Renesas Electronics America Inc - R5F2136ACNFA#50 Datasheet

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Applications of "Embedded - Microcontrollers"

Details	
Product Status	Active
Core Processor	R8C
Core Size	16-Bit
Speed	20MHz
Connectivity	I²C, LINbus, SIO, SSU, UART/USART
Peripherals	POR, PWM, Voltage Detect, WDT
Number of I/O	59
Program Memory Size	96KB (96K x 8)
Program Memory Type	FLASH
EEPROM Size	4K x 8
RAM Size	8K x 8
Voltage - Supply (Vcc/Vdd)	1.8V ~ 5.5V
Data Converters	A/D 12x10b; D/A 2x8b
Oscillator Type	Internal
Operating Temperature	-20°C ~ 85°C (TA)
Mounting Type	Surface Mount
Package / Case	64-LQFP
Supplier Device Package	64-LQFP (14x14)
Purchase URL	https://www.e-xfl.com/product-detail/renesas-electronics-america/r5f2136acnfa-50

1.1.2 Specifications

Tables 1.1 and 1.2 outline the Specifications for R8C/36C Group.

Table 1.1 Specifications for R8C/36C Group (1)

Item	Function	Specification
CPU	Central processing unit	R8C CPU core • Number of fundamental instructions: 89 • Minimum instruction execution time: 50 ns (f(XIN) = 20 MHz, VCC = 2.7 to 5.5 V) 200 ns (f(XIN) = 5 MHz, VCC = 1.8 to 5.5 V) • Multiplier: 16 bits × 16 bits → 32 bits • Multiply-accumulate instruction: 16 bits × 16 bits + 32 bits → 32 bits • Operation mode: Single-chip mode (address space: 1 Mbyte)
Memory	ROM, RAM, Data flash	Refer to **Table 1.3 Product List for R8C/36C Group**
Power Supply Voltage Detection	Voltage detection circuit	• Power-on reset • Voltage detection 3 (detection level of voltage detection 0 and voltage detection 1 selectable)
I/O Ports	Programmable I/O ports	• Input-only: 1 pin • CMOS I/O ports: 59, selectable pull-up resistor • High current drive ports: 59
Clock	Clock generation circuits	• 4 circuits: XIN clock oscillation circuit, XCIN clock oscillation circuit (32 kHz), High-speed on-chip oscillator (with frequency adjustment function), Low-speed on-chip oscillator • Oscillation stop detection: XIN clock oscillation stop detection function • Frequency divider circuit: Dividing selectable 1, 2, 4, 8, and 16 • Low power consumption modes: Standard operating mode (high-speed clock, low-speed clock, high-speed on-chip oscillator, low-speed on-chip oscillator), wait mode, stop mode
		Real-time clock (timer RE)
Interrupts		• Interrupt Vectors: 69 • External: 9 sources ($\overline{\text{INT}}$ × 5, key input × 4) • Priority levels: 7 levels
Watchdog Timer		• 14 bits × 1 (with prescaler) • Reset start selectable • Low-speed on-chip oscillator for watchdog timer selectable
DTC (Data Transfer Controller)		• 1 channel • Activation sources: 39 • Transfer modes: 2 (normal mode, repeat mode)
Timer	Timer RA	8 bits × 1 (with 8-bit prescaler) Timer mode (period timer), pulse output mode (output level inverted every period), event counter mode, pulse width measurement mode, pulse period measurement mode
	Timer RB	8 bits × 1 (with 8-bit prescaler) Timer mode (period timer), programmable waveform generation mode (PWM output), programmable one-shot generation mode, programmable wait one-shot generation mode
	Timer RC	16 bits × 1 (with 4 capture/compare registers) Timer mode (input capture function, output compare function), PWM mode (output 3 pins), PWM2 mode (PWM output pin)
	Timer RD	16 bits × 2 (with 4 capture/compare registers) Timer mode (input capture function, output compare function), PWM mode (output 6 pins), reset synchronous PWM mode (output three-phase waveforms (6 pins), sawtooth wave modulation), complementary PWM mode (output three-phase waveforms (6 pins), triangular wave modulation), PWM3 mode (PWM output 2 pins with fixed period)

Table 1.4 Product List for R8C/36C Group (2) Current of Nov 2010

Part No.	ROM Capacity		RAM Capacity	Package Type	Remarks	
	Program ROM	Data flash				
R5F21364CDFP	16 Kbytes	1 Kbyte × 4	1.5 Kbytes	PLQP0064KB-A	D version	
R5F21365CDFP	24 Kbytes	1 Kbyte × 4	2 Kbytes	PLQP0064KB-A		
R5F21366CDFP	32 Kbytes	1 Kbyte × 4	2.5 Kbytes	PLQP0064KB-A		
R5F21367CDFP	48 Kbytes	1 Kbyte × 4	4 Kbytes	PLQP0064KB-A		
R5F21368CDFP	64 Kbytes	1 Kbyte × 4	6 Kbytes	PLQP0064KB-A		
R5F2136ACDFP	96 Kbytes	1 Kbyte × 4	8 Kbytes	PLQP0064KB-A		
R5F2136CCDFP	128 Kbytes	1 Kbyte × 4	10 Kbytes	PLQP0064KB-A		
R5F21364CDFA	16 Kbytes	1 Kbyte × 4	1.5 Kbytes	PLQP0064GA-A		
R5F21365CDFA	24 Kbytes	1 Kbyte × 4	2 Kbytes	PLQP0064GA-A		
R5F21366CDFA	32 Kbytes	1 Kbyte × 4	2.5 Kbytes	PLQP0064GA-A		
R5F21367CDFA	48 Kbytes	1 Kbyte × 4	4 Kbytes	PLQP0064GA-A		
R5F21368CDFA	64 Kbytes	1 Kbyte × 4	6 Kbytes	PLQP0064GA-A		
R5F2136ACDFA	96 Kbytes	1 Kbyte × 4	8 Kbytes	PLQP0064GA-A		
R5F2136CCDFA	128 Kbytes	1 Kbyte × 4	10 Kbytes	PLQP0064GA-A		
R5F21364CDFB (D)	16 Kbytes	1 Kbyte × 4	1.5 Kbytes	PTQP0064LB-A		
R5F21365CDFB (D)	24 Kbytes	1 Kbyte × 4	2 Kbytes	PTQP0064LB-A		
R5F21366CDFB (D)	32 Kbytes	1 Kbyte × 4	2.5 Kbytes	PTQP0064LB-A		
R5F21367CDFB (D)	48 Kbytes	1 Kbyte × 4	4 Kbytes	PTQP0064LB-A		
R5F21368CDFB (D)	64 Kbytes	1 Kbyte × 4	6 Kbytes	PTQP0064LB-A		
R5F2136ACDFB (D)	96 Kbytes	1 Kbyte × 4	8 Kbytes	PTQP0064LB-A		
R5F2136CCDFB (D)	128 Kbytes	1 Kbyte × 4	10 Kbytes	PTQP0064LB-A		
R5F21364CDXXXFP	16 Kbytes	1 Kbyte × 4	1.5 Kbytes	PLQP0064KB-A	N version	Factory programming product
R5F21365CDXXXFP	24 Kbytes	1 Kbyte × 4	2 Kbytes	PLQP0064KB-A		
R5F21366CDXXXFP	32 Kbytes	1 Kbyte × 4	2.5 Kbytes	PLQP0064KB-A		
R5F21367CDXXXFP	48 Kbytes	1 Kbyte × 4	4 Kbytes	PLQP0064KB-A		
R5F21368CDXXXFP	64 Kbytes	1 Kbyte × 4	6 Kbytes	PLQP0064KB-A		
R5F2136ACDXXXFP	96 Kbytes	1 Kbyte × 4	8 Kbytes	PLQP0064KB-A		
R5F2136CCDXXXFP	128 Kbytes	1 Kbyte × 4	10 Kbytes	PLQP0064KB-A		
R5F21364CDXXXFA	16 Kbytes	1 Kbyte × 4	1.5 Kbytes	PLQP0064GA-A		
R5F21365CDXXXFA	24 Kbytes	1 Kbyte × 4	2 Kbytes	PLQP0064GA-A		
R5F21366CDXXXFA	32 Kbytes	1 Kbyte × 4	2.5 Kbytes	PLQP0064GA-A		
R5F21367CDXXXFA	48 Kbytes	1 Kbyte × 4	4 Kbytes	PLQP0064GA-A		
R5F21368CDXXXFA	64 Kbytes	1 Kbyte × 4	6 Kbytes	PLQP0064GA-A		
R5F2136ACDXXXFA	96 Kbytes	1 Kbyte × 4	8 Kbytes	PLQP0064GA-A		
R5F2136CCDXXXFA	128 Kbytes	1 Kbyte × 4	10 Kbytes	PLQP0064GA-A		
R5F21364CDXXXFB (D)	16 Kbytes	1 Kbyte × 4	1.5 Kbytes	PTQP0064LB-A		
R5F21365CDXXXFB (D)	24 Kbytes	1 Kbyte × 4	2 Kbytes	PTQP0064LB-A		
R5F21366CDXXXFB (D)	32 Kbytes	1 Kbyte × 4	2.5 Kbytes	PTQP0064LB-A		
R5F21367CDXXXFB (D)	48 Kbytes	1 Kbyte × 4	4 Kbytes	PTQP0064LB-A		
R5F21368CDXXXFB (D)	64 Kbytes	1 Kbyte × 4	6 Kbytes	PTQP0064LB-A		
R5F2136ACDXXXFB (D)	96 Kbytes	1 Kbyte × 4	8 Kbytes	PTQP0064LB-A		
R5F2136CCDXXXFB (D)	128 Kbytes	1 Kbyte × 4	10 Kbytes	PTQP0064LB-A		

(D): Under development

Note:

1. The user ROM is programmed before shipment.

1.3 Block Diagram

Figure 1.2 shows a Block Diagram.

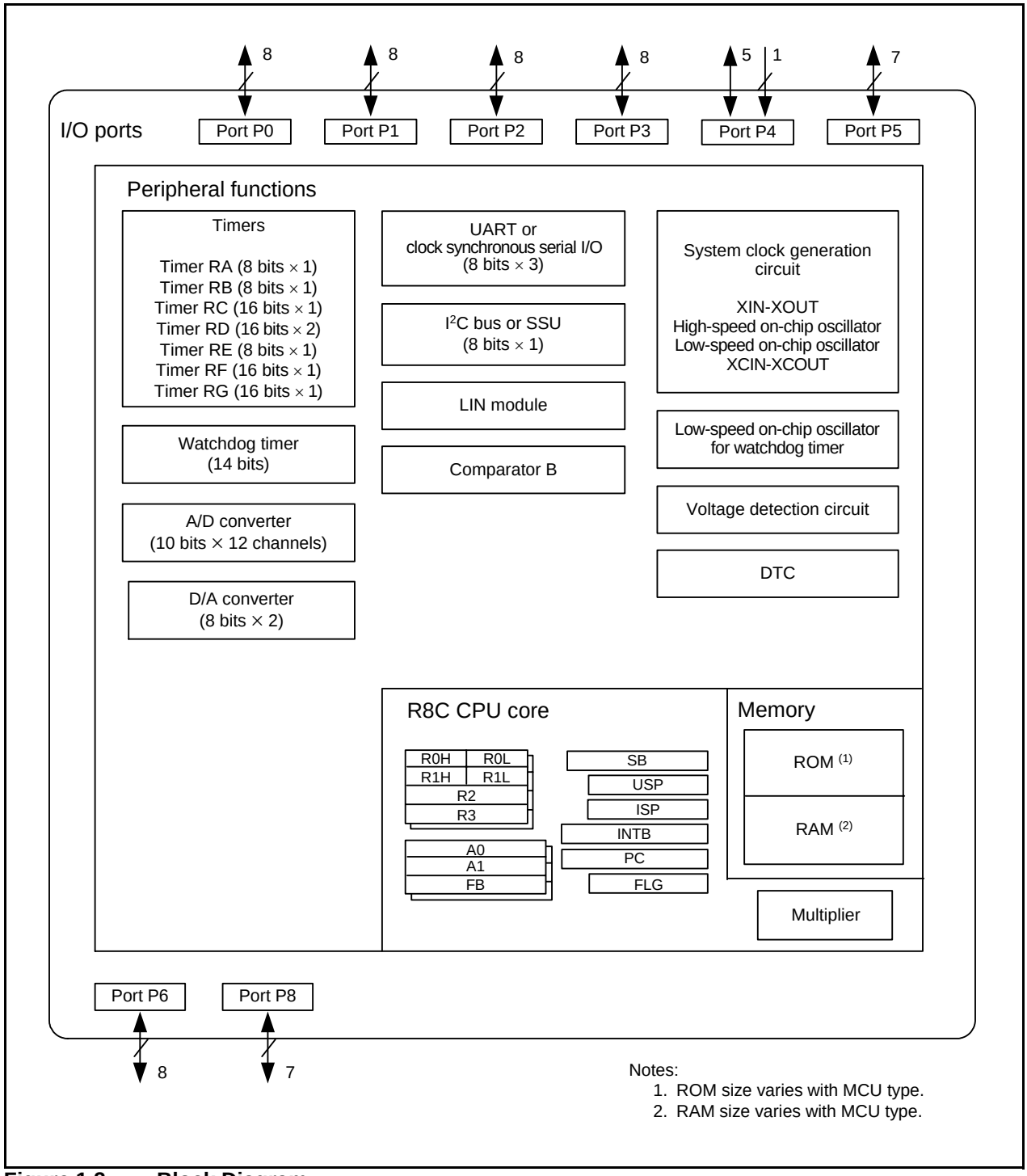


Figure 1.2 Block Diagram

Table 1.5 Pin Name Information by Pin Number (1)

Pin Number	Control Pin	Port	I/O Pin Functions for Peripheral Modules					
			Interrupt	Timer	Serial Interface	SSU	I^2C bus	A/D Converter, D/A Converter, Comparator B
1		P3_0		(TRAO/TRGCLKA)				
2		P4_2						VREF
3	MODE							
4	(XCIN)	P4_3						
5	(XCOUT)	P4_4						
6	$\overline{\text{RESET}}$							
7	$\overline{\text{XOUT}}$	P4_7						
8	VSS/AVSS							
9	XIN	P4_6						
10	VCC/AVCC							
11		P5_4		(TRCIOD)				
12		P5_3		(TRCIOC)				
13		P5_2		(TRCIOB)				
14		P5_1		(TRCIOA/TRCTRG)				
15		P5_0		(TRCCLK)				
16		P3_7		TRAO	(TXD2/SDA2/ RXD2/SCL2)	SSO	SDA	
17		P3_5		(TRCIOD)	(CLK2)	SSCK	SCL	
18		P3_4		(TRCIOC)	(TXD2/SDA2/ RXD2/SCL2)	SSI		IVREF3
19		P3_3	$\overline{\text{INT3}}$	(TRCCLK)	($\overline{\text{CTS2}}$/$\overline{\text{RTS2}}$)	$\overline{\text{SCS}}$		IVCMP3
20		P2_7		(TRDIOD1)				
21		P2_6		(TRDIOC1)				
22		P2_5		(TRDIOB1)				
23		P2_4		(TRDIOA1)				
24		P2_3		(TRDIOD0)				
25		P2_2		(TRCIOD/TRDIOB0)				
26		P2_1		(TRCIOC/TRDIOC0)				
27		P2_0	($\overline{\text{INT1}}$)	(TRCIOB/TRDIOA0/ TRDCLK)				
28		P3_6	($\overline{\text{INT1}}$)					
29		P3_1		(TRBO)				
30		P8_6						
31		P8_5		(TRFO12)				
32		P8_4		(TRFO11)				
33		P8_3		(TRFI/TRFO10)				
34		P8_2		(TRFO02)				
35		P8_1		(TRFO01)				
36		P8_0		(TRFO00)				
37		P6_7	($\overline{\text{INT3}}$)	(TRCIOD)				
38		P6_6	$\overline{\text{INT2}}$	(TRCIOC)	(TXD2/SDA2)			
39		P6_5	$\overline{\text{INT4}}$	(TRCIOB)	(CLK2/CLK1)			

Note:
1. Can be assigned to the pin in parentheses by a program.

Table 1.8 Pin Functions (2)

Item	Pin Name	I/O Type	Description
SSU	SSI	I/O	Data I/O pin.
	$\overline{SCS}$	I/O	Chip-select signal I/O pin.
	SSCK	I/O	Clock I/O pin.
	SSO	I/O	Data I/O pin.
I^2C bus	SCL	I/O	Clock I/O pin
	SDA	I/O	Data I/O pin
Reference voltage input	VREF	I	Reference voltage input pin to A/D converter.
A/D converter	AN0 to AN11	I	Analog input pins to A/D converter.
	$\overline{ADTRG}$	I	AD external trigger input pin.
D/A converter	DA0, DA1	O	D/A converter output pins.
Comparator B	IVCMP1, IVCMP3	I	Comparator B analog voltage input pins.
	IVREF1, IVREF3	I	Comparator B reference voltage input pins.
I/O port	P0_0 to P0_7, P1_0 to P1_7, P2_0 to P2_7, P3_0 to P3_7, P4_3 to P4_7, P5_0 to P5_4, P5_6, P5_7, P6_0 to P6_7, P8_0 to P8_6	I/O	CMOS I/O ports. Each port has an I/O select direction register, allowing each pin in the port to be directed for input or output individually. Any port set to input can be set to use a pull-up resistor or not by a program.
Input port	P4_2	I	Input-only port.

I: Input O: Output I/O: Input and output

2.1 Data Registers (R0, R1, R2, and R3)

R0 is a 16-bit register for transfer, arithmetic, and logic operations. The same applies to R1 to R3. R0 can be split into high-order bits (R0H) and low-order bits (R0L) to be used separately as 8-bit data registers. R1H and R1L are analogous to R0H and R0L. R2 can be combined with R0 and used as a 32-bit data register (R2R0). R3R1 is analogous to R2R0.

2.2 Address Registers (A0 and A1)

A0 is a 16-bit register for address register indirect addressing and address register relative addressing. It is also used for transfer, arithmetic, and logic operations. A1 is analogous to A0. A1 can be combined with A0 and as a 32-bit address register (A1A0).

2.3 Frame Base Register (FB)

FB is a 16-bit register for FB relative addressing.

2.4 Interrupt Table Register (INTB)

INTB is a 20-bit register that indicates the starting address of an interrupt vector table.

2.5 Program Counter (PC)

PC is 20 bits wide and indicates the address of the next instruction to be executed.

2.6 User Stack Pointer (USP) and Interrupt Stack Pointer (ISP)

The stack pointers (SP), USP and ISP, are each 16 bits wide. The U flag of FLG is used to switch between USP and ISP.

2.7 Static Base Register (SB)

SB is a 16-bit register for SB relative addressing.

2.8 Flag Register (FLG)

FLG is an 11-bit register indicating the CPU state.

2.8.1 Carry Flag (C)

The C flag retains carry, borrow, or shift-out bits that have been generated by the arithmetic and logic unit.

2.8.2 Debug Flag (D)

The D flag is for debugging only. Set it to 0.

2.8.3 Zero Flag (Z)

The Z flag is set to 1 when an arithmetic operation results in 0; otherwise to 0.

2.8.4 Sign Flag (S)

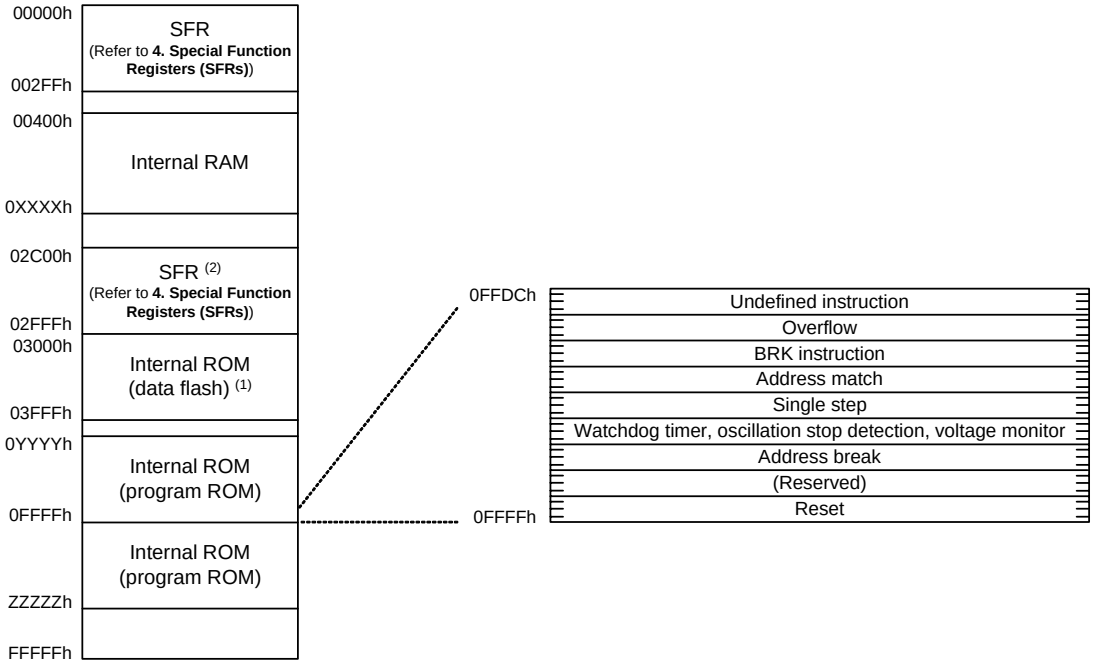
The S flag is set to 1 when an arithmetic operation results in a negative value; otherwise to 0.

2.8.5 Register Bank Select Flag (B)

Register bank 0 is selected when the B flag is 0. Register bank 1 is selected when this flag is set to 1.

2.8.6 Overflow Flag (O)

The O flag is set to 1 when an operation results in an overflow; otherwise to 0.



Notes:
1. The data flash indicates block A (1 Kbyte), block B (1 Kbyte), block C (1 Kbyte), and block D (1 Kbyte).
2. The SFR areas for the DTC and other modules are allocated to addresses 02C00h to 02FFFh.
3. The blank areas are reserved and cannot be accessed by users.

Part Number	Internal ROM			Internal RAM	
	Size	Address 0YYYYh	Address ZZZZZh	Size	Address 0XXXXh
R5F21364CNFP, R5F21364CDFP, R5F21364CNFA, R5F21364CDFA, R5F21364CNFB, R5F21364CDFB, R5F21364CNXXXFP, R5F21364CDXXXFP, R5F21364CNXXXFA, R5F21364CDXXXFA, R5F21364CNXXXFB, R5F21364CDXXXFB	16 Kbytes	0C000h	–	1.5 Kbytes	009FFh
R5F21365CNFP, R5F21365CDFP, R5F21365CNFA, R5F21365CDFA, R5F21365CNFB, R5F21365CDFB, R5F21365CNXXXFP, R5F21365CDXXXFP, R5F21365CNXXXFA, R5F21365CDXXXFA, R5F21365CNXXXFB, R5F21365CDXXXFB	24 Kbytes	0A000h	–	2 Kbytes	00BFFh
R5F21366CNFP, R5F21366CDFP, R5F21366CNFA, R5F21366CDFA, R5F21366CNFB, R5F21366CDFB, R5F21366CNXXXFP, R5F21366CDXXXFP, R5F21366CNXXXFA, R5F21366CDXXXFA, R5F21366CNXXXFB, R5F21366CDXXXFB	32 Kbytes	08000h	–	2.5 Kbytes	00DFFh
R5F21367CNFP, R5F21367CDFP, R5F21367CNFA, R5F21367CDFA, R5F21367CNFB, R5F21367CDFB, R5F21367CNXXXFP, R5F21367CDXXXFP, R5F21367CNXXXFA, R5F21367CDXXXFA, R5F21367CNXXXFB, R5F21367CDXXXFB	48 Kbytes	04000h	–	4 Kbytes	013FFh
R5F21368CNFP, R5F21368CDFP, R5F21368CNFA, R5F21368CDFA, R5F21368CNFB, R5F21368CDFB, R5F21368CNXXXFP, R5F21368CDXXXFP, R5F21368CNXXXFA, R5F21368CDXXXFA, R5F21368CNXXXFB, R5F21368CDXXXFB	64 Kbytes	04000h	13FFFh	6 Kbytes	01BFFh
R5F2136ACNFP, R5F2136ACDFP, R5F2136ACNFA, R5F2136ACDFA, R5F2136ACNFB, R5F2136ACDFB, R5F2136ACNXXXFP, R5F2136ACDXXXFP, R5F2136ACNXXXFA, R5F2136ACDXXXFA, R5F2136ACNXXXFB, R5F2136ACDXXXFB	96 Kbytes	04000h	1BFFFh	8 Kbytes	023FFh
R5F2136CCNFP, R5F2136CCDFP, R5F2136CCNFA, R5F2136CCDFA, R5F2136CCNFB, R5F2136CCDFB, R5F2136CCNXXXFP, R5F2136CCDXXXFP, R5F2136CCNXXXFA, R5F2136CCDXXXFA, R5F2136CCNXXXFB, R5F2136CCDXXXFB	128 Kbytes	04000h	23FFFh	10 Kbytes	02BFFh

Figure 3.1 Memory Map of R8C/36C Group

Table 4.10 SFR Information (10) (1)

Address	Register	Symbol	After Reset
2C70h	DTC Control Data 6	DTCD6	XXh
2C71h			XXh
2C72h			XXh
2C73h			XXh
2C74h			XXh
2C75h			XXh
2C76h			XXh
2C77h			XXh
2C78h	DTC Control Data 7	DTCD7	XXh
2C79h			XXh
2C7Ah			XXh
2C7Bh			XXh
2C7Ch			XXh
2C7Dh			XXh
2C7Eh			XXh
2C7Fh			XXh
2C80h	DTC Control Data 8	DTCD8	XXh
2C81h			XXh
2C82h			XXh
2C83h			XXh
2C84h			XXh
2C85h			XXh
2C86h			XXh
2C87h			XXh
2C88h	DTC Control Data 9	DTCD9	XXh
2C89h			XXh
2C8Ah			XXh
2C8Bh			XXh
2C8Ch			XXh
2C8Dh			XXh
2C8Eh			XXh
2C8Fh			XXh
2C90h	DTC Control Data 10	DTCD10	XXh
2C91h			XXh
2C92h			XXh
2C93h			XXh
2C94h			XXh
2C95h			XXh
2C96h			XXh
2C97h			XXh
2C98h	DTC Control Data 11	DTCD11	XXh
2C99h			XXh
2C9Ah			XXh
2C9Bh			XXh
2C9Ch			XXh
2C9Dh			XXh
2C9Eh			XXh
2C9Fh			XXh
2CA0h	DTC Control Data 12	DTCD12	XXh
2CA1h			XXh
2CA2h			XXh
2CA3h			XXh
2CA4h			XXh
2CA5h			XXh
2CA6h			XXh
2CA7h			XXh
2CA8h	DTC Control Data 13	DTCD13	XXh
2CA9h			XXh
2CAAh			XXh
2CABh			XXh
2CACh			XXh
2CADh			XXh
2CAEh			XXh
2CAFh			XXh

X: Undefined

Note:

1. The blank areas are reserved and cannot be accessed by users.

5. Electrical Characteristics

Table 5.1 Absolute Maximum Ratings

Symbol	Parameter	Condition	Rated Value	Unit
V_{CC}/AV_{CC}	Supply voltage		−0.3 to 6.5	V
V_I	Input voltage		−0.3 to V_{CC} + 0.3	V
V_O	Output voltage		−0.3 to V_{CC} + 0.3	V
P_d	Power dissipation	−40°C ≤ T_{opr} ≤ 85°C	500	mW
T_{opr}	Operating ambient temperature		−20 to 85 (N version)/ −40 to 85 (D version)	°C
T_{stg}	Storage temperature		−65 to 150	°C

Table 5.2 Recommended Operating Conditions (1)

Symbol	Parameter				Conditions	Standard			Unit
						Min.	Typ.	Max.	
V_{CC}/AV_{CC}	Supply voltage					1.8	—	5.5	V
V_{SS}/AV_{SS}	Supply voltage					—	0	—	V
V_{IH}	Input “H” voltage	Other than CMOS input				0.8 V_{CC}	—	V_{CC}	V
		CMOS input	Input level switching function (I/O port)	Input level selection: 0.35 V_{CC}	4.0 V ≤ V_{CC} ≤ 5.5 V	0.5 V_{CC}	—	V_{CC}	V
					2.7 V ≤ V_{CC} < 4.0 V	0.55 V_{CC}	—	V_{CC}	V
					1.8 V ≤ V_{CC} < 2.7 V	0.65 V_{CC}	—	V_{CC}	V
				Input level selection: 0.5 V_{CC}	4.0 V ≤ V_{CC} ≤ 5.5 V	0.65 V_{CC}	—	V_{CC}	V
					2.7 V ≤ V_{CC} < 4.0 V	0.7 V_{CC}	—	V_{CC}	V
					1.8 V ≤ V_{CC} < 2.7 V	0.8 V_{CC}	—	V_{CC}	V
				Input level selection: 0.7 V_{CC}	4.0 V ≤ V_{CC} ≤ 5.5 V	0.85 V_{CC}	—	V_{CC}	V
					2.7 V ≤ V_{CC} < 4.0 V	0.85 V_{CC}	—	V_{CC}	V
					1.8 V ≤ V_{CC} < 2.7 V	0.85 V_{CC}	—	V_{CC}	V
		External clock input (XOUT)				1.2	—	V_{CC}	V
V_{IL}	Input “L” voltage	Other than CMOS input				0	—	0.2 V_{CC}	V
		CMOS input	Input level switching function (I/O port)	Input level selection: 0.35 V_{CC}	4.0 V ≤ V_{CC} ≤ 5.5 V	0	—	0.2 V_{CC}	V
					2.7 V ≤ V_{CC} < 4.0 V	0	—	0.2 V_{CC}	V
					1.8 V ≤ V_{CC} < 2.7 V	0	—	0.2 V_{CC}	V
				Input level selection: 0.5 V_{CC}	4.0 V ≤ V_{CC} ≤ 5.5 V	0	—	0.4 V_{CC}	V
					2.7 V ≤ V_{CC} < 4.0 V	0	—	0.3 V_{CC}	V
					1.8 V ≤ V_{CC} < 2.7 V	0	—	0.2 V_{CC}	V
				Input level selection: 0.7 V_{CC}	4.0 V ≤ V_{CC} ≤ 5.5 V	0	—	0.55 V_{CC}	V
					2.7 V ≤ V_{CC} < 4.0 V	0	—	0.45 V_{CC}	V
					1.8 V ≤ V_{CC} < 2.7 V	0	—	0.35 V_{CC}	V
		External clock input (XOUT)				0	—	0.4	V
$I_{OH(sum)}$	Peak sum output “H” current		Sum of all pins $I_{OH(peak)}$			—	—	–160	mA
$I_{OH(sum)}$	Average sum output “H” current		Sum of all pins $I_{OH(avg)}$			—	—	–80	mA
$I_{OH(peak)}$	Peak output “H” current		Drive capacity Low			—	—	–10	mA
			Drive capacity High			—	—	–40	mA
$I_{OH(avg)}$	Average output “H” current		Drive capacity Low			—	—	–5	mA
			Drive capacity High			—	—	–20	mA
$I_{OL(sum)}$	Peak sum output “L” current		Sum of all pins $I_{OL(peak)}$			—	—	160	mA
$I_{OL(sum)}$	Average sum output “L” current		Sum of all pins $I_{OL(avg)}$			—	—	80	mA
$I_{OL(peak)}$	Peak output “L” current		Drive capacity Low			—	—	10	mA
			Drive capacity High			—	—	40	mA
$I_{OL(avg)}$	Average output “L” current		Drive capacity Low			—	—	5	mA
			Drive capacity High			—	—	20	mA
$f_{(XIN)}$	XIN clock input oscillation frequency				2.7 V ≤ V_{CC} ≤ 5.5 V	—	—	20	MHz
					1.8 V ≤ V_{CC} < 2.7 V	—	—	5	MHz
$f_{(XCIN)}$	XCIN clock input oscillation frequency				1.8 V ≤ V_{CC} ≤ 5.5 V	—	32.768	50	kHz
fOCO40M	When used as the count source for timer RC, timer RD or timer RG (3)				2.7 V ≤ V_{CC} ≤ 5.5 V	32	—	40	MHz
fOCO-F	fOCO-F frequency				2.7 V ≤ V_{CC} ≤ 5.5 V	—	—	20	MHz
					1.8 V ≤ V_{CC} < 2.7 V	—	—	5	MHz
—	System clock frequency				2.7 V ≤ V_{CC} ≤ 5.5 V	—	—	20	MHz
					1.8 V ≤ V_{CC} < 2.7 V	—	—	5	MHz
$f_{(BCLK)}$	CPU clock frequency				2.7 V ≤ V_{CC} ≤ 5.5 V	—	—	20	MHz
					1.8 V ≤ V_{CC} < 2.7 V	—	—	5	MHz

Notes:
1. V_{CC} = 1.8 to 5.5 V and T_{opr} = –20 to 85 °C (N version)/–40 to 85 °C (D version), unless otherwise specified.
2. The average output current indicates the average value of current measured during 100 ms.
3. fOCO40M can be used as the count source for timer RC, timer RD or timer RG in the range of V_{CC} = 2.7 to 5.5 V.

Table 5.4 D/A Converter Characteristics

Symbol	Parameter	Condition	Standard			Unit
			Min.	Typ.	Max.	
—	Resolution		—	—	8	Bit
—	Absolute accuracy		—	—	2.5	LSB
t_{su}	Setup time		—	—	3	µs
R_O	Output resistor		—	6	—	kΩ
I_{Vref}	Reference power input current	(Note 2)	—	—	1.5	mA

Notes:
1. V_{CC}/AV_{CC} = V_{ref} = 2.7 to 5.5 V and T_{opr} = –20 to 85 °C (N version)/–40 to 85 °C (D version), unless otherwise specified.
2. This applies when one D/A converter is used and the value of the DAi register (i = 0 or 1) for the unused D/A converter is 00h. The resistor ladder of the A/D converter is not included.

Table 5.5 Comparator B Electrical Characteristics

Symbol	Parameter	Condition	Standard			Unit
			Min.	Typ.	Max.	
V_{ref}	IVREF1, IVREF3 input reference voltage		0	—	V_{CC} – 1.4	V
V_I	IVCMP1, IVCMP3 input voltage		–0.3	—	V_{CC} + 0.3	V
—	Offset		—	5	100	mV
t_d	Comparator output delay time (2)	V_I = V_{ref} ± 100 mV	—	0.1	—	µs
I_{CMP}	Comparator operating current	V_{CC} = 5.0 V	—	17.5	—	µA

Notes:
1. V_{CC} = 2.7 to 5.5 V and T_{opr} = –20 to 85 °C (N version)/–40 to 85 °C (D version), unless otherwise specified.
2. When the digital filter is disabled.

Table 5.7 Flash Memory (Data flash Block A to Block D) Electrical Characteristics

Symbol	Parameter	Conditions	Standard			Unit
			Min.	Typ.	Max.	
—	Program/erase endurance (2)		10,000 (3)	—	—	times
—	Byte program time (program/erase endurance ≤ 1,000 times)		—	160	1500	µs
—	Byte program time (program/erase endurance > 1,000 times)		—	300	1500	µs
—	Block erase time (program/erase endurance ≤ 1,000 times)		—	0.2	1	s
—	Block erase time (program/erase endurance > 1,000 times)		—	0.3	1	s
$t_{d(SR-SUS)}$	Time delay from suspend request until suspend		—	—	5 + CPU clock × 3 cycles	ms
—	Interval from erase start/restart until following suspend request		0	—	—	µs
—	Time from suspend until erase restart		—	—	30 + CPU clock × 1 cycle	µs
$t_{d(CMDRST-READY)}$	Time from when command is forcibly stopped until reading is enabled		—	—	30 + CPU clock × 1 cycle	µs
—	Program, erase voltage		2.7	—	5.5	V
—	Read voltage		1.8	—	5.5	V
—	Program, erase temperature		−20 (7)	—	85	°C
—	Data hold time (8)	Ambient temperature = 55 °C	20	—	—	year

Notes:
1. V_{CC} = 2.7 to 5.5 V and T_{opr} = −20 to 85 °C (N version)/−40 to 85 °C (D version), unless otherwise specified.
2. Definition of programming/erasure endurance
   The programming and erasure endurance is defined on a per-block basis.
   If the programming and erasure endurance is n (n = 10,000), each block can be erased n times. For example, if 1,024 1-byte writes are performed to different addresses in block A, a 1 Kbyte block, and then the block is erased, the programming/erasure endurance still stands at one. However, the same address must not be programmed more than once per erase operation (overwriting prohibited).
3. Endurance to guarantee all electrical characteristics after program and erase. (1 to Min. value can be guaranteed.)
4. In a system that executes multiple programming operations, the actual erasure count can be reduced by writing to sequential addresses in turn so that as much of the block as possible is used up before performing an erase operation. For example, when programming groups of 16 bytes, the effective number of rewrites can be minimized by programming up to 128 groups before erasing them all in one operation. In addition, averaging the erasure endurance between blocks A to D can further reduce the actual erasure endurance. It is also advisable to retain data on the erasure endurance of each block and limit the number of erase operations to a certain number.
5. If an error occurs during block erase, attempt to execute the clear status register command, then execute the block erase command at least three times until the erase error does not occur.
6. Customers desiring program/erase failure rate information should contact their Renesas technical support representative.
7. −40 °C for D version.
8. The data hold time includes time that the power supply is off or the clock is not supplied.

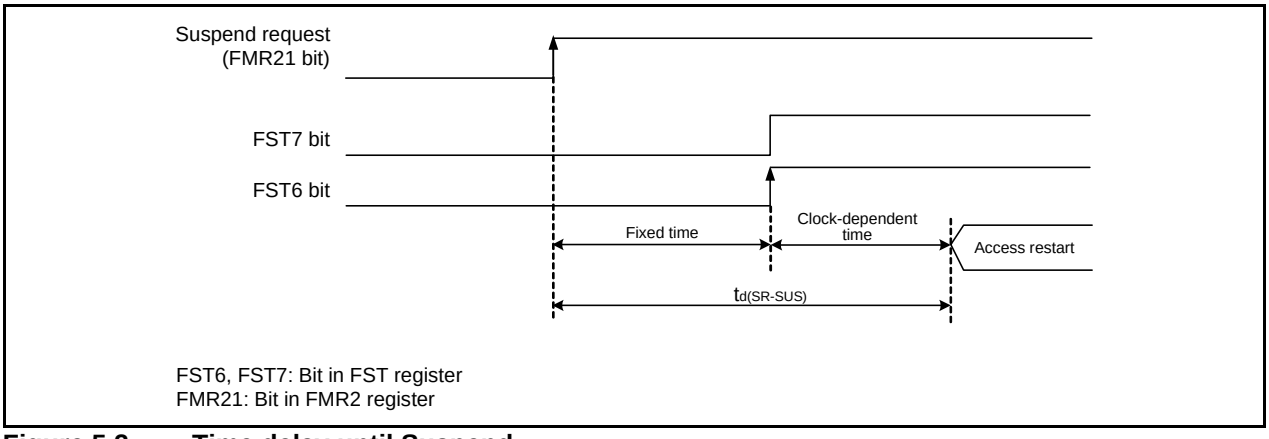


Figure 5.2 Time delay until Suspend

Table 5.10 Voltage Detection 2 Circuit Electrical Characteristics

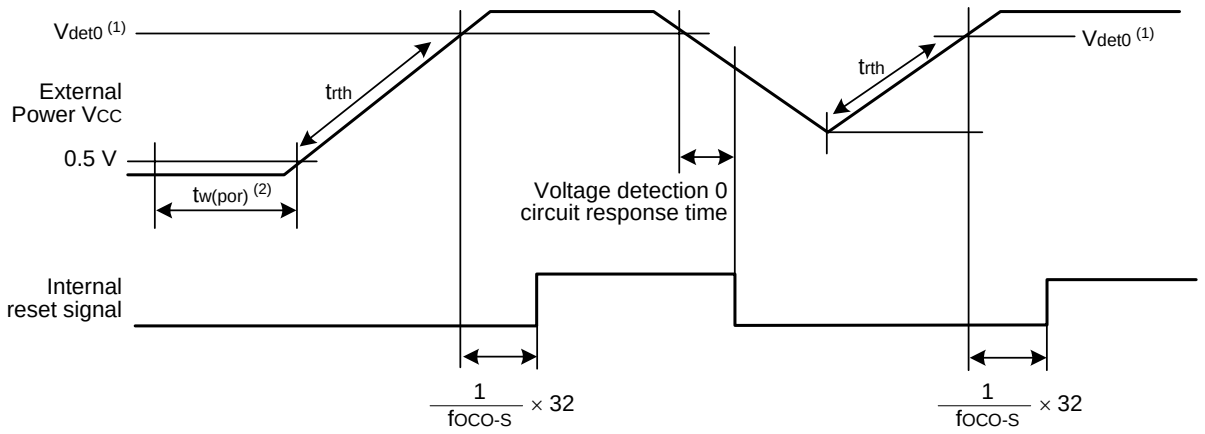
Symbol	Parameter	Condition	Standard			Unit
			Min.	Typ.	Max.	
V_{det2}	Voltage detection level Vdet2_0	At the falling of V_{CC}	3.70	4.00	4.30	V
—	Hysteresis width at the rising of V_{CC} in voltage detection 2 circuit		—	0.10	—	V
—	Voltage detection 2 circuit response time (2)	At the falling of V_{CC} from 5.0 V to (Vdet2_0 – 0.1) V	—	20	150	µs
—	Voltage detection circuit self power consumption	VCA27 = 1, V_{CC} = 5.0 V	—	1.7	—	µA
$t_{d(E-A)}$	Waiting time until voltage detection circuit operation starts (3)		—	—	100	µs

Notes:
1. The measurement condition is V_{CC} = 1.8 to 5.5 V and T_{opr} = –20 to 85 °C (N version)/–40 to 85 °C (D version).
2. Time until the voltage monitor 2 interrupt request is generated after the voltage passes V_{det2}.
3. Necessary time until the voltage detection circuit operates after setting to 1 again after setting the VCA27 bit in the VCA2 register to 0.

Table 5.11 Power-on Reset Circuit (2)

Symbol	Parameter	Condition	Standard			Unit
			Min.	Typ.	Max.	
t_{rth}	External power V_{CC} rise gradient	(1)	0	—	50,000	mV/msec

Notes:
1. The measurement condition is T_{opr} = –20 to 85 °C (N version)/–40 to 85 °C (D version), unless otherwise specified.
2. To use the power-on reset function, enable voltage monitor 0 reset by setting the LVDAS bit in the OFS register to 0.



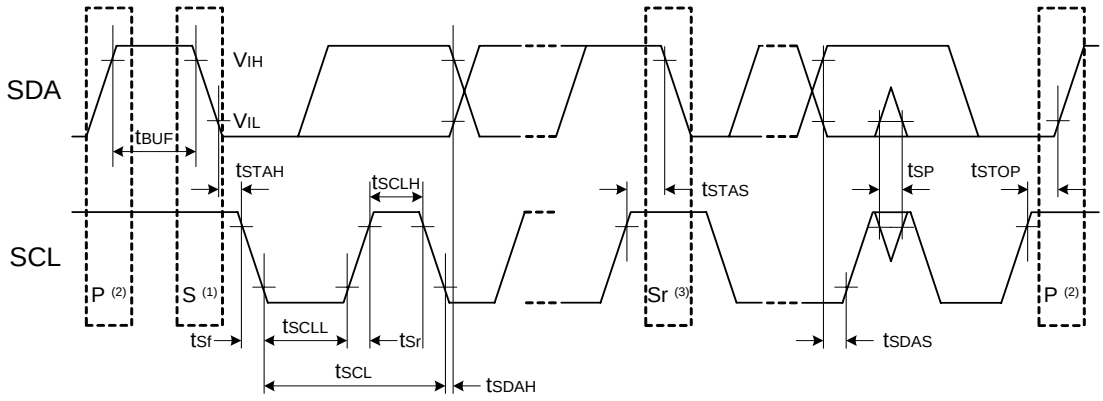
Notes:
1. V_{det0} indicates the voltage detection level of the voltage detection 0 circuit. Refer to **6. Voltage Detection Circuit** of User's Manual: Hardware (R01UH0095EJ0110) for details.
2. $t_{w(por)}$ indicates the duration the external power V_{CC} must be held below the valid voltage (0.5 V) to enable a power-on reset. When turning on the power after it falls with voltage monitor 0 reset disabled, maintain $t_{w(por)}$ for 1 ms or more.

Figure 5.3 Power-on Reset Circuit Electrical Characteristics

Table 5.16 Timing Requirements of I²C bus Interface

Symbol	Parameter	Condition	Standard			Unit
			Min.	Typ.	Max.	
t_{SCL}	SCL input cycle time		$12t_{CYC} + 600$ (2)	—	—	ns
t_{SCLH}	SCL input “H” width		$3t_{CYC} + 300$ (2)	—	—	ns
t_{SCLL}	SCL input “L” width		$5t_{CYC} + 500$ (2)	—	—	ns
t_{sf}	SCL, SDA input fall time		—	—	300	ns
t_{SP}	SCL, SDA input spike pulse rejection time		—	—	$1t_{CYC}$ (2)	ns
t_{BUF}	SDA input bus-free time		$5t_{CYC}$ (2)	—	—	ns
t_{STAH}	Start condition input hold time		$3t_{CYC}$ (2)	—	—	ns
t_{STAS}	Retransmit start condition input setup time		$3t_{CYC}$ (2)	—	—	ns
t_{STOP}	Stop condition input setup time		$3t_{CYC}$ (2)	—	—	ns
t_{SDAS}	Data input setup time		$1t_{CYC} + 40$ (2)	—	—	ns
t_{SDAH}	Data input hold time		10	—	—	ns

Notes:
1. V_{CC} = 1.8 to 5.5 V, V_{SS} = 0 V, and T_{opr} = –20 to 85 °C (N version)/–40 to 85 °C (D version), unless otherwise specified.
2. $1t_{CYC} = 1/f1(s)$



Notes:
1. Start condition
2. Stop condition
3. Retransmit start condition

Figure 5.7 I/O Timing of I²C bus Interface

Timing Requirements (Unless Otherwise Specified: V_{CC} = 5 V, V_{SS} = 0 V, T_{opr} = 25 °C)

Table 5.19 External Clock Input (XOUT, XCIN)

Symbol	Parameter	Standard		Unit
		Min.	Max.	
$t_{c(XOUT)}$	XOUT input cycle time	50	—	ns
$t_{WH(XOUT)}$	XOUT input “H” width	24	—	ns
$t_{WL(XOUT)}$	XOUT input “L” width	24	—	ns
$t_{c(XCIN)}$	XCIN input cycle time	14	—	µs
$t_{WH(XCIN)}$	XCIN input “H” width	7	—	µs
$t_{WL(XCIN)}$	XCIN input “L” width	7	—	µs

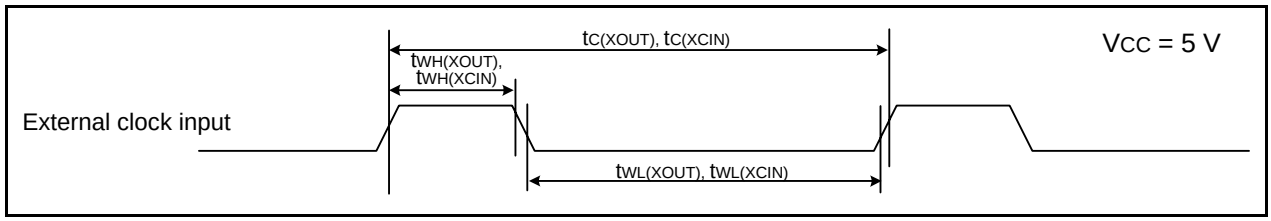


Figure 5.8 External Clock Input Timing Diagram when VCC = 5 V

Table 5.20 TRAIO Input

Symbol	Parameter	Standard		Unit
		Min.	Max.	
$t_{c(TRAIO)}$	TRAIO input cycle time	100	—	ns
$t_{WH(TRAIO)}$	TRAIO input “H” width	40	—	ns
$t_{WL(TRAIO)}$	TRAIO input “L” width	40	—	ns

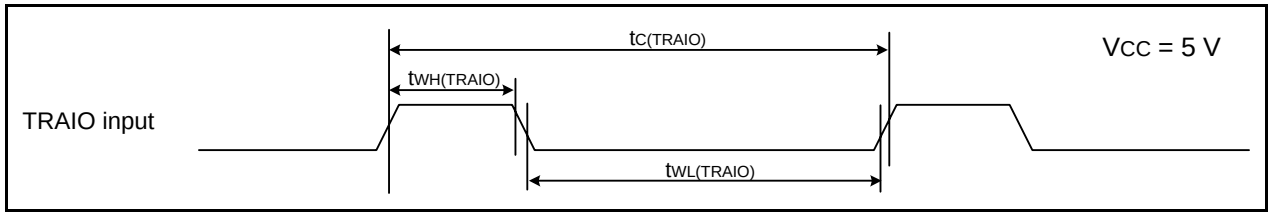


Figure 5.9 TRAIO Input Timing Diagram when V_{CC} = 5 V

Table 5.21 TRFI Input

Symbol	Parameter	Standard		Unit
		Min.	Max.	
$t_{c(TRFI)}$	TRFI input cycle time	400 (1)	—	ns
$t_{WH(TRFI)}$	TRFI input “H” width	200 (2)	—	ns
$t_{WL(TRFI)}$	TRFI input “L” width	200 (2)	—	ns

Notes:
1. When using timer RF input capture mode, adjust the cycle time to (1/timer RF count source frequency × 3) or above.
2. When using timer RF input capture mode, adjust the pulse width to (1/timer RF count source frequency × 1.5) or above.

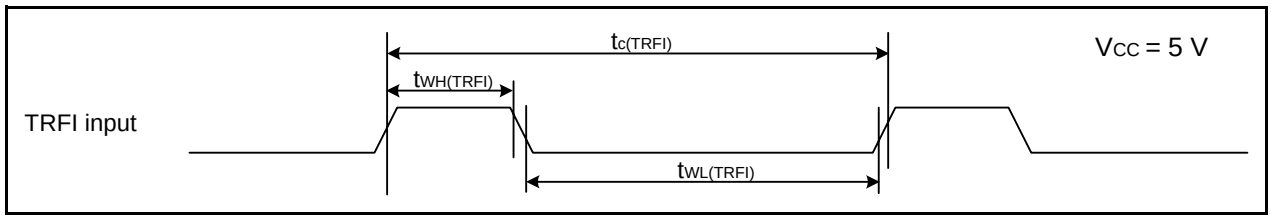


Figure 5.10 TRFI Input Timing Diagram when V_{CC} = 5 V

Timing requirements (Unless Otherwise Specified: V_{CC} = 3 V, V_{SS} = 0 V, T_{opr} = 25 °C)

Table 5.26 External Clock Input (XOUT, XCIN)

Symbol	Parameter	Standard		Unit
		Min.	Max.	
$t_{c(XOUT)}$	XOUT input cycle time	50	—	ns
$t_{WH(XOUT)}$	XOUT input “H” width	24	—	ns
$t_{WL(XOUT)}$	XOUT input “L” width	24	—	ns
$t_{c(XCIN)}$	XCIN input cycle time	14	—	µs
$t_{WH(XCIN)}$	XCIN input “H” width	7	—	µs
$t_{WL(XCIN)}$	XCIN input “L” width	7	—	µs

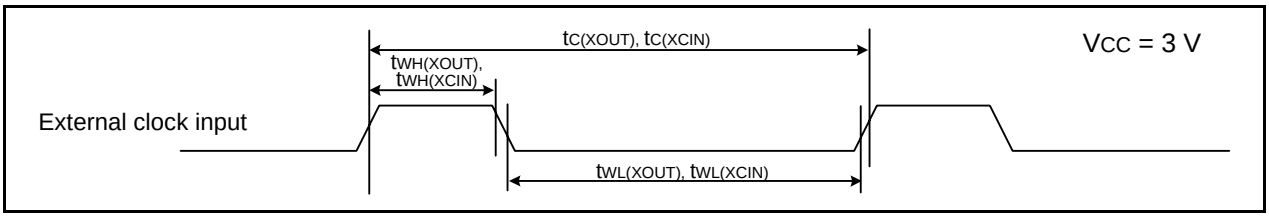


Figure 5.13 External Clock Input Timing Diagram when VCC = 3 V

Table 5.27 TRAIO Input

Symbol	Parameter	Standard		Unit
		Min.	Max.	
$t_{c(TRAIO)}$	TRAIO input cycle time	300	—	ns
$t_{WH(TRAIO)}$	TRAIO input “H” width	120	—	ns
$t_{WL(TRAIO)}$	TRAIO input “L” width	120	—	ns

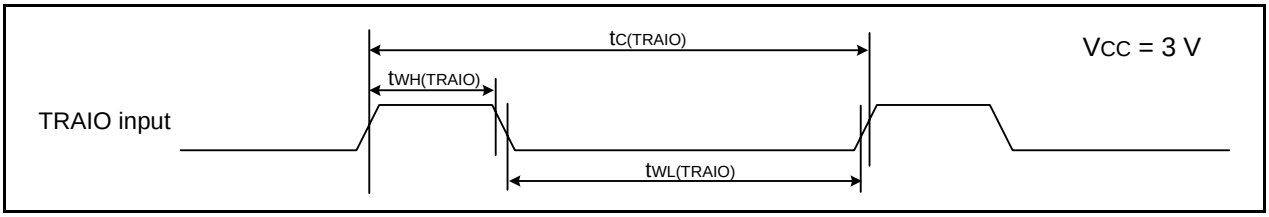


Figure 5.14 TRAIO Input Timing Diagram when Vcc = 3 V

Table 5.28 TRFI Input

Symbol	Parameter	Standard		Unit
		Min.	Max.	
$t_{c(TRFI)}$	TRFI input cycle time	1200 (1)	—	ns
$t_{WH(TRFI)}$	TRFI input “H” width	600 (2)	—	ns
$t_{WL(TRFI)}$	TRFI input “L” width	600 (2)	—	ns

Notes:
1. When using timer RF input capture mode, adjust the cycle time to (1/timer RF count source frequency × 3) or above.
2. When using timer RF input capture mode, adjust the pulse width to (1/timer RF count source frequency × 1.5) or above.

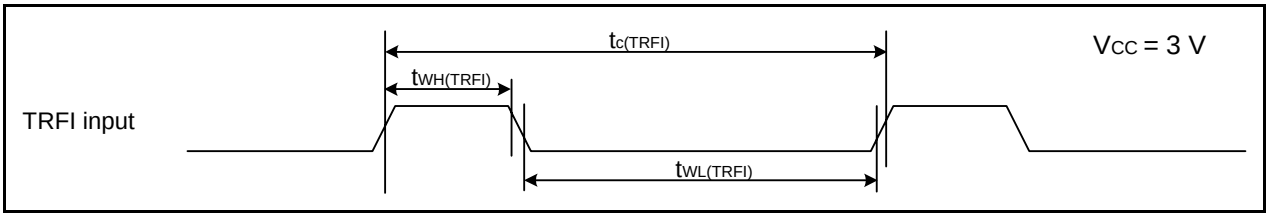


Figure 5.15 TRFI Input Timing Diagram when Vcc = 3 V

Table 5.32 Electrical Characteristics (6) [1.8 V ≤ Vcc < 2.7 V]
(Topr = –20 to 85 °C (N version)/–40 to 85 °C (D version), unless otherwise specified.)

Symbol	Parameter	Condition		Standard			Unit
				Min.	Typ.	Max.	
Icc	Power supply current (Vcc = 1.8 to 2.7 V) Single-chip mode, output pins are open, other pins are Vss	High-speed clock mode	XIN = 5 MHz (square wave) High-speed on-chip oscillator off Low-speed on-chip oscillator on = 125 kHz No division	—	2.2	—	mA
			XIN = 5 MHz (square wave) High-speed on-chip oscillator off Low-speed on-chip oscillator on = 125 kHz Divide-by-8	—	0.8	—	mA
		High-speed on-chip oscillator mode	XIN clock off High-speed on-chip oscillator on fOCO-F = 5 MHz Low-speed on-chip oscillator on = 125 kHz No division	—	2.5	10	mA
			XIN clock off High-speed on-chip oscillator on fOCO-F = 5 MHz Low-speed on-chip oscillator on = 125 kHz Divide-by-8	—	1.7	—	mA
			XIN clock off High-speed on-chip oscillator on fOCO-F = 4 MHz Low-speed on-chip oscillator on = 125 kHz Divide-by-16, MSTIIC = MSTTRD = MSTTRC = 1	—	1	—	mA
		Low-speed on-chip oscillator mode	XIN clock off High-speed on-chip oscillator off Low-speed on-chip oscillator on = 125 kHz Divide-by-8, FMR27 = 1, VCA20 = 0	—	90	300	µA
		Low-speed clock mode	XIN clock off High-speed on-chip oscillator off Low-speed on-chip oscillator off XCIN clock oscillator on = 32 kHz No division FMR27 = 1, VCA20 = 0	—	80	350	µA
			XIN clock off High-speed on-chip oscillator off Low-speed on-chip oscillator off XCIN clock oscillator on = 32 kHz No division Program operation on RAM Flash memory off, FMSTP = 1, VCA20 = 0	—	40	—	µA
		Wait mode	XIN clock off High-speed on-chip oscillator off Low-speed on-chip oscillator on = 125 kHz While a WAIT instruction is executed Peripheral clock operation VCA27 = VCA26 = VCA25 = 0, VCA20 = 1	—	15	90	µA
			XIN clock off High-speed on-chip oscillator off Low-speed on-chip oscillator on = 125 kHz While a WAIT instruction is executed Peripheral clock off VCA27 = VCA26 = VCA25 = 0, VCA20 = 1	—	4	80	µA
			XIN clock off High-speed on-chip oscillator off Low-speed on-chip oscillator off XCIN clock oscillator on = 32 kHz (peripheral clock off) While a WAIT instruction is executed VCA27 = VCA26 = VCA25 = 0, VCA20 = 1	—	3.5	—	µA
		Stop mode	XIN clock off, Topr = 25 °C High-speed on-chip oscillator off Low-speed on-chip oscillator off CM10 = 1 Peripheral clock off VCA27 = VCA26 = VCA25 = 0	—	2.0	5	µA
			XIN clock off, Topr = 85 °C High-speed on-chip oscillator off Low-speed on-chip oscillator off CM10 = 1 Peripheral clock off VCA27 = VCA26 = VCA25 = 0	—	15	—	µA

Table 5.36 Serial Interface

Symbol	Parameter	Standard		Unit
		Min.	Max.	
$t_{c(CK)}$	CLKi input cycle time	800	—	ns
$t_{W(CKH)}$	CLKi input “H” width	400	—	ns
$t_{W(CKL)}$	CLKi input “L” width	400	—	ns
$t_{d(C-Q)}$	TXDi output delay time	—	200	ns
$t_{h(C-Q)}$	TXDi hold time	0	—	ns
$t_{su(D-C)}$	RXDi input setup time	150	—	ns
$t_{h(C-D)}$	RXDi input hold time	90	—	ns

i = 0 to 2

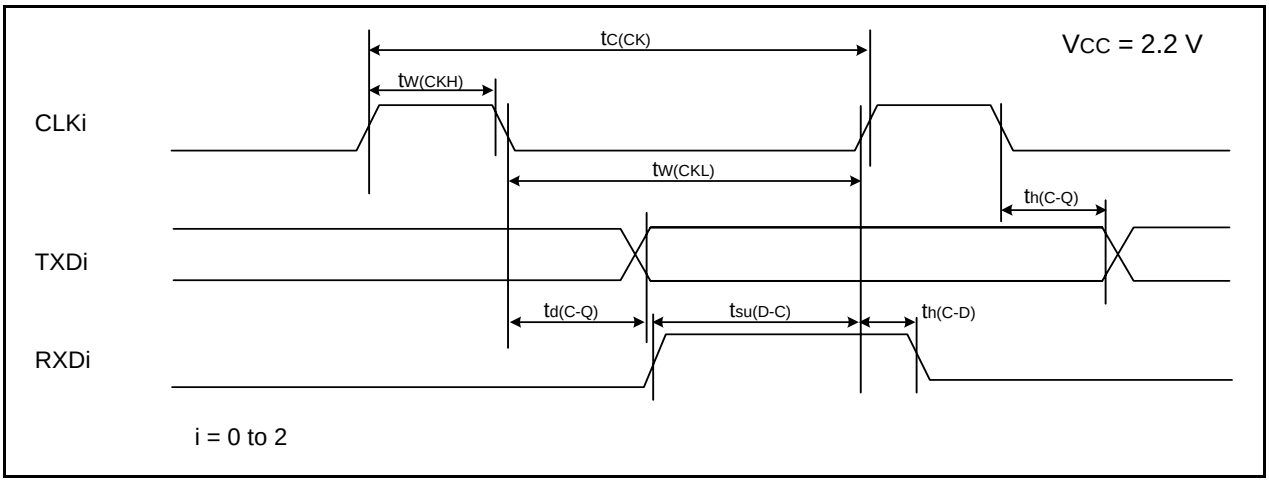


Figure 5.21 Serial Interface Timing Diagram when VCC = 2.2 V

Table 5.37 External Interrupt $\overline{INTi}$ (i = 0 to 4) Input, Key Input Interrupt $\overline{KIi}$ (i = 0 to 3)

Symbol	Parameter	Standard		Unit
		Min.	Max.	
$t_{W(INH)}$	$\overline{INTi}$ input “H” width, $\overline{KIi}$ input “H” width	1000 (1)	—	ns
$t_{W(INL)}$	$\overline{INTi}$ input “L” width, $\overline{KIi}$ input “L” width	1000 (2)	—	ns

Notes:
1. When selecting the digital filter by the $\overline{INTi}$ input filter select bit, use an $\overline{INTi}$ input HIGH width of either (1/digital filter clock frequency × 3) or the minimum value of standard, whichever is greater.
2. When selecting the digital filter by the $\overline{INTi}$ input filter select bit, use an $\overline{INTi}$ input LOW width of either (1/digital filter clock frequency × 3) or the minimum value of standard, whichever is greater.

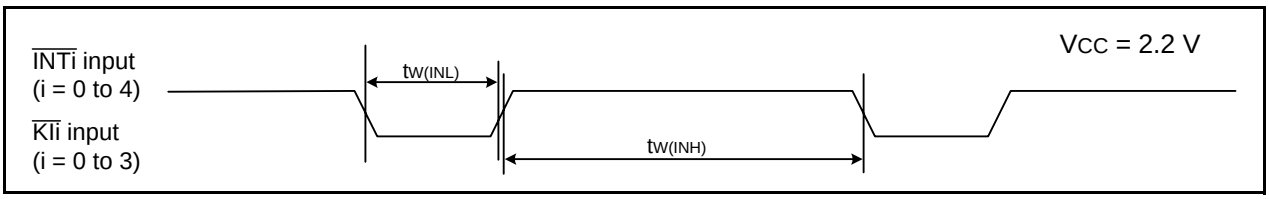


Figure 5.22 Input Timing Diagram for External Interrupt $\overline{INTi}$ and Key Input Interrupt $\overline{KIi}$ when VCC = 2.2 V

General Precautions in the Handling of MPU/MCU Products

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

1. Handling of Unused Pins

   Handle unused pins in accord with the directions given under Handling of Unused Pins in the manual.

   — The input pins of CMOS products are generally in the high-impedance state. In operation with an unused pin in the open-circuit state, extra electromagnetic noise is induced in the vicinity of LSI, an associated shoot-through current flows internally, and malfunctions occur due to the false recognition of the pin state as an input signal become possible. Unused pins should be handled as described under Handling of Unused Pins in the manual.

2. Processing at Power-on

   The state of the product is undefined at the moment when power is supplied.

   — The states of internal circuits in the LSI are indeterminate and the states of register settings and pins are undefined at the moment when power is supplied.

   In a finished product where the reset signal is applied to the external reset pin, the states of pins are not guaranteed from the moment when power is supplied until the reset process is completed.

   In a similar way, the states of pins in a product that is reset by an on-chip power-on reset function are not guaranteed from the moment when power is supplied until the power reaches the level at which resetting has been specified.

3. Prohibition of Access to Reserved Addresses

   Access to reserved addresses is prohibited.

   — The reserved addresses are provided for the possible future expansion of functions. Do not access these addresses; the correct operation of LSI is not guaranteed if they are accessed.

4. Clock Signals

   After applying a reset, only release the reset line after the operating clock signal has become stable. When switching the clock signal during program execution, wait until the target clock signal has stabilized.

   — When the clock signal is generated with an external resonator (or from an external oscillator) during a reset, ensure that the reset line is only released after full stabilization of the clock signal. Moreover, when switching to a clock signal produced with an external resonator (or by an external oscillator) while program execution is in progress, wait until the target clock signal is stable.

5. Differences between Products

   Before changing from one product to another, i.e. to one with a different part number, confirm that the change will not lead to problems.

   — The characteristics of MPU/MCU in the same group but having different part numbers may differ because of the differences in internal memory capacity and layout pattern. When changing to products of different part numbers, implement a system-evaluation test for each of the products.

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