

Block Diagram



Pin Functions

Symbol	I/O	Functions	
PA0 to PA7	I/O	(Port A) 8-bit I/O port. I/O can be specified in 1-bit units. Pull-up resistor is present or not through program in 4-bit units. (8 pins)	
PB0 to PB7	I/O	(Port B) 8-bit I/O port. I/O can be specified in 1-bit units. Pull-up resistor is present or not through program in 4-bit units. (8 pins)	
PC0 to PC7	I/O	(Port C) 8-bit I/O port. I/O can be specified in 1-bit units. Pull-up resistor is present or not through program in 4-bit units. (8 pins)	
PD0 to PD7	I/O	(Port D) 8-bit I/O port. I/O can be specified in 1-bit units. Pull-up resistor is present or not through program in 4-bit units. Can drive 12mA sink current ( $V_{DD} = 4.5$ to $5.5V$ ). (8 pins)	
PE0 to PE7	I/O	(Port E) 8-bit I/O port. I/O can be specified in 1-bit units. Pull-up resistor is present or not through program in 4-bit units. Can drive 12mA sink current ( $V_{DD} = 4.5$ to $5.5V$ ). (8 pins)	
PF0/INT0 to PF4/INT4	Input / Input	(Port F) 8-bit port. Lower 6 bits are for input; upper 2 bits are for output. (6 pins)	External interrupt inputs. (4 pins)
PF5/ $\overline{NMI}$	Input / Input		Non-maskable interrupt input.
PF6/TO0	Output / Output		8-bit timer/counter output.
PF7/TO1/ PWM	Output / Output / Output		16-bit capture timer/ counter output.
AN0 to AN3	Input	Analog input for A/D converter. (4 pins)	
PG0/AN4 to PG3/AN7	I/O / Input	(Port G) 8-bit I/O port. I/O can be specified in 1-bit units. Pull-up resistor is present or not through program in 4-bit units. (8 pins)	Analog input for A/D converter. (4 pins)
PG4 to PG7	I/O		
$\overline{CS0}$	Input	Serial chip select (CH0) input.	
SI0	Input	Serial data (CH0) input.	
SO0	Output	Serial data (CH0) output.	
$\overline{SCK0}$	I/O	Serial clock (CH0) I/O.	

Symbol	I/O	Functions	
PH0/ $\overline{\text{CS1}}$	I/O / Input	(Port H) 8-bit I/O port. I/O can be specified in 1-bit units. Pull-up resistor is present or not through program in 4-bit units. (8 pins)	Serial chip select (CH1) input.
PH1/SI1	I/O / Input		Serial data (CH1) input.
PH2/SO1	I/O / Output		Serial data (CH1) output.
PH3/ $\overline{\text{SCK1}}$	I/O / I/O		Serial clock (CH1) I/O.
PH4/ $\overline{\text{CS2}}$	I/O / Input		Serial chip select (CH2) input.
PH5/SI2	I/O / Input		Serial data (CH2) input.
PH6/SO2	I/O / Output		Serial data (CH2) output.
PH7/ $\overline{\text{SCK2}}$	I/O / I/O		Serial clock (CH2) I/O.
PI0/TxD	I/O / Output	(Port I) 8-bit I/O port. I/O can be specified in 1-bit units. Pull-up resistor is present or not through program in 4-bit units. (8 pins)	UART transmission data output.
PI1/RxD	I/O / Input		UART reception data input.
PI2 to PI3	I/O		
PI4/ $\overline{\text{EC0}}$	I/O / Input		External event input for 8-bit timer/counter.
PI5/ $\overline{\text{EC1}}$	I/O / Input		External event input for 16-bit capture timer/counter.
PI6/CINT	I/O / Input		External capture input for 16-bit capture timer/counter.
PI7/RMC	I/O / Input		Remote control receive circuit input.
PJ0/ $\overline{\text{KS0}}$ to PJ6/ $\overline{\text{KS6}}$	I/O / Input		(Port J) 7-bit I/O port. I/O can be specified in 1-bit units. Pull-up resistor is present or not through program in lower 4-bit units and upper 3-bit units. (7 pins)
EXTAL	Input	Connects a crystal for system clock oscillation. (When the clock is supplied externally, input it to EXTAL and input an opposite phase clock to XTAL.)	
XTAL			
$\overline{\text{RST}}$	Input	System reset. Active at "L" level.	
AVDD		Positive power supply for A/D converter.	
AVREF	Input	Reference voltage input for A/D converter.	
AVSS		GND for A/D converter.	
VDD		Positive power supply. (Connect both VDD pins to positive power supply.)	
VSS		GND (Connect all four VSS pins to GND.)	
VPP		Positive power supply pin used for writing incorporated PROM. (Do not make any connection to NC.)	

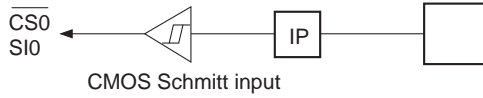
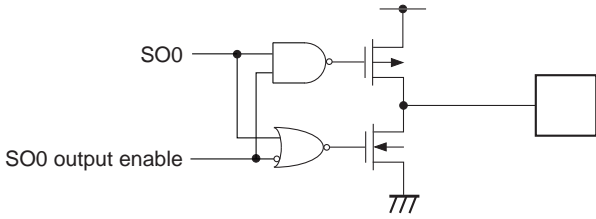
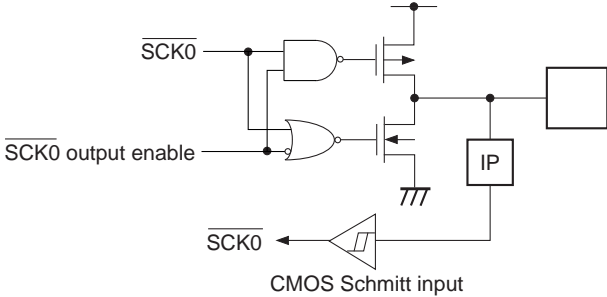
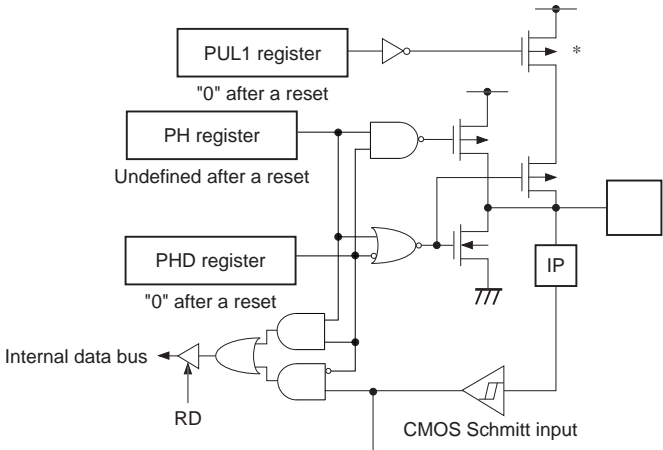
I/O Circuit Format for Pins

Pin	Circuit format	After a reset
PA0 to PA7	<p>* Pull-up transistor approximately 100kΩ (V<sub>DD</sub> = 4.5 to 5.5V) approximately 150kΩ (V<sub>DD</sub> = 3.0 to 3.6V)</p>	Hi-Z
PB0 to PB7	<p>* Pull-up transistor approximately 100kΩ (V<sub>DD</sub> = 4.5 to 5.5V) approximately 150kΩ (V<sub>DD</sub> = 3.0 to 3.6V)</p>	Hi-Z
PC0 to PC7	<p>* Pull-up transistor approximately 100kΩ (V<sub>DD</sub> = 4.5 to 5.5V) approximately 150kΩ (V<sub>DD</sub> = 3.0 to 3.6V)</p>	Hi-Z

Pin	Circuit format	After a reset
<p>PD0 to PD7</p>	<p>PUL0 register "0" after a reset</p> <p>PD register Undefined after a reset</p> <p>PDD register "0" after a reset</p> <p>Internal data bus</p> <p>RD</p> <p>*1 Pull-up transistor approximately 100kΩ (V<sub>DD</sub> = 4.5 to 5.5V) approximately 150kΩ (V<sub>DD</sub> = 3.0 to 3.6V)</p> <p>*2 Large current drive 12mA (V<sub>DD</sub> = 4.5 to 5.5V) 4.5mA (V<sub>DD</sub> = 3.0 to 3.6V)</p>	<p>Hi-Z</p>
<p>PE0 to PE7</p>	<p>PUL1 register "0" after a reset</p> <p>PE register Undefined after a reset</p> <p>PED register "0" after a reset</p> <p>Internal data bus</p> <p>RD</p> <p>*1 Pull-up transistor approximately 100kΩ (V<sub>DD</sub> = 4.5 to 5.5V) approximately 150kΩ (V<sub>DD</sub> = 3.0 to 3.6V)</p> <p>*2 Large current drive 12mA (V<sub>DD</sub> = 4.5 to 5.5V) 4.5mA (V<sub>DD</sub> = 3.0 to 3.6V)</p>	<p>Hi-Z</p>
<p>PF0/INT0 to PF4/INT4 PF5/NMI</p>	<p>INT0, INT1, INT2, INT3, INT4, NMI</p> <p>Internal data bus</p> <p>RD</p> <p>CMOS Schmitt input</p>	<p>Hi-Z</p>

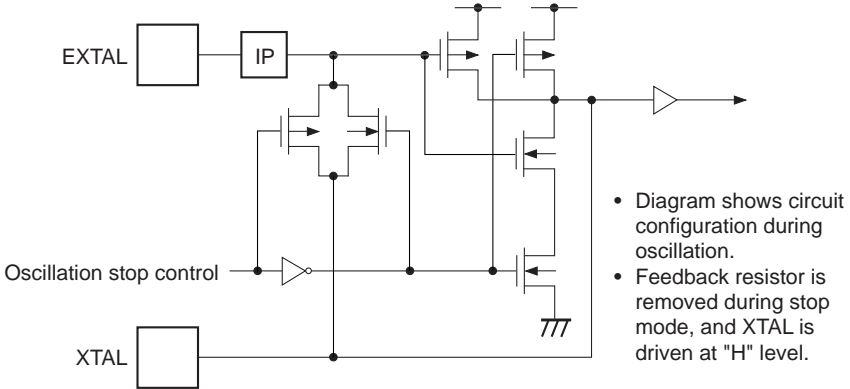
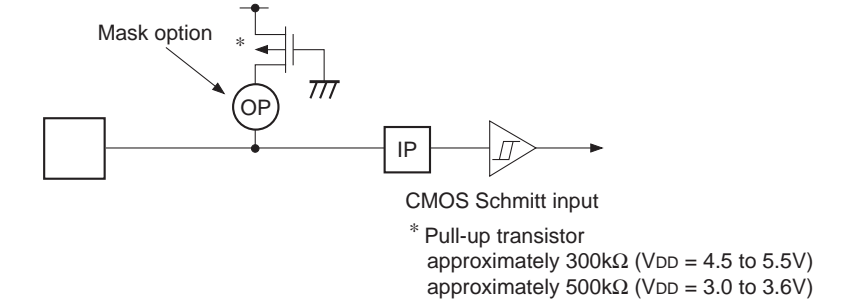
Pin	Circuit format	After a reset
PF6/TO0	<p>TO0</p> <p>PFSL register "0" after a reset</p> <p>PF register "1" after a reset</p> <p>Internal data bus ← RD</p> <p>GND</p>	"H" level
PF7/TO1/ PWM	<p>RD</p> <p>Internal data bus ←</p> <p>Internal reset signal</p> <p>PF register "1" after a reset</p> <p>00 MPX</p> <p>TO1 → 01</p> <p>PWM → 1x</p> <p>PFSL register (Bit 7)</p> <p>PFSL register (Bit 6)</p> <p>"00" after a reset</p> <p>TO1 output enable</p> <p>GND</p> <p>* Pull-up transistor approximately 150kΩ (V<sub>DD</sub> = 4.5 to 5.5V) approximately 200kΩ (V<sub>DD</sub> = 3.0 to 3.6V)</p>	"H" level ("H" level at ON resistance of pull-up transistor during a reset.)
AN0 to AN3	<p>A/D converter ←</p> <p>Input multiplexer</p> <p>IP</p>	Hi-Z

Pin	Circuit format	After a reset
<p>PG0/AN4 to PG3/AN7</p>	<p>PUL1 register "0" after a reset</p> <p>PG register Undefined after a reset</p> <p>PGD register "0" after a reset</p> <p>PGSL register "0" after a reset</p> <p>Internal data bus</p> <p>RD</p> <p>A/D converter</p> <p>Input multiplexer</p> <p>* Pull-up transistor approximately 100kΩ (V<sub>DD</sub> = 4.5 to 5.5V) approximately 150kΩ (V<sub>DD</sub> = 3.0 to 3.6V)</p>	<p>Hi-Z</p>
<p>PG4 to PG7</p>	<p>PUL1 register "0" after a reset</p> <p>PG register Undefined after a reset</p> <p>PGD register "0" after a reset</p> <p>Internal data bus</p> <p>RD</p> <p>* Pull-up transistor approximately 100kΩ (V<sub>DD</sub> = 4.5 to 5.5V) approximately 150kΩ (V<sub>DD</sub> = 3.0 to 3.6V)</p>	<p>Hi-Z</p>

Pin	Circuit format	After a reset
$\overline{\text{CS0}}$ $\text{SI0}$	 <p style="text-align: center;">CMOS Schmitt input</p>	<p style="text-align: center;">Hi-Z</p>
$\text{SO0}$		<p style="text-align: center;">Hi-Z</p>
$\overline{\text{SCK0}}$	 <p style="text-align: center;">CMOS Schmitt input</p>	<p style="text-align: center;">"H" level (Hi-Z during a reset)</p>
$\text{PH0}/\overline{\text{CS1}}$ $\text{PH1}/\overline{\text{S11}}$ $\text{PH4}/\overline{\text{CS2}}$ $\text{PH5}/\overline{\text{S12}}$	 <p style="text-align: center;">CMOS Schmitt input</p> <p style="text-align: center;">* Pull-up transistor approximately 100kΩ (<math>V_{DD} = 4.5</math> to <math>5.5V</math>) approximately 150kΩ (<math>V_{DD} = 3.0</math> to <math>3.6V</math>)</p>	<p style="text-align: center;">Hi-Z</p>

Pin	Circuit format	After a reset
<p>PH2/SO1 PH6/SO2</p>	<p>PUL1 register "0" after a reset</p> <p>SO1, SO2 SO1, SO2 output enable</p> <p>PHSL register "0" after a reset</p> <p>PH register Undefined after a reset</p> <p>PHD register "0" after a reset</p> <p>Internal data bus</p> <p>RD</p> <p>* Pull-up transistor approximately 100kΩ (V<sub>DD</sub> = 4.5 to 5.5V) approximately 150kΩ (V<sub>DD</sub> = 3.0 to 3.6V)</p>	<p>Hi-Z</p>
<p>PH3/SCK1 PH7/SCK2</p>	<p>PUL1 register "0" after a reset</p> <p>SCK1, SCK2 SCK1, SCK2 output enable</p> <p>PHSL register "0" after a reset</p> <p>PH register Undefined after a reset</p> <p>PHD register "0" after a reset</p> <p>Internal data bus</p> <p>RD</p> <p>CMOS Schmitt input</p> <p>SCK1, SCK2</p> <p>* Pull-up transistor approximately 100kΩ (V<sub>DD</sub> = 4.5 to 5.5V) approximately 150kΩ (V<sub>DD</sub> = 3.0 to 3.6V)</p>	<p>Hi-Z</p>
<p>PI0/TxD</p>	<p>PUL2 register "0" after a reset</p> <p>TxD TxD output enable</p> <p>PI register Undefined after a reset</p> <p>PID register "0" after a reset</p> <p>Internal data bus</p> <p>RD</p> <p>* Pull-up transistor approximately 100kΩ (V<sub>DD</sub> = 4.5 to 5.5V) approximately 150kΩ (V<sub>DD</sub> = 3.0 to 3.6V)</p>	<p>Hi-Z</p>

Pin	Circuit format	After a reset
<p>PI1/RxD PI4/EC0 PI5/EC1 PI6/CINT PI7/RMC</p>	<p>* Pull-up transistor approximately 100kΩ (V<sub>DD</sub> = 4.5 to 5.5V) approximately 150kΩ (V<sub>DD</sub> = 3.0 to 3.6V)</p>	<p>Hi-Z</p>
<p>PI2 to PI3</p>	<p>* Pull-up transistor approximately 100kΩ (V<sub>DD</sub> = 4.5 to 5.5V) approximately 150kΩ (V<sub>DD</sub> = 3.0 to 3.6V)</p>	<p>Hi-Z</p>
<p>PJ0/KS0 to PJ6/KS6</p>	<p>* Pull-up transistor approximately 100kΩ (V<sub>DD</sub> = 4.5 to 5.5V) approximately 150kΩ (V<sub>DD</sub> = 3.0 to 3.6V)</p>	<p>Hi-Z</p>

Pin	Circuit format	After a reset
<p>EXTAL XTAL</p>	 <p>• Diagram shows circuit configuration during oscillation. • Feedback resistor is removed during stop mode, and XTAL is driven at "H" level.</p>	<p>Oscillation</p>
<p><math>\overline{\text{RST}}</math></p>	 <p>CMOS Schmitt input * Pull-up transistor approximately 300kΩ (V<sub>DD</sub> = 4.5 to 5.5V) approximately 500kΩ (V<sub>DD</sub> = 3.0 to 3.6V)</p>	<p>"L" level (during a reset)</p>

## Absolute Maximum Ratings

(V<sub>SS</sub> = 0V reference)

Item	Symbol	Rating	Unit	Remarks
Supply voltage	V <sub>DD</sub>	-0.3 to +7.0	V	
	V <sub>PP</sub>	-0.3 to +13.0	V	Unique to version with incorporated PROM
	AV <sub>DD</sub>	AV <sub>SS</sub> to +7.0* <sup>1</sup>	V	
	AV <sub>REF</sub>	AV <sub>SS</sub> to +7.0	V	
	AV <sub>SS</sub>	-0.3 to +0.3	V	
Input voltage	V <sub>IN</sub>	-0.3 to +7.0* <sup>2</sup>	V	
Output voltage	V <sub>OUT</sub>	-0.3 to +7.0* <sup>2</sup>	V	
High level output current	I <sub>OH</sub>	-5	mA	Output (value per pin)
High level total output current	∑I <sub>OH</sub>	-50	mA	Total for all output pins
Low level output current	I <sub>OL</sub>	15	mA	All pins excluding large current output pins (value per pin)
	I <sub>OLC</sub>	20	mA	Large current output pins* <sup>3</sup> (value per pin)
Low level total output current	∑I <sub>OL</sub>	130	mA	Total for all output pins
Operating temperature	T <sub>opr</sub>	-20 to +75	°C	
Storage temperature	T <sub>stg</sub>	-55 to +150	°C	
Allowable power dissipation	P <sub>D</sub>	600	mW	QFP-100P-L01

\*<sup>1</sup> AV<sub>DD</sub> must be the same voltage.

\*<sup>2</sup> V<sub>IN</sub> and V<sub>OUT</sub> must not exceed V<sub>DD</sub> + 0.3V.

\*<sup>3</sup> The large current drive transistor is N-ch transistor of PD and PE.

**Note)** Usage exceeding absolute maximum ratings may permanently impair the LSI. Normal operation should be conducted under the recommended operating conditions. Exceeding these conditions may adversely affect the reliability of the LSI.

## Recommended Operating Conditions

(V<sub>SS</sub> = 0V reference)

Item	Symbol	Min.	Max.	Unit	Remarks	
Supply voltage	V <sub>DD</sub>	3.0	5.5	V	f <sub>EX</sub> = 20MHz or less	Guaranteed operation range for 2, 4 and 8 frequency dividing clocks
		2.7	5.5	V	f <sub>EX</sub> = 12MHz or less	
		2.7	5.5	V		Guaranteed operation range for 1/16 frequency dividing clock or sleep mode
		2.5	5.5	V		Guaranteed data hold range during stop mode
	AV <sub>DD</sub>	2.7	5.5	V	*1	
	AV <sub>REF</sub>	2.7	5.5	V		
High level input voltage	V <sub>IH</sub>	0.7V <sub>DD</sub>	V <sub>DD</sub>	V	*2, *4	
		0.8V <sub>DD</sub>	V <sub>DD</sub>	V	*2, *5	
	V <sub>IHS</sub>	0.8V <sub>DD</sub>	V <sub>DD</sub>	V	CMOS Schmitt input*3	
	V <sub>IHEX</sub>	0.7V <sub>DD</sub>	V <sub>DD</sub> + 0.3	V	EXTAL	
Low level input voltage	V <sub>IL</sub>	0	0.3V <sub>DD</sub>	V	*2, *4	
		0	0.2V <sub>DD</sub>	V	*2, *5	
	V <sub>ILS</sub>	0	0.2V <sub>DD</sub>	V	CMOS Schmitt input*3	
	V <sub>ILEX</sub>	-0.3	0.3V <sub>DD</sub>	V	EXTAL *4	
		-0.3	0.2V <sub>DD</sub>	V	EXTAL *5	
Operating temperature	Topr	-20	+75	°C		

\*1 AV<sub>DD</sub> and V<sub>DD</sub> must be the same voltage.

\*2 PA, PB, PC, PD, PE, PG, PH2, PH6, PI0, PI2, PI3, PJ for normal input port.

\*3 PF0 to PF5, PH0, PH1, PH3 to PH5, PH7, PI1, PI4 to PI7, CS0, SCK0, RST.

\*4 When the supply voltage (V<sub>DD</sub>) is within the range of 4.5 to 5.5V.

\*5 When the supply voltage (V<sub>DD</sub>) is within the range of 2.7 to 5.5V.

**Electrical Characteristics**

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

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

Item	Symbol	Pins	Conditions	Min.	Typ.	Max.	Unit
High level output voltage	$V_{OH}$	PA to PE, PF6, PF7, PG to PJ, SO0, SCK0	$V_{DD} = 4.5V, I_{OH} = -0.5mA$	4.0			V
			$V_{DD} = 4.5V, I_{OH} = -1.2mA$	3.5			V
Low level output voltage	$V_{OL}$	PA to PE, PF6, PF7, PG to PJ, SO0, SCK0	$V_{DD} = 4.5V, I_{OL} = 1.8mA$			0.4	V
			$V_{DD} = 4.5V, I_{OL} = 3.6mA$			0.6	V
		PD, PE	$V_{DD} = 4.5V, I_{OL} = 12.0mA$			1.5	V
Input current	$I_{IHE}$	EXTAL	$V_{DD} = 5.5V, V_{IH} = 5.5V$	0.5		40	$\mu A$
	$I_{ILE}$		$V_{DD} = 5.5V, V_{IL} = 0.4V$	-0.5		-40	$\mu A$
	$I_{ILR}$	$\overline{RST}^{*1}$	$V_{DD} = 5.5V, V_{IL} = 0.4V$	-1.5		-400	$\mu A$
	$I_{IL}$	PA to PE <sup>*2</sup> , PG to PJ <sup>*2</sup>	$V_{DD} = 5.5V, V_{IL} = 0.4V$			-45	$\mu A$
$V_{DD} = 4.5V, V_{IH} = 4.0V$			-2.78			$\mu A$	
I/O leakage current	$I_{IZ}$	PA to PE <sup>*2</sup> , PF0 to PF5, PF7, PG to PJ <sup>*2</sup> , AN0 to AN3, CS0, SI0, SO0, SCK0, $\overline{RST}^{*1}$	$V_{DD} = 5.5V, V_I = 0, 5.5V$			$\pm 10$	$\mu A$
Supply current <sup>*3</sup>	$I_{DD}^{*4}$	$V_{DD}, V_{SS}$	$V_{DD} = 5 \pm 0.5V$ , 20MHz crystal oscillation ( $C_1 = C_2 = 10pF$ )		45	75	mA
	$I_{DDS1}$		$V_{DD} = 5 \pm 0.5V$ , 20MHz crystal oscillation ( $C_1 = C_2 = 10pF$ ), sleep mode		8	14	mA
	$I_{DDS2}$		$V_{DD} = 5.5V$ , stop mode			10	$\mu A$
Input capacitance	$C_{IN}$	PA to PE, PF0 to PF5, PG to PJ, AN0 to AN3, CS0, SI0, SCK0, EXTAL, $\overline{RST}$	Clock 1MHz 0V for all pins excluding measured pins		10	20	pF

\*1  $\overline{RST}$  specifies the input current when pull-up resistor has been selected; the leakage current when no resistor has been selected.

\*2 PA to PE and PG to PJ specify the input current when pull-up resistor has been selected; the leakage current when no resistor has been selected.

\*3 When all output pins are open.

\*4 When the upper two bits (PCK1, PCK0) of the clock control register (CLC: 0002FEh) are set to "00" and the LSI is operated in high-speed mode (2 frequency dividing clock).

DC Characteristics ( $V_{DD} = 3.0$  to  $3.6V$ )(Topr =  $-20$  to  $+75^{\circ}C$ ,  $V_{SS} = 0V$  reference)

Item	Symbol	Pins	Conditions	Min.	Typ.	Max.	Unit
High level output voltage	$V_{OH}$	PA to PE, PF6, PF7, $\overline{PG}$ to $\overline{PJ}$ , $\overline{SO0}$ , $\overline{SCK0}$	$V_{DD} = 3.0V$ , $I_{OH} = -0.15mA$	2.7			V
			$V_{DD} = 3.0V$ , $I_{OH} = -0.5mA$	2.3			V
Low level output voltage	$V_{OL}$	PA to PE, PF6, PF7, $\overline{PG}$ to $\overline{PJ}$ , $\overline{SO0}$ , $\overline{SCK0}$	$V_{DD} = 3.0V$ , $I_{OL} = 1.2mA$			0.3	V
			$V_{DD} = 3.0V$ , $I_{OL} = 1.6mA$			0.5	V
		PD, PE	$V_{DD} = 3.0V$ , $I_{OL} = 5.0mA$			1.0	V
Input current	$I_{IHE}$	EXTAL	$V_{DD} = 3.6V$ , $V_{IH} = 3.6V$	0.3		20	$\mu A$
	$I_{ILE}$		$V_{DD} = 3.6V$ , $V_{IL} = 0.3V$	-0.3		-20	$\mu A$
	$I_{ILR}$	$\overline{RST}^{*1}$	$V_{DD} = 3.6V$ , $V_{IL} = 0.3V$	-0.7		-200	$\mu A$
	$I_{IL}$	PA to PE <sup>*2</sup> , $\overline{PG}$ to $\overline{PJ}^{*2}$	$V_{DD} = 3.6V$ , $V_{IL} = 0.3V$			-30	$\mu A$
			$V_{DD} = 3.0V$ , $V_{IH} = 2.7V$	-1.0			$\mu A$
I/O leakage current	$I_{IZ}$	PA to PE <sup>*2</sup> , PF0 to PF5, PF7, $\overline{PG}$ to $\overline{PJ}^{*2}$ , $\overline{AN0}$ to $\overline{AN3}$ , $\overline{CS0}$ , $\overline{SI0}$ , $\overline{SO0}$ , $\overline{SCK0}$ , $\overline{RST}^{*1}$	$V_{DD} = 3.6V$ , $V_I = 0, 3.6V$			$\pm 10$	$\mu A$
Supply current <sup>*3</sup>	$I_{DD}^{*4}$	$V_{DD}$ , $V_{SS}$	$V_{DD} = 3.3 \pm 0.3V$ , 20MHz crystal oscillation ( $C_1 = C_2 = 10pF$ )		25	45	mA
	$I_{DDS1}$		$V_{DD} = 3.3 \pm 0.3V$ , 20MHz crystal oscillation ( $C_1 = C_2 = 10pF$ ), sleep mode		4.5	8	mA
	$I_{DDS2}$		$V_{DD} = 3.6V$ , stop mode			10	$\mu A$
Input capacitance	$C_{IN}$	PA to PE, PF0 to PF5, $\overline{PG}$ to $\overline{PJ}$ , $\overline{AN0}$ to $\overline{AN3}$ , $\overline{CS0}$ , $\overline{SI0}$ , $\overline{SCK0}$ , $\overline{EXTAL}$ , $\overline{RST}$	Clock 1MHz 0V for all pins excluding measured pins		10	20	pF

\*1  $\overline{RST}$  specifies the input current when pull-up resistor has been selected; the leakage current when no resistor has been selected.

\*2 PA to PE and  $\overline{PG}$  to  $\overline{PJ}$  specify the input current when pull-up resistor has been selected; the leakage current when no resistor has been selected.

\*3 When all output pins are open.

\*4 When the upper two bits (PCK1, PCK0) of the clock control register (CLC: 0002FEh) are set to "00" and the LSI is operated in high-speed mode (2 frequency dividing clock).

AC Characteristics

(1) Clock timing

(Topr = -20 to +75°C, VDD = 2.7 to 5.5V, VSS = 0V reference)

Item	Symbol	Pins	Conditions	Min.	Typ.	Max.	Unit
Main clock base oscillation frequency	fEX	XTAL EXTAL	Fig.1, Fig.2	VDD = 3.0 to 5.5V	1	20	MHz
					1	12	
Main clock base oscillation input pulse width	tXL, tXH	EXTAL	Fig.1, Fig.2 External clock drive	VDD = 3.0 to 5.5V	23		ns
					37.5		
Main clock base oscillation input rise time, fall time	tXR, tXF	EXTAL	Fig.1, Fig.2 External clock drive			100	ns

**Note)** tsys indicates the four values below according to the upper two bits (PCK1,PCK0) of the clock control register (CLC: 0002FEh).  
 tsys [ns] = 2/fEX (PCK1, PCK0 = 00), 4/fEX (PCK1, PCK0 = 01), 8/fEX (PCK1, PCK0 = 10), 16/fEX (PCK1, PCK0 = 11)

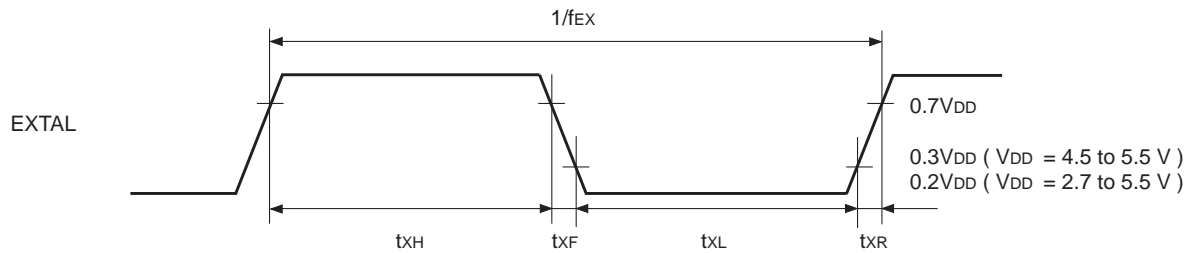


Fig.1. Clock timing

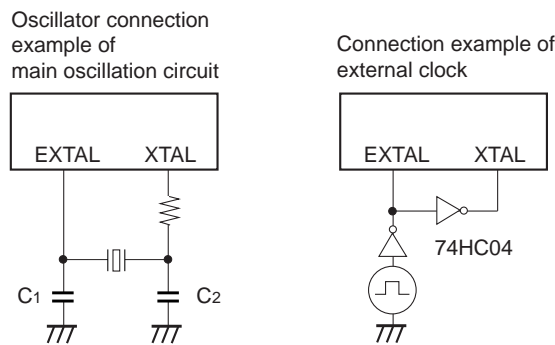
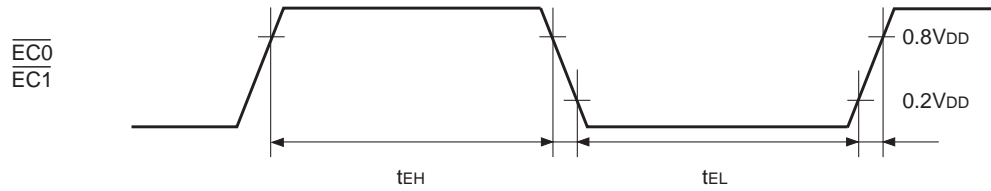


Fig.2. Oscillator connection and clock applied conditions

**(2) Event count input**

(Topr = -20 to +75°C, VDD = 2.7 to 5.5V, VSS = 0V reference)

Item	Symbol	Pins	Conditions	Min.	Max.	Unit
Event count input clock pulse width	$t_{EH}, t_{EL}$	$\overline{EC0}, EC1$	Fig.3	$t_{sys} + 100$		ns

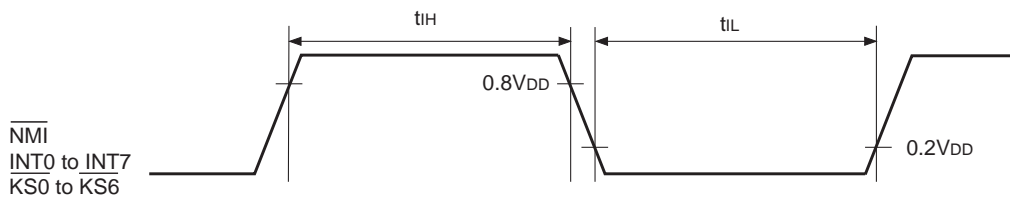


**Fig.3. Event count input timing**

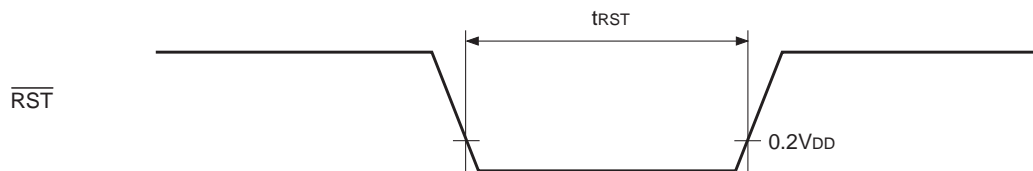
**(3) Interruption and reset input**

(Topr = -20 to +75°C, VDD = 2.7 to 5.5V, VSS = 0V reference)

Item	Symbol	Pins	Conditions	Min.	Max.	Unit	
External interruption high, low level width	$t_{IH}, t_{IL}$	$\overline{NMI}$ INT0 to INT4 KS0 to KS6	Main mode	$t_{sys} + 100$		ns	
			Sleep mode Stop mode	1		$\mu s$	
		INT0, INT1, INT4	Noise filter selected	$\phi$	$2t_{sys} + 100$		ns
				PS4	$32/f_{EX} + 100$		
Reset input low level width	$t_{RST}$	$\overline{RST}$	Fig.5	$3t_{sys} + 200$		ns	



**Fig.4. Interruption input timing**



**Fig.5. Reset input timing**

**(4) A/D converter characteristics**

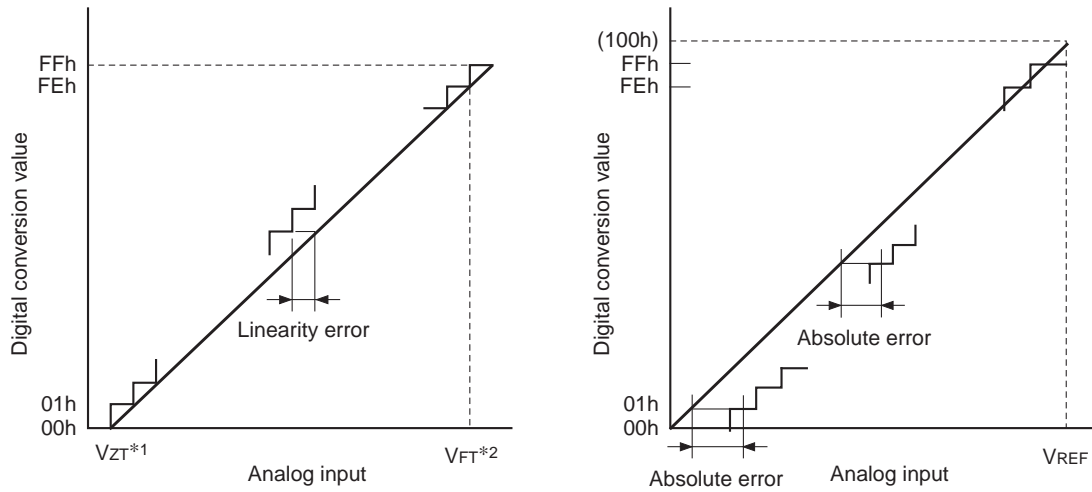
(Topr = -20 to +75°C, VDD = AVDD = 4.5 to 5.5V, AVREF = 4.0 to AVDD, VSS = AVSS = 0V reference)

Item	Symbol	Pins	Conditions	Min.	Typ.	Max.	Unit
Resolution						8	Bits
Linearity error			VDD = AVDD = AVREF = 5.0V			±2	LSB
Absolute error						±3	LSB
Conversion time	t <sub>CONV</sub>			31/f <sub>ADC</sub> *			μs
Sampling time	t <sub>SAMP</sub>			10/f <sub>ADC</sub> *			μs
Reference input voltage	V <sub>REF</sub>	AVREF		AVDD - 0.5			V
Analog input voltage	V <sub>IAN</sub>	AN0 to AN7		0			V
AVREF current	I <sub>REF</sub>	AVREF	Main mode		0.6	1.0	mA
	I <sub>REFS</sub>		Sleep mode Stop mode			10	μA

(Topr = -20 to +75°C, VDD = AVDD = 3.0 to 3.6V, AVREF = 2.7 to AVDD, VSS = AVSS = 0V reference)

Item	Symbol	Pins	Conditions	Min.	Typ.	Max.	Unit
Resolution						8	Bits
Linearity error			VDD = AVDD = AVREF = 3.3V			±2	LSB
Absolute error						±3	LSB
Conversion time	t <sub>CONV</sub>			31/f <sub>ADC</sub> *			μs
Sampling time	t <sub>SAMP</sub>			10/f <sub>ADC</sub> *			μs
Reference input voltage	V <sub>REF</sub>	AVREF		AVDD - 0.3			V
Analog input voltage	V <sub>IAN</sub>	AN0 to AN7		0			V
AVREF current	I <sub>REF</sub>	AVREF	Main mode		0.4	0.7	mA
	I <sub>REFS</sub>		Sleep mode Stop mode			10	μA

\*  $f_{ADC}$  indicates the below values due to the contents of Bit 6 (CKS) of the A/D control register (ADC: 000131h).  
 When PS3 is selected,  $f_{ADC} = f_{EX}/8$   
 When PS4 is selected,  $f_{ADC} = f_{EX}/16$   
 However, when PS3 is selected,  $f_{EX}$  is 12MHz or less.



\*1  $V_{ZT}$ : Value at which the digital conversion value changes from 00h to 01h and vice versa.  
 \*2  $V_{FT}$ : Value at which the digital conversion value changes from FEh to FFh and vice versa.

**Fig.6. Definition of A/D converter terms**

## (5) Serial transfer (CH0, CH1, CH2)

(Topr = -20 to +75°C, V<sub>DD</sub> = 4.5 to 5.5V, V<sub>SS</sub> = 0V reference)

Item	Symbol	Pins	Conditions	Min.	Max.	Unit
$\overline{CS} \downarrow \rightarrow \overline{SCK}$ delay time	t <sub>DCSK</sub>	$\overline{SCK0}$ $\overline{SCK1}$ $\overline{SCK2}$	External start transfer mode ( $\overline{SCK}$ = output mode)		1.5t <sub>sys</sub> + 100	ns
$\overline{CS} \uparrow \rightarrow \overline{SCK}$ float delay time	t <sub>DCSKF</sub>	$\overline{SCK0}$ $\overline{SCK1}$ $\overline{SCK2}$	External start transfer mode ( $\overline{SCK}$ = output mode)		1.5t <sub>sys</sub> + 100	ns
$\overline{CS} \downarrow \rightarrow SO$ delay time	t <sub>DCSO</sub>	SO0 SO1 SO2	External start transfer mode		1.5t <sub>sys</sub> + 100	ns
$\overline{CS} \uparrow \rightarrow SO$ float delay time	t <sub>DCSOF</sub>	SO0 SO1 SO2	External start transfer mode		1.5t <sub>sys</sub> + 100	ns
$\overline{CS}$ high level width	t <sub>WHCS</sub>	$\overline{CS0}$ $\overline{CS1}$ $\overline{CS2}$	External start transfer mode	t <sub>sys</sub> + 100		ns
$\overline{SCK}$ cycle time	t <sub>KCY</sub>	$\overline{SCK0}$ $\overline{SCK1}$ $\overline{SCK2}$	Input mode	2t <sub>sys</sub> + 150		ns
			Output mode	8/f <sub>EX</sub>		ns
$\overline{SCK}$ high, low pulse width	t <sub>KH</sub> t <sub>KL</sub>	$\overline{SCK0}$ $\overline{SCK1}$ $\overline{SCK2}$	Input mode	t <sub>sys</sub> + 60		ns
			Output mode	4/f <sub>EX</sub> - 25		ns
SI input data setup time (for $\overline{SCK} \uparrow$ )	t <sub>SIK</sub>	SI0 SI1 SI2	$\overline{SCK}$ input mode	50		ns
			$\overline{SCK}$ output mode	100		ns
SI input data hold time (for $\overline{SCK} \uparrow$ )	t <sub>KSI</sub>	SI0 SI1 SI2	$\overline{SCK}$ input mode	t <sub>sys</sub> + 100		ns
			$\overline{SCK}$ output mode	50		ns
$\overline{SCK} \downarrow \rightarrow SO$ delay time	t <sub>KSO</sub>	SO0 SO1 SO2	$\overline{SCK}$ input mode		t <sub>sys</sub> + 100	ns
			$\overline{SCK}$ output mode		50	ns
Minimum interval time	t <sub>INT</sub>	$\overline{SCK0}$ $\overline{SCK1}$ $\overline{SCK2}$	$\overline{SCK}$ input mode	3t <sub>sys</sub> + 100		ns
			$\overline{SCK}$ output mode	8/f <sub>EX</sub>		ns

**Note)** The load condition for the  $\overline{SCK}$  output mode and SO output delay time is 50pF+1TTL.

(Topr = -20 to +75°C, V<sub>DD</sub> = 3.0 to 3.6V, V<sub>SS</sub> = 0V reference)

Item	Symbol	Pins	Conditions	Min.	Max.	Unit
$\overline{CS} \downarrow \rightarrow \overline{SCK}$ delay time	t <sub>DCSK</sub>	$\overline{SCK0}$ $\overline{SCK1}$ $\overline{SCK2}$	External start transfer mode ( $\overline{SCK}$ = output mode)		1.5t <sub>sys</sub> + 200	ns
$\overline{CS} \uparrow \rightarrow \overline{SCK}$ float delay time	t <sub>DCSKF</sub>	$\overline{SCK0}$ $\overline{SCK1}$ $\overline{SCK2}$	External start transfer mode ( $\overline{SCK}$ = output mode)		1.5t <sub>sys</sub> + 200	ns
$\overline{CS} \downarrow \rightarrow SO$ delay time	t <sub>DCSO</sub>	SO0 SO1 SO2	External start transfer mode		1.5t <sub>sys</sub> + 200	ns
$\overline{CS} \uparrow \rightarrow SO$ float delay time	t <sub>DCSOF</sub>	SO0 SO1 SO2	External start transfer mode		1.5t <sub>sys</sub> + 200	ns
$\overline{CS}$ high level width	t <sub>WHCS</sub>	$\overline{CS0}$ $\overline{CS1}$ $\overline{CS2}$	External start transfer mode	t <sub>sys</sub> + 200		ns
$\overline{SCK}$ cycle time	t <sub>KCY</sub>	$\overline{SCK0}$ $\overline{SCK1}$ $\overline{SCK2}$	Input mode	2t <sub>sys</sub> + 200		ns
			Output mode	8/f <sub>EX</sub>		ns
$\overline{SCK}$ high, low pulse width	t <sub>KH</sub> t <sub>KL</sub>	$\overline{SCK0}$ $\overline{SCK1}$ $\overline{SCK2}$	Input mode	t <sub>sys</sub> + 80		ns
			Output mode	4/f <sub>EX</sub> - 50		ns
SI input data setup time (for $\overline{SCK} \uparrow$ )	t <sub>SIK</sub>	SI0 SI1 SI2	$\overline{SCK}$ input mode	80		ns
			$\overline{SCK}$ output mode	150		ns
SI input data hold time (for $\overline{SCK} \uparrow$ )	t <sub>KSI</sub>	SI0 SI1 SI2	$\overline{SCK}$ input mode	t <sub>sys</sub> + 120		ns
			$\overline{SCK}$ output mode	70		ns
$\overline{SCK} \downarrow \rightarrow SO$ delay time	t <sub>KSO</sub>	SO0 SO1 SO2	$\overline{SCK}$ input mode		t <sub>sys</sub> + 200	ns
			$\overline{SCK}$ output mode		80	ns
Minimum interval time	t <sub>INT</sub>	$\overline{SCK0}$ $\overline{SCK1}$ $\overline{SCK2}$	$\overline{SCK}$ input mode	3t <sub>sys</sub> + 150		ns
			$\overline{SCK}$ output mode	8/f <sub>EX</sub>		ns

**Note)** The load condition for the  $\overline{SCK}$  output mode and SO output delay time is 50pF.

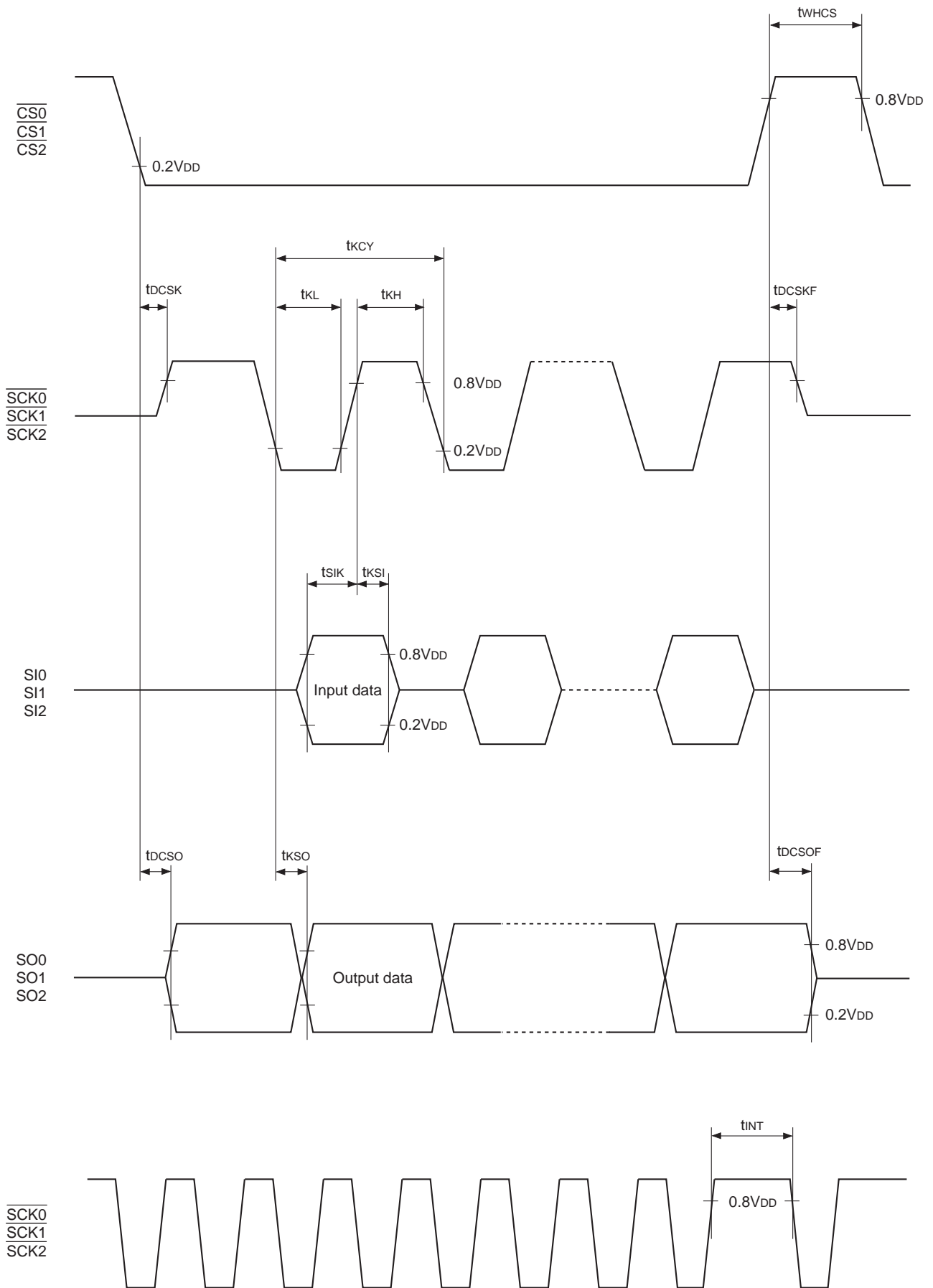
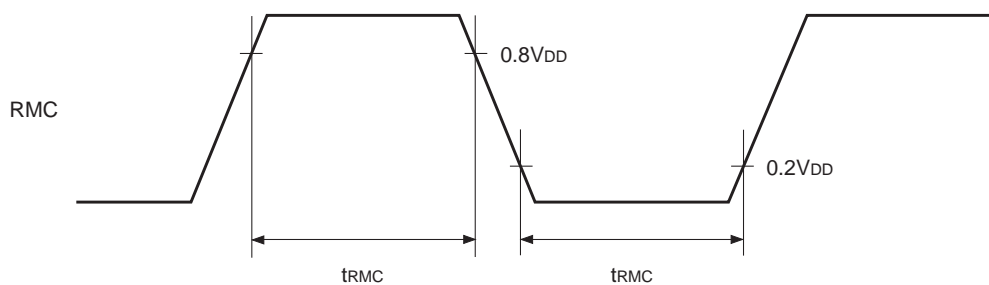


Fig.7. Serial transfer CH0, CH1, CH2 timing

**(6) Remote control reception**

(Topr = -20 to +75°C, V<sub>DD</sub> = 2.7 to 5.5V, V<sub>SS</sub> = 0V reference)

Item	Symbol	Pins	Conditions	Min.	Max.	Unit	
Remote control receive high, low level width	t <sub>RMC</sub>	RMC	Main mode Sleep mode	PS5 selected	128/f <sub>EX</sub> + 100		ns
				PS6 selected	256/f <sub>EX</sub> + 100		
				PS8 selected	1024/f <sub>EX</sub> + 100		



**Fig.8. Remote control signal input timing**

Appendix

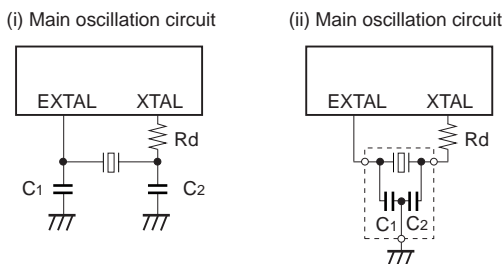


Fig.9. Recommended oscillation circuit

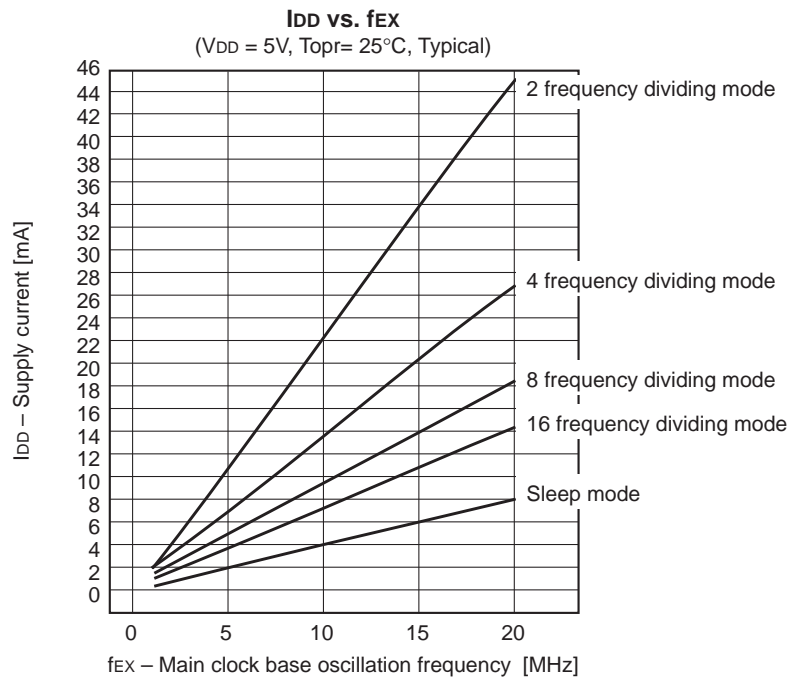
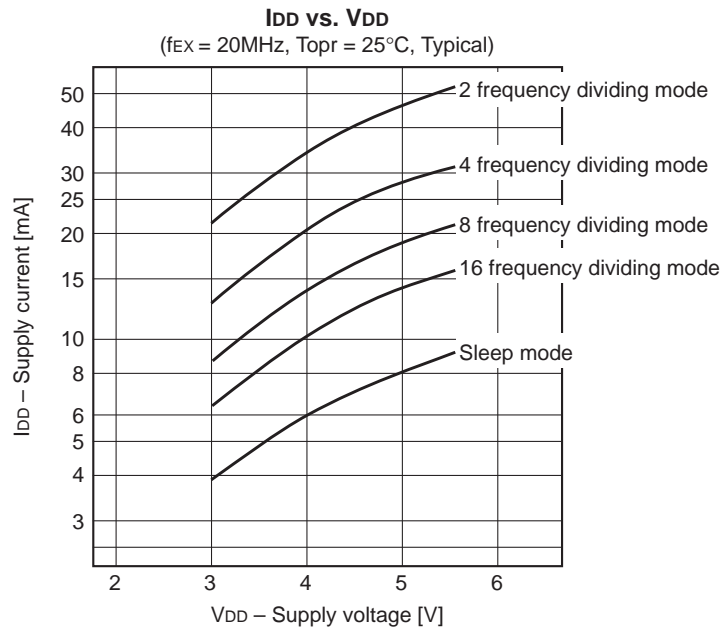
Manufacturer	Model	f <sub>EX</sub> (MHz)	C <sub>1</sub> (pF)	C <sub>2</sub> (pF)	R <sub>d</sub> (Ω)	Circuit example	Remarks
MURATA MFG CO., LTD.	CSA4.00MG	4	30	30	0	(i)	
	CSA8.00MTZ093	8					
	CSA10.0MTZ093	10					
	CSA12.0MTZ093	12					
	CST4.00MGW*	4				(ii)	
	CST8.00MTW093*	8					
	CST10.0MTW093*	10					
	CST12.0MTW093*	12					
	CSA16.00MXZ040	16	5	5	0	(i)	
	CST16.00MXW0C1*	16				(ii)	
	CSA20.00MXZ040	20				(i)	
	CST20.00MXW0H1*	20				(ii)	
RIVER ELETEC CO., LTD.	HC-49/U03	4	27	27	560	(i)	CL = 18.5pF
		8	15	15	330		CL = 13.0pF
		10	10	10	330		CL = 10.5pF
		12	10	10	180		CL = 10.5pF
		16	8	8	0		CL = 10.0pF
		20	6	6	0		CL = 8.5pF
KINSEKI LTD.	HC49/U-S	4	22	22	2.2k	(i)	CL = 16pF V <sub>DD</sub> = 3.0 to 5.5V
		8	10	10	0		CL = 12pF V <sub>DD</sub> = 3.5 to 5.5V
		10					
		12					
		16					
20							
TDK Corporation	CCR4.0MC3*	4	38 (±20%)	38 (±20%)	0	(ii)	
	CCR8.0MC5*	8	20 (±20%)	20 (±20%)	0		
	CCR10.0MC5*	10	20 (±20%)	20 (±20%)	0		
	CCR12.0MC5*	12	20 (±20%)	20 (±20%)	0		
	CCR16.0MC6*	16	10 (±20%)	10 (±20%)	0		
	CCR20.0MC6*	20	10 (±20%)	10 (±20%)	0		V <sub>DD</sub> = 3.5 to 5.5V

\* Indicates types with on-chip grounding capacitor (C<sub>1</sub>, C<sub>2</sub>). CCR\*\*\*: Surface mounted type ceramic oscillator.  
CL : Load capacitor

Mask option table

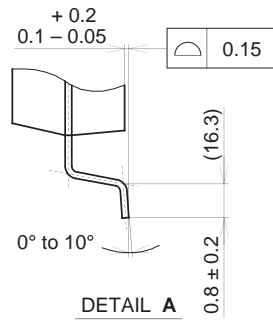
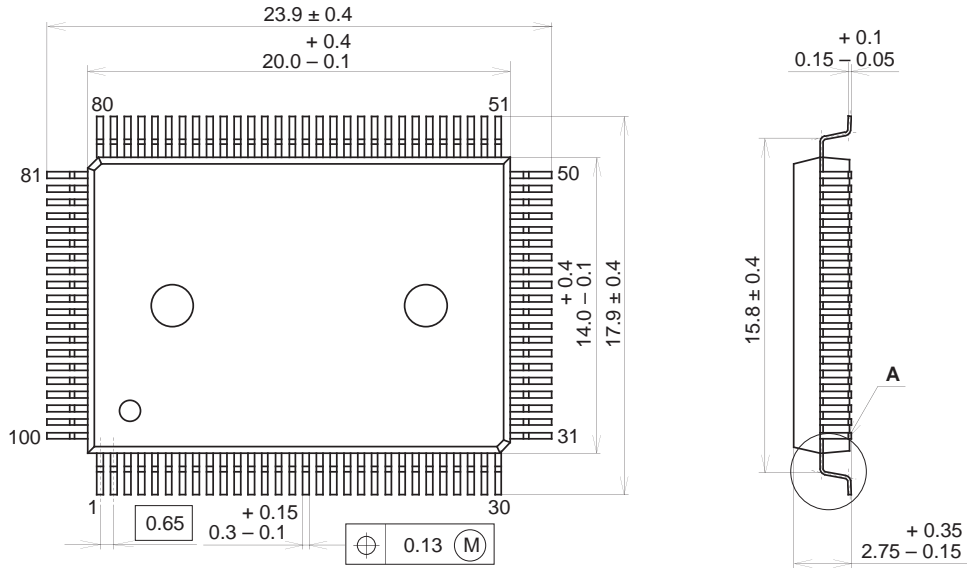
Item	Content	
Reset pin pull-up resistor	Non-existent	Existent

Characteristics Curve



Package Outline Unit: mm

100PIN QFP (PLASTIC)



PACKAGE STRUCTURE

SONY CODE	QFP-100P-L01
EIAJ CODE	QFP100-P-1420
JEDEC CODE	_____

PACKAGE MATERIAL	EPOXY RESIN
LEAD TREATMENT	SOLDER PLATING
LEAD MATERIAL	42/COPPER ALLOY
PACKAGE MASS	1.7g



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