



# LC876132A/24A/16A

## 8 bit Single Chip Microcontroller with 32K/24K/16K-Byte ROM and 768-Byte RAM on Chip

### Preliminary

#### Overview

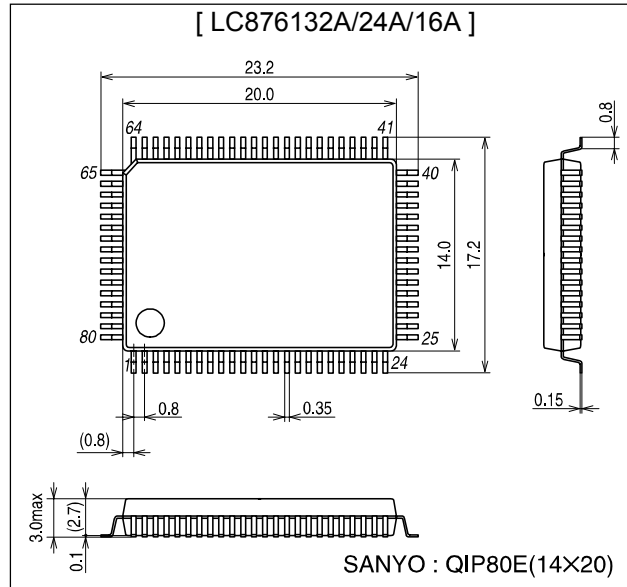
The LC876132A/24A/16A are 8 bit single chip microcontrollers with the following on-chip functional blocks :

- CPU: operable at a minimum bus cycle time of 100ns
- On-chip ROM Maximum Capacity :
 

LC876132A	32K bytes
LC876124A	24K bytes
LC876116A	16K bytes
- On-chip RAM: 768 bytes
- VFD automatic display controller / driver
- 16 bit timer / counter  
(can be divided into two 8 bit timers)
- 16 bit timer / PWM  
(can be divided into two 8 bit timers)
- System clock divider function
- Synchronous serial I/O port  
(with automatic block transmit / receive function)
- Asynchronous / synchronous serial I/O port
- 10-channel × 8-bit AD converter
- 13-source 10-vectored interrupt system

#### Package Dimensions

unit: mm  
3174A



All of the above functions are fabricated on a single chip.

- Any and all SANYO products described or contained herein do not have specifications that can handle applications that require extremely high levels of reliability, such as life-support systems, aircraft's control systems, or other applications whose failure can be reasonably expected to result in serious physical and/or material damage. Consult with your SANYO representative nearest you before using any SANYO products described or contained herein in such applications.
- SANYO assumes no responsibility for equipment failures that result from using products at values that exceed, even momentarily, rated values (such as maximum ratings, operating condition ranges, or other parameters) listed in products specifications of any and all SANYO products described or contained herein.

## Features

- (1) Read-Only Memory (ROM):
- |           |                |
|-----------|----------------|
| LC876132A | 32768 × 8 bits |
| LC876124A | 24576 × 8 bits |
| LC876116A | 16384 × 8 bits |
- (2) Random Access Memory (RAM): LC876132A/24A/16A 768 × 9 bits
- (3) Minimum Bus Cycle Time: 100 ns (10MHz)  
Note: The bus cycle time indicates ROM read time.
- (4) Minimum Instruction Cycle Time: 300 ns (10MHz)
- (5) Ports
- Input / output ports
 

Data direction programmable for each bit individually :	12 (P1n, P70 to P73)
Data direction programmable in nibble unit :	8 (P0n)

 (When N-channel open drain output is selected, data can be input in bit unit.)
  - VFD output ports
 

Large current outputs for digits :	9 (S0 / T0 to S8 / T8)
Large current outputs for digits / segments :	7 (S9 / T9 to S15 / T15)
Digit / segment outputs :	8 (S16 to S23)
Segment outputs :	28 (S24 to S51)
  - Other functions
 

Input ports :	16 (PCn, PDn)
Output ports :	8 (PFn)
Input / output ports :	4 (PGn)
  - Oscillator pins : 2 (CF1, CF2)
  - Reset pin : 1 (RES)
  - Power supply : 4 (VSS1, VDD1 to 3)
  - VFD power supply : 1 (VP)
- (6) VFD automatic display controller
- Programmable segment / digit output pattern
 

Output can be switched between digit / segment waveform output (pins 9 to 24 can be used for output of digit waveforms).

parallel-drive available for large current VFD.
  - 16-step dimmer function available
- (7) Timers
- Timer 0: 16 bit timer / counter with capture register
 

Mode 0: 2 channel 8-bit timer with programmable 8 bit prescaler and 8 bit capture register
Mode 1: 8 bit timer with 8 bit programmable prescaler and 8 bit capture register + 8 bit Counter with 8-bit capture register
Mode 2: 16 bit timer with 8 bit programmable prescaler and 16 bit capture register
Mode 3: 16 bit counter with 16 bit capture register
  - Timer 1: PWM / 16 bit timer toggle output
 

Mode 0: 2 channel 8 bit timer (with toggle output)
Mode 1: 2 channel 8 bit PWM
Mode 2: 16 bit timer (with toggle output) Toggle output also possible using lower 8 bits.
Mode 3: 16 bit timer (with toggle output) Lower 8 bits can be used as PWM output.

## (8) Serial-interface

- SIO 0: 8 bit synchronous serial interface
  - 1) LSB first / MSB first is selectable
  - 2) Internal 8 bit baud-rate generator (maximum transmit clock period  $4 / 3$  tCYC)
  - 3) Continuous automatic data communication (1-256 bits)
- SIO 1: 8 bit asynchronous / synchronous serial interface
  - Mode 0: Synchronous 8 bit serial I<sub>O</sub> (2-wire or 3-wire, transmit clock 2–512 tCYC)
  - Mode 1: Asynchronous serial I<sub>O</sub> (half duplex, 8 data bits, 1 stop bit, baud rate 8–2048 tCYC)
  - Mode 2: Bus mode 1 (start bit, 8 data bits, transmit clock 2–512 tCYC)
  - Mode 3: Bus mode 2 (start detection, 8 data bits, stop detection)

## (9) AD converter

- 8 bits × 10 channels

## (10) Remote control receiver circuit (connected to P73 / INT3 / T0IN terminal)

- Noise rejection function (noise rejection filter time constant can selected from 1 / 32 / 128 tCYC)

## (11) Watchdog timer

- The watching timer period is determined by an external RC.
- Watchdog timer can produce interrupt, system reset

## (12) Interrupts: 13-source, 10-vector interrupts

- 1) Three priority, low (L), high (H) and highest (X), multiple interrupts are supported.  
During interrupt handling, an equal or lower priority interrupt request is postponed.
- 2) If interrupt requests to two or more vector addresses occur at once, the higher priority interrupt takes precedence.

In the case of equal priority levels, the vector with the lowest address takes precedence.

No.	Vector	Selectable level	Interrupt signal
1	00003H	X or L	INT0
2	0000BH	X or L	INT1
3	00013H	H or L	INT2 / T0L
4	0001BH	H or L	INT3
5	00023H	H or L	T0H
6	0002BH	H or L	T1L / T1H
7	00033H	H or L	SIO0
8	0003BH	H or L	SIO1
9	00043H	H or L	ADC
10	0004BH	H or L	VFD automatic display controller / Port0

- Priority Level : X > H > L
- For equal priority levels, vector with lowest address takes precedence.

## (13) Subroutine stack levels: 384 levels max. Stack is located in RAM.

## (14) Multiplication and division

- 16 bits × 8 bits (executed in 5 cycles)
- 24 bits × 16 bits (executed in 12 cycles)
- 16 bits ÷ 8 bits (executed in 8 cycles)
- 24 bits ÷ 16 bits (executed in 12 cycles)

## (15) Oscillation circuits

- On-chip RC oscillation circuit for system clock use.
- On-chip CF oscillation circuit for system clock use. (R<sub>f</sub> built in)
- Frequency variable RC oscillation Circuit (imbedded) for system clock use.

## (16) System clock divider function

- Able to reduce current consumption

Available minimum instruction cycle time: 300ns, 600ns, 1.2 $\mu$ s, 2.4 $\mu$ s, 4.8 $\mu$ s, 9.6 $\mu$ s, 19.2 $\mu$ s, 38.4 $\mu$ s, 76.8 $\mu$ s.  
(Using 10MHz main clock)

## (17) Standby function

- HALT mode

HALT mode is used to reduce power consumption. Program execution is stopped. Peripheral circuits still operate but VFD display and some serial transfer operations stop.

- 1) Oscillation circuits are not stopped automatically.
- 2) Release occurs on system reset or by interrupt.

- HOLD mode

HOLD mode is used to reduce power consumption. Both program execution and peripheral circuits are stopped.

- 1) CF, RC and crystal oscillation circuits stop automatically.
- 2) Release occurs on any of the following conditions.
  - (1) Input to the reset pin goes low
  - (2) A specified level is input at least one of INT0, INT1, INT2
  - (3) An interrupt condition arises at port 0

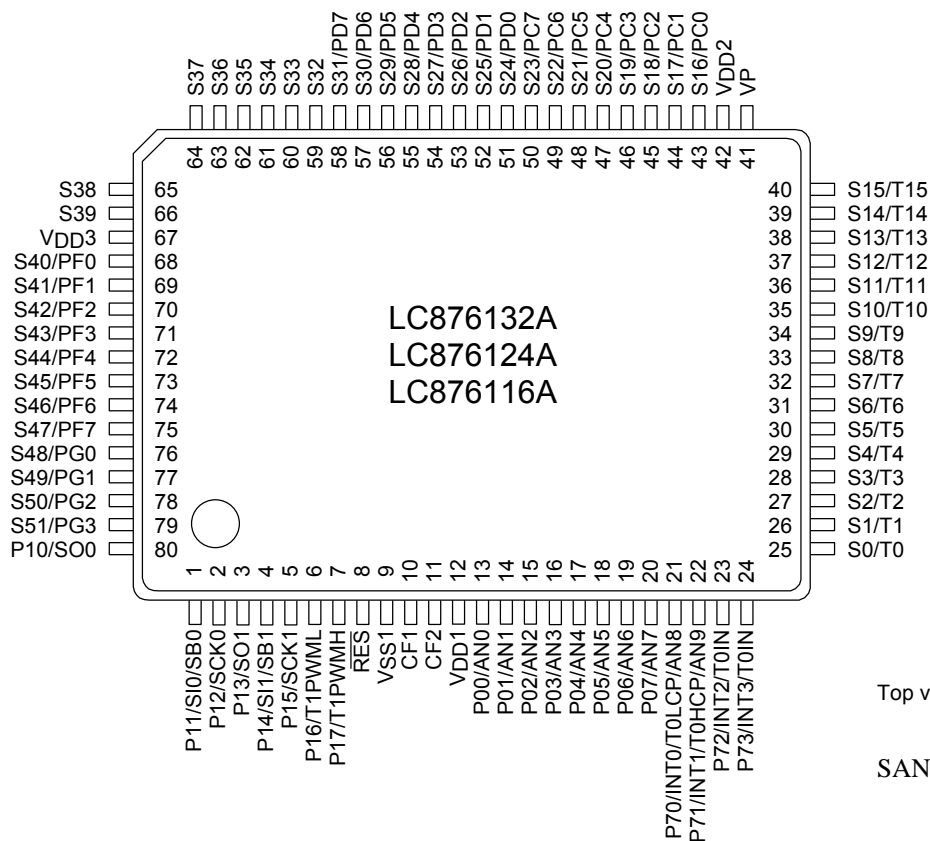
## (18) Factory shipment

- QIP80E

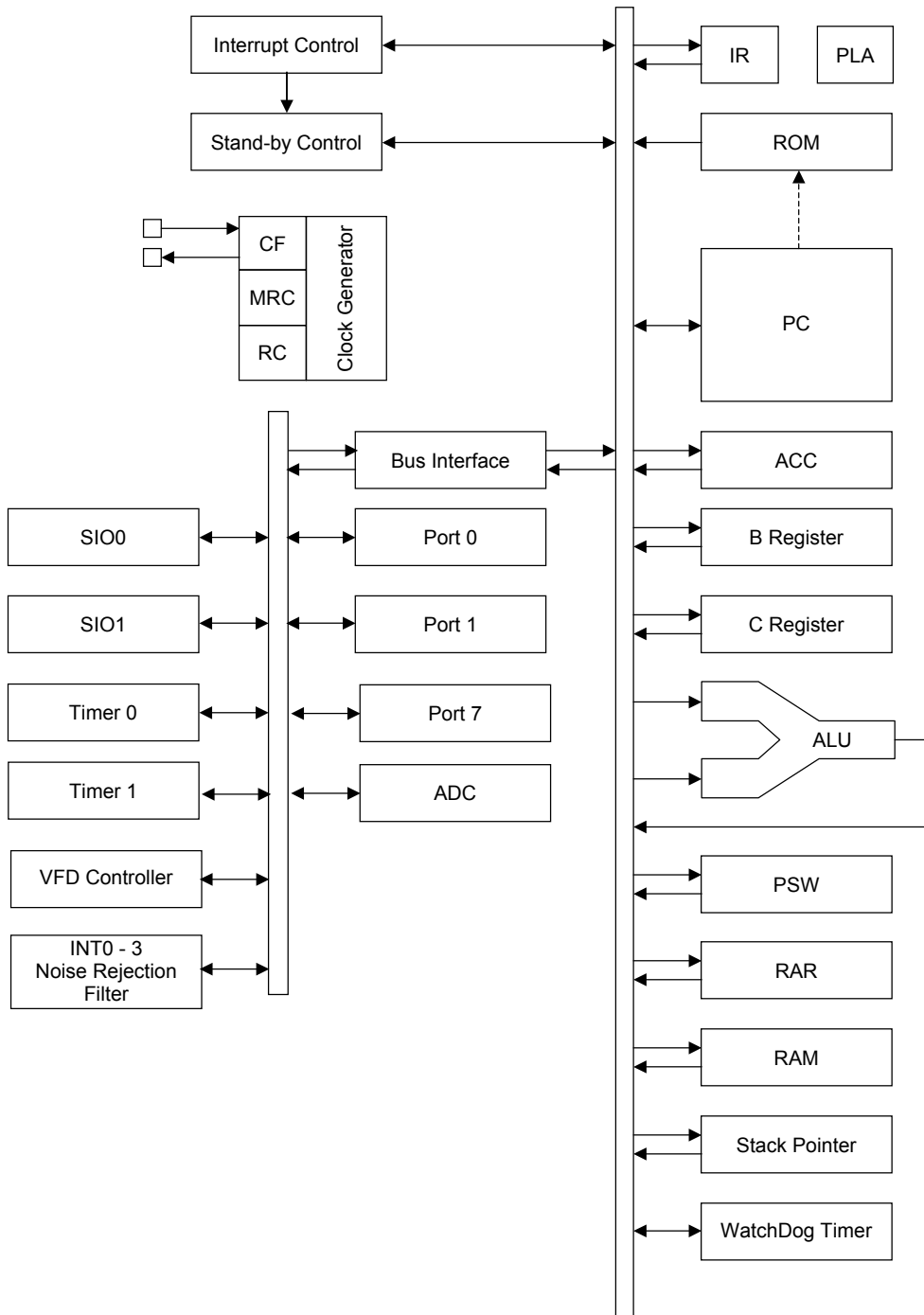
## (19) Development tools

- Evaluation chip: LC876093
- Emulator: EVA62S + ECB876600 (Evaluation chip board) + SUB876100 + POD80QFP  
: ICE-B877300 + SUB876100 + POD80QFP

## Pin Assignment



### System Block Diagram



## Pin Description

Pin name	I/O	Function	Option																														
V <sub>SS1</sub>	-	• Power supply (-)	No																														
V <sub>DD1</sub> V <sub>DD2</sub> V <sub>DD3</sub>	-	• Power supply (+)	No																														
VP	-	• Power supply (-)	No																														
PORT0 P00 to P07	I/O	<ul style="list-style-type: none"> <li>• 8 bit input / output port</li> <li>• Data direction programmable in nibble units</li> <li>• Use of pull-up resistors for P1 to P3 and P4 to P7 can be specified in three bit unit and nibble unit respectively.</li> <li>• Input for HOLD release</li> <li>• Input for port 0 interrupt</li> <li>• Other function</li> </ul> A/D conversion input port: AN0 to AN7	Yes (P00 has no option)																														
PORT1 P10 to P17	I/O	<ul style="list-style-type: none"> <li>• 8-bit input / output port</li> <li>• Data direction programmable for each bit</li> <li>• Use of pull-up resistor can be specified for each bit</li> <li>• Other pin functions</li> </ul> P10: SIO0 data output P11: SIO0 data input / bus input / output P12: SIO0 clock input / output P13: SIO1 data output P14: SIO1 data input / bus input / output P15: SIO1 clock input / output P16: Timer 1 PWML output P17: Timer 1 PWMH output / Buzzer output	Yes																														
PORT7 P70 to P73	I/O	<ul style="list-style-type: none"> <li>• 4-bit Input / output port</li> <li>• Data direction can be specified for each bit</li> <li>• Use of pull-up resistor can be specified</li> <li>• Other functions</li> </ul> P70: INT0 input / HOLD release input / Timer0L capture Input / output for watchdog timer P71: INT1 input / HOLD release input / Timer0H capture input P72: INT2 input / HOLD release input / timer 0 event input / Timer0L capture input / High speed clock counter input P73: INT3 input (noise rejection filter attached input) / timer 0 event input / Timer 0H capture input AD input port: AN8 (P70), AN9 (P71) The following types of interrupt detection are possible: <table border="1" style="margin-left: 20px;"> <thead> <tr> <th></th> <th>Rising</th> <th>Falling</th> <th>Rising / falling</th> <th>H level</th> <th>L level</th> </tr> </thead> <tbody> <tr> <td>INT0</td> <td>Yes</td> <td>Yes</td> <td>No</td> <td>Yes</td> <td>Yes</td> </tr> <tr> <td>INT1</td> <td>Yes</td> <td>Yes</td> <td>No</td> <td>Yes</td> <td>Yes</td> </tr> <tr> <td>INT2</td> <td>Yes</td> <td>Yes</td> <td>Yes</td> <td>No</td> <td>No</td> </tr> <tr> <td>INT3</td> <td>Yes</td> <td>Yes</td> <td>Yes</td> <td>No</td> <td>No</td> </tr> </tbody> </table>		Rising	Falling	Rising / falling	H level	L level	INT0	Yes	Yes	No	Yes	Yes	INT1	Yes	Yes	No	Yes	Yes	INT2	Yes	Yes	Yes	No	No	INT3	Yes	Yes	Yes	No	No	No
	Rising	Falling	Rising / falling	H level	L level																												
INT0	Yes	Yes	No	Yes	Yes																												
INT1	Yes	Yes	No	Yes	Yes																												
INT2	Yes	Yes	Yes	No	No																												
INT3	Yes	Yes	Yes	No	No																												
S0 / T0 to S8 / T8	O	• Large current output for VFD display controller digit (can be used for segment)	No																														
S9 / T9 to S15 / T15	O	• Large current output for VFD display controller segment / digit	No																														
S16 to S23	I/O	<ul style="list-style-type: none"> <li>• Output for VFD display controller segment / digit</li> <li>• Other functions: High voltage input port: PC0 to PC7</li> </ul>	No																														
S24 to S31	I/O	<ul style="list-style-type: none"> <li>• Output for VFD display controller segment</li> <li>• Other functions: High voltage input port: PD0 to PD7</li> </ul>	No																														
S32 to S39	O	• Output for VFD display controller segment	No																														
S40 to S47	O	<ul style="list-style-type: none"> <li>• Output for VFD display controller segment</li> <li>• Other functions: High voltage output port: PF0 to PF7</li> </ul>	No																														
S48 to S51	I/O	<ul style="list-style-type: none"> <li>• Output for VFD display controller segment</li> <li>• Other functions: High voltage input / output port: PG0 to PG3</li> </ul>	No																														
RES	I	Reset terminal	No																														
CF1	I	Input terminal for ceramic oscillator	No																														
CF2	O	Output terminal for ceramic oscillator	No																														

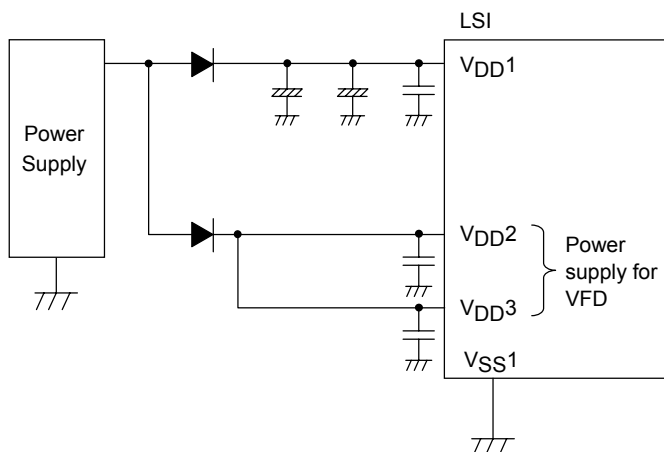
## Port Output Configuration

Output configuration and pull-up / pull-down resistor options are shown in the following table.  
Input / output is possible even when port is set to output mode.

Terminal	Option applies to:	Options	Output Format	Pull-up resistor	Pull-down resistor
P00	-	None	N-ch open drain	None	-
P01 to P07	1 bit unit	1	CMOS	Programmable (Note 1)	-
		2	Nch-open drain	None	-
P10 to P17	1 bit unit	1	CMOS	Programmable	-
		2	Nch-open drain	Programmable	-
P70	-	None	Nch-open drain	Programmable	-
P71 to P73	-	None	CMOS	Programmable	-
S0 / T0 to S6 / T6	-	None	High voltage Pch-open drain	-	None
S7 / T7 to S15 / T15	-	None	High voltage Pch-open drain	-	Fixed
S16 to S31	-	None	High voltage Pch-open drain	-	None
S32 to S39	-	None	High voltage Pch-open drain	-	Fixed
S40 to S47	-	None	High voltage Pch-open drain	-	None
S48 to S51	-	None	High voltage Pch-open drain	-	None

Note 1 Pull-up resistors for Port 0 can be attached in three-bit unit (P01-03) and nibble unit (P04-07) by the program.

\* Note 1: Connect as follows to reduce noise on  $V_{DD}$  and increase the back-up time.



**Absolute Maximum Ratings** / Ta=25°C and V<sub>SS</sub>1=0V

Parameter	Symbol	Pins	Conditions	V <sub>DD</sub> [V]	min	typ	max	unit
Supply voltage	V <sub>DD</sub> max	V <sub>DD</sub> 1, V <sub>DD</sub> 2, V <sub>DD</sub> 3	V <sub>DD</sub> 1=V <sub>DD</sub> 2=V <sub>DD</sub> 3		-0.3		+6.5	V
Input voltage	V <sub>I</sub> (1)	CF1, RES			-0.3		V <sub>DD</sub> +0.3	
	V <sub>I</sub> (2)	VP			V <sub>DD</sub> -45		V <sub>DD</sub> +0.3	
Output voltage	V <sub>O</sub> (1)	S0 / T0 to S15 / T15 S32 to S47			V <sub>DD</sub> -45		V <sub>DD</sub> +0.3	
Input / Output voltage	V <sub>IO</sub> (1)	•Port 0 •Port 1 •Port 7			-0.3		V <sub>DD</sub> +0.3	
	V <sub>IO</sub> (2)	S16 to S31, S48 to S51			V <sub>DD</sub> -45		V <sub>DD</sub> +0.3	
[High level output current]								
Peak output current	IOPH(1)	Port 0, 1	•CMOS output selected •Current at each pin		-10			mA
	IOPH(2)	Port71, 72, 73	Current at each pin		-3			
	IOPH(3)	S0 / T0 to S15 / T15	Current at each pin		-30			
	IOPH(4)	S16 to S51	Current at each pin		-15			
Total output current	∑IOAH(1)	Port 0	Total of all pins		-30			
	∑IOAH(2)	Port 1	Total of all pins		-30			
	∑IOAH(3)	Port 7	Total of all pins		-5			
	∑IOAH(4)	S0 / T0 to S15 / T15	Total of all pins		-65			
	∑IOAH(5)	S16 to S27	Total of all pins		-60			
	∑IOAH(6)	S28 to S39	Total of all pins		-60			
	∑IOAH(7)	S40 to S51	Total of all pins		-60			
[Low level output current]								
Peak output current	IOPL(1)	Port 0, 1	For each pin				20	mA
	IOPL(2)	Port 7	For each pin				5	
Total output current	∑IOAL(1)	Port 0	Total of all pins				60	
	∑IOAL(2)	Ports 1, 7	Total of all pins				60	
Maximum power consumption	Pd max	QIP80E	Ta = -30 to +70°C				478	mW
Operating temperature range	Topr				-30		+70	°C
Storage temperature range	Tstg				-55		+125	



Recommended Operating Range /  $T_a = -30^{\circ}\text{C}$  to  $+70^{\circ}\text{C}$ ,  $V_{SS1} = 0\text{V}$ 

Parameter	Symbol	Pins	Conditions	$V_{DD}$ [V]	min	typ	max	unit	
Operating supply voltage range	$V_{DD}(1)$	$V_{DD1}=V_{DD2}=V_{DD3}$	$0.294\mu\text{s} \leq t_{CYC} \leq 200\mu\text{s}$		4.5		5.5	V	
Hold voltage	VHD	$V_{DD1}$	RAM and the register data are kept in HOLD mode.		2.0		5.5		
Pull-down voltage	VP	VP		4.5 to 5.5	-35		$V_{DD}$		
Input high voltage	$V_{IH}(1)$	•Port 0	Output disable	4.5 to 5.5	$0.3V_{DD} + 0.7$		$V_{DD}$		
	$V_{IH}(2)$	•Port 1 •Port 71, 72, 73 •P70 port input / interrupt	Output disable	4.5 to 5.5	$0.3V_{DD} + 0.7$		$V_{DD}$		
	$V_{IH}(3)$	S16 to S31 S48 to S51	Output P-channel Tr. OFF	4.5 to 5.5	$0.33V_D + 1.0$		$V_{DD}$		
	$V_{IH}(4)$	Port 70 Watchdog timer	Output disable	4.5 to 5.5	$0.9V_{DD}$		$V_{DD}$		
	$V_{IH}(5)$	CF1, RES		4.5 to 5.5	$0.75V_D$		$V_{DD}$		
Input low voltage	$V_{IL}(1)$	•Port 0	Output disable	4.5 to 5.5	$V_{SS}$		$0.15V_{DD} + 0.4$		
	$V_{IL}(2)$	•Port 1 •Port 71, 72, 73 •P70 port input / interrupt	Output disable	4.5 to 5.5	$V_{SS}$		$0.1V_{DD} + 0.4$		
	$V_{IL}(3)$	S16 to S31 S48 to S51	Output P-channel Tr. OFF	4.5 to 5.5	$V_{SS}$		$0.2V_{DD}$		
	$V_{IL}(4)$	Port 70 Watchdog timer	Output disabled	4.5 to 5.5	$V_{SS}$		$0.8V_{DD} - 1.0$		
	$V_{IL}(5)$	CF1, RES		4.5 to 5.5	$V_{SS}$		$0.25V_{DD}$		
Operation cycle time	$t_{CYC}$			4.5 to 5.5	0.294		200		$\mu\text{s}$
External system clock frequency	FEXCF(1)	CF1	•CF2 open circuit •system clock divider set to 1/1 •external clock DUTY = $50 \pm 5\%$	4.5 to 5.5	0.1		10		MHz
			•CF2 open circuit •system clock divider set to 1/2	4.5 to 5.5	0.2		20		
Oscillation stabilizing time period (Note 1)	FmCF(1)	CF1, CF2	10MHz ceramic resonator oscillation Refer to figure 1	4.5 to 5.5		10			
	FmCF(2)	CF1, CF2	4MHz ceramic resonator oscillation Refer to figure 1	4.5 to 5.5		4			
	FmMRC		Frequency variable RC oscillation	4.5 to 5.5		50			
	FmRC		RC oscillation	4.5 to 5.5	0.3	1.0	2.0		

(Note 1) The oscillation constant is shown in table 1 and table 2.

Electrical Characteristics / Ta=-30°C to +70°C, V<sub>SS</sub>1=0V

Parameter	Symbol	Pins	Conditions	V <sub>DD</sub> [V]	min	typ	max	unit
Input high current	I <sub>IH</sub> (1)	Port 0, 1, 7	•Output disabled •Pull-up resistor OFF. •V <sub>IN</sub> =V <sub>DD</sub> (including OFF state leak current of the output Tr.)	4.5 to 5.5			1	μA
	I <sub>IH</sub> (2)	S16 to S31 S48 to S51 (Port C, D, G)	When configured as an input port V <sub>IN</sub> =V <sub>DD</sub>				60	
	I <sub>IH</sub> (3)	RES	V <sub>IN</sub> =V <sub>DD</sub>	4.5 to 5.5			1	
	I <sub>IH</sub> (4)	CF1	V <sub>IN</sub> =V <sub>DD</sub>	4.5 to 5.5			15	
Input low current	I <sub>IL</sub> (1)	Port 0, 1, 7	•Output disabled •Pull-up resistor OFF •V <sub>IN</sub> =V <sub>SS</sub> (including OFF state leak current of the output Tr.)	4.5 to 5.5	-1			
	I <sub>IL</sub> (2)	RES	V <sub>IN</sub> =V <sub>SS</sub>	4.5 to 5.5	-1			
	I <sub>IL</sub> (3)	CF1	V <sub>IN</sub> =V <sub>SS</sub>	4.5 to 5.5	-15			
Output high voltage	V <sub>OH</sub> (1)	Port 0, 1	I <sub>OH</sub> =-1.0mA	4.5 to 5.5	V <sub>DD</sub> -1			V
	V <sub>OH</sub> (2)		I <sub>OH</sub> =-0.1mA	4.5 to 5.5	V <sub>DD</sub> -0.5			
	V <sub>OH</sub> (3)	Port 7	I <sub>OH</sub> =-0.4mA	4.5 to 5.5	V <sub>DD</sub> -1			
	V <sub>OH</sub> (4)	S0 / T0 to S15 / T15	I <sub>OH</sub> =-20.0mA	4.5 to 5.5	V <sub>DD</sub> -1.8			
	V <sub>OH</sub> (5)		I <sub>OH</sub> =-1.0mA I <sub>OH</sub> at any single pin is not over 1mA.	4.5 to 5.5	V <sub>DD</sub> -1			
	V <sub>OH</sub> (6)	S16 to S51	I <sub>OH</sub> =-5.0mA	4.5 to 5.5	V <sub>DD</sub> -1.8			
	V <sub>OH</sub> (7)		I <sub>OH</sub> =-1.0mA I <sub>OH</sub> at any single pin is not over 1mA.	4.5 to 5.5	V <sub>DD</sub> -1			
Output low voltage	V <sub>OL</sub> (1)	Port 0, 1	I <sub>OL</sub> =9mA	4.5 to 5.5			1.5	
	V <sub>OL</sub> (2)		I <sub>OL</sub> =1.5mA	4.5 to 5.5			0.4	
	V <sub>OL</sub> (3)	Port 7	I <sub>OL</sub> =1mA	4.5 to 5.5			0.4	
Pull-up resistor	R <sub>pu</sub>	Port 0, 1, 7	V <sub>OH</sub> =0.9V <sub>DD</sub>	4.5 to 5.5	15	40	70	kΩ
Output off-leak current	I <sub>OFF</sub> (1)	S0 / T0 to S6 / S6, S16 to S31	•Output P-ch Tr. OFF •V <sub>OUT</sub> =V <sub>SS</sub>	4.5 to 5.5	-1			μA
	I <sub>OFF</sub> (2)	S48 to S51	•Output P-ch Tr. OFF •V <sub>OUT</sub> =V <sub>DD</sub> -40V	4.5 to 5.5	-30			
Resistance of the low level hold Tr.	R <sub>inpd</sub>	S16 to S31 S48 to S51	•Output P-ch Tr. OFF	4.5 to 5.5		200		kΩ
High voltage pull-down resistor	R <sub>pd</sub>	S7 / T7 to S15 / T15, S32 to S39	•Output P-ch Tr. OFF •V <sub>OUT</sub> =3V •V <sub>p</sub> =-30V	5.0	60	100	200	
Hysteresis voltage	V <sub>HIS</sub> (1)	•Port 1, 7 •RES		4.5 to 5.5		0.1V <sub>DD</sub>		V
Pin capacitance	CP	All pins	•All other terminals connected to V <sub>SS</sub> . •f=1MHz •Ta=25°C	4.5 to 5.5		10		pF

**Serial Input / Output Characteristics** / Ta=-30°C to +70°C, V<sub>SS</sub>1=0V

Parameter	Symbol	Pins	Conditions	V <sub>DD</sub> [V]	min	typ	max	unit
[Serial clock]								
[Input clock]								
Cycle time	tSCK(1)	SCK0(P12)	Refer to figure 5	4.5 to 5.5	4/3			tCYC
Low level pulse width	tSCKL(1)				2/3			
	tSCKLA(1)				2/3			
High level pulse width	tSCKH(1)				2/3			
	tSCKHA(1)	3						
Cycle time	tSCK(2)	SCK1(P15)	Refer to figure 5	4.5 to 5.5	2			tCYC
Low level pulse width	tSCKL(2)				1			
High level pulse width	tSCKH(2)				1			
[Output clock]								
Cycle time	tSCK(3)	SCK0(P12)	•CMOS output option •Refer to figure 5	4.5 to 5.5	4/3			tCYC
Low level pulse width	tSCKL(3)					1/2		tSCK
	tSCKLA(2)					3/4		
High level pulse width	tSCKH(3)					1/2		
	tSCKHA(2)		2					
Cycle time	tSCK(4)	SCK1(P15)	•CMOS output option •Refer to figure 5	4.5 to 5.5	2			tCYC
Low level pulse width	tSCKL(4)					1/2		tSCK
High level pulse width	tSCKH(4)					1/2		
[Serial input]								
Data set-up time	tsDI	SI0(P11), SI1(P14), SB0(P11), SB1(P14)	•Measured with respect to SI0CLK leading edge. •Refer to figure 5	4.5 to 5.5	0.03			μs
Data hold time	thDI				0.03			
[Serial output]								
Output delay time	tdDO	SO0(P10), SO1(P13), SB0(P11), SB1(P14)	•Measured with respect to SI0CLK trailing edge. •When port is open drain: Time delay from SI0CLK trailing edge to the SO data change. •Refer to figure 5	4.5 to 5.5			1/3 tCYC +0.05	μs

**Pulse Input Conditions** / Ta=-30°C to +70°C, V<sub>SS</sub>1=0V

Parameter	Symbol	Pins	Conditions	V <sub>DD</sub> [V]	min	typ	max	unit
High / low level pulse width	tPIH(1) tPIL(1)	INT0(P70), INT1(P71), INT2(P72)	•Interrupt acceptable •Events to timer 0 can be input.	4.5 to 5.5	1			tCYC
	tPIH(2) tPIL(2)	INT3(P73) (Noise rejection ratio set to 1/1.)	•Interrupt acceptable •Events to timer 0 can be input.	4.5 to 5.5	2			
	tPIH(3) tPIL(3)	INT3(P73) (Noise rejection ratio set to 1/32.)	•Interrupt acceptable •Events to timer 0 can be input.	4.5 to 5.5	64			
	tPIH(4) tPIL(4)	INT3(P73) (Noise rejection ratio set to 1/128.)	•Interrupt acceptable •Events to timer 0 can be input.	4.5 to 5.5	256			
	tPIL(5)	$\overline{\text{RES}}$		•Reset possible	4.5 to 5.5	200		

**AD Converter Characteristics** /  $T_a = -30^{\circ}\text{C}$  to  $+70^{\circ}\text{C}$ ,  $V_{SS1} = 0\text{V}$ 

Parameter	Symbol	Pins	Conditions	$V_{DD}$ [V]	min	typ	max	unit	
Resolution	N	AN0(P00) to AN7(P07)		4.5 to 5.5		8		bit	
Absolute precision	ET	AN8(P70), AN9(P71)	(Note2)	4.5 to 5.5			$\pm 1.5$	LSB	
Conversion time	TCAD		AD conversion time = 32 × tCYC (ADCR2=0) (Note 3)	4.5 to 5.5			15.62 (tCYC= 0.488μs)	97.92 (tCYC= 3.06μs)	μs
			AD conversion time = 64 × tCYC (ADCR2=1) (Note 3)				18.82 (tCYC= 0.294μs)	97.92 (tCYC= 1.53μs)	
Analog input voltage range	VAIN			4.5 to 5.5	$V_{SS}$		$V_{DD}$	V	
Analog port input current	IAINH		$V_{AIN} = V_{DD}$	4.5 to 5.5			1	μA	
	IAINL		$V_{AIN} = V_{SS}$	4.5 to 5.5	-1				

(Note 2) Absolute precision not including quantizing error ( $\pm 1/2$  LSB).

(Note 3) Conversion time means time from executing AD conversion instruction to loading complete digital value to register.

**Current Consumption Characteristics** /  $T_a = -30^{\circ}\text{C}$  to  $+70^{\circ}\text{C}$ ,  $V_{SS1} = 0\text{V}$ 

Parameter	Symbol	Pins	Conditions	$V_{DD}$ [V]	min	typ	max	unit
Current consumption during basic operation (Note 4)	IDDOP(1)	$V_{DD1} = V_{DD2} = V_{DD3}$	•FmCF=10MHz for Ceramic resonator oscillation •System clock: CF oscillation •Internal RC oscillation stopped. •Divider set to 1/1	4.5 to 5.5		8	27	mA
	IDDOP(2)		•CF1=20MHz for external clock •System clock: CF oscillation •Internal RC oscillation stopped. •Divider set to 1/2	4.5 to 5.5		8.5	28	
	IDDOP(3)		•FmCF=4MHz Ceramic resonator oscillation •System clock: CF oscillation •Internal RC oscillation stopped. •Divider set to 1/1	4.5 to 5.5		3.5	15	
	IDDOP(4)		•FmCF=0Hz (No oscillation) •System clock: RC oscillation •Divider set to 1/2	4.5 to 5.5		1	8.5	
	IDDOP(5)		•FmCF=0Hz (No oscillation) •Internal RC oscillation stopped. •System clock: RC oscillation •Divider set to 1/2	4.5 to 5.5		2.0	10.5	

Continued on next page.

Continued from preceding page.

Parameter	Symbol	Pins	Conditions	V <sub>DD</sub> [V]	min	typ	max	unit
Current consumption HALT mode (Note 4)	IDDHALT(1)	V <sub>DD1</sub> =V <sub>DD2</sub> =V <sub>DD3</sub>	HALT mode •FmCF=10MHz for Ceramic resonator oscillation •System clock : CF oscillation •Internal RC oscillation stopped. •Divider: 1/1	4.5 to 5.5				mA
	IDDHALT(2)		HALT mode •CF1=20MHz for external clock •System clock : CF oscillation •Internal RC oscillation stopped. •Divider: 1/2	4.5 to 5.5				
	IDDHALT(3)		HALT mode •FmCF=4MHz for Ceramic resonator oscillation •System clock : CF oscillation •Internal RC oscillation stopped. •Divider: 1/1	4.5 to 5.5				
	IDDHALT(4)		HALT mode •FmCF=0Hz (When oscillation stops.) •System clock : RC oscillation •Divider: 1/2	4.5 to 5.5				μA
Current consumption HOLD mode	IDDHOLD(1)	V <sub>DD1</sub>	HOLD mode •CF1=V <sub>DD</sub> or open circuit (when using external clock)	4.5 to 5.5				μA

(Note 4) The currents of the output transistors and the pull-up MOS transistors are ignored.

### Main system clock oscillation circuit characteristics

The characteristics in the table below is based on the following conditions:

1. Use the standard evaluation board SANYO has provided.
2. Use the peripheral parts with indicated value externally.
3. The peripheral parts value is a recommended value of oscillator manufacturer.

Table 1. Main system clock oscillation circuit characteristics using ceramic resonator

Frequency	Manufacturer	Oscillator	Circuit parameters			Operating supply voltage range	Oscillation stabilizing time		Notes
			C1	C2	Rd1		typ	max	
10MHz	Murata	CSTLS10M0G53-B0	(15pF)	(15pF)	0Ω	4.5 to 5.5V	0.03mS	0/25mS	With C1, C2
		CSTCC10M0G53-R0	(15pF)	(15pF)	100Ω	4.5 to 5.5V	0.03mS	0/25mS	With C1, C2
4MHz	Murata	CSTLS4M00G53-R0	(15pF)	(15pF)	330Ω	4.5 to 5.5V	0.03mS	0/25mS	With C1, C2
		CSTCR4M00G53-R0	(15pF)	(15pF)	330Ω	4.5 to 5.5V	0.05mS	0.3mS	With C1, C2
	Kyosera	PBRC4.00HR	(33pF)	(33pF)	0Ω	4.5 to 5.5V	0.15mS	1.0mS	With C1, C2
		KBR-4.0MKC	(33pF)	(33pF)	0Ω	4.5 to 5.5V	0.15ms	1.0mS	With C1, C2

The oscillation stabilizing time is a period until the oscillation becomes stable after V<sub>DD</sub> becomes higher than minimum operating voltage. (Refer to Figure 3)

- (Notes) • Since the circuit pattern affects the oscillation frequency, place the oscillation-related parts as close to the oscillation pins as possible with the shortest possible pattern length.

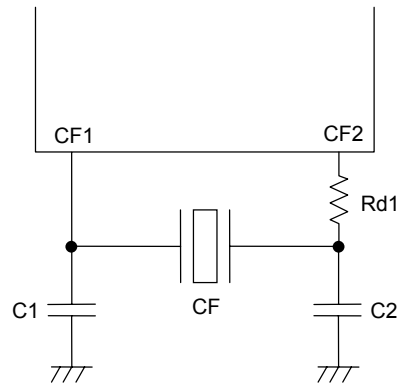


Figure 1. Ceramic oscillation circuit

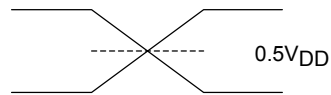
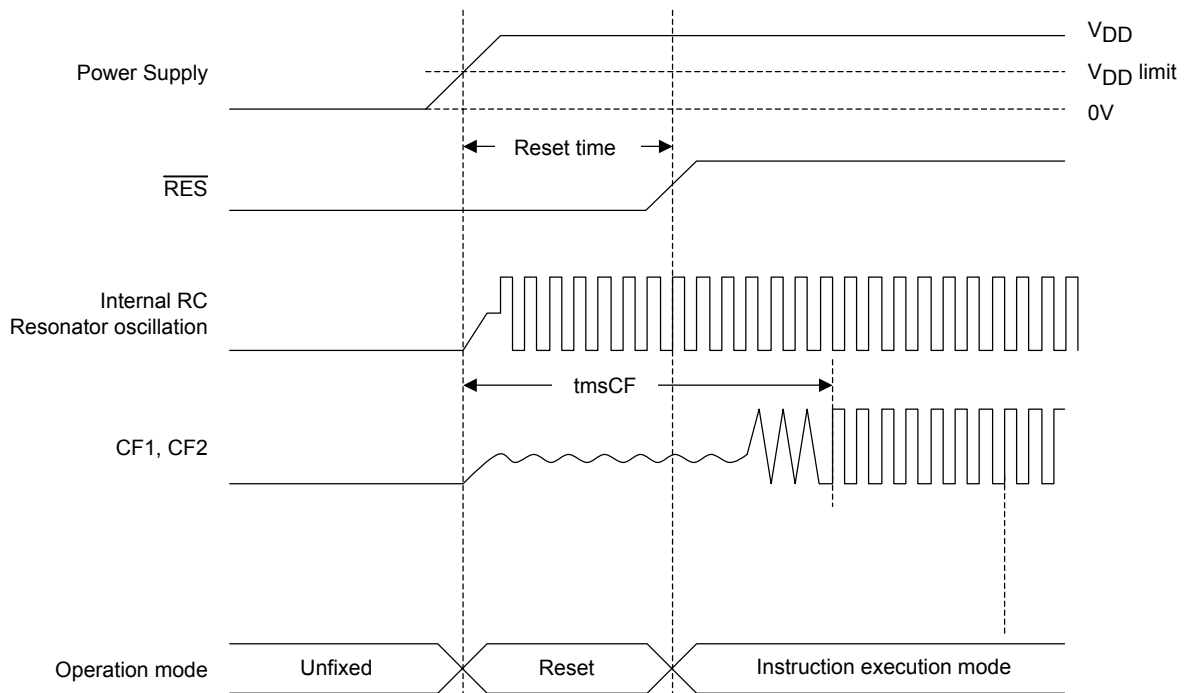
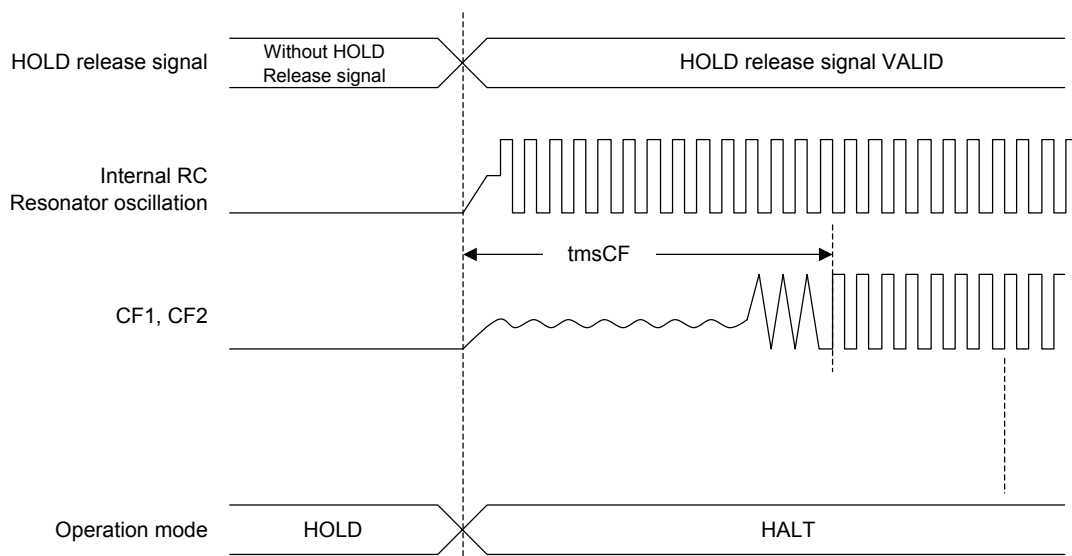


Figure 2. AC timing measurement point

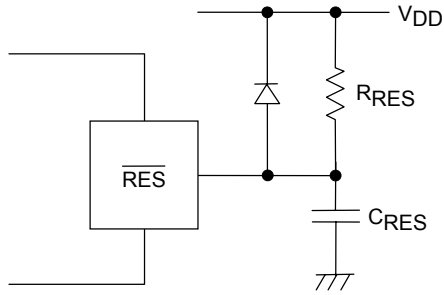


Reset time and oscillation stable time



HOLD release signal and oscillation stable time

Figure 3. Oscillation stabilization time



(Note) Set  $C_{RES}$ ,  $R_{RES}$  values such that reset time exceeds  $200\mu s$ .

Figure 4. Reset circuit

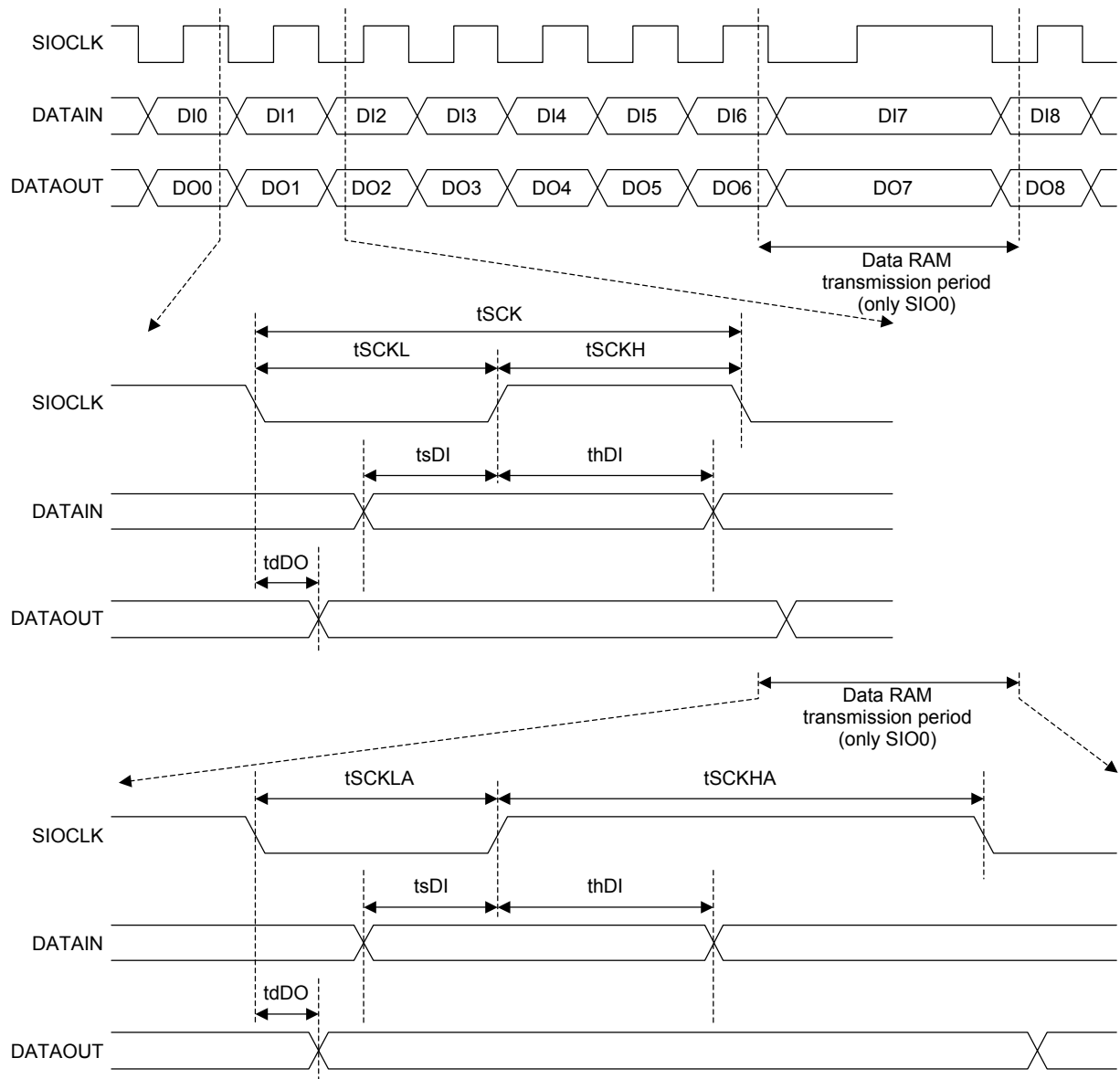


Figure 5. Serial input / output test condition



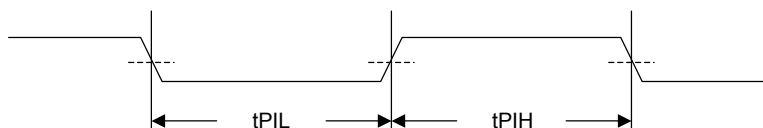


Figure 6. Pulse input timing condition

- Specifications of any and all SANYO products described or contained herein stipulate the performance, characteristics, and functions of the described products in the independent state, and are not guarantees of the performance, characteristics, and functions of the described products as mounted in the customer's products or equipment. To verify symptoms and states that cannot be evaluated in an independent device, the customer should always evaluate and test devices mounted in the customer's products or equipment.
- SANYO Electric Co., Ltd. strives to supply high-quality high-reliability products. However, any and all semiconductor products fail with some probability. It is possible that these probabilistic failures could give rise to accidents or events that could endanger human lives, that could give rise to smoke or fire, or that could cause damage to other property. When designing equipment, adopt safety measures so that these kinds of accidents or events cannot occur. Such measures include but are not limited to protective circuits and error prevention circuits for safe design, redundant design, and structural design.
- In the event that any or all SANYO products (including technical data, services) described or contained herein are controlled under any of applicable local export control laws and regulations, such products must not be exported without obtaining the export license from the authorities concerned in accordance with the above law.
- No part of this publication may be reproduced or transmitted in any form or by any means, electronic or mechanical, including photocopying and recording, or any information storage or retrieval system, or otherwise, without the prior written permission of SANYO Electric Co., Ltd.
- Any and all information described or contained herein are subject to change without notice due to product/technology improvement, etc. When designing equipment, refer to the "Delivery Specification" for the SANYO product that you intend to use.
- Information (including circuit diagrams and circuit parameters) herein is for example only; it is not guaranteed for volume production. SANYO believes information herein is accurate and reliable, but no guarantees are made or implied regarding its use or any infringements of intellectual property rights or other rights of third parties.

This catalog provides information as of February, 2004. Specifications and information herein are subject to change without notice.