sectors and therefore can be erased using the R_FlashErase() function.
- This function is only available for data flash blocks. Cannot be used on ROM blocks.
- Make sure you have enabled modifications of the data flash block by calling the R_FlashDataAreaAccess() function.

5.4 R_FlashWrite

This function allows data to be written into flash.

Format

```
uint8_t R_FlashWrite( uint32_t   flash_addr,
                      uint32_t   buffer_addr,
                      uint16_t   bytes);
```

Parameters

flash_addr

This is a pointer to the Flash or Data Flash area to write. The address must be on a programming line boundary. See *Description* below for important restrictions regarding this parameter.

buffer_addr

This is a pointer to the buffer containing the data to write to Flash.

bytes

The number of bytes contained in the *buffer_addr* buffer. This number must be a multiple of the programming size for memory area you are writing to. See *Special Notes* below for important restrictions regarding this parameter.

Return Values

FLASH_SUCCESS:	*Operation successful (if BGO is enabled this means the operations was started successfully)*
FLASH_FAILURE:	*Operation failed.*
FLASH_BUSY:	*Other flash operation in progress, try again later*
FLASH_ERROR_ALIGNED:	*Flash address was not on a programming boundary*
FLASH_ERROR_BYTES:	*Number of bytes provided was not a multiple of the programming size*
FLASH_ERROR_ADDRESS:	*Invalid address was input*
FLASH_ERROR_BOUNDARY:	*(ROM) Cannot write across ROM Area Boundaries*

Properties

Prototyped in file “r_flash_api_rx_if.h”
Implemented in file “r_flash_api_rx.c”

Description

Writes data to flash memory.

When performing a write the user must make sure to start the write on a programming boundary and the number of bytes to write must be a multiple of the programming size. The boundaries and programming sizes differ depending on what MCU is being used and whether the ROM or data flash is being written to. Programming boundaries start at the beginning of the flash area and then each boundary is a multiple of the programming size. For example, if the programming line size is 256, then the flash address you pass must have bits B0-B7 all be ‘0’.

Some RX MCUs have ROM Area boundaries (different than programming boundaries previously discussed) that cannot be written over. If the user is writing over this location then they will need to make sure to split up the writes such that the first write will program up to the boundary, and the second write will start at the boundary. If the user tries to write over this boundary the function will return an error before doing any programming operations. The user can see the boundaries for their device by looking at the ROM_AREA_# definitions for their device in *r_flash_api_rx_private.h*.

Reentrant

No, but is protected by lock to prevent errors from concurrent function calls.

Example

```
uint8_t ret;
uint8_t write_buffer[PROGRAM_SIZE] = “Hello World...”;

/* Write data to internal memory. */
ret = R_FlashWrite(address, (uint32_t)write_buffer, PROGRAM_SIZE);

/* Check for errors. */
if (FLASH_SUCCESS != ret)
{
    . . .
}
```

Special Notes:

The programming sizes for different RX MCUs are shown in the table below.

MCU	ROM Programming Line Size	Data Flash Programming Line Size
RX61x & RX62x Groups	256 bytes	8 or 128 bytes
RX63x Groups	128 bytes	2 bytes
RX210 Group	2, 8, or 128 bytes	2 or 8 bytes

If you are writing a data flash block then make sure you have enabled modifications of the data flash block by calling the R_FlashDataAreaAccess() function.

5.5 R_FlashDataAreaAccess

This function allows Data Flash areas to be accessed or modified. **The data flash cannot be read, written, or erased before calling this function.**

Format

```
void R_FlashDataAreaAccess(uint16_t read_en_mask,
                           uint16_t write_en_mask);
```

Parameters

read_en_mask

This is a bitmapped value where bits are used to determine which Data blocks should be able to be read by the MCU. A '0' indicates the block cannot be accessed and a '1' indicates it can. Bits 0-3 represent Data Blocks 0-3 respectively.

write_en_mask

This is a bitmapped value where bits are used to determine which Data blocks should be able to be modified (Erase/Write) by the Flash Control Unit (FCU). A '0' indicates the block cannot be modified and a '1' indicates it can. Bits 0-3 represent Data Blocks 0-3 respectively.

Return Values

None.

Properties

Prototyped in file "r_flash_api_rx_if.h"
Implemented in file "r_flash_api_rx.c"

Description

After reset, the data flash area is not readable by the MCU. It is also not enabled for reprogramming. This function is used to select what blocks you would like to be read or modifiable. You only have to set this function once at the beginning of your application.

Reentrant

No, but this function should only need to be called once after reset.

Example

```
/* Enable reading, writing, and erasing of all data flash blocks. */
R_FlashDataAreaAccess(0xFFFF, 0xFFFF);
```

Special Notes:

None.

5.6 R_FlashDataAreaBlankCheck

This function is used to determine if an area in the Data Flash area is blank or not, since this cannot be determined by simply reading the memory location. **This function is required because the user cannot read data flash locations and check they are blank by comparing them to 0xFF.**

Format

```
uint8_t R_FlashDataAreaBlankCheck(uint32_t address,
                                  uint8_t size);
```

Parameters

address

The address of the area to blank check.
If the parameter 'size' is specified as 'BLANK_CHECK_8_BYTE' (available on RX610 and RX62x devices), this should be set to an 8-byte address boundary.
If the parameter 'size' is specified as 'BLANK_CHECK_2_BYTE' (available on RX63x devices), this should be set to a 2-byte address boundary.
If the parameter 'size' is specified as 'BLANK_CHECK_ENTIRE_BLOCK' (available on all RX600 and RX200 Series devices), this should be set to a defined Data Block Number ('BLOCK_DB0', 'BLOCK_DB1', 'BLOCK_DB2' or 'BLOCK_DB3') or an address in the data flash block. Either option will work.

size

This specifies if you are checking an 8-byte location, 2-byte location, or an entire 8KB block. You must set this to either 'BLANK_CHECK_2_BYTE', 'BLANK_CHECK_8_BYTE', or 'BLANK_CHECK_ENTIRE_BLOCK'.

Return Values

FLASH_BLANK:	*(2 or 8 Byte check or non-BGO) Address was blank.* *(Entire Block & BGO) Blank check operation started.*
FLASH_NOT_BLANK:	*Address was not blank*
FLASH_FAILURE:	*Operation Failed*
FLASH_BUSY:	*Another flash operation is in progress*
FLASH_ERROR_ADDRESS:	*Invalid address was input*
FLASH_ERROR_BYTES:	*Incorrect 'size' was submitted*

Properties

Prototyped in file “r_flash_api_rx_if.h”
Implemented in file “r_flash_api_rx.c”

Description

Before you can write to any flash area in an MCU, the area must already be blank. Since the memory locations in RX600 and RX200 Series Data Flash areas are not represented by a defined ‘blank’ value of 0xFF like they are in the User Program area, an additional function is needed to test a section of flash to determine if it is blank.

RX600 and RX200 Series devices have two methods for checking for blank areas; one checks a smaller area and the other a larger area. The number of bytes checked by the smaller method is same as the programming size for the data flash (i.e. 8 bytes on RX610 and RX62x, 2 bytes on RX63x). The larger check performs the blank check on the entire Data Flash block at once. This function does not have to be called for each section prior to programming. It is simply here to assist in application programming.

Reentrant

No, but is protected by lock to prevent errors from concurrent function calls.

Example

```
uint8_t ret;

/* Blank check an entire data flash block. */
ret = R_FlashDataAreaBlankCheck(address, BLANK_CHECK_ENTIRE_BLOCK);

/* Check result. */
if (FLASH_NOT_BLANK == ret)
{
    /* Block is not blank. */
    . . .
}
else if (FLASH_BLANK == ret)
{
    /* Block is blank. */
    . . .
}
```

Special Notes:

The blank check sizes for different RX MCUs are shown in the table below.

MCU	Blank Check Sizes
RX610	8 bytes or Entire Block (8KB)
RX62x	8 bytes or Entire Block (2KB)
RX63x	2 bytes or Entire Block (2KB)
RX210	2 bytes or Entire Block (2KB)

5.7 R_FlashProgramLockBit

Sets the lock bit for a flash block.

Format

```
uint8_t R_FlashProgramLockBit(uint32_t block);
```

Parameters

block

The ROM erasure block that will have its lock bit set.

Return Values

FLASH_SUCCESS:	*Operation successful, lock bit set.*
FLASH_FAILURE:	*Operation failed.*
FLASH_BUSY:	*Other flash operation in progress, try again later*

Properties

Prototyped in file “r_flash_api_rx_if.h”
Implemented in file “r_flash_api_rx.c”

Description

Each block of ROM has a lock bit associated with it. If lock bit protection is enabled and the lock bit is set for a given block then that block cannot be programmed or erased. If an attempt to erase or program the block is made, the operation will be ignored. This function will set the lock bit for the selected flash block. Whether lock bit protection is enabled or not is controlled by the API function R_FlashSetLockBitProtection().

Reentrant

No, but is protected by lock to prevent errors from concurrent function calls.

Example

```
uint8_t ret;

/* Enable lock bit protection (this is default out of reset) */
ret = R_FlashSetLockBitProtection(true);

/* Check for errors. */
if (FLASH_SUCCESS != ret)
{
    . . .
}

/* Program lock bits */
ret = R_FlashProgramLockBit(flash_block);

/* Check for errors. */
if (FLASH_SUCCESS != ret)
{
    . . .
}
```

Special Notes:

- Lock bits for a flash block are cleared by erasing the flash block with lock bit protection disabled.
- This function is not available for use when the *FLASH_API_RX_CFG_IGNORE_LOCK_BITS* macro is defined in *r_flash_api_rx_config.h*.

5.8 R_FlashReadLockBit

Reads the lock bit for a flash block.

Format

```
uint8_t R_FlashReadLockBit(uint32_t block);
```

Parameters

block

The ROM erasure block that will have its lock bit read.

Return Values

FLASH_LOCK_BIT_SET:	*Lock bit is set*
FLASH_LOCK_BIT_NOT_SET:	*Lock bit is not set*
FLASH_FAILURE:	*Operation Failed*
FLASH_BUSY:	*Another flash operation is in progress*

Properties

Prototyped in file “r_flash_api_rx_if.h”
Implemented in file “r_flash_api_rx.c”

Description

Each block of ROM has a lock bit associated with it. If lock bit protection is enabled and the lock bit is set for a given block then that block cannot be programmed or erased. If an attempt to erase or program the block is made, the operation will be ignored. This function will return whether a flash block has its lock bit set or not. Whether lock bit protection is enabled or not is controlled by the API function R_FlashSetLockBitProtection().

Reentrant

No, but is protected by lock to prevent errors from concurrent function calls.

Example

```
uint8_t ret;

/* Program lock bits */
ret = R_FlashReadLockBit(flash_block);

/* Check result. */
if (FLASH_LOCK_BIT_SET == ret)
{
    /* Lock bit is set for this block. */
    . . .
}
else if (FLASH_LOCK_BIT_NOT_SET == ret)
{
    /* Lock bit was not set for this block. */
    . . .
}
```

Special Notes:

- Lock bits for a flash block are cleared by erasing the flash block with lock bit protection disabled.
- This function is not available for use when the *FLASH_API_RX_CFG_IGNORE_LOCK_BITS* macro is defined in *r_flash_api_rx_config.h*.

5.9 R_FlashSetLockBitProtection

Enables or disables lock bit protection.

Format

```
uint8_t R_FlashSetLockBitProtection(uint32_t lock_bit);
```

Parameters

lock_bit

Boolean value that determines whether to enable or disable lock bit protection. If set to 'true' then lock bit protection will be enabled. If set to 'false' then lock bit protection will be disabled.

Return Values

FLASH_SUCCESS:	*Operation was successful*
FLASH_BUSY:	*Flash is busy with another operation*

Properties

Prototyped in file "r_flash_api_rx_if.h"
Implemented in file "r_flash_api_rx.c"

Description

Each block of ROM has a lock bit associated with it. If lock bit protection is enabled and the lock bit is set for a given block then that block cannot be programmed or erased. If an attempt to erase or program the block is made, the operation will be ignored. This function controls whether lock bit protection is enabled. If disabled then all flash blocks are eligible for programming and erasure regardless of whether their lock bit is set or not.

Reentrant

No, but is protected by lock to prevent errors from concurrent function calls.

Example

```
uint8_t ret;

/* Enable lock bit protection (this is default out of reset) */
ret = R_FlashSetLockBitProtection(true);

/* Check for errors. */
if (FLASH_SUCCESS != ret)
{
    . . .
}
```

Special Notes:

- Lock bits for a flash block are cleared by erasing the flash block with lock bit protection disabled.
- This function is not available for use when the *FLASH_API_RX_CFG_IGNORE_LOCK_BITS* macro is defined in *r_flash_api_rx_config.h*.

5.10 R_FlashGetStatus

Returns the current state of the flash.

Format

```
uint8_t R_FlashGetStatus(void);
```

Parameters

None.

Return Values

FLASH_SUCCESS:	*Flash is ready to use*
FLASH_BUSY:	*Flash is busy with another operation*

Properties

Prototyped in file “r_flash_api_rx_if.h”
Implemented in file “r_flash_api_rx.c”

Description

This function will return the current state of the flash. If BGO operations are used then this function call can be used to poll for detecting when the last flash operation has finished.

Reentrant

Yes.

Example

```
uint8_t ret;

/* Blank check an entire data flash block. */
ret = R_FlashDataAreaBlankCheck(address, BLANK_CHECK_ENTIRE_BLOCK);

while( R_FlashGetStatus() == FLASH_BUSY )
{
    /* Wait for previous operation to finish. You could also stall this task
       and do some real work. */
}
```

Special Notes:

None.

5.11 R_FlashCodeCopy

Copies Flash API code from ROM to RAM.

Format

```
void R_FlashCodeCopy(void);
```

Parameters

None.

Return Values

None.

Properties

Prototyped in file “r_flash_api_rx_if.h”
Implemented in file “r_flash_api_rx.c”

Description

When programming or erasing ROM the Flash API code cannot reside in ROM. This function will transfer the code from ROM to RAM.

Reentrant

Yes.

Example

```
/* Transfer Flash API code to RAM so that we can program/erase ROM. */
R_FlashCodeCopy();

/* Flash API can now program/erase ROM. */
```

Special Notes:

- If you are only programming/erasing data flash (not ROM) then all Flash API code will reside in ROM and this function will not need to be called.
- If using the *dbsct.c* method described in Section 2.12 then this function does not need to be run.
- If you are programming/erasing ROM and not using the *dbsct.c* method then this function ***must*** be run before any other Flash API functions are called. If this function is not called first then other Flash API functions will jump to uninitialized RAM.

5.12 R_FlashGetVersion

Returns the current version of the Flash API.

Format

```
uint32_t R_FlashGetVersion(void);
```

Parameters

None.

Return Values

Version of Flash API.

Properties

Prototyped in file “r_flash_api_rx_if.h”
Implemented in file “r_flash_api_rx.c”

Description

This function will return the version of the currently installed Flash API. The version number is encoded where the top 2 bytes are the major version number and the bottom 2 bytes are the minor version number. For example, Version 4.25 would be returned as 0x00040019.

Reentrant

Yes.

Example

```
uint32_t cur_version;

/* Get version of installed Flash API. */
cur_version = R_FlashGetVersion();

/* Check to make sure version is new enough for this application’s use. */
if (MIN_VERSION > cur_version)
{
    /* This Flash API version is not new enough and does not have XXX feature
       that is needed by this application. Alert user. */
    ....
}
```

Special Notes:

- This function is specified to be an inline function in *r_flash_api_rx.c.*

6. Demo Projects

Demo projects that go through all of the API features are included with this application note. *flash_api_rx_demo_main.c* is the file that contains the *main*() function and the demo code.

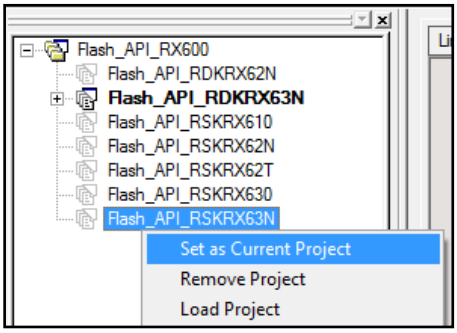
6.1 HEW Workspace

The demo workspace is made up a number of different projects. Each project is setup for a different development board. For example, there are individual projects for the RSKRX62N, RSKRX630, YRDKRX63N, etc. The project is structured this way because this middleware uses the r_bsp package for foundational board support. Therefore, each project has the startup files needed for that board.

To run the demo for a particular board, follow these steps.

In HEW:

1. Select the appropriate project for your board from within the Flash_API_RX workspace. This is done in HEW by right-clicking on the project for your board and selecting 'Set as Current Project'.



2. Select which board you are using from the header file *platform.h*. This file is located in the r_bsp folder. For example, if you are using the RSK+RX63N then you would uncomment the RSKRX63N #include as shown below.

```
/***********************************************************************
DEFINE YOUR SYSTEM - UNCOMMENT THE INCLUDE PATH FOR THE PLATFORM YOU ARE USING.
***********************************************************************/
/* RSKRX610 */
//#include "./board/rskrx610/r_bsp.h"

/* RSKRX62N */
//#include "./board/rskrx62n/r_bsp.h"

/* RSKRX62T */
//#include "./board/rskrx62t/r_bsp.h"

/* RDKRX62N */
//#include "./board/rdkrx62n/r_bsp.h"

/* RSKRX630 */
//#include "./board/rskrx630/r_bsp.h"

/* RSKRX63N */
#include "./board/rskrx63n/r_bsp.h"
```

After these changes are made you can build the project and run the demo.

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Revision Record

Rev.	Date	Description	
		Page	Summary
1.00	Jan.27.10	—	First edition issued
1.20	Feb.11.10	—	Made minor text revisions and added section on disabling interrupts.
1.30	Mar.05.10	—	Made fixes based on recommendations from RTE
1.40	May.26.10	—	Revised to include support for the RX62x Group
1.41	Jun.11.10	—	Fixed some typographical errors
1.43	Feb.18.11	12	Updated blank check function argument description
2.00	Apr.27.11	—	API now includes support for BGO, flash to flash transfers, and lock bit protection.
2.10	Jul.11.11	—	Added support for RX630, RX631, and RX63N devices. Removed ‘DATA_FLASH_OPERATION_PIPL’ and ‘ROM_OPERATION_PIPL’ definitions and added section that talks about why this was done. Added R_FlashEraseRange() function to API. Rewrote section on ROM area boundaries (used to be Section 3.4) to apply to RX610 and RX63x devices.
2.20	Dec.01.11	—	Moved document over to new template. Restructured existing data and added new information about using r_bsp package. Added the R_FlashCodeCopy() function to the API.
2.30	Sep.12.12	—	Added R_FlashGetVersion() function to the API. Removed config macro for not using r_bsp; the code now recognizes this automatically. Added ‘Configure for Only Data Flash Use’, ‘Erased Entire User Application Area’, ‘Reading from Data Flash After Reset’, ‘Checking if a Data Flash Location is Blank’, and ‘Putting Flash API in User Boot Area’ sections. Added blank check size table in R_FlashDataAreaBlankCheck section.
2.40	Dec.12.12	—	Added support for RX210, RX62G, and RX63T MCUs. Since RX200 Series devices are now supported the name was changed from Simple Flash API for RX600 to Simple Flash API for RX. Expanded ‘Checking if a Data Flash Location is Blank (Erased)’ section. Added note on first page about where to find info about why erased data flash locations are not read as 0xFF since this question comes up often. Added API list to beginning of API Functions section. Added Demo Projects section.

General Precautions in the Handling of MPU/MCU Products

The following usage notes are applicable to all MPU/MCU products from Renesas. For detailed usage notes on the products covered by this manual, refer to the relevant sections of the manual. If the descriptions under General Precautions in the Handling of MPU/MCU Products and in the body of the manual differ from each other, the description in the body of the manual takes precedence.

1. Handling of Unused Pins
   Handle unused pins in accord with the directions given under Handling of Unused Pins in the manual.
   — The input pins of CMOS products are generally in the high-impedance state. In operation with an unused pin in the open-circuit state, extra electromagnetic noise is induced in the vicinity of LSI, an associated shoot-through current flows internally, and malfunctions occur due to the false recognition of the pin state as an input signal become possible. Unused pins should be handled as described under Handling of Unused Pins in the manual.
2. Processing at Power-on
   The state of the product is undefined at the moment when power is supplied.
   — The states of internal circuits in the LSI are indeterminate and the states of register settings and pins are undefined at the moment when power is supplied.
   In a finished product where the reset signal is applied to the external reset pin, the states of pins are not guaranteed from the moment when power is supplied until the reset process is completed.
   In a similar way, the states of pins in a product that is reset by an on-chip power-on reset function are not guaranteed from the moment when power is supplied until the power reaches the level at which resetting has been specified.
3. Prohibition of Access to Reserved Addresses
   Access to reserved addresses is prohibited.
   — The reserved addresses are provided for the possible future expansion of functions. Do not access these addresses; the correct operation of LSI is not guaranteed if they are accessed.
4. Clock Signals
   After applying a reset, only release the reset line after the operating clock signal has become stable. When switching the clock signal during program execution, wait until the target clock signal has stabilized.
   — When the clock signal is generated with an external resonator (or from an external oscillator) during a reset, ensure that the reset line is only released after full stabilization of the clock signal. Moreover, when switching to a clock signal produced with an external resonator (or by an external oscillator) while program execution is in progress, wait until the target clock signal is stable.
5. Differences between Products
   Before changing from one product to another, i.e. to one with a different type number, confirm that the change will not lead to problems.
   — The characteristics of MPU/MCU in the same group but having different type numbers may differ because of the differences in internal memory capacity and layout pattern. When changing to products of different type numbers, implement a system-evaluation test for each of the products.

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