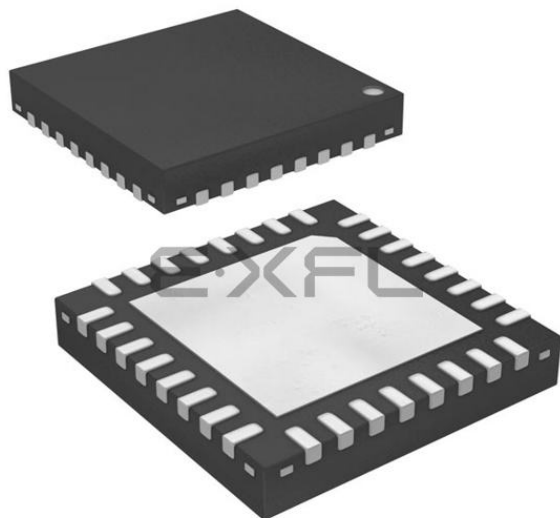




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### What is "[Embedded - Microcontrollers](#)"?

"[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             | Obsolete                                                                                                                                                                      |
| 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              | 22                                                                                                                                                                            |
| Program Memory Size        | 16KB (16K x 8)                                                                                                                                                                |
| Program Memory Type        | FLASH                                                                                                                                                                         |
| EEPROM Size                | 4K x 8                                                                                                                                                                        |
| RAM Size                   | 2K x 8                                                                                                                                                                        |
| Voltage - Supply (Vcc/Vdd) | 1.6V ~ 5.5V                                                                                                                                                                   |
| Data Converters            | A/D 8x8/10b                                                                                                                                                                   |
| Oscillator Type            | Internal                                                                                                                                                                      |
| Operating Temperature      | -40°C ~ 85°C (TA)                                                                                                                                                             |
| Mounting Type              | Surface Mount                                                                                                                                                                 |
| Package / Case             | 32-WFQFN Exposed Pad                                                                                                                                                          |
| Supplier Device Package    | 32-HWQFN (5x5)                                                                                                                                                                |
| Purchase URL               | <a href="https://www.e-xfl.com/product-detail/renesas-electronics-america/r5f100baana-w0">https://www.e-xfl.com/product-detail/renesas-electronics-america/r5f100baana-w0</a> |

Table 1-1. List of Ordering Part Numbers

(2/12)

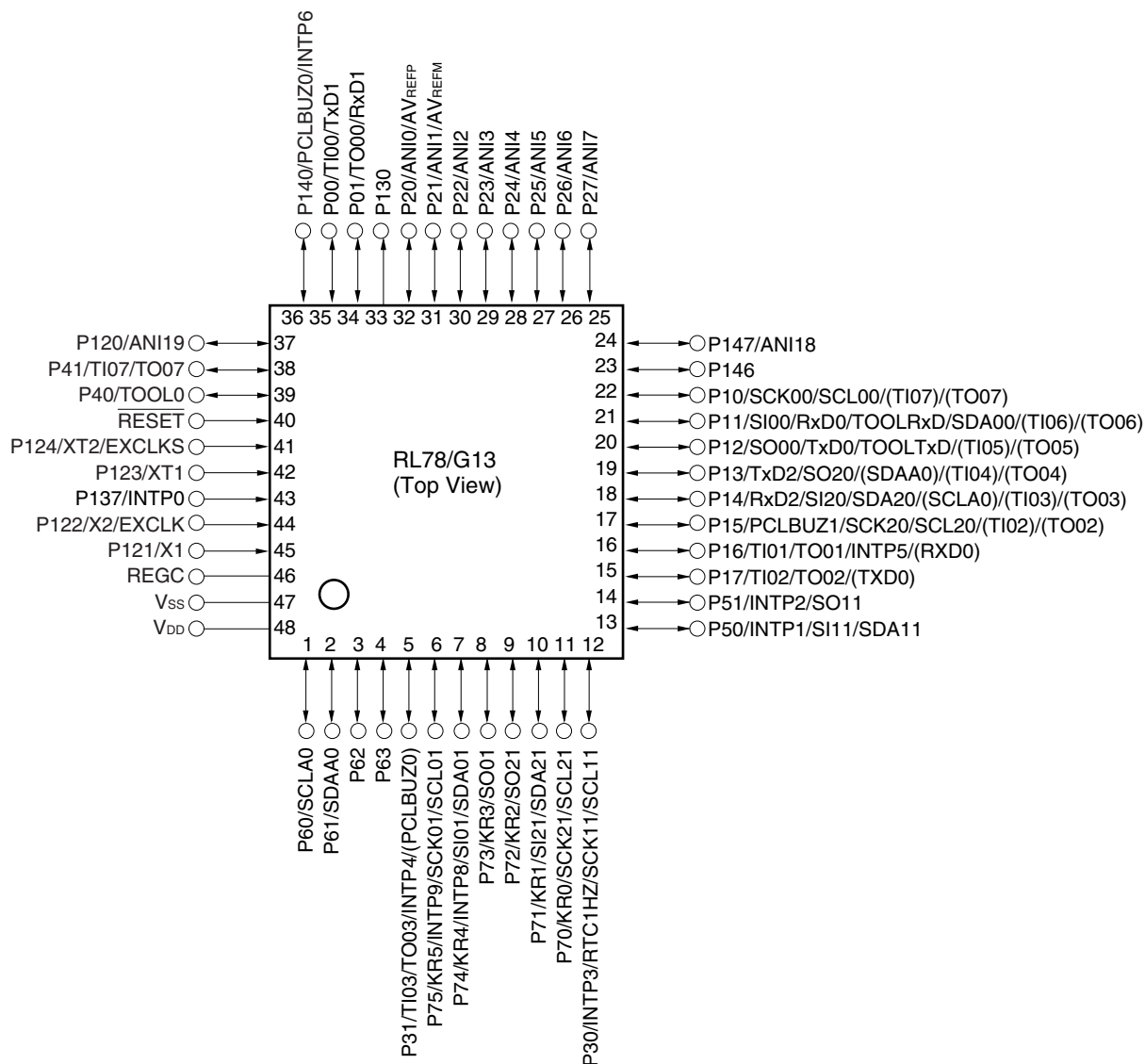
| Pin count | Package                                             | Data flash  | Fields of Application<br>Note | Ordering Part Number                                                                                                                                                                      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

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

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

## 1.3.9 48-pin products

- 48-pin plastic LQFP (7 × 7 mm, 0.5 mm pitch)

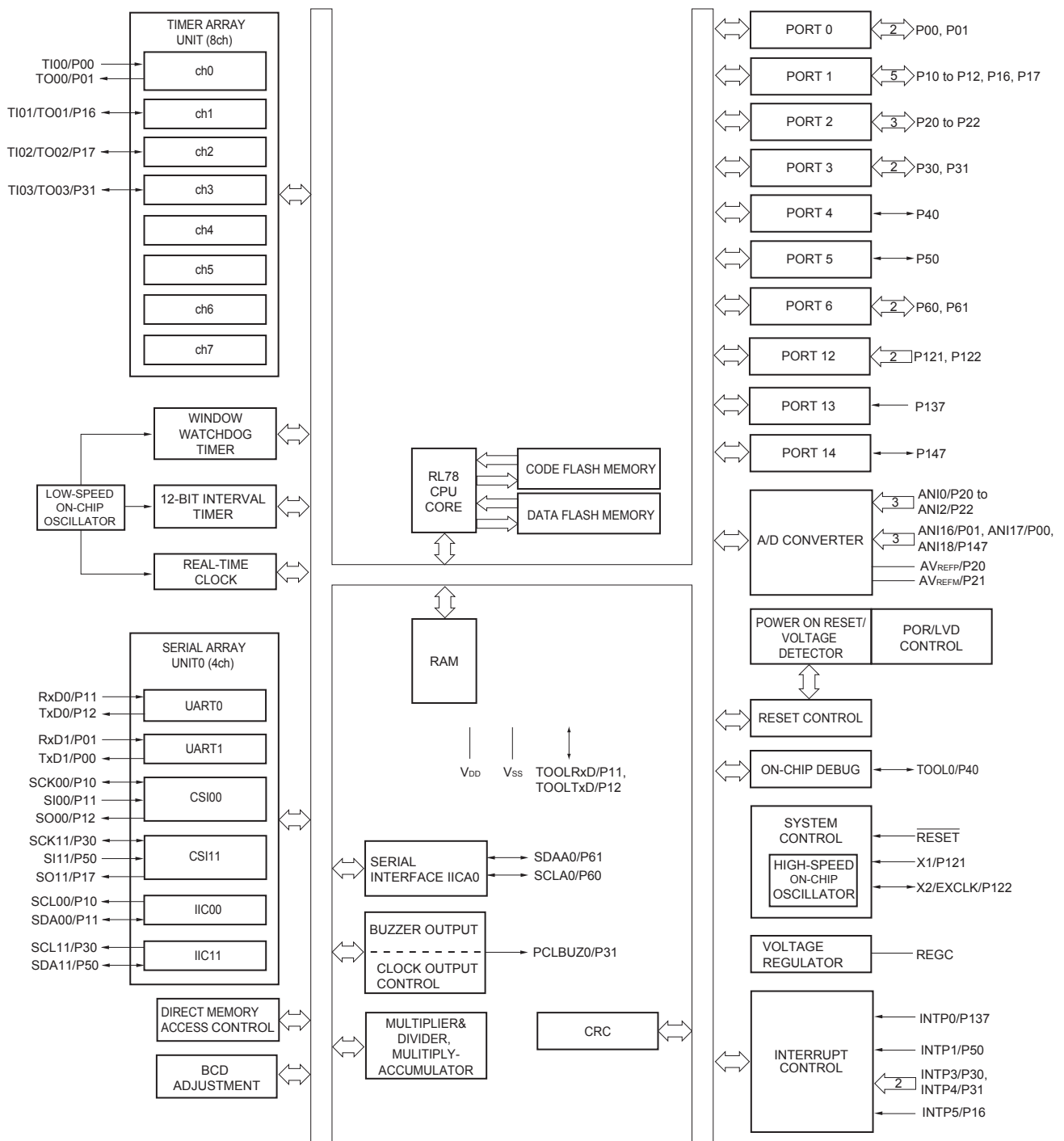


**Caution** Connect the REGC pin to Vss via a capacitor (0.47 to 1  $\mu$ F).

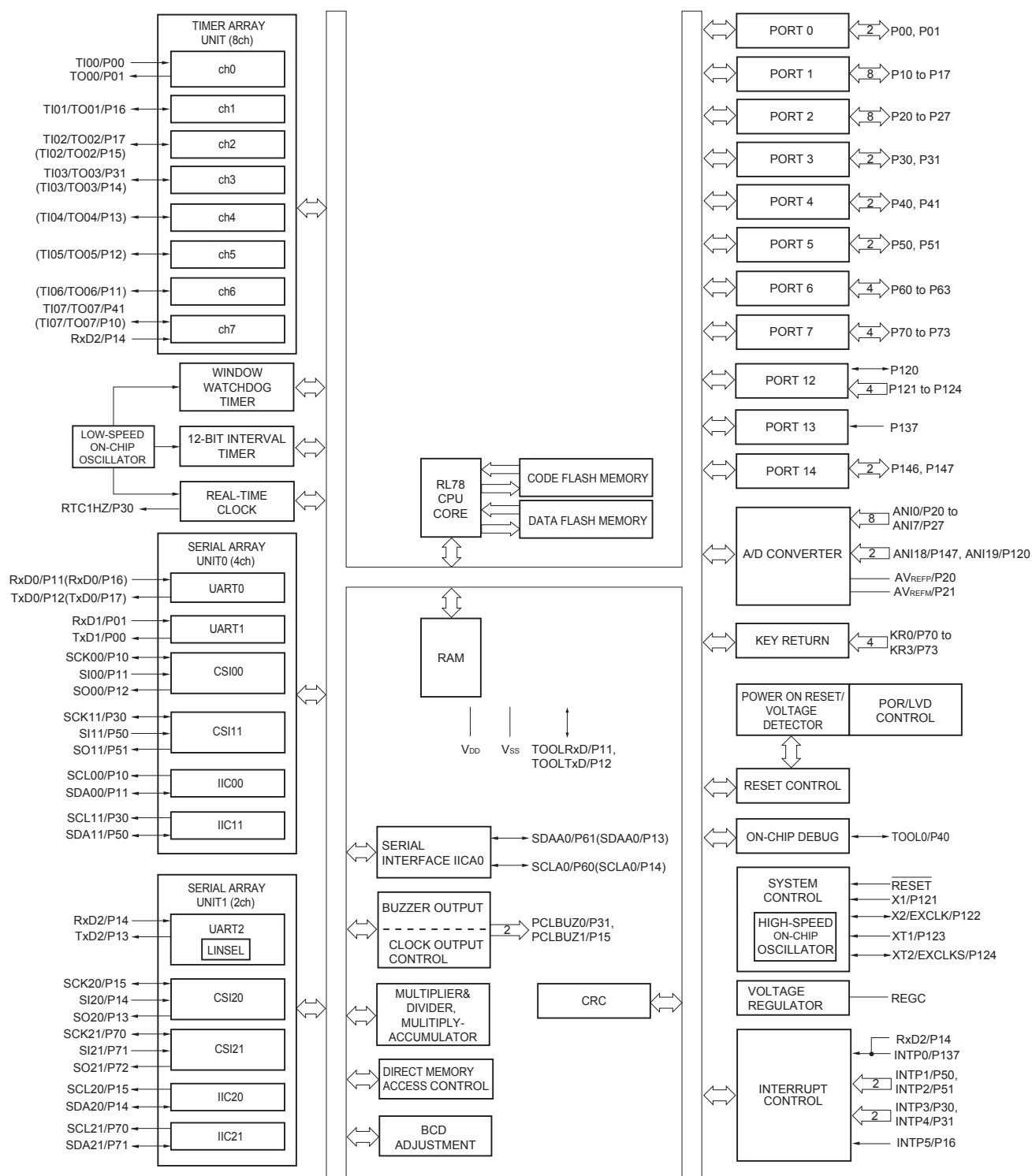
**Remarks 1.** For pin identification, see 1.4 Pin Identification.

- 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.

## 1.5.2 24-pin products

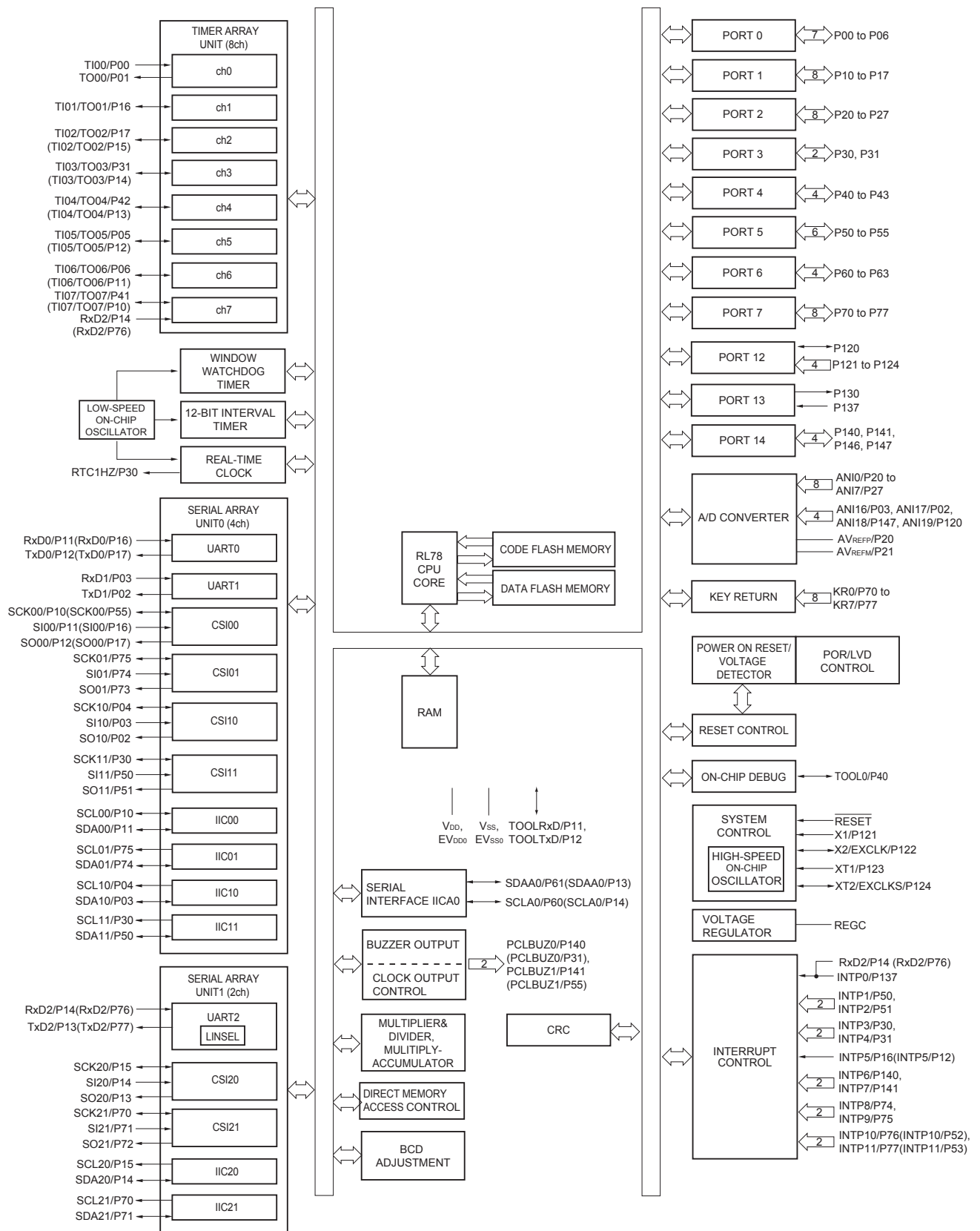


## 1.5.8 44-pin products



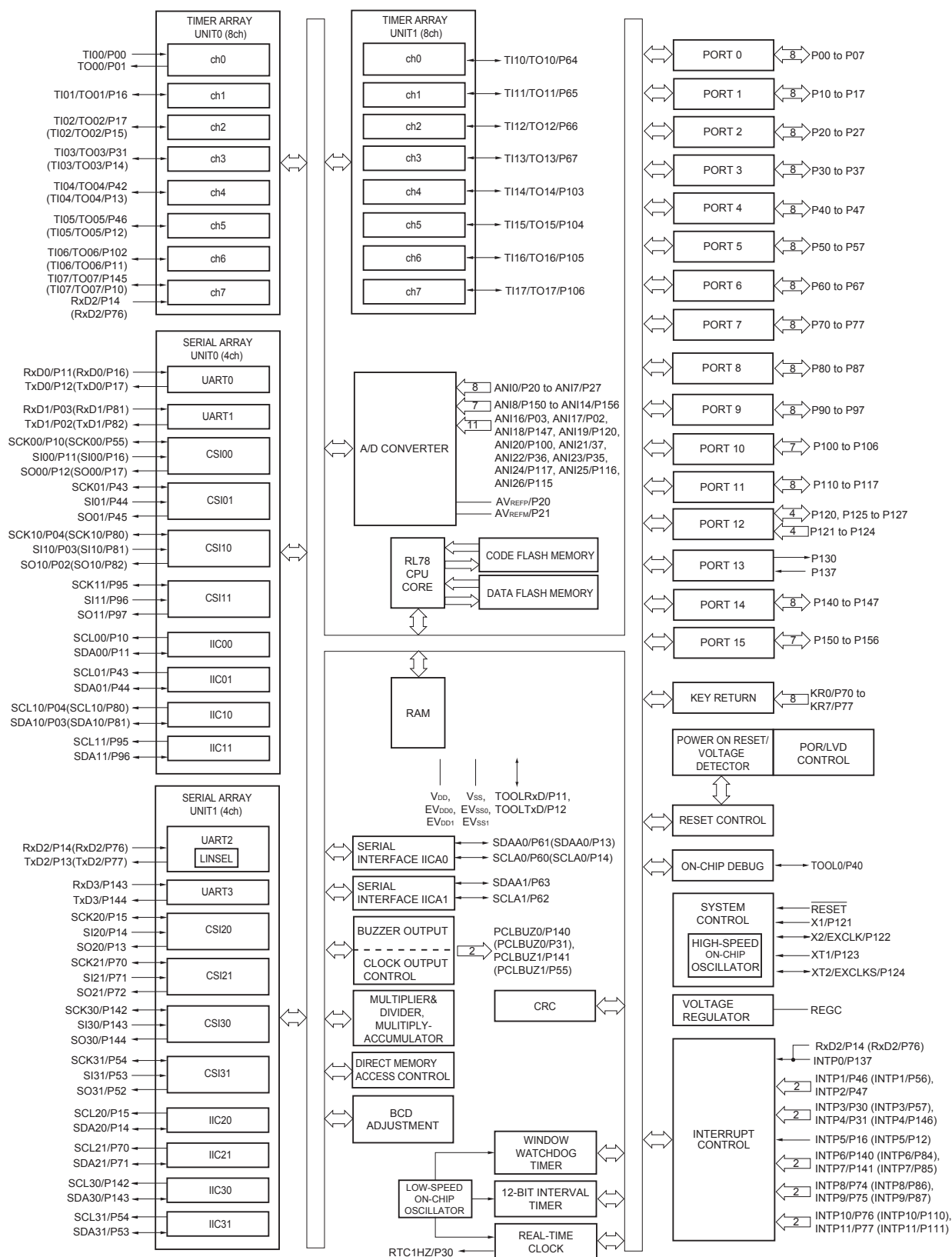
**Remark** Functions in parentheses in the above figure can be assigned via settings in the peripheral I/O redirection register (PIOR). Refer to **Figure 4-8 Format of Peripheral I/O Redirection Register (PIOR)** in the RL78/G13 User's Manual.

## 1.5.11 64-pin products



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

## 1.5.14 128-pin products



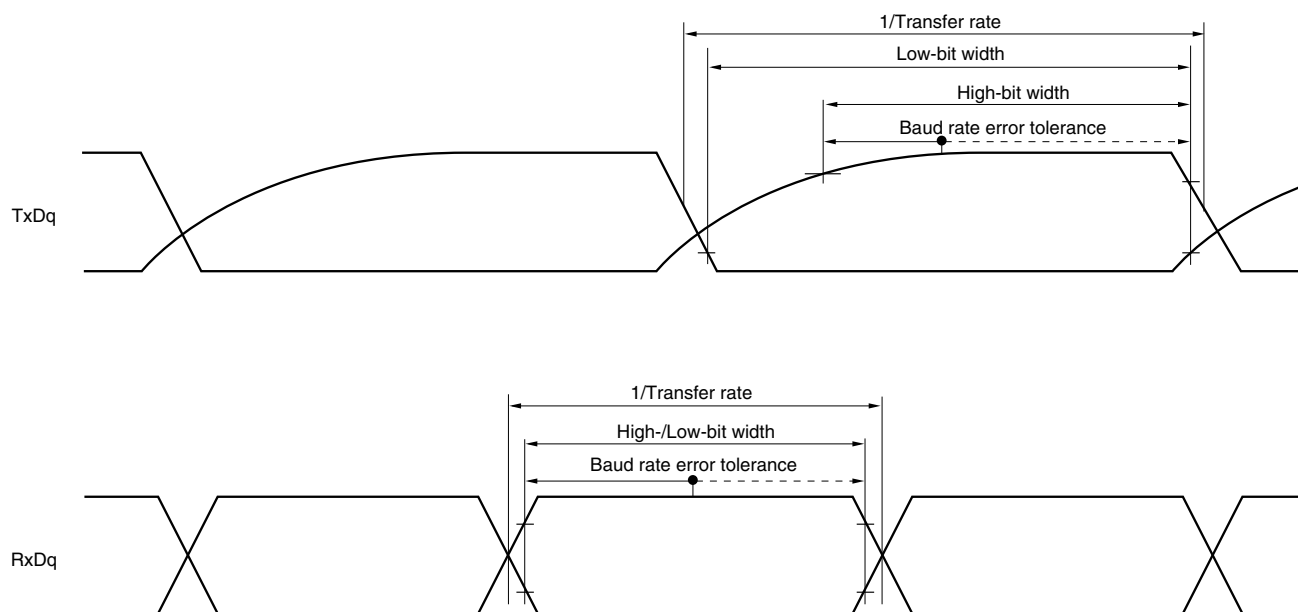
**Remark** Functions in parentheses in the above figure can be assigned via settings in the peripheral I/O redirection register (PIOR). Refer to **Figure 4-8 Format of Peripheral I/O Redirection Register (PIOR)** in the RL78/G13 User's Manual.

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

(T<sub>A</sub> = -40 to +85°C, 1.6 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) (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 | 1.86 | mA   |    |
|                          |                            |                     |                                                                           |                                                                           | V <sub>DD</sub> = 3.0 V                                                |                         | 0.62 | 1.86 | mA   |    |
|                          |                            |                     |                                                                           | f <sub>IH</sub> = 24 MHz <sup>Note 4</sup>                                | V <sub>DD</sub> = 5.0 V                                                |                         | 0.50 | 1.45 | mA   |    |
|                          |                            |                     |                                                                           |                                                                           | V <sub>DD</sub> = 3.0 V                                                |                         | 0.50 | 1.45 | mA   |    |
|                          |                            |                     |                                                                           |                                                                           | f <sub>IH</sub> = 16 MHz <sup>Note 4</sup>                             | V <sub>DD</sub> = 5.0 V |      | 0.44 | 1.11 | mA |
|                          |                            |                     |                                                                           |                                                                           |                                                                        | V <sub>DD</sub> = 3.0 V |      | 0.44 | 1.11 | mA |
|                          |                            |                     | LS (low-speed main) mode<br>Note 7                                        | f <sub>IH</sub> = 8 MHz <sup>Note 4</sup>                                 | V <sub>DD</sub> = 3.0 V                                                |                         | 290  | 620  | μA   |    |
|                          |                            |                     |                                                                           |                                                                           | V <sub>DD</sub> = 2.0 V                                                |                         | 290  | 620  | μA   |    |
|                          |                            |                     | LV (low-voltage main) mode<br>Note 7                                      | f <sub>IH</sub> = 4 MHz <sup>Note 4</sup>                                 | V <sub>DD</sub> = 3.0 V                                                |                         | 440  | 680  | μA   |    |
|                          |                            |                     |                                                                           |                                                                           | V <sub>DD</sub> = 2.0 V                                                |                         | 440  | 680  | μA   |    |
|                          |                            |                     | 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 | 1.08 | mA   |    |
|                          |                            |                     |                                                                           |                                                                           | Resonator connection                                                   |                         | 0.48 | 1.28 | mA   |    |
|                          |                            |                     |                                                                           | f <sub>MX</sub> = 20 MHz <sup>Note 3</sup> ,<br>V <sub>DD</sub> = 3.0 V   | Square wave input                                                      |                         | 0.31 | 1.08 | mA   |    |
|                          |                            |                     |                                                                           |                                                                           | Resonator connection                                                   |                         | 0.48 | 1.28 | mA   |    |
|                          |                            |                     |                                                                           | f <sub>MX</sub> = 10 MHz <sup>Note 3</sup> ,<br>V <sub>DD</sub> = 5.0 V   | Square wave input                                                      |                         | 0.21 | 0.63 | mA   |    |
|                          |                            |                     |                                                                           |                                                                           | Resonator connection                                                   |                         | 0.28 | 0.71 | mA   |    |
|                          |                            |                     |                                                                           | f <sub>MX</sub> = 10 MHz <sup>Note 3</sup> ,<br>V <sub>DD</sub> = 3.0 V   | Square wave input                                                      |                         | 0.21 | 0.63 | mA   |    |
|                          |                            |                     |                                                                           |                                                                           | Resonator connection                                                   |                         | 0.28 | 0.71 | mA   |    |
|                          |                            |                     |                                                                           | LS (low-speed main) mode<br>Note 7                                        | f <sub>MX</sub> = 8 MHz <sup>Note 3</sup> ,<br>V <sub>DD</sub> = 3.0 V | Square wave input       |      | 110  | 360  | μA |
|                          |                            |                     |                                                                           |                                                                           |                                                                        | Resonator connection    |      | 160  | 420  | μA |
|                          |                            |                     | f <sub>MX</sub> = 8 MHz <sup>Note 3</sup> ,<br>V <sub>DD</sub> = 2.0 V    |                                                                           | Square wave input                                                      |                         | 110  | 360  | μA   |    |
|                          |                            |                     |                                                                           |                                                                           | Resonator connection                                                   |                         | 160  | 420  | μA   |    |
|                          |                            |                     | 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   |      |    |
|                          | I <sub>DD3</sub><br>Note 6 | STOP mode<br>Note 8 | 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 |
|                          |                            |                     |                                                                           |                                                                           |                                                                        |                         |      |      |      |    |

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

**UART mode bit width (during communication at different potential) (reference)**

- Remarks**
1.  $R_b[\Omega]$ : Communication line (TxDq) pull-up resistance,  
 $C_b[\text{F}]$ : Communication line (TxDq) load capacitance,  $V_b[\text{V}]$ : Communication line voltage
  2. q: UART number (q = 0 to 3), g: PIM and POM number (g = 0, 1, 8, 14)
  3.  $f_{\text{MCK}}$ : Serial array unit operation clock frequency  
 (Operation clock to be set by the CKSmn bit of serial mode register mn (SMRmn).  
 m: Unit number, n: Channel number (mn = 00 to 03, 10 to 13))
  4. UART2 cannot communicate at different potential when bit 1 (PIOR1) of peripheral I/O redirection register (PIOR) is 1.

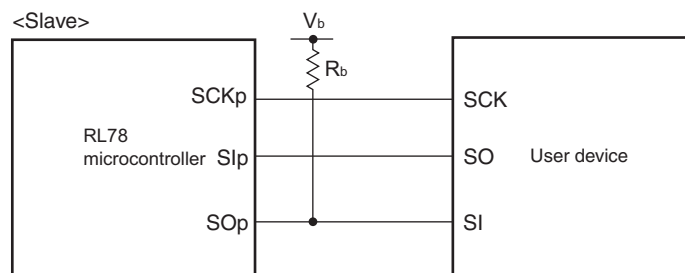
(8) Communication at different potential (1.8 V, 2.5 V, 3 V) (CSI mode) (master mode, SCKp... internal clock output)  
(1/3)(T<sub>A</sub> = -40 to +85°C, 1.8 V ≤ EV<sub>DD0</sub> = EV<sub>DD1</sub> ≤ V<sub>DD</sub> ≤ 5.5 V, V<sub>SS</sub> = EV<sub>SS0</sub> = EV<sub>SS1</sub> = 0 V)

| 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       | t <sub>KCY1</sub> | t <sub>KCY1</sub> ≥ 4/f <sub>CLK</sub><br>4.0 V ≤ EV <sub>DD0</sub> ≤ 5.5 V,<br>2.7 V ≤ V <sub>b</sub> ≤ 4.0 V,<br>C <sub>b</sub> = 30 pF, R <sub>b</sub> = 1.4 kΩ | 300                        |      | 1150                       |      | 1150                       |      | ns   |
|                       |                   | 2.7 V ≤ EV <sub>DD0</sub> < 4.0 V,<br>2.3 V ≤ V <sub>b</sub> ≤ 2.7 V,<br>C <sub>b</sub> = 30 pF, R <sub>b</sub> = 2.7 kΩ                                           | 500                        |      | 1150                       |      | 1150                       |      | ns   |
|                       |                   | 1.8 V ≤ EV <sub>DD0</sub> < 3.3 V,<br>1.6 V ≤ V <sub>b</sub> ≤ 2.0 V <sup>Note</sup> ,<br>C <sub>b</sub> = 30 pF, R <sub>b</sub> = 5.5 kΩ                          | 1150                       |      | 1150                       |      | 1150                       |      | ns   |
| SCKp high-level width | t <sub>KH1</sub>  | 4.0 V ≤ EV <sub>DD0</sub> ≤ 5.5 V,<br>2.7 V ≤ V <sub>b</sub> ≤ 4.0 V,<br>C <sub>b</sub> = 30 pF, R <sub>b</sub> = 1.4 kΩ                                           | t <sub>KCY1</sub> /2 – 75  |      | t <sub>KCY1</sub> /2 – 75  |      | t <sub>KCY1</sub> /2 – 75  |      | ns   |
|                       |                   | 2.7 V ≤ EV <sub>DD0</sub> < 4.0 V,<br>2.3 V ≤ V <sub>b</sub> ≤ 2.7 V,<br>C <sub>b</sub> = 30 pF, R <sub>b</sub> = 2.7 kΩ                                           | t <sub>KCY1</sub> /2 – 170 |      | t <sub>KCY1</sub> /2 – 170 |      | t <sub>KCY1</sub> /2 – 170 |      | ns   |
|                       |                   | 1.8 V ≤ EV <sub>DD0</sub> < 3.3 V,<br>1.6 V ≤ V <sub>b</sub> ≤ 2.0 V <sup>Note</sup> ,<br>C <sub>b</sub> = 30 pF, R <sub>b</sub> = 5.5 kΩ                          | t <sub>KCY1</sub> /2 – 458 |      | t <sub>KCY1</sub> /2 – 458 |      | t <sub>KCY1</sub> /2 – 458 |      | ns   |
| SCKp low-level width  | t <sub>KL1</sub>  | 4.0 V ≤ EV <sub>DD0</sub> ≤ 5.5 V,<br>2.7 V ≤ V <sub>b</sub> ≤ 4.0 V,<br>C <sub>b</sub> = 30 pF, R <sub>b</sub> = 1.4 kΩ                                           | t <sub>KCY1</sub> /2 – 12  |      | t <sub>KCY1</sub> /2 – 50  |      | t <sub>KCY1</sub> /2 – 50  |      | ns   |
|                       |                   | 2.7 V ≤ EV <sub>DD0</sub> < 4.0 V,<br>2.3 V ≤ V <sub>b</sub> ≤ 2.7 V,<br>C <sub>b</sub> = 30 pF, R <sub>b</sub> = 2.7 kΩ                                           | t <sub>KCY1</sub> /2 – 18  |      | t <sub>KCY1</sub> /2 – 50  |      | t <sub>KCY1</sub> /2 – 50  |      | ns   |
|                       |                   | 1.8 V ≤ EV <sub>DD0</sub> < 3.3 V,<br>1.6 V ≤ V <sub>b</sub> ≤ 2.0 V <sup>Note</sup> ,<br>C <sub>b</sub> = 30 pF, R <sub>b</sub> = 5.5 kΩ                          | t <sub>KCY1</sub> /2 – 50  |      | t <sub>KCY1</sub> /2 – 50  |      | t <sub>KCY1</sub> /2 – 50  |      | ns   |

**Note** Use it with EV<sub>DD0</sub> ≥ V<sub>b</sub>.

**Caution** Select the TTL input buffer for the SIp pin and the N-ch open drain output (V<sub>DD</sub> tolerance (When 20- to 52-pin products)/EV<sub>DD</sub> 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 V<sub>IH</sub> and V<sub>IL</sub>, see the DC characteristics with TTL input buffer selected.

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

**CSI mode connection diagram (during communication at different potential)**

- Remarks**
1.  $R_b[\Omega]$ : Communication line (SO<sub>p</sub>) pull-up resistance,  $C_b[F]$ : Communication line (SO<sub>p</sub>) load capacitance,  $V_b[V]$ : Communication line voltage
  2. p: CSI number (p = 00, 01, 10, 20, 30, 31), m: Unit number, n: Channel number (mn = 00, 01, 02, 10, 12, 13), g: PIM and POM number (g = 0, 1, 4, 5, 8, 14)
  3.  $f_{MCK}$ : Serial array unit operation clock frequency  
(Operation clock to be set by the CKSmn bit of serial mode register mn (SMRmn).  
m: Unit number, n: Channel number (mn = 00, 01, 02, 10, 12, 13))
  4. CSI01 of 48-, 52-, 64-pin products, and CSI11 and CSI21 cannot communicate at different potential.  
Use other CSI for communication at different potential.

(4) When reference voltage (+) = Internal reference voltage (ADREFP1 = 1, ADREFP0 = 0), reference voltage (-) = AV<sub>REFM</sub>/ANI1 (ADREFM = 1), target pin : ANI0, ANI2 to ANI14, ANI16 to ANI26

(T<sub>A</sub> = -40 to +85°C, 2.4 V ≤ V<sub>DD</sub> ≤ 5.5 V, 1.6 V ≤ EV<sub>DD0</sub> = EV<sub>DD1</sub> ≤ V<sub>DD</sub>, V<sub>SS</sub> = EV<sub>SS0</sub> = EV<sub>SS1</sub> = 0 V, Reference voltage (+) = V<sub>BGR</sub><sup>Note 3</sup>, Reference voltage (-) = AV<sub>REFM</sub> = 0 V<sup>Note 4</sup>, HS (high-speed main) mode)

| Parameter                                      | Symbol            | Conditions       |                                 | MIN. | TYP. | MAX.                               | Unit |
|------------------------------------------------|-------------------|------------------|---------------------------------|------|------|------------------------------------|------|
| Resolution                                     | RES               |                  |                                 | 8    |      |                                    | bit  |
| Conversion time                                | t <sub>CONV</sub> | 8-bit resolution | 2.4 V ≤ V <sub>DD</sub> ≤ 5.5 V | 17   |      | 39                                 | μs   |
| Zero-scale error <sup>Notes 1, 2</sup>         | E <sub>zs</sub>   | 8-bit resolution | 2.4 V ≤ V <sub>DD</sub> ≤ 5.5 V |      |      | ±0.60                              | %FSR |
| Integral linearity error <sup>Note 1</sup>     | ILE               | 8-bit resolution | 2.4 V ≤ V <sub>DD</sub> ≤ 5.5 V |      |      | ±2.0                               | LSB  |
| Differential linearity error <sup>Note 1</sup> | DLE               | 8-bit resolution | 2.4 V ≤ V <sub>DD</sub> ≤ 5.5 V |      |      | ±1.0                               | LSB  |
| Analog input voltage                           | V <sub>Ain</sub>  |                  |                                 | 0    |      | V <sub>BGR</sub> <sup>Note 3</sup> | V    |

**Notes** 1. Excludes quantization error (±1/2 LSB).

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

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

4. When reference voltage (-) = V<sub>SS</sub>, the MAX. values are as follows.

Zero-scale error: Add ±0.35%FSR to the MAX. value when reference voltage (-) = AV<sub>REFM</sub>.

Integral linearity error: Add ±0.5 LSB to the MAX. value when reference voltage (-) = AV<sub>REFM</sub>.

Differential linearity error: Add ±0.2 LSB to the MAX. value when reference voltage (-) = AV<sub>REFM</sub>.

## 2.6.4 LVD circuit characteristics

**LVD Detection Voltage of Reset Mode and Interrupt Mode**(T<sub>A</sub> = -40 to +85°C, V<sub>PDR</sub> ≤ V<sub>DD</sub> ≤ 5.5 V, V<sub>SS</sub> = 0 V)

| Parameter         |                      | Symbol               | Conditions             | MIN.            | TYP. | MAX. | Unit |     |    |
|-------------------|----------------------|----------------------|------------------------|-----------------|------|------|------|-----|----|
| Detection voltage | Supply voltage level | V <sub>LVD0</sub>    | Power supply rise time | 3.98            | 4.06 | 4.14 | V    |     |    |
|                   |                      |                      | Power supply fall time | 3.90            | 3.98 | 4.06 | V    |     |    |
|                   |                      | V <sub>LVD1</sub>    | Power supply rise time | 3.68            | 3.75 | 3.82 | V    |     |    |
|                   |                      |                      | Power supply fall time | 3.60            | 3.67 | 3.74 | V    |     |    |
|                   |                      | V <sub>LVD2</sub>    | Power supply rise time | 3.07            | 3.13 | 3.19 | V    |     |    |
|                   |                      |                      | Power supply fall time | 3.00            | 3.06 | 3.12 | V    |     |    |
|                   |                      | V <sub>LVD3</sub>    | Power supply rise time | 2.96            | 3.02 | 3.08 | V    |     |    |
|                   |                      |                      | Power supply fall time | 2.90            | 2.96 | 3.02 | V    |     |    |
|                   |                      | V <sub>LVD4</sub>    | Power supply rise time | 2.86            | 2.92 | 2.97 | V    |     |    |
|                   |                      |                      | Power supply fall time | 2.80            | 2.86 | 2.91 | V    |     |    |
|                   |                      | V <sub>LVD5</sub>    | Power supply rise time | 2.76            | 2.81 | 2.87 | V    |     |    |
|                   |                      |                      | Power supply fall time | 2.70            | 2.75 | 2.81 | V    |     |    |
|                   |                      | V <sub>LVD6</sub>    | Power supply rise time | 2.66            | 2.71 | 2.76 | V    |     |    |
|                   |                      |                      | Power supply fall time | 2.60            | 2.65 | 2.70 | V    |     |    |
|                   |                      | V <sub>LVD7</sub>    | Power supply rise time | 2.56            | 2.61 | 2.66 | V    |     |    |
|                   |                      |                      | Power supply fall time | 2.50            | 2.55 | 2.60 | V    |     |    |
|                   |                      | V <sub>LVD8</sub>    | Power supply rise time | 2.45            | 2.50 | 2.55 | V    |     |    |
|                   |                      |                      | Power supply fall time | 2.40            | 2.45 | 2.50 | V    |     |    |
|                   |                      | V <sub>LVD9</sub>    | Power supply rise time | 2.05            | 2.09 | 2.13 | V    |     |    |
|                   |                      |                      | Power supply fall time | 2.00            | 2.04 | 2.08 | V    |     |    |
|                   |                      | V <sub>LVD10</sub>   | Power supply rise time | 1.94            | 1.98 | 2.02 | V    |     |    |
|                   |                      |                      | Power supply fall time | 1.90            | 1.94 | 1.98 | V    |     |    |
|                   |                      | V <sub>LVD11</sub>   | Power supply rise time | 1.84            | 1.88 | 1.91 | V    |     |    |
|                   |                      |                      | Power supply fall time | 1.80            | 1.84 | 1.87 | V    |     |    |
|                   |                      | V <sub>LVD12</sub>   | Power supply rise time | 1.74            | 1.77 | 1.81 | V    |     |    |
|                   |                      |                      | Power supply fall time | 1.70            | 1.73 | 1.77 | V    |     |    |
|                   |                      | V <sub>LVD13</sub>   | Power supply rise time | 1.64            | 1.67 | 1.70 | V    |     |    |
|                   |                      |                      | Power supply fall time | 1.60            | 1.63 | 1.66 | V    |     |    |
|                   |                      | Minimum pulse width  |                        | t <sub>LW</sub> |      | 300  |      |     | μs |
|                   |                      | Detection delay time |                        |                 |      |      |      | 300 | μs |

**( $T_A = -40$  to  $+105^{\circ}\text{C}$ ,  $2.4\text{ V} \leq \text{EV}_{\text{DD0}} = \text{EV}_{\text{DD1}} \leq \text{V}_{\text{DD}} \leq 5.5\text{ V}$ ,  $\text{V}_{\text{SS}} = \text{EV}_{\text{SS0}} = \text{EV}_{\text{SS1}} = 0\text{ V}$ ) (3/5)**

| Items                  | Symbol                  | Conditions                                                                                                                                                                           | MIN.                                                                             | TYP.                        | MAX.                        | Unit |
|------------------------|-------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------|-----------------------------|-----------------------------|------|
| Input voltage,<br>high | $\text{V}_{\text{IH1}}$ | P00 to P07, P10 to P17, P30 to P37,<br>P40 to P47, P50 to P57, P64 to P67,<br>P70 to P77, P80 to P87, P90 to P97,<br>P100 to P106, P110 to P117, P120,<br>P125 to P127, P140 to P147 | Normal input buffer                                                              | $0.8\text{EV}_{\text{DD0}}$ | $\text{EV}_{\text{DD0}}$    | V    |
|                        | $\text{V}_{\text{IH2}}$ | P01, P03, P04, P10, P11,<br>P13 to P17, P43, P44, P53 to P55,<br>P80, P81, P142, P143                                                                                                | TTL input buffer<br>$4.0\text{ V} \leq \text{EV}_{\text{DD0}} \leq 5.5\text{ V}$ | 2.2                         | $\text{EV}_{\text{DD0}}$    | V    |
|                        |                         |                                                                                                                                                                                      | TTL input buffer<br>$3.3\text{ V} \leq \text{EV}_{\text{DD0}} < 4.0\text{ V}$    | 2.0                         | $\text{EV}_{\text{DD0}}$    | V    |
|                        |                         |                                                                                                                                                                                      | TTL input buffer<br>$2.4\text{ V} \leq \text{EV}_{\text{DD0}} < 3.3\text{ V}$    | 1.5                         | $\text{EV}_{\text{DD0}}$    | V    |
|                        | $\text{V}_{\text{IH3}}$ | P20 to P27, P150 to P156                                                                                                                                                             | $0.7\text{V}_{\text{DD}}$                                                        |                             | $\text{V}_{\text{DD}}$      | V    |
|                        | $\text{V}_{\text{IH4}}$ | P60 to P63                                                                                                                                                                           | $0.7\text{EV}_{\text{DD0}}$                                                      |                             | 6.0                         | V    |
|                        | $\text{V}_{\text{IH5}}$ | P121 to P124, P137, EXCLK, EXCLKS, $\overline{\text{RESET}}$                                                                                                                         | $0.8\text{V}_{\text{DD}}$                                                        |                             | $\text{V}_{\text{DD}}$      | V    |
| Input voltage,<br>low  | $\text{V}_{\text{IL1}}$ | P00 to P07, P10 to P17, P30 to P37,<br>P40 to P47, P50 to P57, P64 to P67,<br>P70 to P77, P80 to P87, P90 to P97,<br>P100 to P106, P110 to P117, P120,<br>P125 to P127, P140 to P147 | Normal input buffer                                                              | 0                           | $0.2\text{EV}_{\text{DD0}}$ | V    |
|                        | $\text{V}_{\text{IL2}}$ | P01, P03, P04, P10, P11,<br>P13 to P17, P43, P44, P53 to P55,<br>P80, P81, P142, P143                                                                                                | TTL input buffer<br>$4.0\text{ V} \leq \text{EV}_{\text{DD0}} \leq 5.5\text{ V}$ | 0                           | 0.8                         | V    |
|                        |                         |                                                                                                                                                                                      | TTL input buffer<br>$3.3\text{ V} \leq \text{EV}_{\text{DD0}} < 4.0\text{ V}$    | 0                           | 0.5                         | V    |
|                        |                         |                                                                                                                                                                                      | TTL input buffer<br>$2.4\text{ V} \leq \text{EV}_{\text{DD0}} < 3.3\text{ V}$    | 0                           | 0.32                        | V    |
|                        | $\text{V}_{\text{IL3}}$ | P20 to P27, P150 to P156                                                                                                                                                             | 0                                                                                |                             | $0.3\text{V}_{\text{DD}}$   | V    |
|                        | $\text{V}_{\text{IL4}}$ | P60 to P63                                                                                                                                                                           | 0                                                                                |                             | $0.3\text{EV}_{\text{DD0}}$ | V    |
|                        | $\text{V}_{\text{IL5}}$ | P121 to P124, P137, EXCLK, EXCLKS, $\overline{\text{RESET}}$                                                                                                                         | 0                                                                                |                             | $0.2\text{V}_{\text{DD}}$   | V    |

**Caution** The maximum value of  $\text{V}_{\text{IH}}$  of pins P00, P02 to P04, P10 to P15, P17, P43 to P45, P50, P52 to P55, P71, P74, P80 to P82, P96, and P142 to P144 is  $\text{EV}_{\text{DD0}}$ , even in the N-ch open-drain mode.

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

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

- 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  $T_A = 25^{\circ}\text{C}$

- 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  $T_A = 25^{\circ}\text{C}$

## (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.

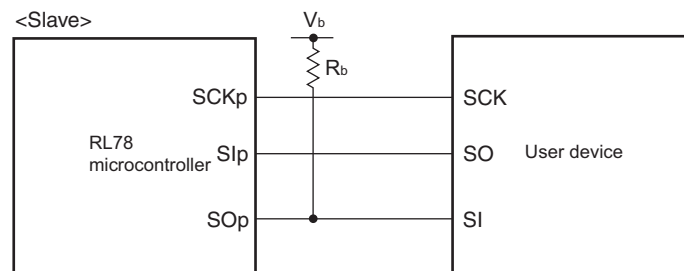
3. Current flowing only to the real-time clock (RTC) (excluding the operating current of the low-speed on-chip oscillator and the XT1 oscillator). The supply current of the RL78 microcontrollers is the sum of the values of either  $I_{\text{DD}1}$  or  $I_{\text{DD}2}$ , and  $I_{\text{RTC}}$ , when 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.

**Notes** 1. Transfer rate in the SNOOZE mode : MAX. 1 Mbps

2. When  $\text{DAPmn} = 0$  and  $\text{CKPmn} = 0$ , or  $\text{DAPmn} = 1$  and  $\text{CKPmn} = 1$ . The  $\text{Slp}$  setup time becomes “to  $\text{SCKp}\downarrow$ ” when  $\text{DAPmn} = 0$  and  $\text{CKPmn} = 1$ , or  $\text{DAPmn} = 1$  and  $\text{CKPmn} = 0$ .
3. When  $\text{DAPmn} = 0$  and  $\text{CKPmn} = 0$ , or  $\text{DAPmn} = 1$  and  $\text{CKPmn} = 1$ . The  $\text{Slp}$  hold time becomes “from  $\text{SCKp}\downarrow$ ” when  $\text{DAPmn} = 0$  and  $\text{CKPmn} = 1$ , or  $\text{DAPmn} = 1$  and  $\text{CKPmn} = 0$ .
4. When  $\text{DAPmn} = 0$  and  $\text{CKPmn} = 0$ , or  $\text{DAPmn} = 1$  and  $\text{CKPmn} = 1$ . The delay time to  $\text{SOp}$  output becomes “from  $\text{SCKp}\uparrow$ ” when  $\text{DAPmn} = 0$  and  $\text{CKPmn} = 1$ , or  $\text{DAPmn} = 1$  and  $\text{CKPmn} = 0$ .

**Caution** Select the TTL input buffer for the  $\text{Slp}$  pin and  $\text{SCKp}$  pin and the N-ch open drain output ( $V_{DD}$  tolerance (for the 20- to 52-pin products)/ $\text{EV}_{DD}$  tolerance (for the 64- to 128-pin products)) mode for the  $\text{SOp}$  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.

**CSI mode connection diagram (during communication at different potential)**



- Remarks** 1.  $R_b[\Omega]$ : Communication line ( $\text{SOp}$ ) pull-up resistance,  $C_b[\text{F}]$ : Communication line ( $\text{SOp}$ ) load capacitance,  $V_b[\text{V}]$ : Communication line voltage
2. p: CSI number (p = 00, 01, 10, 20, 30, 31), m: Unit number (m = 0, 1), n: Channel number (n = 00, 01, 02, 10, 12, 13), g: PIM and POM number (g = 0, 1, 4, 5, 8, 14)
  3.  $f_{\text{MCK}}$ : Serial array unit operation clock frequency  
(Operation clock to be set by the  $\text{CKSmn}$  bit of serial mode register mn ( $\text{SMRmn}$ ).  
m: Unit number, n: Channel number (mn = 00, 01, 02, 10, 12, 13))
  4. CSI01 of 48-, 52-, 64-pin products, and CSI11 and CSI21 cannot communicate at different potential. Use other CSI for communication at different potential.

### 3.6 Analog Characteristics

#### 3.6.1 A/D converter characteristics

Classification of A/D converter characteristics

| Input channel                                                      | Reference Voltage                                                          |                                                                      |                                                                          |
|--------------------------------------------------------------------|----------------------------------------------------------------------------|----------------------------------------------------------------------|--------------------------------------------------------------------------|
|                                                                    | Reference voltage (+) = $AV_{REFP}$<br>Reference voltage (–) = $AV_{REFM}$ | Reference voltage (+) = $V_{DD}$<br>Reference voltage (–) = $V_{SS}$ | Reference voltage (+) = $V_{BGR}$<br>Reference voltage (–) = $AV_{REFM}$ |
| ANI0 to ANI14                                                      | Refer to 3.6.1 (1).                                                        | Refer to 3.6.1 (3).                                                  | Refer to 3.6.1 (4).                                                      |
| ANI16 to ANI26                                                     | Refer to 3.6.1 (2).                                                        |                                                                      |                                                                          |
| Internal reference voltage<br>Temperature sensor output<br>voltage | Refer to 3.6.1 (1).                                                        |                                                                      | –                                                                        |

(1) When reference voltage (+) =  $AV_{REFP}/ANI0$  ( $ADREFP1 = 0$ ,  $ADREFP0 = 1$ ), reference voltage (–) =  $AV_{REFM}/ANI1$  ( $ADREFM = 1$ ), target pin : ANI2 to ANI14, internal reference voltage, and temperature sensor output voltage

( $T_A = -40$  to  $+105^\circ\text{C}$ ,  $2.4\text{ V} \leq AV_{REFP} \leq V_{DD} \leq 5.5\text{ V}$ ,  $V_{SS} = 0\text{ V}$ , Reference voltage (+) =  $AV_{REFP}$ , Reference voltage (–) =  $AV_{REFM} = 0\text{ V}$ )

| Parameter                                         | Symbol     | Conditions                                                                                                                              |                                                 | MIN.                           | TYP. | MAX.        | Unit          |
|---------------------------------------------------|------------|-----------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------|--------------------------------|------|-------------|---------------|
| Resolution                                        | RES        |                                                                                                                                         |                                                 | 8                              |      | 10          | bit           |
| Overall error <sup>Note 1</sup>                   | AINL       | 10-bit resolution<br>$AV_{REFP} = V_{DD}$ <sup>Note 3</sup>                                                                             | $2.4\text{ V} \leq AV_{REFP} \leq 5.5\text{ V}$ |                                | 1.2  | $\pm 3.5$   | LSB           |
| Conversion time                                   | $t_{CONV}$ | 10-bit resolution<br>Target pin: ANI2 to ANI14                                                                                          | $3.6\text{ V} \leq V_{DD} \leq 5.5\text{ V}$    | 2.125                          |      | 39          | $\mu\text{s}$ |
|                                                   |            |                                                                                                                                         | $2.7\text{ V} \leq V_{DD} \leq 5.5\text{ V}$    | 3.1875                         |      | 39          | $\mu\text{s}$ |
|                                                   |            |                                                                                                                                         | $2.4\text{ V} \leq V_{DD} \leq 5.5\text{ V}$    | 17                             |      | 39          | $\mu\text{s}$ |
|                                                   |            | 10-bit resolution<br>Target pin: Internal reference<br>voltage, and temperature<br>sensor output voltage (HS<br>(high-speed main) mode) | $3.6\text{ V} \leq V_{DD} \leq 5.5\text{ V}$    | 2.375                          |      | 39          | $\mu\text{s}$ |
|                                                   |            |                                                                                                                                         | $2.7\text{ V} \leq V_{DD} \leq 5.5\text{ V}$    | 3.5625                         |      | 39          | $\mu\text{s}$ |
|                                                   |            |                                                                                                                                         | $2.4\text{ V} \leq V_{DD} \leq 5.5\text{ V}$    | 17                             |      | 39          | $\mu\text{s}$ |
| Zero-scale error <sup>Notes 1, 2</sup>            | $E_{ZS}$   | 10-bit resolution<br>$AV_{REFP} = V_{DD}$ <sup>Note 3</sup>                                                                             | $2.4\text{ V} \leq AV_{REFP} \leq 5.5\text{ V}$ |                                |      | $\pm 0.25$  | %FSR          |
| Full-scale error <sup>Notes 1, 2</sup>            | $E_{FS}$   | 10-bit resolution<br>$AV_{REFP} = V_{DD}$ <sup>Note 3</sup>                                                                             | $2.4\text{ V} \leq AV_{REFP} \leq 5.5\text{ V}$ |                                |      | $\pm 0.25$  | %FSR          |
| Integral linearity error<br><sup>Note 1</sup>     | ILE        | 10-bit resolution<br>$AV_{REFP} = V_{DD}$ <sup>Note 3</sup>                                                                             | $2.4\text{ V} \leq AV_{REFP} \leq 5.5\text{ V}$ |                                |      | $\pm 2.5$   | LSB           |
| Differential linearity error<br><sup>Note 1</sup> | DLE        | 10-bit resolution<br>$AV_{REFP} = V_{DD}$ <sup>Note 3</sup>                                                                             | $2.4\text{ V} \leq AV_{REFP} \leq 5.5\text{ V}$ |                                |      | $\pm 1.5$   | LSB           |
| Analog input voltage                              | $V_{AIN}$  | ANI2 to ANI14                                                                                                                           |                                                 | 0                              |      | $AV_{REFP}$ | V             |
|                                                   |            | Internal reference voltage output<br>( $2.4\text{ V} \leq V_{DD} \leq 5.5\text{ V}$ , HS (high-speed main) mode)                        |                                                 | $V_{BGR}$ <sup>Note 4</sup>    |      |             | V             |
|                                                   |            | Temperature sensor output voltage<br>( $2.4\text{ V} \leq V_{DD} \leq 5.5\text{ V}$ , HS (high-speed main) mode)                        |                                                 | $V_{TMPS25}$ <sup>Note 4</sup> |      |             | V             |

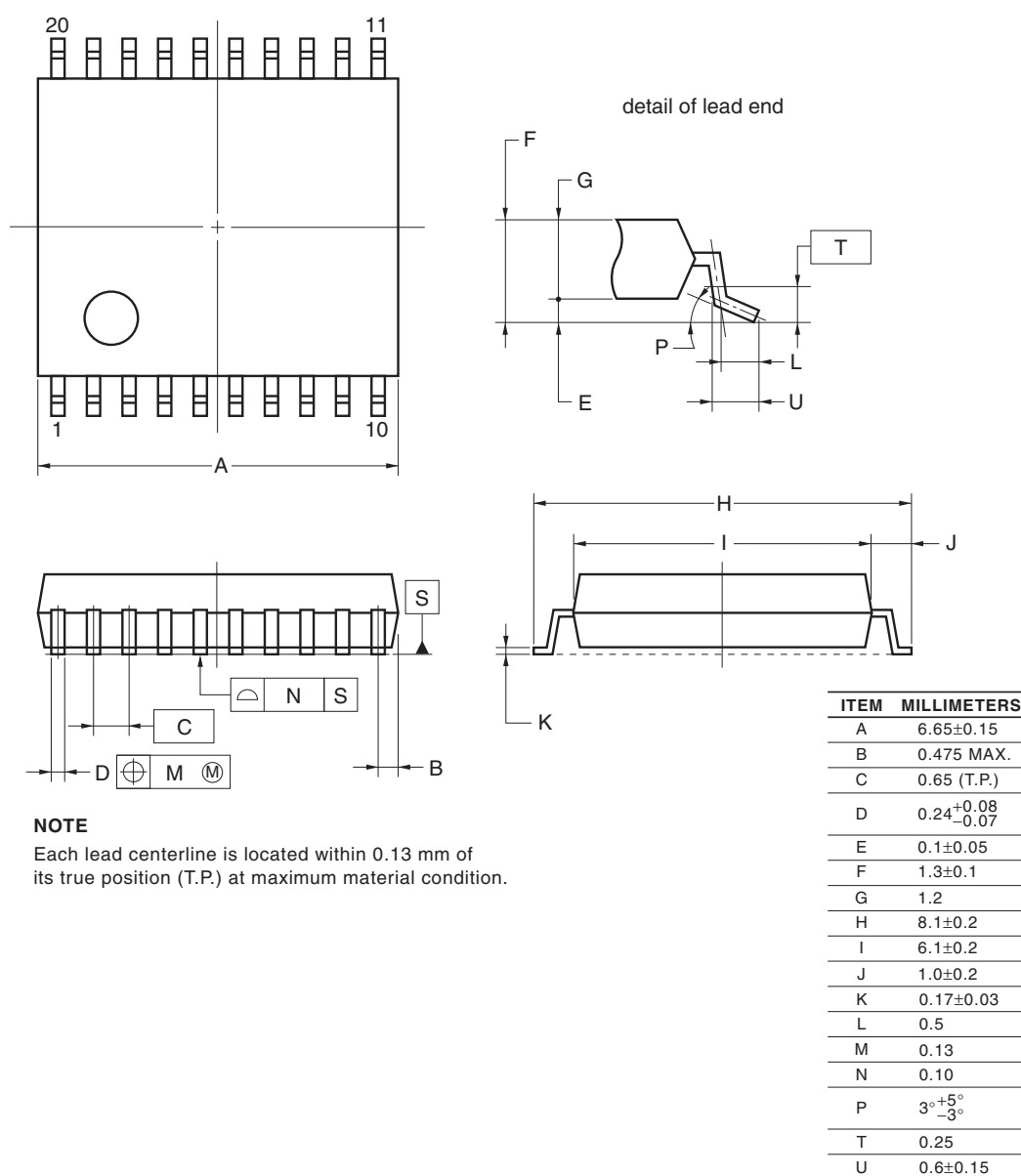
(Notes are listed on the next page.)

## 4. PACKAGE DRAWINGS

### 4.1 20-pin Products

R5F1006AASP, R5F1006CASP, R5F1006DASP, R5F1006EASP  
 R5F1016AASP, R5F1016CASP, R5F1016DASP, R5F1016EASP  
 R5F1006ADSP, R5F1006CDSP, R5F1006DDSP, R5F1006EDSP  
 R5F1016ADSP, R5F1016CDSP, R5F1016DDSP, R5F1016EDSP  
 R5F1006AGSP, R5F1006CGSP, R5F1006DGSP, R5F1006EGSP

| JEITA Package Code  | RENESAS Code | Previous Code  | MASS (TYP.) [g] |
|---------------------|--------------|----------------|-----------------|
| P-LSSOP20-0300-0.65 | PLSP0020JC-A | S20MC-65-5A4-3 | 0.12            |



#### NOTE

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