

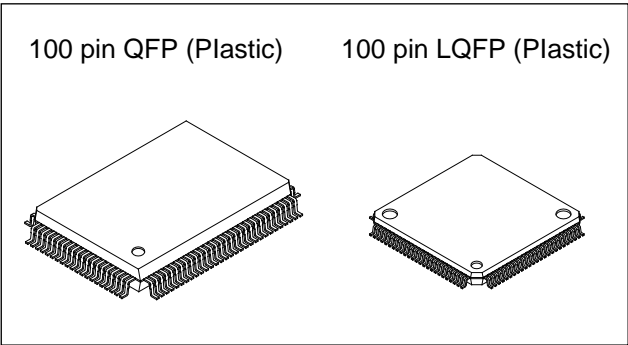
CXP81720A/81724A

CMOS 8-bit Single Chip Microcomputer

Description

The CXP81720A/81724A is a CMOS 8-bit micro-computer which consists of A/D converter, serial interface, timer/counter, time base timer, vector interruption, high precision timing pattern generation circuit, PWM generator, PWM for tuner, 32kHz timer/event counter, remote control receiving circuit, as well as basic configurations like 8-bit CPU, ROM, RAM and I/O port. They are integrated into a single chip.

Also CXP81720A/81724A provides sleep/stop function which enables to lower power consumption and ultra-low speed instruction mode in 32kHz operation.



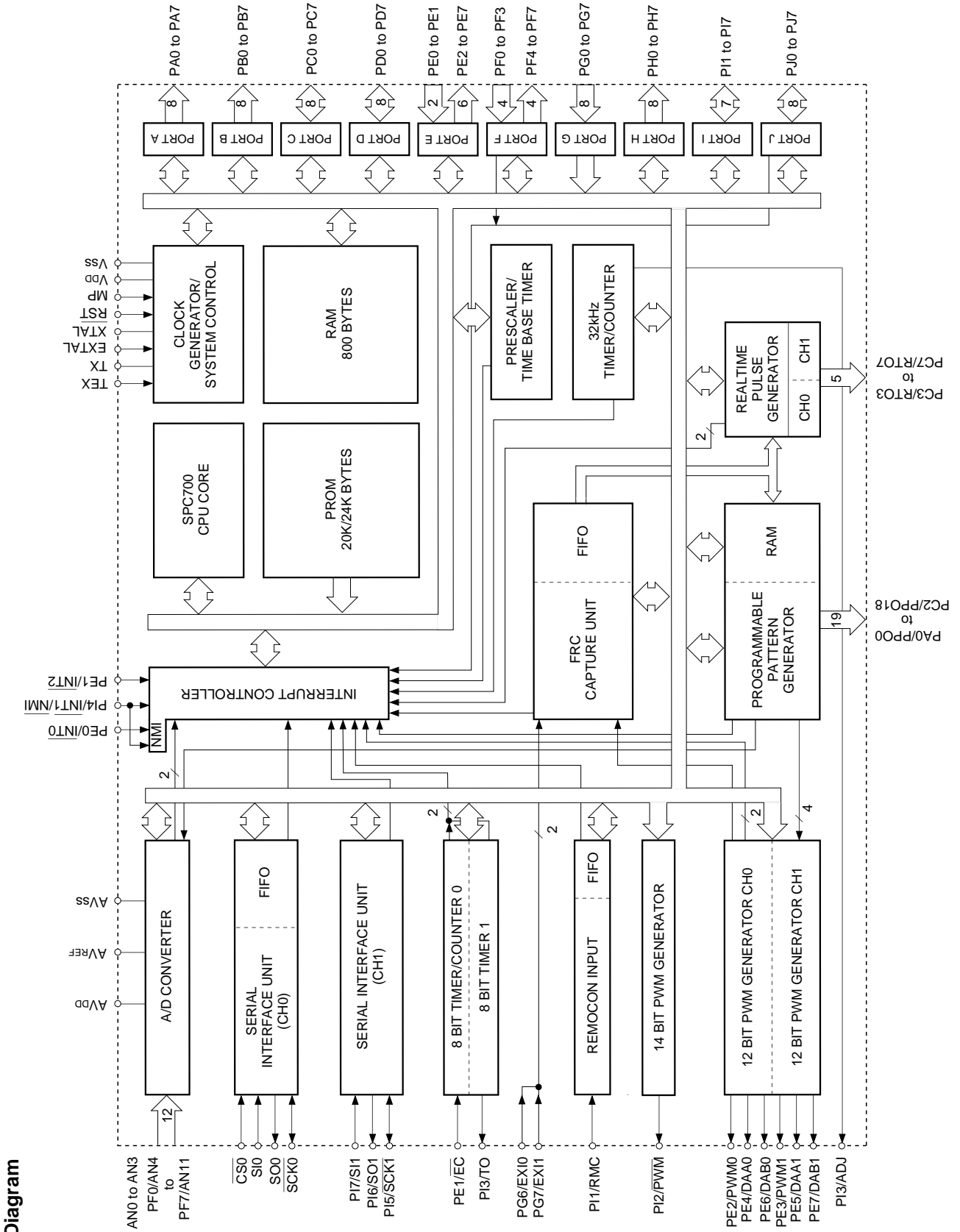
Structure

Silicon gate CMOS IC

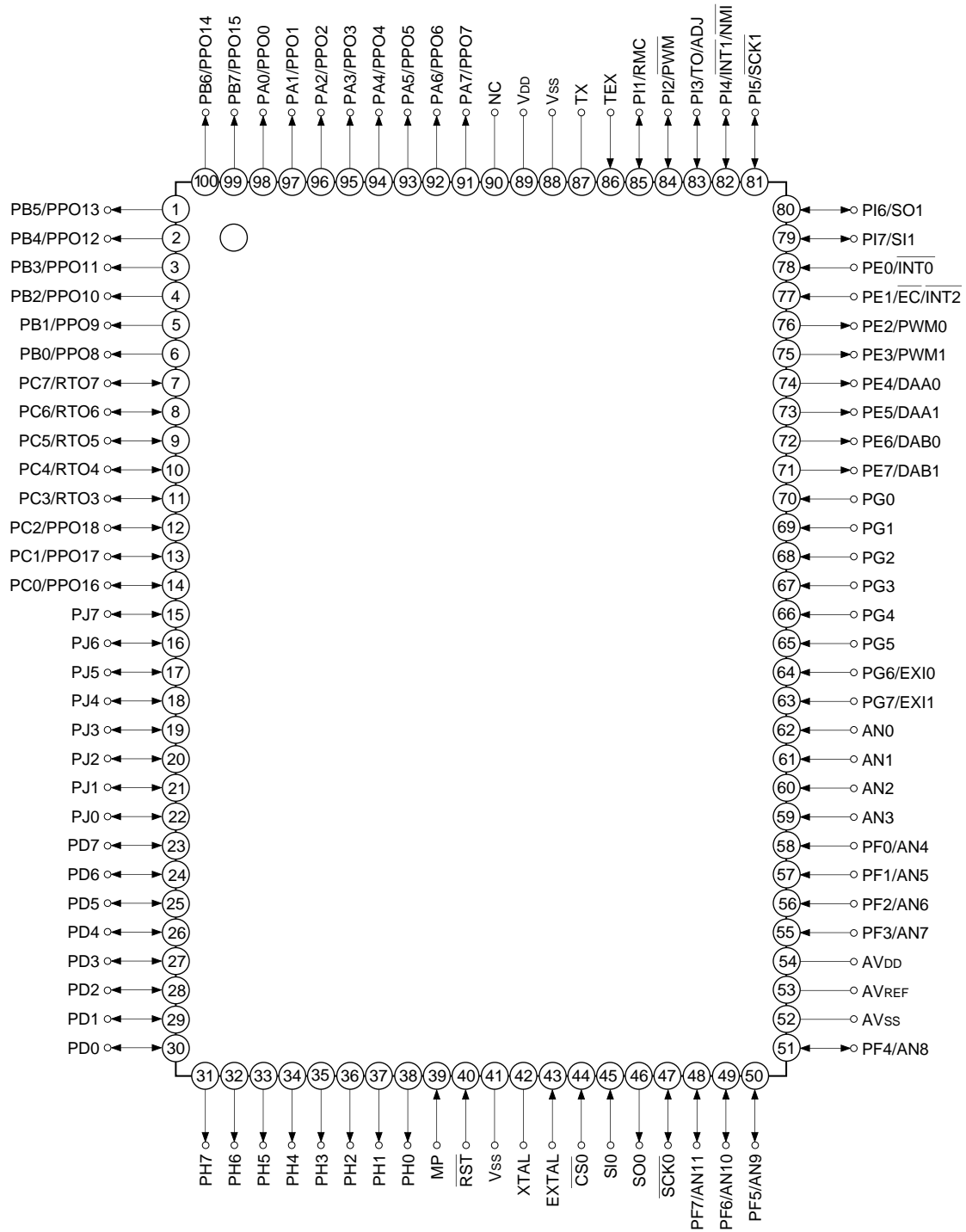
Features

- A wide instruction set (213 instructions) which cover various types of data
 - 16-bit arithmetic instruction/multiplication and division instructions/boolean bit operation instruction
- Minimum instruction cycle During operation 250ns/16MHz (Supply voltage 4.5 to 5.5V)
 During operation 122µs/32kHz
- Incorporated ROM capacity 20K bytes (CXP81720A)
 24K bytes (CXP81724A)
- Incorporated RAM capacity 800 bytes
- Peripheral functions
 - A/D converter 8-bit, 12-channel, successive approximation system
 (Conversion time 20.0µs/16MHz)
 - Serial interface Incorporated 8-bit and 8-stage FIFO, 1-channel
 (1 to 8 bytes auto transfer)
 8-bit serial I/O, 1-channel
 - Timer 8-bit timer, 8-bit timer/counter, 19-bit time base timer
 32kHz timer/counter
 - High precision timing pattern generator PPG 19 pins 32-stage programmable
 RTG 5-pins 2-channel
 - PWM/DA gate output 12-bit, 2-channel (Repetitive frequency 62kHz/16MHz)
 - FRC capture unit Incorporated 26-bit and 8-stage FIFO
 - PWM output 14-bit, 1-channel
 - Remote control receiving circuit 8-bit pulse measuring counter, 6-stage FIFO
- Interruption 20 factors, 15 vectors, multi-interruption possible
- Standby mode SLEEP/STOP
- Package 100-pin plastic QFP/LQFP
- Piggyback/evaluation chip CXP81800 100-pin ceramic QFP/LQFP

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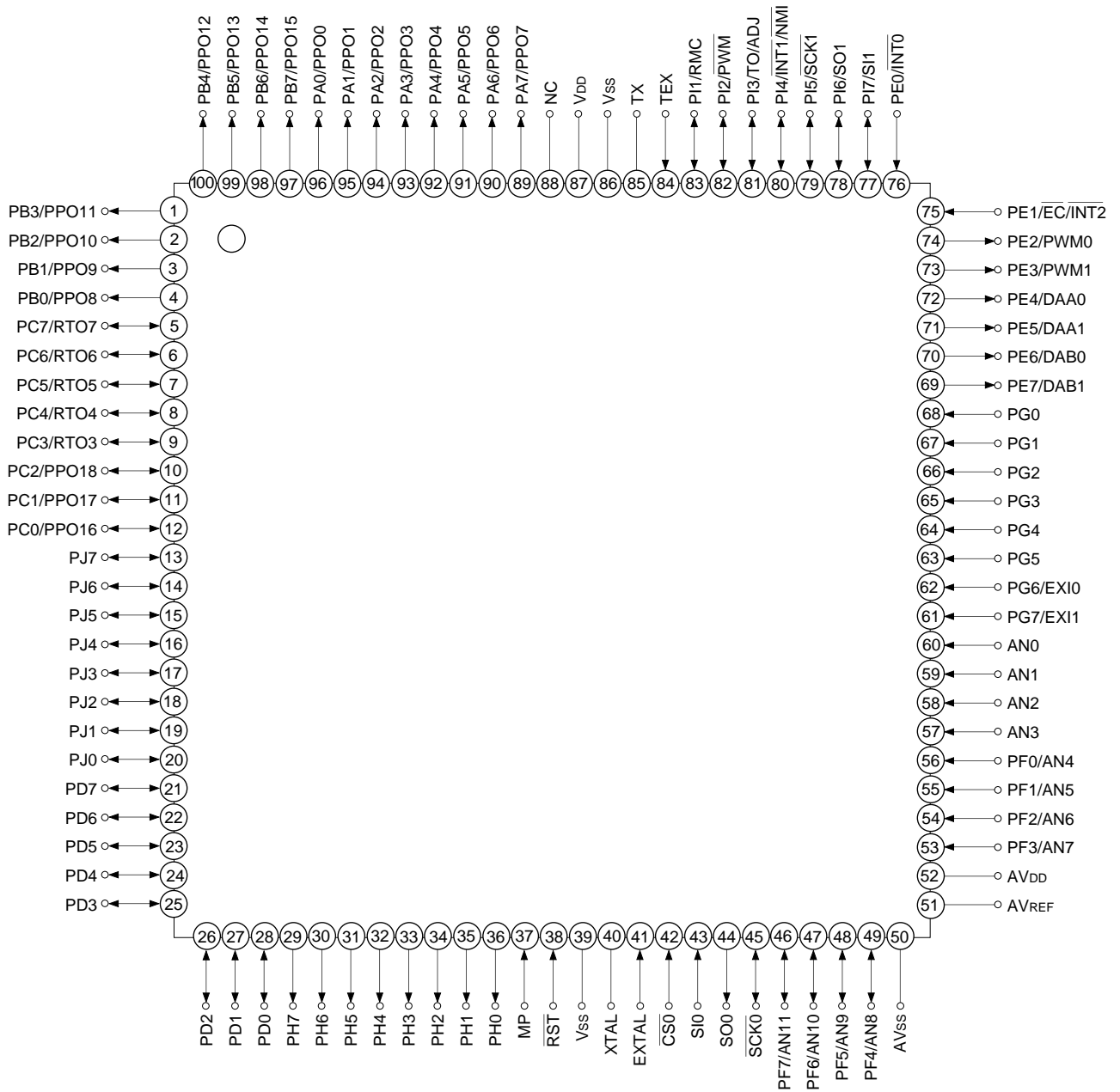


Pin Configuration 1 (Top View) 100 pin QFP package



- Note)** 1. NC (Pin 90) is always connected to V_{DD}.
 2. V_{SS} (Pins 41 and 88) are both connected to GND.

Pin Configuration 2 (Top View) 100 pin LQFP package



- Note**
1. NC (Pin 88) is always connected to VDD.
 2. Vss (Pins 39 and 86) are both connected to GND.

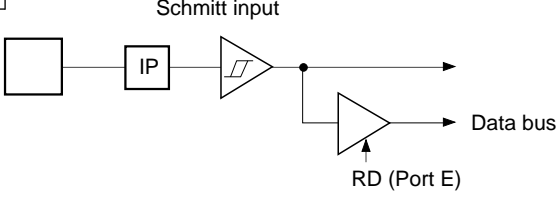
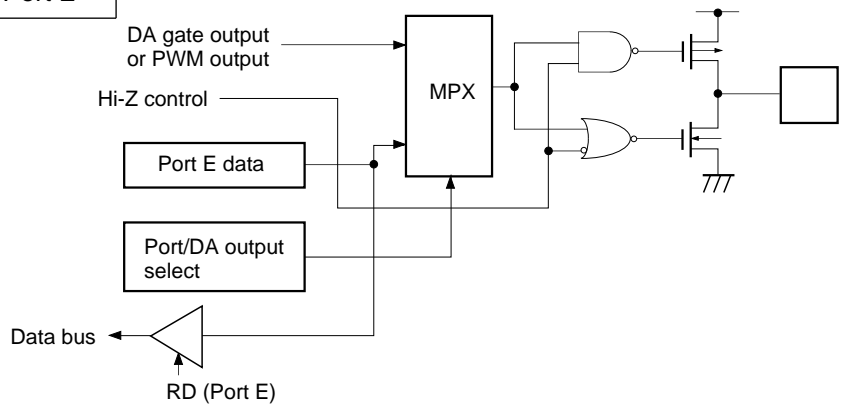
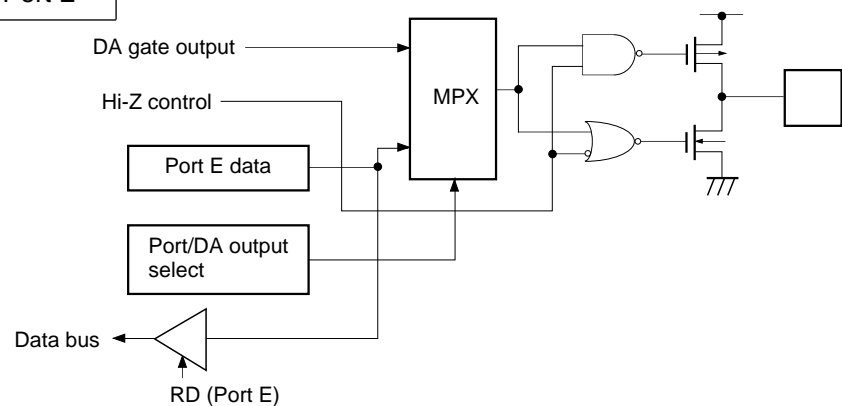
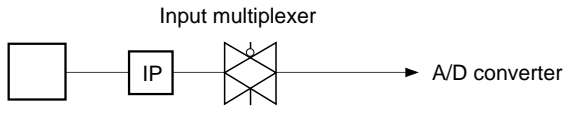
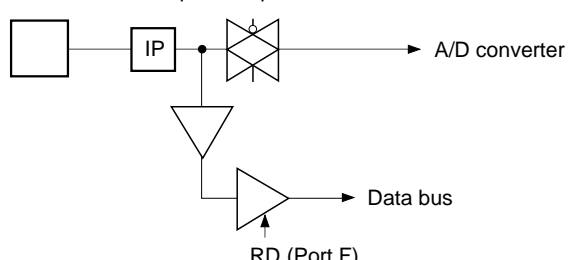
Pin Description

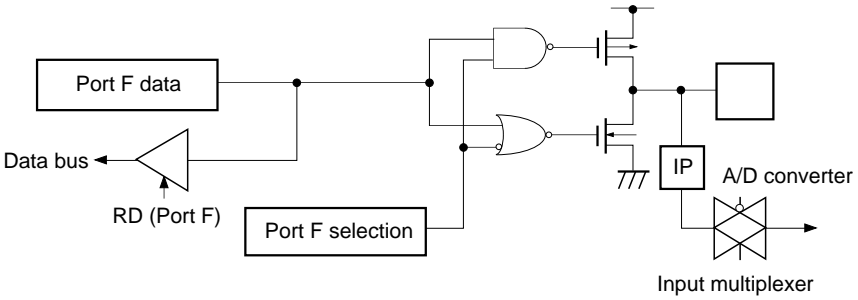
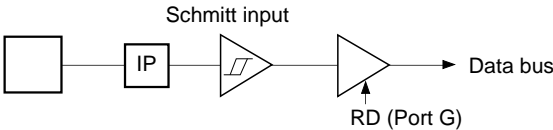
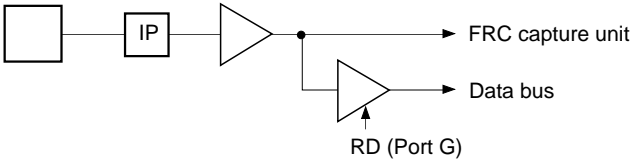
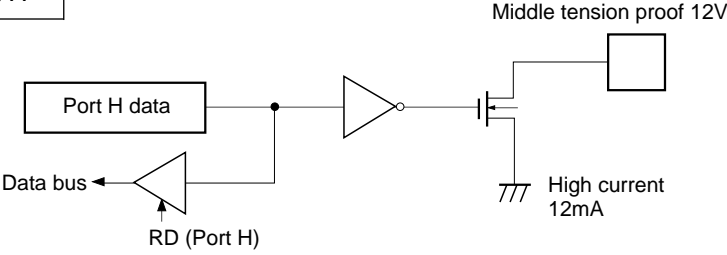
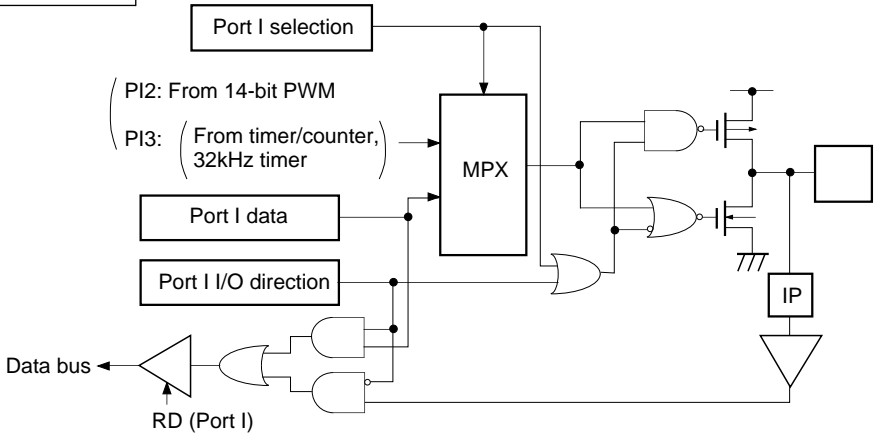
| Symbol | I/O | Description | | |
|--|--------------------------------|--|--|--|
| PA0/PPO0 to PA7/PPO7 | Output/ Real time Output | (Port A) 8-bit output port. Data is gated with PPO contents by OR-gate and they are output. (8 pins) | Programmable pattern generator (PPG) output. Functions as high precision real time pulse output port. (19 pins) | |
| PB0/PPO8 to PB7/PPO15 | Output/ Real time Output | (Port B) 8-bit output port. Data is gated with PPO contents by OR-gate and they are output. (8 pins) | | |
| PC0/PPO16 to PC2/PPO18 | I/O/ Real time Output | (Port C) 8-bit I/O port, enables to specify I/O by bit unit. Data is gated with PPO or RTO contents by OR-gate and they are output. (8 pins) | | |
| PC3/RTO3 to PC7/RTO7 | I/O/ Real time Output | | Real time pulse generator (RTG) output. Functions as high precision real time pulse output port. (5 pins) | |
| PD0 to PD7 | I/O | (Port D) 8-bit I/O port. Enable to specify I/O by 4-bit unit. Enables to drive 12mA sink current. (8 pins) | | |
| PE0/ $\overline{\text{INT0}}$ | Input/input | (Port E) 8-bit port. Lower 2 bits are input pins and upper 6 bits are output pins. (8 pins) | Input pin to request external interruption. Active when falling edge. | |
| PE1/ $\overline{\text{EC}}$ / $\overline{\text{INT2}}$ | Input/input/input | | External event input pin for timer/counter. | Input pin to request external interruption. Active when falling edge. |
| PE2/PWM0 | Output/output | | PWM output pins. (2 pins) | |
| PE3/PWM1 | Output/output | | | |
| PE4/DAA0 | Output/output | | | |
| PE5/DAA1 | Output/output | | | |
| PE6/DAB0 | Output/output | | DA gate pulse output pins. (4 pins) | |
| PE7/DAB1 | Output/output | | | |
| AN0 to AN3 | Input | Analog input pins to A/D converter. (12 pins) | | |
| PF0/AN4 to PF3/AN7 | Input/input | (Port F) Lower 4 bits are input port and upper 4 bits are output port. Lower 4 bits also serve as standby release input pin. (8 pins) | | |
| PF4/AN8 to PF7/AN11 | Output/input | | | |
| $\overline{\text{SCK0}}$ | I/O | Serial clock (CH0) I/O pin. | | |
| SO0 | Output | Serial data (CH0) output pin. | | |
| SI0 | Input | Serial data (CH0) input pin. | | |
| $\overline{\text{CS0}}$ | Input | Serial chip select (CH0) input pin. | | |

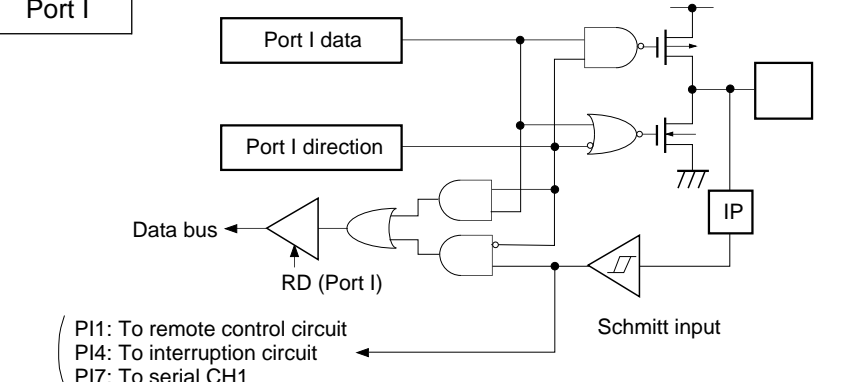
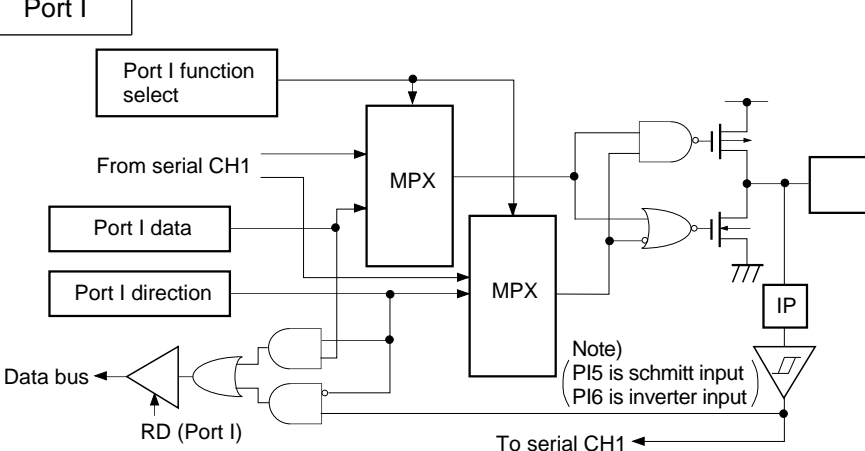
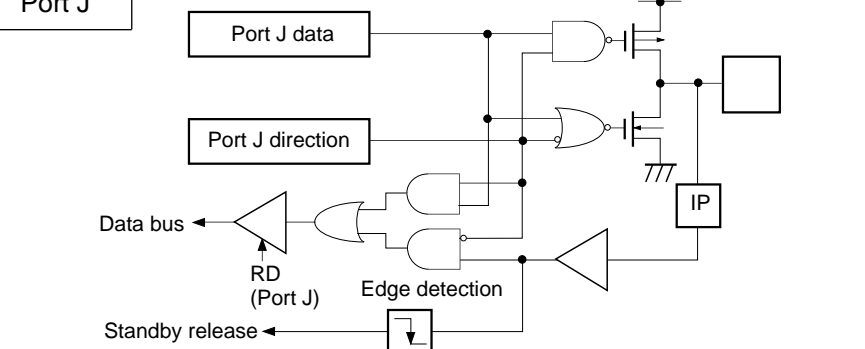
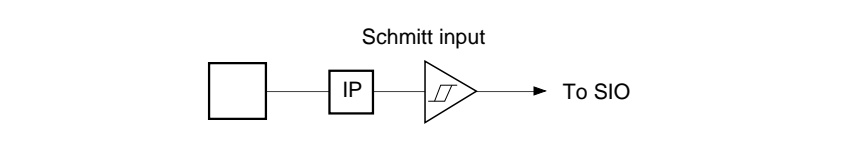
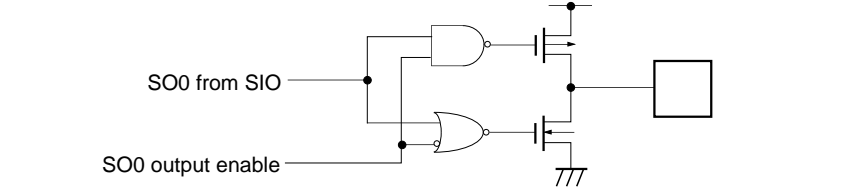
| Symbol | I/O | Description | |
|------------------|-------------------|---|---|
| PG0 to PG5 | Input | (Port G) 8-bit input port. (8 pins) | External input pin to FRC capture unit. |
| PG6/EXI0 | Input/input | | |
| PG7/EXI1 | Input/input | | |
| PH0 to PH7 | Output | (Port H) N-ch open drain output of middle tension proof (12V) and high current (12mA). (8 pins) | |
| PI1/RMC | I/O/input | (Port I) 7-bit I/O port. I/O port can be specified by the bit unit. (7 pins) | Remote control receiving circuit input pin. |
| PI2/PWM | I/O/output | | 14-bit PWM output pin. |
| PI3/TO/ADJ | I/O/output/output | | Timer/counter, 32kHz oscillation adjustment output pin. |
| PI4/INT1/ NMI | I/O/input/input | | Input pin to request external interruption and non maskable interruption. Active when falling edge. |
| PI5/SCK1 | I/O/I/O | | Serial clock (CH1) I/O pin. |
| PI6/SO1 | I/O/output | | Serial data (CH1) output pin. |
| PI7/SI1 | I/O/input | | Serial data (CH1) input pin. |
| PJ0 to PJ7 | I/O | | (Port J) 8-bit I/O port. Function as standby release input can be specified by the bit unit. I/O can be specified by the bit unit. |
| EXTAL | Input | Connecting pin of crystal oscillator for system clock. When supplying the external clock, input the external clock to EXTAL pin and input opposite phase clock to XTAL pin. | |
| XTAL | Output | | |
| TEX | Input | Connecting pin of crystal oscillator for 32kHz timer clock. When used as event counter, input to TEX pin and leave TX pin open. (Feedback resistor is not removed.) | |
| TX | Output | | |
| RST | Input | System reset pin of active "Low" level. | |
| MP | Input | Microprocessor mode input pin. Always connect to GND. | |
| AVDD | | Positive power supply pin of A/D converter. | |
| AVREF | Input | Reference voltage input pin of A/D converter. | |
| AVSS | | GND pin of A/D converter. | |
| VDD | | Positive power supply pin. | |
| VSS | | GND pin. Connect both Vss pins to GND. | |

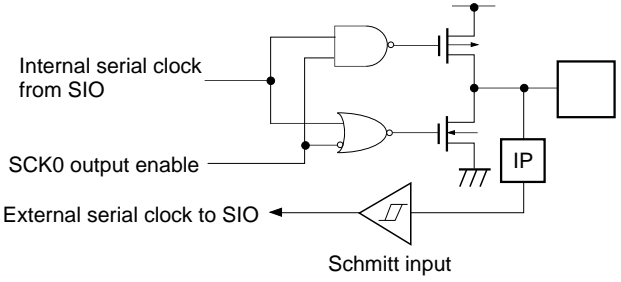
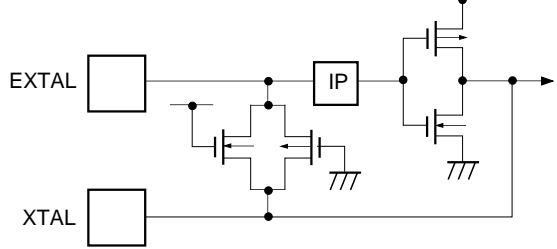
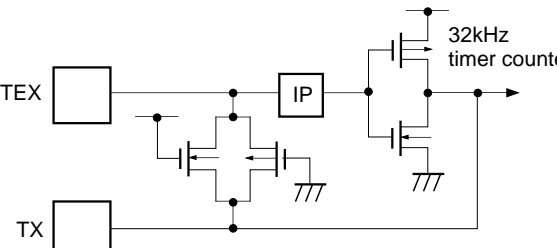
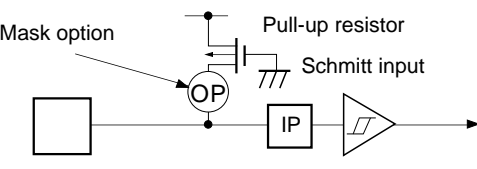
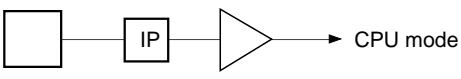
Input/Output Circuit Formats for Pins

| Pin | Circuit format | When reset |
|---|--|-------------|
| <p>Port A Port B</p> <p>PA0/PPO0 to PA7/PPO7 PB0/PPO8 to PB7/PPO15</p> <p>16 pins</p> | <p>PPO data</p> <p>Port A or Port B</p> <p>Data bus</p> <p>RD</p> <p>Output becomes active from high impedance by data writing to port register.</p> | <p>Hi-Z</p> |
| <p>Port C</p> <p>PC0/PPO16 to PC2/PPO18 PC3/RTO3 to PC7/RTO7</p> <p>8 pins</p> | <p>PPO, RTO data</p> <p>Port C data</p> <p>Port C direction</p> <p>Data bus</p> <p>RD (Port C)</p> <p>(Every bit)</p> <p>Input protection circuit</p> <p>IP</p> | <p>Hi-Z</p> |
| <p>Port D</p> <p>PD0 to PD7</p> <p>8 pins</p> | <p>Port D data</p> <p>Port D direction</p> <p>Data bus</p> <p>RD (Port D)</p> <p>(Every 4 bits) (PD0 to 3) (PD4 to 7)</p> <p>High current 12mA</p> <p>IP</p> | <p>Hi-Z</p> |

| Pin | Circuit format | When reset |
|---|---|----------------|
| <p>PE0/$\overline{\text{INT0}}$ PE1/$\overline{\text{EC/INT2}}$</p> <p>2 pins</p> | <p>Port E</p>  <p>Hi-Z</p> | <p>Hi-Z</p> |
| <p>PE2/PWM0 PE3/PWM1 PE4/DAA0 PE5/DAA1</p> <p>4 pins</p> | <p>Port E</p>  <p>Hi-Z</p> | <p>Hi-Z</p> |
| <p>PE6/DAB0 PE7/DAB1</p> <p>2 pins</p> | <p>Port E</p>  <p>H level</p> | <p>H level</p> |
| <p>AN0 to AN3</p> <p>4 pins</p> |  <p>Hi-Z</p> | <p>Hi-Z</p> |
| <p>PF0/AN4 to PF3/AN7</p> <p>4 pins</p> | <p>Port F</p>  <p>Hi-Z</p> | <p>Hi-Z</p> |

| Pin | Circuit format | When reset |
|---|---|-------------|
| <p>PF4/AN8 to PF7/AN11</p> <p>4 pins</p> | <p>Port F</p>  <p>Port F data</p> <p>Data bus</p> <p>RD (Port F)</p> <p>Port F selection</p> <p>Input multiplexer</p> <p>A/D converter</p> <p>IP</p> | <p>Hi-Z</p> |
| <p>PG0 to PG5</p> <p>6 pins</p> | <p>Port G</p>  <p>Schmitt input</p> <p>IP</p> <p>Data bus</p> <p>RD (Port G)</p> <p>Note) For PG4 and PG5, CMOS schmitt input or TTL schmitt input can be selected with the mask option.</p> | <p>Hi-Z</p> |
| <p>PG6/EXI0 PG7/EXI1</p> <p>2 pins</p> | <p>Port G</p>  <p>IP</p> <p>FRC capture unit</p> <p>Data bus</p> <p>RD (Port G)</p> | <p>Hi-Z</p> |
| <p>PH0 to PH7</p> <p>8 pins</p> | <p>Port H</p>  <p>Port H data</p> <p>Data bus</p> <p>RD (Port H)</p> <p>Middle tension proof 12V</p> <p>High current 12mA</p> | <p>Hi-Z</p> |
| <p>PI2/PWM PI3/TO/ADJ</p> <p>2 pins</p> | <p>Port I</p>  <p>Port I selection</p> <p>MPX</p> <p>Port I data</p> <p>Port I I/O direction</p> <p>Data bus</p> <p>RD (Port I)</p> <p>IP</p> <p>PI2: From 14-bit PWM</p> <p>PI3: (From timer/counter, 32kHz timer)</p> | <p>Hi-Z</p> |

| PIn | Circuit format | When reset |
|--|--|------------|
| PI1/RMC PI4/INT1/NMI PI7/SI1 3 pins | <p>Port I</p>  <p>Port I data</p> <p>Port I direction</p> <p>Data bus</p> <p>RD (Port I)</p> <p>Schmitt input</p> <p>IP</p> <p>777</p> <p>(PI1: To remote control circuit PI4: To interruption circuit PI7: To serial CH1</p> | Hi-Z |
| PI5/SCK1 PI6/SO1 2 pins | <p>Port I</p>  <p>Port I function select</p> <p>From serial CH1</p> <p>Port I data</p> <p>Port I direction</p> <p>Data bus</p> <p>RD (Port I)</p> <p>MPX</p> <p>MPX</p> <p>Note) (PI5 is schmitt input PI6 is inverter input)</p> <p>To serial CH1</p> <p>IP</p> <p>777</p> | Hi-Z |
| PJ0 to PJ7 8 pins | <p>Port J</p>  <p>Port J data</p> <p>Port J direction</p> <p>Data bus</p> <p>RD (Port J)</p> <p>Edge detection</p> <p>Standby release</p> <p>IP</p> <p>777</p> | Hi-Z |
| $\overline{\text{CS0}}$ SIO 2 pins | <p>Schmitt input</p>  <p>IP</p> <p>To SIO</p> | Hi-Z |
| SO0 1 pin |  <p>SO0 from SIO</p> <p>SO0 output enable</p> <p>IP</p> <p>777</p> | Hi-Z |

| Pin | Circuit format | When reset |
|---|--|--------------------|
| <p>$\overline{\text{SCK0}}$</p> <p>1 pin</p> |  <p>Internal serial clock from SIO</p> <p>SCK0 output enable</p> <p>External serial clock to SIO</p> <p>Schmitt input</p> | <p>Hi-Z</p> |
| <p>EXTAL XTAL</p> <p>2 pins</p> |  <ul style="list-style-type: none"> • Shows the circuit composition during oscillation. • Feedback resistor is removed during stop. XTAL becomes "H" level. | <p>Oscillation</p> |
| <p>TEX TX</p> <p>2 pins</p> |  <ul style="list-style-type: none"> • Shows the circuit composition during oscillation. • Feedback resistor is removed during 32kHz oscillation circuit stop by software. At this time TEX pin outputs "L" level and TX pin outputs "H" level. | <p>Oscillation</p> |
| <p>$\overline{\text{RST}}$</p> <p>1 pin</p> |  <p>Mask option</p> <p>Pull-up resistor</p> <p>Schmitt input</p> | <p>L level</p> |
| <p>MP</p> <p>1 pin</p> |  <p>CPU mode</p> | <p>Hi-Z</p> |

Absolute Maximum Ratings

(V_{SS} = 0V)

| Item | Symbol | Rating | Unit | Remarks |
|---------------------------------|-------------------|--|------|---|
| Supply voltage | V _{DD} | -0.3 to +7.0 | V | |
| | AV _{DD} | AV _{SS} to +7.0* ¹ | V | |
| | AV _{SS} | -0.3 to +0.3 | V | |
| Input voltage | V _{IN} | -0.3 to +7.0* ² | V | |
| Output voltage | V _{OUT} | -0.3 to +7.0* ² | V | |
| Medium withstand output voltage | V _{OUTP} | -0.3 to +15.0 | V | PH pin |
| High level output current | I _{OH} | -5 | mA | |
| High level total output current | ∑I _{OH} | -50 | mA | Total of output pins |
| Low level output current | I _{OL} | 15 | mA | Other than high current output pins: per pin |
| | I _{OLC} | 20 | mA | High current port pin* ³ : per pin |
| Low level total output current | ∑I _{OL} | 130 | mA | Total of output pins |
| Operating temperature | T _{opr} | -20 to +75 | °C | |
| Storage temperature | T _{stg} | -55 to +150 | °C | |
| Allowable power dissipation | P _D | 600 | mW | QFP package type |
| | | 380 | | LQFP package type |

*¹ AV_{DD} and V_{DD} should be set to a same voltage.

*² V_{IN} and V_{OUT} should not exceed V_{DD} + 0.3V.

*³ The high current operation transistors are the N-CH transistors of the PD and PH ports.

Note) Usage exceeding absolute maximum ratings may permanently impair the LSI. Normal operation should better take place under the recommended operating conditions. Exceeding those conditions may adversely affect the reliability of the LSI.

Recommended Operating Conditions

(V_{SS}=0V)

| Item | Symbol | Min. | Max. | Unit | Remarks |
|--------------------------|-------------------|-----------------------|-----------------------|------|--|
| Supply voltage | V _{DD} | 4.5 | 5.5 | V | Guaranteed range during high speed mode (1/2 dividing clock) operation |
| | | 3.5 | 5.5 | | Guaranteed range during low speed mode (1/16 dividing clock) operation |
| | | 2.7 | 5.5 | | Guaranteed operation range by TEX clock |
| | | 2.5 | 5.5 | | Guaranteed data hold operation range during STOP |
| Analog power supply | AV _{DD} | 3.0 | 5.5 | V | *1 |
| High level input voltage | V _{IH} | 0.7V _{DD} | V _{DD} | V | *2 |
| | V _{IHS} | 0.8V _{DD} | V _{DD} | V | CMOS schmitt input*3 |
| | V _{IHTS} | 2.2 | V _{DD} | V | TTL schmitt input*4 |
| | V _{IHEX} | V _{DD} - 0.4 | V _{DD} + 0.3 | V | EXTAL pin*5 TEX pin*6 |
| Low level input voltage | V _{IL} | 0 | 0.3V _{DD} | V | *2 |
| | V _{ILS} | 0 | 0.2V _{DD} | V | CMOS schmitt input*3 |
| | V _{ILTS} | 0 | 0.8 | V | TTL schmitt input*4 |
| | V _{ILEX} | -0.3 | 0.4 | V | EXTAL pin*5 TEX pin*6 |
| Operating temperature | T _{opr} | -20 | +75 | °C | |

*1 AV_{DD} and V_{DD} should be set to a same voltage.

*2 Normal input port (each pin of PC, PD, PE0, PE1, PF0 to PF3, PG, PI and PJ), MP pin.

*3 Each pin of $\overline{CS0}$, SI0, $\overline{SCK0}$, \overline{RST} , PE0/ $\overline{INT0}$, PE1/ $\overline{EC}/\overline{INT2}$, PG (For PG4 and PG5, when CMOS schmitt input is selected with mask option), PI1/RMC, PI4/ $\overline{INT1}/\overline{NMI}$, PI5/ $\overline{SCK1}$ and PI7/SI1.

*4 Each pin of PG4 and PG5 (When TTL schmitt input is selected with mask option)

*5 It specifies only when the external clock is input.

*6 It specifies only when the event count clock is input.

Electrical Characteristics

DC Characteristics ($V_{DD} = 4.5$ to $5.5V$)

($T_a = -20$ to $+75^\circ C$, $V_{SS} = 0V$)

| Item | Symbol | Pins | Conditions | Min. | Typ. | Max. | Unit |
|--|---|--|--|--------------------------------|---------|----------|---------|
| High level output voltage | V_{OH} | PA to PD, PE2 to PE7, PF4 to PF7, PH (VOL only) | $V_{DD} = 4.5V, I_{OH} = -0.5mA$ | 4.0 | | | V |
| | | | $V_{DD} = 4.5V, I_{OH} = -1.2mA$ | 3.5 | | | V |
| Low level output voltage | V_{OL} | PI1 to PI7 | $V_{DD} = 4.5V, I_{OL} = 1.8mA$ | | | 0.4 | V |
| | | | $V_{DD} = 4.5V, I_{OL} = 3.6mA$ | | | 0.6 | V |
| | | PJ, SO0, SCK0 | $V_{DD} = 4.5V, I_{OL} = 12.0mA$ | | | 1.5 | V |
| Input current | I_{IHE} | EXTAL | $V_{DD} = 5.5V, V_{IH} = 5.5V$ | 0.5 | | 40 | μA |
| | I_{ILE} | | $V_{DD} = 5.5V, V_{IL} = 0.4V$ | -0.5 | | -40 | μA |
| | I_{IHT} | TEX | $V_{DD} = 5.5V, V_{IH} = 5.5V$ | 0.1 | | 10 | μA |
| | I_{ILT} | | $V_{DD} = 5.5V, V_{IL} = 0.4V$ | -0.1 | | -10 | μA |
| | I_{ILR} | | \overline{RST}^{*1} | $V_{DD} = 5.5V, V_{IL} = 0.4V$ | -1.5 | | -400 |
| I/O leakage current | I_{IZ} | PA to PG, PI, PJ, MP, AN0 to AN3, CS0, SI0, SO0, SCK0, \overline{RST}^{*1} | $V_{DD} = 5.5V, V_I = 0, 5.5V$ | | | ± 10 | μA |
| Open drain output leakage current (N-CH Tr OFF in state) | I_{LOH} | PH | $V_{DD} = 5.5V, V_{OH} = 12V$ | | | 50 | μA |
| Supply current*2 | I_{DD1} | V_{DD} | 16MHz crystal oscillation ($C_1 = C_2 = 15pF$) | | 22 | 45 | mA |
| | | | $V_{DD} = 5V \pm 0.5V^{*3}$ | | | | |
| | I_{DDS1} | | SLEEP mode | | 1.1 | 8 | mA |
| | | | $V_{DD} = 5V \pm 0.5V$ | | | | |
| | I_{DD2} | | 32kHz crystal oscillation ($C_1 = C_2 = 47pF$) | | 35 | 100 | μA |
| | | | $V_{DD} = 3V \pm 0.3V$ | | | | |
| I_{DDS2} | SLEEP mode | | 9 | 30 | μA | | |
| | $V_{DD} = 3V \pm 0.3V$ | | | | | | |
| I_{DDS3} | STOP mode (EXTAL and TEX pins oscillation stop) | | | | 10 | μA | |
| | $V_{DD} = 5V \pm 0.5V$ | | | | | | |
| Input capacity | C_{IN} | Other than $V_{DD}, V_{SS}, AV_{DD},$ and AV_{SS} | Clock 1MHz 0V other than the measured pins | | 10 | 20 | pF |

*1 \overline{RST} pin specifies the input current when the pull-up resistor is selected, and specifies leakage current when non-resistor is selected.

*2 When entire output pins are open.

*3 When setting upper 2 bits (CPU clock selection) of clock control register CLC (address: 00FEH) to "00" and operating in high speed mode (1/2 dividing clock).

AC Characteristics

(1) Clock timing

(Ta = -20 to +75°C, VDD = 4.5 to 5.5V, VSS = 0V)

| Item | Symbol | Pins | Conditions | Min. | Max. | Unit |
|---|--------------------------------------|-----------------|---|-----------------------|------|------|
| System clock frequency | fc | XTAL EXTAL | Fig. 1, Fig. 2 | 1 | 16 | MHz |
| System clock input pulse width | t _{XL} , t _{XH} | EXTAL | Fig. 1, Fig. 2 (External clock drive) | 28 | | ns |
| System clock input rise and fall times | t _{CR} , t _{CF} | EXTAL | Fig. 1, Fig. 2 (External clock drive) | | 200 | ns |
| Event count clock input pulse width | t _{EH} , t _{EL} | \overline{EC} | Fig. 3 | t _{sys} × 4* | | ns |
| Event count clock input rise and fall times | t _{ER} , t _{EF} | \overline{EC} | Fig. 3 | | 20 | ns |
| System clock frequency | fc | TEX TX | Fig. 2 VDD = 2.7 to 5.5V (32kHz clock applied condition) | 32.768 | | kHz |
| Event count clock input pulse width | t _{TL} , t _{TH} | TEX | Fig. 3 | 10 | | μs |
| Event count clock input rise and fall times | t _{TR} , t _{TF} | TEX | Fig. 3 | | 20 | ms |

* t_{sys} indicates three values according to the contents of the clock control register (address; 00FEH) upper 2 bits (CPU clock selection).

t_{sys} [ns] = 2000/fc (Upper 2-bit = "00"), 4000/fc (Upper 2-bit = "01"), 16000/fc (Upper 2-bit = "11")

Fig. 1. Clock timing

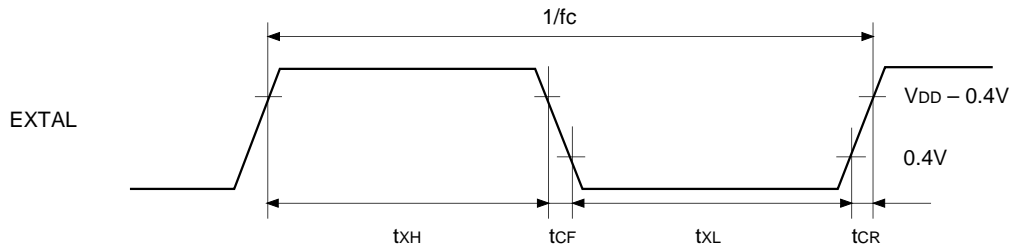


Fig. 2. Clock applied condition

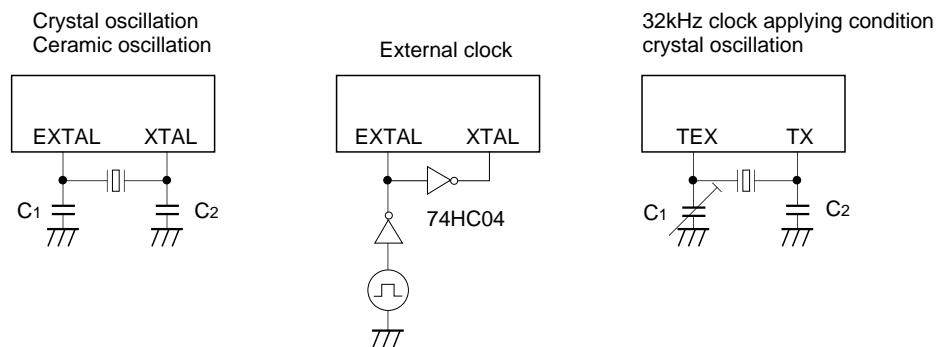
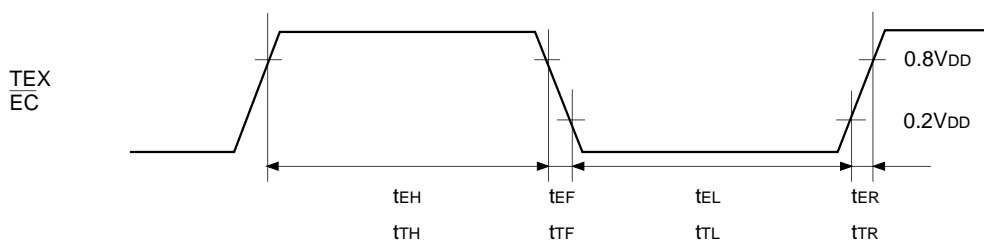


Fig. 3. Event count clock timing



(2) Serial transfer (CH0)

(Ta = -20 to +75°C, VDD = 4.5 to 5.5V, VSS = 0V)

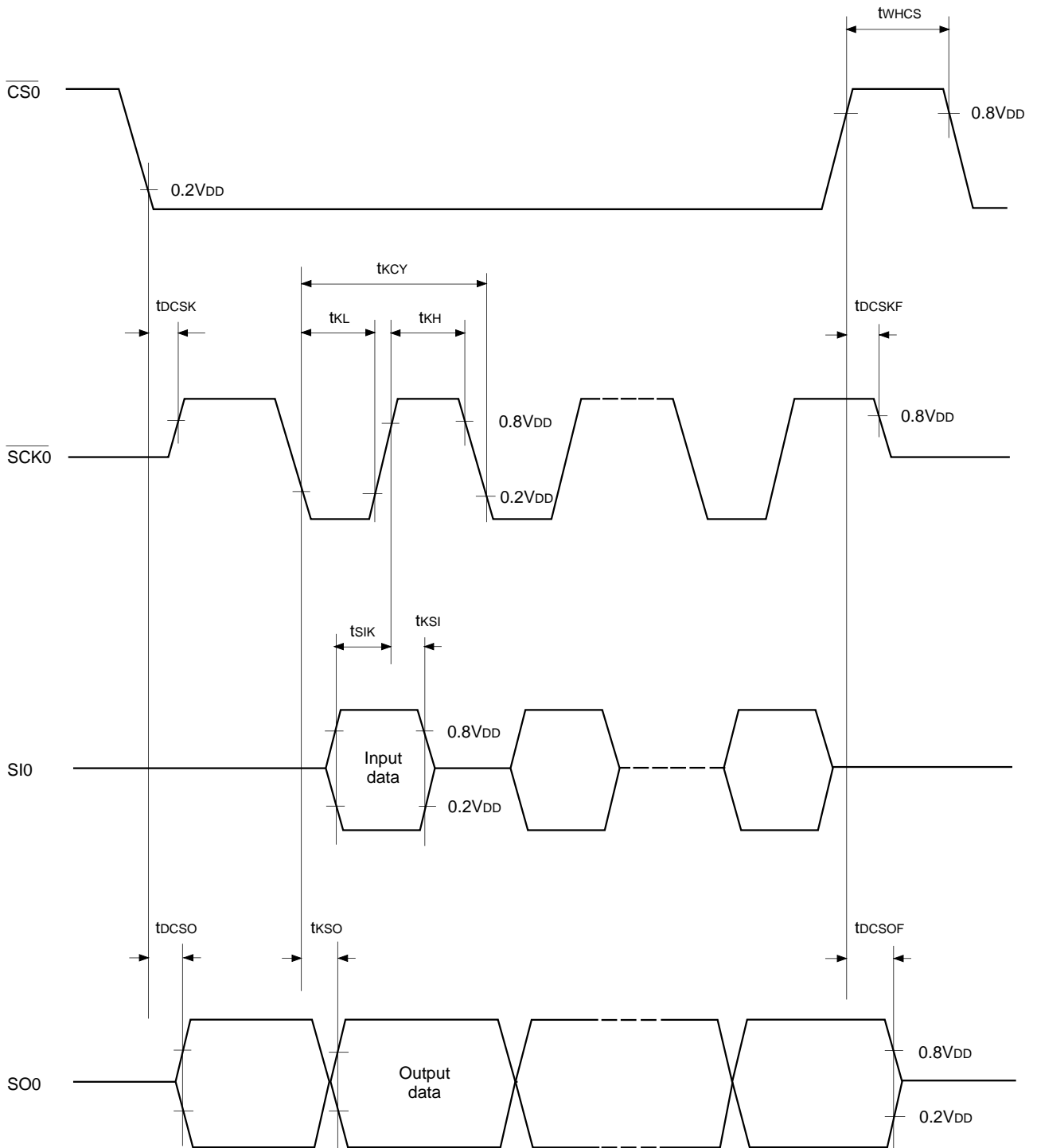
| Item | Symbol | Pin | Condition | Min. | Max. | Unit |
|--|------------------------------------|-------------------|---|-------------------------|------------------------|------|
| $\overline{CS0} \downarrow \rightarrow \overline{SCK0}$ delay time | t _{DCSK} | $\overline{SCK0}$ | Chip select transfer mode ($\overline{SCK0}$ = output mode) | | t _{sys} + 200 | ns |
| $\overline{CS0} \uparrow \rightarrow \overline{SCK0}$ floating delay time | t _{DCSKF} | $\overline{SCK0}$ | Chip select transfer mode ($\overline{SCK0}$ = output mode) | | t _{sys} + 200 | ns |
| $\overline{CS0} \downarrow \rightarrow SO0$ delay time | t _{DCSO} | SO0 | Chip select transfer mode | | t _{sys} + 200 | ns |
| $\overline{CS0} \uparrow \rightarrow SO0$ floating delay time | t _{DCSOF} | SO0 | Chip select transfer mode | | t _{sys} + 200 | ns |
| $\overline{CS0}$ high level width | t _{WHCS} | $\overline{CS0}$ | Chip select transfer mode | t _{sys} + 200 | | ns |
| $\overline{SCK0}$ cycle time | t _{KCY} | $\overline{SCK0}$ | Input mode | 2t _{sys} + 200 | | ns |
| | | | Output mode | 16000/fc | | ns |
| $\overline{SCK0}$ high and low level widths | t _{KH} t _{KL} | $\overline{SCK0}$ | Input mode | t _{sys} + 100 | | ns |
| | | | Output mode | 8000/fc - 50 | | ns |
| SI0 input setup time (against $\overline{SCK0} \uparrow$) | t _{SIK} | SI0 | $\overline{SCK0}$ input mode | 100 | | ns |
| | | | $\overline{SCK0}$ output mode | 200 | | ns |
| SI0 input hold time (against $\overline{SCK0} \uparrow$) | t _{KSI} | SI0 | $\overline{SCK0}$ input mode | t _{sys} + 200 | | ns |
| | | | $\overline{SCK0}$ output mode | 100 | | ns |
| $\overline{SCK0} \downarrow \rightarrow SO0$ delay time | t _{KSO} | SO0 | $\overline{SCK0}$ input mode | | t _{sys} + 200 | ns |
| | | | $\overline{SCK0}$ output mode | | 100 | ns |

Note 1) t_{sys} indicates three values according to the contents of the clock control register (address; 00FEH) upper 2 bits (CPU clock selection).

t_{sys} [ns] = 2000/fc (Upper 2-bit = "00"), 4000/fc (Upper 2-bit = "01"), 16000/fc (Upper 2-bit = "11")

Note 2) The load of $\overline{SCK0}$ output mode and SO0 output delay time is 50pF + 1TTL.

Fig. 4. Serial transfer CH0 timing



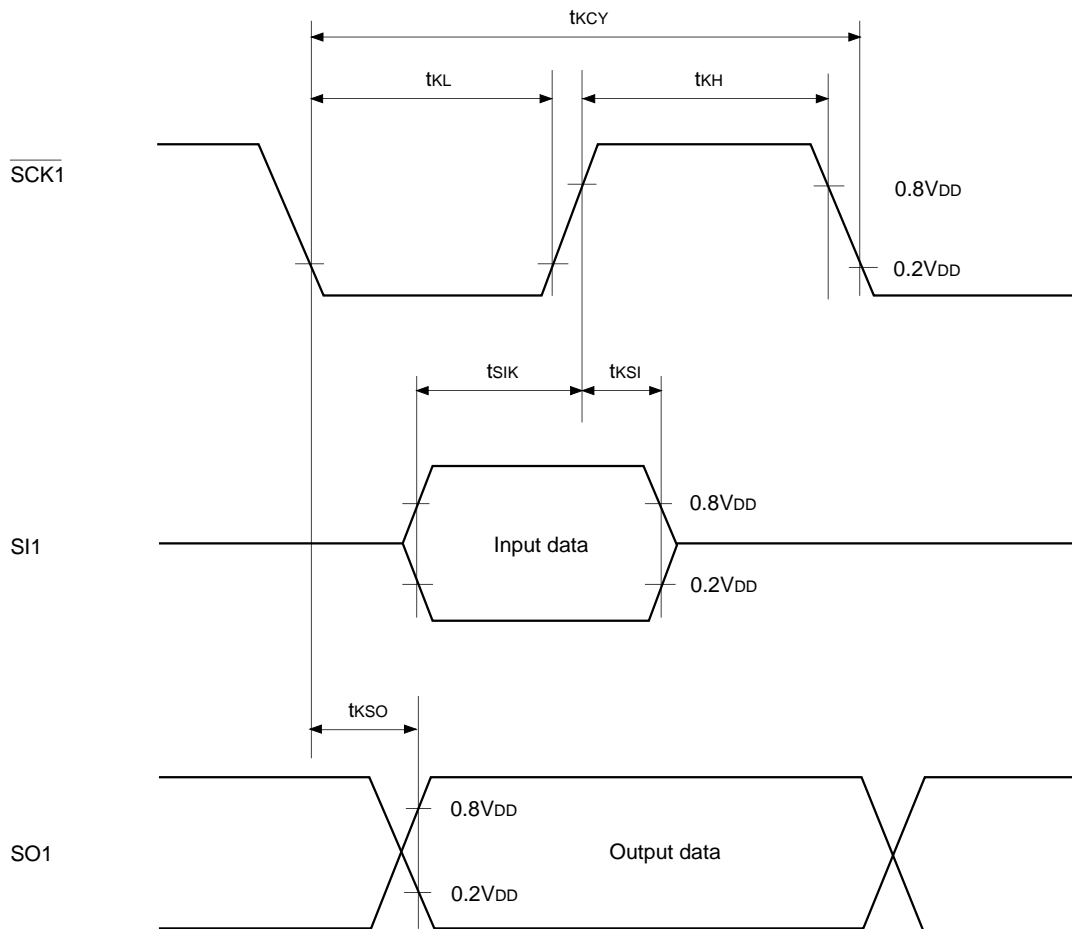
Serial transfer (CH1)

($T_a = -20$ to $+75^\circ\text{C}$, $V_{DD} = 4.5$ to 5.5V , $V_{SS} = 0\text{V}$)

| Item | Symbol | Pins | Conditions | Min. | Max. | Unit |
|---|------------------------------------|--------------------------|--------------------------------------|-----------------|------|------|
| $\overline{\text{SCK1}}$ cycle time | t_{KCY} | $\overline{\text{SCK1}}$ | Input mode | 1000 | | ns |
| | | | Output mode | $16000/f_c$ | | ns |
| $\overline{\text{SCK1}}$ high and low level widths | t_{KH} t_{KL} | $\overline{\text{SCK1}}$ | Input mode | 400 | | ns |
| | | | Output mode | $8000/f_c - 50$ | | ns |
| SI1 input setup time (against $\overline{\text{SCK1}} \uparrow$) | t_{SIK} | SI1 | $\overline{\text{SCK1}}$ input mode | 100 | | ns |
| | | | $\overline{\text{SCK1}}$ output mode | 200 | | ns |
| SI1 input hold time (against $\overline{\text{SCK1}} \uparrow$) | t_{KSI} | SI1 | $\overline{\text{SCK1}}$ input mode | 200 | | ns |
| | | | $\overline{\text{SCK1}}$ output mode | 100 | | ns |
| $\overline{\text{SCK1}} \downarrow \rightarrow \text{SO1}$ delay time | t_{KSO} | SO1 | $\overline{\text{SCK1}}$ input mode | | 200 | ns |
| | | | $\overline{\text{SCK1}}$ output mode | | 100 | ns |

Note) The load of $\overline{\text{SCK1}}$ output mode and SO1 output delay time is $50\text{pF} + 1\text{TTL}$.

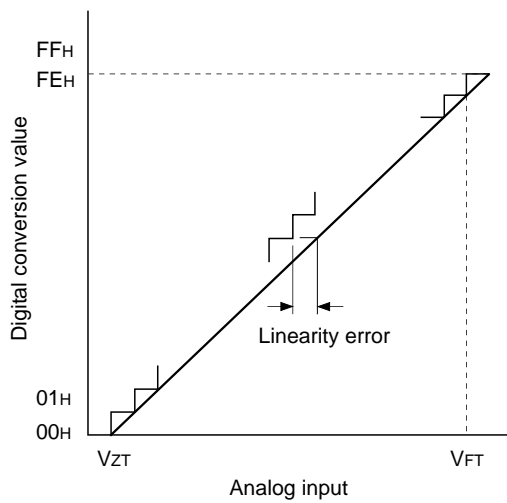
Fig. 5. Serial transfer CH1 timing



(3) A/D converter characteristics ($T_a = -20$ to $+75^\circ\text{C}$, $V_{DD} = AV_{DD} = 4.5$ to 5.5V , $AV_{REF} = 4.0$ to AV_{DD} , $V_{SS} = AV_{SS} = 0\text{V}$)

| Item | Symbol | Pins | Conditions | Min. | Typ. | Max. | Unit |
|-------------------------|------------|-------------|---|-----------------|------|-----------|---------------|
| Resolution | | | | | | 8 | Bits |
| Linearity error | | | $T_a = 25^\circ\text{C}$ $V_{DD} = AV_{DD} = AV_{REF} = 5.0\text{V}$ $V_{SS} = AV_{SS} = 0\text{V}$ | | | ± 1 | LSB |
| Absolute error | | | | | | ± 2 | LSB |
| Conversion time | t_{CONV} | | | $160/f_{ADC}^*$ | | | μs |
| Sampling time | t_{SAMP} | | | $12/f_{ADC}^*$ | | | μs |
| Reference input voltage | V_{REF} | AV_{REF} | $V_{DD} = AV_{DD} = 4.5$ to 5.5V | $AV_{DD} - 0.5$ | | AV_{DD} | V |
| Analog input voltage | V_{IAN} | AN0 to AN11 | | 0 | | | V |
| AV_{REF} current | I_{REF} | AV_{REF} | Operating mode | | 0.6 | 1.0 | mA |
| | I_{REFS} | | SLEEP mode STOP mode 32kHz operating mode | | | 10 | μA |

Fig. 6. Definitions of A/D converter terms



* The value of f_{ADC} is as follows by selecting ADC operation clock (MSC: Address 01FFH bit 0).
 When PS2 is selected, $f_{ADC} = f_c/2$
 When PS1 is selected, $f_{ADC} = f_c$

(4) Interruption, reset input

($T_a = -20$ to $+75^\circ\text{C}$, $V_{DD} = 4.5$ to 5.5V , $V_{SS} = 0\text{V}$)

| Item | Symbol | Pin | Condition | Min. | Max. | Unit |
|---|-----------|---|-----------|----------|------|---------------|
| External interruption high and low level widths | t_{IH} | $\overline{\text{INT0}}$ $\overline{\text{INT1}}$ $\overline{\text{INT2}}$ NMI PJ0 to PJ7 | | 1 | | μs |
| | t_{IL} | | | | | |
| Reset input low level width | t_{RSL} | $\overline{\text{RST}}$ | | $32/f_c$ | | μs |

Fig. 7. Interruption input timing

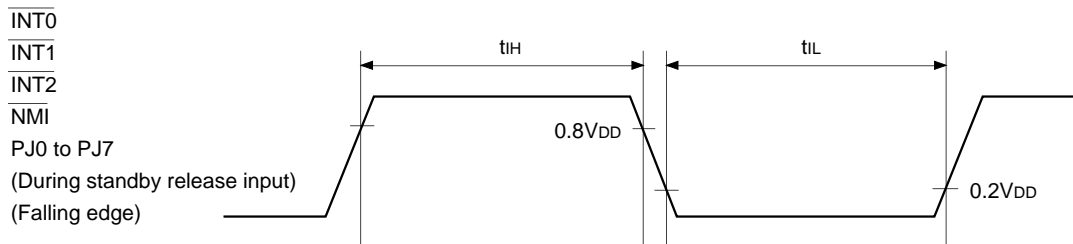
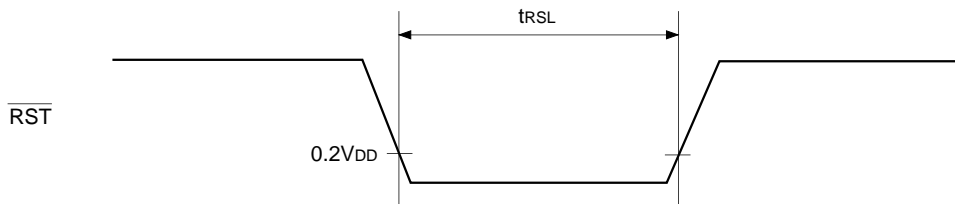


Fig. 8. Reset input timing



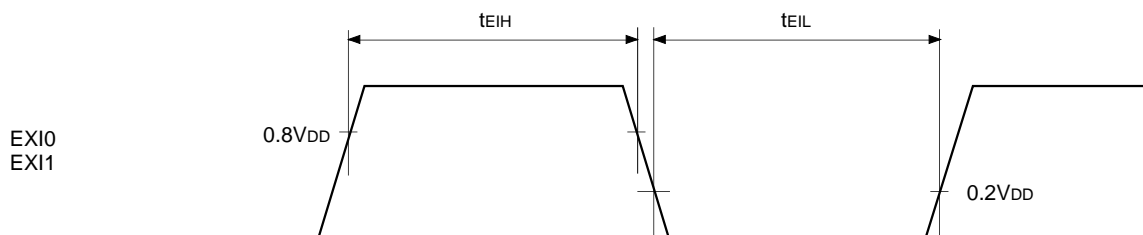
(5) Others

($T_a = -20$ to $+75^\circ\text{C}$, $V_{DD} = 4.5$ to 5.5V , $V_{SS} = 0\text{V}$)

| Item | Symbol | Pin | Condition | Min. | Max. | Unit |
|------------------------------------|-----------|--------------|-----------------------------|------------------------|------|------|
| EXI input high and low level width | t_{EIH} | EXI0 EXI1 | $t_{\text{sys}} = 2000/f_c$ | $t_{\text{sys}} + 200$ | | ns |
| | t_{EIL} | | | | | |

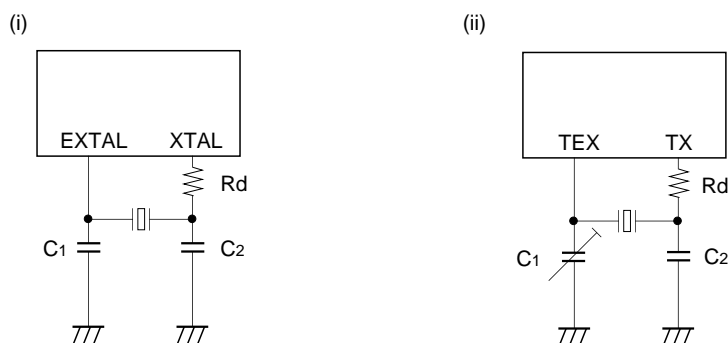
Note) t_{sys} indicates three values according to the contents of the clock control register (address; 00FEH) upper 2 bits (CPU clock selection).
 $t_{\text{sys}} [\text{ns}] = 2000/f_c$ (Upper 2-bit = "00"), $4000/f_c$ (Upper 2-bit = "01"), $16000/f_c$ (Upper 2-bit = "11")
 $t_{\text{FRC}} [\text{ns}] = 1000/f_c$

Fig. 9. Other timings



Supplement

Fig. 10. Recommended oscillation circuit



| Manufacturer | Model | fc (MHz) | C1 (pF) | C2 (pF) | Rd (Ω) | Circuit example |
|------------------------|--------------|-----------|---------|---------|--------|-----------------|
| RIVER ELETEC CO., LTD. | HC-49/U03 | 8.00 | 10 | 10 | 0 | (i) |
| | | 10.00 | | | | |
| | | 12.00 | 5 | 5 | | |
| | | 16.00 | | | | |
| KINSEKI LTD. | HC-49/U (-S) | 8.00 | 16 | 12 | 0 | (i) |
| | | 10.00 | 16 | 12 | | |
| | | 12.00 | 12 | 12 | | |
| | | 16.00 | 12 | 12 | | |
| | P3 | 32.768kHz | 30 | 18 | 470k | (ii) |

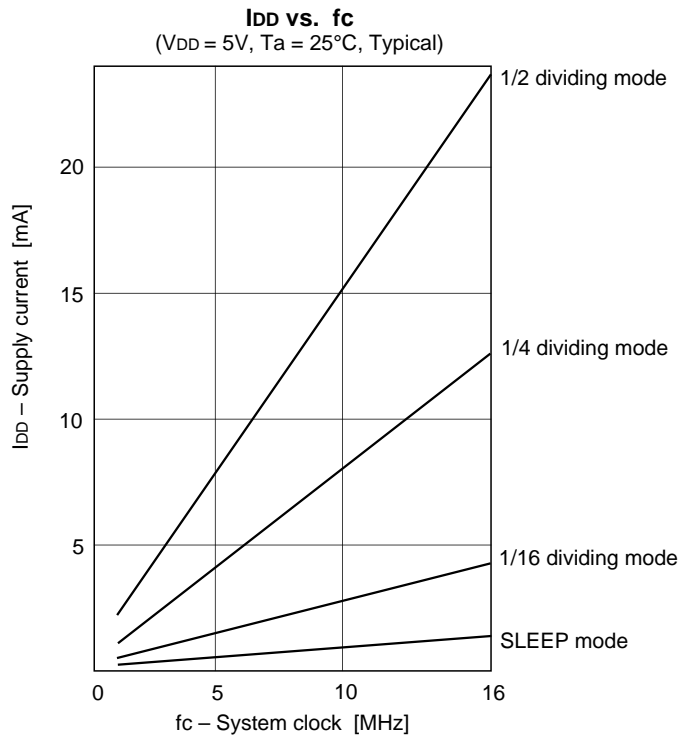
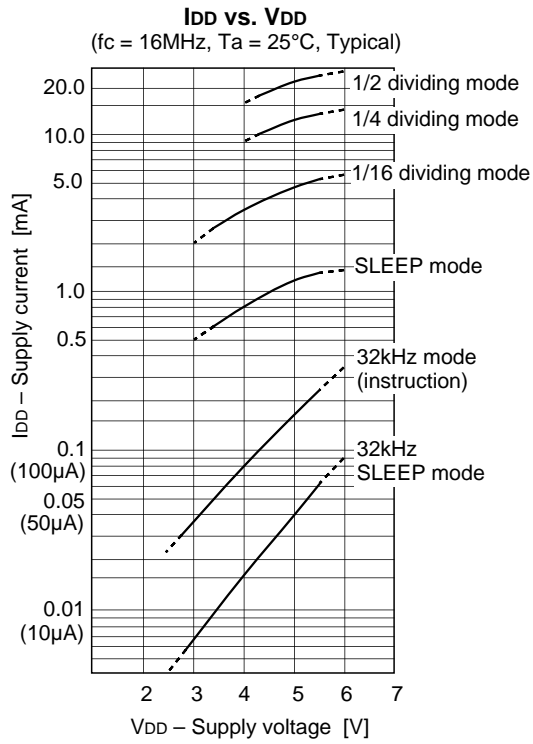
Those marked with an asterisk (*) signify types with built-in ground capacitance (C1, C2).

Mask option table

| Item | Content | |
|-----------------------|----------------------------|--------------|
| | Reset pin pull-up resistor | Non-existent |
| Input circuit format* | CMOS schmitt | TTL schmitt |

* The input circuit format can be selected each for PG4 pin and PG5 pin.

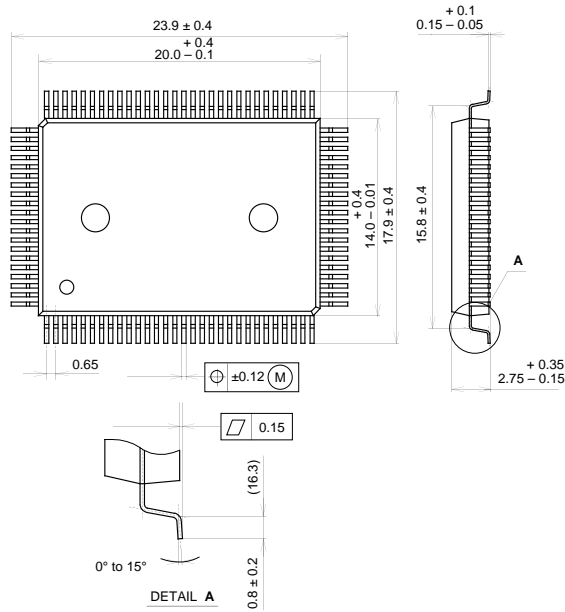
Characteristics Curve



Package Outline

Unit: mm

100PIN QFP (PLASTIC)

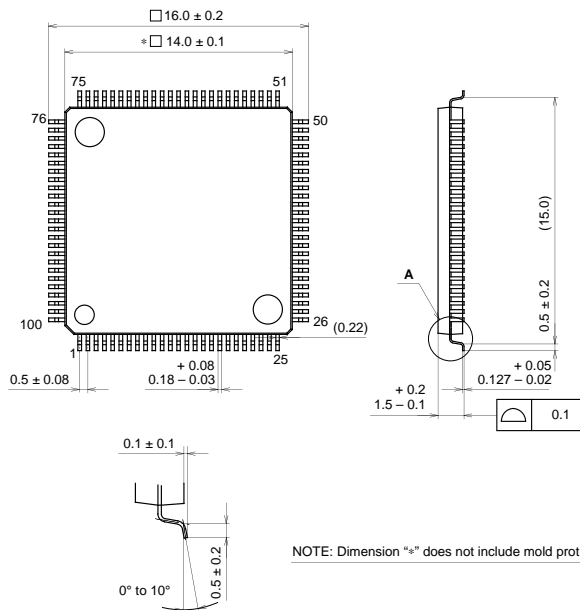


PACKAGE STRUCTURE

| | |
|------------|------------------|
| SONY CODE | QFP-100P-L01 |
| EIAJ CODE | *QFP100-P-1420-A |
| JEDEC CODE | — |

| | |
|------------------|-------------------|
| PACKAGE MATERIAL | EPOXY RESIN |
| LEAD TREATMENT | SOLDER PLATING |
| LEAD MATERIAL | COPPER / 42 ALLOY |
| PACKAGE WEIGHT | 1.4g |

100PIN LQFP (PLASTIC)



NOTE: Dimension "*" does not include mold protrusion.

PACKAGE STRUCTURE

| | |
|------------|------------------|
| SONY CODE | LQFP-100P-L01 |
| EIAJ CODE | *QFP100-P-1414-A |
| JEDEC CODE | — |

| | |
|------------------|--------------------|
| PACKAGE MATERIAL | EPOXY/PHENOL RESIN |
| LEAD TREATMENT | SOLDER PLATING |
| LEAD MATERIAL | 42 ALLOY |
| PACKAGE WEIGHT | — |