RX140 Group, RX231 Group

Differences Between the RX140 Group and the RX231 Group

Introduction

This application note is intended as a reference to points of difference between the peripheral functions, I/O registers, and pin functions of the RX140 Group and RX231 Group, as well as a guide to key points to consider when migrating between the two groups.

Unless specifically otherwise noted, the information in this application note applies to the 80-pin package version of the RX140 Group and the 100-pin package version of the RX231 Group as the maximum specifications. To confirm details of differences in the specifications of the electrical characteristics, usage notes, and setting procedures, refer to the User's Manual: Hardware of the products in question.

Target Devices

RX140 Group and RX231 Group

Contents

1. Comparison of Built-In Functions of RX140 Group and RX231 Group

A comparison of the built-in functions of the RX140 Group and RX231 Group is provided below. For details of the functions, see section 2, Comparative Overview of Specifications and section 5, Reference Documents.

Table 1.1 is a comparison of built-in functions of RX140 Group and RX231 Group.

Table 1.1 Comparison of Built-In Functions of RX140 Group and RX231 Group

Function	RX231	RX140
CPU	●	●
Operating modes	●	●
Address space	▲	▲
Resets	●	●
Option-setting memory (OFSM)	▲	▲
Voltage detection circuit (LVDAb)	●	●
Clock generation circuit	●	●/■
Clock frequency accuracy measurement circuit (CAC)	○	○
Low power consumption	●	●
Battery backup function	○	×
Register write protection function	●	●/■
Exception handling	○	○
Interrupt controller (ICUb)	▲	▲
Buses	▲	▲
Memory-protection unit	○	×
DMA controller	○	×
Data transfer controller (DTCa): RX231, (DTCb): RX140	●	●
Event link controller (ELC)	●	●
I/O ports	●	●/■
Multi-function pin controller (MPC)	▲	▲/■
Multi-function timer pulse unit 2 (MTU2a)	○	○
Port output enable 2 (POE2a)	■	■
16-bit timer pulse unit	○	×
8-bit timer (TMR): RX231, (TMRa): RX140	○	○
Compare match timer (CMT)	■	■
Realtime clock (RTCe): RX231, (RTCc): RX140	■	■
Low-power timer (LPT): RX231, (LPTa): RX140	●	●
Watchdog timer (WDTA)	○	×
Independent watchdog timer (IWDTa)	○	○
USB 2.0 Host/Function module	○	×
Serial communications interface (SCIg, SCIh): RX231, (SCIg*1, SCIk, SCIh): RX140	●	●
IrDA interface	○	×
I²C bus interface (RIICa)	○	○
CAN module (RSCAN)	○*1	○*1
Serial sound interface (SSI)	○	×
Serial peripheral interface (RSPIa): RX231, (RSPIc): RX140	▲	▲/■
CRC calculator (CRC)	○	○
SD host interface (SDHIa)	○	×
Trusted Secure IP (TSIP-Lite)	○	×
Capacitive touch sensing unit (CTSU): RX231, (CTSU2SL*1, CTSU2L): RX140	●	●
AESA	×	○
RNGA	×	○

Function	RX231	RX140
12-bit A/D converter (S12ADE4)	●	
12-bit D/A converter (S12DAA): RX231, D/A converter (DAa): RX140	▲/■	
Temperature sensor (TEMPSA)	▲	
Comparator B (CMPBa)	○	
Data operation circuit (DOC)	○	
RAM	●	
Flash memory (FLASH)	●/■	
Packages	●/■	

○: Available, ×: Unavailable, ●: Differs due to added functionality,
▲: Differs due to change in functionality, ■: Differs due to removed functionality.

Note: 1. Not implemented on RX140 Group products with ROM capacity of 64 KB.

2. Comparative Overview of Specifications

This section presents a comparative overview of specifications, including registers.

In the comparative overview, red text indicates functions which are included only in one of the MCU groups and also functions for which the specifications differ between the two groups.

In the register comparison, red text indicates differences in specifications for registers that are included in both groups and **black text** indicates registers which are included only in one of the MCU groups. Differences in register specifications are not listed.

2.1 CPU

Table 2.1 is a comparative overview of CPU.

Table 2.1 Comparative Overview of CPU

Item	RX231	RX140
CPU	• Maximum operating frequency: 54 MHz • 32-bit RX CPU • Minimum instruction execution time: One instruction per clock cycle • Address space: 4 GB, linear • Register set of the CPU — General purpose: Sixteen 32-bit registers — Control: Ten 32-bit registers — Accumulator: Two 72-bit register • Basic instructions: 75, variable-length instruction format • Floating point instructions: 11 • DSP instructions: 23 • Addressing modes: 10 • Data arrangement — Instructions: Little endian — Data: Selectable between little endian or big endian • On-chip 32-bit multiplier: 32 × 32 → 64 bits • On-chip divider: 32 / 32 → 32 bits • Barrel shifter: 32 bits • Memory-protection unit (MPU)	• Maximum operating frequency: 48 MHz • 32-bit RX CPU (RXv2) • Minimum instruction execution time: One instruction per clock cycle • Address space: 4 GB, linear • Register set of the CPU — General purpose: Sixteen 32-bit registers — Control: Ten 32-bit registers — Accumulator: Two 72-bit registers • Basic instructions: 75, variable-length instruction format • Floating point instructions: 11 • DSP instructions: 23 • Addressing modes: 11 • Data arrangement — Instructions: Little endian — Data: Selectable between little endian or big endian • On-chip 32-bit multiplier: 32 × 32 → 64 bits • On-chip divider: 32 / 32 → 32 bits • Barrel shifter: 32 bits
FPU	• Single-precision floating-point (32 bits) • Data types and floating-point exceptions conform to IEEE 754 standard	• Single-precision floating-point (32 bits) • Data types and floating-point exceptions conform to IEEE 754 standard

2.2 Operating Modes

Table 2.2 is a comparative overview of operating modes, and Table 2.3 is a comparison of operating mode registers.

Table 2.2 Comparative Overview of Operating Modes

Item	RX231	RX140
Operating modes specified by mode setting pins	Single-chip mode	Single-chip mode
	Boot mode (SCI interface)	Boot mode (SCI interface)
	Boot mode (USB interface)	—
	Boot mode (FINE interface)	Boot mode (FINE interface)
Operating modes selected by register settings	Single-chip mode	—
	On-chip ROM disabled extended mode	—
	On-chip ROM enabled extended mode	—

Table 2.3 Comparison of Operating Mode Registers

Register	Bit	RX231	RX140
SYSCR0	—	System control register 0	—

2.3 Address Space

Figure 2.1 is a comparative memory map of single-chip mode.

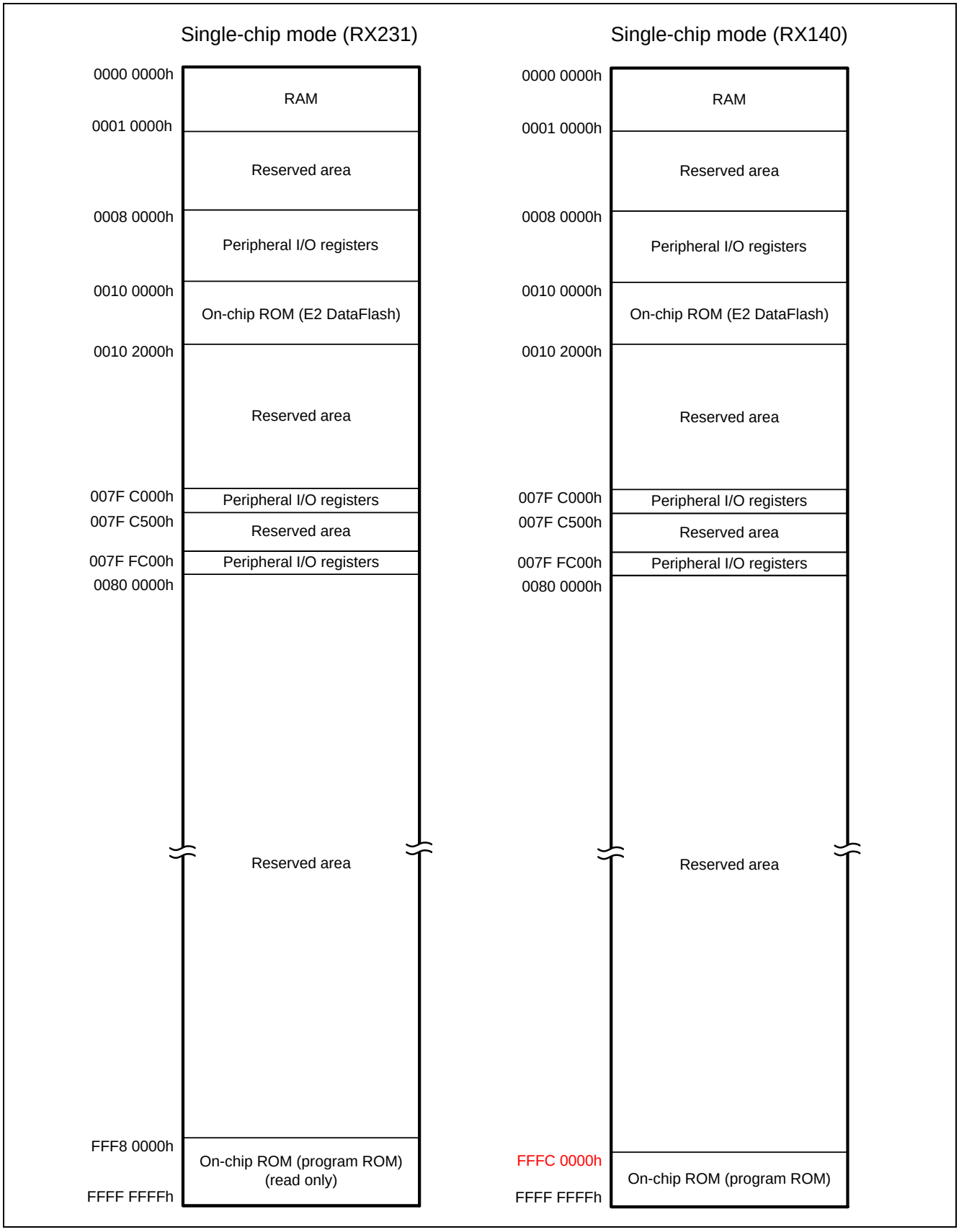

Figure 2.1 Comparative Memory Map of Single-Chip Mode

2.4 Resets

Table 2.4 is a comparative overview of resets, and Table 2.5 is a comparison of reset-related registers.

Table 2.4 Comparative Overview of Resets

Item	RX231	RX140
RES# pin reset	Voltage input to the RES# pin is driven low.	Voltage input to the RES# pin is driven low.
Power-on reset	VCC rises (voltage detection: VPOR).	VCC rises (voltage detection: VPOR).
Voltage monitoring 0 reset	VCC falls (voltage detection: Vdet0).	VCC falls (voltage detection: Vdet0).
Voltage monitoring 1 reset	VCC falls (voltage detection: Vdet1).	VCC falls (voltage detection: Vdet1).
Voltage monitoring 2 reset	VCC falls (voltage detection: Vdet2).	VCC falls (voltage detection: Vdet2).
Independent watchdog timer reset	The independent watchdog timer underflows or a refresh error occurs.	The independent watchdog timer underflows or a refresh error occurs.
Watchdog timer reset	Watchdog timer underflow, or refresh error	—
Software reset	Register setting	Register setting

Table 2.5 Comparison of Reset-Related Registers

Register	Bit	RX231	RX140
RSTSR2	WDTRF	Watchdog timer reset detect flag	—

2.5 Option-Setting Memory

Table 2.6 is a comparison of option-setting memory registers.

Table 2.6 Comparison of Option-Setting Memory Registers

Register	Bit Name	RX231 (OFSM)	RX140 (OFSM)
OFS0	WDTSTRT	WDT start mode select bit	—
	WDTTOPS[1:0]	WDT timeout period select bits	—
	WDTCKS[3:0]	WDT clock frequency division ratio select bits	—
	WDTRPES[1:0]	WDT window end position select bits	—
	WDTRPSS[1:0]	WDT window start position select bits	—
	WDTRSTIRQS	WDT reset interrupt request select bit	—
OFS1	HOCOFQ[1:0]	—	HOCO frequency selection bits

2.6 Voltage Detection Circuit

Table 2.7 is a comparative overview of the voltage detection circuits, and Table 2.8 is a comparison of voltage detection circuit registers.

Table 2.7 Comparative Overview of Voltage Detection Circuits

Item		RX231 (LVDAb)			RX140 (LVDAb)		
		Voltage Monitoring 0	**Voltage Monitoring 1**	**Voltage Monitoring 2**	**Voltage Monitoring 0**	**Voltage Monitoring 1**	**Voltage Monitoring 2**
VCC monitoring	Monitored voltage	Vdet0	Vdet1	Vdet2	Vdet0	Vdet1	Vdet2
	Detection target	When voltage drops below Vdet0	When voltage rises above or drops past Vdet1	When voltage rises above or drops past Vdet2	When voltage drops below Vdet0	When voltage rises above or drops past Vdet1	When voltage rises above or drops past Vdet2
				Switching between VCC and the voltage input on the CMPA2 pin can be accomplished using the LVCMPCR.EXVCCINP2 bit.			Switching between VCC and the voltage input on the CMPA2 pin can be accomplished using the LVCMPCR.EXVCCINP2 bit.
	Detection voltage	Selectable from four levels using the OFS1 register	Selectable from 14 levels using LVDLVLR.LVD1LVL[3:0] bits	Selectable from four levels using LVDLVLR.LVD2LVL[1:0] bits	Selectable from four levels using the OFS1 register	Selectable from 14 levels using LVDLVLR.LVD1LVL[3:0] bits	Selectable from four levels using LVDLVLR.LVD2LVL[1:0] bits
	Monitoring flags	—	LVD1SR.LVD1MON flag: Monitors whether voltage is higher or lower than Vdet1	LVD2SR.LVD2MON flag: Monitors whether voltage is higher or lower than Vdet2	—	LVD1SR.LVD1MON flag: Monitors whether voltage is higher or lower than Vdet1	LVD2SR.LVD2MON flag: Monitors whether voltage is higher or lower than Vdet2
			LVD1SR.LVD1DET flag: Vdet1 passage detection	LVD2SR.LVD2DET flag: Vdet2 passage detection		LVD1SR.LVD1DET flag: Vdet1 passage detection	LVD2SR.LVD2DET flag: Vdet2 passage detection

Item		RX231 (LVDAb)			RX140 (LVDAb)		
		Voltage Monitoring 0	**Voltage Monitoring 1**	**Voltage Monitoring 2**	**Voltage Monitoring 0**	**Voltage Monitoring 1**	**Voltage Monitoring 2**
Voltage detection processing	Reset	Voltage monitoring 0 reset	Voltage monitoring 1 reset	Voltage monitoring 2 reset	Voltage monitoring 0 reset	Voltage monitoring 1 reset	Voltage monitoring 2 reset
		Reset when Vdet0 > VCC: CPU restart timing after specified time with VCC > Vdet0	Reset when Vdet1 > VCC: CPU restart timing selectable between after specified time with VCC > Vdet1 or Vdet1 > VCC	Reset when Vdet2 > VCC or CMPA2 pin: CPU restart timing selectable among after specified time with VCC or CMPA2 pin > Vdet2 or after specified time with Vdet2 > VCC or CMPA2 pin	Reset when Vdet0 > VCC: CPU restart timing after specified time with VCC > Vdet0	Reset when Vdet1 > VCC: CPU restart timing selectable between after specified time with VCC > Vdet1 or Vdet1 > VCC	Reset when Vdet2 > VCC or CMPA2 pin: CPU restart timing selectable among after specified time with VCC or CMPA2 pin > Vdet2 or after specified time with Vdet2 > VCC or CMPA2 pin
	Interrupts	—	Voltage monitoring 1 interrupt	Voltage monitoring 2 interrupt	—	Voltage monitoring 1 interrupt	Voltage monitoring 2 interrupt
			Selectable between non-maskable or maskable interrupt	Selectable between non-maskable or maskable interrupt		Selectable between non-maskable or maskable interrupt	Selectable between non-maskable or maskable interrupt
			Interrupt request issued when Vdet1 > VCC, VCC > Vdet1, or both	Interrupt request issued when Vdet2 > VCC or CMPA2 pin, VCC or CMPA2 pin > Vdet2, or both		Interrupt request issued when Vdet1 > VCC, VCC > Vdet1, or both	Interrupt request issued when Vdet2 > VCC or CMPA2 pin, VCC or CMPA2 pin > Vdet2, or both
Event link function		—	Available: Event output at Vdet1 passage detection	Available: Event output at Vdet1 passage detection	—	Available: Event output at Vdet1 passage detection	—

Table 2.8 Comparison of Voltage Detection Circuit Registers

Register	Bit	RX231 (LVDAb)	RX140 (LVDAb)
LVDLVLR	LVD1LVL[3:0]	Voltage detection 1 level select bits (Standard voltage during drop in voltage) b3 b0 0 0 0 0: 4.29 V 0 0 0 1: 4.14 V 0 0 1 0: 4.02 V 0 0 1 1: 3.84 V 0 1 0 0: 3.10 V 0 1 0 1: 3.00 V 0 1 1 0: 2.90 V 0 1 1 1: 2.79 V 1 0 0 0: 2.68 V 1 0 0 1: 2.58 V 1 0 1 0: 2.48 V 1 0 1 1: 2.20 V 1 1 0 0: 1.96 V 1 1 0 1: 1.86 V Settings other than the above are prohibited.	Voltage detection 1 level select bits (Standard voltage during drop in voltage) b3 b0 0 0 0 0: 4.29 V 0 0 0 1: 4.16 V 0 0 1 0: 4.03 V 0 0 1 1: 3.86 V 0 1 0 0: 3.10 V 0 1 0 1: 3.00 V 0 1 1 0: 2.90 V 0 1 1 1: 2.80 V 1 0 0 0: 2.68 V 1 0 0 1: 2.59 V 1 0 1 0: 2.48 V 1 0 1 1: 2.20 V 1 1 0 0: 1.96 V 1 1 0 1: 1.86 V Settings other than the above are prohibited.
	LVD2LVL[1:0]	Voltage detection 2 level select bits (Standard voltage during drop in voltage) b5 b4 0 0: 4.29 V 0 1: 4.14 V 1 0: 4.02 V 1 1: 3.84 V	Voltage detection 2 level select bits (Standard voltage during drop in voltage) b5 b4 0 0: 4.32 V 0 1: 4.17 V 1 0: 4.03 V 1 1: 3.84 V

2.7 Clock Generation Circuit

Table 2.9 is a comparative overview of the clock generation circuits, and Table 2.10 is a comparison of clock generation circuit registers.

Table 2.9 Comparative Overview of Clock Generation Circuits

Item	RX231	RX140
Use	• Generates the system clock (ICLK) to be supplied to the CPU, DTC, DMAC, ROM, and RAM. • Of the peripheral module clocks (PCLKA, PCLKB, and PCLKD) supplied to the peripheral modules, PCLKA is the operating clock for the MTU2, PCLKD is the operating clock for the S12AD, and PCLKB is the operating clock for modules other than MTU2 and S12AD. • Generates the FlashIF clock (FCLK) to be supplied to the FlashIF. • Generates the external bus clock (BCLK) to be supplied to the external bus. • Generates the USB clock (UCLK) to be supplied to the USB. • Generates the CAC clock (CACCLK) to be supplied to the CAC. • Generates the CAN clock (CANMCLK) to be supplied to the RSCAN. • Generates the RTC-dedicated sub-clock (RTCSCLK) to be supplied to the RTC. • Generates the IWDT-dedicated clock (IWDTCLK) to be supplied to the IWDT. • Generates the SSI clock (SSISCK) to be supplied to the SSI. • Generates the LPT clock (LPTCLK) to be supplied to the LPT.	• Generates the system clock (ICLK) to be supplied to the CPU, DTC, ROM, and RAM. • Of the peripheral module clocks (PCLKB and PCLKD) supplied to the peripheral modules, PCLKD is the operating clock for the S12AD, and PCLKB is the operating clock for modules other than S12AD. • Generates the FlashIF clock (FCLK) to be supplied to the FlashIF. • Generates the CAC clock (CACCLK) to be supplied to the CAC. • Generates the CAN clock (CANMCLK) to be supplied to the CAN. • Generates the RTC-dedicated sub-clock (RTCSCLK) to be supplied to the RTC. • Generates the IWDT-dedicated clock (IWDTCLK) to be supplied to the IWDT • Generates the LPT clock (LPTCLK) to be supplied to the LPT.

Item	RX231	RX140
Operating frequency	• ICLK: 54 MHz (max.) • PCLKA: 54 MHz (max.) • PCLKB: 32 MHz (max.) • PCLKD: 54 MHz (max.) • FCLK: — 1 MHz to 32 MHz (for programming and erasing the ROM and E2 DataFlash) — 32 MHz (max.) (for reading from the E2 DataFlash) • BCLK: 32 MHz (max.) • BCLK pin output: 16 MHz (max.) • UCLK: 48 MHz • CACCLK: Same as clock from respective oscillators • CANMCLK: 20 MHz (max.) • RTCSCLK: 32.768 kHz • IWDTCLK: 15 kHz • SSISCK: 20 MHz (max.) • LPTCLK: Same frequency as that of the selected oscillator	• ICLK: 48 MHz (max.) • PCLKB: 32 MHz (max.) • PCLKD: 48 MHz (max.) • FCLK: — 1 MHz to 48 MHz (for programming and erasing the ROM and E2 DataFlash) — 48 MHz (max.) (for reading from the E2 DataFlash) • CACCLK: Same as clock from respective oscillators • CANMCLK: 20 MHz (max.) • RTCSCLK: 32.768 kHz • IWDTCLK: 15 kHz • LPTCLK: Same as clock from selected oscillator
Main clock oscillator	• Resonator frequency: 1 MHz to 20 MHz (VCC ≥ 2.4 V), 1 MHz to 8 MHz (VCC < 2.4 V) • External clock input frequency: 20 MHz (max.) • Connectable resonator or additional circuit: ceramic resonator, crystal • Connection pins: EXTAL, XTAL • Oscillation stop detection function: When a main clock oscillation stop is detected, the system clock source is switched to LOCO and MTU pin can be forcedly driven to high-impedance. • Drive capacity switching function	• Resonator frequency: 1 MHz to 20 MHz • External clock input frequency: 20 MHz (max.) • Connectable resonator or additional circuit: ceramic resonator, crystal • Connection pins: EXTAL, XTAL • Oscillation stop detection function: When a main clock oscillation stop is detected, the system clock source is switched to LOCO and MTU pin can be forcedly driven to high-impedance. • Drive capacity switching function
Sub-clock oscillator	• Resonator frequency: 32.768 kHz • Connectable resonator or additional circuit: crystal • Connection pin: XCIN, XCOUT • Drive capacity switching function	• Resonator frequency: 32.768 kHz • Connectable resonator or additional circuit: crystal • Connection pins: XCIN and XCOUT • Drive capacity switching function
PLL circuit	• Input clock source: Main clock • Input pulse frequency division ratio: Selectable from 1, 2, and 4 • Input frequency: 4 MHz to 12.5 MHz • Frequency multiplication ratio: Selectable from 4 to 13.5 (increments of 0.5) • Oscillation frequency: 24 MHz to 54 MHz (VCC ≥ 2.4 V)	• Input clock source: Main clock • Input pulse frequency division ratio: Selectable from 1, 2, and 4 • Input frequency: 4 MHz to 12 MHz • Frequency multiplication ratio: Selectable from 4 to 12 (increments of 0.5) • Oscillation frequency: 24 MHz to 48 MHz

Item	RX231	RX140
USB-dedicated PLL circuit	• Input clock source: Main clock • Input pulse frequency division ratio: Selectable from 1, 2, and 4 • Input frequency: 4 MHz, 6 MHz, 8 MHz, and 12 MHz • Frequency multiplication ratio: Selectable from 4, 6, 8, and 12 • Oscillation frequency: 48 MHz (VCC ≥ 2.4 V)	—
High-speed on-chip oscillator (HOCO)	Oscillation frequency: 32 MHz and 54 MHz	Oscillation frequency: 24 MHz, 32 MHz, 48 MHz
Low-speed on-chip oscillator (LOCO)	Oscillation frequency: 4 MHz	Oscillation frequency: 4 MHz
IWDT-dedicated on-chip oscillator	Oscillation frequency: 15 kHz	Oscillation frequency: 15 kHz

Table 2.10 Comparison of Clock Generation Circuit Registers

Register	Bit	RX231	RX140
SCKCR	PCKA[3:0]	Peripheral module clock A (PCLKA) select bits	—
	BCK[3:0]	External bus clock (BCLK) select bits	—
	PSTOP1	BCLK pin output control bit	—
PLLCR	STC[5:0]	Frequency multiplication factor select bits b13 b8 0 0 0 1 1 1: ×4 0 0 1 0 0 0: ×4.5 0 0 1 0 0 1: ×5 0 0 1 0 1 0: ×5.5 0 0 1 0 1 1: ×6 0 0 1 1 0 0: ×6.5 0 0 1 1 0 1: ×7 0 0 1 1 1 0: ×7.5 0 0 1 1 1 1: ×8 0 1 0 0 0 0: ×8.5 0 1 0 0 0 1: ×9 0 1 0 0 1 0: ×9.5 0 1 0 0 1 1: ×10 0 1 0 1 0 0: ×10.5 0 1 0 1 0 1: ×11 0 1 0 1 1 0: ×11.5 0 1 0 1 1 1: ×12 0 1 1 0 0 0: ×12.5 0 1 1 0 0 1: ×13 0 1 1 0 1 0: ×13.5 Settings other than the above are prohibited.	Frequency multiplication factor select bits b13 b8 0 0 0 1 1 1: ×4 0 0 1 0 0 0: ×4.5 0 0 1 0 0 1: ×5 0 0 1 0 1 0: ×5.5 0 0 1 0 1 1: ×6 0 0 1 1 0 0: ×6.5 0 0 1 1 0 1: ×7 0 0 1 1 1 0: ×7.5 0 0 1 1 1 1: ×8 0 1 0 0 0 0: ×8.5 0 1 0 0 0 1: ×9 0 1 0 0 1 0: ×9.5 0 1 0 0 1 1: ×10 0 1 0 1 0 0: ×10.5 0 1 0 1 0 1: ×11 0 1 0 1 1 0: ×11.5 0 1 0 1 1 1: ×12 Settings other than the above are prohibited.
UPLLCR	—	USB-dedicated PLL control register	—

Register	Bit	RX231	RX140
UPLLCR2	—	USB-dedicated PLL control register 2	—
BCKCR	—	External bus clock control register	—
SOSCCR	SOSTP	Sub-clock oscillator stop bit	Sub-clock oscillator stop bit This bit is not initialized by reset sources other than a power-on reset.
		Initial value after a reset differs.	
HOCOCR2	—	High-speed on-chip oscillator control register 2	—
OSCOVFSR	UPLOVF	USB-dedicated PLL clock oscillation stabilization flag	—
MOSCWTCR	MSTS[4:0]	Main clock oscillator wait time bits b4 b0 0 0 0 0 0: Wait time = 2 cycles (0.5 µs) 0 0 0 0 1: Wait time = 1,024 cycles (256 µs) 0 0 0 1 0: Wait time = 2,048 cycles (512 µs) 0 0 0 1 1: Wait time = 4,096 cycles (1.024 ms) 0 0 1 0 0: Wait time = 8,192 cycles (2.048 ms) 0 0 1 0 1: Wait time = 16,384 cycles (4.096 ms) 0 0 1 1 0: Wait time = 32,768 cycles (8.192ms) 0 0 1 1 1: Wait time = 65,536 cycles (16.384 ms) Settings other than the above are prohibited. Wait time when LOCO = 4.0 MHz (0.25 µs, typ.)	Main clock oscillator wait time bits b4 b0 0 0 0 0 0: Wait time = 0 cycles (0 µs) 0 0 0 0 1: Wait time = 1,024 cycles (256 µs) 0 0 0 1 0: Wait time = 2,048 cycles (512 µs) 0 0 0 1 1: Wait time = 4,096 cycles (1.024 ms) 0 0 1 0 0: Wait time = 8,192 cycles (2.048 ms) 0 0 1 0 1: Wait time = 16,384 cycles (4.096 ms) 0 0 1 1 0: Wait time = 32,768 cycles (8.192 ms) 0 0 1 1 1: Wait time = 65,536 cycles (16.384 ms) 0 1 0 0 0: Wait time = 131,072 cycles (32.768 ms) Settings other than the above are prohibited. Wait time when LOCO = 4.0 MHz (0.25 µs, typ.)
LOFCR	—	—	Low-speed on-chip oscillator forced oscillation control register

Register	Bit	RX231	RX140
CKOCR	CKOSEL [3:0]	CLKOUT output source select bit b11 b8 0 0 0 0: LOCO clock 0 0 0 1: HOCO clock 0 0 1 0: Main clock 0 0 1 1: Sub-clock 0 1 0 0: PLL Settings other than the above are prohibited.	CLKOUT output source select bit b11 b8 0 0 0 0: LOCO clock 0 0 0 1: HOCO clock 0 0 1 0: Main clock 0 0 1 1: Sub-clock 0 1 0 0: PLL 1 0 0 0: CTSU internal clock Settings other than the above are prohibited.
	CKODIV [2:0]	CLKOUT output division ratio select bits b14 b12 0 0 0: No division 0 0 1: ×1/2 0 1 0: ×1/4 0 1 1: ×1/8 1 0 0: ×1/16 Settings other than the above are prohibited.	CLKOUT output division ratio select bits b14 b12 0 0 0: No division 0 0 1: ×1/2 0 1 0: ×1/4 0 1 1: ×1/ 8 1 0 0: ×1/16 1 0 1: ×1/32 1 1 0: ×1/ 64 1 1 1: ×1/128
MOFCR	MODRV21	Main clock oscillator drive capability switch bit VCC ≥ 2.4 V 0: 1 MHz to 10 MHz 1: 10 MHz to 20 MHz VCC < 2.4 V 0: 1 MHz to 8 MHz 1: Setting prohibited.	Main clock oscillator drive capability switch bit 0: 1 MHz to less than 10 MHz 1: 10 MHz to 20 MHz
MEMWAIT	—	Memory wait cycle setting register	—
LOCOTRR (RX231) LOCOTRR2 (RX140)	LOCOTRD [4:0](RX231) LOCOTRD2 [7:0](RX140)	Low-speed on-chip oscillator frequency adjustment bits b4 b0 1 0 0 0 0: –16 (Frequency: Low) 1 0 0 0 1: –15 : : 0 1 1 1 0: 14 0 1 1 1 1: 15 (Frequency: High)	Low-speed on-chip oscillator frequency adjustment bits 2 b7 b0 0 0 0 0 0 0 0 0: 0 (Frequency: Low) 0 0 0 0 0 0 0 1: 1 : : 1 1 1 1 1 1 1 0: 254 1 1 1 1 1 1 1 1: 255 (Frequency: High)
HOCOTRRn	—	High-speed on-chip oscillator trimming register n (n = 0, 3)	High-speed on-chip oscillator trimming register n (n = 0)
SOMCR	—	—	Sub-clock oscillator mode control register

2.8 Low Power Consumption

Table 2.11 is a comparative overview of the low power consumption functions, Table 2.12 is a comparison of procedures for entering and exiting low power consumption modes and operating states in each mode, and Table 2.13 is a comparison of low power consumption registers.

Table 2.11 Comparative Overview of Low Power Consumption Functions

Item	RX231	RX140
Reducing power consumption by switching clock signals	The frequency division ratio can be set independently for the system clock (ICLK), high speed peripheral module clock (PCLKA), peripheral module clock (PCLKB), S12AD clock (PCLKD), external bus clock (BCLK), and FlashIF clock (FCLK).	The frequency division ratio can be set independently for the system clock (ICLK), peripheral module clock (PCLKB), S12AD clock (PCLKD), and FlashIF clock (FCLK).
Module stop function	Each peripheral module can be stopped independently by the module stop control register.	Each peripheral module can be stopped independently by the module stop control register.
Function for transition to low power consumption mode	Transition to a low power consumption mode in which the CPU, peripheral modules, or oscillators are stopped is enabled.	Transition to a low power consumption mode in which the CPU, peripheral modules, or oscillators are stopped is enabled.
Low power consumption modes	• Sleep mode • Deep sleep mode • Software standby mode	• Sleep mode • Deep sleep mode • Software standby mode • Snooze mode
Function for lower operating power consumption	• Power consumption can be reduced in normal operation, sleep mode, and deep sleep mode by selecting an appropriate operating power control mode according to the operating frequency and operating voltage. • Three operating power control modes are available — High-speed operating mode — Middle-speed operating mode — Low-speed operating mode	• Power consumption can be reduced in normal operation, sleep mode, deep sleep mode, and snooze mode by selecting an appropriate operating power control mode according to the operating frequency and operating voltage. • Four operating power control modes are available — High-speed operating mode — Middle-speed operating mode — Middle-speed operating mode 2 — Low-speed operating mode

Table 2.12 Comparison of Procedures for Entering and Exiting Low Power Consumption Modes and Operating States in Each Mode

Mode	Entering and Exiting Low Power Consumption Modes and Operating States	RX231	RX140
Sleep mode	Transition method	Control register + instruction	Control register + instruction
	Method of cancellation other than reset	Interrupt	Interrupt
	State after cancellation	Program execution state (interrupt processing)	Program execution state (interrupt processing)
	Main clock oscillator	Operation possible	Operation possible
	Sub-clock oscillator	Operation possible	Operation possible
	High-speed on-chip oscillator	Operation possible	Operation possible
	Low-speed on-chip oscillator	Operation possible	Operation possible
	IWDT-dedicated on-chip oscillator	Operation possible	Operation possible
	PLL	Operation possible	Operation possible
	USB-dedicated PLL	Operation possible	—
	CPU	Stopped (retained)	Stopped (retained)
	RAM0 (0000 0000h to 0000 FFFFh)	Operation possible (retained)	Operation possible (retained)
	DMAC	Operation possible	—
	DTC	Operation possible	Operation possible
	Flash memory	Operation	Operation
	Watchdog timer (WDT)	Stopped (retained)	—
	Independent watchdog timer (IWDT)	Operation possible	Operation possible
	Realtime clock (RTC)	Operation possible	Operation possible
	Low-power timer (LPT)	Operation possible	Operation possible
	Voltage detection circuit (LVD)	Operation possible	Operation possible
	Power-on reset circuit	Operation	Operation
	Peripheral modules	Operation possible	Operation possible
	I/O ports	Operation	Operation
	RTCOUT output	Operation possible	Operation possible
	CLKOUT output	Operation possible	Operation possible
	Comparator B	Operation possible	Operation possible
Deep sleep mode	Transition method	Control register + instruction	Control register + instruction
	Method of cancellation other than reset	Interrupt	Interrupt
	State after cancellation	Program execution state (interrupt processing)	Program execution state (interrupt processing)
	Main clock oscillator	Operation possible	Operation possible
	Sub-clock oscillator	Operation possible	Operation possible
	High-speed on-chip oscillator	Operation possible	Operation possible
	Low-speed on-chip oscillator	Operation possible	Operation possible
	IWDT-dedicated on-chip oscillator	Operation possible	Operation possible
	PLL	Operation possible	Operation possible
	USB-dedicated PLL	Operation possible	—
	CPU	Stopped (retained)	Stopped (retained)
	RAM0 (0000 0000h to 0000 FFFFh)	Stopped (retained)	Stopped (retained)
	DMAC	Stopped (retained)	—

Mode	Entering and Exiting Low Power Consumption Modes and Operating States	RX231	RX140
Deep sleep mode	DTC	Stopped (retained)	Stopped (retained)
	Flash memory	Stopped (retained)	Stopped (retained)
	Watchdog timer (WDT)	Stopped (retained)	—
	Independent watchdog timer (IWDT)	Operation possible	Operation possible
	Realtime clock (RTC)	Operation possible	Operation possible
	Low-power timer (LPT)	Operation possible	Operation possible
	Voltage detection circuit (LVD)	Operation possible	Operation possible
	Power-on reset circuit	Operation	Operation
	Peripheral modules	Operation possible	Operation possible
	I/O ports	Operation	Operation
	RTCOUT output	Operation possible	Operation possible
	CLKOUT output	Operation possible	Operation possible
	Comparator B	Operation possible	Operation possible
Software standby mode	Transition method	Control register + instruction	Control register + instruction
	Method of cancellation other than reset	Interrupt	Interrupt
	State after cancellation	Program execution state (interrupt processing)	Program execution state (interrupt processing)
	Main clock oscillator	Stopped	Stopped
	Sub-clock oscillator	Operation possible	Operation possible
	High-speed on-chip oscillator	Stopped	Operation possible
	Low-speed on-chip oscillator	Stopped	Operation possible
	IWDT-dedicated on-chip oscillator	Operation possible	Operation possible
	PLL	Stopped	Stopped
	USB-dedicated PLL	Stopped	—
	CPU	Stopped (retained)	Stopped (retained)
	RAM0 (0000 0000h to 0000 FFFFh)	Stopped (retained)	Stopped (retained)
	DMAC	Stopped (retained)	—
	DTC	Stopped (retained)	Stopped (retained)
	Flash memory	Stopped (retained)	Stopped (retained)
	Watchdog timer (WDT)	Stopped (retained)	—
	Independent watchdog timer (IWDT)	Operation possible	Operation possible
	Realtime clock (RTC)	Operation possible	Operation possible
	Low-power timer (LPT)	Operation possible	Operation possible
	Voltage detection circuit (LVD)	Operation possible	Operation possible
	Power-on reset circuit	Operation	Operation
	Peripheral modules	Stopped (retained)	Stopped (retained)
	I/O ports	Retained	Retained
	RTCOUT output	Operation possible	Operation possible
	CLKOUT output	Operation possible	Operation possible
	Comparator B	Operation possible	Operation possible

Mode	Entering and Exiting Low Power Consumption Modes and Operating States	RX231	RX140
Snooze mode	Transition method	—	When snooze transition conditions are met while in software standby mode
	Method of cancellation other than reset	—	Interrupt or occurrence of snooze end condition
	State after cancellation	—	Program execution state (interrupt processing) or software standby mode
	Main clock oscillator	—	Operation possible
	Sub-clock oscillator	—	Operation possible
	High-speed on-chip oscillator	—	Operation possible
	Low-speed on-chip oscillator	—	Operation possible
	IWDT-dedicated on-chip oscillator	—	Operation possible
	PLL	—	Operation possible
	CPU	—	Stopped (retained)
	RAM0 (0000 0000h to 0000 FFFFh)	—	Operation possible (retained)
	DTC	—	Operation possible
	Flash memory	—	Stopped (retained)
	Independent watchdog timer (IWDT)	—	Operation possible
	Realtime clock (RTC)	—	Operation possible
	Low-power timer (LPT)	—	Operation possible
	Voltage detection circuit (LVD)	—	Operation possible
	Power-on reset circuit	—	Operation
	Peripheral modules	—	Operation possible
	I/O ports	—	Operation
	RTCOUT output	—	Operation possible
	CLKOUT output	—	Operation possible
	Comparator B	—	Operation possible

Note: “Operation possible” means that whether the state is operating or stopped is controlled by the control register setting.
“Stopped (retained)” means that internal register values are retained and internal operations are suspended.
“Stopped (undefined)” means that internal register values are undefined and power is not supplied to the internal circuit.

Table 2.13 Comparison of Low Power Consumption Registers

Register	Bit	RX231	RX140
SBYCR	—	Standby control register	Standby control register
		Initial value after a reset differs.	
	OPE	Output port enable bit	—
MSTPCRA	MSTPA13	16-bit timer pulse unit 0 (unit 0) module stop bit	—
	MSTPA14	Compare match timer 1 (unit 1) module stop bit	—
	MSTPA28	DMA controller / data transfer controller module stop bit Target module: DMAC/DTC	Data transfer controller module stop bit Target module: DTC
MSTPCRB	MSTPB19	USB0 module stop bit	—
	MSTPB31	Serial communication interface 0 module stop bit	—
MSTPCRC	MSTPC20	IrDA module stop bit	—
MSTPCRD	MSTPD15	Serial sound interface module stop bit	—
	MSTPD19	SD host interface (SDHI) module stop bit	—
	MSTPD29	—	True random number generator module stop bit
	MSTPD30	—	ASE hardware accelerator module stop bit
	MSTPD31	Trusted secure IP function module stop bit	—
OPCCR	OPCM [2:0]	Operating power control mode select bits b2 b0 0 0 0: High-speed operating mode 0 1 0: Middle-speed operating mode Settings other than the above are prohibited.	Operating power control mode select bits b2 b0 0 0 0: High-speed operating mode 0 1 0: Middle-speed operating mode 1 0 0: Middle-speed operating mode 2 Settings other than the above are prohibited.
SNZCR	—	—	Snooze control register
SNZCR2	—	—	Snooze control register 2

2.9 Register Write Protection Function

Table 2.14 is a comparative overview of the register write protection functions.

Table 2.14 Comparative Overview of Register Write Protection Functions

Item	RX231	RX140
PRC0 bit	Registers related to the clock generation circuit: SCKCR, SCKCR3, PLLCR, PLLCR2, MOSCCR, SOSCCR, LOCOCR, ILOCOCR, HOCOCR, OSTDCR, OSTDSR, CKOCR, UPLLCR, UPLLCR2, BCKCR, HOCOCR2, MEMWAIT, LOCOTRR, ILOCOTRR, HOCOTRR0, HOCOTRR3	Registers related to the clock generation circuit: SCKCR, SCKCR3, PLLCR, PLLCR2, MOSCCR, SOSCCR, LOCOCR, ILOCOCR, HOCOCR, LOFCR, OSTDCR, OSTDSR, CKOCR, LOCOTRR2, ILOCOTRR, HOCOTRR0, SOMCR
PRC1 bit	• Register related to the operating modes: SYSCR0, SYSCR1 • Registers related to the low power consumption functions: SBYCR, MSTPCRA, MSTPCRB, MSTPCRC, MSTPCRD, OPCCR, RSTCKCR, SOPCCR • Registers related to the clock generation circuit: MOFCR, MOSCWTCR • Software reset register: SWRR	• Register related to the operating modes: SYSCR1 • Registers related to the low power consumption functions: SBYCR, MSTPCRA, MSTPCRB, MSTPCRC, MSTPCRD, OPCCR, RSTCKCR, SOPCCR, SNZCR, SNZCR2 • Registers related to the clock generation circuit: MOFCR, MOSCWTCR • Software reset register: SWRR
PRC2 bit	Registers related to the low power timer: LPTCR1, LPTCR2, LPTCR3, LPTPRD, LPCMR0, LPWUCR	Registers related to the low power timer: LPTCR1, LPTCR2, LPTCR3, LPTPRD, LPCMR0, LPCMR1, LPWUCR
PRC3 bit	• Registers related to LVD: LVCMPCR, LVDLVLR, LVD1CR0, LVD1CR1, LVD1SR, LVD2CR0, LVD2CR1, LVD2SR • Registers related to the battery backup function: VBATTCR, VBATTSR, VBTLVDICR	• Registers related to LVD: LVCMPCR, LVDLVLR, LVD1CR0, LVD1CR1, LVD1SR, LVD2CR0, LVD2CR1, LVD2SR

2.10 Interrupt Controller

Table 2.15 is a comparative overview of the interrupt controllers, and Table 2.16 is a comparison of interrupt controller registers.

Table 2.15 Comparative Overview of Interrupt Controllers

Item		RX231 (ICUb)	RX140 (ICUb)
Interrupts	Peripheral function interrupts	• Interrupts from peripheral modules • Interrupt detection: Edge detection/level detection The detection method is fixed for each connected peripheral module source.	• Interrupts from peripheral modules • Interrupt detection: Edge detection/level detection The detection method is fixed for each connected peripheral module source.
	External pin interrupts	• Interrupts from pins IRQ0 to IRQ7 • Number of sources: 8 • Interrupt detection: Ability to set as source detection of low level, falling edge, rising edge, or rising and falling edges • Digital filter function: Supported	• Interrupts from pins IRQ0 to IRQ7 • Number of sources: 8 • Interrupt detection: Ability to set as source detection of low level, falling edge, rising edge, or rising and falling edges • Digital filter function: Supported
	Software interrupts	• Interrupt generated by writing to a register • Number of sources: 1	• Interrupt generated by writing to a register • Number of sources: 1
	Event link interrupts	An ELSR8l, ELSR18l or ELSR19l interrupt can be generated by an ELC event.	An ELSR8l or ELSR18l interrupt can be generated by an ELC event.
	Interrupt priority	Specified by registers.	Specified by registers.
	Fast interrupt function	Faster interrupt handling by the CPU can be specified for a single interrupt source only.	Faster interrupt handling by the CPU can be specified for a single interrupt source only.
	DTC and DMAC control (RX231) DTC control (RX140)	The DTC and DMAC can be activated by an interrupt source.	The DTC can be activated by an interrupt source.

Item		RX231 (ICUb)	RX140 (ICUb)
Non-maskable interrupts	NMI pin interrupt	• Interrupt from the NMI pin • Interrupt detection: Falling edge or rising edge • Digital filter function: Supported	• Interrupt from the NMI pin • Interrupt detection: Falling edge or rising edge • Digital filter function: Supported
	Oscillation stop detection interrupt	Interrupt on detection of oscillation having stopped	Interrupt on detection of oscillation having stopped
	WDT underflow/ refresh error interrupt	Interrupt on an underflow of the down counter or occurrence of a refresh error	—
	IWDT underflow/ refresh error interrupt	Interrupt on an underflow of the down counter or occurrence of a refresh error	Interrupt on an underflow of the down counter or occurrence of a refresh error
	Voltage monitoring 1 interrupt	Voltage monitoring interrupt of voltage monitoring circuit 1 (LVD1)	Voltage monitoring interrupt of voltage monitoring circuit 1 (LVD1)
	Voltage monitoring 2 interrupt	Voltage monitoring interrupt of voltage monitoring circuit 2 (LVD2)	Voltage monitoring interrupt of voltage monitoring circuit 2 (LVD2)
	BVATT voltage monitoring interrupt	Voltage monitoring interrupt of the BVATT	—
Return from low power consumption state		• Sleep mode and deep sleep mode: Return is initiated by a non-maskable interrupt or any other interrupt source. • Software standby mode: Return is initiated by a non-maskable interrupt, interrupt IRQ0 to IRQ7, or an RTC alarm or periodic interrupt.	• Sleep mode and deep sleep mode: Return is initiated by a non-maskable interrupt or any other interrupt source. • Software standby mode: Return is initiated by a non-maskable interrupt, interrupt IRQ0 to IRQ7, or an RTC alarm or periodic interrupt.

Table 2.16 Comparison of Interrupt Controller Registers

Register	Bit	RX231 (ICUb)	RX140 (ICUb)
DMRSRm	—	DMAC trigger select register m (m = 0 to 3)	—
NMISR	WDTST	WDT underflow/refresh error status flag	—
	VBATST	VBATT voltage monitoring interrupt status flag	—
NMIER	WDTEN	WDT underflow/refresh error enable bit	—
	VBATEN	VBATT voltage monitoring interrupt enable bit	—
NMICLR	WDTCLR	WDT clear bit	—
	VBATCLR	VBAT clear bit	—

2.11 Buses

Table 2.17 is a comparative overview of the buses, and Table 2.18 is a comparison of bus registers.

Table 2.17 Comparative Overview of Buses

Bus Type		RX231	RX140
CPU buses	Instruction bus	• Connected to the CPU (for instructions) • Connected to on-chip memory (RAM, ROM) • Operates in synchronization with the system clock (ICLK)	• Connected to the CPU (for instructions) • Connected to on-chip memory (RAM, ROM) • Operates in synchronization with the system clock (ICLK)
	Operand bus	• Connected to the CPU (for operands) • Connected to on-chip memory (RAM, ROM) • Operates in synchronization with the system clock (ICLK)	• Connected to the CPU (for operands) • Connected to on-chip memory (RAM, ROM) • Operates in synchronization with the system clock (ICLK)
Memory buses	Memory bus 1	Connected to RAM	Connected to RAM
	Memory bus 2	Connected to ROM	Connected to ROM
Internal main buses	Internal main bus 1	• Connected to the CPU • Operates in synchronization with the system clock (ICLK)	• Connected to the CPU • Operates in synchronization with the system clock (ICLK)
	Internal main bus 2	• Connected to the DTC and DMAC • Connected to on-chip memory (RAM, ROM) • Operates in synchronization with the system clock (ICLK)	• Connected to the DTC • Connected to on-chip memory (RAM, ROM) • Operates in synchronization with the system clock (ICLK)
Internal peripheral buses	Internal peripheral bus 1	• Connected to peripheral modules (DTC, DMAC, interrupt controller, and bus error monitoring section) • Operates in synchronization with the system clock (ICLK)	• Connected to peripheral modules (DTC, interrupt controller, and bus error monitoring section) • Operates in synchronization with the system clock (ICLK)
	Internal peripheral bus 2	• Connected to peripheral modules (modules other than those connected to internal peripheral buses 1, 3, and 4) • Operates in synchronization with the peripheral-module clock (PCLKB)	• Connected to peripheral modules • Operates in synchronization with the peripheral-module clock (PCLKB, PCLKD)
	Internal peripheral bus 3	• Connected to peripheral modules (USB0, RSCAN, and CTSU) • Operates in synchronization with the peripheral-module clock (PCLKB)	• Connected to peripheral modules (CTSU, RSCAN) • Operates in synchronization with the peripheral-module clock (PCLKB)
	Internal peripheral bus 4	• Connected to peripheral modules (MTU2) • Operates in synchronization with the peripheral-module clock (PCLKA)	—

Bus Type		RX231	RX140
Internal peripheral buses	Internal peripheral bus 6	• Connected to the flash control module and E2 DataFlash • Operates in synchronization with the FlashIF clock (FCLK)	• Connected to ROM (P/E) and E2 DataFlash • Operates in synchronization with the FlashIF clock (FCLK)
External bus	CS area	• Connected to the external devices • Operates in synchronization with the external-bus clock (BCLK)	—

Table 2.18 Comparison of Bus Registers

Register	Bit	RX231	RX140
CSnCR	—	CSn control register (n = 0 to 3)	—
CSnREC	—	CSn recovery cycle register (n = 0 to 3)	—
CSRECEN	—	CS recovery cycle insertion enable register	—
CSnMOD	—	CSn mode register (n = 0 to 3)	—
CSnWCR1	—	CSn wait control register 1 (n = 0 to 3)	—
CSnWCR2	—	CSn wait control register 2 (n = 0 to 3)	—
BERSR1	MST[2:0]	Bus master code bits b6 b4 0 0 0: CPU 0 0 1: Reserved 0 1 0: Reserved 0 1 1: DTC/DMAC 1 0 0: Reserved 1 0 1: Reserved 1 1 0: Reserved 1 1 1: Reserved	Bus master code bits b6 b4 0 0 0: CPU 0 0 1: Reserved 0 1 0: Reserved 0 1 1: DTC 1 0 0: Reserved 1 0 1: Reserved 1 1 0: Reserved 1 1 1: Reserved
BUSPRI	BPHB[1:0]	Internal peripheral bus 4 priority control bits	—
	BPEB[1:0]	External bus priority control bits	—

2.12 Data Transfer Controller

Table 2.19 is a comparative overview of the data transfer controllers, and Table 2.20 is a comparison of data transfer controller registers.

Table 2.19 Comparative Overview of Data Transfer Controllers

Item	RX231 (DTCa)	RX140 (DTCb)
Number of transfer channels	Equal to number of all interrupt sources that can start a DTC transfer.	Equal to number of all interrupt sources that can start a DTC transfer.
Transfer modes	• Normal transfer mode — A single activation leads to a single data transfer. • Repeat transfer mode — A single activation leads to a single data transfer. — The transfer address returns to the transfer start address when the number of data transfers equals the repeat size. — The maximum number of repeat transfers is 256, and the maximum data transfer size is 256 × 32 bits, or 1,024 bytes. • Block transfer mode — A single activation leads to the transfer of a single block of data. — The maximum block size is 256 × 32 bits = 1,024 bytes.	• Normal transfer mode — A single activation leads to a single data transfer. • Repeat transfer mode — A single activation leads to a single data transfer. — The transfer address returns to the transfer start address when the number of data transfers equals the repeat size. — The maximum number of repeat transfers is 256, and the maximum data transfer size is 256 × 32 bits, or 1,024 bytes. • Block transfer mode — A single activation leads to the transfer of a single block of data. — The maximum block size is 256 × 32 bits = 1,024 bytes.
Chain transfer function	• Multiple data transfer types can be executed sequentially in response to a single transfer request. • Either “performed only when the transfer counter reaches 0” or “every time” can be selected.	• Multiple data transfer types can be executed sequentially in response to a single transfer request. • Either “performed only when the transfer counter reaches 0” or “every time” can be selected.
Sequence transfer	—	A complex series of transfers can be registered as a sequence. Any sequence can be selected by the transfer data and executed. • Only one sequence transfer trigger source can be selected at a time. • Up to 256 sequences can correspond to a single trigger source. • The data that is initially transferred in response to a transfer request determines the sequence. • The entire sequence can be executed on a single request, or the sequence can be suspended in the middle and resumed on the next transfer request (sequence division).

Item	RX231 (DTCa)	RX140 (DTCb)
Transfer space	• 16 MB in short-address mode (within 0000 0000h to 007F FFFFh or FF80 0000h to FFFF FFFFh, excluding reserved areas) • 4 GB in full-address mode (within 0000 0000h to FFFF FFFFh, excluding reserved areas)	• 16 MB in short-address mode (within 0000 0000h to 007F FFFFh or FF80 0000h to FFFF FFFFh, excluding reserved areas) • 4 GB in full-address mode (within 0000 0000h to FFFF FFFFh, excluding reserved areas)
Data transfer units	• Single data unit: 1 byte (8 bits), 1 word (16 bits), or 1 longword (32 bits) • Single block size: 1 to 256 data units	• Single data unit: 1 byte (8 bits), 1 word (16 bits), or 1 longword (32 bits) • Single block size: 1 to 256 data units
CPU interrupt requests	• An interrupt request to the CPU can be generated by a DTC activation interrupt. • An interrupt request to the CPU can be generated after a single data transfer. • An interrupt request to the CPU can be generated after transfer of the specified number of data units.	• An interrupt request to the CPU can be generated by a DTC activation interrupt. • An interrupt request to the CPU can be generated after a single data transfer. • An interrupt request to the CPU can be generated after transfer of the specified number of data units.
Event link function	An event link request is generated after one data transfer (for block transfers, after one block).	An event link request is generated after one data transfer (for block transfers, after one block).
Read skip	Reading of the transfer information can be skipped when the same transfer is repeated.	Reading of the transfer information can be skipped when the same transfer is repeated.
Write-back skip	Write-back of transferred data that is not updated can be skipped when the address of the transfer source or destination is fixed.	Write-back of transferred data that is not updated can be skipped when the address of the transfer source or destination is fixed.
Write-back disable	—	Ability to disable write-back of transfer information
Displacement addition	—	Ability to add displacement to the transfer source address (selectable by each transfer information)
Low power consumption function	Ability to transition to module stop state	Ability to transition to module stop state

Table 2.20 Comparison of Data Transfer Controller Registers

Register	Bit	RX231 (DTCa)	RX140 (DTCb)
MRA	WBDIS	—	Write-back disable bit*1
MRB	SQEND	—	Sequence transfer end bit
	INDX	—	Index table reference bit
MRC	—	—	DTC mode register C
DTCIBR	—	—	DTC index table base register
DTCOR	—	—	DTC operation register
DTCSQE	—	—	DTC sequence transfer enable register
DTCDISP	—	—	DTC address displacement register

Note: 1. Transfer information is usually allocated to a RAM area, but it can be allocated to a ROM area by setting the MRA.WBDIS bit to 1 (no write-back).

2.13 Event Link Controller

Table 2.21 is a comparative overview of the event link controllers, Table 2.22 is a comparison of event link controller registers, Table 2.23 lists correspondences between values set in ELSRn.ELS[7:0] and event signal names and numbers.

Table 2.21 Comparative Overview of Event Link Controllers

Item	RX231 (ELC)	RX140 (ELC)
Event link function	• 63 types of event signals can be directly connected to peripheral modules. • The operation of peripheral timer modules at event signal input is selectable. • Event link operation is possible for port B and port E. — Single port: Event link operation can be enabled for a single specified port. — Port group: Event link operation can be enabled for multiple specified ports within a group of up to eight ports.	• 48 types of event signals can be directly connected to peripheral modules. • The operation of peripheral timer modules at event signal input is selectable. • Event link operation on port B is supported. — Single port: Event link operation can be enabled for a single specified port. — Port group: Event link operation can be enabled for multiple specified ports within a group of up to eight ports.
Low power consumption function	Ability to transition to module stop state	Ability to transition to module stop state

Table 2.22 Comparison of Event Link Controller Registers

Register	Bit	RX231 (ELC)	RX140 (ELC)
ELSRn	—	Event link setting register n (n = 1 to 4, 7, 8, 10, 12, 14 to 16, 18 to 29)	Event link setting register n (n = 1 to 4, 7, 8, 10, 12, 14 to 16, 18, 20, 22, 24, 25)
ELOPC	LPTMD[1:0]	LPT operation select bits b5 b4 0 0: Output the compare match event to ICU as an interrupt request. 1 1: Event output is disabled. Settings other than the above are prohibited.	LPT operation select bits b5 b4 0 0: Output the LPT compare match 0 event to ICU as an interrupt request. 1 1: Event output is disabled. Settings other than the above are prohibited.
PGRn (RX231) PGR1 (RX140)	—	Port group setting register n (n = 1, 2)	Port group setting register 1
PGCn (RX231) PGC1 (RX140)	—	Port group control register n (n = 1, 2)	Port group control register 1
PDBFn (RX231) PDBF1 (RX140)	—	Port buffer register n (n = 1, 2)	Port buffer register 1
PELm	—	Event link port setting register n (m = 0 to 3)	Event link port setting register n (m = 0, 1)

Register	Bit	RX231 (ELC)	RX140 (ELC)
PELm	PSP[1:0]	Port number specification bits b4 b3 0 0: Setting disabled 0 1: Port B (corresponding to PGR1) 1 0: Port E (corresponding to PGR2) 1 1: Setting prohibited.	Port number specification bits b4 b3 0 0: Setting disabled 0 1: Port B (corresponding to PGR1) 1 0: Setting prohibited. 1 1: Setting prohibited.

Table 2.23 Correspondences between Values Set in ELSRn.ELS[7:0] and Event Signal Names and Numbers

Value of ELS[7:0] Bits	Peripheral Module	RX231 (ELC)	RX140 (ELC)
08h	Multi-function timer pulse unit 2	MTU1 compare match 1A	MTU1 compare match 1A
09h		MTU1 compare match 1B	MTU1 compare match 1B
0Ah		MTU1 overflow	MTU1 overflow
0Bh		MTU1 underflow	MTU1 underflow
0Ch		MTU2 compare match 2A	MTU2 compare match 2A
0Dh		MTU2 compare match 2B	MTU2 compare match 2B
0Eh		MTU2 overflow	MTU2 overflow
0Fh		MTU2 underflow	MTU2 underflow
10h		MTU3 compare match 3A	MTU3 compare match 3A
11h		MTU3 compare match 3B	MTU3 compare match 3B
12h		MTU3 compare match 3C	MTU3 compare match 3C
13h		MTU3 compare match 3D	MTU3 compare match 3D
14h		MTU3 overflow	MTU3 overflow
15h		MTU4 compare match 4A	MTU4 compare match 4A
16h		MTU4 compare match 4B	MTU4 compare match 4B
17h		MTU4 compare match 4C	MTU4 compare match 4C
18h		MTU4 compare match 4D	MTU4 compare match 4D
19h		MTU4 overflow	MTU4 overflow
1Ah		MTU4 underflow	MTU4 underflow
1Fh	Compare match timer	CMT1 compare match 1	CMT1 compare match 1
22h	8-bit timer	TMR0 compare match A0	TMR0 compare match A0
23h		TMR0 compare match B0	TMR0 compare match B0
24h		TMR0 overflow	TMR0 overflow
28h		TMR2 compare match A2	TMR2 compare match A2
29h		TMR2 compare match B2	TMR2 compare match B2
2Ah		TMR2 overflow	TMR2 overflow
2Eh	Realtime clock	RTC periodic event (selectable among 1/256, 1/128, 1/64, 1/32, 1/16, 1/8, 1/4, 1/2, 1, or 2 seconds)	—
31h	Independent watchdog timer	IWDT underflow or refresh error	—
32h	Low-power timer	LPT compare match	LPT compare match 0
33h		—	LPT compare match 1
34h	12-bit A/D converter	S12AD comparison conditions met	S12AD comparison conditions met
35h		S12AD comparison conditions not met	S12AD comparison conditions not met

Value of ELS[7:0] Bits	Peripheral Module	RX231 (ELC)	RX140 (ELC)
3Ah	Serial communications interface	SCI5 error (receive error or error signal detection)	SCI5 error (receive error or error signal detection)
3Bh		SCI5 receive data full	SCI5 receive data full
3Ch		SCI5 transmit data empty	SCI5 transmit data empty
3Dh		SCI5 transmit end	SCI5 transmit end
4Eh	I^2C bus interface	RIIC0 communication error or event generation	RIIC0 communication error or event generation
4Fh		RIIC0 receive data full	RIIC0 receive data full
50h		RIIC0 transmit data empty	RIIC0 transmit data empty
51h		RIIC0 transmit end	RIIC0 transmit end
52h	Serial peripheral interface	RSPI0 error (mode fault, overrun, or parity error)	—
53h		RSPI0 idle	—
54h		RSPI0 receive data full	—
55h		RSPI0 transmit data empty	—
56h		RSPI0 transmit end	—
58h	12-bit A/D converter	S12AD A/D conversion end	S12AD A/D conversion end
59h	Comparator B0	Comparator B0 comparison result change	Comparator B0 comparison result change
5Ah	Comparator B0 and B1	Comparator B0/B1 common comparison result change	Comparator B0/B1 common comparison result change
5Bh	Voltage detection circuit	LVD1 voltage detection	LVD1 voltage detection
5Ch		LVD2 voltage detection	—
5Dh	DMA controller	DMAC0 transfer end	—
5Eh		DMAC1 transfer end	—
5Fh		DMAC2 transfer end	—
60h		DMAC3 transfer end	—
61h	Data transfer controller	DTC transfer end	DTC transfer end
62h	Clock generation circuit	Clock generation circuit oscillation stop detection	—
63h	I/O ports	Input port group 1 input edge detection	Input port group 1 input edge detection
64h		Input port group 2 input edge detection	—
65h		Single input port 0 input edge detection	Single input port 0 input edge detection
66h		Single input port 1 input edge detection	Single input port 1 input edge detection
67h		Single input port 2 input edge detection	—
68h		Single input port 3 input edge detection	—
69h	Event link controller	Software event	Software event
6Ah	Data operation circuit	DOC data operation condition met	DOC data operation condition met
Settings other than the above are prohibited.			

2.14 I/O Ports

Table 2.24 and Table 2.25 are comparative overviews of the I/O ports, Table 2.26 is a comparison of I/O port functions, and Table 2.27 is a comparison of I/O port registers.

Table 2.24 Comparative Overview of I/O Ports (64-Pin)

Port Symbol	RX231 (64-Pin)	RX140 (64-Pin)
PORT0	P03, P05	P03, P05
PORT1	P14 to P17	P14 to P17
PORT2	P26, P27	P26, P27
PORT3	P30, P31, P35 to P37	P30 to P32, P35 to P37
PORT4	P40 to P44, P46	P40 to P47
PORT5	P54, P55	P54, P55
PORTA	PA0, PA1, PA3, PA4, PA6	PA0, PA1, PA3, PA4, PA6
PORTB	PB0, PB1, PB3, PB5 to PB7	PB0, PB1, PB3, PB5 to PB7
PORTC	PC2 to PC7	PC0 to PC7
PORTE	PE0 to PE5	PE0 to PE5
PORTG	—	PG7
PORTH	PH0 to PH3	PH0 to PH3, PH6*1, PH7*1
PORTJ	—	PJ6, PJ7

Note: 1. A product with a ROM capacity of 64 KB is not equipped with this pin.

Table 2.25 Comparative Overview of I/O Ports (48-Pin)

Port Symbol	RX231 (48-Pin)	RX140 (48-Pin)
PORT1	P14 to P17	P14 to P17
PORT2	P26, P27	P26, P27
PORT3	P30, P31, P35 to P37	P30, P31, P35 to P37
PORT4	P40 to P42, P46	P40 to P42, P45 to P47
PORTA	PA1, PA3, PA4, PA6	PA1, PA3, PA4, PA6
PORTB	PB0, PB1, PB3, PB5	PB0, PB1, PB3, PB5
PORTC	PC4 to PC7	PC0 to PC7
PORTE	PE1 to PE4	PE1 to PE4
PORTG	—	PG7
PORTH	PH0 to PH3	PH0 to PH3
PORTJ	—	PJ6, PJ7

Table 2.26 Comparison of I/O Port Functions

Item	Port Symbol	RX231	RX140
Input pull-up function	PORT0	P03, P05, P07	P03 to P07
	PORT1	P12 to P17	P12 to P17
	PORT2	P20 to P27	P20, P21, P26, P27
	PORT3	P30 to P32, P33, P34, P36, P37	P30 to P32, P34, P36, P37
	PORT4	P40 to P47	P40 to P47
	PORT5	P50 to P55	P54, P55
	PORTA	PA0 to PA7	PA0 to PA6
	PORTB	PB0 to PB7	PB0 to PB7
	PORTC	PC0 to PC7	PC2 to PC7
	PORTD	PD0 to PD7	PD0 to PD2
	PORTE	PE0 to PE7	PE0 to PE3, PE4, PE5
	PORTG	—	PG7
	PORTH	PH0 to PH3	PH0 to PH3
	PORTJ	PJ3	PJ1, PJ6, PJ7
Open drain output function	PORT1	P12 to P17	P12 to P17
	PORT2	P20 to P27	P20, P21, P26, P27
	PORT3	P30 to P32, P33, P34, P36, P37	P30 to P32, P34, P36, P37
	PORT5	P50 to P52, P54	—
	PORTA	PA0 to PA7	PA0 to PA6
	PORTB	PB0 to PB7	PB0 to PB7
	PORTC	PC0 to PC7	PC2 to PC7
	PORTD	—	PD0 to PD2
	PORTE	PE0 to PE7	PE0 to PE3
	PORTG	—	PG7
	PORTJ	PJ3	—
Drive capacity switching function	PORT0	P03, P05, P07	—
	PORT1	P12 to P17	—
	PORT2	P20 to P27	—
	PORT3	P30 to P34, P36, P37	—
	PORT4	P40 to P47	—
	PORT5	P50 to P55	—
	PORTA	PA0 to PA7	—
	PORTB	PB0 to PB7	—
	PORTC	PC0 to PC7	—
	PORTD	PD0 to PD7	—
	PORTE	PE0 to PE7	—
	PORTH	PH0 to PH3	—
	PORTJ	PJ3	—
5 V tolerant	PORT1	P12, P13, P16, P17	P12, P13, P16, P17
	PORT3	P30 to P32	—
	PORTB	PB5	—

Table 2.27 Comparison of I/O Port Registers

Register	Bit	RX231	RX140
PDR	B0 to B7	Pm0 to Pm7 I/O select bits (m = 0 to 5, A to E, H, J)	Pm0 to Pm7 I/O select bits (m = 0 to 5, A to E, G, H, J)
PODR	B0 to B7	Pm0 to Pm7 output data store bits (m = 0 to 5, A to E, H, J)	Pm0 to Pm7 output data store bits (m = 0 to 5, A to E, G, H, J)
PIDR	B0 to B7	Pm0 to Pm7 bits (m = 0 to 5, A to E, H, J)	Pm0 to Pm7 bits (m = 0 to 5, A to E, G, H, J)
PMR	B0 to B7	Pm0 pin mode control bits (m = 0 to 5, A to E, H, J) 0: Use pin as general I/O port. 1: Use pin as I/O port for peripheral function.	Pm0 to Pm7 pin mode control bits (m = 0 to 5, A to E, G, H, J) 0: Use pin as general I/O port. 1: Use pin as I/O port for peripheral function. PG7 only 0: Use pin as general I/O port. 1: Use pin as I/O port for MD function (initial value).
ODR0	B2, B3	Pm1 output type select bits (m = 1 to 3, 5, A to C, E, J) • P21, P31, P51, PA1, PB1, and PC1 b2 0: CMOS output 1: N-channel open-drain b3 This bit is read as 0. The write value should be 0. • PE1 b3 b2 0 0: CMOS output 0 1: N-channel open-drain 1 0: P-channel open-drain 1 1: Hi-Z	Pm1 output type select bits (m = 1 to 3, A to E, J) • P21, P31, PA1, PB1, and PD1 b2 0: CMOS output 1: N-channel open-drain b3 This bit is read as 0. The write value should be 0. • PE1 b3 b2 0 0: CMOS output 0 1: N-channel open-drain 1 0: P-channel open-drain 1 1: Hi-Z
ODR1	B0, B2, B4, B6	Pm4, Pm5, Pm6, and Pm7 output type select bits (m = 1 to 3, 5, A to C, E)	Pm4, Pm5, Pm6, and Pm7 output type select bits (m =1 to 3, A to C, G)
PCR	B0 to B7	Pm0 to Pm7 input pull-up resistor control bits (m = 0 to 5, A to E, H, J)	Pm0 to Pm7 input pull-up resistor control bits (m = 0 to 5, A to E, G, H, J)
DSCR	—	Drive capacity control register	—
PRWCNTR	—	—	Port read wait control register

2.15 Multi-Function Pin Controller

Table 2.28 is a comparison of the assignments of multiplexed pins, and Table 2.29 to Table 2.40 are comparisons of multi-function pin controller registers.

In the following comparison of the assignments of multiplexed pins, **blue text** designates pins that exist on the RX140 Group only and **orange text** pins that exist on the RX231 Group only. A circle (○) indicates that a function is assigned, a cross (×) that the pin does not exist or that no function is assigned, and grayed out items mean that the function is not implemented.

Table 2.28 Comparison of Multiplexed Pin Assignments

Module/ Function	Pin Function	Port Allocation	RX231		RX140	
			64-Pin	48-Pin	64-Pin	48-Pin
Interrupt	NMI (input)	P35	○	○	○	○
	IRQ0 (input)	P30	○	○	○	○
		PH1*3	○	○	○	○
	IRQ1 (input)	P31	○	○	○	○
		PH2*3	○	○	○	○
	IRQ2 (input)	P32	×	×	○	×
		P36	×	×	○	○
	IRQ4 (input)	P14	○	○	○	○
		P37	×	×	○	○
		PB1	○	○	○	○
	IRQ5 (input)	P15	○	○	○	○
		PA4	○	○	○	○
		PE5	○	×	○	×
	IRQ6 (input)	P16	○	○	○	○
		PA3	○	○	○	○
	IRQ7 (input)	P17	○	○	○	○
		PE2	○	○	○	○
Clock generation circuit	CLKOUT (output)	PE3	○	○	○	○
		PE4	○	○	○	○
Multi-function timer unit 2	MTIOC0A (input/output)	PB3	○	○	○	○
		PC4	×	×	○	○
	MTIOC0B (input/output)	P15	○	○	○	○
		PA1	○	○	○	○
	MTIOC0C (input/output)	P32	×	×	○	×
		PB1	○	○	○	○
		PC5	×	×	○	○
	MTIOC0D (input/output)	PA3	○	○	○	○
	MTIOC1A (input/output)	PE4	○	○	○	○
	MTIOC1B (input/output)	PB5	○	○	○	○
		PE3	×	×	○	○
	MTIOC2A (input/output)	P26	○	○	○	○
		PB5	○	○	○	○
	MTIOC2B (input/output)	P27	○	○	○	○
		PE5	○	×	○	×
	MTIOC3A (input/output)	P14	○	○	○	○
		P17	○	○	○	○
		PC7	○	○	○	○

Module/ Function	Pin Function	Port Allocation	RX231		RX140	
			64-Pin	48-Pin	64-Pin	48-Pin
Multi-function timer unit 2	MTIOC3B (input/output)	P17	○	○	○	○
		PA1	×	×	○	○
		PB7	○	×	○	×
		PC5	○	○	○	○
		PH0	×	×	○	○
	MTIOC3C (input/output)	P16	○	○	○	○
		PC6	○	○	○	○
	MTIOC3D (input/output)	P16	○	○	○	○
		PA6	×	×	○	○
		PB0	×	×	○	○
		PB6	○	×	○	×
		PC4	○	○	○	○
		PH1	×	×	○	○
	MTIOC4A (input/output)	P55	×	×	○	×
		PA0	○	×	○	×
		PB3	○	○	○	○
		PE2	○	○	○	○
		PE4	×	×	○	○
	MTIOC4B (input/output)	P30	○	○	○	○
		P54	○	×	○	×
		PC2	○	×	○	×
		PE3	○	○	○	○
	MTIOC4C (input/output)	PA4	×	×	○	○
		PB1	○	○	○	○
		PE1	○	○	○	○
		PE5	○	×	○	×
		PH2	×	×	○	○
	MTIOC4D (input/output)	P31	○	○	○	○
		P55	○	×	○	×
		PA3	×	×	○	○
		PC3	○	×	○	×
		PE4	○	○	○	○
		PH3	×	×	○	○
	MTIC5U (input)	PA4	○	○	○	○
	MTIC5V (input)	PA3	×	×	○	○
		PA6	○	○	○	○
	MTIC5W (input)	PB0	○	○	○	○
	MTCLKA (input)	P14	○	○	○	○
		PA4	○	○	○	○
		PC6	○	○	○	○
	MTCLKB (input)	P15	○	○	○	○
		PA6	○	○	○	○
		PC7	○	○	○	○
	MTCLKC (input)	PA1	○	○	○	○
		PC4	○	○	○	○
	MTCLKD (input)	PA3	○	○	○	○
		PC5	○	○	○	○

Module/ Function	Pin Function	Port Allocation	RX231		RX140	
			64-Pin	48-Pin	64-Pin	48-Pin
Port output enable 2	POE0# (input)	PC4	○	○	○	○
	POE1# (input)	PB5	○	○	○	○
	POE2# (input)	PA6	○	○	○	○
	POE3# (input)	PB3	○	○	○	○
	POE8# (input)	P17	○	○	○	○
		P30	○	○	○	○
		PE3	○	○	○	○
16-bit timer pulse unit	TIOCA0 (input/output)	PA0	○	×		
	TIOCB0 (input/output)	P17	○	○		
		PA1	○	○		
	TIOCD0 (input/output)	PA3	○	○		
	TIOCA1 (input/output)	PA4	○	○		
	TIOCB1 (input/output)	P16	○	○		
	TIOCA2 (input/output)	PA6	○	○		
	TIOCB2 (input/output)	P15	○	○		
	TIOCA3 (input/output)	PB0	○	○		
	TIOCB3 (input/output)	PB1	○	○		
	TIOCD3 (input/output)	PB3	○	○		
	TIOCB4 (input/output)	PB5	○	○		
	TIOCA5 (input/output)	PB6	○	×		
	TIOCB5 (input/output)	P14	○	○		
		PB7	○	×		
	TCLKA (input)	P14	○	○		
		PC2	○	×		
	TCLKB (input)	P15	○	○		
		PA3	○	○		
		PC3	○	×		
	TCLKC (input)	P16	○	○		
	TCLKD (input)	P17	○	○		
		PB3	○	○		
8-bit timer	TMO0 (output)	PB3	○	○	○	○
		PH1*3	○	○	○	○
	TMCI0 (input)	PB1	○	○	○	○
		PH3*3	○	○	○	○
	TMRI0 (input)	PA4	○	○	○	○
		PH2*3	○	○	○	○
	TMO1 (output)	P17	○	○	○	○
		P26	○	○	○	○
	TMCI1 (input)	P54	○	×	○	×
		PC4	○	○	○	○
	TMRI1 (input)	PB5	○	○	○	○
	TMO2 (output)	P16	○	○	○	○
		PC7	○	○	○	○
	TMCI2 (input)	P15	○	○	○	○
		P31	○	○	○	○
		PC6	○	○	○	○
	TMRI2 (input)	P14	○	○	○	○
		PC5	○	○	○	○
	TMO3 (output)	P32	×	×	○	×
		P55	○	×	○	×

Module/ Function	Pin Function	Port Allocation	RX231		RX140	
			64-Pin	48-Pin	64-Pin	48-Pin
8-bit timer	TMCI3 (input)	P27	○	○	○	○
	TMCI3 (input)	PA6	○	○	○	○
	TMRI3 (input)	P30	○	○	○	○
Serial communications interface	RXD1 (input) / SMISO1 (input/output) / SSCL1 (input/output)	P15	○	○	○	○
		P30	○	○	○	○
	TXD1 (output) / SMOSI1 (input/output) / SSDA1 (input/output)	P16	○	○	○	○
		P26	○	○	○	○
	SCK1 (input/output)	P17	○	○	○	○
		P27	○	○	○	○
	CTS1# (input) / RTS1# (output) / SS1# (input)	P14	○	○	○	○
		P31	○	○	○	○
	RXD5 (input) / SMISO5 (input/output) / SSCL5 (input/output)	PA3	○	○	○	○
		PC2	○	×	○	×
	TXD5 (output) / SMOSI5 (input/output) / SSDA5 (input/output)	PA4	○	○	○	○
		PC3	○	×	○	×
	SCK5 (input/output)	PA1	○	○	○	○
		PC4	○	○	○	○
	CTS5# (input) / RTS5# (output) / SS5# (input)	PA6	○	○	○	○
	RXD6 (input) / SMISO6 (input/output) / SSCL6 (input/output)	PB0	○	○	○	○
	TXD6 (output) / SMOSI6 (input/output) / SSDA6 (input/output)	P32	×	×	○	×
		PB1	○	○	○	○
	SCK6 (input/output)	PB3	○	○	○	○
	RXD8 (input) / SMISO8 (input/output) / SSCL8 (input/output)	PC6	○	○	○	○
	TXD8 (output) / SMOSI8 (input/output) / SSDA8 (input/output)	PC7	○	○	○	○
	SCK8 (input/output)	PC5	○	○	○	○
	CTS8# (input) / RTS8# (output) / SS8# (input)	PC4	○	○	○	○
	RXD9 (input) / SMISO9 (input/output) / SSCL9 (input/output)	PB6	○	×	○	×
	TXD9 (output) / SMOSI9 (input/output) / SSDA9 (input/output)	PB7	○	×	○	×
	SCK9 (input/output)	PB5	○	×	○	×

Module/ Function	Pin Function	Port Allocation	RX231		RX140	
			64-Pin	48-Pin	64-Pin	48-Pin
Serial communications interface	CTS9# (input) / RTS9# (output) / SS9# (input)	PB4	×	×	○	×
	RXD12 (input) / SMISO12 (input/output) / SSCL12 (input/output) / RXDX12 (input)	PE2	○	○ *1	○	○ *1
	TXD12 (output) / SMOSI12 (input/output) / SSDA12 (input/output) / TXDX12 (output) / SIOX12 (input/output)	PE1	○	○ *1	○	○ *1
	SCK12 (input/output)	PE0	○	×	○	×
	CTS12# (input) / RTS12# (output) / SS12# (input)	PE3	○	○ *2	○	○ *2
I^2C bus interface	SCL (input/output)	P16	○	○	○	○
	SDA (input/output)	P17	○	○	○	○
Serial peripheral interface	RSPCKA (input/output)	PB0	○	○	○	○
		PC5	○	○	○	○
	MOSIA (input/output)	P16	○	○	○	○
		PA6	○	○	○	○
		PC6	○	○	○	○
	MISOA (input/output)	P17	○	○	○	○
		PC7	○	○	○	○
	SSLA0 (input/output)	PA4	○	○	○	○
		PC4	○	○	○	○
	SSLA1 (output)	PA0	○	×	○	×
	SSLA2 (output)	PA1	○	○	○	○
	SSLA3 (output)	PC2	○	×	○	×
Realtime clock	RTCOUT (output)	P16	○	×	○	○
		P32	×	×	○	×
	RTCIC0 (input)	P30	○	×		
	RTCIC1 (input)	P31	○	×		
IrDA interface	IRTXD5 (output)	PA4	○	○		
		PC3	○	×		
	IRRXD5 (input)	PA3	○	○		
		PC2	○	×		
CAN module	CRXD0 (input)	P15	○	○	○	○
		P55	○	×	○	×
	CTXD0 (output)	P14	○	○	○	○
		P54	○	×	○	×
Serial sound interface	SSISCK0 (input/output)	P31	○	○		
		PA1	○	○		
	SSIWS0 (input/output)	P27	○	○		
		PA6	○	○		
	SSITXD0 (output)	P17	○	○		
		PA4	○	○		

Module/ Function	Pin Function	Port Allocation	RX231		RX140	
			64-Pin	48-Pin	64-Pin	48-Pin
Serial sound interface	SSIRXD0 (input)	P26	○	○		
		PA3	○	○		
	AUDIO_MCLK (input)	P30	○	○		
		PE3	○	○		
SD host interface	SDHI_CLK (output)	PB1	○	×		
	SDHI_CMD (input/output)	PB0	○	×		
	SDHI_D0 (input/output)	PC3	○	×		
	SDHI_D1 (input/output)	PB6	○	×		
		PC4	○	×		
	SDHI_D2 (input/output)	PB7	○	×		
	SDHI_D3 (input/output)	PC2	○	×		
	SDHI_CD (input)	PB5	○	×		
	SDHI_WP (input)	PB3	○	×		
USB 2.0 Host/Function module	USB0_VBUS (input)	P16	○	○		
		PB5	○	○		
	USB0_EXICEN (output)	PC6	○	○		
	USB0_VBUSEN (output)	P16	○	○		
		P26	○	○		
	USB0_OVRCURA (input)	P14	○	○		
	USB0_OVRCURB (input)	P16	○	○		
	USB0_ID (input)	PC5	○	○		
12-bit A/D converter	AN000 (input)	P40	○	○	○	○
	AN001 (input)	P41	○	○	○	○
	AN002 (input)	P42	○	○	○	○
	AN003 (input)	P43	○	×	○	×
	AN004 (input)	P44	○	×	○	×
	AN005 (input)	P45	×	×	○	○
	AN006 (input)	P46	○	○	○	○
	AN007 (input)	P47	×	×	○	○
	AN016 (input)	PE0	○	×	○	×
	AN017 (input)	PE1	○	○	○	○
	AN018 (input)	PE2	○	○	○	○
	AN019 (input)	PE3	○	○	○	○
	AN020 (input)	PE4	○	○	○	○
	AN021 (input)	PE5	○	×	○	×
	ADTRG0# (input)	P16	○	○	○	○
D/A converter	DA0 (output)	P03	○	×	○	×
	DA1 (output)	P05	○	×	○	×
Clock frequency accuracy measurement circuit	CACREF (input)	PA0	○	×	○	×
		PC7	○	○	○	○
		PH0*3	○	○	○	○
LVD voltage detection input	CMPA2 (input)	PE4	○	○	○	○

Module/ Function	Pin Function	Port Allocation	RX231		RX140	
			64-Pin	48-Pin	64-Pin	48-Pin
Comparator B	CMPB0 (input)	PE1	○	○	○	○
	CVREFB0 (input)	PE2	○	○	○	○
	CMPB1 (input)	PA3	○	○	○	○
	CVREFB1 (input)	PA4	○	○	○	○
	CMPB2 (input)	P15	○	○		
	CVREFB2 (input)	P14	○	○		
	CMPB3 (input)	P26	○	○		
	CVREFB3 (input)	P27	○	○		
	CMPOB0 (output)	PE5	○	×	○	×
	CMPOB1 (output)	PB1	○	○	○	○
	CMPOB2 (output)	P17	○	○		
	CMPOB3 (output)	P30	○	○		
Capacitive touch sensing unit (CTSU)	TSCAP (output)	PC4	○	○	○	○
	TS0 (output)	P32	×	×	○*3	×
	TS1 (output)	P31	×	×	○*3	○*3
	TS2 (output)	P27	○	○	×	×
		P30	×	×	○*3	○*3
	TS3 (output)	P26	○	○	×	×
		P27	×	×	○	○
	TS4 (output)	P26	×	×	○	○
	TS5 (output)	P15	×	×	○*3	○*3
	TS6 (output)	P14	×	×	○*3	○*3
	TS7 (output)	PH3	×	×	○*3	○*3
	TS8 (output)	PH2	×	×	○*3	○*3
	TS9 (output)	PH1	×	×	○*3	○*3
	TS10 (output)	PH0			○*3	○*3
	TS11 (output)	P55			○*3	×
	TS12 (output)	P15	○	○	×	×
		P54	×	×	○*3	×
	TS13 (output)	P14	○	○	×	×
		PC7	×	×	○	○
	TS14 (output)	PC6			○	○
	TS15 (output)	P55	○	×	×	×
		PC5	×	×	○	○
	TS16 (output)	P54	○	×	×	×
		PC3	×	×	○*3	×
	TS17 (output)	PC2	×	×	○*3	×
	TS18 (output)	PB7	×	×	○*3	×
	TS19 (output)	PB6	×	×	○*3	×
	TS20 (output)	PB5	×	×	○*3	○
	TS22 (output)	PC6	○	○	×	×
		PB3	×	×	○*3	○*3
	TS23 (output)	PC5	○	○	×	×
	TS24 (output)	PB1			○*3	○*3
	TS25 (output)	PB0			○	○
	TS26 (output)	PA6			○*3	○*3
	TS27 (output)	PC3	○	×	×	×
	TS28 (output)	PA4			○	○
	TS29 (output)	PA3			○	○

Module/ Function	Pin Function	Port Allocation	RX231		RX140	
			64-Pin	48-Pin	64-Pin	48-Pin
Capacitive touch sensing unit (CTSU)	TS30 (output)	PC2	○	×	×	×
	TS31 (output)	PA1			○	○
	TS32 (output)	PA0			○	×
	TS33 (output)	PE4	×	×	○ *3	○
	TS34 (output)	PE3			○	○
	TS35 (output)	PE2	×	×	○	○
Low-power timer	LPTO (output)	P26			○	○
		PB3			○	○
		PC7			○	○

Notes: 1. SMOSI12 function not implemented.
2. SS12# function not implemented.
3. This pin exists on the RX230 only.

Table 2.29 Comparison of P1n Pin Function Control Register (P1nPFS)

Register	Bit	RX231 (n = 2 to 7)	RX140 (n = 2 to 7)
P13PFS	PSEL[4:0]	Pin function select bits 00000b: Hi-Z 00001b: MTIOC0B 00011b: TIOCA5 00101b: TMO3 01111b: SDA	Pin function select bits 00000b: Hi-Z 00001b: MTIOC0B 00101b: TMO3 01111b: SDA
P14PFS	PSEL[4:0]	Pin function select bits 00000b: Hi-Z 00001b: MTIOC3A 00010b: MTCLKA 00011b: TIOCB5 00100b: TCLKA 00101b: TMRI2 01011b: CTS1#/RTS1#/SS1# 10000b: CTXD0 10001b: USB0_OVRCURA 11001b: TS13	Pin function select bits 00000b: Hi-Z 00001b: MTIOC3A 00010b: MTCLKA 00101b: TMRI2 01011b: CTS1#/RTS1#/SS1# 11001b: TS6 11100b: CTXD0
P15PFS	PSEL[4:0]	Pin function select bits 00000b: Hi-Z 00001b: MTIOC0B 00010b: MTCLKB 00011b: TIOCB2 00100b: TCLKB 00101b: TMCI2 01010b: RXD1/SMISO1/SSCL1 10000b: CTXD0 11001b: TS5	Pin function select bits 00000b: Hi-Z 00001b: MTIOC0B 00010b: MTCLKB 00101b: TMCI2 01010b: RXD1/SMISO1/SSCL1 11001b: TS5 11100b: CRXD0
P16PFS	PSEL[4:0]	Pin function select bits 00000b: Hi-Z 00001b: MTIOC3C 00010b: MTIOC3D 00011b: TIOCB1 00100b: TCLKC 00101b: TMO2 00111b: RTCOUT 01001b: ADTRG0# 01010b: TXD1/SMOSI1/SSDA1 01101b: MOSIA 01111b: SCL 10001b: USB0_VBUS 10010b: USB0_VBUSEN 10011b: USB0_OVRCURB	Pin function select bits 00000b: Hi-Z 00001b: MTIOC3C 00010b: MTIOC3D 00101b: TMO2 00111b: RTCOUT 01001b: ADTRG0# 01010b: TXD1/SMOSI1/SSDA1 01101b: MOSIA 01111b: SCL

Register	Bit	RX231 (n = 2 to 7)	RX140 (n = 2 to 7)
P17PFS	PSEL[4:0]	Pin function select bits 00000b: Hi-Z 00001b: MTIOC3A 00010b: MTIOC3B 00011b: TIOCB0 00100b: TCLKD 00101b: TMO1 00111b: POE8# 01010b: SCK1 01101b: MISOA 01111b: SDA 10000b: CMPOB2 10111b: SSITXD0	Pin function select bits 00000b: Hi-Z 00001b: MTIOC3A 00010b: MTIOC3B 00101b: TMO1 00111b: POE8# 01010b: SCK1 01101b: MISOA 01111b: SDA
P1nPFS	ASEL	P1n analog function select bit	—

Table 2.30 Comparison of P2n Pin Function Control Register (P2nPFS)

Register	Bit	RX231 (n = 0 to 7)	RX140 (n = 0, 1, 6, 7)
P20PFS	PSEL[4:0]	Pin function select bits 00000b: Hi-Z 00001b: MTIOC1A 00011b: TIOCB3 00101b: TMRI0 01010b: TXD0/SMOSI0/SSDA0 10001b: USB0_ID 10111b: SSIRXD0 11001b: TS9	Pin function select bits 00000b: Hi-Z 00001b: MTIOC1A 00101b: TMRI0
P21PFS	PSEL[4:0]	Pin function select bits 00000b: Hi-Z 00001b: MTIOC1B 00011b: TIOCA3 00101b: TMCI0 01010b: RXD0/SMISO0/SSCL0 10001b: USB0_EXICEN 10111b: SSIWS0 11001b: TS8	Pin function select bits 00000b: Hi-Z 00001b: MTIOC1B 00101b: TMCI0
P22PFS	—	P22 pin function control register	—
P23PFS	—	P23 pin function control register	—
P24PFS	—	P24 pin function control register	—
P25PFS	—	P25 pin function control register	—
P26PFS	PSEL[4:0]	Pin function select bits 00000b: Hi-Z 00001b: MTIOC2A 00101b: TMO1 01010b: TXD1/SMOSI1/SSDA1 10111b: SSIRXD0 11001b: TS3	Pin function select bits 00000b: Hi-Z 00001b: MTIOC2A 00101b: TMO1 01010b: TXD1/SMOSI1/SSDA 11001b: TS4 11011b: LPTO

Register	Bit	RX231 (n = 0 to 7)	RX140 (n = 0, 1, 6, 7)
P27PFS	PSEL[4:0]	Pin function select bits 00000b: Hi-Z 00001b: MTIOC2B 00101b: TMCI3 01010b: SCK1 10111b: SSIWS0 11001b: TS2	Pin function select bits 00000b: Hi-Z 00001b: MTIOC2B 00101b: TMCI3 01010b: SCK1 11001b: TS3
P2nPFS	ASEL	P2n analog function select bit	—

Table 2.31 Comparison of P3n Pin Function Control Register (P3nPFS)

Register	Bit	RX231 (n = 0 to 4)	RX140 (n = 0 to 2, 4, 6, 7)
P30PFS	PSEL[4:0]	Pin function select bits 00000b: Hi-Z 00001b: MTIOC4B 00101b: TMRI3 00111b: POE8# 01010b: RXD1/SMISO1/SSCL1 10000b: CMPOB3 10111b: AUDIO_MCLK	Pin function select bits 00000b: Hi-Z 00001b: MTIOC4B 00101b: TMRI3 00111b: POE8# 01010b: RXD1/SMISO1/SSCL1 11001b: TS2
P31PFS	PSEL[4:0]	Pin function select bits 00000b: Hi-Z 00001b: MTIOC4D 00101b: TMCI2 00111b: CTS1#/RTS1#/SS1# 10111b: SSISCK0	Pin function select bits 00000b: Hi-Z 00001b: MTIOC4D 00101b: TMCI2 01010b: CTS#/RTS1#/SS1# 11001b: TS1
P32PFS	PSEL[4:0]	Pin function select bits 00000b: Hi-Z 00001b: MTIOC0C 00011b: TIOCC0 00101b: TMO3 00111b: RTCOUT 01011b: TXD6/SMOSI6/SSDA6 10001b: USB0_VBUSEN	Pin function select bits 00000b: Hi-Z 00001b: MTIOC0C 00101b: TMO3 00111b: RTCOUT 01011b: TXD6/SMOSI6/SSDA6 11001b: TS0
P33PFS	—	P33 pin function control register	—
P34PFS	PSEL[4:0]	Pin function select bits 00000b: Hi-Z 00001b: MTIOC0A 00101b: TMCI3 00111b: POE2# 01011b: SCK6 11001b: TS0	Pin function select bits 00000b: Hi-Z 00001b: MTIOC0A 00101b: TMCI3 00111b: POE2# 01011b: SCK6
P36PFS	—	—	P36 pin function control register
P37PFS	—	—	P37 pin function control register

Register	Bit	RX231 (n = 0 to 4)	RX140 (n = 0 to 2, 4, 6, 7)
P3nPFS	ISEL	Interrupt input function select bit 0: Not used as IRQn input pin 1: Used as IRQn input pin P30: IRQ0 (100/64/48-pin) P31: IRQ1 (100/64/48-pin) P32: IRQ2 (100-pin) P33: IRQ3 (100-pin) P34: IRQ4 (100-pin)	Interrupt input function select bit 0: Not used as IRQn input pin 1: Used as IRQn input pin P30: IRQ0 (80/64/48/32-pin) P31: IRQ1 (80/64/48/32-pin) P32: IRQ2 (80/64-pin) P34: IRQ4 (80-pin) P36: IRQ2 (80/64/48/32-pin) P37: IRQ4 (80/64/48-pin)

Table 2.32 Comparison of P5n Pin Function Control Register (P5nPFS)

Register	Bit	RX231 (n = 0 to 5)	RX140 (n = 4, 5)
P50PFS	—	P50 pin function control register	—
P51PFS	—	P51 pin function control register	—
P52PFS	—	P52 pin function control register	—
P53PFS	—	P53 pin function control register	—
P54PFS	PSEL[4:0]	Pin function select bits 00000b: Hi-Z 00001b: MTIOC4B 00101b: TMCI1 10000b: CTXD0 11001b: TS16	Pin function select bits 00000b: Hi-Z 00001b: MTIOC4B 00101b: TMCI1 11001b: TS12 11100b: CTXD0
P55PFS	PSEL[4:0]	Pin function select bits 00000b: Hi-Z 00001b: MTIOC4D 00010b: MTIOC4A 00101b: TMO3 10000b: CRXD0 11001b: TS15	Pin function select bits 00000b: Hi-Z 00001b: MTIOC4D 00101b: TMO3 11001b: TS11 11100b: CRXT0

Table 2.33 Comparison of PAn Pin Function Control Register (PAnPFS)

Register	Bit	RX231 (n = 0 to 7)	RX140 (n = 0 to 6)
PA0PFS	PSEL[4:0]	Pin function select bits 00000b: Hi-Z 00001b: MTIOC4A 00011b: TIOCA0 00111b: CACREF 01101b: SSLA1	Pin function select bits 00000b: Hi-Z 00001b: MTIOC4A 00111b: CACREF 01101b: SSLA1 11001b: TS32
PA1PFS	PSEL[4:0]	Pin function select bits 00000b: Hi-Z 00001b: MTIOC0B 00010b: MTCLKC 00011b: TIOCB0 01010b: SCK5 01101b: SSLA2 10111b: SSISCK0	Pin function select bits 00000b: Hi-Z 00001b: MTIOC0B 00010b: MTCLKC 00011b: MTIOC3B 01010b: SCK5 01101b: SSLA2 11001b: TS31
PA2PFS	PSEL[4:0]	Pin function select bits 00000b: Hi-Z 01010b: RXD5/SMISO5/SSCL5 01101b: SSLA3	Pin function select bits 00000b: Hi-Z 01010b: RXD5/SMISO5/SSCL5 01101b: SSLA3 11001b: TS30
PA3PFS	PSEL[4:0]	Pin function select bits 00000b: Hi-Z 00001b: MTIOC0D 00010b: MTCLKD 00011b: TIOCD0 00100b: TCLKB 01010b: RXD5/SMISO5/SSCL5 10111b: SSIRXD0	Pin function select bits 00000b: Hi-Z 00001b: MTIOC0D 00010b: MTCLKD 00011b: MTIOC4D 00100b: MTIC5V 01010b: RXD5/SMISO5/SSCL5 11001b: TS29
PA4PFS	PSEL[4:0]	Pin function select bits 00000b: Hi-Z 00001b: MTIC5U 00010b: MTCLKA 00011b: TIOCA1 00101b: TMRI0 01010b: TXD5/SMOSI5/SSDA5 01101b: SSLA0 10111b: SSITXD0	Pin function select bits 00000b: Hi-Z 00001b: MTIC5U 00010b: MTCLKA 00011b: MTIOC4C 00101b: TMRI0 01010b: TXD5/SMOSI5/SSDA5 01101b: SSLA0 11001b: TS28
PA5PFS	PSEL[4:0]	Pin function select bits 00000b: Hi-Z 00011b: TIOCB1 01101b: RSPCKA	Pin function select bits 00000b: Hi-Z 01101b: RSPCKA 11001b: TS27

Register	Bit	RX231 (n = 0 to 7)	RX140 (n = 0 to 6)
PA6PFS	PSEL[4:0]	Pin function select bits 00000b: Hi-Z 00001b: MTIC5V 00010b: MTCLKB 00011b: TIOCA2 00101b: TMCI3 00111b: POE2# 01011b: CTS5#/RTS5#/SS5# 01101b: MOSIA 10111b: SSIWS0	Pin function select bits 00000b: Hi-Z 00001b: MTIC5V 00010b: MTCLKB 00011b: MTIOC3D 00101b: TMCI3 00111b: POE2# 01011b: CTS5#/RTS5#/SS5# 01101b: MOSIA 11001b: TS26
PA7PFS	—	PA7 pin function control register	—

Table 2.34 Comparison of PBn Pin Function Control Register (PBnPFS)

Register	Bit	RX231 (n = 0 to 7)	RX140 (n = 0 to 7)
PB0PFS	PSEL[4:0]	Pin function select bits 00000b: Hi-Z 00001b: MTIC5W 00011b: TIOCA3 01011b: RXD6/SMISO6/SSCL6 01101b: RSPCKA 11010b: SDHI_CMD	Pin function select bits 00000b: Hi-Z 00001b: MTIC5W 00010b: MTIOC3D 01011b: RXD6/SMISO6/SSCL6 01101b: RSPCKA 11001b: TS25
PB1PFS	PSEL[4:0]	Pin function select bits 00000b: Hi-Z 00001b: MTIOC0C 00010b: MTIOC4C 00011b: TIOCB3 00101b: TMCI0 01011b: TXD6/SMOSI6/SSDA6 10000b: CMPOB1 11010b: SDHI_CLK	Pin function select bits 00000b: Hi-Z 00001b: MTIOC0C 00010b: MTIOC4C 00101b: TMCI0 01011b: TXD6/SMOSI6/SSDA6 10000b: CMPOB1 11001b: TS24
PB2PFS	PSEL[4:0]	Pin function select bits 00000b: Hi-Z 00011b: TIOCC3 00100b: TCLKC 01011b: CTS6#/RTS6#/SS6#	Pin function select bits 00000b: Hi-Z 01011b: CTS6#/RTS6#/SS6# 11001b: TS23

Register	Bit	RX231 (n = 0 to 7)	RX140 (n = 0 to 7)
PB3PFS	PSEL[4:0]	Pin function select bits 00000b: Hi-Z 00001b: MTIOC0A 00010b: MTIOC4A 00011b: TIOCD3 00100b: TCLKD 00101b: TMO0 00111b: POE3# 01011b: SCK6 11010b: SDHI_WP	Pin function select bits 00000b: Hi-Z 00001b: MTIOC0A 00010b: MTIOC4A 00101b: TMO0 00111b: POE3# 01011b: SCK6 11001b: TS22 11011b: LPTO
PB4PFS	PSEL[4:0]	Pin function select bits 00000b: Hi-Z 00011b: TIOCA4 01011b: CTS9#/RTS9#/SS9#	Pin function select bits 00000b: Hi-Z 01011b: CTS9#/RTS9#/SS9# 11001b: TS21
PB5PFS	PSEL[4:0]	Pin function select bits 00000b: Hi-Z 00001b: MTIOC2A 00010b: MTIOC1B 00011b: TIOCB4 00101b: TMRI1 00111b: POE1# 01010b: SCK9 10001b: USB0_VBUS 11010b: SDHI_CD	Pin function select bits 00000b: Hi-Z 00001b: MTIOC2A 00010b: MTIOC1B 00101b: TMRI1 00111b: POE1# 01010b: SCK9 11011b: TS20
PB6PFS	PSEL[4:0]	Pin function select bits 00000b: Hi-Z 00001b: MTIOC3D 00011b: TIOCA5 01010b: RXD9/SMISO9/SSCL9 11010b: SDHI_D1	Pin function select bits 00000b: Hi-Z 00001b: MTIOC3D 01010b: RXD9/SMISO9/SSCL9 11001b: TS19
PB7PFS	PSEL[4:0]	Pin function select bits 00000b: Hi-Z 00001b: MTIOC3B 00011b: TIOCB5 01010b: TXD9/SMOSI9/SSDA9 11010b: SDHI_D2	Pin function select bits 00000b: Hi-Z 00001b: MTIOC3B 01010b: TXD9/SMOSI9/SSDA9 11001b: TS18

Table 2.35 Comparison of PCn Pin Function Control Register (PCnPFS)

Register	Bit	RX231 (n = 0 to 7)	RX140 (n = 2 to 7)
PC0PFS	—	PC0 pin function select register	—
PC1PFS	—	PC1 pin function select register	—
PC2PFS	PSEL[4:0]	Pin function select bits 00000b: Hi-Z 00001b: MTIOC4B 00011b: TCLKA 01010b: RXD5/SMISO5/SSCL5 01101b: SSLA3 11001b: TS30 11010b: SDHI_D3	Pin function select bits 00000b: Hi-Z 00001b: MTIOC4B 01010b: RXD5/SMISO5/SSCL5 01101b: SSLA3 11001b: TS17
PC3PFS	PSEL[4:0]	Pin function select bits 00000b: Hi-Z 00001b: MTIOC4D 00011b: TCLKB 01010b: TXD5/SMOSI5/SSDA5 11001b: TS27 11010b: SDHI_D0	Pin function select bits 00000b: Hi-Z 00001b: MTIOC4D 01010b: TXD5/SMOSI5/SSDA5 11001b: TS16
PC4PFS	PSEL[4:0]	Pin function select bits 00000b: Hi-Z 00001b: MTIOC3D 00010b: MTCLKC 00101b: TMCI1 00111b: POE0# 01010b: SCK5 01011b: CTS8#/RTS8#/SS8# 01101b: SSLA0 11001b: TSCAP 11010b: SDHI_D1	Pin function select bits 00000b: Hi-Z 00001b: MTIOC3D 00010b: MTCLKC 00011b: MTIOC0A 00101b: TMCI1 00111b: POE0# 01010b: SCK5 01011b: CTS8#/RTS8#/SS8# 01101b: SSLA0 11001b: TSCAP
PC5PFS	PSEL[4:0]	Pin function select bits 00000b: Hi-Z 00001b: MTIOC3B 00010b: MTCLKD 00101b: TMRI2 01010b: SCK8 01101b: RSPCKA 11001b: TS23	Pin function select bits 00000b: Hi-Z 00001b: MTIOC3B 00010b: MTCLKD 00011b: MTIOC0C 00101b: TMRI2 01010b: SCK8 01101b: RSPCKA 11001b: TS15

Register	Bit	RX231 (n = 0 to 7)	RX140 (n = 2 to 7)
PC6PFS	PSEL[4:0]	Pin function select bits 00000b: Hi-Z 00001b: MTIOC3C 00010b: MTCLKA 00101b: TMCI2 01010b: RXD8/SMISO8/SSCL8 01101b: MOSIA 11001b: TS22	Pin function select bits 00000b: Hi-Z 00001b: MTIOC3C 00010b: MTCLKA 00101b: TMCI2 01010b: RXD8/SMISO8/SSCL8 01101b: MOSIA 11001b: TS14
PC7PFS	PSEL[4:0]	Pin function select bits 00000b: Hi-Z 00001b: MTIOC3A 00010b: MTCLKB 00101b: TMO2 00111b: CACREF 01010b: TXD8/SMOSI8/SSDA8 01101b: MISOA	Pin function select bits 00000b: Hi-Z 00001b: MTIOC3A 00010b: MTCLKB 00101b: TMO2 00111b: CACREF 01010b: TXD8/SMOSI8/SSDA8 01101b: MISOA 11001b: TS13 11011b: LPTO

Table 2.36 Comparison of PDn Pin Function Control Register (PDnPFS)

Register	Bit	RX231 (n = 0 to 7)	RX140 (n = 0 to 2)
PD0PFS	PSEL[4:0]	—	PD0 pin function select register
PD1PFS	PSEL[4:0]	Pin function select bits 00000b: Hi-Z 00001b: MTIOC4B	Pin function select bits 00000b: Hi-Z 00001b: MTIOC4B 01011b: TXD6/SMOSI6/SSDA6
PD2PFS	PSEL[4:0]	Pin function select bits 00000b: Hi-Z 00001b: MTIOC4D	Pin function select bits 00000b: Hi-Z 00001b: MTIOC4D 01011b: SCK6
PD3PFS	—	PD3 pin function select register	—
PD4PFS	—	PD4 pin function select register	—
PD5PFS	—	PD5 pin function select register	—
PD6PFS	—	PD6 pin function select register	—
PD7PFS	—	PD7 pin function select register	—
PDnPFS	ISEL	Interrupt input function select bit 0: Not used as IRQn input pin 1: Used as IRQn input pin PD0: IRQ0 (100-pin) PD1: IRQ1 (100-pin) PD2: IRQ2 (100-pin) PD3: IRQ3 (100-pin) PD4: IRQ4 (100-pin) PD5: IRQ5 (100-pin) PD6: IRQ6 (100-pin) PD7: IRQ7 (100-pin)	Interrupt input function select bit 0: Not used as IRQn input pin 1: Used as IRQn input pin PD0: IRQ0 (80-pin) PD1: IRQ1 (80-pin) PD2: IRQ2 (80-pin)

Register	Bit	RX231 (n = 0 to 7)	RX140 (n = 0 to 2)
PDnPFS	ASEL	Analog function select bit 0: Used as other than as analog pin 1: Used as analog pin PD0: AN024 (100-pin) PD1: AN025 (100-pin) PD2: AN026 (100-pin) PD3: AN027 (100-pin) PD4: AN028 (100-pin) PD5: AN029 (100-pin) PD6: AN030 (100-pin) PD7: AN031 (100-pin)	Analog function select bit 0: Used as other than as analog pin 1: Used as analog pin PD0: AN024 (80-pin) PD1: AN025 (80-pin) PD2: AN026 (80-pin)

Table 2.37 Comparison of PEn Pin Function Control Register (PEnPFS)

Register	Bit	RX231 (n = 0 to 7)	RX140 (n = 0 to 5)
PE3PFS	PSEL[4:0]	Pin function select bits 00000b: Hi-Z 00001b: MTIOC4B 00111b: POE8# 01001b: CLKOUT 01100b: CTS12#/RTS12#/SS12# 10111b: AUDIO_MCLK	Pin function select bits 00000b: Hi-Z 00001b: MTIOC4B 00010b: MTIOC1B 00111b: POE8# 01001b: CLKOUT 01100b: CTS12#/RTS12#/SS12# 11001b: TS34
PE4PFS	PSEL[4:0]	Pin function select bits 00000b: Hi-Z 00001b: MTIOC4D 00010b: MTIOC1A 01001b: CLKOUT	Pin function select bits 00000b: Hi-Z 00001b: MTIOC4D 00010b: MTIOC1A 00011b: MTIOC4A 01001b: CLKOUT 11001b: TS33
PE6PFS	—	PE6 pin function control register	—
PE7PFS	—	PE7 pin function control register	—
PEnPFS	ISEL	Interrupt input function select bit 0: Not used as IRQn input pin 1: Used as IRQn input pin PE2: IRQ7 (100/64/48-pin) PE5: IRQ5 (100/64-pin) PE6: IRQ6 (100-pin) PE7: IRQ7 (100-pin)	Interrupt input function select bit 0: Not used as IRQn input pin 1: Used as IRQn input pin PE2: IRQ7 (80/64/48/32-pin) PE5: IRQ5 (80/64-pin)

Register	Bit	RX231 (n = 0 to 7)	RX140 (n = 0 to 5)
PEnPFS	ASEL	Analog function select bit 0: Used as other than as analog pin 1: Used as analog pin PE0: AN016 (100/64-pin) PE1: AN017, CMPB0 (100/64/48-pin) PE2: AN018, CVREFB0 (100/64/48-pin) PE3: AN019 (100/64/48-pin) PE4: AN020, CMPA2 (100/64/48-pin) PE5: AN021 (100/64-pin) PE6: AN022 (100-pin) PE7: AN023 (100-pin)	Analog function select bit 0: Used as other than as analog pin 1: Used as analog pin PE0: AN016 (80/64-pin) PE1: AN017, CMPB0 (80/64/48/32-pin) PE2: AN018, CVREFB0 (80/64/48/32-pin) PE3: AN019 (80/64/48/32-pin) PE4: AN020, CMPA2 (80/64/48/32-pin) PE5: AN021 (80/64-pin)

Table 2.38 Comparison of PHn Pin Function Control Register (PHnPFS)

Register	Bit	RX231 (n = 0 to 3)	RX140 (n = 0 to 3)
PH0PFS	PSEL[4:0]	Pin function select bits 00000b: Hi-Z 00111b: CACREF	Pin function select bits 00000b: Hi-Z 00001b: MTIOC3B 00111b: CACREF 11001b: TS10
PH1PFS	PSEL[4:0]	Pin function select bits 00000b: Hi-Z 00101b: TMO0	Pin function select bits 00000b: Hi-Z 00001b: MTIOC3D 00101b: TMO0 11001b: TS9
PH2PFS	PSEL[4:0]	Pin function select bits 00000b: Hi-Z 00101b: TMRI0	Pin function select bits 00000b: Hi-Z 00001b: MTIOC4C 00101b: TMRI0 11001b: TS8
PH3PFS	PSEL[4:0]	Pin function select bits 00000b: Hi-Z 00101b: TMCI0	Pin function select bits 00000b: Hi-Z 00001b: MTIOC4D 00101b: TMCI0 11001b: TS7

Table 2.39 Comparison of PJn Pin Function Control Register (PJnPFS)

Register	Bit	RX231 (n = 3)	RX140 (n = 1, 6, 7)
PJ1PFS	—	—	PJ1 pin function control register
PJ3PFS	—	PJ3 pin function control register	—

Table 2.40 Comparisons of Multi-Function Pin Controller Registers

Register	Bit	RX231	RX140
PFCSE	—	CS output enable register	—
PFAOE0	—	Address output enable register 0	—
PFAOE1	—	Address output enable register 1	—
PFBCR0	—	External bus control register 0	—
PFBCR1	—	External bus control register 1	—

2.16 Port Output Enable 2

Table 2.41 is a comparative overview of the port output enable 2 modules.

Table 2.41 Comparative Overview of Port Output Enable 2 Modules

Item	RX231 (POE2a)	RX140 (POE2a)
High-impedance control by input level detection	• Ability to specify falling-edge detection or sampling of the low level 16 times at PCLK/8, PCLK/16, or PCLK/128 clock cycles for each of the POE0# to POE3# and POE8# input pins • Ability to put pins for complementary PWM output from the MTU in the high-impedance state on detection of falling edges or sampling of the low level on the POE0# to POE3# pins • Ability to put pins for output from MTU0 in the high-impedance state on detection of falling edges or sampling of the low level on the POE8# pin.	• Ability to specify falling-edge detection or sampling of the low level 16 times at PCLK/8, PCLK/16, or PCLK/128 clock cycles for each of the POE0# to POE3#, and POE8# input pins • Ability to put pins for complementary PWM output from the MTU in the high-impedance state on detection of falling edges or sampling of the low level on the POE0# to POE3# pins • Ability to put pins for output from MTU0 in the high-impedance state on detection of falling edges or sampling of the low level on the POE8# pin.
High-impedance control by output level comparison	Ability to compare levels output on pins for complementary PWM output from the MTU and put them in the high-impedance state when simultaneous output of the active level continues for one or more cycles of the PCLK clock	Ability to compare levels output on pins for complementary PWM output from the MTU and put them in the high-impedance state when simultaneous output of the active level continues for one or more cycles of the PCLK clock
High-impedance control by oscillation stop detection	Ability to put pins for complementary PWM output from the MTU and output pins for MTU0 in the high-impedance state when oscillation by the clock generation circuit stops	Ability to put pins for complementary PWM output from the MTU and output pins for MTU0 in the high-impedance state when oscillation by the clock generation circuit stops
High-impedance control by software (registers)	Ability to put pins for complementary PWM output from the MTU and output pins for MTU0 in the high-impedance state by writing to the POE registers	Ability to put pins for complementary PWM output from the MTU and output pins for MTU0 in the high-impedance state by writing to the POE registers
High-impedance control by event signals	Ability to put pins for complementary PWM output from the MTU and output pins for MTU0 in the high-impedance state in response to an event signal from the event link controller (ELC)	—
Interrupts	Ability to generate interrupts in response to the results of POE0# to POE3# and POE8# input-level detection or MTU complementary PWM output-level comparison	Ability to generate interrupts in response to the results of POE0# to POE3#, and POE8# input-level detection or MTU complementary PWM output-level comparison

2.17 Compare Match Timer

Table 2.42 is a comparative overview of the compare match timers, and Table 2.43 is a comparison of compare match timer registers.

Table 2.42 Comparative Overview of Compare Match Timers

Item	RX231 (CMT)	RX140 (CMT)
Number of channels	4 channels	2 channels
Count clocks	Four frequency-divided clocks: One clock from among PCLK/8, PCLK/32, PCLK/128, and PCLK/512 can be selected individually for each channel.	Four frequency-divided clocks: One clock from among PCLK/8, PCLK/32, PCLK/128, and PCLK/512 can be selected individually for each channel.
Interrupt	A compare match interrupt can be requested for each channel.	A compare match interrupt can be requested for each channel.
Event link function (output)	Event signal output at CMT1 compare match	Event signal output at CMT1 compare match
Event link function (input)	• Support for linked operation of specified module • Support for CMT1 counter start, event counter, and count restart	• Support for linked operation of specified module • Support for CMT1 counter start, event counter, and count restart
Low power consumption function	Ability to specify module stop state for each unit	Ability to specify module stop state for each unit

Table 2.43 Comparison of Compare Match Timer Registers

Register	Bit	RX231 (CMT)	RX140 (CMT)
CMSTR1	—	Compare match timer start register 1	—

2.18 Realtime Clock

Table 2.44 is a comparative overview of realtime clocks, and Table 2.45 is a comparison of realtime clock registers.

Table 2.44 Comparative Overview of Realtime Clocks

Item	RX231 (RTCe)	RX140 (RTCc)
Count modes	Calendar count mode/binary count mode	Calendar count mode/binary count mode
Count source	Sub-clock (XCIN)	Sub-clock (XCIN)
Clock and calendar functions	• Calendar count mode — Year, month, date, day-of-week, hour, minute, second are counted, BCD display — 12 hours/24 hours mode switching function — 30 seconds adjustment function (a number less than 30 is rounded down to 00 seconds, and 30 seconds or more are rounded up to one minute) — Automatic adjustment function for leap years • Binary count mode Count seconds in 32 bits, binary display • Common to both modes — Start/stop function — The sub-second digit is displayed in binary units (1 Hz, 2 Hz, 4 Hz, 8 Hz, 16 Hz, 32 Hz, or 64 Hz). — Clock error correction function — Clock (1 Hz/64 Hz) output	• Calendar count mode — Year, month, date, day-of-week, hour, minute, second are counted, BCD display — 12 hours/24 hours mode switching function — 30 seconds adjustment function (a number less than 30 is rounded down to 00 seconds, and 30 seconds or more are rounded up to one minute) — Automatic adjustment function for leap years • Binary count mode Count seconds in 32 bits, binary display • Common to both modes — Start/stop function — The sub-second digit is displayed in binary units (1 Hz, 2 Hz, 4 Hz, 8 Hz, 16 Hz, 32 Hz, or 64 Hz). — Clock error correction function — Clock (1 Hz/64 Hz) output
Interrupt	• Alarm interrupt (ALM) As an alarm interrupt condition, selectable which of the below is compared with: — Calendar count mode: Year, month, date, day-of-week, hour, minute, or second can be selected — Binary count mode: Each bit of the 32-bit binary counter • Periodic interrupt (PRD) 2 seconds, 1 second, 1/2 second, 1/4 second, 1/8 second, 1/16 second, 1/32 second, 1/64 second, or 1/256 second can be selected as an interrupt period.	• Alarm interrupt (ALM) As an alarm interrupt condition, selectable which of the below is compared with: — Calendar count mode: Year, month, date, day-of-week, hour, minute, or second can be selected — Binary count mode: Each bit of the 32-bit binary counter • Periodic interrupt (PRD) 2 seconds, 1 second, 1/2 second, 1/4 second, 1/8 second, 1/16 second, 1/32 second, 1/64 second, or 1/256 second can be selected as an interrupt period.

Item	RX231 (RTCe)	RX140 (RTCc)
Interrupt	• Carry interrupt (CUP) An interrupt is generated at either of the following timings: — When a carry from the 64-Hz counter to the second counter is generated. — When the 64-Hz counter is changed and the R64CNT register is read at the same time. • Recovery from software standby mode can be performed by an alarm interrupt or periodic interrupt	• Carry interrupt (CUP) An interrupt is generated at either of the following timings: — When a carry from the 64-Hz counter to the second counter is generated. — When the 64-Hz counter is changed and the R64CNT register is read at the same time. • Recovery from software standby mode can be performed by an alarm interrupt or periodic interrupt
Time-capture function	Times can be captured when the edge of the time capture event input pin is detected. For every event input, month, date, hour, minute, and second are captured or 32-bit binary counter value is captured.	—
Event link function	Periodic event output	—

Table 2.45 Comparison of Realtime Clock Registers

Register	Bit	RX231 (RTCe)	RX140 (RTCc)
RCR3	—	RTC control register 3	—
RTCCRy	—	Time capture control register y (y = 0 to 2)	—
RSECCPy/ BCNT0CPy	—	Second capture register y (y = 0 to 2)/ BCNT0 capture register y (y = 0 to 2)	—
RMINCPy/ BCNT1CPy	—	Minute capture register y (y = 0 to 2)/ BCNT1 capture register y (y = 0 to 2)	—
RHRCPy/ BCNT2CPy	—	Hour capture register y (y = 0 to 2)/ BCNT2 capture register y (y = 0 to 2)	—
RDAYCPy/ BCNT3CPy	—	Date capture register y (y = 0 to 2)/ BCNT3 capture register y (y = 0 to 2)	—
RMONCPy	—	Month capture register y (y = 0 to 2)	—

2.19 Low-Power Timer

Table 2.46 is a comparative overview of the low-power timers, and Table 2.47 is a comparison of low-power timer registers.

Table 2.46 Comparative Overview of Low-Power Timers

Item	RX231 (LPT)	RX140 (LPTa)
Clock source	Sub-clock oscillator or IWDT-dedicated oscillator	Sub-clock, LOCO clock (divided by 4), or IWDT-dedicated clock
Clock division ratio	Divided by 2, 4, 8, 16, or 32	No division, or divided by 2, 4, 8, 16, or 32
Count operation	• Count up using the 16-bit up-counter • Count operation can be continued even in software standby mode	• Count up using the 16-bit up-counter. • Count operation can be continued even in software standby mode.
Compare match	• Compare match 0 (A compare match signal is generated only in software standby mode)	• Compare match 0 (A compare match signal is generated only in software standby mode.) • Compare match 1
PWM waveform generation	—	A PWM waveform can be output on the LPT0 pin.
Interrupt	—	Compare match 1
Event link function (output)	• Compare match 0 An event signal is output (a compare match signal is generated only in software standby mode).	• Compare match 0 (A compare match signal is generated only in software standby mode.) • Compare match 1

Table 2.47 Comparison of Low-Power Timer Registers

Register	Bit	RX231 (LPT)	RX140 (LPTa)
LPTCR1	LPCNTPSSEL [2:0]	Low-power timer clock division ratio select bits b2 b0 0 0 1: Source clock divided by 2 0 1 0: Source clock divided by 4 0 1 1: Source clock divided by 8 1 0 0: Source clock divided by 16 1 0 1: Source clock divided by 32 Settings other than the above are prohibited.	Clock division ratio select bits b2 b0 0 0 0: No division 0 0 1: Divided by 2 0 1 0: Divided by 4 0 1 1: Divided by 8 0 0 0: Divided by 16 1 0 1: Divided by 32 Settings other than the above are prohibited.
	LPCNTCKSEL (RX231) LPCNTCKSEL2, LPCNTCKSEL (RX140)	Low-power timer clock source select bit 0: Sub-clock oscillator is selected. 1: IWDT-dedicated on-chip oscillator is selected.	Clock source select bit 2 (b3), clock source select bit (b4)*2 b4 b3 0 0: Sub-clock 0 1: LOCO clock divided by 4*1 1 0: IWDT-dedicated clock (IWDTCLK) 1 1: LOCO clock divided by 4*1 Make settings such that the frequency of the system clock (ICLK) and peripheral module clock (PCLKB) ≥ 4 × (the frequency of the clock source).
	LPCMRE1	—	Compare match 1 enable bit
LPTCR2	OPOL	—	Output polarity select bit
	OLVL	—	Output level select bit
	PWME	—	PWM mode enable bit
LPCMR1	—	—	Low-power timer compare register 1

Notes: 1. The clock generated by the low-speed on-chip oscillator (LOCO), divided by 4, is supplied to the low-power timer. To ensure that operation of the LOCO clock continues in software standby mode when it being used as the clock source of the low-power timer, set the LFOCR.LOFXIN bit to 1.
2. Modify these bits when the value of the LPTCR2.LPCNTSTP bit is 1 (low-power timer clock is stopped).

2.20 Independent Watchdog Timer

Table 2.48 is a comparative overview of the independent watchdog timers.

Table 2.48 Comparative Overview of Independent Watchdog Timers

Item	RX231 (IWDTa)	RX140 (IWDTa)
Count source	IWDT-dedicated clock (IWDTCLK)	IWDT-dedicated clock (IWDTCLK)
Clock division ratio	Divide by1, 16, 32, 64, 128, or 256	Divide by 1, 16, 32, 64, 128, or 256
Counter operation	Counting down using a 14-bit down-counter	Counting down using a 14-bit down-counter
Conditions for starting the counter	• Counting automatically starts after a reset (auto-start mode) • Counting is started (register start mode) by refreshing the counter (writing 00h and then FFh to the IWDTRR register).	• Auto-start mode: Counting starts automatically after a reset. • Register start mode: Counting is started by refreshing the counter (writing 00h and then FFh to the IWDTRR register).
Conditions for stopping the counter	• Reset (the down-counter and other registers return to their initial values) • A counter underflows or a refresh error is generated Counting restarts (in auto-start mode, counting automatically restarts after a reset or after a non-maskable interrupt request is output. In register start mode, counting restarts after refreshing.)	• Reset (the down-counter and other registers return to their initial values) • Low power consumption state (by means of register setting) • Underflow or refresh error (register start mode only)
Window function	Window start and end positions can be specified (refresh-permitted and refresh-prohibited periods)	Window start and end positions can be specified (refresh-permitted and refresh-prohibited periods)
Reset output sources	• Down-counter underflows • Refreshing outside the refresh-permitted period (refresh error)	• Down-counter underflows • Refreshing outside the refresh-permitted period (refresh error)
Non-maskable interrupt sources	• Down-counter underflows • When refreshing is done outside the refresh-permitted period (refresh error)	• Down-counter underflows • When refreshing is done outside the refresh-permitted period (refresh error)
Reading the counter value	The down-counter value can be read by the IWDTSR register.	The down-counter value can be read by the IWDTSR register.
Event link function (output)	• Down-counter underflow event output • Refresh error event output	—
Output signals (internal signals)	• Reset output • Interrupt request output • Sleep mode count stop control output	• Reset output • Interrupt request output • Sleep mode count stop control output

Item	RX231 (IWDTa)	RX140 (IWDTa)
Auto-start mode (controlled by option function select register 0 (OFS0))	• Selecting the clock frequency division ratio after a reset (OFS0.IWDTCKS[3:0] bits) • Selecting the timeout period of the independent watchdog timer (OFS0.IWDTTOPS[1:0] bits) • Selecting the window start position in the independent watchdog timer (OFS0.IWDTRPSS[1:0]bits) • Selecting the window end position in the independent watchdog timer (OFS0.IWDTRPES[1:0]bits) • Selecting the reset output or interrupt request output (OFS0.IWDTRSTIRQS bit) • Selecting the down-count stop function at transition to sleep mode, software standby mode, or deep sleep mode (OFS0.IWDTSLCSTP bit)	• Selecting the clock frequency division ratio after a reset (OFS0.IWDTCKS[3:0] bits) • Selecting the timeout period of the independent watchdog timer (OFS0.IWDTTOPS[1:0] bits) • Selecting the window start position in the independent watchdog timer (OFS0.IWDTRPSS[1:0]bits) • Selecting the window end position in the independent watchdog timer (OFS0.IWDTRPES[1:0]bits) • Selecting the reset output or interrupt request output (OFS0.IWDTRSTIRQS bit) • Selecting the down-count stop function at transition to sleep mode, software standby mode, or deep sleep mode (OFS0.IWDTSLCSTP bit)
Register start mode (controlled by the IWDT registers)	• Selecting the clock frequency division ratio after refreshing (IWDTCR.CKS[3:0] bits) • Selecting the timeout period of the independent watchdog timer (IWDTCR.TOPS[1:0] bits) • Selecting the window start position in the independent watchdog timer (IWDTCR.RPSS[1:0] bits) • Selecting the window end position in the independent watchdog timer (IWDTCR.RPES[1:0] bits) • Selecting the reset output or interrupt request output (IWDTRCR.RSTIRQS bit) • Selecting the down-count stop function at transition to sleep mode, software standby mode, or deep sleep mode (IWDTCSTPR.SLCSTP bit)	• Selecting the clock frequency division ratio after refreshing (IWDTCR.CKS[3:0] bits) • Selecting the timeout period of the independent watchdog timer (IWDTCR.TOPS[1:0] bits) • Selecting the window start position in the independent watchdog timer (IWDTCR.RPSS[1:0] bits) • Selecting the window end position in the independent watchdog timer (IWDTCR.RPES[1:0] bits) • Selecting the reset output or interrupt request output (IWDTRCR.RSTIRQS bit) • Selecting the down-count stop function at transition to sleep mode, software standby mode, or deep sleep mode (IWDTCSTPR.SLCSTP bit)

2.21 Serial Communications Interface

Table 2.49 is a comparative overview of the serial communications interfaces, and Table 2.50 is a comparison of serial communications interface channel specifications, and Table 2.51 is a comparison of serial communications interface registers.

Table 2.49 Comparative Overview of Serial Communications Interfaces

Item		RX231 (SCIg, SCIh)	RX140 (SCIg, SCIk, SCIh)
Number of channels		• SCIg: 6 channels • SCIh: 1 channel	• SCIg: 3 channels • SCIk: 2 channels • SCIh: 1 channel
Serial communications modes		• Asynchronous • Clock synchronous • Smart card interface • Simple I^2C bus • Simple SPI bus	• Asynchronous • Clock synchronous • Smart card interface • Simple I^2C bus • Simple SPI bus
Transfer speed		Bit rate specifiable by on-chip baud rate generator.	Bit rate specifiable by on-chip baud rate generator.
Full-duplex communication		• Transmitter: Continuous transmission possible using double-buffer structure. • Receiver: Continuous reception possible using double-buffer structure.	• Transmitter: Continuous transmission possible using double-buffer structure. • Receiver: Continuous reception possible using double-buffer structure.
Data transfer		Selectable as LSB first or MSB first transfer.	Selectable as LSB first or MSB first transfer.
I/O signal level inversion		—	The levels of input and output signals can be inverted independently (SCI1 and SCI5).
Interrupt sources		Transmit end, transmit data empty, receive data full, and receive error, completion of generation of a start condition, restart condition, or stop condition (for simple I^2C mode)	Transmit end, transmit data empty, receive data full, receive error, and data match (SCI1 and SCI5), completion of generation of a start condition, restart condition, or stop condition (for simple I^2C mode)
Low power consumption function		Individual channels can be transitioned to the module stop state.	Individual channels can be transitioned to the module stop state.
Asynchronous mode	Data length	7, 8, or 9 bits	7, 8, or 9 bits
	Transmission stop bits	1 or 2 bits	1 or 2 bits
	Parity	Even parity, odd parity, or no parity	Even parity, odd parity, or no parity
	Receive error detection function	Parity, overrun, and framing errors	Parity, overrun, and framing errors
	Hardware flow control	CTSn# and RTSn# pins can be used in controlling transmission/reception.	CTSn# and RTSn# pins can be used in controlling transmission/reception.

Item		RX231 (SCIg, SCIh)	RX140 (SCIg, SCIk, SCIh)
Asynchronous mode	Data match detection	—	Compares receive data and comparison data, and generates interrupt when they are matched (SCI1 and SCI5)
	Start-bit detection	Low level or falling edge is selectable.	Low level or falling edge is selectable.
	Receive data sampling timing adjustment	—	The receive data sampling point can be shifted from the center of the data forward or backward to a base point (SCI1 and SCI5).
	Transmit signal change timing adjustment	—	Either the falling or rising edge of the transmit data can be delayed (SCI1 and SCI5).
	Break detection	When a framing error occurs, a break can be detected by reading the RXDn pin level directly.	When a framing error occurs, a break can be detected by reading the RXDn pin level directly or by reading the SPTR.RXDMON flag (SCI1 or SCI5).
	Clock source	• An internal or external clock can be selected. • Transfer rate clock input from the TMR can be used (SCI5, SCI6, and SCI12).	• An internal or external clock can be selected. • Transfer rate clock input from the TMR can be used (SCI5, SCI6, and SCI12).
	Double-speed mode	Baud rate generator double-speed mode is selectable.	Baud rate generator double-speed mode is selectable.
	Multi-processor communications function	Serial communication among multiple processors	Serial communication among multiple processors
	Noise cancellation	The signal paths from input on the RXDn pins incorporate digital noise filters.	The signal paths from input on the RXDn pins incorporate digital noise filters.
Clock synchronous mode	Data length	8 bits	8 bits
	Receive error detection	Overrun error	Overrun error
	Hardware flow control	CTSn and RTSn pins can be used in controlling transmission/ reception.	CTSn# and RTSn# pins can be used in controlling transmission/ reception.
Smart card interface mode	Error processing	• An error signal can be automatically transmitted when detecting a parity error during reception • Data can be automatically retransmitted when receiving an error signal during transmission	• An error signal can be automatically transmitted when detecting a parity error during reception • Data can be automatically retransmitted when receiving an error signal during transmission
	Data type	Both direct convention and inverse convention are supported.	Both direct convention and inverse convention are supported.

Item		RX231 (SCIg, SCIh)	RX140 (SCIg, SCIk, SCIh)
Simple I^2C mode	Communication format	I^2C bus format	I^2C bus format
	Operating mode	Master (single-master operation only)	Master (single-master operation only)
	Transfer rate	Fast mode is supported.	Fast mode is supported.
	Noise cancellation	The signal paths from input on the SSCLn and SSDAn pins incorporate digital noise filters, and the interval for noise cancellation is adjustable.	The signal paths from input on the SSCLn and SSDAn pins incorporate digital noise filters, and the interval for noise cancellation is adjustable.
Simple SPI mode	Data length	8 bits	8 bits
	Detection of errors	Overrun error	Overrun error
	SS input pin function	Applying the high level to the SSn# pin can cause the output pins to enter the high-impedance state.	Applying the high level to the SSn# pin can cause the output pins to enter the high-impedance state.
	Clock settings	Four kinds of settings for clock phase and clock polarity are selectable.	Four kinds of settings for clock phase and clock polarity are selectable.
Extended serial mode (supported by SCI12 only)	Start frame transmission	• Break field low width output and generation of interrupt on completion • Detection of bus collision and generation of interrupt on detection	• Break field low width output and generation of interrupt on completion • Detection of bus collision and generation of interrupt on detection
	Start frame reception	• Detection of break field low width and generation of interrupt on detection • Data comparison of control fields 0 and 1 and generation of interrupt when they match • Ability to specify two kinds of data for comparison (primary and secondary) in control field 1 • Ability to specify priority interrupt bit in control field 1 • Support for start frames that do not include a break field • Support for start frames that do not include a control field 0 • Function for measuring bit rates	• Detection of break field low width and generation of interrupt on detection • Data comparison of control fields 0 and 1 and generation of interrupt when they match • Ability to specify two kinds of data for comparison (primary and secondary) in control field 1 • Ability to specify priority interrupt bit in control field 1 • Support for start frames that do not include a break field • Support for start frames that do not include a control field 0 • Function for measuring bit rates

Item		RX231 (SCIg, SCIh)	RX140 (SCIg, SCIk, SCIh)
Extended serial mode (supported by SCI12 only)	I/O control function	• Ability to select polarity or TXDX12 and RXDX12 signals • Ability to specify digital filtering of RXDX12 signal • Half-duplex operation employing RXDX12 and TXDX12 signals multiplexed on the same pin • Ability to select receive data sampling timing of RXDX12 pin • Signals received on RXDX12 can be passed through to SCIg when the extended serial mode control section is turned off.	• Ability to select polarity or TXDX12 and RXDX12 signals • Ability to specify digital filtering of RXDX12 signal • Half-duplex operation employing RXDX12 and TXDX12 signals multiplexed on the same pin • Ability to select receive data sampling timing of RXDX12 pin
	Timer function	Usable as reloading timer	Usable as reloading timer
Bit rate modulation function		Correction of outputs from the on-chip baud rate generator can reduce errors.	Correction of outputs from the on-chip baud rate generator can reduce errors.
Event link function (supported by SCI5 only)		• Error (receive error or error signal detection) event output • Receive data full event output • Transmit data empty event output • Transmit end event output	• Error (receive error or error signal detection) event output • Receive data full event output • Transmit data empty event output • Transmit end event output

Table 2.50 Comparison of Serial Communications Interface Channel Specifications

Item	RX231 (SCIg, SCIh)	RX140 (SCIg, SCIk, SCIh)
Synchronous mode	SCI0, SCI1, SCI5, SCI6, SCI8, SCI9, SCI12	SCI1, SCI5, SCI6, SCI8, SCI9, SCI12
Clock synchronous mode	SCI0, SCI1, SCI5, SCI6, SCI8, SCI9, SCI12	SCI1, SCI5, SCI6, SCI8, SCI9, SCI12
Smart card interface mode	SCI0, SCI1, SCI5, SCI6, SCI8, SCI9, SCI12	SCI1, SCI5, SCI6, SCI8, SCI9, SCI12
Simple I^2C mode	SCI0, SCI1, SCI5, SCI6, SCI8, SCI9, SCI12	SCI1, SCI5, SCI6, SCI8, SCI9, SCI12
Simple SPI mode	SCI0, SCI1, SCI5, SCI6, SCI8, SCI9, SCI12	SCI1, SCI5, SCI6, SCI8, SCI9, SCI12
Data match detection	—	SCI1, SCI5
Extended serial mode	SCI12	SCI12
TMR clock input	SCI5, SCI6, SCI12	SCI5, SCI6, SCI12
Event link function	SCI5	SCI5
Peripheral module clock	PCLKB: SCI0, SCI1, SCI5, SCI6, SCI8, SCI9, SCI12	PCLKB: SCI1, SCI5, SCI6, SCI8, SCI9, SCI12

Table 2.51 Comparison of Serial Communications Interface Registers

Register	Bit	RX231 (SCIg, SCIh)	RX140 (SCIg, SCIk, SCIh)
SCR	CKE[1:0]	Clock enable bits (Asynchronous mode) b1 b0 0 0: On-chip baud rate generator The SCKn pin is in the high-impedance state. 0 1: On-chip baud rate generator A clock with the same frequency as the bit rate is output on the SCKn pin. 1 x: External clock or MTU clock When using an external clock, input a clock with a frequency 16 times the bit rate on the SCKn pin. When the SEMR.ABCS bit is set to 1, input a clock with a frequency eight times the bit rate. When using the MTU clock, the SCKn pin is in the high-impedance state. (Clock synchronous mode) b1 b0 0 x: Internal clock: The SCKn pin functions as the clock output pin. 1 x: External clock: The SCKn pin functions as the clock input pin.	Clock enable bits (Asynchronous mode) b1 b0 0 0: On-chip baud rate generator The SCKn pin is in the high-impedance state. 0 1: On-chip baud rate generator A clock with the same frequency as the bit rate is output on the SCKn pin. 1 x: External clock or TMR clock*1 When using an external clock, input a clock with a frequency 16 times the bit rate on the SCKn pin. When the SEMR.ABCS bit is set to 1, input a clock with a frequency eight times the bit rate. When using the TMR clock, the SCKn pin is in the high-impedance state. (Clock synchronous mode) b1 b0 0 x: Internal clock: The SCKn pin functions as the clock output pin. 1 x: External clock: The SCKn pin functions as the clock input pin.
SEMR	ITE	—	Immediate transmission enable bit
	ABCSE	—	Asynchronous basic clock select extended bit
CDR	—	—	Comparison data register
DCCR	—	—	Data comparison control register
SPTR	—	—	Serial port register
TMGR	—	—	Transmit/receive timing select register
ESMER	—	—	Extended serial module enable register

Note: 1. Selectable on SCI5, SCI6, and SCI12 only.

2.22 Serial Peripheral Interface

Table 2.52 is a comparative overview of serial peripheral interfaces, and Table 2.53 is a comparison of serial peripheral interface registers.

Table 2.52 Comparative Overview of Serial Peripheral Interfaces

Item	RX231 (RSPIa)	RX140 (RSPIc)
Number of channels	1 channel	1 channel
RSPI transfer functions	• Use of MOSI (master out/slave in), MISO (master in/slave out), SSL (slave select), and RSPCK (RSPI clock) signals allows serial communications through SPI operation (4-wire method) or clock synchronous operation (3-wire method). • Transmit-only operation is available. • Communication mode: Full-duplex or transmit-only can be selected. • Switching of the polarity of RSPCK • Switching of the phase of RSPCK	• Use of MOSI (master out/slave in), MISO (master in/slave out), SSL (slave select), and RSPCK (RSPI clock) signals allows serial communications through SPI operation (4-wire method) or clock synchronous operation (3-wire method). • Communication mode: Full-duplex or transmit-only can be selected. • Switching of the polarity of RSPCK • Switching of the phase of RSPCK
Data format	• MSB first/LSB first selectable • Transfer bit length is selectable as 8, 9, 10, 11, 12, 13, 14, 15, 16, 20, 24, or 32 bits. • 128-bit transmit/receive buffers • Up to four frames can be transferred in one round of transmission/reception (each frame consisting of up to 32 bits).	• MSB first/LSB first selectable • Transfer bit length is selectable as 8, 9, 10, 11, 12, 13, 14, 15, 16, 20, 24, or 32 bits. • 128-bit transmit/receive buffers • Up to four frames can be transferred in one round of transmission/reception (each frame consisting of up to 32 bits). • Byte swapping of transmit and receive data is selectable
Bit rate	• In master mode, the on-chip baud rate generator generates RSPCK by frequency-dividing PCLK (the division ratio ranges from divided by 2 to divided by 4096). • In slave mode, the minimum PCLK clock divided by 8 can be input as RSPCK (the maximum frequency of RSPCK is that of PCLK divided by 8). — Width at high level: 4 cycles of PCLK Width at low level: 4 cycles of PCLK	• In master mode, the on-chip baud rate generator generates RSPCK by frequency-dividing PCLK (the division ratio ranges from divided by 2 to divided by 4096). • In slave mode, the minimum PCLK clock divided by 4 can be input as RSPCK (the maximum frequency of RSPCK is that of PCLK divided by 4). — Width at high level: 2 cycles of PCLK Width at low level: 2 cycles of PCLK
Buffer configuration	• Double buffer configuration for the transmit/receive buffers • 128 bits for the transmit/receive buffers	• Double buffer configuration for the transmit/receive buffers • 128 bits for the transmit/receive buffers
Error detection	• Mode fault error detection • Overrun error detection • Parity error detection	• Mode fault error detection • Overrun error detection • Parity error detection • Underrun error detection

Item	RX231 (RSPIa)	RX140 (RSPIc)
SSL control function	• Four SSL pins (SSLA0 to SSLA3) for each channel • In single-master mode, SSLA0 to SSLA3 pins are output. • In multi-master mode: SSLA0 pin for input, and SSLA1 to SSLA3 pins for either output or unused. • In slave mode: SSLA0 pin for input, and SSLA1 to SSLA3 pins for unused. • Controllable delay from SSL output assertion to RSPCK operation (RSPCK delay) — Range: 1 to 8 RSPCK cycles (set in RSPCK-cycle units) • Controllable delay from RSPCK stop to SSL output negation (SSL negation delay) — Range: 1 to 8 RSPCK cycles (set in RSPCK-cycle units) • Controllable wait for next-access SSL output assertion (next-access delay) — Range:1 to 8 RSPCK cycles (set in RSPCK-cycle units) • Function for changing SSL polarity	• Four SSL pins (SSLA0 to SSLA3) for each channel • In single-master mode, SSLA0 to SSLA3 pins are output. • In multi-master mode: SSLA0 pin for input, and SSLA1 to SSLA3 pins for either output or unused. • In slave mode: SSLA0 pin for input, and SSLA1 to SSLA3 pins for unused. • Controllable delay from SSL output assertion to RSPCK operation (RSPCK delay) — Range: 1 to 8 RSPCK cycles (set in RSPCK-cycle units) • Controllable delay from RSPCK stop to SSL output negation (SSL negation delay) — Range: 1 to 8 RSPCK cycles (set in RSPCK-cycle units) • Controllable wait for next-access SSL output assertion (next-access delay) — Range:1 to 8 RSPCK cycles (set in RSPCK-cycle units) • Function for changing SSL polarity
Control in master transfer	• A transfer of up to eight commands can be executed sequentially in looped execution. • For each command, the following can be set: SSL signal value, bit rate, RSPCK polarity/phase, transfer data length, MSB/LSB first, burst, RSPCK delay, SSL negation delay, and next-access delay • A transfer can be initiated by writing to the transmit buffer. • MOSI signal value specifiable in SSL negation • RSPCK auto-stop function	• A transfer of up to eight commands can be executed sequentially in looped execution. • For each command, the following can be set: SSL signal value, bit rate, RSPCK polarity/phase, transfer data length, MSB/LSB first, burst, RSPCK delay, SSL negation delay, and next-access delay • A transfer can be initiated by writing to the transmit buffer. • MOSI signal value specifiable in SSL negation • RSPCK auto-stop function
Interrupt sources	• Receive buffer full interrupt • Transmit buffer empty interrupt • RSPI error interrupt (mode fault, overrun, or parity error) • RSPI idle interrupt (RSPI idle)	• Receive buffer full interrupt • Transmit buffer empty interrupt • Error interrupt (mode fault, overrun, underrun, or parity error) • Idle interrupt
Event link function (output)	The following events can be output to the event link controller. (RSPI0) • Receive buffer full signal • Transmit buffer empty signal • Mode fault, overrun, or parity error signal • RSPI idle signal • Transmission-completed signal	—

Item	RX231 (RSPIa)	RX140 (RSPIc)
Other functions	• Function for switching between CMOS output and open-drain output • Function for initializing the RSPI • Loopback mode	• Function for initializing the RSPI • Loopback mode
Low power consumption function	Ability to specify module stop state	Ability to specify module stop state

Table 2.53 Comparison of Serial Peripheral Interface Registers

Register	Bit	RX231 (RSPIa)	RX140 (RSPIc)
SPSR	MODF	Mode fault error flag 0: No mode fault error occurs 1: A mode fault error occurs	Mode fault error flag 0: Neither a mode fault error nor an underrun error occurs 1: A mode fault error or an underrun error occurs
	UDRF	—	Underrun error flag
SPDR	—	RSPI data register Accessible size • Longwords access (SPDCR.SPLW = 1) • Words access (SPDCR.SPLW = 0)	RSPI data register Accessible size • Longwords access (SPDCR.SPLW = 1, SPBYTE = 0) • Words access (SPDCR.SPLW = 0, SPBYTE = 0) • Bytes access (SPDCR.SPBYT = 1)
SPDCR	SPBYT	—	RSPI byte access specification bit
SPCR2	SPPE	Parity enable bit 0: A parity bit is not added to transmit data, and no parity checking of receive data is performed. 1: A parity bit is added to transmit data, and parity checking of receive data is performed (when SPCR.TXMD = 0). A parity bit is added to transmit data, but no parity checking of receive data is performed (when SPCR.TXMD = 1).	Parity enable bit 0: A parity bit is not added to transmit data, and no parity checking of receive data is performed. 1: A parity bit is added to transmit data, and parity checking of receive data is performed.
SPDCR2	—	—	RSPI data control register 2

2.23 Capacitive Touch Sensing Unit

Table 2.54 is a comparative overview of the capacitive touch sensing units, and Table 2.55 is a comparison of capacitive touch sensing unit registers.

Table 2.54 Comparative Overview of Capacitive Touch Sensing Units

Item		RX231 (CTSUa)	RX140 (CTSU2SL, CTSU2L)
Operating clock		PCLK, PCLK/2, or PCLK/4	Selectable among PCLKB (1 MHz and above), PCLKB/2, or PCLKB/4, and PCLKB/8
I/O pins	Electrostatic capacitance measurement pins	Electrostatic capacitance measurement pins (24 channels)	Electrostatic capacitance measurement pins (36*1/12 channels)
	Measurement power supply capacitor connection pin	TSCAP	TSCAP (0.01 µF)
Measurement modes	Self-capacitance method	A single touch key is assigned to a single touch pin, and the electrostatic capacitance when in proximity to the human body is measured.	The electrostatic capacitance of pins is determined by measuring the current flow to a switched capacitor.
	Mutual capacitance method	The electrostatic capacitance between two electrodes facing each other (transmission electrode and reception electrode) is measured. • The transmission power supply can be switched between the internal logic power supply and VCC (dedicated).	The mutual capacitance between two pins is determined by measuring the current flow to a switched capacitor. • The transmission power supply can be switched among the internal logic power supply, I/O power supply, and VCC (dedicated).
	Current measurement mode	—	Direct reading of current flowing to pin
Scan modes	Single-scan mode	Electrostatic capacitance is measured on a user-defined channel.	Electrostatic capacitance is measured on one channel.
	Multi-scan mode	Electrostatic capacitance is measured on multiple user-defined channels successively.	Electrostatic capacitance is measured on multiple channels successively.
Noise prevention		Synchronous noise prevention, high-range noise prevention	• Sensor drive pulse spectrum diffusion function • Sensor drive pulse random phase shift function • Noise hopping function using multiple-frequency sensor drive pulses
Individual pin adjustments		• Offset current adjustment function • Specification of sensor drive pulse frequency • Specification of measurement duration	• Offset current adjustment function • Specification of sensor drive pulse frequency • Specification of measurement duration

Item	RX231 (CTSUa)	RX140 (CTSU2SL, CTSU2L)
Measurement start conditions	• Software trigger • External trigger (event input from event link controller (ELC))	• Software trigger • External trigger (event input from event link controller (ELC))
Automatic processing functions	—	• Automatic correction function*1 • Automatic determination function*1
Low-power functions	—	Ability to perform measurement in snooze mode • Measurement start by external trigger input via ELC • Ability to end snooze mode by contactless determination using automatic determination function*1 • Ability to cancel snooze mode by measurement end interrupt
Interrupt sources	• Channel-specific setting register write request interrupt (CTSUWR) • Measurement data transfer request interrupt (CTSURD) • Measurement end interrupt (CTSUFN)	• Register setting request interrupt (CTSUWR) • Measurement result read request interrupt (CTSURD) • Measurement end interrupt (CTSUFN)
Event link function	—	Measurement start trigger input

Note: 1. These functions are implemented on products with ROM capacity of 128 KB or greater.

Table 2.55 Comparison of Capacitive Touch Sensing Unit Registers

Register	Bit	RX231 (CTSUa)	RX140 (CTSU2SL, CTSU2L)
CTSUCR0, CTSUCR1 (RX231) CTSUCRA (RX140)	—	CTSU control register 0, CTSU control register 1 CTSUCR0 and CTSUCR1 are 8-bit registers.	CTSU control register A CTSUCRA is a 32-bit register.
	CTSUCR0.CTSUSTRT (RX231) STRT (RX140)	CTSU measurement operation start bit	Measurement operation start bit
	CTSUCR0.CTSUCAP (RX231) CAP (RX140)	CTSU measurement operation start trigger select bit	Measurement start trigger select bit
	CTSUCR0.CTSUSNZ (RX231) SNZ (RX140)	CTSU wait state power-saving enable bit	Snooze function enable bit
	CTSUCR0.CTSUIOC	CTSU transmit pin control bit	— (The CTSUCALIB.IOC bit performs the same function.)
	CTSUCR0.CTSUINIT (RX231) INIT (RX140)	CTSU control block initialization bit	Control block initialization bit
	TXVSEL[1:0] (RX140)	—	Transmission power supply select bit (b7 and b6) b7 b6 0 0: I/O power supply 0 1: VCC 1 0: Internal logic power supply 1 1: VCC
	CTSUCR1.CTSUPON (RX231) PON (RX140)	CTSU power supply enable bit (b0)	Measurement power supply enable bit (b8)
	CTSUCR1.CTSUCSW (RX231) CSW (RX140)	CTSU LPF capacitance charging control bit (b1)	LPF capacitance charging control bit (b9)
	CTSUCR1.CTSUATUNE0 (RX231) ATUNE0 (RX140)	CTSU power supply operating mode setting bit (b2)	Power supply operating mode setting bit (b10) Set this bit to 1 when the VCC voltage is less than 2.4 V.

Register	Bit	RX231 (CTSUa)	RX140 (CTSU2SL, CTSU2L)
CTSUCR0, CTSUCR1 (RX231) CTSUCRA (RX140)	CTSUCR1.CTSUATUNE1 (RX231) ATUNE1, ATUNE12 (RX140)	CTSU power supply capacity adjustment bit (b3) 0: Normal output 1: High-current output	Current range setting bit 1 (b11) Current range setting bit 2 (b17) ATUNE2 ATUNE1 0 0: 80 µA 0 1: 40 µA 0 0: 20 µA 1 1: 160 µA
	CTSUCR1.CTSUCLK[1:0] (RX231) CLK[1:0] (RX140)	CTSU operating clock select bits (b5 and b4) b5 b4 0 0: PCLK 0 1: PCLK/2 (PCLK divided by 2) 1 0: PCLK/4 (PCLK divided by 4) 1 1: Setting prohibited.	Operating clock select bits (b13 and b12) b13 b12 0 0: PCLKB 0 1: PCLKB/2 (PCLKB divided by 2) 1 0: PCLKB/4 (PCLKB divided by 4) 1 1: PCLKB/8 (PCLKB divided by 4)
	CTSUCR1.CTSUMD[1:0] (RX231) MD0, MD1 (RX140)	CTSU measurement mode select bits (b7 and b6) b7 b6 0 0: Self-capacitance single-scan mode 0 1: Self-capacitance multi-scan mode 1 0: Setting prohibited. 1 1: Mutual capacitance full-scan mode	Measurement mode select bits 0 and 1 (b15 and b14) b15 b14 0 0: Self-capacitance single-scan mode 0 1: Self-capacitance multi-scan mode 1 0: Mutual capacitance single-scan mode 1 1: Mutual capacitance multi-scan mode
	PUMPON	—	Step-up circuit activation bit Set this bit to 1 when the VCC voltage is less than 4.5 V.
	LOAD[1:0]	—	Measurement load control bits
	POSEL[1:0]	—	Non-measurement channel output select bits
	SDPSEL	—	Sensor drive panel select bit
	PCSEL	—	Step-up circuit clock select bit
	STCLK[5:0]	—	State clock select bits
	DCMODE	—	Current measurement mode select bit
	DCBACK	—	Current measurement feedback select bit

Register	Bit	RX231 (CTSUa)	RX140 (CTSU2SL, CTSU2L)
CTSUSDPRS, CTSUSST (RX231) CTSUCRB (RX140)	—	CTSU synchronous noise reduction setting register, CTSU sensor stabilization wait control register CTSUSDPRS and CTSUSST are 8-bit registers.	CTSU control register B CTSUCRB is a 32-bit register.
	CTSUSDPRS.CTSUPRRATIO[3:0] (RX231) PRRATIO (RX140)	CTSU measurement time and pulse count adjustment bits Recommended setting value: 3 (0011b)	Pseudorandom number update period setting bit*1 Sets the shift period of the linear feedback shift register (LFSR) used to generate pseudorandom numbers.
	CTSUSDPRS.CTSUPRMODE[1:0] (RX231) PRMODE (RX140)	CTSU base period and pulse count setting bits b5 b4 0 0: 510 pulses 0 1: 126 pulses 1 0: 62 pulses (recommended setting value) 1 1: Setting prohibited.	Pseudorandom number generation cycle setting bit*1 b5 b4 0 0: 255 cycles 0 1: 63 cycles 1 0: 31 cycles 1 1: 3 cycles
	CTSUSDPRS.CTSUSOFF (RX231) SOFF (RX140)	CTSU high-pass noise reduction function off setting bit	Frequency diffusion function off bit
	PROFF	—	Pseudorandom number off bit
	CTSUSST.CTSUSST[7:0] (RX231) SST[7:0] (RX140)	CTSU sensor stabilization wait control bits (b7 to b0) The value of these bits should be fixed at 0001 0000b.	Sensor stabilization wait time setting bits (b15 to b8) • Random pulse mode If n is defined as the setting value when (CTSUCRA.SDPSEL = 0), the stabilization wait time is 2 (n + 1) cycles of the PCLKB-synchronous sensor drive pulse. • High-resolution pulse mode If n is defined as the setting value when (CTSUCRA.SDPSEL = 1), the stabilization wait time is n + 1 cycles of STCLK.

Register	Bit	RX231 (CTSUa)	RX140 (CTSU2SL, CTSU2L)
CTSUSDPRS, CTSUSST (RX231) CTSUCRB (RX140)	SSMOD[2:0]	—	SUCLK diffusion mode select bits
	SSCNT[1:0]	—	SUCLK diffusion control bits
CTSUMCH0, CTSUMCH1 (RX231) CTSUMCH (RX140)	—	CTSU measurement channel register 0, CTSU measurement channel register 1 CTSUMCH0 and CTSUMCH1 are 8-bit registers.	CTSU measurement channel register CTSUMCHCTSUCRB is a 32-bit register.
	CTSUMCH0.CTSUMCH0 [5:0] (RX231) MCH0[5:0] (RX140)	CTSU measurement channel 0 bits (b5 to b0) • Self-capacitance single-scan mode b5 b0 0 0 0 0 0 0: TS0 : : 1 0 0 0 1 1: TS35 Other than above: Starting measurement operation (CTSUCR0.CTSUSTRT bit = 1) is prohibited after these bits are set. • Measurement modes other than self-capacitance single-scan mode b5 b0 0 0 0 0 0 0: TS0 : : 1 0 0 0 1 1: TS35 1 1 1 1 1 1: Measurement is stopped.	Measurement channel 0 bits (b5 to b0) • Single-scan mode Specifies the number of the receive channel to be measured. • Multi-scan mode Specifies the number of the receive channel currently being measured.
	CTSUMCH1.CTSUMCH1 [5:0] (RX231) MCH1[5:0] (RX140)	CTSU measurement channel 1 bits (b5 to b0) B5 b0 0 0 0 0 0 0: TS0 : : 1 0 0 0 1 1: TS35 1 1 1 1 1 1: Measurement is stopped.	Measurement channel 1 bits (b13 to b8) • Single-scan mode Specifies the number of the transmit channel to be measured. • Multi-scan mode Specifies the number of the transmit channel currently being measured.
	MCAn	—	Multi-clock n enable bit (n = 0 to 3)

Register	Bit	RX231 (CTSUa)	RX140 (CTSU2SL, CTSU2L)
CTSUCHACn (RX231) CTSUCHACx (RX140)	—	CTSU channel enable control register n (n = 0 to 4) CTSUCHACn is an 8-bit register.	CTSU channel enable control register x (x = A, B) CTSUCHACx is a 32-bit register.
	CTSUCHACnj (RX231) CHACm (RX140)	CTSU channel enable control nj bit (n = 0 to 4) (j = 0 to 7)	Channel m enable control bit (m = 0 to 35)
CTSUCHTRCn (RX231) CTSUCHTRCx (RX140)	—	CTSU channel transmit/ receive control register n (n = 0 to 4) CTSUCHTRCn is an 8-bit register.	CTSU channel transmit/ receive control register x (x = A, B) CTSUCHTRCA is a 32-bit register.
	CTSUCHTRCnj (RX231) CHTRCm (RX140)	CTSU channel transmit/ receive control nj bit (n = 0 to 4) (j = 0 to 7)	Channel m transmit/ receive control bit (m = 0 to 35)
CTSUDCLKC	CTSUSSMOD[1:0]	CTSU diffusion clock mode select bits	— (The CTSUCRB.SSMOD[2:0] bits perform the same function.)
	CTSUSSCNT[1:0]	CTSU diffusion clock control bits	— (The CTSUCRB.CTSUSSCNT [1:0] bits perform the same function.)
CTSUST (RX231) CTSUSR (RX140)	—	CTSU status register CTSUST is an 8-bit register.	CTSU status register CTSUSR is a 32-bit register.
	CTSUSTC[2:0] (RX231) STC[2:0] (RX140)	CTSU measurement status counter (b2 to b0)	Measurement status counter (b10 to b8)
	CTSUDTSR (RX231) DTSR (RX140)	CTSU data transfer status flag (b4)	Data transfer status flag (b12)
	CTSUSOVF (RX231) SOVF (RX140)	CTSU sensor counter overflow flag (b5)	Sensor counter overflow flag (b13)
	CTSUROVF (RX231) UCOVF (RX140)	CTSU reference counter overflow flag (b6)	Sensor unit clock counter overflow flag (b14)
	CTSUPS (RX231) PS (RX140)	CTSU mutual capacitance status flag (b7)	Mutual capacitance status flag (b15)
	MFC[1:0]	—	Multi-clock counter
	ICOMPRST	—	ICOMP0 and ICOMP1 flag reset bit
	ICOMP1	—	Overcurrent detection flag
	ICOMP0	—	Overvoltage detection flag
CTSUSSC	—	CTSU high-pass noise reduction spectrum diffusion control register	—

Register	Bit	RX231 (CTSUa)	RX140 (CTSU2SL, CTSU2L)
CTSUSO0, CTSUSO1 (RX231) CTSUSO (RX140)	—	CTSU sensor offset registers 0 and 1 CTSUSO0 and CTSUSO1 are 16-bit registers.	CTSU sensor offset register CTSUSO is a 32-bit register.
	CTSUSO0.CTSUSO[9:0] (RX231) SO[9:0] (RX140)	CTSU sensor offset adjustment bits	Sensor offset adjustment bits
	CTSUSO0.CTSUSNUM [5:0] (RX231) SNUM[7:0] (RX140)	CTSU measurement count setting bits (b15 to b10) These bits specify the number of measurements by the CTSU.	Measurement period setting bits (b17 to b10) • Random pulse mode (CTSUCRA.SDPSEL = 0) The CTSU measurement period is specified as the number of times the basic measurement unit is repeated. The allowable setting range is 00h to 3Fh. If the setting value is n, the basic measurement unit is repeated n + 1 times. • High-resolution pulse mode (CTSUCRA.SDPSEL = 1) The CTSU measurement period is based on STCLK cycles. If the setting value is n, measurement takes place for a period equal to 8 (n + 1) cycles of STCLK.
	CTSUSO1.CTSURICOA [7:0]	CTSU reference ICO current adjustment bits	—

Register	Bit	RX231 (CTSUa)	RX140 (CTSU2SL, CTSU2L)
CTSUSO0, CTSUSO1 (RX231) CTSUSO (RX140)	CTSUSO1.CTSUSDPA [4:0] (RX231) SDPA[7:0] (RX140)	CTSU base clock setting bits (b12 to b8) b12 b8 0 0 0 0 0: Operating clock divided by 2 0 0 0 0 1: Operating clock divided by 4 : : 1 1 1 1 0: Operating clock divided by 62 1 1 1 1 1: Operating clock divided by 64	Base clock setting bits (b31 to b24) • Random pulse mode (CTSUCRA.SDPSEL = 0) If the setting value is n, the base clock frequency is the operating clock divided by 2 (n + 1). • High-resolution pulse mode (CTSUCRA.SDPSEL = 1) If the setting value is n, the base clock frequency is n + 1 SUCLK cycles.
	CTSUSO1.CTSUICOG [1:0]	CTSUICO gain adjustment bits	—
	SSDIV[3:0]	—	Spectrum diffusion sampling cycle control bits
CTSURC	—	CTSU reference counter	—
CTSUERRS (RX231) CTSUCALIB (RX140)	—	CTSU error status register CTSUERRS is a 16-bit register.	CTSU calibration register CTSUCALIB is a 32-bit register.
	CTSUSPMD[1:0]	Calibration mode bits	—
	CTSUTSOD (RX231) TSOD (RX140)	TS pin fixed output bit	TS all-pin output control bit
	CTSUDRV (RX231) DRV (RX140)	Calibration setting bit 1	Calibration setting bit 1
	CTSUTSOC (RX231) TSOC (RX140)	Calibration setting bit 2	Calibration setting bit 2
	CTSUICOMP	TSCAP voltage error monitor bit	—
	CLKSEL[1:0]	—	Monitor clock select bits
	SUCLKEN	—	SUCLK enable bit
	IOC	—	Transmit pin control bit
	DCOFF	—	Down-convert off bit
	IOCSEL*2	—	TS pin IOC fixed select bit
	DACCARRY	—	DAC upper current source carry input
	SUCARRY	—	CCO carry input
	DACCLK	—	DAC modulation circuit clock select bit
	CCOCLK	—	CCO modulation circuit clock select bit
	CCOCALIB	—	CCO calibration mode select bit
	TXREV	—	Transit pin inverted output bit

Register	Bit	RX231 (CTSUa)	RX140 (CTSU2SL, CTSU2L)
CTSUSUCLKA	—	—	CTSU sensor unit clock control register A
CTSUSUCLKB	—	—	CTSU sensor unit clock control register B
CTSUTRIMA	—	—	CTSU trimming register A
CTSUTRIMB	—	—	CTSU trimming register B
CTSUOPT*2	—	—	CTSU option setting register
CTSUSCNTACT*2	—	—	CTSU sensor counter automatic correction table access register
CTSUAJCR*2	—	—	CTSU automatic judgment control register
CTSUAJTHR*2	—	—	CTSU threshold register
CTSUAJMMAR*2	—	—	CTSU moving average result register
CTSUAJBLACT*2	—	—	CTSU baseline average intermediate result register
CTSUAJBLAR*2	—	—	CTSU baseline average result register
CTSUAJRR*2	—	—	CTSU automatic judgment result register
CTSUADCC	—	—	CTSU A/D converter connection control register

Note: 1. Valid only when the value of the CTSUCRA.SDPSEL bit is 0 (random pulse mode).
Note: 2. These registers are implemented on products with ROM capacity of 128 KB or greater.

2.24 12-Bit A/D Converter

Table 2.56 is a comparative overview of the 12-bit A/D converters, and Table 2.57 is a comparison of 12-bit A/D converter registers.

Table 2.56 Comparative Overview of 12-Bit A/D Converters

Item	RX231 (S12ADE)	RX140 (S12ADE)
Number of units	1 unit	1 unit
Input channels	24 channels	18 channels
Extended analog function	Temperature sensor output, internal reference voltage	Temperature sensor output, internal reference voltage
A/D conversion method	Successive approximation method	Successive approximation method
Resolution	12 bits	12 bits
Conversion time	0.83 µs per channel (when A/D conversion clock ADCLK = 32 MHz)	Per channel Conversion cycle bit = 0: 0.88 µs, conversion cycle bit = 1: 0.67 µs (when A/D conversion clock (ADCLK) = 48 MHz)
A/D conversion clock	Peripheral module clock PCLK and A/D conversion clock ADCLK can be set so that the frequency ratio should be one of the following. PCLK to ADCLK frequency ratio = 1:1, 1:2, 2:1, 4:1, 8:1 ADCLK is set using the clock generation circuit.	Peripheral module clock PCLKB and A/D conversion clock ADCLK can be set so that the frequency ratio should be one of the following. PCLKB to ADCLK frequency ratio = 1:1, 1:2, 2:1, 4:1, 8:1 ADCLK is set using the clock generation circuit.
Data registers	• 24 registers for analog input and one for A/D-converted data duplication in double trigger mode • One register for temperature sensor output • One register for internal reference • One register for self-diagnosis • The results of A/D conversion are stored in 12-bit A/D data registers. • 12-bit accuracy output for the results of A/D conversion • The value obtained by adding up A/D-converted results is stored as a value in the number of bit for conversion accuracy + 2 bits/4 bits in the A/D data registers in A/D-converted value addition mode. • Double trigger mode (selectable in single scan and group scan modes): The first piece of A/D-converted analog-input data on one selected channel is stored in the data register for the channel, and the second piece is stored in the duplication register.	• 18 registers for analog input, one for A/D-converted data duplication in double trigger mode • One register for temperature sensor output • One register for internal reference • One register for self-diagnosis • The results of A/D conversion are stored in 12-bit A/D data registers. • 12-bit accuracy output for the results of A/D conversion • The value obtained by adding up A/D-converted results is stored as a value in the number of bit for conversion accuracy + 2 bits/4 bits in the A/D data registers in A/D-converted value addition mode. • Double trigger mode (selectable in single scan and group scan modes): The first piece of A/D-converted analog-input data on one selected channel is stored in the data register for the channel, and the second piece is stored in the duplication register.

Item	RX231 (S12ADE)	RX140 (S12ADE)
Operating modes	• Single scan mode: — A/D conversion is performed only once on the analog inputs of up to 24 channels arbitrarily selected. — A/D conversion is performed only once on the temperature sensor output. — A/D conversion is performed only once on the internal reference voltage. • Continuous scan mode: A/D conversion is performed repeatedly on the analog inputs of up to 24 channels arbitrarily selected. • Group scan mode: — Analog inputs of up to 24 arbitrarily selected channels are divided into group A and group B, and A/D conversion of the analog inputs selected on a group basis is performed only once. — Conversion start conditions (synchronous trigger) can be selected independently for group A and group B, allowing A/D conversion of the groups to start at different times. • Group scan mode (when group A is given priority): — If a group A trigger is input during A/D conversion on group B, A/D conversion on group B is stopped and A/D conversion is performed on group A. — Restart (rescan) of A/D conversion on group B after completion of A/D conversion on group A can be enabled.	• Single scan mode: — A/D conversion is performed only once on the analog inputs of up to 18 channels arbitrarily selected. — A/D conversion is performed only once on the temperature sensor output. — A/D conversion is performed only once on the internal reference voltage. • Continuous scan mode: A/D conversion is performed repeatedly on the analog inputs of up to 18 channels arbitrarily selected. • Group scan mode: — Analog inputs of up to 18 arbitrarily selected channels are divided into group A and group B, and A/D conversion of the analog inputs selected on a group basis is performed only once. — Conversion start conditions (synchronous trigger) can be selected independently for group A and group B, allowing A/D conversion of the groups to start at different times. • Group scan mode (when group A is given priority): — If a group A trigger is input during A/D conversion on group B, A/D conversion on group B is stopped and A/D conversion is performed on group A. — Restart (rescan) of A/D conversion on group B after completion of A/D conversion on group A can be enabled.
Conditions for A/D conversion start	• Software trigger • Synchronous trigger Trigger by the multi-function timer pulse unit (MTU), the event link controller (ELC), or the 16-bit timer pulse unit (TPU). • Asynchronous trigger A/D conversion can be triggered by the external trigger ADTRG0# pin.	• Software trigger • Synchronous trigger Trigger by the multi-function timer pulse unit (MTU) or event link controller (ELC) • Asynchronous trigger A/D conversion can be triggered by the external trigger ADTRG0# pin.

Item	RX231 (S12ADE)	RX140 (S12ADE)
Functions	• Variable sampling state count • Self-diagnosis of 12-bit A/D converter • Selectable A/D-converted value addition mode or average mode • Analog input disconnection detection function (discharge function/precharge function) • Double trigger mode (duplication of A/D conversion data) • Automatic clear function of A/D data registers • Compare function (window A and window B) 16 ring buffers when the compare function is used	• Variable sampling state count • Self-diagnosis of 12-bit A/D converter • Selectable A/D-converted value addition mode or average mode • Analog input disconnection detection function (discharge function/precharge function) • Double trigger mode (duplication of A/D conversion data) • Automatic clear function of A/D data registers • Compare function (window A and window B) • 16 ring buffers when the compare function is used
Interrupt sources	• In the modes except double trigger mode and group scan mode, A/D scan end interrupt request (S12ADI0) can be generated on completion of single scan. • In double trigger mode, A/D scan end interrupt request (S12ADI0) can be generated on completion of double scan. • In group scan mode, an A/D scan end interrupt request (S12ADI0) can be generated on completion of group A scan, whereas an A/D scan end interrupt request (GBADI) for group B can be generated on completion of group B scan. • When double trigger mode is selected in group scan mode, A/D scan end interrupt request (S12ADI0) can be generated on completion of double scan of group A, whereas A/D scan end interrupt request (GBADI) specially for group B can be generated on completion of group B scan. • The S12ADI and GBADI interrupts can activate the DMA controller (DMAC) and the data transfer controller (DTC).	• In the modes except double trigger mode and group scan mode, A/D scan end interrupt request (S12ADI0) can be generated on completion of single scan. • In double trigger mode, A/D scan end interrupt request (S12ADI0) can be generated on completion of double scan. • In group scan mode, an A/D scan end interrupt request (S12ADI0) can be generated on completion of group A scan, whereas an A/D scan end interrupt request (GBADI) for group B can be generated on completion of group B scan. • When double trigger mode is selected in group scan mode, A/D scan end interrupt request (S12ADI0) can be generated on completion of double scan of group A, whereas A/D scan end interrupt request (GBADI) specially for group B can be generated on completion of group B scan. • The S12ADI0 and GBADI interrupts can activate the data transfer controller (DTC).
Event link function	• An ELC event is generated on completion of scans other than group B scan in group scan mode. • An ELC event is generated on completion of group B scan in group scan mode. • An ELC event is generated on completion of all scans. • Scan can be started by a trigger output by the ELC. An ELC event is generated according to the event conditions of the window compare function in single scan mode.	• An ELC event is generated on completion of scans other than group B scan in group scan mode. • An ELC event is generated on completion of group B scan in group scan mode. • An ELC event is generated on completion of all scans. • Scan can be started by a trigger output by the ELC. • An ELC event is generated according to the event conditions of the window compare function in single scan mode.

Item	RX231 (S12ADE)	RX140 (S12ADE)
Low power consumption function	Ability to specify module stop state	Ability to specify module stop state

Table 2.57 Comparison of 12-Bit A/D Converter Registers

Register	Bit	RX231 (S12ADE)	RX140 (S12ADE)
ADDRy	—	A/D data register y (y = 0 to 7, 16 to 31)	A/D data register y (y = 0 to 8, 16 to 21, 24 to 26)
ADANSA0	ANSA008	—	A/D conversion channel select bit
ADANSA1	ANSA106, ANSA107, ANSA111 to ANSA115	A/D conversion channel select bits	—
ADANSB0	ANSB008	—	A/D conversion channel select bit
ADANSB1	ANSB106, ANSB107, ANSB111 to ANSB115	A/D conversion channel select bits	—
ADADS0	ADS008	—	A/D-converted value addition/ average channel select bit
ADADS1	ADS106, ADS107, ADS111 to ADS115	A/D-converted value addition/ average channel select bits	—
ADSSTRn	—	A/D sampling state register n (n = 0 to 7, L, T, O)	A/D sampling state register n (n = 0 to 8, L, T, O)
ADCMPANSR0	CMPCHA008	—	Compare window A channel select bit
ADCMPANSR1	CMPCHA106, CMPCHA107, CMPCHA111 to CMPCHA115	Compare window A channel select bits	—
ADCMPLR0	CMPLCHA008	—	Compare window A comparison condition select bit
ADCMPLR1	CMPLCHA106, CMPLCHA107, CMPLCHA111 to CMPLCHA115	Compare window A comparison condition select bits	—
ADCMPSR0	CMPSTCHA008	—	Compare window A flag
ADCMPSR1	CMPSTCHA106, CMPSTCHA107, CMPSTCHA111 to CMPSTCHA115	Compare window A flag	—

Register	Bit	RX231 (S12ADE)	RX140 (S12ADE)
ADHVREFCNT	HVSEL[1:0]	High-potential reference voltage select bits b1 b0 0 0: AVCC0 is selected as the high-potential reference voltage. 0 1: VREFH0 is selected as the high-potential reference voltage. Settings other than the above are prohibited.	High-potential reference voltage select bits b1 b0 0 0: AVCC0 is selected as the high-potential reference voltage. 0 1: VREFH0 is selected as the high-potential reference voltage. Settings other than the above are prohibited. On 32-pin package products, set these bits to 01b.
ADCMPBNSR	CMPCHB[5:0]	Compare window B channel select bits These bits select channels to be compared with the compare window B conditions. b5 b0 0 0 0 0 0 0: AN000 0 0 0 0 0 1: AN001 0 0 0 0 1 0: AN002 : : 0 0 0 1 1 0: AN006 0 0 0 1 1 1: AN007 0 1 0 0 0 0: AN016 0 1 0 0 0 1: AN017 : 0 1 0 1 0 1: AN021 0 1 0 1 1 0: AN022 0 1 0 1 1 1: AN023 0 1 1 0 0 0: AN024 0 1 1 0 0 1: AN025 0 1 1 0 1 0: AN026 0 1 1 0 1 1: AN027 0 1 1 1 0 0: AN028 0 1 1 1 0 1: AN029 0 1 1 1 1 0: AN030 0 1 1 1 1 1: AN031 1 0 0 0 0 0: Temperature sensor 1 0 0 0 0 1: Internal reference voltage Settings other than the above are prohibited.	Compare window B channel select bits These bits select channels to be compared with the compare window B conditions. b5 b0 0 0 0 0 0 0: AN000 0 0 0 0 0 1: AN001 0 0 0 0 1 0: AN002 : : 0 0 0 1 1 0: AN006 0 0 0 1 1 1: AN007 0 0 1 0 0 0: AN008 0 1 0 0 0 0: AN016 0 1 0 0 0 1: AN017 : 0 1 0 1 0 1: AN021 0 1 1 0 0 0: AN024 0 1 1 0 0 1: AN025 0 1 1 0 1 0: AN026 1 0 0 0 0 0: Temperature sensor 1 0 0 0 0 1: Internal reference voltage Settings other than the above are prohibited.
ADCCR	—	—	A/D conversion cycle control register

2.25 D/A Converter

Table 2.58 is a comparative overview of the D/A converters, and Table 2.59 is a comparison of D/A converter registers.

Table 2.58 Comparative Overview of D/A Converters

Item	RX231 (R12DAA)	RX140 (DAa)
Resolution	12 bits	8 bits
Output channels	2 channels	2 channels
Measure against interference between analog modules	Measure against interference between D/A and A/D converters: D/A converted data update timing is controlled by the 12-bit A/D converter synchronous D/A conversion enable signal output by the 12-bit A/D converter. This reduces degradation of A/D conversion accuracy due to interference by controlling the timing of the 12-bit D/A converter inrush current with the enable signal.	Measure against interference between D/A and A/D converters: D/A converted data update timing is controlled by the 12-bit A/D converter synchronous D/A conversion enable signal output by the 12-bit A/D converter. This reduces degradation of A/D conversion accuracy due to interference by controlling the timing of the 8-bit D/A converter inrush current with the enable signal.
Low power consumption function	Ability to transition to module stop state	Ability to transition to module stop state
Event link function (input)	Ability to start D/A conversion on channel 0 when an event signal is input	Ability to start D/A conversion on channel 0 when an event signal is input

Table 2.59 Comparison of D/A Converter Registers

Register	Bit	RX231 (R12DAA)	RX140 (DAa)
DAVREFCR	—	D/A VREF control register	—

2.26 Temperature Sensor

Table 2.60 is a comparison of temperature sensor registers.

Table 2.60 Comparison of Temperature Sensor Registers

Register	Bit	RX231 (TEMPSA)	RX140 (TEMPSA)
TSCDRH, TSCDRL (RX231) TSCDR (RX140)	—	Temperature sensor calibration data register	Temperature sensor calibration data register

2.27 Comparator B

Table 2.61 is a comparative overview of the comparator B modules, and Table 2.62 is a comparison of comparator B registers.

Table 2.61 Comparative Overview of Comparator B Modules

Item	RX231 (CMPBa)	RX140 (CMPBa)
Number of channels	2 channels × 2 units	2 channels × 1 unit
Analog input voltage	Voltage input to CMPBn pin (n = 0 to 3)	Voltage input to CMPBn pin (n = 0 or 1)
Reference input voltage	Voltage input to CVREFBn pin (n = 0 to 3) or internal reference voltage	Voltage input to CVREFBn pin (n = 0 or 1) or internal reference voltage
Comparison result	• Read from the CPBFLG.CPBnOUT flag (n = 0 to 3) • Ability to output comparison result to CMPOBn pin (n = 0 to 3).	• Read from the CPBFLG.CPBnOUT flag (n = 0 or 1) • Ability to output comparison result to CMPOBn pin (n = 0 or 1).
Interrupt request generation timing	• When comparator B0 comparison result changes • When comparator B1 comparison result changes • When comparator B2 comparison result changes • When comparator B3 comparison result changes	• When comparator B0 comparison result changes • When comparator B1 comparison result changes
Timing of event generation to ELC	• When comparator B0 comparison result changes • When comparator B0 or comparator B1 comparison result changes	• When comparator B0 comparison result changes • When comparator B0 or comparator B1 comparison result changes
Selectable functions	• Digital filter function Ability to specify whether or not the digital filter is applied and to select the sampling frequency • Window function Ability to specify whether or the window function is enabled or disabled (low-side reference (VRFL)) < CMPBn (n = 0 to 3) < high-side reference (VRFH)) • Reference input voltage Ability to select CVREFBn pin (n = 0 to 3) input or internal reference voltage (generated internally) • Comparator B response speed Ability to select high-speed or low-speed mode	• Digital filter function Ability to specify whether or not the digital filter is applied and to select the sampling frequency • Window function Ability to specify whether or the window function is enabled or disabled (VRFL < CMPBn (n = 0 or 1) < VRFH) • Reference input voltage Ability to select CVREFBn pin (n = 0 or 1) input or internal reference voltage (generated internally) • Comparator B response speed Ability to select high-speed or low-speed mode
Low power consumption function	Ability to specify module stop state	Ability to transition to module stop state

Table 2.62 Comparison of Comparator B Registers

Register	Bit	RX231 (CMPBa)	RX140 (CMPBa)
CPB1CNT1	—	Comparator B1 control register 1	—
CPB1CNT2	—	Comparator B1 control register 2	—
CPB1FLG	—	Comparator B1 flag register	—
CPB1INT	—	Comparator B1 interrupt control register	—
CPB1F	—	Comparator B1 filter select register	—
CPB1MD	—	Comparator B1 mode select register	—
CPB1REF	—	Comparator B1 reference input voltage select register	—
CPB1OCR	—	Comparator B1 output control register	—

2.28 RAM

Table 2.63 is a comparative overview of RAM.

Table 2.63 Comparative Overview of RAM

Item	RX231	RX140
RAM capacity	Max. 64 KB	Max. 64 KB
RAM address	• RAM capacity 64 KB RAM0: 0000 0000h to 0000 FFFFh • RAM capacity 32 KB RAM0: 0000 0000h to 0000 7FFFh	• RAM capacity 64 KB RAM0: 0000 0000h to 0000 FFFFh • RAM capacity 32 KB RAM0: 0000 0000h to 0000 7FFFh • RAM capacity 16 KB RAM0: 0000 0000h to 0000 3FFFh
Access	• Single-cycle access is possible for both reading and writing. • RAM can be enabled or disabled.	• Single-cycle access is possible for both reading and writing. • RAM can be enabled or disabled.
Low power consumption function	Ability to specify module stop state	Ability to specify module stop state

2.29 Flash Memory

Table 2.64 is a comparative overview of flash memory, and Table 2.65 is a comparison of flash memory registers.

Table 2.64 Comparative Overview of Flash Memory

Item	RX231	RX140 (FLASH)
Memory capacity	• User area: Up to 512 KB • Data area: 8 KB • Extra area: Stores the start-up area information, access window information, and unique ID	• User area: Up to 256 KB • Data area: Up to 8 KB • Extra area: Stores the start-up area information, access window information, and unique ID
Addresses	• Products with capacity of 512 KB FFF8 0000h to FFFF FFFFh • Products with capacity of 384 KB FFFA 0000h to FFFF FFFFh • Products with capacity of 256 KB FFFC 0000h to FFFF FFFFh • Products with capacity of 128 KB FFFE 0000h to FFFF FFFFh	• Products with capacity of 256 KB FFFC 0000h to FFFF FFFFh • Products with capacity of 128 KB FFFE 0000h to FFFF FFFFh • Products with capacity of 64 KB FFFF 0000h to FFFF FFFFh
Software commands	• The following software commands are implemented: Program, blank check, block erase, and all-block erase • The following commands are implemented for programming the extra area: Start-up area information program and access window information program	• The following software commands are implemented: Program, blank check, block erase, and all-block erase • The following commands are implemented for programming the extra area: Start-up area information program, access window protect, and access window information program
Value after erasure	• ROM: FFh • E2 DataFlash: FFh	• ROM: FFh • E2 DataFlash: FFh
Interrupt	An interrupt (FRDYI) is generated upon completion of software command processing or forced stop processing.	An interrupt (FRDYI) is generated upon completion of software command processing or forced stop processing.

Item	RX231	RX140 (FLASH)
On-board programming	• Boot mode (SCI interface) — Channel 1 of the serial communications interface (SCI1) is used for asynchronous communication. — The user area and data area can be programmed. • Boot mode (FINE interface) — The FINE interface is used. — The user area and data area can be programmed. • Boot mode (USB interface) — Channel 0 (USB0) of the USB 2.0 function module is used. — The user area and data area can be programmed. — The flash memory can be programmed in self-powered or bus-powered mode. — A personal computer can be connected using only a USB cable. • Self-programming (single-chip mode) — The user area and data area can be programmed using a flash programming routine in a user program.	• Boot mode (SCI interface) — Channel 1 of the serial communications interface (SCI1) is used for asynchronous communication. — The user area and data area can be programmed. • Boot mode (FINE interface) — The FINE interface is used. — The user area and data area can be programmed. • Self-programming (single-chip mode) — The user area and data area can be programmed using a flash programming routine in a user program.
Off-board programming	The user area and data area can be programmed using a flash programmer (serial programmer or parallel programmer) compatible with the MCU.	The user area and data area can be programmed using a flash programmer compatible with the MCU.
ID codes protection	• Connection with a serial programmer can be controlled using ID codes in boot mode. • Connection with an on-chip debugging emulator can be controlled using ID codes. • Connection with a parallel programmer can be controlled using ROM codes.	• Connection with a serial programmer can be controlled using ID codes in boot mode. • Connection with an on-chip debugging emulator can be controlled using ID codes.
Start-up program protection function	This function is used to safely program blocks 0 to 7.	This function is used to safely program blocks 0 to 7.
Area protection	During self-programming, this function enables programming only of specified blocks in the user area and disables programming of the other blocks.	During self-programming, this function enables programming only of specified blocks in the user area and disables programming of the other blocks.
Background operation (BGO) function	Programs in the ROM can run while the E2 DataFlash is being programmed.	Programs in the ROM can run while the E2 DataFlash is being programmed.

Table 2.65 Comparison of Flash Memory Registers

Register	Bit	RX231	RX140 (FLASH)
MEMWAITR	—	—	Memory wait cycle setting register
DFLWAITR	—	—	Data flash wait cycle setting register
FPMCR	FMS0, FMS1, FSM2 (RX231) FMS0, FMS1 (RX140)	Flash operating mode select bits 0, 1, and 2 FMS2 FMS1 FMS0 0 0 0: ROM/E2 DataFlash read mode 0 1 0: E2 DataFlash P/E mode 0 1 1: Discharge mode 1 1 0 1: ROM P/E mode 1 1 1: Discharge mode 2 Settings other than the above are prohibited.	Flash operating mode select bits 0 and 1 FMS1 FMS0 0 0: ROM/E2 DataFlash read mode 0 1: ROMP/E mode 1 0: E2 DataFlash P/E mode 1 1: Setting prohibited.
	LVPE	Low-voltage P/E mode enable bit	—
FISR	PCKA[4:0] (RX231) PCKA[5:0] (RX140)	Peripheral clock notification bits	Peripheral clock notification bits
FEXCR	CMD[2:0]	Software command setting bits b2 b0 0 0 1: Start-up area information program 0 1 0: Access window information program Settings other than the above are prohibited.	Software command setting bits b2 b0 0 0 1: Start-up area information program/access window protect 0 1 0: Access window information program Settings other than the above are prohibited.
FSCMR	AWPR	—	Access window protect flag
FAWSMR	—	Flash access window start address monitor register	Flash access window start address monitor register
		Initial value after a reset differs.	
FAWEMR	—	Flash access window end address monitor register	Flash access window end address monitor register
		Initial value after a reset differs.	

2.30 Packages

As indicated in Table 2.66, there are discrepancies in the package drawing codes and availability of some package types, and this should be borne in mind at the board design stage.

Table 2.66 Packages

Package Type	Renesas Code	
	RX231	**RX140**
100-pin LFQFP	○	×
100-pin TFLGA	○	×
80-pin LFQFP	×	○
64-pin LQFP	×	○
64-pin WFLGA	○	×
64-pin HWQFN	○	×
48-pin HWQFN	PWQN0048KB-A	PWQN0048KC-A
32-pin LQFP	×	○
32-pin HWQFN	×	○

○: Package available (Renesas code omitted); ×: Package not available

3. Comparison of Pin Functions

This section presents a comparative description of pin functions as well as a comparison of the pins for the power supply, clocks, and system control. Items that exist only on one group are indicated by **blue text**. Items that exists on both groups with different specifications are indicated by **red text**. **Black text** indicates there is no differences in the item's specifications between groups.

3.1 64-Pin Package

Table 3.1 is a comparative listing of the pin functions of 64-pin package products.

Table 3.1 Comparative Listing of 64-Pin Package Pin Functions

64-Pin LFQFP/ LQFP	RX231	RX140
1	P03/DA0	P03*1/DA0
2	VCL	VCL
3	MD/FINED	MD/PG7/FINED
4	XCIN	XCIN/PH7*3
5	XCOUT	XCOUT/PH6*3
6	RES#	RES#
7	XTAL/P37	XTAL/P37/IRQ4
8	VSS	VSS
9	EXTAL/P36	EXTAL/P36/IRQ2
10	VCC	VCC
11	UPSEL/P35/NMI	P35/NMI
12	VBATT	P32/MTIOC0C/TMO3/TXD6*3/SMOSI6*3/ SSDA6*3/TS0*3/IRQ2/RTCOUT
13	P31/MTIOC4D/TMCI2/RTCIC1/CTS1#/ RTS1#/SS1#/SSISCK0/IRQ1	P31/MTIOC4D/TMCI2/CTS1#/RTS1#/SS1#/ TS1*3/IRQ1
14	P30/MTIOC4B/TMRI3/POE8#/RTCIC0/ RXD1/SMISO1/SSCL1/AUDIO_MCLK/IRQ0/ CMPOB3	P30/MTIOC4B/TMRI3/POE8#/RXD1/ SMISO1/SSCL1/TS2*3/IRQ0
15	P27/MTIOC2B/TMCI3/SCK1/SSIWS0/TS2/ CVREFB3	P27/MTIOC2B/TMCI3/SCK1/TS3
16	P26/MTIOC2A/TMO1/TXD1/SMOSI1/ SSDA1/USB0_VBUSEN/SSIRXD0/TS3/ CMPB3	P26/MTIOC2A/TMO1/LPTO/TXD1/SMOSI1/ SSDA1/TS4
17	P17/MTIOC3A/MTIOC3B/TMO1/POE8#/ TIOCB0/TCLKD/SCK1/MISOA/SDA/ SSITXD0/IRQ7/CMPOB2	P17/MTIOC3A/MTIOC3B/TMO1/POE8#/ SCK1/MISOA/SDA0/IRQ7
18	P16/MTIOC3C/MTIOC3D/TMO2/TIOCB1/ TCLKC/RTCOUT/TXD1/SMOSI1/SSDA1/ MOSIA/SCL/USB0_VBUS/USB0_VBUSEN/ USB0_OVRCURB/IRQ6/ADTRG0#	P16/MTIOC3C/MTIOC3D/TMO2/TXD1/ SMOSI1/SSDA1/MOSIA/SCL0/IRQ6/ RTCOUT/ADTRG0#
19	P15/MTIOC0B/MTCLKB/TMCI2/TIOCB2/ TCLKB/RXD1/SMISO1/SSCL1/CRXD0/TS12/ IRQ5/CMPB2	P15/MTIOC0B/MTCLKB/TMCI2/RXD1/ SMISO1/SSCL1/CRXD0/TS5*3/IRQ5
20	P14/MTIOC3A/MTCLKA/TMRI2/TIOCB5/ TCLKA/CTS1#/RTS1#/SS1#/CTXD0/ USB0_OVRCURA/TS13/IRQ4/CVREFB2	P14/MTIOC3A/MTCLKA/TMRI2/CTS1#/ RTS1#/SS1#/CTXD0/TS6*3/IRQ4
21	VCC_USB*4/PH3*4/TMCI0*4	PH3/MTIOC4D/TMCI0/TS7*3
22	PH2*4/TMRI0*4/USB0_DM*4/IRQ1*4	PH2/MTIOC4C/TMRI0/TS8*3/IRQ1

64-Pin LFQFP/ LQFP	RX231	RX140
23	PH1*4/TMO0*4/USB0_DP*4/IRQ0*4	PH1/MTIOC3D/TMO0/TS9*3/IRQ0
24	VSS_USB*4/PH0*4/CACREF*4	PH0/MTIOC3B/TS10*3/CACREF
25	P55/MTIOC4D/TMO3/CRXD0/TS15	P55/MTIOC4A/MTIOC4D/TMO3/CRXD0/ TS11*3
26	P54/MTIOC4B/TMCI1/CTXD0/TS16	P54/MTIOC4B/TMCI1/CTXD0/TS12*3
27	UB/PC7/MTIOC3A/MTCLKB/TMO2/TXD8/ SMOSI8/SSDA8/MISOA/CACREF	PC7/MTIOC3A/MTCLKB/TMO2/LPTO/ TXD8*3/SMOSI8*3/SSDA8*3/MISOA/TS13/ CACREF
28	PC6/MTIOC3C/MTCLKA/TMCI2/RXD8/ SMISO8/SSCL8/MOSIA/USB0_EXICEN/ TS22	PC6/MTIOC3C/MTCLKA/TMCI2/RXD8*3/ SMISO8*3/SSCL8*3/MOSIA/TS14
29	PC5/MTIOC3B/MTCLKD/TMRI2/SCK8/ RSPCKA/USB0_ID/TS23	PC5/MTIOC0C/MTIOC3B/MTCLKD/TMRI2/ SCK8*3/RSPCKA/TS15
30	PC4/MTIOC3D/MTCLKC/TMCI1/POE0#/ SCK5/CTS8#/RTS8#/SS8#/SSLA0/SDHI_D1/ TSCAP	PC4/MTIOC0A/MTIOC3D/MTCLKC/TMCI1/ POE0#/SCK5/CTS8#*3/RTS8#*3/SS8#*3/ SSLA0/TSCAP
31	PC3/MTIOC4D/TCLKB/TXD5/SMOSI5/ SSDA5/IRTXD5/SDHI_D0/TS27	PC3/MTIOC4D/TXD5/SMOSI5/SSDA5/ TS16*3
32	PC2/MTIOC4B/TCLKA/RXD5/SMISO5/ SSCL5/SSLA3/IRRXD5/SDHI_D3/TS30	PC2/MTIOC4B/RXD5/SMISO5/SSCL5/ SSLA3/TS17*3
33	PB7/PC1/MTIOC3B/TIOCB5/TXD9/SMOSI9/ SSDA9/SDHI_D2	PB7/PC1*2/MTIOC3B/TXD9*3/SMOSI9*3/ SSDA9*3/TS18*3
34	PB6/PC0/MTIOC3D/TIOCA5/RXD9/SMISO9/ SSCL9/SDHI_D1	PB6/PC0*2/MTIOC3D/RXD9*3/SMISO9*3/ SSCL9*3/TS19*3
35	PB5/MTIOC2A/MTIOC1B/TMRI1/POE1#/ TIOCB4/SCK9/USB0_VBUS/SDHI_CD	PB5/MTIOC2A/MTIOC1B/TMRI1/POE1#/ SCK9*3/TS20*3
36	PB3/MTIOC0A/MTIOC4A/TMO0/POE3#/ TIOCD3/TCLKD/SCK6/SDHI_WP	PB3/MTIOC0A/MTIOC4A/TMO0/POE3#/ LPTO/SCK6*3/TS22*3
37	PB1/MTIOC0C/MTIOC4C/TMCI0/TIOCB3/ TXD6/SMOSI6/SSDA6/SDHI_CLK/IRQ4/ CMPOB1	PB1/MTIOC0C/MTIOC4C/TMCI0/TXD6*3/ SMOSI6*3/SSDA6*3/TS24*3/IRQ4/CMPOB1
38	VCC	VCC
39	PB0/MTIC5W/TIOCA3/RXD6/SMISO6/ SSCL6/RSPCKA/SDHI_CMD	PB0/MTIOC3D/MTIC5W/RXD6*3/SMISO6*3/ SSCL6*3/RSPCKA/TS25
40	VSS	VSS
41	PA6/MTIC5V/MTCLKB/TMCI3/POE2#/ TIOCA2/CTS5#/RTS5#/SS5#/MOSIA/ SSIWS0	PA6/MTIOC3D/MTIC5V/MTCLKB/TMCI3/ POE2#/CTS5#/RTS5#/SS5#/MOSIA/TS26*3
42	PA4/MTIC5U/MTCLKA/TMRI0/TIOCA1/ TXD5/SMOSI5/SSDA5/SSLA0/SSITXD0/ IRTXD5/IRQ5 /CVREFB1	PA4/MTIOC4C/MTIC5U/MTCLKA/TMRI0/ TXD5/SMOSI5/SSDA5/SSLA0/TS28/IRQ5/ CVREFB1
43	PA3/MTIOC0D/MTCLKD/TIOCD0/TCLKB/ RXD5/SMISO5/SSCL5/SSIRXD0/IRRXD5/ IRQ6 /CMPB1	PA3/MTIOC0D/MTIOC4D/MTIC5V/MTCLKD/ RXD5/SMISO5/SSCL5/TS29/IRQ6/CMPB1
44	PA1/MTIOC0B/MTCLKC/TIOCB0/SCK5/ SSLA2/SSISCK0	PA1/MTIOC0B/MTIOC3B/MTCLKC/SCK5/ SSLA2/TS31
45	PA0/MTIOC4A/TIOCA0/SSLA1/CACREF	PA0/MTIOC4A/SSLA1/TS32*3/CACREF
46	PE5/MTIOC4C/MTIOC2B/IRQ5/AN021/ CMPOB0	PE5/MTIOC4C/MTIOC2B/IRQ5/AN021/ CMPOB0

64-Pin LFQFP/ LQFP	RX231	RX140
47	PE4/MTIOC4D/MTIOC1A/AN020/CMPA2/ CLKOUT	PE4/MTIOC4D/MTIOC1A/MTIOC4A/TS33/ AN020/CMPA2/CLKOUT
48	PE3/MTIOC4B/POE8#/CTS12#/RTS12#/ SS12#/AUDIO_MCLK/AN019/CLKOUT	PE3/MTIOC1B/MTIOC4B/POE8#/CTS12#/ RTS12#/SS12#/TS34/AN019/CLKOUT
49	PE2/MTIOC4A/RXD12/RXDX12/SMISO12/ SSCL12/IRQ7/AN018/CVREFB0	PE2/MTIOC4A/RXD12/RXDX12/SMISO12/ SSCL12/TS35/IRQ7/AN018/CVREFB0
50	PE1/MTIOC4C/TXD12/TXDX12/SIOX12/ SMOSI12/SSDA12/AN017/CMPB0	PE1/MTIOC4C/TXD12/TXDX12/SIOX12/ SMOSI12/SSDA12/AN017/CMPB0
51	PE0/SCK12/AN016	PE0/SCK12/AN016
52	VREFL	P47*1/AN007
53	P46/AN006	P46*1/AN006
54	VREFH	P45*1/AN005
55	P44/AN004	P44*1/AN004
56	P43/AN003	P43*1/AN003
57	P42/AN002	P42*1/AN002
58	P41/AN001	P41*1/AN001
59	VREFL0	VREFL0/PJ7*1
60	P40/AN000	P40*1/AN000
61	VREFH0	VREFH0/PJ6*1
62	AVCC0	AVCC0
63	P05/DA1	P05*1/DA1
64	AVSS0	AVSS0/

Notes: 1. The power supply of the I/O buffer for these pins is AVCC0.
2. PC0 and PC1 are valid only when the port switching function is selected.
3. Not implemented on products with a ROM capacity of 64 KB.
4. PH0/CACREF, PH1/IRQ0/TMO0, PH2/IRQ1/TMRI0, and PH3/TMCI0 on the RX230. VSS_USB, USB0_DP, USB0_DM, and VCC_USB on the RX231.

3.2 48-Pin Package

Table 3.2 is a comparative listing of the pin functions of 48-pin package products.

Table 3.2 Comparative Listing of 48-Pin Package Pin Functions

48-Pin LFQFP/ HWQFN	RX231	RX140
1	VCL	VCL
2	MD/FINED	MD/PG7/FINED
3	RES#	RES#
4	XTAL/P37	XTAL/P37/IRQ4
5	VSS	VSS
6	EXTAL/P36	EXTAL/P36/IRQ2
7	VCC	VCC
8	UPSEL/P35/NMI	P35/NMI
9	P31/MTIOC4D/TMCI2/CTS1#/RTS1#/SS1#/ SSISCK0/IRQ1	P31/MTIOC4D/TMCI2/CTS1#/RTS1#/SS1#/ TS1*3/IRQ1
10	P30/MTIOC4B/TMRI3/POE8#/RXD1/ SMISO1/SSCL1/AUDIO_MCLK/IRQ0/ CMPOB3	P30/MTIOC4B/TMRI3/POE8#/RXD1/ SMISO1/SSCL1/TS2*3/IRQ0
11	P27/MTIOC2B/TMCI3/SCK1/SSIWS0/TS2/ CVREFB3	P27/MTIOC2B/TMCI3/SCK1/TS3
12	P26/MTIOC2A/TMO1/TXD1/SMOSI1/ SSDA1/USB0_VBUSEN/SSIRXD0/TS3/ CMPB3	P26/MTIOC2A/TMO1/LPTO/TXD1/SMOSI1/ SSDA1/TS4
13	P17/MTIOC3A/MTIOC3B/TMO1/POE8#/ TIOCB0/TCLKD/SCK1/MISOA/SDA/ SSITXD0/IRQ7/CMPOB2	P17/MTIOC3A/MTIOC3B/TMO1/POE8#/ SCK1/MISOA/SDA0/IRQ7
14	P16/MTIOC3C/MTIOC3D/TMO2/TIOCB1/ TCLKC/TXD1/SMOSI1/SSDA1/MOSIA/SCL/ USB0_VBUS/USB0_VBUSEN/ USB0_OVRCURB/IRQ6/ADTRG0#	P16/MTIOC3C/MTIOC3D/TMO2/TXD1/ SMOSI1/SSDA1/MOSIA/SCL0/IRQ6/ ADTRG0#/RTCOUT
15	P15/MTIOC0B/MTCLKB/TMCI2/TIOCB2/ TCLKB/RXD1/SMISO1/SSCL1/CRXD0/TS12/ IRQ5/CMPB2	P15/MTIOC0B/MTCLKB/TMCI2/RXD1/ SMISO1/SSCL1/CRXD0/TS5*3/IRQ5
16	P14/MTIOC3A/MTCLKA/TMRI2/TIOCB5/ TCLKA/CTS1#/RTS1#/SS1#/CTXD0/ USB0_OVRCURA/TS13/IRQ4/CVREFB2	P14/MTIOC3A/MTCLKA/TMRI2/CTS1#/ RTS1#/SS1#/CTXD0/TS6*3/IRQ4
17	VCC_USB*4/PH3*4/TMCI0*4	PH3/MTIOC4D/TMCI0/TS7*3
18	PH2*4/TMRI0*4/USB0_DM*4/IRQ1*4	PH2/MTIOC4C/TMRI0/TS8*3/IRQ1
19	PH1*4/TMO0*4/USB0_DP*4/IRQ0*4	PH1/MTIOC3D/TMO0/TS9*3/IRQ0
20	VSS_USB*4/PH0*4/CACREF*4	PH0/MTIOC3B/TS10*3/CACREF
21	UB/PC7/MTIOC3A/MTCLKB/TMO2/TXD8/ SMOSI8/SSDA8/MISOA/CACREF	PC7/MTIOC3A/TMO2/MTCLKB/LPTO/ TXD8*3/SMOSI8*3/SSDA8*3/MISOA/TS13/ CACREF
22	PC6/MTIOC3C/MTCLKA/TMCI2/RXD8/ SMISO8/SSCL8/MOSIA/USB0_EXICEN/ TS22	PC6/MTIOC3C/MTCLKA/TMCI2/RXD8*3/ SMISO8*3/SSCL8*3/MOSIA/TS14
23	PC5/MTIOC3B/MTCLKD/TMRI2/SCK8/ RSPCKA/USB0_ID/TS23	PC5/MTIOC0C/MTIOC3B/MTCLKD/TMRI2/ SCK8*3/RSPCKA/TS15

48-Pin LFQFP/ HWQFN	RX231	RX140
24	PC4/MTIOC3D/MTCLKC/TMCI1/POE0#/ SCK5/CTS8#/RTS8#/SS8#/SSLA0/TSCAP	PC4/MTIOC0A/MTIOC3D/MTCLKC/TMCI1/ POE0#/SCK5/CTS8#*3/RTS8#*3/SS8#*3/ SSLA0/TSCAP
25	PB5/PC3/MTIOC2A/MTIOC1B/TMRI1/ POE1#/TIOCB4/USB0_VBUS	PB5/PC3*1/MTIOC2A/MTIOC1B/TMRI1/ POE1#/TS20*3
26	PB3/PC2/MTIOC0A/MTIOC4A/TMO0/ POE3#/TIOCD3/TCLKD/SCK6	PB3/PC2*1/MTIOC0A/MTIOC4A/TMO0/ POE3#/LPTO/SCK6*3/TS22*3
27	PB1/PC1/MTIOC0C/MTIOC4C/TMCI0/ TIOCB3/TXD6/SMOSI6/SSDA6/IRQ4/ CMPOB1	PB1/PC1*1/MTIOC0C/MTIOC4C/TMCI0/ TXD6*3/SMOSI6*3/SSDA6*3/TS24*3/IRQ4/ CMPOB1
28	VCC	VCC
29	PB0/PC0/MTIC5W/TIOCA3/RXD6/SMISO6/ SSCL6/RSPCKA	PB0/PC0*1/MTIOC3D/MTIC5W/RXD6*3/ SMISO6*3/SSCL6*3/RSPCKA/TS25
30	VSS	VSS
31	PA6/MTIC5V/MTCLKB/TMCI3/POE2#/ TIOCA2/CTS5#/RTS5#/SS5#/MOSIA/ SSIWS0	PA6/MTIOC3D/MTIC5V/MTCLKB/TMCI3/ POE2#/CTS5#/RTS5#/SS5#/MOSIA/TS26*3
32	PA4/MTIC5U/MTCLKA/TMRI0/TIOCA1/ TXD5/SMOSI5/SSDA5/SSLA0/SSITXD0/ IRTXD5/IRQ5 /CVREFB1	PA4/MTIOC4C/MTIC5U/MTCLKA/TMRI0/ TXD5/SMOSI5/SSDA5/SSLA0/TS28/IRQ5/ CVREFB1
33	PA3/MTIOC0D/MTCLKD/TIOCD0/TCLKB/ RXD5/SMISO5/SSCL5/SSIRXD0/IRRXD5/ IRQ6 /CMPB1	PA3/MTIOC0D/MTIOC4D/MTIC5V/MTCLKD/ RXD5/SMISO5/SSCL5/TS29/IRQ6/CMPB1
34	PA1/MTIOC0B/MTCLKC/TIOCB0/SCK5/ SSLA2/SSISCK0	PA1/MTIOC0B/MTIOC3B/MTCLKC/SCK5/ SSLA2/TS31
35	PE4/MTIOC4D/MTIOC1A/AN020/CMPA2/ CLKOUT	PE4/MTIOC4D/MTIOC1A/MTIOC4A/TS33/ AN020/CMPA2/CLKOUT
36	PE3/MTIOC4B/POE8#/CTS12#/RTS12#/ AUDIO_MCLK/AN019/CLKOUT	PE3/MTIOC1B/MTIOC4B/POE8#/CTS12#/ RTS12#/TS34/AN019/CLKOUT
37	PE2/MTIOC4A/RXD12/RXDX12/SSCL12/ IRQ7/AN018/CVREFB0	PE2/MTIOC4A/RXD12/RXDX12/SSCL12/ TS35/IRQ7/AN018/CVREFB0
38	PE1/MTIOC4C/TXD12/TXDX12/SIOX12/ SSDA12/AN017/CMPB0	PE1/MTIOC4C/TXD12/TXDX12/SIOX12/ SSDA12/AN017/CMPB0
39	VREFL	P47*2/AN007
40	P46/AN006	P46*2/AN006
41	VREFH	P45*2/AN005
42	P42/AN002	P42*2/AN002
43	P41/AN001	P41*2/AN001
44	VREFL0	VREFL0/PJ7*2
45	P40/AN000	P40*2/AN000
46	VREFH0	VREFH0/PJ6*2
47	AVCC0	AVCC0
48	AVSS0	AVSS0

Notes: 1. PC0 to PC3 are valid only when the port switching function is selected.
2. The power supply of the I/O buffer for these pins is AVCC0.
3. Not implemented on products with a ROM capacity of 64 KB.
4. PH0/CACREF, PH1/IRQ0/TMO0, PH2/IRQ1/TMRI0, and PH3/TMCI0 on the RX230. VSS_USB, USB0_DP, USB0_DM, and VCC_USB on the RX231.

4. Important Information when Migrating Between MCUs

This section presents important information on differences between the RX140 Group and the RX231 Group. 4.1, Notes on Functional Design, presents information regarding the software.

4.1 Notes on Functional Design

Some software that runs on the RX231 Group is compatible with the RX140 Group. Nevertheless, appropriate caution must be exercised due to differences in aspects such as operation timing and electrical characteristics.

Software-related considerations regarding function settings that differ between the RX140 Group and RX231 Group are as follows:

For differences between modules and functions, refer to 2, Comparative Overview of Specifications. For further information, refer to the User's Manual: Hardware of each MCU group, listed in 5, Reference Documents.

4.1.1 Mode Setting Pins

The mode setting pins after reset cancellation are the MD pin only on the RX140 Group and the MD pin and UB pin on the RX231 Group.

4.1.2 PLL Circuit

The frequency multiplication factor of the PLL circuit can be set to ×4 to ×12 (in ×0.5 increments) on the RX140 Group and to ×4 or ×13.5 (in ×0.5 increments) on the RX231 Group. To use the PLL circuit, change the setting of the PLLCR.STC bits to an appropriate value.

4.1.3 Port Direction Register (PDR) Initialization

PDR register initialization differs even between products with the same pin count.

5. Reference Documents

User's Manual: Hardware

RX230 Group, RX231 Group User's Manual: Hardware Rev.1.20 (R01UH0496EJ0120)
(The latest version can be downloaded from the Renesas Electronics website.)

RX140 Group User's Manual: Hardware Rev.1.10 (R01UH0905EJ0110)
(The latest version can be downloaded from the Renesas Electronics website.)

Technical Update/Technical News

(The latest information can be downloaded from the Renesas Electronics website.)

Related Technical Updates

This module reflects the content of the following technical updates:

TN-RX*-A0237B/E

TN-RX*-A0227A/E

TN-RX*-A0224B/E

TN-RX*-A0217A/E

TN-RX*-A0214A/E

TN-RX*-A0198B/E

TN-RX*-A0147B/E

TN-RX*-A198A/E

TN-RX*-A168A/E

TN-RX*-A0258A/E

Revision History

Rev.	Date	Description	
		Page	Summary
1.00	Aug. 30, 2021	—	First edition issued
1.10	Feb. 21, 2022	18	*Revised:* Table 2.10 Comparison of Clock Generation Circuit Registers
		35	*Revised:* Table 2.24 Comparative Overview of I/O Ports (64-Pin)
		83	*Revised:* Table 2.55 Comparison of Capacitive Touch Sensing Unit Registers
		98	*Revised:* Table 3.1 Comparative Listing of 64-Pin Package Pin Functions

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.

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