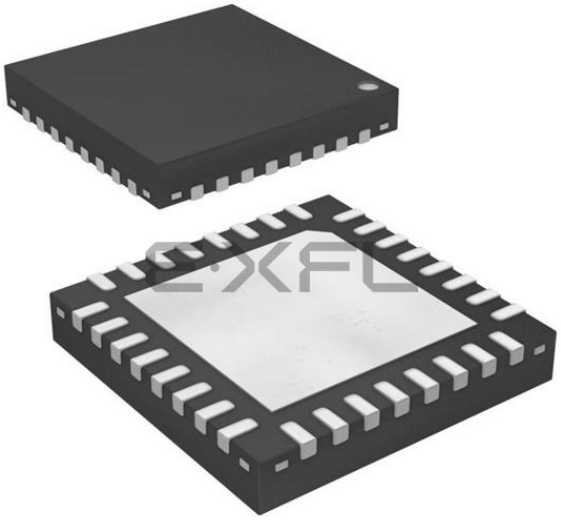
Renesas Electronics America Inc - R7FS128783A01CNG#AC1 Datasheet



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Applications of "Embedded - Microcontrollers"

Details	
Product Status	Active
Core Processor	ARM® Cortex®-M0+
Core Size	32-Bit Single-Core
Speed	32MHz
Connectivity	CANbus, DALI, I²C, SCI, SPI, UART/USART, USB
Peripherals	DMA, LVD, POR, PWM, WDT
Number of I/O	24
Program Memory Size	256KB (256K x 8)
Program Memory Type	FLASH
EEPROM Size	4K x 8
RAM Size	24K x 8
Voltage - Supply (Vcc/Vdd)	1.6V ~ 5.5V
Data Converters	A/D 10x14b; D/A 3x8b
Oscillator Type	Internal
Operating Temperature	-40°C ~ 105°C (TA)
Mounting Type	Surface Mount
Package / Case	32-WFQFN Exposed Pad
Supplier Device Package	32-HWQFN (5x5)
Purchase URL	https://www.e-xfl.com/product-detail/renesas-electronics-america/r7fs128783a01cng-ac1

1.2 Block Diagram

Figure 1.1 shows a block diagram of the MCU superset. Some individual devices within the group may have a subset of the features.

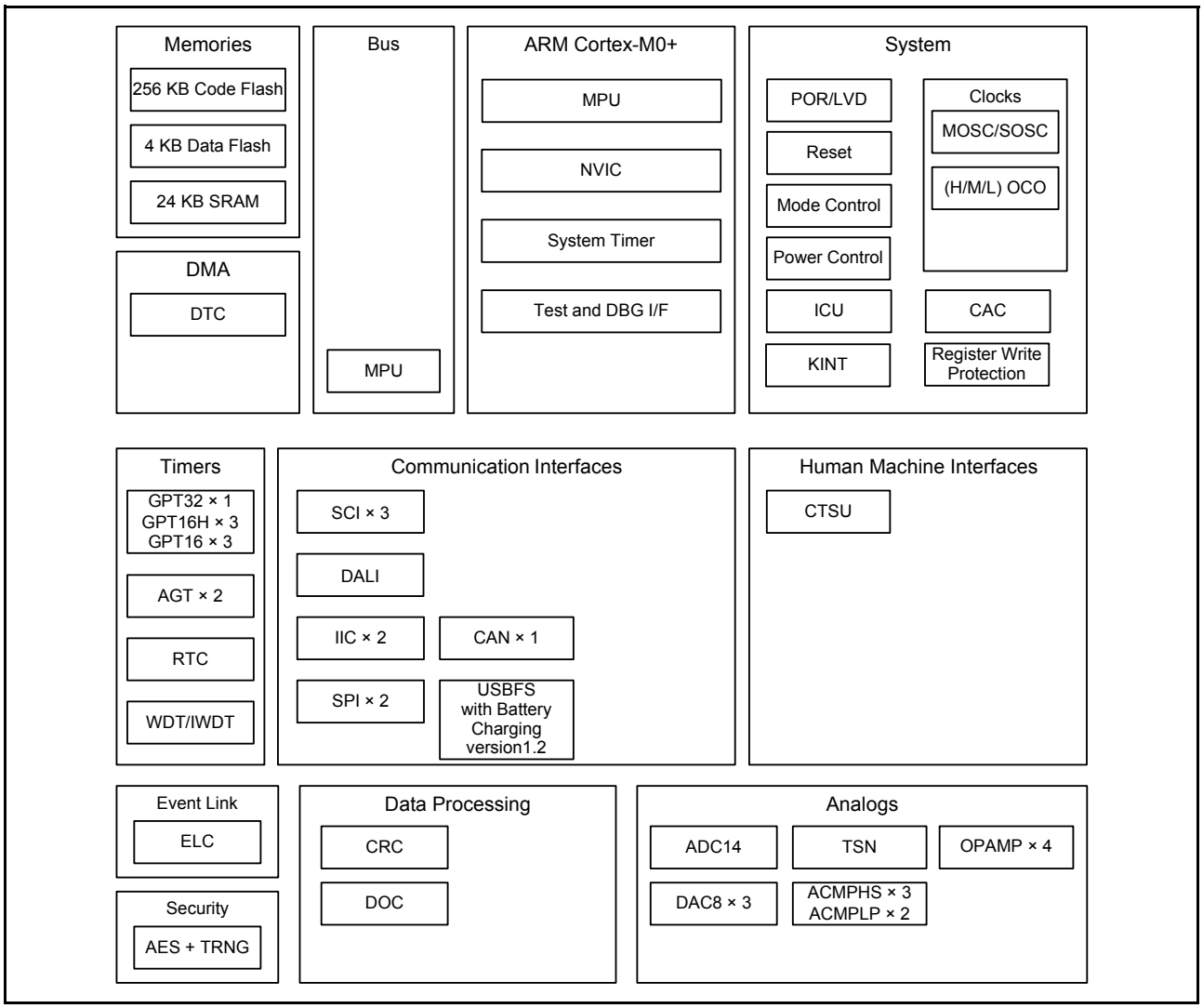


Figure 1.1 Block diagram

1.3 Part Numbering

Figure 1.2 shows the product part number information, including memory capacity, and package type. Table 1.12 shows a product list.

Pin number						Power, System, Clock, Debug, CAC	I/O ports	Timers				Communication Interfaces				Analogs				HMI	
LQFP64	LQFP48	QFN48	LGA36	LQFP32	QFN32			AGT	GPT_OPS, POEG	GPT	RTC	USBFS,CAN, DALI	SCI	IIC	SPI	ADC14	DAC8	ACMPHS, ACMPLP	OPAMP	CTSU	Interrupt
56	42	42	A4	29	29	AVCC0															
57	43	43	A3	30	30	AVSS0															
58	44	44	B3	31	31	VREFL0	P011									AN006	DA2_A		AMP2O		
59	45	45	A2	32	32	VREFH0	P010									AN005			AMP1O		
60	-	-	-	-	-		P004									AN004	DA2_B			TS25	IRQ3
61	-	-	-	-	-		P003									AN003			AMP3O		
62	46	46	F1	-	-		P002									AN002			AMP0O		IRQ2
63	47	47	C2	-	-		P001									AN001		IVREF2	AMP0-	TS22	IRQ7
64	48	48	B2	-	-		P000									AN000		IVCMP2	AMP0+	TS21	IRQ6

Note: Several pin names have the added suffix of _A, _B, _C, _D and _E. The suffix can be ignored when assigning functionality.

2.2 DC Characteristics

2.2.1 Tj/Ta Definition

Table 2.3 DC characteristics
Conditions: Products with operating temperature (T_a) –40 to +105°C

Parameter	Symbol	Typ	Max	Unit	Test conditions
Permissible junction temperature	Tj	-	125	°C	High-speed mode Middle-speed mode Low-voltage mode Low-speed mode SubOSC-speed mode

Note: Make sure that Tj = T_a + θja × total power consumption (W), where total power consumption = (VCC – V_{OH}) × ΣI_{OH} + V_{OL} × ΣI_{OL} + I_{CC}max × VCC.

2.2.2 I/O V_{IH}, V_{IL}

Table 2.4 I/O V_{IH}, V_{IL} (1)
Conditions: VCC = AVCC0 = VCC_USB = VCC_USB_LDO = 2.7 to 5.5 V

Parameter		Symbol	Min	Typ	Max	Unit	Test Conditions
Schmitt trigger input voltage	IIC (except for SMBus)*1	V_{IH}	VCC × 0.7	-	5.8	V	-
		V_{IL}	-	-	VCC × 0.3		
		ΔV_T	VCC × 0.05	-	-		
	RES, NMI Other peripheral input pins excluding IIC	V_{IH}	VCC × 0.8	-	-		
		V_{IL}	-	-	VCC × 0.2		
		ΔV_T	VCC × 0.1	-	-		
Input voltage (except for Schmitt trigger input pin)	IIC (SMBus)*2	V_{IH}	2.2	-	-		VCC = 3.6 to 5.5 V
		V_{IH}	2.0	-	-		VCC =2.7 to 3.6 V
		V_{IL}	–0.3	-	0.8		-
	5V-tolerant ports*3	V_{IH}	VCC × 0.8	-	5.8		
		V_{IL}	-	-	VCC × 0.2		
	P000 to P004 P010 to P015 P500 to P502	V_{IH}	AVCC0 × 0.8	-	-		
		V_{IL}	-	-	AVCC0 × 0.2		
	P914, P915	V_{IH}	VCC_USB × 0.8	-	VCC_USB + 0.3		
		V_{IL}	-	-	VCC_USB × 0.2		
	EXTAL Input ports pins except for P000 to P004, P010 to P015, P500 to P502, P914, P915	V_{IH}	VCC × 0.8	-	-		
		V_{IL}	-	-	VCC × 0.2		

Note 1. SCL0_A, SDA0_A, SDA0_B, SCL1_A, SDA1_A (total 5 pins)
Note 2. SCL0_A, SDA0_A, SCL0_B, SDA0_B, SCL0_C, SCL1_A, SDA1_A, SCL1_B, SDA1_B (total 9 pins)
Note 3. P205, P206, P400, P401, P407 (total 5pins)

Table 2.5 I/O V_{IH}, V_{IL} (2)
Conditions: VCC = AVCC0 = VCC_USB = VCC_USB_LDO = 1.6 to 2.7 V

Parameter		Symbol	Min	Typ	Max	Unit	Test Conditions
Schmitt trigger input voltage	RES, NMI Peripheral input pins	V_{IH}	VCC × 0.8	-	-3	V	-
		V_{IL}	-	-	VCC × 0.2		
		ΔV_T	VCC × 0.01	-	-		
Input voltage (except for Schmitt trigger input pin)	5V-tolerant ports*1	V_{IH}	VCC × 0.8	-	5.8		
		V_{IL}	-	-	VCC × 0.2		
	P000 to P004 P010 to P015 P500 to P502	V_{IH}	AVCC0 × 0.8	-	-		
		V_{IL}	-	-	AVCC0 × 0.2		
	P914, P915	V_{IH}	VCC_USB × 0.8	-	VCC_USB + 0.3		
		V_{IL}	-	-	VCC_USB × 0.2		
	EXTAL Input ports pins except for P000 to P004, P010 to P015, P500 to P502, P914, P915	V_{IH}	VCC × 0.8	-	-		
		V_{IL}	-	-	VCC × 0.2		

Note 1. P205, P206, P400, P401, P407 (total 5pins)

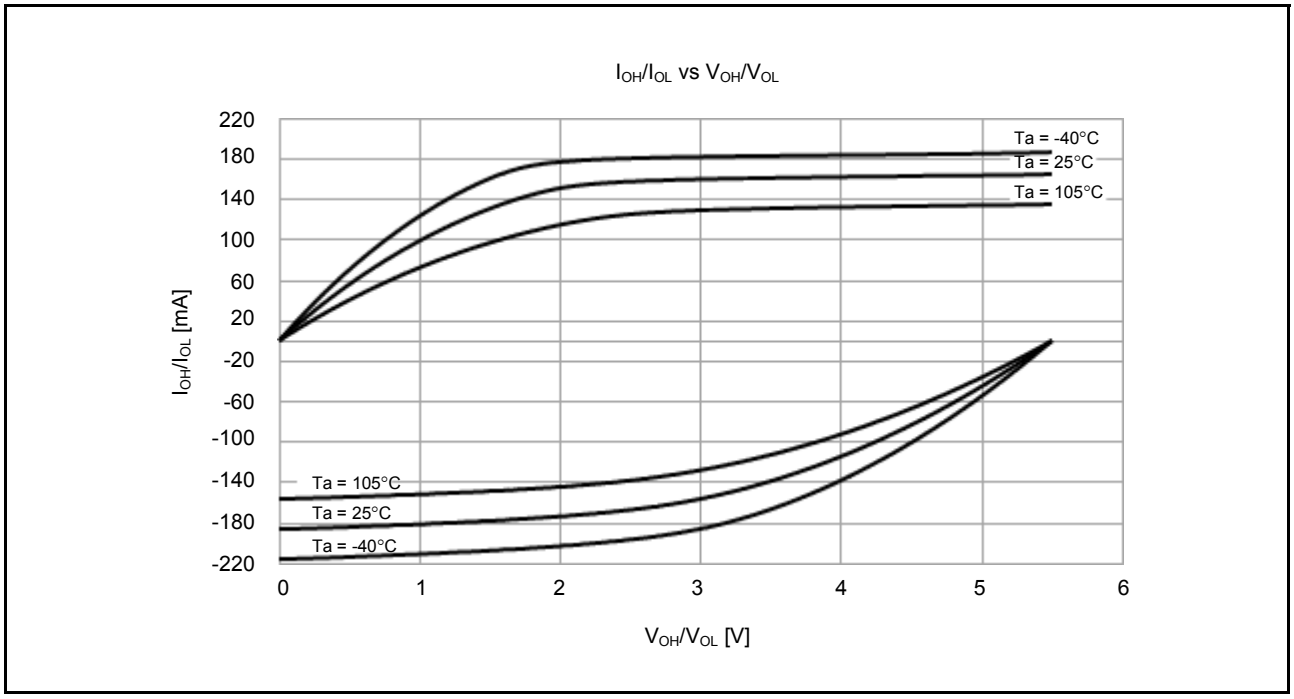


Figure 2.15 **V_{OH}/V_{OL} and I_{OH}/I_{OL} temperature characteristics at VCC = 5.5 V when middle drive output is selected (reference data)**

2.2.8 Output Characteristics for IIC I/O Pins

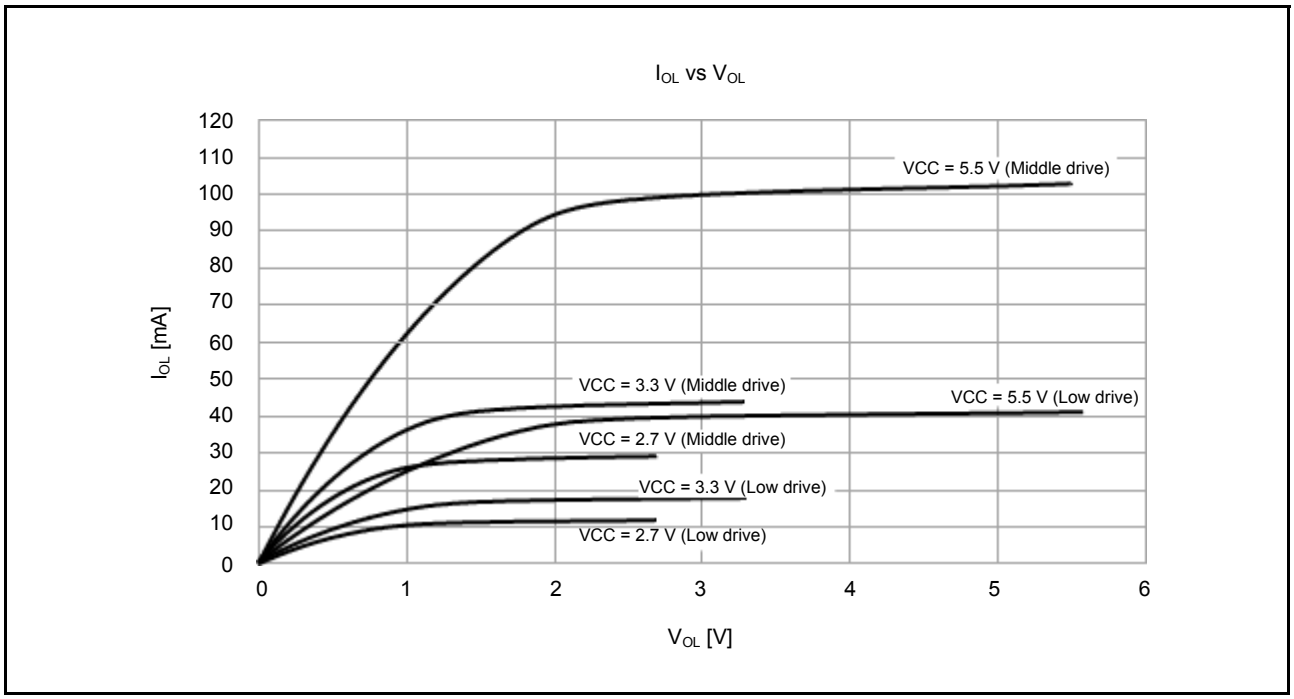


Figure 2.16 **V_{OH}/V_{OL} and I_{OH}/I_{OL} voltage characteristics at Ta = 25°C**

Table 2.11 Operating and standby current (1) (2 of 2)
Conditions: VCC = AVCC0 = 1.6 to 5.5 V

Parameter					Symbol	Typ*9	Max	Unit	Test Conditions
Supply current*1	Low-voltage mode*3	Normal mode	All peripheral clock disabled, while (1) code executing from flash*5	ICLK = 4 MHz	I_{CC}	1.5	-	mA	*7
			All peripheral clock disabled, CoreMark code executing from flash*5	ICLK = 4 MHz		1.4	-		
			All peripheral clock enabled, while (1) code executing from flash*5	ICLK = 4 MHz		2.3	-		*8
			All peripheral clock enabled, code executing from flash*5	ICLK = 4 MHz		-	4.0		
		Sleep mode	All peripheral clock disabled*5	ICLK = 4 MHz		0.9	-		*7
			All peripheral clock enabled*5	ICLK = 4 MHz		1.7	-		*8
	Subosc-speed mode*4	Normal mode	All peripheral clock disabled, while (1) code executing from flash*5	ICLK = 32.768 kHz	I_{CC}	5.9	-	µA	*7
			All peripheral clock enabled, while (1) code executing from flash*5	ICLK = 32.768 kHz		13.0	-		*8
			All peripheral clock enabled, code executing from flash*5	ICLK = 32.768 kHz		128.3 (17.8)*10	163.7		
		Sleep mode	All peripheral clock disabled*5	ICLK = 32.768 kHz		3.2	-		*7
			All peripheral clock enabled*5	ICLK = 32.768 kHz		10.0	-		*8

Note 1. Supply current values do not include output charge/discharge current from all pins. The values apply when internal pull-up MOSs are in the off state.
Note 2. The clock source is HOCO.
Note 3. The clock source is MOCO.
Note 4. The clock source is the sub-clock oscillator.
Note 5. This does not include BGO operation.
Note 6. This is the increase for programming or erasure of the ROM or flash memory for data storage during program execution.
Note 7. PCLKB and PCLKD are set to divided by 64.
Note 8. PCLKB and PCLKD are the same frequency as that of ICLK.
Note 9. VCC = 3.3 V.
Note 10. MOCO and DAC is stopped.

2.3 AC Characteristics

2.3.1 Frequency

Table 2.16 Operation frequency in high-speed operating mode
Conditions: VCC = AVCC0 = 2.4 to 5.5 V

Parameter			Symbol	Min	Typ	Max*5	Unit
Operation frequency	System clock (ICLK)*1, *2, *4	2.7 to 5.5 V	f	0.032768	-	32	MHz
		2.4 to 2.7 V		0.032768	-	16	
	Peripheral module clock (PCLKB)*4	2.7 to 5.5 V		-	-	32	
		2.4 to 2.7 V		-	-	16	
	Peripheral module clock (PCLKD)*3, *4	2.7 to 5.5 V		-	-	64	
		2.4 to 2.7 V		-	-	16	

Note 1. The lower-limit frequency of ICLK is 1 MHz while programming or erasing the flash memory. When using ICLK for programming or erasing the flash memory at below 4 MHz, the frequency can be set to 1 MHz, 2 MHz, or 3 MHz. A non-integer frequency such as 1.5 MHz cannot be set.
Note 2. The frequency accuracy of ICLK must be ±3.5% during programming or erasing the flash memory. Confirm the frequency accuracy of the clock source.
Note 3. The lower-limit frequency of PCLKD is 4 MHz at 2.4 V or above and 1 MHz at below 2.4 V when the 14-bit A/D converter is in use.
Note 4. See section 8, Clock Generation Circuit in User's Manual for the relationship of frequencies between ICLK, PCLKB, and PCLKD.
Note 5. The maximum value of operation frequency does not include internal oscillator errors. For details on the range of guaranteed operation, see Table 2.21, Clock timing.

Table 2.17 Operation frequency in middle-speed mode
Conditions: VCC = AVCC0 = 1.8 to 5.5 V

Parameter			Symbol	Min	Typ	Max*5	Unit
Operation frequency	System clock (ICLK)*1, *2, *4	2.7 to 5.5 V	f	0.032768	-	12	MHz
		2.4 to 2.7 V		0.032768	-	12	
		1.8 to 2.4 V		0.032768	-	8	
	Peripheral module clock (PCLKB)*4	2.7 to 5.5 V		-	-	12	
		2.4 to 2.7 V		-	-	12	
		1.8 to 2.4 V		-	-	8	
	Peripheral module clock (PCLKD)*3, *4	2.7 to 5.5 V		-	-	12	
		2.4 to 2.7 V		-	-	12	
		1.8 to 2.4 V		-	-	8	

Note 1. The lower-limit frequency of ICLK is 1 MHz while programming or erasing the flash memory. When using ICLK for programming or erasing the flash memory at below 4 MHz, the frequency can be set to 1 MHz, 2 MHz, or 3 MHz. A non-integer frequency such as 1.5 MHz cannot be set.
Note 2. The frequency accuracy of ICLK must be ±3.5% during programming or erasing the flash memory. Confirm the frequency accuracy of the clock source.
Note 3. The lower-limit frequency of PCLKD is 4 MHz at 2.4 V or above and 1 MHz at below 2.4 V when the 14-bit A/D converter is in use.
Note 4. See section 8, Clock Generation Circuit in User's Manual for the relationship of frequencies between ICLK, PCLKB, and PCLKD.
Note 5. The maximum value of operation frequency does not include internal oscillator errors. For details on the range of guaranteed operation, see Table 2.21, Clock timing.

Table 2.18 Operation frequency in low-speed mode

Conditions: VCC = AVCC0 = 1.8 to 5.5 V

Parameter			Symbol	Min	Typ	Max*5	Unit
Operation frequency	System clock (ICLK)*1, *2, *4	1.8 to 5.5 V	f	0.032768	-	1	MHz
	Peripheral module clock (PCLKB)*4	1.8 to 5.5 V		-	-	1	
	Peripheral module clock (PCLKD)*3, *4	1.8 to 5.5 V		-	-	1	

Note 1. The lower-limit frequency of ICLK is 1 MHz while programming or erasing the flash memory.
Note 2. The frequency accuracy of ICLK must be ±3.5% during programming or erasing the flash memory. Confirm the frequency accuracy of the clock source.
Note 3. The lower-limit frequency of PCLKD is 1 MHz when the A/D converter is in use.
Note 4. See section 8, Clock Generation Circuit in User's Manual for the relationship of frequencies between ICLK, PCLKB, and PCLKD.
Note 5. The maximum value of operation frequency does not include internal oscillator errors. For details on the range of guaranteed operation, see Table 2.21, Clock timing.

Table 2.19 Operation frequency in low-voltage mode

Conditions: VCC = AVCC0 = 1.6 to 5.5 V

Parameter			Symbol	Min	Typ	Max*5	Unit
Operation frequency	System clock (ICLK)*1, *2, *4	1.6 to 5.5 V	f	0.032768	-	4	MHz
	Peripheral module clock (PCLKB)*4	1.6 to 5.5 V		-	-	4	
	Peripheral module clock (PCLKD)*3, *4	1.6 to 5.5 V		-	-	4	

Note 1. The lower-limit frequency of ICLK is 1 MHz while programming or erasing the flash memory. When using ICLK for programming or erasing the flash memory at below 4 MHz, the frequency can be set to 1 MHz, 2 MHz, or 3 MHz. A non-integer frequency such as 1.5 MHz cannot be set.
Note 2. The frequency accuracy of ICLK must be ±3.5% during programming or erasing the flash memory. Confirm the frequency accuracy of the clock source.
Note 3. The lower-limit frequency of PCLKD is 4 MHz at 2.4 V or above and 1 MHz at below 2.4 V when the 14-bit A/D converter is in use.
Note 4. See section 8, Clock Generation Circuit in User's Manual for the relationship of frequencies between ICLK, PCLKB, and PCLKD.
Note 5. The maximum value of operation frequency does not include internal oscillator errors. For details on the range of guaranteed operation, see Table 2.21, Clock timing.

Table 2.20 Operation frequency in Subosc-speed mode

Conditions: VCC = AVCC0 = 1.8 to 5.5 V

Parameter			Symbol	Min	Typ	Max	Unit
Operation frequency	System clock (ICLK)*1, *3	1.8 to 5.5 V	f	27.8528	32.768	37.6832	kHz
	Peripheral module clock (PCLKB)*3	1.8 to 5.5 V		-	-	37.6832	
	Peripheral module clock (PCLKD)*2, *3	1.8 to 5.5 V		-	-	37.6832	

Note 1. Programming and erasing the flash memory is not possible.
Note 2. The 14-bit A/D converter cannot be used.
Note 3. See section 8, Clock Generation Circuit in User's Manual for the relationship between ICLK, PCLKB, and PCLKD frequencies.

2.3.3 Reset Timing

Table 2.22 Reset timing

Parameter		Symbol	Min	Typ	Max	Unit	Test conditions
RES pulse width	At power-on	t_{RESWP}	3	-	-	ms	Figure 2.29
	Not at power-on	t_{RESW}	30	-	-	μs	Figure 2.30
Wait time after RES cancellation (at power-on)	LVD0 enabled*1	t_{RESWT}	-	0.7	-	ms	Figure 2.29
	LVD0 disabled*2		-	0.3	-		
Wait time after RES cancellation (during powered-on state)	LVD0 enabled*1	t_{RESWT2}	-	0.5	-	ms	Figure 2.30
	LVD0 disabled*2		-	0.05	-		
Wait time after internal reset cancellation (watchdog timer reset, SRAM parity error reset, SRAM ECC error reset, bus master MPU error reset, bus slave MPU error reset, stack pointer error reset, software reset)	LVD0 enabled*1	t_{RESWT3}	-	0.6	-	ms	-
	LVD0 disabled*2		-	0.15	-		-

Note 1. When OFS1.LVDAS = 0.
Note 2. When OFS1.LVDAS = 1.

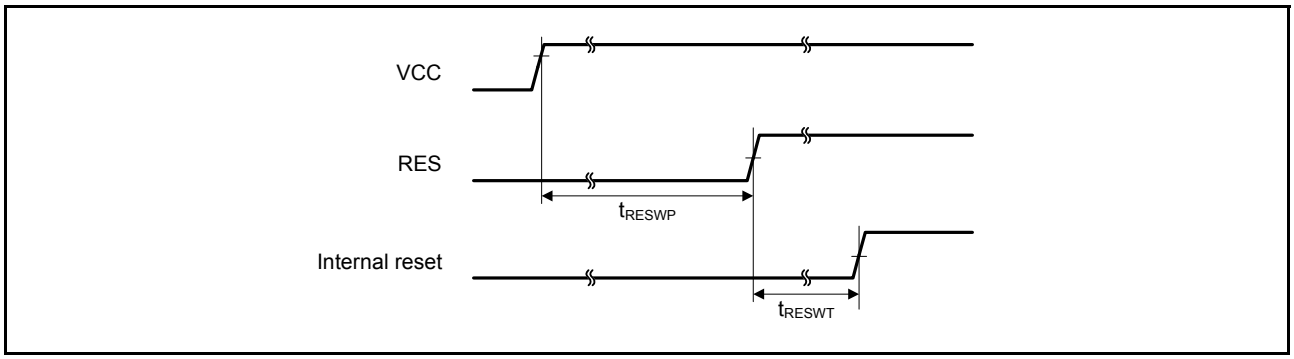


Figure 2.29 Reset input timing at power-on

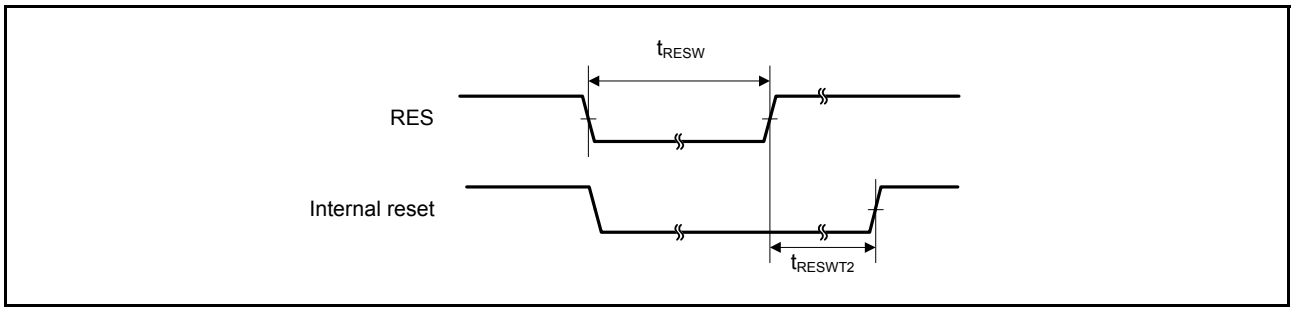
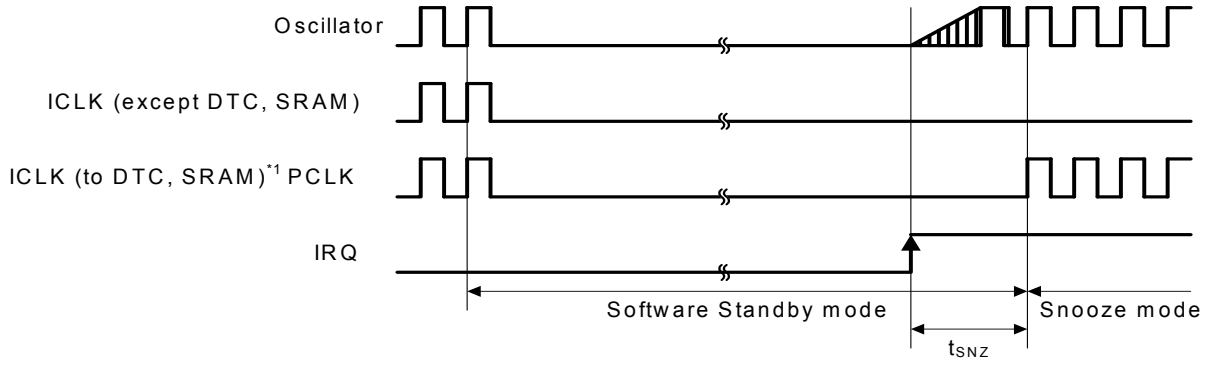


Figure 2.30 Reset input timing



Note 1. When SNZCR.SNZDTCEN is set to 1, ICLK is supplied to DTC and SRAM.

Figure 2.32 Recovery timing from Software Standby mode to Snooze mode

2.3.5 NMI and IRQ Noise Filter

Table 2.29 NMI and IRQ noise filter

Parameter	Symbol	Min	Typ	Max	Unit	Test conditions	
NMI pulse width	t_{NMIW}	200	-	-	ns	NMI digital filter disabled	$t_{Pcyc} \times 2 \leq 200$ ns
		$t_{Pcyc} \times 2$*1	-	-			$t_{Pcyc} \times 2 > 200$ ns
		200	-	-		NMI digital filter enabled	$t_{NMICK} \times 3 \leq 200$ ns
		$t_{NMICK} \times 3.5$*2	-	-			$t_{NMICK} \times 3 > 200$ ns
IRQ pulse width	t_{IRQW}	200	-	-	ns	IRQ digital filter disabled	$t_{Pcyc} \times 2 \leq 200$ ns
		$t_{Pcyc} \times 2$*1	-	-			$t_{Pcyc} \times 2 > 200$ ns
		200	-	-		IRQ digital filter enabled	$t_{IRQCK} \times 3 \leq 200$ ns
		$t_{IRQCK} \times 3.5$*3	-	-			$t_{IRQCK} \times 3 > 200$ ns

Note: 200 ns minimum in Software Standby mode.
Note 1. t_{Pcyc} indicates the PCLKB cycle.
Note 2. t_{NMICK} indicates the cycle of the NMI digital filter sampling clock.
Note 3. t_{IRQCK} indicates the cycle of the IRQi digital filter sampling clock (i = 0 to 7).

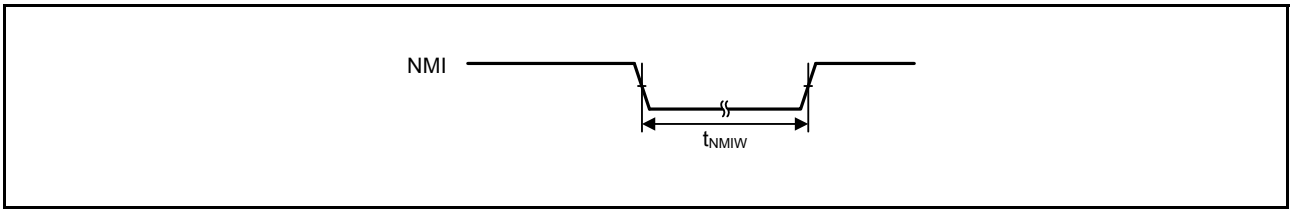


Figure 2.33 NMI interrupt input timing

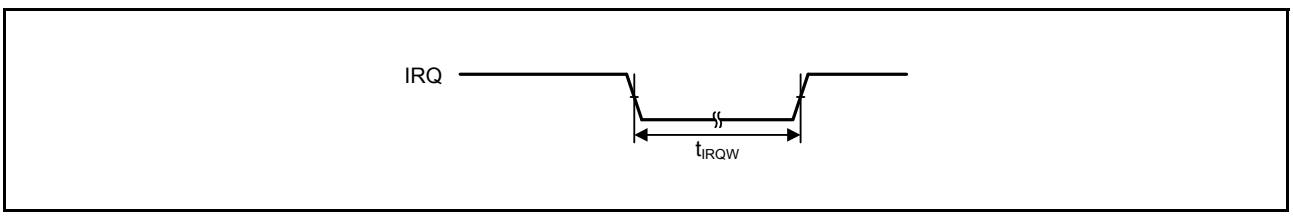


Figure 2.34 IRQ interrupt input timing

Table 2.34 SCI timing (2)
Conditions: VCC = AVCC0 = 1.6 to 5.5 V

Parameter				Symbol	Min	Max	Unit*1	Test conditions
Simple SPI	SCK clock cycle output (master)			t_{SPcyc}	4	65536	t_{Pcyc}	Figure 2.43
	SCK clock cycle input (slave)				6	65536		
	SCK clock high pulse width			t_{SPCKWH}	0.4	0.6	t_{SPcyc}	
	SCK clock low pulse width			t_{SPCKWL}	0.4	0.6	t_{SPcyc}	
	SCK clock rise and fall time		1.8V or above	t_{SPCKr}, t_{SPCKf}	-	20	ns	
			1.6V or above		-	30		
	Data input setup time	Master	2.7V or above	t_{SU}	45	-	ns	Figure 2.44 to Figure 2.47
			2.4V or above		55	-		
			1.8V or above		80	-		
			1.6V or above		110	-		
		Slave	2.7V or above		40	-		
			1.6V or above		45	-		
	Data input hold time	Master		t_H	33.3	-	ns	
		Slave			40	-		
	SS input setup time			t_{LEAD}	1	-	t_{SPcyc}	
	SS input hold time			t_{LAG}	1	-	t_{SPcyc}	
	Data output delay	Master	1.8V or above	t_{OD}	-	40	ns	
			1.6V or above		-	50		
		Slave	2.4V or above		-	65		
			1.8V or above		-	100		
			1.6V or above		-	125		
	Data output hold time	Master	2.7V or above	t_{OH}	–10	-	ns	
			2.4V or above		–20	-		
			1.8V or above		–30	-		
			1.6V or above		–40	-		
		Slave			–10	-		
	Data rise and fall time	Master		t_{Dr}, t_{Df}	-	20	ns	
		Slave	1.8V or above		-	20		
			1.6V or above		-	30		
Simple SPI	Slave access time			t_{SA}	-	6	t_{Pcyc}	Figure 2.47
	Slave output release time			t_{REL}	-	6	t_{Pcyc}	

Note 1. t_{Pcyc}: PCLKB cycle.

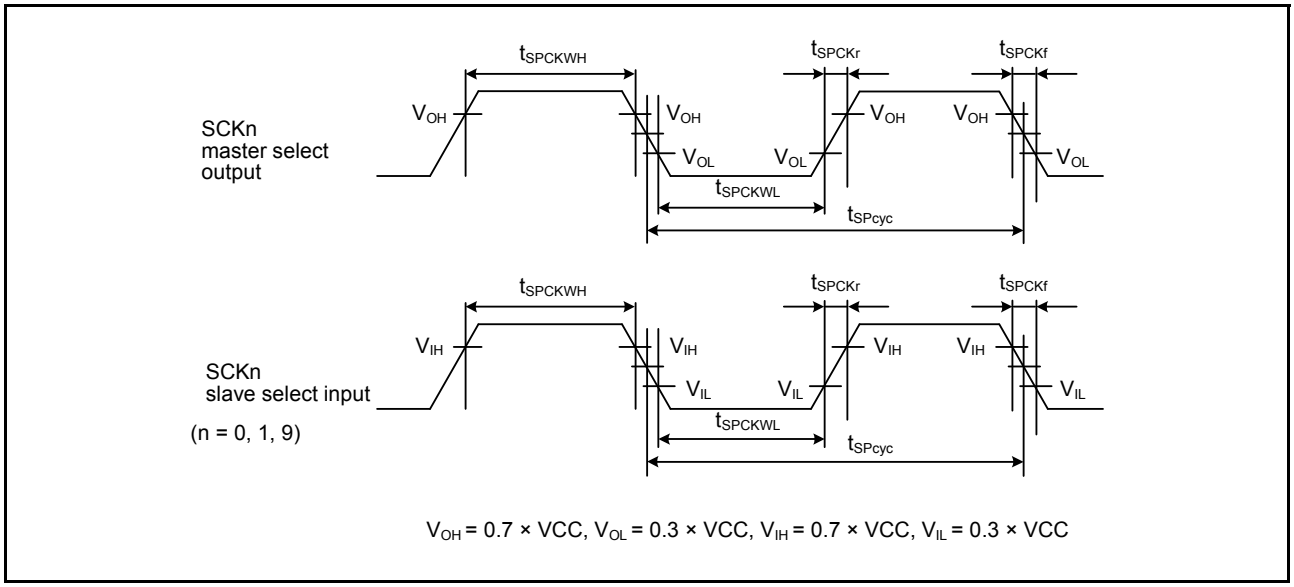


Figure 2.43 SCI simple SPI mode clock timing

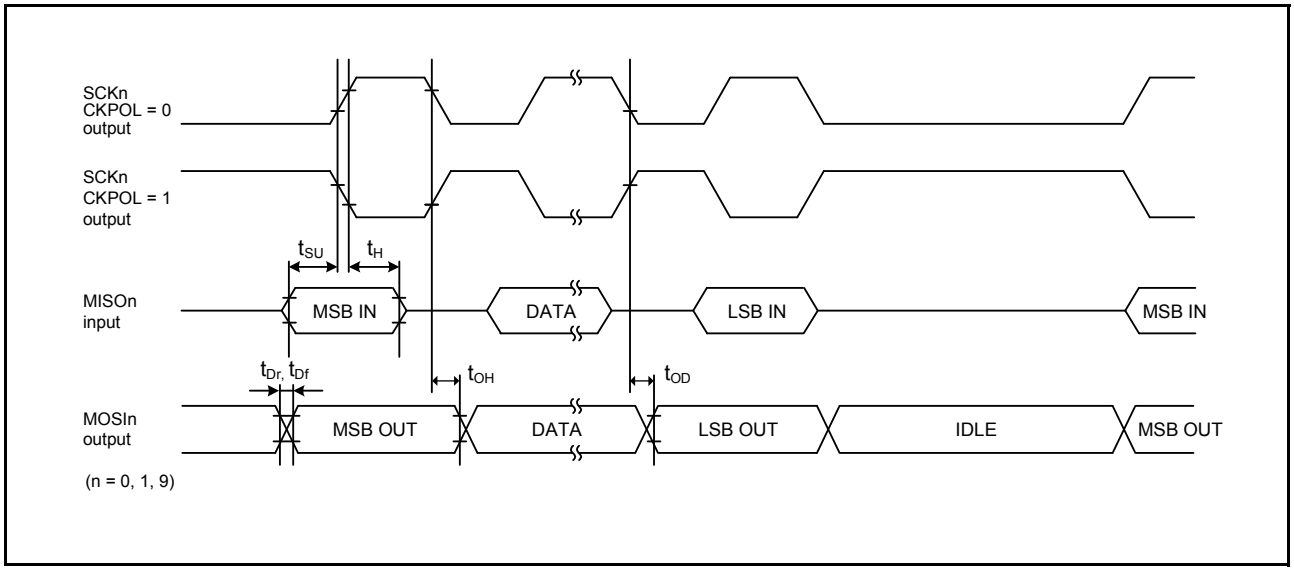


Figure 2.44 SCI simple SPI mode timing (master, CKPH = 1)

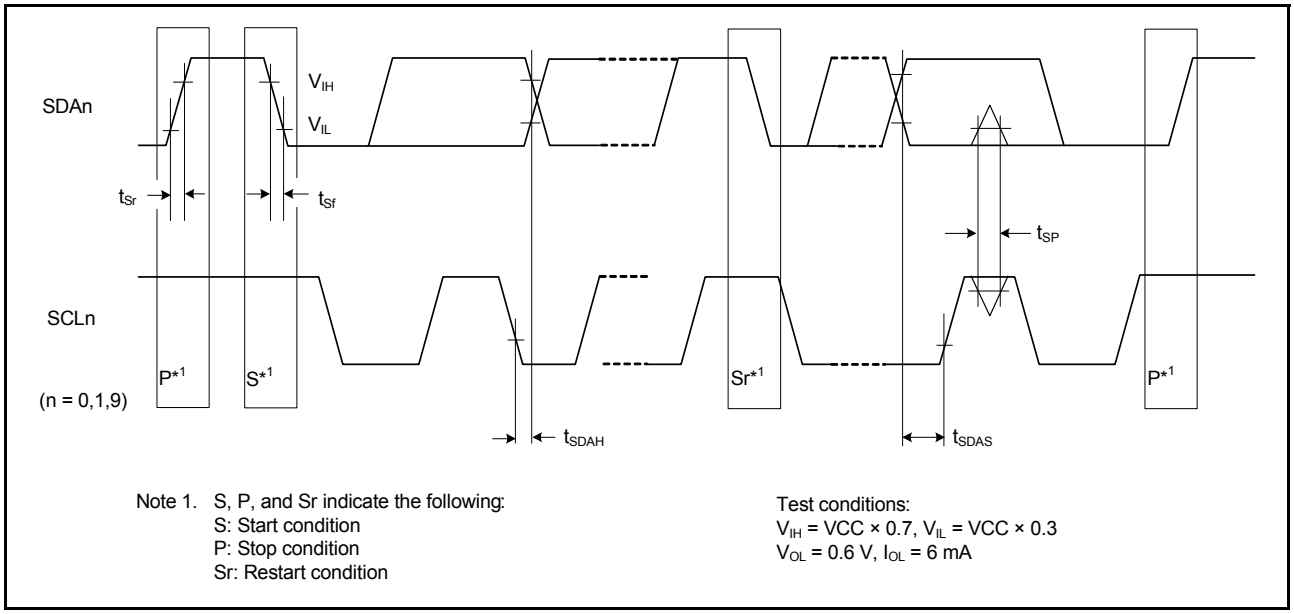


Figure 2.48 SCI simple IIC mode timing

2.3.10 SPI Timing

Table 2.36 SPI timing (1 of 2)

Conditions: Middle drive output is selected in the Port Drive Capability bit in the PmnPFS register.

Parameter				Symbol	Min	Max	Unit*1	Test conditions
SPI	RSPCK clock cycle	Master		t_{SPcyc}	2	4096	t_{Pcyc}	Figure 2.49 C = 30pF
		Slave			6	4096		
	RSPCK clock high pulse width	Master		t_{SPCKWH}	$(t_{SPcyc} - t_{SPCKR} - t_{SPCKF}) / 2 - 3$	-	ns	
		Slave			$3 \times t_{Pcyc}$	-		
	RSPCK clock low pulse width	Master		t_{SPCKWL}	$(t_{SPcyc} - t_{SPCKR} - t_{SPCKF}) / 2 - 3$	-	ns	
		Slave			$3 \times t_{Pcyc}$	-		
	RSPCK clock rise and fall time	Output	2.7V or above	t_{SPCKr}, t_{SPCKf}	-	10	ns	
			2.4V or above		-	15		
			1.8V or above		-	20		
			1.6V or above		-	30		
		Input			-	1	µs	

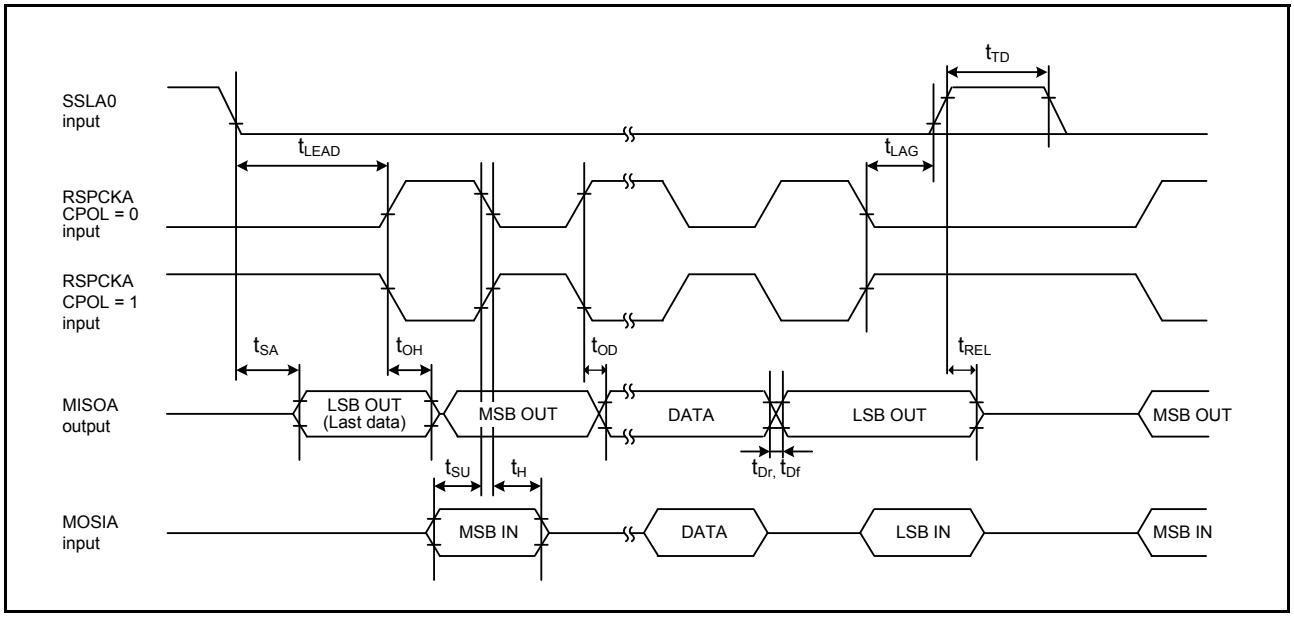
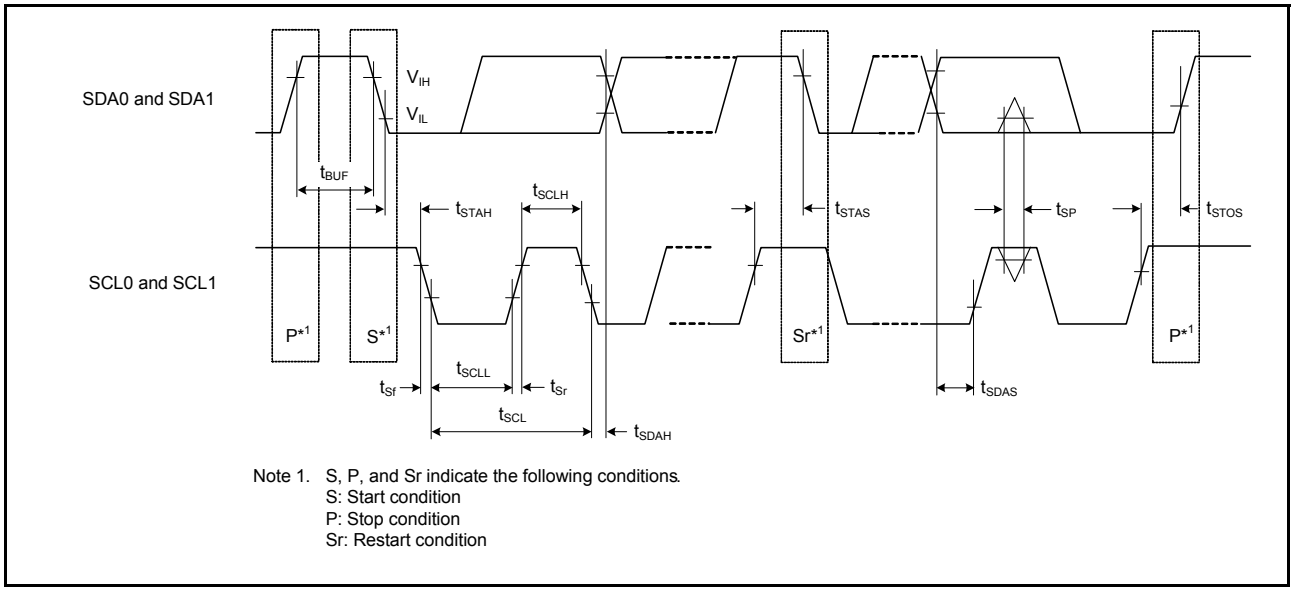


Figure 2.55 SPI timing (slave, CPHA = 1)



Note 1. S, P, and Sr indicate the following conditions.
S: Start condition
P: Stop condition
Sr: Restart condition

Figure 2.56 I²C bus interface input/output timing

2.3.12 CLKOUT Timing

Table 2.38 CLKOUT timing

Parameter			Symbol	Min	Max	Unit	Test conditions
CLKOUT	CLKOUT pin output cycle*1	VCC = 2.7 V or above	t_{Ccyc}	62.5	-	ns	Figure 2.57
		VCC = 1.8 V or above		125	-		
		VCC = 1.6 V or above		250	-		
	CLKOUT pin high pulse width*2	VCC = 2.7 V or above	t_{CH}	15	-	ns	
		VCC = 1.8 V or above		30	-		
		VCC = 1.6 V or above		150	-		
	CLKOUT pin low pulse width*2	VCC = 2.7 V or above	t_{CL}	15	-	ns	
		VCC = 1.8 V or above		30	-		
		VCC = 1.6 V or above		150	-		
	CLKOUT pin output rise time	VCC = 2.7 V or above	t_{Cr}	-	12	ns	
		VCC = 1.8 V or above		-	25		
		VCC = 1.6 V or above		-	50		
	CLKOUT pin output fall time	VCC = 2.7 V or above	t_{Cf}	-	12	ns	
		VCC = 1.8 V or above		-	25		
		VCC = 1.6 V or above		-	50		

Note 1. When the EXTAL external clock input or an oscillator divided by 1 (the CKOCR.CKOSEL[2:0] bits are 011b and the CKOCR.CKODIV[2:0] bits are 000b) is used for output from CLKOUT, specifications in Table 2.38 should be satisfied with 45% to 55% of input duty cycle.

Note 2. When MOCO is selected as the clock output source (the CKOCR.CKOSEL[2:0] bits are 001b), set the clock output division ratio to 2 (the CKOCR.CKODIV[2:0] bits are 001b).

2.4 USB Characteristics

2.4.1 USBFS Timing

Table 2.39 USB characteristics

Conditions: VCC = AVCC0 = VCC_USB = 3.0 to 3.6 V, Ta = –20 to +85°C

Parameter			Symbol	Min	Max	Unit	Test conditions
Input characteristics	Input high level voltage		V_{IH}	2.0	-	V	-
	Input low level voltage		V_{IL}	-	0.8	V	-
	Differential input sensitivity		V_{DI}	0.2	-	V	| USB_DP – USB_DM |
	Differential common mode range		V_{CM}	0.8	2.5	V	-
Output characteristics	Output high level voltage		V_{OH}	2.8	VCC_USB	V	I_{OH} = –200 µA
	Output low level voltage		V_{OL}	0.0	0.3	V	I_{OL}= 2 mA
	Cross-over voltage		V_{CRS}	1.3	2.0	V	Figure 2.58, Figure 2.59, Figure 2.60
	Rise time	FS	t_r	4	20	ns	
		LS		75	300		
	Fall time	FS	t_f	4	20	ns	
		LS		75	300		
	Rise/fall time ratio	FS	t_r/t_f	90	111.11	%	
		LS		80	125		
	Output resistance		Z_{DRV}	28	44	Ω	(Adjusting the resistance of external elements is not necessary.)
VBUS characteristics	VBUS input voltage		V_{IH}	VCC × 0.8	-	V	-
			V_{IL}	-	VCC × 0.2	V	-
Pull-up, pull-down	Pull-down resistor		R_{PD}	14.25	24.80	kΩ	-
	Pull-up resistor		R_{PUI}	0.9	1.575	kΩ	During idle state
			R_{PUA}	1.425	3.09	kΩ	During reception
Battery Charging Specification Ver 1.2	D + sink current		I_{DP_SINK}	25	175	µA	-
	D – sink current		I_{DM_SINK}	25	175	µA	-
	DCD source current		I_{DP_SRC}	7	13	µA	-
	Data detection voltage		V_{DAT_REF}	0.25	0.4	V	-
	D + source voltage		V_{DP_SRC}	0.5	0.7	V	Output current = 250 µA
	D – source voltage		V_{DM_SRC}	0.5	0.7	V	Output current = 250 µA

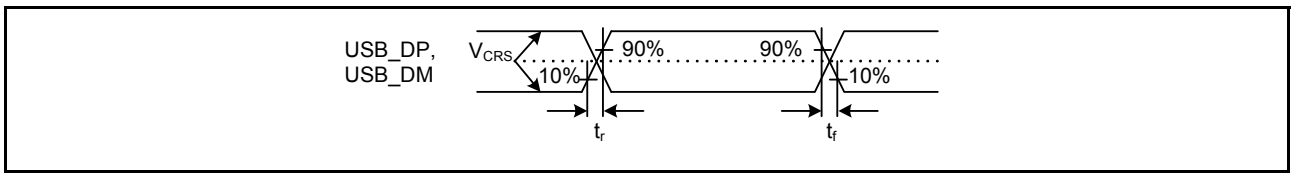


Figure 2.58 USB_DP and USB_DM output timing

Table 2.47 A/D conversion characteristics (7) in low-power A/D conversion mode (2 of 2)

Conditions: VCC = AVCC0 = 1.6 to 5.5 V (AVCC0 = VCC when VCC < 2.0 V), VREFH0 = 1.6 to 5.5 V, VSS = AVSS0 = VREFL0 = 0
Reference voltage range applied to the VREFH0 and VREFL0.

Parameter	Min	Typ	Max	Unit	Test Conditions
Offset error	-	±4.0	±30.0	LSB	High-precision channel
			±40.0	LSB	Other than above
Full-scale error	-	±6.0	±30.0	LSB	High-precision channel
			±40.0	LSB	Other than above
Quantization error	-	±0.5	-	LSB	-
Absolute accuracy	-	±12.0	±32.0	LSB	High-precision channel
			±48.0	LSB	Other than above
DNL differential nonlinearity error	-	±4.0	-	LSB	-
INL integral nonlinearity error	-	±4.0	±12.0	LSB	-

Note: The characteristics apply when no pin functions other than 14-bit A/D converter input are used. Absolute accuracy does not include quantization errors. Offset error, full-scale error, DNL differential nonlinearity error, and INL integral nonlinearity error do not include quantization errors.

Note 1. The conversion time is the sum of the sampling time and the comparison time. The number of sampling states is indicated for the test conditions.

Table 2.48 14-bit A/D converter channel classification

Classification	Channel	Conditions	Remarks
High-precision channel	AN000 to AN013	AVCC0 = 1.6 to 5.5 V	Pins AN000 to AN013 cannot be used as general I/O, IRQ2 input, or for TS transmission when the A/D converter is in use.
Normal-precision channel	AN016 to AN022		-
Internal reference voltage input channel	Internal reference voltage	AVCC0 = 2.0 to 5.5 V	-
Temperature sensor input channel	Temperature sensor output	AVCC0 = 2.0 to 5.5 V	-

Table 2.49 A/D internal reference voltage characteristics

Conditions: VCC = AVCC0 = VREFH0 = 2.0 to 5.5 V*1

Parameter	Min	Typ	Max	Unit	Test conditions
Internal reference voltage input channel*2	1.36	1.43	1.50	V	-
Sampling time	5.0	-	-	µs	-

Note 1. The internal reference voltage cannot be selected for input channels when AVCC0 < 2.0 V.

Note 2. The 14-bit A/D internal reference voltage indicates the voltage when the internal reference voltage is input to the 14-bit A/D converter.

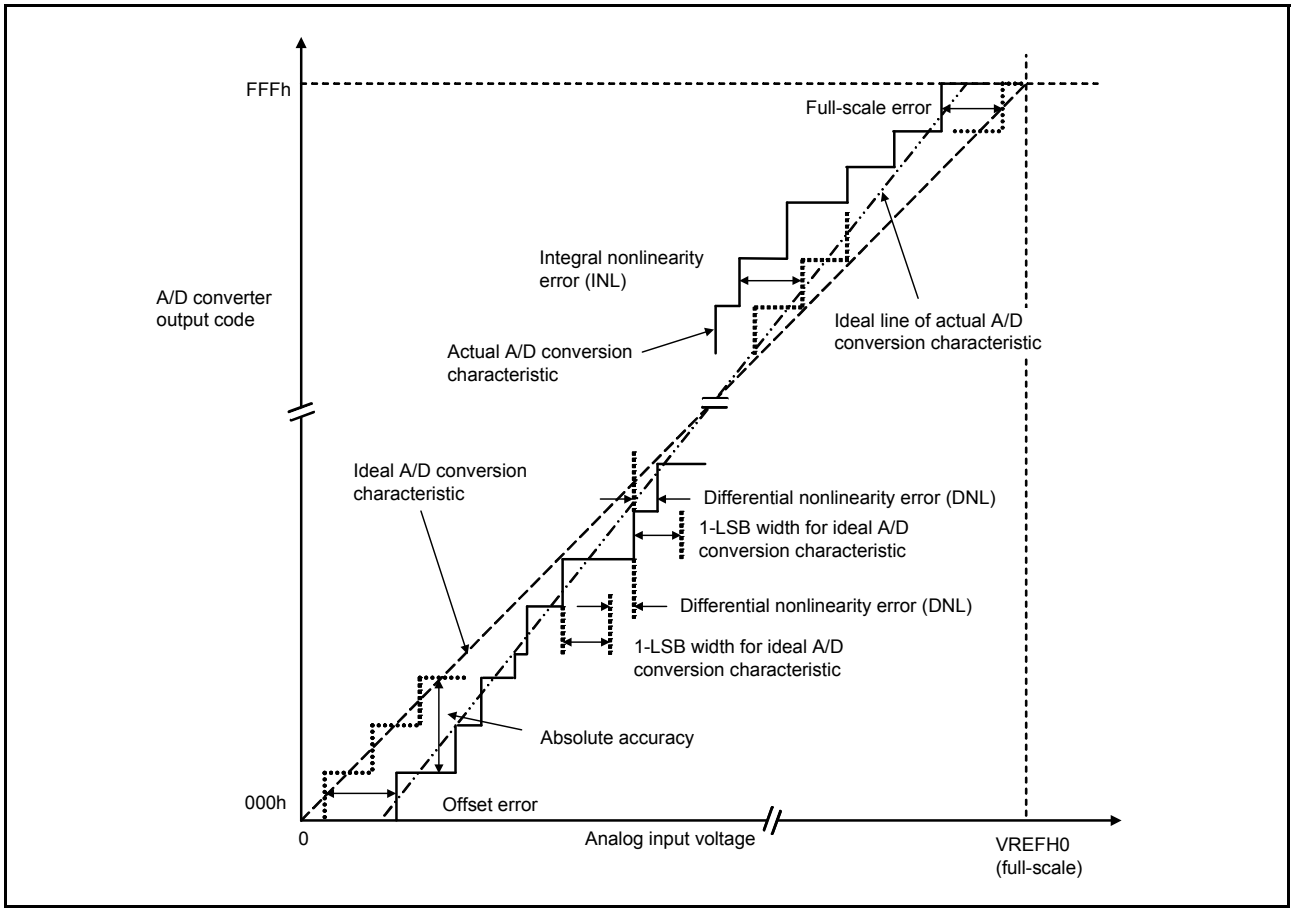


Figure 2.62 Illustration of 14-bit A/D converter characteristic terms

Absolute accuracy

Absolute accuracy is the difference between output code based on the theoretical A/D conversion characteristics, and the actual A/D conversion result. When measuring absolute accuracy, the voltage at the midpoint of the width of the analog input voltage (1-LSB width), which can meet the expectation of outputting an equal code based on the theoretical A/D conversion characteristics, is used as the analog input voltage. For example, if 12-bit resolution is used and the reference voltage VREFH0 = 3.072 V, then 1-LSB width becomes 0.75 mV, and 0 mV, 0.75 mV, and 1.5 mV are used as the analog input voltages. If analog input voltage is 6 mV, an absolute accuracy of ±5 LSB means that the actual A/D conversion result is in the range of 003h to 00Dh, though an output code of 008h can be expected from the theoretical A/D conversion characteristics.

Integral nonlinearity error (INL)

Integral nonlinearity error is the maximum deviation between the ideal line when the measured offset and full-scale errors are zeroed, and the actual output code.

Differential nonlinearity error (DNL)

Differential nonlinearity error is the difference between 1-LSB width based on the ideal A/D conversion characteristics and the width of the actual output code.

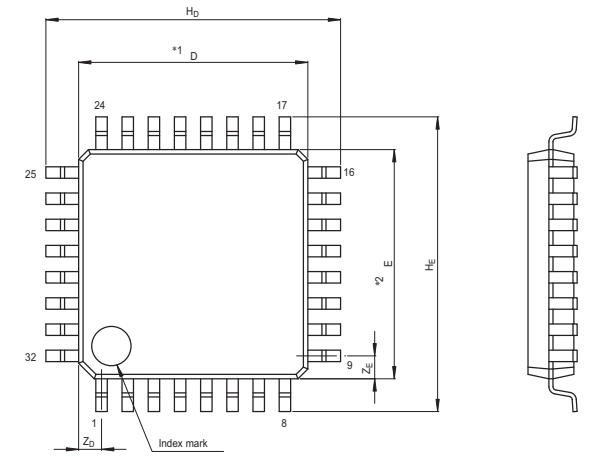
Offset error

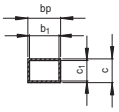
Offset error is the difference between the transition point of the ideal first output code and the actual first output code.

Full-scale error

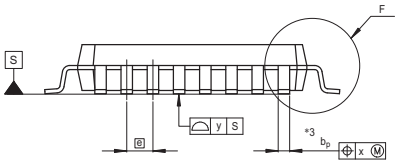
Full-scale error is the difference between the transition point of the ideal last output code and the actual last output code.

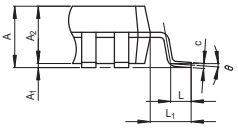
JEITA Package Code	RENESAS Code	Previous Code	MASS[Typ.]
P-LQFP32-7x7-0.80	PLQP0032GB-A	32P6U-A	0.2g





Terminal cross section





Detail F

NOTE)
1. DIMENSIONS "*1" AND "*2" DO NOT INCLUDE MOLD FLASH.
2. DIMENSION "*3" DOES NOT INCLUDE TRIM OFFSET.

Reference Symbol	Dimension in Millimeters		
	Min	Nom	Max
D	6.9	7.0	7.1
E	6.9	7.0	7.1
A_2	—	1.4	—
H_D	8.8	9.0	9.2
H_E	8.8	9.0	9.2
A	—	—	1.7
A_1	0	0.1	0.2
b_p	0.32	0.37	0.42
b_1	—	0.35	—
c	0.09	0.145	0.20
c_1	—	0.125	—
θ	0°	—	8°
e	—	0.8	—
x	—	—	0.20
y	—	—	0.10
Z_D	—	0.7	—
Z_E	—	0.7	—
L	0.3	0.5	0.7
L_1	—	1.0	—

Figure 1.3 LQFP 32-pin

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