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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.

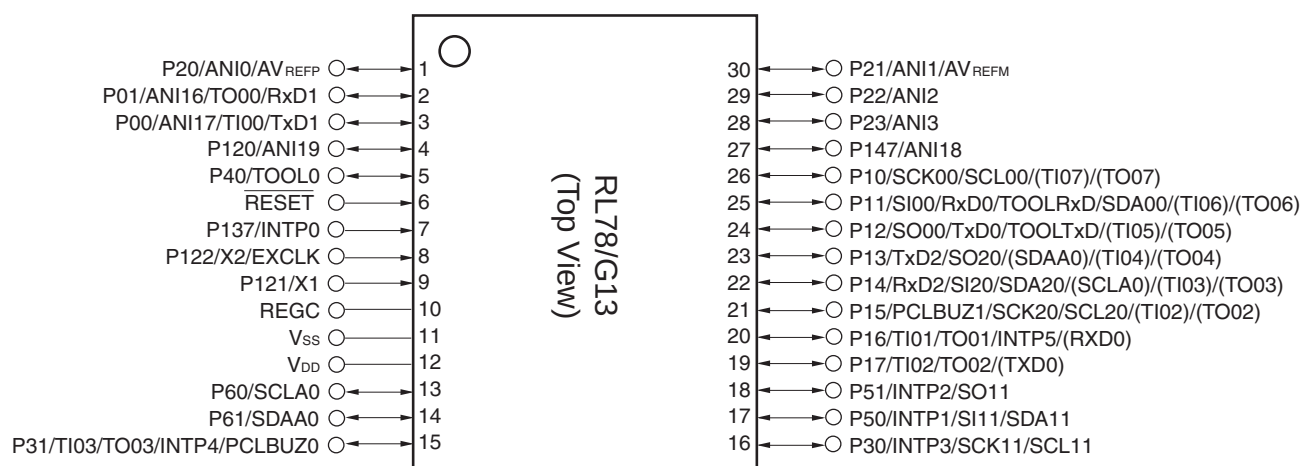
### Applications of "[Embedded - Microcontrollers](#)"

#### Details

|                            |                                                                                                                                                                               |
|----------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Product Status             | Discontinued at Digi-Key                                                                                                                                                      |
| 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              | 64                                                                                                                                                                            |
| Program Memory Size        | 256KB (256K x 8)                                                                                                                                                              |
| Program Memory Type        | FLASH                                                                                                                                                                         |
| EEPROM Size                | -                                                                                                                                                                             |
| RAM Size                   | 20K x 8                                                                                                                                                                       |
| Voltage - Supply (Vcc/Vdd) | 1.6V ~ 5.5V                                                                                                                                                                   |
| Data Converters            | A/D 17x8/10b                                                                                                                                                                  |
| Oscillator Type            | Internal                                                                                                                                                                      |
| Operating Temperature      | -40°C ~ 85°C (TA)                                                                                                                                                             |
| Mounting Type              | Surface Mount                                                                                                                                                                 |
| Package / Case             | 80-LQFP                                                                                                                                                                       |
| Supplier Device Package    | 80-LQFP (14x14)                                                                                                                                                               |
| Purchase URL               | <a href="https://www.e-xfl.com/product-detail/renesas-electronics-america/r5f101mjafa-v0">https://www.e-xfl.com/product-detail/renesas-electronics-america/r5f101mjafa-v0</a> |

## 1.3.4 30-pin products

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

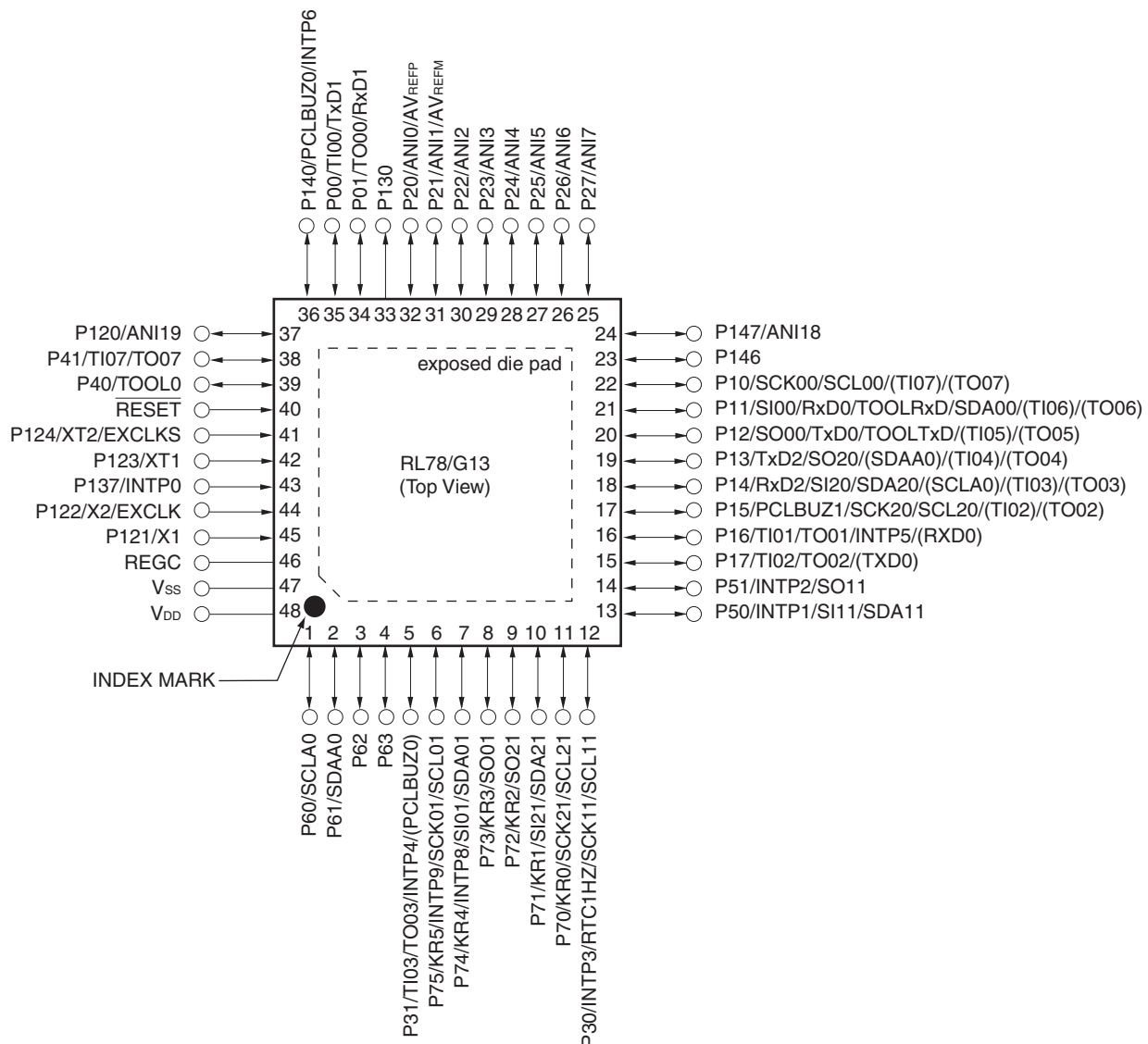


**Caution** Connect the REGC pin to V<sub>ss</sub> via a capacitor (0.47 to 1  $\mu$ F).

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

- 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.

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

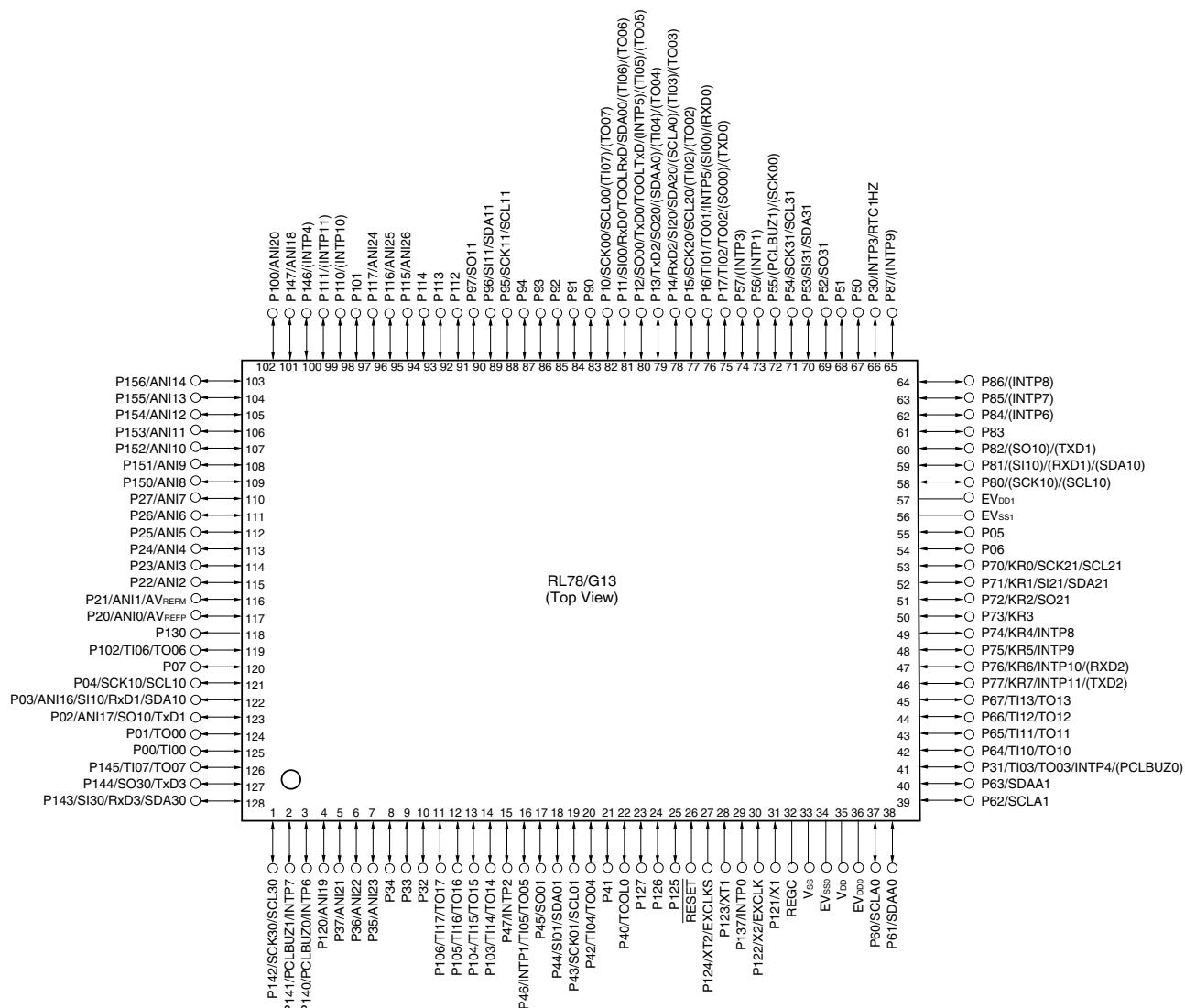


**Caution** Connect the REGC pin to Vss via a capacitor (0.47 to 1  $\mu$ F).

**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.
- It is recommended to connect an exposed die pad to Vss.

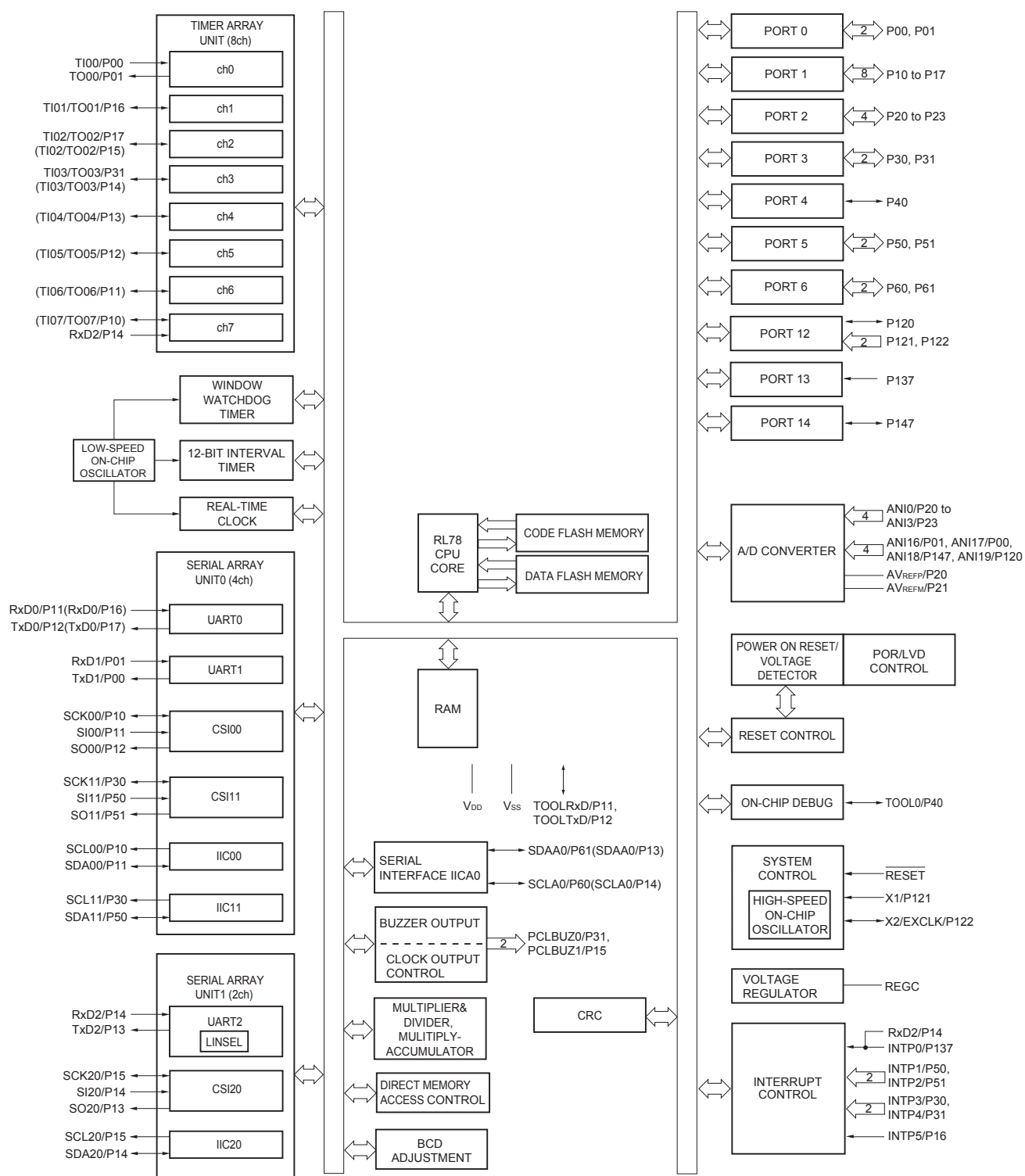
- 128-pin plastic LFQFP (14 × 20 mm, 0.5 mm pitch)



- 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).

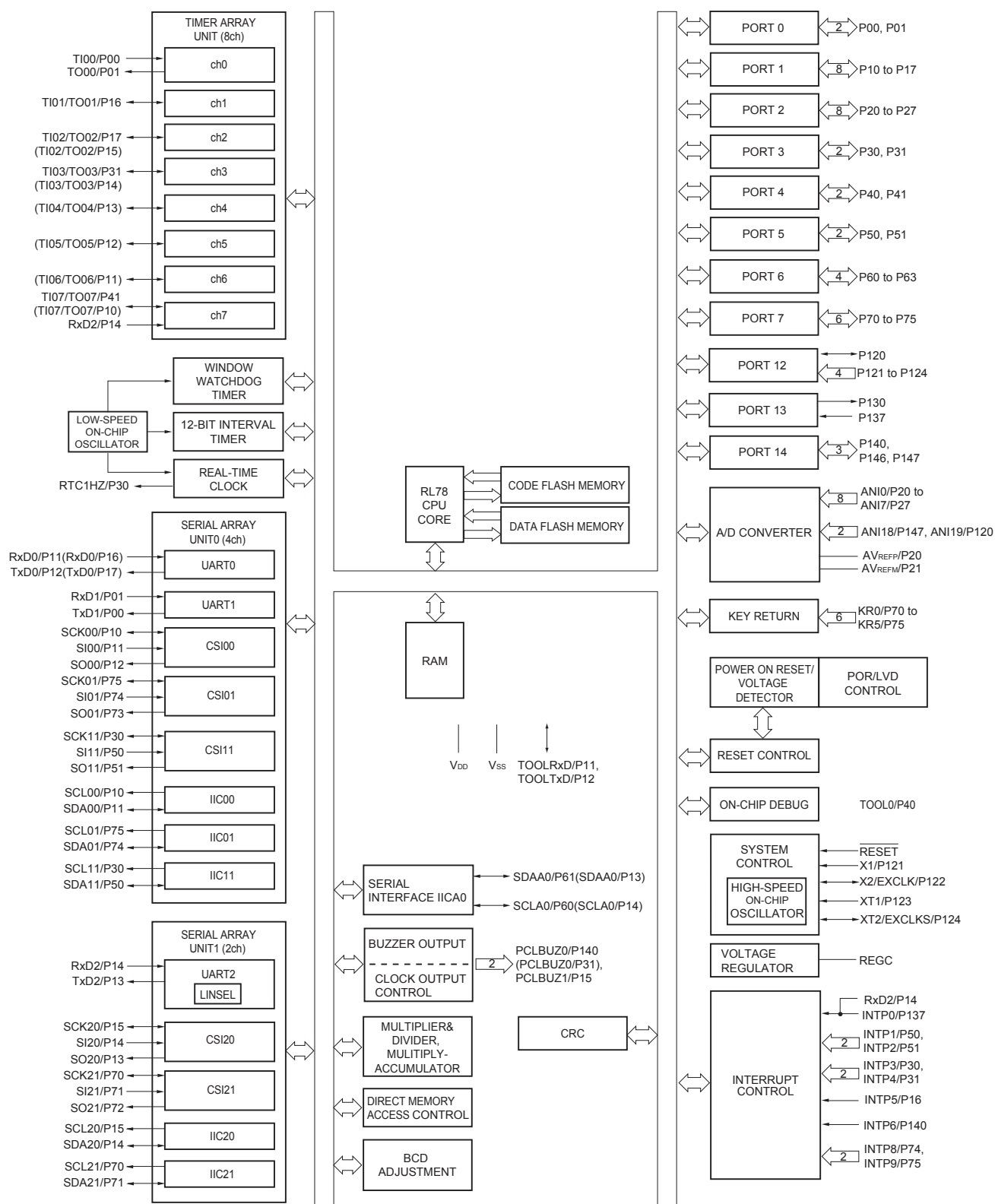
- Remarks**
1. For pin identification, see **1.4 Pin Identification**.
  2. When using the microcontroller for an application where the noise generated inside the microcontroller must be reduced, it is recommended to supply separate powers to the  $V_{DD}$ ,  $EV_{DD0}$  and  $EV_{DD1}$  pins and connect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

## 1.5.4 30-pin products



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

## 1.5.9 48-pin products



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

(T<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.

## 2.3.2 Supply current characteristics

## (1) Flash ROM: 16 to 64 KB of 20- to 64-pin products

(T<sub>A</sub> = -40 to +85°C, 1.6 V ≤ E<sub>VDD0</sub> ≤ V<sub>DD</sub> ≤ 5.5 V, V<sub>SS</sub> = E<sub>VSS0</sub> = 0 V) (1/2)

| Parameter                        | Symbol           | Conditions     |                                             |                                                                           |                                                                         | MIN.                    | TYP.                    | MAX. | Unit |     |    |
|----------------------------------|------------------|----------------|---------------------------------------------|---------------------------------------------------------------------------|-------------------------------------------------------------------------|-------------------------|-------------------------|------|------|-----|----|
| Supply current <sup>Note 1</sup> | I <sub>DD1</sub> | Operating mode | HS (high-speed main) mode <sup>Note 5</sup> | f <sub>IH</sub> = 32 MHz <sup>Note 3</sup>                                | Basic operation                                                         | V <sub>DD</sub> = 5.0 V |                         | 2.1  |      | mA  |    |
|                                  |                  |                |                                             |                                                                           |                                                                         | V <sub>DD</sub> = 3.0 V |                         | 2.1  |      | mA  |    |
|                                  |                  |                |                                             |                                                                           | Normal operation                                                        | V <sub>DD</sub> = 5.0 V |                         | 4.6  | 7.0  | mA  |    |
|                                  |                  |                |                                             |                                                                           |                                                                         | V <sub>DD</sub> = 3.0 V |                         | 4.6  | 7.0  | mA  |    |
|                                  |                  |                |                                             | f <sub>IH</sub> = 24 MHz <sup>Note 3</sup>                                | Normal operation                                                        | V <sub>DD</sub> = 5.0 V |                         | 3.7  | 5.5  | mA  |    |
|                                  |                  |                |                                             |                                                                           |                                                                         | V <sub>DD</sub> = 3.0 V |                         | 3.7  | 5.5  | mA  |    |
|                                  |                  |                |                                             | f <sub>IH</sub> = 16 MHz <sup>Note 3</sup>                                | Normal operation                                                        | V <sub>DD</sub> = 5.0 V |                         | 2.7  | 4.0  | mA  |    |
|                                  |                  |                |                                             |                                                                           |                                                                         | V <sub>DD</sub> = 3.0 V |                         | 2.7  | 4.0  | mA  |    |
|                                  |                  |                |                                             | LS (low-speed main) mode <sup>Note 5</sup>                                | f <sub>IH</sub> = 8 MHz <sup>Note 3</sup>                               | Normal operation        | V <sub>DD</sub> = 3.0 V |      | 1.2  | 1.8 | mA |
|                                  |                  |                |                                             |                                                                           |                                                                         |                         | V <sub>DD</sub> = 2.0 V |      | 1.2  | 1.8 | mA |
|                                  |                  |                |                                             | LV (low-voltage main) mode <sup>Note 5</sup>                              | f <sub>IH</sub> = 4 MHz <sup>Note 3</sup>                               | Normal operation        | V <sub>DD</sub> = 3.0 V |      | 1.2  | 1.7 | mA |
|                                  |                  |                |                                             |                                                                           |                                                                         |                         | V <sub>DD</sub> = 2.0 V |      | 1.2  | 1.7 | mA |
|                                  |                  |                | HS (high-speed main) mode <sup>Note 5</sup> | f <sub>MX</sub> = 20 MHz <sup>Note 2</sup> ,<br>V <sub>DD</sub> = 5.0 V   | Normal operation                                                        | Square wave input       |                         | 3.0  | 4.6  | mA  |    |
|                                  |                  |                |                                             |                                                                           |                                                                         | Resonator connection    |                         | 3.2  | 4.8  | mA  |    |
|                                  |                  |                |                                             |                                                                           | Normal operation                                                        | Square wave input       |                         | 3.0  | 4.6  | mA  |    |
|                                  |                  |                |                                             |                                                                           |                                                                         | Resonator connection    |                         | 3.2  | 4.8  | mA  |    |
|                                  |                  |                |                                             |                                                                           | f <sub>MX</sub> = 10 MHz <sup>Note 2</sup> ,<br>V <sub>DD</sub> = 5.0 V | Normal operation        | Square wave input       |      | 1.9  | 2.7 | mA |
|                                  |                  |                |                                             |                                                                           |                                                                         |                         | Resonator connection    |      | 1.9  | 2.7 | mA |
|                                  |                  |                |                                             |                                                                           | f <sub>MX</sub> = 10 MHz <sup>Note 2</sup> ,<br>V <sub>DD</sub> = 3.0 V | Normal operation        | Square wave input       |      | 1.9  | 2.7 | mA |
|                                  |                  |                |                                             |                                                                           |                                                                         |                         | Resonator connection    |      | 1.9  | 2.7 | mA |
|                                  |                  |                |                                             | LS (low-speed main) mode <sup>Note 5</sup>                                | f <sub>MX</sub> = 8 MHz <sup>Note 2</sup> ,<br>V <sub>DD</sub> = 3.0 V  | Normal operation        | Square wave input       |      | 1.1  | 1.7 | mA |
|                                  |                  |                |                                             |                                                                           |                                                                         |                         | Resonator connection    |      | 1.1  | 1.7 | mA |
|                                  |                  |                |                                             |                                                                           | f <sub>MX</sub> = 8 MHz <sup>Note 2</sup> ,<br>V <sub>DD</sub> = 2.0 V  | Normal operation        | Square wave input       |      | 1.1  | 1.7 | mA |
|                                  |                  |                |                                             |                                                                           |                                                                         |                         | Resonator connection    |      | 1.1  | 1.7 | mA |
|                                  |                  |                | Subsystem clock operation                   | f <sub>SUB</sub> = 32.768 kHz <sup>Note 4</sup><br>T <sub>A</sub> = −40°C | Normal operation                                                        | Square wave input       |                         | 4.1  | 4.9  | μA  |    |
|                                  |                  |                |                                             |                                                                           |                                                                         | Resonator connection    |                         | 4.2  | 5.0  | μA  |    |
|                                  |                  |                |                                             | f <sub>SUB</sub> = 32.768 kHz <sup>Note 4</sup><br>T <sub>A</sub> = +25°C | Normal operation                                                        | Square wave input       |                         | 4.1  | 4.9  | μA  |    |
|                                  |                  |                |                                             |                                                                           |                                                                         | Resonator connection    |                         | 4.2  | 5.0  | μA  |    |
|                                  |                  |                |                                             | f <sub>SUB</sub> = 32.768 kHz <sup>Note 4</sup><br>T <sub>A</sub> = +50°C | Normal operation                                                        | Square wave input       |                         | 4.2  | 5.5  | μA  |    |
|                                  |                  |                |                                             |                                                                           |                                                                         | Resonator connection    |                         | 4.3  | 5.6  | μA  |    |
|                                  |                  |                |                                             | f <sub>SUB</sub> = 32.768 kHz <sup>Note 4</sup><br>T <sub>A</sub> = +70°C | Normal operation                                                        | Square wave input       |                         | 4.3  | 6.3  | μA  |    |
|                                  |                  |                |                                             |                                                                           |                                                                         | Resonator connection    |                         | 4.4  | 6.4  | μA  |    |
|                                  |                  |                |                                             | f <sub>SUB</sub> = 32.768 kHz <sup>Note 4</sup><br>T <sub>A</sub> = +85°C | Normal operation                                                        | Square wave input       |                         | 4.6  | 7.7  | μA  |    |
|                                  |                  |                |                                             |                                                                           |                                                                         | Resonator connection    |                         | 4.7  | 7.8  | μA  |    |

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

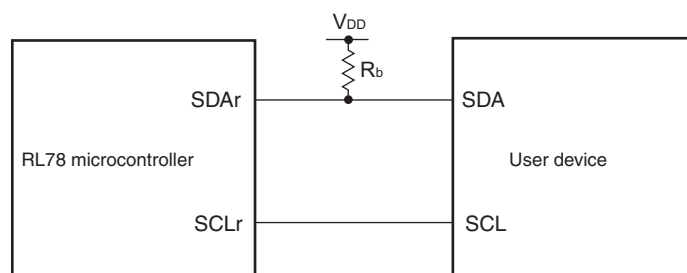
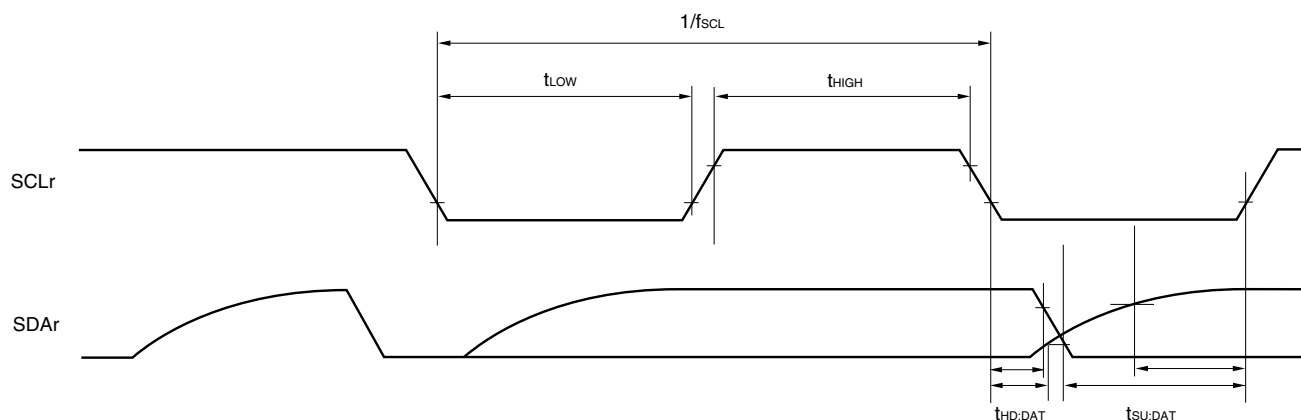


## (1) Flash ROM: 16 to 64 KB of 20- to 64-pin products

(T<sub>A</sub> = -40 to +85°C, 1.6 V ≤ E<sub>VDD0</sub> ≤ V<sub>DD</sub> ≤ 5.5 V, V<sub>SS</sub> = E<sub>VSS0</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                                                |                         | 0.54 | 1.63 | mA   |    |
|                          |                            |                             |                                                                        |                                                                             | V <sub>DD</sub> = 3.0 V                                                |                         | 0.54 | 1.63 | mA   |    |
|                          |                            |                             |                                                                        | f <sub>IH</sub> = 24 MHz <sup>Note 4</sup>                                  | V <sub>DD</sub> = 5.0 V                                                |                         | 0.44 | 1.28 | mA   |    |
|                          |                            |                             |                                                                        |                                                                             | V <sub>DD</sub> = 3.0 V                                                |                         | 0.44 | 1.28 | mA   |    |
|                          |                            |                             |                                                                        | f <sub>IH</sub> = 16 MHz <sup>Note 4</sup>                                  | V <sub>DD</sub> = 5.0 V                                                |                         | 0.40 | 1.00 | mA   |    |
|                          |                            |                             |                                                                        |                                                                             | V <sub>DD</sub> = 3.0 V                                                |                         | 0.40 | 1.00 | 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 |      | 260  | 530  | μA |
|                          |                            |                             |                                                                        |                                                                             |                                                                        | V <sub>DD</sub> = 2.0 V |      | 260  | 530  | 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 |      | 420  | 640  | μA |
|                          |                            |                             |                                                                        |                                                                             |                                                                        | V <sub>DD</sub> = 2.0 V |      | 420  | 640  | 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                                                      |                         | 0.28 | 1.00 | mA   |    |
|                          |                            |                             |                                                                        |                                                                             | Resonator connection                                                   |                         | 0.45 | 1.17 | mA   |    |
|                          |                            |                             |                                                                        | f <sub>MX</sub> = 20 MHz <sup>Note 3</sup> ,<br>V <sub>DD</sub> = 3.0 V     | Square wave input                                                      |                         | 0.28 | 1.00 | mA   |    |
|                          |                            |                             |                                                                        |                                                                             | Resonator connection                                                   |                         | 0.45 | 1.17 | mA   |    |
|                          |                            |                             |                                                                        | f <sub>MX</sub> = 10 MHz <sup>Note 3</sup> ,<br>V <sub>DD</sub> = 5.0 V     | Square wave input                                                      |                         | 0.19 | 0.60 | mA   |    |
|                          |                            |                             |                                                                        |                                                                             | Resonator connection                                                   |                         | 0.26 | 0.67 | mA   |    |
|                          |                            |                             |                                                                        | f <sub>MX</sub> = 10 MHz <sup>Note 3</sup> ,<br>V <sub>DD</sub> = 3.0 V     | Square wave input                                                      |                         | 0.19 | 0.60 | mA   |    |
|                          |                            |                             |                                                                        |                                                                             | Resonator connection                                                   |                         | 0.26 | 0.67 | 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       |      | 95   | 330  | μA |
|                          |                            |                             |                                                                        |                                                                             |                                                                        | Resonator connection    |      | 145  | 380  | μA |
|                          |                            |                             | f <sub>MX</sub> = 8 MHz <sup>Note 3</sup> ,<br>V <sub>DD</sub> = 2.0 V |                                                                             | Square wave input                                                      |                         | 95   | 330  | μA   |    |
|                          |                            |                             |                                                                        |                                                                             | Resonator connection                                                   |                         | 145  | 380  | 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                                                      |                         | 0.25 | 0.57 | μA   |    |
|                          |                            |                             |                                                                        |                                                                             | Resonator connection                                                   |                         | 0.44 | 0.76 | μA   |    |
|                          |                            |                             |                                                                        | f <sub>SUB</sub> = 32.768 kHz <sup>Note 5</sup> ,<br>T <sub>A</sub> = +25°C | Square wave input                                                      |                         | 0.30 | 0.57 | μA   |    |
|                          |                            |                             |                                                                        |                                                                             | Resonator connection                                                   |                         | 0.49 | 0.76 | μA   |    |
|                          |                            |                             |                                                                        | f <sub>SUB</sub> = 32.768 kHz <sup>Note 5</sup> ,<br>T <sub>A</sub> = +50°C | Square wave input                                                      |                         | 0.37 | 1.17 | μA   |    |
|                          |                            |                             |                                                                        |                                                                             | Resonator connection                                                   |                         | 0.56 | 1.36 | μA   |    |
|                          |                            |                             |                                                                        | f <sub>SUB</sub> = 32.768 kHz <sup>Note 5</sup> ,<br>T <sub>A</sub> = +70°C | Square wave input                                                      |                         | 0.53 | 1.97 | μA   |    |
|                          |                            |                             |                                                                        |                                                                             | Resonator connection                                                   |                         | 0.72 | 2.16 | μA   |    |
|                          |                            |                             |                                                                        | f <sub>SUB</sub> = 32.768 kHz <sup>Note 5</sup> ,<br>T <sub>A</sub> = +85°C | Square wave input                                                      |                         | 0.82 | 3.37 | μA   |    |
|                          |                            |                             |                                                                        |                                                                             | Resonator connection                                                   |                         | 1.01 | 3.56 | μA   |    |
|                          | I <sub>DD3</sub><br>Note 6 | STOP mode <sup>Note 8</sup> | T <sub>A</sub> = −40°C                                                 |                                                                             |                                                                        |                         |      | 0.18 | 0.50 | μA |
|                          |                            |                             | T <sub>A</sub> = +25°C                                                 |                                                                             |                                                                        |                         |      | 0.23 | 0.50 | μA |
|                          |                            |                             | T <sub>A</sub> = +50°C                                                 |                                                                             |                                                                        |                         |      | 0.30 | 1.10 | μA |
|                          |                            |                             | T <sub>A</sub> = +70°C                                                 |                                                                             |                                                                        |                         |      | 0.46 | 1.90 | μA |
|                          |                            |                             | T <sub>A</sub> = +85°C                                                 |                                                                             |                                                                        |                         |      | 0.75 | 3.30 | μA |
|                          |                            |                             |                                                                        |                                                                             |                                                                        |                         |      |      |      |    |

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

**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)**

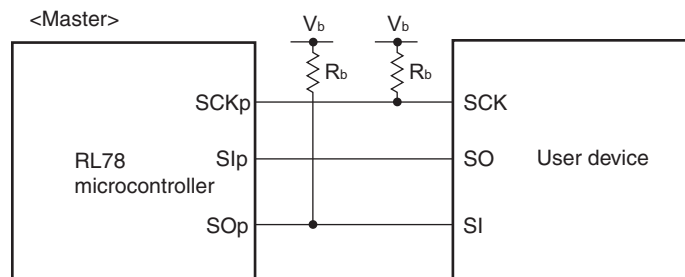
- Remarks**
1.  $R_b[\Omega]$ : Communication line (SDAr) pull-up resistance,  $C_b[F]$ : Communication line (SDAr, SCLr) load capacitance
  2. r: IIC number (r = 00, 01, 10, 11, 20, 21, 30, 31), g: PIM number (g = 0, 1, 4, 5, 8, 14),  
h: POM number (g = 0, 1, 4, 5, 7 to 9, 14)
  3.  $f_{MCK}$ : Serial 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)

## (7) Communication at different potential (2.5 V, 3 V) (CSI mode) (master mode, SCKp... internal clock output, corresponding CSI00 only) (1/2)

(T<sub>A</sub> = -40 to +85°C, 2.7 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> | 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> = 20 pF, R <sub>b</sub> = 1.4 kΩ | 200                        |      | 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> = 20 pF, R <sub>b</sub> = 2.7 kΩ | 300                        |      | 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> = 20 pF, R <sub>b</sub> = 1.4 kΩ | t <sub>KCY1</sub> /2 – 50  |      | 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> = 20 pF, R <sub>b</sub> = 2.7 kΩ | t <sub>KCY1</sub> /2 – 120 |      | t <sub>KCY1</sub> /2 – 120 |      | t <sub>KCY1</sub> /2 – 120 |      | 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> = 20 pF, R <sub>b</sub> = 1.4 kΩ | t <sub>KCY1</sub> /2 – 7   |      | 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> = 20 pF, R <sub>b</sub> = 2.7 kΩ | t <sub>KCY1</sub> /2 – 10  |      | t <sub>KCY1</sub> /2 – 50  |      | t <sub>KCY1</sub> /2 – 50  |      | ns   |
| Slp setup time (to SCKp↑) <sup>Note 1</sup>           | t <sub>SIK1</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> = 20 pF, R <sub>b</sub> = 1.4 kΩ | 58                         |      | 479                        |      | 479                        |      | 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> = 20 pF, R <sub>b</sub> = 2.7 kΩ | 121                        |      | 479                        |      | 479                        |      | ns   |
| Slp hold time (from SCKp↑) <sup>Note 1</sup>          | t <sub>SH1</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> = 20 pF, R <sub>b</sub> = 1.4 kΩ | 10                         |      | 10                         |      | 10                         |      | 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> = 20 pF, R <sub>b</sub> = 2.7 kΩ | 10                         |      | 10                         |      | 10                         |      | ns   |
| Delay time from SCKp↓ to SOp output <sup>Note 1</sup> | t <sub>KSO1</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> = 20 pF, R <sub>b</sub> = 1.4 kΩ |                            | 60   |                            | 60   |                            | 60   | 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> = 20 pF, R <sub>b</sub> = 2.7 kΩ |                            | 130  |                            | 130  |                            | 130  | ns   |

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

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

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

## 2.6.5 Power supply voltage rising slope characteristics

( $T_A = -40$  to  $+85^\circ\text{C}$ ,  $V_{SS} = 0\text{ V}$ )

| Parameter                         | Symbol    | Conditions | MIN. | TYP. | MAX. | Unit |
|-----------------------------------|-----------|------------|------|------|------|------|
| Power supply voltage rising slope | $S_{VDD}$ |            |      |      | 54   | V/ms |

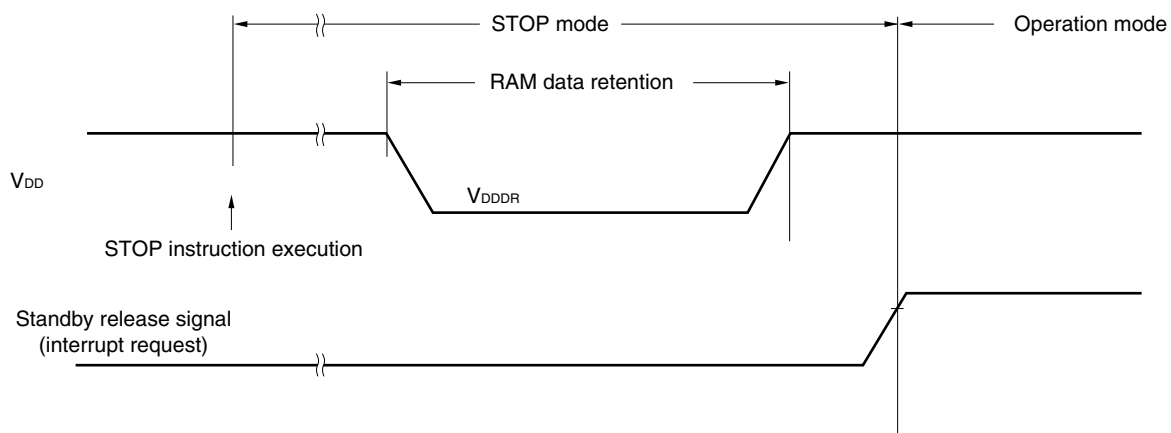
**Caution** Make sure to keep the internal reset state by the LVD circuit or an external reset until  $V_{DD}$  reaches the operating voltage range shown in 2.4 AC Characteristics.

## 2.7 RAM Data Retention Characteristics

( $T_A = -40$  to  $+85^\circ\text{C}$ ,  $V_{SS} = 0\text{ V}$ )

| Parameter                     | Symbol     | Conditions | MIN.                 | TYP. | MAX. | Unit |
|-------------------------------|------------|------------|----------------------|------|------|------|
| Data retention supply voltage | $V_{DDDR}$ |            | 1.46 <sup>Note</sup> |      | 5.5  | V    |

**Note** This depends on the POR detection voltage. For a falling voltage, data in RAM are retained until the voltage reaches the level that triggers a POR reset but not once it reaches the level at which a POR reset is generated.



**( $T_A = -40$  to  $+105^\circ\text{C}$ ,  $2.4\text{ V} \leq \text{EV}_{\text{DD0}} = \text{EV}_{\text{DD1}} \leq \text{V}_{\text{DD}} \leq 5.5\text{ V}$ ,  $\text{V}_{\text{SS}} = \text{EV}_{\text{SS0}} = \text{EV}_{\text{SS1}} = 0\text{ V}$ ) (4/5)**

| Items                | Symbol                  | Conditions                                                                                                                                                                     | MIN.                                                                                                              | TYP.                           | MAX. | Unit |
|----------------------|-------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------|--------------------------------|------|------|
| Output voltage, high | $\text{V}_{\text{OH1}}$ | 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 | $4.0\text{ V} \leq \text{EV}_{\text{DD0}} \leq 5.5\text{ V}$ ,<br>$\text{I}_{\text{OH1}} = -3.0\text{ mA}$        | $\text{EV}_{\text{DD0}} - 0.7$ |      | V    |
|                      |                         |                                                                                                                                                                                | $2.7\text{ V} \leq \text{EV}_{\text{DD0}} \leq 5.5\text{ V}$ ,<br>$\text{I}_{\text{OH1}} = -2.0\text{ mA}$        | $\text{EV}_{\text{DD0}} - 0.6$ |      | V    |
|                      |                         |                                                                                                                                                                                | $2.4\text{ V} \leq \text{EV}_{\text{DD0}} \leq 5.5\text{ V}$ ,<br>$\text{I}_{\text{OH1}} = -1.5\text{ mA}$        | $\text{EV}_{\text{DD0}} - 0.5$ |      | V    |
|                      | $\text{V}_{\text{OH2}}$ | P20 to P27, P150 to P156                                                                                                                                                       | $2.4\text{ V} \leq \text{V}_{\text{DD}} \leq 5.5\text{ V}$ ,<br>$\text{I}_{\text{OH2}} = -100\text{ }\mu\text{A}$ | $\text{V}_{\text{DD}} - 0.5$   |      | V    |
| Output voltage, low  | $\text{V}_{\text{OL1}}$ | 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 | $4.0\text{ V} \leq \text{EV}_{\text{DD0}} \leq 5.5\text{ V}$ ,<br>$\text{I}_{\text{OL1}} = 8.5\text{ mA}$         |                                | 0.7  | V    |
|                      |                         |                                                                                                                                                                                | $4.0\text{ V} \leq \text{EV}_{\text{DD0}} \leq 5.5\text{ V}$ ,<br>$\text{I}_{\text{OL1}} = 3.0\text{ mA}$         |                                | 0.6  | V    |
|                      |                         |                                                                                                                                                                                | $2.7\text{ V} \leq \text{EV}_{\text{DD0}} \leq 5.5\text{ V}$ ,<br>$\text{I}_{\text{OL1}} = 1.5\text{ mA}$         |                                | 0.4  | V    |
|                      |                         |                                                                                                                                                                                | $2.4\text{ V} \leq \text{EV}_{\text{DD0}} \leq 5.5\text{ V}$ ,<br>$\text{I}_{\text{OL1}} = 0.6\text{ mA}$         |                                | 0.4  | V    |
|                      | $\text{V}_{\text{OL2}}$ | P20 to P27, P150 to P156                                                                                                                                                       | $2.4\text{ V} \leq \text{V}_{\text{DD}} \leq 5.5\text{ V}$ ,<br>$\text{I}_{\text{OL2}} = 400\text{ }\mu\text{A}$  |                                | 0.4  | V    |
|                      | $\text{V}_{\text{OL3}}$ | P60 to P63                                                                                                                                                                     | $4.0\text{ V} \leq \text{EV}_{\text{DD0}} \leq 5.5\text{ V}$ ,<br>$\text{I}_{\text{OL3}} = 15.0\text{ mA}$        |                                | 2.0  | V    |
|                      |                         |                                                                                                                                                                                | $4.0\text{ V} \leq \text{EV}_{\text{DD0}} \leq 5.5\text{ V}$ ,<br>$\text{I}_{\text{OL3}} = 5.0\text{ mA}$         |                                | 0.4  | V    |
|                      |                         |                                                                                                                                                                                | $2.7\text{ V} \leq \text{EV}_{\text{DD0}} \leq 5.5\text{ V}$ ,<br>$\text{I}_{\text{OL3}} = 3.0\text{ mA}$         |                                | 0.4  | V    |
|                      |                         |                                                                                                                                                                                | $2.4\text{ V} \leq \text{EV}_{\text{DD0}} \leq 5.5\text{ V}$ ,<br>$\text{I}_{\text{OL3}} = 2.0\text{ mA}$         |                                | 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.

- 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  $V_{DD}$ ,  $EV_{DD0}$ , 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  $T_A = 25^{\circ}\text{C}$



## (5) Communication at different potential (1.8 V, 2.5 V, 3 V) (UART mode) (2/2)

(T<sub>A</sub> = -40 to +105°C, 2.4 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                                                                                                 |                        | Unit |
|---------------|--------|--------------|---------------------------------------------------------------------------------------------------------------------------|------------------------|------|
|               |        |              | MIN.                                                                                                                      | MAX.                   |      |
| Transfer rate |        | Transmission | 4.0 V ≤ EV <sub>DD0</sub> ≤ 5.5 V,<br>V <sub>b</sub> = 2.7 V ≤ V <sub>b</sub> ≤ 4.0 V                                     |                        |      |
|               |        |              | Theoretical value of the maximum transfer rate<br>C <sub>b</sub> = 50 pF, R <sub>b</sub> = 1.4 kΩ, V <sub>b</sub> = 2.7 V |                        |      |
|               |        |              |                                                                                                                           | <b>Note 1</b>          | bps  |
|               |        |              |                                                                                                                           | 2.6 <sup>Note 2</sup>  | Mbps |
|               |        |              | 2.7 V ≤ EV <sub>DD0</sub> < 4.0 V,<br>V <sub>b</sub> = 2.3 V ≤ V <sub>b</sub> ≤ 2.7 V                                     |                        |      |
|               |        |              | Theoretical value of the maximum transfer rate<br>C <sub>b</sub> = 50 pF, R <sub>b</sub> = 2.7 kΩ, V <sub>b</sub> = 2.3 V |                        |      |
|               |        |              |                                                                                                                           | <b>Note 3</b>          | bps  |
|               |        |              |                                                                                                                           | 1.2 <sup>Note 4</sup>  | Mbps |
|               |        |              | 2.4 V ≤ EV <sub>DD0</sub> < 3.3 V,<br>V <sub>b</sub> = 1.6 V ≤ V <sub>b</sub> ≤ 2.0 V                                     |                        |      |
|               |        |              | Theoretical value of the maximum transfer rate<br>C <sub>b</sub> = 50 pF, R <sub>b</sub> = 5.5 kΩ, V <sub>b</sub> = 1.6 V |                        |      |
|               |        |              |                                                                                                                           | <b>Note 5</b>          | bps  |
|               |        |              |                                                                                                                           | 0.43 <sup>Note 6</sup> | Mbps |

**Notes 1.** The smaller maximum transfer rate derived by using f<sub>MCK</sub>/12 or the following expression is the valid maximum transfer rate.

Expression for calculating the transfer rate when 4.0 V ≤ EV<sub>DD0</sub> ≤ 5.5 V and 2.7 V ≤ V<sub>b</sub> ≤ 4.0 V

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

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

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

- This value as an example is calculated when the conditions described in the “Conditions” column are met. Refer to Note 1 above to calculate the maximum transfer rate under conditions of the customer.
- The smaller maximum transfer rate derived by using f<sub>MCK</sub>/12 or the following expression is the valid maximum transfer rate.

Expression for calculating the transfer rate when 2.7 V ≤ EV<sub>DD0</sub> < 4.0 V and 2.4 V ≤ V<sub>b</sub> ≤ 2.7 V

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

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

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

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

**(6) Communication at different potential (1.8 V, 2.5 V, 3 V) (CSI mode) (master mode, SCKp... internal clock output) (1/3)****( $T_A = -40$  to  $+105^\circ\text{C}$ ,  $2.4\text{ V} \leq \text{EV}_{\text{DD0}} = \text{EV}_{\text{DD1}} \leq \text{V}_{\text{DD}} \leq 5.5\text{ V}$ ,  $\text{V}_{\text{SS}} = \text{EV}_{\text{SS0}} = \text{EV}_{\text{SS1}} = 0\text{ V}$ )**

| Parameter             | Symbol            | Conditions                              |                                                                                                                                                                                      | HS (high-speed main) Mode |      | Unit |
|-----------------------|-------------------|-----------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------|------|------|
|                       |                   |                                         |                                                                                                                                                                                      | MIN.                      | MAX. |      |
| SCKp cycle time       | $t_{\text{KCY1}}$ | $t_{\text{KCY1}} \geq 4/f_{\text{CLK}}$ | $4.0\text{ V} \leq \text{EV}_{\text{DD0}} \leq 5.5\text{ V}$ , $2.7\text{ V} \leq \text{V}_b \leq 4.0\text{ V}$ ,<br>$\text{C}_b = 30\text{ pF}$ , $\text{R}_b = 1.4\text{ k}\Omega$ | 600                       |      | ns   |
|                       |                   |                                         | $2.7\text{ V} \leq \text{EV}_{\text{DD0}} < 4.0\text{ V}$ , $2.3\text{ V} \leq \text{V}_b \leq 2.7\text{ V}$ ,<br>$\text{C}_b = 30\text{ pF}$ , $\text{R}_b = 2.7\text{ k}\Omega$    | 1000                      |      | ns   |
|                       |                   |                                         | $2.4\text{ V} \leq \text{EV}_{\text{DD0}} < 3.3\text{ V}$ , $1.6\text{ V} \leq \text{V}_b \leq 2.0\text{ V}$ ,<br>$\text{C}_b = 30\text{ pF}$ , $\text{R}_b = 5.5\text{ k}\Omega$    | 2300                      |      | ns   |
| SCKp high-level width | $t_{\text{KH1}}$  |                                         | $4.0\text{ V} \leq \text{EV}_{\text{DD0}} \leq 5.5\text{ V}$ , $2.7\text{ V} \leq \text{V}_b \leq 4.0\text{ V}$ ,<br>$\text{C}_b = 30\text{ pF}$ , $\text{R}_b = 1.4\text{ k}\Omega$ | $t_{\text{KCY1}}/2 - 150$ |      | ns   |
|                       |                   |                                         | $2.7\text{ V} \leq \text{EV}_{\text{DD0}} < 4.0\text{ V}$ , $2.3\text{ V} \leq \text{V}_b \leq 2.7\text{ V}$ ,<br>$\text{C}_b = 30\text{ pF}$ , $\text{R}_b = 2.7\text{ k}\Omega$    | $t_{\text{KCY1}}/2 - 340$ |      | ns   |
|                       |                   |                                         | $2.4\text{ V} \leq \text{EV}_{\text{DD0}} < 3.3\text{ V}$ , $1.6\text{ V} \leq \text{V}_b \leq 2.0\text{ V}$ ,<br>$\text{C}_b = 30\text{ pF}$ , $\text{R}_b = 5.5\text{ k}\Omega$    | $t_{\text{KCY1}}/2 - 916$ |      | ns   |
| SCKp low-level width  | $t_{\text{KL1}}$  |                                         | $4.0\text{ V} \leq \text{EV}_{\text{DD0}} \leq 5.5\text{ V}$ , $2.7\text{ V} \leq \text{V}_b \leq 4.0\text{ V}$ ,<br>$\text{C}_b = 30\text{ pF}$ , $\text{R}_b = 1.4\text{ k}\Omega$ | $t_{\text{KCY1}}/2 - 24$  |      | ns   |
|                       |                   |                                         | $2.7\text{ V} \leq \text{EV}_{\text{DD0}} < 4.0\text{ V}$ , $2.3\text{ V} \leq \text{V}_b \leq 2.7\text{ V}$ ,<br>$\text{C}_b = 30\text{ pF}$ , $\text{R}_b = 2.7\text{ k}\Omega$    | $t_{\text{KCY1}}/2 - 36$  |      | ns   |
|                       |                   |                                         | $2.4\text{ V} \leq \text{EV}_{\text{DD0}} < 3.3\text{ V}$ , $1.6\text{ V} \leq \text{V}_b \leq 2.0\text{ V}$ ,<br>$\text{C}_b = 30\text{ pF}$ , $\text{R}_b = 5.5\text{ k}\Omega$    | $t_{\text{KCY1}}/2 - 100$ |      | ns   |

**Caution** Select the TTL input buffer for the SIp pin and the N-ch open drain output ( $\text{V}_{\text{DD}}$  tolerance (for the 20- to 52-pin products)/ $\text{EV}_{\text{DD}}$  tolerance (for the 64- to 100-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  $\text{V}_{\text{IH}}$  and  $\text{V}_{\text{IL}}$ , see the DC characteristics with TTL input buffer selected.

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

## (7) 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  $+105^{\circ}\text{C}$ ,  $2.4\text{ V} \leq \text{EV}_{\text{DD0}} = \text{EV}_{\text{DD1}} \leq \text{V}_{\text{DD}} \leq 5.5\text{ V}$ ,  $\text{V}_{\text{SS}} = \text{EV}_{\text{SS0}} = \text{EV}_{\text{SS1}} = 0\text{ V}$ )

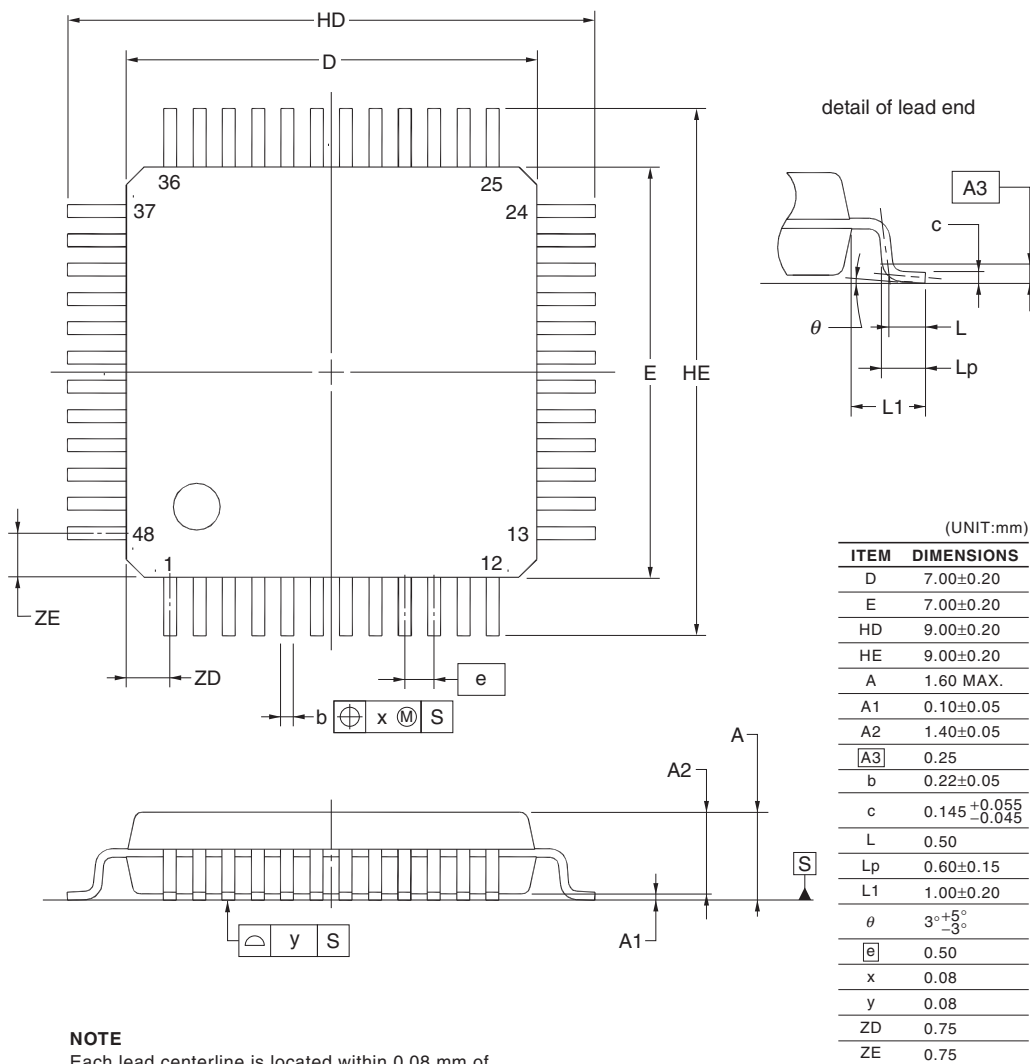
| Parameter                                                | Symbol                                 | Conditions                                                                                                                                                             |                              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

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

## 4.9 48-pin Products

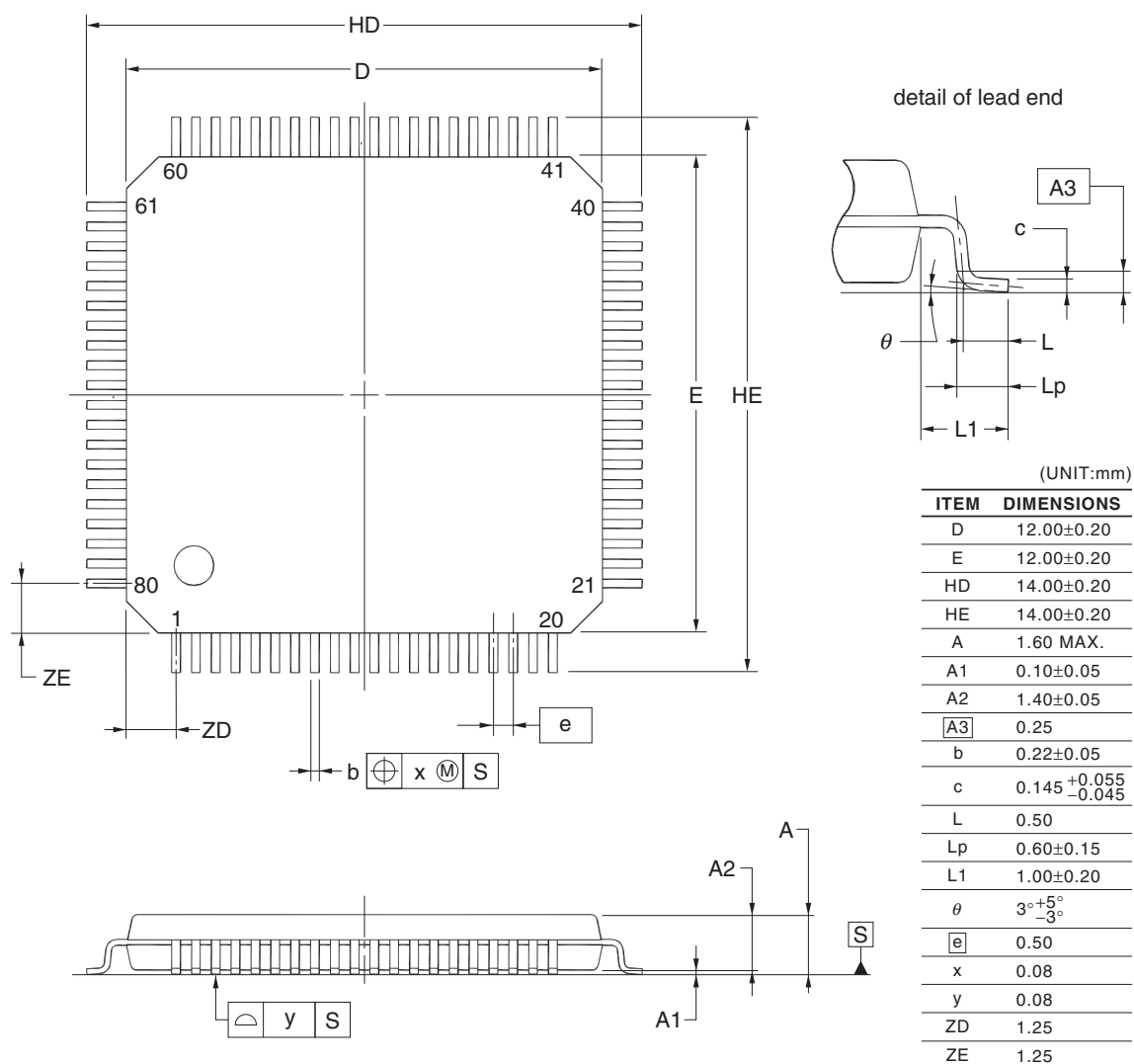
R5F100GAAFB, R5F100GCAFB, R5F100GDAFB, R5F100GEAFB, R5F100GFAFB, R5F100GGAFB,  
 R5F100GHAFB, R5F100GJAFB, R5F100GKAFB, R5F100GLAFB  
 R5F101GAAFB, R5F101GCAFB, R5F101GDAFB, R5F101GEAFB, R5F101GFAFB, R5F101GGAFB,  
 R5F101GHAFB, R5F101GJAFB, R5F101GKAFB, R5F101GLAFB  
 R5F100GADFB, R5F100GCDFB, R5F100GDDFB, R5F100GEDFB, R5F100GFDFB, R5F100GGDFB,  
 R5F100GHDFB, R5F100GJDFB, R5F100GKDFB, R5F100GLDFB  
 R5F101GADFB, R5F101GCDFB, R5F101GDDFB, R5F101GEDFB, R5F101GFDFB, R5F101GGDFB,  
 R5F101GHDFB, R5F101GJDFB, R5F101GKDFB, R5F101GLDFB  
 R5F100GAGFB, R5F100GCGFB, R5F100GDGFB, R5F100GEGFB, R5F100GFGFB, R5F100GGGFB,  
 R5F100GHGFB, R5F100GJGFB

| JEITA Package Code | RENESAS Code | Previous Code  | MASS (TYP.) [g] |
|--------------------|--------------|----------------|-----------------|
| P-LFQFP48-7x7-0.50 | PLQP0048KF-A | P48GA-50-8EU-1 | 0.16            |



R5F100MFAFB, R5F100MGAFB, R5F100MHAFB, R5F100MJAFB, R5F100MKAFB, R5F100MLAFB  
 R5F101MFAFB, R5F101MGAFB, R5F101MHAFB, R5F101MJAFB, R5F101MKAFB, R5F101MLAFB  
 R5F100MFDDB, R5F100MGDFB, R5F100MHDFB, R5F100MJDFB, R5F100MKDFB, R5F100MLDFB  
 R5F101MFDDB, R5F101MGDFB, R5F101MHDFB, R5F101MJDFB, R5F101MKDFB, R5F101MLDFB  
 R5F100MFGFB, R5F100MGGB, R5F100MHGFB, R5F100MJGFB

| JEITA Package Code   | RENESAS Code | Previous Code  | MASS (TYP.) [g] |
|----------------------|--------------|----------------|-----------------|
| P-LFQFP80-12x12-0.50 | PLQP0080KE-A | P80GK-50-8EU-2 | 0.53            |

**NOTE**

Each lead centerline is located within 0.08 mm of its true position at maximum material condition.

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