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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	32MHz
Connectivity	CSI, I ² C, LINbus, UART/USART
Peripherals	DMA, LVD, POR, PWM, WDT
Number of I/O	31
Program Memory Size	48KB (48K x 8)
Program Memory Type	FLASH
EEPROM Size	-
RAM Size	3K x 8
Voltage - Supply (Vcc/Vdd)	1.6V ~ 5.5V
Data Converters	A/D 10x8/10b
Oscillator Type	Internal
Operating Temperature	-40°C ~ 85°C (TA)
Mounting Type	Surface Mount
Package / Case	44-LQFP
Supplier Device Package	44-LQFP (10x10)
Purchase URL	https://www.e-xfl.com/product-detail/renesas-electronics-america/r5f101fdafp-30

Table 1-1. List of Ordering Part Numbers

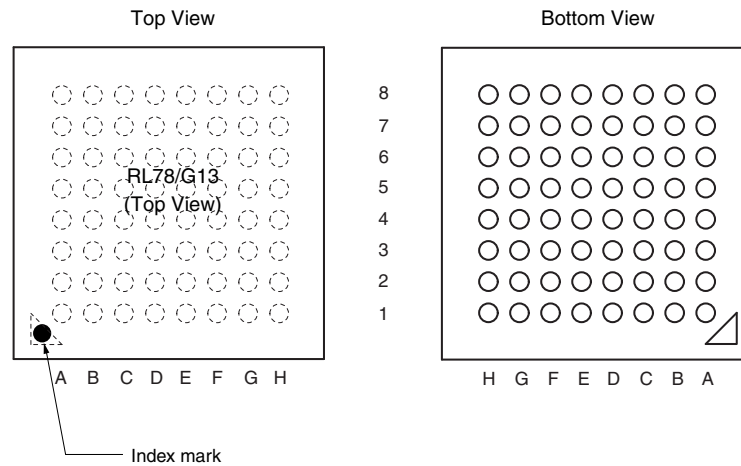
(2/12)

Pin count	Package	Data flash	Fields of Application Note	Ordering Part Number
25 pins	25-pin plastic WFLGA (3 × 3 mm, 0.5 mm pitch)	Mounted	A G	R5F1008AALA#U0, R5F1008CALA#U0, R5F1008DALA#U0, R5F1008EALA#U0 R5F1008AALA#W0, R5F1008CALA#W0, R5F1008DALA#W0, R5F1008EALA#W0 R5F1008AGLA#U0, R5F1008CGLA#U0, R5F1008DGLA#U0, R5F1008EGLA#U0 R5F1008AGLA#W0, R5F1008CGLA#W0, R5F1008DGLA#W0, R5F1008EGLA#W0
		Not mounted	A	R5F1018AALA#U0, R5F1018CALA#U0, R5F1018DALA#U0, R5F1018EALA#U0 R5F1018AALA#W0, R5F1018CALA#W0, R5F1018DALA#W0, R5F1018EALA#W0
30 pins	30-pin plastic LSSOP (7.62 mm (300), 0.65 mm pitch)	Mounted	A D G	R5F100AAASP#V0, R5F100ACASP#V0, R5F100ADASP#V0, R5F100AEASP#V0, R5F100AFASP#V0, R5F100AGASP#V0 R5F100AAASP#X0, R5F100ACASP#X0, R5F100ADASP#X0, R5F100AEASP#X0, R5F100AFASP#X0, R5F100AGASP#X0 R5F100AADSP#V0, R5F100ACDSP#V0, R5F100ADDSP#V0, R5F100AEDSP#V0, R5F100AFDSP#V0, R5F100AGDSP#V0 R5F100AADSP#X0, R5F100ACDSP#X0, R5F100ADDSP#X0, R5F100AEDSP#X0, R5F100AFDSP#X0, R5F100AGDSP#X0 R5F100AAGSP#V0, R5F100ACGSP#V0, R5F100ADGSP#V0, R5F100AEGSP#V0, R5F100AFGSP#V0, R5F100AGGSP#V0 R5F100AAGSP#X0, R5F100ACGSP#X0, R5F100ADGSP#X0, R5F100AEGSP#X0, R5F100AFGSP#X0, R5F100AGGSP#X0
		Not mounted	A D	R5F101AAASP#V0, R5F101ACASP#V0, R5F101ADASP#V0, R5F101AEASP#V0, R5F101AFASP#V0, R5F101AGASP#V0 R5F101AAASP#X0, R5F101ACASP#X0, R5F101ADASP#X0, R5F101AEASP#X0, R5F101AFASP#X0, R5F101AGASP#X0 R5F101AADSP#V0, R5F101ACDSP#V0, R5F101ADDSP#V0, R5F101AEDSP#V0, R5F101AFDSP#V0, R5F101AGDSP#V0 R5F101AADSP#X0, R5F101ACDSP#X0, R5F101ADDSP#X0, R5F101AEDSP#X0, R5F101AFDSP#X0, R5F101AGDSP#X0
32 pins	32-pin plastic HWQFN (5 × 5 mm, 0.5 mm pitch)	Mounted	A D G	R5F100BAANA#U0, R5F100BCANA#U0, R5F100BDANA#U0, R5F100BEANA#U0, R5F100BFANA#U0, R5F100BGANA#U0 R5F100BAANA#W0, R5F100BCANA#W0, R5F100BDANA#W0, R5F100BEANA#W0, R5F100BFANA#W0, R5F100BGANA#W0 R5F100BADNA#U0, R5F100BCDNA#U0, R5F100BDDNA#U0, R5F100BEDNA#U0, R5F100BFDNA#U0, R5F100BGDNA#U0 R5F100BADNA#W0, R5F100BCDNA#W0, R5F100BDDNA#W0, R5F100BEDNA#W0, R5F100BFDNA#W0, R5F100BGDNA#W0 R5F100BAGNA#U0, R5F100BCGNA#U0, R5F100BDGNA#U0, R5F100BEGNA#U0, R5F100BFGNA#U0, R5F100BGGNA#U0 R5F100BAGNA#W0, R5F100BCGNA#W0, R5F100BDGNA#W0, R5F100BEGNA#W0, R5F100BFGNA#W0, R5F100BGGNA#W0
		Not mounted	A D	R5F101BAANA#U0, R5F101BCANA#U0, R5F101BDANA#U0, R5F101BEANA#U0, R5F101BFANA#U0, R5F101BGANA#U0 R5F101BAANA#W0, R5F101BCANA#W0, R5F101BDANA#W0, R5F101BEANA#W0, R5F101BFANA#W0, R5F101BGANA#W0 R5F101BADNA#U0, R5F101BCDNA#U0, R5F101BDDNA#U0, R5F101BEDNA#U0, R5F101BFDNA#U0, R5F101BGDNA#U0 R5F101BADNA#W0, R5F101BCDNA#W0, R5F101BDDNA#W0, R5F101BEDNA#W0, R5F101BFDNA#W0, R5F101BGDNA#W0

Note For the fields of application, refer to **Figure 1-1 Part Number, Memory Size, and Package of RL78/G13**.

Caution The ordering part numbers represent the numbers at the time of publication. For the latest ordering part numbers, refer to the target product page of the Renesas Electronics website.

- 64-pin plastic VFBGA (4 × 4 mm, 0.4 mm pitch)



Pin No.	Name	Pin No.	Name	Pin No.	Name	Pin No.	Name
A1	P05/TI05/TO05	C1	P51/INTP2/SO11	E1	P13/TxD2/SO20/(SDAA0)/(TI04)/(TO04)	G1	P146
A2	P30/INTP3/RTC1HZ/SCK11/SCL11	C2	P71/KR1/SI21/SDA21	E2	P14/RxD2/SI20/SDA20/(SCLA0)/(TI03)/(TO03)	G2	P25/ANI5
A3	P70/KR0/SCK21/SCL21	C3	P74/KR4/INTP8/SI01/SDA01	E3	P15/SCK20/SCL20/(TI02)/(TO02)	G3	P24/ANI4
A4	P75/KR5/INTP9/SCK01/SCL01	C4	P52/(INTP10)	E4	P16/TI01/TO01/INTP5/(SI00)/(RxD0)	G4	P22/ANI2
A5	P77/KR7/INTP11/(TxD2)	C5	P53/(INTP11)	E5	P03/ANI16/SI10/RxD1/SDA10	G5	P130
A6	P61/SDAA0	C6	P63	E6	P41/TI07/TO07	G6	P02/ANI17/SO10/TxD1
A7	P60/SCLA0	C7	V _{SS}	E7	RESET	G7	P00/TI00
A8	EV _{DD0}	C8	P121/X1	E8	P137/INTP0	G8	P124/XT2/EXCLKS
B1	P50/INTP1/SI11/SDA11	D1	P55/(PCLBUZ1)/(SCK00)	F1	P10/SCK00/SCL00/(TI07)/(TO07)	H1	P147/ANI18
B2	P72/KR2/SO21	D2	P06/TI06/TO06	F2	P11/SI00/RxD0/TOOLRxD/SDA00/(TI06)/(TO06)	H2	P27/ANI7
B3	P73/KR3/SO01	D3	P17/TI02/TO02/(SO00)/(TxD0)	F3	P12/SO00/TxD0/TOOLTxD/(INTP5)/(TI05)/(TO05)	H3	P26/ANI6
B4	P76/KR6/INTP10/(RxD2)	D4	P54	F4	P21/ANI1/AV _{REFM}	H4	P23/ANI3
B5	P31/TI03/TO03/INTP4/(PCLBUZ0)	D5	P42/TI04/TO04	F5	P04/SCK10/SCL10	H5	P20/ANI0/AV _{REFP}
B6	P62	D6	P40/TOOL0	F6	P43	H6	P141/PCLBUZ1/INTP7
B7	V _{DD}	D7	REGC	F7	P01/TO00	H7	P140/PCLBUZ0/INTP6
B8	EV _{SS0}	D8	P122/X2/EXCLK	F8	P123/XT1	H8	P120/ANI19

Cautions 1. Make EV_{SS0} pin the same potential as V_{SS} pin.

2. Make V_{DD} pin the potential that is higher than EV_{DD0} pin.

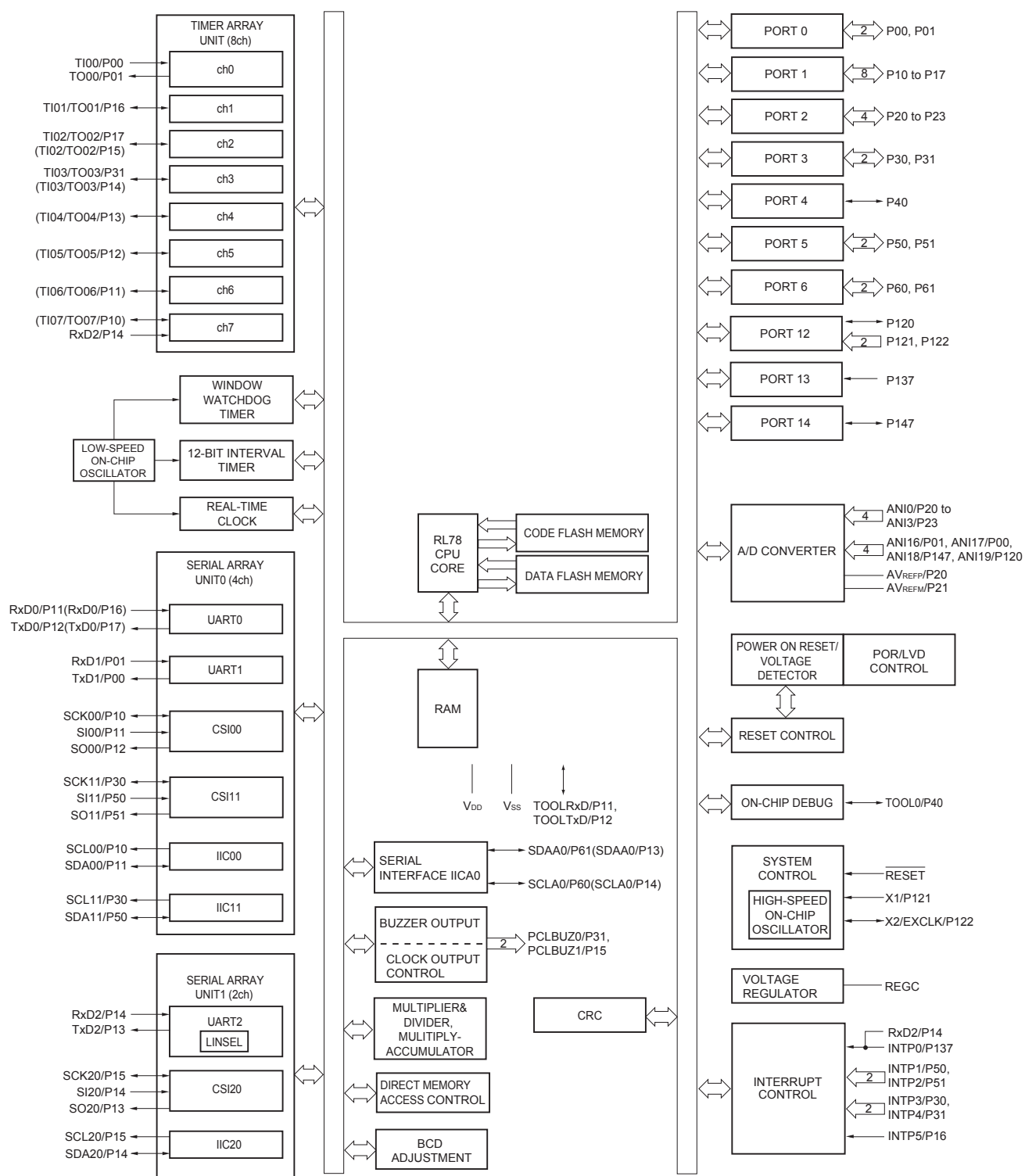
3. Connect the REGC pin to V_{SS} via a capacitor (0.47 to 1 μ F).

Remarks 1. For pin identification, see 1.4 Pin Identification.

2. When using the microcontroller for an application where the noise generated inside the microcontroller must be reduced, it is recommended to supply separate powers to the V_{DD} and EV_{DD0} pins and connect the V_{SS} and EV_{SS0} pins to separate ground lines.

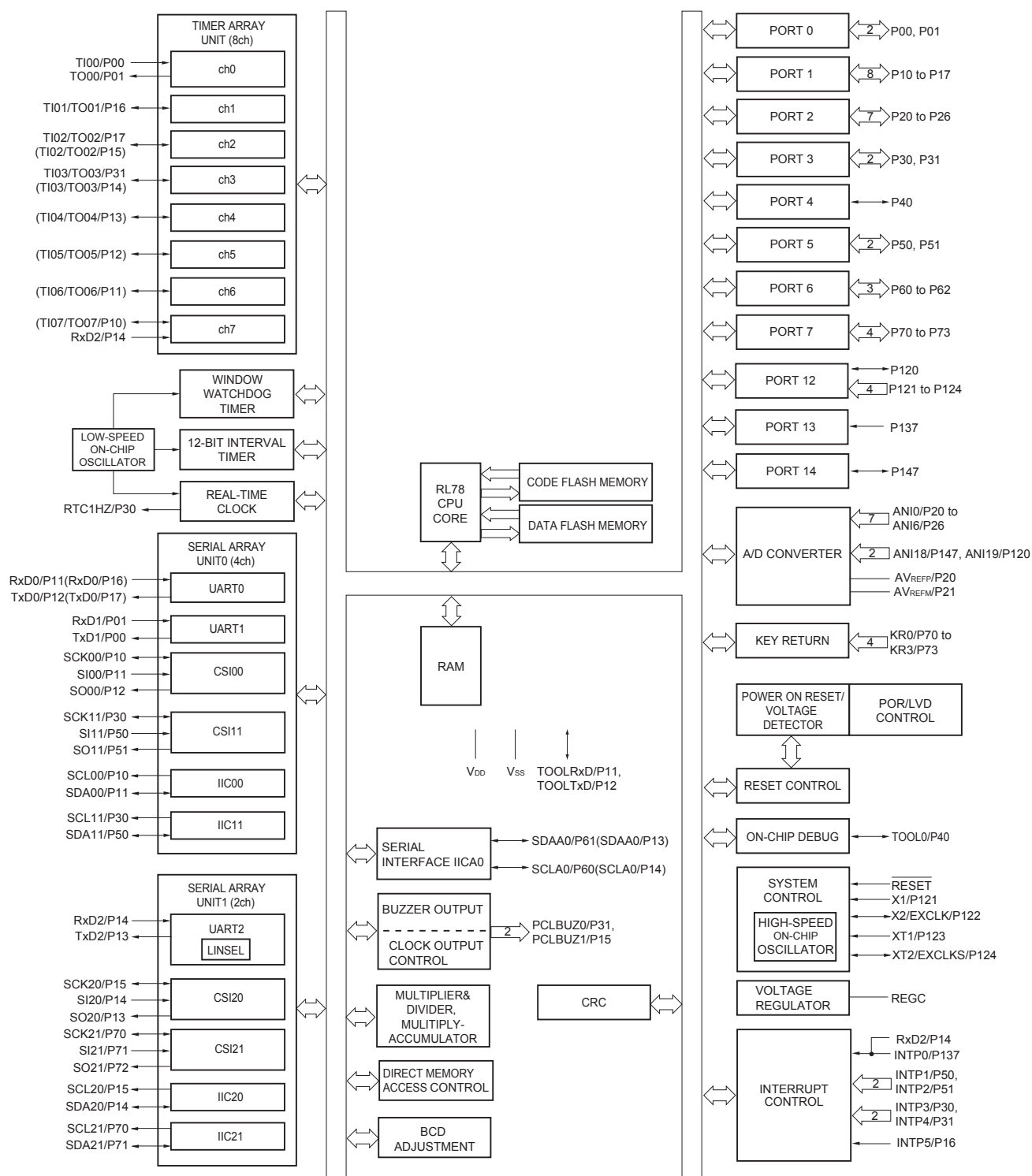
3. Functions in parentheses in the above figure can be assigned via settings in the peripheral I/O redirection register (PIOR). Refer to **Figure 4-8 Format of Peripheral I/O Redirection Register (PIOR)** in the RL78/G13 User's Manual.

1.5.4 30-pin products



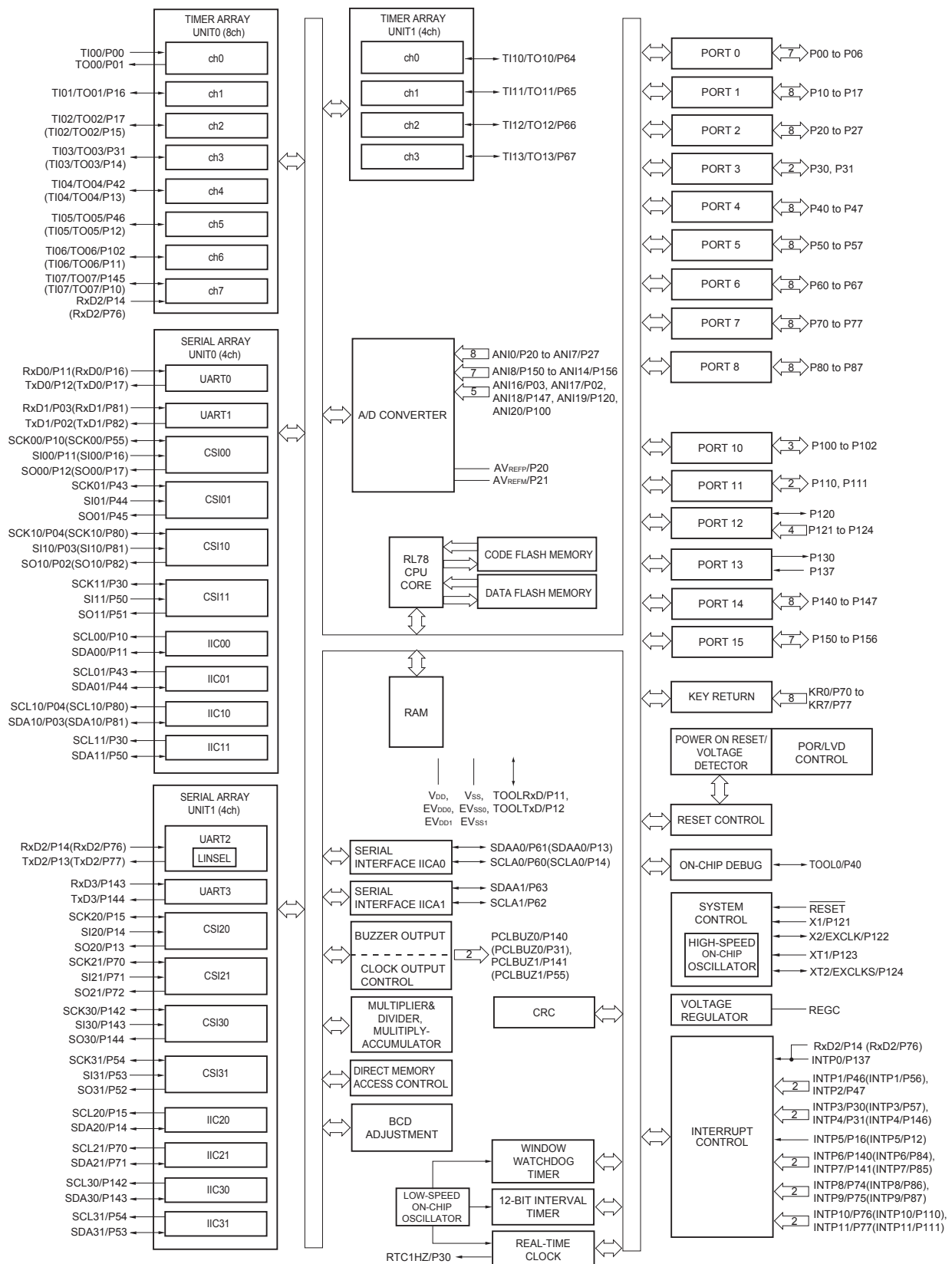
Remark Functions in parentheses in the above figure can be assigned via settings in the peripheral I/O redirection register (PIOR). Refer to **Figure 4-8 Format of Peripheral I/O Redirection Register (PIOR)** in the RL78/G13 User's Manual.

1.5.7 40-pin products



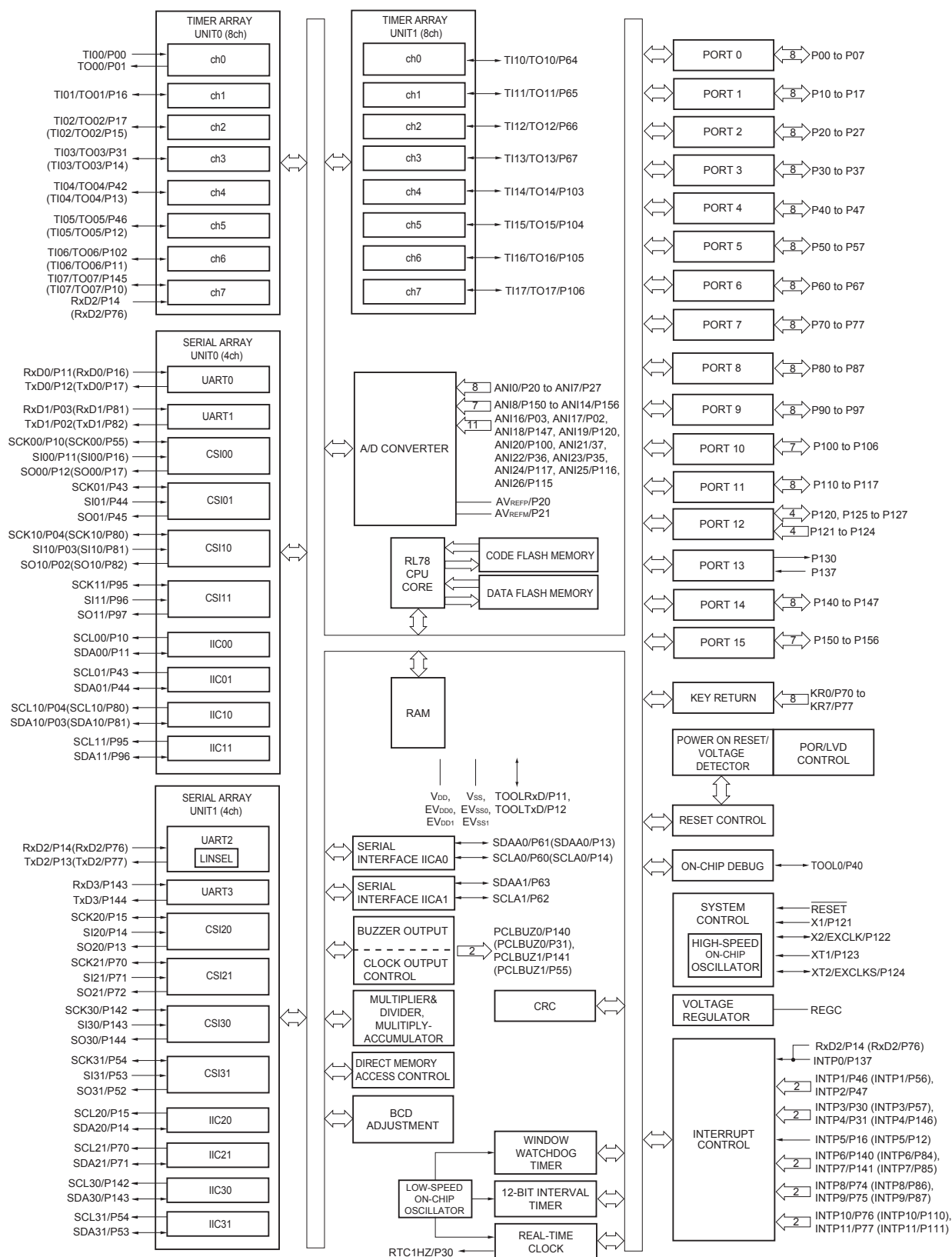
Remark Functions in parentheses in the above figure can be assigned via settings in the peripheral I/O redirection register (PIOR). Refer to **Figure 4-8 Format of Peripheral I/O Redirection Register (PIOR)** in the RL78/G13 User's Manual.

1.5.13 100-pin products



Remark Functions in parentheses in the above figure can be assigned via settings in the peripheral I/O redirection register (PIOR). Refer to **Figure 4-8 Format of Peripheral I/O Redirection Register (PIOR)** in the RL78/G13 User's Manual.

1.5.14 128-pin products



Remark Functions in parentheses in the above figure can be assigned via settings in the peripheral I/O redirection register (PIOR). Refer to **Figure 4-8 Format of Peripheral I/O Redirection Register (PIOR)** in the RL78/G13 User's Manual.

(T_A = -40 to +85°C, 1.6 V ≤ EV_{DD0} = EV_{DD1} ≤ V_{DD} ≤ 5.5 V, V_{SS} = EV_{SS0} = EV_{SS1} = 0 V) (3/5)

Items	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
Input voltage, high	V _{IH1}	P00 to P07, P10 to P17, P30 to P37, P40 to P47, P50 to P57, P64 to P67, P70 to P77, P80 to P87, P90 to P97, P100 to P106, P110 to P117, P120, P125 to P127, P140 to P147	Normal input buffer	0.8EV _{DD0}	EV _{DD0}	V
	V _{IH2}	P01, P03, P04, P10, P11, P13 to P17, P43, P44, P53 to P55, P80, P81, P142, P143	TTL input buffer 4.0 V ≤ EV _{DD0} ≤ 5.5 V	2.2	EV _{DD0}	V
			TTL input buffer 3.3 V ≤ EV _{DD0} < 4.0 V	2.0	EV _{DD0}	V
			TTL input buffer 1.6 V ≤ EV _{DD0} < 3.3 V	1.5	EV _{DD0}	V
	V _{IH3}	P20 to P27, P150 to P156	0.7V _{DD}		V _{DD}	V
	V _{IH4}	P60 to P63	0.7EV _{DD0}		6.0	V
	V _{IH5}	P121 to P124, P137, EXCLK, EXCLKS, RESET	0.8V _{DD}		V _{DD}	V
Input voltage, low	V _{IL1}	P00 to P07, P10 to P17, P30 to P37, P40 to P47, P50 to P57, P64 to P67, P70 to P77, P80 to P87, P90 to P97, P100 to P106, P110 to P117, P120, P125 to P127, P140 to P147	Normal input buffer	0	0.2EV _{DD0}	V
	V _{IL2}	P01, P03, P04, P10, P11, P13 to P17, P43, P44, P53 to P55, P80, P81, P142, P143	TTL input buffer 4.0 V ≤ EV _{DD0} ≤ 5.5 V	0	0.8	V
			TTL input buffer 3.3 V ≤ EV _{DD0} < 4.0 V	0	0.5	V
			TTL input buffer 1.6 V ≤ EV _{DD0} < 3.3 V	0	0.32	V
	V _{IL3}	P20 to P27, P150 to P156	0		0.3V _{DD}	V
	V _{IL4}	P60 to P63	0		0.3EV _{DD0}	V
	V _{IL5}	P121 to P124, P137, EXCLK, EXCLKS, RESET	0		0.2V _{DD}	V

Caution The maximum value of V_{IH} of pins P00, P02 to P04, P10 to P15, P17, P43 to P45, P50, P52 to P55, P71, P74, P80 to P82, P96, and P142 to P144 is EV_{DD0}, 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.

- Notes**
1. Total current flowing into V_{DD} and EV_{DD0} , including the input leakage current flowing when the level of the input pin is fixed to V_{DD} , EV_{DD0} or V_{SS} , EV_{SS0} . The values below the MAX. column include the peripheral operation current. However, not including the current flowing into the A/D converter, LVD circuit, I/O port, and on-chip pull-up/pull-down resistors and the current flowing during data flash rewrite.
 2. During HALT instruction execution by flash memory.
 3. When high-speed on-chip oscillator and subsystem clock are stopped.
 4. When high-speed system clock and subsystem clock are stopped.
 5. When high-speed on-chip oscillator and high-speed system clock are stopped. When $RTCLPC = 1$ and setting ultra-low current consumption ($AMPHS1 = 1$). The current flowing into the RTC is included. However, not including the current flowing into the 12-bit interval timer and watchdog timer.
 6. Not including the current flowing into the RTC, 12-bit interval timer, and watchdog timer.
 7. Relationship between operation voltage width, operation frequency of CPU and operation mode is as below.
HS (high-speed main) mode: $2.7\text{ V} \leq V_{DD} \leq 5.5\text{ V}$ @ 1 MHz to 32 MHz
 $2.4\text{ V} \leq V_{DD} \leq 5.5\text{ V}$ @ 1 MHz to 16 MHz
LS (low-speed main) mode: $1.8\text{ V} \leq V_{DD} \leq 5.5\text{ V}$ @ 1 MHz to 8 MHz
LV (low-voltage main) mode: $1.6\text{ V} \leq V_{DD} \leq 5.5\text{ V}$ @ 1 MHz to 4 MHz
 8. Regarding the value for current to operate the subsystem clock in STOP mode, refer to that in HALT mode.

- Remarks 1.** f_{MX}: High-speed system clock frequency (X1 clock oscillation frequency or external main system clock frequency)
2. f_{IH}: High-speed on-chip oscillator clock frequency
3. f_{SUB}: Subsystem clock frequency (XT1 clock oscillation frequency)
4. Except subsystem clock operation and STOP mode, temperature condition of the TYP. value is T_A = 25°C

- Remarks 1.** p: CSI number (p = 00, 01, 10, 11, 20, 21, 30, 31), m: Unit number (m = 0, 1), n: Channel number (n = 0 to 3),
g: PIM and POM numbers (g = 0, 1, 4, 5, 8, 14)
- 2.** 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,
n: Channel number (mn = 00 to 03, 10 to 13))

(4) During communication at same potential (CSI mode) (slave mode, SCKp... external clock input) (1/2)
(T_A = -40 to +85°C, 1.6 V ≤ EV_{DD0} = EV_{DD1} ≤ V_{DD} ≤ 5.5 V, V_{SS} = EV_{SS0} = EV_{SS1} = 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.	
SCKp cycle time Note 5	t _{KCY2}	4.0 V ≤ EV _{DD0} ≤ 5.5 V	20 MHz < f _{MCK}	8/f _{MCK}		—		—		ns
			f _{MCK} ≤ 20 MHz	6/f _{MCK}		6/f _{MCK}		6/f _{MCK}		ns
		2.7 V ≤ EV _{DD0} ≤ 5.5 V	16 MHz < f _{MCK}	8/f _{MCK}		—		—		ns
			f _{MCK} ≤ 16 MHz	6/f _{MCK}		6/f _{MCK}		6/f _{MCK}		ns
		2.4 V ≤ EV _{DD0} ≤ 5.5 V		6/f _{MCK} and 500		6/f _{MCK} and 500		6/f _{MCK} and 500		ns
		1.8 V ≤ EV _{DD0} ≤ 5.5 V		6/f _{MCK} and 750		6/f _{MCK} and 750		6/f _{MCK} and 750		ns
		1.7 V ≤ EV _{DD0} ≤ 5.5 V		6/f _{MCK} and 1500		6/f _{MCK} and 1500		6/f _{MCK} and 1500		ns
		1.6 V ≤ EV _{DD0} ≤ 5.5 V		—		6/f _{MCK} and 1500		6/f _{MCK} and 1500		ns
SCKp high-/low-level width	t _{KH2} , t _{KL2}	4.0 V ≤ EV _{DD0} ≤ 5.5 V		t _{KCY2} /2 – 7		t _{KCY2} /2 – 7		t _{KCY2} /2 – 7		ns
		2.7 V ≤ EV _{DD0} ≤ 5.5 V		t _{KCY2} /2 – 8		t _{KCY2} /2 – 8		t _{KCY2} /2 – 8		ns
		1.8 V ≤ EV _{DD0} ≤ 5.5 V		t _{KCY2} /2 – 18		t _{KCY2} /2 – 18		t _{KCY2} /2 – 18		ns
		1.7 V ≤ EV _{DD0} ≤ 5.5 V		t _{KCY2} /2 – 66		t _{KCY2} /2 – 66		t _{KCY2} /2 – 66		ns
		1.6 V ≤ EV _{DD0} ≤ 5.5 V		—		t _{KCY2} /2 – 66		t _{KCY2} /2 – 66		ns

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

(4) During communication at same potential (CSI mode) (slave mode, SCKp... external clock input) (2/2)

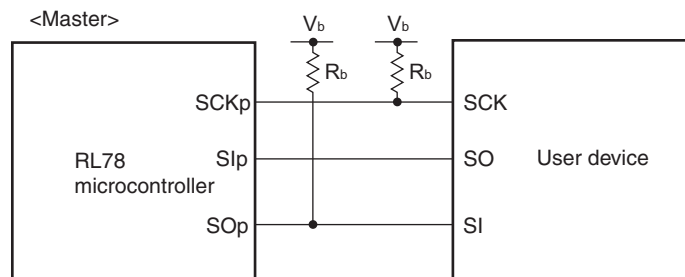
(T_A = -40 to +85°C, 1.6 V ≤ EV_{DD0} = EV_{DD1} ≤ V_{DD} ≤ 5.5 V, V_{SS} = EV_{SS0} = EV_{SS1} = 0 V)

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.	
Slp setup time (to SCKp↑) ^{Note 1}	t _{SIK2}	2.7 V ≤ EV _{DD0} ≤ 5.5 V		1/f _{MCK} +2 0		1/f _{MCK} +30		1/f _{MCK} +30		ns
		1.8 V ≤ EV _{DD0} ≤ 5.5 V		1/f _{MCK} +3 0		1/f _{MCK} +30		1/f _{MCK} +30		ns
		1.7 V ≤ EV _{DD0} ≤ 5.5 V		1/f _{MCK} +4 0		1/f _{MCK} +40		1/f _{MCK} +40		ns
		1.6 V ≤ EV _{DD0} ≤ 5.5 V		—		1/f _{MCK} +40		1/f _{MCK} +40		ns
Slp hold time (from SCKp↑) ^{Note 2}	t _{KSI2}	1.8 V ≤ EV _{DD0} ≤ 5.5 V		1/f _{MCK} +3 1		1/f _{MCK} +31		1/f _{MCK} +31		ns
		1.7 V ≤ EV _{DD0} ≤ 5.5 V		1/f _{MCK} + 250		1/f _{MCK} + 250		1/f _{MCK} + 250		ns
		1.6 V ≤ EV _{DD0} ≤ 5.5 V		—		1/f _{MCK} + 250		1/f _{MCK} + 250		ns
Delay time from SCKp↓ to SOp output ^{Note 3}	t _{KSO2}	C = 30 pF ^{Note 4}	2.7 V ≤ EV _{DD0} ≤ 5.5 V		2/f _{MCK} + 44		2/f _{MCK} + 110		2/f _{MCK} + 110	ns
			2.4 V ≤ EV _{DD0} ≤ 5.5 V		2/f _{MCK} + 75		2/f _{MCK} + 110		2/f _{MCK} + 110	ns
			1.8 V ≤ EV _{DD0} ≤ 5.5 V		2/f _{MCK} + 110		2/f _{MCK} + 110		2/f _{MCK} + 110	ns
			1.7 V ≤ EV _{DD0} ≤ 5.5 V		2/f _{MCK} + 220		2/f _{MCK} + 220		2/f _{MCK} + 220	ns
			1.6 V ≤ EV _{DD0} ≤ 5.5 V		—		2/f _{MCK} + 220		2/f _{MCK} + 220	ns

- Notes**
1. When DAP_{mn} = 0 and CKP_{mn} = 0, or DAP_{mn} = 1 and CKP_{mn} = 1. The Slp setup time becomes “to SCKp↓” when DAP_{mn} = 0 and CKP_{mn} = 1, or DAP_{mn} = 1 and CKP_{mn} = 0.
 2. When DAP_{mn} = 0 and CKP_{mn} = 0, or DAP_{mn} = 1 and CKP_{mn} = 1. The Slp hold time becomes “from SCKp↓” when DAP_{mn} = 0 and CKP_{mn} = 1, or DAP_{mn} = 1 and CKP_{mn} = 0.
 3. When DAP_{mn} = 0 and CKP_{mn} = 0, or DAP_{mn} = 1 and CKP_{mn} = 1. The delay time to SOp output becomes “from SCKp↑” when DAP_{mn} = 0 and CKP_{mn} = 1, or DAP_{mn} = 1 and CKP_{mn} = 0.
 4. C is the load capacitance of the SOp output lines.
 5. Transfer rate in the SNOOZE mode: MAX. 1 Mbps

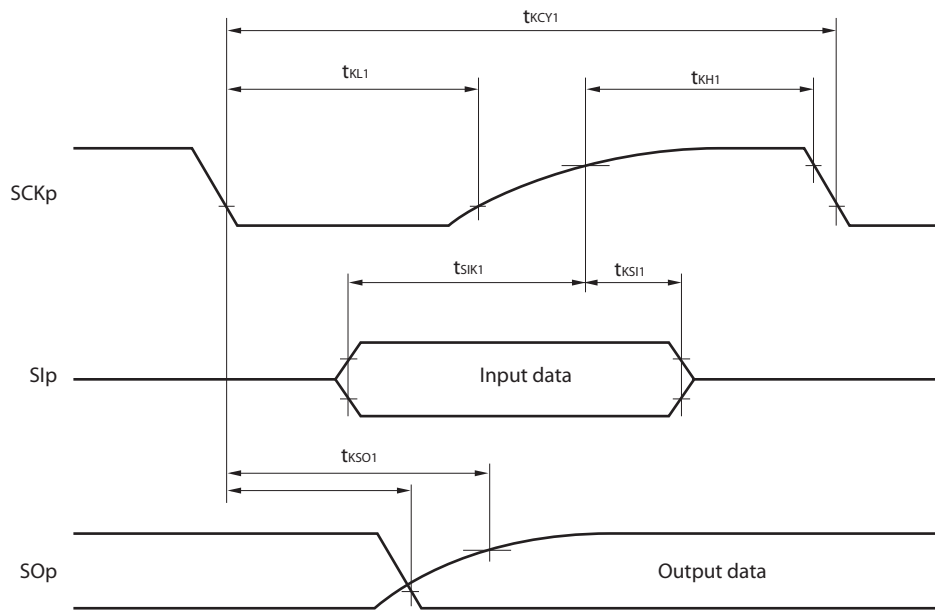
Caution Select the normal input buffer for the Slp pin and SCKp pin and the normal output mode for the SOp pin by using port input mode register g (PIMg) and port output mode register g (POMg).

- Remarks**
1. p: CSI number (p = 00, 01, 10, 11, 20, 21, 30, 31), m: Unit number (m = 0, 1),
n: Channel number (n = 0 to 3), g: PIM number (g = 0, 1, 4, 5, 8, 14)
 2. f_{MCK}: Serial array unit operation clock frequency
(Operation clock to be set by the CKS_{mn} bit of serial mode register mn (SMR_{mn}). m: Unit number,
n: Channel number (mn = 00 to 03, 10 to 13))

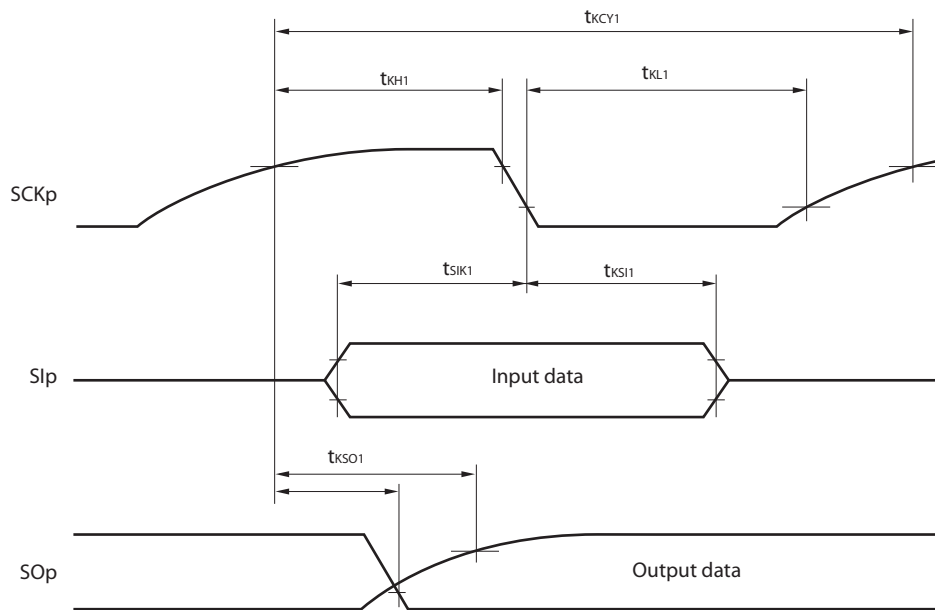
CSI mode connection diagram (during communication at different potential)

- Remarks**
1. $R_b[\Omega]$: Communication line (SCKp, SOp) pull-up resistance, $C_b[F]$: Communication line (SCKp, SOp) load capacitance, $V_b[V]$: Communication line voltage
 2. p: CSI number ($p = 00, 01, 10, 20, 30, 31$), m: Unit number, n: Channel number ($mn = 00, 01, 02, 10, 12, 13$), g: PIM and POM number ($g = 0, 1, 4, 5, 8, 14$)
 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, n: Channel number ($mn = 00$))
 4. CSI01 of 48-, 52-, 64-pin products, and CSI11 and CSI21 cannot communicate at different potential.
Use other CSI for communication at different potential.

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



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



- Remarks 1.** p: CSI number (p = 00, 01, 10, 20, 30, 31), m: Unit number, n: Channel number (mn = 00, 01, 02, 10, 12, 13), g: PIM and POM number (g = 0, 1, 4, 5, 8, 14)
- 2.** CSI01 of 48-, 52-, 64-pin products, and CSI11 and CSI21 cannot communicate at different potential. Use other CSI for communication at different potential.

(10) Communication at different potential (1.8 V, 2.5 V, 3 V) (simplified I²C mode) (2/2)**(T_A = -40 to +85°C, 1.8 V ≤ EV_{DD0} = EV_{DD1} ≤ V_{DD} ≤ 5.5 V, V_{SS} = EV_{SS0} = EV_{SS1} = 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.	
Data setup time (reception)	t _{SU:DAT}	4.0 V ≤ EV _{DD0} ≤ 5.5 V, 2.7 V ≤ V _b ≤ 4.0 V, C _b = 50 pF, R _b = 2.7 kΩ	1/f _{MCK} + 135 ^{Note 3}		1/f _{MCK} + 190 ^{Note 3}		1/f _{MCK} + 190 ^{Note 3}		kHz
		2.7 V ≤ EV _{DD0} < 4.0 V, 2.3 V ≤ V _b ≤ 2.7 V, C _b = 50 pF, R _b = 2.7 kΩ	1/f _{MCK} + 135 ^{Note 3}		1/f _{MCK} + 190 ^{Note 3}		1/f _{MCK} + 190 ^{Note 3}		kHz
		4.0 V ≤ EV _{DD0} ≤ 5.5 V, 2.7 V ≤ V _b ≤ 4.0 V, C _b = 100 pF, R _b = 2.8 kΩ	1/f _{MCK} + 190 ^{Note 3}		1/f _{MCK} + 190 ^{Note 3}		1/f _{MCK} + 190 ^{Note 3}		kHz
		2.7 V ≤ EV _{DD0} < 4.0 V, 2.3 V ≤ V _b ≤ 2.7 V, C _b = 100 pF, R _b = 2.7 kΩ	1/f _{MCK} + 190 ^{Note 3}		1/f _{MCK} + 190 ^{Note 3}		1/f _{MCK} + 190 ^{Note 3}		kHz
		1.8 V ≤ EV _{DD0} < 3.3 V, 1.6 V ≤ V _b ≤ 2.0 V ^{Note 2} , C _b = 100 pF, R _b = 5.5 kΩ	1/f _{MCK} + 190 ^{Note 3}		1/f _{MCK} + 190 ^{Note 3}		1/f _{MCK} + 190 ^{Note 3}		kHz
Data hold time (transmission)	t _{HD:DAT}	4.0 V ≤ EV _{DD0} ≤ 5.5 V, 2.7 V ≤ V _b ≤ 4.0 V, C _b = 50 pF, R _b = 2.7 kΩ	0	305	0	305	0	305	ns
		2.7 V ≤ EV _{DD0} < 4.0 V, 2.3 V ≤ V _b ≤ 2.7 V, C _b = 50 pF, R _b = 2.7 kΩ	0	305	0	305	0	305	ns
		4.0 V ≤ EV _{DD0} ≤ 5.5 V, 2.7 V ≤ V _b ≤ 4.0 V, C _b = 100 pF, R _b = 2.8 kΩ	0	355	0	355	0	355	ns
		2.7 V ≤ EV _{DD0} < 4.0 V, 2.3 V ≤ V _b ≤ 2.7 V, C _b = 100 pF, R _b = 2.7 kΩ	0	355	0	355	0	355	ns
		1.8 V ≤ EV _{DD0} < 3.3 V, 1.6 V ≤ V _b ≤ 2.0 V ^{Note 2} , C _b = 100 pF, R _b = 5.5 kΩ	0	405	0	405	0	405	ns

Notes 1. The value must also be equal to or less than f_{MCK}/4.2. Use it with EV_{DD0} ≥ V_b.3. Set the f_{MCK} value to keep the hold time of SCLr = "L" and SCLr = "H".

Caution Select the TTL input buffer and the N-ch open drain output (V_{DD} tolerance (for the 20- to 52-pin products)/EV_{DD} tolerance (for the 64- to 128-pin products)) mode for the SDAr pin and the N-ch open drain output (V_{DD} tolerance (for the 20- to 52-pin products)/EV_{DD} tolerance (for the 64- to 128-pin products)) mode for the SCLr 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 next page.)

<R>

- Notes**
1. The first clock pulse is generated after this period when the start/restart condition is detected.
 2. The maximum value (MAX.) of t_{HD:DAT} is during normal transfer and a wait state is inserted in the ACK (acknowledge) timing.

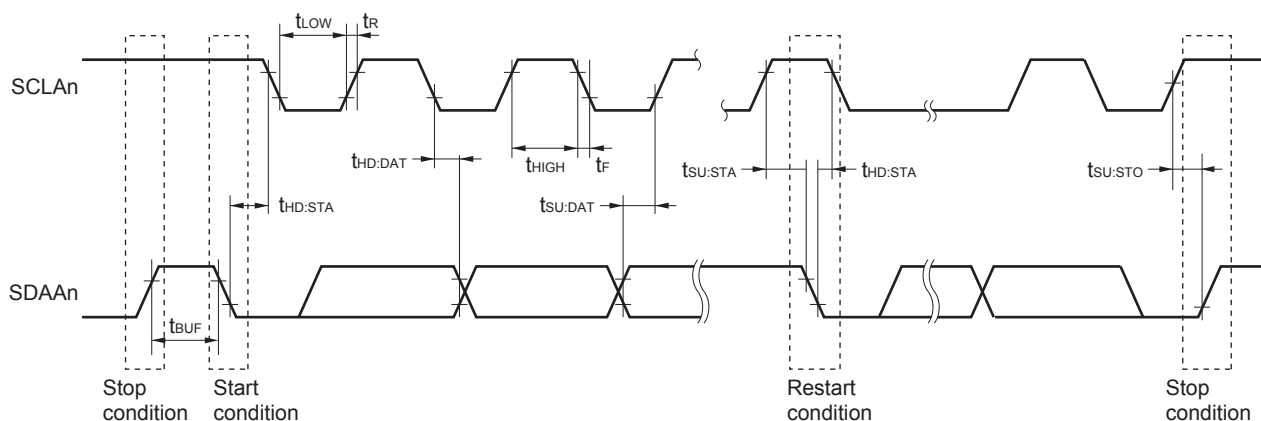
Caution The values in the above table are applied even when bit 2 (PIOR2) in the peripheral I/O redirection register (PIOR) is 1. At this time, the pin characteristics (I_{OH1}, I_{OL1}, V_{OH1}, V_{OL1}) must satisfy the values in the redirect destination.

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.

Standard mode: C_b = 400 pF, R_b = 2.7 kΩ

(3) I²C fast mode plus(T_A = -40 to +85°C, 1.6 V ≤ EV_{DD0} = EV_{DD1} ≤ V_{DD} ≤ 5.5 V, V_{SS} = EV_{SS0} = EV_{SS1} = 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 ≤ EV _{DD0} ≤ 5.5 V	0	1000	—	—	—	—	kHz
Setup time of restart condition	t _{SU:STA}	2.7 V ≤ EV _{DD0} ≤ 5.5 V	0.26	—	—	—	—	—	μs
Hold time ^{Note 1}	t _{HD:STA}	2.7 V ≤ EV _{DD0} ≤ 5.5 V	0.26	—	—	—	—	—	μs
Hold time when SCLA0 = "L"	t _{LOW}	2.7 V ≤ EV _{DD0} ≤ 5.5 V	0.5	—	—	—	—	—	μs
Hold time when SCLA0 = "H"	t _{HIGH}	2.7 V ≤ EV _{DD0} ≤ 5.5 V	0.26	—	—	—	—	—	μs
Data setup time (reception)	t _{SU:DAT}	2.7 V ≤ EV _{DD0} ≤ 5.5 V	50	—	—	—	—	—	μs
Data hold time (transmission) ^{Note 2}	t _{HD:DAT}	2.7 V ≤ EV _{DD0} ≤ 5.5 V	0	0.45	—	—	—	—	μs
Setup time of stop condition	t _{SU:STO}	2.7 V ≤ EV _{DD0} ≤ 5.5 V	0.26	—	—	—	—	—	μs
Bus-free time	t _{BUF}	2.7 V ≤ EV _{DD0} ≤ 5.5 V	0.5	—	—	—	—	—	μs

Notes 1. The first clock pulse is generated after this period when the start/restart condition is detected.<R> 2. The maximum value (MAX.) of t_{HD:DAT} is during normal transfer and a wait state is inserted in the ACK (acknowledge) timing.**Caution** The values in the above table are applied even when bit 2 (PIOR2) in the peripheral I/O redirection register (PIOR) is 1. At this time, the pin characteristics (I_{OH1}, I_{OL1}, V_{OH1}, V_{OL1}) must satisfy the values in the redirect destination.**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**I²C serial transfer timing****Remark** n = 0, 1

- Notes**
1. Excludes quantization error ($\pm 1/2$ LSB).
 2. This value is indicated as a ratio (%FSR) to the full-scale value.
 3. When $AV_{REFP} < V_{DD}$, the MAX. values are as follows.
Overall error: Add ± 1.0 LSB to the MAX. value when $AV_{REFP} = V_{DD}$.
Zero-scale error/Full-scale error: Add $\pm 0.05\%$ FSR to the MAX. value when $AV_{REFP} = V_{DD}$.
Integral linearity error/ Differential linearity error: Add ± 0.5 LSB to the MAX. value when $AV_{REFP} = V_{DD}$.
 4. Values when the conversion time is set to $57\ \mu\text{s}$ (min.) and $95\ \mu\text{s}$ (max.).
 5. Refer to **2.6.2 Temperature sensor/internal reference voltage characteristics**.

- Notes**
1. Total current flowing into V_{DD} and EV_{DD0} , including the input leakage current flowing when the level of the input pin is fixed to V_{DD} , EV_{DD0} or V_{SS} , EV_{SS0} . The values below the MAX. column include the peripheral operation current. However, not including the current flowing into the A/D converter, LVD circuit, I/O port, and on-chip pull-up/pull-down resistors and the current flowing during data flash rewrite.
 2. When high-speed on-chip oscillator and subsystem clock are stopped.
 3. When high-speed system clock and subsystem clock are stopped.
 4. When high-speed on-chip oscillator and high-speed system clock are stopped. When $AMPHS1 = 1$ (Ultra-low power consumption oscillation). However, not including the current flowing into the RTC, 12-bit interval timer, and watchdog timer.
 5. Relationship between operation voltage width, operation frequency of CPU and operation mode is as below.
 HS (high-speed main) mode: $2.7\text{ V} \leq V_{DD} \leq 5.5\text{ V}$ @ 1 MHz to 32 MHz
 $2.4\text{ V} \leq V_{DD} \leq 5.5\text{ V}$ @ 1 MHz to 16 MHz

- Remarks**
1. f_{MX} : High-speed system clock frequency (X1 clock oscillation frequency or external main system clock frequency)
 2. f_{IH} : High-speed on-chip oscillator clock frequency
 3. f_{SUB} : Subsystem clock frequency (XT1 clock oscillation frequency)
 4. Except subsystem clock operation, temperature condition of the TYP. value is $T_A = 25^{\circ}\text{C}$

(7) Communication at different potential (1.8 V, 2.5 V, 3 V) (CSI mode) (slave mode, SCKp... external clock input)

(T_A = -40 to $+105^{\circ}\text{C}$, $2.4\text{ V} \leq \text{EV}_{\text{DD0}} = \text{EV}_{\text{DD1}} \leq \text{V}_{\text{DD}} \leq 5.5\text{ V}$, $\text{V}_{\text{SS}} = \text{EV}_{\text{SS0}} = \text{EV}_{\text{SS1}} = 0\text{ V}$)

Parameter	Symbol	Conditions		HS (high-speed main) Mode		Unit
				MIN.	MAX.	
SCKp cycle time ^{Note 1}	t _{KCY2}	$4.0\text{ V} \leq \text{EV}_{\text{DD0}} \leq 5.5\text{ V}$, $2.7\text{ V} \leq \text{V}_b \leq 4.0\text{ V}$	$24\text{ MHz} < f_{\text{MCK}}$	$28/f_{\text{MCK}}$		ns
			$20\text{ MHz} < f_{\text{MCK}} \leq 24\text{ MHz}$	$24/f_{\text{MCK}}$		ns
			$8\text{ MHz} < f_{\text{MCK}} \leq 20\text{ MHz}$	$20/f_{\text{MCK}}$		ns
			$4\text{ MHz} < f_{\text{MCK}} \leq 8\text{ MHz}$	$16/f_{\text{MCK}}$		ns
			$f_{\text{MCK}} \leq 4\text{ MHz}$	$12/f_{\text{MCK}}$		ns
		$2.7\text{ V} \leq \text{EV}_{\text{DD0}} < 4.0\text{ V}$, $2.3\text{ V} \leq \text{V}_b \leq 2.7\text{ V}$	$24\text{ MHz} < f_{\text{MCK}}$	$40/f_{\text{MCK}}$		ns
			$20\text{ MHz} < f_{\text{MCK}} \leq 24\text{ MHz}$	$32/f_{\text{MCK}}$		ns
			$16\text{ MHz} < f_{\text{MCK}} \leq 20\text{ MHz}$	$28/f_{\text{MCK}}$		ns
			$8\text{ MHz} < f_{\text{MCK}} \leq 16\text{ MHz}$	$24/f_{\text{MCK}}$		ns
			$4\text{ MHz} < f_{\text{MCK}} \leq 8\text{ MHz}$	$16/f_{\text{MCK}}$		ns
			$f_{\text{MCK}} \leq 4\text{ MHz}$	$12/f_{\text{MCK}}$		ns
		$2.4\text{ V} \leq \text{EV}_{\text{DD0}} < 3.3\text{ V}$, $1.6\text{ V} \leq \text{V}_b \leq 2.0\text{ V}$	$24\text{ MHz} < f_{\text{MCK}}$	$96/f_{\text{MCK}}$		ns
			$20\text{ MHz} < f_{\text{MCK}} \leq 24\text{ MHz}$	$72/f_{\text{MCK}}$		ns
			$16\text{ MHz} < f_{\text{MCK}} \leq 20\text{ MHz}$	$64/f_{\text{MCK}}$		ns
			$8\text{ MHz} < f_{\text{MCK}} \leq 16\text{ MHz}$	$52/f_{\text{MCK}}$		ns
			$4\text{ MHz} < f_{\text{MCK}} \leq 8\text{ MHz}$	$32/f_{\text{MCK}}$		ns
			$f_{\text{MCK}} \leq 4\text{ MHz}$	$20/f_{\text{MCK}}$		ns
SCKp high-/low-level width	t _{KH2} , t _{KL2}	$4.0\text{ V} \leq \text{EV}_{\text{DD0}} \leq 5.5\text{ V}$, $2.7\text{ V} \leq \text{V}_b \leq 4.0\text{ V}$		t _{KCY2} /2 – 24		ns
		$2.7\text{ V} \leq \text{EV}_{\text{DD0}} < 4.0\text{ V}$, $2.3\text{ V} \leq \text{V}_b \leq 2.7\text{ V}$		t _{KCY2} /2 – 36		ns
		$2.4\text{ V} \leq \text{EV}_{\text{DD0}} < 3.3\text{ V}$, $1.6\text{ V} \leq \text{V}_b \leq 2.0\text{ V}$ ^{Note 2}		t _{KCY2} /2 – 100		ns
Slp setup time (to SCKp↑) ^{Note 2}	t _{SIK2}	$4.0\text{ V} \leq \text{EV}_{\text{DD0}} \leq 5.5\text{ V}$, $2.7\text{ V} \leq \text{V}_b \leq 4.0\text{ V}$		$1/f_{\text{MCK}} + 40$		ns
		$2.7\text{ V} \leq \text{EV}_{\text{DD0}} < 4.0\text{ V}$, $2.3\text{ V} \leq \text{V}_b \leq 2.7\text{ V}$		$1/f_{\text{MCK}} + 40$		ns
		$2.4\text{ V} \leq \text{EV}_{\text{DD0}} < 3.3\text{ V}$, $1.6\text{ V} \leq \text{V}_b \leq 2.0\text{ V}$		$1/f_{\text{MCK}} + 60$		ns
Slp hold time (from SCKp↑) ^{Note 3}	t _{KSI2}			$1/f_{\text{MCK}} + 62$		ns
Delay time from SCKp↓ to SOp output ^{Note 4}	t _{KSO2}	$4.0\text{ V} \leq \text{EV}_{\text{DD0}} \leq 5.5\text{ V}$, $2.7\text{ V} \leq \text{V}_b \leq 4.0\text{ V}$, $C_b = 30\text{ pF}$, $R_b = 1.4\text{ k}\Omega$			$2/f_{\text{MCK}} + 240$	ns
		$2.7\text{ V} \leq \text{EV}_{\text{DD0}} < 4.0\text{ V}$, $2.3\text{ V} \leq \text{V}_b \leq 2.7\text{ V}$, $C_b = 30\text{ pF}$, $R_b = 2.7\text{ k}\Omega$			$2/f_{\text{MCK}} + 428$	ns
		$2.4\text{ V} \leq \text{EV}_{\text{DD0}} < 3.3\text{ V}$, $1.6\text{ V} \leq \text{V}_b \leq 2.0\text{ V}$, $C_b = 30\text{ pF}$, $R_b = 5.5\text{ k}\Omega$			$2/f_{\text{MCK}} + 1146$	ns

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

3.5.2 Serial interface IICA

(TA = -40 to +105°C, 2.4 V ≤ EVDD0 = EVDD1 ≤ VDD ≤ 5.5 V, VSS = EVSS0 = EVSS1 = 0 V)

Parameter	Symbol	Conditions	HS (high-speed main) Mode				Unit
			Standard Mode		Fast Mode		
			MIN.	MAX.	MIN.	MAX.	
SCLA0 clock frequency	f _{SCL}	Fast mode: f _{CLK} ≥ 3.5 MHz	–	–	0	400	kHz
		Standard mode: f _{CLK} ≥ 1 MHz	0	100	–	–	kHz
Setup time of restart condition	t _{SU:STA}		4.7		0.6		μs
Hold time ^{Note 1}	t _{HD:STA}		4.0		0.6		μs
Hold time when SCLA0 = “L”	t _{LOW}		4.7		1.3		μs
Hold time when SCLA0 = “H”	t _{HIGH}		4.0		0.6		μs
Data setup time (reception)	t _{SU:DAT}		250		100		ns
Data hold time (transmission) ^{Note 2}	t _{HD:DAT}		0	3.45	0	0.9	μs
Setup time of stop condition	t _{SU:STO}		4.0		0.6		μs
Bus-free time	t _{BUF}		4.7		1.3		μs

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

<R> 2. The maximum value (MAX.) of tHD:DAT is during normal transfer and a wait state is inserted in the ACK (acknowledge) timing.

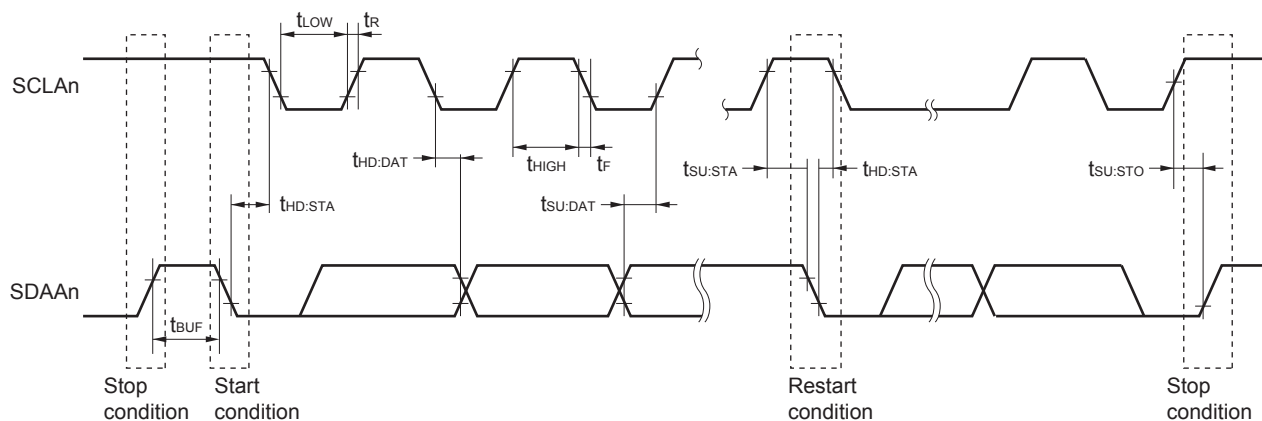
Caution The values in the above table are applied even when bit 2 (PIOR2) in the peripheral I/O redirection register (PIOR) is 1. At this time, the pin characteristics (IOH1, IOL1, VOH1, VOL1) must satisfy the values in the redirect destination.

Remark The maximum value of Cb (communication line capacitance) and the value of Rb (communication line pull-up resistor) at that time in each mode are as follows.

Standard mode: Cb = 400 pF, Rb = 2.7 kΩ

Fast mode: Cb = 320 pF, Rb = 1.1 kΩ

IICA serial transfer timing

**Remark** n = 0, 1

3.6.4 LVD circuit characteristics

LVD Detection Voltage of Reset Mode and Interrupt Mode**($T_A = -40$ to $+105^\circ\text{C}$, $V_{PDR} \leq V_{DD} \leq 5.5\text{ V}$, $V_{SS} = 0\text{ V}$)**

Parameter		Symbol	Conditions	MIN.	TYP.	MAX.	Unit
Detection voltage	Supply voltage level	V _{LVD0}	Power supply rise time	3.90	4.06	4.22	V
			Power supply fall time	3.83	3.98	4.13	V
		V _{LVD1}	Power supply rise time	3.60	3.75	3.90	V
			Power supply fall time	3.53	3.67	3.81	V
		V _{LVD2}	Power supply rise time	3.01	3.13	3.25	V
			Power supply fall time	2.94	3.06	3.18	V
		V _{LVD3}	Power supply rise time	2.90	3.02	3.14	V
			Power supply fall time	2.85	2.96	3.07	V
		V _{LVD4}	Power supply rise time	2.81	2.92	3.03	V
			Power supply fall time	2.75	2.86	2.97	V
		V _{LVD5}	Power supply rise time	2.70	2.81	2.92	V
			Power supply fall time	2.64	2.75	2.86	V
		V _{LVD6}	Power supply rise time	2.61	2.71	2.81	V
			Power supply fall time	2.55	2.65	2.75	V
		V _{LVD7}	Power supply rise time	2.51	2.61	2.71	V
			Power supply fall time	2.45	2.55	2.65	V
Minimum pulse width		t _{LW}		300			μs
Detection delay time						300	μs

LVD Detection Voltage of Interrupt & Reset Mode**($T_A = -40$ to $+105^\circ\text{C}$, $V_{PDR} \leq V_{DD} \leq 5.5\text{ V}$, $V_{SS} = 0\text{ V}$)**

Parameter	Symbol	Conditions		MIN.	TYP.	MAX.	Unit
Interrupt and reset mode	V _{LVDD0}	V _{POC2} , V _{POC1} , V _{POC0} = 0, 1, 1, falling reset voltage		2.64	2.75	2.86	V
	V _{LVDD1}	LVIS1, LVIS0 = 1, 0	Rising release reset voltage	2.81	2.92	3.03	V
			Falling interrupt voltage	2.75	2.86	2.97	V
	V _{LVDD2}	LVIS1, LVIS0 = 0, 1	Rising release reset voltage	2.90	3.02	3.14	V
			Falling interrupt voltage	2.85	2.96	3.07	V
	V _{LVDD3}	LVIS1, LVIS0 = 0, 0	Rising release reset voltage	3.90	4.06	4.22	V
			Falling interrupt voltage	3.83	3.98	4.13	V