

RL78/G23

R01DS0395EJ0100

RENESAS MCU

Rev.1.00

Apr 13, 2021

True low-power platform, 44- μ A/MHz operating current, 210-nA holding current for 4 KB of RAM, up to 768-KB code flash memory and 48-KB RAM, Capacitive sensing unit, from 30 to 128 pins, 1.6-5.5 V

1. OUTLINE

1.1 Features

Ultra-low power consumption technology

- VDD = single power supply voltage of 1.6 to 5.5 V
- HALT mode
- STOP mode
 - High-speed wakeup from the STOP mode is possible.
- SNOOZE mode

RL78 CPU core

- CISC architecture with 3-stage pipeline
- Minimum instruction execution time: Can be changed from high speed (0.03125 μ s @ 32 MHz operation with the high-speed on-chip oscillator clock) to ultra-low speed (30.5 μ s @ 32.768 kHz operation with the subsystem clock)
- Multiply/divide/multiply & accumulate instructions are supported.
- Address space: 1 MB
- General-purpose registers: (8-bit register \times 8) \times 4 banks
- On-chip RAM: 12 to 48 KB

Code flash memory

- Code flash memory: 96 to 768 KB
- Block size: 2 KB
- Prohibition of block erase and rewriting (security function)
- On-chip debugging
- Self-programming (with boot swapping and flash shield window)

Data flash memory

- Data flash memory: 8 KB
- Back ground operation (BGO): Instructions can be executed from the program memory while rewriting the data flash memory.
- Number of rewrites: 1,000,000 times (typ.)

High-speed on-chip oscillator

- Select from 32 MHz, 24 MHz, 16 MHz, 12 MHz, 8 MHz, 6 MHz, 4 MHz, 3 MHz, 2 MHz, or 1 MHz
- High accuracy: $\pm 1.0\%$ (VDD = 1.8 to 5.5 V, TA = -20 to +85°C)

Middle-speed on-chip oscillator

- Select from 4 MHz, 3 MHz, 2 MHz, or 1 MHz (with adjustability)

Low-speed on-chip oscillator

- 32.768 kHz (typ.) (with adjustability)

Operating ambient temperature

- TA = -40 to +85°C (2D: Consumer applications)
- TA = -40 to +105°C (3C: Industrial applications)

Power management and reset function

- On-chip power-on-reset (POR) circuit
- On-chip voltage detectors (LVD0 and LVD1)

Data transfer controller (DTC)

- Transfer modes: Normal transfer mode, repeat transfer mode, block transfer mode
- Activation sources: Activated by interrupt sources.
- Chain transfer function

SNOOZE mode sequencer (SMS)

- Calculations and comparison of values by the commands for use in processing by the sequencer can realize intermittent operations where the RL78/G23 does not have to return to normal operation.
- Sequentially handling a total of 32 processes with the use of desired commands from among 21 different ones
- The SNOOZE mode sequencer offers operation with low power consumption without using the CPU, flash memory, and RAM.

Logic and event link controller (ELCL)

- Event signals can be set up between specified peripheral functions.
- The signals can be generated by the input of multiple event signals to the logic circuit.
- Flip-flop circuits are incorporated to handle setting and resetting functions.

Serial interface

- SPI (CSI^{Note 1}): 3 to 8 channels
- UART/UART (LIN-bus supported)/UARTA: 3 to 6 channels
- I²C/Simplified I²C: 4 to 10 channels

Remote control signal receiver

- 1 channel
- Matching of 4 waveform patterns (header, data 0, data 1, and special data)

Timer

- 16-bit timer: 8 to 16 channels
- 32-bit interval timer: 1 channel in 32-bit mode
2 channels in 16-bit mode
4 channels in 8-bit mode
- Realtime clock: 1 channel (counting of one second to 99 years, alarm interrupt, and clock correction)
- Watchdog timer: 1 channel (operates with the dedicated low-speed on-chip oscillator clock)

A/D converter

- 8-/10-/12-bit resolution A/D converter (V_{DD} = 1.6 to 5.5 V)
- Analog input: 8 to 26 channels
- Internal reference voltage (1.48 V) and temperature sensor

D/A converter

- 8-bit resolution D/A converter (V_{DD} = 1.6 to 5.5 V)
- Analog output: 2 channels
- Output voltage: 0 V to V_{DD}
- Realtime output function

Comparator

- 2 channels
- Operating modes: Comparator high-speed mode and comparator low-speed mode
- The external reference voltage and the internal reference voltage or D/A converter output are selectable as the reference voltage.

Capacitive sensing unit

- CTSU2L operating voltage condition: V_{DD} = 1.8 to 5.5 V
- Self-capacitance method: A single pin configures a single key, supporting up to 32 keys
- Mutual capacitance method: Matrix configuration with 8 × 8 pins, supporting up to 64 keys

Input/output port pins

- Number of port pins: 26 to 120 (N-ch open drain I/O [withstand voltage of 6 V]: 2 to 4, N-ch open drain I/O [V_{DD} withstand voltage^{Note 2}/EV_{DD} withstand voltage^{Note 3}]: 10 to 33, output current control pins: 6 to 8)
- Can be set to N-ch open drain or TTL input buffer, and use of an on-chip pull-up resistor can be specified.
- Connectable to a device with different voltage (1.8, 2.5, or 3 V)

Others

- BCD (binary-coded decimal) correction circuit
- Key interrupt input
- Clock output/buzzer output controller

Note 1. Although the CSI function is generally called SPI, it is also called CSI in this product, so it is referred to as such in this manual.

Note 2. This applies to the 30- to 52-pin products.

Note 3. This applies to the 64- to 128-pin products.

Remark The functions mounted depend on the product. See **1.6 Outline of Functions**.

O ROM, RAM capacities

Flash ROM	Data flash	RAM	RL78/G23					
			30 pins	32 pins	36 pins	40 pins	44 pins	48 pins
768 KB	8 KB	48 KB	—	—	—	—	R7F100GFN	R7F100GGN
512 KB	8 KB	48 KB	—	—	—	—	R7F100GFL	R7F100GGL
384 KB	8 KB	32 KB	—	—	—	—	R7F100GFK	R7F100GGK
256 KB	8 KB	24 KB	R7F100GAJ	R7F100GBJ	R7F100GCJ	R7F100GEJ	R7F100GFJ	R7F100GGJ
192 KB	8 KB	20 KB	R7F100GAH	R7F100GBH	R7F100GCH	R7F100GEH	R7F100GFH	R7F100GGH
128 KB	8 KB	16 KB	R7F100GAG	R7F100GBG	R7F100GCG	R7F100GEG	R7F100GFG	R7F100GGG
96 KB	8 KB	12 KB	R7F100GAF	R7F100GBF	R7F100GCF	R7F100GEF	R7F100GFF	R7F100GGF

Flash ROM	Data flash	RAM	RL78/G23				
			52 pins	64 pins	80 pins	100 pins	128 pins
768 KB	8 KB	48 KB	R7F100GJN	R7F100GLN	R7F100GMN	R7F100GPN	R7F100GSN
512 KB	8 KB	48 KB	R7F100GJL	R7F100GLL	R7F100GML	R7F100GPL	R7F100GSL
384 KB	8 KB	32 KB	R7F100GJK	R7F100GLK	R7F100GMK	R7F100GPK	R7F100GSK
256 KB	8 KB	24 KB	R7F100GJJ	R7F100GLJ	R7F100GMJ	R7F100GPJ	R7F100GSJ
192 KB	8 KB	20 KB	R7F100GJH	R7F100GLH	R7F100GMH	R7F100GPH	—
128 KB	8 KB	16 KB	R7F100GJG	R7F100GLG	R7F100GMG	R7F100GPG	—
96 KB	8 KB	12 KB	R7F100GJF	R7F100GLF	—	—	—

1.2 List of Part Numbers

Figure 1 - 1 Part Number, Memory Size, and Package of RL78/G23

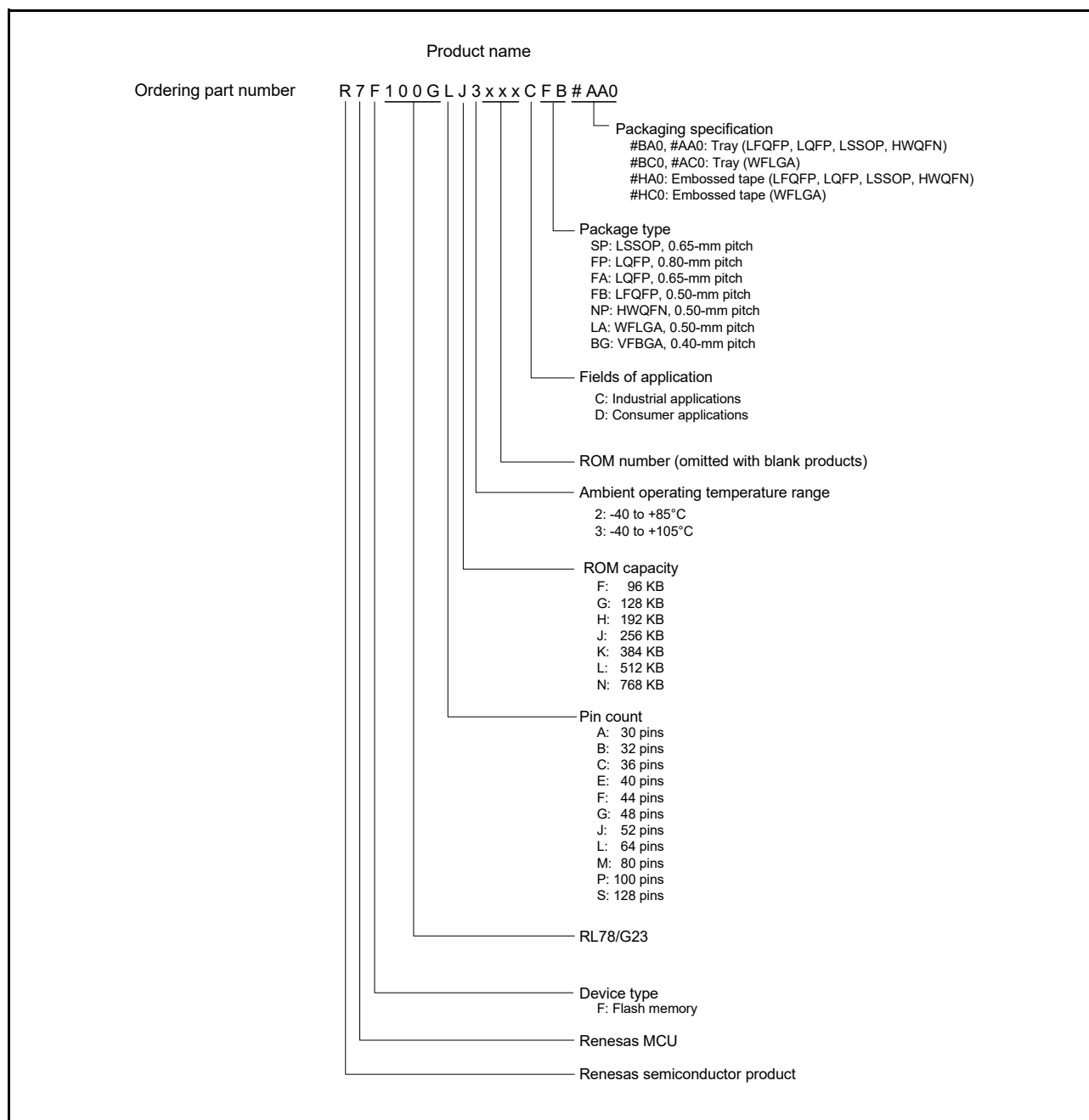


Table 1 - 1 List of Ordering Part Numbers (1/3)

Pin count	Package	Fields of Application Note 1	Ordering Part Number		Renesas Code
			Product Name	Packaging Specification	
30 pins	30-pin plastic LSSOP (7.62 mm (300), 0.65-mm pitch)	C	R7F100GAF3CSP, R7F100GAG3CSP, R7F100GAH3CSP, R7F100GAJ3CSP	#AA0, #BA0 #HA0	PLSP0030JB-B
		D	R7F100GAF2DSP, R7F100GAG2DSP, R7F100GAH2DSP, R7F100GAJ2DSP		
32 pins	32-pin plastic HWQFN (5 × 5 mm, 0.5-mm pitch)	C	R7F100GBF3CNP, R7F100GBG3CNP, R7F100GBH3CNP, R7F100GBJ3CNP	#AA0, #BA0 #HA0	PWQN0032KE-A
		D	R7F100GBF2DNP, R7F100GBG2DNP, R7F100GBH2DNP, R7F100GBJ2DNP		
32 pins	32-pin plastic LQFP (7 × 7 mm, 0.80-mm pitch)	C	R7F100GBF3CFP, R7F100GBG3CFP, R7F100GBH3CFP, R7F100GBJ3CFP	#AA0, #BA0 #HA0	PLQP0032GB-A
		D	R7F100GBF2DFP, R7F100GBG2DFP, R7F100GBH2DFP, R7F100GBJ2DFP		
36 pins	36-pin plastic WFLGA (4 × 4 mm, 0.50-mm pitch)	C	R7F100GCF3CLA, R7F100GCG3CLA, R7F100GCH3CLA, R7F100GCJ3CLA	#BC0, #AC0 #HC0	Note 2
		D	R7F100GCF2DLA, R7F100GCG2DLA, R7F100GCH2DLA, R7F100GCJ2DLA		
40 pins	40-pin plastic HWQFN (6 × 6 mm, 0.50-mm pitch)	C	R7F100GEF3CNP, R7F100GEG3CNP, R7F100GEH3CNP, R7F100GEJ3CNP	#AA0, #BA0 #HA0	PWQN0040KD-A
		D	R7F100GEF2DNP, R7F100GEG2DNP, R7F100GEH2DNP, R7F100GEJ2DNP		
44 pins	44-pin plastic LQFP (10 × 10 mm, 0.80-mm pitch)	C	R7F100GFF3CFP, R7F100GFG3CFP, R7F100GFH3CFP, R7F100GFJ3CFP, R7F100GFK3CFP, R7F100GFL3CFP, R7F100GFN3CFP	#AA0, #BA0 #HA0	PLQP0044GC-A
		D	R7F100GFF2DFP, R7F100GFG2DFP, R7F100GFH2DFP, R7F100GFJ2DFP, R7F100GFK2DFP, R7F100GFL2DFP, R7F100GFN2DFP		
48 pins	48-pin plastic LFQFP (7 × 7 mm, 0.50-mm pitch)	C	R7F100GGF3CFB, R7F100GGG3CFB, R7F100GGH3CFB, R7F100GGJ3CFB, R7F100GGK3CFB, R7F100GGL3CFB, R7F100GGN3CFB	#AA0, #BA0 #HA0	PLQP00048KB-B
		D	R7F100GGF2DFB, R7F100GGG2DFB, R7F100GGH2DFB, R7F100GGJ2DFB, R7F100GGK2DFB, R7F100GGL2DFB, R7F100GGN2DFB		
48 pins	48-pin plastic HWQFN (7 × 7 mm, 0.50-mm pitch)	C	R7F100GGF3CNP, R7F100GGG3CNP, R7F100GGH3CNP, R7F100GGJ3CNP, R7F100GGK3CNP, R7F100GGL3CNP, R7F100GGN3CNP	#AA0, #BA0 #HA0	PWQN0048KC-A
		D	R7F100GGF2DNP, R7F100GGG2DNP, R7F100GGH2DNP, R7F100GGJ2DNP, R7F100GGK2DNP, R7F100GGL2DNP, R7F100GGN2DNP		

Table 1 - 1 List of Ordering Part Numbers (2/3)

Pin count	Package	Fields of Application Note 1	Ordering Part Number		Renesas Code
			Product Name	Packaging Specification	
52 pins	52-pin plastic LQFP (10 × 10 mm, 0.65-mm pitch)	C	R7F100GJF3CFA, R7F100GJG3CFA, R7F100GJH3CFA, R7F100GJJ3CFA, R7F100GJK3CFA, R7F100GJL3CFA, R7F100GJN3CFA	#AA0, #BA0 #HA0	PLQP0052JA-A
		D	R7F100GJF2DFA, R7F100GJG2DFA, R7F100GJH2DFA, R7F100GJJ2DFA, R7F100GJK2DFA, R7F100GJL2DFA, R7F100GJN2DFA		
64 pins	64-pin plastic LQFP (12 × 12 mm, 0.65-mm pitch)	C	R7F100GLF3CFA, R7F100GLG3CFA, R7F100GLH3CFA, R7F100GLJ3CFA, R7F100GLK3CFA, R7F100GLL3CFA, R7F100GLN3CFA	#AA0, #BA0 #HA0	PLQP0064JA-A
		D	R7F100GLF2DFA, R7F100GLG2DFA, R7F100GLH2DFA, R7F100GLJ2DFA, R7F100GLK2DFA, R7F100GLL2DFA, R7F100GLN2DFA		
64 pins	64-pin plastic LFQFP (10 × 10 mm, 0.50-mm pitch)	C	R7F100GLF3CFB, R7F100GLG3CFB, R7F100GLH3CFB, R7F100GLJ3CFB, R7F100GLK3CFB, R7F100GLL3CFB, R7F100GLN3CFB	#AA0, #BA0 #HA0	PLQP0064KB-C
		D	R7F100GLF2DFB, R7F100GLG2DFB, R7F100GLH2DFB, R7F100GLJ2DFB, R7F100GLK2DFB, R7F100GLL2DFB, R7F100GLN2DFB		
64 pins	64-pin plastic WFLGA (5 × 5 mm, 0.50-mm pitch)	C	R7F100GLF3CLA, R7F100GLG3CLA, R7F100GLH3CLA, R7F100GLJ3CLA, R7F100GLK3CLA, R7F100GLL3CLA, R7F100GLN3CLA	#BC0, #AC0 #HC0	Note 3
		D	R7F100GLF2DLA, R7F100GLG2DLA, R7F100GLH2DLA, R7F100GLJ2DLA, R7F100GLK2DLA, R7F100GLL2DLA, R7F100GLN2DLA		
80 pins	80-pin plastic LQFP (14 × 14 mm, 0.65-mm pitch)	C	R7F100GMG3CFA, R7F100GMH3CFA, R7F100GMJ3CFA, R7F100GMK3CFA, R7F100GML3CFA, R7F100GMN3CFA	#AA0, #BA0 #HA0	PLQP0080JA-B
		D	R7F100GMG2DFA, R7F100GMH2DFA, R7F100GMJ2DFA, R7F100GMK2DFA, R7F100GML2DFA, R7F100GMN2DFA		
80 pins	80-pin plastic LFQFP (12 × 12 mm, 0.50-mm pitch)	C	R7F100GMG3CFB, R7F100GMH3CFB, R7F100GMJ3CFB, R7F100GMK3CFB, R7F100GML3CFB, R7F100GMN3CFB	#AA0, #BA0 #HA0	PLQP0080KB-B
		D	R7F100GMG2DFB, R7F100GMH2DFB, R7F100GMJ2DFB, R7F100GMK2DFB, R7F100GML2DFB, R7F100GMN2DFB		
100 pins	100-pin plastic LFQFP (14 × 14 mm, 0.50-mm pitch)	C	R7F100GPG3CFB, R7F100GPH3CFB, R7F100GPJ3CFB, R7F100GPK3CFB, R7F100GPL3CFB, R7F100GPN3CFB	#AA0, #BA0 #HA0	PLQP0100KB-B
		D	R7F100GPG2DFB, R7F100GPH2DFB, R7F100GPJ2DFB, R7F100GPK2DFB, R7F100GPL2DFB, R7F100GPN2DFB		

Table 1 - 1 List of Ordering Part Numbers (3/3)

Pin count	Package	Fields of Application Note 1	Ordering Part Number		Renesas Code
			Product Name	Packaging Specification	
100 pins	100-pin plastic LQFP (14 × 20 mm, 0.65-mm pitch)	C	R7F100GPG3CFA, R7F100GPH3CFA, R7F100GPJ3CFA, R7F100GPK3CFA, R7F100GPL3CFA, R7F100GPN3CFA	#AA0, #BA0 #HA0	PLQP0100JC-A
		D	R7F100GPG2DFA, R7F100GPH2DFA, R7F100GPJ2DFA, R7F100GPK2DFA, R7F100GPL2DFA, R7F100GPN2DFA		
128 pins	128-pin plastic LFQFP (14 × 20 mm, 0.50-mm pitch)	C	R7F100GSJ3CFB, R7F100GSK3CFB, R7F100GSL3CFB, R7F100GSN3CFB	#AA0, #BA0 #HA0	PLQP0128KD-A
		D	R7F100GSJ2DFB, R7F100GSK2DFB, R7F100GSL2DFB, R7F100GSN2DFB		

Note 1. For the fields of application, see **Figure 1 - 1 Part Number, Memory Size, and Package of RL78/G23**.

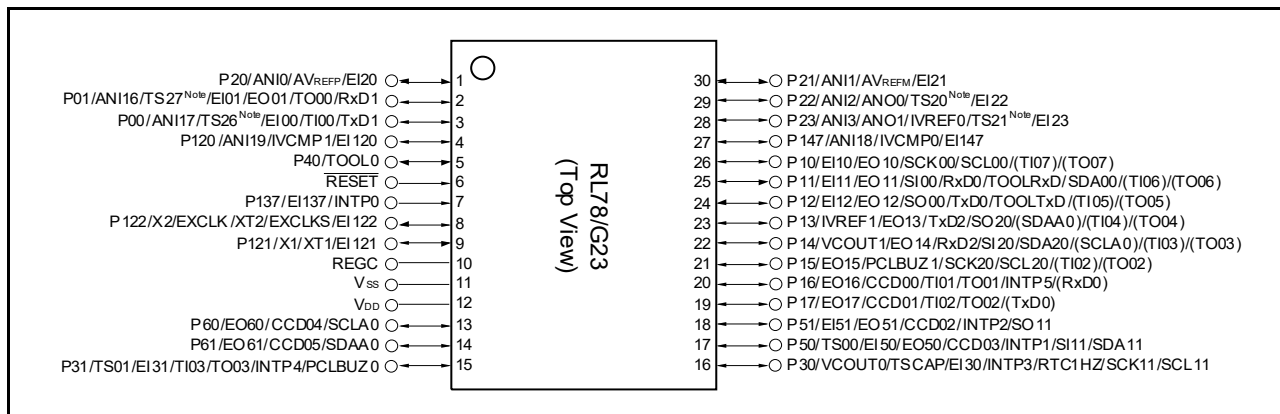
Note 2. The 36-pin plastic WFLGA products are in planning. Contact a Renesas Electronics sales office for details.

Note 3. The 64-pin plastic WFLGA products are in planning. Contact a Renesas Electronics sales office for details.

1.3 Pin Configuration (Top View)

1.3.1 30-pin products

- 30-pin plastic LSSOP (7.62 mm (300), 0.65-mm pitch)



Note Not present in products with 128 or fewer Kbytes of code flash memory.

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

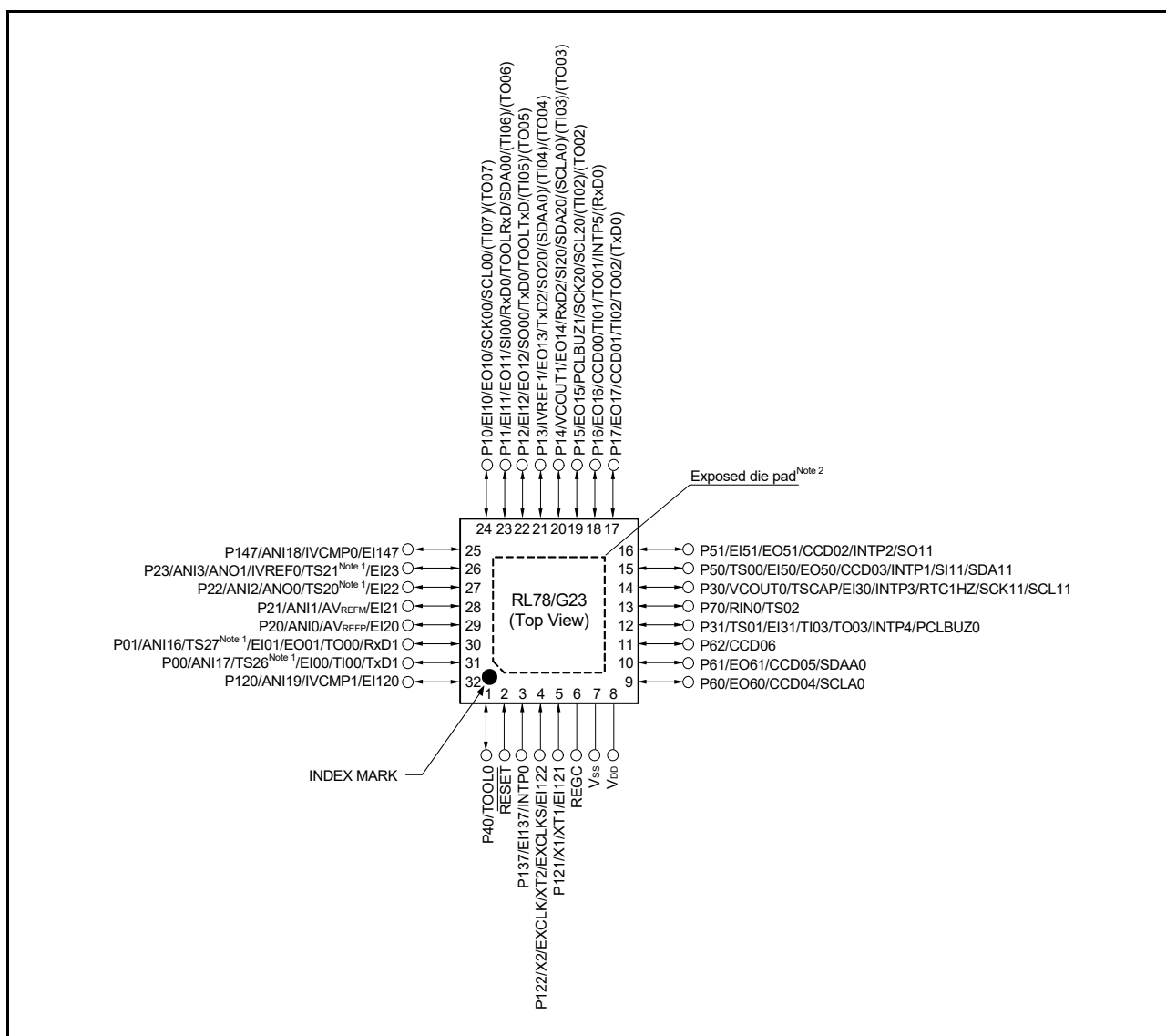
Remark 1. For pin identification, see 1.4 Pin Identification.

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

Refer to **Figure 4 - 10 Format of Peripheral I/O Redirection Register (PIOR)** in the RL78/G23 User's Manual.

1.3.2 32-pin products

- 32-pin plastic HWQFN (5 × 5 mm, 0.50-mm pitch)
- 32-pin plastic LQFP (7 × 7 mm, 0.80-mm pitch)



Note 1. Not present in products with 128 or fewer Kbytes of code flash memory.

Note 2. The 32-pin plastic LQFP (7 × 7 mm, 0.80-mm pitch) products do not have an exposed die pad.

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

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

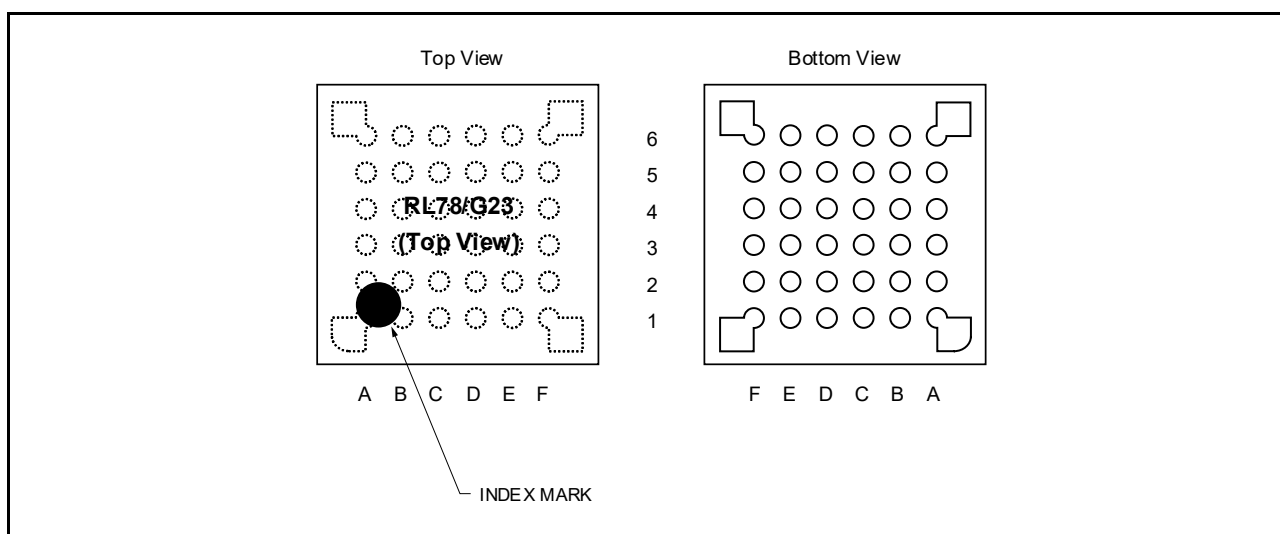
Remark 2. Functions in parentheses in the above figure can be assigned via settings in the peripheral I/O redirection register (PIOR).

Refer to **Figure 4 - 10 Format of Peripheral I/O Redirection Register (PIOR)** in the RL78/G23 User's Manual.

Remark 3. It is recommended to connect an exposed die pad to Vss.

1.3.3 36-pin products

- 36-pin plastic WFLGA (4 × 4 mm, 0.50-mm pitch)



	A	B	C	D	E	F
6	P60/EO60/CCD04/ SCLA0	VDD	P121/X1/XT1/EI121	P122/X2/EXCLK/XT2/ EXCLKS/EI122	P137/EI137/INTP0	P40/TOOL0
5	P62/CCD06	P61/EO61/CCD05/SD AA0	VSS	REGC	RESET	P120/ANI19/IVCMP1/ EI120
4	P72/TS04/SO21/ TxDA0	P71/TS03/SI21/ SDA21/RxDA0	P14/VCOUT1/EO14/ RxD2/SI20/SDA20/ (SCLA0)/(TI03)/ (TO03)	P31/TS01/EI31/TI03/ TO03/INTP4/ PCLBUZ0	P00/TS26 ^{Note} /EI00/ TI00/TxD1	P01/TS27 ^{Note} /EI01/ EO01/TO00/RxD1
3	P50/TS00/EI50/EO50/ CCD03/INTP1/SI11/ SDA11	P70/TS02/RIN0/ SCK21/SCL21	P15/EO15/PCLBUZ1/ SCK20/SCL20/ (TI02)/(TO02)	P22/ANI2/ANO0/ TS20 ^{Note} /EI22	P20/ANI0/AVREFP/ EI20	P21/ANI1/AVREFM/ EI21
2	P30/VCOUT0/TSCAP/ EI30/INTP3/RTC1HZ/ SCK11/SCL11	P16/EO16/CCD00/ TI01/TO01/INTP5/ (RxD0)	P12/EI12/EO12/SO00/ TxD0/TOOLTxD/ (TI05)/(TO05)	P11/EI11/EO11/SI00/ RxD0/TOOLRxD/ SDA00/(TI06)/(TO06)	P24/ANI4/TS22 ^{Note}	P23/ANI3/ANO1/ IVREF0/TS21 ^{Note} / EI23
1	P51/EI51/EO51/ CCD02/INTP2/ SO11	P17/EO17/CCD01/ TI02/TO02/(TxD0)	P13/IVREF1/EO13/ TxD2/SO20/(SDAA0)/ (TI04)/(TO04)	P10/EI10/EO10/ SCK00/SCL00/ (TI07)/(TO07)	P147/ANI18/IVCMP0/ EI147	P25/ANI5/TS23 ^{Note}

Note Not present in products with 128 or fewer Kbytes of code flash memory.

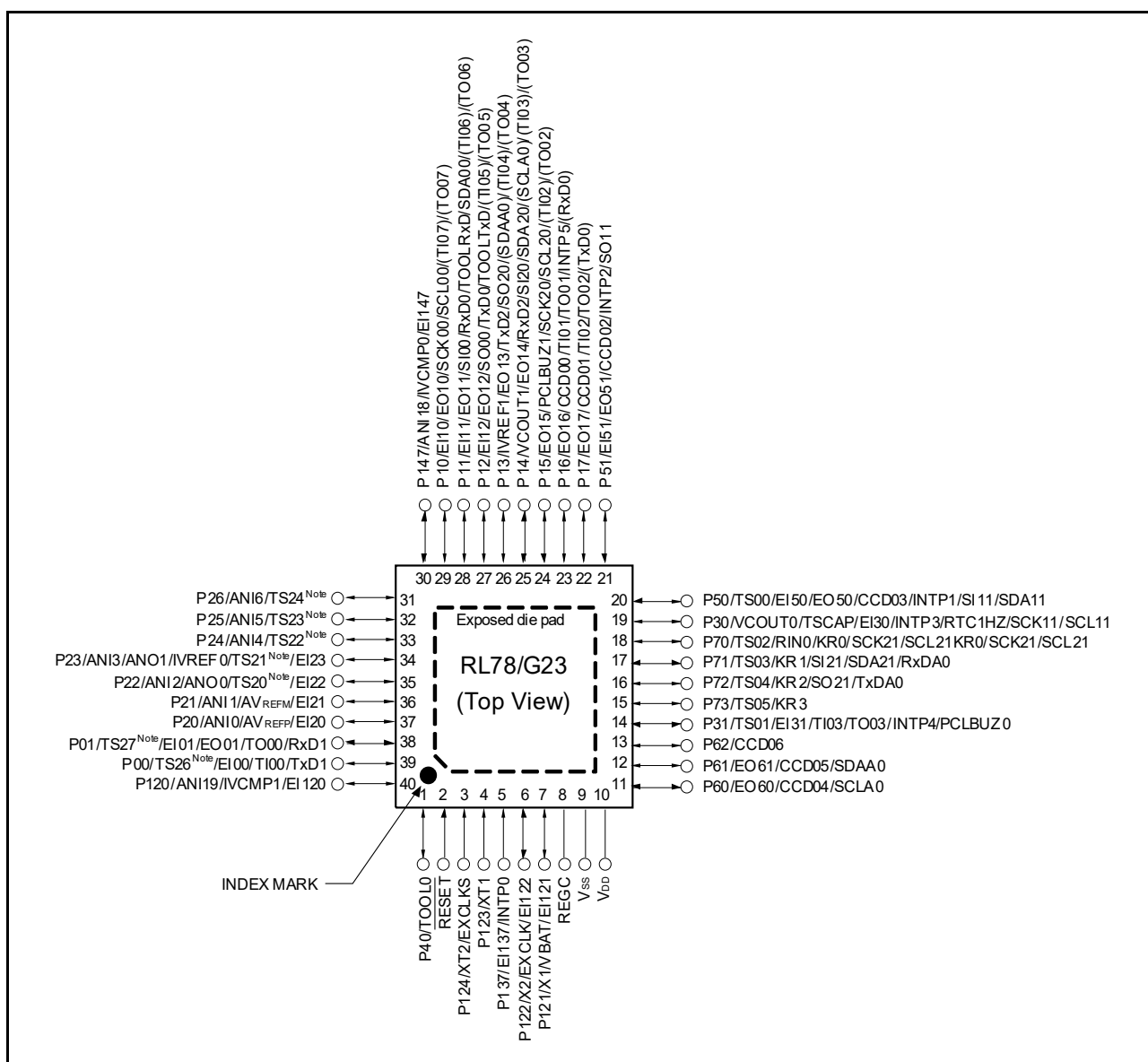
Caution Connect the REGC pin to Vss via a capacitor (0.47 to 1 μF).

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).
Refer to **Figure 4 - 10 Format of Peripheral I/O Redirection Register (PIOR)** in the RL78/G23 User's Manual.

1.3.4 40-pin products

- 40-pin plastic HWQFN (6 × 6 mm, 0.50-mm pitch)



Note Not present in products with 128 or fewer Kbytes of code flash memory.

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

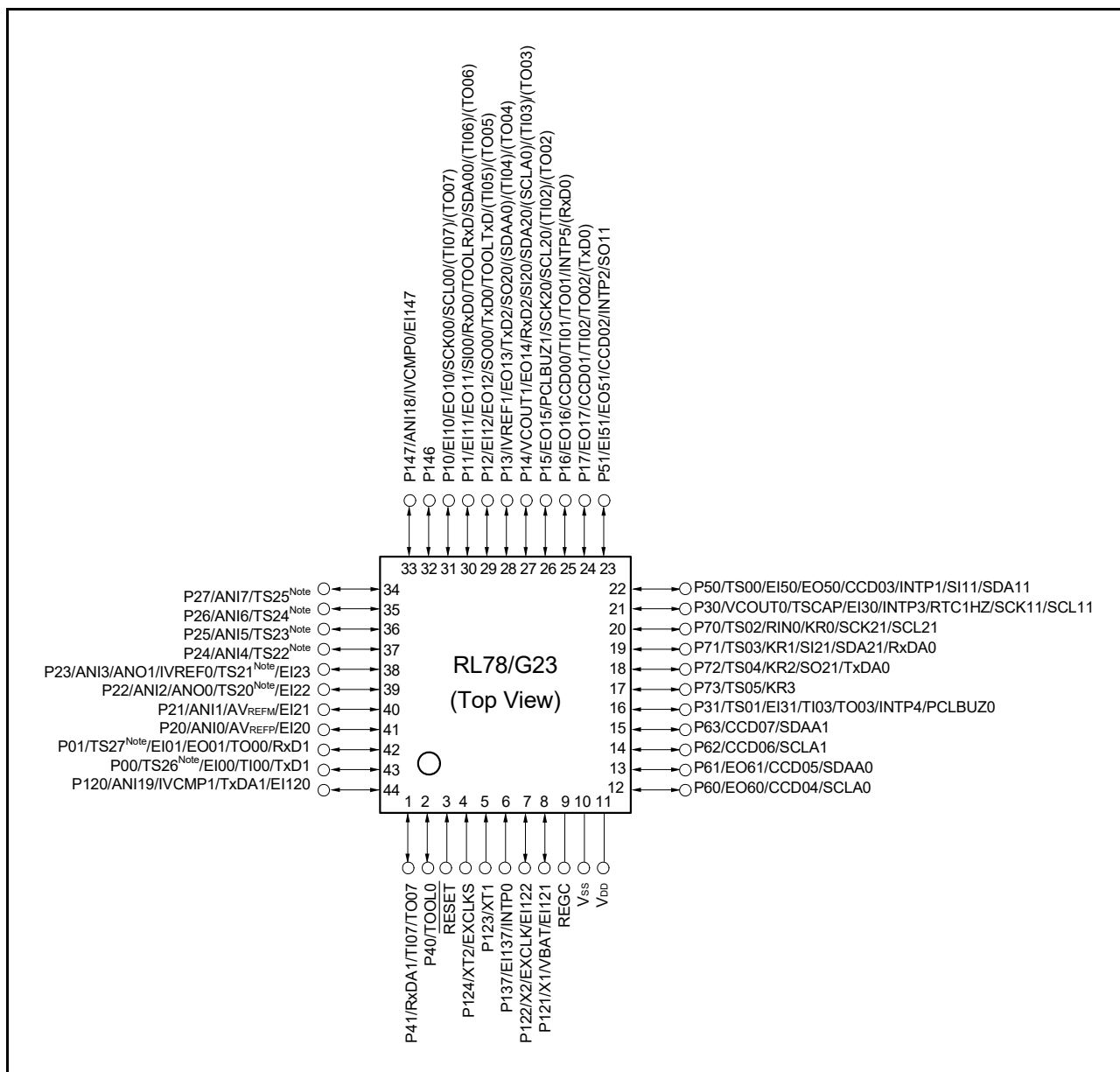
Remark 1. For pin identification, see 1.4 Pin Identification.

Remark 2. Functions in parentheses in the above figure can be assigned via settings in the peripheral I/O redirection register (PIOR).
Refer to **Figure 4 - 10 Format of Peripheral I/O Redirection Register (PIOR)** in the RL78/G23 User's Manual.

Remark 3. It is recommended to connect an exposed die pad to Vss.

1.3.5 44-pin products

- 44-pin plastic LQFP (10 × 10 mm, 0.80-mm pitch)



Note Not present in products with 128 or fewer Kbytes of code flash memory.

Caution Connect the REGC pin to V_{SS} via a capacitor (0.47 to 1 μF).

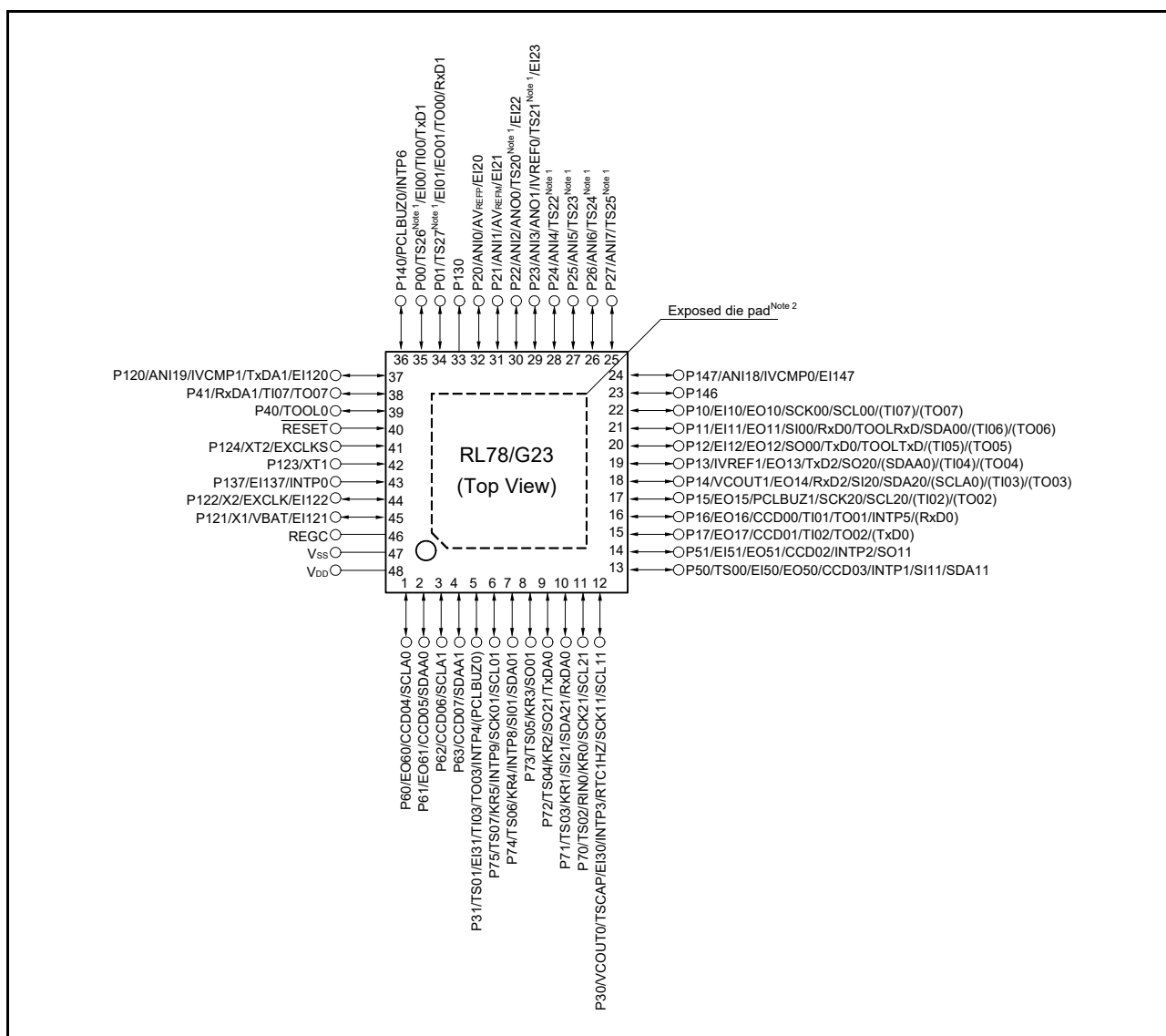
Remark 1. For pin identification, see 1.4 Pin Identification.

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

Refer to **Figure 4 - 10 Format of Peripheral I/O Redirection Register (PIOR)** in the RL78/G23 User's Manual.

1.3.6 48-pin products

- 48-pin plastic LFQFP (7 × 7 mm, 0.50-mm pitch)
- 48-pin plastic HWQFN (7 × 7 mm, 0.50-mm pitch)



Note 1. Not present in products with 128 or fewer Kbytes of code flash memory.

Note 2. The 32-pin plastic LQFP (7 × 7 mm, 0.80-mm pitch) products do not have an exposed die pad.

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

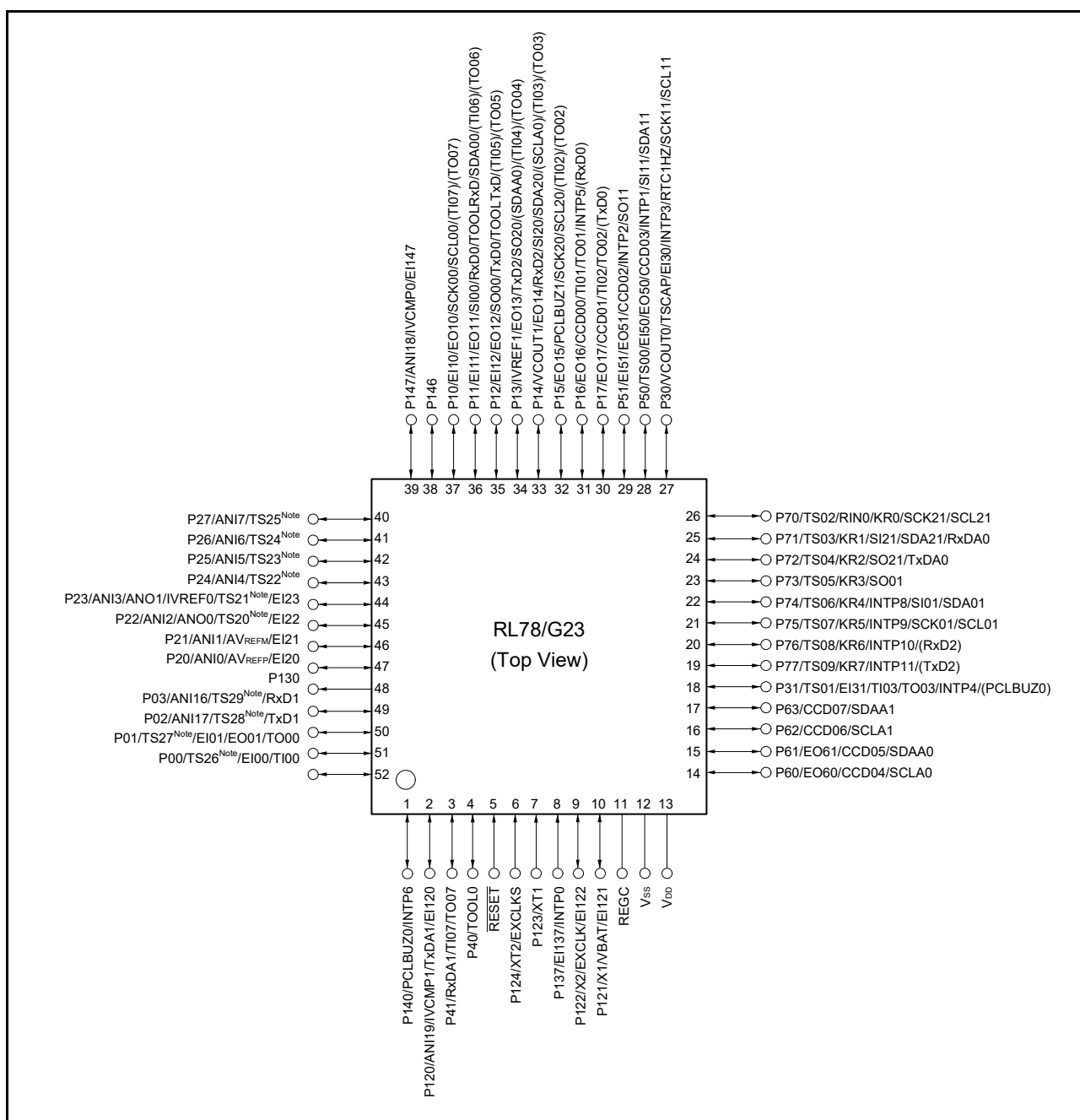
Remark 1. For pin identification, see 1.4 Pin Identification.

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

Refer to **Figure 4 - 10 Format of Peripheral I/O Redirection Register (PIOR)** in the RL78/G23 User's Manual.

1.3.7 52-pin products

- 52-pin plastic LQFP (10 × 10 mm, 0.65-mm pitch)



Note Not present in products with 128 or fewer Kbytes of code flash memory.

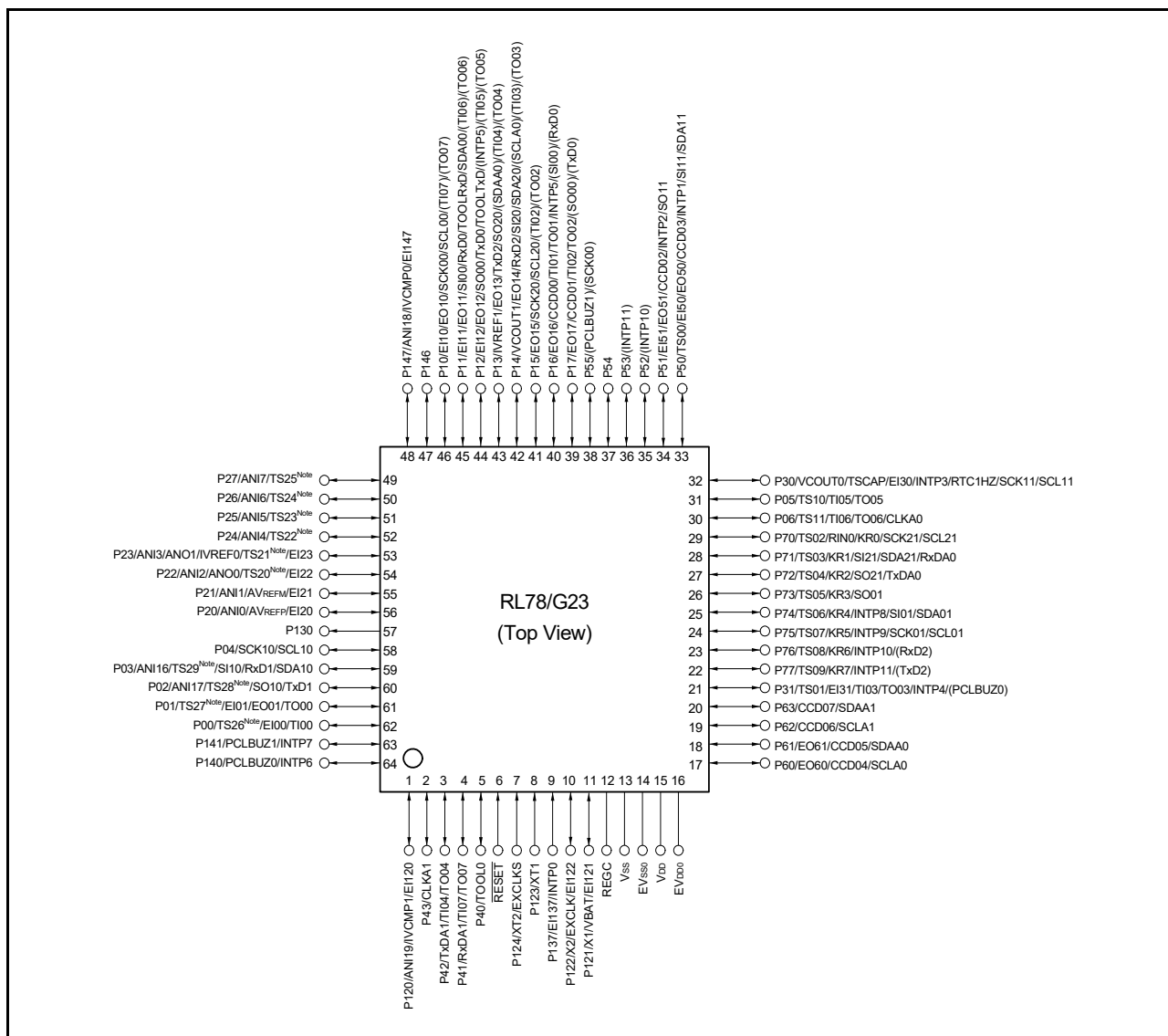
Caution Connect the REGC pin to V_{SS} via a capacitor (0.47 to 1 μF).

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). Refer to **Figure 4 - 10 Format of Peripheral I/O Redirection Register (PIOR)** in the RL78/G23 User's Manual.

1.3.8 64-pin products

- 64-pin plastic LQFP (12 × 12 mm, 0.65-mm pitch)
- 64-pin plastic LFQFP (10 × 10 mm, 0.50-mm pitch)



Note Not present in products with 128 or fewer Kbytes of code flash memory.

Caution 1. Connect the EVss0 pin to the same ground as the Vss pin.

Caution 2. Make sure that the voltage on the VDD pin is no less than that on the EVDD0 pin.

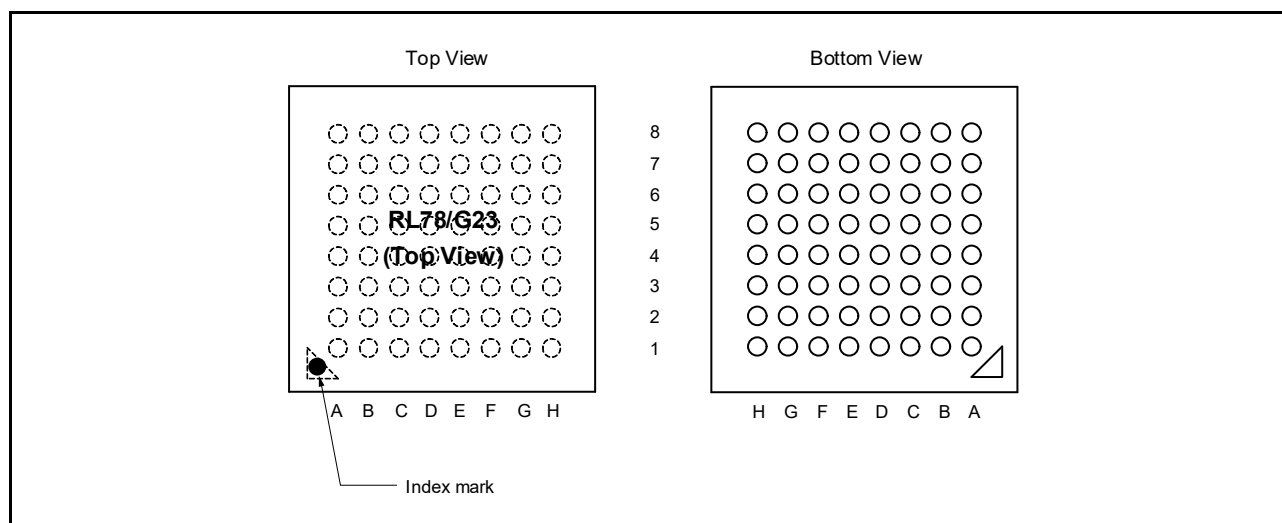
Caution 3. Connect the REGC pin to Vss via a capacitor (0.47 to 1 μF).

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

Remark 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 VDD and EVDD0 pins and connect the Vss and EVss0 pins to separate ground lines.

Remark 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 - 10 Format of Peripheral I/O Redirection Register (PIOR)** in the RL78/G23 User's Manual.

- 64-pin plastic WFLGA (5 × 5 mm, 0.50-mm pitch)



	A	B	C	D	E	F	G	H
8	EVDD0	EVSS0	P121/X1/EI121/ VBAT	P122/X2/EXCLK /EI122	P137/INTP0/ EI137	P123/XT1	P124/XT2/ EXCLKS	P120/ANI19/ IVCMP1/EI120
7	P60/CCD04/ SCLA0/EO60	VDD	VSS	REGC	RESET	P01/TS27 ^{Note} / EI01/EO01/ TO00	P00/TS26 ^{Note} / EI00/TI00	P140/PCLBUZ0/ INTP6
6	P61/CCD05/ SDAA0/EO61	P62/CCD06/ SCLA1	P63/CCD07/ SDAA1	P40/TOOL0	P41/TI07/TO07/ RxD A1	P43/CLKA1	P02/ANI17/ TS28 ^{Note} / SO10/TxD1	P141/PCLBUZ1/ INTP7
5	P77/KR7/TS09/ INTP11/(TxD2)	P31/TI03/TO03/ INTP4/TS01/ EI31/(PCLBUZ0)	P53/(INTP11)	P42/TI04/TO04/ TxD A1	P03/ANI16/ TS29 ^{Note} / SI10/RxD1/ SDA10	P04/SCK10/ SCL10	P130	P20/ANI0/ AVREFP/EI20
4	P75/KR5/TS07/ INTP9/SCK01/ SCL01	P76/KR6/TS08/ INTP10/(RxD2)	P52/(INTP10)	P54	P16/CCD00/ TI01/TO01/ INTP5/EO16/ (SI00)/(RxD0)	P21/ANI1/ AVREFM/EI21	P22/ANI2/ANO0 /EI22/TS20 ^{Note}	P23/ANI3/ANO1 /IVREF0/EI23/ TS21 ^{Note}
3	P70/KR0/TS02/ RIN0/SCK21/ SCL21	P73/KR3/TS05/ SO01	P74/KR4/TS06/ INTP8/SI01/ SDA01	P17/CCD01/ TI02/TO02/ EO17/(SO00)/ (TxD0)	P15/SCK20/ SCL20/EO15/ (TI02)/(TO02)	P12/SO00/TxD0 /TOOLTxD/EI12/ EO12/(INTP5)/ (TI05)/(TO05)	P24/ANI4/ TS22 ^{Note}	P26/ANI6/ TS24 ^{Note}
2	P30/INTP3/ TSCAP/ RTC1HZ/EI30/ VCOUT0/ SCK11/SCL11	P72/KR2/TS04/ SO21/TxD A0	P71/KR1/TS03/ SI21/SDA21/ RxD A0	P06/TS11/TI06/ TO06/CLKA0	P14/RxD2/ SI20/SDA20/ VCOUT1/EO14/ (SCLA0)/(TI03)/ (TO03)	P11/SI00/RxD0/ TOOLRxD/ SDA00/EI11/ EO11/(TI06)/ (TO06)	P25/ANI5/ TS23 ^{Note}	P27/ANI7/ TS25 ^{Note}
1	P05/TS10/TI05/ TO05	P50/CCD03/ TS00/EI50/ EO50/INTP1/ SI11/SDA11	P51/CCD02/ EI51/EO51/ INTP2/SO11	P55/(PCLBUZ1)/ (SCK00)	P13/TxD2/SO20 /IVREF1/EO13/ (SDAA0)/(TI04)/ (TO04)	P10/SCK00/ SCL00/EI10/ EO10/(TI07)/ (TO07)	P146	P147/ANI18/ EI147/IVCMP0

Note Not present in products with 128 or fewer Kbytes of code flash memory.

Caution 1. Connect the EVSS0 pin to the same ground as the VSS pin.

Caution 2. Make sure that the voltage on the VDD pin is no less than that on the EVDD0 pin.

Caution 3. Connect the REGC pin to VSS via a capacitor (0.47 to 1 μF).

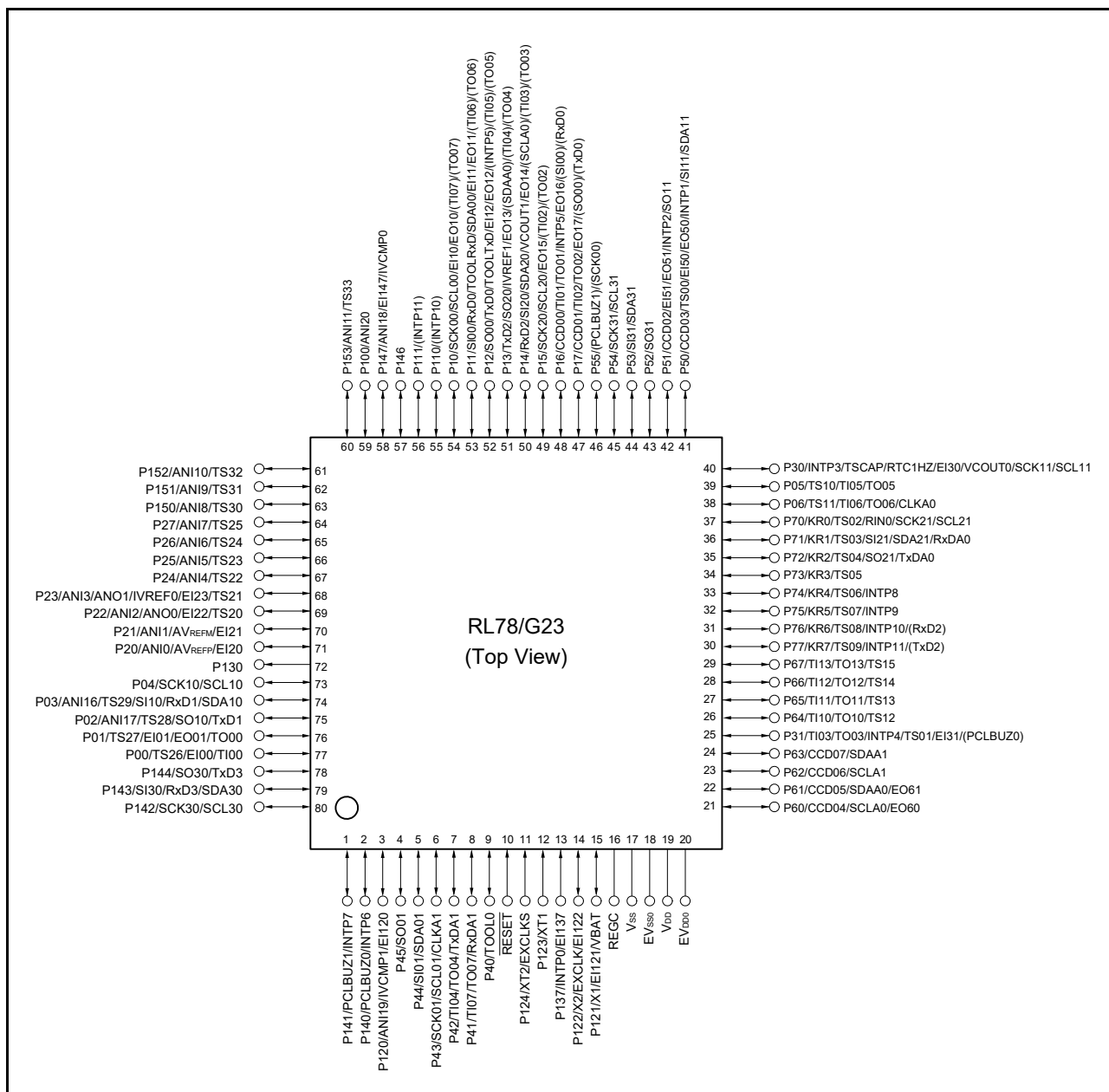
Remark 1. For pin identification, see **1.4 Pin Identification**.

Remark 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 VDD and EVDD0 pins and connect the VSS and EVSS0 pins to separate ground lines.

Remark 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 - 10 Format of Peripheral I/O Redirection Register (PIOR)** in the RL78/G23 User's Manual.

1.3.9 80-pin products

- 80-pin plastic LQFP (14 × 14 mm, 0.65-mm pitch)
- 80-pin plastic LFQFP (12 × 12 mm, 0.50-mm pitch)



Caution 1. Connect the EVSS0 pin to the same ground as the VSS pin.

Caution 2. Make sure that the voltage on the VDD pin is no less than that on the EVDD0 pin.

Caution 3. Connect the REGC pin to VSS via a capacitor (0.47 to 1 μF).

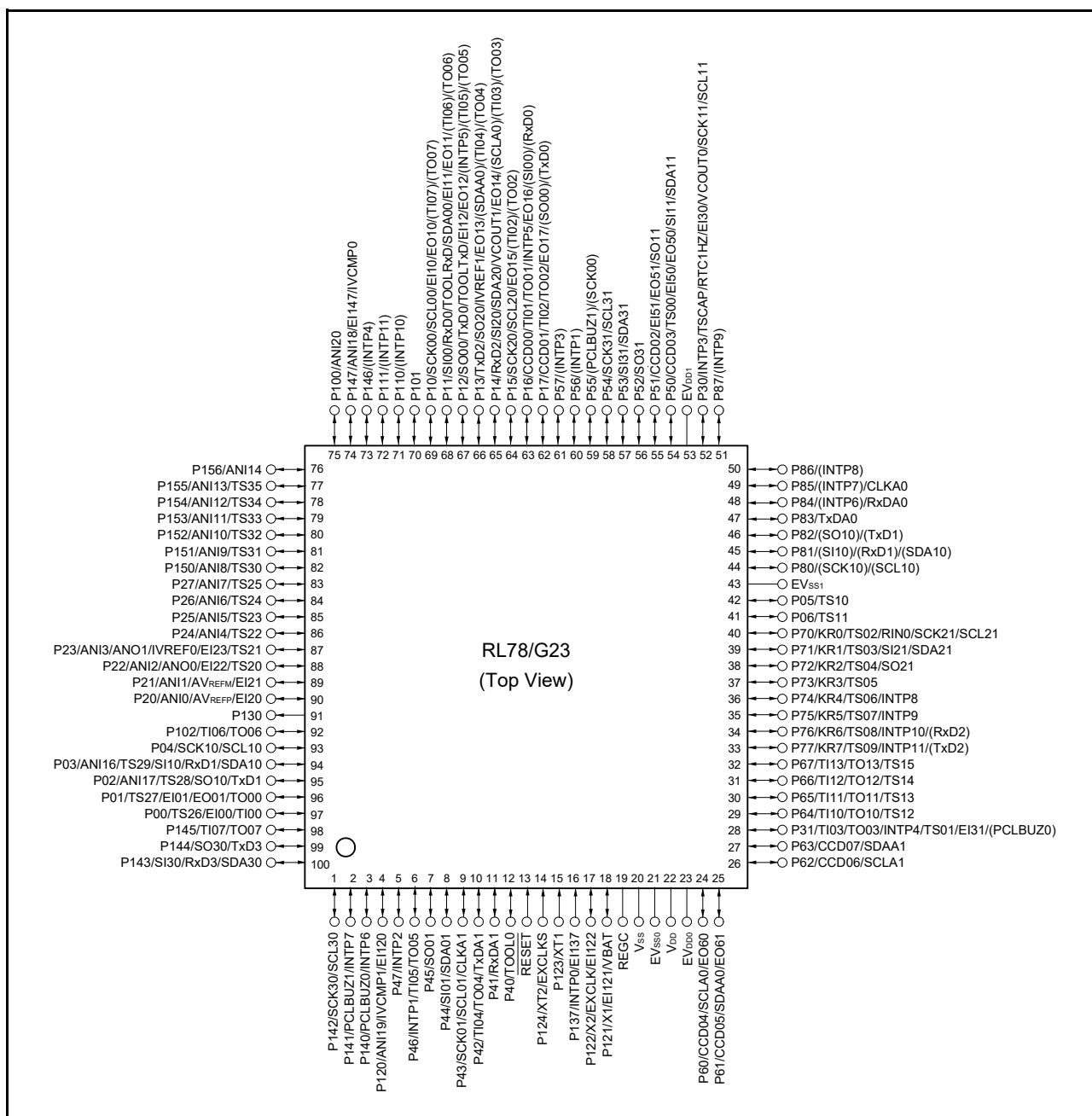
Remark 1. For pin identification, see 1.4 Pin Identification.

Remark 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 VDD and EVDD0 pins and connect the VSS and EVSS0 pins to separate ground lines.

Remark 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 - 10 Format of Peripheral I/O Redirection Register (PIOR)** in the RL78/G23 User's Manual.

1.3.10 100-pin products

- 100-pin plastic LFQFP (14 × 14 mm, 0.50-mm pitch)



Caution 1. Connect the EV_{SS0} and EV_{SS1} pins to the same ground as the V_{SS} pin.

Caution 2. Make sure that the voltage on the V_{DD} pin is no less than that on the EV_{DD0} and EV_{DD1} pins. Also make sure that the voltage on the EV_{DD0} is the same as that on the EV_{DD1} pin.

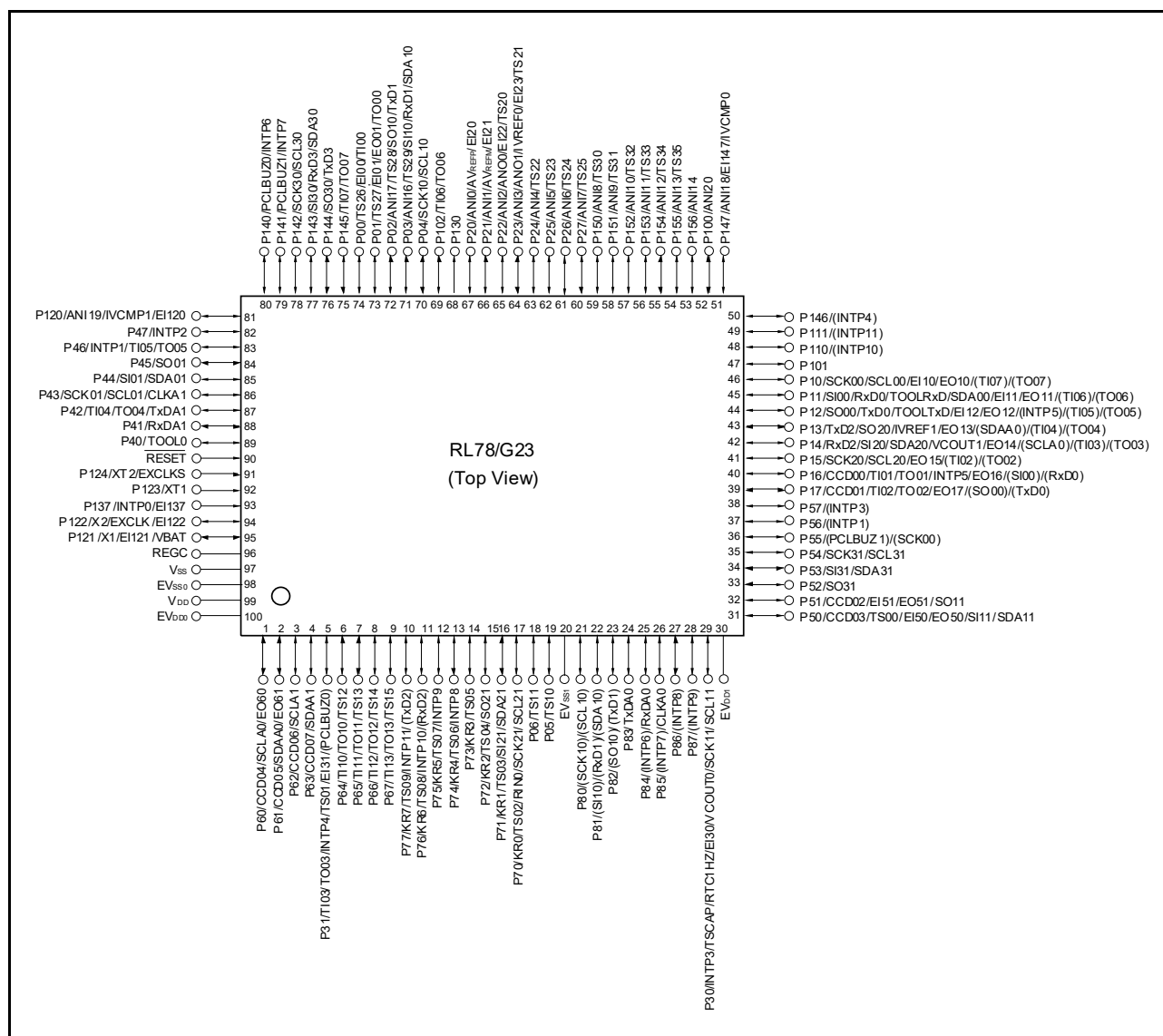
Caution 3. Connect the REGC pin to V_{SS} via a capacitor (0.47 to 1 μF).

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

Remark 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}, EV_{DD0}, and EV_{DD1} pins and connect the V_{SS}, EV_{SS0}, and EV_{SS1} pins to separate ground lines.

Remark 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 - 10 Format of Peripheral I/O Redirection Register (PIOR)** in the RL78/G23 User's Manual.

- 100-pin plastic LQFP (14 × 20 mm, 0.65-mm pitch)



Caution 1. Connect the EVSS0 and EVSS1 pins to the same ground as the VSS pin.

Caution 2. Make sure that the voltage on the VDD pin is no less than that on the EVDD0 and EVDD1 pins. Also make sure that the voltage on the EVDD0 is the same as that on the EVDD1 pin.

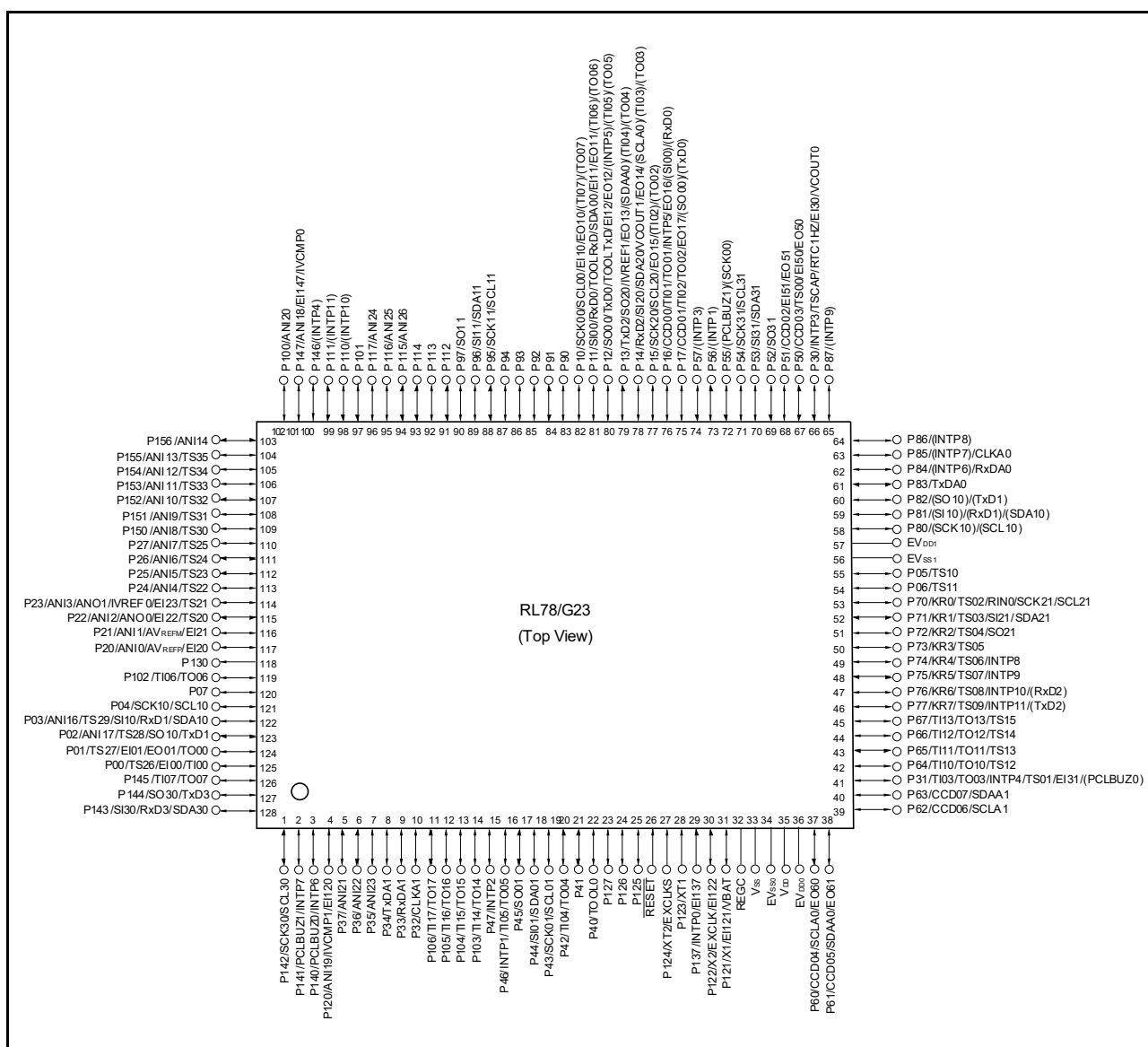
Caution 3. Connect the REGC pin to VSS via a capacitor (0.47 to 1 μF).

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

Remark 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 VDD, EVDD0, and EVDD1 pins and connect the VSS, EVSS0, and EVSS1 pins to separate ground lines.

Remark 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 - 10 Format of Peripheral I/O Redirection Register (PIOR)** in the RL78/G23 User's Manual.

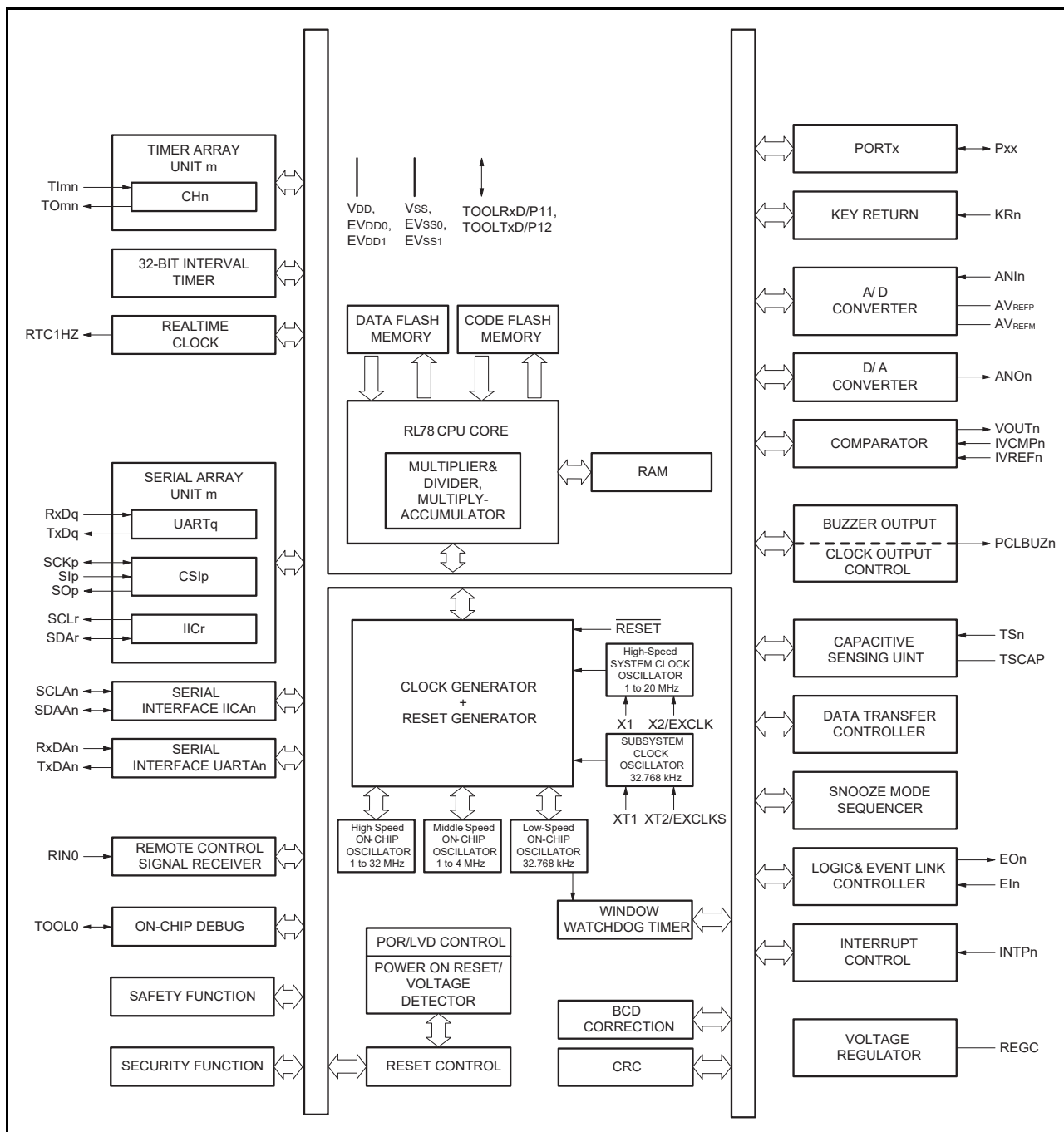
- 128-pin plastic LFQFP (14 × 20 mm, 0.50-mm pitch)



1.4 Pin Identification

ANI0 to ANI14,		PCLBUZ0, PCLBUZ1:	Programmable clock output/buzzer
ANI16 to ANI26:	Analog input		Output
ANO0, ANO1:	Analog output	REGC:	Regulator capacitance
AVREFM:	Analog reference voltage minus	RESET:	Reset
AVREFP:	Analog reference voltage plus	RIN0:	IR remote controller input
CCD00 to CCD07:	Controlled current drive output	RTC1HZ:	Realtime clock correction clock (1 Hz)
CLKA0, CLKA1:	Asynchronous serial clock output		Output
EI00, EI01, EI10 to EI12,		RxD0 to RxD3,	
EI20 to EI23, EI30, EI31,		RxDA0, RxDA1:	Receive data
EI50, EI51,		SCLA0, SCLA1,	
EI120 to EI122,		SCK00, SCK01, SCK10,	
EI137, EI147:	Logic & event link controller input	SCK11, SCK20, SCK21,	
EO01, EO10 to EO17,		SCK30, SCK31:	Serial clock input/output
EO50, EO51,		SCLA0, SCLA1, SCL00,	
EO60, EO61:	Logic & event link controller output	SCL01, SCL10, SCL11,	
EVDD0, EVDD1:	Power supply for port	SCL20, SCL21, SCL30,	
EVSS0, EVSS1:	Ground for port	SCL31:	Serial clock output
EXCLK:	External clock input	SDAA0, SDAA1, SDA00,	
	(main system clock)	SDA01, SDA10, SDA11,	
EXCLKS:	External clock input	SDA20, SDA21, SDA30,	
	(subsystem clock)	SDA31:	Serial data input/output
INTP0 to INTP11:	Interrupt request from	SI00, SI01, SI10, SI11,	
	Peripheral	SI20, SI21, SI30, SI31:	Serial data input
IVCMP0, IVCMP1:	Comparator input	SO00, SO01, SO10,	
IVREF0, IVREF1:	Comparator reference input	SO11, SO20, SO21,	
KR0 to KR7:	Key return	SO30, SO31:	Serial data output
P00 to P07:	Port 0	TSCAP:	Touch sensor capacitance
P10 to P17:	Port 1	TI00 to TI07, TI10 to TI17:	Timer input
P20 to P27:	Port 2	TO00 to TO07,	
P30 to P37:	Port 3	TO10 to TO17:	Timer output
P40 to P47:	Port 4	TOOL0:	Data input/output for tool
P50 to P57:	Port 5	TOOLRxD, TOOLTxD:	Data input/output for external device
P60 to P67:	Port 6	TS00 to TS15, TS20 to TS35:	Capacitive sensor
P70 to P77:	Port 7	TxD0 to TxD3,	
P80 to P87:	Port 8	TxDA0, TxDA1:	Transmit data
P90 to P97:	Port 9	VBAT:	Battery backup power supply
P100 to P106:	Port 10	VCOUT0, VCOUT1:	Comparator output
P110 to P117:	Port 11	VDD:	Power supply
P120 to P127:	Port 12	VSS:	Ground
P130, P137:	Port 13	X1, X2:	Crystal oscillator (main system clock)
P140 to P147:	Port 14	XT1, XT2:	Crystal oscillator (subsystem clock)
P150 to P156:	Port 15	TOOL0:	Data input/output for tool

1.5 Block Diagram



Caution 1. 32- to 128-pin products incorporate the remote control signal receiver.

Caution 2. 36- to 128-pin products incorporate the serial interface UARTA.

Caution 3. 40- to 128-pin products incorporate the key return function.

Remark m: Unit number, n: Channel number, p: CSI number, q: UART number, r: Simplified I²C number, xx: Port number

1.6 Outline of Functions

[30-, 32-, 36-, 40-, 44-, and 48-pin products]

Caution This outline describes the functions at the time when peripheral I/O redirection register (PIOR) is set to 00H.

(1/3)

Item		30-pin	32-pin	36-pin	40-pin	44-pin	48-pin
		R7F100GAx	R7F100GBx	R7F100GCx	R7F100GEx	R7F100GFx	R7F100GGx
Code flash memory		96 to 256 KB	96 to 256 KB	96 to 256 KB	96 to 256 KB	96 to 768 KB	96 to 768 KB
Data flash memory		8 KB	8 KB	8 KB	8 KB	8 KB	8 KB
RAM		12 to 24 KB	12 to 24 KB	12 to 24 KB	12 to 24 KB	12 to 48 KB	12 to 48 KB
Address space		1 MB					
CPU/peripheral hardware clock frequency (fCLK)		Main system clock HS mode: 1 to 32 MHz (VDD = 1.8 to 5.5 V) Main system clock HS mode: 1 to 4 MHz ^{Note 1} (VDD = 1.6 to 5.5 V) Main system clock LS mode: 1 to 24 MHz (VDD = 1.8 to 5.5 V) Main system clock LS mode: 1 to 4 MHz ^{Note 1} (VDD = 1.6 to 5.5 V) Main system clock LP mode: 1 to 2 MHz ^{Note 2} (VDD = 1.6 to 5.5 V) Subsystem clock: 32.768 kHz (VDD = 1.6 to 5.5 V)					
Main system clock	High-speed system clock (fMX)	1 to 20 MHz					
	High-speed on-chip oscillator clock (fIH)	1 MHz, 2 MHz, 3 MHz, 4 MHz, 6 MHz, 8 MHz, 12 MHz, 16 MHz 24 MHz, 32 MHz					
	Middle-speed on-chip oscillator clock (fIM)	1 MHz, 2 MHz, 4 MHz					
Subsystem clock	Subsystem clock X (fsx)	32.768 kHz (VDD = 2.4 to 5.5 V)			32.768 kHz (VDD = 1.6 to 5.5 V)		
	Low-speed on-chip oscillator clock (fIL)	32.768 kHz (typ.)					
General-purpose registers		8 bits × 32 registers (8 bits × 8 registers × 4 banks)					
Minimum instruction execution time		0.03125 μs (at the 32-MHz operation with the high-speed on-chip oscillator clock (fIH))					
Instruction set		• Data transfer (8/16 bits) • Adder and subtractor/logical operation (8/16 bits) • Multiplication (8 bits × 8 bits, 16 bits × 16 bits), division (16 bits ÷ 16 bits, 32 bits ÷ 32 bits) • Multiplication and accumulation (16 bits × 16 bits + 32 bits) • Rotate, barrel shift, and bit manipulation (set, reset, test, and Boolean operation), etc.					
I/O port	Total number of pins	26	28	32	36	40	44
	CMOS I/O	23 (N-ch open drain I/O [VDD withstand voltage]: 10)	24 (N-ch open drain I/O [VDD withstand voltage]: 10)	28 (N-ch open drain I/O [VDD withstand voltage]: 12)	30 (N-ch open drain I/O [VDD withstand voltage]: 12)	33 (N-ch open drain I/O [VDD withstand voltage]: 12)	36 (N-ch open drain I/O [VDD withstand voltage]: 13)
	CMOS input	1	1	1	3	3	3
	CMOS output	—	—	—	—	—	1
	N-ch open drain I/O (withstand voltage: 6 V)	2	3	3	3	4	4
	Output current control port	6	7	7	7	8	8

(2/3)

Item		30-pin	32-pin	36-pin	40-pin	44-pin	48-pin	
		R7F100GAx	R7F100GBx	R7F100GCx	R7F100GEx	R7F100GFx	R7F100GGx	
Timers	16-bit timer	8 channels						
	Watchdog timer	1 channel						
	Realtime clock (RTC)	1 channel						
	32-bit interval timer (TML32)	1 channel in 32-bit mode, 2 channels in 16-bit mode, 4 channels in 8-bit mode						
	Timer output	4 channels (PWM outputs: 3 ^{Note 3}), 8 channels (PWM outputs: 7 ^{Note 3}) ^{Note 4}				5 channels (PWM outputs: 4 ^{Note 3}), 8 channels (PWM outputs: 7 ^{Note 3}) ^{Note 4}		
	RTC output	1 channel						
Clock output/buzzer output		2						
		• 3.91 kHz, 7.81 kHz, 15.63 kHz, 2 MHz, 4 MHz, 8 MHz, 16 MHz (at the 32-MHz operation with the main system clock (f _{MAIN})) • 256 Hz, 512 Hz, 1.024 kHz, 2.048 kHz, 4.096 kHz, 8.192 kHz, 16.384 kHz, 32.768 kHz (at the 32.768-kHz operation with the low-speed peripheral clock (fs _{XP}))						
8-/10-/12-bit resolution A/D converter		8 channels	8 channels	8 channels	9 channels	10 channels	10 channels	
D/A converter		2 channels	2 channels	2 channels	2 channels	2 channels	2 channels	
Comparator		2 channels	2 channels	2 channels	2 channels	2 channels	2 channels	
Serial interface		[30- and 32-pin products] • SPI (CSI): 1 channel/simplified I ² C: 1 channel/UART: 1 channel • SPI (CSI): 1 channel/simplified I ² C: 1 channel/UART: 1 channel • SPI (CSI): 1 channel/simplified I ² C: 1 channel/UART (UART supporting LIN-bus): 1 channel [36-, 40-, and 44-pin products] • SPI (CSI): 1 channel/simplified I ² C: 1 channel/UART: 1 channel • SPI (CSI): 1 channel/simplified I ² C: 1 channel/UART: 1 channel • SPI (CSI): 2 channels/simplified I ² C: 2 channels/UART (UART supporting LIN-bus): 1 channel [48-pin products] • SPI (CSI): 2 channels/simplified I ² C: 2 channels/UART: 1 channel • SPI (CSI): 1 channel/simplified I ² C: 1 channel/UART: 1 channel • SPI (CSI): 2 channels/simplified I ² C: 2 channels/UART (UART supporting LIN-bus): 1 channel						
		UARTA	—		1 channel	1 channel	2 channels	2 channels
		I ² C bus	1 channel	1 channel	1 channel	1 channel	2 channels	2 channels
Remote control signal receiver		—	1 channel	1 channel	1 channel	1 channel	1 channel	
Data transfer controller (DTC)		30 sources	30 sources	32 sources	33 sources	35 sources	36 sources	
Logic and event link controller (ELCL)		1						
SNOOZE mode sequencer (SMS)		1						
Capacitive sensing unit		6	7	11	13	14	16	
Vectored interrupt sources	Internal	31	32	35	35	39	39	
	External	6	6	6	7	7	10	
Key interrupt		—	—	—	4	4	6	
Reset		• Reset by $\overline{\text{RESET}}$ pin • Internal reset by watchdog timer • Internal reset by power-on-reset • Internal reset by voltage detectors (LVD0 and LVD1) • Internal reset by illegal instruction execution ^{Note 5} • Internal reset by RAM parity error • Internal reset by illegal-memory access						

(3/3)

Item	30-pin	32-pin	36-pin	40-pin	44-pin	48-pin
	R7F100GAx	R7F100GBx	R7F100GCx	R7F100GEx	R7F100GFx	R7F100GGx
Power-on-reset circuit	Detection voltage • 1.50 V (typ.)					
Voltage detector	Detection voltage • Rising edge: 1.67 to 4.00 V (6 stages) for LVD0 1.67 to 4.16 V (18 stages) for LVD1 • Falling edge : 1.63 to 3.92 V (6 stages) for LVD0 1.63 to 4.08 V (18 stages) for LVD1					
On-chip debugging	Available (tracing supported)					
Power supply voltage	VDD = 1.6 to 5.5 V (2D: Consumer applications), VDD = 1.8 to 5.5 V (3C: Industrial applications)					
Operating ambient temperature	TA = -40 to +85°C (2D: Consumer applications), TA = -40 to +105°C (3C: Industrial applications)					

Note 1. Overwrite the flash memory during operation at 2 MHz or a lower frequency.

Note 2. When the flash memory is to be overwritten, switch to high-speed main (HS) mode or low-speed main (LS) mode.

Note 3. The number of PWM outputs varies depending on the setting of channels in use (the number of masters and slaves).
For details, see **7.9.3 Operation for the multiple PWM output function** in the RL78/G23 User's Manual.

Note 4. This applies when the setting of the PIOR0 bit is 1.

Note 5. In normal operation, executing the instruction code FFH triggers an internal reset, but this is not the case during emulation by the in-circuit emulator or on-chip debugging emulator.

[52-, 64-, 80-, 100-, and 128-pin products]

Caution This outline describes the functions at the time when peripheral I/O redirection register (PIOR) is set to 00H.

(1/3)

Item		52-pin	64-pin	80-pin	100-pin	128-pin
		R7F100GJx	R7F100GLx	R7F100GMx	R7F100GPx	R7F100GSx
Code flash memory		96 to 768 KB	96 to 768 KB	128 to 768 KB	128 to 768 KB	256 to 768 KB
Data flash memory		8 KB	8 KB	8 KB	8 KB	8 KB
RAM		12 to 48 KB	12 to 48 KB	16 to 48 KB	16 to 48 KB	24 to 48 KB
Address space		1 MB				
CPU/peripheral hardware clock frequency (fCLK)		Main system clock HS mode: 1 to 32 MHz (V _{DD} = 1.8 to 5.5 V) Main system clock HS mode: 1 to 4 MHz ^{Note 1} (V _{DD} = 1.6 to 5.5 V) Main system clock LS mode: 1 to 24 MHz (V _{DD} = 1.8 to 5.5 V) Main system clock LS mode: 1 to 4 MHz ^{Note 1} (V _{DD} = 1.6 to 5.5 V) Main system clock LP mode: 1 to 2 MHz ^{Note 2} (V _{DD} = 1.6 to 5.5 V) Subsystem clock: 32.768 kHz (V _{DD} = 1.6 to 5.5 V)				
Main system clock	High-speed system clock (f _{MX})	1 to 20 MHz				
	High-speed on-chip oscillator clock (f _{IH})	1 MHz, 2 MHz, 3 MHz, 4 MHz, 6 MHz, 8 MHz, 12 MHz, 16 MHz, 24 MHz, 32 MHz				
	Middle-speed on-chip oscillator clock (f _{IM})	1 MHz, 2 MHz, 4 MHz				
Subsystem clock	Subsystem clock X (f _{SX})	32.768 kHz (V _{DD} = 1.6 to 5.5 V)				
	Low-speed on-chip oscillator clock (f _{IL})	32.768 kHz (typ.)				
General-purpose registers		8 bits × 32 registers (8 bits × 8 registers × 4 banks)				
Minimum instruction execution time		0.03125 μs (at the 32-MHz operation with the high-speed on-chip oscillator clock (f _{IH}))				
Instruction set		<ul style="list-style-type: none"> • Data transfer (8/16 bits) • Adder and subtractor/logical operation (8/16 bits) • Multiplication (8 bits × 8 bits, 16 bits × 16 bits), division (16 bits ÷ 16 bits, 32 bits ÷ 32 bits) • Multiplication and accumulation (16 bits × 16 bits + 32 bits) • Rotate, barrel shift, and bit manipulation (set, reset, test, and Boolean operation), etc. 				
I/O port	Total number of pins	48	58	74	92	120
	CMOS I/O	40 (N-ch open drain I/O [V _{DD} withstand voltage]: 15)	50 (N-ch open drain I/O [EV _{DD} withstand voltage]: 22 ^{Note 6} / 18 ^{Note 7})	66 (N-ch open drain I/O [EV _{DD} withstand voltage]: 27)	84 (N-ch open drain I/O [EV _{DD} withstand voltage]: 31)	112 (N-ch open drain I/O [EV _{DD} withstand voltage]: 33)
	CMOS input	3	3	3	3	3
	CMOS output	1	1	1	1	1
	N-ch open drain I/O (withstand voltage: 6 V)	4	4	4	4	4
	Output current control port	8	8	8	8	8

(2/3)

Item		52-pin	64-pin	80-pin	100-pin	128-pin
		R7F100GJx	R7F100GLx	R7F100GMx	R7F100GPx	R7F100GSx
Timers	16-bit timer	8 channels		12 channels		16 channels
	Watchdog timer	1 channel				
	Realtime clock (RTC)	1 channel				
	32-bit interval timer (TML32)	1 channel in 32-bit mode, 2 channels in 16-bit mode, 4 channels in 8-bit mode				
	Timer output	5 channels (PWM outputs: 4 ^{Note 3}), 8 channels (PWM outputs: 7 ^{Note 3}) ^{Note 4}	8 channels (PWM outputs: 7 ^{Note 3})	12 channels (PWM outputs: 10 ^{Note 3})		16 channels (PWM outputs: 14 ^{Note 3})
	RTC output	1 channel				
Clock output/buzzer output		2	2	2	2	2
		• 3.91 kHz, 7.81 kHz, 15.63 kHz, 2 MHz, 4 MHz, 8 MHz, 16 MHz (at the 32-MHz operation with the main system clock (f _{MAIN})) • 256 Hz, 512 Hz, 1.024 kHz, 2.048 kHz, 4.096 kHz, 8.192 kHz, 16.384 kHz, 32.768 kHz (at the 32.768-kHz operation with the low-speed peripheral clock (f _{SXP}))				
8-/10-/12-bit resolution A/D converter		12 channels	12 channels	17 channels	20 channels	26 channels
D/A converter		2 channels	2 channels	2 channels	2 channels	2 channels
Comparator		2 channels	2 channels	2 channels	2 channels	2 channels
Serial interface		[52-pin products] • SPI (CSI): 2 channels/simplified I ² C: 2 channels/UART: 1 channel • SPI (CSI): 1 channel/simplified I ² C: 1 channel/UART: 1 channel • SPI (CSI): 2 channels/simplified I ² C: 2 channels/UART (UART supporting LIN-bus): 1 channel				
		[64-pin products] • SPI (CSI): 2 channels/simplified I ² C: 2 channels/UART: 1 channel • SPI (CSI): 2 channels/simplified I ² C: 2 channels/UART: 1 channel • SPI (CSI): 2 channels/simplified I ² C: 2 channels/UART (UART supporting LIN-bus): 1 channel				
		[80-, 100-, and 128-pin products] • SPI (CSI): 2 channels/simplified I ² C: 2 channels/UART: 1 channel • SPI (CSI): 2 channels/simplified I ² C: 2 channels/UART: 1 channel • SPI (CSI): 2 channels/simplified I ² C: 2 channels/UART (UART supporting LIN-bus): 1 channel • SPI (CSI): 2 channels/simplified I ² C: 2 channels/UART: 1 channel				
	UARTA	2 channels	2 channels	2 channels	2 channels	2 channels
	I ² C bus	2 channels	2 channels	2 channels	2 channels	2 channels
Remote control signal receiver		1 channel	1 channel	1 channel	1 channel	1 channel
Data transfer controller (DTC)		36 sources	37 sources	39 sources		
Logic and event link controller (ELCL)		1				
SNOOZE mode sequencer (SMS)		1				
Capacitive sensing unit		20	22	30	32	32

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Item		52-pin	64-pin	80-pin	100-pin	128-pin
		R7F100GJx	R7F100GLx	R7F100GMx	R7F100GPx	R7F100GSx
Vectored interrupt sources	Internal	39	39	44	44	48
	External	12	13	13	13	13
Key interrupt		8	8	8	8	8
Reset		<ul style="list-style-type: none"> Reset by RESET pin Internal reset by watchdog timer Internal reset by power-on-reset Internal reset by voltage detectors (LVD0 and LVD1) Internal reset by illegal instruction execution^{Note 5} Internal reset by RAM parity error Internal reset by illegal-memory access 				
Power-on-reset circuit		Detection voltage <ul style="list-style-type: none"> 1.50 V (typ.) 				
Voltage detector		Detection voltage <ul style="list-style-type: none"> Rising edge: 1.67 to 4.00 V (6 stages) for LVD0 1.67 to 4.16 V (18 stages) for LVD1 Falling edge: 1.63 to 3.92 V (6 stages) for LVD0 1.63 to 4.08 V (18 stages) for LVD1 				
On-chip debugging		Available (tracing supported)				
Power supply voltage		VDD = 1.6 to 5.5 V (2D: Consumer applications), VDD = 1.8 to 5.5 V (3C: Industrial applications)				
Operating ambient temperature		TA = -40 to +85°C (2D: Consumer applications), TA = -40 to +105°C (3C: Industrial applications)				

Note 1. Overwrite the flash memory during operation at 2 MHz or a lower frequency.

Note 2. When the flash memory is to be overwritten, switch to high-speed main (HS) mode or low-speed main (LS) mode.

Note 3. The number of PWM outputs varies depending on the setting of channels in use (the number of masters and slaves).
For details, see **7.9.3 Operation for the multiple PWM output function** in the RL78/G23 User's Manual.

Note 4. This applies when the setting of the PIOR0 bit is 1.

Note 5. In normal operation, executing the instruction code FFH triggers an internal reset, but this is not the case during emulation by the in-circuit emulator or on-chip debugging emulator.

Note 6. This only applies to the products with 96- and 128-Kbyte flash memory.

Note 7. This only applies to the products with 192- to 768-Kbyte flash memory.

2. ELECTRICAL CHARACTERISTICS T_A = -40 to +105°C

2.1 Absolute Maximum Ratings

Absolute Maximum Ratings

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Item	Symbols	Conditions	Ratings	Unit
Supply voltage	V _{DD}		-0.5 to +6.5	V
	EV _{DD0} , EV _{DD1}	EV _{DD0} = EV _{DD1}	-0.5 to +6.5	V
	EV _{SS0} , EV _{SS1}	EV _{SS0} = EV _{SS1}	-0.5 to +0.3	V
REGC pin input voltage	V _I REGC	REGC	-0.3 to +2.1 and -0.3 to V _{DD} + 0.3 ^{Note 1}	V
Input voltage	V _{I1}	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	-0.3 to EV _{DD0} + 0.3 and -0.3 to V _{DD} + 0.3 ^{Note 2}	V
	V _{I2}	P60 to P63 (N-ch open-drain)	-0.3 to +6.5	V
	V _{I3}	P20 to P27, P121 to P124, P137, P150 to P156, EXCLK, EXCLKS, RESET	-0.3 to V _{DD} + 0.3 ^{Note 2}	V
Output voltage	V _{O1}	P00 to P07, P10 to P17, P30 to P37, P40 to P47, P50 to P57, P60 to P67, P70 to P77, P80 to P87, P90 to P97, P100 to P106, P110 to P117, P120, P125 to P127, P130, P140 to P147	-0.3 to EV _{DD0} + 0.3 and -0.3 to V _{DD} + 0.3 ^{Note 2}	V
	V _{O2}	P20 to P27, P150 to P156	-0.3 to V _{DD} + 0.3 ^{Note 2}	V
Analog input voltage	V _{AI1}	ANI16 to ANI26	-0.3 to EV _{DD0} + 0.3 and -0.3 to AV _{REFP} + 0.3 Notes 2, 3	V
	V _{AI2}	ANI0 to ANI14	-0.3 to V _{DD} + 0.3 and -0.3 to AV _{REFP} + 0.3 Notes 2, 3	V

Note 1. Connect the REGC pin to V_{SS} via a capacitor (0.47 to 1 μF). The listed value is the absolute maximum rating of the REGC pin. Only use the capacitor connection. Do not apply a specific voltage to this pin.

Note 2. This voltage must be no higher than 6.5 V.

Note 3. The voltage on a pin in use for A/D conversion must not exceed AV_{REFP} + 0.3.

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. The characteristics of functions multiplexed on a given pin are the same as those for the port pin unless otherwise specified.

Remark 2. AV_{REFP} refers to the positive reference voltage of the A/D converter.

Remark 3. The reference voltage is V_{SS}.

Absolute Maximum Ratings

(2/2)

Item	Symbols	Conditions		Ratings	Unit
High-level output current	IOH1	Per pin	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, P130, P140 to P147	-40	mA
		Total of all pins -170 mA	P00 to P04, P07, P32 to P37, P40 to P47, P102 to P106, P120, P125 to P127, P130, P140 to P145	-70	mA
			P05, P06, P10 to P17, P30, P31, P50 to P57, P64 to P67, P70 to P77, P80 to P87, P90 to P97, P100, P101, P110 to P117, P146, P147	-100	mA
	IOH2	Per pin	P20 to P27, P121 to P124, P150 to P156	-0.5	mA
		Total of all pins		-2	mA
Low-level output current	IOL1	Per pin	P00 to P07, P10 to P17, P30 to P37, P40 to P47, P50 to P57, P60 to P67, P70 to P77, P80 to P87, P90 to P97, P100 to P106, P110 to P117, P120, P125 to P127, P130, P140 to P147	40 Note	mA
		Total of all pins 170 mA	P00 to P04, P07, P32 to P37, P40 to P47, P102 to P106, P120, P125 to P127, P130, P140 to P145	70	mA
			P05, P06, P10 to P17, P30, P31, P50 to P57, P60 to P67, P70 to P77, P80 to P87, P90 to P97, P100, P101, P110 to P117, P146, P147	100	mA
	IOL2	Per pin	P20 to P27, P121 to P124, P150 to P156	1	mA
		Total of all pins		5	mA
Ambient operating temperature	TA	In normal operation mode		-40 to +105	°C
		In flash memory programming mode			
Storage temperature	Tstg			-65 to +150	°C

Note The rating for the following port pins is 80 mA when IOL1 = 40.0 mA is specified by the 40-mA port output control register (PTDC).

- Pins P04, P10, and P120 of the 64- to 100-pin package products with 384- to 768-Kbyte flash ROM
- Pin P110 of the 100-pin package products with 384- to 768-Kbyte flash ROM
- Pins P17, P51, and P70 of the 30- to 52-pin package products

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 The characteristics of functions multiplexed on a given pin are the same as those for the port pin unless otherwise specified.

2.2 Characteristics of the Oscillators

2.2.1 Characteristics of the X1 and XT1 oscillators

($T_A = -40$ to $+105^{\circ}\text{C}$, $1.6\text{ V} \leq V_{DD} \leq 5.5\text{ V}$, $V_{SS} = 0\text{ V}$)

Item	Resonator	Conditions	Min.	Typ.	Max.	Unit
X1 clock oscillation allowable input cycle time Note	Ceramic resonator/ crystal resonator		0.05		1	μs
XT1 clock oscillation frequency (f_{XT}) Note	Crystal resonator			32.768		kHz

Note The listed time and frequency indicate permissible ranges of the oscillator. For actual applications, request evaluation by the manufacturer of the oscillator circuit mounted on a board so you can use appropriate values. Refer to AC Characteristics for instruction execution time.

Caution Since the CPU is started by the high-speed on-chip oscillator clock after release from the reset state, the user should use the oscillation stabilization time counter status register (OSTC) to check the X1 clock oscillation stabilization time. Specify the values for the oscillation stabilization time in the OSTC register and the oscillation stabilization time select register (OSTS) after having sufficiently evaluated the oscillation stabilization time with the resonator to be used.

2.2.2 Characteristics of the On-chip Oscillators

(TA = -40 to +105°C, 1.6 V ≤ VDD ≤ 5.5 V, VSS = 0 V)

Item	Symbol	Conditions			Min.	Typ.	Max.	Unit
High-speed on-chip oscillator clock frequency	f _{IH}				1		32	MHz
High-speed on-chip oscillator clock frequency accuracy ^{Note 1}		HIPREC = 1	+85 to +105°C	1.8 V ≤ V _{DD} ≤ 5.5 V	-2.0		+2.0	%
				1.6 V ≤ V _{DD} ≤ 5.5 V	-6.0		+6.0	%
			-20 to +85°C	1.8 V ≤ V _{DD} ≤ 5.5 V	-1.0		+1.0	%
				1.6 V ≤ V _{DD} ≤ 5.5 V	-5.0		+5.0	%
			-40 to -20°C	1.8 V ≤ V _{DD} ≤ 5.5 V	-1.5		+1.5	%
				1.6 V ≤ V _{DD} ≤ 5.5 V	-5.5		+5.5	%
		HIPREC = 0 ^{Note 4}			-15		0	%
High-speed on-chip oscillator clock correction resolution						0.05		%
Middle-speed on-chip oscillator clock frequency ^{Note 2}	f _{IM}				1		4	MHz
Middle-speed on-chip oscillator clock frequency accuracy ^{Note 1}					-12		+12	%
Middle-speed on-chip oscillator clock correction resolution						0.15		%
Middle-speed on-chip oscillator frequency temperature coefficient							±0.17 Note 3	%/°C
Low-speed on-chip oscillator clock frequency ^{Note 2}	f _{IL}					32.768		kHz
Low-speed on-chip oscillator clock frequency accuracy ^{Note 1}					-15		+15	%
Low-speed on-chip oscillator clock correction resolution						0.3		%
Low-speed on-chip oscillator frequency temperature coefficient							±0.21 Note 3	%/°C

Note 1. The accuracy values were obtained in testing of this product.

Note 2. The listed values only indicate the characteristics of the oscillators. Refer to AC Characteristics for instruction execution time.

Note 3. Guaranteed by characterization results.

Note 4. The listed condition applies when the setting of the FRQSEL3 bit is 1.

2.3 DC Characteristics

2.3.1 Pin characteristics

(TA = -40 to +105°C, 1.6 V ≤ EVDD0 = EVDD1 ≤ VDD ≤ 5.5 V, VSS = EVSS0 = EVSS1 = 0 V)

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Item	Symbol	Conditions		Min.	Typ.	Max.	Unit
Allowable high-level output current Note 1	IOH1	Per pin for 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, P130, P140 to P147	$1.6\text{ V} \leq \text{EVDD0} \leq 5.5\text{ V}$			-10.0 Note 2	mA
		Total of P00 to P04, P07, P32 to P37, P40 to P47, P102 to P106, P120, P125 to P127, P130, P140 to P145 (when duty $\leq 70\%$ Note 3)	$4.0\text{ V} \leq \text{EVDD0} \leq 5.5\text{ V}$			-55.0 Note 4	mA
			$2.7\text{ V} \leq \text{EVDD0} < 4.0\text{ V}$			-10.0	mA
			$1.8\text{ V} \leq \text{EVDD0} < 2.7\text{ V}$			-5.0	mA
			$1.6\text{ V} \leq \text{EVDD0} < 1.8\text{ V}$			-2.5	mA
		Total of P05, P06, P10 to P17, P30, P31, P50 to P57, P64 to P67, P70 to P77, P80 to P87, P90 to P97, P100, P101, P110 to P117, P146, P147 (when duty $\leq 70\%$ Note 3)	$4.0\text{ V} \leq \text{EVDD0} \leq 5.5\text{ V}$			-80.0 Note 5	mA
			$2.7\text{ V} \leq \text{EVDD0} < 4.0\text{ V}$			-19.0	mA
			$1.8\text{ V} \leq \text{EVDD0} < 2.7\text{ V}$			-10.0	mA
			$1.6\text{ V} \leq \text{EVDD0} < 1.8\text{ V}$			-5.0	mA
		Total of all pins (when duty $\leq 70\%$ Note 3)	$1.6\text{ V} \leq \text{EVDD0} \leq 5.5\text{ V}$			-135.0 Note 6	mA
	IOH2	Per pin for P20 to P27, P121, P122, P150 to P156	$4.0\text{ V} \leq \text{VDD} \leq 5.5\text{ V}$			-3.0 Note 2	mA
			$2.7\text{ V} \leq \text{VDD} < 4.0\text{ V}$			-1.0 Note 2	mA
			$1.8\text{ V} \leq \text{VDD} < 2.7\text{ V}$			-1.0 Note 2	mA
			$1.6\text{ V} \leq \text{VDD} < 1.8\text{ V}$			-0.5 Note 2	mA
		Total of all pins (when duty $\leq 70\%$ Note 3)	$4.0\text{ V} \leq \text{VDD} \leq 5.5\text{ V}$			-20.0	mA
			$2.7\text{ V} \leq \text{VDD} < 4.0\text{ V}$			-10.0	mA
			$1.8\text{ V} \leq \text{VDD} < 2.7\text{ V}$			-5.0	mA
			$1.6\text{ V} \leq \text{VDD} < 1.8\text{ V}$			-5.0	mA

Note 1. Device operation is guaranteed at the listed currents even if current is flowing from the EVDD0, EVDD1, or VDD pin to an output pin.

Note 2. The combination of these and other pins must also not exceed the value for maximum total current.

Note 3. The listed currents apply when the duty cycle is no greater than 70%.

Use the following formula to calculate the output current when the duty cycle is greater than 70%, where n is the duty cycle.

• Total output current from the listed pins = $(IOH \times 0.7)/(n \times 0.01)$

Example when n = 80% and IOH = -10.0 mA

Total output current from the listed pins = $(-10.0 \times 0.7)/(80 \times 0.01) \cong -8.7$ mA

Note that the duty cycle has no effect on the current that is allowed to flow into a single pin. A current higher than the absolute maximum rating must not flow into a single pin.

Note 4. The maximum value is -30 mA in the products for industrial applications (R7F100Gxx3xxx) with an ambient operating temperature range of 85°C to 105°C.

- Note 5.** The maximum value is -50 mA in the products for industrial applications (R7F100Gxx3xxxC) with an ambient operating temperature range of 85°C to 105°C .
- Note 6.** The maximum values are respectively -100 mA and -60 mA in the products for industrial applications (R7F100Gxx3xxxC) with an ambient operating temperature range of -40°C to 85°C and of 85°C to 105°C .
- Caution** The following pins are not capable of the output of high-level signals in the N-ch open-drain mode.
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
- Remark** The characteristics of functions multiplexed on a given pin are the same as those for the port pin unless otherwise specified.

(TA = -40 to +105°C, 1.6 V ≤ EVDD0 = EVDD1 ≤ VDD ≤ 5.5 V, VSS = EVSS0 = EVSS1 = 0 V)

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Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
Allowable low-level output current ^{Note 1}	IoL1	Per pin for 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, P130, P140 to P147			20.0 Notes 2, 3	mA
		Per pin for P60 to P63			15.0 Note 2	mA
		Total of P00 to P04, P07, P32 to P37, P40 to P47, P102 to P106, P120, P125 to P127, P130, P140 to P145 (when duty ≤ 70% ^{Note 4})	4.0 V ≤ EVDD0 ≤ 5.5 V		70.0 Note 5	mA
			2.7 V ≤ EVDD0 < 4.0 V		15.0	mA
			1.8 V ≤ EVDD0 < 2.7 V		9.0	mA
			1.6 V ≤ EVDD0 < 1.8 V		4.5	mA
		Total of P05, P06, P10 to P17, P30, P31, P50 to P57, P60 to P67, P70 to P77, P80 to P87, P90 to P97, P100, P101, P110 to P117, P146, P147 (when duty ≤ 70% ^{Note 4})	4.0 V ≤ EVDD0 ≤ 5.5 V		80.0 Note 5	mA
			2.7 V ≤ EVDD0 < 4.0 V		35.0	mA
			1.8 V ≤ EVDD0 < 2.7 V		20.0	mA
			1.6 V ≤ EVDD0 < 1.8 V		10.0	mA
		Total of all pins (when duty ≤ 70% ^{Note 4})			150.0 Note 6	mA
	IoL2	Per pin for P20 to P27, P121, P122, P150 to P156	4.0 V ≤ VDD ≤ 5.5 V		8.5 ^{Note 2}	mA
			2.7 V ≤ VDD < 4.0 V		1.5 ^{Note 2}	mA
			1.8 V ≤ VDD < 2.7 V		0.6 ^{Note 2}	mA
			1.6 V ≤ VDD < 1.8 V		0.4 ^{Note 2}	mA
		Total of all pins (when duty ≤ 70% ^{Note 4})	4.0 V ≤ VDD ≤ 5.5 V		20	mA
			2.7 V ≤ VDD < 4.0 V		20	mA
			1.8 V ≤ VDD < 2.7 V		15	mA
			1.6 V ≤ VDD < 1.8 V		10	mA

Note 1. Device operation is guaranteed at the listed currents even if current is flowing from an output pin to the EVSS0, EVSS1, or VSS pin.

Note 2. The combination of these and other pins must also not exceed the value for maximum total current.

Note 3. The maximum rating for the following port pins is 40 mA when IoL1 = 40.0 mA is specified by the 40-mA port output control register (PTDC).

- Pins P04, P10, and P120 of the 64- to 100-pin package products with 384- to 768-Kbyte flash ROM
- Pin P101 of the 100-pin package products with 384- to 768-Kbyte flash ROM
- Pins P17, P51, and P70 of the 30- to 52-pin package products

Note 4. The listed currents apply when the duty cycle is no greater than 70%.

Use the following formula to calculate the output current when the duty cycle is greater than 70%, where n is the duty cycle.

- Total output current from the listed pins = (IoL × 0.7)/(n × 0.01)

Example when n = 80% and IoL = 10.0 mA

Total output current from the listed pins = (10.0 × 0.7)/(80 × 0.01) ≅ 8.7 mA

Note that the duty cycle has no effect on the current that is allowed to flow into a single pin. A current higher than the absolute maximum rating must not flow into a single pin.

Note 5. The maximum value is 40 mA in the products for industrial applications (R7F100Gxx3xxx) with an ambient operating temperature range of 85°C to 105°C.

Note 6. The maximum value is 80 mA in the products for industrial applications (R7F100Gxx3xxxC) with an ambient operating temperature range of 85°C to 105°C .

Remark The characteristics of functions multiplexed on a given pin are the same as those for the port pin unless otherwise specified.

(TA = -40 to +105°C, 1.6 V ≤ EVDD0 = EVDD1 ≤ VDD ≤ 5.5 V, VSS = EVSS0 = EVSS1 = 0 V)

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Item	Symbol	Conditions		Min.	Typ.	Max.	Unit
Input voltage, high	VIH1	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	0.8 EVDD0		EVDD0	V
	VIH2	P01, P03, P04, P10, P11, P13 to P17, P43, P44, P53 to P55, P80, P81, P142, P143	TTL input buffer 4.0 V ≤ EVDD0 ≤ 5.5 V	2.2		EVDD0	V
			TTL input buffer 3.3 V ≤ EVDD0 < 4.0 V	2.0		EVDD0	V
			TTL input buffer 1.6 V ≤ EVDD0 < 3.3 V	1.5		EVDD0	V
	VIH3	P20 to P27, P150 to P156		0.7 VDD		VDD	V
	VIH4	P60 to P63		0.7 EVDD0		6.0	V
	VIH5	P121 to P124, P137, EXCLK, EXCLKS, $\overline{\text{RESET}}$		0.8 VDD		VDD	V
Input voltage, low	VIL1	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		0.2 EVDD0	V
	VIL2	P01, P03, P04, P10, P11, P13 to P17, P43, P44, P53 to P55, P80, P81, P142, P143	TTL input buffer 4.0 V ≤ EVDD0 ≤ 5.5 V	0		0.8	V
			TTL input buffer 3.3 V ≤ EVDD0 < 4.0 V	0		0.5	V
			TTL input buffer 1.6 V ≤ EVDD0 < 3.3 V	0		0.32	V
	VIL3	P20 to P27, P150 to P156		0		0.3 VDD	V
	VIL4	P60 to P63		0		0.3 EVDD0	V
	VIL5	P121 to P124, P137, EXCLK, EXCLKS, $\overline{\text{RESET}}$		0		0.2 VDD	V

Caution The maximum value of VIH 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 EVDD0, even in the N-ch open-drain mode.

Remark The characteristics of functions multiplexed on a given pin are the same as those for the port pin unless otherwise specified.

(TA = -40 to +105°C, 1.6 V ≤ EVDD0 = EVDD1 ≤ VDD ≤ 5.5 V, VSS = EVSS0 = EVSS1 = 0 V)

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Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
Output voltage, high	VOH1	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, P130, P140 to P147	4.0 V ≤ EVDD0 ≤ 5.5 V, IOH1 = -10.0 mA	EVDD0 - 1.5		V
			4.0 V ≤ EVDD0 ≤ 5.5 V, IOH1 = -3.0 mA	EVDD0 - 0.7		V
			2.7 V ≤ EVDD0 ≤ 5.5 V, IOH1 = -2.0 mA	EVDD0 - 0.6		V
			1.8 V ≤ EVDD0 ≤ 5.5 V, IOH1 = -1.5 mA	EVDD0 - 0.5		V
			1.6 V ≤ EVDD0 < 5.5 V, IOH1 = -1.0 mA	EVDD0 - 0.5		V
	VOH2	P20 to P27, P121, P122, P150 to P156	4.0 V ≤ VDD ≤ 5.5 V, IOH2 = -3.0 mA	VDD - 0.7		V
			2.7 V ≤ VDD < 4.0 V, IOH2 = -1.0 mA	VDD - 0.5		V
			1.8 V ≤ VDD < 2.7 V, IOH2 = -1.0 mA	VDD - 0.5		V
			1.6 V ≤ VDD < 1.8 V, IOH2 = -0.5 mA	VDD - 0.5		V

Caution 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 do not output high-level signals in the N-ch open-drain mode.

Remark The characteristics of functions multiplexed on a given pin are the same as those for the port pin unless otherwise specified.

(TA = -40 to +105°C, 1.6 V ≤ EVDD0 = EVDD1 ≤ VDD ≤ 5.5 V, VSS = EVSS0 = EVSS1 = 0 V)

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Item	Symbol	Conditions		Min.	Typ.	Max.	Unit	
Output voltage, low	VOL1	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, P130, P140 to P147	4.0 V ≤ EV _{DD0} ≤ 5.5 V	IOL1 = 20.0 mA			1.3	V
				IOL1 = 40.0 mA ^{Note}			1.3	V
			4.0 V ≤ EV _{DD0} ≤ 5.5 V	IOL1 = 8.5 mA			0.7	V
				IOL1 = 17.0 mA ^{Note}			0.7	V
			2.7 V ≤ EV _{DD0} ≤ 5.5 V	IOL1 = 3.0 mA			0.6	V
				IOL1 = 6.0 mA ^{Note}			0.6	V
			2.7 V ≤ EV _{DD0} ≤ 5.5 V	IOL1 = 1.5 mA			0.4	V
				IOL1 = 3.0 mA ^{Note}			0.4	V
			1.8 V ≤ EV _{DD0} ≤ 5.5 V	IOL1 = 0.6 mA			0.4	V
				IOL1 = 1.2 mA ^{Note}			0.4	V
			1.6 V ≤ EV _{DD0} ≤ 5.5 V	IOL1 = 0.3 mA			0.4	V
				IOL1 = 0.6 mA ^{Note}			0.4	V
	VOL2	P20 to P27, P121, P122, P150 to P156	4.0 V ≤ V _{DD} ≤ 5.5 V, IOL2 = 8.5 mA				0.7	V
			2.7 V ≤ V _{DD} < 4.0 V, IOL2 = 1.5 mA				0.5	V
			1.8 V ≤ V _{DD} < 2.7 V, IOL2 = 0.6 mA				0.4	V
			1.6 V ≤ V _{DD} < 1.8 V, IOL2 = 0.4 mA				0.4	V
	VOL3	P60 to P63	4.0 V ≤ EV _{DD0} ≤ 5.5 V, IOL3 = 15.0 mA				2.0	V
			4.0 V ≤ EV _{DD0} ≤ 5.5 V, IOL3 = 5.0 mA				0.4	V
			2.7 V ≤ EV _{DD0} ≤ 5.5 V, IOL3 = 3.0 mA				0.4	V
			1.8 V ≤ EV _{DD0} ≤ 5.5 V, IOL3 = 2.0 mA				0.4	V
			1.6 V ≤ EV _{DD0} ≤ 5.5 V, IOL3 = 1.0 mA				0.4	V

Note

This setting applies to the following port pins.

- Pins P04, P10, and P120 of the 64- to 100-pin package products with 384- to 768-Kbyte flash ROM
- Pin P101 of the 100-pin package products with 384- to 768-Kbyte flash ROM
- Pins P17, P51, and P70 of the 30- to 52-pin package products

Remark

The characteristics of functions multiplexed on a given pin are the same as those for the port pin unless otherwise specified.

(TA = -40 to +105°C, 1.6 V ≤ EVDD0 = EVDD1 ≤ VDD ≤ 5.5 V, VSS = EVSS0 = EVSS1 = 0 V)

(6/7)

Item	Symbol	Conditions			Min.	Typ.	Max.	Unit
Output current ^{Note}	CCDIOL	P16, P17, P50, P51 P60 to P63	CCSm = 01H	4.0 V ≤ EVDD0 ≤ 5.5 V	1.0	1.8	2.6	mA
				2.7 V ≤ EVDD0 < 4.0 V	0.8	1.5	2.3	mA
			CCSm = 02H	4.0 V ≤ EVDD0 ≤ 5.5 V	3.0	4.9	6.5	mA
				3.0 V ≤ EVDD0 < 4.0 V	2.7	4.3	5.9	mA
			CCSm = 03H	4.0 V ≤ EVDD0 ≤ 5.5 V	6.6	10.0	13.2	mA
				3.3 V ≤ EVDD0 < 4.0 V	6.0	9.1	12.1	mA
		P60 to P63	CCSm = 04H	4.0 V ≤ EVDD0 ≤ 5.5 V	10.2	15.0	19.8	mA
				3.3 V ≤ EVDD0 < 4.0 V	9.4	13.8	18.2	mA

Note The listed currents apply when the output current control function is enabled.

(TA = -40 to +105°C, 1.6 V ≤ EVDD0 = EVDD1 ≤ VDD ≤ 5.5 V, VSS = EVSS0 = EVSS1 = 0 V)

(7/7)

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
Input leakage current, high	ILI _{H1}	P00 to P07, P10 to P17, P30 to P37, P40 to P47, P50 to P57, P60 to P67, P70 to P77, P80 to P87, P90 to P97, P100 to P106, P110 to P117, P120, P125 to P127, P140 to P147			0.5	μA
	ILI _{H2}	P20 to P27, P137, P150 to P156, RESET			0.5	μA
	ILI _{H3}	P121 to P124 (X1, X2, XT1, XT2, EXCLK, EXCLKS)			0.5	μA
Input leakage current, low	ILI _{L1}	P00 to P07, P10 to P17, P30 to P37, P40 to P47, P50 to P57, P60 to P67, P70 to P77, P80 to P87, P90 to P97, P100 to P106, P110 to P117, P120, P125 to P127, P140 to P147			0.5	μA
	ILI _{L2}	P20 to P27, P137, P150 to P156, RESET			0.5	μA
	ILI _{L3}	P121 to P124 (X1, X2, XT1, XT2, EXCLK, EXCLKS)			0.5	μA
On-chip pll-up resistance	RU	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 to P122, P125 to P127, P140 to P147	10	20	100	kΩ

Remark The characteristics of functions multiplexed on a given pin are the same as those for the port pin unless otherwise specified.

2.3.2 Supply current characteristics

(1) 30- to 64-pin package products with 96- to 128-Kbyte flash ROM

(TA = -40 to +105°C, 1.6 V ≤ EVDD0 ≤ VDD ≤ 5.5 V, VSS = EVSS0 = 0 V)

(1/4)

Item	Symbol	Conditions					Min.	Typ.	Max.	Unit
Supply current Note 1	IDD1	Operating mode	HS (high-speed main) mode	f _{IH} = 32 MHz ^{Note 2}	Basic operation	VDD = 5.0 V		1.4	—	mA
						VDD = 1.8 V		1.4	—	
					Normal operation	VDD = 5.0 V		3.1	5.1	mA
						VDD = 1.8 V		3.1	5.1	
			LS (low-speed main) mode	f _{IH} = 24 MHz ^{Note 2}	Normal operation	VDD = 5.0 V		2.3	3.9	mA
						VDD = 1.8 V		2.3	3.9	
				f _{IH} = 16 MHz ^{Note 2}	Normal operation	VDD = 5.0 V		1.7	2.8	mA
						VDD = 1.8 V		1.7	2.8	
				f _{IM} = 4 MHz ^{Note 3}	Normal operation	VDD = 5.0 V		0.4	0.7	mA
						VDD = 1.6 V		0.4	0.7	
			LP (low-power main) mode	f _{IM} = 2 MHz ^{Note 3}	Normal operation	VDD = 5.0 V		206	332	μA
						VDD = 1.6 V		205	331	
				f _{IM} = 1 MHz ^{Note 3}	Normal operation	VDD = 5.0 V		115	181	μA
						VDD = 1.6 V		114	180	
			HS (high-speed main) mode	f _{MX} = 20 MHz ^{Note 4} , Square wave input	Normal operation	VDD = 5.0 V		1.9	3.2	mA
						VDD = 1.8 V		1.9	3.2	
			LS (low-speed main) mode	f _{MX} = 20 MHz ^{Note 4} , Square wave input	Normal operation	VDD = 5.0 V		1.8	3.0	mA
						VDD = 1.8 V		1.8	3.0	
				f _{MX} = 20 MHz ^{Note 4} , Resonator connection	Normal operation	VDD = 5.0 V		2.0	3.3	mA
						VDD = 1.8 V		2.0	3.2	
				f _{MX} = 10 MHz ^{Note 4} , Square wave input	Normal operation	VDD = 5.0 V		0.9	1.6	mA
						VDD = 1.8 V		0.9	1.6	
				f _{MX} = 10 MHz ^{Note 4} , Resonator connection	Normal operation	VDD = 5.0 V		1.0	1.7	mA
						VDD = 1.8 V		1.0	1.7	
				f _{MX} = 8 MHz ^{Note 4} , Square wave input	Normal operation	VDD = 5.0 V		0.8	1.3	mA
						VDD = 1.8 V		0.8	1.3	
				f _{MX} = 8 MHz ^{Note 4} , Resonator connection	Normal operation	VDD = 5.0 V		0.9	1.4	mA
						VDD = 1.8 V		0.9	1.4	

Note 1. The listed currents are the total currents flowing into VDD and EVDD0, including the input leakage currents flowing when the level of the input pin is fixed to VDD, EVDD0 or VSS, EVSS0. The currents in the Max. column include the peripheral operation current, but do not include those flowing into the A/D converter, LVD circuit, I/O port, and on-chip pull-up/pull-down resistors, and those flowing while the data flash memory is being rewritten.

Note 2. The listed currents apply when the high-speed system clock, middle-speed on-chip oscillator, low-speed on-chip oscillator, and subsystem clock are stopped.

Note 3. The listed currents apply when the high-speed on-chip oscillator, high-speed system clock, low-speed on-chip oscillator, and subsystem clock are stopped.

Note 4. The listed currents apply when the high-speed on-chip oscillator, middle-speed on-chip oscillator, low-speed on-chip oscillator, and subsystem clock are stopped.

Remark 1. f_H: High-speed on-chip oscillator clock frequency

Remark 2. f_M: Middle-speed on-chip oscillator clock frequency

Remark 3. f_{MX}: High-speed system clock frequency (X1 clock oscillation frequency or external main system clock frequency)

Remark 4. The typical value for the ambient operating temperature (T_A) is 25°C unless otherwise specified.

(1) 30- to 64-pin package products with 96- to 128-Kbyte flash ROM

(TA = -40 to +105°C, 1.6 V ≤ EVDD0 ≤ VDD ≤ 5.5 V, VSS = EVSS0 = 0 V)

(2/4)

Item	Symbol	Conditions					Min.	Typ.	Max.	Unit
Supply current Note 1	IDD1	Operating mode	Subsystem clock operation mode	fSUB = 32.768 kHz ^{Note 2} , Low-speed on-chip oscillator operation	Normal operation	TA = -40°C		3.7	6.3	μA
						TA = +25°C		4.1	6.8	
						TA = +50°C		4.4	9.7	
						TA = +70°C		5.1	15.0	
						TA = +85°C		6.0	23.4	
						TA = +105°C		8.7	42.5	
				fSUB = 32.768 kHz ^{Note 3} , Square wave input	Normal operation	TA = -40°C		3.3	5.6	μA
						TA = +25°C		3.5	5.7	
						TA = +50°C		3.7	8.4	
						TA = +70°C		4.3	13.5	
						TA = +85°C		5.2	21.3	
						TA = +105°C		7.6	38.7	
				fSUB = 32.768 kHz ^{Note 3} , Resonator connection	Normal operation	TA = -40°C		3.3	5.2	μA
						TA = +25°C		3.6	5.5	
						TA = +50°C		3.8	7.9	
						TA = +70°C		4.4	13.5	
						TA = +85°C		5.3	21.1	
						TA = +105°C		7.9	38.9	

Note 1. The listed currents are the total currents flowing into VDD and EVDD0, including the input leakage currents flowing when the level of the input pin is fixed to VDD, EVDD0 or VSS, EVSS0. The currents in the Max. column include the peripheral operation current, but do not include those flowing into the A/D converter, LVD circuit, I/O port, and on-chip pull-up/pull-down resistors, and those flowing while the data flash memory is being rewritten.

Note 2. The listed currents apply when the high-speed on-chip oscillator, middle-speed on-chip oscillator, high-speed system clock, and subsystem clock are stopped. They do not include the current flowing into the RTC, 32-bit interval timer, and watchdog timer.

Note 3. The listed currents apply when the high-speed on-chip oscillator, high-speed system clock, middle-speed on-chip oscillator, and low-speed on-chip oscillator are stopped, and the low power consumption oscillation 3 is specified (AMPHS1, AMPHS0 = 1, 1). They do not include the currents flowing into the RTC, 32-bit interval timer, and watchdog timer.

Remark 1. fIL: Low-speed on-chip oscillator clock frequency

Remark 2. fSUB: Subsystem clock frequency (XT1 clock oscillation frequency)

(1) 30- to 64-pin package products with 96- to 128-Kbyte flash ROM

(TA = -40 to +105°C, 1.6 V ≤ EVDD0 ≤ VDD ≤ 5.5 V, VSS = EVSS0 = 0 V)

(3/4)

Item	Symbol	Conditions				Min.	Typ.	Max.	Unit
Supply current Note 1	IDD2 Note 2	HALT mode	HS (high-speed main) mode	f _{IH} = 32 MHz Note 3	VDD = 5.0 V		0.58	1.98	mA
					VDD = 1.8 V		0.58	1.98	
			LS (low-speed main) mode	f _{IH} = 24 MHz Note 3	VDD = 5.0 V		0.48	1.54	mA
					VDD = 1.8 V		0.48	1.54	
				f _{IH} = 16 MHz Note 3	VDD = 5.0 V		0.48	1.23	mA
					VDD = 1.8 V		0.48	1.23	
				f _{IM} = 4 MHz Note 4	VDD = 5.0 V		0.09	0.27	mA
					VDD = 1.6 V		0.09	0.27	
			LP (low-power main) mode	f _{IM} = 2 MHz Note 4	VDD = 5.0 V		34	121	μA
					VDD = 1.6 V		34	121	
				f _{IM} = 1 MHz Note 4	VDD = 5.0 V		29	75	μA
					VDD = 1.6 V		29	75	
			HS (high-speed main) mode	f _{MX} = 20 MHz Note 5 , Square wave input	VDD = 5.0 V		0.23	1.07	mA
					VDD = 1.8 V		0.20	1.04	
			LS (low-speed main) mode	f _{MX} = 20 MHz Note 5 , Square wave input	VDD = 5.0 V		0.23	1.07	mA
					VDD = 1.8 V		0.20	1.04	
				f _{MX} = 20 MHz Note 5 , Resonator connection	VDD = 5.0 V		0.41	1.29	mA
					VDD = 1.8 V		0.41	1.29	
				f _{MX} = 10 MHz Note 5 , Square wave input	VDD = 5.0 V		0.14	0.57	mA
					VDD = 1.8 V		0.12	0.55	
				f _{MX} = 10 MHz Note 5 , Resonator connection	VDD = 5.0 V		0.24	0.69	mA
					VDD = 1.8 V		0.24	0.69	
				f _{MX} = 8 MHz Note 5 , Square wave input	VDD = 5.0 V		0.12	0.47	mA
					VDD = 1.8 V		0.10	0.45	
				f _{MX} = 8 MHz Note 5 , Resonator connection	VDD = 5.0 V		0.21	0.58	mA
					VDD = 1.8 V		0.21	0.58	

Note 1. The listed currents are the total currents flowing into VDD and EVDD0, including the input leakage currents flowing when the level of the input pin is fixed to VDD, EVDD0 or VSS, EVSS0. The currents in the Max. column include the peripheral operation current, but do not include those flowing into the A/D converter, LVD circuit, I/O port, and on-chip pull-up/pull-down resistors, and those flowing while the data flash memory is being rewritten.

Note 2. The listed currents apply when the HALT instruction has been fetched from the flash memory for execution.

Note 3. The listed currents apply when the high-speed system clock, middle-speed on-chip oscillator, low-speed on-chip oscillator, and subsystem clock are stopped.

Note 4. The listed currents apply when the high-speed on-chip oscillator, high-speed system clock, low-speed on-chip oscillator, and subsystem clock are stopped.

Note 5. The listed currents apply when the high-speed on-chip oscillator, middle-speed on-chip oscillator, low-speed on-chip oscillator, and subsystem clock are stopped.

Remark 1. f_{IH}: High-speed on-chip oscillator clock frequency

Remark 2. f_{IM}: Middle-speed on-chip oscillator clock frequency

Remark 3. f_{MX}: High-speed system clock frequency (X1 clock oscillation frequency or external main system clock frequency)

Remark 4. The typical value for the ambient operating temperature (TA) is 25°C unless otherwise specified.

(1) 30- to 64-pin package products with 96- to 128-Kbyte flash ROM

(TA = -40 to +105°C, 1.6 V ≤ EVDD0 ≤ VDD ≤ 5.5 V, VSS = EVSS0 = 0 V)

(4/4)

Item	Symbol	Conditions				Min.	Typ.	Max.	Unit
Supply current Note 1	IDD2 Note 2	HALT mode	Subsystem clock operation mode	fSUB = 32.768 kHzNote 3, Low-speed on-chip oscillator operation	TA = -40°C		0.85	2.94	μA
					TA = +25°C		1.08	3.25	
					TA = +50°C		1.30	5.95	
					TA = +70°C		1.72	11.05	
					TA = +85°C		2.40	19.17	
					TA = +105°C		4.32	37.31	
				fSUB = 32.768 kHz, Square wave input Note 4	TA = -40°C		0.22	2.01	μA
					TA = +25°C		0.29	1.90	
					TA = +50°C		0.44	4.46	
					TA = +70°C		0.80	9.36	
					TA = +85°C		1.44	17.53	
					TA = +105°C		3.24	35.11	
				fSUB = 32.768 kHz, Resonator connection Note 5	TA = -40°C		0.23	2.06	μA
					TA = +25°C		0.34	2.24	
					TA = +50°C		0.51	4.91	
					TA = +70°C		0.88	9.93	
					TA = +85°C		1.52	18.11	
					TA = +105°C		3.37	36.04	
	IDD3	STOP mode	RAMSDS = 0Note 6	TA = -40°C		0.15	1.45	μA	
				TA = +25°C		0.23	1.45		
				TA = +50°C		0.45	4		
				TA = +70°C		0.9	9		
				TA = +85°C		1.6	17		
				TA = +105°C		4	35		
				RAMSDS = 1Note 7	TA = -40°C		0.14	1.45	μA
					TA = +25°C		0.21	1.45	
					TA = +50°C		0.4	3.5	
					TA = +70°C		0.8	8.5	
					TA = +85°C		1.4	15	
					TA = +105°C		3.2	30	
				RAMSDS = 1, 128-Hz realtime clock operationNote 8	TA = -40°C		0.22	1.53	μA
					TA = +25°C		0.32	1.56	
					TA = +50°C		0.52	3.62	
					TA = +70°C		0.93	8.63	
					TA = +85°C		1.54	15.14	
					TA = +105°C		3.34	30.14	

- Note 1.** The listed currents are the total currents flowing into VDD and EVDD0, including the input leakage currents flowing when the level of the input pin is fixed to VDD, EVDD0 or VSS, EVSS0. The currents in the Max. column include the peripheral operation current, but do not include those flowing into the A/D converter, LVD circuit, I/O port, and on-chip pull-up/pull-down resistors, and those flowing while the data flash memory is being rewritten.
- Note 2.** The listed currents apply when the HALT instruction has been fetched from the flash memory for execution.
- Note 3.** The listed currents apply when the high-speed on-chip oscillator, middle-speed on-chip oscillator, high-speed system clock, and subsystem clock are stopped. They include the currents flowing into the RTC, but do not include those into the 32-bit interval timer and watchdog timer.
- Note 4.** The listed currents apply when the high-speed on-chip oscillator, middle-speed on-chip oscillator, high-speed system clock, and low-speed on-chip oscillator are stopped. They include the currents flowing into the RTC, but do not include those into the 32-bit interval timer and watchdog timer.
- Note 5.** The listed currents apply when the high-speed on-chip oscillator, middle-speed on-chip oscillator, high-speed system clock, and low-speed on-chip oscillator are stopped, and the setting of RTCLPC is 1, and the low power consumption oscillation 3 is specified (AMPHS1, AMPHS0 = 1, 1). They include the currents flowing into the RTC, but do not include those into the 32-bit interval timer and watchdog timer.
- Note 6.** The listed currents with this setting allow retention of the contents of the entire RAM area.
The listed currents apply when the low-speed on-chip oscillator and subsystem clock oscillation are stopped. They do not include the current flowing into the RTC, 32-bit interval timer, and watchdog timer. For the current for operation of the subsystem clock in the STOP mode, refer to that in the HALT mode.
- Note 7.** The listed currents with this setting allow retention of the contents of a specified 4-Kbyte area of the RAM.
The listed currents apply when the low-speed on-chip oscillator and subsystem clock oscillation are stopped. They do not include the currents flowing into the RTC, 32-bit interval timer, and watchdog timer.
- Note 8.** The listed currents with this setting allow retention of the contents of a specified 4-Kbyte area of the RAM.
The listed currents apply when the low-speed on-chip oscillator is stopped, the setting of RTCLPC is 1, and the low power consumption oscillation 3 is specified (AMPHS1, AMPHS0 = 1, 1). They do not include the currents flowing into the RTC, 32-bit interval timer, and watchdog timer.

Remark 1. fIL: Low-speed on-chip oscillator clock frequency

Remark 2. fSUB: Subsystem clock frequency (XT1 clock oscillation frequency)

(2) Peripheral Functions (Common to all products)

(TA = -40 to +105°C, 1.6 V ≤ EVDD0 = EVDD1 ≤ VDD ≤ 5.5 V, VSS = EVSS0 = EVSS1 = 0 V)

Item	Symbol	Conditions		Min.	Typ.	Max.	Unit
High-speed on-chip oscillator operating current	IFIH Note 1	HIPREC = 1			380	—	μA
		HIPREC = 0			240	—	μA
Middle-speed on-chip oscillator operating current	IFIM Note 1				20	—	μA
Low-speed on-chip oscillator operating current	IFIL Note 1				0.3	—	μA
RTC operating current	IRTC Notes 1, 2, 3	fRTCCLK = 32.768 kHz			0.005	—	μA
		fRTCCLK = 128 Hz			0.002	—	μA
32-bit interval timer operating current	IIT Notes 1, 2, 4				0.04	—	μA
Watchdog timer operating current	IWDT Notes 1, 2, 5	fIL = 32.768 kHz (typ.)			0.32	—	μA
A/D converter operating current	IADC Notes 1, 6	When conversion at maximum speed	Normal mode, AVREFP = VDD = 5.0 V		0.95	1.6	mA
			Low voltage mode, AVREFP = VDD = 3.0 V		0.5	0.75	mA
AVREFP current	IADREF Note 7	AVREFP = 5.0 V			52	—	μA
A/D converter internal reference voltage current	IADREF Note 1				114	—	μA
Temperature sensor operating current	ITMPS Note 1				110	—	μA
D/A converter operating current	IDAC Notes 1, 8	Per channel			150	—	μA
Comparator operating current	ICMP Notes 1, 9				6	—	μA
LVD operating current	ILVD0 Notes 1, 10				0.02	—	μA
	ILVD1 Notes 1, 10				0.02	—	μA
Self-programming operating current	IFSP Notes 1, 11				2.5	12.2	mA
Data flash rewrite operating current	IBGO Notes 1, 12				2.5	12.2	mA
SNOOZE mode sequencer operating current	ISMS Notes 1, 13	fIH = 32 MHz			1.1	—	mA
		fIL = 32.768 kHz			1.2	—	μA
SNOOZE operating current	ISNOZ Note 1	ADC to be in use	The ADC is shifting from the STOP mode to the SNOOZE mode. Note 14		0.6	0.81	mA
			The ADC is operating in the low-voltage mode. AVREFP = VDD = 3.0 V		1.2	1.56	
		SPI (CSI)/UART to be in use			0.7	0.92	
Remote control signal receiver operating current	IREM Notes 1, 15				0.03	—	μA
Low-speed peripheral clock supply current	ISXP Notes 1, 16	RTCLPC = 0			0.22	—	μA

(TA = -40 to +105°C, 1.6 V ≤ EVDD0 = EVDD1 ≤ VDD ≤ 5.5 V, VSS = EVSS0 = EVSS1 = 0 V)

Item	Symbol	Conditions		Min.	Typ.	Max.	Unit
Output current control operating current	ICCDA Notes 1, 17	The setting of the CCDE register is not 00H.			100	—	μA
	ICCDP Notes 1, 18	Per single output current control port	Setting of the low-level output current: Hi-Z		30	—	μA
			Setting of the low-level output current: 2 to 15 mA		200	—	μA

Note 1. This current flows into VDD.**Note 2.** The listed currents apply when the high-speed on-chip oscillator, middle-speed on-chip oscillator, and high-speed system clock are stopped.**Note 3.** This current flows into the realtime clock (RTC). It does not include the operating current of the low-speed on-chip oscillator or the XT1 oscillator. The supply current of the RL78 microcontrollers is the sum of either IDD1 or IDD2, and IRTC, when the realtime clock is operating or in the HALT mode. When the low-speed on-chip oscillator is selected, IFIL should be included in the supply current. IDD2 in the subsystem clock operation mode includes the operating current of the realtime clock.**Note 4.** This current only flows to the 32-bit interval timer. It does not include the operating current of the low-speed on-chip oscillator or the XT1 oscillator. The supply current of the RL78 microcontrollers is the sum of either IDD1 or IDD2, and IIT, when the 32-bit interval timer is operating or in the HALT mode. When the low-speed on-chip oscillator is selected, IFIL should be included in the supply current.**Note 5.** This current only flows to the watchdog timer. It includes the operating current of the low-speed on-chip oscillator. The supply current of the RL78 microcontrollers is the sum of IDD1, IDD2 or IDD3 and IWDI when the watchdog timer is operating.**Note 6.** This current only flows to the A/D converter. The supply current of the RL78 microcontrollers is the sum of IDD1 or IDD2 and IADC when the A/D converter is operating or in the HALT mode.**Note 7.** This current flows into AVREFP.**Note 8.** This current only flows to the D/A converter.

The supply current of the RL78 microcontrollers is the sum of the values of either IDD1 or IDD2, and IDAC, when the D/A converter is operating or in the HALT mode.

Note 9. This current only flows to the comparator. The supply current of the RL78 microcontrollers is the sum of IDD1, IDD2 or IDD3 and ICMP when the comparator is in operation.**Note 10.** This current only flows to the LVD circuit. The supply current of the RL78 microcontrollers is the sum of IDD1, IDD2 or IDD3 and ILVD when the LVD circuit is in operation.**Note 11.** This current only flows during self programming.**Note 12.** This current only flows while the data flash memory is being rewritten.**Note 13.** This current only flows into the SNOOZE mode sequencer. Note that the operating current of the low-speed on-chip oscillator and the XT1 oscillator are not included. The supply current of the RL78 microcontrollers is the sum of either IDD1 or IDD2, and ISMS, when the SNOOZE mode sequencer is operating or in the HALT mode.**Note 14.** For shift time to the SNOOZE mode, see **18.3.13 SNOOZE Mode Function** in the RL78/G23 User's Manual.**Note 15.** This current flows into the remote control signal receiver. It does not include the operating current of the low-speed on-chip oscillator or the XT1 oscillator. The supply current of the RL78 microcontrollers is the sum of either IDD1 or IDD2, and IIT, when the remote control signal receiver is operating or in the HALT mode. When the low-speed on-chip oscillator is selected, IFIL should be included in the supply current.**Note 16.** This current is added to the supply current in the HALT mode when the setting of RTCLPC is 0 in the STOP mode, or when the setting of RTCLPC is 0 with the sub-system clock (fSUB) selected as the CPU clock.**Note 17.** This current is added to the supply current when the output voltage control port is set.**Note 18.** This current does not include the current flowing into the I/O port pins.**Remark 1.** fIL: Low-speed on-chip oscillator clock frequency**Remark 2.** fSUB: Subsystem clock frequency (XT1 clock oscillation frequency)**Remark 3.** fCLK: CPU/peripheral hardware clock frequency**Remark 4.** The typical value for the ambient operating temperature (TA) is 25°C unless otherwise specified.

2.4 AC Characteristics

(TA = -40 to +105°C, 1.6 V ≤ EVDD0 = EVDD1 ≤ VDD ≤ 5.5 V, VSS = EVSS0 = EVSS1 = 0 V)

Item	Symbol	Conditions		Min.	Typ.	Max.	Unit
Instruction cycle (minimum instruction execution time)	TCY	Main system clock (fMAIN) operation	HS (high-speed main) mode	1.8 V ≤ VDD ≤ 5.5 V	0.03125	1	μs
				1.6 V ≤ VDD ≤ 1.8 V	0.25	1	μs
			LS (low-speed main) mode	1.8 V ≤ VDD ≤ 5.5 V	0.04167	1	μs
				1.6 V ≤ VDD ≤ 1.8 V	0.25	1	μs
		LP (low-power main) mode		1.6 V ≤ VDD ≤ 5.5 V	0.5	1	μs
Subsystem clock (fSUB) operation				1.8 V ≤ VDD ≤ 5.5 V	26.041	30.5	31.3 μs
In the self programming mode		HS (high-speed main) mode		1.8 V ≤ VDD ≤ 5.5 V	0.03125	1	μs
				1.6 V ≤ VDD ≤ 1.8 V	0.5	1	μs
		LS (low-speed main) mode		1.8 V ≤ VDD ≤ 5.5 V	0.04167	1	μs
				1.6 V ≤ VDD ≤ 1.8 V	0.5	1	μs
External system clock frequency	fEX	1.8 V ≤ VDD ≤ 5.5 V		1.0		20.0	MHz
		1.6 V ≤ VDD < 1.8 V		1.0		4.0	MHz
	fEXS			32		38.4	kHz
External system clock input high-level width, low-level width	texH, texL	1.8 V ≤ VDD ≤ 5.5 V		15			ns
		1.6 V ≤ VDD < 1.8 V		120			ns
	texHS, texLS			13.7			μs
TI00 to TI07, TI10 to TI17 input high-level width, low-level width	tTIH, tTIL			1/fMCK + 10			ns ^{Note}
TO00 to TO07, TO10 to TO17 output frequency	fTO	HS (high-speed main) mode LS (low-speed main) mode		4.0 V ≤ EVDD0 ≤ 5.5 V		16	MHz
				2.7 V ≤ EVDD0 < 4.0 V		8	MHz
				1.8 V ≤ EVDD0 < 2.7 V		4	MHz
				1.6 V ≤ EVDD0 < 1.8 V		2	MHz
		LP (low-power main) mode		1.6 V ≤ EVDD0 ≤ 5.5 V		2	MHz
PCLBUZ0, PCLBUZ1 output frequency	fPCL	HS (high-speed main) mode LS (low-speed main) mode		4.0 V ≤ EVDD0 ≤ 5.5 V		16	MHz
				2.7 V ≤ EVDD0 < 4.0 V		8	MHz
				1.8 V ≤ EVDD0 < 2.7 V		4	MHz
				1.6 V ≤ EVDD0 < 1.8 V		2	MHz
		LP (low-power main) mode		1.6 V ≤ EVDD0 < 1.8 V		2	MHz
Interrupt input high-level width, low-level width	fINTH, fINTL	INTP0	1.6 V ≤ VDD ≤ 5.5 V	1			μs
		INTP1 to INTP11	1.6 V ≤ EVDD0 ≤ 5.5 V	1			μs
Key interrupt input low- level width	fKRH, fKRL	KR0 to KR7	1.8 V ≤ EVDD0 ≤ 5.5 V	250			ns
			1.6 V ≤ EVDD0 < 1.8 V	1			μs
RESET low-level width	fRSL			10			μs

(**Note** and **Remark** are listed on the next page.)

Note The following conditions are required for low voltage interface when $EV_{DD0} < V_{DD}$.

$1.8\text{ V} \leq EV_{DD0} < 2.7\text{ V}$: 125 ns min.

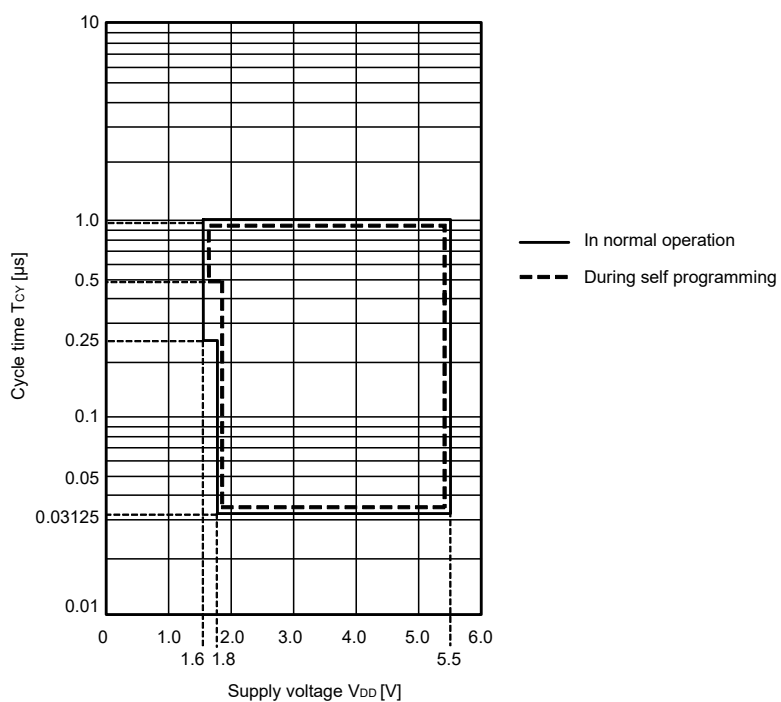
$1.6\text{ V} \leq EV_{DD0} < 1.8\text{ V}$: 250 ns min.

Remark f_{MCK} : Timer array unit operating clock frequency

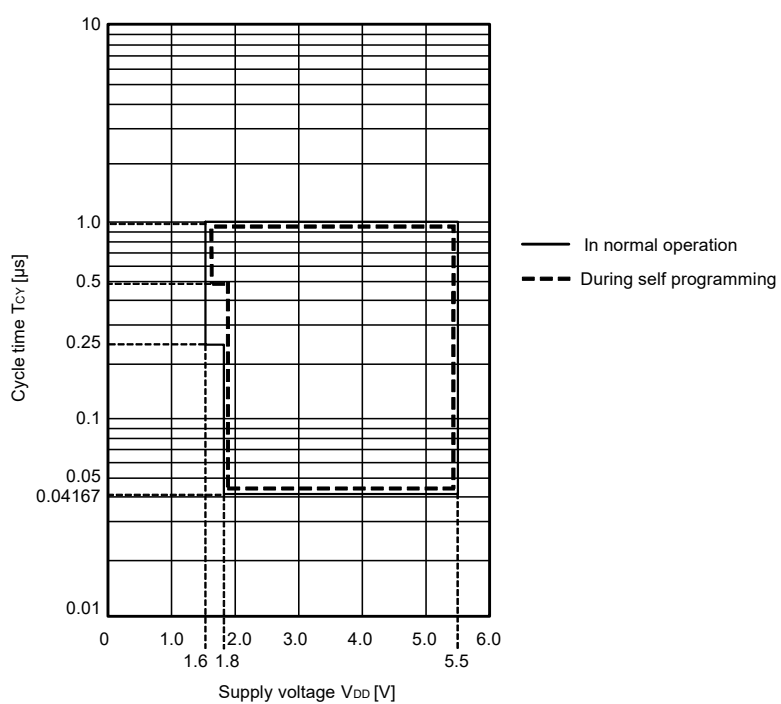
(To set this operating clock, use the $CKSmn0$ and $CKSmn1$ bits of the timer mode register mn ($TMRmn$) (m : Unit number ($m = 0, 1$), n : Channel number ($n = 0$ to 3).))

Minimum Instruction Execution Time during Main System Clock Operation

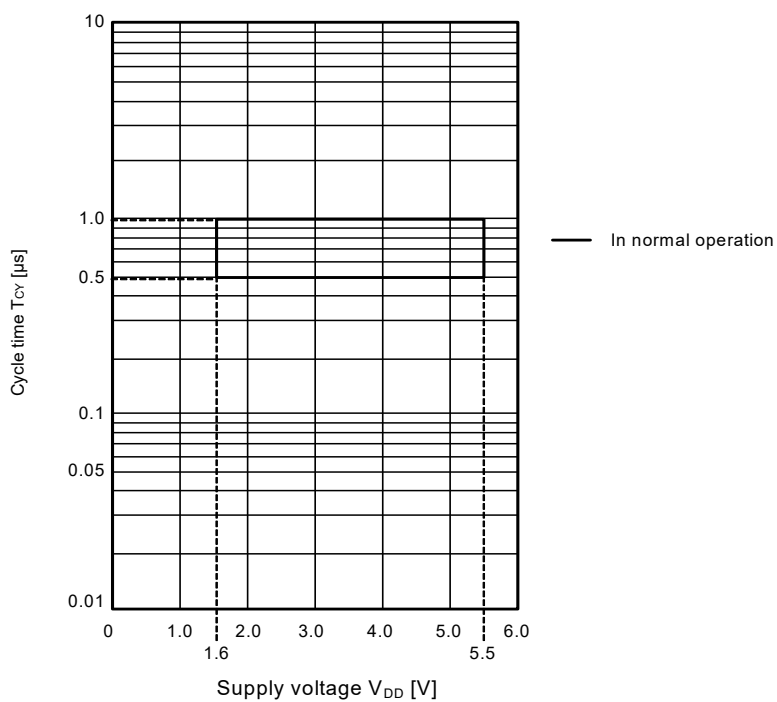
TCY vs VDD (HS (high-speed main) mode)



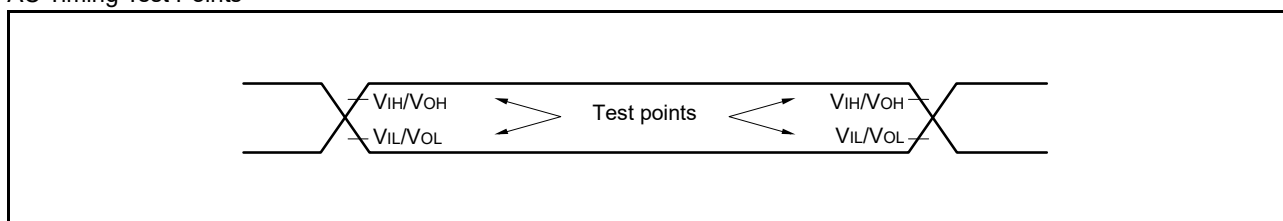
TCY vs VDD (LS (low-speed main) mode)



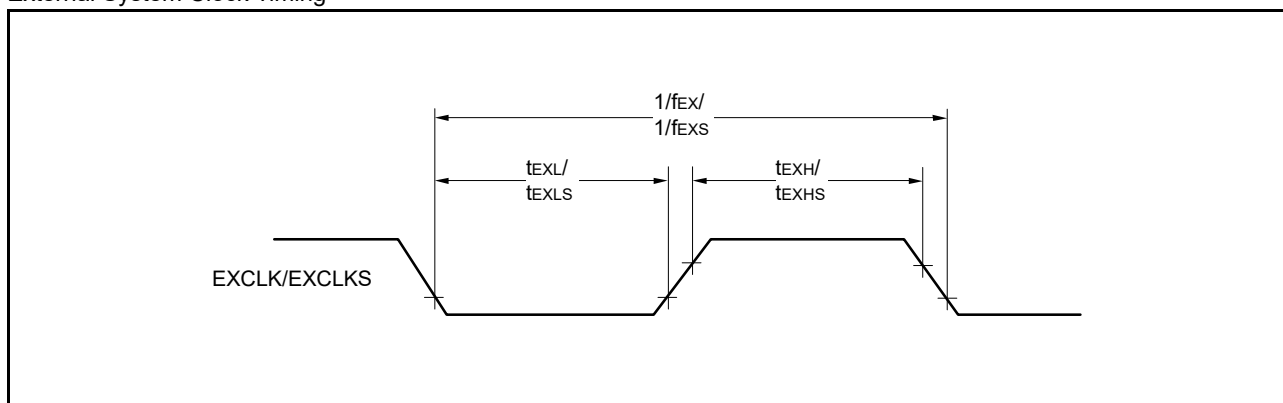
TCY vs VDD (LP (low-power main) mode)



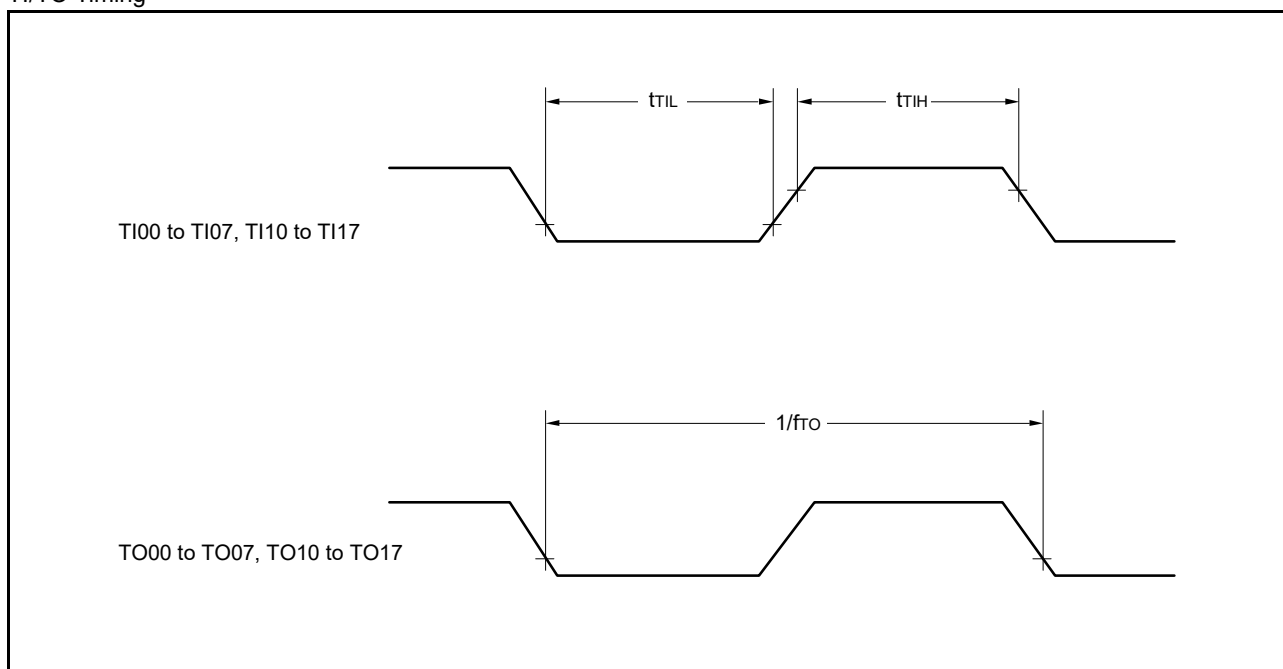
AC Timing Test Points



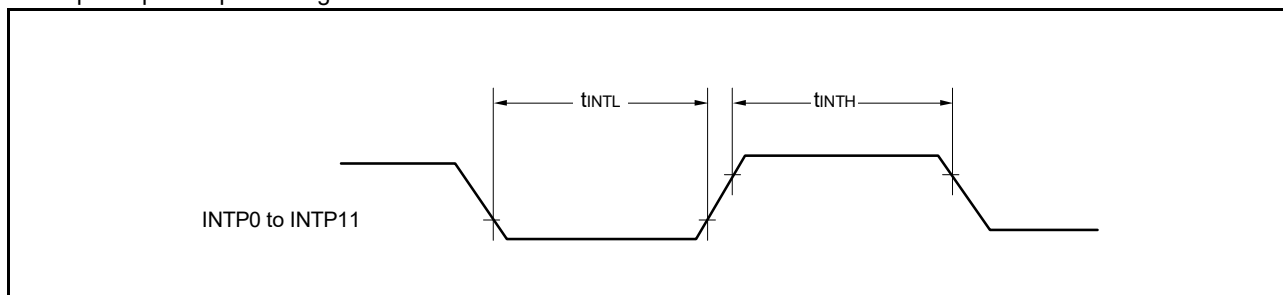
External System Clock Timing



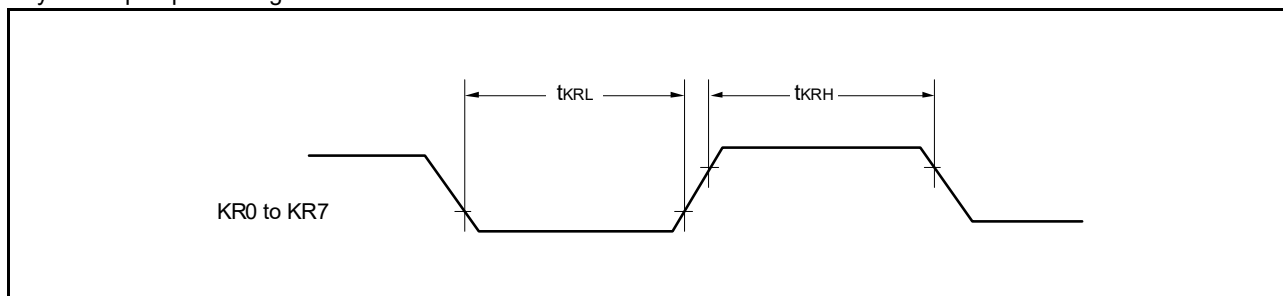
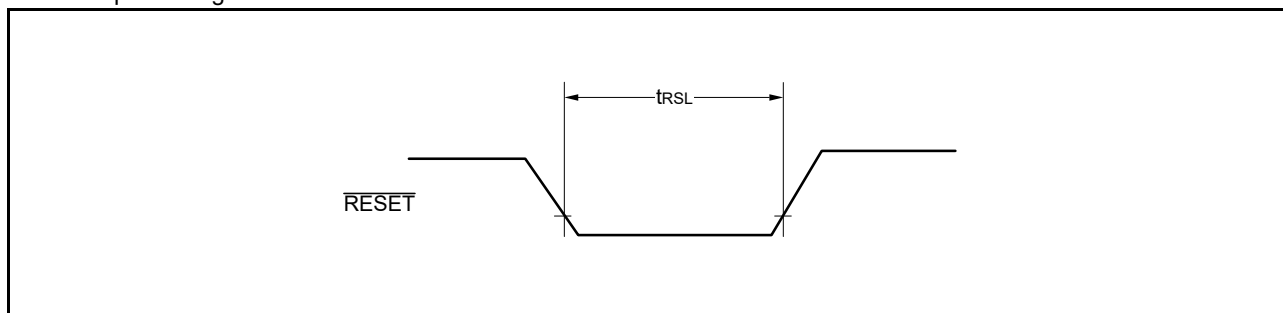
TI/TO Timing



Interrupt Request Input Timing

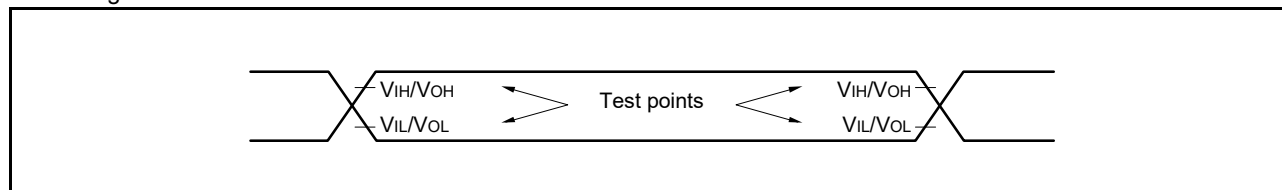


Key Interrupt Input Timing

 $\overline{\text{RESET}}$ Input Timing

2.5 Characteristics of the Peripheral Functions

AC Timing Test Points



2.5.1 Serial array unit

(1) In UART communications with devices operating at same voltage levels

($T_A = -40$ to $+105^\circ\text{C}$, $1.6\text{ V} \leq \text{EVDD0} = \text{EVDD1} \leq \text{VDD} \leq 5.5\text{ V}$, $\text{VSS} = \text{EVSS0} = \text{EVSS1} = 0\text{ V}$)

Item	Symbol	Conditions	HS (High-Speed Main) Mode		LS (Low-Speed Main) Mode		LP (Low-Power Main) Mode		Unit
			Min.	Max.	Min.	Max.	Min.	Max.	
Transfer rate Note 1		$1.6\text{ V} \leq \text{EVDD0} \leq 5.5\text{ V}$		fMCK/6 Note 2		fMCK/6 Note 2		fMCK/6	bps
		Theoretical value of the maximum transfer rate fMCK = fCLKNote 3		5.3		4		0.33	Mbps

Note 1. The transfer rate in the SNOOZE mode is within the range from 4800 to 9600 bps.

Note 2. The following conditions are required for low voltage interface when $\text{EVDD0} < \text{VDD}$.

$2.4\text{ V} \leq \text{EVDD0} < 2.7\text{ V}$: 2.6 Mbps max.

$1.8\text{ V} \leq \text{EVDD0} < 2.4\text{ V}$: 1.3 Mbps max.

$1.6\text{ V} \leq \text{EVDD0} < 1.8\text{ V}$: 0.6 Mbps max.

Note 3. The maximum operating frequencies of the CPU/peripheral hardware clock (fCLK) are as follows.

HS (high-speed main) mode: 32 MHz ($1.8\text{ V} \leq \text{VDD} \leq 5.5\text{ V}$)

4 MHz ($1.6\text{ V} \leq \text{VDD} \leq 5.5\text{ V}$)

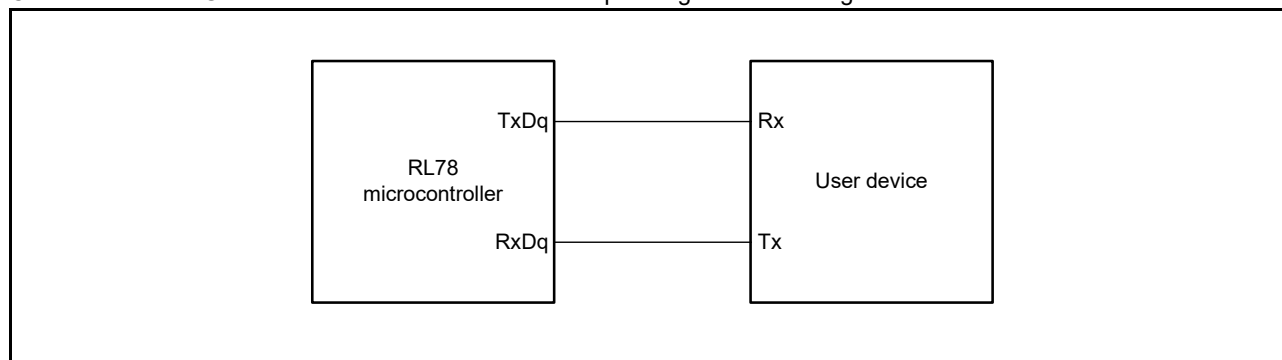
LS (low-speed main) mode: 24 MHz ($1.8\text{ V} \leq \text{VDD} \leq 5.5\text{ V}$)

4 MHz ($1.6\text{ V} \leq \text{VDD} \leq 5.5\text{ V}$)

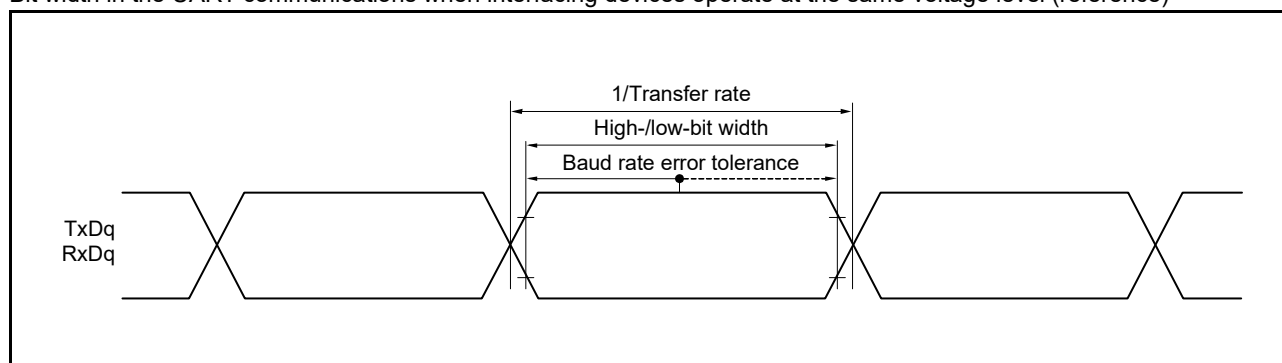
LP (low-power main) mode: 2 MHz ($1.6\text{ V} \leq \text{VDD} \leq 5.5\text{ V}$)

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

Connection in the UART communications with devices operating at same voltage levels



Bit width in the UART communications when interfacing devices operate at the same voltage level (reference)



Remark 1. q: UART number (q = 0 to 3), g: PIM and POM number (g = 0, 1, 8, 14)

Remark 2. f_{MCK}: Serial array unit operation clock frequency

(To set this operating clock, set the CKSmn bit in the serial mode register mn (SMRmn) (m: Unit number, n: Channel number (mn = 00 to 03, 10 to 13).)

- (2) In SPI (CSI) communications in the master mode with devices operating at same voltage levels with the internal SCKp clock (the ratings below are only applicable to CSI00)

(TA = -40 to +85°C, 2.7 V ≤ EVDD0 = EVDD1 ≤ VDD ≤ 5.5 V, VSS = EVSS0 = EVSS1 = 0 V)

Item	Symbol	Conditions		HS (High-Speed Main) Mode		LS (Low-Speed Main) Mode		LP (Low-Power Main) Mode		Unit
				Min.	Max.	Min.	Max.	Min.	Max.	
SCKp cycle time	tkCY1	tkCY1 ≥ 2/fCLK	4.0 V ≤ EVDD0 ≤ 5.5 V	62.5		83.3		1000		ns
			2.7 V ≤ EVDD0 ≤ 5.5 V	83.3		125		1000		ns
SCKp high-/low-level width	tkH1, tkL1	4.0 V ≤ EVDD0 ≤ 5.5 V		tkCY1/2 - 7		tkCY1/2 - 10		tkCY1/2 - 50		ns
		2.7 V ≤ EVDD0 ≤ 5.5 V		tkCY1/2 - 10		tkCY1/2 - 15		tkCY1/2 - 50		ns
Slp setup time (to SCKp↑) Note 1	tsIK1	4.0 V ≤ EVDD0 ≤ 5.5 V		23		33		110		ns
		2.7 V ≤ EVDD0 ≤ 5.5 V		33		50		110		ns
Slp hold time (from SCKp↑) Note 1	tkSI1	2.7 V ≤ EVDD0 ≤ 5.5 V		10		10		10		ns
Delay time from SCKp↓ to SOp output Note 2	tkSO1	C = 20 pF Note 3			10		10		10	ns

Note 1. The setting applies when DAPmn = 0 and CKPmn = 0, or DAPmn = 1 and CKPmn = 1. The setting for the Slp setup time becomes “to SCKp↓” and that for the Slp hold time becomes “from SCKp↓” when DAPmn = 0 and CKPmn = 1, or DAPmn = 1 and CKPmn = 0.

Note 2. This setting applies when DAPmn = 0 and CKPmn = 0, or DAPmn = 1 and CKPmn = 1. The setting for the delay time to SOp output becomes “from SCKp↑” when DAPmn = 0 and CKPmn = 1, or DAPmn = 1 and CKPmn = 0.

Note 3. C is the load capacitance of the SCKp and SOp output lines.

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

Remark 1. The listed times are only valid when the peripheral I/O redirect function of CSI00 is not in use.

Remark 2. p: CSI number (p = 00), m: Unit number (m = 0), n: Channel number (n = 0), g: PIM and POM numbers (g = 1)

Remark 3. fMCK: Serial array unit operation clock frequency

(To set this operating clock, use the CKSmn bit in the serial mode register mn (SMRmn) (m: Unit number, n: Channel number (mn = 00).)

- (3) In SPI (CSI) communications in the master mode with devices operating at same voltage levels with the internal SCKp clock

(TA = -40 to +105°C, 1.6 V ≤ EVDD0 = EVDD1 ≤ VDD ≤ 5.5 V, VSS = EVSS0 = EVSS1 = 0 V)

Item	Symbol	Conditions		HS (High-Speed Main) Mode		LS (Low-Speed Main) Mode		LP (Low-Power Main) Mode		Unit
				Min.	Max.	Min.	Max.	Min.	Max.	
SCKp cycle time	tkCY1	tkCY1 ≥ 4/fCLK	2.7 V ≤ EVDD0 ≤ 5.5 V	125		166		2000		ns
			2.4 V ≤ EVDD0 ≤ 5.5 V	250		250		2000		ns
			1.8 V ≤ EVDD0 ≤ 5.5 V	500		500		2000		ns
			1.6 V ≤ EVDD0 ≤ 5.5 V	1000		1000		2000		ns
SCKp high-/low-level width	tkH1, tkL1	4.0 V ≤ EVDD0 ≤ 5.5 V		tkCY1/2 - 12		tkCY1/2 - 21		tkCY1/2 - 50		ns
		2.7 V ≤ EVDD0 ≤ 5.5 V		tkCY1/2 - 18		tkCY1/2 - 25		tkCY1/2 - 50		ns
		2.4 V ≤ EVDD0 ≤ 5.5 V		tkCY1/2 - 38		tkCY1/2 - 38		tkCY1/2 - 50		ns
		1.8 V ≤ EVDD0 ≤ 5.5 V		tkCY1/2 - 50		tkCY1/2 - 50		tkCY1/2 - 50		ns
		1.6 V ≤ EVDD0 ≤ 5.5 V		tkCY1/2 - 100		tkCY1/2 - 100		tkCY1/2 - 100		ns
Slp setup time (to SCKp↑) ^{Note 1}	tsIK1	4.0 V ≤ EVDD0 ≤ 5.5 V		44		54		110		ns
		2.7 V ≤ EVDD0 ≤ 5.5 V		44		54		110		ns
		2.4 V ≤ EVDD0 ≤ 5.5 V		75		75		110		ns
		1.8 V ≤ EVDD0 ≤ 5.5 V		110		110		110		ns
		1.6 V ≤ EVDD0 ≤ 5.5 V		220		220		220		ns
Slp hold time (from SCKp↑) ^{Note 1}	tkSI1	1.6 V ≤ EVDD0 ≤ 5.5 V		19		19		19		ns
Delay time from SCKp↓ to SOp output ^{Note 2}	tkSO1	1.6 V ≤ EVDD0 ≤ 5.5 V C = 30 pF ^{Note 3}			25		25		25	ns

Note 1. This setting applies when DAPmn = 0 and CKPmn = 0, or DAPmn = 1 and CKPmn = 1. The setting for the Slp setup time becomes “to SCKp↓” and that for the Slp hold time becomes “from SCKp↓” when DAPmn = 0 and CKPmn = 1, or DAPmn = 1 and CKPmn = 0.

Note 2. This setting applies when DAPmn = 0 and CKPmn = 0, or DAPmn = 1 and CKPmn = 1. The setting for the delay time to SOp output becomes “from SCKp↑” when DAPmn = 0 and CKPmn = 1, or DAPmn = 1 and CKPmn = 0.

Note 3. C is the load capacitance of the SCKp and SOp output lines.

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

Remark 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)

Remark 2. fmCK: Serial array unit operation clock frequency

(To set this operating clock, use the CKSmn bit in the serial mode register mn (SMRmn) (m: Unit number, n: Channel number = 00 to 03, 10 to 13).)

- (4) In SPI (CSI) communications in the slave mode with devices operating at same voltage levels with the SCKp external clock

(TA = -40 to +105°C, 1.6 V ≤ EVDD0 = EVDD1 ≤ VDD ≤ 5.5 V, VSS = EVSS0 = EVSS1 = 0 V)

(1/2)

Item	Symbol	Conditions		HS (High-Speed Main) Mode		LS (Low-Speed Main) Mode		LP (Low-Power Main) Mode		Unit
				Min.	Max.	Min.	Max.	Min.	Max.	
SCKp cycle time Note 4	tkCY2	4.0 V ≤ EVDD0 ≤ 5.5 V	20 MHz < fMCK	8/fMCK		8/fMCK		—		ns
			fMCK ≤ 20 MHz	6/fMCK		6/fMCK		6/fMCK		ns
		2.7 V ≤ EVDD0 ≤ 5.5 V	16 MHz < fMCK	8/fMCK		8/fMCK		—		ns
			fMCK ≤ 16 MHz	6/fMCK		6/fMCK		6/fMCK		ns
		2.4 V ≤ EVDD0 ≤ 5.5 V		6/fMCK and 500		6/fMCK and 500		6/fMCK and 500		ns
		1.8 V ≤ EVDD0 ≤ 5.5 V		6/fMCK and 750		6/fMCK and 750		6/fMCK and 750		ns
		1.6 V ≤ EVDD0 ≤ 5.5 V		6/fMCK and 1500		6/fMCK and 1500		6/fMCK and 1500		ns
SCKp high-/ low-level width	tkH2, tkL2	4.0 V ≤ EVDD0 ≤ 5.5 V		tkCY2/2 - 7		tkCY2/2 - 7		tkCY2/2 - 7		ns
		2.7 V ≤ EVDD0 ≤ 5.5 V		tkCY2/2 - 8		tkCY2/2 - 8		tkCY2/2 - 8		ns
		1.8 V ≤ EVDD0 ≤ 5.5 V		tkCY2/2 - 18		tkCY2/2 - 18		tkCY2/2 - 18		ns
		1.6 V ≤ EVDD0 ≤ 5.5 V		tkCY2/2 - 66		tkCY2/2 - 66		tkCY2/2 - 66		ns

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

- (4) In SPI (CSI) communications in the slave mode with devices operating at same voltage levels with the SCKp external clock

(TA = -40 to +105°C, 1.6 V ≤ EVDD0 = EVDD1 ≤ VDD ≤ 5.5 V, VSS = EVSS0 = EVSS1 = 0 V)

(2/2)

Item	Symbol	Conditions	HS (High-Speed Main) Mode		LS (Low-Speed Main) Mode		LP (Low-Power Main) Mode		Unit
			Min.	Max.	Min.	Max.	Min.	Max.	
Slp setup time (to SCKp↑) Note 1	tsIK2	2.7 V ≤ EVDD0 ≤ 5.5 V	1/fMCK + 20		1/fMCK + 30		1/fMCK + 30		ns
		1.8 V ≤ EVDD0 ≤ 5.5 V	1/fMCK + 30		1/fMCK + 30		1/fMCK + 30		ns
		1.6 V ≤ EVDD0 ≤ 5.5 V	1/fMCK + 40		1/fMCK + 40		1/fMCK + 40		ns
Slp hold time (from SCKp↑) Note 1	tsIH2	1.8 V ≤ EVDD0 ≤ 5.5 V	1/fMCK + 31		1/fMCK + 31		1/fMCK + 31		ns
		1.6 V ≤ EVDD0 ≤ 5.5 V	1/fMCK + 250		1/fMCK + 250		1/fMCK + 250		ns
Delay time from SCKp↓ to SOp output Note 2	tkSO2	C = 30 pF Note 3	2.7 V ≤ EVDD0 ≤ 5.5 V		2/fMCK + 44		2/fMCK + 110		ns
			2.4 V ≤ EVDD0 ≤ 5.5 V		2/fMCK + 75		2/fMCK + 110		ns
			1.8 V ≤ EVDD0 ≤ 5.5 V		2/fMCK + 110		2/fMCK + 110		ns
			1.6 V ≤ EVDD0 ≤ 5.5 V		2/fMCK + 220		2/fMCK + 220		ns

Note 1. This setting applies when DAPmn = 0 and CKPmn = 0, or DAPmn = 1 and CKPmn = 1. The setting for the Slp setup time becomes “to SCKp↓” and that for the Slp hold time becomes “from SCKp↓” when DAPmn = 0 and CKPmn = 1, or DAPmn = 1 and CKPmn = 0.

Note 2. This setting applies when DAPmn = 0 and CKPmn = 0, or DAPmn = 1 and CKPmn = 1. The setting for the delay time to SOp output becomes “from SCKp↑” when DAPmn = 0 and CKPmn = 1, or DAPmn = 1 and CKPmn = 0.

Note 3. C is the load capacitance of the SOp output line.

Note 4. Transfer rate in the SNOOZE mode is 1 Mbps at the maximum.

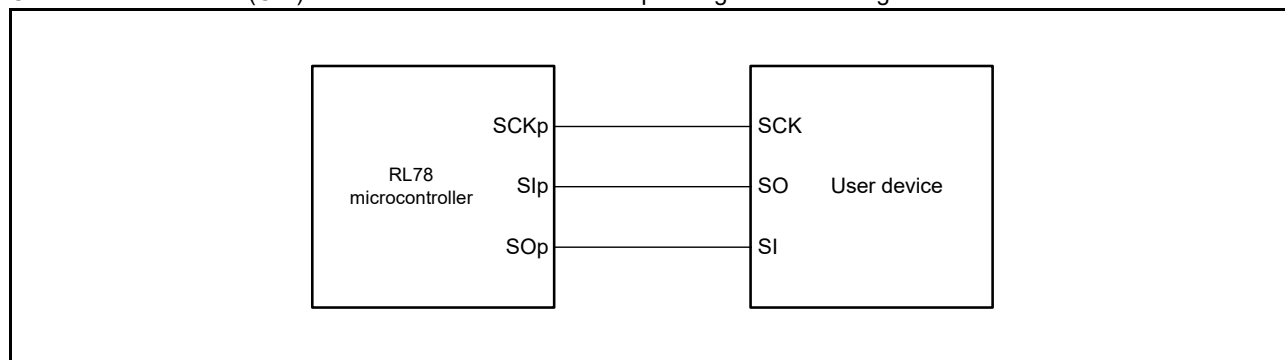
Caution Select the normal input buffer for the Slp pin and SCKp pin and the normal output mode for the SOp pin by using the port input mode register g (PIMg) and the port output mode register g (POMg).

Remark 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)

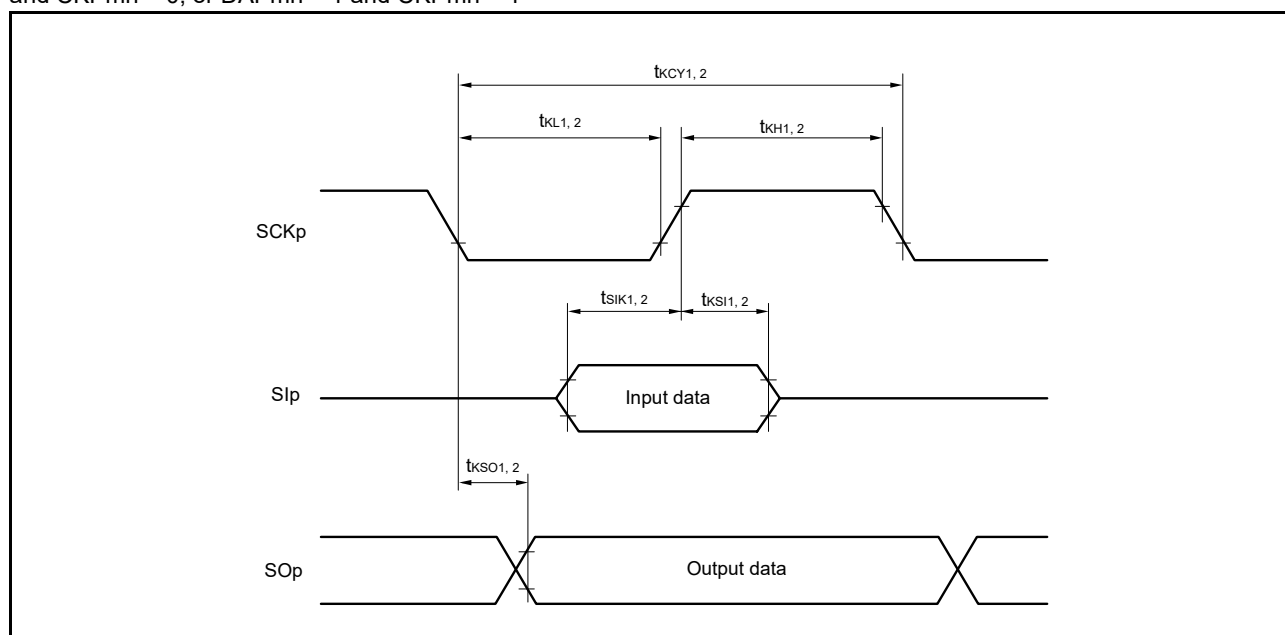
Remark 2. fMCK: Serial array unit operation clock frequency

(To set this operating clock, use the CKSmn bit in the serial mode register mn (SMRmn) (m: Unit number, n: Channel number = 00 to 03, 10 to 13).)

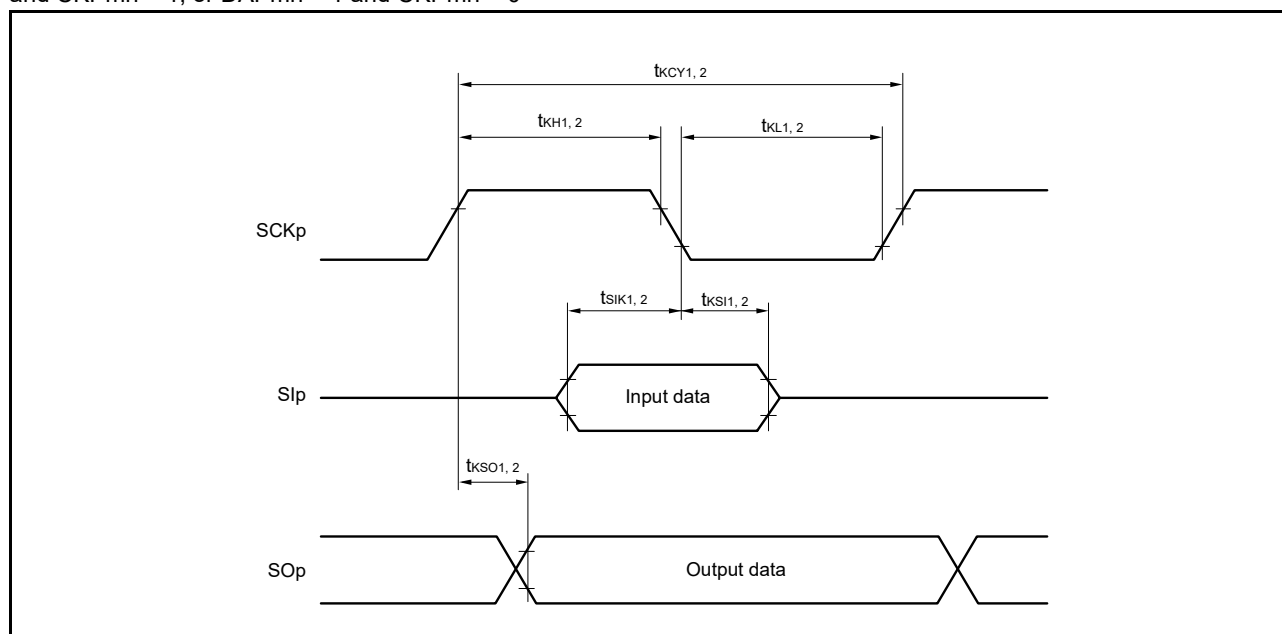
Connection in the SPI (CSI) communications with devices operating at same voltage levels



Timing of serial transfer in the SPI (CSI) communications with devices operating at same voltage levels when DAPmn = 0 and CKPmn = 0, or DAPmn = 1 and CKPmn = 1



Timing of serial transfer in the SPI (CSI) communications with devices operating at same voltage levels when $\text{DAPmn} = 0$ and $\text{CKPmn} = 1$, or $\text{DAPmn} = 1$ and $\text{CKPmn} = 0$



Remark 1. p: CSI number (p = 00, 01, 10, 11, 20, 21, 30, 31)

Remark 2. m: Unit number, n: Channel number (mn = 00 to 03, 10 to 13)

(5) In simplified I²C communications with devices operating at same voltage levels

(TA = -40 to +105°C, 1.6 V ≤ EVDD0 = EVDD1 ≤ VDD ≤ 5.5 V, VSS = EVSS0 = EVSS1 = 0 V)

(1/2)

Item	Symbol	Conditions	HS (High-Speed Main) Mode		LS (Low-Speed Main) Mode		LP (Low-Power Main) Mode		Unit
			Min.	Max.	Min.	Max.	Min.	Max.	
SCLr clock frequency	fSCL	2.7 V ≤ EVDD0 ≤ 5.5 V, Cb = 50 pF, Rb = 2.7 kΩ		1000 Note 1		1000 Note 1		400Note 1	kHz
		1.8 V ≤ EVDD0 ≤ 5.5 V, Cb = 100 pF, Rb = 3 kΩ		400Note 1		400Note 1		400Note 1	kHz
		1.8 V ≤ EVDD0 < 2.7 V, Cb = 100 pF, Rb = 5 kΩ		300Note 1		300Note 1		300Note 1	kHz
		1.6 V ≤ EVDD0 < 1.8 V, Cb = 100 pF, Rb = 5 kΩ		250Note 1		250Note 1		250Note 1	kHz
Hold time when SCLr is low	tLOW	2.7 V ≤ EVDD0 ≤ 5.5 V, Cb = 50 pF, Rb = 2.7 kΩ	475		475		1150		ns
		1.8 V ≤ EVDD0 ≤ 5.5 V, Cb = 100 pF, Rb = 3 kΩ	1150		1150		1150		ns
		1.8 V ≤ EVDD0 < 2.7 V, Cb = 100 pF, Rb = 5 kΩ	1550		1550		1550		ns
		1.6 V ≤ EVDD0 < 1.8 V, Cb = 100 pF, Rb = 5 kΩ	1850		1850		1850		ns
Hold time when SCLr is high	tHIGH	2.7 V ≤ EVDD0 ≤ 5.5 V, Cb = 50 pF, Rb = 2.7 kΩ	475		475		1150		ns
		1.8 V ≤ EVDD0 ≤ 5.5 V, Cb = 100 pF, Rb = 3 kΩ	1150		1150		1150		ns
		1.8 V ≤ EVDD0 < 2.7 V, Cb = 100 pF, Rb = 5 kΩ	1550		1550		1550		ns
		1.6 V ≤ EVDD0 < 1.8 V, Cb = 100 pF, Rb = 5 kΩ	1850		1850		1850		ns

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

(5) In simplified I²C communications with devices operating at same voltage levels

(TA = -40 to +105°C, 1.6 V ≤ EVDD0 = EVDD1 ≤ VDD ≤ 5.5 V, VSS = EVSS0 = EVSS1 = 0 V)

(2/2)

Item	Symbol	Conditions	HS (High-Speed Main) Mode		LS (Low-Speed Main) Mode		LP (Low-Power Main) Mode		Unit
			Min.	Max.	Min.	Max.	Min.	Max.	
Data setup time (reception)	tsu:DAT	2.7 V ≤ EVDD0 ≤ 5.5 V, Cb = 50 pF, Rb = 2.7 kΩ	1/fMCK + 85 Note 2		1/fMCK + 85 Note 2		1/fMCK + 145 Note 2		ns
		1.8 V ≤ EVDD0 ≤ 5.5 V, Cb = 100 pF, Rb = 3 kΩ	1/fMCK + 145 Note 2		1/fMCK + 145 Note 2		1/fMCK + 145 Note 2		ns
		1.8 V ≤ EVDD0 < 2.7 V, Cb = 100 pF, Rb = 5 kΩ	1/fMCK + 230 Note 2		1/fMCK + 230 Note 2		1/fMCK + 230 Note 2		ns
		1.6 V ≤ EVDD0 < 1.8 V, Cb = 100 pF, Rb = 5 kΩ	1/fMCK + 290 Note 2		1/fMCK + 290 Note 2		1/fMCK + 290 Note 2		ns
Data hold time (transmission)	thd:DAT	2.7 V ≤ EVDD0 ≤ 5.5 V, Cb = 50 pF, Rb = 2.7 kΩ	0	305	0	305	0	305	ns
		1.8 V ≤ EVDD0 ≤ 5.5 V, Cb = 100 pF, Rb = 3 kΩ	0	355	0	355	0	355	ns
		1.8 V ≤ EVDD0 < 2.7 V, Cb = 100 pF, Rb = 5 kΩ	0	405	0	405	0	405	ns
		1.6 V ≤ EVDD0 < 1.8 V, Cb = 100 pF, Rb = 5 kΩ	0	405	0	405	0	405	ns

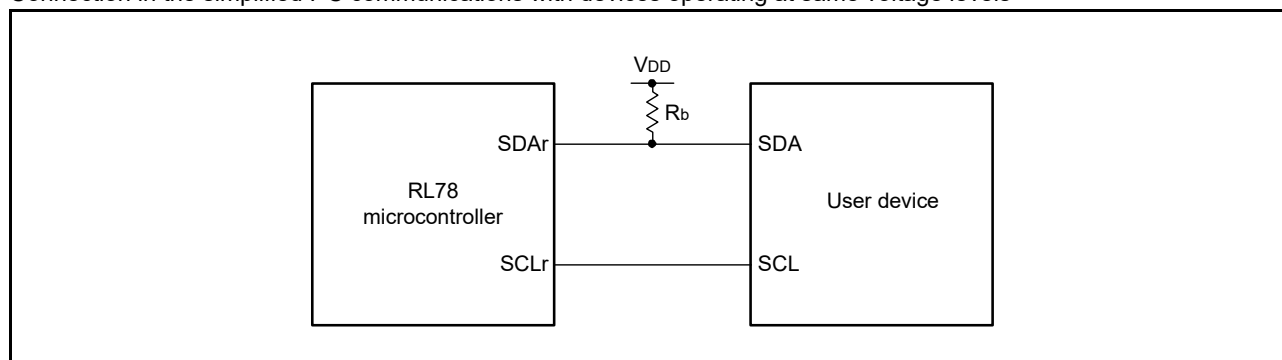
Note 1. The listed times must be no greater than fMCK/4.

Note 2. Set fMCK so that it will not exceed the hold time when SCLr is low or high.

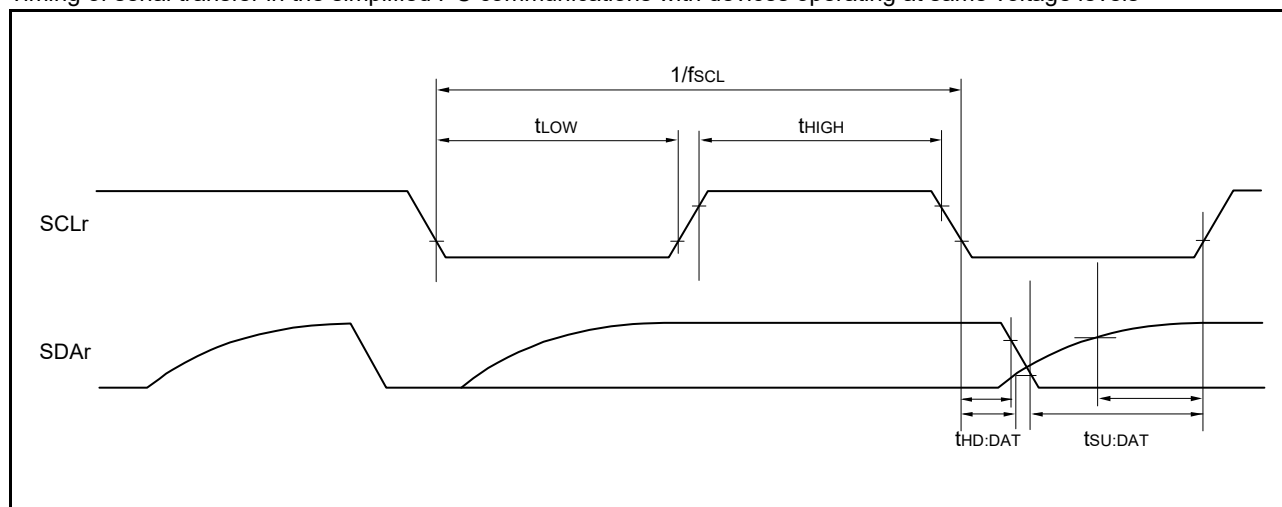
Caution Select the normal input buffer and the N-ch open drain output (VDD tolerance (when 30- to 52-pin products)/EVDD tolerance (when 64- to 128-pin products)) mode for the SDAr pin and the normal output mode for the SCLr pin by using port input mode register g (PIMg) and port output mode register h (POMh).

(Remarks are listed on the next page.)

Connection in the simplified I²C communications with devices operating at same voltage levels



Timing of serial transfer in the simplified I²C communications with devices operating at same voltage levels



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

Remark 2. r: IIC number (r = 00, 01, 10, 11, 20, 21, 30, 31), g: PIM number (g = 0, 1, 4, 5, 8, 14), h: POM number (g = 0, 1, 4, 5, 7 to 9, 14)

Remark 3. f_{MCK}: Serial array unit operation clock frequency

(To set this operating clock, use the CKSmn bit in the serial mode register mn (SMRmn) (m: Unit number, n: Channel number = 00 to 03, 10 to 13).)

(6) In UART communications with devices operating at different voltage levels (1.8 V, 2.5 V, 3 V)

(TA = -40 to +105°C, 1.8 V ≤ EVDD0 = EVDD1 ≤ VDD ≤ 5.5 V, VSS = EVSS0 = EVSS1 = 0 V)

(1/2)

Item	Symbol	Conditions	HS (High-Speed Main) Mode		LS (Low-Speed Main) Mode		LP (Low-Power Main) Mode		Unit
			Min.	Max.	Min.	Max.	Min.	Max.	
Transfer rate		Reception	4.0 V ≤ EVDD0 ≤ 5.5 V, 2.7 V ≤ Vb ≤ 4.0 V	fMCK/6 Note 1		fMCK/6 Note 1		fMCK/6 Note 1	bps
				5.3		4		0.33	Mbps
			2.7 V ≤ EVDD0 < 4.0 V, 2.3 V ≤ Vb ≤ 2.7 V	fMCK/6 Note 1		fMCK/6 Note 1		fMCK/6 Note 1	bps
				5.3		4		0.33	Mbps
			1.8 V ≤ EVDD0 < 3.3 V, 1.6 V ≤ Vb ≤ 2.0 V	fMCK/6 Notes 1, 2, 3		fMCK/6 Notes 1, 2		fMCK/6 Notes 1, 2	bps
				5.3		4		0.33	Mbps

Note 1. Transfer rate in the SNOOZE mode is within the range from 4800 to 9600 bps.

Note 2. Use this rate with EVDD0 ≥ Vb.

Note 3. The following conditions are required for low voltage interface when EVDD0 < VDD.

2.4 V ≤ EVDD0 < 2.7 V: 2.6 Mbps (max.)

1.8 V ≤ EVDD0 < 2.4 V: 1.3 Mbps (max.)

Note 4. The maximum operating frequencies of the CPU/peripheral hardware clock (fCLK) are:

HS (high-speed main) mode: 32 MHz (1.8 V ≤ VDD ≤ 5.5 V)

4 MHz (1.6 V ≤ VDD ≤ 5.5 V)

LS (low-speed main) mode: 24 MHz (1.8 V ≤ VDD ≤ 5.5 V)

4 MHz (1.6 V ≤ VDD ≤ 5.5 V)

LP (low-power main) mode: 2 MHz (1.6 V ≤ VDD ≤ 5.5 V)

Caution Select the TTL input buffer for the RxDq pin and the N-ch open drain output (VDD tolerance (when 30- to 52-pin products)/EVDD tolerance (when 64- to 128-pin products)) mode for the TxDq pin by using port input mode register g (PIMg) and port output mode register g (POMg). For VIH and VIL, see the DC characteristics with TTL input buffer selected.

Remark 1. Vb[V]: Communication line voltage

Remark 2. q: UART number (q = 0 to 3), g: PIM and POM number (g = 0, 1, 8, 14)

Remark 3. fMCK: Serial array unit operation clock frequency

(To set this operating clock, use the CKSmn bit in the serial mode register mn (SMRmn) (m: Unit number, n: Channel number = 00 to 03, 10 to 13).)

Remark 4. Communications by using UART2 with devices operating at different voltage levels are not possible when the setting of bit 1 (PIOR1) of the peripheral I/O redirection register (PIOR) is 1.

(6) In UART communications with devices operating at different voltage levels (1.8 V, 2.5 V, 3 V)

(TA = -40 to +105°C, 1.8 V ≤ EVDD0 = EVDD1 ≤ VDD ≤ 5.5 V, VSS = EVSS0 = EVSS1 = 0 V)

(2/2)

Item	Symbol	Conditions	HS (High-Speed Main) Mode		LS (Low-Speed Main) Mode		LP (Low-Power Main) Mode		Unit
			Min.	Max.	Min.	Max.	Min.	Max.	
Transfer rate		Transmission	4.0 V ≤ EVDD0 ≤ 5.5 V, 2.7 V ≤ Vb ≤ 4.0 V			Note 1		Note 1	bps
			Theoretical value of the maximum transfer rate Cb = 50 pF, Rb = 1.4 kΩ, Vb = 2.7 V			2.8Note 2		2.8Note 2	Mbps
			2.7 V ≤ EVDD0 < 4.0 V, 2.3 V ≤ Vb ≤ 2.7 V			Note 3		Note 3	bps
			Theoretical value of the maximum transfer rate Cb = 50 pF, Rb = 2.7 kΩ, Vb = 2.3 V			1.2Note 4		1.2Note 4	Mbps
			1.8 V ≤ EVDD0 < 3.3 V, 1.6 V ≤ Vb ≤ 2.0 V			Notes 5, 6		Notes 5, 6	bps
			Theoretical value of the maximum transfer rate Cb = 50 pF, Rb = 5.5 kΩ, Vb = 1.6 V			0.43 Note 7		0.43 Note 7	Mbps

Note 1. The smaller maximum transfer rate derived by using fmck/6 or the following expression is the valid maximum transfer rate.
Expression for calculating the transfer rate when 4.0 V ≤ EVDD0 ≤ 5.5 V, 2.7 V ≤ Vb ≤ 4.0 V

$$\text{Maximum transfer rate} = \frac{1}{\{-C_b \times R_b \times \ln(1 - \frac{2.2}{V_b})\} \times 3} \text{ [bps]}$$

$$\text{Baud rate error (theoretical value)} = \frac{\frac{1}{\text{Transfer rate} \times 2} - \{-C_b \times R_b \times \ln(1 - \frac{2.2}{V_b})\}}{\left(\frac{1}{\text{Transfer rate}}\right) \times \text{Number of transferred bits}} \times 100 \text{ [%]}$$

* This value is the theoretical value of the relative difference between the transmission and reception sides.

Note 2. This rate is calculated as an example when the conditions described in the "Conditions" column are met. See **Note 1** above to calculate the maximum transfer rate under conditions of the customer.

- Note 3.** The smaller maximum transfer rate derived by using fmck/6 or the following expression is the valid maximum transfer rate. Expression for calculating the transfer rate when 2.7 V ≤ EVDD0 < 4.0 V, 2.3 V ≤ V_b ≤ 2.7 V

$$\text{Maximum transfer rate} = \frac{1}{\{-C_b \times R_b \times \ln(1 - \frac{2.0}{V_b})\} \times 3} \text{ [bps]}$$

$$\text{Baud rate error (theoretical value)} = \frac{\frac{1}{\text{Transfer rate} \times 2} - \{-C_b \times R_b \times \ln(1 - \frac{2.0}{V_b})\}}{(\frac{1}{\text{Transfer rate}}) \times \text{Number of transferred bits}} \times 100 \text{ [%]}$$

* This value is the theoretical value of the relative difference between the transmission and reception sides.

- Note 4.** This rate is calculated as an example when the conditions described in the “Conditions” column are met. See **Note 3** above to calculate the maximum transfer rate under conditions of the customer.

- Note 5.** Use this rate with EVDD0 ≥ V_b.

- Note 6.** The smaller maximum transfer rate derived by using fmck/6 or the following expression is the valid maximum transfer rate. Expression for calculating the transfer rate when 1.8 V ≤ EVDD0 < 3.3 V, 1.6 V ≤ V_b ≤ 2.0 V

$$\text{Maximum transfer rate} = \frac{1}{\{-C_b \times R_b \times \ln(1 - \frac{1.5}{V_b})\} \times 3} \text{ [bps]}$$

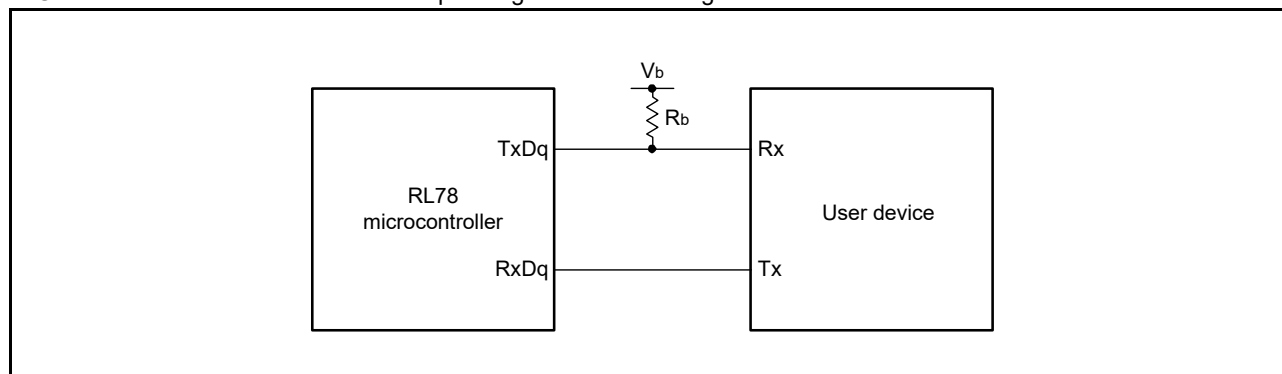
$$\text{Baud rate error (theoretical value)} = \frac{\frac{1}{\text{Transfer rate} \times 2} - \{-C_b \times R_b \times \ln(1 - \frac{1.5}{V_b})\}}{(\frac{1}{\text{Transfer rate}}) \times \text{Number of transferred bits}} \times 100 \text{ [%]}$$

* This value is the theoretical value of the relative difference between the transmission and reception sides.

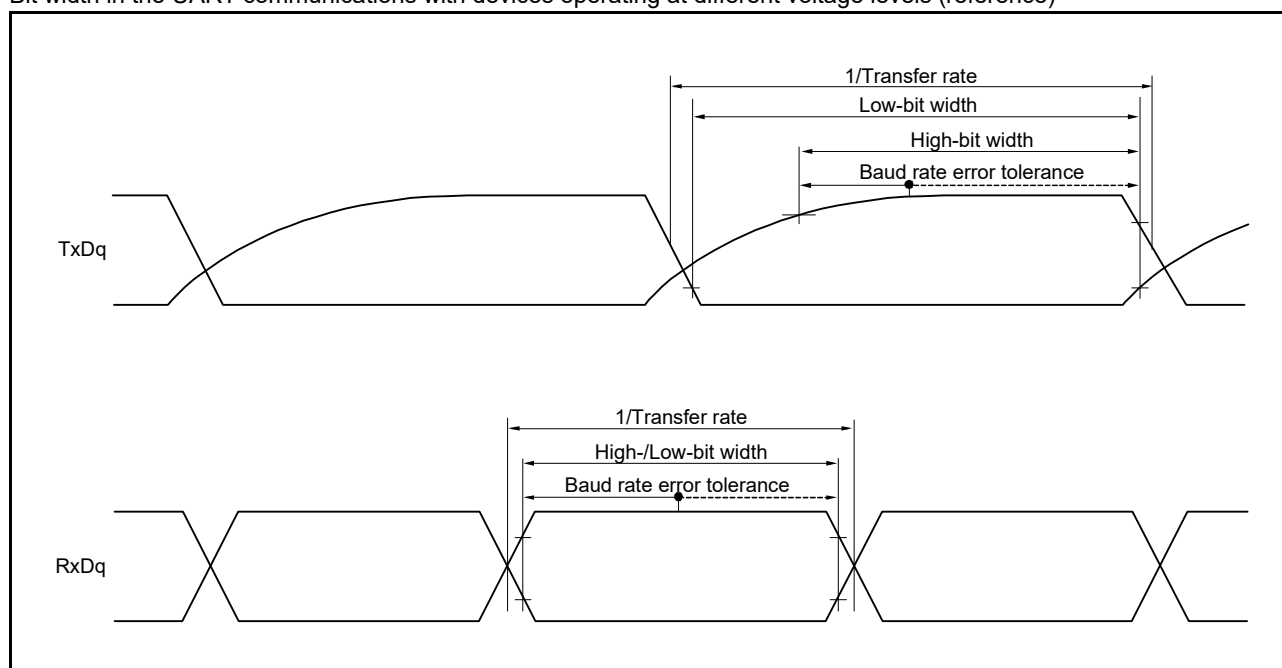
- Note 7.** This rate is calculated as an example when the conditions described in the “Conditions” column are met. Refer to **Note 6** above to calculate the maximum transfer rate under conditions of the customer.

- Caution** Select the TTL input buffer for the RxDq pin and the N-ch open drain output (VDD tolerance (when 30- to 52-pin products)/EVDD tolerance (when 64- to 128-pin products)) mode for the TxDq 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.

In UART communications with devices operating at different voltage levels



Bit width in the UART communications with devices operating at different voltage levels (reference)



Remark 1. $R_b[\Omega]$: Communication line (TxDq) pull-up resistance, $C_b[F]$: Communication line (TxDq) load capacitance, $V_b[V]$: Communication line voltage

Remark 2. q: UART number (q = 0 to 3), g: PIM and POM number (g = 0, 1, 8, 14)

Remark 3. f_{MCK} : Serial array unit operation clock frequency

(To set this operating clock, use the CKSmn bit in the serial mode register mn (SMRmn) (m: Unit number, n: Channel number = 00 to 03, 10 to 13).)

Remark 4. Communications by using UART2 with devices operating at different voltage levels are not possible when the setting of bit 1 (PIOR1) of the peripheral I/O redirection register (PIOR) is 1.

(7) In SPI (CSI) communications in the master mode with devices operating at different voltage levels (2.5 V or 3 V) with the internal SCKp clock (the ratings below are only applicable to CSI00)

(TA = -40 to +105°C, 2.7 V ≤ EVDD0 = EVDD1 ≤ VDD ≤ 5.5 V, VSS = EVSS0 = EVSS1 = 0 V)

(1/2)

Item	Symbol	Conditions		HS (High-Speed Main) Mode		LS (Low-Speed Main) Mode		LP (Low-Power Main) Mode		Unit
				Min.	Max.	Min.	Max.	Min.	Max.	
SCKp cycle time	tkCY1	tkCY1 ≥ 2/fCLK	4.0 V ≤ EVDD0 ≤ 5.5 V, 2.7 V ≤ Vb ≤ 4.0 V, Cb = 20 pF, Rb = 1.4 kΩ	200		200		2300		ns
			2.7 V ≤ EVDD0 < 4.0 V, 2.3 V ≤ Vb ≤ 2.7 V, Cb = 20 pF, Rb = 2.7 kΩ	300		300		2300		ns
SCKp high-level width	tkH1	4.0 V ≤ EVDD0 ≤ 5.5 V, 2.7 V ≤ Vb ≤ 4.0 V, Cb = 20 pF, Rb = 1.4 kΩ		tkCY1/2 - 50		tkCY1/2 - 50		tkCY1/2 - 50		ns
		2.7 V ≤ EVDD0 < 4.0 V, 2.3 V ≤ Vb ≤ 2.7 V, Cb = 20 pF, Rb = 2.7 kΩ		tkCY1/2 - 120		tkCY1/2 - 120		tkCY1/2 - 120		ns
SCKp low-level width	tkL1	4.0 V ≤ EVDD0 ≤ 5.5 V, 2.7 V ≤ Vb ≤ 4.0 V, Cb = 20 pF, Rb = 1.4 kΩ		tkCY1/2 - 7		tkCY1/2 - 7		tkCY1/2 - 50		ns
		2.7 V ≤ EVDD0 < 4.0 V, 2.3 V ≤ Vb ≤ 2.7 V, Cb = 20 pF, Rb = 2.7 kΩ		tkCY1/2 - 10		tkCY1/2 - 10		tkCY1/2 - 50		ns
Slp setup time (to SCKp↑) ^{Note 1}	tSIK1	4.0 V ≤ EVDD0 ≤ 5.5 V, 2.7 V ≤ Vb ≤ 4.0 V, Cb = 20 pF, Rb = 1.4 kΩ		58		58		479		ns
		2.7 V ≤ EVDD0 < 4.0 V, 2.3 V ≤ Vb ≤ 2.7 V, Cb = 20 pF, Rb = 2.7 kΩ		121		121		479		ns
Slp hold time (from SCKp↑) ^{Note 1}	tSIH1	4.0 V ≤ EVDD0 ≤ 5.5 V, 2.7 V ≤ Vb ≤ 4.0 V, Cb = 20 pF, Rb = 1.4 kΩ		10		10		10		ns
		2.7 V ≤ EVDD0 < 4.0 V, 2.3 V ≤ Vb ≤ 2.7 V, Cb = 20 pF, Rb = 2.7 kΩ		10		10		10		ns
Delay time from SCKp↓ to SOp output ^{Note 1}	tkSO1	4.0 V ≤ EVDD0 ≤ 5.5 V, 2.7 V ≤ Vb ≤ 4.0 V, Cb = 20 pF, Rb = 1.4 kΩ			60		60		60	ns
		2.7 V ≤ EVDD0 < 4.0 V, 2.3 V ≤ Vb ≤ 2.7 V, Cb = 20 pF, Rb = 2.7 kΩ			130		130		130	ns

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

(7) In SPI (CSI) communications in the master mode with devices operating at different voltage levels (2.5 V or 3 V) with the internal SCKp clock (the ratings below are only applicable to CSI00)

(TA = -40 to +105°C, 2.7 V ≤ EVDD0 = EVDD1 ≤ VDD ≤ 5.5 V, VSS = EVSS0 = EVSS1 = 0 V)

(2/2)

Item	Symbol	Conditions	HS (High-Speed Main) Mode		LS (Low-Speed Main) Mode		LP (Low-Power Main) Mode		Unit
			Min.	Max.	Min.	Max.	Min.	Max.	
Slp setup time (to SCKp↓) ^{Note 2}	tsIK1	4.0 V ≤ EVDD0 ≤ 5.5 V, 2.7 V ≤ Vb ≤ 4.0 V, Cb = 20 pF, Rb = 1.4 kΩ	23		23		110		ns
		2.7 V ≤ EVDD0 < 4.0 V, 2.3 V ≤ Vb ≤ 2.7 V, Cb = 20 pF, Rb = 2.7 kΩ	33		33		110		ns
Slp hold time (from SCKp↓) ^{Note 2}	tkSI1	4.0 V ≤ EVDD0 ≤ 5.5 V, 2.7 V ≤ Vb ≤ 4.0 V, Cb = 20 pF, Rb = 1.4 kΩ	10		10		10		ns
		2.7 V ≤ EVDD0 < 4.0 V, 2.3 V ≤ Vb ≤ 2.7 V, Cb = 20 pF, Rb = 2.7 kΩ	10		10		10		ns
Delay time from SCKp↑ to SOp output ^{Note 2}	tkSO1	4.0 V ≤ EVDD0 ≤ 5.5 V, 2.7 V ≤ Vb ≤ 4.0 V, Cb = 20 pF, Rb = 1.4 kΩ		10		10		10	ns
		2.7 V ≤ EVDD0 < 4.0 V, 2.3 V ≤ Vb ≤ 2.7 V, Cb = 20 pF, Rb = 2.7 kΩ		10		10		10	ns

Note 1. This setting applies when DAPmn = 0 and CKPmn = 0, or DAPmn = 1 and CKPmn = 1.

Note 2. This setting applies when DAPmn = 0 and CKPmn = 1, or DAPmn = 1 and CKPmn = 0.

Caution Select the TTL input buffer for the Slp pin and the N-ch open drain output (VDD tolerance (when 30- to 52-pin products)/EVDD tolerance (when 64- to 128-pin products)) mode for the SOp pin and SCKp pin by using port input mode register g (PIMg) and port output mode register g (POMg). For VIH and VIL, see the DC characteristics with TTL input buffer selected.

Remark 1. Rb[Ω]: Communication line (SCKp, SOp) pull-up resistance, Cb[F]: Communication line (SCKp, SOp) load capacitance, Vb[V]: Communication line voltage

Remark 2. p: CSI number (p = 00), m: Unit number (m = 0), n: Channel number (n = 0), g: PIM and POM numbers (g = 1)

Remark 3. fMCK: Serial array unit operation clock frequency
(To set this operating clock, use the CKSmn bit in the serial mode register mn (SMRmn) (m: Unit number, n: Channel number = 00).)

Remark 4. The listed times are only valid when the peripheral I/O redirect function of CSI00 is not in use.

(8) In SPI (CSI) communications in the master mode with devices operating at different voltage levels (1.8 V, 2.5 V, or 3 V) with the internal SCKp clock

(TA = -40 to +105°C, 1.8 V ≤ EVDD0 = EVDD1 ≤ VDD ≤ 5.5 V, VSS = EVSS0 = EVSS1 = 0 V)

(1/3)

Item	Symbol	Conditions	HS (High-Speed Main) Mode		LS (Low-Speed Main) Mode		LP (Low-Power Main) Mode		Unit
			Min.	Max.	Min.	Max.	Min.	Max.	
SCKp cycle time	tkCY1	tkCY1 ≥ 4/fCLK 4.0 V ≤ EVDD0 ≤ 5.5 V, 2.7 V ≤ Vb ≤ 4.0 V, Cb = 30 pF, Rb = 1.4 kΩ	300		300		2300		ns
		2.7 V ≤ EVDD0 < 4.0 V, 2.3 V ≤ Vb ≤ 2.7 V, Cb = 30 pF, Rb = 2.7 kΩ	500		500		2300		ns
		1.8 V ≤ EVDD0 < 3.3 V, 1.6 V ≤ Vb ≤ 2.0 V ^{Note} , Cb = 30 pF, Rb = 5.5 kΩ	1150		1150		2300		ns
SCKp high-level width	tkH1	4.0 V ≤ EVDD0 ≤ 5.5 V, 2.7 V ≤ Vb ≤ 4.0 V, Cb = 30 pF, Rb = 1.4 kΩ	tkCY1/2 - 75		tkCY1/2 - 75		tkCY1/2 - 75		ns
		2.7 V ≤ EVDD0 < 4.0 V, 2.3 V ≤ Vb ≤ 2.7 V, Cb = 30 pF, Rb = 2.7 kΩ	tkCY1/2 - 170		tkCY1/2 - 170		tkCY1/2 - 170		ns
		1.8 V ≤ EVDD0 < 3.3 V, 1.6 V ≤ Vb ≤ 2.0 V ^{Note} , Cb = 30 pF, Rb = 5.5 kΩ	tkCY1/2 - 458		tkCY1/2 - 458		tkCY1/2 - 458		ns
SCKp low-level width	tkL1	4.0 V ≤ EVDD0 ≤ 5.5 V, 2.7 V ≤ Vb ≤ 4.0 V, Cb = 30 pF, Rb = 1.4 kΩ	tkCY1/2 - 12		tkCY1/2 - 12		tkCY1/2 - 50		ns
		2.7 V ≤ EVDD0 < 4.0 V, 2.3 V ≤ Vb ≤ 2.7 V, Cb = 30 pF, Rb = 2.7 kΩ	tkCY1/2 - 18		tkCY1/2 - 18		tkCY1/2 - 50		ns
		1.8 V ≤ EVDD0 < 3.3 V, 1.6 V ≤ Vb ≤ 2.0 V ^{Note} , Cb = 30 pF, Rb = 5.5 kΩ	tkCY1/2 - 50		tkCY1/2 - 50		tkCY1/2 - 50		ns

Note Use this setting with EVDD0 ≥ Vb.

Caution Select the TTL input buffer for the SIp pin and the N-ch open drain output (VDD tolerance (when 30- to 52-pin products)/EVDD tolerance (when 64- to 128-pin products)) mode for the SOp pin and SCKp pin by using port input mode register g (PIMg) and port output mode register g (POMg). For VIH and VIL, see the DC characteristics with TTL input buffer selected.

(Remarks are listed two pages after the next page.)

(8) In SPI (CSI) communications in the master mode with devices operating at different voltage levels (1.8 V, 2.5 V, or 3 V) with the internal SCKp clock

(TA = -40 to +105°C, 1.8 V ≤ EVDD0 = EVDD1 ≤ VDD ≤ 5.5 V, VSS = EVSS0 = EVSS1 = 0 V)

(2/3)

Item	Symbol	Conditions	HS (High-Speed Main) Mode		LS (Low-Speed Main) Mode		LP (Low-Power Main) Mode		Unit
			Min.	Max.	Min.	Max.	Min.	Max.	
Slp setup time (to SCKp↑) ^{Note 1}	tsIK1	4.0 V ≤ EVDD0 ≤ 5.5 V, 2.7 V ≤ Vb ≤ 4.0 V, Cb = 30 pF, Rb = 1.4 kΩ	81		81		479		ns
		2.7 V ≤ EVDD0 < 4.0 V, 2.3 V ≤ Vb ≤ 2.7 V, Cb = 30 pF, Rb = 2.7 kΩ	177		177		479		ns
		1.8 V ≤ EVDD0 < 3.3 V, 1.6 V ≤ Vb ≤ 2.0 V ^{Note 2} , Cb = 30 pF, Rb = 5.5 kΩ	479		479		479		ns
Slp hold time (from SCKp↑) ^{Note 1}	tkSI1	4.0 V ≤ EVDD0 ≤ 5.5 V, 2.7 V ≤ Vb ≤ 4.0 V, Cb = 30 pF, Rb = 1.4 kΩ	19		19		19		ns
		2.7 V ≤ EVDD0 < 4.0 V, 2.3 V ≤ Vb ≤ 2.7 V, Cb = 30 pF, Rb = 2.7 kΩ	19		19		19		ns
		1.8 V ≤ EVDD0 < 3.3 V, 1.6 V ≤ Vb ≤ 2.0 V ^{Note 2} , Cb = 30 pF, Rb = 5.5 kΩ	19		19		19		ns
Delay time from SCKp↓ to SOp output ^{Note 1}	tkSO1	4.0 V ≤ EVDD0 ≤ 5.5 V, 2.7 V ≤ Vb ≤ 4.0 V, Cb = 30 pF, Rb = 1.4 kΩ		100		100		100	ns
		2.7 V ≤ EVDD0 < 4.0 V, 2.3 V ≤ Vb ≤ 2.7 V, Cb = 30 pF, Rb = 2.7 kΩ		195		195		195	ns
		1.8 V ≤ EVDD0 < 3.3 V, 1.6 V ≤ Vb ≤ 2.0 V ^{Note 2} , Cb = 30 pF, Rb = 5.5 kΩ		483		483		483	ns

Note 1. This setting applies when DAPmn = 0 and CKPmn = 0, or DAPmn = 1 and CKPmn = 1.

Note 2. Use this setting with EVDD0 ≥ Vb.

Caution Select the TTL input buffer for the Slp pin and the N-ch open drain output (VDD tolerance (when 30- to 52-pin products)/EVDD tolerance (when 64- to 128-pin products)) mode for the SOp pin and SCKp pin by using port input mode register g (PIMg) and port output mode register g (POMg). For VIH and VIL, see the DC characteristics with TTL input buffer selected.

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

(8) In SPI (CSI) communications in the master mode with devices operating at different voltage levels (1.8 V, 2.5 V, or 3 V) with the internal SCKp clock

(TA = -40 to +105°C, 1.8 V ≤ EVDD0 = EVDD1 ≤ VDD ≤ 5.5 V, VSS = EVSS0 = EVSS1 = 0 V)

(3/3)

Item	Symbol	Conditions	HS (High-Speed Main) Mode		LS (Low-Speed Main) Mode		LP (Low-Power Main) Mode		Unit
			Min.	Max.	Min.	Max.	Min.	Max.	
Slp setup time (to SCKp↓) ^{Note 1}	tsIK1	4.0 V ≤ EVDD0 ≤ 5.5 V, 2.7 V ≤ Vb ≤ 4.0 V, Cb = 30 pF, Rb = 1.4 kΩ	44		44		110		ns
		2.7 V ≤ EVDD0 < 4.0 V, 2.3 V ≤ Vb ≤ 2.7 V, Cb = 30 pF, Rb = 2.7 kΩ	44		44		110		ns
		1.8 V ≤ EVDD0 < 3.3 V, 1.6 V ≤ Vb ≤ 2.0 V ^{Note 2} , Cb = 30 pF, Rb = 5.5 kΩ	110		110		110		ns
Slp hold time (from SCKp↓) ^{Note 1}	tKSI1	4.0 V ≤ EVDD0 ≤ 5.5 V, 2.7 V ≤ Vb ≤ 4.0 V, Cb = 30 pF, Rb = 1.4 kΩ	19		19		19		ns
		2.7 V ≤ EVDD0 < 4.0 V, 2.3 V ≤ Vb ≤ 2.7 V, Cb = 30 pF, Rb = 2.7 kΩ	19		19		19		ns
		1.8 V ≤ EVDD0 < 3.3 V, 1.6 V ≤ Vb ≤ 2.0 V ^{Note 2} , Cb = 30 pF, Rb = 5.5 kΩ	19		19		19		ns
Delay time from SCKp↑ to SOp output ^{Note 1}	tKSO1	4.0 V ≤ EVDD0 ≤ 5.5 V, 2.7 V ≤ Vb ≤ 4.0 V, Cb = 30 pF, Rb = 1.4 kΩ		25		25		25	ns
		2.7 V ≤ EVDD0 < 4.0 V, 2.3 V ≤ Vb ≤ 2.7 V, Cb = 30 pF, Rb = 2.7 kΩ		25		25		25	ns
		1.8 V ≤ EVDD0 < 3.3 V, 1.6 V ≤ Vb ≤ 2.0 V ^{Note 2} , Cb = 30 pF, Rb = 5.5 kΩ		25		25		25	ns

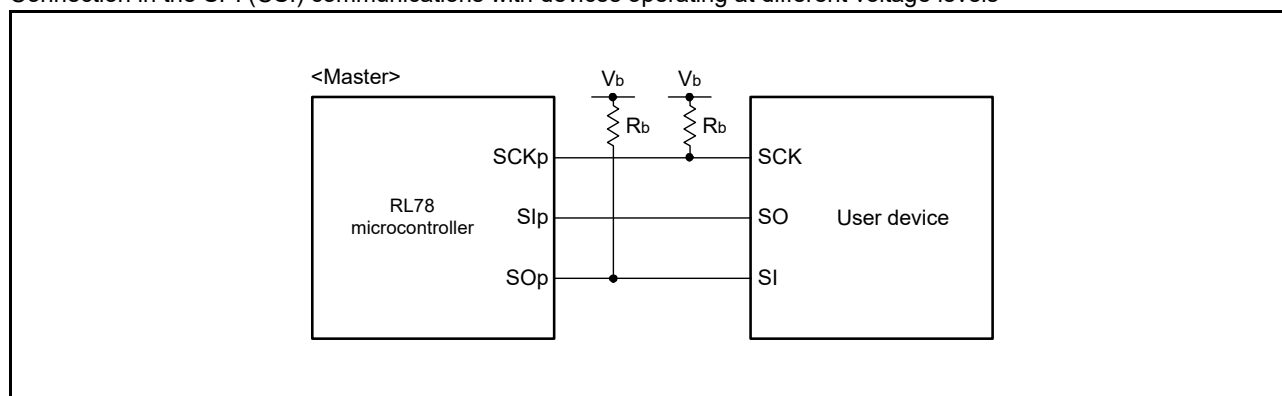
Note 1. This setting applies when DAPmn = 0 and CKPmn = 1, or DAPmn = 1 and CKPmn = 0.

Note 2. Use this setting with EVDD0 ≥ Vb.

Caution Select the TTL input buffer for the Slp pin and the N-ch open drain output (VDD tolerance (when 30- to 52-pin products)/EVDD tolerance (when 64- to 128-pin products)) mode for the SOp pin and SCKp pin by using port input mode register g (PIMg) and port output mode register g (POMg). For VIH and VIL, see the DC characteristics with TTL input buffer selected.

(Remarks are listed on the next page.)

Connection in the SPI (CSI) communications with devices operating at different voltage levels



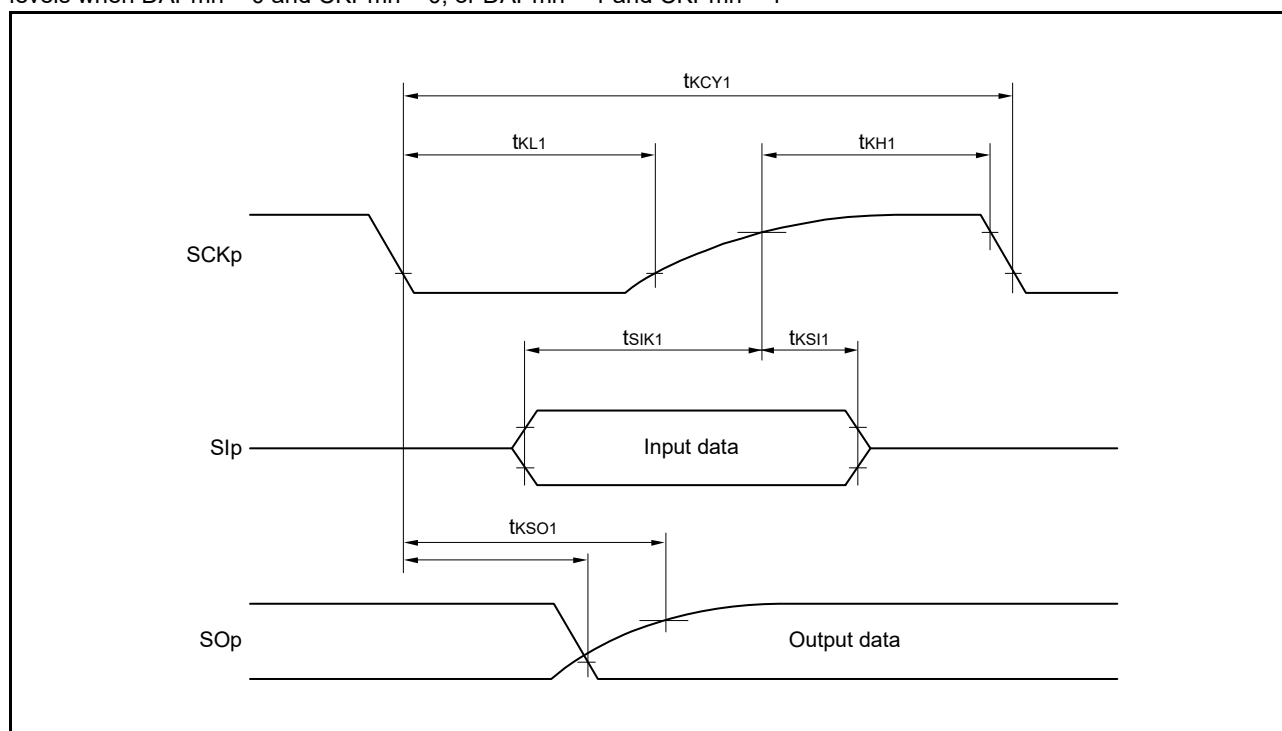
Remark 1. $R_b[\Omega]$: Communication line (SCKp, SOp) pull-up resistance, $C_b[F]$: Communication line (SCKp, SOp) load capacitance, $V_b[V]$: Communication line voltage

Remark 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)

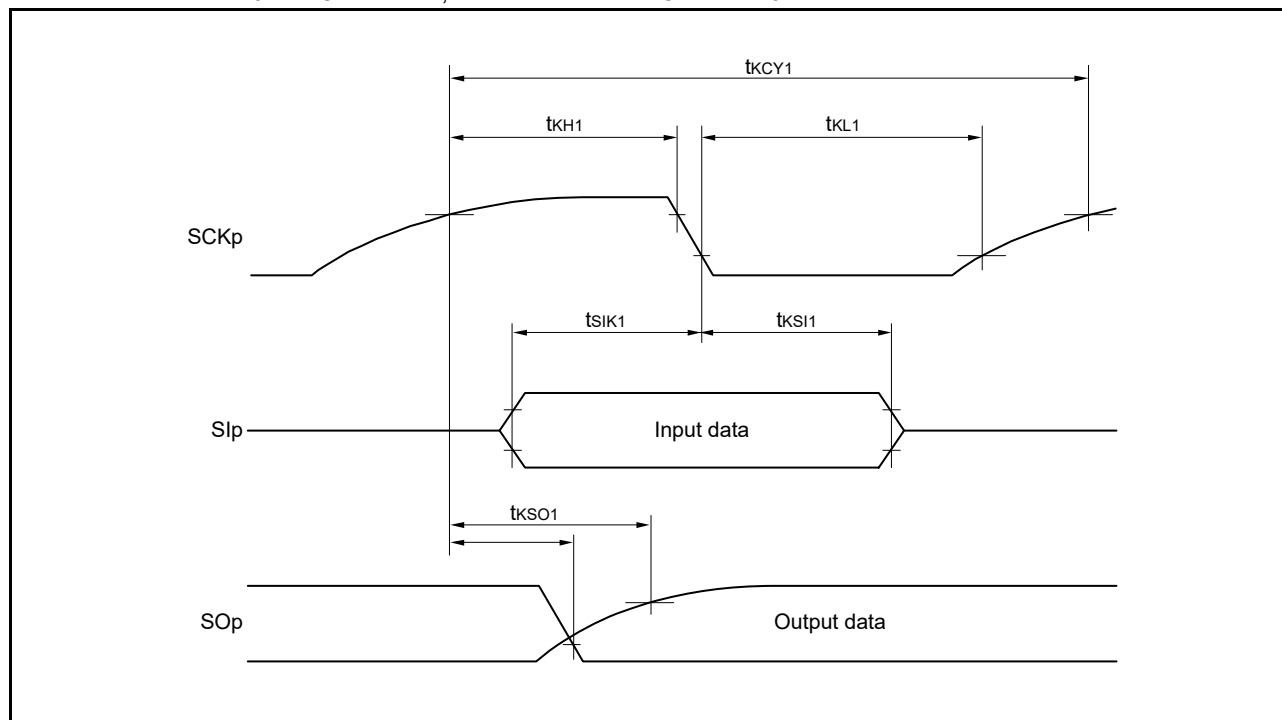
Remark 3. f_{MCK} : Serial array unit operation clock frequency

(To set this operating clock, use the CKSmn bit in the serial mode register mn (SMRmn) (m: Unit number, n: Channel number = 00).)

Remark 4. Communications by using CSI01 of 48-, 52-, and 64-pin products, and CSI11 and CSI21 with devices operating at different voltage levels are not possible. Use other CSI channels to handle such communications.

Timing of serial transfer in the SPI (CSI) communications in the master mode with devices operating at different voltage levels when $DAPmn = 0$ and $CKPmn = 0$, or $DAPmn = 1$ and $CKPmn = 1$ 

Timing of serial transfer in the SPI (CSI) communications in the master mode with devices operating at different voltage levels when $\text{DAPmn} = 0$ and $\text{CKPmn} = 1$, or $\text{DAPmn} = 1$ and $\text{CKPmn} = 0$



Remark 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 ($g = 0, 1, 4, 5, 8, 14$)

Remark 2. Communications by using CSI01 of 48-, 52-, and 64-pin products, and CSI11 and CSI21 with devices operating at different voltage levels are not possible. Use other CSI channels to handle such communications.

- (9) In SPI (CSI) communications in the slave mode with devices operating at different voltage levels (1.8 V, 2.5 V, or 3 V) with the external SCKp clock

(TA = -40 to +105°C, 1.8 V ≤ EVDD0 = EVDD1 ≤ VDD ≤ 5.5 V, VSS = EVSS0 = EVSS1 = 0 V)

(1/2)

Item	Symbol	Conditions		HS (High-Speed Main) Mode		LS (Low-Speed Main) Mode		LP (Low-Power Main) Mode		Unit
				Min.	Max.	Min.	Max.	Min.	Max.	
SCKp cycle time Note 1	tkCY2	4.0 V ≤ EVDD0 ≤ 5.5 V, 2.7 V ≤ Vb ≤ 4.0 V	24 MHz < fMCK	14/fMCK		—		—		ns
			20 MHz < fMCK ≤ 24 MHz	12/fMCK		12/fMCK		—		ns
			8 MHz < fMCK ≤ 20 MHz	10/fMCK		10/fMCK		—		ns
			4 MHz < fMCK ≤ 8 MHz	8/fMCK		8/fMCK		—		ns
			fMCK ≤ 4 MHz	6/fMCK		6/fMCK		10/fMCK		ns
		2.7 V ≤ EVDD0 < 4.0 V, 2.3 V ≤ Vb ≤ 2.7 V,	24 MHz < fMCK	20/fMCK		—		—		ns
			20 MHz < fMCK ≤ 24 MHz	16/fMCK		16/fMCK		—		ns
			16 MHz < fMCK ≤ 20 MHz	14/fMCK		14/fMCK		—		ns
			8 MHz < fMCK ≤ 16 MHz	12/fMCK		12/fMCK		—		ns
			4 MHz < fMCK ≤ 8 MHz	8/fMCK		8/fMCK		—		ns
			fMCK ≤ 4 MHz	6/fMCK		6/fMCK		10/fMCK		ns
		1.8 V ≤ EVDD0 < 3.3 V, 1.6 V ≤ Vb ≤ 2.0 V Note 2	24 MHz < fMCK	48/fMCK		—		—		ns
			20 MHz < fMCK ≤ 24 MHz	36/fMCK		36/fMCK		—		ns
			16 MHz < fMCK ≤ 20 MHz	32/fMCK		32/fMCK		—		ns
			8 MHz < fMCK ≤ 16 MHz	26/fMCK		26/fMCK		—		ns
			4 MHz < fMCK ≤ 8 MHz	16/fMCK		16/fMCK		—		ns
			fMCK ≤ 4 MHz	10/fMCK		10/fMCK		10/fMCK		ns

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

- (9) In SPI (CSI) communications in the slave mode with devices operating at different voltage levels (1.8 V, 2.5 V, or 3 V) with the external SCKp clock

(TA = -40 to +105°C, 1.8 V ≤ EVDD0 = EVDD1 ≤ VDD ≤ 5.5 V, VSS = EVSS0 = EVSS1 = 0 V)

(2/2)

Item	Symbol	Conditions	HS (High-Speed Main) Mode		LS (Low-Speed Main) Mode		LP (Low-Power Main) Mode		Unit
			Min.	Max.	Min.	Max.	Min.	Max.	
SCKp high-/low-level width	tkH2, tkL2	4.0 V ≤ EVDD0 ≤ 5.5 V, 2.7 V ≤ Vb ≤ 4.0 V	tkCY2/2 - 12		tkCY2/2 - 12		tkCY2/2 - 50		ns
		2.7 V ≤ EVDD0 < 4.0 V, 2.3 V ≤ Vb ≤ 2.7 V	tkCY2/2 - 18		tkCY2/2 - 18		tkCY2/2 - 50		ns
		1.8 V ≤ EVDD0 < 3.3 V, 1.6 V ≤ Vb ≤ 2.0 V ^{Note 2}	tkCY2/2 - 50		tkCY2/2 - 50		tkCY2/2 - 50		ns
Slp setup time (to SCKp↑) ^{Note 3}	tSIK2	4.0 V ≤ EVDD0 ≤ 5.5 V, 2.7 V ≤ Vb ≤ 4.0 V	1/fMCK + 20		1/fMCK + 20		1/fMCK + 30		ns
		2.7 V ≤ EVDD0 < 4.0 V, 2.3 V ≤ Vb ≤ 2.7 V	1/fMCK + 20		1/fMCK + 20		1/fMCK + 30		ns
		1.8 V ≤ EVDD0 < 3.3 V, 1.6 V ≤ Vb ≤ 2.0 V ^{Note 2}	1/fMCK + 30		1/fMCK + 30		1/fMCK + 30		ns
Slp hold time (from SCKp↑) ^{Note 3}	tSI2		1/fMCK + 31		1/fMCK + 31		1/fMCK + 31		ns
Delay time from SCKp↓ to SOp output ^{Note 4}	tkSO2	4.0 V ≤ EVDD0 ≤ 5.5 V, 2.7 V ≤ Vb ≤ 4.0 V, Cb = 30 pF, Rb = 1.4 kΩ		2/fMCK + 120		2/fMCK + 120		2/fMCK + 573	ns
		2.7 V ≤ EVDD0 < 4.0 V, 2.3 V ≤ Vb ≤ 2.7 V, Cb = 30 pF, Rb = 2.7 kΩ		2/fMCK + 214		2/fMCK + 214		2/fMCK + 573	ns
		1.8 V ≤ EVDD0 < 3.3 V, 1.6 V ≤ Vb ≤ 2.0 V ^{Note 2} , Cb = 30 pF, Rb = 5.5 kΩ		2/fMCK + 573		2/fMCK + 573		2/fMCK + 573	ns

Note 1. Transfer rate in the SNOOZE mode: 1 Mbps (max.)

Note 2. Use this setting with EVDD0 ≥ Vb.

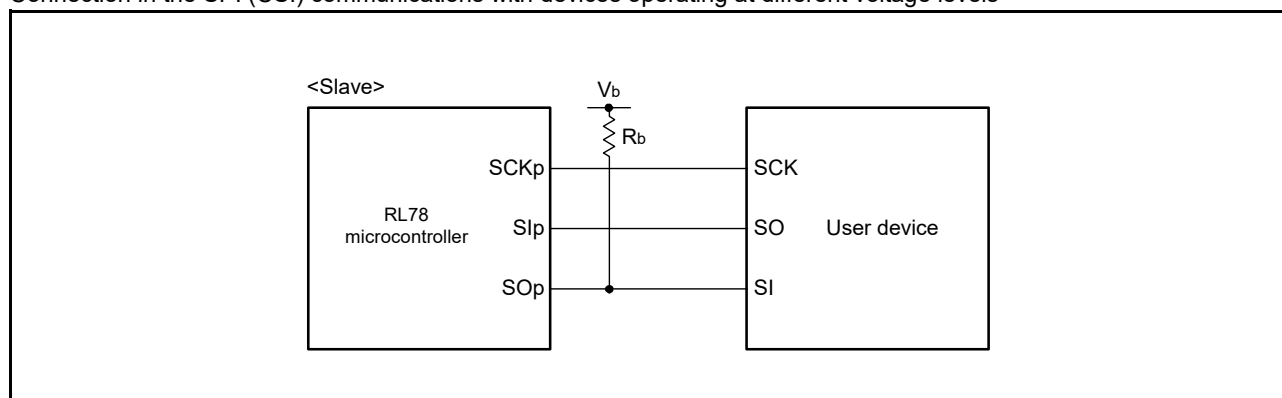
Note 3. This setting applies when DAPmn = 0 and CKPmn = 0, or DAPmn = 1 and CKPmn = 1. The Slp setup time becomes "to SCKp↓" and Slp hold time becomes "from SCKp↓" when DAPmn = 0 and CKPmn = 1, or DAPmn = 1 and CKPmn = 0.

Note 4. This setting applies when DAPmn = 0 and CKPmn = 0, or DAPmn = 1 and CKPmn = 1. The delay time to SOp output becomes "from SCKp↑" when DAPmn = 0 and CKPmn = 1, or DAPmn = 1 and CKPmn = 0.

Caution Select the TTL input buffer for the Slp pin and the N-ch open drain output (VDD tolerance (for the 30- to 52-pin products)/EVDD tolerance (for the 64- to 128-pin products)) mode for the SOp pin and SCKp pin by using port input mode register g (PIMg) and port output mode register g (POMg). For VIH and VIL, see the DC characteristics with TTL input buffer selected.

(Remarks are listed on the next page.)

Connection in the SPI (CSI) communications with devices operating at different voltage levels



Remark 1. $R_b[Q]$: Communication line (SO_p) pull-up resistance, $C_b[F]$: Communication line (SO_p) load capacitance, $V_b[V]$: Communication line voltage

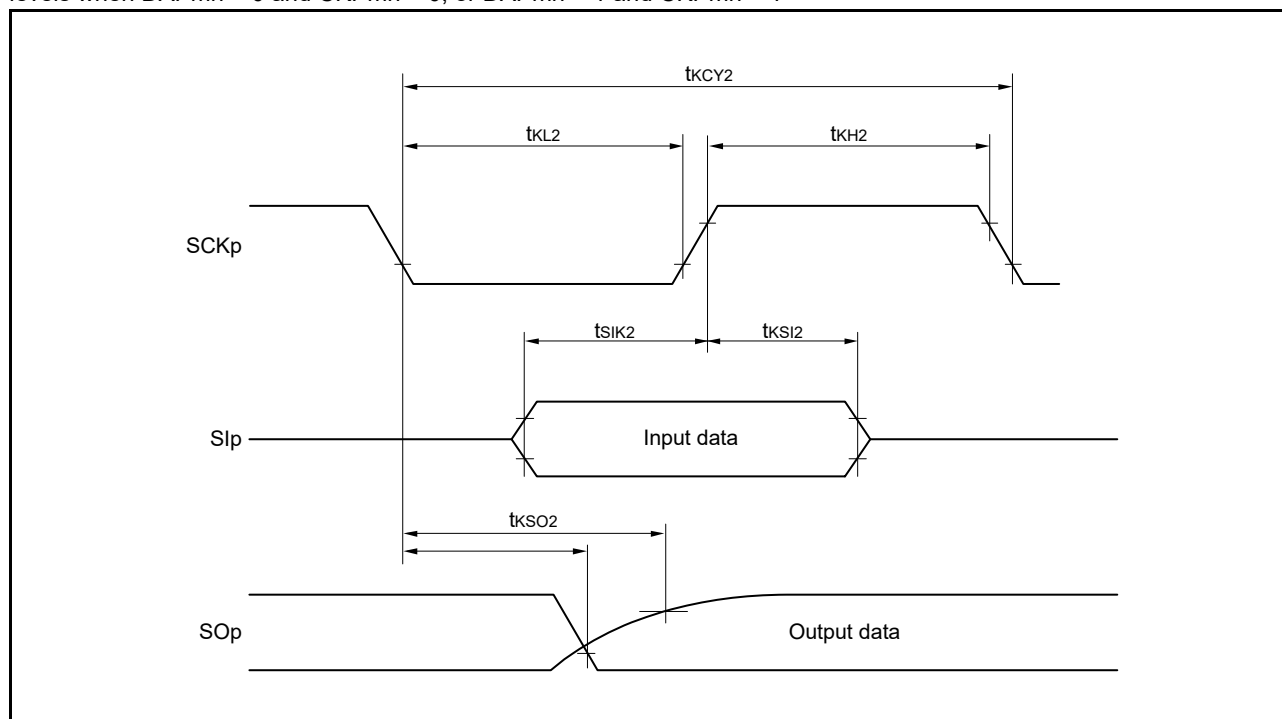
Remark 2. p: CSI number (p = 00, 01, 10, 20, 30, 31), m: Unit number, n: Channel number (mn = 00, 01, 02, 10, 12, 13), g: PIM and POM number (g = 0, 1, 4, 5, 8, 14)

Remark 3. f_{MCK} : Serial array unit operation clock frequency

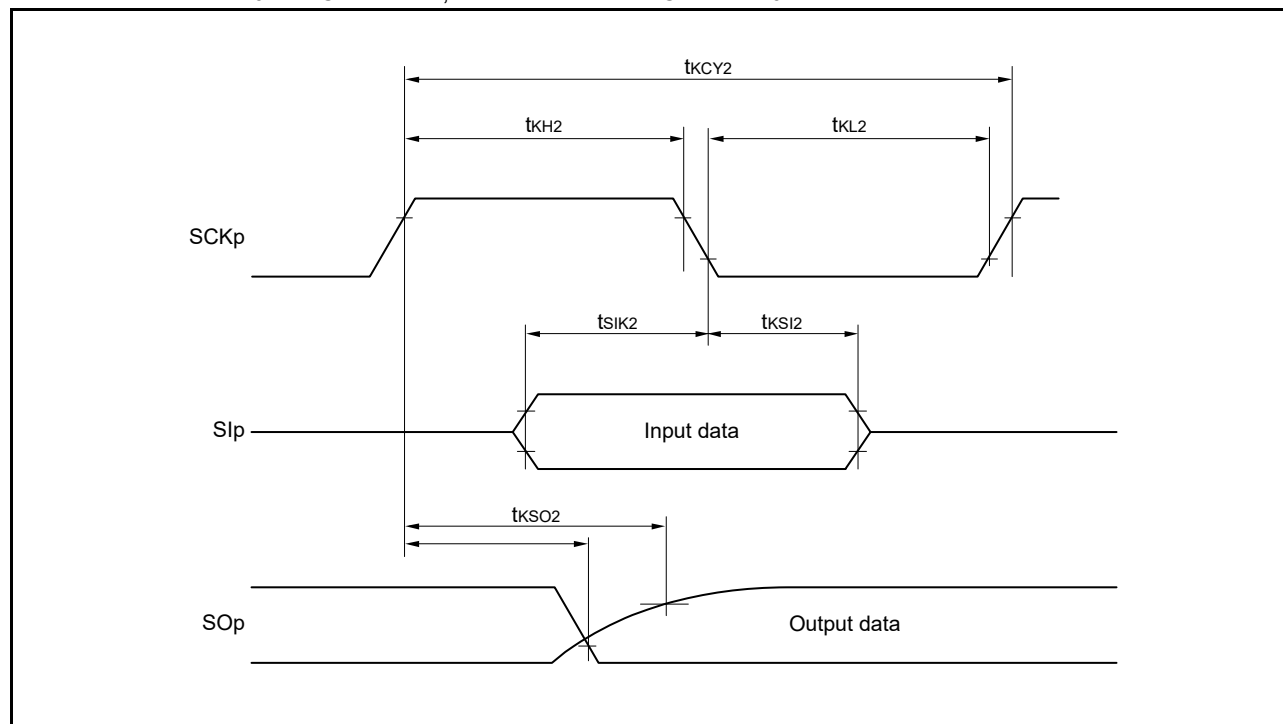
(To set this operating clock, use the CKSmn bit in the serial mode register mn (SMRmn) (m: Unit number, n: Channel number = 00, 01, 02, 10, 12 and 13).)

Remark 4. Communications by using CSI01 of 48-, 52-, and 64-pin products, and CSI11 and CSI21 with devices operating at different voltage levels are not possible. Use other CSI channels to handle such communications.

Timing of serial transfer in the SPI (CSI) communications in the slave mode with devices operating at different voltage levels when DAPmn = 0 and CKPmn = 0, or DAPmn = 1 and CKPmn = 1



Timing of serial transfer in the SPI (CSI) communications in the slave mode with devices operating at different voltage levels when $\text{DAPmn} = 0$ and $\text{CKPmn} = 1$, or $\text{DAPmn} = 1$ and $\text{CKPmn} = 0$



Remark 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 ($g = 0, 1, 4, 5, 8, 14$)

Remark 2. Communications by using CSI01 of 48-, 52-, and 64-pin products, and CSI11 and CSI21 with devices operating at different voltage levels are not possible. Use other CSI channels to handle such communications.

(10) Simplified I²C communications with devices operating at different voltage levels (1.8 V, 2.5 V, or 3 V)

(TA = -40 to +105°C, 1.8 V ≤ EVDD0 = EVDD1 ≤ VDD ≤ 5.5 V, VSS = EVSS0 = EVSS1 = 0 V)

(1/2)

Item	Symbol	Conditions	HS (High-Speed Main) Mode		LS (Low-Speed Main) Mode		LP (Low-Power Main) Mode		Unit
			Min.	Max.	Min.	Max.	Min.	Max.	
SCLr clock frequency	fSCL	4.0 V ≤ EVDD0 ≤ 5.5 V, 2.7 V ≤ Vb ≤ 4.0 V, Cb = 50 pF, Rb = 2.7 kΩ		1000 Note 1		1000 Note 1		300 Note 1	kHz
		2.7 V ≤ EVDD0 < 4.0 V, 2.3 V ≤ Vb ≤ 2.7 V, Cb = 50 pF, Rb = 2.7 kΩ		1000 Note 1		1000 Note 1		300 Note 1	kHz
		4.0 V ≤ EVDD0 ≤ 5.5 V, 2.7 V ≤ Vb ≤ 4.0 V, Cb = 100 pF, Rb = 2.8 kΩ		400 Note 1		400 Note 1		300 Note 1	kHz
		2.7 V ≤ EVDD0 < 4.0 V, 2.3 V ≤ Vb ≤ 2.7 V, Cb = 100 pF, Rb = 2.7 kΩ		400 Note 1		400 Note 1		300 Note 1	kHz
		1.8 V ≤ EVDD0 < 3.3 V, 1.6 V ≤ Vb ≤ 2.0 V ^{Note 2} , Cb = 100 pF, Rb = 5.5 kΩ		300 Note 1		300 Note 1		300 Note 1	kHz
Hold time when SCLr is low	tLOW	4.0 V ≤ EVDD0 ≤ 5.5 V, 2.7 V ≤ Vb ≤ 4.0 V, Cb = 50 pF, Rb = 2.7 kΩ	475		475		1550		ns
		2.7 V ≤ EVDD0 < 4.0 V, 2.3 V ≤ Vb ≤ 2.7 V, Cb = 50 pF, Rb = 2.7 kΩ	475		475		1550		ns
		4.0 V ≤ EVDD0 ≤ 5.5 V, 2.7 V ≤ Vb ≤ 4.0 V, Cb = 100 pF, Rb = 2.8 kΩ	1150		1550		1550		ns
		2.7 V ≤ EVDD0 < 4.0 V, 2.3 V ≤ Vb ≤ 2.7 V, Cb = 100 pF, Rb = 2.7 kΩ	1150		1550		1550		ns
		1.8 V ≤ EVDD0 < 3.3 V, 1.6 V ≤ Vb ≤ 2.0 V ^{Note 2} , Cb = 100 pF, Rb = 5.5 kΩ	1550		1550		1550		ns
Hold time when SCLr is high	tHIGH	4.0 V ≤ EVDD0 ≤ 5.5 V, 2.7 V ≤ Vb ≤ 4.0 V, Cb = 50 pF, Rb = 2.7 kΩ	245		245		610		ns
		2.7 V ≤ EVDD0 < 4.0 V, 2.3 V ≤ Vb ≤ 2.7 V, Cb = 50 pF, Rb = 2.7 kΩ	200		200		610		ns
		4.0 V ≤ EVDD0 ≤ 5.5 V, 2.7 V ≤ Vb ≤ 4.0 V, Cb = 100 pF, Rb = 2.8 kΩ	675		675		610		ns
		2.7 V ≤ EVDD0 < 4.0 V, 2.3 V ≤ Vb ≤ 2.7 V, Cb = 100 pF, Rb = 2.7 kΩ	600		600		610		ns
		1.8 V ≤ EVDD0 < 3.3 V, 1.6 V ≤ Vb ≤ 2.0 V ^{Note 2} , Cb = 100 pF, Rb = 5.5 kΩ	610		610		610		ns

(10) Simplified I²C communications with devices operating at different voltage levels (1.8 V, 2.5 V, and 3 V)

(TA = -40 to +105°C, 1.8 V ≤ EVDD0 = EVDD1 ≤ VDD ≤ 5.5 V, VSS = EVSS0 = EVSS1 = 0 V)

(2/2)

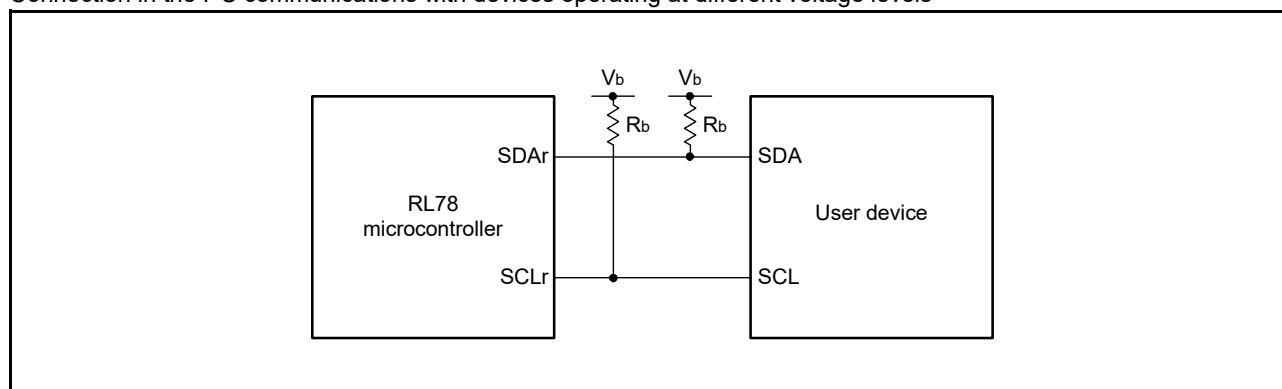
Item	Symbol	Conditions	HS (High-Speed Main) Mode		LS (Low-Speed Main) Mode		LP (Low-Power Main) Mode		Unit
			Min.	Max.	Min.	Max.	Min.	Max.	
Data setup time (reception)	tsu:DAT	4.0 V ≤ EVDD0 ≤ 5.5 V, 2.7 V ≤ Vb ≤ 4.0 V, Cb = 50 pF, Rb = 2.7 kΩ	1/fMCK + 135 Note 3		1/fMCK + 135 Note 3		1/fMCK + 190 Note 3		ns
		2.7 V ≤ EVDD0 < 4.0 V, 2.3 V ≤ Vb ≤ 2.7 V, Cb = 50 pF, Rb = 2.7 kΩ	1/fMCK + 135 Note 3		1/fMCK + 135 Note 3		1/fMCK + 190 Note 3		ns
		4.0 V ≤ EVDD0 ≤ 5.5 V, 2.7 V ≤ Vb ≤ 4.0 V, Cb = 100 pF, Rb = 2.8 kΩ	1/fMCK + 190 Note 3		1/fMCK + 190 Note 3		1/fMCK + 190 Note 3		ns
		2.7 V ≤ EVDD0 < 4.0 V, 2.3 V ≤ Vb ≤ 2.7 V, Cb = 100 pF, Rb = 2.7 kΩ	1/fMCK + 190 Note 3		1/fMCK + 190 Note 3		1/fMCK + 190 Note 3		ns
		1.8 V ≤ EVDD0 < 3.3 V, 1.6 V ≤ Vb ≤ 2.0 V>Note 2, Cb = 100 pF, Rb = 5.5 kΩ	1/fMCK + 190 Note 3		1/fMCK + 190 Note 3		1/fMCK + 190 Note 3		ns
Data hold time (transmission)	thd:DAT	4.0 V ≤ EVDD0 ≤ 5.5 V, 2.7 V ≤ Vb ≤ 4.0 V, Cb = 50 pF, Rb = 2.7 kΩ	0	305	0	305	0	305	ns
		2.7 V ≤ EVDD0 < 4.0 V, 2.3 V ≤ Vb ≤ 2.7 V, Cb = 50 pF, Rb = 2.7 kΩ	0	305	0	305	0	305	ns
		4.0 V ≤ EVDD0 ≤ 5.5 V, 2.7 V ≤ Vb ≤ 4.0 V, Cb = 100 pF, Rb = 2.8 kΩ	0	355	0	355	0	355	ns
		2.7 V ≤ EVDD0 < 4.0 V, 2.3 V ≤ Vb ≤ 2.7 V, Cb = 100 pF, Rb = 2.7 kΩ	0	355	0	355	0	355	ns
		1.8 V ≤ EVDD0 < 3.3 V, 1.6 V ≤ Vb ≤ 2.0 V>Note 2, Cb = 100 pF, Rb = 5.5 kΩ	0	405	0	405	0	405	ns

Note 1. The listed times must be no greater than fMCK/4.**Note 2.** Use this setting with EVDD0 ≥ Vb.**Note 3.** Set fMCK so that it will not exceed the hold time when SCLr is low or high.

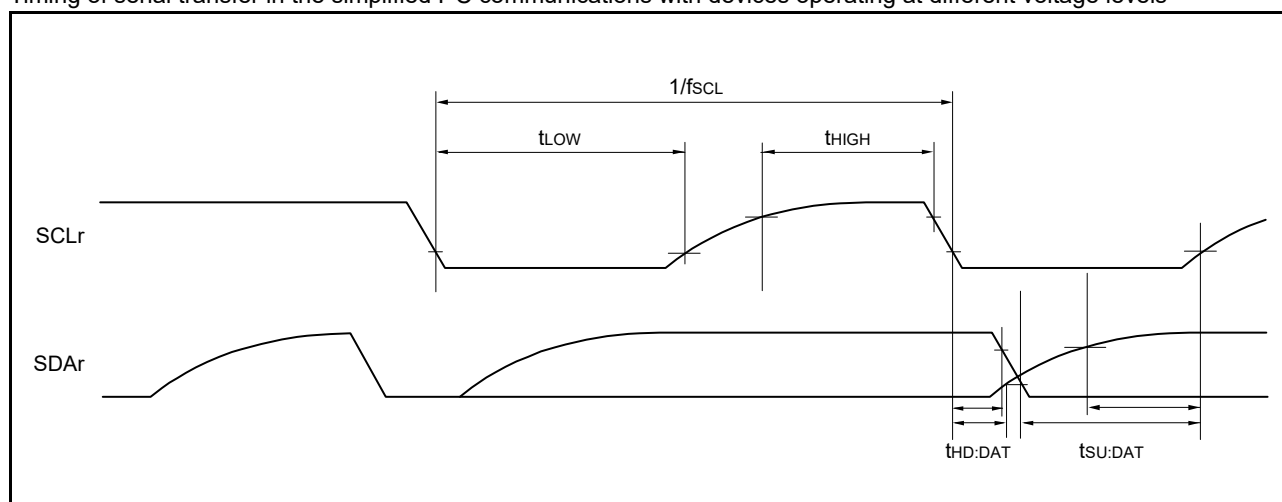
Caution Select the TTL input buffer and the N-ch open drain output (VDD tolerance (for the 30- to 52-pin products)/EVDD tolerance (for the 64- to 128-pin products)) mode for the SDAr pin and the N-ch open drain output (VDD tolerance (for the 30- to 52-pin products)/EVDD tolerance (for the 64- to 128-pin products)) mode for the SCLr pin by using port input mode register g (PIMg) and port output mode register g (POMg). For VIH and VIL, see the DC characteristics with TTL input buffer selected.

(Remarks are listed on the next page.)

Connection in the I²C communications with devices operating at different voltage levels



Timing of serial transfer in the simplified I²C communications with devices operating at different voltage levels



Remark 1. $R_b[\Omega]$: Communication line (SDAr, SCLr) pull-up resistance, $C_b[F]$: Communication line (SDAr, SCLr) load capacitance, $V_b[V]$: Communication line voltage

Remark 2. r: IIC number (r = 00, 01, 10, 20, 30, 31), g: PIM and POM number (g = 0, 1, 4, 5, 8, 14)

Remark 3. f_{MCK} : Serial array unit operation clock frequency

(To set this operating clock, use the CKSMn bit in the serial mode register mn (SMRmn) (m: Unit number, n: Channel number = 00, 01, 02, 10, 12 and 13).)

2.5.2 Serial interface UARTA

($T_A = -40$ to $+105^{\circ}\text{C}$, $1.6\text{ V} \leq \text{EVDD0} = \text{EVDD1} \leq \text{VDD} \leq 5.5\text{ V}$, $\text{VSS} = \text{EVSS0} = \text{EVSS1} = 0\text{ V}$)

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
Transfer rate			200	0	19200	bps

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

Remark g: PIM number (g = 3, 4, 7, 8), h: POM number (h = 3, 4, 7, 8, 12)

2.5.3 Serial interface IICA

(1) I²C standard mode

($T_A = -40$ to $+105^{\circ}\text{C}$, $1.6\text{ V} \leq \text{EVDD0} = \text{EVDD1} \leq \text{VDD} \leq 5.5\text{ V}$, $\text{VSS} = \text{EVSS0} = \text{EVSS1} = 0\text{ V}$)

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
SCLA0 clock frequency	fSCL	Standard mode: fCLK $\geq 1\text{ MHz}$	0		100	kHz
Setup time of restart condition	tSU:STA		4.7			μs
Hold time ^{Note 1}	tHD:STA		4.0			μs
Hold time when SCLA0 is low	tLOW		4.7			μs
Hold time when SCLA0 is high	tHIGH		4.0			μs
Data setup time (reception)	tSU:DAT		250			ns
Data hold time (transmission) ^{Note 2}	tHD:DAT		0		3.45	μs
Setup time of stop condition	tSU:STO		4.0			μs
Bus-free time	tBUF		4.7			μs

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

Note 2. The maximum value of tHD:DAT applies to normal transfer. The clock stretching will be inserted on reception of an acknowledgment (ACK) signal.

Caution The listed frequency and times apply even when bit 2 (PIOR2) in the peripheral I/O redirection register (PIOR) is 1. In such cases, the pin characteristics (IOH1, IOL1, VOH1, VOL1) must satisfy the values in the redirect destination.

Remark The maximum value of communication line capacitance (C_b) and communication line pull-up resistor (R_b) are as follows.
 $C_b = 400\text{ pF}$, $R_b = 2.7\text{ k}\Omega$

(2) I²C fast mode

(TA = -40 to +105°C, 1.6 V ≤ EVDD0 = EVDD1 ≤ VDD ≤ 5.5 V, VSS = EVSS0 = EVSS1 = 0 V)

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
SCLA0 clock frequency	fSCL	Fast mode: fCLK ≥ 3.5 MHz 1.8 V ≤ EVDD0 ≤ 5.5 V	0		400	kHz
Setup time of restart condition	tSU:STA	1.8 V ≤ EVDD0 ≤ 5.5 V	0.6			μs
Hold time ^{Note 1}	tHD:STA	1.8 V ≤ EVDD0 ≤ 5.5 V	0.6			μs
Hold time when SCLA0 is low	tLOW	1.8 V ≤ EVDD0 ≤ 5.5 V	1.3			μs
Hold time when SCLA0 is high	tHIGH	1.8 V ≤ EVDD0 ≤ 5.5 V	0.6			μs
Data setup time (reception)	tSU:DAT	1.8 V ≤ EVDD0 ≤ 5.5 V	100			ns
Data hold time (transmission) ^{Note 2}	tHD:DAT	1.8 V ≤ EVDD0 ≤ 5.5 V	0		0.9	μs
Setup time of stop condition	tSU:STO	1.8 V ≤ EVDD0 ≤ 5.5 V	0.6			μs
Bus-free time	tBUF	1.8 V ≤ EVDD0 ≤ 5.5 V	1.3			μs

Note 1. The first clock pulse is generated after this period when the start or restart condition is detected.**Note 2.** The maximum value of tHD:DAT applies to normal transfer. The clock stretching will be inserted on reception of an acknowledgment (ACK) signal.**Caution** The values in the above table apply even when bit 2 (PIOR2) in the peripheral I/O redirection register (PIOR) is 1. In such cases, the pin characteristics (IOH1, IOL1, VOH1, VOL1) must satisfy the values in the redirect destination.**Remark** The maximum value of communication line capacitance (Cb) and communication line pull-up resistor (Rb) are as follows.
Cb = 320 pF, Rb = 1.1 kΩ

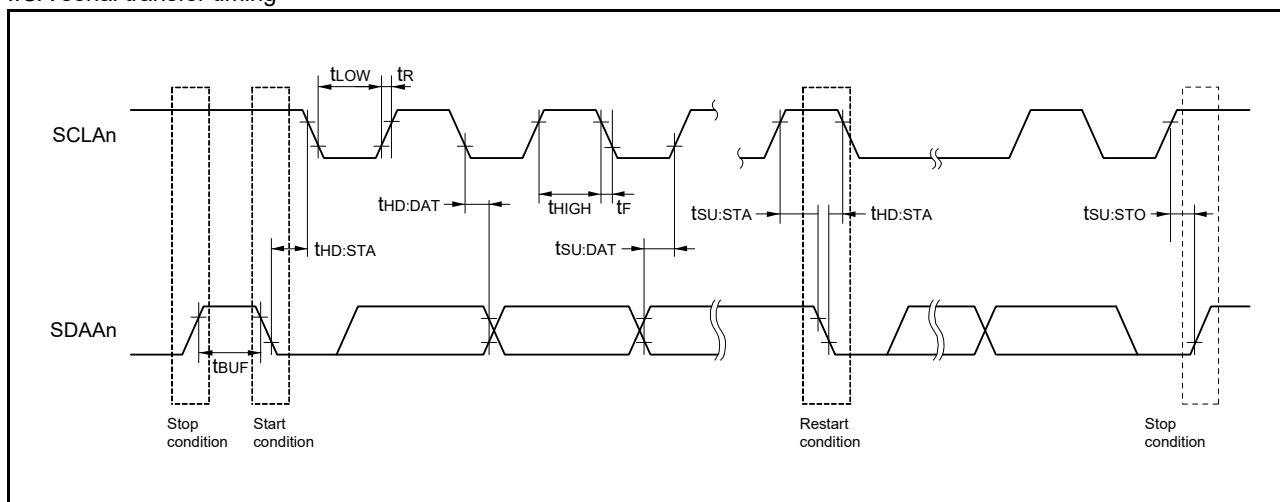
(3) I²C fast mode plus

(TA = -40 to +105°C, 1.6 V ≤ EVDD0 = EVDD1 ≤ VDD ≤ 5.5 V, VSS = EVSS0 = EVSS1 = 0 V)

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
SCLA0 clock frequency	fSCL	Fast mode plus: fCLK ≥ 10 MHz 2.7 V ≤ EVDD0 ≤ 5.5 V	0		1000	kHz
Setup time of restart condition	tSU:STA	2.7 V ≤ EVDD0 ≤ 5.5 V	0.26			μs
Hold time ^{Note 1}	tHD:STA	2.7 V ≤ EVDD0 ≤ 5.5 V	0.26			μs
Hold time when SCLA0 is low	tLOW	2.7 V ≤ EVDD0 ≤ 5.5 V	0.5			μs
Hold time when SCLA0 is high	tHIGH	2.7 V ≤ EVDD0 ≤ 5.5 V	0.26			μs
Data setup time (reception)	tSU:DAT	2.7 V ≤ EVDD0 ≤ 5.5 V	50			ns
Data hold time (transmission) ^{Note 2}	tHD:DAT	2.7 V ≤ EVDD0 ≤ 5.5 V	0		0.45	μs
Setup time of stop condition	tSU:STO	2.7 V ≤ EVDD0 ≤ 5.5 V	0.26			μs
Bus-free time	tBUF	2.7 V ≤ EVDD0 ≤ 5.5 V	0.5			μs

Note 1. The first clock pulse is generated after this period when the start or restart condition is detected.**Note 2.** The maximum value of tHD:DAT applies to normal transfer. The clock stretching will be inserted on reception of an acknowledgment (ACK) signal.**Caution** The values in the above table apply even when bit 2 (PIOR2) in the peripheral I/O redirection register (PIOR) is 1. In such cases, the pin characteristics (IOH1, IOL1, VOH1, VOL1) must satisfy the values in the redirect destination.**Remark** The maximum value of communication line capacitance (Cb) and communication line pull-up resistor (Rb) are as follows.
Cb = 120 pF, Rb = 1.1 kΩ

IICA serial transfer timing

**Remark** n = 0, 1

2.6 Analog Characteristics

2.6.1 A/D converter characteristics

(1) Normal modes 1 and 2

(TA = -40 to +105°C, 2.4 V ≤ AVREFP ≤ VDD ≤ 5.5 V, VSS = 0 V,

reference voltage (+) = AVREFP (ADREFP1 = 0, ADREFP0 = 1), reference voltage (-) = AVREFM (ADREFM = 1),

target pins: ANI2 to ANI14, internal reference voltage, and temperature sensor output voltage)

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
Resolution	RES		8		12	Bit
Conversion clock	fAD		1		32	MHz
Overall error ^{Notes 1, 3, 4, 5}	AINL	4.5 V ≤ AVREFP = VDD ≤ 5.5 V			±7.5	LSB
		2.7 V ≤ AVREFP = VDD ≤ 5.5 V			±9.0	LSB
		2.4 V ≤ AVREFP = VDD ≤ 5.5 V			±9.0	LSB
Conversion time ^{Note 6}	tCONV	4.5 V ≤ AVREFP = VDD ≤ 5.5 V	2.0			μs
		2.7 V ≤ AVREFP = VDD ≤ 5.5 V	2.0			μs
		2.4 V ≤ AVREFP = VDD ≤ 5.5 V	2.0			μs
Zero-scale error ^{Notes 1, 2, 3, 4, 5}	EZS	4.5 V ≤ AVREFP = VDD ≤ 5.5 V			±0.17	%FSR
		2.7 V ≤ AVREFP = VDD ≤ 5.5 V			±0.21	%FSR
		2.4 V ≤ AVREFP = VDD ≤ 5.5 V			±0.21	%FSR
Full-scale error ^{Notes 1, 2, 3, 4, 5}	EFS	4.5 V ≤ AVREFP = VDD ≤ 5.5 V			±0.17	%FSR
		2.7 V ≤ AVREFP = VDD ≤ 5.5 V			±0.21	%FSR
		2.4 V ≤ AVREFP = VDD ≤ 5.5 V			±0.21	%FSR
Integral linearity error ^{Notes 1, 4, 5}	ILE	4.5 V ≤ AVREFP = VDD ≤ 5.5 V			±3.0	LSB
		2.7 V ≤ AVREFP = VDD ≤ 5.5 V			±3.0	LSB
		2.4 V ≤ AVREFP = VDD ≤ 5.5 V			±3.0	LSB
Differential linearity error ^{Note 1}	DLE	4.5 V ≤ AVREFP = VDD ≤ 5.5 V		±1.0		LSB
		2.7 V ≤ AVREFP = VDD ≤ 5.5 V		±1.0		LSB
		2.4 V ≤ AVREFP = VDD ≤ 5.5 V		±1.0		LSB
Analog input voltage	VAIN		0		AVREFP	V

Note 1. This value does not include the quantization error (±1/2 LSB).

Note 2. This value is indicated as a ratio (%FSR) to the full-scale value.

Note 3. When pins ANI16 to ANI31 are selected as the target pins for conversion, the maximum values are as follows.

Overall error: Add ±3 LSB to the maximum value.

Zero-scale/full-scale error: Add ±0.04%FSR to the maximum value.

Note 4. When reference voltage (+) = VDD and reference voltage (-) = VSS, the maximum values are as follows.

Overall error: Add ±10 LSB to the maximum value.

Zero-scale/full-scale error: Add ±0.25%FSR to the maximum value.

Integral linearity error: Add ±4 LSB to the maximum value.

Note 5. When AVREFP < VDD, the maximum values are as follows.

Overall error/zero-scale error/full-scale error: Add (±0.75 LSB × (VDD voltage (V) - AVREFP voltage (V))) to the maximum value.

Integral linearity error: Add (±0.2 LSB × (VDD voltage (V) - AVREFP voltage (V))) to the maximum value.

Note 6. When the internal reference voltage or the temperature sensor output voltage is selected as the target for conversion, the sampling time must be at least 5 μs. Accordingly, use standard mode 2 with the longer sampling time.

(2) Low-voltage modes 1 and 2

(TA = -40 to +105°C, 1.6 V ≤ AVREFP ≤ VDD ≤ 5.5 V, VSS = 0 V,

reference voltage (+) = AVREFP (ADREFP1 = 0, ADREFP0 = 1), reference voltage (-) = AVREFM (ADREFM = 1),

target pins ANI2 to ANI14, internal reference voltage, and temperature sensor output voltage)

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
Resolution	RES		8		12	Bit
Conversion clock	fAD		1		24	MHz
Overall error ^{Notes 1, 3, 4, 5}	AINL	2.7 V ≤ AVREFP = VDD ≤ 5.5 V			±9	LSB
		2.4 V ≤ AVREFP = VDD ≤ 5.5 V			±9	LSB
		1.8 V ≤ AVREFP = VDD ≤ 5.5 V			±11.5	LSB
		1.6 V ≤ AVREFP = VDD ≤ 5.5 V			±12.0	LSB
Conversion time ^{Note 6}	tCONV	2.7 V ≤ AVREFP = VDD ≤ 5.5 V	3.33			μs
		2.4 V ≤ AVREFP = VDD ≤ 5.5 V	5.0			μs
		1.8 V ≤ AVREFP = VDD ≤ 5.5 V	10.0			μs
		1.6 V ≤ AVREFP = VDD ≤ 5.5 V	20.0			μs
Zero-scale error ^{Notes 1, 2, 3, 4, 5}	Ezs	2.7 V ≤ AVREFP = VDD ≤ 5.5 V			±0.21	%FSR
		2.4 V ≤ AVREFP = VDD ≤ 5.5 V			±0.21	%FSR
		1.8 V ≤ AVREFP = VDD ≤ 5.5 V			±0.27	%FSR
		1.6 V ≤ AVREFP = VDD ≤ 5.5 V			±0.28	%FSR
Full-scale error ^{Notes 1, 2, 3, 4, 5}	Efs	2.7 V ≤ AVREFP = VDD ≤ 5.5 V			±0.21	%FSR
		2.4 V ≤ AVREFP = VDD ≤ 5.5 V			±0.21	%FSR
		1.8 V ≤ AVREFP = VDD ≤ 5.5 V			±0.27	%FSR
		1.6 V ≤ AVREFP = VDD ≤ 5.5 V			±0.28	%FSR
Integral linearity error ^{Notes 1, 4, 5}	ILE	2.7 V ≤ AVREFP = VDD ≤ 5.5 V			±4.0	LSB
		2.4 V ≤ AVREFP = VDD ≤ 5.5 V			±4.0	LSB
		1.8 V ≤ AVREFP = VDD ≤ 5.5 V			±4.5	LSB
		1.6 V ≤ AVREFP = VDD ≤ 5.5 V			±4.5	LSB
Differential linearity error ^{Note 1}	DLE	2.7 V ≤ AVREFP = VDD ≤ 5.5 V		±1.5		LSB
		2.4 V ≤ AVREFP = VDD ≤ 5.5 V		±1.5		LSB
		1.8 V ≤ AVREFP = VDD ≤ 5.5 V		±2.0		LSB
		1.6 V ≤ AVREFP = VDD ≤ 5.5 V		±2.0		LSB
Analog input voltage	VAIN		0		AVREFP	V

Note 1. This value does not include the quantization error (±1/2 LSB).**Note 2.** This value is indicated as a ratio (%FSR) to the full-scale value.**Note 3.** When pins ANI16 to ANI31 are selected as the target pins for conversion, the maximum values are as follows.

Overall error: Add ±3 LSB to the maximum value.

Zero-scale/full-scale error: Add ±0.04%FSR to the maximum value.

Note 4. When reference voltage (+) = VDD and reference voltage (-) = VSS, the maximum values are as follows.

Overall error: Add ±10 LSB to the maximum value.

Zero-scale/full-scale error: Add ±0.25%FSR to the maximum value.

Integral linearity error: Add ±4 LSB to the maximum value.

Note 5. When AVREFP < VDD, the maximum values are as follows.

Overall error/zero-scale error/full-scale error: Add (±0.75 LSB × (VDD voltage (V) - AVREFP voltage (V))) to the maximum value.

Integral linearity error: Add (±0.2 LSB × (VDD voltage (V) - AVREFP voltage (V))) to the maximum value.

Note 6. When the internal reference voltage or the temperature sensor output voltage is selected as the target for conversion, the sampling time must be at least 5 μs . Accordingly, use standard mode 2 with the longer sampling time, and use the conversion clock (fAD) of no more than 16 MHz.

(3) When the internal reference voltage is selected as reference voltage (+)

($T_A = -40$ to $+105^\circ\text{C}$, $1.8\text{ V} \leq V_{DD} \leq 5.5\text{ V}$, $V_{SS} = 0\text{ V}$, low-voltage modes 1 and 2,
reference voltage (+) = internal reference voltage (ADREFP1 = 1, ADREFP0 = 0),
reference voltage (-) = AVREFM (ADREFM = 1)

Item	Symbol	Conditions		Min.	Typ.	Max.	Unit
Resolution	RES			8			Bit
Conversion clock	f _{AD}	8-bit resolution	$1.6\text{ V} \leq V_{DD} \leq 5.5\text{ V}$	1		2	MHz
Zero-scale error ^{Notes 1, 2}	E _{ZS}	8-bit resolution	$1.6\text{ V} \leq V_{DD} \leq 5.5\text{ V}$			±0.6	%FSR
Integral linearity error ^{Note 1}	I _{LE}	8-bit resolution	$1.6\text{ V} \leq V_{DD} \leq 5.5\text{ V}$			±2.0	LSB
Differential linearity error ^{Note 1}	D _{LE}	8-bit resolution	$1.6\text{ V} \leq V_{DD} \leq 5.5\text{ V}$		±1.0		LSB
Analog input voltage	V _{AIN}			0		V _{BGR} Note 3	V

Note 1. This value does not include the quantization error ($\pm 1/2$ LSB).

Note 2. This value is indicated as a ratio (%FSR) to the full-scale value.

Note 3. Refer to 2.6.2 Temperature sensor/internal reference voltage characteristics.

Note 4. When reference voltage (-) is selected as V_{SS} , the maximum values are as follows.

Zero-scale error: Add $\pm 0.35\%$ FSR to the maximum value.

Integral linearity error: Add ± 0.5 LSB to the maximum value.

2.6.2 Temperature sensor/internal reference voltage characteristics

($T_A = -40$ to $+105^{\circ}\text{C}$, $1.8\text{ V} \leq V_{DD} \leq 5.5\text{ V}$, $V_{SS} = 0\text{ V}$)

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
Temperature sensor output voltage	VTMPS25	Setting ADS register = 80H, $T_A = +25^{\circ}\text{C}$		1.05		V
Internal reference voltage	VBGR	Setting ADS register = 81H	1.42	1.48	1.54	V
Temperature coefficient	FVTMPS	Temperature dependency of the temperature sensor voltage		-3.3		mV/ $^{\circ}\text{C}$
Operation stabilization wait time	tAMP		5			μs

2.6.3 D/A converter characteristics

($T_A = -40$ to $+105^{\circ}\text{C}$, $1.6\text{ V} \leq EV_{DD0} = EV_{DD1} \leq V_{DD} \leq 5.5\text{ V}$, $V_{SS} = EV_{SS0} = EV_{SS1} = 0\text{ V}$)

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
Resolution	RES				8	Bit
Overall error	AINL	Rload = 8 M Ω , $1.8\text{ V} \leq V_{DD} \leq 5.5\text{ V}$			± 2.5	LSB
		Rload = 4 M Ω , $1.8\text{ V} \leq V_{DD} \leq 5.5\text{ V}$			± 2.5	LSB
Settling time	tSET	Cload = 20 pF, $2.7\text{ V} \leq V_{DD} \leq 5.5\text{ V}$			3	μs
		$1.6\text{ V} \leq V_{DD} \leq 5.5\text{ V}$			6	μs

2.6.4 Comparator characteristics

($T_A = -40$ to $+105^{\circ}\text{C}$, $1.6\text{ V} \leq EV_{DD0} = EV_{DD1} \leq V_{DD} \leq 5.5\text{ V}$, $V_{SS} = EV_{SS0} = EV_{SS1} = 0\text{ V}$)

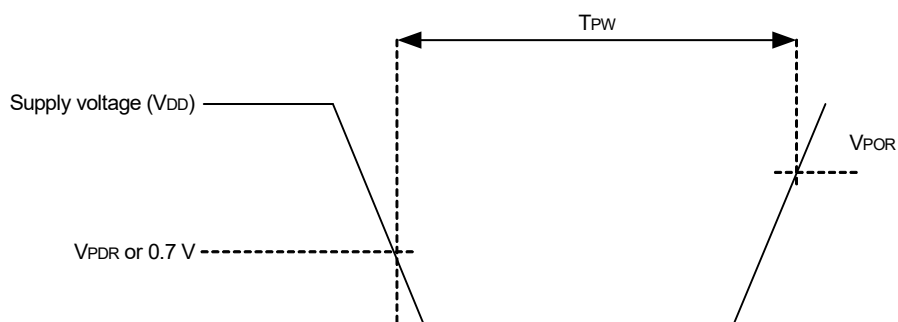
Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
Input voltage range	IVREF	Input to the IVREF0 and IVREF1 pins C0LVL = 0, C1LVL = 0	0		$V_{DD} - 1.4$	V
		Input to the IVREF0 and IVREF1 pins C0LVL = 1, C1LVL = 1	1.4		V_{DD}	V
	IVCMP	Input to the IVCMP0 and IVCMP1 pins	-0.3		$V_{DD} + 0.3$	V
Output delay	td	$V_{DD} = 3.0\text{ V}$, Input slew rate $> 1\text{ V}/\mu\text{s}$	High-speed mode		1.5	μs
			Low-speed mode	3.0		μs
Offset voltage	—	High-speed mode			50	mV
		Low-speed mode			40	mV
Operation stabilization wait time	tcMP		30			μs
Internal reference voltage	VBGR2		1.4		1.6	V

2.6.5 POR circuit characteristics

($T_A = -40$ to $+105^\circ\text{C}$, $V_{SS} = 0\text{ V}$)

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
Detection voltage	V_{POR} , V_{PDR}		1.43	1.50	1.57	V
Minimum pulse width ^{Note}	T_{PW}		300			μs

Note This width is the minimum time required for a POR reset when V_{DD} falls below V_{PDR} . This width is also the minimum time required for a POR reset from when V_{DD} falls below 0.7 V to when V_{DD} exceeds V_{POR} in the STOP mode or while the main system clock is stopped through setting bit 0 (HIOSTOP) and bit 7 (MSTOP) in the clock operation status control register (CSC).



2.6.6 LVD circuit characteristics

(1) LVD0 Detection Voltage in the Reset Mode and Interrupt Mode

(TA = -40 to +105°C, VPDR ≤ VDD ≤ 5.5 V, VSS = 0 V)

Item		Symbol	Conditions	Min.	Typ.	Max.	Unit
Detection voltage	Supply voltage level	VLVD00	The power supply voltage is rising.	3.84	3.96	4.08	V
			The power supply voltage is falling.	3.76	3.88	4.00	V
		VLVD01	The power supply voltage is rising.	2.88	2.97	3.06	V
			The power supply voltage is falling.	2.82	2.91	3.00	V
		VLVD02	The power supply voltage is rising.	2.59	2.67	2.75	V
			The power supply voltage is falling.	2.54	2.62	2.70	V
		VLVD03	The power supply voltage is rising.	2.31	2.38	2.45	V
			The power supply voltage is falling.	2.26	2.33	2.40	V
		VLVD04	The power supply voltage is rising.	1.84	1.90	1.95	V
			The power supply voltage is falling.	1.80	1.86	1.91	V
		VLVD05	The power supply voltage is rising.	1.64	1.69	1.74	V
			The power supply voltage is falling.	1.60	1.65	1.70	V
Minimum pulse width		tLW		500			μs
Detection delay time						500	μs

(2) LVD1 Detection Voltage of Reset Mode and Interrupt Mode

(TA = -40 to +105°C, VPDR ≤ VDD ≤ 5.5 V, VSS = 0 V)

Item		Symbol	Conditions	Min.	Typ.	Max.	Unit
Detection voltage	Supply voltage level	VLVD10	The power supply voltage is rising.	4.08	4.16	4.24	V
			The power supply voltage is falling.	4.00	4.08	4.16	V
		VLVD11	The power supply voltage is rising.	3.88	3.96	4.04	V
			The power supply voltage is falling.	3.80	3.88	3.96	V
		VLVD12	The power supply voltage is rising.	3.68	3.75	3.82	V
			The power supply voltage is falling.	3.60	3.67	3.74	V
		VLVD13	The power supply voltage is rising.	3.48	3.55	3.62	V
			The power supply voltage is falling.	3.40	3.49	3.54	V
		VLVD14	The power supply voltage is rising.	3.28	3.35	3.42	V
			The power supply voltage is falling.	3.20	3.27	3.34	V
		VLVD15	The power supply voltage is rising.	3.07	3.13	3.19	V
			The power supply voltage is falling.	3.00	3.06	3.12	V
		VLVD16	The power supply voltage is rising.	2.91	2.97	3.03	V
			The power supply voltage is falling.	2.85	2.91	2.97	V
		VLVD17	The power supply voltage is rising.	2.76	2.815	2.87	V
			The power supply voltage is falling.	2.70	2.755	2.81	V
		VLVD18	The power supply voltage is rising.	2.61	2.66	2.71	V
			The power supply voltage is falling.	2.55	2.60	2.65	V
		VLVD19	The power supply voltage is rising.	2.45	2.50	2.55	V
			The power supply voltage is falling.	2.40	2.45	2.50	V
		VLVD110	The power supply voltage is rising.	2.35	2.40	2.45	V
			The power supply voltage is falling.	2.30	2.35	2.40	V
		VLVD111	The power supply voltage is rising.	2.25	2.295	2.34	V
			The power supply voltage is falling.	2.20	2.25	2.29	V
		VLVD112	The power supply voltage is rising.	2.15	2.195	2.24	V
			The power supply voltage is falling.	2.10	2.145	2.19	V
		VLVD113	The power supply voltage is rising.	2.05	2.09	2.13	V
			The power supply voltage is falling.	2.00	2.04	2.08	V
		VLVD114	The power supply voltage is rising.	1.94	1.98	2.02	V
			The power supply voltage is falling.	1.90	1.94	1.98	V
		VLVD115 Note	The power supply voltage is rising.	1.84	1.875	1.91	V
			The power supply voltage is falling.	1.80	1.835	1.87	V
		VLVD116 Note	The power supply voltage is rising.	1.74	1.775	1.81	V
			The power supply voltage is falling.	1.70	1.735	1.77	V
		VLVD117 Note	The power supply voltage is rising.	1.64	1.67	1.70	V
			The power supply voltage is falling.	1.60	1.63	1.66	V
Minimum pulse width		tLW		500			μs
Detection delay time						500	μs

Note This setting can only be used when LVD0 is disabled.

2.6.7 Power supply voltage rising slope characteristics

($T_A = -40$ to $+105^{\circ}\text{C}$, $V_{SS} = 0\text{ V}$)

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
Power supply voltage rising slope	SVDD				54	V/ms

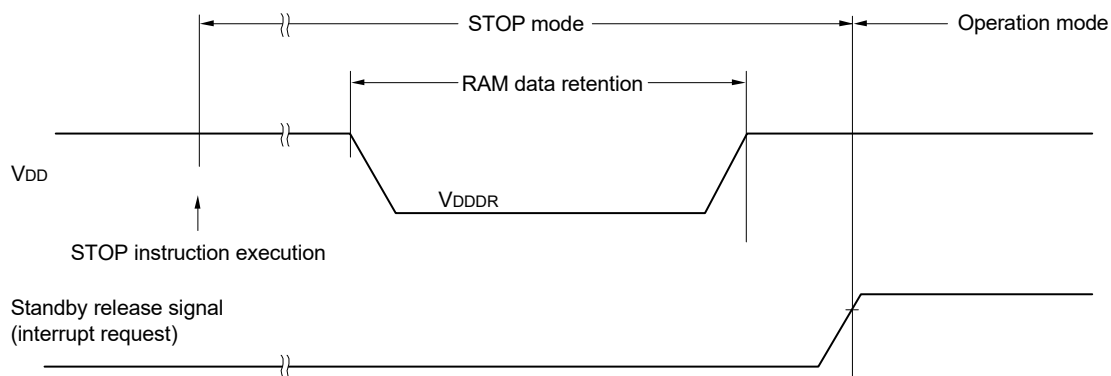
Caution Make sure to keep the internal reset state by the LVD0 circuit or an external reset until V_{DD} reaches the operating voltage range shown in AC characteristics.

2.7 RAM Data Retention Characteristics

($T_A = -40$ to $+105^\circ\text{C}$, $V_{SS} = 0\text{V}$)

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
Data retention supply voltage	VDDDR		1.43 ^{Note}		5.5	V

Note This voltage depends on the POR detection voltage. When the voltage drops, the data in RAM are retained until a POR is applied, but are not retained following a POR.



2.8 Flash Memory Programming Characteristics

($T_A = -40$ to $+105^\circ\text{C}$, $1.6\text{ V} \leq V_{DD} \leq 5.5\text{ V}$, $V_{SS} = 0\text{ V}$)

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
CPU/peripheral hardware clock frequency	fCLK		1		32	MHz
Number of code flash rewrites ^{Notes 1, 2, 3}	C _{erwr}	Retained for 20 years T _A = 85°C	1,000			Times
Number of data flash rewrites ^{Notes 1, 2, 3}		Retained for 1 year T _A = 25°C		1,000,000		
		Retained for 5 years T _A = 85°C	100,000			
		Retained for 20 years T _A = 85°C	10,000			

Note 1. 1 erase + 1 write after the erase is regarded as 1 rewrite.

The retaining years are until next rewrite after the rewrite.

Note 2. The listed numbers of times apply when using flash memory programmer and Renesas Electronics self programming library.

Note 3. These are the characteristics of the flash memory and the results obtained from reliability testing by Renesas Electronics Corporation.

(1) Code flash memory

(TA = -40 to +105°C, 1.6 V ≤ VDD ≤ 5.5 V, VSS = 0 V)

Item		Symbol	fCLK = 1 MHz			fCLK = 2 MHz, 3 MHz			4 MHz ≤ fCLK < 8 MHz			8 MHz ≤ fCLK < 32 MHz			fCLK = 32 MHz			Unit
			Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	
Programming time	4 bytes	tp4	—	74.7	656.5	—	51.0	464.6	—	41.7	384.8	—	37.1	346.2	—	34.2	321.9	μs
Erasure time	2 Kbytes	te2K	—	10.4	312.2	—	7.7	258.5	—	6.4	231.8	—	5.8	218.4	—	5.6	214.4	ms
Blank checking time	4 bytes	tbc4	—	—	38.4	—	—	19.2	—	—	13.1	—	—	10.2	—	—	8.3	μs
	2 Kbytes	tbc2K	—	—	2618.9	—	—	1309.5	—	—	658.3	—	—	332.8	—	—	234.1	μs
Time taken to forcibly stop the erasure		tSED	—	—	18.0	—	—	14.0	—	—	12.0	—	—	11.0	—	—	10.3	μs
Security setting time		tAWSSAS	—	18.2	526.2	—	14.4	469.2	—	12.5	441.1	—	11.6	427.1	—	11.3	422.6	ms
Time until programming starts following cancellation of the STOP instruction		—	20	—	—	20	—	—	20	—	—	20	—	—	20	—	—	μs

Caution The listed values do not include the time until the operations of the flash memory start following execution of an instruction by software.

(2) Data flash memory

(TA = -40 to +105°C, 1.6 V ≤ VDD ≤ 5.5 V, VSS = 0 V)

Item		Symbol	fCLK = 1 MHz			fCLK = 2 MHz, 3 MHz			4 MHz ≤ fCLK < 8 MHz			8 MHz ≤ fCLK < 32 MHz			fCLK = 32 MHz			Unit
			Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	
Programming time	1 byte	tp4	—	74.7	656.5	—	51.0	464.6	—	41.7	384.8	—	37.1	346.2	—	34.2	321.9	μs
Erasure time	256 bytes	te2K	—	7.8	259.2	—	6.4	232.0	—	5.8	218.5	—	5.5	211.8	—	5.4	209.7	ms
Blank checking time	1 byte	tbc4	—	—	38.4	—	—	19.2	—	—	13.1	—	—	10.2	—	—	8.3	μs
	256 bytes	tbc2K	—	—	1326.1	—	—	663.1	—	—	335.1	—	—	171.2	—	—	121.0	μs
Time taken to forcibly stop the erasure		tSED	—	—	18.0	—	—	14.0	—	—	12.0	—	—	11.0	—	—	10.3	μs
Time until programming starts following cancellation of the STOP instruction		—	20	—	—	20	—	—	20	—	—	20	—	—	20	—	—	μs
Time until reading starts following setting DFLEN to 1		—	0.25	—	—	0.25	—	—	0.25	—	—	0.25	—	—	0.25	—	—	ns

Caution The listed values do not include the time until the operations of the flash memory start following execution of an instruction by software.

2.9 Dedicated Flash Memory Programmer Communication (UART)

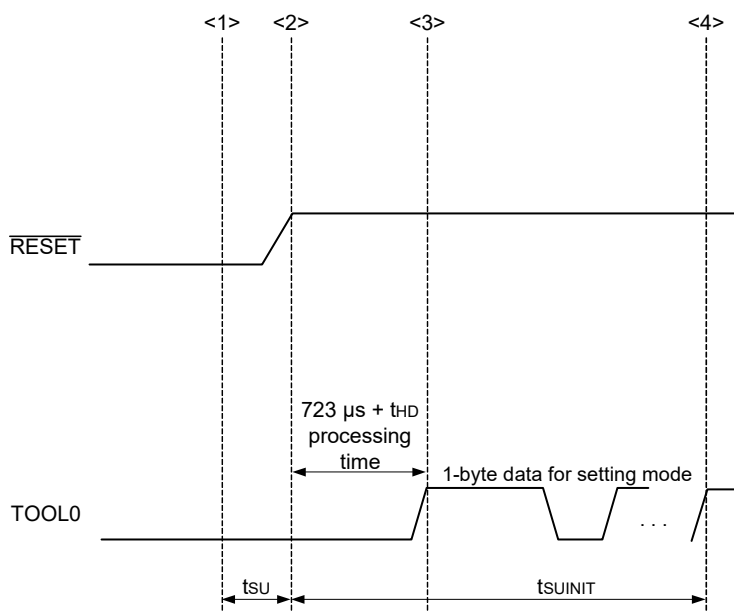
(TA = -40 to +105°C, 1.8 V ≤ EVDD0 = EVDD1 ≤ VDD ≤ 5.5 V, VSS = EVSS0 = EVSS1 = 0 V)

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
Transfer rate		During serial programming	115,200		1,000,000	bps

2.10 Timing of Entry to Flash Memory Programming Modes

(TA = -40 to +105°C, 1.8 V ≤ EVDD0 = EVDD1 ≤ VDD ≤ 5.5 V, VSS = EVSS0 = EVSS1 = 0 V)

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
Time to complete the communication for the initial setting after the external reset is released	tsuINIT	POR and LVD reset must be released before the external reset is released.			100	ms
Time to release the external reset after the TOOL0 pin is set to the low level	tsu	POR and LVD reset must be released before the external reset is released.	10			μs
Time to hold the TOOL0 pin at the low level after the external reset is released (the processing time of the firmware to control the flash memory is not included)	tHD	POR and LVD reset must be released before the external reset is released.	1			ms



<1> The low level is input to the TOOL0 pin.

<2> The external reset is released. Note that the POR and LVD reset must be released before the external reset is released.

<3> The TOOL0 pin is set to the high level.

<4> Setting of the flash memory programming mode by UART reception and complete the baud rate setting.

Remark tsuINIT: The time during which the communications for the initial setting must be completed within 100 ms after the external reset is released.

tsu: Time to release the external reset after the TOOL0 pin is set to the low level

tHD: Time to hold the TOOL0 pin at the low level after the external reset is released. It does not include the processing time of the firmware to control the flash memory.

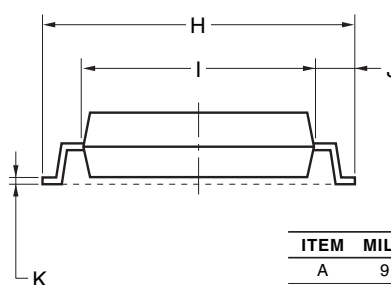
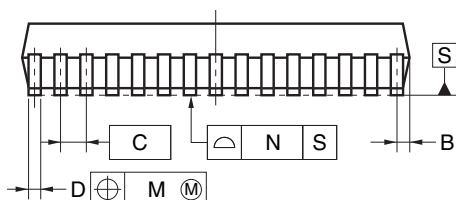
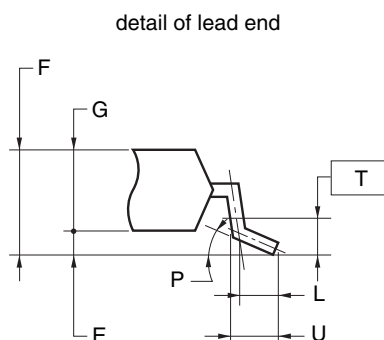
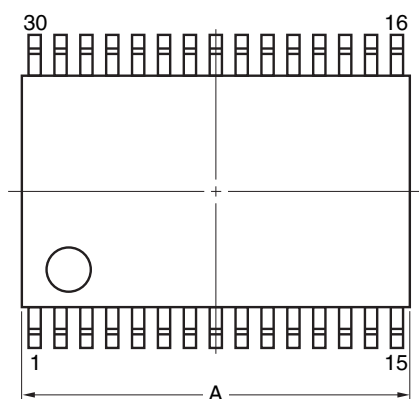
3. PACKAGE DRAWINGS

3.1 30-Pin Products

R7F100GAF3CSP, R7F100GAG3CSP, R7F100GAH3CSP, R7F100GAJ3CSP

R7F100GAF2DSP, R7F100GAG2DSP, R7F100GAH2DSP, R7F100GAJ2DSP

JEITA Package Code	RENESAS Code	Previous Code	MASS (TYP.) [g]
P-LSSOP30-0300-0.65	PLSP0030JB-B	S30MC-65-5A4-3	0.18



NOTE

Each lead centerline is located within 0.13 mm of its true position (T.P.) at maximum material condition.

ITEM	MILLIMETERS
A	9.85±0.15
B	0.45 MAX.
C	0.65 (T.P.)
D	0.24 ^{+0.08} _{-0.07}
E	0.1±0.05
F	1.3±0.1
G	1.2
H	8.1±0.2
I	6.1±0.2
J	1.0±0.2
K	0.17±0.03
L	0.5
M	0.13
N	0.10
P	3° ^{+5°} _{-3°}
T	0.25
U	0.6±0.15

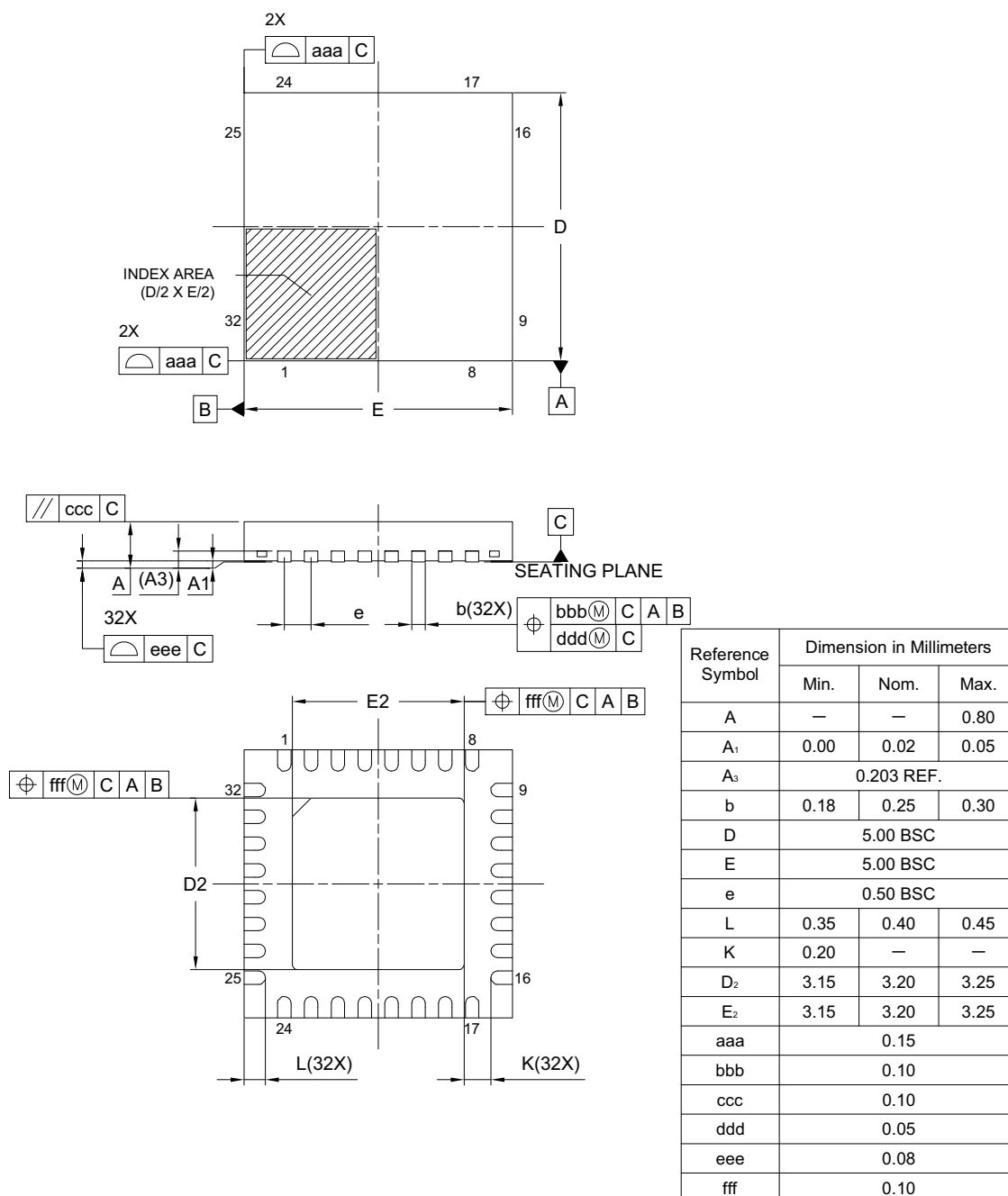
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3.2 32-Pin Products

R7F100GBF3CNP, R7F100GBG3CNP, R7F100GBH3CNP, R7F100GBJ3CNP

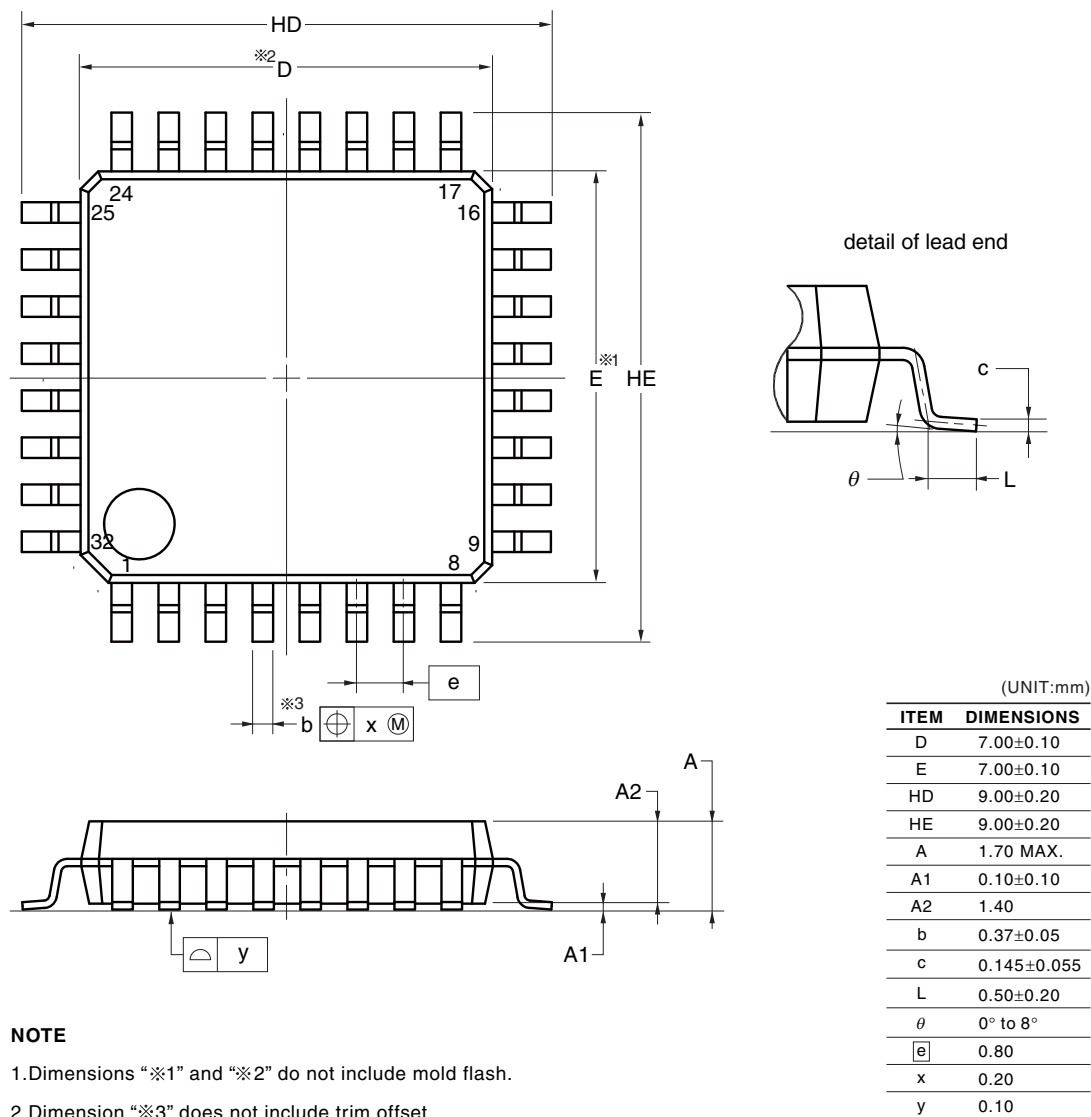
R7F100GBF2DNP, R7F100GBG2DNP, R7F100GBH2DNP, R7F100GBJ2DNP

JEITA Package code	RENESAS code	MASS(TYP.)[g]
P-HWQFN032-5x5-0.50	PWQN0032KE-A	0.06



R7F100GBF3CFP, R7F100GBG3CFP, R7F100GBH3CFP, R7F100GBJ3CFP
 R7F100GBF2DFP, R7F100GBG2DFP, R7F100GBH2DFP, R7F100GBJ2DFP

JEITA Package Code	RENESAS Code	Previous Code	MASS (TYP.) [g]
P-LQFP32-7x7-0.80	PLQP0032GB-A	P32GA-80-GBT-1	0.2



NOTE

1. Dimensions " $\times 1$ " and " $\times 2$ " do not include mold flash.
2. Dimension " $\times 3$ " does not include trim offset.

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3.3 36-Pin Products

R7F100GCF3CLA, R7F100GCG3CLA, R7F100GCH3CLA, R7F100GCJ3CLA
R7F100GCF2DLA, R7F100GCG2DLA, R7F100GCH2DLA, R7F100GCJ2DLA

Contact a Renesas Electronics sales office for details.

3.4 40-Pin Products

R7F100GEF3CNP, R7F100GEG3CNP, R7F100GEH3CNP, R7F100GEJ3CNP
R7F100GEF2DNP, R7F100GEG2DNP, R7F100GEH2DNP, R7F100GEJ2DNP

Contact a Renesas Electronics sales office for details.

3.5 44-Pin Products

R7F100GFF3CFP, R7F100GFG3CFP, R7F100GFH3CFP, R7F100GFJ3CFP

R7F100GFK3CFP, R7F100GFL3CFP

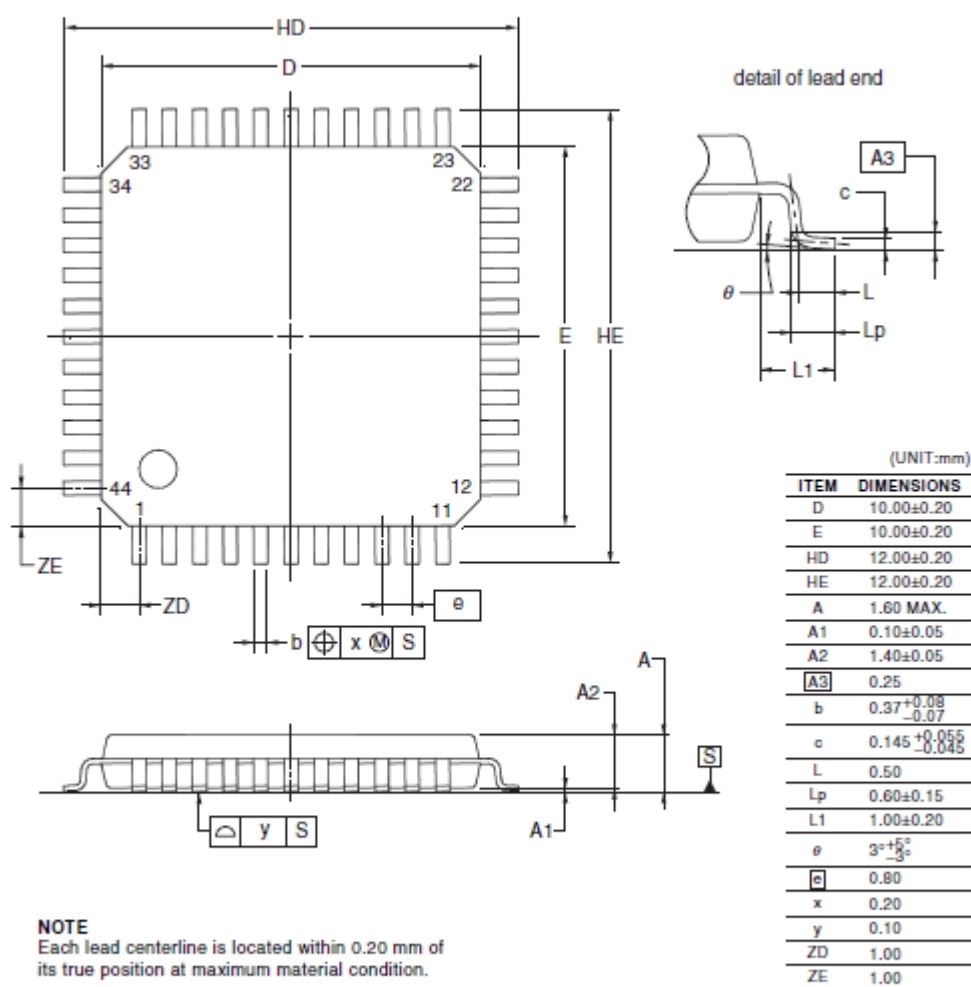
R7F100GFN3CFP

R7F100GFF2DFP, R7F100GFG2DFP, R7F100GFH2DFP, R7F100GFJ2DFP

R7F100GFK2DFP, R7F100GFL2DFP

R7F100GFN2DFP

JEITA Package Code	RENESAS Code	Previous Code	MASS (TYP.) [g]
P-LQFP44-10x10-0.80	PLQP0044GC-A	P44GB-80-UES-2	0.36

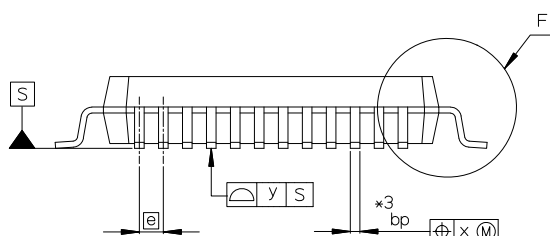
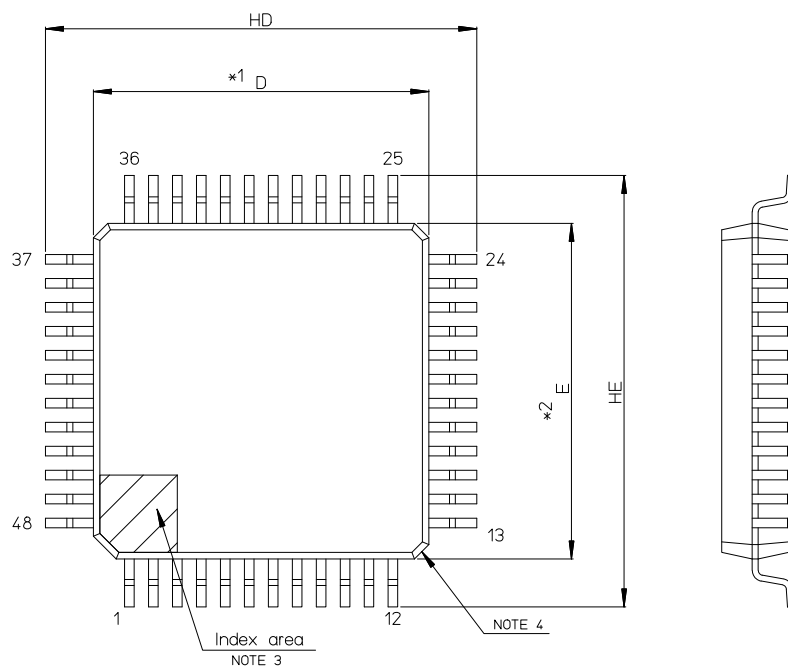


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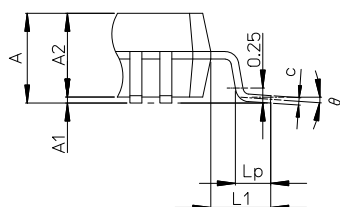
3.6 48-Pin Products

R7F100GGF3CFB, R7F100GGG3CFB, R7F100GGH3CFB, R7F100GGJ3CFB
 R7F100GGK3CFB, R7F100GGL3CFB, R7F100GGN3CFB
 R7F100GGF2DFB, R7F100GGG2DFB, R7F100GGH2DFB, R7F100GGJ2DFB
 R7F100GGK2DFB, R7F100GGL2DFB, R7F100GGN2CFB

JEITA Package Code	RENESAS Code	Previous Code	MASS[Typ.]
P-LFQFP48-7x7-0.50	PLQP0048KB-B	—	0.2g



- NOTE)
1. DIMENSIONS *1* AND *2* DO NOT INCLUDE MOLD FLASH.
 2. DIMENSION *3* DOES NOT INCLUDE TRIM OFFSET.
 3. PIN 1 VISUAL INDEX FEATURE MAY VARY, BUT MUST BE LOCATED WITHIN THE HATCHED AREA.
 4. CHAMFERS AT CORNERS ARE OPTIONAL; SIZE MAY VARY.



Detail F

Reference Symbol	Dimension in Millimeters		
	Min	Nom	Max
D	6.9	7.0	7.1
E	6.9	7.0	7.1
A2	—	1.4	—
HD	8.8	9.0	9.2
HE	8.8	9.0	9.2
A	—	—	1.7
A1	0.05	—	0.15
bp	0.17	0.20	0.27
c	0.09	—	0.20
θ	0°	3.5°	8°
e	—	0.5	—
x	—	—	0.08
y	—	—	0.08
Lp	0.45	0.6	0.75
L1	—	1.0	—

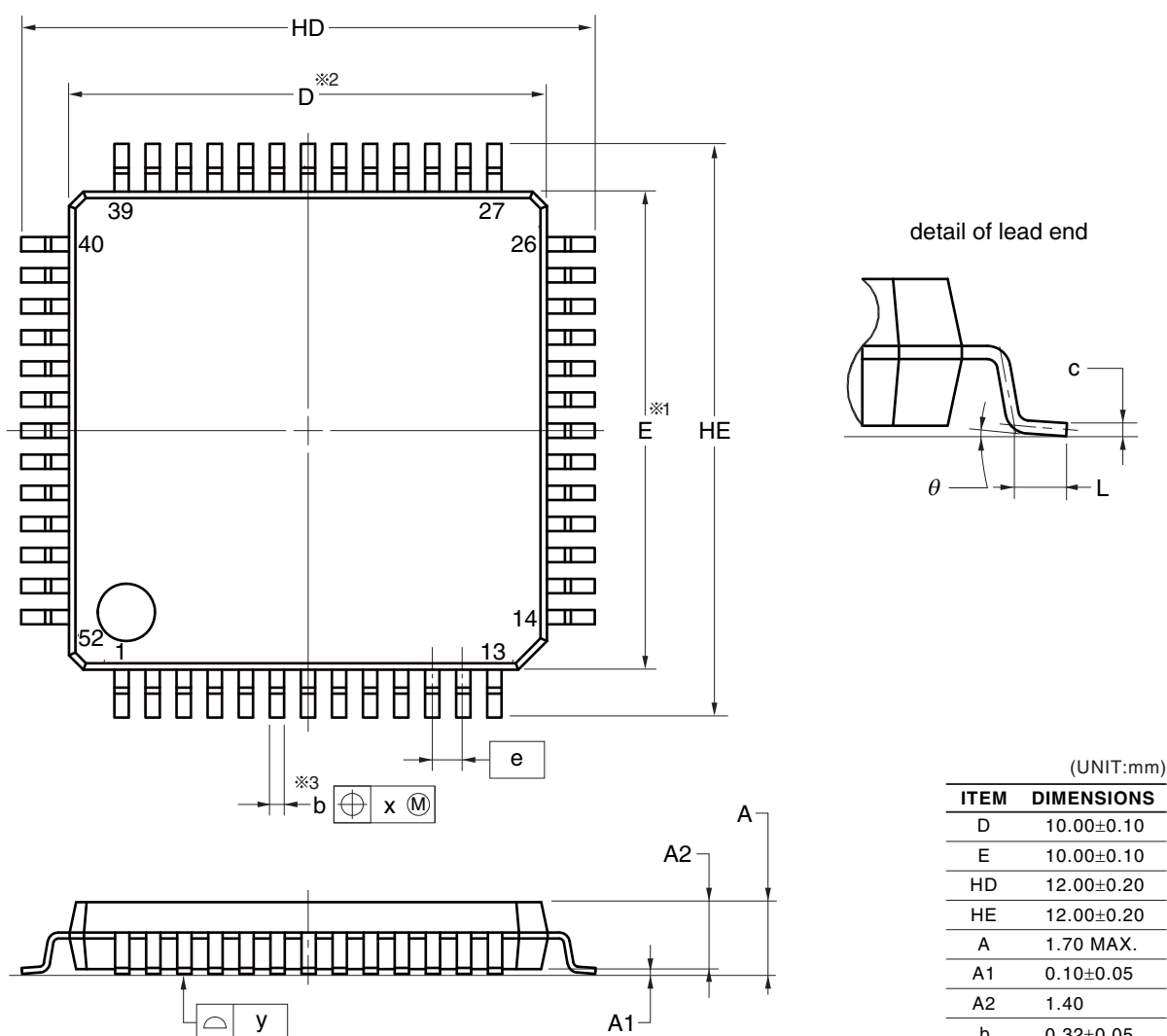
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R7F100GGK3CNP, R7F100GGL3CNP, R7F100GGN3CNP
R7F100GGF2DNP, R7F100GGG2DNP, R7F100GGH2DNP, R7F100GGJ2DNP
R7F100GGK2DNP, R7F100GGL2DNP, R7F100GGN2CNP

Contact a Renesas Electronics sales office for details.

3.7 52-Pin Products

R7F100GJF3CFA, R7F100GJG3CFA, R7F100GJH3CFA, R7F100GJJ3CFA
 R7F100GJK3CFA, R7F100GJL3CFA, R7F100GJN3CFA
 R7F100GJF2DFA, R7F100GJG2DFA, R7F100GJH2DFA, R7F100GJJ2DFA
 R7F100GJK2DFA, R7F100GJL2DFA, R7F100GJN2DFA

JEITA Package Code	RENESAS Code	Previous Code	MASS (TYP.) [g]
P-LQFP52-10x10-0.65	PLQP0052JA-A	P52GB-65-GBS-1	0.3



NOTE

1. Dimensions "※1" and "※2" do not include mold flash.
2. Dimension "※3" does not include trim offset.

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3.8 64-Pin Products

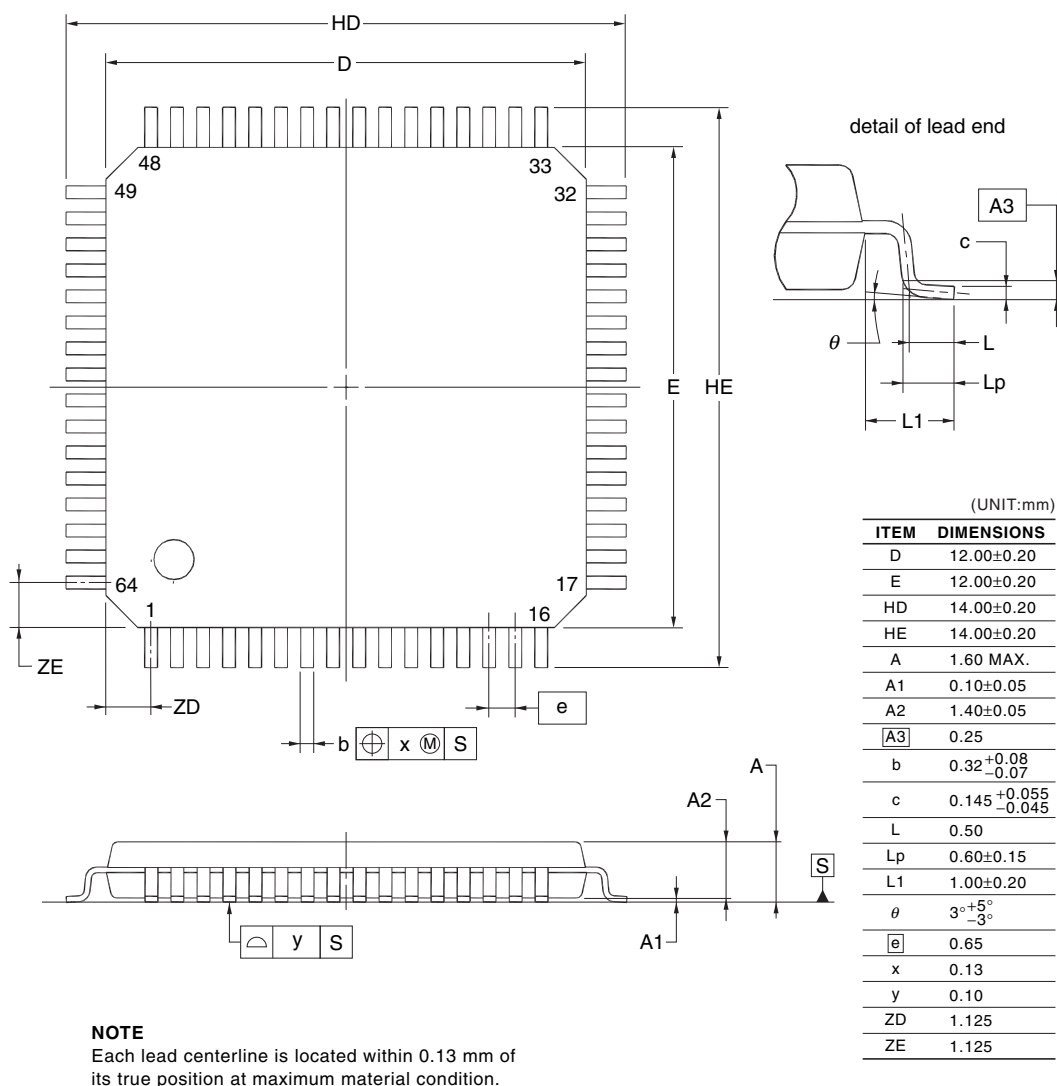
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R7F100GLK3CFA, R7F100GLL3CFA, R7F100GLN3CFA

R7F100GLF2DFA, R7F100GLG2DFA, R7F100GLH2DFA, R7F100GLJ2DFA

R7F100GLK2DFA, R7F100GLL2DFA, R7F100GLN2DFA

JEITA Package Code	RENESAS Code	Previous Code	MASS (TYP.) [g]
P-LQFP64-12x12-0.65	PLQP0064JA-A	P64GK-65-UET-2	0.51

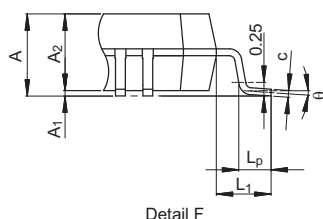
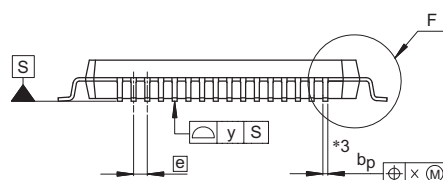
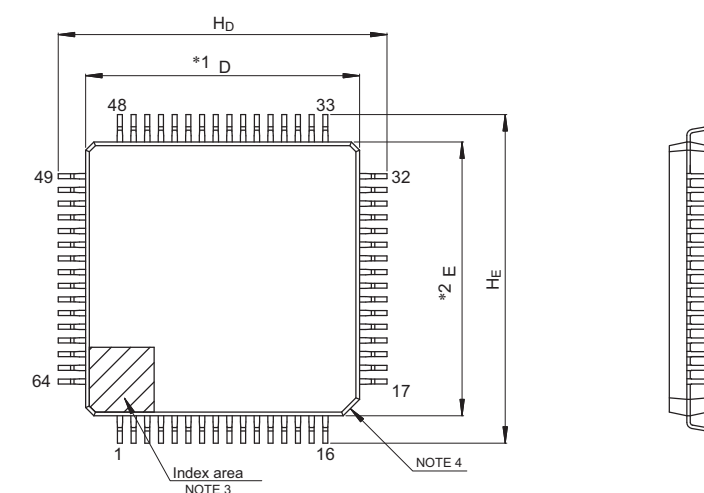


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R7F100GLF3CFB, R7F100GLG3CFB, R7F100GLH3CFB, R7F100GLJ3CFB,
 R7F100GLK3CFB, R7F100GLL3CFB, R7F100GLN3CFB
 R7F100GLF2DFB, R7F100GLG2DFB, R7F100GLH2DFB, R7F100GLJ2DFB,
 R7F100GLK2DFB, R7F100GLL2DFB, R7F100GLN2DFB

JEITA Package Code	RENESAS Code	Previous Code	MASS (Typ) [g]
P-LFQFP64-10x10-0.50	PLQP0064KB-C	—	0.3

Unit: mm



NOTE)

1. DIMENSIONS **1" AND **2" DO NOT INCLUDE MOLD FLASH.
2. DIMENSION **3" DOES NOT INCLUDE TRIM OFFSET.
3. PIN 1 VISUAL INDEX FEATURE MAY VARY, BUT MUST BE LOCATED WITHIN THE HATCHED AREA.
4. CHAMFERS AT CORNERS ARE OPTIONAL, SIZE MAY VARY.

Reference Symbol	Dimensions in millimeters		
	Min	Nom	Max
D	9.9	10.0	10.1
E	9.9	10.0	10.1
A ₂	—	1.4	—
H _D	11.8	12.0	12.2
H _E	11.8	12.0	12.2
A	—	—	1.7
A ₁	0.05	—	0.15
b _p	0.15	0.20	0.27
c	0.09	—	0.20
θ	0°	3.5°	8°
e	—	0.5	—
x	—	—	0.08
y	—	—	0.08
L _p	0.45	0.6	0.75
L ₁	—	1.0	—

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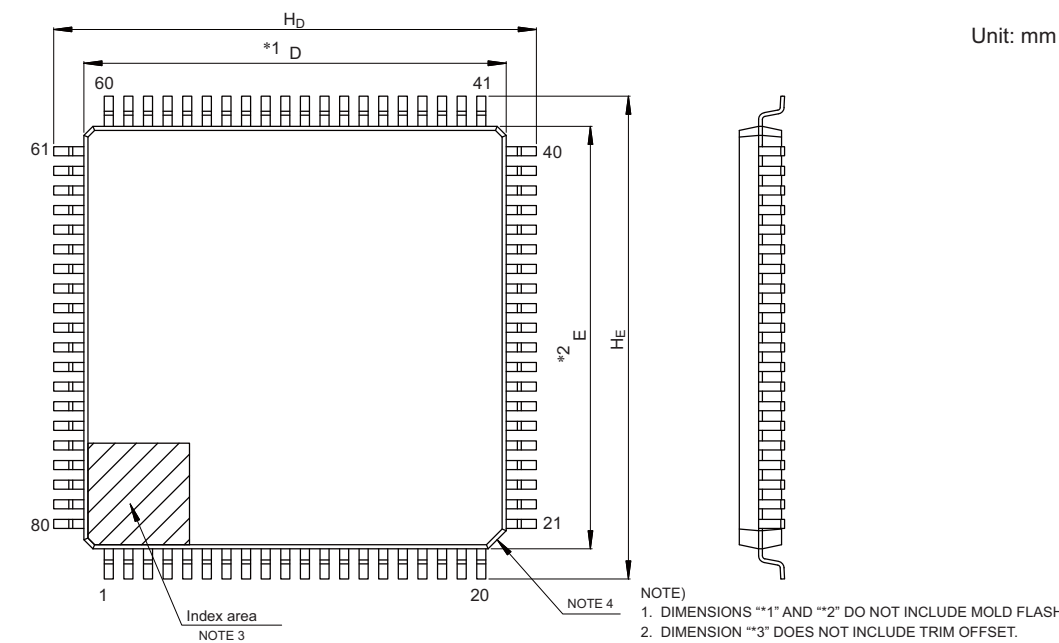
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R7F100GLK3CLA, R7F100GLL3CLA, R7F100GLN3CLA
R7F100GLF2DLA, R7F100GLG2DLA, R7F100GLH2DLA, R7F100GLJ2DLA,
R7F100GLK2DLA, R7F100GLL2DLA, R7F100GLN2DLA

Contact a Renesas Electronics sales office for details.

3.9 80-Pin Products

R7F100GMG3CFA, R7F100GMH3CFA, R7F100GMJ3CFA, R7F100GMK3CFA,
 R7F100GML3CFA, R7F100GMN3CFA
 R7F100GMG2DFA, R7F100GMH2DFA, R7F100GM2DFA, R7F100GMK2DFA,
 R7F100GML2DFA, R7F100GMN2DFA

JEITA Package Code	RENESAS Code	Previous Code	MASS (Typ) [g]
P-LQFP80-14x14-0.65	PLQP0080JA-B	—	0.6

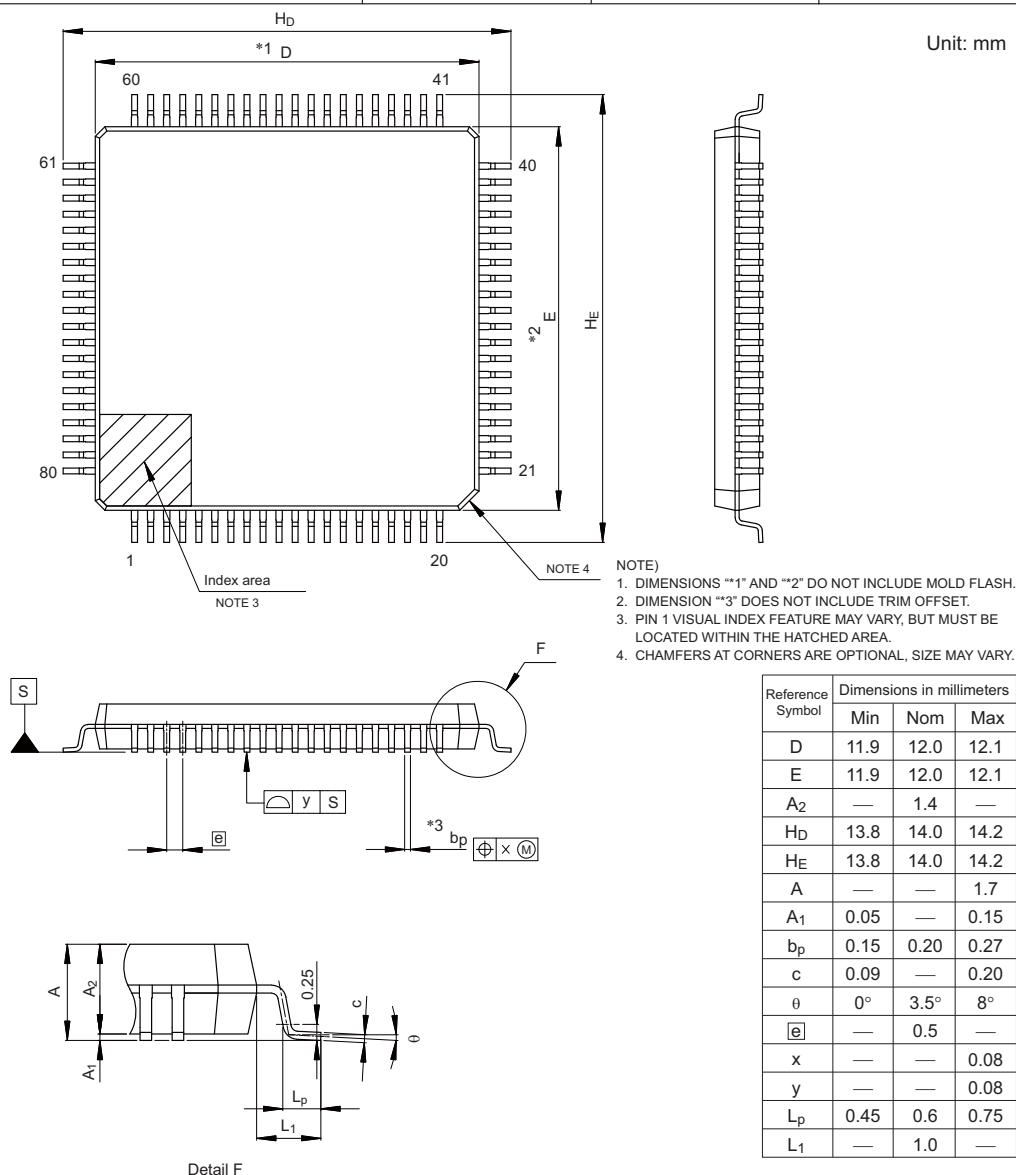


Reference Symbol	Dimensions in millimeters		
	Min	Nom	Max
D	13.9	14.0	14.1
E	13.9	14.0	14.1
A ₂	—	1.4	—
H _D	15.8	16.0	16.2
H _E	15.8	16.0	16.2
A	—	—	1.7
A ₁	0.05	—	0.15
b _p	0.22	0.30	0.38
c	0.09	—	0.20
θ	0°	3.5°	8°
e	—	0.65	—
x	—	—	0.13
y	—	—	0.10
L _p	0.45	0.6	0.75
L ₁	—	1.0	—

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R7F100GMG3CFB, R7F100GMH3CFB, R7F100GMJ3CFB, R7F100GMK3CFB,
 R7F100GML3CFB, R7F100GMN3CFB
 R7F100GMG2DFB, R7F100GMH2DFB, R7F100GM2DFB, R7F100GMK2DFB,
 R7F100GML2DFB, R7F100GMN2DFB

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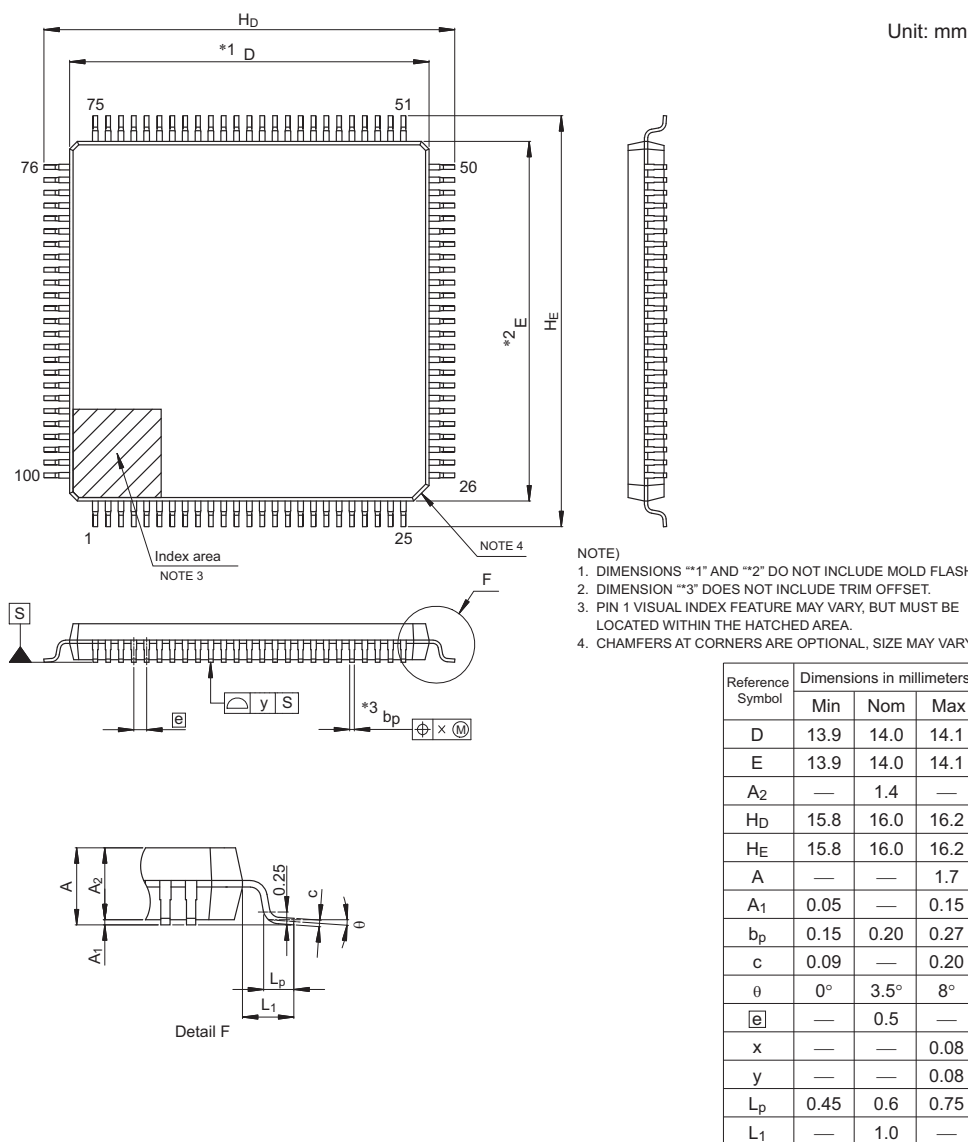


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3.10 100-Pin Products

R7F100GPG3CFB, R7F100GPH3CFB, R7F100GPJ3CFB, R7F100GPK3CFB,
 R7F100GPL3CFB, R7F100GPN3CFB
 R7F100GPG2DFB, R7F100GPH2DFB, R7F100GPJ2DFB, R7F100GPK2DFB,
 R7F100GPL2DFB, R7F100GPN2DFB

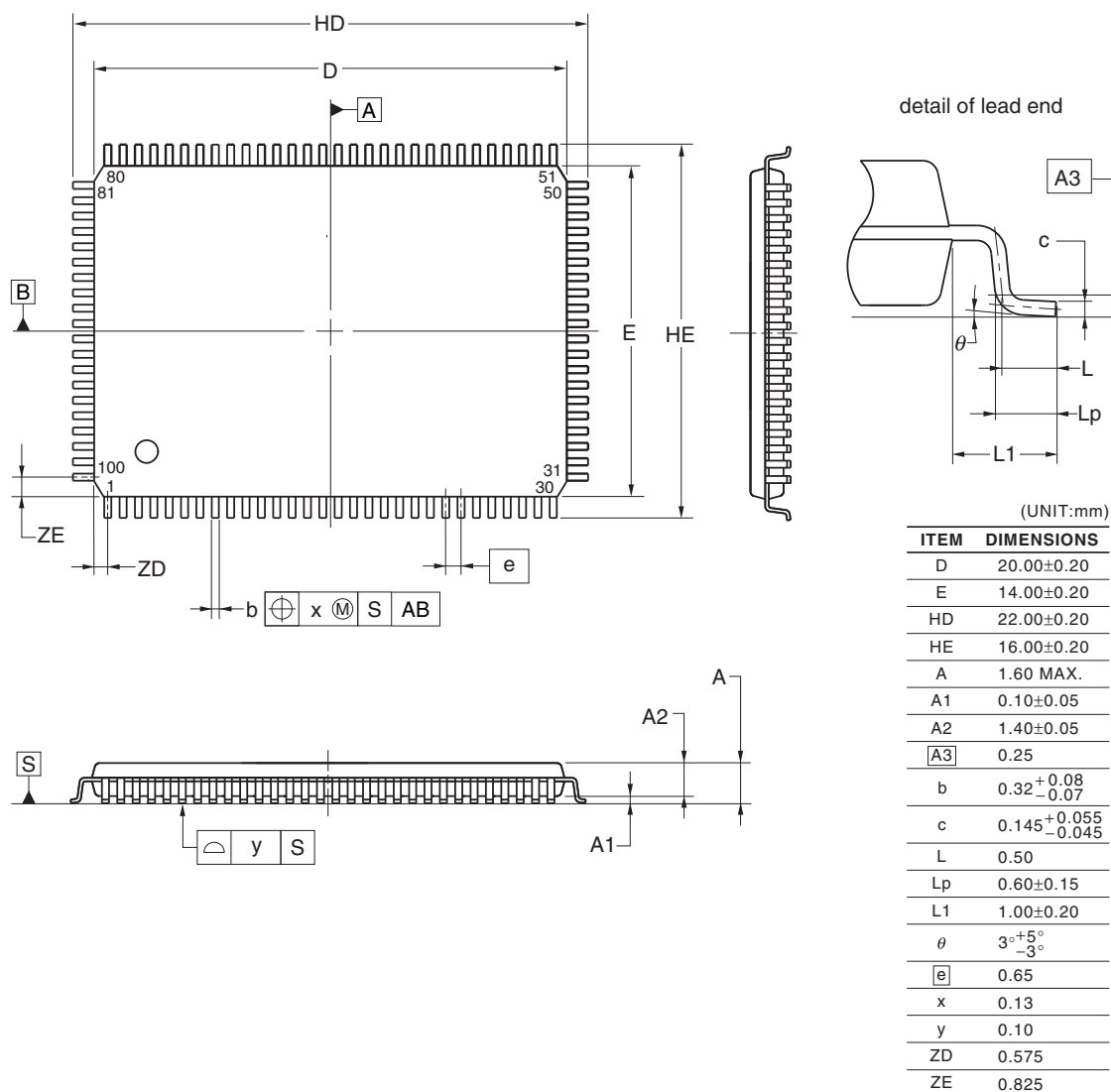
JEITA Package Code	RENESAS Code	Previous Code	MASS (Typ) [g]
P-LFQFP100-14x14-0.50	PLQP0100KB-B	—	0.6



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R7F100GPG3CFA, R7F100GPH3CFA, R7F100GPJ3CFA, R7F100GPK3CFA,
 R7F100GPL3CFA, R7F100GPN3CFA
 R7F100GPG2DFA, R7F100GPH2DFA, R7F100GPJ2DFA, R7F100GPK2DFA,
 R7F100GPL2DFA, R7F100GPN2DFA

JEITA Package Code	RENESAS Code	Previous Code	MASS (TYP.) [g]
P-LQFP100-14x20-0.65	PLQP0100JC-A	P100GF-65-GBN-1	0.92



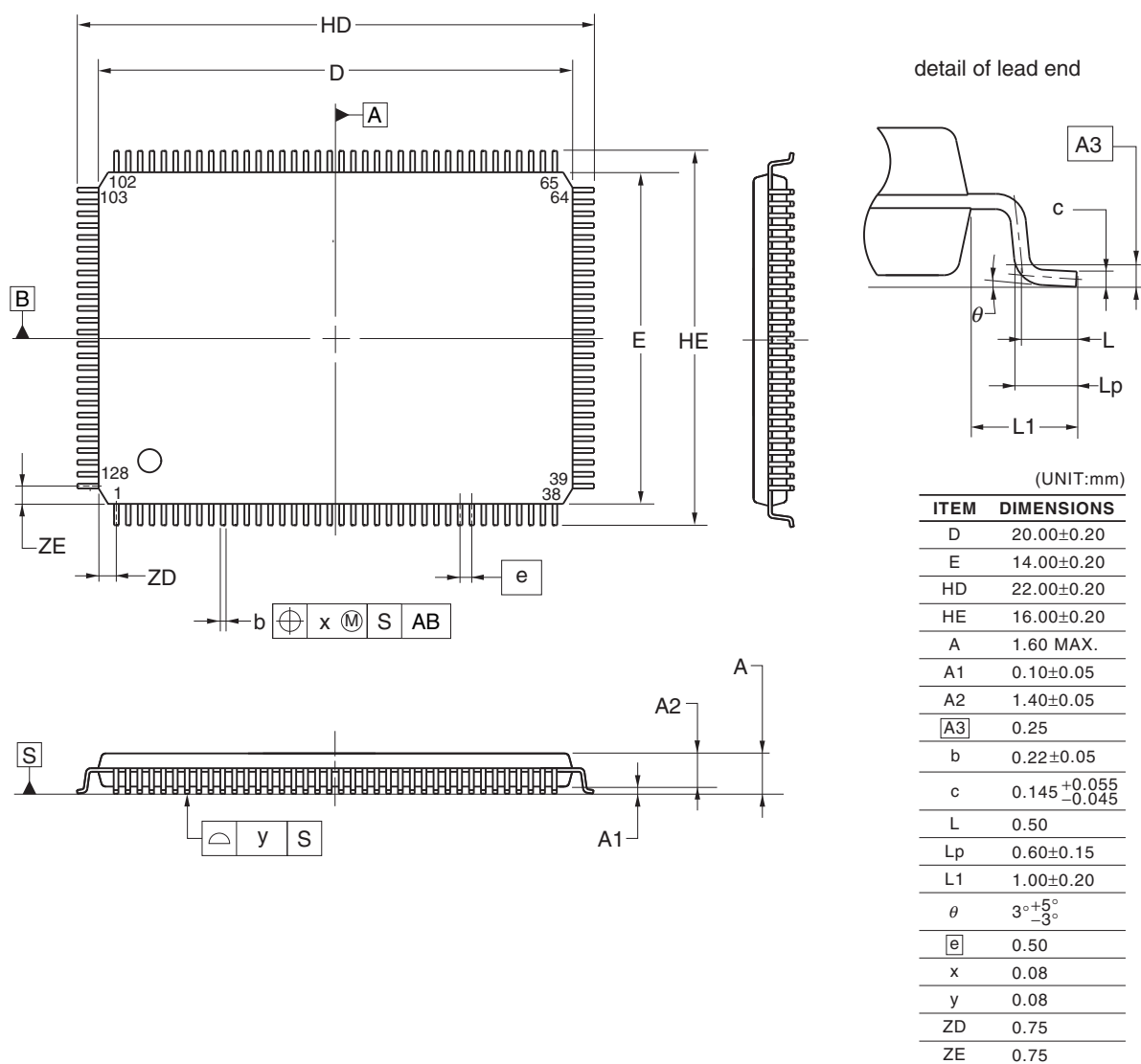
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3.11 128-Pin Products

R7F100GSJ3CFB, R7F100GSK3CFB, R7F100GSL3CFB, R7F100GSN3CFB

R7F100GSJ2DFB, R7F100GSK2DFB, R7F100GSL2DFB, R7F100GSN2DFB

JEITA Package Code	RENESAS Code	Previous Code	MASS (TYP.) [g]
P-LFQFP128-14x20-0.50	PLQP0128KD-A	P128GF-50-GBP-1	0.92



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REVISION HISTORY	RL78/G23 Datasheet
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Rev.	Date	Description	
		Page	Summary
1.00	Apr 13, 2021	—	First edition issued

SuperFlash is a registered trademark of Silicon Storage Technology, Inc. in several countries including the United States and Japan.

Caution: This product uses SuperFlash® technology licensed from Silicon Storage Technology, Inc.

All trademarks and registered trademarks are the property of their respective owners.

General Precautions in the Handling of Microprocessing Unit and Microcontroller Unit Products

The following usage notes are applicable to all Microprocessing unit and Microcontroller unit products from Renesas. For detailed usage notes on the products covered by this document, refer to the relevant sections of the document as well as any technical updates that have been issued for the products.

1. Precaution against Electrostatic Discharge (ESD)

A strong electrical field, when exposed to a CMOS device, can cause destruction of the gate oxide and ultimately degrade the device operation. Steps must be taken to stop the generation of static electricity as much as possible, and quickly dissipate it when it occurs. Environmental control must be adequate. When it is dry, a humidifier should be used. This is recommended to avoid using insulators that can easily build up static electricity. Semiconductor devices must be stored and transported in an anti-static container, static shielding bag or conductive material. All test and measurement tools including work benches and floors must be grounded. The operator must also be grounded using a wrist strap. Semiconductor devices must not be touched with bare hands. Similar precautions must be taken for printed circuit boards with mounted semiconductor devices.

2. Processing at power-on

The state of the product is undefined at the time when power is supplied. The states of internal circuits in the LSI are indeterminate and the states of register settings and pins are undefined at the time when power is supplied. In a finished product where the reset signal is applied to the external reset pin, the states of pins are not guaranteed from the time when power is supplied until the reset process is completed. In a similar way, the states of pins in a product that is reset by an on-chip power-on reset function are not guaranteed from the time when power is supplied until the power reaches the level at which resetting is specified.

3. Input of signal during power-off state

Do not input signals or an I/O pull-up power supply while the device is powered off. The current injection that results from input of such a signal or I/O pull-up power supply may cause malfunction and the abnormal current that passes in the device at this time may cause degradation of internal elements. Follow the guideline for input signal during power-off state as described in your product documentation.

4. Handling of unused pins

Handle unused pins in accordance with the directions given under handling of unused pins in the manual. The input pins of CMOS products are generally in the high-impedance state. In operation with an unused pin in the open-circuit state, extra electromagnetic noise is induced in the vicinity of the LSI, an associated shoot-through current flows internally, and malfunctions occur due to the false recognition of the pin state as an input signal become possible.

5. Clock signals

After applying a reset, only release the reset line after the operating clock signal becomes stable. When switching the clock signal during program execution, wait until the target clock signal is stabilized. When the clock signal is generated with an external resonator or from an external oscillator during a reset, ensure that the reset line is only released after full stabilization of the clock signal. Additionally, when switching to a clock signal produced with an external resonator or by an external oscillator while program execution is in progress, wait until the target clock signal is stable.

6. Voltage application waveform at input pin

Waveform distortion due to input noise or a reflected wave may cause malfunction. If the input of the CMOS device stays in the area between V_{IL} (Max.) and V_{IH} (Min.) due to noise, for example, the device may malfunction. Take care to prevent chattering noise from entering the device when the input level is fixed, and also in the transition period when the input level passes through the area between V_{IL} (Max.) and V_{IH} (Min.).

7. Prohibition of access to reserved addresses

Access to reserved addresses is prohibited. The reserved addresses are provided for possible future expansion of functions. Do not access these addresses as the correct operation of the LSI is not guaranteed.

8. Differences between products

Before changing from one product to another, for example to a product with a different part number, confirm that the change will not lead to problems. The characteristics of a microprocessing unit or microcontroller unit products in the same group but having a different part number might differ in terms of internal memory capacity, layout pattern, and other factors, which can affect the ranges of electrical characteristics, such as characteristic values, operating margins, immunity to noise, and amount of radiated noise. When changing to a product with a different part number, implement a system-evaluation test for the given product.

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