

Ordering number: EN2412A

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|--|-----------|-----------------------|
| SANYO | No. 2412A | CMOS LSI |
| | | LC6568D, 6568H |
| 8K-Byte ROM-Contained Single-Chip 4-Bit Microcomputers with FLT/LED Drivers, Comparator Input | | |

The LC6568D/H are single-chip 4-bit microcomputers that contain an 8K-byte ROM, 1K-bit RAM, and have 64 pins. The LC6568D/H have 57 pins for ports – 28 pins for 7 input/output common ports, 21 pins for 6 output ports, and 8 pins for 2 input ports. The LC6568D/H have specific ports that are used to provide the interrupt function, 4-bit/8-bit serial input/output function and burst pulse output function. Each of the 28 pins for input/output common ports contains a driver with a withstand voltage of 15V max. and a drive current of 15mA max. and each of the 21 pins for output ports contains a high-voltage output driver of the P-channel open drain type. Since the high-voltage output driver can be used as general-purpose high-current driver as well as fluorescent tube driver, the LC6568D/H can be also widely used in applications where no fluorescent display is provided.

The LC6568D/H are the same as our LC6500 series in the basic architecture of the CPU and the instruction set, but are made more powerful in the stack level and also made easier-to-use in the standby function.

Features

- Instruction set with 81 instructions (Common to the LC6500 series)
- On-chip 8192-byte ROM, 1024-bit RAM
- Instruction cycle time: 2.77 μ s (D version, $V_{DD} = 4$ to 6V)
0.92 μ s (H version, $V_{DD} = 4.5$ to 6V)
- Serial input/output interface x 1 (4 bits/8 bits program-selectable)
- I/O ports: 57 pins in all
 - Input ports 8 pins
 - Input/output common ports 28 pins: 15V max., 15mA max., LED drivable, pull-up resistance option available
 - Output ports 21 pins: $V_{DD}-45$ V withstand voltage, FLT drivable, common with general-purpose output, pull-down resistance option available
- Output level during reset: For ports C, D, output (H or L) during reset may be specified portwise by option.
- Interrupt function
 - Timer interrupt: 1 line
 - INT0 to 3 pin or serial I/O interrupt: 1 line
- Stack level: 8 levels (Common with interrupt)
- Timer: 4-bit prescaler +8-bit programmable timer
- Burst pulse (64 x cycle time, duty 50%) output function
- Oscillator option
 - Circuit mode: Ceramic resonator mode, RC mode, external clock mode (384kHz to 4.33MHz)
 - Predivider option: 1/1, 1/3, 1/4
- Standby function: Standby function provided by the HALT instruction. Provides the function to absorb the OSC stabilizing time in the ceramic resonator mode.
- Supply Voltage: 4 to 6V (D version)
4.5 to 6V (H version)
- Package: DIP 64 shrink type, QIP64A
- Evaluation LSI: LC6595 (Evaluation chip) + EVA800-TB6568 (Evaluation chip board),
LC65PG68 (Piggyback)
- 4-channel comparator input
- 4-channel external interrupt input (1 vector)

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Development Support Tools

The following development tools are available.

1. Document support (1) Documentation LC6568 User's Manual
(2) Development Tools User's Manual, EVA800-LC6568
2. Software support (1) MS-DOS (Note) for the host system and cross-assembler software
 - i. Host processor control program
 - ii. LC65S.EXE cross assembler
3. Hardware support (1) Evaluation chip: LC6595
(2) Piggyback microcomputer: LC65PG68
(3) Emulator: EVA-800 or EVA-850 emulator and evaluation boards

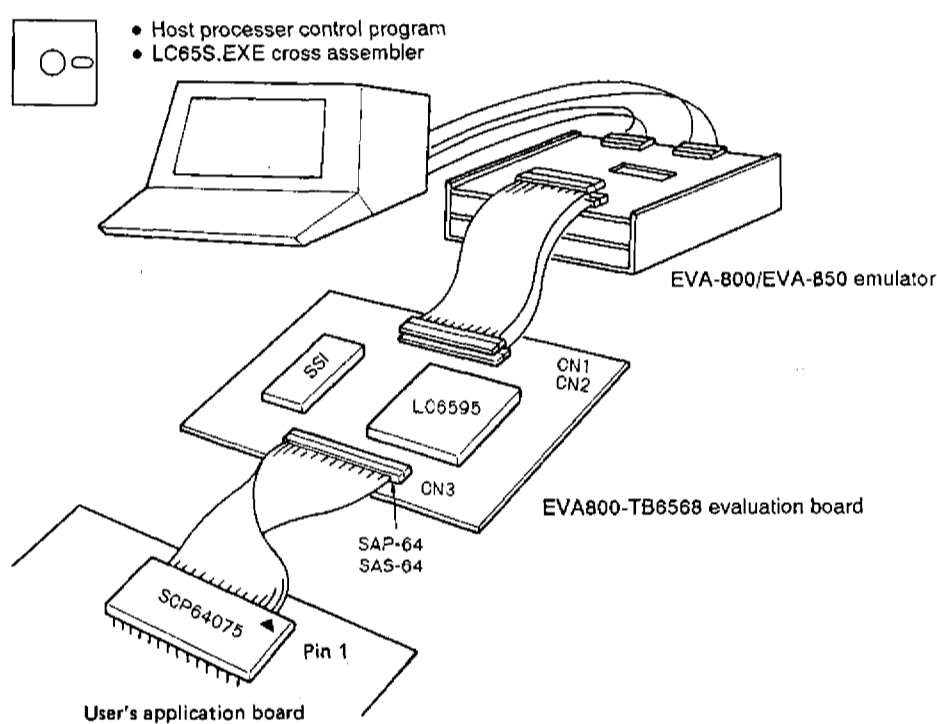


Fig. 1 Appearance of Development Support System

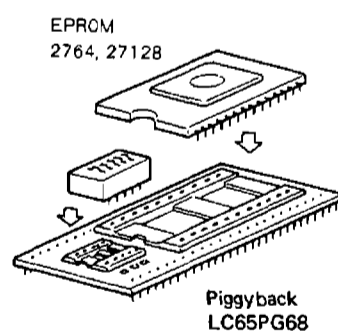
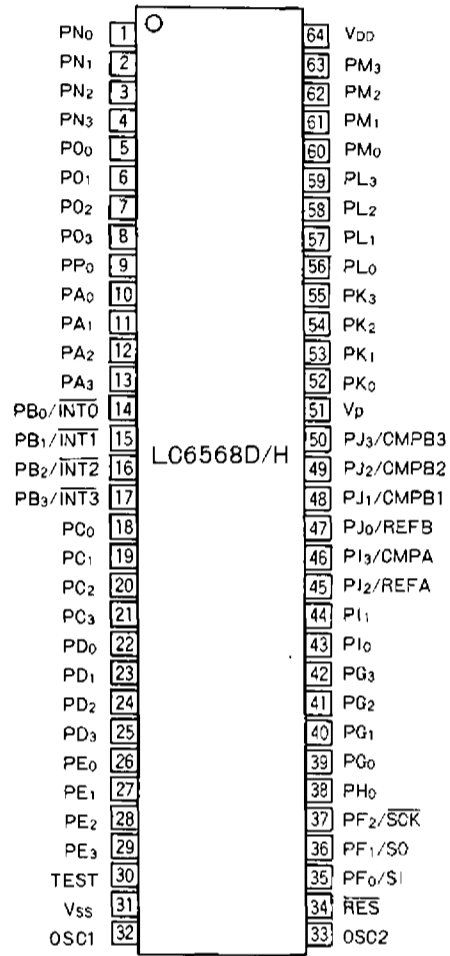


Fig. 2 Piggyback (For Program Evaluation)

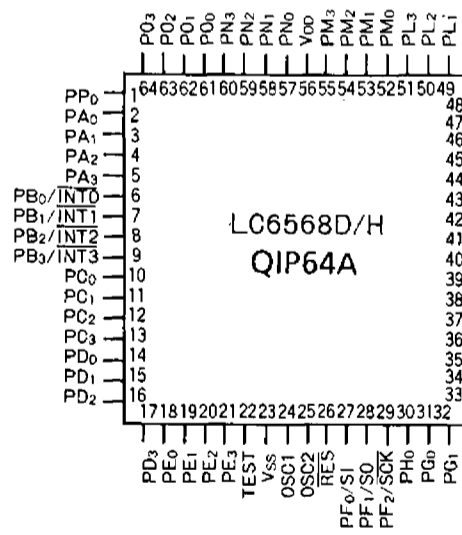
(Note) MS-DOS is a registered trademark of Microsoft Corporation

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Pin Assignment

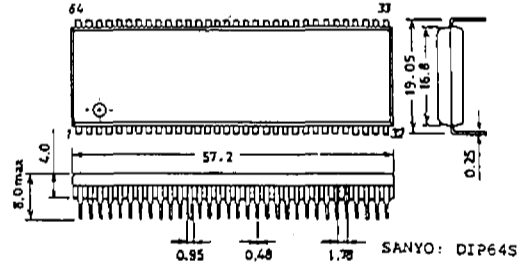


- OSC1, OSC2 : C, R, or ceramic resonator oscillator for OSC
- PA0 to 3 : Port for input only
- PB0 to 3 : Port for input only
- PC0 to 3 : Input/output common port
- PD0 to 3 : Input/output common port
- PE0 to 3 : Input/output common port
- PF0 to 3 : Input/output common port
- PG0 to 3 : Input/output common port
- PH0 : Input/output common port
- PI0 to 3 : Input/output common port
- PJ0 to 3 : Input/output common port
- PK0 to 3 : port for output only
- PL0 to 3 : Port for output only
- PM0 to 3 : Port for output only
- PN0 to 3 : Port for output only
- PO0 to 3 : Port for output only
- PP0 : Port for output only
- SI : 4-bit/8-bit serial input port
- SO : 4-bit/8-bit serial output port
- SCK : Input/output for serial clock
- INT0 to 3 : Interrupt request input
- Vp : Vp pin
- RES : Reset
- TEST : Test
- CMPA : Comparator A input pin
- CMPB1 to 3 : Comparator B1 to 3 input pins
- REFA : Comparator A reference voltage input pin
- REFB : Comparator B reference voltage input pin

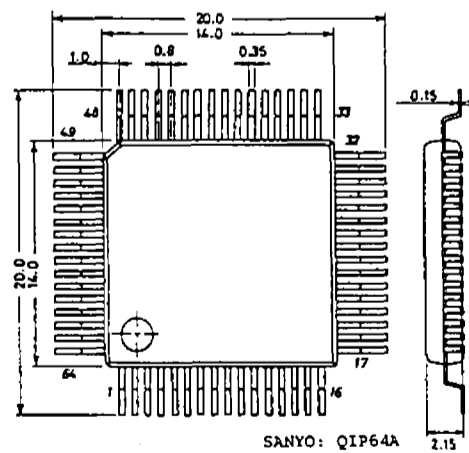


Note: When mounting the QIP version on the board, do not dip it in solder.

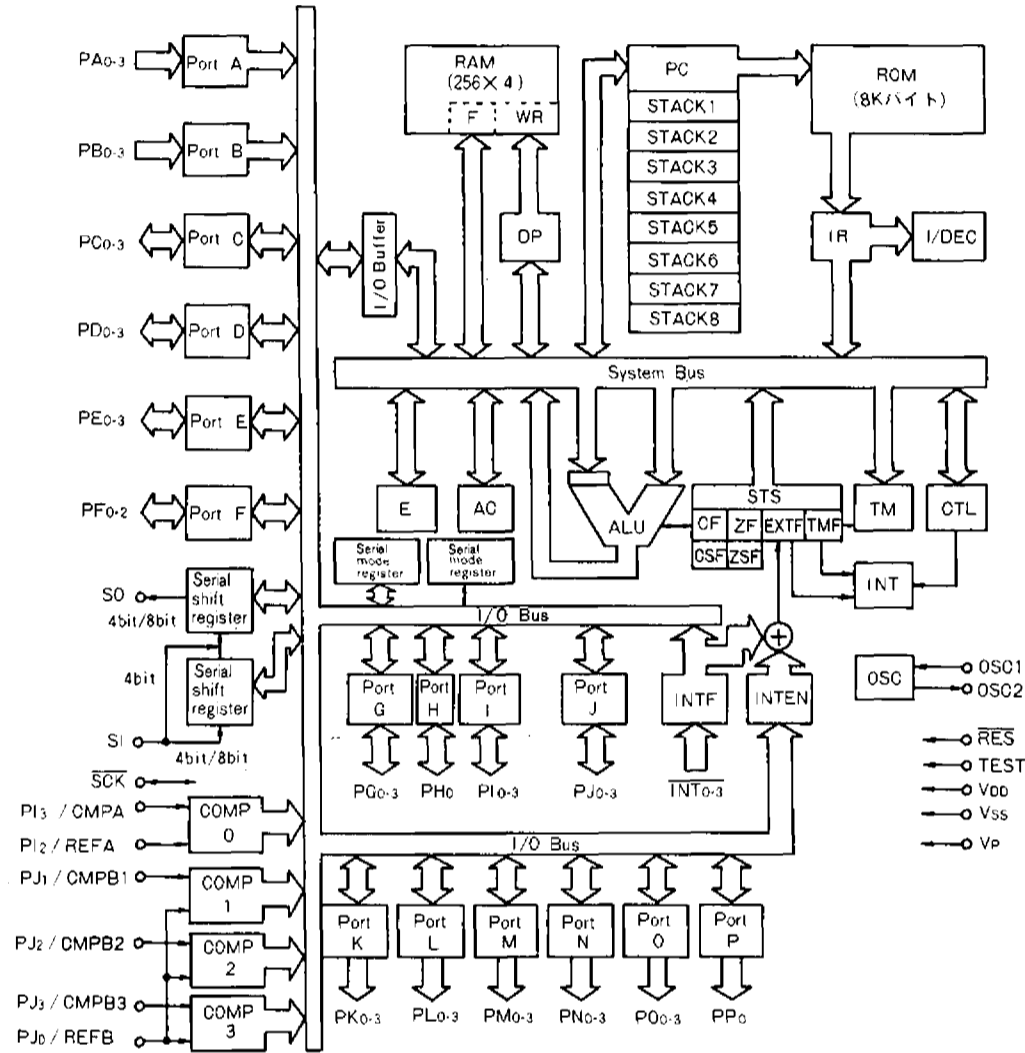
Package Dimensions 3071-D64IC (unit: mm)



Package Dimensions 3057-Q64AIC (unit: mm)



System Block Diagram



- | | | | |
|-----|-----------------------------|---------|-------------------------------|
| RAM | : Data memory | ROM | : Program memory |
| F | : Flag | PC | : Program counter |
| WR | : Working register | INT | : Interrupt control |
| AC | : Accumulator | IR | : Instruction register |
| ALU | : Arithmetic and logic unit | I.DEC | : Instruction decoder |
| DP | : Data pointer | CF, CSF | : Carry flag, carry save flag |
| E | : E register | ZF, ZSF | : Zero flag, zero save flag |
| CTL | : Control register | EXTF | : External interrupt request |
| OSC | : Oscillator | TMF | : Internal interrupt request |
| TM | : Timer | INTF | : Interrupt request flag |
| STS | : Status register | INTEN | : Interrupt enable flag |

(Note) SI, SO, SCK: Common to PF₀ to PF₂
 INT₀ to INT₃: Common to PB₀ to PB₃
 REFA, CMPA or PI₂, PI₃ port: Option-selectable
 REFB, CMPB₁ to CMPB₃ or PJ₀ to PJ₃ port: Option-selectable

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Pin Description

| Pin Name | Pins | I/O | Functions | Options | During Reset |
|--|--------|--------------|---|---|--|
| V _{DD} V _{SS} | 1 1 | — | Power supply | — | — |
| OSC1 | 1 | Input | <ul style="list-style-type: none"> Pin for externally connecting R, C or a ceramic resonator for system clock generation. | <ul style="list-style-type: none"> (1) External clock input (2) 2-pin RC OSC (3) 2-pin ceramic resonator OSC | — |
| OSC2 | 1 | Output | <ul style="list-style-type: none"> For the external clock mode, the OSC2 pin is open. | <ul style="list-style-type: none"> (4) Predivider option 1: No predivider 2: 1/3 predivider 3: 1/4 predivider | |
| PA ₀ PA ₁ PA ₂ PA ₃ | 4 | Input | <ul style="list-style-type: none"> Input port A₀ to 3 (Low-threshold input) 4-bit input (IP instruction) Single-bit decision (BP, BNP instructions) | — | — |
| PB ₀ /INT ₀ PB ₁ /INT ₁ PB ₂ /INT ₂ PB ₃ /INT ₃ | 4 | Input | <ul style="list-style-type: none"> Input port B₀ to 3 4-bit input (IP instruction) Single-bit decision (BP, BNP instructions) Standby is controlled by the PB₃. The PB₃ pin must be free from chattering during the HALT instruction execution cycle. PB₀ to 3: Common with INT₀ to 3 Program-selectable (1 interrupt vector, 4 senses) | — | <ul style="list-style-type: none"> Individual interrupt flag (INT₀F to INT₃F): Reset Individual interrupt enable flag (INT₀EN to INT₃EN): Disable mode |
| PC ₀ PC ₁ PC ₂ PC ₃ | 4 | Input/Output | <ul style="list-style-type: none"> Input/output common port C₀ to 3. 4-bit input (IP instruction) 4-bit output (OP instruction) Single-bit decision (BP, BNP instructions) Single-bit set/reset (SPB, RPB instructions) Output ("H" or "L") during reset may be specified by option. | <ul style="list-style-type: none"> (1) Open drain type output (2) With pull-up resistance (3) Output during reset: "H" (4) Output during reset: "L" (1), (2): Specified bit by bit. (3), (4): Specified in a group of 4 bits. | <ul style="list-style-type: none"> "H" output "L" output (Option-selectable) |
| PD ₀ PD ₁ PD ₂ PD ₃ | 4 | Input/Output | <ul style="list-style-type: none"> Input/output common port D₀ to 3. The functions, options are the same as for the PC₀ to 3. | Same as for the PC ₀ to 3. | Same as for the PC ₀ to 3. |
| PE ₀ PE ₁ PE ₂ PE ₃ | 4 | Input/Output | <ul style="list-style-type: none"> Input/output common port E₀ to 3. 4-bit input (IP instruction) 4-bit output (OP instruction) Single-bit decision (BP, BNP instructions) Single-bit set/reset (SPB, RPB instructions) PE₀: With burst pulse (64T_{cyc}) output function | <ul style="list-style-type: none"> (1) Open drain type output (2) With pull-up resistance (1), (2): Specified bit by bit. | "H" output |

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| Pin Name | Pins | I/O | Functions | Options | During Reset |
|---|------|------------------|--|---------------------------------------|---|
| PF0/SI PF1/SO PF2/ \overline{SCK} | 3 | Input/ Output | <ul style="list-style-type: none"> Input/output port F₀ to 2. The functions, options are the same as for the PE₀ to 3. However, no burst pulse output function is provided. PF₀ to 2: Also used for serial interface. Program-selectable. SI: Serial input port SO: Serial output port \overline{SCK}: Serial clock input/output | Same as for the PE ₀ to 3. | Sample as for the PE ₀ to 3. Serial port: Disable |
| PG0 PG1 PG2 PG3 | 4 | Input/ Output | <ul style="list-style-type: none"> Input/output common port G₀ to 3. The functions, options are the same as for the PE₀ to 3. However, no burst pulse output function is provided. | Same as for the PE ₀ to 3. | Same as for the PE ₀ to 3. |
| PH0 | 1 | Input/ Output | <ul style="list-style-type: none"> Input/output common port H₀. The functions, options are the same as for the PG₀ to 3. This port consists of a single bit. | Same as for the PG ₀ to 3. | Same as for the PG ₀ to 3. |
| PI0 PI1 PI2/REFA PI3/CMPA | 4 | Input/ Output | <ul style="list-style-type: none"> Input/output common port I₀ to 3. (Port input/output option selected mode) The functions, options are the same as for the PG₀ to 3. | Same as for the PG ₀ to 3. | Same as for the PG ₀ to 3. |
| | 2 | Input | <ul style="list-style-type: none"> Comparator input option selected mode REFA: Comparator reference voltage input CMPA: Comparator input | | |
| PJ0/REFB PJ1/CMPB1 PJ2/CMPB2 PJ3/CMPB3 | 4 | Input/ Output | <ul style="list-style-type: none"> Input/output common port J₀ to 3. (Port input/output option selected mode) The functions, options are the same as for the PG₀ to 3. | Same as for the PG ₀ to 3. | Same as for the PG ₀ to 3. |
| | 4 | Input | <ul style="list-style-type: none"> Comparator input option selected mode REFB: Common reference voltage input for CMPB₁ to 3 CMPB₁ to 3: Comparator input <ul style="list-style-type: none"> 4-bit input together with CMPA (BANK IP) Single-bit decision (BANK BP, BNP) (at DPL = 9) | | |

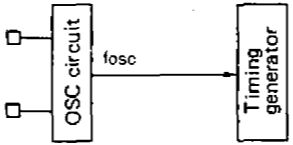
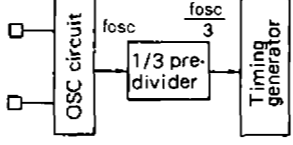
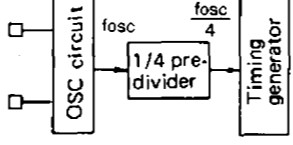
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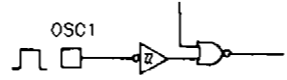
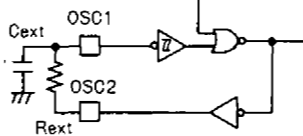
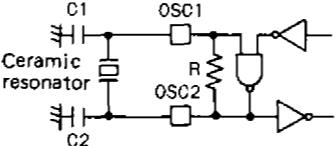
| Pin Name | Pins | I/O | Functions | Options | During Reset |
|--|------|--------|---|--|---------------------------------------|
| PK ₀ PK ₁ PK ₂ PK ₃ | 4 | Output | <ul style="list-style-type: none"> Output port K₀ to 3 (Segment driver output) 4-bit output (OP instruction) Single-bit decision (BP, BNP instructions) Single-bit set/reset (SPB, RPB instructions) | (1) Open drain type output (2) With pull-down resistance • (1), (2): Specified bit by bit. | "L" output |
| PL ₀ PL ₁ PL ₂ PL ₃ | 4 | Output | <ul style="list-style-type: none"> Output port L₀ to 3 (Segment driver output) The functions, options are the same as for the PK ₀ to 3. | Same as for the PK ₀ to 3. | Same as for the PK ₀ to 3. |
| PM ₀ PM ₁ PM ₂ PM ₃ | 4 | Output | <ul style="list-style-type: none"> Output port M₀ to 3 (Digit driver Output) The functions, options are the same as for the PK ₀ to 3. | Same as for the PK ₀ to 3. | Same as for the PK ₀ to 3. |
| PN ₀ PN ₁ PN ₂ PN ₃ | 4 | Output | <ul style="list-style-type: none"> Output port N₀ to 3 (Digit driver output) The functions, options are the same as for the PK ₀ to 3. | Same as for the PK ₀ to 3. | Same as for the PK ₀ to 3. |
| PO ₀ PO ₁ PO ₂ PO ₃ | 4 | Output | <ul style="list-style-type: none"> Output port O₀ to 3 (Digit driver output) The functions, options are the same as for the PK ₀ to 3. | Same as for the PK ₀ to 3. | Same as for the PK ₀ to 3. |
| PP ₀ | 1 | Output | <ul style="list-style-type: none"> Output port P₀ (Digit driver output) The functions, options are the same as for the PK ₀ to 3. This port consists of a single bit. | Same as for the PK ₀ to 3. | Same as for the PK ₀ to 3. |
| RES | 1 | Input | <ul style="list-style-type: none"> System reset input For power-up reset, "L" level is applied for 4 clock cycles or more. | — | — |
| TEST | 1 | Input | <ul style="list-style-type: none"> LSI test pin Normally connected to V_{SS} | — | — |
| V _p | 1 | — | <ul style="list-style-type: none"> Power supply pin for pull-down resistance | — | — |

Predivider Option

| Option Name | Circuit | Conditions, etc. |
|-------------------|---|--|
| 1. No predivider |  | <ul style="list-style-type: none"> • Applicable to all of 3 OSC options. • The OSC frequency, external clock do not exceed 1444 kHz. (LC6568D) • The OSC frequency, external clock do not exceed 4330 kHz. (LC6568H) • Refer to Table of OSC, Predivider Option (Table 2). |
| 2. 1/3 predivider |  | <ul style="list-style-type: none"> • Applicable to only 2 options of external clock, ceramic resonator OSC. • The OSC frequency, external clock do not exceed 4330 kHz. • Refer to Table of OSC, Predivider Option (Table 2). |
| 3. 1/4 predivider |  | <ul style="list-style-type: none"> • Applicable to only 2 options of external clock, ceramic resonator OSC. • The OSC frequency, external clock do not exceed 4330 kHz. • Refer to Table of OSC, Predivider Option (Table 2). |

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Oscillator Circuit Option

| Option Name | Circuit | Conditions, etc. |
|--------------------------|---|--|
| 1. External Clock |  | <ul style="list-style-type: none"> • Input: Schmitt type. |
| 2. 2-pin RC OSC |  | <ul style="list-style-type: none"> • Input: Schmitt type. |
| 3. Ceramic Resonator OSC |  | |

(Note) High-speed version: Ceramic resonator OSC option or external clock option only

Options of Ports C, D Output Level during Reset

For input/output common ports C, D, either of the following two output levels may be selected in a group of 4 bits during reset by option.

| Option Name | Conditions, etc. |
|-----------------------------------|-----------------------------|
| 1. Output during reset: "H" level | All of 4 bits of ports C, D |
| 2. Output during reset: "L" level | All of 4 bits of ports C, D |

Options of Port Output Configuration

For each input/output common port, either of the following two output configurations may be selected by option (bitwise).

| Option Name | Circuit | Applicable Ports |
|-------------------------------------|---------|---|
| 1. Open drain type output | | Ports C, D, E, F, G, H, I, J |
| | | Ports K, L, M, N, O, P |
| 2. Output with pull-up resistance | | Ports C, D, E, F, G, H, I, J (Note) Not applicable to P12/REFA, P13/CMPA, PJ0/REFB, PJ1 to 3/CMP1 to 3 ports at the comparator input function option selected mode |
| 3. Output with pull-down resistance | | Ports K, L, M, N, O, P |

Port input/output } Option
 Comparator input }

- For six ports of PI₂/REFA, PI₃/CMPA, PJ₀/REFB, PJ₁/CMPB1, PJ₂/CMPB2, PJ₃/CMPB3, either of the two options – port input/output, comparator input – may be selected. (Note)
- Selection between port input/output and comparator input may be made in bit units.
 - (a) Port input/output
 - (b) Comparator input

| Pin | Circuit Configuration | Conditions, etc. | | | | | | |
|---|---|------------------|----|--------------------------|---|-------------------------|---|---|
| PI ₂ /REFA PI ₃ /CMPA PJ ₀ /REFB PJ ₁ /CMPB1 PJ ₂ /CMPB2 PJ ₃ /CMPB3 | <p>(PI₂/REFA) (PI₃/CMPA) (PJ₀/REFB) (PJ₁₋₃/CMPB1~3)</p> <p>REF (REF) CMP (CMP)</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th>Option</th> <th>SW</th> </tr> </thead> <tbody> <tr> <td>Port input/output option</td> <td>b</td> </tr> <tr> <td>Comparator input option</td> <td>a</td> </tr> </tbody> </table> | Option | SW | Port input/output option | b | Comparator input option | a | Selection of (b) port input/output option permits either of the two port output type options (OD, PU) to be selected. |
| Option | SW | | | | | | | |
| Port input/output option | b | | | | | | | |
| Comparator input option | a | | | | | | | |

(Note) Selection of option for PI₃/CMPA provides automatic selection of option for PI₂/REFA.
 Selection of option for PJ₁/CMPB1, PJ₂/CMPB2, PJ₃/CMPB3 provides automatic selection of option for PJ₀/REFB.

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LC6568D

1. Absolute Maximum Ratings/ $T_a = 25^\circ\text{C}$, $V_{SS} = 0\text{V}$

| | | | min | typ | max | unit |
|-----------------------------|---------------------|---|-------------------------------------|-----|--------------|------------------|
| Maximum Supply Voltage | $V_{DD\text{ max}}$ | V_{DD} | -0.3 | | +7.0 | V |
| Output Voltage | $V_{O(1)}$ | OSC2 | Allowable up to voltage generated | | | V |
| | $V_{O(2)}$ | Port K, L, M, N, O, P0 | $V_{DD}-45$ | | $V_{DD}+0.3$ | V |
| Input Voltage | $V_{I(1)}$ | OSC1 (Note 1) TEST, $\overline{\text{RES}}$ | -0.3 | | $V_{DD}+0.3$ | V |
| | $V_{I(2)}$ | Port A, B | -0.3 | | +15 | V |
| Input/Output Voltage | $V_{I(3)}$ | Vp | $V_{DD}-45$ | | $V_{DD}+0.3$ | V |
| | $V_{IO(1)}$ | Port of OD type (Port C, D, E, F0 to F2, G, H0, I, J) | -0.3 | | +15 | V |
| | $V_{IO(2)}$ | Port of PU type (Port C, D, E, F0 to F2, G, H0, I, J) | -0.3 | | $V_{DD}+0.3$ | V |
| Peak Output Current | $I_{OP(1)}$ | Port C, D, E, F0 to F2, G, H0, I, J | -2 | | +15 | mA |
| | $I_{OP(2)}$ | Port K, L | -10 | | 0 | mA |
| | $I_{OP(3)}$ | Port M, N, O, P0 | -30 | | 0 | mA |
| Allowable Power Dissipation | $P_d\text{ max}$ | $T_a = -30\text{ to }+70^\circ\text{C}$ | | | | |
| | | | | | 600 | mW |
| | | | | | 430 | mW |
| Operating Temperature | T_{opr} | | -30 | | +70 | $^\circ\text{C}$ |
| Storage Temperature | T_{stg} | | -55 | | +125 | $^\circ\text{C}$ |
| Average Output Current | $I_{OA(1)}$ | Per pin over the period of 100msec. | Port C, D, E, F0 to F2, G, H0, I, J | | +15 | mA |
| | $I_{OA(2)}$ | Per pin over the period of 100msec. | Port K, L | -10 | 0 | mA |
| | $I_{OA(3)}$ | Per pin over the period of 100msec. | Port M, N, O, P0 | -30 | 0 | mA |
| | $\Sigma I_{OA(1)}$ | Total current of PC0 to 3, PD0 to 3, PE0 to 3 (Note 2) | | -30 | +50 | mA |
| | $\Sigma I_{OA(2)}$ | Total current of PF0 to 2, PG0 to 3, PH0, PI0 to 3, PJ0 to 3 (Note 2) | | -30 | +50 | mA |
| | $\Sigma I_{OA(3)}$ | Total current of PK0 to 3, PL0 to 3, PM0 to 3 (Note 2) | | -50 | 0 | mA |
| | $\Sigma I_{OA(4)}$ | Total current of PN0 to 3, PO0 to 3, PP0 (Note 2) | | -50 | 0 | mA |

2. Allowable Operating Conditions/ $T_a = -30\text{ to }+70^\circ\text{C}$, $V_{SS} = 0\text{V}$, $V_{DD} = 4.0\text{ to }6.0\text{V}$ unless otherwise specified

| | | | min | typ | max | unit |
|--------------------------|-------------|---|-------------|-----|----------|------|
| Operating Supply Voltage | V_{DD} | | 4.0 | | 6.0 | V |
| Standby Supply Voltage | V_{ST} | RAM, register hold (Note 3) | 1.8 | | 6.0 | V |
| "H"-Level Input Voltage | $V_{IH(1)}$ | Port A | 1.9 | | +13.5 | V |
| | $V_{IH(2)}$ | Output Nch Tr OFF type (Port C to J) | $0.7V_{DD}$ | | +13.5 | V |
| | $V_{IH(3)}$ | Output Nch Tr OFF type (Port C to J) | $0.7V_{DD}$ | | V_{DD} | V |
| | $V_{IH(4)}$ | Output Nch Tr OFF SCK, SI of OD type | $0.8V_{DD}$ | | +13.5 | V |

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| | | | | min | typ | max | unit | |
|---|--------------------------------------|--------------------------------------|--|--|-----------------|-----------------|---------------------|---|
| "H"-Level Input Voltage | V _{IH} (5) | Output Nch Tr OFF | \overline{SCK} , SI of PU type | 0.8V _{DD} | | V _{DD} | V | |
| | V _{IH} (6) | Fig. 7 | High V _t input circuit of Port B ₃ | V _{DD} -0.5 | | +13.5 | V | |
| | V _{IH} (7) | Fig. 7 | Low V _t input circuit of Port B ₃ | 0.5V _{DD} | | +13.5 | V | |
| | V _{IH} (8) | Fig. 3 V _{DD} : 1.8 to 6.0V | RES | 0.8V _{DD} | | V _{DD} | V | |
| | V _{IH} (9) | | PB ₀ to 2, INT ₀ to 3 | 0.8V _{DD} | | +13.5 | V | |
| | V _{IH} (10) | External clock mode | OSC1 | 0.8V _{DD} | | V _{DD} | V | |
| | "L"-Level Input Voltage | V _{IL} (1) | Fig. 7 V _{DD} : 1.8 to 6.0V | PA ₀ to 3 | V _{SS} | | +0.5 | V |
| | | V _{IL} (2) | | PC to PJ, TEST | V _{SS} | | 0.3V _{DD} | V |
| | | V _{IL} (3) | Fig. 7 | PB ₀ to 2, \overline{SCK} , SI, INT ₀ to 3 | V _{SS} | | 0.25V _{DD} | V |
| | | V _{IL} (4) | | RES | V _{SS} | | 0.25V _{DD} | V |
| V _{IL} (5) | | PB ₃ | | V _{SS} | | 0.9 | V | |
| V _{IL} (6) | | Fig. 7 | PB ₃ | V _{SS} | | 0.3 | V | |
| V _{IL} (7) | | | External clock mode | OSC1 | V _{SS} | | 0.25V _{DD} | V |
| Operating Frequency (Cycle Time) | f _{op} (TCYC) | | OSC1 | 384 | | 1444 | kHz | |
| Ceramic Resonator Oscillation Constants | | | OSC2 | (10.4) | | (2.77) | (μs) | |
| External Clock Conditions | | | OSC1 | See Fig. 1, Table 1. | | | | |
| Frequency | f _{EXT} | | OSC1 (Fig. 4) | See Table 2. | | | | |
| "H"-Level/"L"-Level Clock Pulse Width | t _{EXTH} /t _{EXTL} | | OSC1 (Fig. 4) | 90 | | | ns | |
| Rise/Fall Time | t _{EXTR} /t _{EXTF} | | OSC1 (Fig. 4) | | | | 30 ns | |
| 2-pin RC Oscillation | | | | | | | | |
| External Capacitance | C _{EXT} | | OSC1, OSC2 (Fig. 9) | 220±5% | | | pF | |
| External Resistance | R _{EXT} | | OSC1, OSC2 (Fig. 9) | 6.8±1% | | | kΩ | |

3. Electrical Characteristics/T_a = -30 to +70°C, V_{SS} = 0V, V_{DD} = 4.0 to 6.0V unless otherwise specified

| | | | | min | typ | max | unit |
|--------------------------|---------------------|---|--|----------------------|-------|------|------|
| "H"-Level Input Current | I _{IH} (1) | Output Nch Tr OFF (Including OFF leakage current of Nch Tr) | Port of OD type (Port C to J) Port A, B | | | +5.0 | μA |
| | I _{IH} (2) | Output Nch Tr OFF (Including OFF leakage current of Nch Tr) | Port of PU type (Port C to J) OSC1 (External clock mode) | | | +1.0 | μA |
| "L"-Level Input Current | I _{IL} (1) | Output Nch Tr OFF | Port of OD type (Port C to J) Port A, B | -1.0 | | | μA |
| | I _{IL} (2) | Output Nch Tr OFF | Port of PU type (Port C to J) | -1.3 | -0.35 | | mA |
| "H"-Level Output Voltage | I _{IL} (3) | V _{IN} =V _{SS} | RES | -45 | -10 | | μA |
| | V _{OH} (1) | I _{OH} =-50μA | Port of PU type (Port C to J) | V _{DD} -1.2 | | | V |
| | V _{OH} (2) | I _{OH} =-3mA | Port K, L | V _{DD} -1.8 | | | V |
| | V _{OH} (3) | I _{OH} =-15mA | Port M, N, O, P ₀ | V _{DD} -1.8 | | | V |

Continued on next page.

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Continued from preceding page.

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| | | | | min | typ | max | unit |
|------------------------------------|---|---|---|--------------------|-----|------|------|
| "L"-Level Output Voltage | VOL(1) | I _{OL} =10mA, Other ports: ΣI _{OLmax} | Port C, D, E, F ₀ to F ₂ , G, H ₀ , I, J | | | 1.5 | V |
| | VOL(2) | I _{OL} =2mA, Each port: I _{OL} =2mA | Port C, D, E, F ₀ to F ₂ , G, H ₀ , I, J | | | 0.5 | V |
| | VOL(3) | V _p =-35V, Output Pch Tr OFF Output open | Port of PD type (Port K to P) | | | -33 | V |
| Output OFF Leakage Current | I _{OFF} (1) | Output Pch Tr OFF V _{OUT} =V _{DD} | Port of OD type (Port K to P) | | | +30 | μA |
| | I _{OFF} (2) | Output Pch Tr OFF V _{OUT} =V _{DD} -40V | Port of OD type (Port K to P) | -30 | | | μA |
| Hysteresis Voltage | V _{HYS} | | RES, INT ₀ to 3 SCK, SI, OSC1 of Schmitt type (Note 5) | 0.1V _{DD} | | | V |
| Pull-up Resistance | R _{PP} | V _{DD} : 5.0V | Port of PU type (Port C to J) | | 14 | | kΩ |
| Pull-down Resistance | R _{PD} | V _{DD} : 5.0V | Port of PD type (Port K to P) | 50 | | 200 | kΩ |
| Current Dissipation | Operation mode, Output Nch Tr, Pch Tr OFF, V _{IN} =V _{DD} | | | | | | |
| 2-Pin RC Oscillation Mode | I _{DDOP} (1) | Fig. 9 f _{osc} =750kHz (typ) | V _{DD} | | 2.5 | 8 | mA |
| Ceramic Resonator Oscillation Mode | I _{DDOP} (2) | Fig. 1 4MHz, 1/3 predivider | V _{DD} | | 8 | 15 | mA |
| | I _{DDOP} (3) | Fig. 1 4MHz, 1/4 predivider | V _{DD} | | 8 | 15 | mA |
| External Clock Mode | I _{DDOP} (4) | Fig. 1 3MHz, 1/3 predivider | V _{DD} | | 6.5 | 14 | mA |
| | I _{DDOP} (5) | Fig. 1 3MHz, 1/4 predivider | V _{DD} | | 6.5 | 14 | mA |
| | I _{DDOP} (6) | Fig. 1 400kHz | V _{DD} | | 1.0 | 4.5 | mA |
| | I _{DDOP} (7) | Fig. 1 800kHz | V _{DD} | | 2.0 | 6 | mA |
| | I _{DDOP} (8) | 384kHz to 1444kHz, 1/1 predivider | V _{DD} | | 3.5 | 9 | mA |
| | | 1152kHz to 4330kHz, 1/3 predivider | V _{DD} | | 8 | 15 | mA |
| | | 1536kHz to 4330kHz, 1/4 predivider | V _{DD} | | 8 | 15 | mA |
| | Standby Mode | I _{DDST} | V _{IN} =V _{DD} Output Nch Tr OFF Output Pch Tr OFF Output pin open | | | 0.05 | 10 |
| Ceramic Resonator Oscillation | | | | | | | |
| Oscillation Frequency | f _{CFOSC} (Note 4) | 1/1 (10μs) 400K | OSC1, OS2 (Fig. 1) | 392 | 400 | 408 | kHz |
| | | 1/1 (5μs) 800K | OSC1, OSC2 (Fig. 1) | 784 | 800 | 816 | kHz |
| | | 1/3 (4μs) 3M | OSC1, OSC2 (Fig. 1) | 2.94 | 3 | 3.06 | MHz |
| | | 1/4 (5.33μs) | OSC1, OSC2 (Fig. 1) | 3.92 | 4 | 4.08 | MHz |
| | | 1/3 (3μs) 4M | OSC1, OSC2 (Fig. 1) | | | | |
| Oscillation Stabilizing Period | t _{CFS} | 1/4 (4μs) | | | | 10 | ms |
| RC Oscillation | | | | | | | |
| Oscillation Frequency | f _{CRS} | 1/1 predivider C _{ext} =220pF±5% R _{ext} =6.8kΩ±1% | OSC1, OSC2 (Fig. 9) | 554 | 750 | 1235 | kHz |
| Pin Capacitance | CP | f=1MHz Other than pins to be tested: V _{IN} =V _{SS} | | | 10 | | pF |

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LC6568D

4. Serial Interface Characteristics/ $V_{SS} = 0V$, $T_a = -30^{\circ}C$ to $+70^{\circ}C$,
 $V_{DD} = 4.0V$ to $6.0V$ unless otherwise specified

| | | | | min | typ | max | unit |
|-------------------------|----------|---|------------------|-----|---------------------|-----|---------|
| Serial Clock | | | | | | | |
| Input Clock Cycle Time | tCKCY(1) | Fig. 5 | \overline{SCK} | 3.0 | | | μs |
| Output Clock Cycle Time | tCKCY(2) | Fig. 5 | \overline{SCK} | | 64 x TCYC | | μs |
| Input Clock | tCKL(1) | Fig. 5 | \overline{SCK} | 1.0 | | | μs |
| "L"-Level Pulse Width | | | | | | | |
| Output Clock | tCKL(2) | Fig. 5 | \overline{SCK} | | 32 x TCYC | | μs |
| "L"-Level Pulse Width | | | | | | | |
| Input Clock | tCKH(1) | Fig. 5 | \overline{SCK} | 1.0 | | | μs |
| "H"-Level Pulse Width | | | | | | | |
| Output Clock | tCKH(2) | Fig. 5 | \overline{SCK} | | 32 x TCYC | | μs |
| "H"-Level Pulse Width | | | | | | | |
| Serial Input | | | | | | | |
| Data Setup Time | tJCK | Specified for \uparrow of \overline{SCK} , Fig. 5 | SI | 0.5 | | | μs |
| Data Hold Time | tCKI | Specified for \uparrow of \overline{SCK} , Fig. 5 | SI | 0.5 | | | μs |
| Serial Output | | | | | | | |
| Output Delay Time | tCKO | Specified for \downarrow of \overline{SCK} , Nch OD only: External 1kohm, external 50pF Fig. 5 | SO | | | 0.5 | μs |
| Pulse Output | | | | | | | |
| Period | tpCY | Fig. 6 | PE0 | | 64 x TCYC | | μs |
| "H"-Level Pulse Width | tpH | TCYC=4 x System clock period, Nch OD only: External 1kohm, external 50pF | PE0 | | 32 x TCYC \pm 10% | | μs |
| "L"-Level Pulse Width | tpL | | PE0 | | 32 x TCYC \pm 10% | | μs |

5. Comparator Characteristics/ $V_{SS} = 0V$, $T_a = -30^{\circ}C$ to $+70^{\circ}C$, $V_{DD} = 4.5V$ to $6.0V$
 unless otherwise specified

| | | | | min | typ | max | unit |
|----------------------------|-------|--|---------------|--------------|----------|--------------|---------|
| Comparator Characteristics | | | | | | | |
| Input Voltage Range | VCMIN | | PI3, PJ1 to 3 | $V_{SS}+1.0$ | | $V_{DD}-1.5$ | V |
| Response Speed | TRS | 100mV overdrive mode | | | | 50 | μs |
| Offset Voltage | VOFS | $V_{CMIN}=V_{SS}+1.0V$ to $V_{DD}-1.5V$ | | | ± 20 | ± 100 | mV |

- (Note 1) When oscillated internally under the oscillating conditions in Fig. 1, up to the oscillation amplitude generated is allowable.
- (Note 2) Average over the period of 100msec.
- (Note 3) Operating supply voltage V_{DD} must be held until the standby mode is entered after the execution of the HALT instruction.
The PB3 pin must be free from chattering during the HALT instruction execution cycle.
- (Note 4) fCFOSC represents an oscillatable frequency.
- (Note 5) The OSC1 becomes the Schmitt type when the OSC option is the 2-pin RC OSC or external clock OSC.
- (Note 6) When mounting the QIP version on the board, do not dip it in solder.

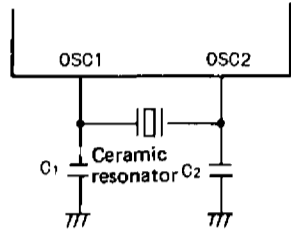


Fig. 1 Ceramic Resonator Oscillation Circuit

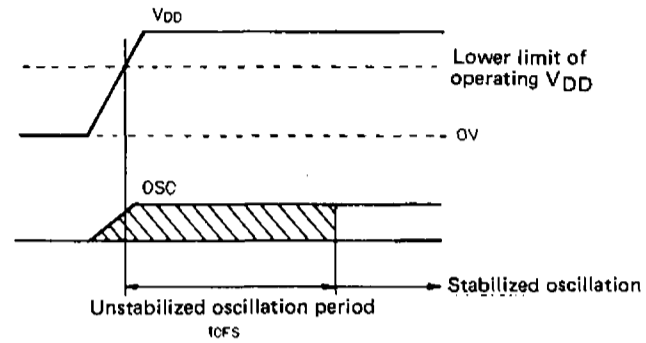


Fig. 2 Oscillation Stabilizing Period

Table 1 Constants Guaranteed for LC6568D Ceramic Resonator Oscillation

| | | | | | |
|-----------------------------|----|------------|-----------------------------|------------------------------|-------------|
| 4 MHz (Murata) CSA4.00MG | C1 | 33pF ± 10% | 800 kHz (Murata) CSB800D | C1 | 220pF ± 10% |
| | C2 | 33pF ± 10% | | 800 kHz (Kyocera) CSB800K | C2 |
| 4 MHz (Kyocera) KBR4.0MS | C1 | 33pF ± 10% | 400 kHz (Murata) CSB400P | | C1 |
| | C2 | 33pF ± 10% | | 400 kHz (Kyocera) KBR400B | C2 |
| 3 MHz (Murata) CSA3.00MG | C1 | 33pF ± 10% | | | |
| | C2 | 33pF ± 10% | | | |
| 3 MHz (Kyocera) KBR3.0MS | C1 | 33pF ± 10% | | | |
| | C2 | 33pF ± 10% | | | |

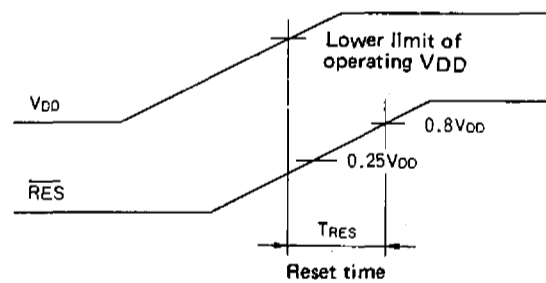
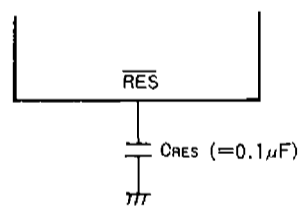


Fig. 3 Reset Circuit and Reset Time

(Note 7) When the rise time of the power supply is 0, the reset time becomes 10ms to 100ms at $C_{RES}=0.1\mu F$. If the rise time of the power supply is long, the value of C_{RES} must be increased so that the reset time becomes 10ms or greater.

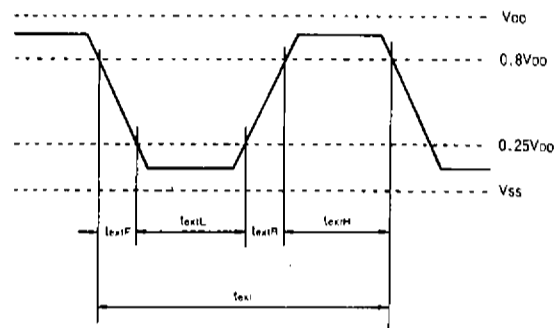
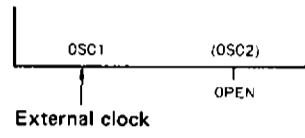


Fig. 1 External Clock Input Waveform

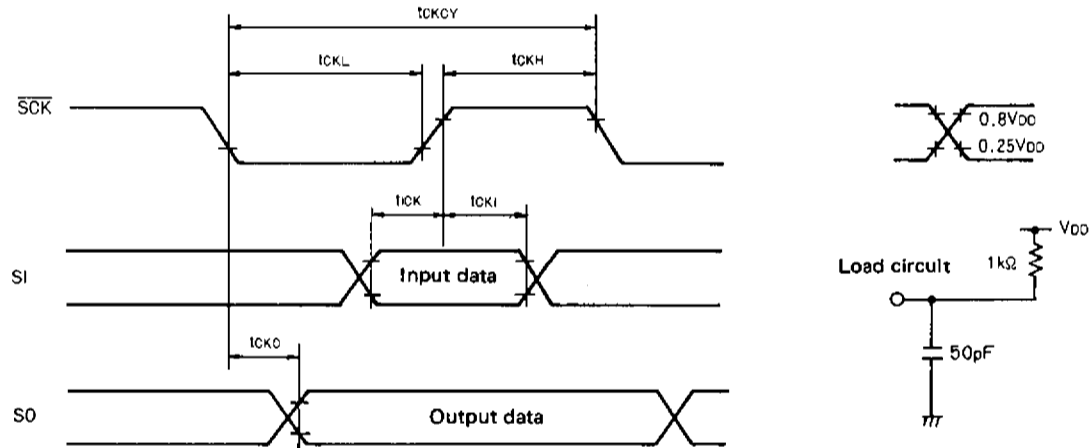
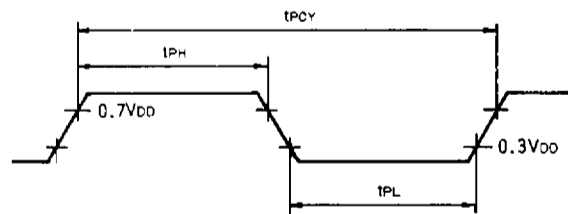


Fig. 5 Serial Input/Output Timing



The load conditions are the same as in Fig. 5.

Fig. 6 Pulse Output Timing at Port E0

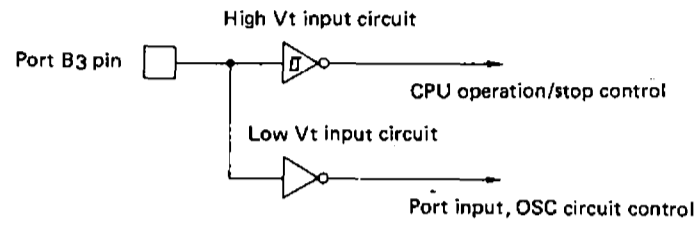


Fig. 7 Port B3 High Vt/Low Vt Input Circuit

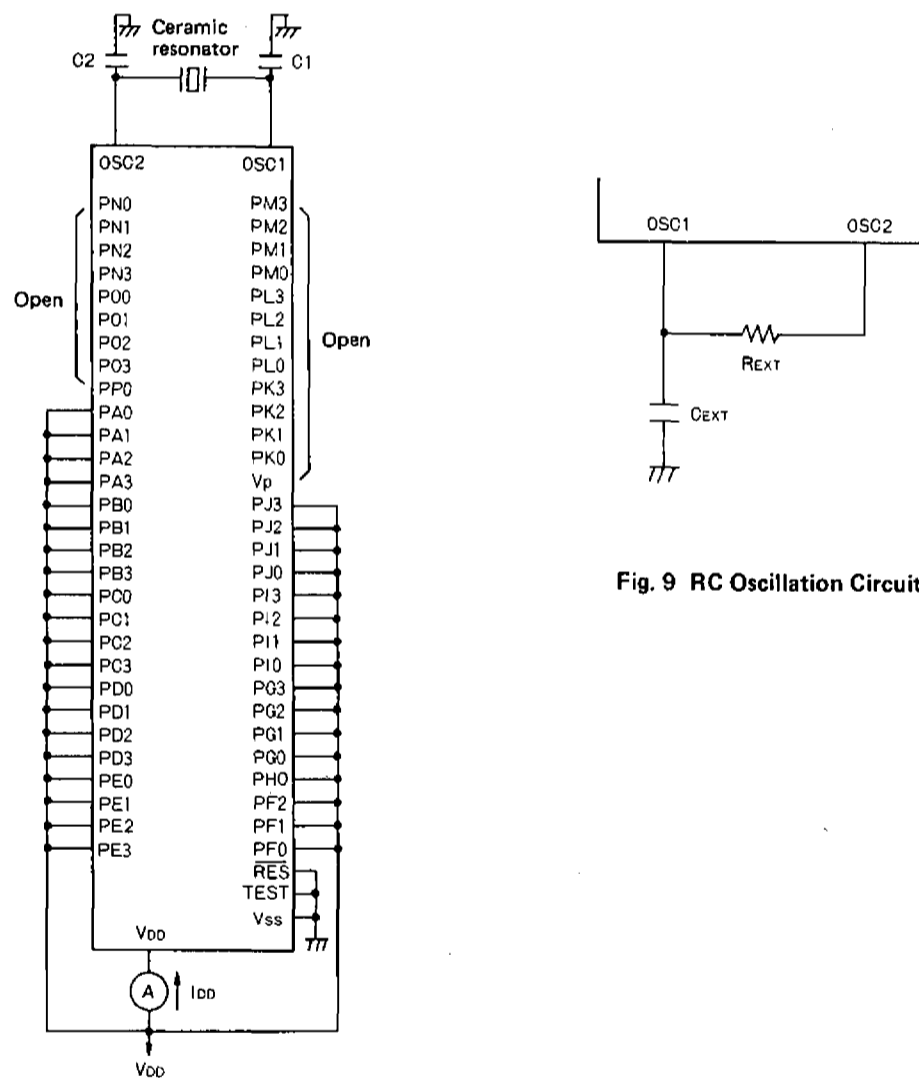


Fig. 8 IDDOP Test Circuit (f=4MHz)

Fig. 9 RC Oscillation Circuit

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Table 2 LC6568D

Table of Oscillation, Predivider Option (All selectable combinations are shown. Do not use any other combinations than shown below.) $V_{DD} = 4$ to $6V$

| Circuit Configuration | Frequency | Predivider Option (Cycle Time) | Remarks |
|--|--|---|-----------------------------------|
| Ceramic Resonator Option | 400 kHz | 1/1 (10 μs) | Unusable with 1/3, 1/4 predivider |
| | 800 kHz | 1/1 (5 μs) | Unusable with 1/3, 1/4 predivider |
| | 3 MHz | 1/3 (4 μs) 1/4 (5.33 μs) | Unusable with 1/1 predivider |
| | 4 MHz | 1/3 (3 μs) 1/4 (4 μs) | Unusable with 1/1 predivider |
| External Clock Option or External Clock Drive by RC OSC Option | 384 to 1444 kHz 1152 to 4330 kHz 1536 to 4330 kHz | 1/1 (10.4 to 2.77 μs) 1/3 (10.4 to 2.77 μs) 1/4 (10.4 to 3.70 μs) | |
| External Clock Drive by Ceramic Resonator OSC Option | The external clock drive is impossible. When using the external clock drive, specify the external clock option or CR OSC option. | | |
| RC OSC Option | Used with 1/1 predivider, recommended constants. If used with other than recommended constants, the predivider option, frequency, V_{DD} range must be the same as for the external clock option. | | |

RC Oscillation Characteristic of the LC6568D

Fig. 10 shows the RC oscillation characteristic of the LC6568D. For the variation range of RC OSC frequency of the LC6568D, the following are guaranteed at the external constants only shown below.

External constants $C_{ext} = 220pF$, $R_{ext} = 6.8kohms$

$554kHz \leq f_{CRS} \leq 1235kHz$ ($T_a = -30^\circ C$ to $+70^\circ C$, $V_{DD} = 4.0$ to $6.0V$)

If any other constants than specified above are used, the range of $R_{ext} = 4kohms$ to $20kohms$, $C_{ext} = 150pF$ to $390pF$ must be observed. (See Fig. 10.)

(Note 8) The oscillation frequency at $V_{DD} = 5.0V$, $T_a = 25^\circ C$ must not exceed $750kHz$.

(Note 9) The oscillation frequency at $V_{DD} = 4$ to $6V$, $T_a = -30$ to $+70^\circ C$ must be within the operation clock frequency range ($384kHz$ to $1444kHz$).

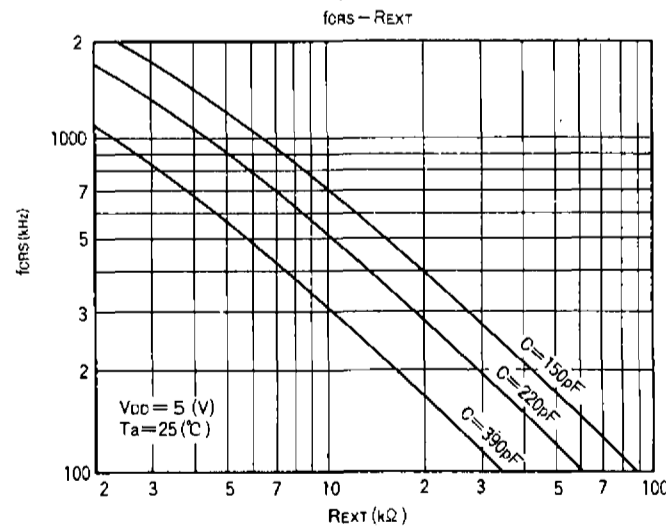


Fig. 10 RC Oscillation Frequency Data (Typ.)

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1. Absolute Maximum Ratings/ $T_a = 25^\circ\text{C}$, $V_{SS} = 0\text{V}$

| | | | min | typ | max | unit | |
|-----------------------------|--------------------|---|--------------------------------------|-----|--------------|------------------|----|
| Maximum Supply Voltage | V_{DD} max | | -0.3 | | +7.0 | V | |
| Output Voltage | $V_{O(1)}$ | | Allowable up to voltage generated | | | V | |
| | $V_{O(2)}$ | Port K, L, M, N, O, P0 | $V_{DD}-45$ | | $V_{DD}+0.3$ | V | |
| Input Voltage | $V_{I(1)}$ | OSC1 (Note 1) TEST, RES | -0.3 | | $V_{DD}+0.3$ | V | |
| | $V_{I(2)}$ | Port A, B | -0.3 | | +15 | V | |
| Input/Output Voltage | $V_{I(3)}$ | V_p | $V_{DD}-45$ | | $V_{DD}+0.3$ | V | |
| | $V_{IO(1)}$ | Port of OD type (Port C, D, E, F0 to F2, G, H0, I, J) | -0.3 | | +15 | V | |
| | $V_{IO(2)}$ | Port of PU type (Port C, D, E, F0 to F2, G, H0, I, J) | -0.3 | | $V_{DD}+0.3$ | V | |
| Peak Output Current | $I_{OP(1)}$ | Port C, D, E, F0 to F2, G, H0, I, J) | -2 | | +15 | mA | |
| | $I_{OP(2)}$ | Port K, L | -10 | | 0 | mA | |
| | $I_{OP(3)}$ | Port M, N, O, P0 | -30 | | 0 | mA | |
| Allowable Power Dissipation | P_d max | $T_a = -30$ to $+70^\circ\text{C}$ | | | | | |
| Operating Temperature | T_{opr} | | -30 | | +70 | $^\circ\text{C}$ | |
| Storage Temperature | T_{stg} | | -55 | | +125 | $^\circ\text{C}$ | |
| Average Output Current | $I_{OA(1)}$ | Per pin over the period of 100msec. | Port C, D, E, F0 to F2, G, H0, I, J) | -2 | | +15 | mA |
| | $I_{OA(2)}$ | Per pin over the period of 100msec. | Port K, L | -10 | | 0 | mA |
| | $I_{OA(3)}$ | Per pin over the period of 100msec. | Port M, N, O, P0 | -30 | | 0 | mA |
| | $\Sigma I_{OA(1)}$ | Total current of PC0 to 3, PD0 to 3, PE0 to 3 (Note 2) | | -30 | | +50 | mA |
| | $\Sigma I_{OA(2)}$ | Total current of PF0 to 2, PG0 to 3, PH0, PI0 to 3, PJ0 to 3 (Note 2) | | -30 | | +50 | mA |
| | $\Sigma I_{OA(3)}$ | Total current of PK0 to 3, PL0 to 3, PM0 to 3 (Note 2) | | -50 | | 0 | mA |
| | $\Sigma I_{OA(4)}$ | Total current of PN0 to 3, PO0 to 3, PP0 (Note 2) | | -50 | | 0 | mA |

2. Allowable Operating Conditions/ $T_a = -30$ to $+70^\circ\text{C}$, $V_{SS} = 0\text{V}$, $V_{DD} = 4.5$ to 6.0V unless otherwise specified

| | | | min | typ | max | unit |
|--------------------------|-------------|-----------------------------|----------------------------------|-------------|----------|------|
| Operating Supply Voltage | V_{DD} | | 4.5 | | 6.0 | V |
| Standby Supply Voltage | V_{ST} | RAM, register hold (Note 3) | 1.8 | | 6.0 | V |
| "H"-Level Input Voltage | $V_{IH(1)}$ | | 1.9 | | +13.5 | V |
| | $V_{IH(2)}$ | Output Nch Tr OFF | Port of OD type (Port C to J) | $0.7V_{DD}$ | +13.5 | V |
| | $V_{IH(3)}$ | Output Nch Tr OFF | Port of PU type (Port C to J) | $0.7V_{DD}$ | V_{DD} | V |

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Continued from preceding page.

| LC6568H | | | | min | typ | max | unit |
|---|---------------------------------------|---|--|---|---------------------|---------------------|------|
| "L"-Level Input Voltage | V _{IH} (4) | Output Nch Tr OFF | \overline{SCK} , SI of OD type | 0.8V _{DD} | | +13.5 | V |
| | V _{IH} (5) | Output Nch Tr OFF | \overline{SCK} , SI of PU type | 0.8V _{DD} | | V _{DD} | V |
| | V _{IH} (6) | Fig. 7 | High V _t input circuit of PB ₃ | V _{DD} -0.5 | | +13.5 | V |
| | V _{IH} (7) | Fig. 7 | Low V _t input circuit of PB ₃ | 0.5V _{DD} | | +13.5 | V |
| | V _{IH} (8) | Fig. 3 | V _{DD} : 1.8 to 6.0V | RES | 0.8V _{DD} | V _{DD} | V |
| | V _{IH} (9) | | | PB ₀ to 2, INT ₀ to 3 | 0.8V _{DD} | +13.5 | V |
| | V _{IH} (10) | External clock mode | OSC1 | 0.8V _{DD} | | V _{DD} | V |
| | V _{IL} (1) | | PA ₀ to 3 | V _{SS} | | +0.5 | V |
| | V _{IL} (2) | | PCto PJ TEST | V _{SS} | | 0.3V _{DD} | V |
| | V _{IL} (3) | | PB ₀ to 2 | V _{SS} | | 0.25V _{DD} | V |
| V _{IL} (4) | | \overline{SCK} , SI' INT ₀ to 3 | | | | | |
| V _{IL} (5) | Fig. 7 | RES | V _{SS} | | 0.25V _{DD} | V | |
| V _{IL} (6) | Fig. 7 | PB ₃ | V _{SS} | | 0.9 | V | |
| V _{IL} (7) | Fig. 7 | V _{DD} : 1.8 to 6.0V | PB ₃ | V _{SS} | 0.3 | V | |
| Operating Frequency (Cycle Time) | f _{op} (T _{CYC}) | External clock mode | OSC1 | V _{SS} | 0.25V _{DD} | 4330 | kHz |
| Ceramic Resonator Oscillation Constants | | | OSC1 | 384 | | 4330 | kHz |
| External Clock Conditions | | | OSC2 | (10.4) | | (0.92) | (μS) |
| Frequency | f _{EXT} | 1/1 predivider | OSC1 (Fig. 4) | | See Table 2. | | |
| "H"-Level/"L"-Level Clock Pulse Width | t _{EXH} , t _{EXTL} | | OSC1 (Fig. 4) | | 90 | | ns |
| Rise/Fall Time | t _{EXTR} , t _{EXTF} | | OSC1 (Fig. 4) | | | 30 | ns |
| 3. Electrical Characteristics/T_a = -30 to +70°C, V_{SS} = 0V, V_{DD} = 4.5 to 6.0V unless otherwise specified | | | | | | | |
| "H"-Level Input Current | I _{IH} (1) | Output Nch Tr OFF (Including OFF leakage current of Nch Tr) | Port of OD type (Port C to J) Port A, B | | | +5.0 | μA |
| | I _{IH} (2) | Output Nch Tr OFF (Including OFF leakage current of Nch Tr) | Port of PU type (Port C to J) OSC1 (External clock mode) | | | +1.0 | μA |
| "L"-Level Input Current | I _{IL} (1) | Output Nch Tr OFF | Port of OD type (Port C to J) Port A, B OSC1 (External clock mode) | | | -1.0 | μA |
| | I _{IL} (2) | Output Nch Tr OFF | Port of PU type (Port C to J) | -1.3 | -0.35 | | mA |
| "H"-Level Output Voltage | I _{IL} (3) | V _{IN} =V _{SS} | RES | -45 | -10 | | μA |
| | V _{OH} (1) | I _{OH} =-50μA | Port of PU type (Port C to J) | V _{DD} -1.2 | | | V |
| | V _{OH} (2) | I _{OH} =-3mA | Port K, L | V _{DD} -1.8 | | | V |
| | V _{OH} (3) | I _{OH} =-15mA | Port M, N, O, P ₀ | V _{DD} -1.8 | | | V |

Continued on next page.

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Continued from preceding page.

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| | | | | min | typ | max | unit |
|--------------------------------|---|---|--|--------------------|------|------|------|
| “L”-Level Output Voltage | VOL(1) | I _{OL} =10mA, Other ports: ΣI _{OLmax} | Port C, D, E, F ₀ to F ₂ G, H ₀ , I, J) | | | 1.5 | V |
| | VOL(2) | I _{OL} =2mA, Each port: I _{OL} =2mA | Port C, D, E, F ₀ to F ₂ , G, H ₀ , I, J) | | | 0.5 | V |
| | VOL(3) | V _p =-35V, Output Pch Tr OFF Output open | Port of PD type (Port K to P) | | | -33 | V |
| Output OFF Leakage Current | I _{OFF} (1) | Output Pch Tr OFF V _{OUT} =V _{DD} | Port of OD type (Port K to P) | | | +30 | μA |
| | I _{OFF} (2) | Output Pch Tr OFF V _{OUT} =V _{DD} -40V | Port of OD type (Port K to P) | -30 | | | μA |
| Hysteresis Voltage | V _{HYS} | | RES, INT ₀ to 3, SCK, SI, OSC1 of Schmitt type (Note 5) | 0.1V _{DD} | | | V |
| Pull-up Resistance | R _{PP} | V _{DD} : 5.0V | Port of PU type (Port C to J) | | 14 | | kΩ |
| Pull-down Resistance | R _{PD} | V _{DD} : 5.0V | Port of PD type (Port K to P) | 50 | | 200 | kΩ |
| Current Dissipation | Operation mode, Output Nch Tr, Pch Tr OFF, V _{IN} =V _{DD} | | | | | | |
| | I _{DDOP} (1) | 4MHz OSC (Fig. 8) | V _{DD} | | 8 | 15 | mA |
| | I _{DDOP} (2) | External Clock mode 384kHz to 4330kHz | V _{DD} | | 8 | 15 | mA |
| | I _{DDST} | Standby mode Output Nch, Pch Tr OFF Output pin open V _{IN} =V _{DD} | V _{DD} | | 0.05 | 10 | μA |
| Ceramic Resonator Oscillation | | | | | | | |
| Oscillation Frequency | f _{CFOSC} (Note 4) | 1/1 (1μs) 4MHz | OSC1 OSC2 (Fig. 1) | 3.92 | 4.00 | 4.08 | MHz |
| Oscillation Stabilizing Period | t _{CFCS} | Fig. 2 | | | | 10 | ms |
| Pin Capacitance | CP | f=1MHz Other than pins to be tested: V _{IN} =V _{SS} | | | 10 | | pF |

4. Serial Interface Characteristics/V_{SS} = 0V, T_a = -30°C to +70°C,

V_{DD} = 4.5V to 6.0V unless otherwise specified

| | | | | min | typ | max | unit |
|------------------------------------|-----------------------|--------|-------------------------|-----|-----------------------|-----|------|
| Serial Clock | | | | | | | |
| Input Clock Cycle Time | t _{CKCY} (1) | Fig. 5 | $\overline{\text{SCK}}$ | 3.0 | | | μs |
| Output Clock Cycle Time | t _{CKCY} (2) | Fig. 5 | $\overline{\text{SCK}}$ | | 64 x T _{CYC} | | μs |
| Input Clock “L”-Level Pulse Width | t _{CKL} (1) | Fig. 5 | $\overline{\text{SCK}}$ | 1.0 | | | μs |
| Output Clock “L”-Level Pulse Width | t _{CKL} (2) | Fig. 5 | $\overline{\text{SCK}}$ | | 32 x T _{CYC} | | μs |
| Input Clock “H”-Level Pulse Width | t _{CKH} (1) | Fig. 5 | $\overline{\text{SCK}}$ | 1.0 | | | μs |
| Output Clock “H”-Level Pulse Width | t _{CKH} (2) | Fig. 5 | $\overline{\text{SCK}}$ | | 32 x T _{CYC} | | μs |

Continued on next page.

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Continued from preceding page.

| LC6568H | | | | min | typ | max | unit |
|-----------------------|------------------|--|-----|-----|----------------------------|-----|------|
| Serial Input | | | | | | | |
| Data Setup Time | t _{ICK} | Specified for ↑ of \overline{SCK} , Fig. 5 | SI | 0.5 | | | μs |
| Data Hold Time | t _{CKI} | Specified for ↑ of \overline{SCK} , Fig. 5 | SI | 0.5 | | | μs |
| Serial Output | | | | | | | |
| Output Delay Time | t _{CKO} | Specified for ↓ of \overline{SCK} , Nch OD only: External 1kohm, external 50pF Fig. 5 | SO | | | 0.5 | μs |
| Pulse Output | | | | | | | |
| Period | t _{PCY} | Fig. 6 T _{CYC} =4 x System clock period, Nch OD only: External 1kohm, external 50pF | PE0 | | 64 x T _{CYC} | | μs |
| "H"-Level Pulse Width | t _{PH} | | PE0 | | 32 x T _{CYC} ±10% | | μs |
| "L"-Level Pulse Width | t _{PL} | | PE0 | | 32 x T _{CYC} ±10% | | μs |

5. Comparator Characteristics/V_{SS} = 0V, T_a = -30°C to +70°C V_{DD} = 4.5V to 6.0V
unless otherwise specified

| Comparator Characteristics | | | | min | typ | max | unit |
|----------------------------|-------------------|--|---------------|----------------------|----------------------|------|------|
| Input Voltage Range | V _{CMIN} | | PI3, PJ1 to 3 | V _{SS} +1.0 | V _{DD} -1.5 | | V |
| Response Speed | T _{RS} | 100mV overdrive mode | | | | 50 | μs |
| Offset Voltage | V _{OFS} | V _{CMIN} =V _{SS} +1.0V to V _{DD} -1.5V | | | ±20 | ±100 | mV |

(Note 1) When oscillated internally under the oscillating conditions in Fig. 1, up to the oscillation amplitude generated is allowable.

(Note 2) Average over the period of 100msec.

(Note 3) Operating supply voltage V_{DD} must be held until the standby mode is entered after the execution of the HALT instruction.

The PB3 pin must be free from chattering during the HALT instruction execution cycle.

(Note 4) f_{CFOSC} represents an oscillatable frequency.

(Note 5) The OSC1 becomes the Schmitt type when the OSC option is the 2-pin RC OSC or external clock OSC.

(Note 6) When mounting the QIP version on the board, do not dip it in solder.

- No products described or contained herein are intended for use in surgical implants, life-support systems, aerospace equipment, nuclear power control systems, vehicles, disaster/crime-prevention equipment and the like, the failure of which may directly or indirectly cause injury, death or property loss.
- Anyone purchasing any products described or contained herein for an above-mentioned use shall:
 - ① Accept full responsibility and indemnify and defend SANYO ELECTRIC CO., LTD., its affiliates, subsidiaries and distributors and all their officers and employees, jointly and severally, against any and all claims and litigation and all damages, cost and expenses associated with such use;
 - ② Not impose any responsibility for any fault or negligence which may be cited in any such claim or litigation on SANYO ELECTRIC CO., LTD., its affiliates, subsidiaries and distributors or any of their officers and employees jointly or severally.
- 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.

Table 1 Constants Guaranteed for LC6568H Ceramic Resonator Oscillation

| | | |
|-----------------------------|----|------------|
| 4 MHz (Murata) CSA4.00MG | C1 | 33pF ± 10% |
| | C2 | 33pF ± 10% |
| 4 MHz (Kyocera) KBR4.0MS | C1 | 33pF ± 10% |
| | C2 | 33pF ± 10% |
| 3 MHz (Murata) CSA3.00MG | C1 | 33pF ± 10% |
| | C2 | 33pF ± 10% |
| 3 MHz (Kyocera) KBR3.0MS | C1 | 33pF ± 10% |
| | C2 | 33pF ± 10% |

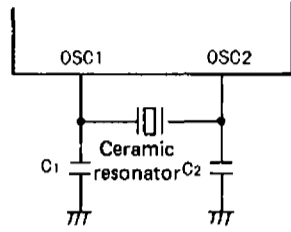


Fig. 1 Ceramic Resonator Oscillation Circuit

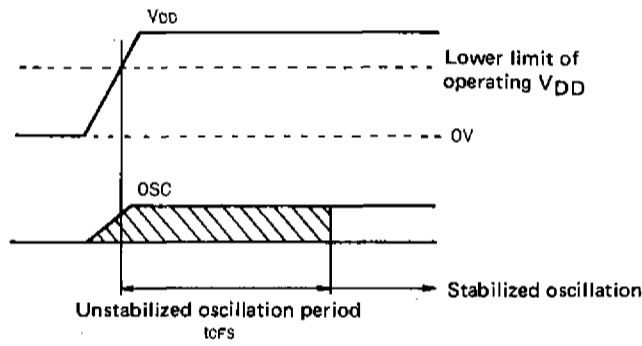


Fig. 2 Oscillation Stabilizing Period

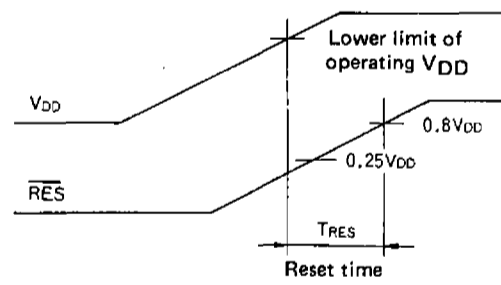
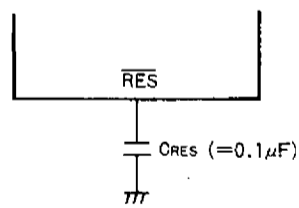


Fig. 3 Reset Circuit and Reset Time

(Note 7) When the rise time of the power supply is 0, the reset time becomes 10ms to 100ms at $C_{RES} = 0.1\mu F$. If the rise time of the power supply is long, the value of C_{RES} must be increased so that the reset time becomes 10ms or greater.

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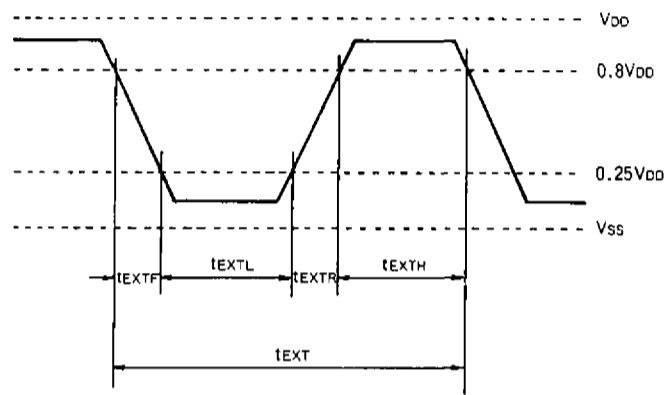
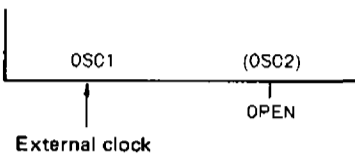


Fig. 4 External Clock Input Waveform

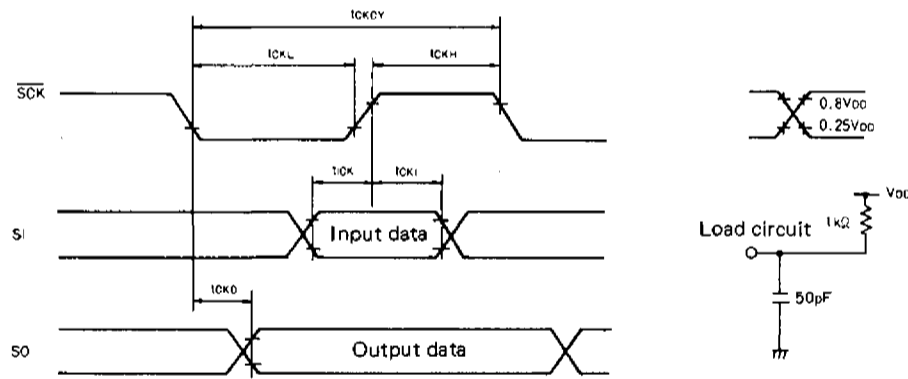
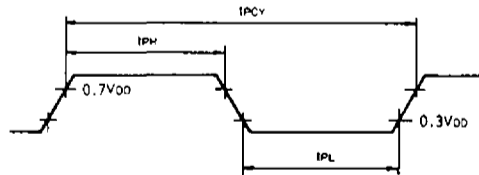


Fig. 5 Serial Input/Output Timing



The load conditions are the same as in Fig. 5.

Fig. 6 Pulse Output Timing at Port E0

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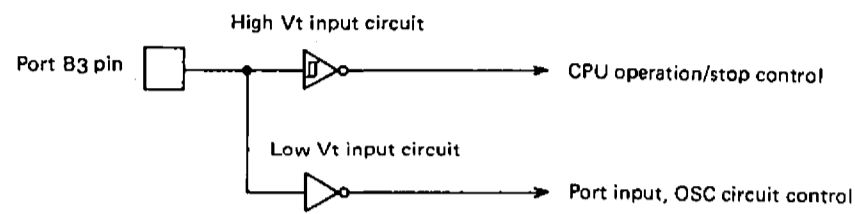


Fig. 7 Port B3 High Vt/Low Vt Input Circuit

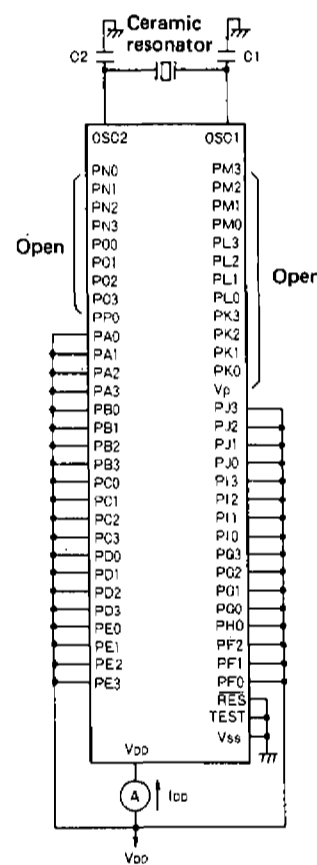


Fig. 8 IDDOP Test Circuit (f=4MHz)

Table 2 LC6568H

Table of Oscillation, Predivider Option (All selectable combinations are shown. Do not use any other combinations than shown below.) $V_{DD} = 4.5$ to $6V$

| Circuit Configuration | Frequency | Predivider Option (Cycle Time) | Remarks |
|--|---|--------------------------------|---------|
| Ceramic Resonator OSC Option | 4 MHz | 1/1 (1 μs) | |
| External Clock Option | 384 to 4330 kHz | 1/1 (10.4 to 0.92 μs) | |
| External Clock Drive by Ceramic Resonator OSC Option | The external clock drive is impossible. When using the external clock drive, specify the external clock option. | | |

LC6568D, 6568H

Notes for Program Evaluation

- When evaluating the LC6568D/H with the evaluation chip (LC6595, LC65PG68), the following must be observed.

| Classi- fication | Item | Function | |
|---------------------|--|--|--|
| | | Mass-production chip | Evaluation chip |
| Notes for option | OSC divider | 3 selections (1/1, 1/3, 1/4) by option (Note) For H version, 1/1 divider only is available. | 3 selections (1/1, 1/3, 1/4) available by 2 pins of DIV pin, 3OR4 pin. DIV pin, 3OR4 pin must be set according to option specified for mass-production chip. |
| | Ports C, D output level at reset mode | Ports C, D can be brought to "H" or "L" in a group of 4 bits. | Port C and Port D can be brought to "H" and "L" by CHL pin and DHL pin respectively. CHL pin and DHL pin must be set according to option specified for mass-production chip. |
| | Port output configuration PU/OD | PU or OD can be selected bitwise. | Only Nch OD without PU. [Evaluation chip-applied evaluation] External resistor (10kohms) on evaluation board must be connected to necessary port. [Simulation chip-applied evaluation] Resistor must be connected to necessary port on application board. |
| | PU resistor configuration | PU resistor brought to Hi-Z at "L" output mode (Pch Tr is turned OFF). | PU resistor, being external resistor, whose impedance remains unchanged at "L" output mode. For mass-production chip, leakage current only flows in Pch Tr at "L" output mode; for evaluation chip, current continues flowing in PU resistor at "L" output mode. |
| | Port output configuration PD/OD | PD or OD can be selected bitwise. | Only Pch OD without PD. [Evaluation chip-applied evaluation] External resistor (100kohms) on evaluation board must be connected to necessary port. [Simulation chip-applied evaluation] Resistor must be connected to necessary port on application board. In this case, load power source must be also supplied on application board. |
| | Port function, port input/output or comparator input | If the input instruction (IP, BP) is executed with port input/output or comparator input function not option-selected, "0" is input from the port bits not specified as port input/output or comparator input. | The input pins with options not selected are in floating state. That is, the data input from such pins are indeterminate. If the input instruction (IP, BP, BNP) for these input pins, unpredictable data is input from them. Do not use any input instruction for such input pins. |
| Notes for OSC | OSC constants -1 | [2-pin RC OSC] Catalog-guaranteed constants in catalog. | [2-pin RC OSC] Different from mass-production chip in circuit design and characteristic. Frequency must be adjusted to OSC frequency of mass-production chip by adjusting variable resistor. |
| | | [2-pin ceramic resonator OSC] Catalog-guaranteed constants provide OSC at frequency specified in catalog. | [2-pin ceramic resonator OSC] Different from mass-production chip in circuit design and characteristic. Wiring capacitance may provide unstable OSC. External constants must be fine-adjusted according to service conditions. |

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Continued from preceding page.

| Classi- fication | Item | Function | |
|--|------------------------------------|---|--|
| | | Mass-production chip | Evaluation chip |
| Notes for OSC | OSC constants -2 | [2-pin ceramic resonator OSC] Feedback resistor is contained. | [2-pin ceramic resonator OSC] No feedback resistor is contained. Feedback resistor of 1Mohm must be connected externally. |
| | OSC frequency | OSC frequency characteristic as indicated in catalog. | Different from mass-production chip in circuit design, and characteristic. ES, CS must be used to evaluate characteristic in detail. |
| Notes for electrical characteristics | Operating current, standby current | Current characteristic as indicated in catalog. | Different from mass-production chip in circuit design, characteristic. The standby current cannot be evaluated in detail. However, the standby current can be confirmed roughly in the manner discussed later. Be sure to confirm the standby current. ES, CS must be used to evaluate characteristic in detail. |
| | Operating voltage | Supply voltage range as indicated in catalog. | Evaluation chip must be also used at $V_{DD}=5V\pm 5\%$ at which EPROM, other LSI are used. Therefore, $V_{DD}=5V\pm 5\%$ only can be used for evaluation of mass-production microcomputers. |
| | Operating temperature | Temperature range as indicated in catalog. | Evaluation chip and simulation chip must be used at $10^{\circ}C$ to $40^{\circ}C$ for evaluation. |
| Notes for I/O port circuit configuration | Port A | Input-only port | Port A is an input/output common port. Do not use the output instructions (OP, SPB, RPB). When performing evaluation, do not fail to turn OFF the pull-up resistance option switch for port A on the evaluation chip board. |
| | Port F3 | The PF3 is not available. Even when the output instruction (OP, SPB, RPB) is executed, no operation is performed. | The PF3 exists. However, do not use the output instruction (OP, SPB, RPB) for this pin. When the output instruction is executed and "0" is output to the pin, the interrupt circuit is affected. |
| | | When the IP instruction is executed "0" is always input to AC from pin PF3. | When the IP instruction is executed, "1" is always input to AC from pin PF3. However, "0" is input if "0" has been output to pin PF3 by the OP instruction. |

The EVA800-TB6568 board and LC65PG68 incorporates an LC6568 evaluation IC and a gate array. Actual performance may differ from evaluation performance because of the gate array which is used to emulate interrupts and control bidirectional port, PH₀.

1. Operation

The gate array can go out of sync with the LC6568D/H due to slight variations in the reset rise time. If this occurs, the LC6568 evaluation IC will not accept interrupts or PH₀ port instructions for several ms after program startup. When running programs, always ensure that interrupts or PH₀ port instructions are processed correctly.

2. Characteristics

When output driver options have been selected, ports PB_{0,1,2} and PH₀ have a breakdown voltage of 15V in the case of volume fabrication devices. In the LC6568 evaluation IC, however, these ports have a withstanding voltage equal to V_{DD} . Take care that test circuit designs do not exceed this limit.

< Confirmation methods for the standby function >

The standby current at the standby mode of the simulation chip can be evaluated not exactly but approximately. Then, do the following steps.

(a) Confirmation of the standby state

Be sure to confirm whether or not the LSI enters the standby mode when the standby conditions are satisfied.

(i) When the OSC1 and OSC2 oscillation option is selected, confirm on an oscilloscope that the oscillation stops in the standby mode.

(ii) Confirmation by the current dissipation

Remove the EPROM when confirming whether or not the LSI enters the standby mode. The I_{DD} of the LSI can determine whether or not the LSI is now in the standby mode.

When the LSI is in the operating mode, more than some $100\mu\text{A}$ current is transmitted. When in the standby mode, the current of the I_{DD} is $150\mu\text{A}$ or less if the DIV, 3OR4, CHL, DHL are all set to "H" (excluding the load current). If the DIV, 3OR4, CHL, DHL, ---, etc. are all set to "L", the current of the I_{DD} is approximately $20\mu\text{A}$.

(b) Confirmation by the load current

Your program must be designed so that the current is not transmitted to the input/output ports prior to the execution of the HALT instruction. This can reduce the useless dissipation of the load current at the standby mode and be confirmed on an oscilloscope.

(i) Design your program so that the current is not transmitted to the output ports prior to the execution of the HALT instruction.

(ii) Design your program and peripherals so that the input ports and input/output ports are not brought to the floating state at the standby mode.

If brought to the floating state, current flows in the microcomputer input circuit section, causing more current dissipation. Therefore, the backup enable time is shortened extremely in applications where the capacitor backup is used. (For the evaluation chip, there is appreciable current because the option circuit section to select the port input/output or comparator input is partly in the floating state.)

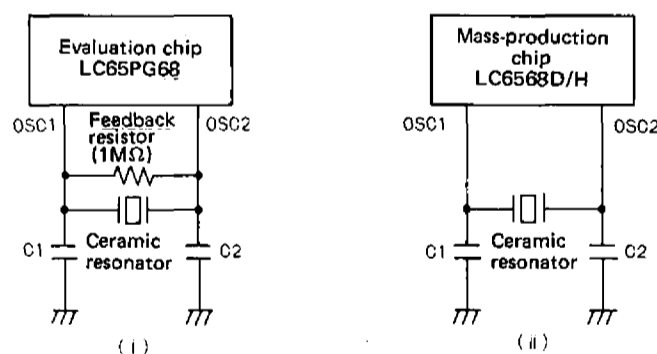
Ceramic resonator oscillation constants when the EVA800-TB6568 is used

When developing your program using the eva-chip board EVA800-TB6568, adjust the capacitor value according to the stray capacitance of the circuit because the ceramic resonator oscillation constants depend on the conditions for evaluation and the cable length, etc.

Note) When the evaluation chip is used in the 2-pin ceramic resonator oscillation mode, no feedback resistor is contained unlike the mass-production chip.

Connect a feedback resistor of 1Mohm externally as shown below.

Since constants R, C are also differ from those for the mass-production chip, adjust the capacitor value according to the stray capacitance of the circuit.



2-pin Ceramic Resonator Oscillation Circuit for Evaluation Chip and Mass-production Chip

LC6568D, 6568H

LC6568 INSTRUCTION SET

| | | | | | |
|--------|-----------------------------------|--|---|------------------|--------------------------|
| Symbol | Description | M(DP) | : Memory addressed by DP | { } _n | : Contents |
| AC | : Accumulator | P(DP _L) | : Input/output port addressed by DP _L | - | : Transfer and direction |
| ACr | : Accumulator bit r | PC | : Program counter | + | : Addition |
| CF | : Carry flag | STACK | : Stack register | - | : Subtraction |
| CTL | : Control register | TM | : Timer | ∧ | : AND |
| DP | : Data pointer | TMF | : Timer (internal) interrupt request flag | ∨ | : OR |
| E | : E register | A _r , H _a , L _a | : Working register | ⊙ | : Exclusive OR |
| EXTF | : External interrupt request flag | ZF | : Zero flag | | |
| Fn | : Flag bit n | P(DP _L) | : Pseudo input/output port specified by DP _L | | |
| M | : Memory | | | | |

| Instruction group | Mnemonic | Instruction code | | Bytes | Cycles | Function | Description | Status flag affected | Remarks | | | | | | | | | | | | | |
|--|---|---|---|--|---------|---|---|--|--|---|-------------------------|----------------|---|-------------------------|----------------|---|-------------------------|----------------|---|-------|-------|--|
| | | D ₇ D ₆ D ₅ D ₄ | D ₃ D ₂ D ₁ D ₀ | | | | | | | | | | | | | | | | | | | |
| Accumulator manipulation instructions | CLA | Clear AC | 1 1 0 0 | 0 0 0 0 | 1 | 1 | AC ← 0 | The AC contents are cleared. | ZF | * 1 | | | | | | | | | | | | |
| | CLC | Clear CF | 1 1 1 0 | 0 0 0 1 | 1 | 1 | CF ← 0 | The CF contents are cleared. | CF | | | | | | | | | | | | | |
| | STC | Set CF | 1 1 1 1 | 0 0 0 1 | 1 | 1 | CF ← 1 | The CF is set. | CF | | | | | | | | | | | | | |
| | CMA | Complement AC | 1 1 1 0 | 1 0 1 1 | 1 | 1 | AC ← $\overline{(AC)}$ | The AC contents are complemented. | ZF | | | | | | | | | | | | | |
| | INC | Increment AC | 0 0 0 0 | 1 1 1 0 | 1 | 1 | AC ← (AC) + 1 | The AC contents are incremented +1. | ZF CF | | | | | | | | | | | | | |
| | DEC | Decrement AC | 0 0 0 0 | 1 1 1 1 | 1 | 1 | AC ← (AC) - 1 | The AC contents are decremented -1. | ZF CF | | | | | | | | | | | | | |
| | RAL | Rotate AC left through CF | 0 0 0 0 | 0 0 0 1 | 1 | 1 | AC ₀ ← (CF), AC _{n+1} ← AC _{n}, CF ← (AC₇)} | The AC contents are shifted left through the CF. | ZF CF | | | | | | | | | | | | | |
| | TAE | Transfer AC to E | 0 0 0 0 | 0 0 1 1 | 1 | 1 | E ← (AC) | The AC contents are transferred to the E. | | | | | | | | | | | | | | |
| | XAE | Exchange AC with E | 0 0 0 0 | 1 1 0 1 | 1 | 1 | (AC) ↔ (E) | The AC contents and the E contents are exchanged. | | | | | | | | | | | | | | |
| | Memory manipulation instructions | INM | Increment M | 0 0 1 0 | 1 1 1 0 | 1 | 1 | M(DP) ← (M(DP)) + 1 | The M(DP) contents are incremented +1. | ZF CF | | | | | | | | | | | | |
| DEM | | Decrement M | 0 0 1 0 | 1 1 1 1 | 1 | 1 | M(DP) ← (M(DP)) - 1 | The M(DP) contents are decremented -1. | ZF CF | | | | | | | | | | | | | |
| SMB bit | | Set M data bit | 0 0 0 0 | 1 0 B ₁ B ₀ | 1 | 1 | M(DP, B ₁ B ₀) ← 1 | A single bit of the M(DP) specified with B ₁ B ₀ is set. | | | | | | | | | | | | | | |
| RMB bit | | Reset M data bit | 0 0 1 0 | 1 0 B ₁ B ₀ | 1 | 1 | M(DP, B ₁ B ₀) ← 0 | A single bit of the M(DP) specified with B ₁ B ₀ is reset. | ZF | | | | | | | | | | | | | |
| Arithmetic operation/comparison instructions | AD | Add M to AC | 0 1 1 0 | 0 0 0 0 | 1 | 1 | AC ← (AC) + (M(DP)) | Binary addition of the AC contents and the M(DP) contents is performed and the result is stored in the AC. | ZF CF | | | | | | | | | | | | | |
| | ADC | Add M to AC with CF | 0 0 1 0 | 0 0 0 0 | 1 | 1 | AC ← (AC) + (M(DP)) + (CF) | Binary addition of the AC, CF contents and the M(DP) contents is performed and the result is stored in the AC. | ZF CF | | | | | | | | | | | | | |
| | DAA | Decimal adjust AC in addition | 1 1 1 0 | 0 1 1 0 | 1 | 1 | AC ← (AC) + 6 | 6 is added to the AC contents. | ZF | | | | | | | | | | | | | |
| | DAS | Decimal adjust AC in subtraction | 1 1 1 0 | 1 0 1 0 | 1 | 1 | AC ← (AC) + 10 | 10 is added to the AC contents. | ZF | | | | | | | | | | | | | |
| | EXL | Exclusive or M to AC | 1 1 1 1 | 0 1 0 1 | 1 | 1 | AC ← (AC) ∨ (M(DP)) | The AC contents and the M(DP) contents are exclusive-ORed and the result is stored in the AC. | ZF | | | | | | | | | | | | | |
| | AND | And M to AC | 1 1 1 0 | 0 1 1 1 | 1 | 1 | AC ← (AC) ∧ (M(DP)) | The AC contents and the M(DP) contents are ANDed and the result is stored in the AC. | ZF | | | | | | | | | | | | | |
| | OR | Or M to AC | 1 1 1 0 | 0 1 0 1 | 1 | 1 | AC ← (AC) ∨ (M(DP)) | The AC contents and the M(DP) contents are ORed and the result is stored in the AC. | ZF | | | | | | | | | | | | | |
| | CM | Compare AC with M | 1 1 1 1 | 1 0 1 1 | 1 | 1 | (M(DP)) + (AC) + 1 | The AC contents and the M(DP) contents are compared and the CF and ZF are set/reset. <table border="1"> <tr><td>Comparison result</td><td>CF</td><td>ZF</td></tr> <tr><td>(M(DP)) > (AC)</td><td>0</td><td>0</td></tr> <tr><td>(M(DP)) = (AC)</td><td>1</td><td>1</td></tr> <tr><td>(M(DP)) < (AC)</td><td>1</td><td>0</td></tr> </table> | Comparison result | CF | ZF | (M(DP)) > (AC) | 0 | 0 | (M(DP)) = (AC) | 1 | 1 | (M(DP)) < (AC) | 1 | 0 | ZF CF | |
| | Comparison result | CF | ZF | | | | | | | | | | | | | | | | | | | |
| | (M(DP)) > (AC) | 0 | 0 | | | | | | | | | | | | | | | | | | | |
| (M(DP)) = (AC) | 1 | 1 | | | | | | | | | | | | | | | | | | | | |
| (M(DP)) < (AC) | 1 | 0 | | | | | | | | | | | | | | | | | | | | |
| CI data | Compare AC with immediate data | 0 0 1 0 | 1 1 0 0 | 2 | 2 | $\{3\}_2\{1\}_0 + (AC) + 1$ $\{3\}_2\{1\}_0$ | The AC contents and the immediate data $\{3\}_2\{1\}_0$ are compared and the ZF and CF are set/reset. <table border="1"> <tr><td>Comparison result</td><td>CF</td><td>ZF</td></tr> <tr><td>$\{3\}_2\{1\}_0 > (AC)$</td><td>0</td><td>0</td></tr> <tr><td>$\{3\}_2\{1\}_0 = (AC)$</td><td>1</td><td>1</td></tr> <tr><td>$\{3\}_2\{1\}_0 < (AC)$</td><td>1</td><td>0</td></tr> </table> | Comparison result | CF | ZF | $\{3\}_2\{1\}_0 > (AC)$ | 0 | 0 | $\{3\}_2\{1\}_0 = (AC)$ | 1 | 1 | $\{3\}_2\{1\}_0 < (AC)$ | 1 | 0 | ZF CF | | |
| Comparison result | CF | ZF | | | | | | | | | | | | | | | | | | | | |
| $\{3\}_2\{1\}_0 > (AC)$ | 0 | 0 | | | | | | | | | | | | | | | | | | | | |
| $\{3\}_2\{1\}_0 = (AC)$ | 1 | 1 | | | | | | | | | | | | | | | | | | | | |
| $\{3\}_2\{1\}_0 < (AC)$ | 1 | 0 | | | | | | | | | | | | | | | | | | | | |
| CLI data | Compare DP _L with immediate data | 0 0 1 0 | 0 1 0 1 | 2 | 2 | (DP _L) ∨ $\{3\}_2\{1\}_0$ $\{3\}_2\{1\}_0$ | The DP _L contents and the immediate data $\{3\}_2\{1\}_0$ are compared. | ZF | | | | | | | | | | | | | | |
| Load/store instructions | LI data | Load AC with immediate data | 1 1 0 0 | $\{3\}_2\{1\}_0$ | 1 | 1 | AC ← $\{3\}_2\{1\}_0$ | The immediate data $\{3\}_2\{1\}_0$ is loaded in the AC. | ZF | * 1 | | | | | | | | | | | | |
| | S | Store AC to M | 0 0 0 0 | 0 0 1 0 | 1 | 1 | M(DP) ← (AC) | The AC contents are stored in the M(DP). | | | | | | | | | | | | | | |
| | L | Load AC from M | 0 0 1 0 | 0 0 0 1 | 1 | 1 | AC ← (M(DP)) | The M(DP) contents are loaded in the AC. | ZF | | | | | | | | | | | | | |
| | XM data | Exchange AC with M, then modify DP _H with immediate data | 1 0 1 0 | 0 M ₂ M ₁ M ₀ | 2 | 2 | (AC) ↔ (M(DP)) DP _H ← (DP _H) ∨ 0M ₂ M ₁ M ₀ | The AC contents and the M(DP) contents are exchanged and then the DP _H contents are modified with the contents of (DP _H) ∨ 0M ₂ M ₁ M ₀ . | ZF | The ZF is set/reset according to the result of (DP _H) ∨ 0M ₂ M ₁ M ₀ . | | | | | | | | | | | | |
| | X | Exchange AC with M | 1 0 1 0 | 0 0 0 0 | 2 | 2 | (AC) ↔ (M(DP)) | The AC contents and the M(DP) contents are exchanged. | ZF | The ZF is set/reset according to the DP _L contents at the time of instruction execution. | | | | | | | | | | | | |
| | XI | Exchange AC with M, then increment DP _L | 1 1 1 1 | 1 1 1 0 | 2 | 2 | (AC) ↔ (M(DP)) DP _L ← (DP _L) + 1 | The AC contents and the M(DP) contents are exchanged and then the DP _L contents are incremented +1. | ZF | The ZF is set/reset according to the result of (DP _L) + 1. | | | | | | | | | | | | |
| | XD | Exchange AC with M, then decrement DP _L | 1 1 1 1 | 1 1 1 1 | 2 | 2 | (AC) ↔ (M(DP)) DP _L ← (DP _L) - 1 | The AC contents and the M(DP) contents are exchanged and then the DP _L contents are decremented -1. | ZF | The ZF is set/reset according to the result of (DP _L) - 1. | | | | | | | | | | | | |
| | RTBL | Read table data from program ROM | 0 1 1 0 | 0 0 1 1 | 2 | 2 | AC ← ROM (PCh, E, AC) | The contents of ROM addressed by the PC whose low-order 8 bits are replaced with the E and AC contents are loaded in the AC and E. | | | | | | | | | | | | | | |

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| Instruction group | Mnemonic | Instruction code | | Bytes | Cycles | Function | Description | Status flag affected | Remarks | |
|--|---|---|--|--|--------|--|--|--|---------|--|
| | | D ₇ D ₆ D ₅ D ₄ | D ₃ D ₂ D ₁ D ₀ | | | | | | | |
| Data pointer manipulation instructions | LDZ data | 1 0 0 0 | 13 12 11 10 | 1 | 1 | DP _H ← 0 DP _L ← 13 12 11 10 | The DP _H and DP _L are loaded with 0 and the immediate data 13 12 11 10 respectively. | | | |
| | LHI data | 0 1 0 0 | 13 12 11 10 | 1 | 1 | DP _H ← 13 12 11 10 | The DP _H is loaded with the immediate data 13 12 11 10. | | | |
| | IND | 1 1 1 0 | 1 1 1 0 | 1 | 1 | DP _L ← (DP _L) + 1 | The DP _L contents are incremented +1. | ZF | | |
| | DED | 1 1 1 0 | 1 1 1 1 | 1 | 1 | DP _L ← (DP _L) - 1 | The DP _L contents are decremented -1. | ZF | | |
| | TAL | 1 1 1 1 | 0 1 1 1 | 1 | 1 | DP _L ← (AC) | The AC contents are transferred to the DP _L . | | | |
| | TLA | 1 1 1 0 | 1 0 0 1 | 1 | 1 | AC ← (DP _L) | The DP _L contents are transferred to the AC. | ZF | | |
| | XAH | Exchange AC with DP _H | 0 0 1 0 | 0 0 1 1 | 1 | 1 | (AC) ↔ (DP _H) | The AC contents and the DP _H contents are exchanged. | | |
| Working register manipulation instructions | XA _t | Exchange AC with working register A _t | 1 1 1 0 | 1 1 0 | 1 | 1 | (AC) ↔ (A ₀) (AC) ↔ (A ₁) (AC) ↔ (A ₂) (AC) ↔ (A ₃) | The AC contents and the contents of working register A _t are exchanged. A _t is assigned one of A ₀ , A ₁ , A ₂ , A ₃ according to t ₁ t ₀ . | | |
| | XH _a | Exchange DP _H with working register H _a | 1 1 1 1 | 1 1 0 | 1 | 1 | (DP _H) ↔ (H ₀) (DP _H) ↔ (H ₁) | The DP _H contents and the contents of working register H _a are exchanged. H _a is assigned either of H ₀ or H ₁ according to a. | | |
| | XL _a | Exchange DP _L with working register L _a | 1 1 1 1 | 0 1 0 | 1 | 1 | (DP _L) ↔ (L ₀) (DP _L) ↔ (L ₁) | The DP _L contents and the contents of working register L _a are exchanged. L _a is assigned either of L ₀ or L ₁ according to a. | | |
| | SFB flag | Set flag bit | 0 1 0 1 | B ₃ B ₂ B ₁ B ₀ | 1 | 1 | F _n ← 1 | The flag specified with B ₃ B ₂ B ₁ B ₀ is set. | | |
| | RFB flag | Reset flag bit | 0 0 0 1 | B ₃ B ₂ B ₁ B ₀ | 1 | 1 | F _n ← 0 | The flag specified with B ₃ B ₂ B ₁ B ₀ is reset. | ZF | The flag is divided into 4 groups of F ₀ to F ₃ , F ₄ to F ₇ , F ₈ to F ₁₁ , F ₁₂ to F ₁₅ . The ZF is set/reset according to the 4 bits including a single bit specified with the immediate data B ₃ B ₂ B ₁ B ₀ . |
| | JMP addr | Jump in the current bank | 0 1 1 0 | 1 P ₁₀ P ₉ P ₈ P ₇ P ₆ P ₅ P ₄ | 2 | 2 | PC ← PC ₁₁ (or PC ₁₁) P ₁₀ P ₉ P ₈ P ₇ P ₆ P ₅ P ₄ P ₃ P ₂ P ₁ P ₀ | A jump to the address specified with the PC ₁₂ PC ₁₁ (or PC ₁₁) and immediate data P ₁₀ P ₉ P ₈ P ₇ P ₆ P ₅ P ₄ P ₃ P ₂ P ₁ P ₀ occurs. | | If the BANK and SB instructions are executed consecutively, the bank is changed. |
| JPEA | Jump in the current page modified by E and AC | 1 1 1 1 | 1 0 1 0 | 1 | 1 | PC _{7~0} ← (E, AC) | A jump to the address specified with the contents of the PC whose low-order 8 bits are replaced by the E and AC contents occurs. | | | |
| CZP addr | Call subroutine in the zero page | 1 0 1 1 | P ₃ P ₂ P ₁ P ₀ | 1 | 1 | STACK ← (PC) + 1 PC _{11~6} , PC _{1~0} ← 0 PC _{5~2} ← P ₃ P ₂ P ₁ P ₀ | A subroutine in page 0 of bank 0 is called. | | | |
| CAL addr | Call subroutine in the zero bank | 1 0 1 0 | 1 P ₁₀ P ₉ P ₈ P ₇ P ₆ P ₅ P ₄ | 2 | 2 | STACK ← (PC) + 2 PC _{11~0} ← 0P ₁₀ P ₉ P ₈ P ₇ P ₆ P ₅ P ₄ P ₃ P ₂ P ₁ P ₀ | A subroutine in bank 0 is called. | | | |
| RT | Return from subroutine | 0 1 1 0 | 0 0 1 0 | 1 | 1 | PC ← (STACK) | A return from a subroutine occurs. | | | |
| RTI | Return from interrupt routine | 0 0 1 0 | 0 0 1 0 | 1 | 1 | PC ← (STACK) CF ZF ← CSF, ZSF | A return from an interrupt service routine occurs. | ZF CF | | |
| BANK | Change bank | 1 1 1 1 | 1 1 0 1 | 1 | 1 | PC ₁₁ ← (PC ₁₁) | The bank is changed. (Effective only when immediately followed by the JMP instruction) The pseudo I/O port is specified. (Effective when immediately followed by the IP, OP, SPB, RPB, BP, BNP instruction) | | | |
| SB | Set bank | 0 1 1 0 | 0 1 1 0 | 1 | 1 | PC ₂ PC ₁₁ ← 11, 10 | The bank is changed. Effective only when used immediately before the JMP instruction. | | | |
| Branch instructions | BAI addr | Branch on AC bit | 0 1 1 1 | 0 0 1 1 0 | 2 | 2 | PC _{7~0} ← P ₇ P ₆ P ₅ P ₄ P ₃ P ₂ P ₁ P ₀ if AC ₁ = 1 | If a single bit of the AC specified with the immediate data t ₁ t ₀ is 1, a branch to the address specified with the immediate data P ₇ P ₆ P ₅ P ₄ P ₃ P ₂ P ₁ P ₀ within the same page occurs. | | Mnemonic is BA0 to BA3 according to the value of t. |
| | BNAt addr | Branch on no AC bit | 0 0 1 1 | 0 0 1 1 0 | 2 | 2 | PC _{7~0} ← P ₇ P ₆ P ₅ P ₄ P ₃ P ₂ P ₁ P ₀ if AC ₁ = 0 | If a single bit of the AC specified with the immediate data t ₁ t ₀ is 0, a branch to the address specified with the immediate data P ₇ P ₆ P ₅ P ₄ P ₃ P ₂ P ₁ P ₀ within the same page occurs. | | Mnemonic is BNA0 to BNA3 according to the value of t. |
| | BMI addr | Branch on M bit | 0 1 1 1 | 0 1 1 1 0 | 2 | 2 | PC _{7~0} ← P ₇ P ₆ P ₅ P ₄ P ₃ P ₂ P ₁ P ₀ if (M(DP), t ₁ t ₀) = 1 | If a single bit of the M(DP) specified with the immediate data t ₁ t ₀ is 1, a branch to the address specified with the immediate data P ₇ P ₆ P ₅ P ₄ P ₃ P ₂ P ₁ P ₀ within the same page occurs. | | Mnemonic is BM0 to BM3 according to the value of t. |
| | BNMt addr | Branch on no M bit | 0 0 1 1 | 0 1 1 1 0 | 2 | 2 | PC _{7~0} ← P ₇ P ₆ P ₅ P ₄ P ₃ P ₂ P ₁ P ₀ if (M(DP), t ₁ t ₀) = 0 | If a single bit of the M(DP) specified with the immediate data t ₁ t ₀ is 0, a branch to the address specified with the immediate data P ₇ P ₆ P ₅ P ₄ P ₃ P ₂ P ₁ P ₀ within the same page occurs. | | Mnemonic is BNM0 to BNM3 according to the value of t. |
| | BPI addr | Branch on Port bit | 0 1 1 1 | 1 0 1 1 0 | 2 | 2 | PC _{7~0} ← P ₇ P ₆ P ₅ P ₄ P ₃ P ₂ P ₁ P ₀ if (P(DP), t ₁ t ₀) = 1 | If a single bit of port P(DP) specified with the immediate data t ₁ t ₀ is 1, a branch to the address specified with the immediate data P ₇ P ₆ P ₅ P ₄ P ₃ P ₂ P ₁ P ₀ within the same page occurs. | | Mnemonic is BP0 to BP3 according to the value of t. |

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| Instruction group | Mnemonic | Instruction code | | Bytes | Cycles | Function | Description | Status flag affected | Remarks | |
|---------------------------|-----------------------|--|--|--|--------|---|--|--|--|--|
| | | D ₇ D ₆ D ₅ D ₄ | D ₃ D ₂ D ₁ D ₀ | | | | | | | |
| Branch instructions | BNP _n addr | Branch on no Port bit | 0 0 1 1 P ₇ P ₆ P ₅ P ₄ | 1 0 1 1 0 P ₃ P ₂ P ₁ P ₀ | 2 | 2 | PC ₇₋₀ ← P ₇ P ₆ P ₅ P ₄ P ₃ P ₂ P ₁ P ₀ if (P ₇ D ₇ ...1110) = 0 | If a single bit of port P(DP _L) specified with the immediate data t ₁ t ₀ is 0, a branch to the address specified with the immediate data P ₇ P ₆ P ₅ P ₄ P ₃ P ₂ P ₁ P ₀ within the same page occurs. | | Mnemonic is BNP0 to BNP3 according to the value of t. |
| | BTM addr | Branch on timer | 0 1 1 1 P ₇ P ₆ P ₅ P ₄ | 1 1 0 0 P ₃ P ₂ P ₁ P ₀ | 2 | 2 | PC ₇₋₀ ← P ₇ P ₆ P ₅ P ₄ P ₃ P ₂ P ₁ P ₀ if TMF = 1 then TMF ← 0 | If the TMF is 1, a branch to the address specified with the immediate data P ₇ P ₆ P ₅ P ₄ P ₃ P ₂ P ₁ P ₀ within the same page occurs. The TMF is reset. | TMF | |
| | BNTM addr | Branch on no timer | 0 0 1 1 P ₇ P ₆ P ₅ P ₄ | 1 1 0 0 P ₃ P ₂ P ₁ P ₀ | 2 | 2 | PC ₇₋₀ ← P ₇ P ₆ P ₅ P ₄ P ₃ P ₂ P ₁ P ₀ if TMF = 0 then TMF ← 0 | If the TMF is 0, a branch to the address specified with the immediate data P ₇ P ₆ P ₅ P ₄ P ₃ P ₂ P ₁ P ₀ within the same page occurs. The TMF is reset. | TMF | |
| | BI addr | Branch on interrupt | 0 1 1 1 P ₇ P ₆ P ₅ P ₄ | 1 1 0 1 P ₃ P ₂ P ₁ P ₀ | 2 | 2 | PC ₇₋₀ ← P ₇ P ₆ P ₅ P ₄ P ₃ P ₂ P ₁ P ₀ if EXTF = 1 then EXTF ← 0 | If the EXTF is 1, a branch to the address specified with the immediate data P ₇ P ₆ P ₅ P ₄ P ₃ P ₂ P ₁ P ₀ within the same page occurs. The EXTF is reset. | EXTF | |
| | BNI addr | Branch on no interrupt | 0 0 1 1 P ₇ P ₆ P ₅ P ₄ | 1 1 0 1 P ₃ P ₂ P ₁ P ₀ | 2 | 2 | PC ₇₋₀ ← P ₇ P ₆ P ₅ P ₄ P ₃ P ₂ P ₁ P ₀ if EXTF = 0 then EXTF ← 0 | If the EXTF is 0, a branch to the address specified with the immediate data P ₇ P ₆ P ₅ P ₄ P ₃ P ₂ P ₁ P ₀ within the same page occurs. The EXTF is reset. | EXTF | |
| | BC addr | Branch on CF | 0 1 1 1 P ₇ P ₆ P ₅ P ₄ | 1 1 1 1 P ₃ P ₂ P ₁ P ₀ | 2 | 2 | PC ₇₋₀ ← P ₇ P ₆ P ₅ P ₄ P ₃ P ₂ P ₁ P ₀ if CF = 1 | If the CF is 1, a branch to the address specified with the immediate data P ₇ P ₆ P ₅ P ₄ P ₃ P ₂ P ₁ P ₀ within the same page occurs. | | |
| | BNC addr | Branch on no CF | 0 0 1 1 P ₇ P ₆ P ₅ P ₄ | 1 1 1 1 P ₃ P ₂ P ₁ P ₀ | 2 | 2 | PC ₇₋₀ ← P ₇ P ₆ P ₅ P ₄ P ₃ P ₂ P ₁ P ₀ if CF = 0 | If the CF is 0, a branch to the address specified with the immediate data P ₇ P ₆ P ₅ P ₄ P ₃ P ₂ P ₁ P ₀ within the same page occurs. | | |
| | BZ addr | Branch on ZF | 0 1 1 1 P ₇ P ₆ P ₅ P ₄ | 1 1 1 0 P ₃ P ₂ P ₁ P ₀ | 2 | 2 | PC ₇₋₀ ← P ₇ P ₆ P ₅ P ₄ P ₃ P ₂ P ₁ P ₀ if ZF = 1 | If the ZF is 1, a branch to the address specified with the immediate data P ₇ P ₆ P ₅ P ₄ P ₃ P ₂ P ₁ P ₀ within the same page occurs. | | |
| | BNZ addr | Branch on no ZF | 0 0 1 1 P ₇ P ₆ P ₅ P ₄ | 1 1 1 0 P ₃ P ₂ P ₁ P ₀ | 2 | 2 | PC ₇₋₀ ← P ₇ P ₆ P ₅ P ₄ P ₃ P ₂ P ₁ P ₀ if ZF = 0 | If the ZF is 0, a branch to the address specified with the immediate data P ₇ P ₆ P ₅ P ₄ P ₃ P ₂ P ₁ P ₀ within the same page occurs. | | |
| | BF _n addr | Branch on flag bit | 1 1 0 1 P ₇ P ₆ P ₅ P ₄ | n ₃ n ₂ n ₁ n ₀ P ₃ P ₂ P ₁ P ₀ | 2 | 2 | PC ₇₋₀ ← P ₇ P ₆ P ₅ P ₄ P ₃ P ₂ P ₁ P ₀ if F _n = 1 | If the flag bit of the 16 flags specified with the immediate data n ₃ n ₂ n ₁ n ₀ is 1, a branch to the address specified with the immediate data P ₇ P ₆ P ₅ P ₄ P ₃ P ₂ P ₁ P ₀ within the same page occurs. | | Mnemonic is BF0 to BF15 according to the value of n. |
| BNF _n addr | Branch on no flag bit | 1 1 0 1 P ₇ P ₆ P ₅ P ₄ | n ₃ n ₂ n ₁ n ₀ P ₃ P ₂ P ₁ P ₀ | 2 | 2 | PC ₇₋₀ ← P ₇ P ₆ P ₅ P ₄ P ₃ P ₂ P ₁ P ₀ if F _n = 0 | If the flag bit of the 16 flags specified with the immediate data n ₃ n ₂ n ₁ n ₀ is 0, a branch to the address specified with the immediate data P ₇ P ₆ P ₅ P ₄ P ₃ P ₂ P ₁ P ₀ within the same page occurs. | | Mnemonic is BNF0 to BNF15 according to the value of n. | |
| Input/Output instructions | IP | Input port to AC | 0 0 0 0 | 1 1 0 0 | 1 | 1 | AC ← (P(DP _L)) | Port P(DP _L) contents are loaded in the AC. | ZF | |
| | OP | Output AC to port | 0 1 1 0 | 0 0 0 1 | 1 | 1 | P(DP _L) ← (AC) | The AC contents are outputted to port P(DP _L). | | |
| | SPB bit | Set port bit | 0 0 0 0 | 0 1 B ₁ B ₀ | 1 | 2 | P(DP _L .B ₁ B ₀) ← 1 | A single bit in port P(DP _L) specified with the immediate data B ₁ B ₀ is set. | | When this instruction is executed, the E contents are destroyed. |
| | RPB bit | Reset port bit | 0 0 1 0 | 0 1 B ₁ B ₀ | 1 | 2 | P(DP _L .B ₁ B ₀) ← 0 | A single bit in port P(DP _L) specified with the immediate data B ₁ B ₀ is reset. | ZF | When this instruction is executed, the E contents are destroyed. |
| Other instructions | SCTL bit | Set control register bit(S) | 0 0 1 0 1 0 0 0 | 1 1 0 0 B ₃ B ₂ B ₁ B ₀ | 2 | 2 | CTL ← (CTL) V B ₃ B ₂ B ₁ B ₀ | The bits of the control register specified with the immediate data B ₃ B ₂ B ₁ B ₀ are set. | | |
| | RCTL bit | Reset control register bit(S) | 0 0 1 0 1 0 0 1 | 1 1 0 0 B ₃ B ₂ B ₁ B ₀ | 2 | 2 | CTL ← (CTL) Λ B ₃ B ₂ B ₁ B ₀ | The bits of the control register specified with the immediate data B ₃ B ₂ B ₁ B ₀ are reset. | ZF | |
| | WTTM | Write timer | 1 1 1 1 | 1 0 0 1 | 1 | 1 | TM ← (E) (AC) TMF ← 0 | The E and AC contents are loaded in the timer. The TMF is reset. | TMF | |
| | HALT | Halt | 1 1 1 1 | 0 1 1 0 | 1 | 1 | Halt | All operations stop. | | |
| | NOP | No operation | 0 0 0 0 | 0 0 0 0 | 1 | 1 | No operation | No operation is performed, but 1 machine cycle is consumed. | | |

*1 If the CLA instruction is used consecutively in such a manner as CLA, CLA, -----, the first CLA instruction only is effective and the following CLA instructions are changed to the NOP instructions. This is also true of the LI instruction.