

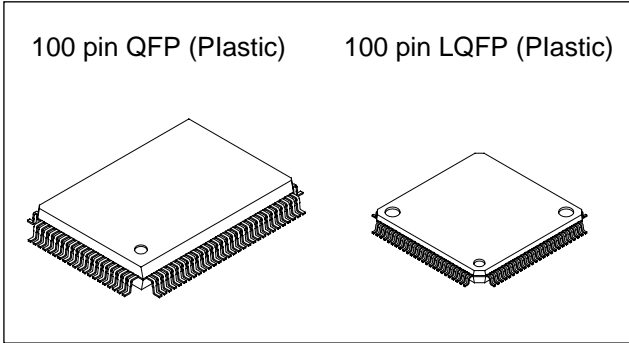
CXP81840A/81848A

CMOS 8-bit Single Chip Microcomputer

Description

The CXP81840A/81848A 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 CXP81840A/81848A provides sleep/stop function which enables to lower power consumption and ultra-low speed instruction mode in 32kHz operation.



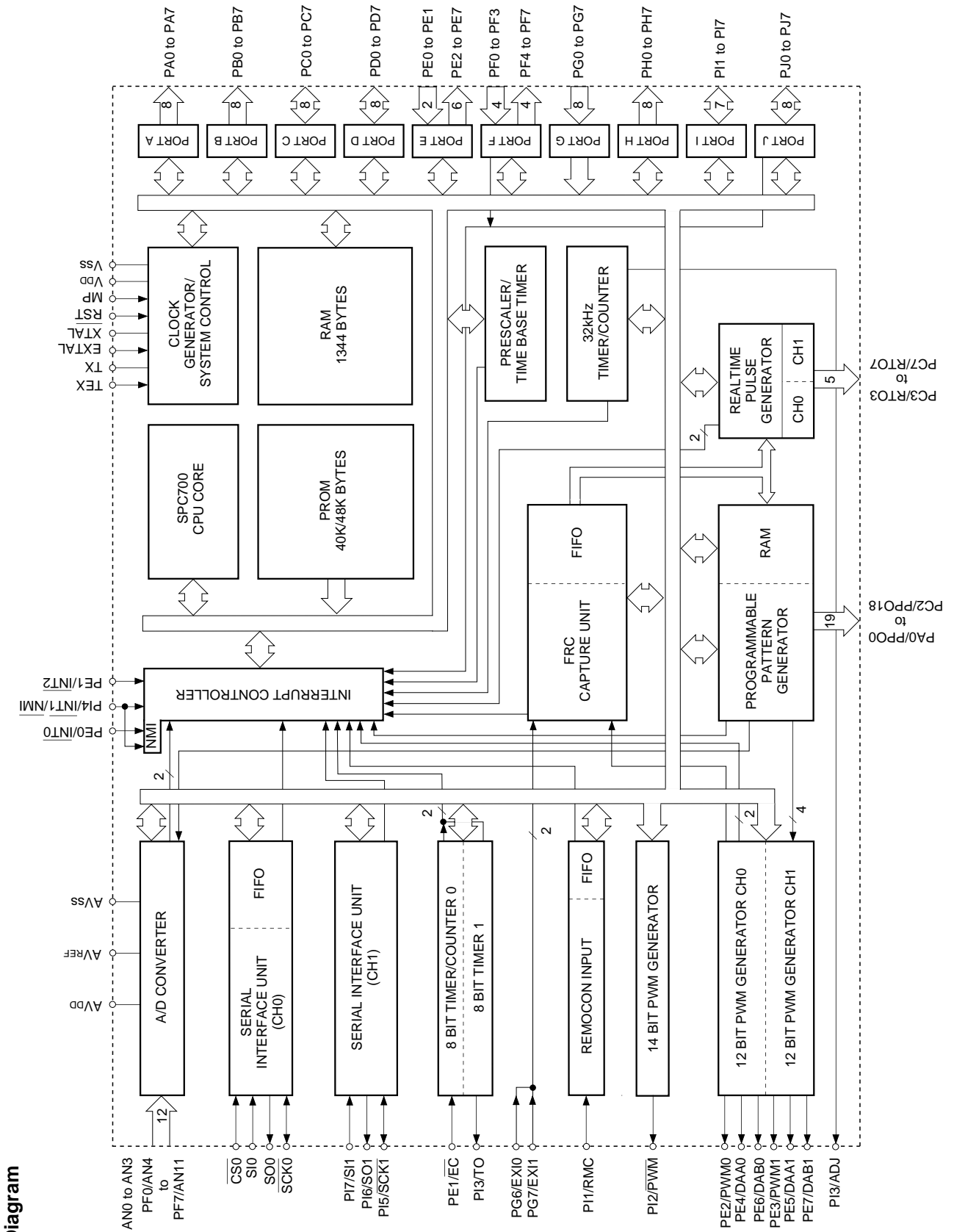
Structure

Silicon gate CMOS IC

Features

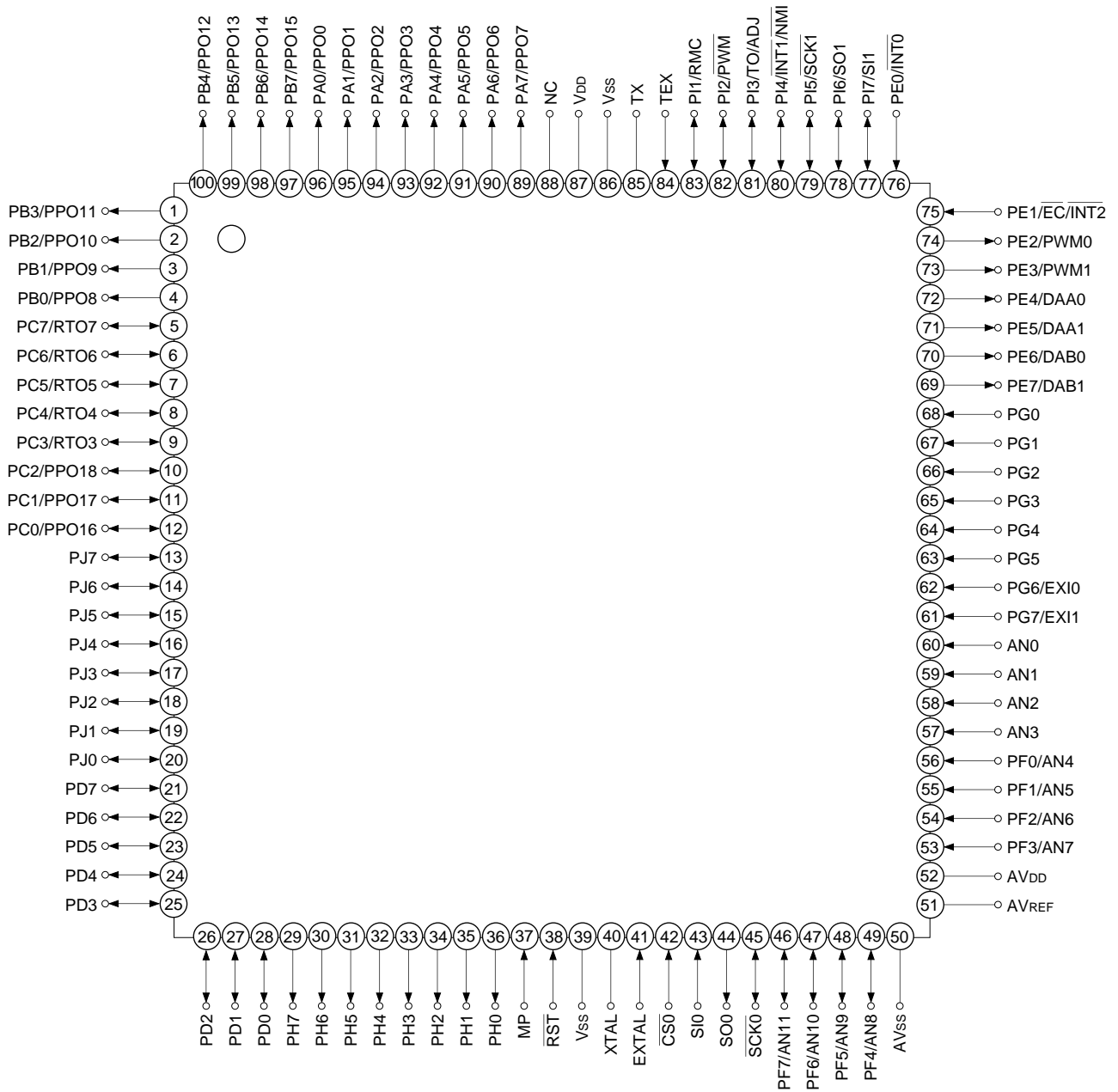
- A wide instruction set (213 instructions) which cover various types of data
 - 16-bit arithmetic instruction/multiplication and division instructions/boolean bit operation instruction
- Minimum instruction cycle
 - During operation 333ns/12MHz (Supply voltage 3.0 to 5.5V)
 - During operation 250ns/16MHz (Supply voltage 4.5 to 5.5V)
 - During operation 122µs/32kHz
- Incorporated ROM capacity
 - 40K bytes (CXP81840A)
 - 48K bytes (CXP81848A)
- Incorporated RAM capacity
 - 1344bytes
- 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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Block Diagram

Pin Configuration 2 (Top View) 100 pin LQFP package



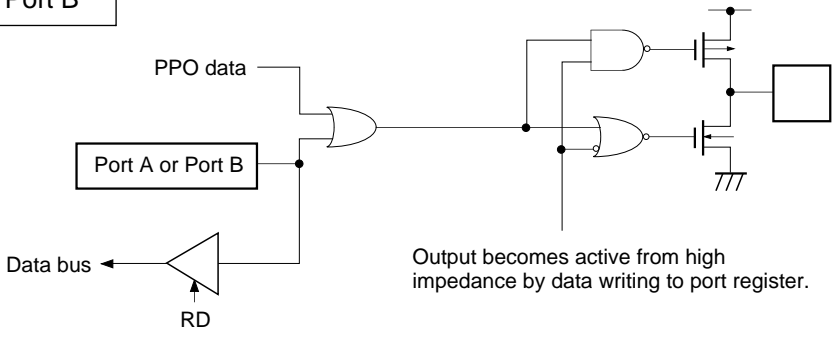
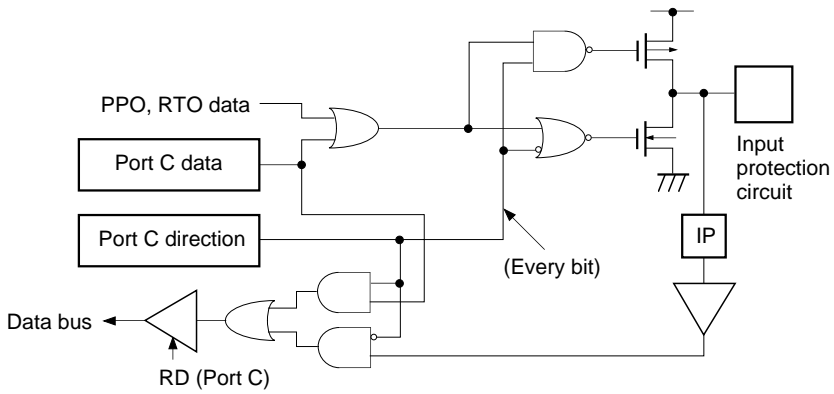
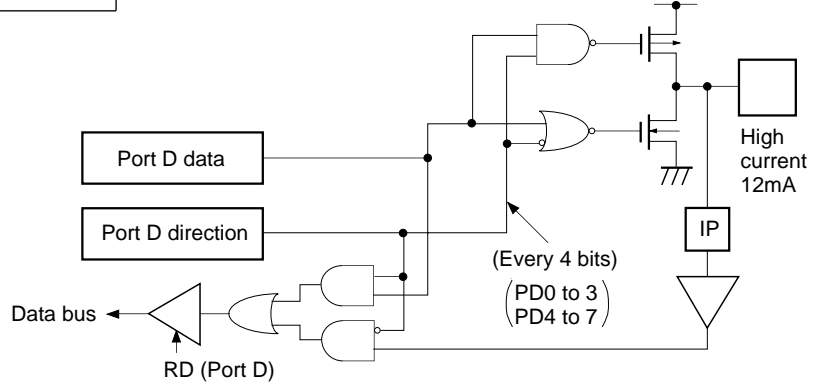
- Note**
1. NC (Pin 88) is always connected to V_{DD}.
 2. V_{SS} (Pins 39 and 86) are both connected to GND.

Pin Description

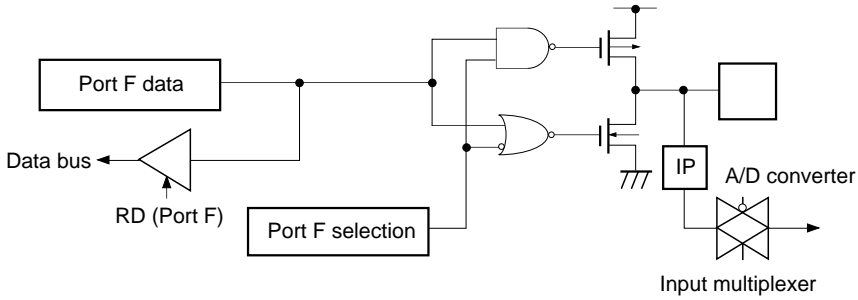
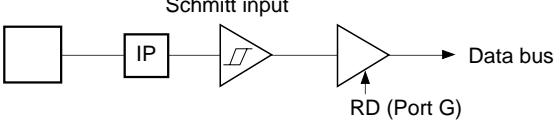
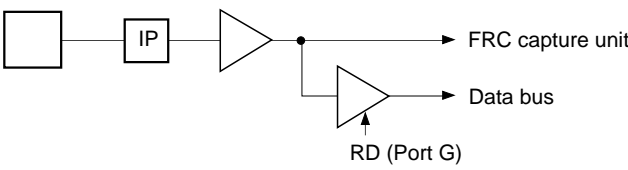
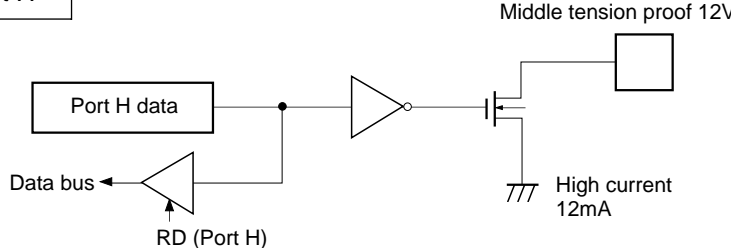
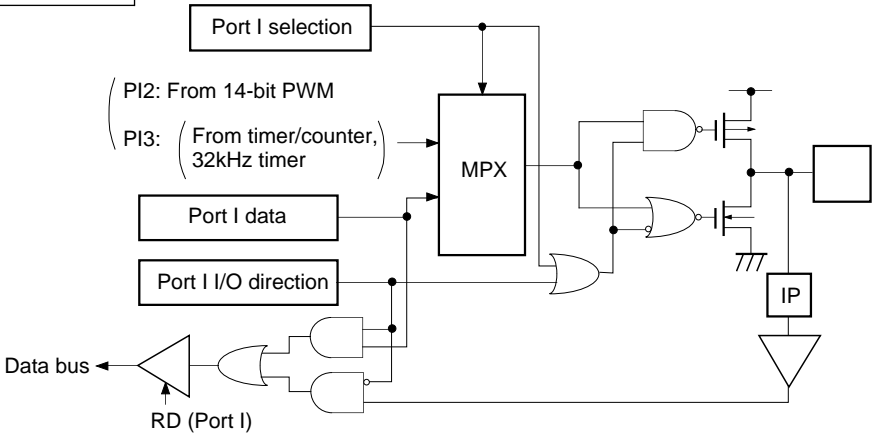
Symbol	I/O	Description		
PA0/PPO0 to PA7/PPO7	Output/ Real time Output	(Port A) 8-bit output port. Data is gated with PPO contents by OR-gate and they are output. (8 pins)	Programmable pattern generator (PPG) output. Functions as high precision real time pulse output port. (19 pins)	
PB0/PPO8 to PB7/PPO15	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			
PE7/DAB1	Output/output			
			DA gate pulse output pins. (4 pins)	
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.	

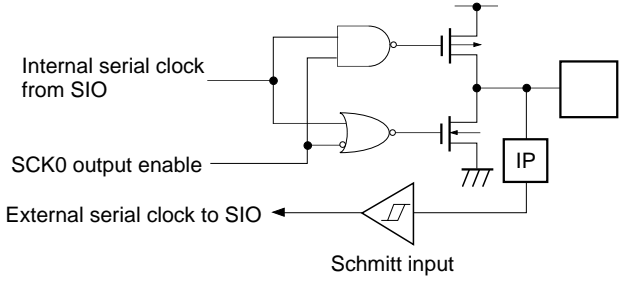
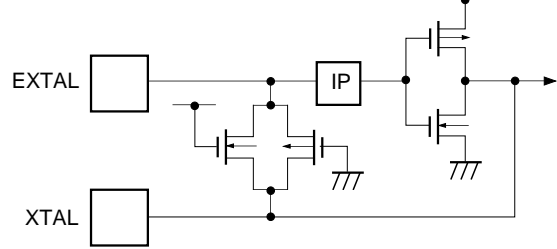
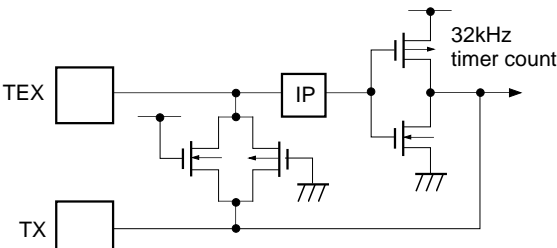
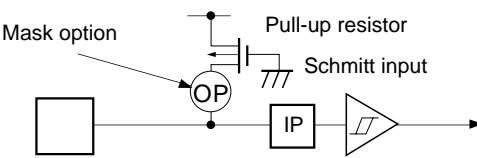
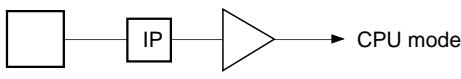
Input/Output Circuit Formats for Pins

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
PE0/ $\overline{\text{INT0}}$ PE1/ $\overline{\text{EC/INT2}}$ 2 pins		Hi-Z
PE2/PWM0 PE3/PWM1 PE4/DAA0 PE5/DAA1 4 pins		Hi-Z
PE6/DAB0 PE7/DAB1 2 pins		H level
AN0 to AN3 4 pins		Hi-Z
PF0/AN4 to PF3/AN7 4 pins		Hi-Z

Pin	Circuit format	When reset
<p>PF4/AN8 to PF7/AN11</p> <p>4 pins</p>	<p>Port F</p> 	<p>Hi-Z</p>
<p>PG0 to PG5</p> <p>6 pins</p>	<p>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/EX10 PG7/EX11</p> <p>2 pins</p>	<p>Port G</p> 	<p>Hi-Z</p>
<p>PH0 to PH7</p> <p>8 pins</p>	<p>Port H</p> 	<p>Hi-Z</p>
<p>PI2/PWM PI3/TO/ADJ</p> <p>2 pins</p>	<p>Port I</p>  <p>(PI2: From 14-bit PWM 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>(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>	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>	Hi-Z
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>	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>IP</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>IP</p> <p>OP</p>	<p>L level</p>
<p>MP</p> <p>1 pin</p>	 <p>IP</p> <p>Schmitt input</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	fc = less than 16MHz	Guaranteed range during high speed mode (1/2 dividing clock) operation
		3.0	5.5		fc = less than 12MHz	
		2.7	5.5	V	Guaranteed range during low speed mode (1/16 dividing clock) operation	
		2.7	5.5	V	Guaranteed operation range by TEX clock	
		2.5	5.5	V	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, *7	
	V _{IHEX}	V _{DD} - 0.4	V _{DD} + 0.3	V	EXTAL pin*5, *7	TEX pin*6, *7
		V _{DD} - 0.2	V _{DD} + 0.2	V	EXTAL pin*5, *8	TEX pin*6, *8
Low level input voltage	V _{IL}	0	0.3V _{DD}	V	*2, *7	
		0	0.2V _{DD}	V	*2, *8	
	V _{ILS}	0	0.2V _{DD}	V	CMOS schmitt input*3	
	V _{ILTS}	0	0.8	V	TTL schmitt input*4, *7	
	V _{ILEX}	-0.3	0.4	V	EXTAL pin*5, *7	TEX pin*6, *7
		-0.3	0.2	V	EXTAL pin*5, *8	TEX pin*6, *8
Operating temperature	Topr	-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 CS0, SI0, SCK0, RST, PE0/INT0, PE1/EC/INT2, PG (For PG4 and PG5, when CMOS schmitt input is selected with mask option), PI1/RMC, PI4/INT1/NMI, PI5/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.

*7 This case applies to the range of 4.5 to 5.5V supply voltage (V_{DD}).

*8 This case applies to the range of 3.0 to 3.6V supply voltage (V_{DD}).

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 ($C_1 = C_2 = 15pF$)		24	45	mA
			$V_{DD} = 5V \pm 0.5V^{*3}$				
	I_{DDS1}		SLEEP mode		1.3	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		6	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).

DC Characteristics (V_{DD} = 3.0 to 3.6V)

(T_a = -20 to +75°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 (V _{OL} only)	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}	PI1 to PI7 PJ, SO0, SCK0	V _{DD} = 3.0V, I _{OL} = 1.2mA			0.3	V
			V _{DD} = 3.0V, I _{OL} = 1.6mA			0.5	V
		PD, PH	V _{DD} = 3.0V, I _{OL} = 5mA			1.0	V
Input current	I _{IHE}	EXTAL	V _{DD} = 3.6V, V _{IH} = 3.6V	0.3		20	μA
	I _{ILE}		V _{DD} = 3.6V, V _{IL} = 0.3V	-0.3		-20	μA
	I _{IHT}	TEX	V _{DD} = 3.6V, V _{IH} = 3.6V	0.1		10	μA
	I _{I LT}		V _{DD} = 3.6V, V _{IL} = 0.3V	-0.1		-10	μA
	I _{ILR}	RST*1	V _{DD} = 3.6V, V _{IL} = 0.3V	-0.9		-200	μA
I/O leakage current	I _{Iz}	PA to PG, PI, PJ, MP AN0 to AN3, CS0, SI0, SO0 SCK0, RST*1	V _{DD} = 3.6V, V _I = 0, 3.6V			±10	μA
Open drain output leakage current	I _{LOH}	PH	V _{DD} = 3.6V, V _{OH} = 12V			50	μA
Supply current*2	I _{DD1}	V _{DD}	12MHz crystal oscillation (C ₁ = C ₂ = 15pF)		11	25	mA
			V _{DD} = 3.3V ± 0.3V*3				
	I _{DDS1}		SLEEP mode		0.5	2.5	mA
I _{DDS3}	STOP mode (EXTAL and TEX pins oscillation stop)	V _{DD} = 3.3V ± 0.3V					
		V _{DD} = 3.3V ± 0.3V			10	μA	
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 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 = 3.0 to 5.5V, VSS = 0V)

Item	Symbol	Pins	Conditions	Min.	Max.	Unit	
System clock frequency	fc	XTAL EXTAL	Fig. 1, Fig. 2	VDD = 4.5 to 5.5V	1	16	MHz
					1	12	
System clock input pulse width	tXL, tXH	EXTAL	Fig. 1, Fig. 2 (External clock drive)	VDD = 4.5 to 5.5V	28		ns
					37.5		
System clock input rise and fall times	tCR, tCF	EXTAL	Fig. 1, Fig. 2 (External clock drive)		200	ns	
Event count clock input pulse width	tEH, tEL	\overline{EC}	Fig. 3	tsys × 4*		ns	
Event count clock input rise and fall times	tER, tEF	\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	tTL, tTH	TEX	Fig. 3	10		μs	
Event count clock input rise and fall times	tTR, tTF	TEX	Fig. 3		20	ms	

* tsys 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

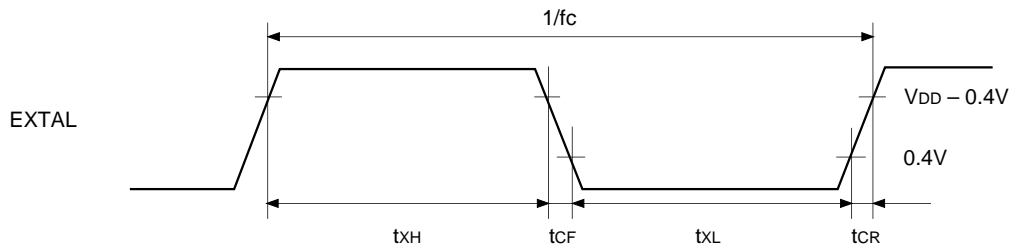


Fig. 2. Clock applied condition

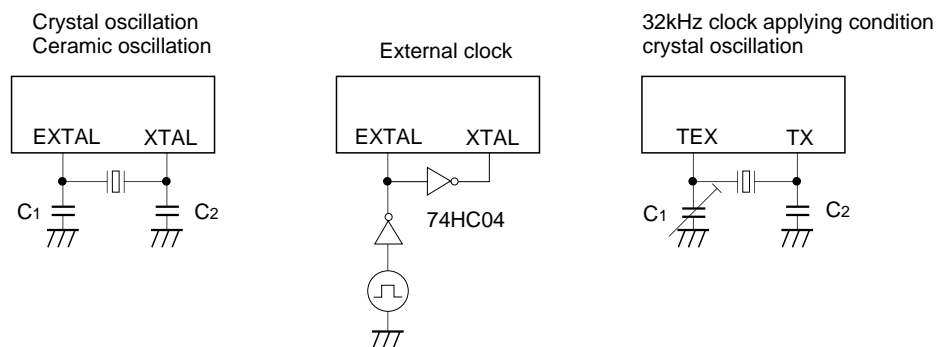
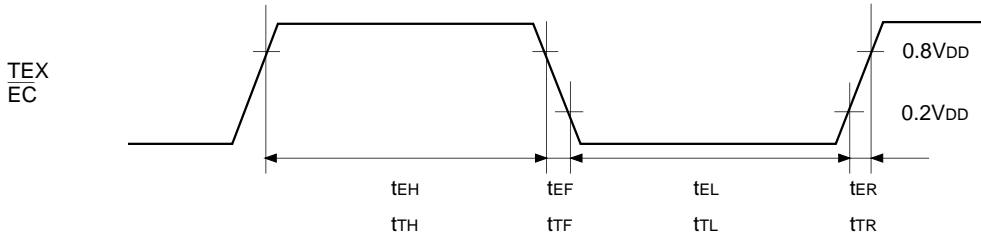


Fig. 3. Event count clock timing



(2) Serial transfer (CH0)

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

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

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

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

Serial transfer (CH0)

(Ta = -20 to +75°C, VDD = 3.0 to 3.6V, VSS = 0V)

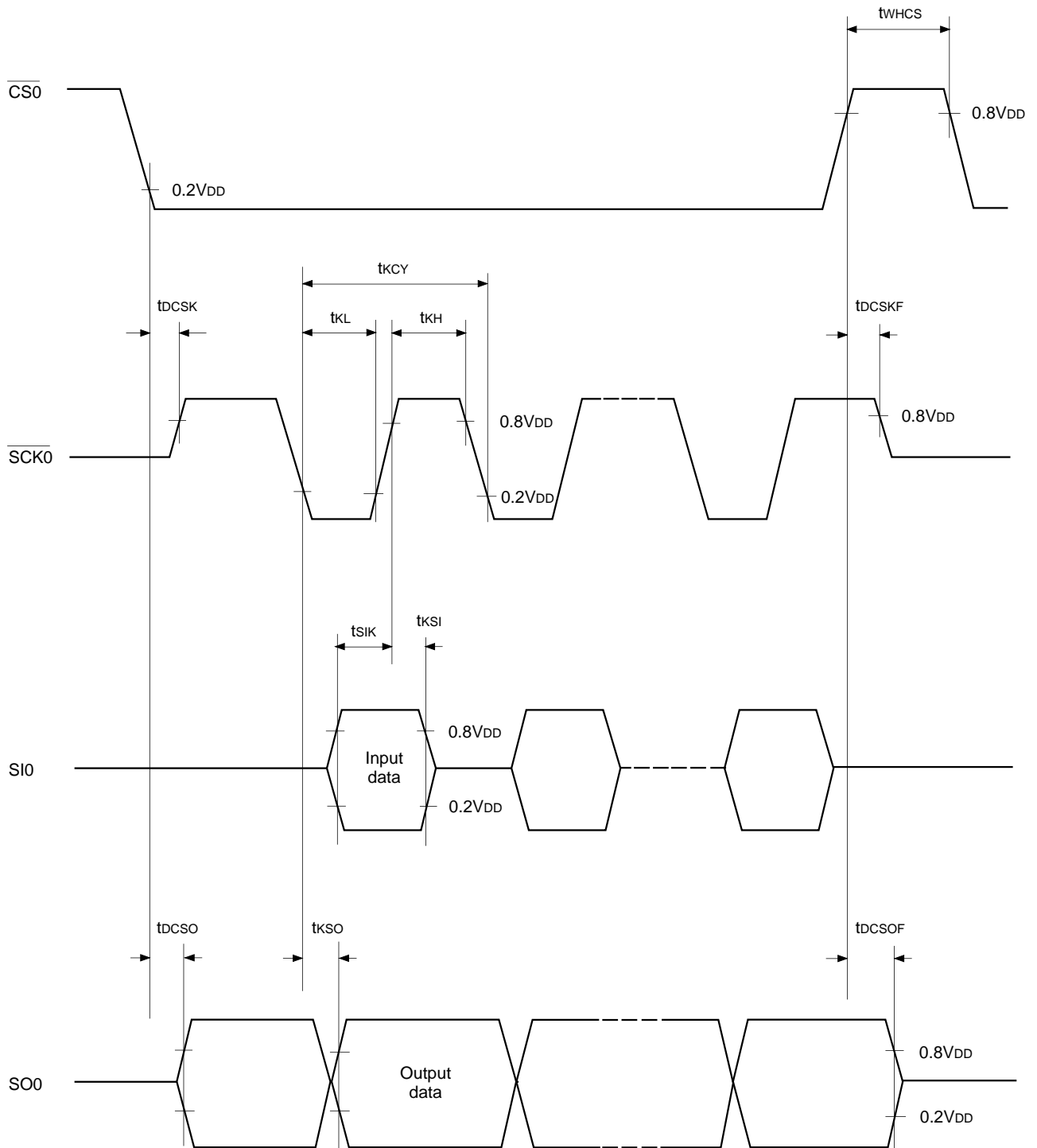
Item	Symbol	Pin	Condition	Min.	Max.	Unit
$\overline{CS0} \downarrow \rightarrow \overline{SCK0}$ delay time	tDCSK	$\overline{SCK0}$	Chip select transfer mode ($\overline{SCK0}$ = output mode)		t _{sys} + 250	ns
$\overline{CS0} \uparrow \rightarrow \overline{SCK0}$ floating delay time	tDCSKF	$\overline{SCK0}$	Chip select transfer mode ($\overline{SCK0}$ = output mode)		t _{sys} + 200	ns
$\overline{CS0} \downarrow \rightarrow SO0$ delay time	tDCSO	SO0	Chip select transfer mode		t _{sys} + 250	ns
$\overline{CS0} \uparrow \rightarrow SO0$ floating delay time	tDCSOF	SO0	Chip select transfer mode		t _{sys} + 200	ns
$\overline{CS0}$ high level width	tWHCS	$\overline{CS0}$	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 - 100		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} + 250	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.

Fig. 4. Serial transfer CH0 timing



Serial transfer (CH1)

(Ta = -20 to +75°C, V_{DD} = 4.5 to 5.5V, V_{SS} = 0V)

Item	Symbol	Pins	Conditions	Min.	Max.	Unit
$\overline{\text{SCK1}}$ cycle time	t _{KCY}	$\overline{\text{SCK1}}$	Input mode	1000		ns
			Output mode	16000/fc		ns
$\overline{\text{SCK1}}$ high and low level widths	t _{KH} t _{KL}	$\overline{\text{SCK1}}$	Input mode	400		ns
			Output mode	8000/fc - 50		ns
SI1 input setup time (against $\overline{\text{SCK1}}$ ↑)	t _{SIK}	SI1	$\overline{\text{SCK1}}$ input mode	100		ns
			$\overline{\text{SCK1}}$ output mode	200		ns
SI1 input hold time (against $\overline{\text{SCK1}}$ ↑)	t _{KSI}	SI1	$\overline{\text{SCK1}}$ input mode	200		ns
			$\overline{\text{SCK1}}$ output mode	100		ns
$\overline{\text{SCK1}}$ ↓ → 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 50pF + 1TTL.

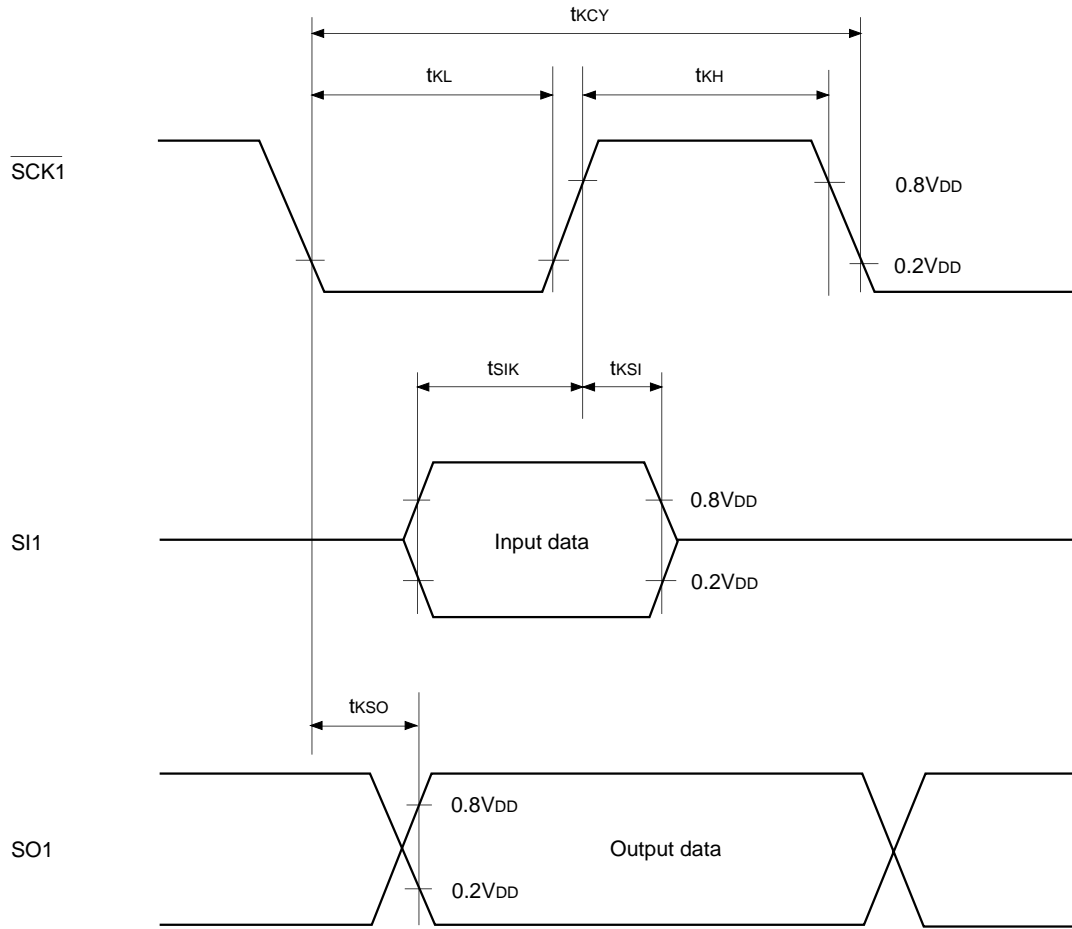
Serial transfer (CH1)

(Ta = -20 to +75°C, V_{DD} = 3.0 to 3.6V, V_{SS} = 0V)

Item	Symbol	Pins	Conditions	Min.	Max.	Unit
$\overline{\text{SCK1}}$ cycle time	t _{KCY}	$\overline{\text{SCK1}}$	Input mode	1000		ns
			Output mode	16000/fc		ns
$\overline{\text{SCK1}}$ high and low level widths	t _{KH} t _{KL}	$\overline{\text{SCK1}}$	Input mode	400		ns
			Output mode	8000/fc - 100		ns
SI1 input setup time (against $\overline{\text{SCK1}}$ ↑)	t _{SIK}	SI1	$\overline{\text{SCK1}}$ input mode	100		ns
			$\overline{\text{SCK1}}$ output mode	200		ns
SI1 input hold time (against $\overline{\text{SCK1}}$ ↑)	t _{KSI}	SI1	$\overline{\text{SCK1}}$ input mode	200		ns
			$\overline{\text{SCK1}}$ output mode	100		ns
$\overline{\text{SCK1}}$ ↓ → SO1 delay time	t _{KSO}	SO1	$\overline{\text{SCK1}}$ input mode		250	ns
			$\overline{\text{SCK1}}$ output mode		100	ns

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

Fig. 5. Serial transfer CH1 timing



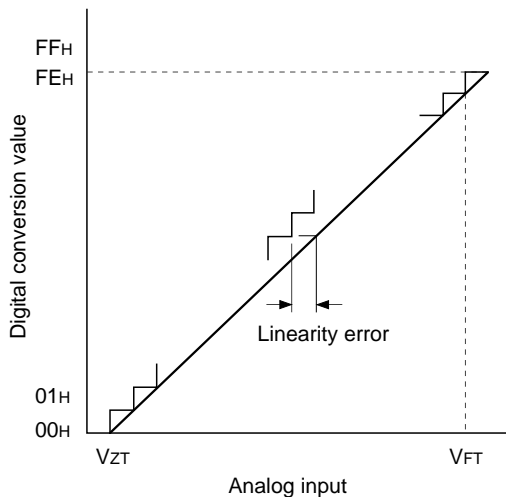
(3) A/D converter characteristics ($T_a = -20$ to $+75^\circ\text{C}$, $V_{DD} = AV_{DD} = 4.5$ to 5.5V , $AV_{REF} = 4.0$ to AV_{DD} , $V_{SS} = AV_{SS} = 0\text{V}$)

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

($T_a = -20$ to $+75^\circ\text{C}$, $V_{DD} = AV_{DD} = 3.0$ to 3.6V , $AV_{REF} = 2.7$ to AV_{DD} , $V_{SS} = AV_{SS} = 0\text{V}$)

Item	Symbol	Pins	Conditions	Min.	Typ.	Max.	Unit
Resolution						8	Bits
Linearity error			$T_a = 25^\circ\text{C}$ $V_{DD} = AV_{DD} = AV_{REF} = 3.3\text{V}$ $V_{SS} = AV_{SS} = 0\text{V}$			± 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}	$V_{DD} = AV_{DD} = 3.0$ to 3.6V	$AV_{DD} - 0.3$		AV_{DD}	V
Analog input voltage	V_{IAN}	AN0 to AN11		0			V
AV_{REF} current	I_{REF}	AV_{REF}	Operating mode		0.4	0.7	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 (Ta = -20 to +75°C, VDD = 3.0 to 5.5V, VSS = 0V)

Item	Symbol	Pin	Condition	Min.	Max.	Unit
External interruption high and low level widths	t _{IH}	INT0 INT1 INT2 NMI PJ0 to PJ7		1		μs
	t _{IL}					
Reset input low level width	t _{RSL}	RST		32/fc		μs

Fig. 7. Interruption input timing

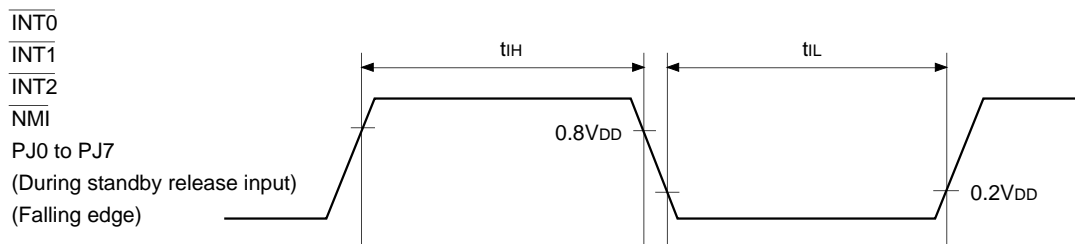
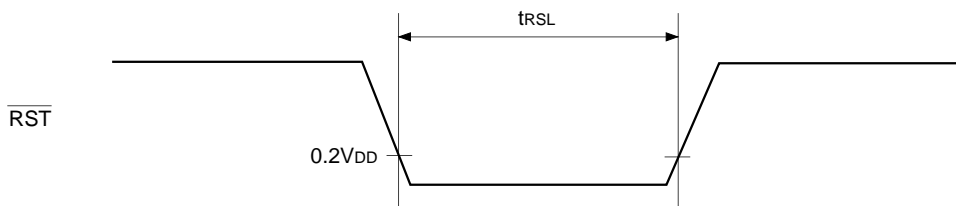


Fig. 8. Reset input timing



(5) Others (Ta = -20 to +75°C, VDD = 3.0 to 5.5V, VSS = 0V)

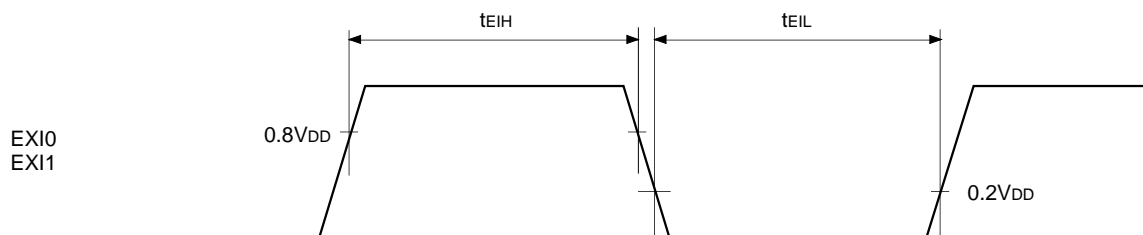
Item	Symbol	Pin	Condition	Min.	Max.	Unit
EXI input high and low level width	t _{EIH}	EXI0 EXI1	tsys = 2000/fc	tsys + 200		ns
	t _{EIL}					

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

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

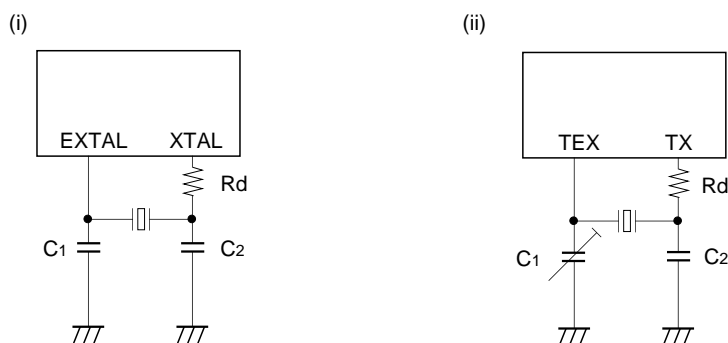
tFRC [ns] = 1000/fc

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.

However, TTL schmitt can not be selected when the supply voltage (V_{DD}) ranges from 3.0V to 5.5V.

Characteristics Curve

