RX Family

MPC Module Using Firmware Integration Technology

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Introduction

This Firmware Integration Technology (FIT) Module implements a Multi-Function Pin Controller Driver.

Target Device

The following is a list of devices that are currently supported by this API:

- **RX110, RX111, RX113 Groups**
- **RX130 Group**
- **RX210 Group**
- **RX230 Group**
- **RX231 Group**
- **RX23T Group**
- **RX24T Group**
- **RX24U Group**
- **RX63N Group**
- **RX64M Group**
- **RX651, RX65N Groups**
- **RX71M Group**

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

Related Documents

- Firmware Integration Technology User's Manual (R01AN1833)
- Board Support Package Firmware Integration Technology Module (R01AN1685)
- Adding Firmware Integration Technology Modules to Projects (R01AN1723)
- Adding Firmware Integration Technology Modules to CS+ Projects (R01AN1826)
- GPIO Module Using Firmware Integration Technology (R01AN1721)

Contents

1. Overview

Modern MCUs have continued to add more peripherals while still maintaining relatively low pin counts. When this occurs, each pin will have multiple functions allocated to it. On RX MCUs, the routing of a function to a pin is controlled by the Multi-Function Pin Controller. This driver abstracts this functionality allowing use of the same pin definitions from the r_gpio_rx module.

2. API Information

The sample code in this application note has been run and confirmed under the following conditions.

2.1 Hardware Requirements

This driver requires that your MCU supports the following peripheral(s):

- A Multi-Function Pin Controller for routing peripheral functions to pins

2.2 Hardware Resource Requirements

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

2.2.1 MPC Registers

This module's API functions have the ability to write all MPC registers. It is OK for the user to modify these registers outside of the APIs in their own code.

2.3 Software Requirements

This driver is dependent upon the following FIT packages:

- Renesas Board Support Package (r_bsp)
- General Purpose Input/Output Driver (r_gpio_rx)

2.4 Limitations

- No software limitations.

2.5 Supported Toolchains

This driver is tested and working with the following toolchains:

- Renesas RX Toolchain v.2.02.00 (RX110, RX111, RX113, RX210, RX231, RX63N, RX64M, RX71M)
- Renesas RX Toolchain v.2.03.00 (RX130, RX230, RX23T, RX24T)
- Renesas RX Toolchain v.2.05.00 (RX24U, RX65N)
- Renesas RX Toolchain v.2.06.00 (RX24U)
- Renesas RX Toolchain v.2.07.00 (RX65N-2MB, RX130-512KB)

2.6 Header Files

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

Build-time configuration options are selected or defined in the file "r_mpc_rx_config.h".

Both of these files should be included by the user's application.

2.7 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.

2.8 Configuration Overview

All configurable options that can be set at build time are located in the file “r_mpc_rx_config.h”. A summary of these settings are provided in Table 1.

Configuration options in r_mpc_rx_config.h	
Equate	**Description**
`MPC_CFG_PARAM_CHECKING_ENABLE`	= 1: Include parameter checking in the build. = 0: Omit parameter checking from the build. = BSP_CFG_PARAM_CHECKING_ENABLE: Use the system default setting. (This is the default setting) Note: Code size can be reduced by excluding parameter checking from the build.

Table 1: Info about the configuration

2.9 Code Size

Typical code sizes 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 2.8, Configuration Overview. The table lists reference values when the C compiler’s compile options are set to their default values, as described in 2.5, Supported Toolchains. The compile option default values are optimization level: 2, optimization type: for size, and data endianness: little-endian. The code size varies depending on the C compiler version and compile options.

ROM, RAM and Stack Code Sizes			
Item	**Category**	**Memory Used**	**Remarks**
With Parameter Checking	ROM	125 bytes	
	RAM	0 bytes	
	Maximum stack usage	24 bytes	
Without Parameter Checking	ROM	107 bytes	
	RAM	0bytes	
	Maximum stack usage	24 bytes	

Table 2: ROM, RAM and Stack Code Sizes

2.10 API Data Types

2.10.1 MPC Pin Configuration

This data structure is used for configuring a pin's function. To find valid settings for *pin_function*, refer to the Multi-Function Pin Controller (MPC) section of your MCU's hardware manual. Select the Pin Function Control Register for the port that your pin is on. On this page you will find a table with available functions for each pin on the selected port.

```
/* Options for configuring the MPC register of a pin. */
typedef struct
{
    uint8_t pin_function;  //Which peripheral function is assigned to this pin
    bool    irq_enable;    //This pin is used as IRQ pin
    bool    analog_enable; //This pin is used as ADC input, DAC output, or for
                           //LVD (CMPA2)
} mpc_config_t;
```

2.11 Return Values

Below are the available return values for the R_MPC_Write() function.

```
/* Function return type. */
typedef enum
{
    MPC_SUCCESS = 0,
    MPC_ERR_INVALID_CFG, // The configuration specified cannot be applied to
                         // this pin
} mpc_err_t;
```

2.12 Adding the FIT Module to Your Project

This module must be added to each project in which it is used. Renesas recommends using "Smart Configurator" described in (1) or (3). However, "Smart Configurator" only supports some RX devices. Please use the methods of (2) or (4) for unsupported RX devices.

(1) Adding the FIT module to your project using "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 "Renesas e^2 studio Smart Configurator User Guide (R20AN0451)" for details.

(2) Adding the FIT module to your project using "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 "Adding Firmware Integration Technology Modules to Projects (R01AN1723)" for details.

(3) Adding the FIT module to your project using "Smart Configurator" on CS+
By using the "Smart Configurator Standalone version" in CS+, the FIT module is automatically added to your project. Refer to "Renesas e^2 studio Smart Configurator User Guide (R20AN0451)" 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 "Adding Firmware Integration Technology Modules to CS+ Projects (R01AN1826)" for details.

3. API Functions

3.1 Summary

The following functions are included in this design:

Function	Description
R_MPC_Write()	Sets the function of a pin.
R_MPC_Read()	Reads the function configuration of a pin.
R_MPC_GetVersion()	Returns the current version of this module.

3.2 R_MPC_Write

This function sets the function of a pin.

Format

```
mpc_err_t   R_MPC_Write(gpio_port_pin_t pin, mpc_config_t * pconfig);
```

Parameters

pin

Which pin to configure.

pconfig

Pointer to structure with pin configuration information. See section 2.10.1

Return Values

MPC_SUCCESS:	*Successful; pin configured.*
MPC_ERR_INVALID_CFG:	*Error; invalid configuration input*

Properties

Prototyped in file “r_mpc_rx_if.h”

Description

This function will configure a pin based on the information in the mpc_config_t structure. Not all pins support the same functionality. For example, not all pins are able to be configured as analog pins for ADC or DAC use. Also, not all combinations of functionality are capable. For example, a pin cannot be configured as an analog pin and for peripheral use at the same time.

To see what functions are available for a pin, refer to the Multi-Function Pin Controller (MPC) section of your MCU’s hardware manual. Select the Pin Function Control Register for the port that your pin is on. On this page you will find a table with available functions for each pin on the selected port.

Which pin is to be configured by this function is defined using the gpio_port_pin_t type from the r_gpio_rx module.

Reentrant

Function is re-entrant for different ports.

Example

```
mpc_config_t      config;
gpio_port_pin_t   pin;

/* Set PE0 to be used as analog pin for ADC. */
pin = GPIO_PORT_E_PIN_0;

config.analog_enable = true;
config.irq_enable = false;
config.pin_function = 0;

if (MPC_SUCCESS != R_MPC_Write(pin, &config))
{
    /* Error, pin does not support this configuration. Handle error. */
    …
}

/* Set P27 to be used as IRQ pin and for SCI operations. */
pin = GPIO_PORT_2_PIN_7;

config.analog_enable = false;
config.irq_enable = true;
config.pin_function = 0xA;

if (MPC_SUCCESS != R_MPC_Write(pin, &config))
{
    /* Error, pin does not support this configuration. Handle error. */
    …
}
```

3.3 R_MPC_Read

This function reads the function configuration of a pin.

Format
```
void R_MPC_Read(gpio_port_pin_t pin, mpc_config_t * pconfig);
```

Parameters
pin
Which pin to read configuration information for.
pconfig
Pointer to structure where pin configuration information will be stored. See Section 2.10.1

Return Values
None

Properties
Prototyped in file “r_mpc_rx_if.h”

Description
This function will read the configuration information for a pin and store it in a structure supplied by the user.

Reentrant
Yes

Example
```
mpc_config_t config;

/* See if P03 has already been configured as analog pin for DAC use. */
R_MPC_Read(GPIO_PORT_0_PIN_3, &config);

if (config.analog_enable == true)
{
    /* P03 has already been set as analog pin. */
    …
}
else
{
    /* P03 has not been configured yet. Configure it now. */
    …
}
```

Special Notes:
None

3.4 R_MPC_GetVersion

Returns the current version of this API.

Format
```
uint32_t   R_MPC_GetVersion(void);
```

Parameters
None

Return Values
Version of this API.

Properties
Prototyped in file “r_mpc_rx_if.h”

Description
This function will return the version of the currently running 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 running r_mpc_rx API. */
cur_version = R_MPC_GetVersion();

/* Check to make sure version is new enough for this application’s use. */
if (MIN_VERSION > cur_version)
{
    /* This r_mpc_rx 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_mpc_rx.c.

4. Demo Projects

Demo projects are complete stand-alone programs. They include function main() that utilizes the module and its dependent modules (e.g. r_bsp).

4.1 mpc_demo_rskrx113, mpc_demo_rskrx64m and mpc_demo_rskrx71m

These are the demo programs for the RX113 , RX64M and RX71M MPC FIT modules. The programs demonstrate how to use the MPC to configure a port bit as an interrupt input. IRQ2 is chosen as the interrupt for these demos and is used to detect key-presses on SW2. Once the code is compiled and down-loaded to the target board and running, SW2 can be pressed to cause IRQ2 interrupts to occur. The IRQ2 interrupt handler in turn toggles the state of LED3.

4.2 mpc_demo_rskrx231

This is the demo program for the RX231 FIT module. The description for this program is the same as for the mpc_demo_rskrx113 demo except that IRQ4 is used to detect SW2 key-presses.

4.3 Adding a Demo to a Workspace

Demo projects are found in the FITDemos subdirectory of the distribution file for this application note. To add a demo project to a workspace, select File>Import>General>Existing Projects into Workspace, then click “Next”. From the Import Projects dialog, choose the “Select archive file” radio button. “Browse” to the FITDemos subdirectory, select the desired demo zip file, then click “Finish”.

Related Technical Updates

This module reflects the content of the following technical updates.

None

Website and Support

Renesas Electronics Website

http://www.renesas.com/

Inquiries

http://www.renesas.com/contact/

Revision Record

Rev.	Date	Description	
		Page	Summary
1.00	Nov15, 2013	—	Initial release.
1.20	Apr 17, 2014	1,3	Added support for the RX64M Group.
1.30	Jul 02, 2014	—	Fixed RX63N receive bug. Used latest Colophon.
1.40	Dec 12,2014	Various 1 5	Updated to current app-note template Added RX113 to the list of supported MCUs Added a Code Size section.
1.50	Jan 17,2015	—	Added support for the RX71M Group.
1.60	Jun 30,2015	—	Added support for the RX231 Group.
1.70	Sep 30,2015	—	Added support for the RX23T Group.
1.80	Oct 1,2015	—	Added support for the RX130 Group.
1.90	Dec 1,2015	— 1, 6 4 11	Added support for the RX24T Group. Changed the document number for the “Board Support Package Firmware Integration Technology Module” application note. Changed the description in section 2. Added “4. Demo Projects”.
2.00	Feb 1,2016	— 12	Added support for the RX230 Group. Added “Related Technical Updates”.
2.01	Jul 29, 2016	11	Added RSKRX64M to “4. Demo Projects”.
2.10	Oct 1,2016	— 5	Added support for the RX65N Group. Changed 2.9 Code Size for the tabular format of Code Size. Updated 2.9 Code Size for the RX65N Group.
2.20	Feb 28, 2017	— 4	Added support for the RX24U Group. Added RXC v2.06.00 to “2.5 Supported Toolchains”.
2.30	Jul 21, 2017	- 4 6	Added support for the RX130-512KB and RX65N-2MB. Added RXC v2.07.00 to “2.5 Supported Toolchains”. Updated “2.12 Adding the FIT Module to Your Project”.

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The following usage notes are applicable to all Microprocessing unit and Microcontroller unit products from Renesas. For detailed usage notes on the products covered by this document, refer to the relevant sections of the document as well as any technical updates that have been issued for the products.

1. 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 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 a product with a different part number, confirm that the change will not lead to problems.

   — The characteristics of Microprocessing unit or Microcontroller unit products in the same group but having a different part number may differ in terms of the 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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Renesas Electronics America Inc.
2801 Scott Boulevard Santa Clara, CA 95050-2549, U.S.A.
Tel: +1-408-588-6000, Fax: +1-408-588-6130

Renesas Electronics Canada Limited
9251 Yonge Street, Suite 8309 Richmond Hill, Ontario Canada L4C 9T3
Tel: +1-905-237-2004

Renesas Electronics Europe Limited
Dukes Meadow, Millboard Road, Bourne End, Buckinghamshire, SL8 5FH, U.K
Tel: +44-1628-585-100, Fax: +44-1628-585-900

Renesas Electronics Europe GmbH
Arcadiastrasse 10, 40472 Düsseldorf, Germany
Tel: +49-211-6503-0, Fax: +49-211-6503-1327

Renesas Electronics (China) Co., Ltd.
Room 1709, Quantum Plaza, No.27 ZhiChunLu Haidian District, Beijing 100191, P.R.China
Tel: +86-10-8235-1155, Fax: +86-10-8235-7679

Renesas Electronics (Shanghai) Co., Ltd.
Unit 301, Tower A, Central Towers, 555 Langao Road, Putuo District, Shanghai, P. R. China 200333
Tel: +86-21-2226-0888, Fax: +86-21-2226-0999

Renesas Electronics Hong Kong Limited
Unit 1601-1611, 16/F., Tower 2, Grand Century Place, 193 Prince Edward Road West, Mongkok, Kowloon, Hong Kong
Tel: +852-2265-6688, Fax: +852 2886-9022

Renesas Electronics Taiwan Co., Ltd.
13F, No. 363, Fu Shing North Road, Taipei 10543, Taiwan
Tel: +886-2-8175-9600, Fax: +886 2-8175-9670

Renesas Electronics Singapore Pte. Ltd.
80 Bendemeer Road, Unit #06-02 Hyflux Innovation Centre, Singapore 339949
Tel: +65-6213-0200, Fax: +65-6213-0300

Renesas Electronics Malaysia Sdn.Bhd.
Unit 1207, Block B, Menara Amcorp, Amcorp Trade Centre, No. 18, Jln Persiaran Barat, 46050 Petaling Jaya, Selangor Darul Ehsan, Malaysia
Tel: +60-3-7955-9390, Fax: +60-3-7955-9510

Renesas Electronics India Pvt. Ltd.
No.777C, 100 Feet Road, HAL II Stage, Indiranagar, Bangalore, India
Tel: +91-80-67208700, Fax: +91-80-67208777

Renesas Electronics Korea Co., Ltd.
12F., 234 Teheran-ro, Gangnam-Gu, Seoul, 135-080, Korea
Tel: +82-2-558-3737, Fax: +82-2-558-5141

Colophon 6.0