

**8-Bit Single Chip Microcontroller****Under Development****LC87F67C8A****Overview**

8-bit single-chip microcontroller with the following on-chip functional blocks.

- CPU: operable at a minimum bus cycle time of 100 ns
- 128K bytes flash ROM (rewritable on-board)
- On-chip RAM: 4096 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)
- 8-bit timer x 4 with prescaler
- timer for use as date / time clock
- High-speed clock counter
- System clock divider function
- synchronous serial I/O port (with automatic block transmit / receive function)
- asynchronous / synchronous serial I/O port
- 14-channel × 8-bit AD converter
- Weak signal detector
- 21-source 10-vectored interrupt system

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

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Features

(1) Read-Only Memory (Flash ROM)

- single 5V power supply, write able on-board
- block erase in 128 byte units
- 131072×8bits (LC87F67C8A)

(2) Random Access Memory (RAM): 4096 × 9 bits (LC87F67C8A)

(3) Minimum Bus Cycle Time: 100 ns (10 MHz)

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: 20 (P1n, P70 to P73, P8n)
- 14V withstand input/output ports
 - Data direction programmable in nibble units: 8 (P0n)
 - (When N-channel open drain output is selected, data can be input in bit units.)
 - Data direction programmable for each bit individually: 8 (P3n)
- Input ports: 2 (XT1,XT2)
- 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/output ports: 12(PFn, PG0 to3)
 - Input ports: 24 (PCn, PDn, PEn)
- Oscillator pins: 2 (CF1,CF2)
- Reset pin: 1 (RES#)
- Power supply: 6 (VSS1 to 2, VDD1 to 4)

(6) VFD automatic display controller

- Programmable segment/digit output pattern
 - Output can be switched between digit/segment waveform output (pins 9–24 can be used for output of digit waveforms.
 - parallel-drive available for large current VFD.
- 16-step dimmer function available

(7) Weak signal detection (MIC signals etc)

- Counts pulses with width greater than a preset value
- 2 bit counter

(8) 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 order 8 bits.
 - Mode 3: 16 bit timer (with toggle output) Lower order 8 bits can be used as PWM output.
- Timer 4: 8-bit timer (with 6-bit prescaler)
- Timer 5: 8-bit timer (with 6-bit prescaler)
- Timer 6: 8-bit timer (with 6-bit prescaler)
- Timer 7: 8-bit timer (with 6-bit prescaler)
- Base Timer
 - 1) The clock signal can be selected from any of the following:
 - Sub-clock (32.768kHz crystal oscillator), system clock, and prescaler output from timer 0
 - 2) Interrupts can be selected to occur at one of five different times.

(9) High speed clock counter

- 1) Capable of counting maximum: 20MHz clock (Using main clock 10MHz)
- 2) Real time output

(10) Serial-interface

- SIO 0: 8 bit synchronous serial Interface
 - 1) LSB first / MSB first function available
 - 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 IO (2-wire or 3-wire, transmit clock 2–512 Tcyc)
 - Mode 1: Asynchronous serial IO (half duplex, 8 data bits, 1 stop bit, baud rate 8–2048Tcyc)
 - 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)

(11) AD converter

- 8 bits × 14 channels

(12) 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)

(13) Watchdog timer

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

(14) Interrupts: 21 source, 10-vector interrupts

- 1) Three priority (low, high and highest) multiple interrupts are supported. During interrupt handling, an equal or lower priority interrupt request is refused.
- 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	Select Level	Interrupt Source
1	00003H	X or L	INT0
2	0000BH	X or L	INT1
3	00013H	H or L	INT2/T0L/INT4
4	0001BH	H or L	INT3/Base timer/INT5
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/MIC/T6/T7
10	0004BH	H or L	VFD Automatic Display Controller/Port 0/T4/T5

(15) Subroutine stack levels: 2048 levels max. Stack is located in RAM.

(16) Multiplication and division

- 16 bit $\times$ 8 bit (executed in 5 cycles)
- 24 bit $\times$ 16 bit (12 cycles)
- 16 bit $\div$ 8 bit (8 cycles)
- 24 bit $\div$ 16 bit (12 cycles)

(17) Oscillation circuits

- On-chip RC oscillation circuit for system clock use.
- On-chip CF oscillation circuit for system clock use. (R_f built in)
- On-chip Crystal oscillation circuit low speed system clock use. (R_d , R_f external)
- On-chip frequency -variable RC oscillation Circuit for system clock use.

(18) System clock divider function

- Able to reduce current consumption
Available minimum instruction cycle time: 300ns, 600ns, 1.2 μ s, 2.4 μ s, 4.8 μ s, 9.6 μ s, 19.2 μ s, 38.4 μ s, 76.8 μ s. (Using 10MHz main clock)

(19) 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, INT4 or INT5.
 - (3) an interrupt condition arises at port 0

-X'tal HOLD mode

X'tal HOLD mode is used to reduce power consumption. Program execution is stopped.

All peripheral circuits except the base timer are stopped.

- 1) CF and RC oscillation circuits stop automatically.
- 2) Crystal oscillator is maintained in its state at HOLD mode inception.
- 3) Release occurs on any an any of the following conditions
 - (1) input to the reset pin goes low
 - (2) a specified level is input to at least one of INT0, INT1, INT2, INT4 or INT5.
 - (3) an interrupt condition arises at port 0
 - (4) an interrupt condition arises at the base-timer

(20) Factory shipment

- package: QIP100E

(21) Development tools

- Evaluation chip: LC876093
- Emulator: EVA62S + ECB876600 (Evaluation chip board) + SUB876700 + POD100QFP
: ICE-B877300 + SUB876700 + POD100QFP
- Flash ROM write-in adaptor : W87FQ100

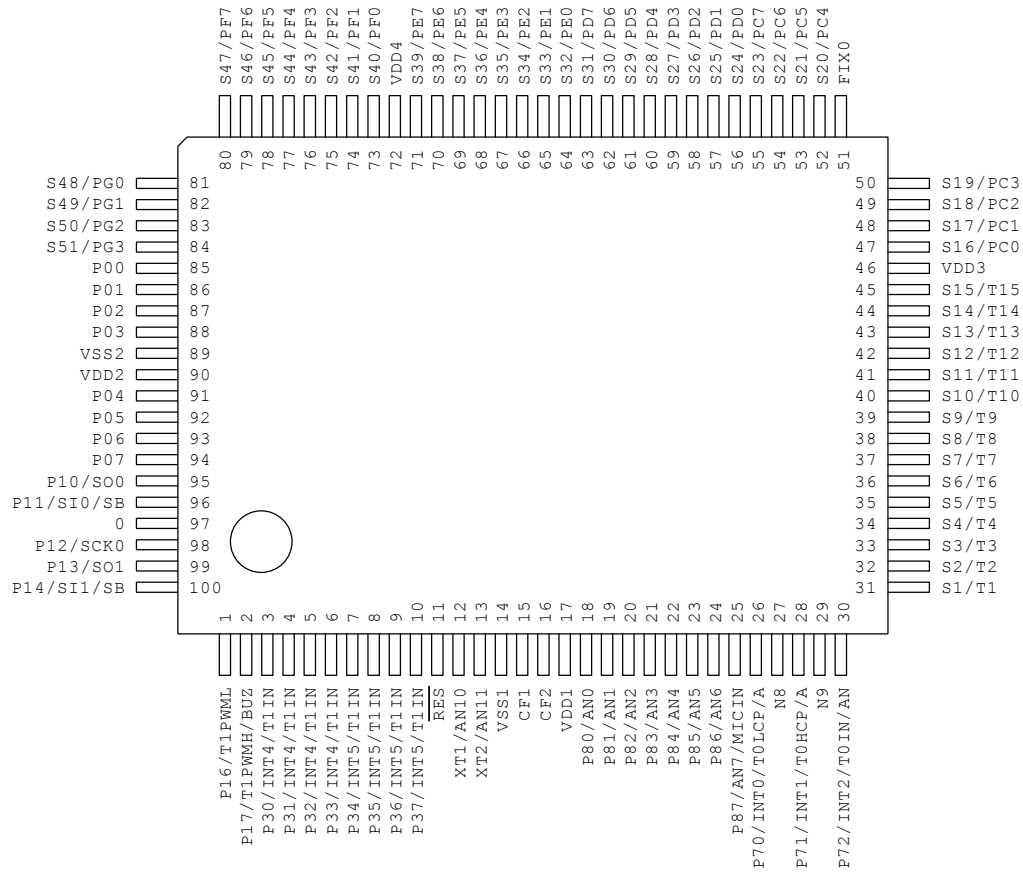
(22) Same package and pin arrangement as mask ROM version.

- 1) LC876700 series options can be set using flash ROM data. Thus testing and evaluation of mass production boards is possible.
- 2) When using mask ROM software version, the usable ROM/RAM capacity is the same as the mask ROM version.

Difference between LC87F67C8A and LC876700 Series

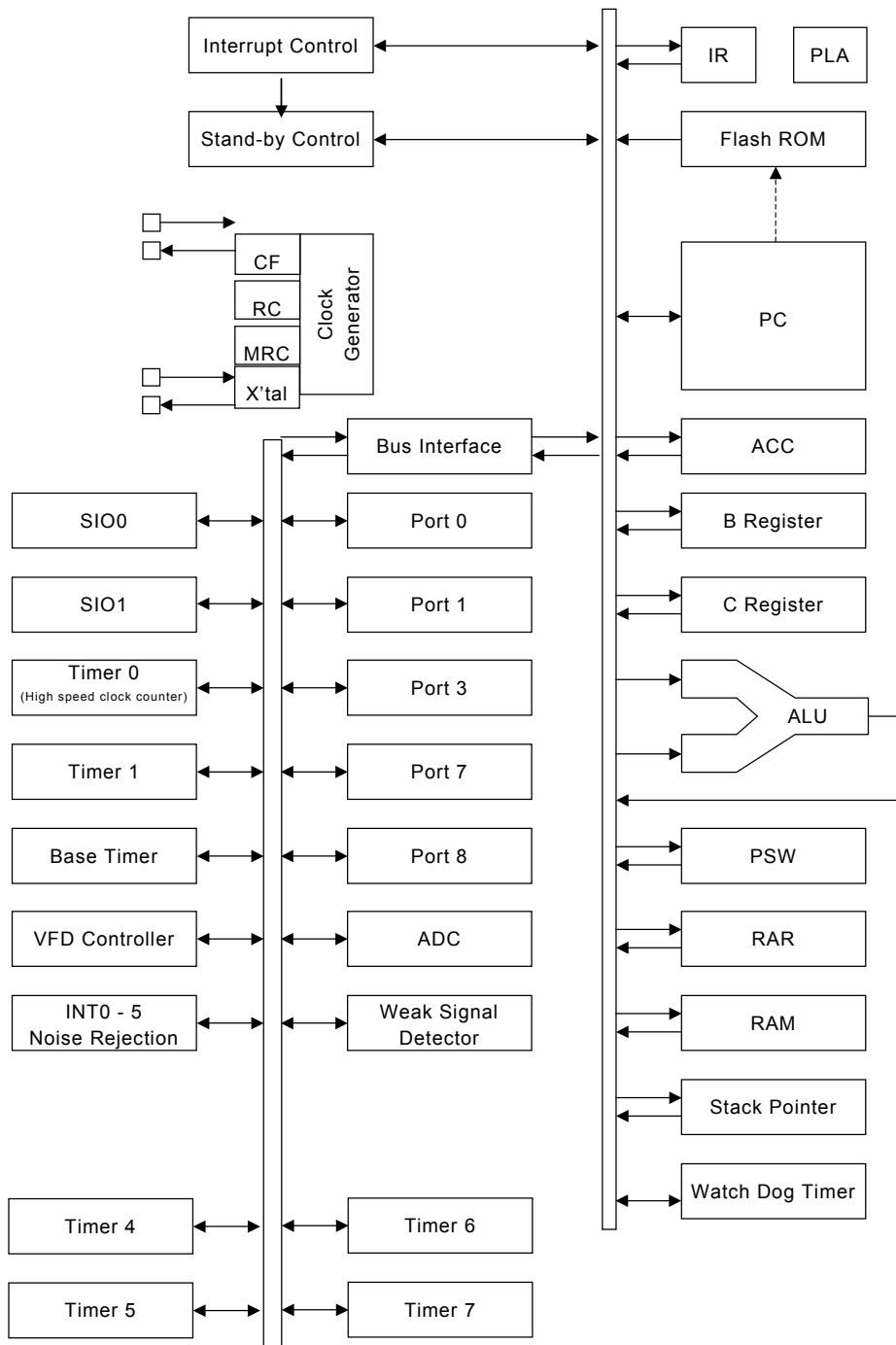
Parameter	LC87F67C8A	LC876700 Series Mask ROM Version
Operation after reset release	After impressing "H" level to the reset pin, it sets up options inside the LSI during the period for about 2ms. During this period, the options are gradually set. Then, a program is executed from the address 0 of the program counter.	Shortly after impressing "H" level to the reset pin, a program is executed from the address 0 of the program counter.
ROM	It has a built-in flash ROM. Flash ROM is Rewritable	Mask ROM is used.
Withstand pressure voltage of Port 0 and 3 pins selected N-channel open drain option	Absolute maximum ratings: -0.3V-14V Recommended operating range: VSS-12.5V	Absolute maximum ratings: -0.3V-15V Recommended operating range: VSS-13.5V
Operation supply voltage	Refer to "Electrical characteristics" of the respective data sheets.	
Current dissipation characteristics	Refer to "Electrical characteristics" of the respective data sheets.	
Built-in RC oscillation	Varies within the range shown in "Electrical characteristics" of the respective data sheets. It differs in lot dependency, voltage dependency, temperature dependency, etc.	

Pin Assignment



SANYO: QIP100E

System Block Diagram



Pin Assignment

Pin name	I/O	Function	Option																		
VSS1 VSS2	-	• Power supply (-)	No																		
VDD1 VDD2 VDD3 VDD4	-	• Power supply (+)	No																		
FIX0	-	• Test Pin Set as VSS with the user’s option. (Note1)	No																		
PORT0 P00 to P07	I/O	• 8bit input/output port • data direction programmable in nibble units • Use of pull-up resistor can be specified in nibble units • Input for HOLD release • Input for port 0 interrupt • 14V withstand at N-channel open drain output	Yes																		
PORT1 P10 to P17	I/O	• 8bit input/output port • data direction programmable for each bit • Use of pull-up resistor can be specified for each bit • Other pin functions 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																		
PORT3 P30 to P33	I/O	• 8bit Input/output port • Data direction can be specified for each bit • Use of pull-up resistor can be specified for each bit • 14V withstand at N-channel open drain output •Other functions P30-P33 : INT4 Input/HOLD release input/Timer 1 event input/Timer 0L Capture Input/Timer 0H capture input P34-P37 : INT5 input/HOLD release input/Timer 1 event input/Timer 0L capture input/Timer 0H capture input •The following types of interrupt detection are possible: <table><tr><td></td><td>Rising</td><td>Falling</td><td>Rising/ falling</td><td>H level</td><td>L level</td></tr><tr><td>INT4</td><td>Yes</td><td>Yes</td><td>Yes</td><td>No</td><td>No</td></tr><tr><td>INT5</td><td>Yes</td><td>Yes</td><td>Yes</td><td>No</td><td>No</td></tr></table>		Rising	Falling	Rising/ falling	H level	L level	INT4	Yes	Yes	Yes	No	No	INT5	Yes	Yes	Yes	No	No	Yes
	Rising	Falling	Rising/ falling	H level	L level																
INT4	Yes	Yes	Yes	No	No																
INT5	Yes	Yes	Yes	No	No																

Pin name	I/O	Function	Option																														
PORT7 P70 to P73	I/O	• 4-bit Input/output port • Data direction can be specified for each bit • Use of pull-up resistor can be specified for each bit • Other functions 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), AN12(P72), AN13(P73) The following types of interrupt detection are possible: <table><tr><td></td><td>Rising</td><td>Falling</td><td>Rising/ falling</td><td>H level</td><td>L level</td></tr><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></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																												
PORT8 P80 to P87	I/O	• 8bit Input/output port • Input/output can be specified in a bit unit • Other functions: AD input port: AN0 to AN7 Weak signal detector input port: MICIN(P87)	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	• Output for VFD display controller segment/digit • Other functions: High voltage input port: PC0 to PC7	No																														
S24 to S31	I/O	• Output for VFD display controller segment • Other functions: High voltage input port: PD0 to PD7	No																														
S32 to S39	I/O	• Output for VFD display controller segment • Other functions High voltage input port: PE0 to PE7	No																														
S40 to S47	I/O	• Output for VFD display controller segment • Other functions: High voltage input/output port: PF0 to PF7	No																														
S48 to S51	I/O	• Output for VFD display controller segment • Other functions: High voltage input/output port: PG0 to PG3	No																														
$\overline{\text{RES}}$	I	Reset terminal	No																														
XT1	I	• Input for 32.768kHz crystal oscillation • Other functions: General purpose input port When not in use, connect to VDD1. AD input port: AN10	No																														

LC87F67C8A

Pin name	I/O	Function	Option
XT2	I/O	• Output for 32.768kHz crystal oscillation • Other functions: General purpose input port When not in use, set to oscillation mode and leave open circuit. AD input port: AN11	No
CF1	I	Input terminal for ceramic oscillator	No
CF2	O	Output terminal for ceramic oscillator	No

Note1:) The LC876700 series can be mounted onto the circuit board of the LC 876500, LC876600 series.

In this case, the fluorescent character display tube power voltage (minus voltage) is supplied to the FIX0 pin. This would not cause any error.

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.

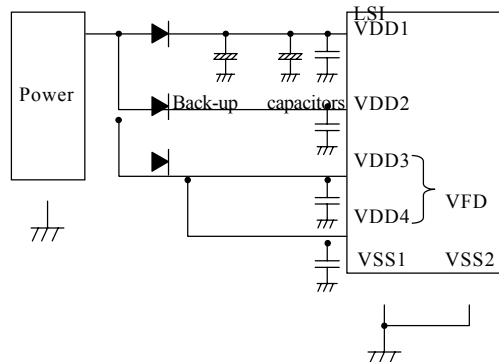
Terminal	Option applies to:	Options	Output Format	Pull-up resistor	Pull-down resistor
P00 to P07	1 bit units	1	CMOS	Programmable (Note 1)	–
		2	14 voltage Nch-open drain	None	–
P10 to P17	each bit	1	CMOS	Programmable	–
		2	Nch-open drain	Programmable	–
P30 to P37	each bit	1	CMOS	Programmable	–
		2	14V Nch-open drain	None	–
P70	–	None	Nch-open drain	Programmable	–
P71 to P73	–	None	CMOS	Programmable	–
P80 to P87	–	None	Nch-open drain	None	–
S0/T0 to S15/T15 S16-S51	–	None	High voltage Pch-open drain	–	None
XT1	–	None	Input only	None	–
XT2	–	None	Output for 32.768kHz crystal oscillation	None	–

Note 1 Programmable pull-up resistors of Port 0 can be attached in nibble units (P00-03, P04-07).

* Note 1: Connect as follows to reduce noise on VDD and increase the back-up time.

VSS1, and VSS2 must be connected together and grounded.

*Note 2 : The power supply for the internal memory is VDD1 but it uses the VDD2 as the power supply for ports. When the VDD2 is not backed up, the port level does not become “H” even if the port latch is in the “H” level. Therefore, when the VDD2 is not backed up and the port latch is “H” level, the port level is unstable in the HOLD mode, and the back up time becomes shorter because the through current runs from VDD to GND in the input buffer.
If VDD2 is not backed up, output “L” by the program or pull the port to “L” by the external circuit in the HOLD mode so that the port level becomes “L” level and unnecessary current consumption is prevented.



1. Absolute maximum ratings / Ta=25°C and VSS1=VSS2=0V

Parameter		Symbol	Pins	Conditions	Limits				unit
					VDD[V]	min.	typ.	max.	
Supply voltage		VDDMAX	VDD1,VDD2,VDD3,VDD4	VDD1=VDD2=VDD3=VDD4		-0.3		+6.5	V
Input voltage		VI(1)	XT1,XT2,CF1, RES			-0.3		VDD+0.3	
		VI(2)	VP			VDD-45		VDD+0.3	
Output voltage		VO(1)	S0/T0 to S15/T15			VDD-45		VDD+0.3	
Input/Output voltage		VIO(1)	•Port 0: CMOS output option •Port 1 •Port 3: CMOS output option •Port 7 •Port 8			-0.3		VDD+0.3	
		VIO(2)	•Port 0 open drain •Port 3 open drain			-0.3		14	
		VIO(3)	S16 to S51			VDD-45		VDD+0.3	
High level output current	Peak output current	IOPH(1)	Port 0, 1, 3	•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	ΣIOAH(1)	Port 0	Total of all pins		-30			
		ΣIOAH(2)	Port 1,3	Total of all pins		-30			
		ΣIOAH(3)	Port 7	Total of all pins		-5			
		ΣIOAH(4)	S0/T0 to S15/T15	Total of all pins		-65			
		ΣIOAH(5)	S16 to S27	Total of all pins		-60			
		ΣIOAH(6)	S28 to S39	Total of all pins		-60			
ΣIOAH(7)		S40 to S51	Total of all pins		-60				
Low level output current	Peak output current	IOPL(2)	•Port 0, 1, 3	For each pin				20	
		IOPL(3)	Port 7,8	For each pin				5	
	Total output current	ΣIOAL(1)	Port 00,01,02,03	For each pin				50	
		ΣIOAL(2)	•Port 04,05,06,07 •Port 1,3	For each pin				50	
		ΣIOAL(3)	Ports 7,8	For each pin				20	
Maximum power dissipation		Pdmax	QIP100E	Ta = -20 to+70°C					mW
Operating temperature range		Topg				-20		70	°C
Storage temperature range		Tstg				-55		125	

2. Recommended operating range / Ta=-20°C to +70°C, VSS1=VSS2=0V

Parameter	Symbol	Pins	Conditions	Limits				
				VDD[V]	min.	typ.	max.	unit
Operating supply voltage range	VDD(1)	VDD1=VDD2=VDD3=VDD4	$0.294\mu s \leq t_{CYC} \leq 200\mu s$		4.5		5.5	V
Hold voltage	VHD	VDD1	RAM and the register data are kept in HOLD mode.		2.0		5.5	
Input high voltage	VIH(1)	•Port 0,3: CMOS output option •Port 8	Output disable	4.5–5.5	$0.3VDD + 0.7$		VDD	
	VIH(2)	Port 0,3: N-ch open drain output	Output disable	4.5–5.5	$0.3VDD + 0.7$		12.5	
	VIH(3)	•Port 1 •Port 71,72,73 •P70 port input/interrupt	Output disable	4.5–5.5	$0.3VDD + 0.7$		VDD	
	VIH(4)	S16 to S51	Output P-channel Tr. OFF	4.5–5.5	$0.3VDD + 1.0$		VDD	
	VIH(5)	P70 Weak signal input	Output disable	4.5–5.5	$0.75VDD$		VDD	
	VIH(6)	Port 70 Watchdog timer	Output disable	4.5–5.5	$0.9VDD$		VDD	
	VIH(7)	XT1, XT2, CF1, $\overline{RES}$		4.5–5.5	$0.75VDD$		VDD	
Input low voltage	VIL(1)	•Port 0,3: CMOS output option •Port 8	Output disable	4.5–5.5	VSS		$0.15VDD + 0.4$	
	VIL(2)	Port 0,3: N-ch open drain output	Output disable	4.5–5.5	VSS		$0.15VDD + 0.4$	
	VIL(3)	•Port 1 •Port 71,72,73 •P70 port input/interrupt	Output disable	4.5–5.5	VSS		$0.1VDD + 0.4$	
	VIL(4)	S16 to S51	Output P-channel Tr. OFF	4.5–5.5	-35		$0.2VDD$	
	VIL(5)	Port 87 weak signal input	Output disabled	4.5–5.5	VSS		$0.25VDD$	
	VIL(6)	Port 70 Watchdog timer	Output disabled	4.5–5.5	VSS		$0.8VDD - 1.0$	
	VIL(7)	XT1,XT2,CF1, $\overline{RES}$		4.5–5.5	VSS		$0.25VDD$	
Operation cycle time	tCYC			4.5–5.5	0.294		200	μs
External system clock frequency	fEXCF(1)	CF1	•CF2 open circuit •system clock divider set to 1/1 •external clock DUTY = 50±50%	4.5–5.5	0.1		10	MHz
			•CF2 open circuit •system clock divider set to 1/2	4.5–5.5	0.2		20	

Continued

Parameter	Symbol	Pins	Conditions	Limits				
				VDD[V]	min.	typ.	max.	unit
Oscillation stabilizing time period (Note 1)	FmCF(1)	CF1, CF2	10MHz ceramic resonator oscillation Refer to figure 1	4.5–5.5		10		MHz
	FmCF(2)	CF1, CF2	4MHz ceramic resonator oscillation Refer to figure 1	4.5–5.5		4		
	FmRC		RC oscillation	4.5–5.5	0.3	1.0	2.0	
	FmMRC		Frequency variable RC oscillation	4.5–5.5		50		
	FsX'tal	XT1, XT2	32.768kHz crystal resonator oscillation Refer to figure 2	4.5–5.5		32.768		kHz

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

3. Electrical characteristics / Ta=-30°C to +70°C, VSS1=VSS2=0V

Parameter	Symbol	Pins	Conditions	VDD[V]	Limits			
					min.	typ.	max.	unit
Input high current	IIH(1)	Ports 0,3: N-ch open drain output	•Output disabled •VIN=12.5V (including OFF state leak current of the output Tr.)	4.5–5.5			5	μA
	IIH(2)	Port 0,1,3,7,8	•Output disabled •Pull-up resistor OFF. •VIN=VDD (including OFF state leak current of the output Tr.)	4.5–5.5			1	
	IIH(3)	S16 to S51 (Port C,D,E,F,G)	When configured as an input port VIN=VDD	4.5–5.5			60	
	IIH(4)	$\overline{\text{RES}}$	VIN=VDD	4.5–5.5			1	
	IIH(5)	XT1,XT2	When configured as an input port VIN=VDD	4.5–5.5			1	
	IIH(6)	CF1	VIN=VDD	4.5–5.5			15	
	IIH(7)	P87/AN7/MICIN weak signal input	VIN=V _{BIS} +0.5V (V _{BIS} : Bias voltage)	4.5–5.5	4.2	8.5	15	
Input low current	IIL(1)	Port 0,1,3,7,8	•Output disabled •VIN=VSS (including OFF state leak current of the output Tr.)	4.5–5.5	-1			
	IIL(2)	$\overline{\text{RES}}$	VIN=VSS	4.5–5.5	-1			
	IIL(3)	XT1,XT2	When configured as an input port VIN=VSS	4.5–5.5	-1			
	IIL(4)	CF1	VIN=VSS	4.5–5.5	-15			
	IIL(5)	P87/AN7/MICIN weak signal input	VIN=V _{BIS} -0.5V (V _{BIS} : Bias voltage)		-15	-8.5	-4.2	
Output high voltage	VOH(1)	Port 0,1,3: CMOS output option	IOH=-1.0mA	4.5–5.5	VDD-1			V
	VOH(2)		IOH=-0.1mA	4.5–5.5	VDD-0.5			
	VOH(3)	Port 7	IOH=-0.4mA	4.5–5.5	VDD-1			
	VOH(4)	S0/T0–S15/T15	IOH=-20.0mA	4.5–5.5	VDD-1.8			
	VOH(5)		IOH=-1.0mA IOH at any single pin is not over 1mA.	4.5–5.5	VDD-1			
	VOH(6)	S2+ to S51	IOH=-5.0mA	4.5–5.5	VDD-1.8			
	VOH(7)		IOH=-1.0mA IOH at any single pin is not over 1mA.	4.5–5.5	VDD-1			
Output low voltage	VOL(1)	Port 0,1,3	IOL=10mA	4.5–5.5			1.5	
	VOL(2)		IOL=1.6mA	4.5–5.5			0.4	
	VOL(3)	Port 7, 8	IOL=1mA	4.5–5.5			0.4	
Pull-up resistor	Rpu	Port 0,1,3,7	VOH=0.9VDD	4.5–5.5	15	40	70	kΩ

Continued

Parameter	Symbol	Pins	Conditions	Limits				
				VDD[V]	min.	typ.	Max.	unit
Output off-leak current	IOFF(1)	S0/T0 to S15/T15, S16 to S51	•Output P-ch Tr. OFF •VOUT=VSS	4.5–5.5	-1			μA
	IOFF(2)		•Output P-ch Tr. OFF •VOUT=VDD-40V	4.5–5.5	-30			
Resistance of the low level hold Tr.	Rinpd	S16 to S51	•Output P-ch Tr. OFF	4.5–5.5		200		k Ω
Hysteresis voltage	VHIS(1)	•Port 1,7 • $\overline{\text{RES}}$		4.5–5.5		0.1VDD		V
	VHIS(2)	Port 87 weak signal input		4.5–5.5		0.1VDD		
Pin capacitance	CP	All pins	•All other terminals connected to VSS. •f=1MHz •T _a =25°C	4.5–5.5		10		pF
Input sensitivity	Vsen	Port 87 weak signal input		4.5–5.5	0.12VDD			V _{pp}

4. Serial input/output characteristics / Ta=-20°C to +70°C, VSS1=VSS2=0V

Parameter			Symbol	Pins	Conditions	VDD[V]	Limits			
							min.	typ.	max.	unit
Serial clock	Input clock	Cycle Time	tSCK(1)	SCK0(P12)	Refer to figure 6	4.5–5.5	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 6	4.5–5.5	2			
	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 6	4.5–5.5	4/3			tSCK
		Low Level pulse width	tSCKL(3)					1/2		
			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 6	4.5–5.5	2			tCYC	
Low Level pulse width	tSCKL(4)					1/2		tSCK		
High Level pulse width	tSCKH(4)					1/2				
Serial	Data set-up time	tsDI	SI0(P11), SI1(P14), SB0(P11), SB1(P14)	•Measured with respect to SI0CLK leading edge. •Refer to figure 6	4.5–5.5	0.03			μs	
	Data hold time	thDI				0.03				
Serial output	Output delay time	tdDO	SO0(P10), SO1(P13), SB0(011), SB1(P14)	•When port is open drain: Time delay from SI0CLK trailing edge to the SO data change. •Use pull-up resistor (1KΩ) when open drain output selected. •Refer to figure 6	4.5–5.5			1/3 tCYC +0.05		

5. Pulse input conditions / Ta=-20°C to +70°C, VSS1=VSS2=0V

Parameter	Symbol	Pins	Conditions	Limits				
				VDD[V]	min.	typ.	max.	unit
High/low level pulse width	tPIH(1) tPIL(1)	INT0(P70), INT1(P71), INT2(P72) INT4(P30-P33) INT5(P34-P37)	•Interrupt acceptable •Events to timer 0 can be input.	4.5-5.5	1			tCYC
	tPIH(2) tPIL(2)	INT3(P73) (Noise rejection ratio set to 1/1.)	•Interrupt acceptable •Events to timer 0 can be input.	4.5-5.5	2			
	tPIH(3) tPIL(3)	INT3(P73) (Noise rejection ratio set to 1/32.)	•Interrupt acceptable •Events to timer 0 can be input.	4.5-5.5	64			
	tPIH(4) tPIL(4)	INT3(P73) (Noise rejection ratio set to 1/128.)	•Interrupt acceptable •Events to timer 0 can be input.	4.5-5.5	256			
	tPIH(5) tPIL(5)	MICIN(P87)	•Weak signal detection counter enabled	4.5-5.5	1			
	tPIH(6) tPIL(6)	NKIN(P72)	•High speed clock counter countable	4.5-5.5	1/12			
	tPIL(7)	$\overline{\text{RES}}$	•Reset possible	4.5-5.5	200			μs

6. AD converter characteristics / Ta=-20°C to + 70°C, VSS1=VSS2=0V

Parameter	Symbol	Pins	Conditions	Limits				
				VDD[V]	min.	typ.	max.	unit
Resolution	N	AN0(P80) to AN7(P87) AN8(P70), AN9(P71) AN10(XT1), AN11(XT2) AN12(P72), AN13(P73)		4.5–5.5		8		bit
Absolute precision	ET		(Note2)	4.5–5.5			±1.5	LSB
Conversion time	TCAD		AD conversion time = $32 \times \text{tCYC}$ (ADCR2=0) (Note 3)	4.5–5.5	15.62 (tCYC= 0.488μs)		97.92 (tCYC= 3.06μs)	μs
			AD conversion time = $64 \times \text{tCYC}$ (ADCR2=1) (Note 3)		18.82 (tCYC= 0.294μs)		97.92 (tCYC= 1.53μs)	
Analog input voltage range	VAIN			4.5–5.5	VSS		VDD	V
Analog port input current	IAINH		VAIN=VDD	4.5–5.5			1	μA
	IAINL		VAIN=VSS	4.5–5.5	-1			

(Note 2) Absolute precision not including quantizing error (±1/2 LSB).

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

7. Current dissipation characteristics / Ta=-20°C to +70°C, VSS1=VSS2=0V

Parameter	Symbol	Pins	Conditions	Limits				
				VDD[V]	min.	typ.	max	unit
Current dissipation during basic operation (Note 4)	IDDOP(1)	VDD1= VDD2= VDD3= VDD4	•FmCF=10MHz for Ceramic resonator oscillation •FsX'tal=32.768kHz for crystal oscillation •System clock: CF oscillation •Internal RC oscillation stopped. •Frequency Variable RC oscillation halted. •Divider set to 1/1	4.5-5.5		16	35	mA
	IDDOP(2)		•CF1=20MHz for external clock •FsX'tal=32.768kHz for crystal oscillation •System clock: CF oscillation •Internal RC oscillation stopped. •Frequency Variable RC oscillation halted. •Divider set to 1/2	4.5-5.5		17	36	
	IDDOP(3)		•FmCF=4MHz Ceramic resonator oscillation •FsX'tal=32.768kHz for crystal oscillation •System clock: CF oscillation •Internal RC oscillation stopped. •Frequency Variable RC oscillation halted. •Divider set to 1/1	4.5-5.5		7.5	21	
	IDDOP(4)		•FmCF=0Hz (No oscillation) •FsX'tal=32.768kHz for crystal oscillation •Frequency Variable RC oscillation halted. •System clock: RC oscillation •Divider set to 1/2	4.5-5.5		1.8	11	

Continued

Parameter	Symbol	Pins	Conditions	Limits				
				VDD[V]	min.	typ.	max	unit
Current dissipation during basic operation (Note 4)	IDDOP(5)	VDD1= VDD2= VDD3= VDD4	•FmCF=0Hz (No oscillation) •FsX'tal=32.768kHz for crystal oscillation •Internal RC oscillation stopped. •System clock=1MHz with the frequency variable RC oscillation •Divider set to 1/2	4.5-5.5		2.7	13	mA
	IDDOP(6)		•FmCF=0Hz (No oscillation) •FsX'tal=32.768kHz for crystal oscillation •System clock: 32.768kHz •Internal RC oscillation stopped. •Frequency Variable RC oscillation halted. •Divider set to 1/2	4.5-5.5		85	450	μA
Current dissipation HALT mode (Note 4)	IDDHALT(1)	VDD1= VDD2= VDD3= VDD4	HALT mode •FmCF=10MHz for Ceramic resonator oscillation •FsX'tal=32.768kHz for crystal oscillation •System clock : CF oscillation •Internal RC oscillation stopped. •Frequency Variable RC oscillation halted. •Divider: 1/1	4.5-5.5		4	12	mA
	IDDHALT(2)		HALT mode •CF1=20MHz for external clock •FsX'tal=32.768kHz for crystal oscillation •System clock : CF oscillation •Internal RC oscillation stopped. •Frequency Variable RC oscillation halted. •Divider 1/2	4.5-5.5		4.5	13	

Continued

Parameter	Symbol	Pins	Conditions	Limits				
				VDD[V]	min.	typ.	max	unit
Current dissipation HALT mode (Note 4)	IDDHALT(3)	VDD1= VDD2= VDD3= VDD4	HALT mode •FmCF=4MHz for Ceramic resonator oscillation •FsX'tal=32.768kHz for crystal oscillation •System clock : CF oscillation •Internal RC oscillation •Frequency Variable RC oscillation halted. •Divider: 1/1	4.5-5.5		2	6	mA
	IDDHALT(4)		HALT mode •FmCF=0Hz (When oscillation stops.) •FsX'tal=32.768kHz for crystal oscillation •System clock : RC oscillation •Frequency Variable RC oscillation halted. •Divider: 1/2	4.5-5.5		500	1600	μA
	IDDHALT(5)		•HALT mode •FmCF=0Hz (When oscillation stops.) •FsX'tal=32.768kHz for crystal oscillation •System clock : 32.768kHz •Internal RC oscillation stopped. •System clock=1MHz with the frequency variable RC oscillation •Divider: 1/2	4.5-5.5		1500	3600	
	IDDHALT(6)		•HALT mode •FmCF=0Hz (When oscillation stops.) •FsX'tal=32.768kHz for crystal oscillation •System clock : 32.768kHz •Internal RC oscillation stopped. •Frequency Variable RC oscillation halted. •Divider: 1/2	4.5-5.5		25	100	

Continued

Parameter	Symbol	Pins	Conditions	Limits				
				VDD[V]	min.	typ.	max	unit
Current dissipation HOLD mode	IDDHOLD(1)	VDD1	HOLD mode •CF1=VDD or open circuit (when using external clock)	4.5-5.5		0.05	25	μA
Current dissipation Date/time clock HOLD mode	IDDHOLD(2)	VDD1	Date/time clock HOLD mode •CF1=VDD or open circuit (when using external clock) •FmX'tal=32.768kHz for crystal oscillation	4.5-5.5		20	90	

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

8. F-ROM write characteristics / Ta=+10 to +55°C VSSI=VSS2=0V

Parameter	Symbol	Pins	Conditions	Limits				
				VDD[V]	min.	typ.	max.	unit
On board write current	IDDF(1)	VDD1	•128-byte write •Including erase current	4.5-5.5		30	65	mA
Write cycle time	tFW(1)		•128-byte write •Including erase current •Not including time to prepare 128-byte data	4.5-5.5		6.3	9	mS

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 (Ta=-20 to +70°C)

Frequency	Manufacturer	Oscillator	Circuit parameters			Operating supply voltage range	Oscillation stabilizing time		Notes
			C1	C2	Rd1		typ	max	
10MHz									
4MHz									

*The oscillation stabilizing time is a period until the oscillation becomes stable after VDD becomes higher than minimum operating voltage. (Refer to Figure4)

Subsystem 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 2. Subsystem clock oscillation circuit characteristics using crystal oscillator (Ta=-20 to +70°C)

Frequency	Manufacturer	Oscillator	Circuit Parameters				Operating supply voltage range	Oscillation stabilizing time		Notes
			C3	C4	Rf	Rd2		typ	max	
32.768kHz										

*The oscillation stabilizing time is a period until the oscillation becomes stable after executing the instruction which starts the sub-clock oscillation or after releasing the HOLD mode. (Refer to Figure4)

(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.

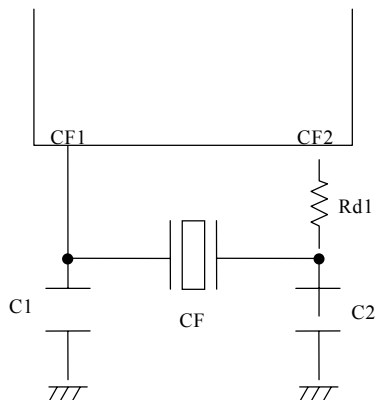


Figure 1 Ceramic oscillation circuit

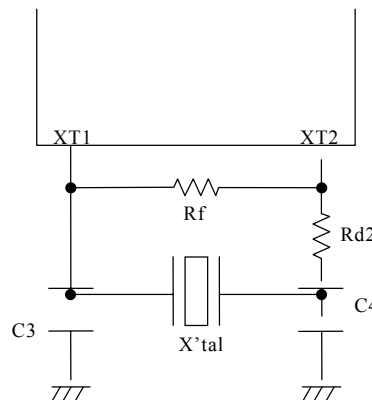


Figure 2 Crystal oscillation circuit

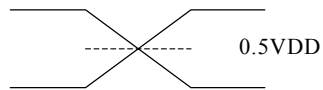


Figure 3 AC timing measurement point

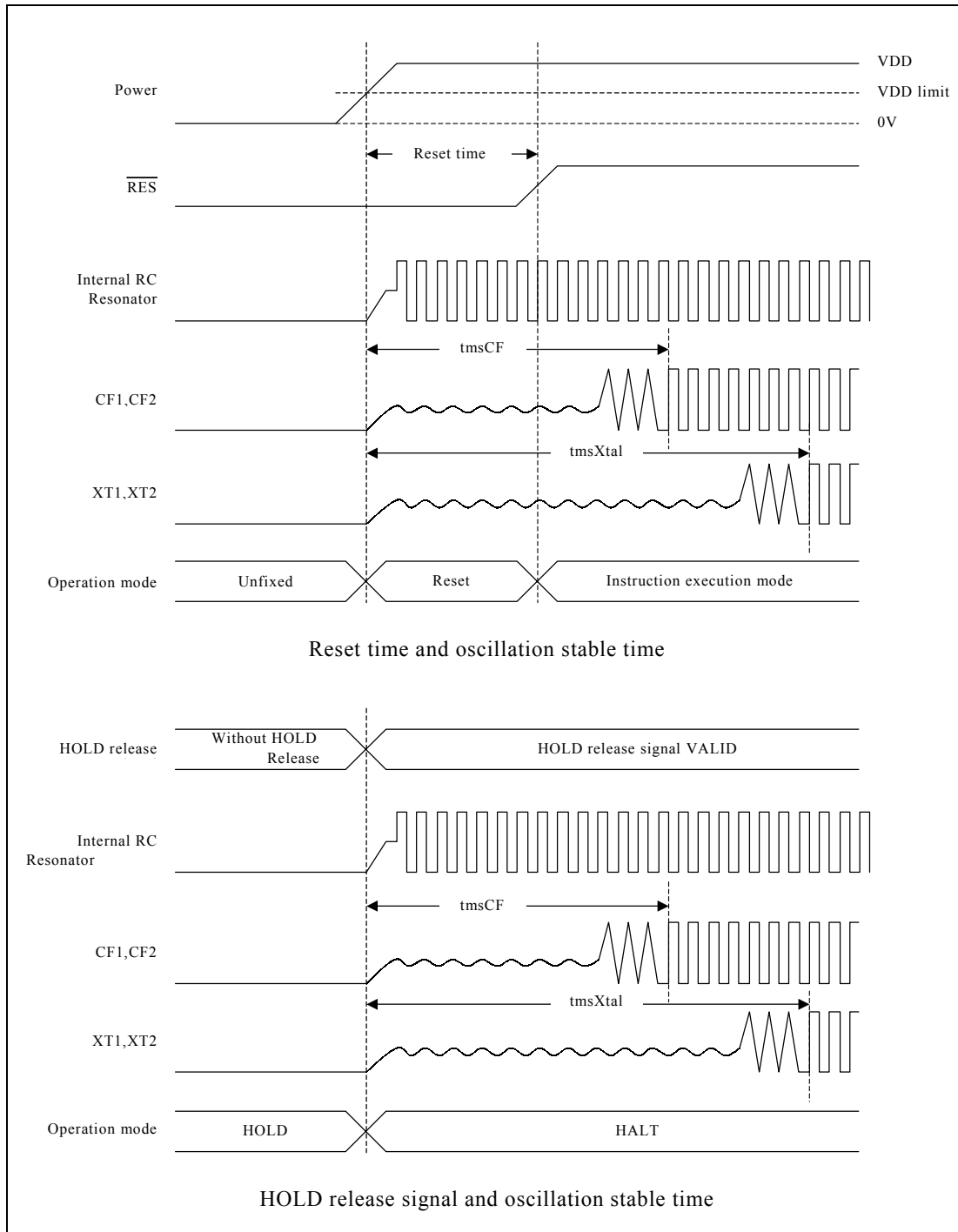
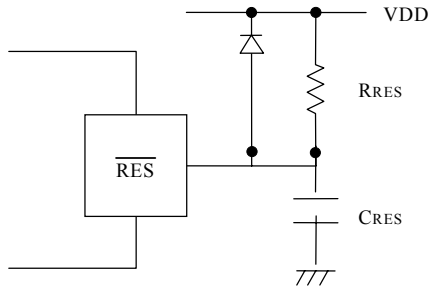


Figure 4 Oscillation stabilization time



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

Figure 5 Reset circuit

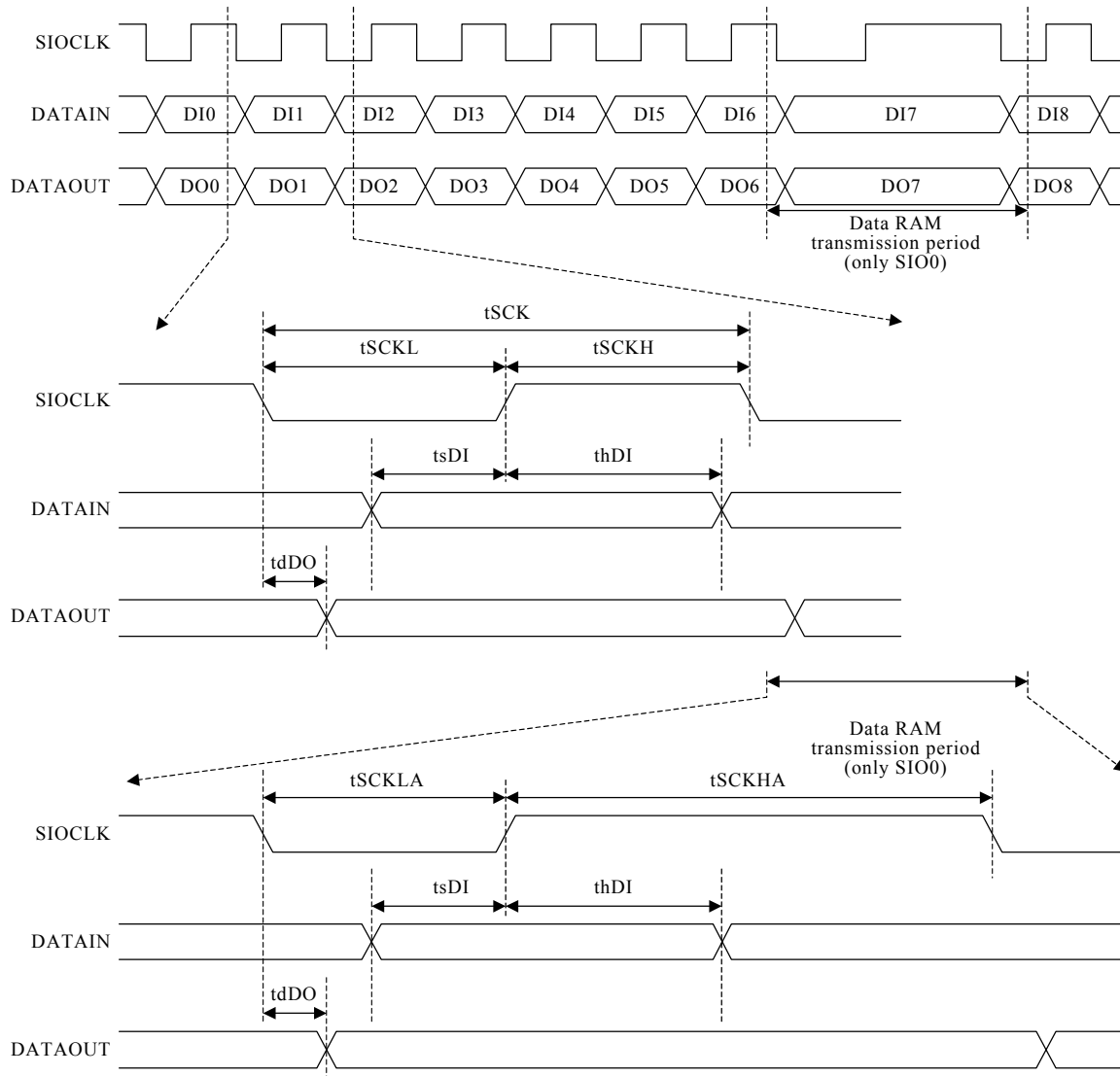


Figure 6 Serial input / output test condition

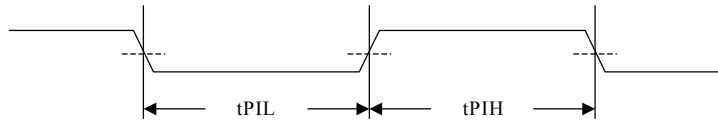


Figure 7 Pulse input timing condition

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