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What is "Embedded - Microcontrollers"?

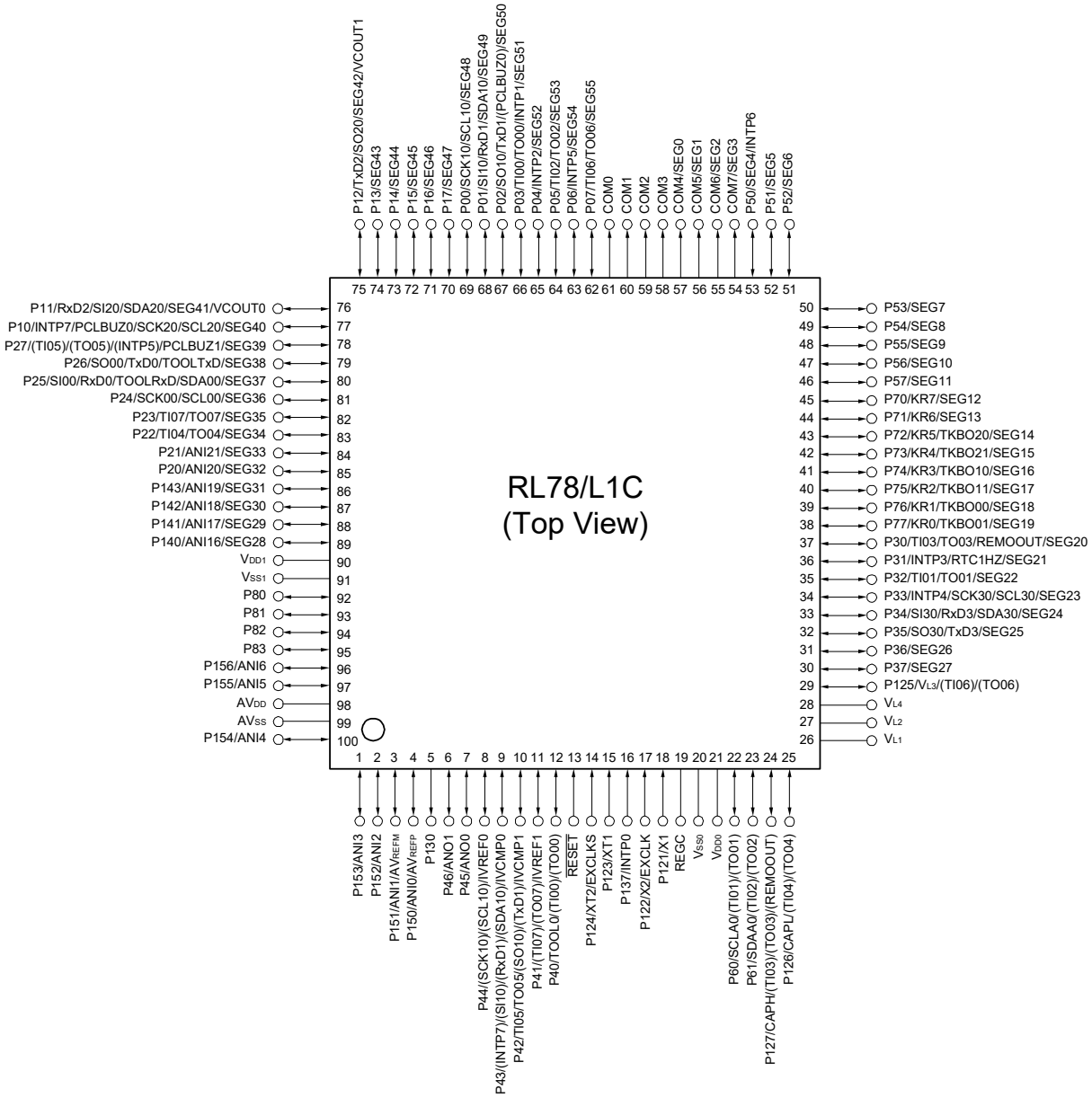
"Embedded - Microcontrollers" refer to small, integrated circuits designed to perform specific tasks within larger systems. These microcontrollers are essentially compact computers on a single chip, containing a processor core, memory, and programmable input/output peripherals. They are called "embedded" because they are embedded within electronic devices to control various functions, rather than serving as standalone computers. Microcontrollers are crucial in modern electronics, providing the intelligence and control needed for a wide range of applications.

Applications of "Embedded - Microcontrollers"

Details	
Product Status	Active
Core Processor	RL78
Core Size	16-Bit
Speed	24MHz
Connectivity	CSI, I²C, LINbus, UART/USART
Peripherals	LCD, LVD, POR, PWM, WDT
Number of I/O	55
Program Memory Size	256KB (256K x 8)
Program Memory Type	FLASH
EEPROM Size	8K x 8
RAM Size	16K x 8
Voltage - Supply (Vcc/Vdd)	1.6V ~ 3.6V
Data Converters	A/D 11x8/12b; D/A 2x8b
Oscillator Type	Internal
Operating Temperature	-40°C ~ 105°C (TA)
Mounting Type	Surface Mount
Package / Case	80-LQFP
Supplier Device Package	80-LQFP (12x12)
Purchase URL	https://www.e-xfl.com/product-detail/renesas-electronics-america/r5f111mjgfb-30

1.3.6 100-pin products (without USB)

• 100-pin plastic LFQFP (fine pitch) (14 × 14 mm, 0.5 mm pitch)



Caution Connect the REGC pin to Vss pin via a capacitor (0.47 to 1 µF).

Remark 1. For pin identification, see **1.4 Pin Identification**.

Remark 2. Functions in parentheses in the above figure can be assigned via settings in the peripheral I/O redirection register (PIOR).

2.1 Absolute Maximum Ratings

Absolute Maximum Ratings (T_A = 25°C) **(1/3)**

Parameter	Symbols	Conditions	Ratings	Unit
Supply voltage	V_{DD}		-0.5 to + 6.5	V
	UV_{BUS}		-0.5 to + 6.5	V
	AV_{DD}	$AV_{DD} \leq V_{DD}$	-0.5 to + 4.6	V
REGC pin input voltage	V_{IREGC}	REGC	-0.3 to + 2.8 and -0.3 to V_{DD} + 0.3 Note 1	V
U_{REGC} pin input voltage	V_{IUREGC}	U_{REGC}	-0.3 to UV_{BUS} + 0.3 Note 2	V
Input voltage	V_{I1}	P00 to P07, P10 to P17, P20 to P27, P30 to P37, P40 to P46, P50 to P57, P70 to P77, P80 to P83, P125 to P127, P137, P140 to P143, EXCLK, EXCLKS, $\overline{\text{RESET}}$	-0.3 to V_{DD} + 0.3 Note 3	V
	V_{I2}	P60, P61 (N-ch open-drain)	-0.3 to + 6.5	V
	V_{I3}	UDP, UDM	-0.3 to + 6.5	V
	V_{I4}	P150 to P156	-0.3 to AV_{DD} + 0.3 Note 4	V
Output voltage	V_{O1}	P00 to P07, P10 to P17, P20 to P27, P30 to P37, P40 to P46, P50 to P57, P60, P61, P70 to P77, P80 to P83, P125 to P127, P130, P140 to P143	-0.3 to V_{DD} + 0.3 Note 3	V
	V_{O2}	P150 to P156	-0.3 to AV_{DD} + 0.3 Note 3	V
	V_{O3}	UDP, UDM	-0.3 to + 3.8	V
Analog input voltage	V_{AI1}	ANI16 to ANI21	-0.3 to V_{DD} + 0.3 and $AV_{REF(+)}$ + 0.3 Notes 3, 5	V
	V_{AI2}	ANI0 to ANI6	-0.3 to AV_{DD} + 0.3 and $AV_{REF(+)}$ + 0.3 Notes 3, 5	V

Note 1. Connect the REGC pin to V_{SS} via a capacitor (0.47 to 1 μF). This value regulates the absolute maximum rating of the REGC pin. Do not use this pin with voltage applied to it.

Note 2. Connect the U_{REGC} pin to Vss via a capacitor (0.33 μF). This value regulates the absolute maximum rating of the U_{REGC} pin. Do not use this pin with voltage applied to it.

Note 3. Must be 6.5 V or lower.

Note 4. Must be 4.6 V or lower.

Note 5. Do not exceed $AV_{REF(+)}$ + 0.3 V in case of A/D conversion target pin.

Caution **Product quality may suffer if the absolute maximum rating is exceeded even momentarily for any parameter. That is, the absolute maximum ratings are rated values at which the product is on the verge of suffering physical damage, and therefore the product must be used under conditions that ensure that the absolute maximum ratings are not exceeded.**

Remark 1. Unless specified otherwise, the characteristics of alternate-function pins are the same as those of the port pins.

Remark 2. $AV_{REF(+)}$: + side reference voltage of the A/D converter.

Remark 3. V_{SS}: Reference voltage

(T_A = -40 to +85°C, 1.6 V ≤ AV_{DD} = V_{DD} ≤ 3.6 V, V_{SS} = 0 V)

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Items	Symbol	Conditions		MIN.	TYP.	MAX.	Unit
Output current, low Note 1	I_{OL1}	Per pin for P00 to P07, P10 to P17, P20 to P27, P30 to P37, P40 to P46, P50 to P57, P70 to P77, P80 to P83, P125 to P127, P130, P140 to P143				20.0 Note 2	mA
		Per pin for P60 and P61				15.0 Note 2	mA
		Total of P40 to P46, P130 (When duty ≤ 70% Note 3)	2.7 V ≤ V_{DD} ≤ 3.6 V			15.0	mA
			1.8 V ≤ V_{DD} < 2.7 V			9.0	mA
			1.6 V ≤ V_{DD} < 1.8 V			4.5	mA
		Total of P00 to P07, P10 to P17, P20 to P27, P30 to P37, P50 to P57, P60, P61, P70 to P77, P80 to P83, P125 to P127, P140 to P143 (When duty ≤ 70% Note 3)	2.7 V ≤ V_{DD} ≤ 3.6 V			35.0	mA
			1.8 V ≤ V_{DD} < 2.7 V			20.0	mA
			1.6 V ≤ V_{DD} < 1.8 V			10.0	mA
		Total of all pins (When duty ≤ 70% Note 3)				50.0	mA
	I_{OL2}	Per pin for P150 to P156				0.4 Note 2	mA
		Total of all pins	1.6 V ≤ V_{DD} ≤ 3.6 V			2.8	mA

Note 1. Value of current at which the device operation is guaranteed even if the current flows from an output pin to the V_{SS} pin.

Note 2. However, do not exceed the total current value.

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Note 3. Specification under conditions where the duty factor ≤ 70%.
The output current value that has changed to the duty factor > 70% the duty ratio can be calculated with the following expression
(when changing the duty factor from 70% to n%).

- Total output current of pins = (I_{OL} × 0.7)/(n × 0.01)

<Example> Where n = 80% and I_{OL} = 10.0 mA
Total output current of pins = (10.0 × 0.7)/(80 × 0.01) ≈ 8.7 mA

However, the current that is allowed to flow into one pin does not vary depending on the duty factor. A current higher than the absolute maximum rating must not flow into one pin.

Remark Unless specified otherwise, the characteristics of alternate-function pins are the same as those of the port pins.

(T_A = -40 to +85°C, 1.6 V ≤ AV_{DD} = V_{DD} ≤ 3.6 V, V_{SS} = 0 V)

Items	Symbol	Conditions			MIN.	TYP.	MAX.	Unit
Input leakage current, high	I_{LIH1}	P00 to P07, P10 to P17, P20 to P27, P30 to P37, P40 to P46, P50 to P57, P60, P61, P70 to P77, P80 to P83, P125 to P127, P137, P140 to P143, $\overline{RESET}$	V_I = V_{DD}				1	μA
	I_{LIH2}	P20, P21, P140 to P143	V_I = V_{DD}				1	μA
	I_{LIH3}	P121 to P124 (X1, X2, EXCLK, XT1, XT2, EXCLKS)	V_I = V_{DD}	In input port or external clock input			1	μA
				In resonator connection			10	μA
	I_{LIH4}	P150 to P156	V_I = AV_{DD}				1	μA
Input leakage current, low	I_{LIL1}	P00 to P07, P10 to P17, P20 to P27, P30 to P37, P40 to P46, P50 to P57, P60, P61, P70 to P77, P80 to P83, P125 to P127, P137, P140 to P143, $\overline{RESET}$	V_I = V_{SS}				-1	μA
	I_{LIL2}	P20, P21, P140 to P143	V_I = V_{SS}				-1	μA
	I_{LIL3}	P121 to P124 (X1, X2, EXCLK, XT1, XT2, EXCLKS)	V_I = V_{SS}	In input port or external clock input			-1	μA
				In resonator connection			-10	μA
	I_{LIL4}	P150 to P156	V_I = AV_{SS}				-1	μA
On-chip pull-up resistance	R_{U1}	P00 to P07, P10 to P17, P20 to P27, P30 to P37, P50 to P57, P70 to P77, P140 to P143, P125 to P127	V_I = V_{SS}	2.4 V ≤ V_{DD} ≤ 3.6 V	10	20	100	kΩ
				1.6 V ≤ V_{DD} ≤ 2.4 V	10	30	100	
	R_{U2}	P40 to P46, P80 to P83	V_I = V_{SS}		10	20	100	kΩ

Remark Unless specified otherwise, the characteristics of alternate-function pins are the same as those of the port pins.

2.4 AC Characteristics

2.4.1 Basic operation

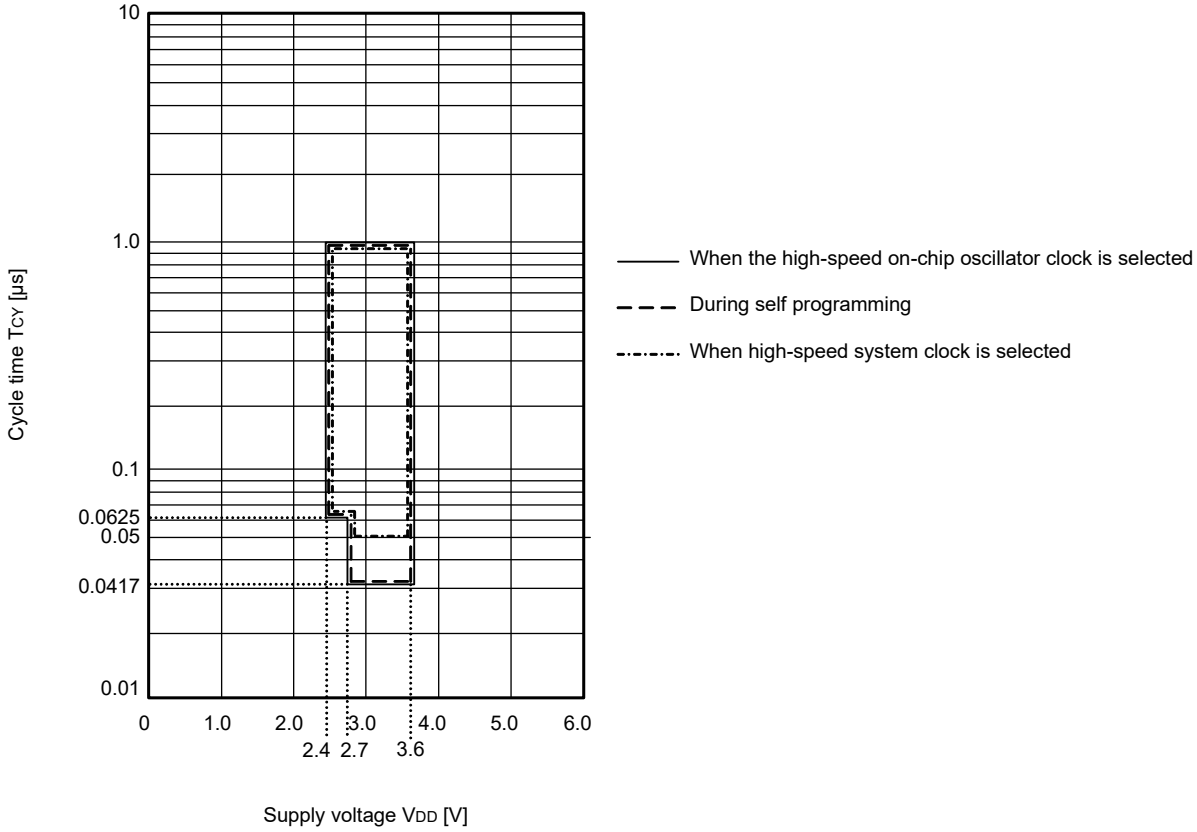
(T_A = -40 to +85°C, 1.6 V ≤ AV_{DD} = V_{DD} ≤ 3.6 V, V_{SS} = 0 V) **(1/2)**

Items	Symbol	Conditions			MIN.	TYP.	MAX.	Unit
Instruction cycle (minimum instruction execution time)	T_{CY}	Main system clock (f_{MAIN}) operation	HS (high-speed main) mode	2.7 V ≤ V_{DD} ≤ 3.6 V	0.0417		1	μs
				2.4 V ≤ V_{DD} < 2.7 V	0.0625		1	μs
			LS (low-speed main) mode	1.8 V ≤ V_{DD} ≤ 3.6 V	0.125		1	μs
			LV (low-voltage main) mode	1.6 V ≤ V_{DD} ≤ 3.6 V	0.25		1	μs
		Subsystem clock (f_{SUB}) operation		1.8 V ≤ V_{DD} ≤ 3.6 V	28.5	30.5	31.3	μs
		In the self-programming mode	HS (high-speed main) mode	2.7 V ≤ V_{DD} ≤ 3.6 V	0.0417		1	μs
				2.4 V ≤ V_{DD} < 2.7 V	0.0625		1	μs
			LS (low-speed main) mode	1.8 V ≤ V_{DD} ≤ 3.6 V	0.125		1	μs
			LV (low-voltage main) mode	1.8 V ≤ V_{DD} ≤ 3.6 V	0.25		1	μs
External main system clock frequency	f_{EX}	2.7 V ≤ V_{DD} ≤ 3.6 V			1.0		20.0	MHz
		2.4 V ≤ V_{DD} < 2.7 V			1.0		16.0	MHz
		1.8 V ≤ V_{DD} < 2.4 V			1.0		8.0	MHz
		1.6 V ≤ V_{DD} < 1.8 V			1.0		4.0	MHz
	f_{EXT}				32		35	kHz
External main system clock input high-level width, low-level width	t_{EXH}, t_{EXL}	2.7 V ≤ V_{DD} ≤ 3.6 V			24			ns
		2.4 V ≤ V_{DD} < 2.7 V			30			ns
		1.8 V ≤ V_{DD} < 2.4 V			60			ns
		1.6 V ≤ V_{DD} < 1.8 V			120			ns
	t_{EXHS}, t_{EXLS}				13.7			μs
TI00 to TI07 input high-level width, low-level width	t_{TIH}, t_{TIL}				1/f_{MCK} + 10			ns

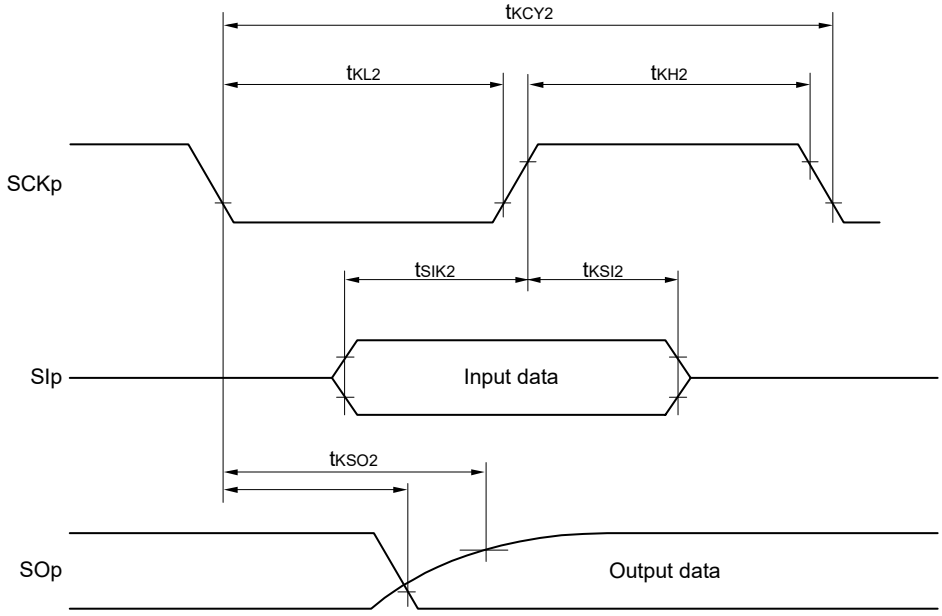
Remark f_{MCK}: Timer array unit operation clock frequency
(Operation clock to be set by the CKSmn bit of timer mode register mn (TMRmn). m: Unit number (m = 0), n: Channel number (n = 0 to 7))

Minimum Instruction Execution Time during Main System Clock Operation

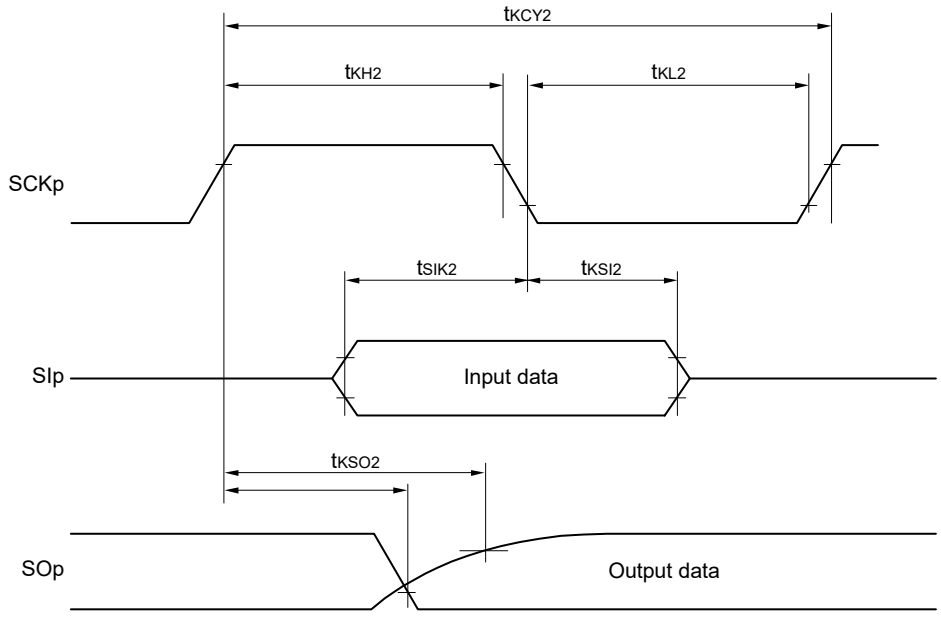
T_{CY} vs V_{DD} (HS (high-speed main) mode)



CSI mode serial transfer timing (slave mode) (during communication at different potential)
(When DAPmn = 0 and CKPmn = 0, or DAPmn = 1 and CKPmn = 1.)



CSI mode serial transfer timing (slave mode) (during communication at different potential)
(When DAPmn = 0 and CKPmn = 1, or DAPmn = 1 and CKPmn = 0.)



Remark p: CSI number (p = 00, 10, 20, 30), m: Unit number (m = 0, 1),
n: Channel number (n = 0 to 3), g: PIM and POM number (g = 0 to 3)

(2) I^2C fast mode

(T_A = -40 to +85°C, 1.8 V ≤ V_{DD} ≤ 3.6 V, V_{SS} = 0 V)

Parameter	Symbol	Conditions		HS (high-speed main) Mode		LS (low-speed main) Mode		LV (low-voltage main) Mode		Unit
				MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	
SCLA0 clock frequency	f_{SCL}	Fast mode: f_{CLK} ≥ 3.5 MHz	2.7 V ≤ V_{DD} ≤ 3.6 V	0	400	0	400	0	400	kHz
			1.8 V ≤ V_{DD} ≤ 3.6 V	0	400	0	400	0	400	kHz
Setup time of restart condition	$t_{SU: STA}$	2.7 V ≤ V_{DD} ≤ 3.6 V		0.6		0.6		0.6		μs
		1.8 V ≤ V_{DD} ≤ 3.6 V		0.6		0.6		0.6		μs
Hold time Note 1	$t_{HD: STA}$	2.7 V ≤ V_{DD} ≤ 3.6 V		0.6		0.6		0.6		μs
		1.8 V ≤ V_{DD} ≤ 3.6 V		0.6		0.6		0.6		μs
Hold time when SCLA0 = "L"	t_{LOW}	2.7 V ≤ V_{DD} ≤ 3.6 V		1.3		1.3		1.3		μs
		1.8 V ≤ V_{DD} ≤ 3.6 V		1.3		1.3		1.3		μs
Hold time when SCLA0 = "H"	t_{HIGH}	2.7 V ≤ V_{DD} ≤ 3.6 V		0.6		0.6		0.6		μs
		1.8 V ≤ V_{DD} ≤ 3.6 V		0.6		0.6		0.6		μs
Data setup time (reception)	$t_{SU: DAT}$	2.7 V ≤ V_{DD} ≤ 3.6 V		100		100		100		ns
		1.8 V ≤ V_{DD} ≤ 3.6 V		100		100		100		ns
Data hold time (transmission) Note 2	$t_{HD: DAT}$	2.7 V ≤ V_{DD} ≤ 3.6 V		0	0.9	0	0.9	0	0.9	μs
		1.8 V ≤ V_{DD} ≤ 3.6 V		0	0.9	0	0.9	0	0.9	μs
Setup time of stop condition	$t_{SU: STO}$	2.7 V ≤ V_{DD} ≤ 3.6 V		0.6		0.6		0.6		μs
		1.8 V ≤ V_{DD} ≤ 3.6 V		0.6		0.6		0.6		μs
Bus-free time	t_{BUF}	2.7 V ≤ V_{DD} ≤ 3.6 V		1.3		1.3		1.3		μs
		1.8 V ≤ V_{DD} ≤ 3.6 V		1.3		1.3		1.3		μs

Note 1. The first clock pulse is generated after this period when the start/restart condition is detected.

Note 2. The maximum value (MAX.) of $t_{HD: DAT}$ is during normal transfer and a wait state is inserted in the ACK (acknowledge) timing.

Remark The maximum value of C_b (communication line capacitance) and the value of R_b (communication line pull-up resistor) at that time in each mode are as follows.
Fast mode: C_b = 320 pF, R_b = 1.1 kΩ

(3) I^2C fast mode plus

(T_A = -40 to +85°C, 2.7 V ≤ V_{DD} ≤ 3.6 V, V_{SS} = 0 V)

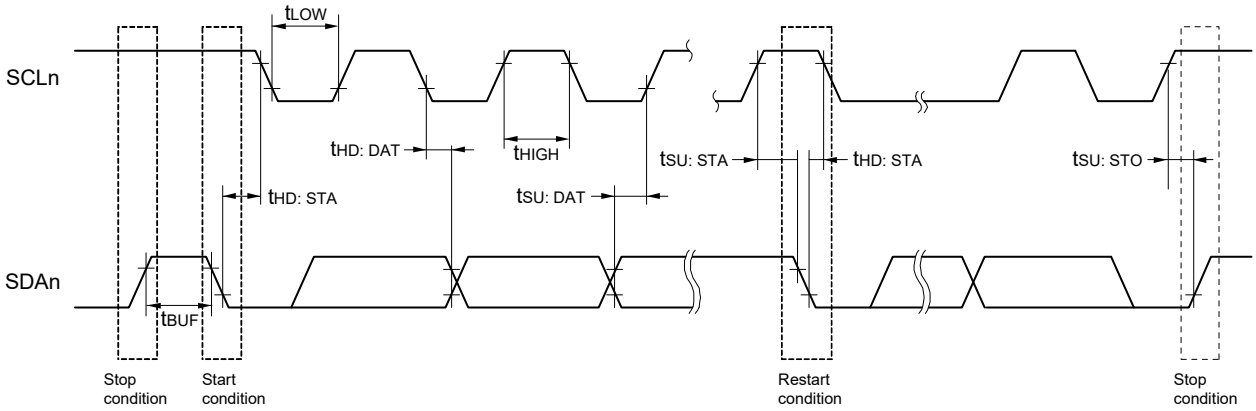
Parameter	Symbol	Conditions		HS (high-speed main) Mode		LS (low-speed main) Mode		LV (low-voltage main) Mode		Unit
				MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	
SCLA0 clock frequency	f_{SCL}	Fast mode plus: f_{CLK} ≥ 10 MHz	2.7 V ≤ V_{DD} ≤ 3.6 V	0	1000	—		—		kHz
Setup time of restart condition	$t_{SU: STA}$	2.7 V ≤ V_{DD} ≤ 3.6 V		0.26		—		—		μs
Hold time Note 1	$t_{HD: STA}$	2.7 V ≤ V_{DD} ≤ 3.6 V		0.26		—		—		μs
Hold time when SCLA0 = "L"	t_{LOW}	2.7 V ≤ V_{DD} ≤ 3.6 V		0.5		—		—		μs
Hold time when SCLA0 = "H"	t_{HIGH}	2.7 V ≤ V_{DD} ≤ 3.6 V		0.26		—		—		μs
Data setup time (reception)	$t_{SU: DAT}$	2.7 V ≤ V_{DD} ≤ 3.6 V		50		—		—		ns
Data hold time (transmission) Note 2	$t_{HD: DAT}$	2.7 V ≤ V_{DD} ≤ 3.6 V		0	0.45	—		—		μs
Setup time of stop condition	$t_{SU: STO}$	2.7 V ≤ V_{DD} ≤ 3.6 V		0.26		—		—		μs
Bus-free time	t_{BUF}	2.7 V ≤ V_{DD} ≤ 3.6 V		0.5		—		—		μs

Note 1. The first clock pulse is generated after this period when the start/restart condition is detected.

Note 2. The maximum value (MAX.) of $t_{HD: DAT}$ is during normal transfer and a wait state is inserted in the ACK (acknowledge) timing.

Remark The maximum value of C_b (communication line capacitance) and the value of R_b (communication line pull-up resistor) at that time in each mode are as follows.
Fast mode plus: C_b = 120 pF, R_b = 1.1 kΩ

IICA serial transfer timing



(2) When reference voltage (+) = AV_{REFP}/ANI0 (ADREFP1 = 0, ADREFP0 = 1), reference voltage (-) = AV_{REFM}/ANI1 (ADREFM = 1), conversion target: ANI2 to ANI6

(T_A = -40 to +85°C, 1.6 V ≤ AV_{REFP} ≤ AV_{DD} = V_{DD} ≤ 3.6 V, V_{SS} = 0 V, AV_{SS} = 0 V, Reference voltage (+) = AV_{REFP}, Reference voltage (-) = AV_{REFM} = 0 V)

Parameter	Symbol	Conditions		MIN.	TYP.	MAX.	Unit
Resolution	RES		2.4 V ≤ AV_{REFP} ≤ AV_{DD} ≤ 3.6 V	8		12	bit
			1.8 V ≤ AV_{REFP} ≤ AV_{DD} ≤ 3.6 V	8		10 Note 1	
			1.6 V ≤ AV_{REFP} ≤ AV_{DD} ≤ 3.6 V	8 Note 2			
Overall error Note 3	AINL	12-bit resolution	2.4 V ≤ AV_{REFP} ≤ AV_{DD} ≤ 3.6 V			±6.0	LSB
		10-bit resolution	1.8 V ≤ AV_{REFP} ≤ AV_{DD} ≤ 3.6 V			±5.0	
		8-bit resolution	1.6 V ≤ AV_{REFP} ≤ AV_{DD} ≤ 3.6 V			±2.5	
Conversion time	t_{CONV}	ADTYP = 0, 12-bit resolution	2.4 V ≤ AV_{REFP} ≤ AV_{DD} ≤ 3.6 V	3.375			µs
		ADTYP = 0, 10-bit resolution Note 1	1.8 V ≤ AV_{REFP} ≤ AV_{DD} ≤ 3.6 V	6.75			
		ADTYP = 0, 8-bit resolution Note 2	1.6 V ≤ AV_{REFP} ≤ AV_{DD} ≤ 3.6 V	13.5			
		ADTYP = 1, 8-bit resolution	2.4 V ≤ AV_{REFP} ≤ AV_{DD} ≤ 3.6 V	2.5625			
			1.8 V ≤ AV_{REFP} ≤ AV_{DD} ≤ 3.6 V	5.125			
			1.6 V ≤ AV_{REFP} ≤ AV_{DD} ≤ 3.6 V	10.25			
Zero-scale error Note 3	E_{ZS}	12-bit resolution	2.4 V ≤ AV_{REFP} ≤ AV_{DD} ≤ 3.6 V			±4.5	LSB
		10-bit resolution	1.8 V ≤ AV_{REFP} ≤ AV_{DD} ≤ 3.6 V			±4.5	
		8-bit resolution	1.6 V ≤ AV_{REFP} ≤ AV_{DD} ≤ 3.6 V			±2.0	
Full-scale error Note 3	E_{FS}	12-bit resolution	2.4 V ≤ AV_{REFP} ≤ AV_{DD} ≤ 3.6 V			±4.5	LSB
		10-bit resolution	1.8 V ≤ AV_{REFP} ≤ AV_{DD} ≤ 3.6 V			±4.5	
		8-bit resolution	1.6 V ≤ AV_{REFP} ≤ AV_{DD} ≤ 3.6 V			±2.0	
Integral linearity error Note 3	ILE	12-bit resolution	2.4 V ≤ AV_{REFP} ≤ AV_{DD} ≤ 3.6 V			±2.0	LSB
		10-bit resolution	1.8 V ≤ AV_{REFP} ≤ AV_{DD} ≤ 3.6 V			±1.5	
		8-bit resolution	1.6 V ≤ AV_{REFP} ≤ AV_{DD} ≤ 3.6 V			±1.0	
Differential linearity error Note 3	DLE	12-bit resolution	2.4 V ≤ AV_{REFP} ≤ AV_{DD} ≤ 3.6 V			±1.5	LSB
		10-bit resolution	1.8 V ≤ AV_{REFP} ≤ AV_{DD} ≤ 3.6 V			±1.5	
		8-bit resolution	1.6 V ≤ AV_{REFP} ≤ AV_{DD} ≤ 3.6 V			±1.0	
Analog input voltage	V_{AIN}			0		AV_{REFP}	V

Note 1. Cannot be used for lower 2 bit of ADCR register

Note 2. Cannot be used for lower 4 bit of ADCR register

Note 3. Excludes quantization error (±1/2 LSB).

Caution Always use AV_{DD} pin with the same potential as the V_{DD} pin.

(3) When reference voltage (+) = AV_{DD} (ADREFP1 = 0, ADREFP0 = 0), reference voltage (-) = AV_{SS} (ADREFM = 0), conversion target: ANI0 to ANI6

(T_A = -40 to +85°C, 1.6 V ≤ AV_{DD} = V_{DD} ≤ 3.6 V, V_{SS} = 0 V, AV_{SS} = 0 V, Reference voltage (+) = AV_{DD}, Reference voltage (-) = AV_{SS} = 0 V)

Parameter	Symbol	Conditions		MIN.	TYP.	MAX.	Unit
Resolution	RES		2.4 V ≤ AV_{DD} ≤ 3.6 V	8		12	bit
			1.8 V ≤ AV_{DD} ≤ 3.6 V	8		10 Note 1	
			1.6 V ≤ AV_{DD} ≤ 3.6 V	8 Note 2			
Overall error Note 3	AINL	12-bit resolution	2.4 V ≤ AV_{DD} ≤ 3.6 V			±7.5	LSB
		10-bit resolution	1.8 V ≤ AV_{DD} ≤ 3.6 V			±5.5	
		8-bit resolution	1.6 V ≤ AV_{DD} ≤ 3.6 V			±3.0	
Conversion time	tCONV	ADTYP = 0, 12-bit resolution	2.4 V ≤ AV_{DD} ≤ 3.6 V	3.375			µs
		ADTYP = 0, 10-bit resolution Note 1	1.8 V ≤ AV_{DD} ≤ 3.6 V	6.75			
		ADTYP = 0, 8-bit resolution Note 2	1.6 V ≤ AV_{DD} ≤ 3.6 V	13.5			
		ADTYP = 1, 8-bit resolution	2.4 V ≤ AV_{DD} ≤ 3.6 V	2.5625			
			1.8 V ≤ AV_{DD} ≤ 3.6 V	5.125			
			1.6 V ≤ AV_{DD} ≤ 3.6 V	10.25			
Zero-scale error Note 3	EZS	12-bit resolution	2.4 V ≤ AV_{DD} ≤ 3.6 V			±6.0	LSB
		10-bit resolution	1.8 V ≤ AV_{DD} ≤ 3.6 V			±5.0	
		8-bit resolution	1.6 V ≤ AV_{DD} ≤ 3.6 V			±2.5	
Full-scale error Note 3	EFS	12-bit resolution	2.4 V ≤ AV_{DD} ≤ 3.6 V			±6.0	LSB
		10-bit resolution	1.8 V ≤ AV_{DD} ≤ 3.6 V			±5.0	
		8-bit resolution	1.6 V ≤ AV_{DD} ≤ 3.6 V			±2.5	
Integral linearity error Note 3	ILE	12-bit resolution	2.4 V ≤ AV_{DD} ≤ 3.6 V			±3.0	LSB
		10-bit resolution	1.8 V ≤ AV_{DD} ≤ 3.6 V			±2.0	
		8-bit resolution	1.6 V ≤ AV_{DD} ≤ 3.6 V			±1.5	
Differential linearity error Note 3	DLE	12-bit resolution	2.4 V ≤ AV_{DD} ≤ 3.6 V			±2.0	LSB
		10-bit resolution	1.8 V ≤ AV_{DD} ≤ 3.6 V			±2.0	
		8-bit resolution	1.6 V ≤ AV_{DD} ≤ 3.6 V			±1.5	
Analog input voltage	VAIN	ANI0 to ANI6		0		AV_{DD}	V

Note 1. Cannot be used for lower 2 bit of ADCR register

Note 2. Cannot be used for lower 4 bit of ADCR register

Note 3. Excludes quantization error (±1/2 LSB).

Caution Always use AV_{DD} pin with the same potential as the V_{DD} pin.

2.6.6 LVD circuit characteristics

(T_A = -40 to +85°C, $V_{PDR} \leq V_{DD} \leq 3.6$ V $\leq V_{SS}$ = 0 V)

Parameter		Symbol	Conditions	MIN.	TYP.	MAX.	Unit
Detection voltage	Supply voltage level	V_{LVD2}	Power supply rise time	3.07	3.13	3.19	V
			Power supply fall time	3.00	3.06	3.12	V
		V_{LVD3}	Power supply rise time	2.96	3.02	3.08	V
			Power supply fall time	2.90	2.96	3.02	V
		V_{LVD4}	Power supply rise time	2.86	2.92	2.97	V
			Power supply fall time	2.80	2.86	2.91	V
		V_{LVD5}	Power supply rise time	2.76	2.81	2.87	V
			Power supply fall time	2.70	2.75	2.81	V
		V_{LVD6}	Power supply rise time	2.66	2.71	2.76	V
			Power supply fall time	2.60	2.65	2.70	V
		V_{LVD7}	Power supply rise time	2.56	2.61	2.66	V
			Power supply fall time	2.50	2.55	2.60	V
		V_{LVD8}	Power supply rise time	2.45	2.50	2.55	V
			Power supply fall time	2.40	2.45	2.50	V
		V_{LVD9}	Power supply rise time	2.05	2.09	2.13	V
			Power supply fall time	2.00	2.04	2.08	V
		V_{LVD10}	Power supply rise time	1.94	1.98	2.02	V
			Power supply fall time	1.90	1.94	1.98	V
		V_{LVD11}	Power supply rise time	1.84	1.88	1.91	V
			Power supply fall time	1.80	1.84	1.87	V
		V_{LVD12}	Power supply rise time	1.74	1.77	1.81	V
			Power supply fall time	1.70	1.73	1.77	V
		V_{LVD13}	Power supply rise time	1.64	1.67	1.70	V
			Power supply fall time	1.60	1.63	1.66	V
Minimum pulse width		t_{LW}		300			μs
Detection delay time						300	μs

Caution Set the detection voltage (V_{LVD}) to be within the operating voltage range. The operating voltage range depends on the setting of the user option byte (000C2H/010C2H). The following shows the operating voltage range.

HS (high-speed main) mode: V_{DD} = 2.7 to 3.6 V at 1 MHz to 24 MHz
V_{DD} = 2.4 to 3.6 V at 1 MHz to 16 MHz
LS (low-speed main) mode: V_{DD} = 1.8 to 3.6 V at 1 MHz to 8 MHz
LV (low-voltage main) mode: V_{DD} = 1.6 to 3.6 V at 1 MHz to 4 MHz

3.1 Absolute Maximum Ratings

Absolute Maximum Ratings (T_A = 25°C) **(1/3)**

Parameter	Symbols	Conditions	Ratings	Unit
Supply voltage	V_{DD}		-0.5 to + 6.5	V
	UV_{BUS}		-0.5 to + 6.5	V
	AV_{DD}	$AV_{DD} \leq V_{DD}$	-0.5 to + 4.6	V
REGC pin input voltage	V_{IREGC}	REGC	-0.3 to + 2.8 and -0.3 to V_{DD} + 0.3 Note 1	V
U_{REGC} pin input voltage	V_{IUREGC}	U_{REGC}	-0.3 to UV_{BUS} + 0.3 Note 2	V
Input voltage	V_{I1}	P00 to P07, P10 to P17, P20 to P27, P30 to P37, P40 to P46, P50 to P57, P70 to P77, P80 to P83, P125 to P127, P137, P140 to P143, EXCLK, EXCLKS, $\overline{\text{RESET}}$	-0.3 to V_{DD} + 0.3 Note 3	V
	V_{I2}	P60, P61 (N-ch open-drain)	-0.3 to + 6.5	V
	V_{I3}	UDP, UDM	-0.3 to + 6.5	V
	V_{I4}	P150 to P156	-0.3 to AV_{DD} + 0.3 Note 4	V
Output voltage	V_{O1}	P00 to P07, P10 to P17, P20 to P27, P30 to P37, P40 to P46, P50 to P57, P60, P61, P70 to P77, P80 to P83, P125 to P127, P130, P140 to P143	-0.3 to V_{DD} + 0.3 Note 3	V
	V_{O2}	P150 to P156	-0.3 to AV_{DD} + 0.3 Note 3	V
	V_{O3}	UDP, UDM	-0.3 to + 3.8	V
Analog input voltage	V_{AI1}	ANI16 to ANI21	-0.3 to V_{DD} + 0.3 and $AV_{REF(+)}$ + 0.3 Notes 3, 5	V
	V_{AI2}	ANI0 to ANI6	-0.3 to AV_{DD} + 0.3 and $AV_{REF(+)}$ + 0.3 Notes 3, 5	V

Note 1. Connect the REGC pin to V_{SS} via a capacitor (0.47 to 1 μF). This value regulates the absolute maximum rating of the REGC pin. Do not use this pin with voltage applied to it.

Note 2. Connect the U_{REGC} pin to Vss via a capacitor (0.33 μF). This value regulates the absolute maximum rating of the U_{REGC} pin. Do not use this pin with voltage applied to it.

Note 3. Must be 6.5 V or lower.

Note 4. Must be 4.6 V or lower.

Note 5. Do not exceed $AV_{REF(+)}$ + 0.3 V in case of A/D conversion target pin.

Caution **Product quality may suffer if the absolute maximum rating is exceeded even momentarily for any parameter. That is, the absolute maximum ratings are rated values at which the product is on the verge of suffering physical damage, and therefore the product must be used under conditions that ensure that the absolute maximum ratings are not exceeded.**

Remark 1. Unless specified otherwise, the characteristics of alternate-function pins are the same as those of the port pins.

Remark 2. $AV_{REF(+)}$: + side reference voltage of the A/D converter.

Remark 3. V_{SS}: Reference voltage

(T_A = -40 to +105°C, 2.4 V ≤ AV_{DD} = V_{DD} ≤ 3.6 V, V_{SS} = 0 V)

Items	Symbol	Conditions		MIN.	TYP.	MAX.	Unit
Input voltage, high	VIH1	P00 to P07, P10 to P17, P20 to P27, P30 to P37, P40 to P46, P50 to P57, P70 to P77, P80 to P83, P125 to P127, P140 to P143	Normal input buffer	0.8 V_{DD}		V_{DD}	V
	V_{IH2}	P00, P01, P10, P11, P24, P25, P33, P34, P43, P44	TTL input buffer 3.3 V ≤ V_{DD} ≤ 3.6 V	2.0		V_{DD}	V
			TTL input buffer 2.4 V ≤ V_{DD} < 3.3 V	1.50		V_{DD}	V
	V_{IH3}	P150 to P156		0.7 AV_{DD}		AV_{DD}	V
	V_{IH4}	P60, P61		0.7 V_{DD}		6.0	V
	V_{IH5}	P121 to P124, P137, EXCLK, EXCLKS, $\overline{RESET}$		0.8 V_{DD}		V_{DD}	V
Input voltage, low	V_{IL1}	P00 to P07, P10 to P17, P20 to P27, P30 to P37, P40 to P46, P50 to P57, P70 to P77, P80 to P83, P125 to P127, P140 to P143	Normal input buffer	0		0.2 V_{DD}	V
	V_{IL2}	P00, P01, P10, P11, P24, P25, P33, P34, P43, P44	TTL input buffer 3.3 V ≤ V_{DD} ≤ 3.6 V	0		0.5	V
			TTL input buffer 2.4 V ≤ V_{DD} < 3.3 V	0		0.32	V
	V_{IL3}	P150 to P156		0		0.3 AV_{DD}	V
	V_{IL4}	P60, P61		0		0.3 V_{DD}	V
	V_{IL5}	P121 to P124, P137, EXCLK, EXCLKS, $\overline{RESET}$		0		0.2 V_{DD}	V

Caution The maximum value of V_{IH} of pins P00 to P02, P10 to P12, P24 to P26, P33 to P35, and P42 to P44 is V_{DD}, even in the N-ch open-drain mode.

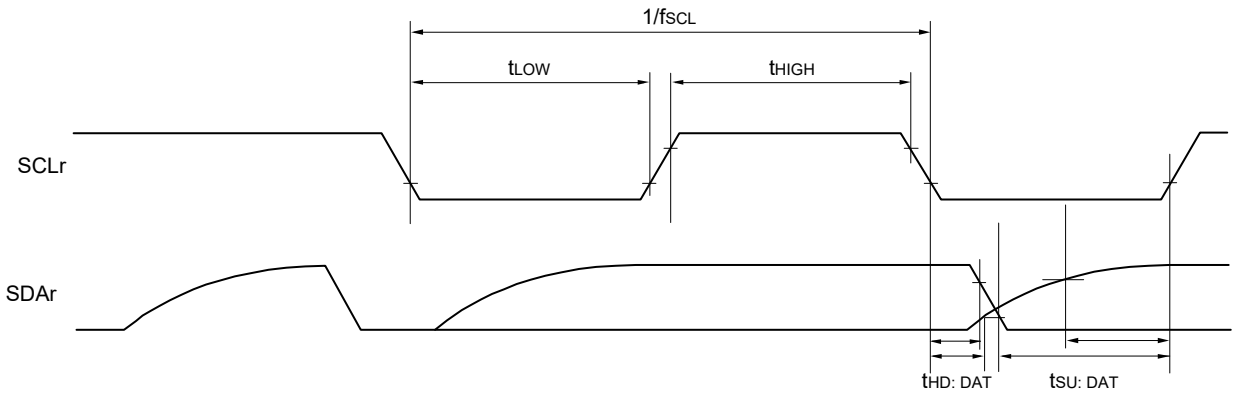
Remark Unless specified otherwise, the characteristics of alternate-function pins are the same as those of the port pins.

(T_A = -40 to +105°C, 2.4 V ≤ V_{DD} ≤ 3.6 V, V_{SS} = 0 V) (2/2)

Parameter	Symbol	Conditions				MIN.	TYP.	MAX.	Unit
Supply current Note 1	I_{DD2} Note 2	HALT mode	HS (high-speed main) mode Note 7	f_{HOCO} = 48 MHz Note 4, f_{IH} = 24 MHz Note 4	V_{DD} = 3.6 V		0.77	3.4	mA
					V_{DD} = 3.0 V		0.77	3.4	
				f_{HOCO} = 24 MHz Note 4, f_{IH} = 24 MHz Note 4	V_{DD} = 3.6 V		0.55	2.7	
					V_{DD} = 3.0 V		0.55	2.7	
				f_{HOCO} = 16 MHz Note 4, f_{IH} = 16 MHz Note 4	V_{DD} = 3.6 V		0.48	1.9	
					V_{DD} = 3.0 V		0.47	1.9	
			HS (high-speed main) mode Note 7	f_{MX} = 20 MHz Note 3, V_{DD} = 3.6 V	Square wave input		0.35	2.10	mA
					Resonator connection		0.51	2.20	
				f_{MX} = 20 MHz Note 3, V_{DD} = 3.0 V	Square wave input		0.34	2.10	
					Resonator connection		0.51	2.20	
				f_{MX} = 16 MHz Note 3, V_{DD} = 3.6 V	Square wave input		0.30	1.25	
					Resonator connection		0.45	1.41	
				f_{MX} = 16 MHz Note 3, V_{DD} = 3.0 V	Square wave input		0.29	1.23	
					Resonator connection		0.45	1.41	
				f_{MX} = 10 MHz Note 3, V_{DD} = 3.6 V	Square wave input		0.23	1.10	
					Resonator connection		0.30	1.20	
				f_{MX} = 10 MHz Note 3, V_{DD} = 3.0 V	Square wave input		0.22	1.10	
					Resonator connection		0.30	1.20	
			HS (High-speed main) mode (PLL operation)	f_{MX} = 48 MHz, f_{CLK} = 24 MHz Note 3	V_{DD} = 3.6 V		0.99	2.93	mA
					V_{DD} = 3.0 V		0.99	2.92	
				f_{MX} = 48 MHz, f_{CLK} = 12 MHz Note 3	V_{DD} = 3.6 V		0.89	2.51	
					V_{DD} = 3.0 V		0.89	2.50	
				f_{MX} = 48 MHz, f_{CLK} = 6 MHz Note 3	V_{DD} = 3.6 V		0.84	2.30	
					V_{DD} = 3.0 V		0.84	2.29	
			Subsystem clock operation	f_{SUB} = 32.768 kHz Note 5 T_A = -40°C	Square wave input		0.32	0.61	μA
					Resonator connection		0.51	0.80	
				f_{SUB} = 32.768 kHz Note 5 T_A = +25°C	Square wave input		0.41	0.74	
					Resonator connection		0.62	0.91	
				f_{SUB} = 32.768 kHz Note 5 T_A = +50°C	Square wave input		0.52	2.30	
					Resonator connection		0.75	2.49	
				f_{SUB} = 32.768 kHz Note 5 T_A = +70°C	Square wave input		0.82	4.03	
					Resonator connection		1.08	4.22	
				f_{SUB} = 32.768 kHz Note 5 T_A = +85°C	Square wave input		1.38	8.04	
					Resonator connection		1.62	8.23	
				f_{SUB} = 32.768 kHz Note 5 T_A = +105°C	Square wave input		3.29	41.00	
					Resonator connection		3.63	41.00	
	I_{DD3} Note 6	STOP mode Note 8	T_A = -40°C				0.18	0.52	μA
			T_A = +25°C				0.25	0.52	
			T_A = +50°C				0.34	2.21	
			T_A = +70°C				0.64	3.94	
			T_A = +85°C				1.18	7.95	
			T_A = +105°C				2.92	40.00	

(**Notes** and **Remarks** are listed on the next page.)

Simplified I²C mode serial transfer timing (during communication at same potential)



Remark 1. R_b[Ω]: Communication line (SDAr) pull-up resistance, C_b[F]: Communication line (SDAr, SCLr) load capacitance

Remark 2. r: IIC number (r = 00, 10, 20, 30), g: PIM number (g = 0 to 3),
h: POM number (h = 0 to 3)

Remark 3. f_{MCK}: Serial array unit operation clock frequency
(Operation clock to be set by the CKSmn bit of serial mode register mn (SMRmn). m: Unit number (m = 0, 1),
n: Channel number (n = 0 to 3), mn = 00 to 03, 10 to 13)

(6) Communication at different potential (1.8 V, 2.5 V) (CSI mode) (master mode, SCKp... internal clock output)

(T_A = -40 to +105°C, 2.4 V ≤ V_{DD} ≤ 3.6 V, V_{SS} = 0 V) (1/2)

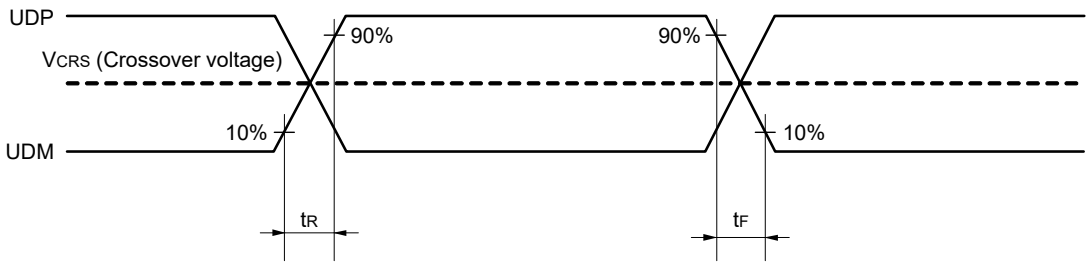
Parameter	Symbol	Conditions		HS (high-speed main) Mode		Unit
				MIN.	MAX.	
SCKp cycle time	t_{KCY1}	$t_{KCY1} \geq f_{CLK}/4$	2.7 V ≤ V_{DD} ≤ 3.6 V, 2.3 V ≤ V_b ≤ 2.7 V, C_b = 30 pF, R_b = 2.7 kΩ	1000 Note		ns
			2.4 V ≤ V_{DD} < 3.3 V, 1.6 V ≤ V_b ≤ 1.8 V, C_b = 30 pF, R_b = 5.5 kΩ	2300 Note		ns
SCKp high-level width	t_{KH1}	2.7 V ≤ V_{DD} ≤ 3.6 V, 2.3 V ≤ V_b ≤ 2.7 V, C_b = 30 pF, R_b = 2.7 kΩ		t_{KCY1}/2 - 340		ns
		2.4 V ≤ V_{DD} < 3.3 V, 1.6 V ≤ V_b ≤ 2.0 V, C_b = 30 pF, R_b = 5.5 kΩ		t_{KCY1}/2 - 916		ns
SCKp low-level width	t_{KL1}	2.7 V ≤ V_{DD} ≤ 3.6 V, 2.3 V ≤ V_b ≤ 2.7 V, C_b = 30 pF, R_b = 2.7 kΩ		t_{KCY1}/2 - 36		ns
		2.4 V ≤ V_{DD} < 3.3 V, 1.6 V ≤ V_b ≤ 2.0 V, C_b = 30 pF, R_b = 5.5 kΩ		t_{KCY1}/2 - 100		ns

Note Use it with $V_{DD} \geq V_b$.

Caution Select the TTL input buffer for the SIp pin and the N-ch open drain output (V_{DD} tolerance) mode for the SOp pin and SCKp pin by using port input mode register g (PIMg) and port output mode register g (POMg). For V_{IH} and V_{IL}, see the DC characteristics with TTL input buffer selected.

(**Remarks** are listed on the page after the next page.)

Timing of UDP and UDM



(2) BC standard

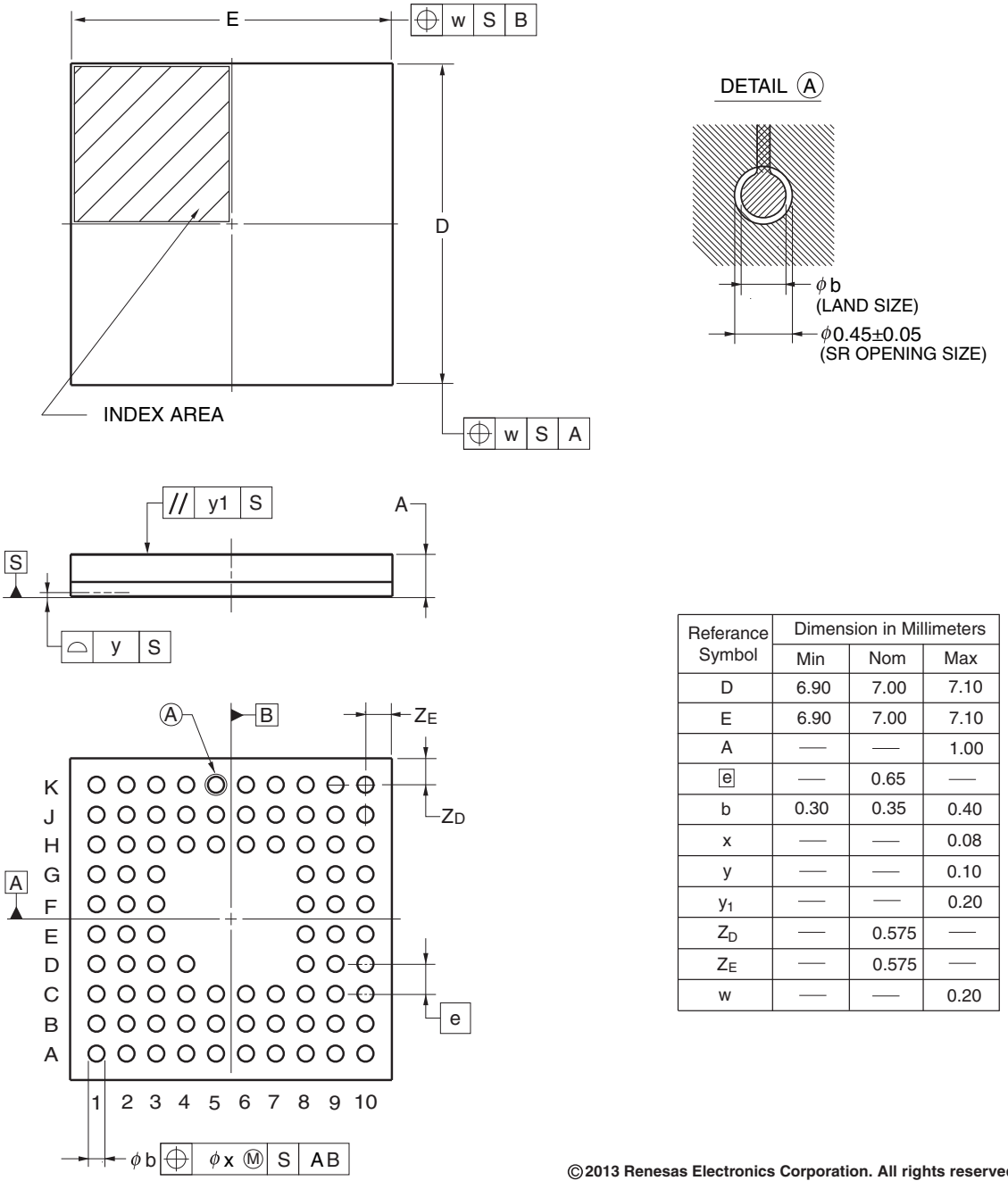
(TA = -40 to +105°C, 4.35 V ≤ UVBUS ≤ 5.25 V, 2.4 V ≤ VDD ≤ 3.6 V, VSS = 0 V)

Parameter		Symbol	Conditions	MIN.	TYP.	MAX.	Unit
USB standard BC1.2	UDP sink current	IDP_SINK		25	100	175	μA
	UDM sink current	IDM_SINK		25	100	175	μA
	DCD source current	IDP_SRC		7	10	13	μA
	Data detection voltage	VDAT_REF		0.25	0.325	0.4	V
	UDP source voltage	VDP_SRC	Output current 250 μA	0.5	0.6	0.7	V
	UDM source voltage	VDM_SRC	Output current 250 μA	0.5	0.6	0.7	V

4.2 85-pin products

R5F110NEALA, R5F110NFALA, R5F110NGALA, R5F110NHALA, R5F110NJALA
R5F111NEALA, R5F111NFALA, R5F111NGALA, R5F111NHALA, R5F111NJALA
R5F110NEGLA, R5F110NFGLA, R5F110NGGLA, R5F110NHGLA, R5F110NJGLA
R5F111NEGLA, R5F111NFGLA, R5F111NGGLA, R5F111NHGLA, R5F111NJGLA

JEITA Package code	RENESAS code	Previous code	MASS(TYP.)[g]
P-VFLGA85-7x7-0.65	PVLG0085JA-A	P85FC-65-BN4	0.1



Referance Symbol	Dimension in Millimeters		
	Min	Nom	Max
D	6.90	7.00	7.10
E	6.90	7.00	7.10
A	—	—	1.00
e	—	0.65	—
b	0.30	0.35	0.40
x	—	—	0.08
y	—	—	0.10
y_1	—	—	0.20
Z_D	—	0.575	—
Z_E	—	0.575	—
w	—	—	0.20

REVISION HISTORY	RL78/L1C Datasheet