RX Family

Battery Backup Function Module Firmware Integration Technology

Introduction

This application note describes a battery backup function module that uses Firmware Integration Technology (FIT).

This module reports to the user whether or not a voltage drop has occurred in either the battery backup supply voltage or the VBATT pin voltage. Based on the content reported, the user can determine whether or not the value of the real-time clock can be guaranteed, and whether or not the VBATT pin voltage has fallen.

This module is referred to as the battery backup function FIT module in the remainder of this document.

Target Device

- RX230 Group
- RX231 Group
- RX23W Group

When using this application note with other Renesas MCUs, careful evaluation is recommended after making modifications to comply with the alternate MCU.

Target Compilers

- Renesas Electronics C/C++ Compiler Package for RX Family
- GCC for Renesas RX
- IAR C/C++ Compiler for Renesas RX

For details of the confirmed operation contents of each compiler, refer to “4.1 Confirmed Operation Environment".

Related Documents

- RX Family Board Support Package Module Using Firmware Integration Technology (R01AN1685)

Contents

1. Overview

1.1 The Battery Backup Function FIT Module

This module is embedded in projects as an API. See section 2.12, Adding the FIT Module to Your Project, for embedding this module.

1.2 Battery Backup Function FIT Module Overview

When this module is used, the VBATT pin voltage drop detection function can be set up and the state of the battery backup function can be read out. Furthermore, the following four states can be recognized using callback function arguments.

(1) No battery backup supply voltage drop detected
(2) Battery backup supply voltage drop detected
(3) A nonmaskable interrupt due to VBATT pin voltage drop detection occurred
(4) A maskable interrupt due to VBATT pin voltage drop detection occurred

1.2.1 API Function Specifications

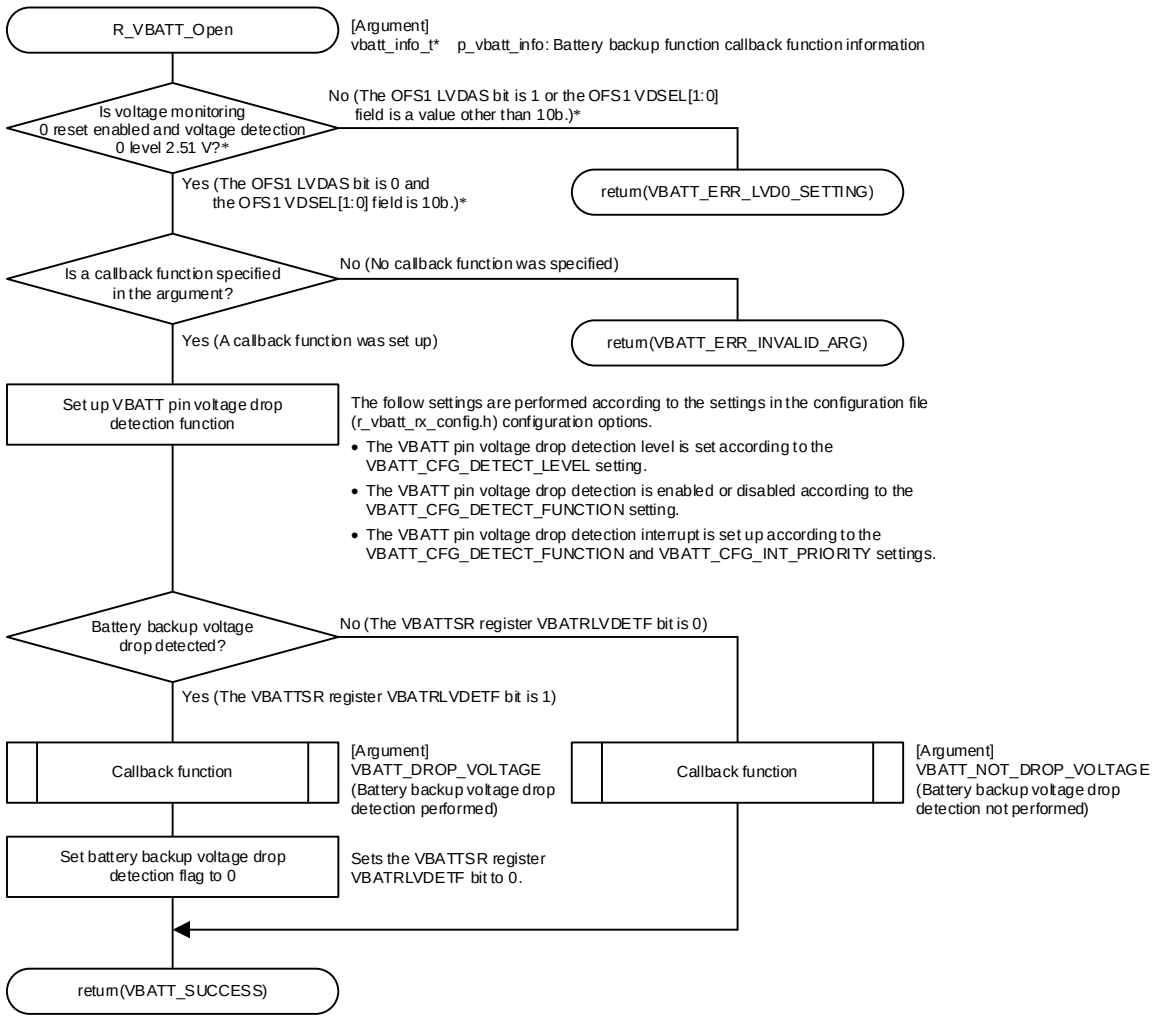
When the R_VBATT_Open() function is called, it checks whether or not the voltage monitoring 0 settings are correct and whether or not a callback function was specified and if there is a problem, it returns an error and terminates function execution. If the argument settings are valid, it sets up the VBATT pin voltage drop detection function according to the settings in the configuration file (r_vbatt_rx_config.h) configuration options. After that it checks if the battery backup voltages (the VCC and VBATT pins) have fallen (the VBATTSR register VBATRLVDETF bits) and performs the following processing according to that result.

If a battery backup voltage drop has been detected, it calls the callback function with VBATT_DROP_VOLTAGE as the argument. After calling the callback function, it sets the battery backup voltage drop detection flag to 0 (battery backup voltage drop not detected).

If no battery backup voltage drop was detected, it calls the callback function with VBATT_NOT_DROP_VOLTAGE as the argument.

Figure 1.1 shows the flowchart of the R_VBATT_Open() function.

See section 2.7, Configuration Overview, and section 2.11, Callback Function, for details on the configuration file options and macro definitions used as callback function arguments.



Note: * For the RX231 microcontroller.

Figure 1.1 R_VBATT_Open() Function Flowchart

When the R_VBATT_Control() function is called, it checks whether or not the argument values are correct and, and if there is a problem, it returns an error and terminates function execution. If the argument settings are valid, it sets the VBATT pin voltage drop detection function enabled/disabled state and the detection level, and it sets up the interrupt, according to the values set in the arguments.

Figure 1.2 shows the flowchart of the R_VBATT_Control() function.

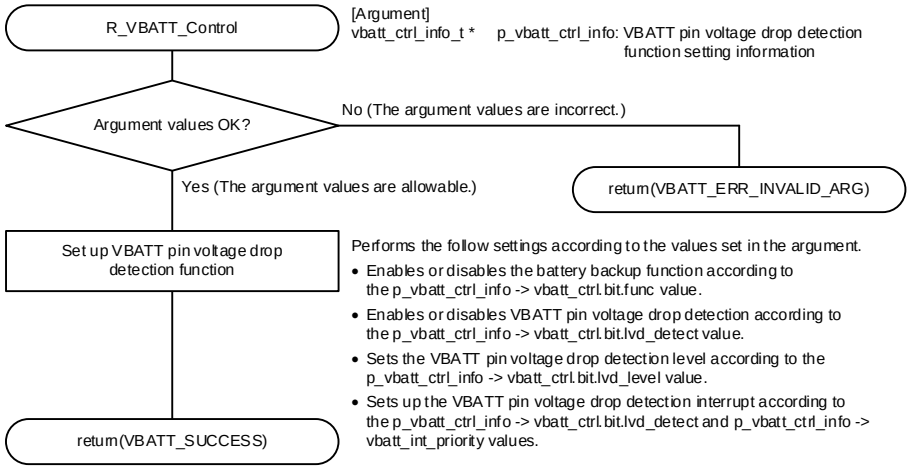


Figure 1.2 R_VBATT_Control() Function Flowchart

When the R_VBATT_GetStatus() function is called, it determines if VBATT pin voltage drop detection is enabled and if whether or not the argument values are correct and, and if there is a problem, it returns an error and terminates function execution. If the argument settings are valid, it reads out the value of the VBATT status register (VBATTSR). The read out value is stored at the address received as an argument.

Figure 1.3 shows the flowchart of the R_VBATT_GetStatus() function.

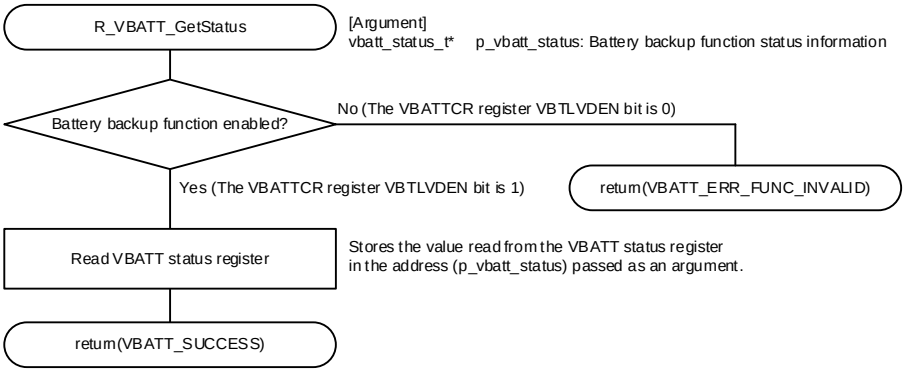


Figure 1.3 R_VBATT_GetStatus() Function Flowchart

1.2.2 Interrupt Specifications

When the interrupt used when a VBATT pin voltage drop is set to be a maskable interrupt, when this maskable interrupt occurs, the callback function is called with VBATT_MASKABLE_INTERRUPT as the argument.

Figure 1.4 shows the flowchart of the r_vbatt_isr() function.

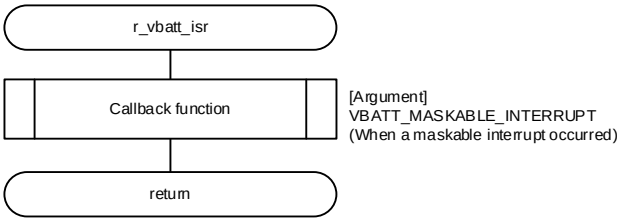


Figure 1.4 r_vbatt_isr() Function Flowchart

When the interrupt used when a VBATT pin voltage drop is set to be a nonmaskable interrupt, when this nonmaskable interrupt occurs, the callback function is called with VBATT_NON_MASKABLE_INTERRUPT as the argument.

Figure 1.5 shows the flowchart of the r_vbatt_nmi_isr() function.

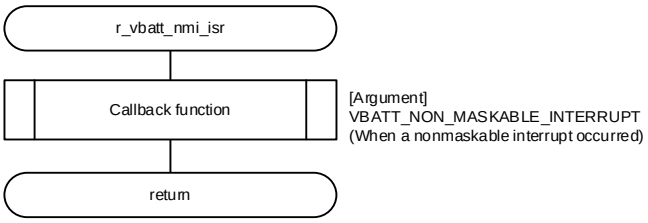


Figure 1.5 r_vbatt_nmi_isr() Function Flowchart

1.3 API Overview

Table 1.1 lists the API functions provided by this module.

Table 1.1 API Functions

Function	Function description
R_VBATT_Open()	Sets the VBATT pin voltage drop detection enabled/disabled state and the detection level and sets up the interrupt according to the configuration option settings. After that, it discriminates whether or not a battery backup supply voltage drop has occurred and calls the callback function.
R_VBATT_Control()	Sets the VBATT pin voltage drop detection enabled/disabled state and the detection level and sets up the interrupt according to the settings specified in the arguments.
R_VBATT_GetStatus()	Acquires the status of the battery backup function.
R_VBATT_GetVersion()	Returns the version number of this module.

1.4 Usage Example

Call the R_VBATT_Open() function immediately after the reset start. The callback function should perform processing based on the value of its arguments.

Table 1.2 lists the callback function's arguments and processing that should be performed, and Figure 1.6 shows a usage example of the battery backup function FIT module.

Table 1.2 Callback Function's Arguments and Processing that Should be Performed

Argument	VBATT_NOT_DROP_VOLTAGE (Battery backup voltage drop detection not performed)	VBATT_DROP_VOLTAGE (Battery backup voltage drop detection performed)	VBATT_MASKABLE_INTERRUPT VBATT_NON_MASKABLE_INTERRUPT (VBATT pin voltage drop detection interrupt)
Processing that Should be Performed	Reset the RAM and RTC registers as required.	The real-time clock must be initialized.	Operations such as displaying a warning that the external battery level is low and backing up data should be performed.
Reason	When the battery backup supply voltage has not dropped, the value of the RTC register will be saved, but RAM and the RTC interrupt registers will be set to their post-reset values. Therefore, the RAM and RTC interrupt register values must be set again.	When the battery backup supply voltage drops, the real-time clock registers and RAM go to their values after a reset. Therefore initialization is required.	This interrupt occurs when the supply voltage on the VBATT pin falls. Processing to handle the situation where the VBATT pin supply voltage has fallen can be performed.

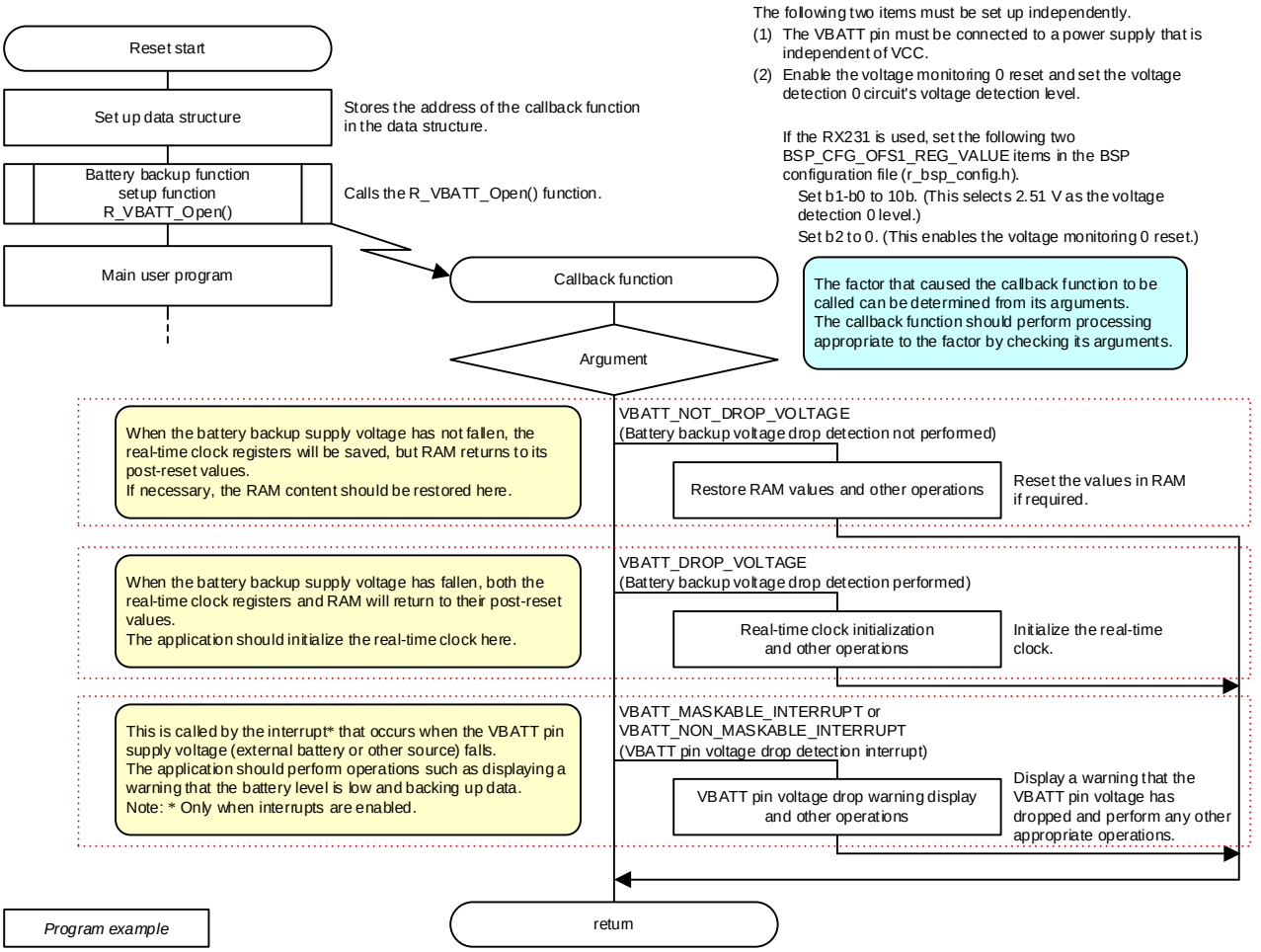


Figure 1.6 Usage Example of the Battery Backup Function FIT Module

1.5 Limitations

- The VBATT pin must be connected to a power supply independent from VCC.
- The voltage monitoring function 0 reset should be enabled and the voltage detection level for voltage detection 0 circuit should be set. (This is 2.51 V for RX231 Group microcontrollers.)

2. API Information

This FIT module has been confirmed to operate under the following conditions.

2.1 Hardware Requirements

The microcontroller used must support the following function.

- Battery backup function

2.2 Software Requirements

This driver is dependent upon the following FIT module:

- Renesas Board Support Package (r_bsp) v5.00 or higher

2.3 Supported Toolchain

This driver has been confirmed to work with the toolchain listed in 4.1, Confirmed Operation Environment.

2.4 Interrupt Vector

The VBATT pin voltage drop detection interrupt is enabled by executing the R_VBATT_Open function (while the macro definition VBATT_CFG_DETECT_FUNCTION is VBATT_DTCT_ENABLE_NMI_ENABLE or VBATT_DTCT_ENABLE_INT_ENABLE).

Table 2.1 lists the interrupt vector used in the Battery Backup Function FIT Module.

Table 2.1 Interrupt Vector Used in the Battery Backup Function FIT Module

Device	Interrupt Vector
RX230 RX231 RX23W	VBATT pin voltage drop detection interrupt (vector no.: 91) (1)

Note 1. A non-maskable interrupt is generated if the macro definition VBATT_CFG_DETECT_FUNCTION is VBATT_DTCT_ENABLE_NMI_ENABLE, and a maskable interrupt is generated if VBATT_DTCT_ENABLE_INT_ENABLE.

2.5 Header Files

All API calls and their supporting interface definitions are located in r_vbatt_rx_if.h.

2.6 Integer Types

This project uses ANSI C99. These types are defined in stdint.h.

2.7 Configuration Overview

This module configuration options are set in r_vbatt_rx_config.h.

The table below lists the option names and set values.

Configuration options in r_vbatt_rx_config.h	
#define VBATT_CFG_DETECT_FUNCTION Note: The default value is "VBATT_DTCT_DISABLE"	Selects whether or not the VBATT pin voltage drop detection function is used. This also selects the interrupt generated when a voltage drop is detected. For VBATT_DTCT_DISABLE: The VBATT pin voltage drop detection function is set to invalid and the interrupt is disabled. For VBATT_DTCT_ENABLE_INT_DISABLE: The VBATT pin voltage drop detection function is enabled and the interrupt is disabled. For VBATT_DTCT_ENABLE_NMI_ENABLE: The VBATT pin voltage drop detection function is enabled and the nonmaskable interrupt is enabled as the interrupt. For VBATT_DTCT_ENABLE_INT_ENABLE: The VBATT pin voltage drop detection function is enabled and the maskable interrupt is enabled as the interrupt.
#define VBATT_CFG_DETECT_LEVEL Note: The default value is "VBATT_DTCT_LEVEL_2_20_V"	The VBATT pin voltage drop detection level can be selected. For VBATT_DTCT_LEVEL_2_20_V, the detection level is set to 2.20 V. For VBATT_DTCT_LEVEL_2_00_V, the detection level is set to 2.00 V.
#define VBATT_CFG_INT_PRIORITY Note: The default value is "5"	The interrupt priority level can be selected when a maskable interrupt is used as the VBATT pin voltage drop detection interrupt. The value selected by a value from 1 to 15 is set as the interrupt level. Note: This setting is only valid when VBATT_DTCT_ENABLE_INT_ENABLE is selected by VBATT_CFG_DETECT_FUNCTION.

2.8 Code Size

The sizes of ROM, RAM, and maximum stack usage associated with this module are listed below.

The ROM (code and constants) and RAM (global data) sizes are determined by the build-time configuration options described in 2.7 Configuration Overview, Configuration Overview.

The values in the table below are confirmed under the following conditions.

Module Revision: r_vbatt_rx rev1.03

Compiler Version: Renesas Electronics C/C++ Compiler Package for RX Family V3.01.00

(The option of “-lang = c99” is added to the default settings of the integrated development environment.)

GCC for Renesas RX 4.8.4.201801

(The option of “-std = gnu99” is added to the default settings of the integrated development environment.)

IAR C/C++ Compiler for Renesas RX version 4.10.1

(The default settings of the integrated development environment)

Configuration Options: Default settings

ROM, RAM and Stack Code Sizes

Device	Category	Memory Used					
		Renesas Compiler		GCC		IAR Compiler	
		With Parameter Checking	Without Parameter Checking	With Parameter Checking	Without Parameter Checking	With Parameter Checking	Without Parameter Checking
RX230	ROM	**6117 bytes**	**6060 bytes**	**8844 bytes**	**8788 bytes**	**5126 bytes**	**4946 bytes**
	RAM	**6958 bytes**		**6764 bytes**		**1640 bytes**	
	STACK	**128 bytes**		**-**		**184 bytes**	
RX231	ROM	**6177 bytes**	**6120 bytes**	**8972 bytes**	**8916 bytes**	**5206 bytes**	**5026 bytes**
	RAM	**6974 bytes**		**6780 bytes**		**1656 bytes**	
	STACK	**128 bytes**		**-**		**184 bytes**	

Note 1. The size includes BSP.

2.9 Arguments

This section presents the structures used as arguments to the API functions. These structures are included in the file r_vbatt_rx_if.h along with the API function prototype declarations.

```
/* Battery backup function data structure */
typedef volatile struct
{
   vbatt_callback_t    callbackfunc;    /* Callback function */
} vbatt_info_t;



/* Structure used to set up the VBATT pin voltage drop detection function
again */
typedef volatile struct
{
   uint8_t  rsv2;                   /* Reserved area */
   uint8_t  rsv1;                   /* Reserved area */
   uint8_t  vbatt_int_priority;     /* Interrupt priority level for
                                       the VBATT pin voltage drop detection
                                       interrupt (maskable interrupt) */
   union
   {
      uint8_t  byte;
      struct
      {
         uint8_t  rsv:3;       /* Reserved area */
         uint8_t  lvd_level:2; /* VBATT pin voltage drop detection level */
         uint8_t  lvd_detect:2;/* VBATT pin voltage drop detection function */
         uint8_t  func:1;      /* Enabled/disabled state of the battery backup
                                  function */
      } bit;
   } vbatt_ctrl;
} vbatt_ctrl_info_t;



/* Structure used to hold the state of the battery backup function */
typedef volatile struct
{
   union
   {
      uint8_t     byte;
      struct
      {
         uint8_t  rsv:6;            /* Reserved area */
         uint8_t  vbatt_mon:1;      /* VBATT pin voltage monitor flag */
         uint8_t  pwr_drp_dtct:1;   /* Battery backup supply voltage drop
                                       detection flag */
      } bit;
   } vbatt_status;
} vbatt_status_t;
```

2.10 Return Values

This section presents the return values from the API functions. This enumeration type is defined in the file r_vbatt_rx_if.h along with the API function prototype declarations.

```
typedef enum                /* Return value used for calls to battery backup
                               API functions */
{
   VBATT_SUCCESS,           /* Processing completed without problem */
   VBATT_ERR_LOCK_FUNC,     /* The function was called multiple times */
                               (Not implemented)
   VBATT_ERR_LVD0_SETTING,  /* Illegal voltage monitoring 0 settings in
                               option function selection register 1 (OFS1) */
   VBATT_ERR_INVALID_ARG,   /* Invalid argument */
   VBATT_ERR_FUNC_INVALID,  /* R_VBATT_GetStatus() was called when VBATT pin
                               voltage drop detection was invalid */
   VBATT_ERR_OTHER          /* Other error */
} vbatt_return_t;
```

2.11 Callback Function

In this module, a callback function is called when the R_VBATT_Open() function is called or when an interrupt occurs. The callback function takes an argument whose set value determines whether a battery backup voltage drop was detected, or whether it was called from an interrupt handler when the VBATT pin voltage fell.

Table 2.2 lists the constant definitions (enum vbatt_cb_evt_t) for the argument passed to the callback function.

For callback function setup, the address of the callback function to be registered should be stored in “callbackfunc” member in the structure described in section 2.9, Arguments.

Table 2.2 Definitions of Constants Passed as an Argument to the Callback Function (enum vbatt_cb_evt_t)

Defined Constant	Conditions for Passing as an Argument
VBATT_NOT_DROP_VOLTAGE	When R_VBATT_Open() was called in the state where a battery backup supply voltage drop was not detected (the VBATTSR register VBATRLVDETF bit was 0)
VBATT_DROP_VOLTAGE	When R_VBATT_Open() was called in the state where a battery backup supply voltage drop was detected (the VBATTSR register VBATRLVDETF bit was 1)
VBATT_MASKABLE_INTERRUPT	When a maskable interrupt due to a voltage drop on the VBATT pin occurred
VBATT_NON_MASKABLE_INTERRUPT	When a nonmaskable interrupt due to a voltage drop on the VBATT pin occurred

2.12 Adding the FIT Module to Your Project

This module must be added to each project in which it is used. Renesas recommends the method using the Smart Configurator described in (1) or (3) or (5) below. However, the Smart Configurator only supports some RX devices. Please use the methods of (2) or (4) for RX devices that are not supported by the Smart Configurator.

(1) Adding the FIT module to your project using the Smart Configurator in e^2 studio
By using the Smart Configurator in e^2 studio, the FIT module is automatically added to your project. Refer to “RX Smart Configurator User’s Guide: e^2 studio (R20AN0451)” for details.

(2) Adding the FIT module to your project using the FIT Configurator in e^2 studio
By using the FIT Configurator in e^2 studio, the FIT module is automatically added to your project. Refer to “RX Family Adding Firmware Integration Technology Modules to Projects (R01AN1723)” for details.

(3) Adding the FIT module to your project using the Smart Configurator in CS+
By using the Smart Configurator Standalone version in CS+, the FIT module is automatically added to your project. Refer to “RX Smart Configurator User’s Guide: CS+ (R20AN0470)” for details.

(4) Adding the FIT module to your project in CS+
In CS+, please manually add the FIT module to your project. Refer to “RX Family Adding Firmware Integration Technology Modules to CS+ Projects (R01AN1826)” for details.

(5) Adding the FIT module to your project using the Smart Configurator in IAREW
By using the Smart Configurator Standalone version, the FIT module is automatically added to your project. Refer to “RX Smart Configurator User’s Guide: IAREW (R20AN0535)” for details.

2.13 “for”, “while” and “do while” statements

In this module, “for”, “while” and “do while” statements (loop processing) are used in processing to wait for register to be reflected and so on. For these loop processing, comments with “WAIT_LOOP” as a keyword are described. Therefore, if user incorporates fail-safe processing into loop processing, user can search the corresponding processing with “WAIT_LOOP”.

The following shows example of description.

while statement example :

```
/* WAIT_LOOP */
while(0 == SYSTEM.OSCOVFSR.BIT.PLOVF)
{
    /* The delay period needed is to make sure that the PLL has stabilized. */
}
```

for statement example :

```
/* Initialize reference counters to 0. */
/* WAIT_LOOP */
for (i = 0; i < BSP_REG_PROTECT_TOTAL_ITEMS; i++)
{
    g_protect_counters[i] = 0;
}
```

do while statement example :

```
/* Reset completion waiting */
do
{
    reg = phy_read(ether_channel, PHY_REG_CONTROL);
    count++;
} while ((reg & PHY_CONTROL_RESET) && (count < ETHER_CFG_PHY_DELAY_RESET)); /* WAIT_LOOP */
```

3. API Functions

R_VBATT_Open()

This function sets up the VBATT pin voltage drop detection function and determines whether or not the battery backup supply voltage has fallen.

This function is called once and only once after a reset start. The processing performed when a drop in the battery backup supply voltage is detected and when no drop is detected are performed by a callback function called by this function.

Format

```
vbatt_return_t    R_VBATT_Open (
   vbatt_info_t *       p_vbatt_info
)
```

Parameters

p_vbatt_info

Pointer to a data structure for the battery backup information.

The following members are used by this function. See section 2.9, Arguments, for details on this structure.

```
vbatt_callback_t      callbackfunc;          /* Address of the callback function */
```

Return Values

```
VBATT_SUCCESS                 /* Processing completed without problem */
VBATT_ERR_LVD0_SETTING        /* Illegal voltage monitoring 0 settings in
                                    option function selection register 1 (OFS1) */
VBATT_ERR_INVALID_ARG         /* Invalid argument */
```

Properties

A prototype declaration for this function appears in r_vbatt_rx_if.h.

Description

This function sets the enabled or disabled state of the VBATT pin voltage drop detection function, the detection level, and the interrupts according to settings in the configuration options. After that, it determines whether or not the battery backup supply voltage has dropped and calls the callback function.

When calling the callback function:

- If a battery backup supply voltage drop has not been detected:
  A pointer to a variable that has been set to VBATT_NOT_DROP_VOLTAGE is passed as an argument.
- If a battery backup supply voltage drop has been detected:
  A pointer to a variable that has been set to VBATT_DROP_VOLTAGE is passed as an argument.

Example

```
#include "r_vbatt_rx_if.h"

void vbatt_callback(vbatt_cb_evt_t * vbatt_cb_event);

void main(void)
{
    vbatt_return_t          ret;
    vbatt_info_t            vbatt_info;

    vbatt_info.callbackfunc = vbatt_callback;

    ret = R_VBATT_Open(&vbatt_info);
    if (VBATT_SUCCESS != ret)
    {
          /* Please do the processing at the time of the error */
    }

    while(1);

}

void vbatt_callback(vbatt_cb_evt_t * vbatt_cb_event)
{
    switch(*vbatt_cb_event)
    {
          /* Battery backup power voltage drop not detected */
          case VBATT_NOT_DROP_VOLTAGE:

                /* Please set RAM again as needed */

          break;

          /* Battery backup power voltage drop detected */
          case VBATT_DROP_VOLTAGE:

                /* Please initialize the Realtime Clock */

          break;

          /* VBATT voltage drop detected interrupt */
          case VBATT_MASKABLE_INTERRUPT:
          case VBATT_NON_MASKABLE_INTERRUPT:

                /* Please process warning indication, backup, etc. */

          break;

          default:

                /* Do nothing */

          break;
    }
}
```

Special Notes

None

R_VBATT_Control()

This function sets the enabled or disabled state of the battery backup function and sets up the VBATT pin voltage drop detection function. This function is used when changing the content of these settings from those made with the R_VBATT_Open() function.

Format

```
vbatt_return_t          R_VBATT_Control (
    vbatt_ctrl_info_t *       p_vbatt_ctrl_info
)
```

Parameters

p_vbatt_ctrl_info

Pointer to the data structure used by the VBATT pin voltage drop detection function.

The following members are used by this function. See section 2.9, Arguments, for details on this structure.

```
typedef volatile struct
{
    uint8_t     rsv2;                       /* Reserved area */
    uint8_t     rsv1;                       /* Reserved area */
    uint8_t     vbatt_int_priority;     /* Interrupt priority level for
                                               the VBATT pin voltage drop detection
                                               interrupt (maskable interrupt) */
    union
    {
        uint8_t         byte;
        struct
        {
            uint8_t  rsv:3;                 /* Reserved area */
            uint8_t lvd_level:2;        /* VBATT pin voltage drop detection level */
            uint8_t lvd_detect:2;       /* VBATT pin voltage drop detection function */
            uint8_t func:1;                 /* Enabled/disabled state of the battery backup
                                               function */
        } bit;
    } vbatt_ctrl;
} vbatt_ctrl_info_t;
```

Return Values

```
VBATT_SUCCESS                   /* Processing completed without problem */
VBATT_ERR_INVALID_ARG               /* Invalid argument */
```

Properties

A prototype declaration for this function appears in r_vbatt_rx_if.h.

Description

This function sets the enabled or disabled state of the battery backup function, the enabled or disabled state of the VBATT pin voltage drop detection function, the detection level, and the interrupts according to the settings of the arguments.

Example

```
#include "r_vbatt_rx_if.h"

void main(void)
{
    vbatt_return_t          ret;
    vbatt_ctrl_info_t       vbatt_ctrl_info;

    /* Battery backup function enable */
    vbatt_ctrl_info.vbatt_ctrl.bit.func = 1;
    /* VBATT drop detect function enable and maskable interrupt enable */
    vbatt_ctrl_info.vbatt_ctrl.bit.lvd_detect = VBATT_DTCT_ENABLE_INT_ENABLE;
    /* VBATT drop detect level is 2.00V */
    vbatt_ctrl_info.vbatt_ctrl.bit.lvd_level = VBATT_DTCT_LEVEL_2_00_V;
    /* interrupt priority level is 7*/
    vbatt_ctrl_info.vbatt_int_priority = 7;

    ret = R_VBATT_Control(&vbatt_ctrl_info);
    if (VBATT_SUCCESS != ret)
    {
                /* Please do the processing at the time of the error */
    }

    while(1);
}
```

Special Notes

The table below lists and describes the range of values the arguments may be set to and the meanings of those arguments.

Structure (vbatt_ctrl_info_t)			
Member	**Bit**	**Allowable Range**	**Meaning**
vbatt_ctrl	func	0 to 1	The enabled or disabled state of the battery backup function can be changed. 0: The battery backup function is disabled. 1: The battery backup function is enabled.
	lvd_detect	Selected from macro definitions for the corresponding meaning	Selects whether or not the VBATT pin voltage drop detection function is used. This also selects the interrupt generated when a voltage drop is detected. For VBATT_DTCT_DISABLE: The VBATT pin voltage drop detection function is set to invalid and the interrupt is disabled. For VBATT_DTCT_ENABLE_INT_DISABLE: The VBATT pin voltage drop detection function is enabled and the interrupt is disabled. For VBATT_DTCT_ENABLE_NMI_ENABLE: The VBATT pin voltage drop detection function is enabled and the nonmaskable interrupt is enabled as the interrupt. For VBATT_DTCT_ENABLE_INT_ENABLE: The VBATT pin voltage drop detection function is enabled and the maskable interrupt is enabled as the interrupt.
	lvd_level	Selected from macro definitions for the corresponding meaning	The VBATT pin voltage drop detection level can be selected. For VBATT_DTCT_LEVEL_2_20_V, the detection level is set to 2.20 V. For VBATT_DTCT_LEVEL_2_00_V, the detection level is set to 2.00 V.
vbatt_int_priority	—	1 to 15	The interrupt priority level can be selected when a maskable interrupt is used as the VBATT pin voltage drop detection interrupt. The value selected by a value from 1 to 15 is set as the interrupt level. Note: This setting is only valid when VBATT_DTCT_ENABLE_INT_ENABLE is selected by lvd_detect.

R_VBATT_GetStatus()

This function acquires the status for the battery backup function. This function is used to check the status of the battery backup function.

Format

```
vbatt_return_t          R_VBATT_GetStatus (
    vbatt_status_t *            p_vbatt_status
)
```

Parameters

p_vbatt_status

Pointer to a variable to hold the battery backup function status.

The following members are used by this function. See section 2.9, Arguments, for details on this structure.

```
typedef volatile struct
{
    union
    {
        uint8_t       byte;
        struct
        {
            uint8_t  rsv:6;                 /* Reserved area */
            uint8_t  vbatt_mon:1;           /* VBATT pin voltage monitor flag */
            uint8_t  pwr_drp_dtct:1;        /* Battery backup supply voltage drop
                                                detection flag */
        } bit;
    } vbatt_status;
} vbatt_status_t;
```

Return Values

```
VBATT_SUCCESS               /* Processing completed without problem */
VBATT_ERR_INVALID_ARG           /* Invalid argument */
VBATT_ERR_FUNC_INVALID      /* R_VBATT_GetStatus() was called when VBATT pin
                               voltage drop detection was invalid */
```

Properties

A prototype declaration for this function appears in r_vbatt_rx_if.h.

Description

This function reads out the VBATT status register (VBATTSR) to acquire the status of the battery backup function. It then stores that information at the address passed as an argument.

Example

```
#include "r_vbatt_rx_if.h"

void main(void)
{
    vbatt_return_t              ret;
    vbatt_status_t              vbatt_status;
    vbatt_ctrl_info_t           vbatt_ctrl_info;

    /* VBATT drop detect function enable */
    vbatt_ctrl_info.vbatt_ctrl.bit.func = 1;
    vbatt_ctrl_info.vbatt_ctrl.bit.lvd_detect = VBATT_DTCT_ENABLE_INT_DISABLE;
    vbatt_ctrl_info.vbatt_ctrl.bit.lvd_level = VBATT_DTCT_LEVEL_2_20_V;
    vbatt_ctrl_info.vbatt_int_priority = 5;
    ret = R_VBATT_Control(&vbatt_ctrl_info);
    if (VBATT_SUCCESS != ret)
    {
            /* Please do the processing at the time of the error */
    }

    /* gets the state of the battery backup function */
    ret = R_VBATT_GetStatus(&vbatt_status);
    if (VBATT_SUCCESS != ret)
    {
            /* Please do the processing at the time of the error */
    }

    while(1);
}
```

Special Notes

The table below shows the layout of the status flags.

Bit	b7 to b2	b1	b0
Bit Name	Reserved area	VBATT pin voltage monitor flag	Battery backup supply voltage drop detection flag
Symbol	rsv	vbatt_mon	pwr_drp_dtct
Function	Undefined	0: VBATT < Vdetvbt 1: VBATT ≥ Vdetvbt or the VBATT detection function was disabled.	0: Battery backup supply voltage drop not detected 1: Battery backup supply voltage drop detected

R_VBATT_GetVersion()

This function returns the version number of the API.

Format

uint32_tR_VBATT_GetVersion(void)

Parameters

None

Return Values

Version number

Properties

A prototype declaration for this function appears in r_vbatt_rx_if.h.

Description

This function returns the version number of this API.

Example

```
uint32_t        version;

version = R_VBATT_GetVersion();
```

Special Notes

None

4. Appendices

4.1 Confirmed Operation Environment

This section describes confirmed operation environment for the battery backup function FIT module.

Table 4.1 Confirmed Operation Environment (Rev. 1.04)

Item	Contents
Integrated development environment	Renesas Electronics e^2 studio Version 7.1.0
C compiler	Renesas Electronics C/C++ Compiler Package for RX Family V3.01.00 Compiler option: The following option is added to the default settings of the integrated development environment. -lang = c99
Endian	Big endian/little endian
Revision of the module	Rev. 1.04
Board used	Renesas Solution Starter Kit for RX23W (product No.: RTK5523Wxxxxxxxxx)

Table 4.2 Confirmed Operation Environment (Rev. 1.03)

Item	Contents
Integrated development environment	Renesas Electronics e^2 studio Version 7.3.0 IAR Embedded Workbench for Renesas RX 4.10.1
C compiler	Renesas Electronics C/C++ Compiler Package for RX Family V3.01.00 Compiler option: The following option is added to the default settings of the integrated development environment. -lang = c99
	GCC for Renesas RX 4.8.4.2018.01 Compiler option: The following option is added to the default settings of the integrated development environment. -std = gnu99
	IAR C/C++ Compiler for Renesas RX version 4.10.1 Compiler option: The default settings of the integrated development environment.
Endian	Big endian/little endian
Revision of the module	Rev. 1.03
Board used	Renesas Starter Kit for RX231 (product No.: R0K505231S900BE)

4.2 Troubleshooting

(1) Q: I have added the FIT module to the project and built it. Then I got the error: Could not open source file "platform.h".

A: The FIT module may not be added to the project properly. Check if the method for adding FIT modules is correct with the following documents:

- Using CS+:

  Application note "Adding Firmware Integration Technology Modules to CS+ Projects (R01AN1826)"

- Using e^2 studio:

  Application note "Adding Firmware Integration Technology Modules to Projects (R01AN1723)"

When using this FIT module, the board support package FIT module (BSP module) must also be added to the project. Refer to the application note "Board Support Package Module Using Firmware Integration Technology (R01AN1685)".

(2) Q: I have added the FIT module to the project and built it. Then I got the error: This MCU is not supported by the current r_vbatt_rx module.

A: The FIT module you added may not support the target device chosen in your project. Check the supported devices of added FIT modules.

(3) Q: I have added the FIT module to the project and built it. Then I got the error: Parameter error in configures file

A: The setting in the file "r_vbatt_rx_config.h" may be wrong. Check the file "r_vbatt_rx_config.h". If there is a wrong setting, set the correct value for that. Refer to 2.7 Configuration Overview for details.

4.3 Sample Code

4.3.1 Example of Use Combined with the RTC FIT Module

This sample code shows the use of the battery backup function FIT module in combination with the RTF FIT module, which is used for real-time clock settings.

The configuration options are set as follows.

- The BSP FIT module BSP_CFG_OFS1_REG_VALUE is set to 0xFFFFFFFA.
- The default values are used for the RTC FIT module and the VBATT FIT module settings.

This sample code operates in the sequence (1) to (3) shown below.

(1) The R_VBATT_Open() function is called.
(The callback function is called when the R_VBATT_Open() function is called.)
(2) The callback function for the battery backup function sets up the RTC according to whether or not a battery backup supply voltage drop is detected. Whether or not there is a battery backup supply voltage drop is recognized from the arguments to the callback function.
(2-A) If the callback function argument is VBATT_NOT_DROP_VOLTAGE, the RTC FIT module is set up again using the R_RTC_Open() and R_RTC_Read() functions.
(2-B) If the callback function argument is VBATT_DROP_VOLTAGE, the R_RTC_Open() function is used to initialize the RTC.
(3) In the RTC periodic interrupt callback function, the R_RTC_Read() function is used to read out the current time. The read out time is displayed on the debugging console.

```
#include <stdio.h>                          /* This is required because printf() is used for debugging display. */
#include "r_rtc_rx_if.h"
#include "r_vbatt_rx_if.h"

static void vbatt_callback(vbatt_cb_evt_t * vbatt_cb_event);
static void rtc_callback(void *event);

static tm_t rtc_curr_time;  /* Data structure used to store the current time from the RTC. */

void main(void)
{
    vbatt_return_t      ret;                    /* For confirming the return value from the API function. */
    vbatt_info_t        vbatt_info;             /* Data structure for the battery backup function */

    SYSTEM.RSTSR1.BIT.CWSF = 1;                 /* set Cold/Warm Start Determination Flag. */

    vbatt_info.callbackfunc = vbatt_callback;   /* Callback function setup */

    /* VBATT pin voltage detection function setup and battery backup supply voltage drop determination. */
    ret = R_VBATT_Open(&vbatt_info);
    if (VBATT_SUCCESS != ret)
    {
        while(1);
    }

    while(1);
}


/* Battery backup function callback function */
static void vbatt_callback(vbatt_cb_evt_t * vbatt_cb_event)
{
    rtc_err_t   ret;                            /* For confirming the return value from the API function. */
    rtc_init_t  rtc_info;                       /* RTC data structure */
```

Executing this function results in the set up callback function (vbatt_callback()) being called.

Figure 4.1 Usage Example in Combination with the RTC FIT Module (1/3)

```
    /* Discriminate based on the argument */
    switch(*vbatt_cb_event)
    {
        /* If no battery backup supply voltage drop is detected. */
        case VBATT_NOT_DROP_VOLTAGE:
            /* Set up the RTC data structure again */
            rtc_info.output_freq = RTC_OUTPUT_OFF;          /* Stop RTCOUT output */
            rtc_info.periodic_freq = RTC_PERIODIC_1_HZ;     /* RTC periodic interrupt generation period: 1 second */
            rtc_info.periodic_priority = 8;                 /* Interrupt priority level */
            rtc_info.set_time = false;                      /* Do not update the RTC clock counter I/O register. */
            rtc_info.p_callback = rtc_callback;             /* Callback function setup */

            /* RTC re-setup */
            ret = R_RTC_Open(&rtc_info, &rtc_curr_time);
            if (RTC_SUCCESS != ret)
            {
                while(1);
            }

            /* Read out the current time information from the RTC clock counter I/O register
               and store it in the data structure. */
            ret = R_RTC_Read(&rtc_curr_time, NULL);
            if (RTC_SUCCESS != ret)
            {
                while(1);
            }

        break;

        /*  When a battery backup supply voltage drop was detected */
        case VBATT_DROP_VOLTAGE:
            /* RTC data structure setup */
            rtc_info.output_freq = RTC_OUTPUT_OFF;          /* Stop RTCOUT output */
            rtc_info.periodic_freq = RTC_PERIODIC_1_HZ;     /* RTC periodic interrupt generation period: 1 second */
            rtc_info.periodic_priority = 8;                 /* Interrupt priority level */
            rtc_info.set_time = true;                       /* Update the RTC clock counter I/O register. */
            rtc_info.p_callback = rtc_callback;             /* Callback function setup */

            /* Set the current time information structure time setting to "2015-06-30 12:34:56" */
            rtc_curr_time.tm_sec   = 56;                    /* Seconds (0 - 59) */
            rtc_curr_time.tm_min   = 34;                    /* Minutes (0 - 59) */
            rtc_curr_time.tm_hour  = 12;                    /* Hours (0 - 23) */
            rtc_curr_time.tm_mday  = 30;                    /* Day (1 - 31) */
            rtc_curr_time.tm_mon   = 6;                     /* Month (0 - 11, 0 = January) */
            rtc_curr_time.tm_year  = 115;                   /* Year (referenced to 1900) */
            rtc_curr_time.tm_wday  = 0;                     /* Day of week (0 - 6, 0 = Sunday) */
            rtc_curr_time.tm_yday  = 0;                     /* Day in year (0 - 365) */
            rtc_curr_time.tm_isdst = 0;                     /* Daylight saving time in effect (> 0),
                                                               not in effect (= 0). */

            /* RTC initialization */
            ret = R_RTC_Open(&rtc_info, &rtc_curr_time);
            if (RTC_SUCCESS != ret)
            {
                while(1);
            }

        break;

        /* Interrupt due to VBATT pin voltage drop */
        case VBATT_MASKABLE_INTERRUPT:
        case VBATT_NON_MASKABLE_INTERRUPT:
            /* Unused in this sample code */
        break;

        default:
            /* No processing */
        break;
    }
}
```

Although the RTC I/O register is saved, RAM and other registers are reset. Therefore, the RTC FIT module is setup again.

Since the RTC I/O register is saved, the current time information is read from the RTC I/O register by the R_RTC_Read() function and stored again in the data structure.

If a battery backup supply voltage drop was detected, the microcontroller is in a state where RTC operation is not guaranteed. Therefore the RTC is reinitialized.

Figure 4.2 Usage Example in Combination with the RTC FIT Module (2/3)

```
/* RTC callback function */
static void rtc_callback(void *event)
{
    rtc_err_t ret;                                  /* For confirming the return value from the API function. */

    /* For a periodic interrupt */
    if (*(rtc_cb_evt_t *)event == RTC_EVT_PERIODIC)
    {
        /* For a periodic interrupt */
        /* Read out the current time information from the RTC clock counter I/O register
           and store it in the data structure. */
        ret = R_RTC_Read(&rtc_curr_time, NULL);
        if (RTC_SUCCESS != ret)
        {
            while(1);
        }

        /* Display on the debugging console. */
        printf("%d/%d/%d %02d:%02d:%02d\n",   rtc_curr_time.tm_year + 1900,
                                              rtc_curr_time.tm_mon,
                                              rtc_curr_time.tm_mday,
                                              rtc_curr_time.tm_hour,
                                              rtc_curr_time.tm_min,
                                              rtc_curr_time.tm_sec);
    }
}
```

Each time a period interrupt occurs (at 1-second intervals) the current time is read out.

Figure 4.3 Usage Example in Combination with the RTC FIT Module (3/3)

5. Reference Documents

User’s Manual: Hardware
The latest versions can be downloaded from the Renesas Electronics website.

Technical Update/Technical News
The latest information can be downloaded from the Renesas Electronics website.

User’s Manual: Development Tools
RX Family C/C++ Compiler CC-RX User's Manual (R20UT3248)
The latest version can be downloaded from the Renesas Electronics website.

Related Technical Updates

This module reflects the content of the following technical updates.

None

Revision History

Rev.	Date	Description	
		Page	Summary
1.00	Aug. 24, 2015	—	First edition issued
1.01	Aug. 31, 2015	Program	Modified the battery backup function FIT module due to the iodefine.h (V1.0C) is updated. [Description] Compilations error occurs when the iodefine.h (V0.9E) is used. [Workaround] Please use rev.1.01 or a later version of the battery backup function FIT module.
1.02	Feb. 01, 2019	Program	Changes associated with functions: Added support setting function of configuration option Using GUI on Smart Configurator. [Description] Added a setting file to support configuration option setting function by GUI.
1.03	May 20, 2019	—	Supported the following compilers: - GCC for Renesas RX - IAR C/C++ Compiler for Renesas RX
		1	Added the section of Target Compilers.
		3	Updated the section of 1.2 Battery Backup Function FIT Module Overview.
		8	Added the section of 1.5 Limitations.
		9	Added the section of 2.4 Interrupt Vector.
		11	Added the section of 2.8 Code Size.
		15	Added the section of 2.13 “for”, “while” and “do while” statements.
		23	Updated the section of R_VBATT_GetVersion().
		24	Added the section of 4.1 Confirmed Operation Environment.
		program	Deleted the inline expansion of the R_VBATT_GetVersion function.
1.04	Jun.30,2019	1	Target Device: Added the RX23W support.
		24	Added Table 4.1 Confirmed Operation Environment (Rev. 1.04) to the section of 4.1 Confirmed Operation Environment.
		26	Updated the section of 4.3 Sample Code.
1.05	Jun.10,2020	—	Changed API function comments to Doxygen style.
		1	Deleted Related Documents R01AN1833.
		14	Changed Section 2.12 Adding the FIT Module to Your Project.
		16 to 21	Deleted “Reentrant” item on the API description page.

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1. Precaution against Electrostatic Discharge (ESD)

   A strong electrical field, when exposed to a CMOS device, can cause destruction of the gate oxide and ultimately degrade the device operation. Steps must be taken to stop the generation of static electricity as much as possible, and quickly dissipate it when it occurs. Environmental control must be adequate. When it is dry, a humidifier should be used. This is recommended to avoid using insulators that can easily build up static electricity. Semiconductor devices must be stored and transported in an anti-static container, static shielding bag or conductive material. All test and measurement tools including work benches and floors must be grounded. The operator must also be grounded using a wrist strap. Semiconductor devices must not be touched with bare hands. Similar precautions must be taken for printed circuit boards with mounted semiconductor devices.
2. Processing at power-on

   The state of the product is undefined at the time 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 time 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 time 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 time when power is supplied until the power reaches the level at which resetting is specified.
3. Input of signal during power-off state

   Do not input signals or an I/O pull-up power supply while the device is powered off. The current injection that results from input of such a signal or I/O pull-up power supply may cause malfunction and the abnormal current that passes in the device at this time may cause degradation of internal elements. Follow the guideline for input signal during power-off state as described in your product documentation.
4. Handling of unused pins

   Handle unused pins in accordance 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 the 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.
5. Clock signals

   After applying a reset, only release the reset line after the operating clock signal becomes stable. When switching the clock signal during program execution, wait until the target clock signal is 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. Additionally, 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.
6. Voltage application waveform at input pin

   Waveform distortion due to input noise or a reflected wave may cause malfunction. If the input of the CMOS device stays in the area between V_{IL} (Max.) and V_{IH} (Min.) due to noise, for example, the device may malfunction. Take care to prevent chattering noise from entering the device when the input level is fixed, and also in the transition period when the input level passes through the area between V_{IL} (Max.) and V_{IH} (Min.).
7. Prohibition of access to reserved addresses

   Access to reserved addresses is prohibited. The reserved addresses are provided for possible future expansion of functions. Do not access these addresses as the correct operation of the LSI is not guaranteed.
8. Differences between products

   Before changing from one product to another, for example to a product with a different part number, confirm that the change will not lead to problems. The characteristics of a microprocessing unit or microcontroller unit products in the same group but having a different part number might differ in terms of internal memory capacity, layout pattern, and other factors, which can affect the ranges of electrical characteristics, such as characteristic values, operating margins, immunity to noise, and amount of radiated noise. When changing to a product with a different part number, implement a system-evaluation test for the given product.

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