

RX Family and M16C Family

Guide for Migration from the M16C to the RX: Timers (MTU2/MTU3)

Abstract

This document describes migration from the timers in the M16C Family (Timer A and Timer B) to the timers in the RX Family (MTU2a and MTU3a).

Products

RX Family

M16C Family

When this document explains migration from the M16C Family to the RX Family, the M16C/65C Group MCU is used as an example of the M16C Family MCU, and the RX231 Group and RX660 Group MCUs are used as examples of the RX Family MCU. When using this application note with other Renesas MCUs, careful evaluation is recommended after making modifications to comply with the alternate MCU.

RX Family and M16C Family Guide for Migration from the M16C to the RX: Timers (MTU2/MTU3)

There are differences in the terminology between the M16C Family and RX Family.

The table below shows the differences in terminology related to timers.

Differences in Terminology Between the RX Family and the M16C Family

Item	M16C Family	RX Family
Timer modules	Timer A Timer B ...	Multi-function timer pulse unit 2 (MTU2a) Multi-function timer pulse unit 3 (MTU3a) Compare match timer (CMT) Compare match timer (CMTW) 16-bit timer pulse unit (TPUa) 8-bit timers (TMR and TMRb) (The above items are examples.)
Peripheral function operating clocks	Peripheral function clocks: fC, fC32, fOCO40M, fOCO-F, fOCO-S, f1	Peripheral module clocks: PCLKA, PCLKB, PCLKD
Timer operating clocks (hereinafter count clock)	Count source	Count clock
Function for selecting peripheral function input and output for pins	Function select register and input function select register ^{*2}	MPC ^{*1}
Registers for peripheral functions	I/O registers	I/O registers

Notes: 1. The MPC is not available in some groups.

2. Only available in the M32C Series and R32C Series.

Contents

1. Peripheral Functions Used	4
1.1 Outputting a PWM Waveform.....	5
1.2 One-Shot Timer	7
1.3 Measuring a Pulse Period	9
1.4 Measuring a Pulse Width	11
2. Related Sections in the RX User's Manual: Hardware	13
3. Appendix.....	14
3.1 Points on Migration From the M16C Family to the RX Family	14
3.1.1 Interrupts	14
3.1.2 I/O Ports	15
3.1.3 Module Stop Function	15
3.2 I/O Register Macros	16
3.3 Intrinsic Functions	16
4. Reference Documents	17

1. Peripheral Functions Used

This document shows an example of operation that uses MTU2a and MTU3a of the RX Family MCU, and Timer A and Timer B of the M16C Family MCU.

Table 1.1 shows Peripheral Functions and Modes Used in Relation to the Operating Example.

Table 1.1 Peripheral Functions and Modes Used in Relation to the Operating Example

No.	Operation	M16C		RX	
		Peripheral Function	Mode	Peripheral Function	Mode
1	Outputting a PWM waveform	Timer A	PWM mode, timer mode *1	MTU2a MTU3a	PWM1 mode
2	One-shot timer (single pulse output)		One-shot timer mode		PWM1 mode
3	Measuring a pulse period	Timer B	Pulse period measurement mode		Normal mode
4	Measuring a pulse width		Pulse width measurement mode		Normal mode

Note: 1. In timer mode, only a pulse with a duty cycle of 50% can be output.

1.1 Outputting a PWM Waveform

This section describes the differences in the operation that outputs a PWM waveform from an output pin between the case where MTU3a and MTU2a are used in PWM mode 1 on the RX Family MCU, and the case where Timer A is used in timer mode on the M16C Family MCU.

MTU3a and MTU2a of the RX Family MCU have free-running counters (hereinafter, "TCNT registers"). In PWM1 mode, a value is set to the TGR register, and when the values for the TGR register and TCNT register match (compare match occurs), output can be high, low, or inverted.

This section describes an example of a PWM waveform being output. A high is output when the TCNT register and TGRA register values match, and a low is output when the TCNT register and TGRB register values match. This example assumes a duty cycle of 50%, and the M16C uses timer mode and not PWM mode

Using PWM1 mode of MTU3a as an example, by making the TGRA register and TGRB register values the same, a pulse can be output with a duty cycle of 0% or 100%. Because Timer A in the M16C Family cannot output a pulse with a duty cycle of 100%, timer output is stopped, and control must be performed by ports.

Figure 1.1 shows Example of Outputting a PWM Waveform. Table 1.2 shows Operational Overview of Outputting a PWM Waveform.

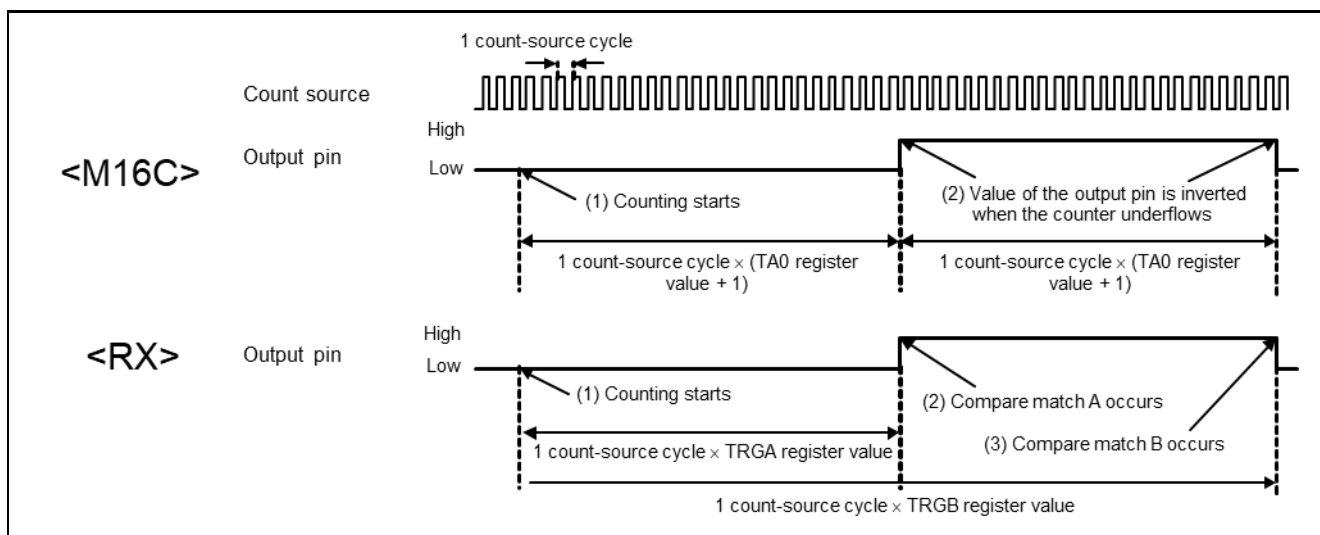


Figure 1.1 Example of Outputting a PWM Waveform

Table 1.2 Operational Overview of Outputting a PWM Waveform

Item	M16C (in the case of Timer A on the M16C/65C)	RX (in the case of MTU3a on the RX660 or MTU2a on the RX231)
Operating mode	Timer mode	PWM mode 1
Overview of operations	(1) Counting starts The count operation is started. (2) Counter underflows Each time the counter underflows, output from the pin is inverted.	(1) Counting starts The count operation is started. (2) Compare match A occurs When the TCNT and TGRA values match, compare match A occurs, and output from the pin changes from low to high. (3) Compare match B occurs When the TCNT and TGRB values match, compare match B occurs, and output from the pin changes from high to low. When compare match B occurs, the TCNT value is cleared.

1.2 One-Shot Timer

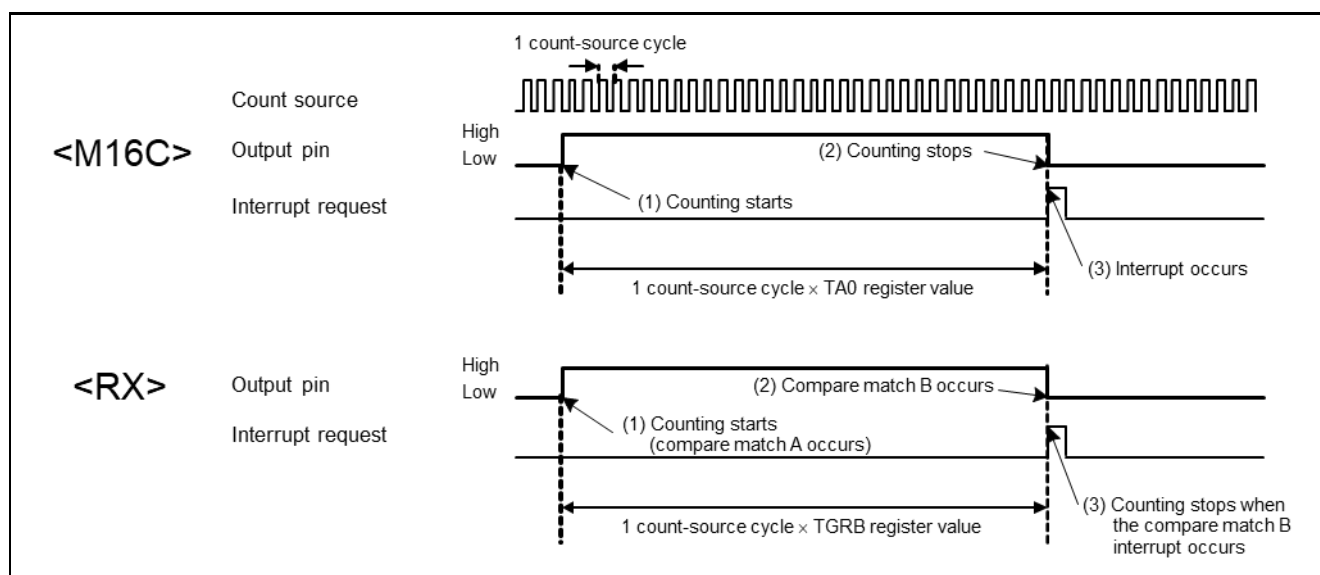
This section explains the difference in the operation that outputs a pulse only once from an output pin between the case where MTU3a and MTU2a are used in PWM mode 1 on the RX, and the case where Timer A is used in one-shot timer mode on the M16C.

MTU3a and MTU2a of the RX Family MCU have free-running counters (hereinafter, "TCNT registers"). In PWM1 mode, a value is set to the TGR register, and when the values for the TGR register and TCNT register match (compare match occurs), output can be high, low, or inverted.

This section describes an example of a pulse being output only once. A high is output when the TCNT register and TGRA register values match, and a low is output when the TCNT register and TGRB register values match. In addition, when the TCNT register and TGRA register values match, buffer operation is used to transfer FFFFh to the TGRA, when the TCNT register and TGRB register values match, buffer operation is used to transfer FFFEh to the TGRB register. Furthermore, the TCNT register is cleared. Therefore, by preventing a second compare match with the TGRA register, changes in the state of the output pin can be avoided.

For the example used in this section, the value to be set for the TGRA register must be 0000h and the value to be set for the TGRB register must be in the range from 0001h to FFFEh. In addition, after outputting a single one-shot time pulse, when you want to output another pulse, stop the count and reset registers like the TCNT register and TGR register.

Figure 1.2 shows Example of Outputting a One-Shot Pulse. Table 1.3 shows Operational Overview of the One-Shot Timer.


Figure 1.2 Example of Outputting a One-Shot Pulse
Table 1.3 Operational Overview of the One-Shot Timer

Item	M16C (in the case of Timer A on the M16C/65C)	RX (in the case of MTU3a on the RX660 or MTU2a on the RX231)
Operating mode	One-shot timer mode	PWM mode 1
Overview of operations	(1) Counting starts At the same time the count starts, the output pin changes from low to high. (2) Counting stops When the TA0 count value becomes 0000h, the count stops, and the output pin changes from high to low. (3) Interrupt occurs A TA0 interrupt occurs when the TA0 count value becomes 0000h.	(1) Counting starts (compare match A occurs) When the TCNT and TGRA values match at the same time the count operation starts, compare match A occurs, and the output pin changes from low to high. Also, buffer operation is performed when compare match A occurs, and the value in TGRC (FFFFh) is transferred to TGRA. (2) Compare match B occurs When the TCNT and TGRB values match, compare match B occurs, and output from the pin changes from high to low. Also, when compare match B occurs, the TCNT value is cleared, buffer operation is performed, and the value in TGRD (FFFEh) is transferred to TGRB. (3) Counting stops when the compare match B interrupt occurs The count stops by the compare match B interrupt handling program.

1.3 Measuring a Pulse Period

This section describes the differences in the operation that measures the period from one rising edge to the next rising edge of a pulse input to an external input pin between the case where MTU2a and MTU3a are used in normal mode on the RX, and the case where Timer B is used in pulse period measurement mode on the M16C.

MTU2a and MTU3a of the RX Family MCU have free-running counters (hereinafter, "TCNT registers"). When using the input capture function in normal mode, the input edge of the pin is detected, and the TCNT register value can be transferred to the TGR register. The input capture interrupt is generated when the input edge of the pin is detected, the overflow interrupt is generated when the TCNT register overflows, and these interrupts can be used independently.

In the pulse period measurement example in this section, each time a rising edge is detected on the external input pin, the value in the TCNT register is transferred to the TGRA register, at which time the TCNT register is set to be cleared. Each time the overflow interrupt is generated, the variable counts the number of overflows, and when the input capture interrupt is generated, the TGRA register value and the number of overflows counted are used to calculate the pulse period.

Figure 1.3 shows Example of Measuring the Pulse Period. Table 1.4 shows Operational Overview of Measuring the Pulse Period.

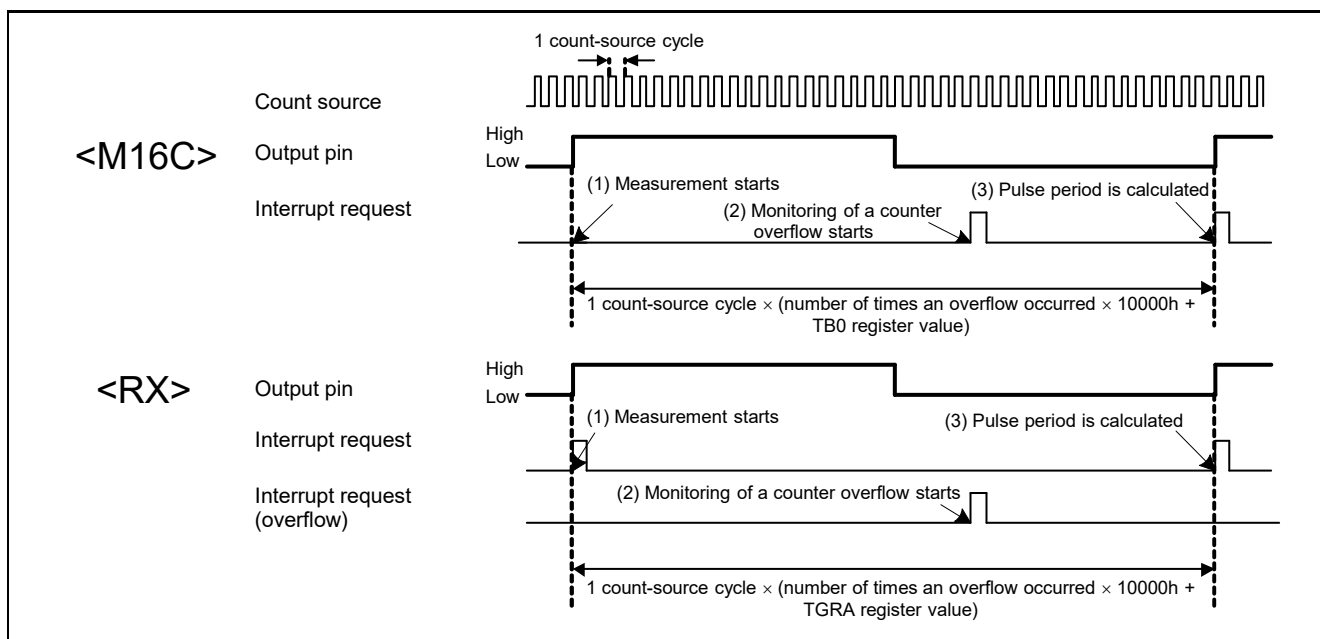


Figure 1.3 Example of Measuring the Pulse Period

Table 1.4 Operational Overview of Measuring the Pulse Period

Item	M16C (in the case of Timer B on the M16C/65C)	RX (in the case of MTU3a on the RX660 or MTU2a on the RX231)
Operating mode	Pulse period measurement mode	Normal mode
Overview of operations	(1) Measurement starts When a rising edge of a pulse input on an external input pin is detected, the TB0 interrupt occurs. (2) Monitoring of a counter overflow starts When TB0 overflows, the TB0 interrupt occurs. Read the overflow flag in the interrupt handler, and count the number of overflows. (3) Pulse period is calculated The pulse period can be calculated using the number of overflows and the TB0 register value.	(1) Measurement starts When a rising edge of a pulse input on an external input pin is detected, the input capture interrupt occurs. (2) Monitoring of a counter overflow starts When TCNT overflows, the overflow interrupt occurs. Count the number of overflows in the interrupt handler. (3) Pulse period is calculated The pulse period can be calculated using the number of overflows and the TGRB register value.

1.4 Measuring a Pulse Width

This section describes the differences in the operation that measures the pulse width from one rising edge to the next falling edge of a pulse input to an external input pin between the case where MTU2a and MTU3a are used in normal mode on the RX, and the case where Timer B is used in pulse width measurement mode on the M16C.

MTU2a and MTU3a of the RX Family MCU have free-running counters (hereinafter, "TCNT registers"). When using the input capture function in normal mode, the input edge of the pin is detected, and the TCNT register value can be transferred to the TGR register. The input capture interrupt is generated when the input edge of the pin is detected, the overflow interrupt is generated when the TCNT register overflows, and these interrupts can be used independently.

In the pulse width measurement example in this section, each time an edge is detected (rising edge or falling edge) on the external input pin, the value in the TCNT register is transferred to the TGRA register, at which time the TCNT register is set to be cleared. Each time the overflow interrupt is generated, the variable counts the number of overflows, and when the input capture interrupt is generated, the TGRA register value and the number of overflows counted are used to calculate the pulse width.

Figure 1.4 shows Example of Measuring the Pulse Width. Table 1.5 shows Operational Overview of the Example of Measuring the Pulse Width.

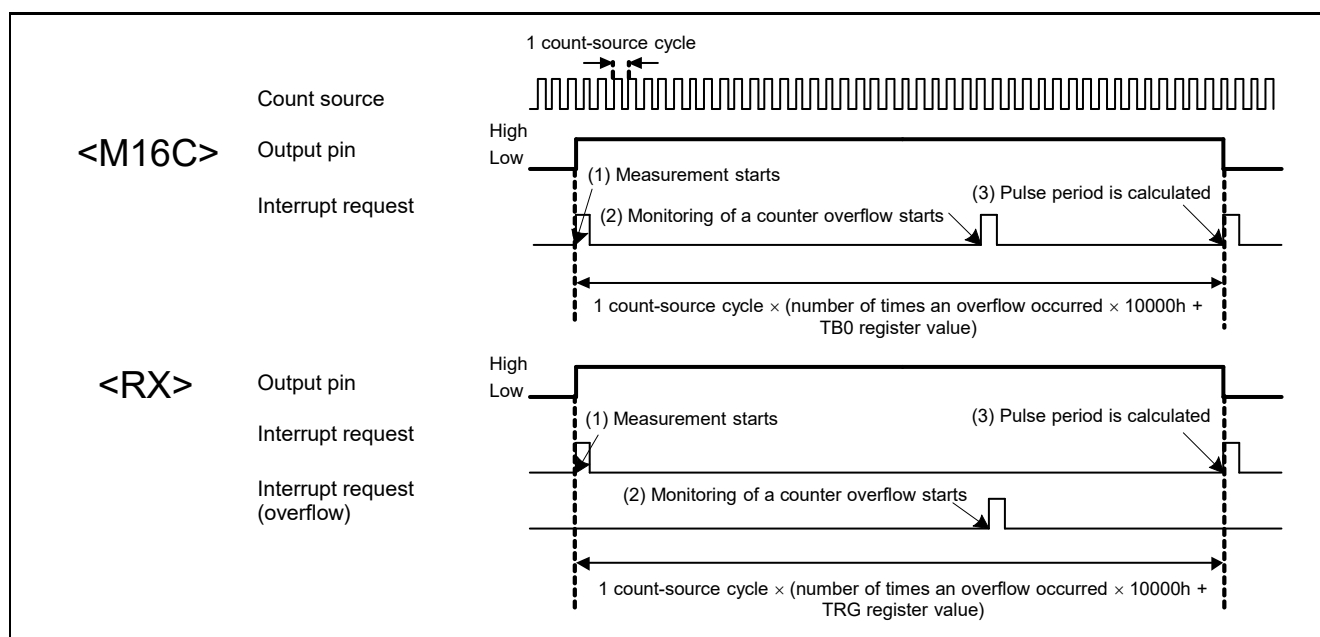


Figure 1.4 Example of Measuring the Pulse Width

Table 1.5 Operational Overview of the Example of Measuring the Pulse Width

Item	M16C (in the case of Timer B on the M16C/65C)	RX (in the case of MTU3a on the RX660 or MTU2a on the RX231)
Operating mode	Pulse width measurement mode	Normal mode
Overview of operations	(1) Measurement starts When a rising edge or falling edge of a pulse input on an external input pin is detected, the TB0 interrupt occurs. (2) Monitoring of a counter overflow starts When TB0 overflows, the TB0 interrupt occurs. Read the overflow flag in the interrupt handler, and count the number of overflows. (3) Pulse width is calculated The pulse width can be calculated using the number of overflows and the TB0 register value	(1) Measurement starts When a rising edge or falling edge of a pulse input on an external input pin is detected, the input capture interrupt occurs. (2) Monitoring of a counter overflow starts When TCNT overflows, the overflow interrupt occurs. Count the number of overflows in the interrupt handler. (3) Pulse width is calculated The pulse width can be calculated using the number of overflows and the TGR register value.

2. Related Sections in the RX User's Manual: Hardware

When migrating from the M16C Family to the RX Family, refer to the following sections of the RX User's Manual: Hardware.

- Multi-Function Timer Pulse Unit 2
- Multi-Function Timer Pulse Unit 3
- Clock Generation Circuit
- Low Power Consumption
- Interrupt Controller, CPU
- I/O Ports, MPC
- Register Write Protection Function

3. Appendix

3.1 Points on Migration From the M16C Family to the RX Family

This chapter explains points on migration from the M16C Family to the RX Family.

3.1.1 Interrupts

For the RX Family, when an interrupt request is received while all of the following conditions are met, the interrupt occurs.

- The I flag (PSW.I bit) is 1.
- Registers IER and IPR in the ICU are set to enable interrupts.
- The interrupt request enable bit for peripheral functions is enabled.

Table 3.1 shows Comparison of Conditions for Interrupt Generation Between the RX and the M16C.

Table 3.1 Comparison of Conditions for Interrupt Generation Between the RX and the M16C

Item	M16C	RX
I flag	When the I flag is set to 1 (enabled), the maskable interrupt request can be accepted.	
Interrupt request flag	When there is an interrupt request from a peripheral function, the interrupt request flag becomes 1 (interrupt requested).	
Interrupt priority level	Selected by setting bits ILVL2 to ILVL0.	Selected by setting the IPR[3:0] bits.
Interrupt request enable	—	Controlled by using the IER register.
Interrupt enable for peripheral functions	—	Interrupts can be enabled or disabled in each peripheral function.

For more information, refer to sections Interrupt Controller (ICU), CPU, and sections for other peripheral functions used in the User's Manual: Hardware.

3.1.2 I/O Ports

In the RX Family, the MPC must be configured in order to assign I/O signals from peripheral functions to pins.

Before controlling the input and output pins in the RX Family, the following two items must be set.

- In the MPC.PFS register, select the peripheral functions that are assigned to the appropriate pins.
- In the PMR register for I/O ports, select the function for the pin to be used as a general I/O port or I/O port for a peripheral function.

Table 3.2 shows Comparison of I/O Settings for Peripheral Function Pins Between the RX and the M16C.

Table 3.2 Comparison of I/O Settings for Peripheral Function Pins Between the RX and the M16C

Function	M16C (in the case of the M16C/65C)	RX (in the case of the RX660/RX231)
Select the pin function	These are not available in the M16C. ^{*1} When a mode is set for a peripheral function, appropriate pins are assigned as I/O pins for the peripheral function.	With the PFS register, I/O ports for peripheral functions can be assigned by selecting from multiple pins.
Switch between general I/O port and peripheral function		With the PMR register, the corresponding pin function can be selected as a general I/O port or a peripheral function.

Note: 1. Register for similar functions are available in the M32C Series and R32C Series.

For more information, refer to the Multi-Function Pin Controller (MPC) and I/O port sections in the User's Manual: Hardware.

3.1.3 Module Stop Function

The RX Family has the ability to stop each peripheral module individually.

By transitioning unused peripheral modules to the module stop state, power consumption can be reduced.

After the reset is released, all modules (with a few exceptions) are in the module stop state.

Registers for modules in the module stop state cannot be written to or read.

For more information, refer to the Low Power Consumption section in the User's Manual: Hardware.

3.2 I/O Register Macros

Macro definitions listed in Table 3.3 can be found in the RX I/O register definitions (iodefine.h).

The readability of programs can be achieved with these macro definitions.

Table 3.3 shows Macro Usage Examples.

Table 3.3 Macro Usage Examples

Macro	Usage Example
IR("module name", "bit name")	IR(MTU0, TGIA0) = 0 ; The IR bit corresponding to MTU0.TGIA0 is cleared to 0 (no interrupt request is generated).
DTCE("module name", "bit name")	DTCE(MTU0, TGIA0) = 1 ; The DTCE bit corresponding to MTU0.TGIA0 is set to 1 (DTC activation is enabled).
IEN("module name", "bit name")	IEN(MTU0, TGIA0) = 1 ; The IEN bit corresponding to MTU0.TGIA0 is set to 1 (interrupt enabled).
IPR("module name", "bit name")	IPR(MTU0, TGIA0) = 0x02 ; The IPR bit corresponding to MTU0.TGIA0 is set to 2 (interrupt priority level 2).
MSTP("module name")	MSTP(MTU) = 0 ; The MTU0 Module Stop bit is set to 0 (module stop state is canceled).
VECT("module name", "bit name")	#pragma interrupt (Excep_MTU0_TGIA0 (vect = VECT(MTU0, TGIA0)) The interrupt function is declared for the corresponding MTU0.TGIA0 register.

3.3 Intrinsic Functions

The RX Family has intrinsic functions for setting control registers and special instructions. When using intrinsic functions, include machine.h.

Table 3.4 shows Examples of Differences in the Settings of Control Registers and Descriptions of Special Instructions Between the RX and the M16C.

Table 3.4 Examples of Differences in the Settings of Control Registers and Descriptions of Special Instructions Between the RX and the M16C

Item	Description	
	M16C	RX
Set the I flag to 1	asm("fset i");	setpsw_i (); *1
Set the I flag to 0	asm("fclr i");	clrpsw_i (); *1
Expanded into the WAIT instruction	asm("wait");	wait(); *1
Expanded into the NOP instruction	asm("nop");	nop(); *1

Note: 1. The machine.h file must be included.

4. Reference Documents

User's Manual: Hardware

RX230/RX231 Group User's Manual: Hardware (R01UH0496EJ)

RX660 Group User's Manual: Hardware (R01UH0037EJ)

M16C/65C Group User's Manual: Hardware (R01UH0093EJ)

If you are using a product that does not belong to the RX231, RX660, or M16C/65C Group, refer to the applicable user's manual for 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 CC-RX Compiler User's Manual (R20UT3248EJ)

M16C Series, R8C Family C Compiler Package (M3T-NC30WA)

The latest versions can be downloaded from the Renesas Electronics website.

REVISION HISTORY

Rev.	Date	Description	
		Page/Section	Summary
1.00	Dec. 16, 2013	—	First edition issued
1.10	July 1, 2014	All	Format overhaul
		2	Added table “Differences in Terminology”
		Section 1.2	Changed setting value for TGRD register from FFFFh to FFFEh
		19	Deleted references to non-maskable interrupts
2.00	June 12, 2023	All	The product model of the target device for the RX Family MCU was changed from RX210 to RX231/RX660.
2.01	Oct 21, 2025	-	Title updated

General Precautions in the Handling of Microprocessing Unit and Microcontroller Unit Products

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. 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.

Notice

1. Descriptions of circuits, software and other related information in this document are provided only to illustrate the operation of semiconductor products and application examples. You are fully responsible for the incorporation or any other use of the circuits, software, and information in the design of your product or system. Renesas Electronics disclaims any and all liability for any losses and damages incurred by you or third parties arising from the use of these circuits, software, or information.
2. Renesas Electronics hereby expressly disclaims any warranties against and liability for infringement or any other claims involving patents, copyrights, or other intellectual property rights of third parties, by or arising from the use of Renesas Electronics products or technical information described in this document, including but not limited to, the product data, drawings, charts, programs, algorithms, and application examples.
3. No license, express, implied or otherwise, is granted hereby under any patents, copyrights or other intellectual property rights of Renesas Electronics or others.
4. You shall be responsible for determining what licenses are required from any third parties, and obtaining such licenses for the lawful import, export, manufacture, sales, utilization, distribution or other disposal of any products incorporating Renesas Electronics products, if required.
5. You shall not alter, modify, copy, or reverse engineer any Renesas Electronics product, whether in whole or in part. Renesas Electronics disclaims any and all liability for any losses or damages incurred by you or third parties arising from such alteration, modification, copying or reverse engineering.
6. Renesas Electronics products are classified according to the following two quality grades: "Standard" and "High Quality". The intended applications for each Renesas Electronics product depends on the product's quality grade, as indicated below.

"Standard": Computers; office equipment; communications equipment; test and measurement equipment; audio and visual equipment; home electronic appliances; machine tools; personal electronic equipment; industrial robots; etc.

"High Quality": Transportation equipment (automobiles, trains, ships, etc.); traffic control (traffic lights); large-scale communication equipment; key financial terminal systems; safety control equipment; etc.

Unless expressly designated as a high reliability product or a product for harsh environments in a Renesas Electronics data sheet or other Renesas Electronics document, Renesas Electronics products are not intended or authorized for use in products or systems that may pose a direct threat to human life or bodily injury (artificial life support devices or systems; surgical implantations; etc.), or may cause serious property damage (space system; undersea repeaters; nuclear power control systems; aircraft control systems; key plant systems; military equipment; etc.). Renesas Electronics disclaims any and all liability for any damages or losses incurred by you or any third parties arising from the use of any Renesas Electronics product that is inconsistent with any Renesas Electronics data sheet, user's manual or other Renesas Electronics document.

7. No semiconductor product is absolutely secure. Notwithstanding any security measures or features that may be implemented in Renesas Electronics hardware or software products, Renesas Electronics shall have absolutely no liability arising out of any vulnerability or security breach, including but not limited to any unauthorized access to or use of a Renesas Electronics product or a system that uses a Renesas Electronics product. RENESAS ELECTRONICS DOES NOT WARRANT OR GUARANTEE THAT RENESAS ELECTRONICS PRODUCTS, OR ANY SYSTEMS CREATED USING RENESAS ELECTRONICS PRODUCTS WILL BE INVULNERABLE OR FREE FROM CORRUPTION, ATTACK, VIRUSES, INTERFERENCE, HACKING, DATA LOSS OR THEFT, OR OTHER SECURITY INTRUSION ("Vulnerability Issues"). RENESAS ELECTRONICS DISCLAIMS ANY AND ALL RESPONSIBILITY OR LIABILITY ARISING FROM OR RELATED TO ANY VULNERABILITY ISSUES. FURTHERMORE, TO THE EXTENT PERMITTED BY APPLICABLE LAW, RENESAS ELECTRONICS DISCLAIMS ANY AND ALL WARRANTIES, EXPRESS OR IMPLIED, WITH RESPECT TO THIS DOCUMENT AND ANY RELATED OR ACCOMPANYING SOFTWARE OR HARDWARE, INCLUDING BUT NOT LIMITED TO THE IMPLIED WARRANTIES OF MERCHANTABILITY, OR FITNESS FOR A PARTICULAR PURPOSE.
8. When using Renesas Electronics products, refer to the latest product information (data sheets, user's manuals, application notes, "General Notes for Handling and Using Semiconductor Devices" in the reliability handbook, etc.), and ensure that usage conditions are within the ranges specified by Renesas Electronics with respect to maximum ratings, operating power supply voltage range, heat dissipation characteristics, installation, etc. Renesas Electronics disclaims any and all liability for any malfunctions, failure or accident arising out of the use of Renesas Electronics products outside of such specified ranges.
9. Although Renesas Electronics endeavors to improve the quality and reliability of Renesas Electronics products, semiconductor products have specific characteristics, such as the occurrence of failure at a certain rate and malfunctions under certain use conditions. Unless designated as a high reliability product or a product for harsh environments in a Renesas Electronics data sheet or other Renesas Electronics document, Renesas Electronics products are not subject to radiation resistance design. You are responsible for implementing safety measures to guard against the possibility of bodily injury, injury or damage caused by fire, and/or danger to the public in the event of a failure or malfunction of Renesas Electronics products, such as safety design for hardware and software, including but not limited to redundancy, fire control and malfunction prevention, appropriate treatment for aging degradation or any other appropriate measures. Because the evaluation of microcomputer software alone is very difficult and impractical, you are responsible for evaluating the safety of the final products or systems manufactured by you.
10. Please contact a Renesas Electronics sales office for details as to environmental matters such as the environmental compatibility of each Renesas Electronics product. You are responsible for carefully and sufficiently investigating applicable laws and regulations that regulate the inclusion or use of controlled substances, including without limitation, the EU RoHS Directive, and using Renesas Electronics products in compliance with all these applicable laws and regulations. Renesas Electronics disclaims any and all liability for damages or losses occurring as a result of your noncompliance with applicable laws and regulations.
11. Renesas Electronics products and technologies shall not be used for or incorporated into any products or systems whose manufacture, use, or sale is prohibited under any applicable domestic or foreign laws or regulations. You shall comply with any applicable export control laws and regulations promulgated and administered by the governments of any countries asserting jurisdiction over the parties or transactions.
12. It is the responsibility of the buyer or distributor of Renesas Electronics products, or any other party who distributes, disposes of, or otherwise sells or transfers the product to a third party, to notify such third party in advance of the contents and conditions set forth in this document.
13. This document shall not be reprinted, reproduced or duplicated in any form, in whole or in part, without prior written consent of Renesas Electronics.
14. Please contact a Renesas Electronics sales office if you have any questions regarding the information contained in this document or Renesas Electronics products.

(Note1) "Renesas Electronics" as used in this document means Renesas Electronics Corporation and also includes its directly or indirectly controlled subsidiaries.

(Note2) "Renesas Electronics product(s)" means any product developed or manufactured by or for Renesas Electronics.

(Rev.5.0-1 October 2020)

Corporate Headquarters

TOYOSU FORESIA, 3-2-24 Toyosu,
Koto-ku, Tokyo 135-0061, Japan
www.renesas.com

Trademarks

Renesas and the Renesas logo are trademarks of Renesas Electronics Corporation. All trademarks and registered trademarks are the property of their respective owners.

Contact information

For further information on a product, technology, the most up-to-date version of a document, or your nearest sales office, please visit:
www.renesas.com/contact/.