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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             | Not For New Designs                                                                                                                                                             |
| Core Processor             | RXv2                                                                                                                                                                            |
| Core Size                  | 32-Bit Single-Core                                                                                                                                                              |
| Speed                      | 54MHz                                                                                                                                                                           |
| Connectivity               | CANbus, I <sup>2</sup> C, IrDA, SCI, SD/SDIO, SPI, SSI, USB OTG                                                                                                                 |
| Peripherals                | DMA, LVD, POR, PWM, WDT                                                                                                                                                         |
| Number of I/O              | 30                                                                                                                                                                              |
| Program Memory Size        | 128KB (128K x 8)                                                                                                                                                                |
| Program Memory Type        | FLASH                                                                                                                                                                           |
| EEPROM Size                | 8K x 8                                                                                                                                                                          |
| RAM Size                   | 32K x 8                                                                                                                                                                         |
| Voltage - Supply (Vcc/Vdd) | 1.8V ~ 5.5V                                                                                                                                                                     |
| Data Converters            | A/D 8x12b                                                                                                                                                                       |
| Oscillator Type            | Internal                                                                                                                                                                        |
| Operating Temperature      | -40°C ~ 85°C (TA)                                                                                                                                                               |
| Mounting Type              | Surface Mount                                                                                                                                                                   |
| Package / Case             | 48-WFQFN Exposed Pad                                                                                                                                                            |
| Supplier Device Package    | 48-HWQFN (7x7)                                                                                                                                                                  |
| Purchase URL               | <a href="https://www.e-xfl.com/product-detail/renesas-electronics-america/r5f52315adne-u0">https://www.e-xfl.com/product-detail/renesas-electronics-america/r5f52315adne-u0</a> |

**Table 1.2 Comparison of Functions for Different Packages**

| Module/Functions                                         |                                         | RX230 Group                      |                                              |                               | RX231 Group                      |                                              |                               |
|----------------------------------------------------------|-----------------------------------------|----------------------------------|----------------------------------------------|-------------------------------|----------------------------------|----------------------------------------------|-------------------------------|
|                                                          |                                         | 100 Pins                         | 64 Pins                                      | 48 Pins                       | 100 Pins                         | 64 Pins                                      | 48 Pins                       |
| External bus                                             | External bus                            | 16 bit                           | Not supported                                |                               | 16 bit                           | Not supported                                |                               |
| Interrupts                                               | External interrupts                     | NMI, IRQ0 to IRQ7                | NMI, IRQ0, IRQ1, IRQ4 to IRQ7                | NMI, IRQ0, IRQ1, IRQ4 to IRQ7 | NMI, IRQ0 to IRQ7                | NMI, IRQ0, IRQ1, IRQ4 to IRQ7                | NMI, IRQ0, IRQ1, IRQ4 to IRQ7 |
| DMA                                                      | DMA controller                          | 4 channels (DMAC0 to DMAC3)      |                                              |                               | 4 channels (DMAC0 to DMAC3)      |                                              |                               |
|                                                          | Data transfer controller                | Available                        |                                              |                               | Available                        |                                              |                               |
| Timers                                                   | 16-bit timer pulse unit                 | 6 channels (TPU0 to TPU5)        |                                              |                               | 6 channels (TPU0 to TPU5)        |                                              |                               |
|                                                          | Multi-function timer pulse unit 2       | 6 channels (MTU0 to MTU5)        |                                              |                               | 6 channels (MTU0 to MTU5)        |                                              |                               |
|                                                          | Port output enable 2                    | POE0# to POE3#, POE8#            |                                              |                               | POE0# to POE3#, POE8#            |                                              |                               |
|                                                          | 8-bit timer                             | 2 channels× 2 units              |                                              |                               | 2 channels× 2 units              |                                              |                               |
|                                                          | Compare match timer                     | 2 channels× 2 units              |                                              |                               | 2 channels× 2 units              |                                              |                               |
|                                                          | Low power timer                         | 1 channel                        |                                              |                               | 1 channel                        |                                              |                               |
|                                                          | Realtime clock                          | Available                        |                                              | Not supported                 | Available                        |                                              | Not supported                 |
|                                                          | Watchdog timer                          | Available                        |                                              |                               | Available                        |                                              |                               |
|                                                          | Independent watchdog timer              | Available                        |                                              |                               | Available                        |                                              |                               |
| Communication functions                                  | Serial communications interfaces (SCIg) | 6 channels (SCI0, 1, 5, 6, 8, 9) | 5 channels (SCI1, 5, 6, 8, 9)                | 4 channels (SCI1, 5, 6, 8)    | 6 channels (SCI0, 1, 5, 6, 8, 9) | 5 channels (SCI1, 5, 6, 8, 9)                | 4 channels (SCI1, 5, 6, 8)    |
|                                                          | IrDA interface                          | 1 channel (SCI5)                 |                                              |                               | 1 channel (SCI5)                 |                                              |                               |
|                                                          | Serial communications interfaces (SCIh) | 1 channel (SCI12)                |                                              |                               | 1 channel (SCI12)                |                                              |                               |
|                                                          | I <sup>2</sup> C bus interface          | 1 channel                        |                                              |                               | 1 channel                        |                                              |                               |
|                                                          | CAN module                              | Not supported                    |                                              |                               | 1 channel*1                      |                                              |                               |
|                                                          | Serial peripheral interface             | 1 channel                        |                                              |                               | 1 channel                        |                                              |                               |
|                                                          | USB 2.0 host/function module            | Not supported                    |                                              |                               | 1 channel                        |                                              |                               |
|                                                          | Serial sound interface                  | 1 channel                        |                                              |                               | 1 channel                        |                                              |                               |
|                                                          | SD Host Interface                       | Not supported                    |                                              |                               | 1 channel*1                      |                                              | Not supported                 |
| Capacitive touch sensing unit                            |                                         | 24 channels                      | 10 channels                                  | 6 channels                    | 24 channels                      | 10 channels                                  | 6 channels                    |
| 12-bit A/D converter (including high-precision channels) |                                         | 24 channels (8 channels)         | 12 channels (6 channels)                     | 8 channels (4 channels)       | 24 channels (8 channels)         | 12 channels (6 channels)                     | 8 channels (4 channels)       |
| Temperature sensor                                       |                                         | Available                        |                                              |                               | Available                        |                                              |                               |
| D/A converter                                            |                                         | 2 channels                       |                                              | Not supported                 | 2 channels                       |                                              | Not supported                 |
| CRC calculator                                           |                                         | Available                        |                                              |                               | Available                        |                                              |                               |
| Event link controller                                    |                                         | Available                        |                                              |                               | Available                        |                                              |                               |
| Comparator B                                             |                                         | 4 channels                       |                                              |                               | 4 channels                       |                                              |                               |
| Packages                                                 |                                         | 100-pin TFLGA<br>100-pin LFQFP   | 64-pin WFLGA<br>64-pin HWQFN<br>64-pin LFQFP | 48-pin HWQFN<br>48-pin LFQFP  | 100-pin TFLGA<br>100-pin LFQFP   | 64-pin WFLGA<br>64-pin HWQFN<br>64-pin LFQFP | 48-pin HWQFN<br>48-pin LFQFP  |

Note 1. Only for chip version B

## 1.2 List of Products

Table 1.3 and Table 1.4 are a list of products, and Figure 1.1 shows how to read the product part no., memory capacity, and package type.

**Table 1.3 List of Products: D Version (T<sub>a</sub> = –40 to +85°C) (1/2)**

| Group | Part No.     | Order Part No.  | Package      | ROM Capacity | RAM Capacity | E2 DataFlash | Operating Frequency | Security Function | SDHI          | CAN           | Operating Temperature |
|-------|--------------|-----------------|--------------|--------------|--------------|--------------|---------------------|-------------------|---------------|---------------|-----------------------|
| RX231 | R5F52318ADLA | R5F52318ADLA#20 | PTLG0100KA-A | 512 Kbytes   | 64 Kbytes    | 8 Kbytes     | 54 MHz              | Not available     | Not available | Available     | –40 to +85°C          |
|       | R5F52318BDLA | R5F52318BDLA#20 |              |              |              |              |                     | Available         | Available     | Available     |                       |
|       | R5F52318ADFP | R5F52318ADFP#30 | PLQP0100KB-B |              |              |              |                     | Not available     | Not available | Available     |                       |
|       | R5F52318BDFP | R5F52318BDFP#30 |              |              |              |              |                     | Available         | Available     | Available     |                       |
|       | R5F52318ADND | R5F52318ADND#U0 | PWQN0064KC-A |              |              |              |                     | Not available     | Not available | Available     |                       |
|       | R5F52318BDND | R5F52318BDND#U0 |              |              |              |              |                     | Available         | Available     | Available     |                       |
|       | R5F52318ADFM | R5F52318ADFM#30 | PLQP0064KB-C |              |              |              |                     | Not available     | Not available | Available     |                       |
|       | R5F52318BDFM | R5F52318BDFM#30 |              |              |              |              |                     | Available         | Available     | Available     |                       |
|       | R5F52318ADNE | R5F52318ADNE#U0 | PWQN0048KB-A |              |              |              |                     | Not available     | Not available | Available     |                       |
|       | R5F52318BDNE | R5F52318BDNE#U0 |              |              |              |              |                     | Available         | Not available | Available     |                       |
|       | R5F52318ADFL | R5F52318ADFL#30 | PLQP0048KB-B |              |              |              |                     | Not available     | Not available | Available     |                       |
|       | R5F52318BDFL | R5F52318BDFL#30 |              |              |              |              |                     | Available         | Not available | Available     |                       |
|       | R5F52317ADLA | R5F52317ADLA#20 | PTLG0100KA-A | 384 Kbytes   |              |              |                     | Not available     | Not available | Available     |                       |
|       | R5F52317BDLA | R5F52317BDLA#20 |              |              |              |              |                     | Available         | Available     | Available     |                       |
|       | R5F52317ADFP | R5F52317ADFP#30 | PLQP0100KB-B |              |              |              |                     | Not available     | Not available | Available     |                       |
|       | R5F52317BDFP | R5F52317BDFP#30 |              |              |              |              |                     | Available         | Available     | Available     |                       |
|       | R5F52317ADND | R5F52317ADND#U0 | PWQN0064KC-A |              |              |              |                     | Not available     | Not available | Available     |                       |
|       | R5F52317BDND | R5F52317BDND#U0 |              |              |              |              |                     | Available         | Available     | Available     |                       |
|       | R5F52317ADFM | R5F52317ADFM#30 | PLQP0064KB-C |              |              |              |                     | Not available     | Not available | Available     |                       |
|       | R5F52317BDFM | R5F52317BDFM#30 |              |              |              |              |                     | Available         | Available     | Available     |                       |
|       | R5F52317ADNE | R5F52317ADNE#U0 | PWQN0048KB-A |              |              |              |                     | Not available     | Not available | Available     |                       |
|       | R5F52317BDNE | R5F52317BDNE#U0 |              |              |              |              |                     | Available         | Not available | Available     |                       |
|       | R5F52317ADFL | R5F52317ADFL#30 | PLQP0048KB-B |              |              |              |                     | Not available     | Not available | Available     |                       |
|       | R5F52317BDFL | R5F52317BDFL#30 |              |              |              |              |                     | Available         | Not available | Available     |                       |
|       | R5F52316ADLA | R5F52316ADLA#20 | PTLG0100KA-A | 256 Kbytes   | 32 Kbytes    |              |                     | Not available     | Not available | Available     |                       |
|       | R5F52316CDLA | R5F52316CDLA#20 |              |              |              |              |                     | Not available     | Not available | Not available |                       |
|       | R5F52316ADFP | R5F52316ADFP#30 | PLQP0100KB-B |              |              |              |                     | Not available     | Not available | Available     |                       |
|       | R5F52316CDFP | R5F52316CDFP#30 |              |              |              |              |                     | Not available     | Not available | Not available |                       |
|       | R5F52316CDLF | R5F52316CDLF#U0 | PWL0064KA-A  |              |              |              |                     | Not available     | Not available | Not available |                       |
|       | R5F52316ADND | R5F52316ADND#U0 | PWQN0064KC-A |              |              |              |                     | Not available     | Not available | Available     |                       |
|       | R5F52316CDND | R5F52316CDND#U0 |              |              |              |              |                     | Not available     | Not available | Not available |                       |
|       | R5F52316ADFM | R5F52316ADFM#30 | PLQP0064KB-C |              |              |              |                     | Not available     | Not available | Available     |                       |
|       | R5F52316CDFM | R5F52316CDFM#30 |              |              |              |              |                     | Not available     | Not available | Not available |                       |
|       | R5F52316ADNE | R5F52316ADNE#U0 | PWQN0048KB-A |              |              |              |                     | Not available     | Not available | Available     |                       |
|       | R5F52316CDNE | R5F52316CDNE#U0 |              |              |              |              |                     | Not available     | Not available | Not available |                       |

**Table 1.5 Pin Functions (3/4)**

| Classifications                        | Pin Name                                       | I/O    | Description                                                                                                                |
|----------------------------------------|------------------------------------------------|--------|----------------------------------------------------------------------------------------------------------------------------|
| Serial communications interface (SClg) | • Simple SPI mode                              |        |                                                                                                                            |
|                                        | SCK0, SCK1, SCK5, SCK6, SCK8, SCK9             | I/O    | Input/output pins for the clock.                                                                                           |
|                                        | SMISO0, SMISO1, SMISO5, SMISO6, SMISO8, SMISO9 | I/O    | Input/output pins for slave transmit data.                                                                                 |
|                                        | SMOSI0, SMOSI1, SMOSI5, SMOSI6, SMOSI8, SMOSI9 | I/O    | Input/output pins for master transmit data.                                                                                |
|                                        | SS0#, SS1#, SS5#, SS6#, SS8#, SS9#             | Input  | Slave-select input pins.                                                                                                   |
| IrDA interface                         | IRTXD5                                         | Output | Data output pin in the IrDA format.                                                                                        |
|                                        | IRRXD5                                         | Input  | Data input pin in the IrDA format.                                                                                         |
| Serial communications interface (SClh) | • Asynchronous mode/clock synchronous mode     |        |                                                                                                                            |
|                                        | SCK12                                          | I/O    | Input/output pin for the clock.                                                                                            |
|                                        | RXD12                                          | Input  | Input pin for receiving data.                                                                                              |
|                                        | TXD12                                          | Output | Output pin for transmitting data.                                                                                          |
|                                        | CTS12#                                         | Input  | Input pin for controlling the start of transmission and reception.                                                         |
|                                        | RTS12#                                         | Output | Output pin for controlling the start of transmission and reception.                                                        |
|                                        | • Simple I <sup>2</sup> C mode                 |        |                                                                                                                            |
|                                        | SSCL12                                         | I/O    | Input/output pin for the I <sup>2</sup> C clock.                                                                           |
|                                        | SSDA12                                         | I/O    | Input/output pin for the I <sup>2</sup> C data.                                                                            |
|                                        | • Simple SPI mode                              |        |                                                                                                                            |
|                                        | SCK12                                          | I/O    | Input/output pin for the clock.                                                                                            |
|                                        | SMISO12                                        | I/O    | Input/output pin for slave transmit data.                                                                                  |
|                                        | SMOSI12                                        | I/O    | Input/output pin for master transmit data.                                                                                 |
|                                        | SS12#                                          | Input  | Slave-select input pin.                                                                                                    |
|                                        | • Extended serial mode                         |        |                                                                                                                            |
|                                        | RDX12                                          | Input  | Input pin for data reception by SCIf.                                                                                      |
|                                        | TXDX12                                         | Output | Output pin for data transmission by SCIf.                                                                                  |
|                                        | SIOX12                                         | I/O    | Input/output pin for data reception or transmission by SCIf.                                                               |
| I <sup>2</sup> C bus interface         | SCL                                            | I/O    | Input/output pin for I <sup>2</sup> C bus interface clocks. Bus can be directly driven by the N-channel open drain output. |
|                                        | SDA                                            | I/O    | Input/output pin for I <sup>2</sup> C bus interface data. Bus can be directly driven by the N-channel open drain output.   |
| Serial peripheral interface            | RSPCKA                                         | I/O    | Input/output pin for the RSPI clock.                                                                                       |
|                                        | MOSIA                                          | I/O    | Input/output pin for transmitting data from the RSPI master.                                                               |
|                                        | MISOA                                          | I/O    | Input/output pin for transmitting data from the RSPI slave.                                                                |
|                                        | SSLA0                                          | I/O    | Input/output pin to select the slave for the RSPI.                                                                         |
|                                        | SSLA1 to SSLA3                                 | Output | Output pins to select the slave for the RSPI.                                                                              |
| Serial sound interface                 | SSISCK0                                        | I/O    | SSI serial bit clock pin.                                                                                                  |
|                                        | SSIWS0                                         | I/O    | Word selection pin.                                                                                                        |
|                                        | SSITXD0                                        | Output | Serial data output pin.                                                                                                    |
|                                        | SSIRXD0                                        | Input  | Serial data input pin.                                                                                                     |
|                                        | AUDIO_MCLK                                     | Input  | Master clock pin for audio.                                                                                                |
| CAN module                             | CRXD0                                          | Input  | Input pin                                                                                                                  |
|                                        | CTXD0                                          | Output | Output pin                                                                                                                 |
| SD host interface                      | SDHI_CLK                                       | Output | SD clock output pin                                                                                                        |
|                                        | SDHI_CMD                                       | I/O    | SD command output, response input signal pin                                                                               |

**Table 1.5 Pin Functions (4/4)**

| Classifications               | Pin Name                                                                 | I/O    | Description                                                                                                                                                    |
|-------------------------------|--------------------------------------------------------------------------|--------|----------------------------------------------------------------------------------------------------------------------------------------------------------------|
| SD host interface             | SDHI_D3 to SD_D0                                                         | I/O    | SD data bus pins                                                                                                                                               |
|                               | SDHI_CD                                                                  | Input  | SD card detection pin                                                                                                                                          |
|                               | SDHI_WP                                                                  | Input  | SD write-protect signal                                                                                                                                        |
| USB 2.0 host/ function module | VCC_USB                                                                  | Input  | Power supply pin for USB. Connect this pin to VCC or connect this pin to VSS via a 0.33 $\mu$ F smoothing capacitor for stabilizing the internal power supply. |
|                               | VSS_USB                                                                  | Input  | Ground pin for USB. Connect this pin to VSS.                                                                                                                   |
|                               | USB0_DP                                                                  | I/O    | D+ I/O pin of the USB on-chip transceiver.                                                                                                                     |
|                               | USB0_DM                                                                  | I/O    | D- I/O pin of the USB on-chip transceiver.                                                                                                                     |
|                               | USB0_VBUS                                                                | Input  | USB cable connection monitor pin.                                                                                                                              |
|                               | USB0_EXICEN                                                              | Output | Low-power control signal for the OTG chip.                                                                                                                     |
|                               | USB0_VBUSEN                                                              | Output | VBUS (5 V) supply enable signal for the OTG chip.                                                                                                              |
|                               | USB0_OVRCURA, USB0_OVRCURB                                               | Input  | External overcurrent detection pins.                                                                                                                           |
|                               | USB0_ID                                                                  | Input  | Mini-AB connector ID input pin during operation in OTG mode.                                                                                                   |
| 12-bit A/D converter          | AN000 to AN007, AN016 to AN031                                           | Input  | Input pins for the analog signals to be processed by the A/D converter.                                                                                        |
|                               | ADTRG0#                                                                  | Input  | Input pin for the external trigger signal that start the A/D conversion.                                                                                       |
| 12-bit D/A converter          | DA0, DA1                                                                 | Output | Analog output pins of the D/A converter.                                                                                                                       |
| Comparator B                  | CMPB0 to CMPB3                                                           | Input  | Input pin for the analog signal to be processed by comparator B.                                                                                               |
|                               | CVREFB0 to CVREFB3                                                       | Input  | Analog reference voltage supply pin for comparator B.                                                                                                          |
|                               | CMPOB0 to CMPOB3                                                         | Output | Output pin for comparator B.                                                                                                                                   |
| CTSU                          | TS0 to TS9, TS12, TS13, TS15 to TS20, TS22, TS23, TS27, TS30, TS33, TS35 | Output | Electrostatic capacitance measurement pins (touch pins).                                                                                                       |
|                               | TSCAP                                                                    | Output | LPF connection pin.                                                                                                                                            |
| Analog power supply           | AVCC0                                                                    | Input  | Analog voltage supply pin for the 12-bit A/D converter and D/A converter. Connect this pin to VCC when not using the 12-bit A/D converter and D/A converter.   |
|                               | AVSS0                                                                    | Input  | Analog ground pin for the 12-bit A/D converter and D/A converter. Connect this pin to VSS when not using the 12-bit A/D converter and D/A converter.           |
|                               | VREFH0                                                                   | Input  | Analog reference voltage supply pin for the 12-bit A/D converter.                                                                                              |
|                               | VREFL0                                                                   | Input  | Analog reference ground pin for the 12-bit A/D converter.                                                                                                      |
|                               | VREFH                                                                    | Input  | Analog reference voltage supply pin for the 12-bit D/A converter.                                                                                              |
|                               | VREFL                                                                    | Input  | Analog reference ground pin for the 12-bit D/A converter.                                                                                                      |
| I/O ports                     | P03, P05, P07                                                            | I/O    | 3-bit input/output pins.                                                                                                                                       |
|                               | P12 to P17                                                               | I/O    | 6-bit input/output pins.                                                                                                                                       |
|                               | P20 to P27                                                               | I/O    | 8-bit input/output pins.                                                                                                                                       |
|                               | P30 to P37                                                               | I/O    | 8-bit input/output pins (P35 input pin).                                                                                                                       |
|                               | P40 to P47                                                               | I/O    | 8-bit input/output pins.                                                                                                                                       |
|                               | P50 to P55                                                               | I/O    | 6-bit input/output pins.                                                                                                                                       |
|                               | PA0 to PA7                                                               | I/O    | 8-bit input/output pins.                                                                                                                                       |
|                               | PB0 to PB7                                                               | I/O    | 8-bit input/output pins.                                                                                                                                       |
|                               | PC0 to PC7                                                               | I/O    | 8-bit input/output pins.                                                                                                                                       |
|                               | PD0 to PD7                                                               | I/O    | 8-bit input/output pins.                                                                                                                                       |
|                               | PE0 to PE7                                                               | I/O    | 8-bit input/output pins.                                                                                                                                       |
|                               | PH0 to PH3                                                               | I/O    | 4-bit input/output pins.                                                                                                                                       |
|                               | PJ3                                                                      | I/O    | 1-bit input/output pin.                                                                                                                                        |

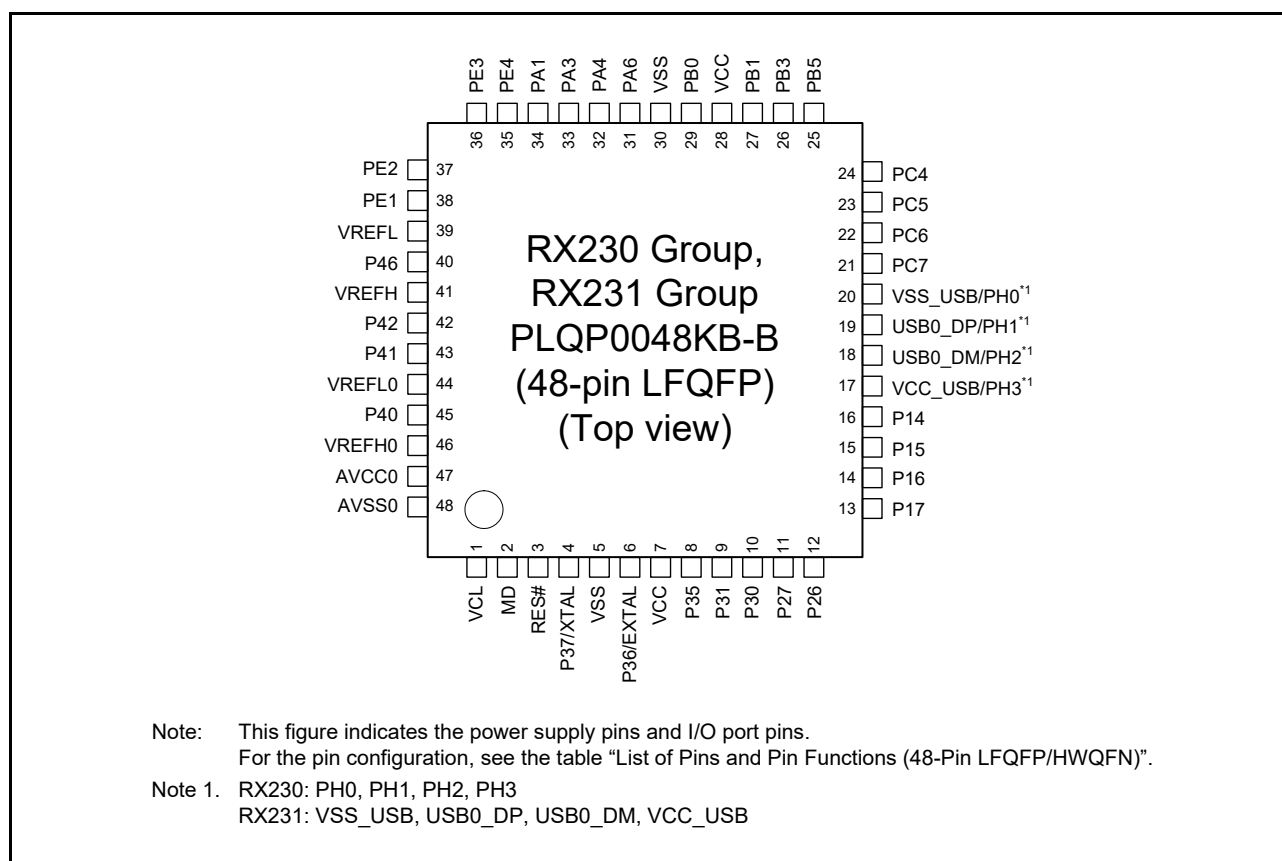


Figure 1.8 Pin Assignments of the 48-Pin LQFP

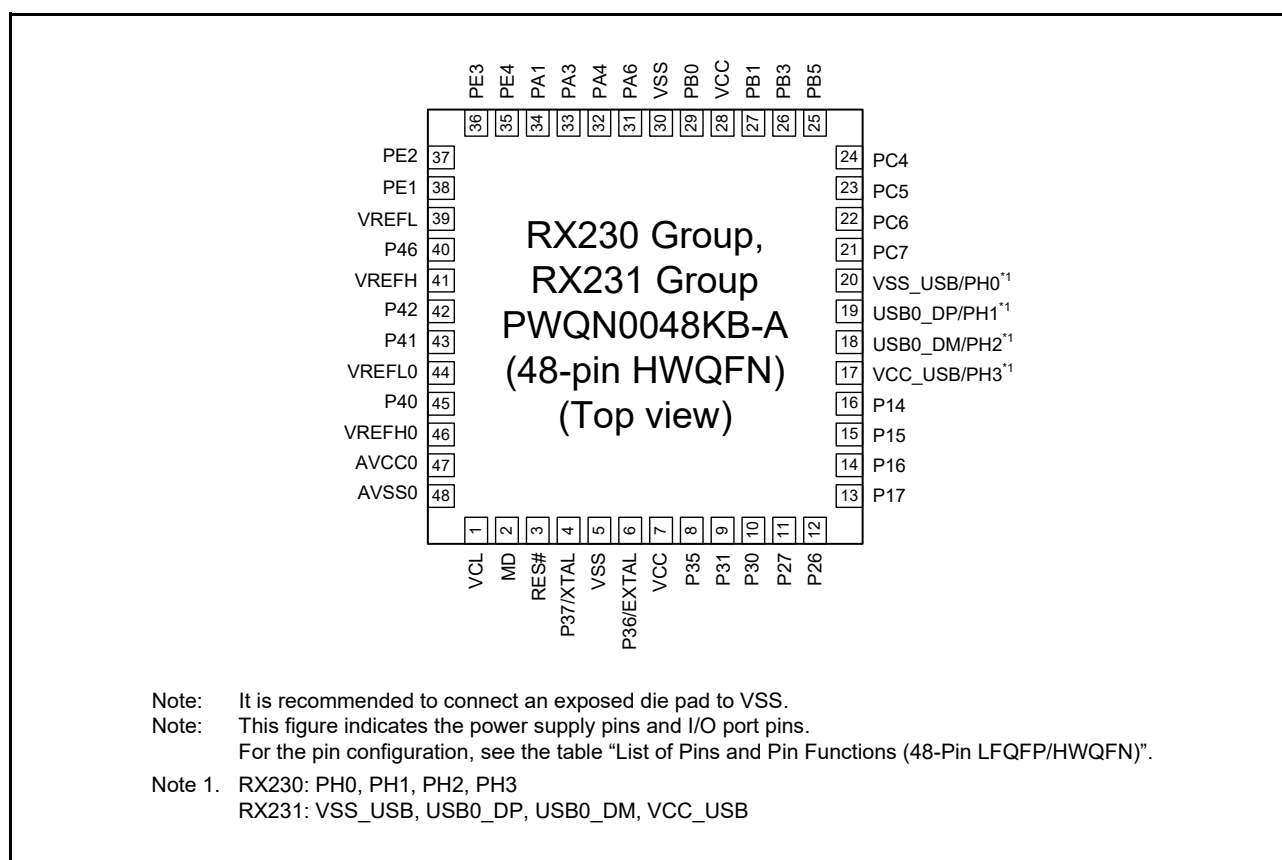


Figure 1.9 Pin Assignments of the 48-Pin HWQFN

**Table 1.9 List of Pins and Pin Functions (64-Pin LFQFP/HWQFN) (1/2)**

| Pin No. | Power Supply, Clock, System Control | I/O Port | Timers (MTU, TPU, TMR, RTC, CMT, POE, CAC) | Communications (SCI, RSPI, IIC, RSCAN, USB, SSI)               | Memory Interface (SDHI) | Touch sensing | Others       |
|---------|-------------------------------------|----------|--------------------------------------------|----------------------------------------------------------------|-------------------------|---------------|--------------|
| 1       |                                     | P03      |                                            |                                                                |                         |               | DA0          |
| 2       | VCL                                 |          |                                            |                                                                |                         |               |              |
| 3       | MD                                  |          |                                            |                                                                |                         |               | FINED        |
| 4       | XCIN                                |          |                                            |                                                                |                         |               |              |
| 5       | XCOUT                               |          |                                            |                                                                |                         |               |              |
| 6       | RES#                                |          |                                            |                                                                |                         |               |              |
| 7       | XTAL                                | P37      |                                            |                                                                |                         |               |              |
| 8       | VSS                                 |          |                                            |                                                                |                         |               |              |
| 9       | EXTAL                               | P36      |                                            |                                                                |                         |               |              |
| 10      | VCC                                 |          |                                            |                                                                |                         |               |              |
| 11      | UPSEL                               | P35      |                                            |                                                                |                         |               | NMI          |
| 12      | VBATT                               |          |                                            |                                                                |                         |               |              |
| 13      |                                     | P31      | MTIOC4D/TMC12/RTCIC1                       | CTS1#/RTS1#/SS1#/SSISCK0                                       |                         |               | IRQ1         |
| 14      |                                     | P30      | MTIOC4B/TMRI3/POE8#/RTCIC0                 | RXD1/SMISO1/SSCL1/AUDIO_MCLK                                   |                         |               | IRQ0/CMPOB3  |
| 15      |                                     | P27      | MTIOC2B/TMC13                              | SCK1/SSIWS0                                                    |                         | TS2           | CVREFB3      |
| 16      |                                     | P26      | MTIOC2A/TMO1                               | TXD1/SMOSI1/SSDA1/USB0_VBUSEN/SSIRXD0                          |                         | TS3           | CMPB3        |
| 17      |                                     | P17      | MTIOC3A/MTIOC3B/TMO1/POE8#/TIOCB0/TCLKD    | SCK1/MISOA/SDA/SSITXD0                                         |                         |               | IRQ7/ CMPOB2 |
| 18      |                                     | P16      | MTIOC3C/MTIOC3D/TMO2/TIOCB1/TCLKC/RTXCOUT  | TXD1/SMOSI1/SSDA1/MOSIA/SCL/USB0_VBUS/USB0_VBUSEN/USB0_OVRCURB |                         |               | IRQ6/ADTRG0# |
| 19      |                                     | P15      | MTIOC0B/MTCLKB/TMC12/TIOCB2/TCLKB          | RXD1/SMISO1/SSCL1/CRXD0                                        |                         | TS12          | IRQ5/CMPB2   |
| 20      |                                     | P14      | MTIOC3A/MTCLKA/TMRI2/TIOCB5/TCLKA          | CTS1#/RTS1#/SS1#/CTXD0/USB0_OVRCURA                            |                         | TS13          | IRQ4/CVREFB2 |
| 21      | VCC_USB*1                           | PH3*1    | TMC10*1                                    |                                                                |                         |               |              |
| 22      |                                     | PH2*1    | TMRI0*1                                    | USB0_DM*1                                                      |                         |               | IRQ1*1       |
| 23      |                                     | PH1*1    | TMO0*1                                     | USB0_DP*1                                                      |                         |               | IRQ0*1       |
| 24      | VSS_USB*1                           | PH0*1    |                                            |                                                                |                         |               | CACREF*1     |
| 25      |                                     | P55      | MTIOC4D/TMO3                               | CRXD0                                                          |                         | TS15          |              |
| 26      |                                     | P54      | MTIOC4B/TMC11                              | CTXD0                                                          |                         | TS16          |              |
| 27      | UB                                  | PC7      | MTIOC3A/MTCLKB/TMO2                        | TXD8/SMOSI8/SSDA8/MISOA                                        |                         |               | CACREF       |
| 28      |                                     | PC6      | MTIOC3C/MTCLKA/TMC12                       | RXD8/SMISO8/SSCL8/MOSIA/USB0_EXICEN                            |                         | TS22          |              |
| 29      |                                     | PC5      | MTIOC3B/MTCLKD/TMRI2                       | SCK8/RSPCKA/USB0_ID                                            |                         | TS23          |              |
| 30      |                                     | PC4      | MTIOC3D/MTCLKC/TMC11/POE0#                 | SCK5/CTS8#/RTS8#/SS8#/SSLA0                                    | SDHI_D1                 | TSCAP         |              |
| 31      |                                     | PC3      | MTIOC4D/TCLKB                              | TXD5/SMOSI5/SSDA5/ IRTXD5                                      | SDHI_D0                 | TS27          |              |
| 32      |                                     | PC2      | MTIOC4B/TCLKA                              | RXD5/SMISO5/SSCL5/SSLA3/IRRXD5                                 | SDHI_D3                 | TS30          |              |
| 33      |                                     | PB7/PC1  | MTIOC3B/TIOCB5                             | TXD9/SMOSI9/SSDA9                                              | SDHI_D2                 |               |              |
| 34      |                                     | PB6/PC0  | MTIOC3D/TIOCA5                             | RXD9/SMISO9/SSCL9                                              | SDHI_D1                 |               |              |
| 35      |                                     | PB5      | MTIOC2A/MTIOC1B/TMRI1/POE1#/TIOCB4         | SCK9/USB0_VBUS                                                 | SDHI_CD                 |               |              |
| 36      |                                     | PB3      | MTIOC0A/MTIOC4A/TMO0/POE3#/TIOCD3/TCLKD    | SCK6                                                           | SDHI_W P                |               |              |
| 37      |                                     | PB1      | MTIOC0C/MTIOC4C/TMC10/TIOCB3               | TXD6/SMOSI6/SSDA6                                              | SDHI_CL K               |               | IRQ4/ CMPOB1 |
| 38      | VCC                                 |          |                                            |                                                                |                         |               |              |
| 39      |                                     | PB0      | MTIC5W/TIOCA3                              | RXD6/SMISO6/SSCL6/RSPCKA                                       | SDHI_C MD               |               |              |
| 40      | VSS                                 |          |                                            |                                                                |                         |               |              |
| 41      |                                     | PA6      | MTIC5V/MTCLKB/TMC13/POE2#/TIOCA2           | CTS5#/RTS5#/SS5#/MOSIA/SSIWS0                                  |                         |               |              |

**Table 1.10 List of Pins and Pin Functions (48-Pin LFQFP/HWQFN) (2/2)**

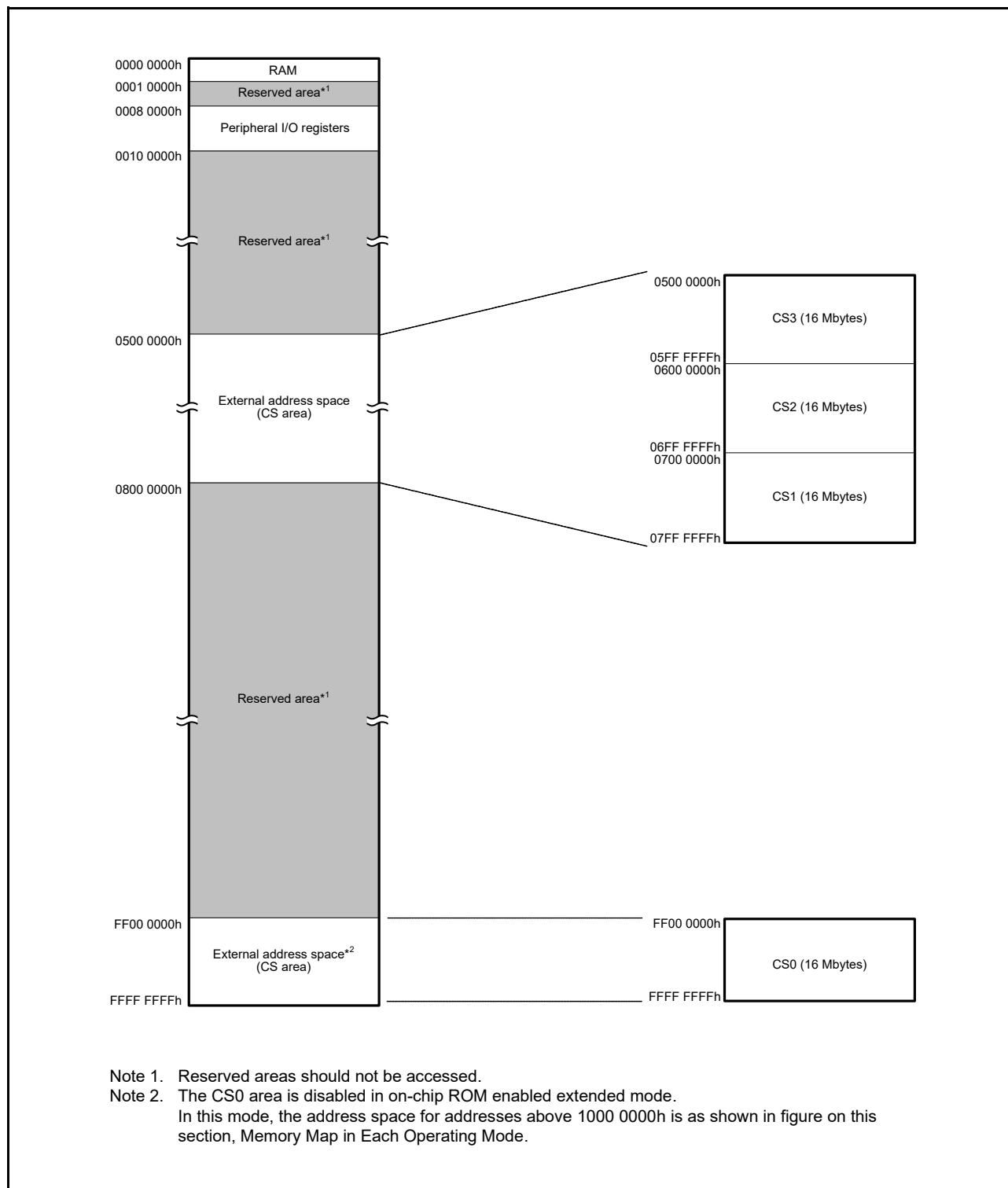
| Pin No. | Power Supply, Clock, System Control | I/O Port | Timers (MTU, TPU, TMR, RTC, CMT, POE, CAC) | Communications (SCI, RSPI, IIC, RSCAN, USB, SSI) | Memory Interface (SDHI) | Touch sensing | Others |
|---------|-------------------------------------|----------|--------------------------------------------|--------------------------------------------------|-------------------------|---------------|--------|
| 42      |                                     | P42      |                                            |                                                  |                         |               | AN002  |
| 43      |                                     | P41      |                                            |                                                  |                         |               | AN001  |
| 44      | VREFL0                              |          |                                            |                                                  |                         |               |        |
| 45      |                                     | P40      |                                            |                                                  |                         |               | AN000  |
| 46      | VREFH0                              |          |                                            |                                                  |                         |               |        |
| 47      | AVCC0                               |          |                                            |                                                  |                         |               |        |
| 48      | AVSS0                               |          |                                            |                                                  |                         |               |        |

Note 1. RX230: PH0/CACREF, PH1/IRQ0/TMO0, PH2/IRQ1/TMRI0, PH3/TMCI0  
 RX231: VSS\_USB, USB0\_DP, USB0\_DM, VCC\_USB



### 3.2 External Address Space

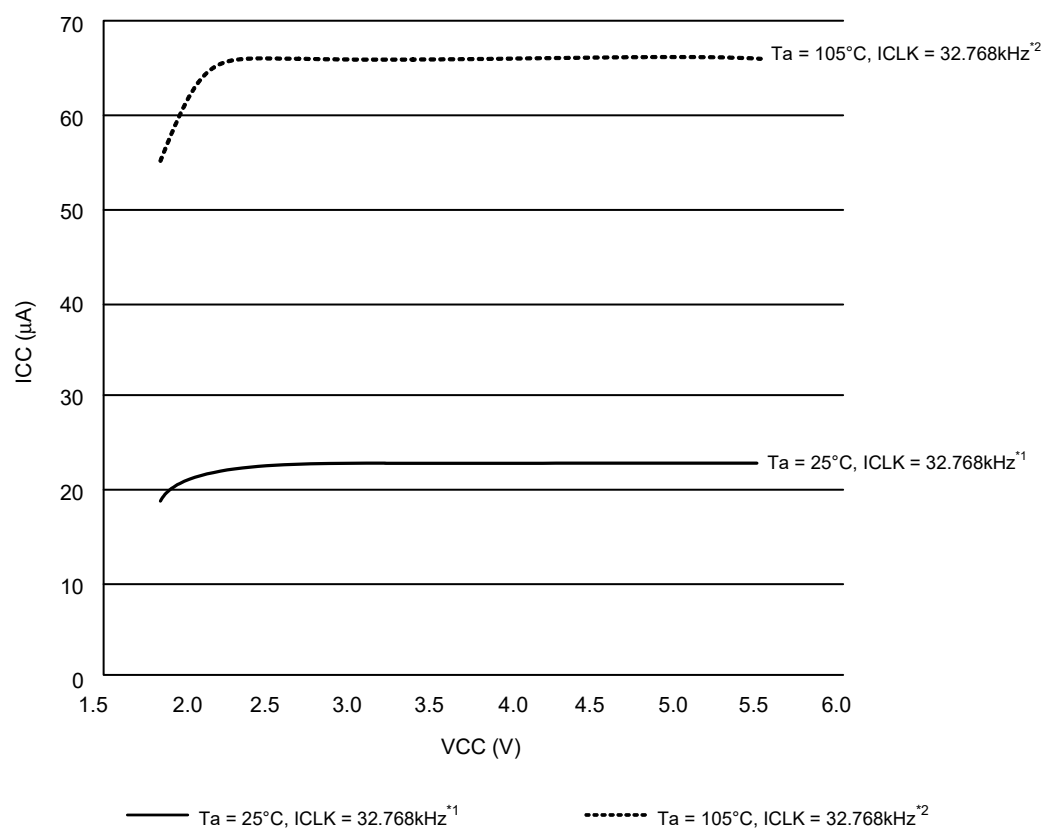
The external address space is divided into up to four CS areas (CS0 to CS3), each corresponding to the CSn# signal output from a CSn# (n = 0 to 3) pin. Figure 3.2 shows the address ranges corresponding to the individual CS areas (CS0 to CS3) in on-chip ROM disabled extended mode.



**Figure 3.2 Correspondence between External Address Spaces and CS Areas  
(In On-Chip ROM Disabled Extended Mode)**

**Table 4.1 List of I/O Registers (Address Order) (11/33)**

| Address    | Module Symbol | Register Name                    | Register Symbol | Number of Bits | Access Size | Number of Access Cycles |             |
|------------|---------------|----------------------------------|-----------------|----------------|-------------|-------------------------|-------------|
|            |               |                                  |                 |                |             | ICLK ≥ PCLK             | ICLK < PCLK |
| 0008 A0C9h | SCI6          | I <sup>2</sup> C Mode Register 1 | SIMR1           | 8              | 8           | 2 or 3 PCLKB            | 2 ICLK      |
| 0008 A0CAh | SCI6          | I <sup>2</sup> C Mode Register 2 | SIMR2           | 8              | 8           | 2 or 3 PCLKB            | 2 ICLK      |
| 0008 A0CBh | SCI6          | I <sup>2</sup> C Mode Register 3 | SIMR3           | 8              | 8           | 2 or 3 PCLKB            | 2 ICLK      |
| 0008 A0CCh | SCI6          | I <sup>2</sup> C Status Register | SISR            | 8              | 8           | 2 or 3 PCLKB            | 2 ICLK      |
| 0008 A0CDh | SCI6          | SPI Mode Register                | SPMR            | 8              | 8           | 2 or 3 PCLKB            | 2 ICLK      |
| 0008 A0CEh | SCI6          | Transmit Data Register HL        | TDRHL           | 16             | 16          | 4 or 5 PCLKB            | 2 ICLK      |
| 0008 A0CEh | SCI6          | Transmit Data Register H         | TDRH            | 8              | 8           | 2 or 3 PCLKB            | 2 ICLK      |
| 0008 A0CFh | SCI6          | Transmit Data Register L         | TDRL            | 8              | 8           | 2 or 3 PCLKB            | 2 ICLK      |
| 0008 A0D0h | SCI6          | Receive Data Register HL         | RDRHL           | 16             | 16          | 4 or 5 PCLKB            | 2 ICLK      |
| 0008 A0D0h | SCI6          | Receive Data Register H          | RDRH            | 8              | 8           | 2 or 3 PCLKB            | 2 ICLK      |
| 0008 A0D1h | SCI6          | Receive Data Register L          | RDRL            | 8              | 8           | 2 or 3 PCLKB            | 2 ICLK      |
| 0008 A0D2h | SCI6          | Modulation Duty Register         | MDDR            | 8              | 8           | 2 or 3 PCLKB            | 2 ICLK      |
| 0008 A100h | SCI8          | Serial Mode Register             | SMR             | 8              | 8           | 2 or 3 PCLKB            | 2 ICLK      |
| 0008 A101h | SCI8          | Bit Rate Register                | BRR             | 8              | 8           | 2 or 3 PCLKB            | 2 ICLK      |
| 0008 A102h | SCI8          | Serial Control Register          | SCR             | 8              | 8           | 2 or 3 PCLKB            | 2 ICLK      |
| 0008 A103h | SCI8          | Transmit Data Register           | TDR             | 8              | 8           | 2 or 3 PCLKB            | 2 ICLK      |
| 0008 A104h | SCI8          | Serial Status Register           | SSR             | 8              | 8           | 2 or 3 PCLKB            | 2 ICLK      |
| 0008 A105h | SCI8          | Receive Data Register            | RDR             | 8              | 8           | 2 or 3 PCLKB            | 2 ICLK      |
| 0008 A106h | SCI8          | Smart Card Mode Register         | SCMR            | 8              | 8           | 2 or 3 PCLKB            | 2 ICLK      |
| 0008 A107h | SCI8          | Serial Extended Mode Register    | SEMR            | 8              | 8           | 2 or 3 PCLKB            | 2 ICLK      |
| 0008 A108h | SCI8          | Noise Filter Setting Register    | SNFR            | 8              | 8           | 2 or 3 PCLKB            | 2 ICLK      |
| 0008 A109h | SCI8          | I <sup>2</sup> C Mode Register 1 | SIMR1           | 8              | 8           | 2 or 3 PCLKB            | 2 ICLK      |
| 0008 A10Ah | SCI8          | I <sup>2</sup> C Mode Register 2 | SIMR2           | 8              | 8           | 2 or 3 PCLKB            | 2 ICLK      |
| 0008 A10Bh | SCI8          | I <sup>2</sup> C Mode Register 3 | SIMR3           | 8              | 8           | 2 or 3 PCLKB            | 2 ICLK      |
| 0008 A10Ch | SCI8          | I <sup>2</sup> C Status Register | SISR            | 8              | 8           | 2 or 3 PCLKB            | 2 ICLK      |
| 0008 A10Dh | SCI8          | SPI Mode Register                | SPMR            | 8              | 8           | 2 or 3 PCLKB            | 2 ICLK      |
| 0008 A10Eh | SCI8          | Transmit Data Register HL        | TDRHL           | 16             | 16          | 4 or 5 PCLKB            | 2 ICLK      |
| 0008 A10Eh | SCI8          | Transmit Data Register H         | TDRH            | 8              | 8           | 2 or 3 PCLKB            | 2 ICLK      |
| 0008 A10Fh | SCI8          | Transmit Data Register L         | TDRL            | 8              | 8           | 2 or 3 PCLKB            | 2 ICLK      |
| 0008 A110h | SCI8          | Receive Data Register HL         | RDRHL           | 16             | 16          | 4 or 5 PCLKB            | 2 ICLK      |
| 0008 A110h | SCI8          | Receive Data Register H          | RDRH            | 8              | 8           | 2 or 3 PCLKB            | 2 ICLK      |
| 0008 A111h | SCI8          | Receive Data Register L          | RDRL            | 8              | 8           | 2 or 3 PCLKB            | 2 ICLK      |
| 0008 A112h | SCI8          | Modulation Duty Register         | MDDR            | 8              | 8           | 2 or 3 PCLKB            | 2 ICLK      |
| 0008 A120h | SCI9          | Serial Mode Register             | SMR             | 8              | 8           | 2 or 3 PCLKB            | 2 ICLK      |
| 0008 A121h | SCI9          | Bit Rate Register                | BRR             | 8              | 8           | 2 or 3 PCLKB            | 2 ICLK      |
| 0008 A122h | SCI9          | Serial Control Register          | SCR             | 8              | 8           | 2 or 3 PCLKB            | 2 ICLK      |
| 0008 A123h | SCI9          | Transmit Data Register           | TDR             | 8              | 8           | 2 or 3 PCLKB            | 2 ICLK      |
| 0008 A124h | SCI9          | Serial Status Register           | SSR             | 8              | 8           | 2 or 3 PCLKB            | 2 ICLK      |
| 0008 A125h | SCI9          | Receive Data Register            | RDR             | 8              | 8           | 2 or 3 PCLKB            | 2 ICLK      |
| 0008 A126h | SCI9          | Smart Card Mode Register         | SCMR            | 8              | 8           | 2 or 3 PCLKB            | 2 ICLK      |
| 0008 A127h | SCI9          | Serial Extended Mode Register    | SEMR            | 8              | 8           | 2 or 3 PCLKB            | 2 ICLK      |
| 0008 A128h | SCI9          | Noise Filter Setting Register    | SNFR            | 8              | 8           | 2 or 3 PCLKB            | 2 ICLK      |
| 0008 A129h | SCI9          | I <sup>2</sup> C Mode Register 1 | SIMR1           | 8              | 8           | 2 or 3 PCLKB            | 2 ICLK      |
| 0008 A12Ah | SCI9          | I <sup>2</sup> C Mode Register 2 | SIMR2           | 8              | 8           | 2 or 3 PCLKB            | 2 ICLK      |
| 0008 A12Bh | SCI9          | I <sup>2</sup> C Mode Register 3 | SIMR3           | 8              | 8           | 2 or 3 PCLKB            | 2 ICLK      |
| 0008 A12Ch | SCI9          | I <sup>2</sup> C Status Register | SISR            | 8              | 8           | 2 or 3 PCLKB            | 2 ICLK      |
| 0008 A12Dh | SCI9          | SPI Mode Register                | SPMR            | 8              | 8           | 2 or 3 PCLKB            | 2 ICLK      |
| 0008 A12Eh | SCI9          | Transmit Data Register HL        | TDRHL           | 16             | 16          | 4 or 5 PCLKB            | 2 ICLK      |
| 0008 A12Eh | SCI9          | Transmit Data Register H         | TDRH            | 8              | 8           | 2 or 3 PCLKB            | 2 ICLK      |
| 0008 A12Fh | SCI9          | Transmit Data Register L         | TDRL            | 8              | 8           | 2 or 3 PCLKB            | 2 ICLK      |
| 0008 A130h | SCI9          | Receive Data Register HL         | RDRHL           | 16             | 16          | 4 or 5 PCLKB            | 2 ICLK      |
| 0008 A130h | SCI9          | Receive Data Register H          | RDRH            | 8              | 8           | 2 or 3 PCLKB            | 2 ICLK      |



Note 1. All peripheral operations except any BGO operation are operating normally. Indicates the average of the typical samples through actual measurement during product evaluation.

Note 2. All peripheral operations except any BGO operation are operating at maximum. Indicates the average of the upper-limit samples through actual measurement during product evaluation.

**Figure 5.3 Voltage Dependency in Low-Speed Operating Mode (Reference Data)**

**Table 5.8 DC Characteristics (6)**Conditions:  $1.8\text{ V} \leq V_{CC} = V_{CC\_USB} = AV_{CC0} \leq 5.5\text{ V}$ ,  $V_{SS} = AV_{SS0} = V_{SS\_USB} = 0\text{ V}$ ,  $T_a = -40\text{ to }+105^\circ\text{C}$ 

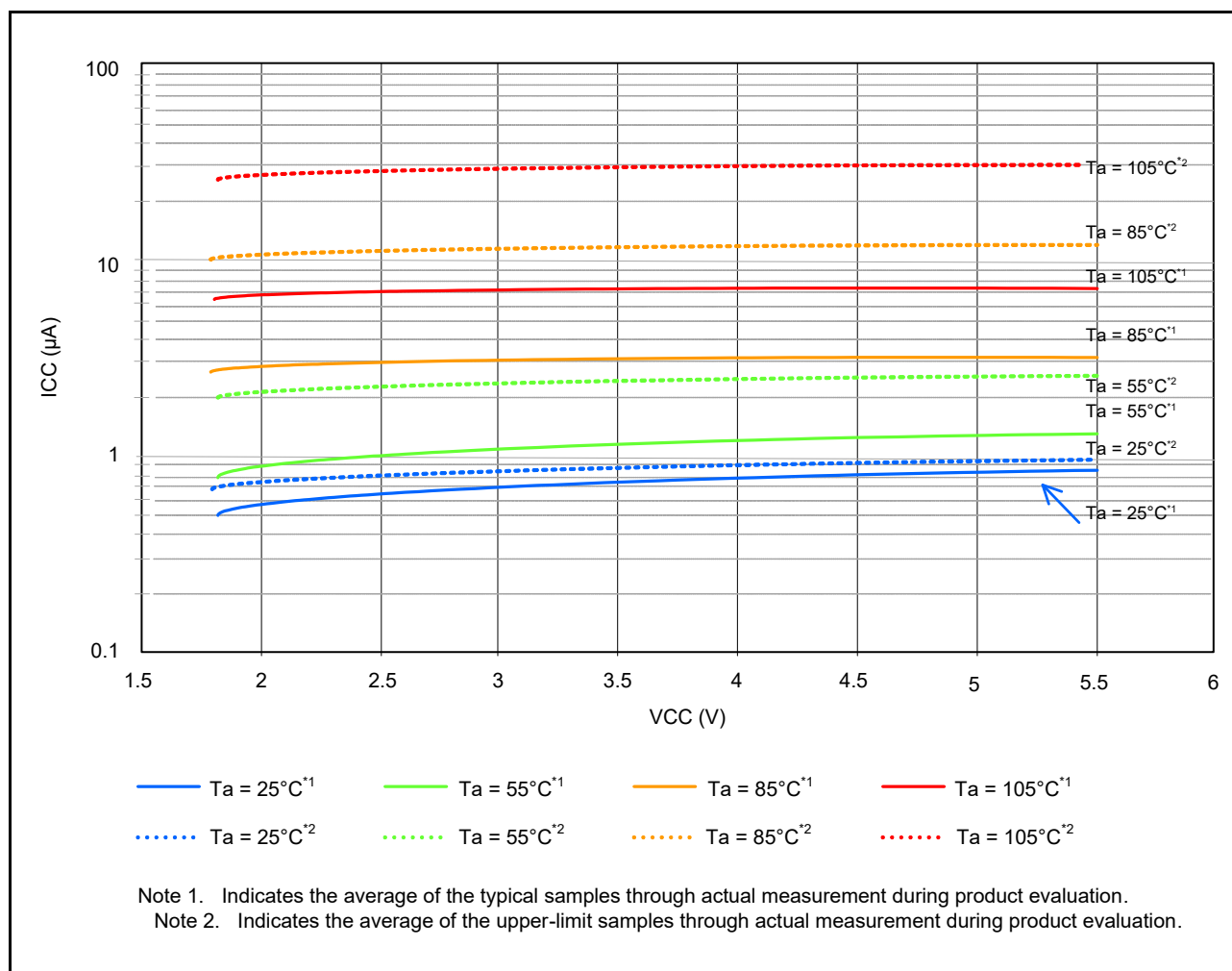
| Item             |                               |                        | Symbol          | Typ.*3 | Max. | Unit | Test Conditions                                        |
|------------------|-------------------------------|------------------------|-----------------|--------|------|------|--------------------------------------------------------|
| Supply current*1 | Software standby mode*2       | T <sub>a</sub> = 25°C  | I <sub>CC</sub> | 0.8    | 3.7  | μA   |                                                        |
|                  |                               | T <sub>a</sub> = 55°C  |                 | 1.2    | 4.3  |      |                                                        |
|                  |                               | T <sub>a</sub> = 85°C  |                 | 3.5    | 18.6 |      |                                                        |
|                  |                               | T <sub>a</sub> = 105°C |                 | 7.9    | 45.2 |      |                                                        |
|                  | Increment for IWDT operation  |                        |                 | 0.4    | —    |      | Use IWDT-Dedicated On-Chip Oscillator for clock source |
|                  | Increment for LPT operation   |                        |                 | 0.4    | —    |      |                                                        |
|                  | Increment for RTC operation*4 |                        |                 | 0.4    | —    |      |                                                        |
|                  |                               |                        |                 | 1.2    | —    |      | RCR3.RTCDV[2:0] set to normal drive capacity           |

Note 1. Supply current values are with all output pins unloaded and all input pull-up MOSs in the off state.

Note 2. The IWDN, LVD, and CMPB are stopped.

Note 3. When  $V_{CC}$  is 3.3 V.

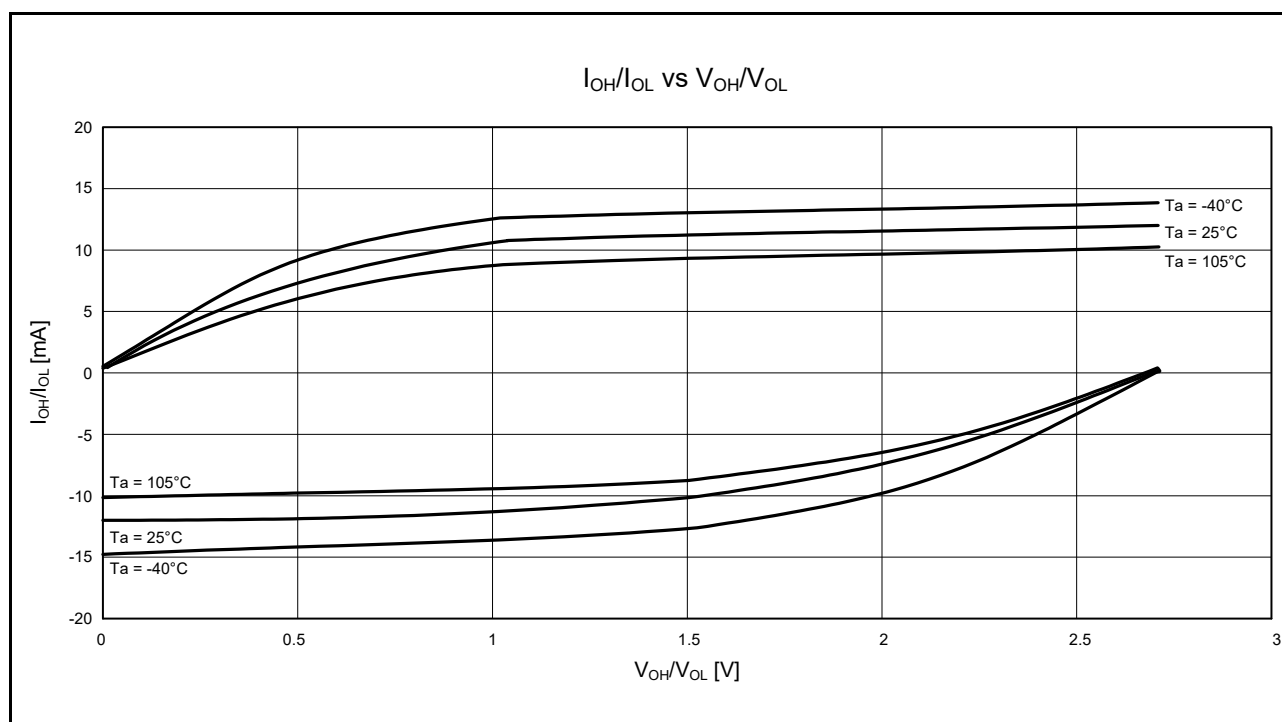
Note 4. This increment includes the oscillation circuit.

**Figure 5.4 Voltage Dependency in Software Standby Mode (Reference Data)**

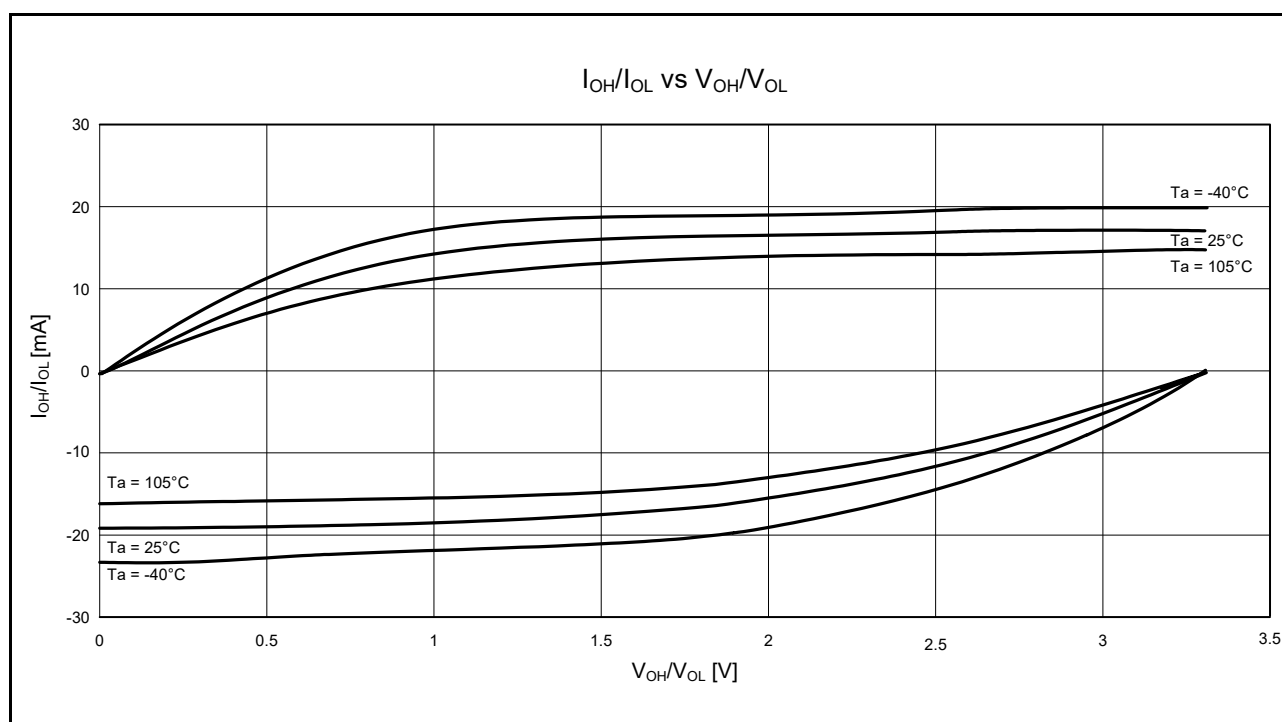
**Table 5.17 Permissible Output Currents (2)**Conditions:  $1.8\text{ V} \leq VCC = VCC\_USB = AVCC0 \leq 5.5\text{ V}$ ,  $VSS = AVSS0 = VSS\_USB = 0\text{ V}$ ,  $T_a = -40\text{ to }+105^\circ\text{C}$ 

| Item                                                       |                                                                   |                        | Symbol           | Max. | Unit |
|------------------------------------------------------------|-------------------------------------------------------------------|------------------------|------------------|------|------|
| Permissible output low current<br>(average value per pin)  | Ports 40 to 47, ports 03, 05, 07, port 36, 37                     |                        | I <sub>OL</sub>  | 4.0  | mA   |
|                                                            | Ports other than above                                            | Normal output mode     |                  | 4.0  |      |
|                                                            |                                                                   | High-drive output mode |                  | 8.0  |      |
| Permissible output low current<br>(maximum value per pin)  | Ports 40 to 47, ports 03, 05, 07, ports 36, 37                    |                        |                  | 4.0  |      |
|                                                            | Ports other than above                                            | Normal output mode     |                  | 4.0  |      |
|                                                            |                                                                   | High-drive output mode |                  | 8.0  |      |
| Permissible output low current                             | Total of ports 40 to 47, ports 03, 05, 07                         |                        | ΣI <sub>OL</sub> | 30   |      |
|                                                            | Total of ports 12 to 17, ports 20 to 27, ports 30 to 37, port PJ3 |                        |                  | 30   |      |
|                                                            | Total of ports 50 to 55, ports C0 to C7, ports B0 to B7           |                        |                  | 30   |      |
|                                                            | Total of ports E0 to E7, ports A0 to A7, ports D0 to D4           |                        |                  | 30   |      |
|                                                            | Total of all output pins                                          |                        |                  | 60   |      |
| Permissible output high current<br>(average value per pin) | Ports 40 to 47, ports 03, 05, 07, ports 36, 37                    |                        | I <sub>OH</sub>  | −4.0 |      |
|                                                            | Ports other than above                                            | Normal output mode     |                  | −4.0 |      |
|                                                            |                                                                   | High-drive output mode |                  | −8.0 |      |
| Permissible output high current<br>(maximum value per pin) | Ports 40 to 47, ports 03, 05, 07, ports 36, 37                    |                        |                  | −4.0 |      |
|                                                            | Ports other than above                                            | Normal output mode     |                  | −4.0 |      |
|                                                            |                                                                   | High-drive output mode |                  | −8.0 |      |
| Permissible output high current                            | Total of ports 40 to 47, ports 03, 05, 07                         |                        | ΣI <sub>OH</sub> | −30  |      |
|                                                            | Total of ports 12 to 17, ports 20 to 27, ports 30 to 37, port PJ3 |                        |                  | −30  |      |
|                                                            | Total of ports 50 to 55, ports C0 to C7, ports B0 to B7           |                        |                  | −30  |      |
|                                                            | Total of ports E0 to E7, ports A0 to A7, ports D0 to D4           |                        |                  | −30  |      |
|                                                            | Total of all output pins                                          |                        |                  | −60  |      |

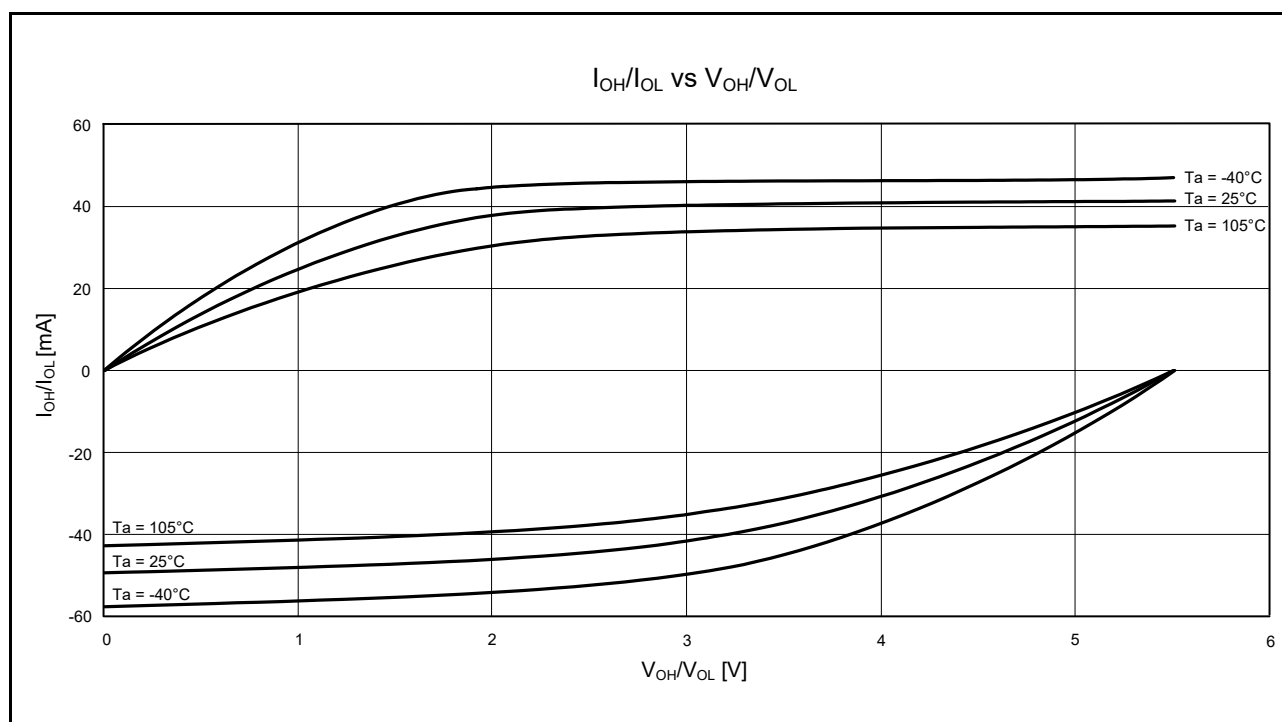
Note: Do not exceed the permissible total supply current.



**Figure 5.10**  $V_{OH}/V_{OL}$  and  $I_{OH}/I_{OL}$  Temperature Characteristics at  $V_{CC} = 2.7$  V When Normal Output is Selected (Reference Data)



**Figure 5.11**  $V_{OH}/V_{OL}$  and  $I_{OH}/I_{OL}$  Temperature Characteristics at  $V_{CC} = 3.3$  V When Normal Output is Selected (Reference Data)



**Figure 5.12**  $V_{OH}/V_{OL}$  and  $I_{OH}/I_{OL}$  Temperature Characteristics at  $V_{CC} = 5.5\text{ V}$  When Normal Output is Selected (Reference Data)

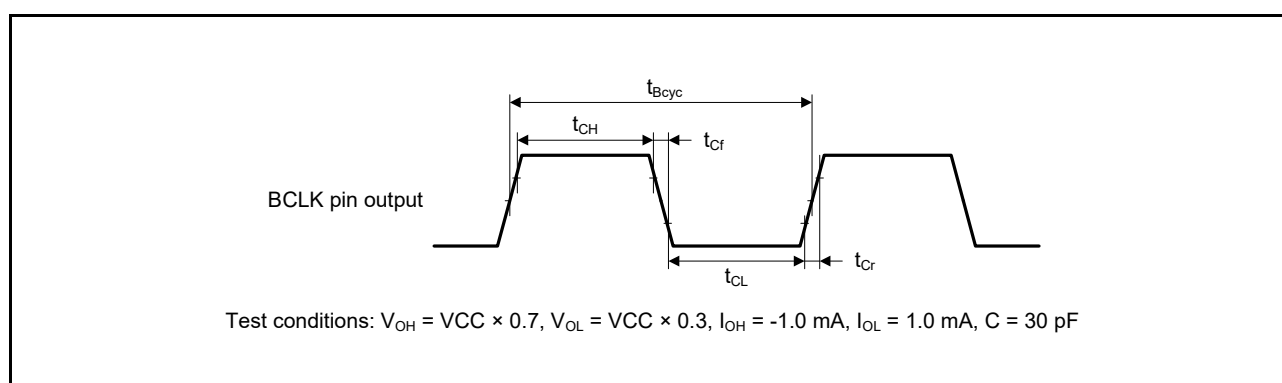


Figure 5.22 BCLK Pin Output Timing

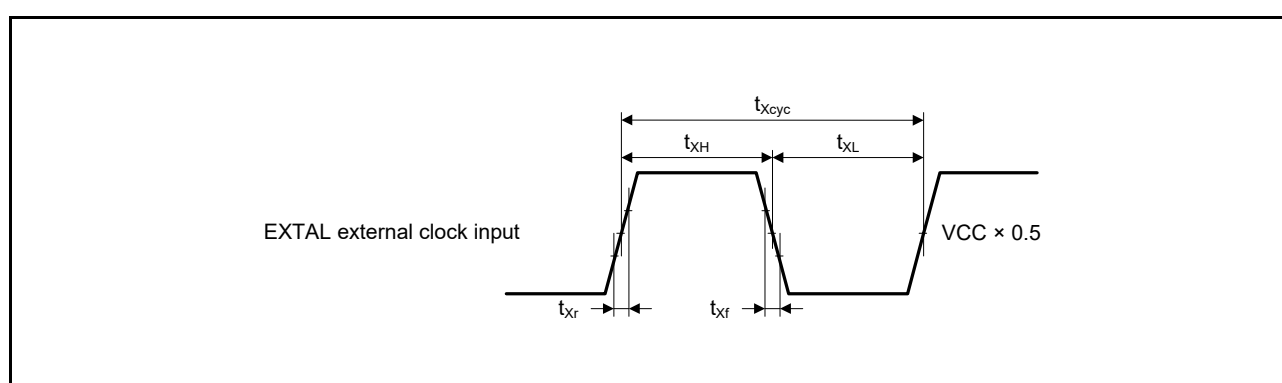


Figure 5.23 EXTAL External Clock Input Timing

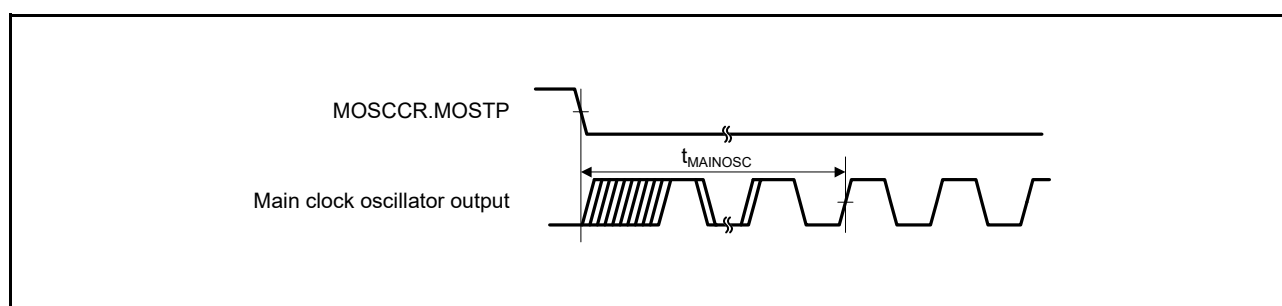


Figure 5.24 Main Clock Oscillation Start Timing

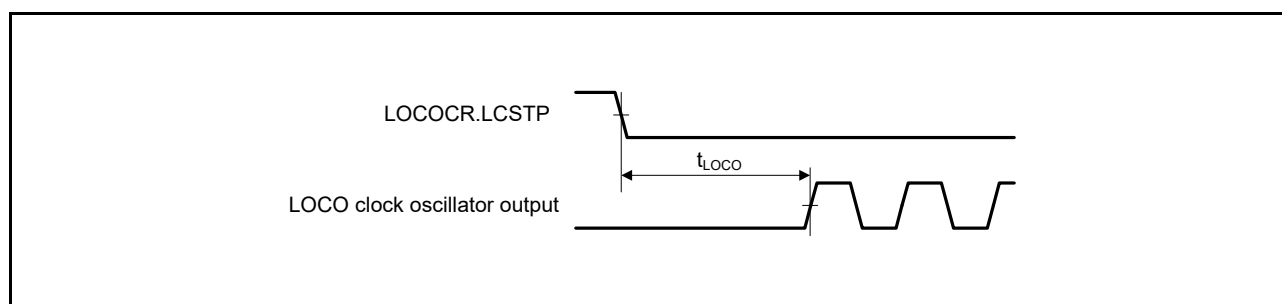


Figure 5.25 LOCO Clock Oscillation Start Timing



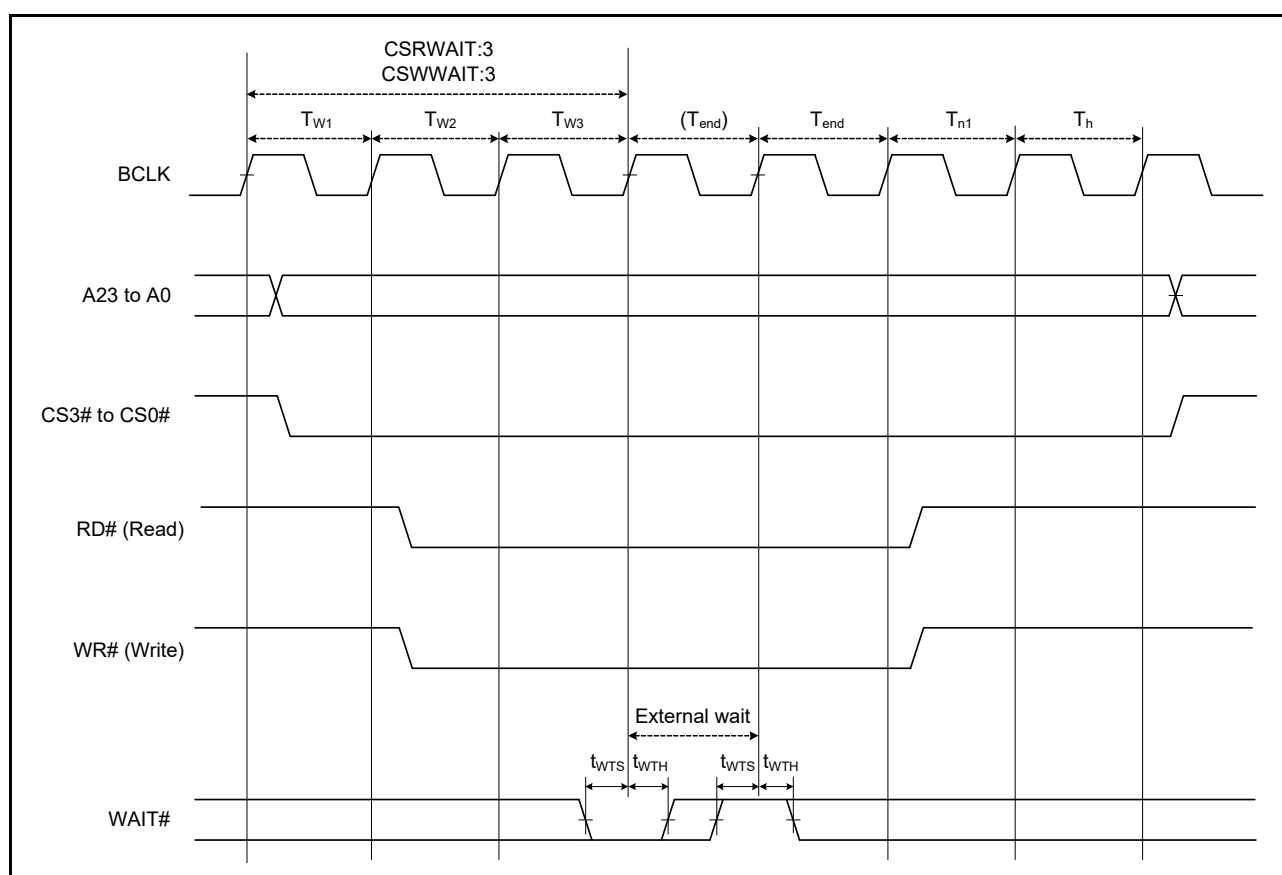
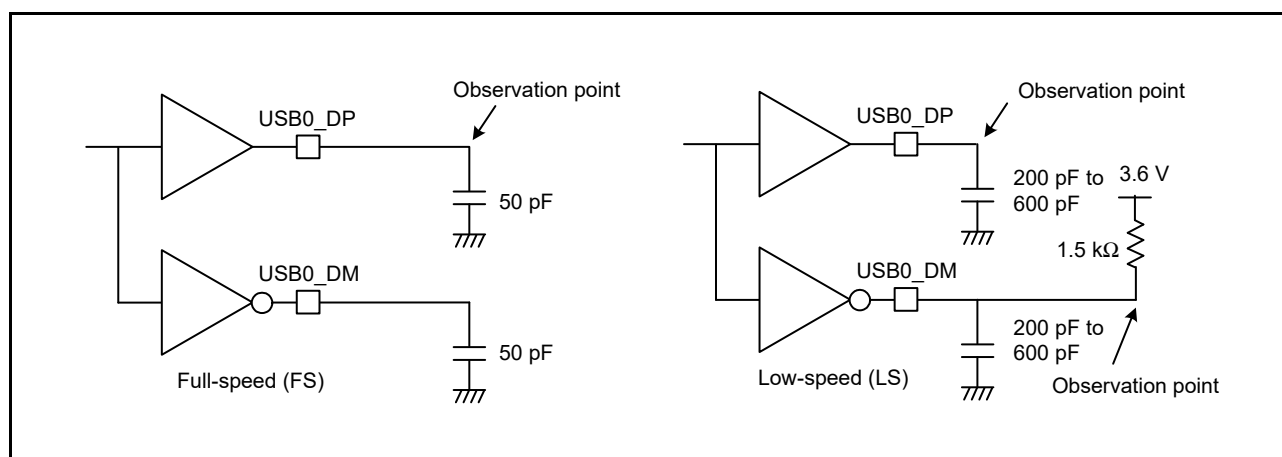


Figure 5.42 External Bus Timing/External Wait Control



**Figure 5.66**     **Test Circuit**

## 5.6 D/A Conversion Characteristics

**Table 5.52 D/A Conversion Characteristics (1)**

Conditions:  $1.8\text{ V} \leq V_{CC} = V_{CC\_USB} = AV_{CC0} \leq 5.5\text{ V}$ ,  $V_{SS} = AV_{SS0} = V_{SS\_USB} = 0\text{ V}$ ,  $T_a = -40\text{ to }+105^\circ\text{C}$   
 Reference voltage = VREFH or VREFL selected

| Item                                 | Min. | Typ.      | Max.              | Unit          | Test Conditions |
|--------------------------------------|------|-----------|-------------------|---------------|-----------------|
| Resolution                           | —    | —         | 12                | Bit           |                 |
| Resistive load                       | 30   | —         | —                 | k $\Omega$    |                 |
| Capacitive load                      | —    | —         | 50                | pF            |                 |
| Output voltage range                 | 0.35 | —         | $AV_{CC0} - 0.47$ | V             |                 |
| DNL differential non-linearity error | —    | $\pm 0.5$ | $\pm 1.0$         | LSB           |                 |
| INL integral non-linearity error     | —    | $\pm 2.0$ | $\pm 8.0$         | LSB           |                 |
| Offset error                         | —    | —         | $\pm 20$          | mV            |                 |
| Full-scale error                     | —    | —         | $\pm 20$          | mV            |                 |
| Output resistance                    | —    | 5         | —                 | $\Omega$      |                 |
| Conversion time                      | —    | —         | 30                | $\mu\text{s}$ |                 |

**Table 5.53 D/A Conversion Characteristics (2)**

Conditions:  $1.8\text{ V} \leq V_{CC} = V_{CC\_USB} = AV_{CC0} \leq 5.5\text{ V}$ ,  $V_{SS} = AV_{SS0} = V_{REFL} = V_{SS\_USB} = 0\text{ V}$ ,  $T_a = -40\text{ to }+105^\circ\text{C}$   
 Reference voltage = AVCC0 or AVSS0 selected

| Item                                 | Min. | Typ.      | Max.              | Unit          | Test Conditions |
|--------------------------------------|------|-----------|-------------------|---------------|-----------------|
| Resolution                           | —    | —         | 12                | Bit           |                 |
| Resistive load                       | 30   | —         | —                 | k $\Omega$    |                 |
| Capacitive load                      | —    | —         | 50                | pF            |                 |
| Output voltage range                 | 0.35 | —         | $AV_{CC0} - 0.47$ | V             |                 |
| DNL differential non-linearity error | —    | $\pm 0.5$ | $\pm 2.0$         | LSB           |                 |
| INL integral non-linearity error     | —    | $\pm 2.0$ | $\pm 8.0$         | LSB           |                 |
| Offset error                         | —    | —         | $\pm 30$          | mV            |                 |
| Full-scale error                     | —    | —         | $\pm 30$          | mV            |                 |
| Output resistance                    | —    | 5         | —                 | $\Omega$      |                 |
| Conversion time                      | —    | —         | 30                | $\mu\text{s}$ |                 |

**Table 5.54 D/A Conversion Characteristics (3)**

Conditions:  $1.8\text{ V} \leq V_{CC} = V_{CC\_USB} = AV_{CC0} \leq 5.5\text{ V}$ ,  $V_{SS} = AV_{SS0} = V_{SS\_USB} = 0\text{ V}$ ,  $T_a = -40\text{ to }+105^\circ\text{C}$   
 Reference voltage = internal reference voltage selected

| Item                                 | Min. | Typ.      | Max.       | Unit          | Test Conditions |
|--------------------------------------|------|-----------|------------|---------------|-----------------|
| Resolution                           | —    | —         | 12         | Bit           |                 |
| Internal reference voltage (Vbgr)    | 1.36 | 1.43      | 1.50       | V             |                 |
| Resistive load                       | 30   | —         | —          | k $\Omega$    |                 |
| Capacitive load                      | —    | —         | 50         | pF            |                 |
| Output voltage range                 | 0.35 | —         | Vbgr       | V             |                 |
| DNL differential non-linearity error | —    | $\pm 2.0$ | $\pm 16.0$ | LSB           |                 |
| INL integral non-linearity error     | —    | $\pm 8.0$ | $\pm 16.0$ | LSB           |                 |
| Offset error                         | —    | —         | 30         | mV            |                 |
| Output resistance                    | —    | 5         | —          | $\Omega$      |                 |
| Conversion time                      | —    | —         | 30         | $\mu\text{s}$ |                 |

## 5.13 ROM (Flash Memory for Code Storage) Characteristics

**Table 5.62 ROM (Flash Memory for Code Storage) Characteristics (1)**

| Item                          | Symbol                                     | Min.     | Typ. | Max. | Unit  | Conditions                  |
|-------------------------------|--------------------------------------------|----------|------|------|-------|-----------------------------|
| Reprogramming/erasure cycle*1 | $N_{PEC}$                                  | 1000     | —    | —    | Times |                             |
| Data hold time                | After 1000 times of $N_{PEC}$<br>$t_{DRP}$ | 20*2, *3 | —    | —    | Year  | $T_a = +85^{\circ}\text{C}$ |

Note 1. Definition of reprogram/erase cycle: The reprogram/erase cycle is the number of erasing for each block. When the reprogram/erase cycle is n times ( $n = 1000$ ), erasing can be performed n times for each block. For instance, when 4-byte programming is performed 256 times for different addresses in a 1-Kbyte block and then the entire block is erased, the reprogram/erase cycle is counted as one. However, programming the same address for several times as one erasing is not enabled (overwriting is prohibited).

Note 2. Characteristic when using the flash memory programmer and the self-programming library provided from Renesas Electronics.

Note 3. This result is obtained from reliability testing.

**Table 5.63 ROM (Flash Memory for Code Storage) Characteristics (2) High-Speed Operating Mode**

Conditions:  $2.7\text{ V} \leq V_{CC} = V_{CC\_USB} = AV_{CC0} \leq 5.5\text{ V}$ ,  $V_{SS} = AV_{SS0} = V_{SS\_USB} = 0\text{ V}$

Temperature range for the programming/erasure operation:  $T_a = -40$  to  $+105^{\circ}\text{C}$

| Item                                 |                                                     | Symbol       | FCLK = 1 MHz |      |       | FCLK = 32 MHz |      |      | Unit          |
|--------------------------------------|-----------------------------------------------------|--------------|--------------|------|-------|---------------|------|------|---------------|
|                                      |                                                     |              | Min.         | Typ. | Max.  | Min.          | Typ. | Max. |               |
| Programming time                     | 8-byte                                              | $t_{P8}$     | —            | 112  | 967   | —             | 52.3 | 491  | $\mu\text{s}$ |
| Erasure time                         | 2-Kbyte                                             | $t_{E2K}$    | —            | 8.75 | 278   | —             | 5.50 | 215  | ms            |
|                                      | 512-Kbyte<br>(when block erase command is used)     | $t_{E512K}$  | —            | 928  | 19218 | —             | 72.0 | 1679 | ms            |
|                                      | 512-Kbyte<br>(when all-block erase command is used) | $t_{EA512K}$ | —            | 923  | 19013 | —             | 66.7 | 1469 | ms            |
| Blank check time                     | 8-byte                                              | $t_{BC8}$    | —            | —    | 55.0  | —             | —    | 16.1 | $\mu\text{s}$ |
|                                      | 2-Kbyte                                             | $t_{BC2K}$   | —            | —    | 1840  | —             | —    | 136  | ms            |
| Erasure operation forced stop time   |                                                     | $t_{SED}$    | —            | —    | 18.0  | —             | —    | 10.7 | $\mu\text{s}$ |
| Start-up area switching setting time |                                                     | $t_{SAS}$    | —            | 12.3 | 566.5 | —             | 6.2  | 434  | ms            |
| Access window time                   |                                                     | $t_{AWS}$    | —            | 12.3 | 566.5 | —             | 6.2  | 434  | ms            |
| ROM mode transition wait time 1      |                                                     | $t_{DIS}$    | 2.0          | —    | —     | 2.0           | —    | —    | $\mu\text{s}$ |
| ROM mode transition wait time 2      |                                                     | $t_{MS}$     | 5.0          | —    | —     | 5.0           | —    | —    | $\mu\text{s}$ |

Note: The time until each operation of the flash memory is started after instructions are executed by software is not included.

Note: The lower-limit frequency of FCLK is 1 MHz during programming or erasing of the flash memory. When using FCLK at below 4 MHz, the frequency can be set to 1 MHz, 2 MHz, or 3 MHz. A non-integer frequency such as 1.5 MHz cannot be set.

Note: The frequency accuracy of FCLK must be within  $\pm 3.5\%$ .

| JEITA Package code | RENESAS code | Previous code             | MASS(TYP.)[g] |
|--------------------|--------------|---------------------------|---------------|
| P-HWQFN48-7x7-0.50 | PWQN0048KB-A | 48PJN-A<br>P48K8-50-5B4-7 | 0.13          |

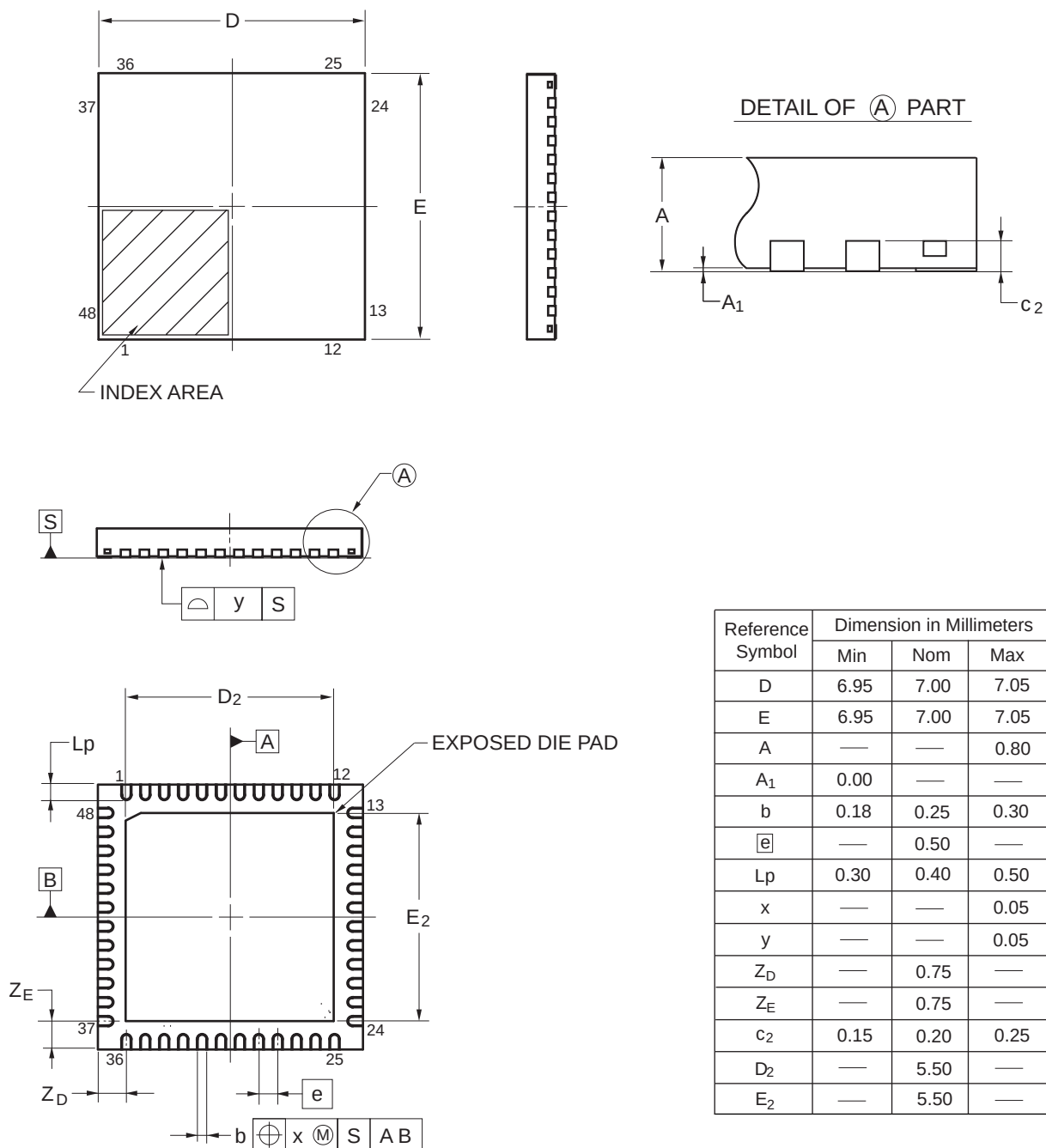


Figure F 48-Pin HWQFN (PWQN0048KB-A)