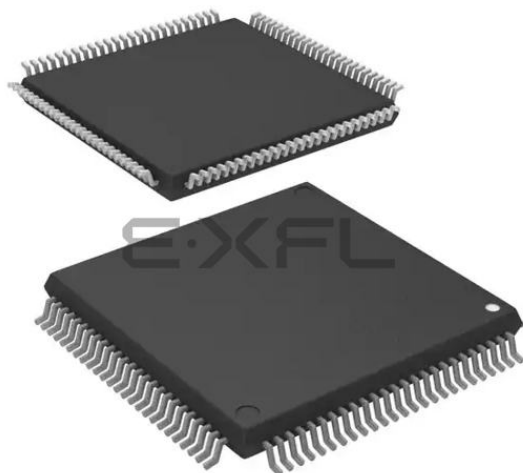




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### What is "[Embedded - Microcontrollers](#)"?

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

### Applications of "[Embedded - Microcontrollers](#)"

#### Details

|                            |                                                                                                                                                                               |
|----------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Product Status             | Active                                                                                                                                                                        |
| Core Processor             | RL78                                                                                                                                                                          |
| Core Size                  | 16-Bit                                                                                                                                                                        |
| Speed                      | 32MHz                                                                                                                                                                         |
| Connectivity               | CSI, I <sup>2</sup> C, LINbus, UART/USART                                                                                                                                     |
| Peripherals                | DMA, LVD, POR, PWM, WDT                                                                                                                                                       |
| Number of I/O              | 82                                                                                                                                                                            |
| Program Memory Size        | 256KB (256K x 8)                                                                                                                                                              |
| Program Memory Type        | FLASH                                                                                                                                                                         |
| EEPROM Size                | 8K x 8                                                                                                                                                                        |
| RAM Size                   | 20K x 8                                                                                                                                                                       |
| Voltage - Supply (Vcc/Vdd) | 1.6V ~ 5.5V                                                                                                                                                                   |
| Data Converters            | A/D 20x8/10b                                                                                                                                                                  |
| Oscillator Type            | Internal                                                                                                                                                                      |
| Operating Temperature      | -40°C ~ 85°C (TA)                                                                                                                                                             |
| Mounting Type              | Surface Mount                                                                                                                                                                 |
| Package / Case             | 100-LQFP                                                                                                                                                                      |
| Supplier Device Package    | 100-LQFP (14x14)                                                                                                                                                              |
| Purchase URL               | <a href="https://www.e-xfl.com/product-detail/renesas-electronics-america/r5f100pjafb-50">https://www.e-xfl.com/product-detail/renesas-electronics-america/r5f100pjafb-50</a> |

## ○ ROM, RAM capacities

| Flash ROM | Data flash | RAM          | RL78/G13 |          |          |          |          |          |
|-----------|------------|--------------|----------|----------|----------|----------|----------|----------|
|           |            |              | 20 pins  | 24 pins  | 25 pins  | 30 pins  | 32 pins  | 36 pins  |
| 128 KB    | 8 KB       | 12 KB        | —        | —        | —        | R5F100AG | R5F100BG | R5F100CG |
|           | —          |              | —        | —        | —        | R5F101AG | R5F101BG | R5F101CG |
| 96 KB     | 8 KB       | 8 KB         | —        | —        | —        | R5F100AF | R5F100BF | R5F100CF |
|           | —          |              | —        | —        | —        | R5F101AF | R5F101BF | R5F101CF |
| 64 KB     | 4 KB       | 4 KB<br>Note | R5F1006E | R5F1007E | R5F1008E | R5F100AE | R5F100BE | R5F100CE |
|           | —          |              | R5F1016E | R5F1017E | R5F1018E | R5F101AE | R5F101BE | R5F101CE |
| 48 KB     | 4 KB       | 3 KB<br>Note | R5F1006D | R5F1007D | R5F1008D | R5F100AD | R5F100BD | R5F100CD |
|           | —          |              | R5F1016D | R5F1017D | R5F1018D | R5F101AD | R5F101BD | R5F101CD |
| 32 KB     | 4 KB       | 2 KB         | R5F1006C | R5F1007C | R5F1008C | R5F100AC | R5F100BC | R5F100CC |
|           | —          |              | R5F1016C | R5F1017C | R5F1018C | R5F101AC | R5F101BC | R5F101CC |
| 16 KB     | 4 KB       | 2 KB         | R5F1006A | R5F1007A | R5F1008A | R5F100AA | R5F100BA | R5F100CA |
|           | —          |              | R5F1016A | R5F1017A | R5F1018A | R5F101AA | R5F101BA | R5F101CA |

| Flash ROM | Data flash | RAM           | RL78/G13 |          |          |          |          |          |          |          |
|-----------|------------|---------------|----------|----------|----------|----------|----------|----------|----------|----------|
|           |            |               | 40 pins  | 44 pins  | 48 pins  | 52 pins  | 64 pins  | 80 pins  | 100 pins | 128 pins |
| 512 KB    | 8 KB       | 32 KB<br>Note | —        | R5F100FL | R5F100GL | R5F100JL | R5F100LL | R5F100ML | R5F100PL | R5F100SL |
|           | —          |               | —        | R5F101FL | R5F101GL | R5F101JL | R5F101LL | R5F101ML | R5F101PL | R5F101SL |
| 384 KB    | 8 KB       | 24 KB         | —        | R5F100FK | R5F100GK | R5F100JK | R5F100LK | R5F100MK | R5F100PK | R5F100SK |
|           | —          |               | —        | R5F101FK | R5F101GK | R5F101JK | R5F101LK | R5F101MK | R5F101PK | R5F101SK |
| 256 KB    | 8 KB       | 20 KB<br>Note | —        | R5F100FJ | R5F100GJ | R5F100JJ | R5F100LJ | R5F100MJ | R5F100PJ | R5F100SJ |
|           | —          |               | —        | R5F101FJ | R5F101GJ | R5F101JJ | R5F101LJ | R5F101MJ | R5F101PJ | R5F101SJ |
| 192 KB    | 8 KB       | 16 KB         | R5F100EH | R5F100FH | R5F100GH | R5F100JH | R5F100LH | R5F100MH | R5F100PH | R5F100SH |
|           | —          |               | R5F101EH | R5F101FH | R5F101GH | R5F101JH | R5F101LH | R5F101MH | R5F101PH | R5F101SH |
| 128 KB    | 8 KB       | 12 KB         | R5F100EG | R5F100FG | R5F100GG | R5F100JG | R5F100LG | R5F100MG | R5F100PG | —        |
|           | —          |               | R5F101EG | R5F101FG | R5F101GG | R5F101JG | R5F101LG | R5F101MG | R5F101PG | —        |
| 96 KB     | 8 KB       | 8 KB          | R5F100EF | R5F100FF | R5F100GF | R5F100JF | R5F100LF | R5F100MF | R5F100PF | —        |
|           | —          |               | R5F101EF | R5F101FF | R5F101GF | R5F101JF | R5F101LF | R5F101MF | R5F101PF | —        |
| 64 KB     | 4 KB       | 4 KB<br>Note  | R5F100EE | R5F100FE | R5F100GE | R5F100JE | R5F100LE | —        | —        | —        |
|           | —          |               | R5F101EE | R5F101FE | R5F101GE | R5F101JE | R5F101LE | —        | —        | —        |
| 48 KB     | 4 KB       | 3 KB<br>Note  | R5F100ED | R5F100FD | R5F100GD | R5F100JD | R5F100LD | —        | —        | —        |
|           | —          |               | R5F101ED | R5F101FD | R5F101GD | R5F101JD | R5F101LD | —        | —        | —        |
| 32 KB     | 4 KB       | 2 KB          | R5F100EC | R5F100FC | R5F100GC | R5F100JC | R5F100LC | —        | —        | —        |
|           | —          |               | R5F101EC | R5F101FC | R5F101GC | R5F101JC | R5F101LC | —        | —        | —        |
| 16 KB     | 4 KB       | 2 KB          | R5F100EA | R5F100FA | R5F100GA | —        | —        | —        | —        | —        |
|           | —          |               | R5F101EA | R5F101FA | R5F101GA | —        | —        | —        | —        | —        |

**Note** The flash library uses RAM in self-programming and rewriting of the data flash memory.

The target products and start address of the RAM areas used by the flash library are shown below.

R5F100xD, R5F101xD (x = 6 to 8, A to C, E to G, J, L): Start address FF300H

R5F100xE, R5F101xE (x = 6 to 8, A to C, E to G, J, L): Start address FEF00H

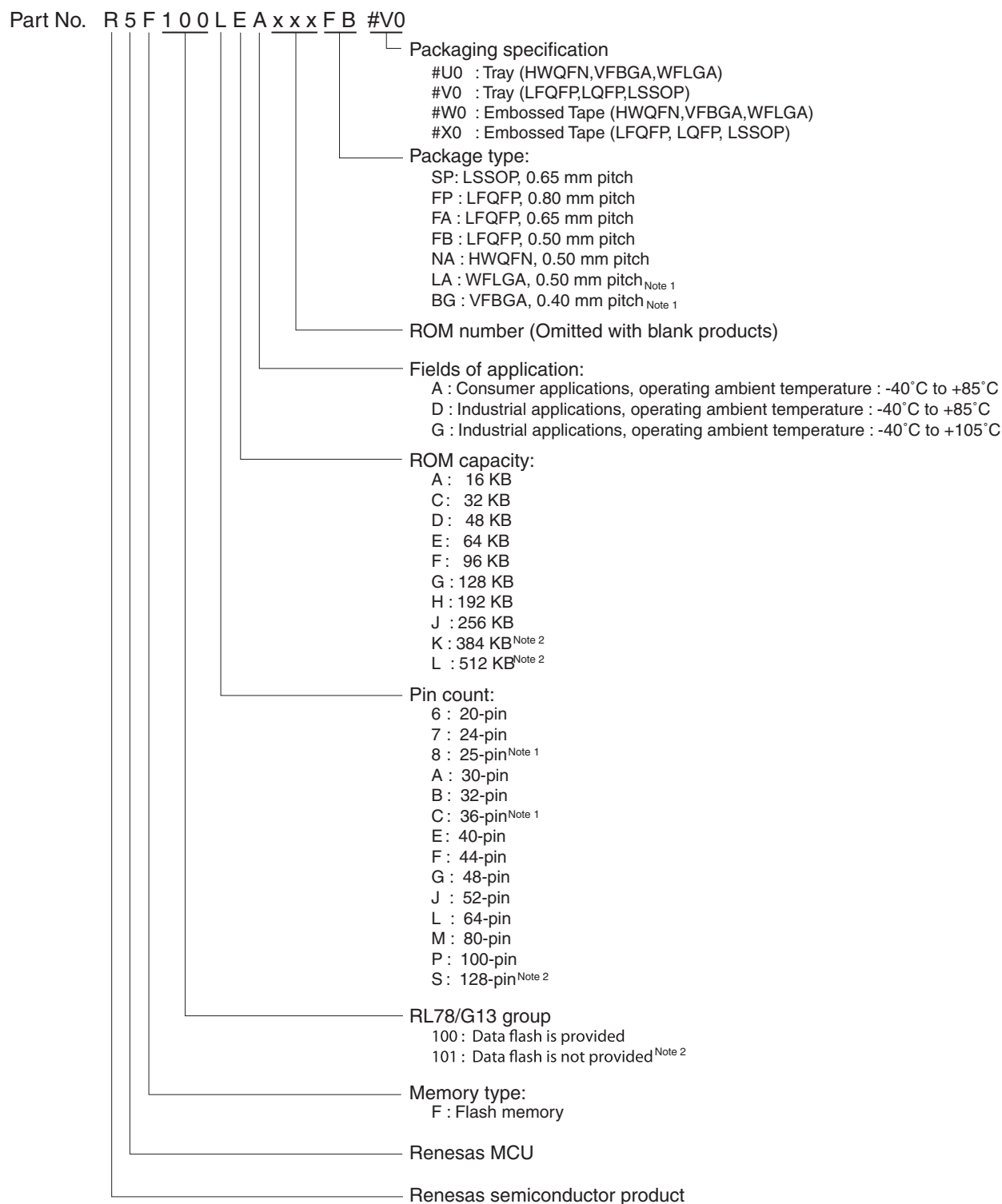
R5F100xJ, R5F101xJ (x = F, G, J, L, M, P): Start address FAF00H

R5F100xL, R5F101xL (x = F, G, J, L, M, P, S): Start address F7F00H

For the RAM areas used by the flash library, see **Self RAM list of Flash Self-Programming Library for RL78 Family (R20UT2944)**.

## 1.2 List of Part Numbers

Figure 1-1. Part Number, Memory Size, and Package of RL78/G13



- Notes**
1. Products only for "A: Consumer applications ( $T_A = -40$  to  $+85^\circ\text{C}$ )", and "G: Industrial applications ( $T_A = -40$  to  $+105^\circ\text{C}$ )"
  2. Products only for "A: Consumer applications ( $T_A = -40$  to  $+85^\circ\text{C}$ )", and "D: Industrial applications ( $T_A = -40$  to  $+85^\circ\text{C}$ )"

Table 1-1. List of Ordering Part Numbers

(9/12)

| Pin count | Package                                             | Data flash  | Fields of Application<br>Note | Ordering Part Number                                                                                                                                                                                                                                                                             |
|-----------|-----------------------------------------------------|-------------|-------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 64 pins   | 64-pin plastic<br>LFQFP (10 × 10 mm, 0.5 mm pitch)  | Mounted     | A                             | R5F100LCAFB#V0, R5F100LDAFB#V0, R5F100LEAFB#V0, R5F100LFAFB#V0, R5F100LGAFB#V0, R5F100LHAFB#V0, R5F100LJAFB#V0, R5F100LKAFB#V0, R5F100LLAFB#V0<br>R5F100LCAFB#X0, R5F100LDAFB#X0, R5F100LEAFB#X0, R5F100LFAFB#X0, R5F100LGAFB#X0, R5F100LHAFB#X0, R5F100LJAFB#X0, R5F100LKAFB#X0, R5F100LLAFB#X0 |
|           |                                                     |             | D                             | R5F100LCDFB#V0, R5F100LDDFB#V0, R5F100LEDFB#V0, R5F100LFDDB#V0, R5F100LGDFB#V0, R5F100LHDFB#V0, R5F100LJDFB#V0, R5F100LKDFB#V0, R5F100LLDFB#V0<br>R5F100LCDFB#X0, R5F100LDDFB#X0, R5F100LEDFB#X0, R5F100LFDDB#X0, R5F100LGDFB#X0, R5F100LHDFB#X0, R5F100LJDFB#X0, R5F100LKDFB#X0, R5F100LLDFB#X0 |
|           |                                                     |             | G                             | R5F100LCGFB#V0, R5F100LDGFB#V0, R5F100LEGFB#V0, R5F100LFGFB#V0<br>R5F100LCGFB#X0, R5F100LDGFB#X0, R5F100LEGFB#X0, R5F100LFGFB#X0                                                                                                                                                                 |
|           |                                                     |             |                               | R5F100LGGFB#V0, R5F100LHGFB#V0, R5F100LJGFB#V0, R5F100LGGFB#X0, R5F100LHGFB#X0, R5F100LJGFB#X0                                                                                                                                                                                                   |
|           | 64-pin plastic<br>VFBGA<br>(4 × 4 mm, 0.4 mm pitch) | Not mounted | A                             | R5F101LCAFB#V0, R5F101LDAFB#V0, R5F101LEAFB#V0, R5F101LFAFB#V0, R5F101LGAFB#V0, R5F101LHAFB#V0, R5F101LJAFB#V0, R5F101LKAFB#V0, R5F101LLAFB#V0<br>R5F101LCAFB#X0, R5F101LDAFB#X0, R5F101LEAFB#X0, R5F101LFAFB#X0, R5F101LGAFB#X0, R5F101LHAFB#X0, R5F101LJAFB#X0, R5F101LKAFB#X0, R5F101LLAFB#X0 |
|           |                                                     |             | D                             | R5F101LCDFB#V0, R5F101LDDFB#V0, R5F101LEDFB#V0, R5F101LFDDB#V0, R5F101LGDFB#V0, R5F101LHDFB#V0, R5F101LJDFB#V0, R5F101LKDFB#V0, R5F101LLDFB#V0<br>R5F101LCDFB#X0, R5F101LDDFB#X0, R5F101LEDFB#X0, R5F101LFDDB#X0, R5F101LGDFB#X0, R5F101LHDFB#X0, R5F101LJDFB#X0, R5F101LKDFB#X0, R5F101LLDFB#X0 |
|           | 64-pin plastic<br>VFBGA<br>(4 × 4 mm, 0.4 mm pitch) | Mounted     | A                             | R5F100LCABG#U0, R5F100LDABG#U0, R5F100LEABG#U0, R5F100LFABG#U0, R5F100LGABG#U0, R5F100LHABG#U0, R5F100LJABG#U0<br>R5F100LCABG#W0, R5F100LDABG#W0, R5F100LEABG#W0, R5F100LFABG#W0, R5F100LGABG#W0, R5F100LHABG#W0, R5F100LJABG#W0                                                                 |
|           |                                                     |             | G                             | R5F100LCGBG#U0, R5F100LDGBG#U0, R5F100LEGBG#U0, R5F100LFGBG#U0, R5F100LGGBG#U0, R5F100LHGBG#U0, R5F100LJGBG#U0<br>R5F100LCGBG#W0, R5F100LDGBG#W0, R5F100LEGBG#W0, R5F100LFGBG#W0, R5F100LGGBG#W0, R5F100LHGBG#W0, R5F100LJGBG#W0                                                                 |
|           | 64-pin plastic<br>VFBGA<br>(4 × 4 mm, 0.4 mm pitch) | Not mounted | A                             | R5F101LCABG#U0, R5F101LDABG#U0, R5F101LEABG#U0, R5F101LFABG#U0, R5F101LGABG#U0, R5F101LHABG#U0, R5F101LJABG#U0<br>R5F101LCABG#W0, R5F101LDABG#W0, R5F101LEABG#W0, R5F101LFABG#W0, R5F101LGABG#W0, R5F101LHABG#W0, R5F101LJABG#W0                                                                 |

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

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

Table 1-1. List of Ordering Part Numbers

(12/12)

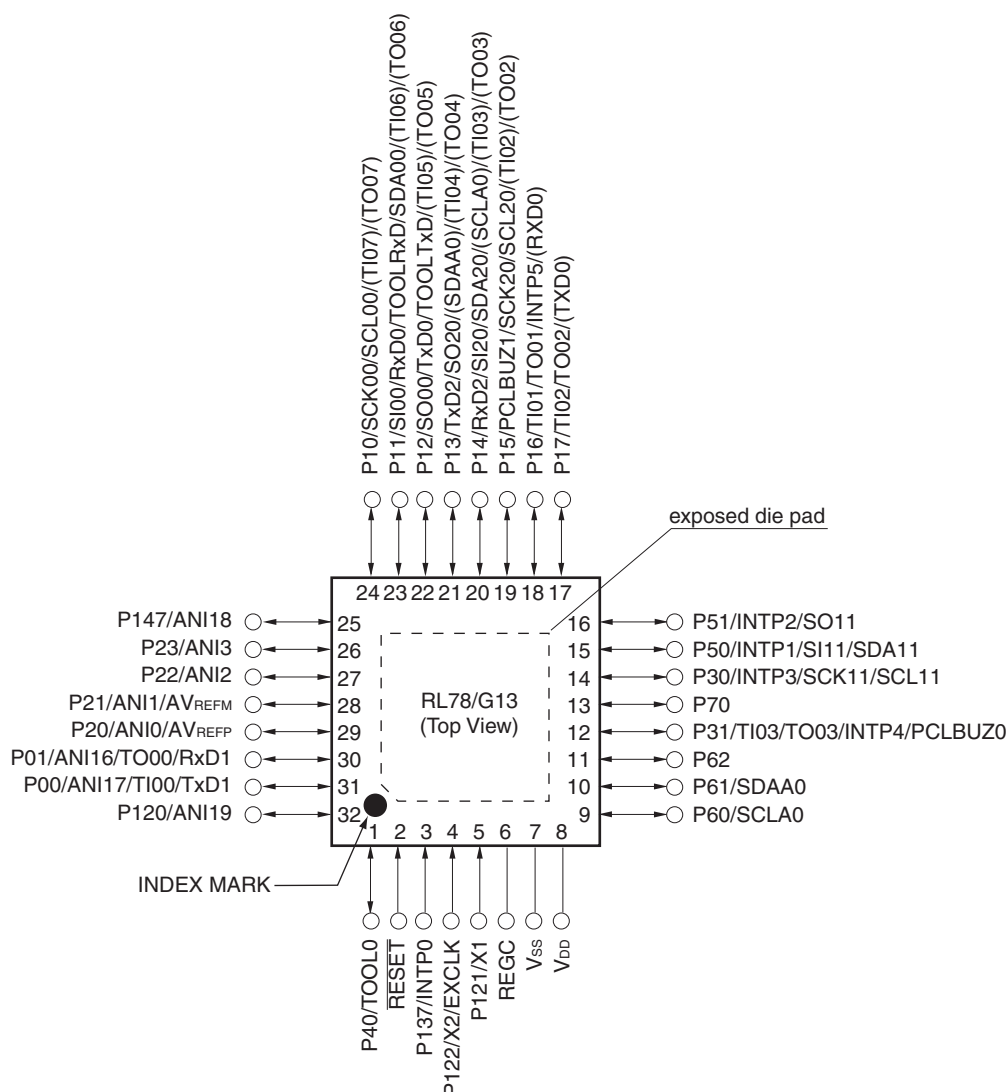
| Pin count | Package                                             | Data flash  | Fields of Application <sup>Note</sup>      | Ordering Part Number                                                                                                                                                                                                                                                             |
|-----------|-----------------------------------------------------|-------------|--------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 128 pins  | 128-pin plastic LFQFP<br>(14 × 20 mm, 0.5 mm pitch) | Mounted     | A<br><br><br><br><br><br><br><br><br><br>D | R5F100SHAFB#V0, R5F100SJAFB#V0,<br>R5F100SKAFB#V0, R5F100SLAFB#V0<br>R5F100SHAFB#X0, R5F100SJAFB#X0,<br>R5F100SKAFB#X0, R5F100SLAFB#X0<br>R5F100SHDFB#V0, R5F100SJDFB#V0,<br>R5F100SKDFB#V0, R5F100SLDFB#V0<br>R5F100SHDFB#X0, R5F100SJDFB#X0,<br>R5F100SKDFB#X0, R5F100SLDFB#X0 |
|           |                                                     | Not mounted | A<br><br><br><br><br><br><br><br><br><br>D | R5F101SHAFB#V0, R5F101SJAFB#V0,<br>R5F101SKAFB#V0, R5F101SLAFB#V0<br>R5F101SHAFB#X0, R5F101SJAFB#X0,<br>R5F101SKAFB#X0, R5F101SLAFB#X0<br>R5F101SHDFB#V0, R5F101SJDFB#V0,<br>R5F101SKDFB#V0, R5F101SLDFB#V0<br>R5F101SHDFB#X0, R5F101SJDFB#X0,<br>R5F101SKDFB#X0, R5F101SLDFB#X0 |

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

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

## 1.3.5 32-pin products

- 32-pin plastic HWQFN (5 × 5 mm, 0.5 mm pitch)



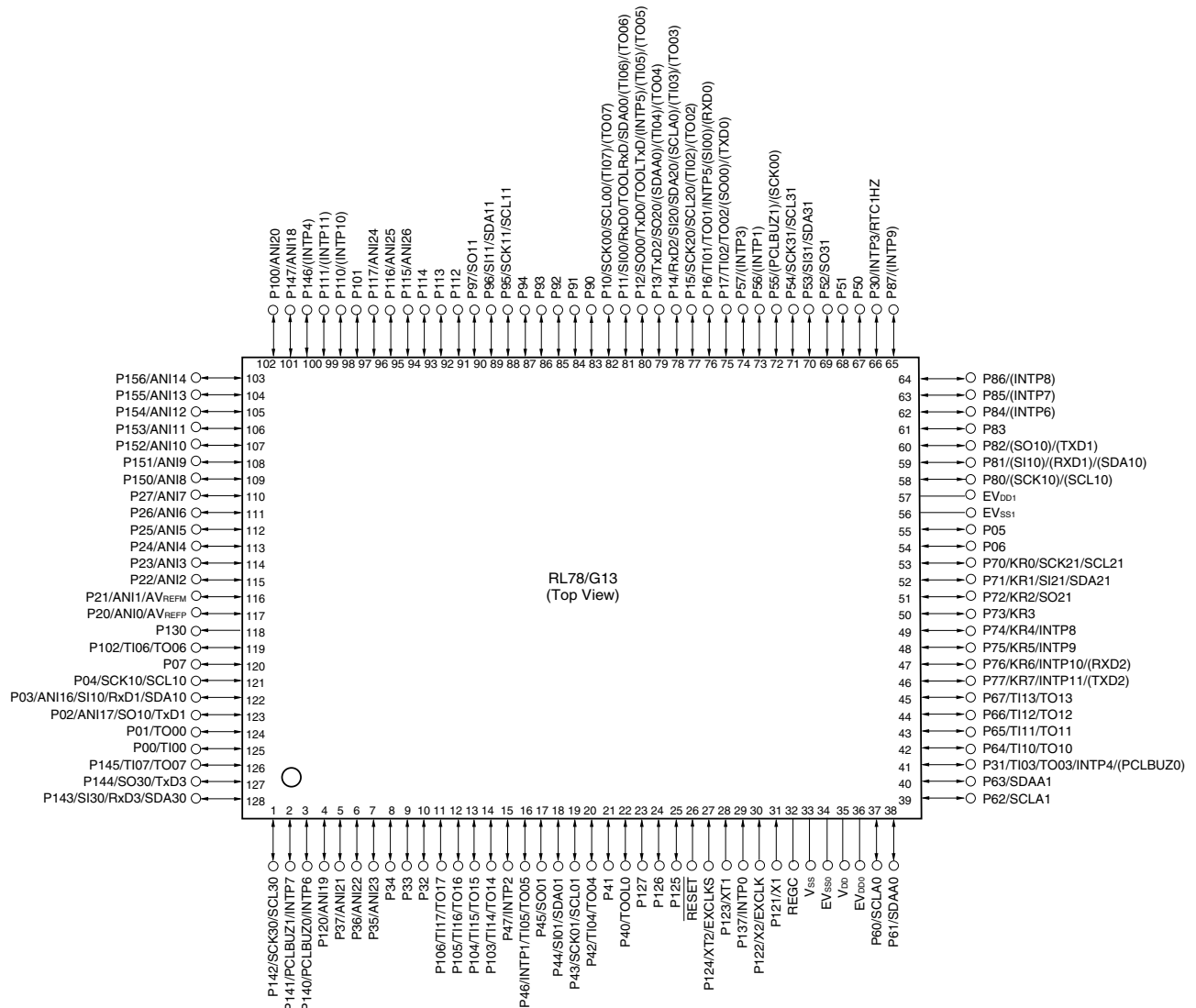
**Caution** Connect the REGC pin to Vss via a capacitor (0.47 to 1  $\mu$ F).

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

- Functions in parentheses in the above figure can be assigned via settings in the peripheral I/O redirection register (PIOR). Refer to **Figure 4-8 Format of Peripheral I/O Redirection Register (PIOR)** in the RL78/G13 User's Manual.
- It is recommended to connect an exposed die pad to Vss.

## 1.3.14 128-pin products

- 128-pin plastic LFQFP (14 × 20 mm, 0.5 mm pitch)



- Cautions**
1. Make EV<sub>SS0</sub>, EV<sub>SS1</sub> pins the same potential as V<sub>SS</sub> pin.
  2. Make V<sub>DD</sub> pin the potential that is higher than EV<sub>DD0</sub>, EV<sub>DD1</sub> pins (EV<sub>DD0</sub> = EV<sub>DD1</sub>).
  3. Connect the REGC pin to V<sub>SS</sub> via a capacitor (0.47 to 1  $\mu$ F).

- Remarks**
1. For pin identification, see 1.4 Pin Identification.
  2. When using the microcontroller for an application where the noise generated inside the microcontroller must be reduced, it is recommended to supply separate powers to the V<sub>DD</sub>, EV<sub>DD0</sub> and EV<sub>DD1</sub> pins and connect the V<sub>SS</sub>, EV<sub>SS0</sub> and EV<sub>SS1</sub> pins to separate ground lines.
  3. Functions in parentheses in the above figure can be assigned via settings in the peripheral I/O redirection register (PIOR). Refer to **Figure 4-8 Format of Peripheral I/O Redirection Register (PIOR)** in the RL78/G13 User's Manual.

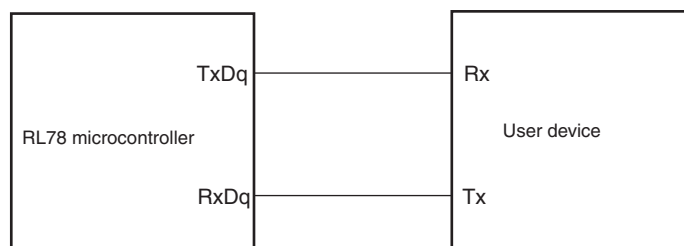
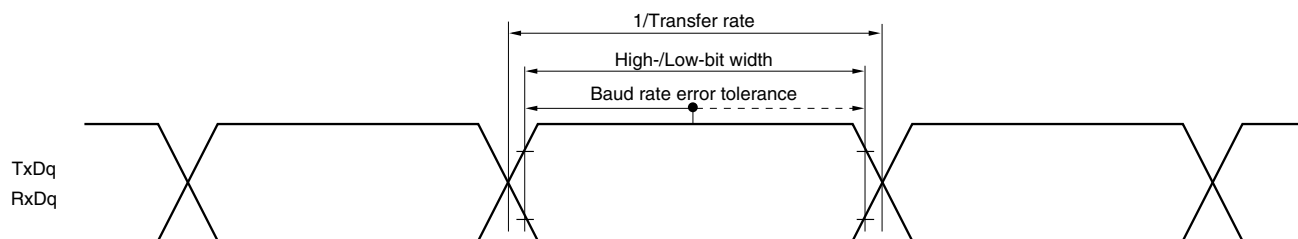
(T<sub>A</sub> = -40 to +85°C, 1.6 V ≤ E<sub>VDD0</sub> = E<sub>VDD1</sub> ≤ V<sub>DD</sub> ≤ 5.5 V, V<sub>SS</sub> = E<sub>VSS0</sub> = E<sub>VSS1</sub> = 0 V) (4/5)

| Items                | Symbol           | Conditions                                                                                                                                                                     | MIN.                                                           | TYP.                    | MAX. | Unit |
|----------------------|------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------|-------------------------|------|------|
| Output voltage, high | V <sub>OH1</sub> | 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 ≤ E <sub>VDD0</sub> ≤ 5.5 V, I <sub>OH1</sub> = -10.0 mA | E <sub>VDD0</sub> - 1.5 |      | V    |
|                      |                  |                                                                                                                                                                                | 4.0 V ≤ E <sub>VDD0</sub> ≤ 5.5 V, I <sub>OH1</sub> = -3.0 mA  | E <sub>VDD0</sub> - 0.7 |      | V    |
|                      |                  |                                                                                                                                                                                | 2.7 V ≤ E <sub>VDD0</sub> ≤ 5.5 V, I <sub>OH1</sub> = -2.0 mA  | E <sub>VDD0</sub> - 0.6 |      | V    |
|                      |                  |                                                                                                                                                                                | 1.8 V ≤ E <sub>VDD0</sub> ≤ 5.5 V, I <sub>OH1</sub> = -1.5 mA  | E <sub>VDD0</sub> - 0.5 |      | V    |
|                      |                  |                                                                                                                                                                                | 1.6 V ≤ E <sub>VDD0</sub> < 5.5 V, I <sub>OH1</sub> = -1.0 mA  | E <sub>VDD0</sub> - 0.5 |      | V    |
|                      | V <sub>OH2</sub> | P20 to P27, P150 to P156                                                                                                                                                       | 1.6 V ≤ V <sub>DD</sub> ≤ 5.5 V, I <sub>OH2</sub> = -100 μA    | V <sub>DD</sub> - 0.5   |      | V    |
| Output voltage, low  | V <sub>OL1</sub> | 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 ≤ E <sub>VDD0</sub> ≤ 5.5 V, I <sub>OL1</sub> = 20 mA    |                         | 1.3  | V    |
|                      |                  |                                                                                                                                                                                | 4.0 V ≤ E <sub>VDD0</sub> ≤ 5.5 V, I <sub>OL1</sub> = 8.5 mA   |                         | 0.7  | V    |
|                      |                  |                                                                                                                                                                                | 2.7 V ≤ E <sub>VDD0</sub> ≤ 5.5 V, I <sub>OL1</sub> = 3.0 mA   |                         | 0.6  | V    |
|                      |                  |                                                                                                                                                                                | 2.7 V ≤ E <sub>VDD0</sub> ≤ 5.5 V, I <sub>OL1</sub> = 1.5 mA   |                         | 0.4  | V    |
|                      |                  |                                                                                                                                                                                | 1.8 V ≤ E <sub>VDD0</sub> ≤ 5.5 V, I <sub>OL1</sub> = 0.6 mA   |                         | 0.4  | V    |
|                      |                  |                                                                                                                                                                                | 1.6 V ≤ E <sub>VDD0</sub> < 5.5 V, I <sub>OL1</sub> = 0.3 mA   |                         | 0.4  | V    |
|                      | V <sub>OL2</sub> | P20 to P27, P150 to P156                                                                                                                                                       | 1.6 V ≤ V <sub>DD</sub> ≤ 5.5 V, I <sub>OL2</sub> = 400 μA     |                         | 0.4  | V    |
|                      | V <sub>OL3</sub> | P60 to P63                                                                                                                                                                     | 4.0 V ≤ E <sub>VDD0</sub> ≤ 5.5 V, I <sub>OL3</sub> = 15.0 mA  |                         | 2.0  | V    |
|                      |                  |                                                                                                                                                                                | 4.0 V ≤ E <sub>VDD0</sub> ≤ 5.5 V, I <sub>OL3</sub> = 5.0 mA   |                         | 0.4  | V    |
|                      |                  |                                                                                                                                                                                | 2.7 V ≤ E <sub>VDD0</sub> ≤ 5.5 V, I <sub>OL3</sub> = 3.0 mA   |                         | 0.4  | V    |
|                      |                  |                                                                                                                                                                                | 1.8 V ≤ E <sub>VDD0</sub> ≤ 5.5 V, I <sub>OL3</sub> = 2.0 mA   |                         | 0.4  | V    |
|                      |                  |                                                                                                                                                                                | 1.6 V ≤ E <sub>VDD0</sub> < 5.5 V, I <sub>OL3</sub> = 1.0 mA   |                         | 0.4  | 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 in N-ch open-drain mode.

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

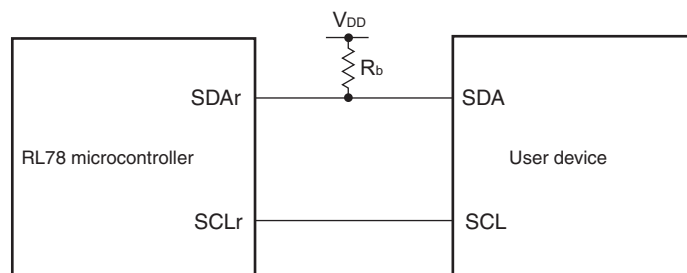
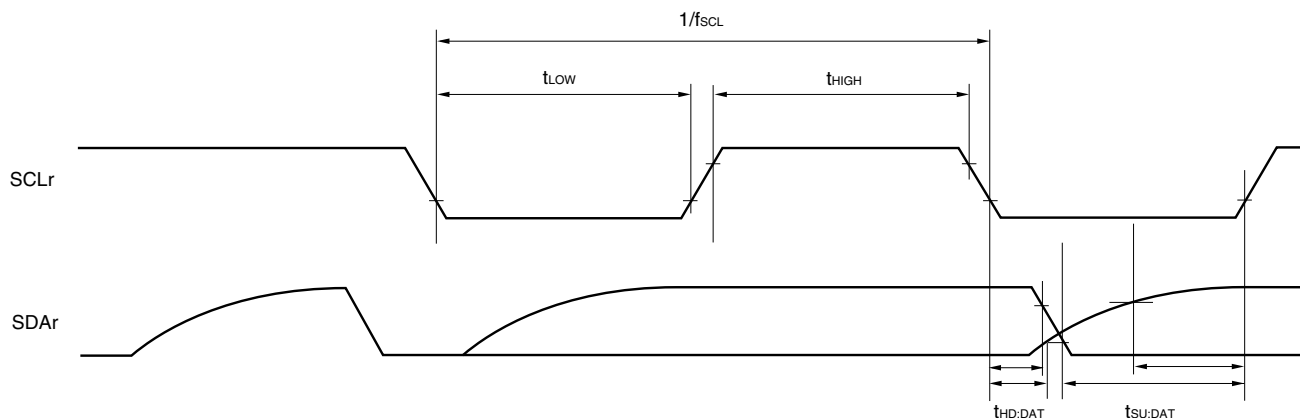


**UART mode connection diagram (during communication at same potential)****UART mode bit width (during communication at same potential) (reference)**

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

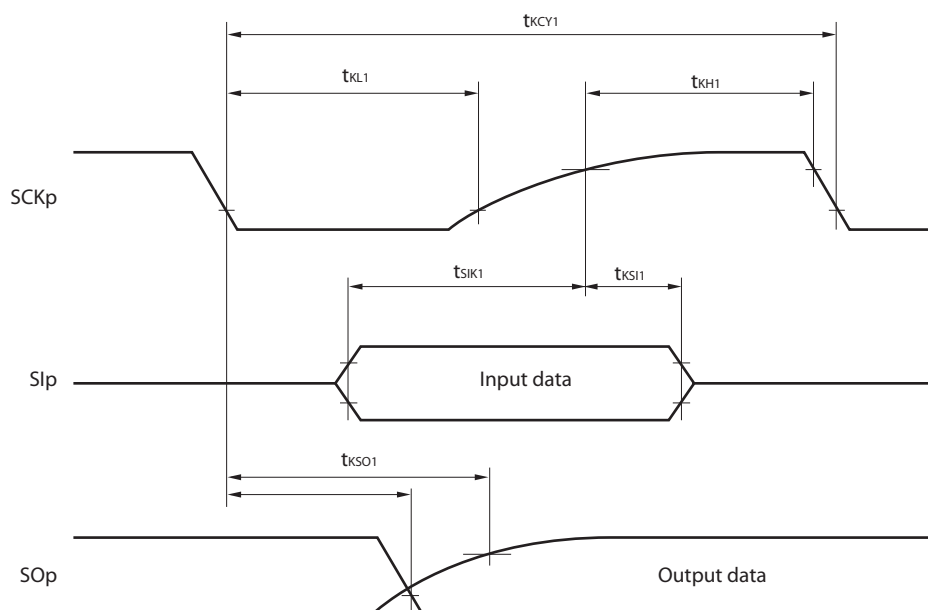
**2.**  $f_{MCK}$ : Serial array unit operation clock frequency

(Operation clock to be set by the CKSmn bit of serial mode register mn (SMRmn). m: Unit number, n: Channel number (mn = 00 to 03, 10 to 13))

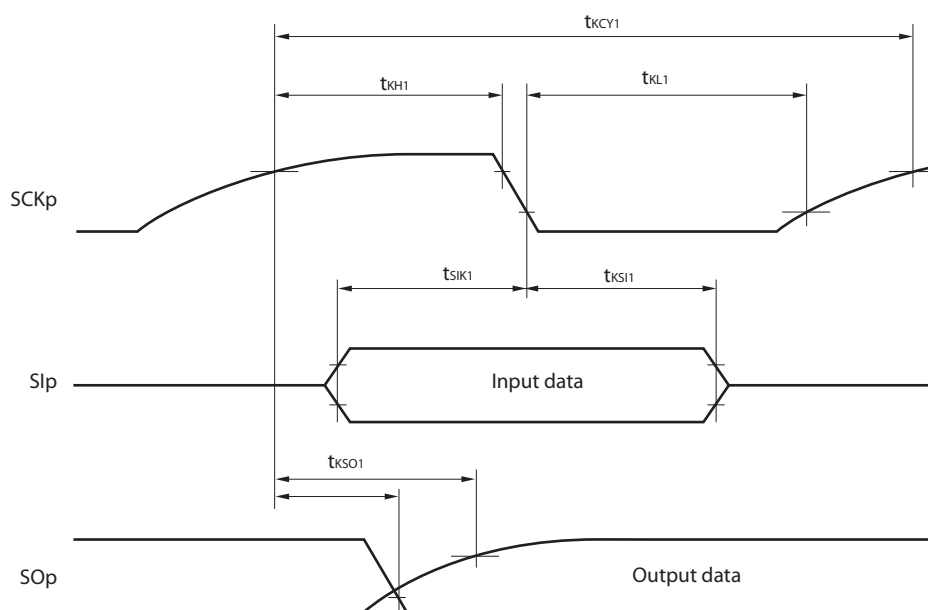
**Simplified I<sup>2</sup>C mode connection diagram (during communication at same potential)****Simplified I<sup>2</sup>C mode serial transfer timing (during communication at same potential)**

- Remarks**
1.  $R_b[\Omega]$ : Communication line (SDAr) pull-up resistance,  $C_b[F]$ : Communication line (SDAr, SCLr) load capacitance
  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)
  3.  $f_{MCK}$ : Serial array unit operation clock frequency  
(Operation clock to be set by the CKSmn bit of serial mode register mn (SMRmn). m: Unit number (m = 0, 1),  
n: Channel number (n = 0 to 3), mn = 00 to 03, 10 to 13)

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



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



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

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

(T<sub>A</sub> = -40 to +85°C, 1.8 V ≤ EV<sub>DD0</sub> = EV<sub>DD1</sub> ≤ V<sub>DD</sub> ≤ 5.5 V, V<sub>SS</sub> = EV<sub>SS0</sub> = EV<sub>SS1</sub> = 0 V) (1/2)

| Parameter                         | Symbol            | Conditions                                                                             |                                    | HS (high-speed main) Mode |      | LS (low-speed main) Mode |      | LV (low-voltage main) Mode |      | Unit |
|-----------------------------------|-------------------|----------------------------------------------------------------------------------------|------------------------------------|---------------------------|------|--------------------------|------|----------------------------|------|------|
|                                   |                   |                                                                                        |                                    | MIN.                      | MAX. | MIN.                     | MAX. | MIN.                       | MAX. |      |
| SCKp cycle time <sup>Note 1</sup> | t <sub>KCY2</sub> | 4.0 V ≤ EV <sub>DD0</sub> ≤ 5.5 V,<br>2.7 V ≤ V <sub>b</sub> ≤ 4.0 V                   | 24 MHz < f <sub>MCK</sub>          | 14/<br>f <sub>MCK</sub>   |      | —                        |      | —                          |      | ns   |
|                                   |                   |                                                                                        | 20 MHz < f <sub>MCK</sub> ≤ 24 MHz | 12/<br>f <sub>MCK</sub>   |      | —                        |      | —                          |      | ns   |
|                                   |                   |                                                                                        | 8 MHz < f <sub>MCK</sub> ≤ 20 MHz  | 10/<br>f <sub>MCK</sub>   |      | —                        |      | —                          |      | ns   |
|                                   |                   |                                                                                        | 4 MHz < f <sub>MCK</sub> ≤ 8 MHz   | 8/f <sub>MCK</sub>        |      | 16/<br>f <sub>MCK</sub>  |      | —                          |      | ns   |
|                                   |                   |                                                                                        | f <sub>MCK</sub> ≤ 4 MHz           | 6/f <sub>MCK</sub>        |      | 10/<br>f <sub>MCK</sub>  |      | 10/<br>f <sub>MCK</sub>    |      | ns   |
|                                   |                   | 2.7 V ≤ EV <sub>DD0</sub> < 4.0 V,<br>2.3 V ≤ V <sub>b</sub> ≤ 2.7 V                   | 24 MHz < f <sub>MCK</sub>          | 20/<br>f <sub>MCK</sub>   |      | —                        |      | —                          |      | ns   |
|                                   |                   |                                                                                        | 20 MHz < f <sub>MCK</sub> ≤ 24 MHz | 16/<br>f <sub>MCK</sub>   |      | —                        |      | —                          |      | ns   |
|                                   |                   |                                                                                        | 16 MHz < f <sub>MCK</sub> ≤ 20 MHz | 14/<br>f <sub>MCK</sub>   |      | —                        |      | —                          |      | ns   |
|                                   |                   |                                                                                        | 8 MHz < f <sub>MCK</sub> ≤ 16 MHz  | 12/<br>f <sub>MCK</sub>   |      | —                        |      | —                          |      | ns   |
|                                   |                   |                                                                                        | 4 MHz < f <sub>MCK</sub> ≤ 8 MHz   | 8/f <sub>MCK</sub>        |      | 16/<br>f <sub>MCK</sub>  |      | —                          |      | ns   |
|                                   |                   |                                                                                        | f <sub>MCK</sub> ≤ 4 MHz           | 6/f <sub>MCK</sub>        |      | 10/<br>f <sub>MCK</sub>  |      | 10/<br>f <sub>MCK</sub>    |      | ns   |
|                                   |                   | 1.8 V ≤ EV <sub>DD0</sub> < 3.3 V,<br>1.6 V ≤ V <sub>b</sub> ≤ 2.0 V <sup>Note 2</sup> | 24 MHz < f <sub>MCK</sub>          | 48/<br>f <sub>MCK</sub>   |      | —                        |      | —                          |      | ns   |
|                                   |                   |                                                                                        | 20 MHz < f <sub>MCK</sub> ≤ 24 MHz | 36/<br>f <sub>MCK</sub>   |      | —                        |      | —                          |      | ns   |
|                                   |                   |                                                                                        | 16 MHz < f <sub>MCK</sub> ≤ 20 MHz | 32/<br>f <sub>MCK</sub>   |      | —                        |      | —                          |      | ns   |
|                                   |                   |                                                                                        | 8 MHz < f <sub>MCK</sub> ≤ 16 MHz  | 26/<br>f <sub>MCK</sub>   |      | —                        |      | —                          |      | ns   |
|                                   |                   |                                                                                        | 4 MHz < f <sub>MCK</sub> ≤ 8 MHz   | 16/<br>f <sub>MCK</sub>   |      | 16/<br>f <sub>MCK</sub>  |      | —                          |      | ns   |
|                                   |                   |                                                                                        | f <sub>MCK</sub> ≤ 4 MHz           | 10/<br>f <sub>MCK</sub>   |      | 10/<br>f <sub>MCK</sub>  |      | 10/<br>f <sub>MCK</sub>    |      | ns   |

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

**Absolute Maximum Ratings ( $T_A = 25^{\circ}\text{C}$ ) (2/2)**

| Parameter                     | Symbols                          | Conditions                   |                                                                                                                                                                                | Ratings                                                                                                                                                                        | Unit        |
|-------------------------------|----------------------------------|------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|
| Output current, high          | I <sub>OH1</sub>                 | 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<br>−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          |
|                               | I <sub>OH2</sub>                 | Per pin                      | P20 to P27, P150 to P156                                                                                                                                                       | −0.5                                                                                                                                                                           | mA          |
|                               |                                  | Total of all pins            |                                                                                                                                                                                | −2                                                                                                                                                                             | mA          |
|                               | Output current, low              | I <sub>OL1</sub>             | 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          |
| Total of all pins<br>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          |
| I <sub>OL2</sub>              |                                  | Per pin                      | P20 to P27, P150 to P156                                                                                                                                                       | 1                                                                                                                                                                              | mA          |
|                               |                                  | Total of all pins            |                                                                                                                                                                                | 5                                                                                                                                                                              | mA          |
| Operating ambient temperature |                                  | T <sub>A</sub>               | In normal operation mode                                                                                                                                                       |                                                                                                                                                                                | −40 to +105 |
|                               | In flash memory programming mode |                              |                                                                                                                                                                                |                                                                                                                                                                                |             |
| Storage temperature           | T <sub>stg</sub>                 |                              |                                                                                                                                                                                | −65 to +150                                                                                                                                                                    | °C          |

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

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

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

- Notes**
1. Total current flowing into  $V_{DD}$ ,  $EV_{DD0}$ , and  $EV_{DD1}$ , including the input leakage current flowing when the level of the input pin is fixed to  $V_{DD}$ ,  $EV_{DD0}$ , and  $EV_{DD1}$ , or  $V_{SS}$ ,  $EV_{SS0}$ , and  $EV_{SS1}$ . The values below the MAX. column include the peripheral operation current. However, not including the current flowing into the A/D converter, LVD circuit, I/O port, and on-chip pull-up/pull-down resistors and the current flowing during data flash rewrite.
  2. When high-speed on-chip oscillator and subsystem clock are stopped.
  3. When high-speed system clock and subsystem clock are stopped.
  4. When high-speed on-chip oscillator and high-speed system clock are stopped. When  $AMPHS1 = 1$  (Ultra-low power consumption oscillation). However, not including the current flowing into the 12-bit interval timer and watchdog timer.
  5. Relationship between operation voltage width, operation frequency of CPU and operation mode is as below.

HS (high-speed main) mode:  $2.7\text{ V} \leq V_{DD} \leq 5.5\text{ V}@1\text{ MHz to }32\text{ MHz}$

$2.4\text{ V} \leq V_{DD} \leq 5.5\text{ V}@1\text{ MHz to }16\text{ MHz}$

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

## (2) Flash ROM: 96 to 256 KB of 30- to 100-pin products

(TA =  $-40$  to  $+105^\circ\text{C}$ ,  $2.4\text{ V} \leq \text{EV}_{\text{DD}0} = \text{EV}_{\text{DD}1} \leq \text{V}_{\text{DD}} \leq 5.5\text{ V}$ ,  $\text{V}_{\text{SS}} = \text{EV}_{\text{SS}0} = \text{EV}_{\text{SS}1} = 0\text{ V}$ ) (2/2)

| Parameter                | Symbol                             | Conditions                  |                                                                            |                                                                           |                                                                         | MIN.                 | TYP.  | MAX. | Unit  |    |
|--------------------------|------------------------------------|-----------------------------|----------------------------------------------------------------------------|---------------------------------------------------------------------------|-------------------------------------------------------------------------|----------------------|-------|------|-------|----|
| Supply current<br>Note 1 | I <sub>DD2</sub><br>Note 2         | HALT mode                   | HS (high-speed main) mode<br>Note 7                                        | f <sub>IH</sub> = 32 MHz <sup>Note 4</sup>                                | V <sub>DD</sub> = 5.0 V                                                 |                      | 0.62  | 3.40 | mA    |    |
|                          |                                    |                             |                                                                            |                                                                           | V <sub>DD</sub> = 3.0 V                                                 |                      | 0.62  | 3.40 | mA    |    |
|                          |                                    |                             |                                                                            | f <sub>IH</sub> = 24 MHz <sup>Note 4</sup>                                | V <sub>DD</sub> = 5.0 V                                                 |                      | 0.50  | 2.70 | mA    |    |
|                          |                                    |                             |                                                                            |                                                                           | V <sub>DD</sub> = 3.0 V                                                 |                      | 0.50  | 2.70 | mA    |    |
|                          |                                    |                             |                                                                            | f <sub>IH</sub> = 16 MHz <sup>Note 4</sup>                                | V <sub>DD</sub> = 5.0 V                                                 |                      | 0.44  | 1.90 | mA    |    |
|                          |                                    |                             |                                                                            |                                                                           | V <sub>DD</sub> = 3.0 V                                                 |                      | 0.44  | 1.90 | mA    |    |
|                          |                                    |                             |                                                                            | HS (high-speed main) mode<br>Note 7                                       | f <sub>MX</sub> = 20 MHz <sup>Note 3</sup> ,<br>V <sub>DD</sub> = 5.0 V | Square wave input    |       | 0.31 | 2.10  | mA |
|                          |                                    |                             |                                                                            |                                                                           |                                                                         | Resonator connection |       | 0.48 | 2.20  | mA |
|                          |                                    |                             |                                                                            |                                                                           | f <sub>MX</sub> = 20 MHz <sup>Note 3</sup> ,<br>V <sub>DD</sub> = 3.0 V | Square wave input    |       | 0.31 | 2.10  | mA |
|                          |                                    |                             |                                                                            |                                                                           |                                                                         | Resonator connection |       | 0.48 | 2.20  | mA |
|                          |                                    |                             | f <sub>MX</sub> = 10 MHz <sup>Note 3</sup> ,<br>V <sub>DD</sub> = 5.0 V    |                                                                           | Square wave input                                                       |                      | 0.21  | 1.10 | mA    |    |
|                          |                                    |                             |                                                                            |                                                                           | Resonator connection                                                    |                      | 0.28  | 1.20 | mA    |    |
|                          |                                    |                             | f <sub>MX</sub> = 10 MHz <sup>Note 3</sup> ,<br>V <sub>DD</sub> = 3.0 V    |                                                                           | Square wave input                                                       |                      | 0.21  | 1.10 | mA    |    |
|                          |                                    |                             |                                                                            |                                                                           | Resonator connection                                                    |                      | 0.28  | 1.20 | mA    |    |
|                          |                                    |                             | Subsystem clock operation                                                  | f <sub>SUB</sub> = 32.768 kHz <sup>Note 5</sup><br>T <sub>A</sub> = −40°C | Square wave input                                                       |                      | 0.28  | 0.61 | μA    |    |
|                          |                                    |                             |                                                                            |                                                                           | Resonator connection                                                    |                      | 0.47  | 0.80 | μA    |    |
|                          |                                    |                             |                                                                            | f <sub>SUB</sub> = 32.768 kHz <sup>Note 5</sup><br>T <sub>A</sub> = +25°C | Square wave input                                                       |                      | 0.34  | 0.61 | μA    |    |
|                          |                                    |                             |                                                                            |                                                                           | Resonator connection                                                    |                      | 0.53  | 0.80 | μA    |    |
|                          |                                    |                             |                                                                            | f <sub>SUB</sub> = 32.768 kHz <sup>Note 5</sup><br>T <sub>A</sub> = +50°C | Square wave input                                                       |                      | 0.41  | 2.30 | μA    |    |
|                          |                                    |                             |                                                                            |                                                                           | Resonator connection                                                    |                      | 0.60  | 2.49 | μA    |    |
|                          |                                    |                             |                                                                            | f <sub>SUB</sub> = 32.768 kHz <sup>Note 5</sup><br>T <sub>A</sub> = +70°C | Square wave input                                                       |                      | 0.64  | 4.03 | μA    |    |
|                          |                                    |                             |                                                                            |                                                                           | Resonator connection                                                    |                      | 0.83  | 4.22 | μA    |    |
|                          |                                    |                             |                                                                            | f <sub>SUB</sub> = 32.768 kHz <sup>Note 5</sup><br>T <sub>A</sub> = +85°C | Square wave input                                                       |                      | 1.09  | 8.04 | μA    |    |
|                          |                                    |                             |                                                                            |                                                                           | Resonator connection                                                    |                      | 1.28  | 8.23 | μA    |    |
|                          |                                    |                             | f <sub>SUB</sub> = 32.768 kHz <sup>Note 5</sup><br>T <sub>A</sub> = +105°C | Square wave input                                                         |                                                                         | 5.50                 | 41.00 | μA   |       |    |
|                          |                                    |                             |                                                                            | Resonator connection                                                      |                                                                         | 5.50                 | 41.00 | μA   |       |    |
|                          | I <sub>DD3</sub> <sup>Note 6</sup> | STOP mode <sup>Note 8</sup> | T <sub>A</sub> = −40°C                                                     |                                                                           |                                                                         |                      |       | 0.19 | 0.52  | μA |
|                          |                                    |                             | T <sub>A</sub> = +25°C                                                     |                                                                           |                                                                         |                      |       | 0.25 | 0.52  | μA |
|                          |                                    |                             | T <sub>A</sub> = +50°C                                                     |                                                                           |                                                                         |                      |       | 0.32 | 2.21  | μA |
|                          |                                    |                             | T <sub>A</sub> = +70°C                                                     |                                                                           |                                                                         |                      |       | 0.55 | 3.94  | μA |
|                          |                                    |                             | T <sub>A</sub> = +85°C                                                     |                                                                           |                                                                         |                      |       | 1.00 | 7.95  | μA |
|                          |                                    |                             | T <sub>A</sub> = +105°C                                                    |                                                                           |                                                                         |                      |       | 5.00 | 40.00 | μA |

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



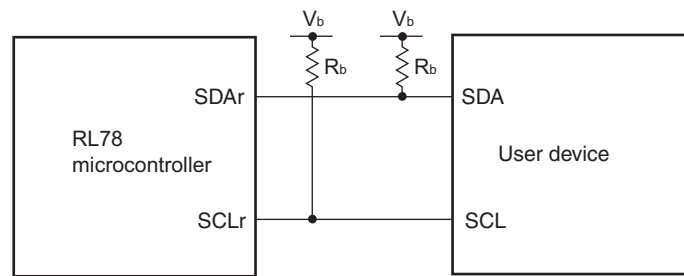
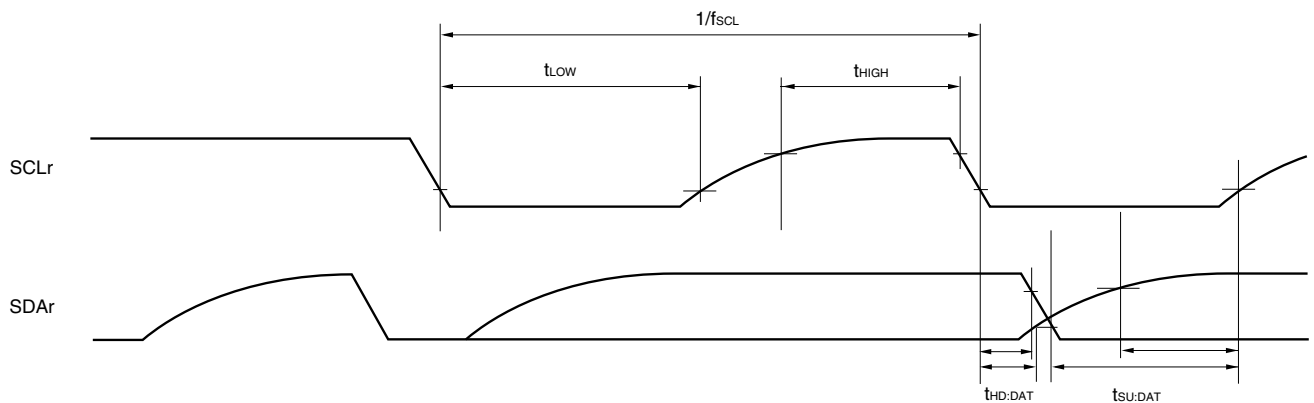
**(3) Peripheral Functions (Common to all products)****( $T_A = -40$  to  $+105^\circ\text{C}$ ,  $2.4\text{ V} \leq \text{EV}_{\text{DD}0} = \text{EV}_{\text{DD}1} \leq \text{V}_{\text{DD}} \leq 5.5\text{ V}$ ,  $\text{V}_{\text{SS}} = \text{EV}_{\text{SS}0} = \text{EV}_{\text{SS}1} = 0\text{ V}$ )**

| Parameter                                      | Symbol                            | Conditions                       |                                                                                                                                | MIN. | TYP. | MAX.  | Unit          |
|------------------------------------------------|-----------------------------------|----------------------------------|--------------------------------------------------------------------------------------------------------------------------------|------|------|-------|---------------|
| Low-speed on-chip oscillator operating current | $I_{\text{FIL}}$<br>Note 1        |                                  |                                                                                                                                |      | 0.20 |       | $\mu\text{A}$ |
| RTC operating current                          | $I_{\text{RTC}}$<br>Notes 1, 2, 3 |                                  |                                                                                                                                |      | 0.02 |       | $\mu\text{A}$ |
| 12-bit interval timer operating current        | $I_{\text{IT}}$<br>Notes 1, 2, 4  |                                  |                                                                                                                                |      | 0.02 |       | $\mu\text{A}$ |
| Watchdog timer operating current               | $I_{\text{WDT}}$<br>Notes 1, 2, 5 | $f_{\text{IL}} = 15\text{ kHz}$  |                                                                                                                                |      | 0.22 |       | $\mu\text{A}$ |
| A/D converter operating current                | $I_{\text{ADC}}$<br>Notes 1, 6    | When conversion at maximum speed | Normal mode, $\text{AV}_{\text{REFP}} = \text{V}_{\text{DD}} = 5.0\text{ V}$                                                   |      | 1.3  | 1.7   | $\text{mA}$   |
|                                                |                                   |                                  | Low voltage mode, $\text{AV}_{\text{REFP}} = \text{V}_{\text{DD}} = 3.0\text{ V}$                                              |      | 0.5  | 0.7   | $\text{mA}$   |
| A/D converter reference voltage current        | $I_{\text{ADREF}}$<br>Note 1      |                                  |                                                                                                                                |      | 75.0 |       | $\mu\text{A}$ |
| Temperature sensor operating current           | $I_{\text{TMPS}}$<br>Note 1       |                                  |                                                                                                                                |      | 75.0 |       | $\mu\text{A}$ |
| LVD operating current                          | $I_{\text{LVD}}$<br>Notes 1, 7    |                                  |                                                                                                                                |      | 0.08 |       | $\mu\text{A}$ |
| Self programming operating current             | $I_{\text{FSP}}$<br>Notes 1, 9    |                                  |                                                                                                                                |      | 2.50 | 12.20 | $\text{mA}$   |
| BGO operating current                          | $I_{\text{BGO}}$<br>Notes 1, 8    |                                  |                                                                                                                                |      | 2.50 | 12.20 | $\text{mA}$   |
| SNOOZE operating current                       | $I_{\text{SNOZ}}$<br>Note 1       | ADC operation                    | The mode is performed <sup>Note 10</sup>                                                                                       |      | 0.50 | 1.10  | $\text{mA}$   |
|                                                |                                   |                                  | The A/D conversion operations are performed, Low voltage mode, $\text{AV}_{\text{REFP}} = \text{V}_{\text{DD}} = 3.0\text{ V}$ |      | 1.20 | 2.04  | $\text{mA}$   |
|                                                |                                   | CSI/UART operation               |                                                                                                                                |      | 0.70 | 1.54  | $\text{mA}$   |

**Notes** 1. Current flowing to the  $\text{V}_{\text{DD}}$ .

2. When high speed on-chip oscillator and high-speed system clock are stopped.

3. Current flowing only to the real-time clock (RTC) (excluding the operating current of the low-speed on-chip oscillator and the XT1 oscillator). The supply current of the RL78 microcontrollers is the sum of the values of either  $I_{\text{DD}1}$  or  $I_{\text{DD}2}$ , and  $I_{\text{RTC}}$ , when the real-time clock operates in operation mode or HALT mode. When the low-speed on-chip oscillator is selected,  $I_{\text{FIL}}$  should be added.  $I_{\text{DD}2}$  subsystem clock operation includes the operational current of the real-time clock.4. Current flowing only to the 12-bit interval timer (excluding the operating current of the low-speed on-chip oscillator and the XT1 oscillator). The supply current of the RL78 microcontrollers is the sum of the values of either  $I_{\text{DD}1}$  or  $I_{\text{DD}2}$ , and  $I_{\text{IT}}$ , when the 12-bit interval timer operates in operation mode or HALT mode. When the low-speed on-chip oscillator is selected,  $I_{\text{FIL}}$  should be added.5. Current flowing only to the watchdog timer (including the operating current of the low-speed on-chip oscillator). The supply current of the RL78 is the sum of  $I_{\text{DD}1}$ ,  $I_{\text{DD}2}$  or  $I_{\text{DD}3}$  and  $I_{\text{WDT}}$  when the watchdog timer operates.

**Simplified I<sup>2</sup>C mode connection diagram (during communication at different potential)****Simplified I<sup>2</sup>C mode serial transfer timing (during communication at different potential)**

**Caution** Select the TTL input buffer and the N-ch open drain output ( $V_{DD}$  tolerance (for the 20- to 52-pin products)/ $EV_{DD}$  tolerance (for the 64- to 100-pin products)) mode for the SDAr pin and the N-ch open drain output ( $V_{DD}$  tolerance (for the 20- to 52-pin products)/ $EV_{DD}$  tolerance (for the 64- to 100-pin products)) mode for the SCLr pin by using port input mode register g (PIMg) and port output mode register g (POMg). For  $V_{IH}$  and  $V_{IL}$ , see the DC characteristics with TTL input buffer selected.

- Remarks**
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
  2. r: IIC number (r = 00, 01, 10, 20, 30, 31), g: PIM, POM number (g = 0, 1, 4, 5, 8, 14)
  3.  $f_{MCK}$ : Serial array unit operation clock frequency  
(Operation clock to be set by the CKSmn bit of serial mode register mn (SMRmn). m: Unit number, n: Channel number (mn = 00, 01, 02, 10, 12, 13))

## 3.5.2 Serial interface IICA

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

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

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

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

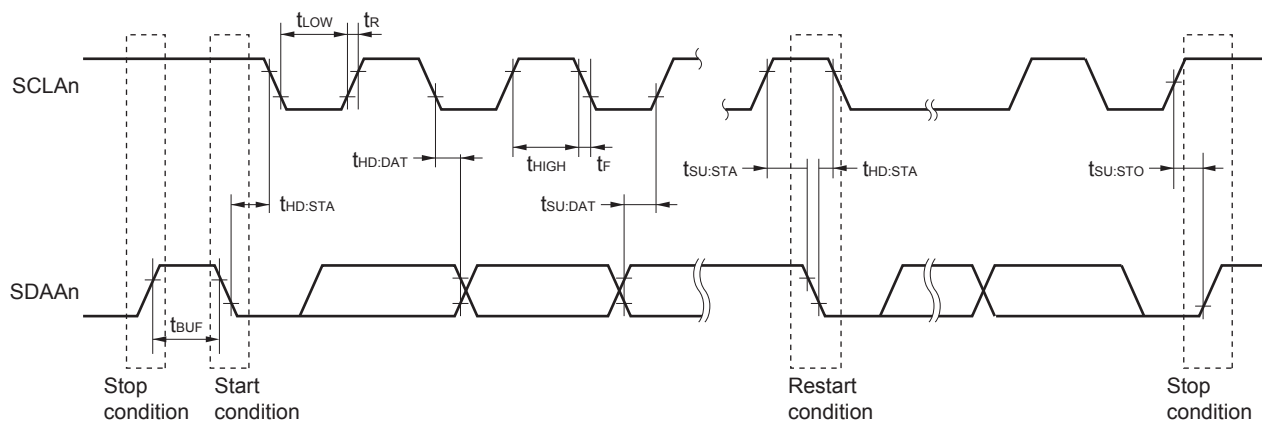
**Caution** The values in the above table are applied even when bit 2 (PIOR2) in the peripheral I/O redirection register (PIOR) is 1. At this time, the pin characteristics (IOH1, IOL1, VOH1, VOL1) must satisfy the values in the redirect destination.

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

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

Fast mode: Cb = 320 pF, Rb = 1.1 kΩ

IICA serial transfer timing

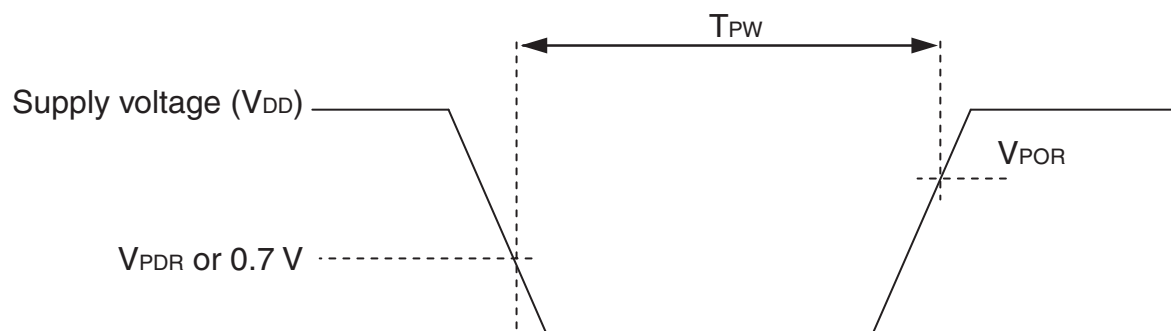
**Remark** n = 0, 1

## 3.6.3 POR circuit characteristics

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

| Parameter           | Symbol    | Conditions             | MIN. | TYP. | MAX. | Unit          |
|---------------------|-----------|------------------------|------|------|------|---------------|
| Detection voltage   | $V_{POR}$ | Power supply rise time | 1.45 | 1.51 | 1.57 | V             |
|                     | $V_{PDR}$ | Power supply fall time | 1.44 | 1.50 | 1.56 | V             |
| Minimum pulse width | $T_{PW}$  |                        | 300  |      |      | $\mu\text{s}$ |

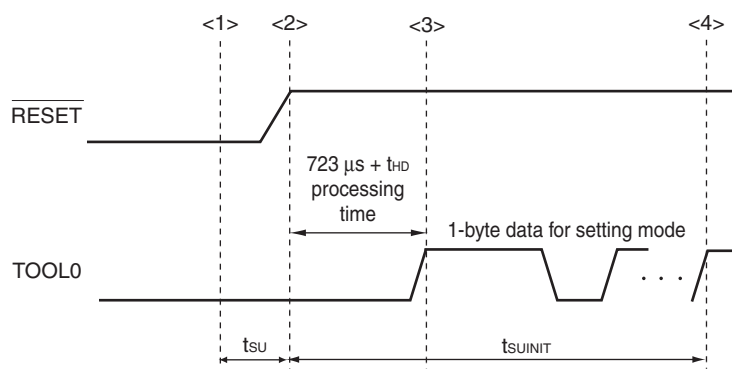
**Note** Minimum time required for a POR reset when  $V_{DD}$  exceeds below  $V_{PDR}$ . This is also the minimum time required for a POR reset from when  $V_{DD}$  exceeds below 0.7 V to when  $V_{DD}$  exceeds  $V_{POR}$  while STOP mode is entered or the main system clock is stopped through setting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



## 3.10 Timing of Entry to Flash Memory Programming Modes

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

| Parameter                                                                                                                                                       | Symbol             | Conditions                                                                | MIN. | TYP. | MAX. | Unit          |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|---------------------------------------------------------------------------|------|------|------|---------------|
| Time to complete the communication for the initial setting after the external reset is released                                                                 | $t_{\text{SUNIT}}$ | 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                                                                                  | $t_{\text{SU}}$    | POR and LVD reset must be released before the external reset is released. | 10   |      |      | $\mu\text{s}$ |
| Time to hold the TOOL0 pin at the low level after the external reset is released<br>(excluding the processing time of the firmware to control the flash memory) | $t_{\text{HD}}$    | POR and LVD reset must be released before the external reset is released. | 1    |      |      | ms            |



&lt;1&gt; The low level is input to the TOOL0 pin.

&lt;2&gt; The external reset is released (POR and LVD reset must be released before the external reset is released.).

&lt;3&gt; The TOOL0 pin is set to the high level.

&lt;4&gt; Setting of the flash memory programming mode by UART reception and complete the baud rate setting.

**Remark**  $t_{\text{SUNIT}}$ : Communication for the initial setting must be completed within 100 ms after the external reset is released during this period.

$t_{\text{SU}}$ : Time to release the external reset after the TOOL0 pin is set to the low level

$t_{\text{HD}}$ : Time to hold the TOOL0 pin at the low level after the external reset is released (excluding the processing time of the firmware to control the flash memory)