

MOS INTEGRATED CIRCUIT

μ PD75402A(A)

4 BIT SINGLE-CHIP MICROCOMPUTER

The μ PD75402A(A) is a CMOS single-chip microcomputer which uses the 75X series architecture. It operates at high speed with a minimum instruction execution time of 0.95 μ s.

The μ PD75P402 is also available for system development evaluation. It contains one-time PROM instead of mask ROM used in the μ PD75402A(A).

The following user's manual describes the details of the functions of the μ PD75402A(A). Be sure to read it before designing an application system.

μ PD75402A User's Manual: IEU-644

FEATURES

- More reliable than the μ PD75402A
- High-speed operation with a minimum instruction execution time of 0.95 μ s (when the microcomputer operates at 4.19 MHz)
- Low voltage and low-speed instruction execution time of 15.3 μ s (when the microcomputer operates at 4.19 MHz)
- Memory mapping by on-chip peripheral hardware
- NEC standard serial bus interface (SBI)
- 8-bit basic interval timer (watchdog timer applicable)
- Interrupt function
 - Three vectored interrupts (one external and two internal interrupts)
 - One external test input
- Clock output function (remote controller output applicable)
- Capable of specifying the incorporation of 16 pull-up resistors by software

APPLICATIONS

Electronic units for automobiles, and suchlike

ORDERING INFORMATION

| Part number | Package | Quality grade |
|-----------------------------|-------------------------------------|---------------|
| μ PD75402AC(A)-xxx | 28-pin plastic DIP (600 mil) | Special |
| μ PD75402ACT(A)-xxx | 28-pin plastic shrink DIP (400 mil) | Special |
| μ PD75402AGB(A)-xxx-3B4 | 44-pin plastic QFP (10 × 10 mm) | Special |

Remark xxx indicates the ROM code number.

Please refer to "Quality Grades on NEC Semiconductor Devices" (Document number IEI-1209) published by NEC Corporation to know the specification of quality grade on the devices and its recommended applications.

The information in this document is subject to change without notice.

DIFFERENCES BETWEEN THE μPD75402A(A) AND μPD75402A

| Item \ Product | μPD75402A(A) | μPD75402A |
|----------------|--------------|-----------|
| Quality grade | Special | Standard |

FUNCTIONAL OVERVIEW

| Item | Function | |
|------------------------------------|--|---------------|
| Number of basic instructions | 37 | |
| Minimum instruction execution time | <ul style="list-style-type: none"> • 0.95, 1.91, or 15.3 μs (when operating at 4.19 MHz) • Switchable among three speeds | |
| Built-in memory | ROM | 1920 × 8 bits |
| | RAM | 64 × 4 bits |
| General register | 4 bits × 4 or 8 bits × 2 (memory mapping) | |
| I/O line | <ul style="list-style-type: none"> • CMOS input ports : 6 lines • CMOS I/O ports : 12 lines (8 lines can drive the LED directly.) • N-ch open-drain I/O ports : 4 lines (All lines can drive the LED directly.) | |
| Pull-up resistor | <ul style="list-style-type: none"> • Capable of controlling the incorporation of 16 pull-up resistors by software • Capable of controlling the incorporation of 4 pull-up resistors by mask option | |
| Clock output | <ul style="list-style-type: none"> • 1.05 MHz, 524 kHz, or 65.5 kHz (when operating at 4.19 MHz) • Applicable to remote controller output | |
| Timer/counter | 8-bit basic interval timer (watchdog timer applicable) | |
| Serial interface | <ul style="list-style-type: none"> • 8 bits • Two transfer modes (three-wire synchronous mode and SBI mode) | |
| Vectored interrupt | One external and two internal interrupts | |
| Test input | One external input (See Chapter 6 for details.) | |
| Standby | STOP/HALT mode | |
| Instruction set | <ul style="list-style-type: none"> • Bit manipulation instructions (set, clear, test, and Boolean operation) • 1-byte relative branch instructions • 4-bit operation instructions (add, Boolean operation, and compare) • 4- and 8-bit transfer instructions | |
| Package | <ul style="list-style-type: none"> • 28-pin plastic DIP (600 mil) • 28-pin plastic shrink DIP (400 mil) • 44-pin plastic QFP (10 × 10 mm) | |

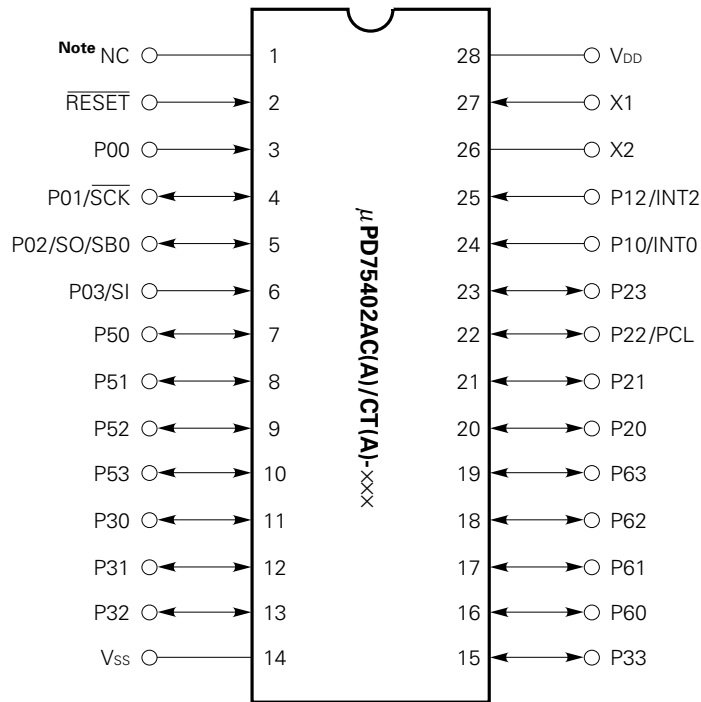
CONTENTS

| | |
|--|-----------|
| 1. PIN CONFIGURATION (TOP VIEW) | 4 |
| 2. BLOCK DIAGRAM | 6 |
| 3. PIN FUNCTIONS | 7 |
| 3.1 PORT PINS | 7 |
| 3.2 NON-PORT PINS | 8 |
| 3.3 PIN INPUT/OUTPUT CIRCUITS | 8 |
| 3.4 SELECTION OF A MASK OPTION | 10 |
| 3.5 HANDLING UNUSED PINS | 11 |
| 3.6 NOTES ON USING THE P00 AND RESET PINS | 11 |
| 4. MEMORY CONFIGURATION | 12 |
| 5. PERIPHERAL HARDWARE FUNCTIONS | 14 |
| 5.1 PORTS | 14 |
| 5.2 CLOCK GENERATOR | 15 |
| 5.3 CLOCK OUTPUT CIRCUIT | 16 |
| 5.4 BASIC INTERVAL TIMER | 17 |
| 5.5 SERIAL INTERFACE | 18 |
| 6. INTERRUPT FUNCTION | 20 |
| 7. STANDBY FUNCTION | 22 |
| 8. RESET FUNCTION | 23 |
| 9. INSTRUCTION SET | 25 |
| 10. ELECTRICAL CHARACTERISTICS | 29 |
| 11. PACKAGE DIMENSIONS | 38 |
| 12. RECOMMENDED SOLDERING CONDITIONS | 42 |
| APPENDIX A DIFFERENCES BETWEEN THE μPD75402A(A) AND μPD75P402 | 43 |
| APPENDIX B DEVELOPMENT TOOLS | 44 |
| APPENDIX C RELATED DOCUMENTS | 45 |

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1. PIN CONFIGURATION (TOP VIEW)

28-pin plastic DIP (600 mil), 28-pin plastic shrink DIP (400 mil)

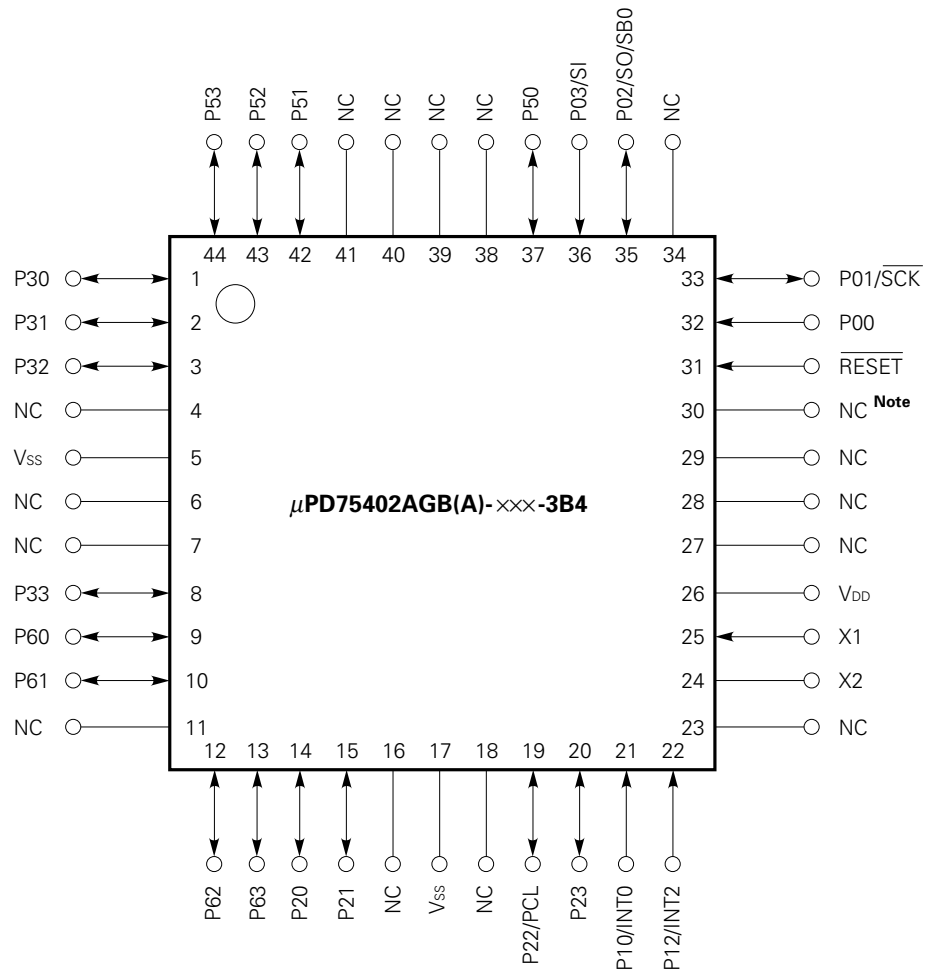


P00 - P03 : Port 0
 P10 and P12: Port 1
 P20 - P23 : Port 2
 P30 - P33 : Port 3
 P50 - P53 : Port 5
 P60 - P63 : Port 6

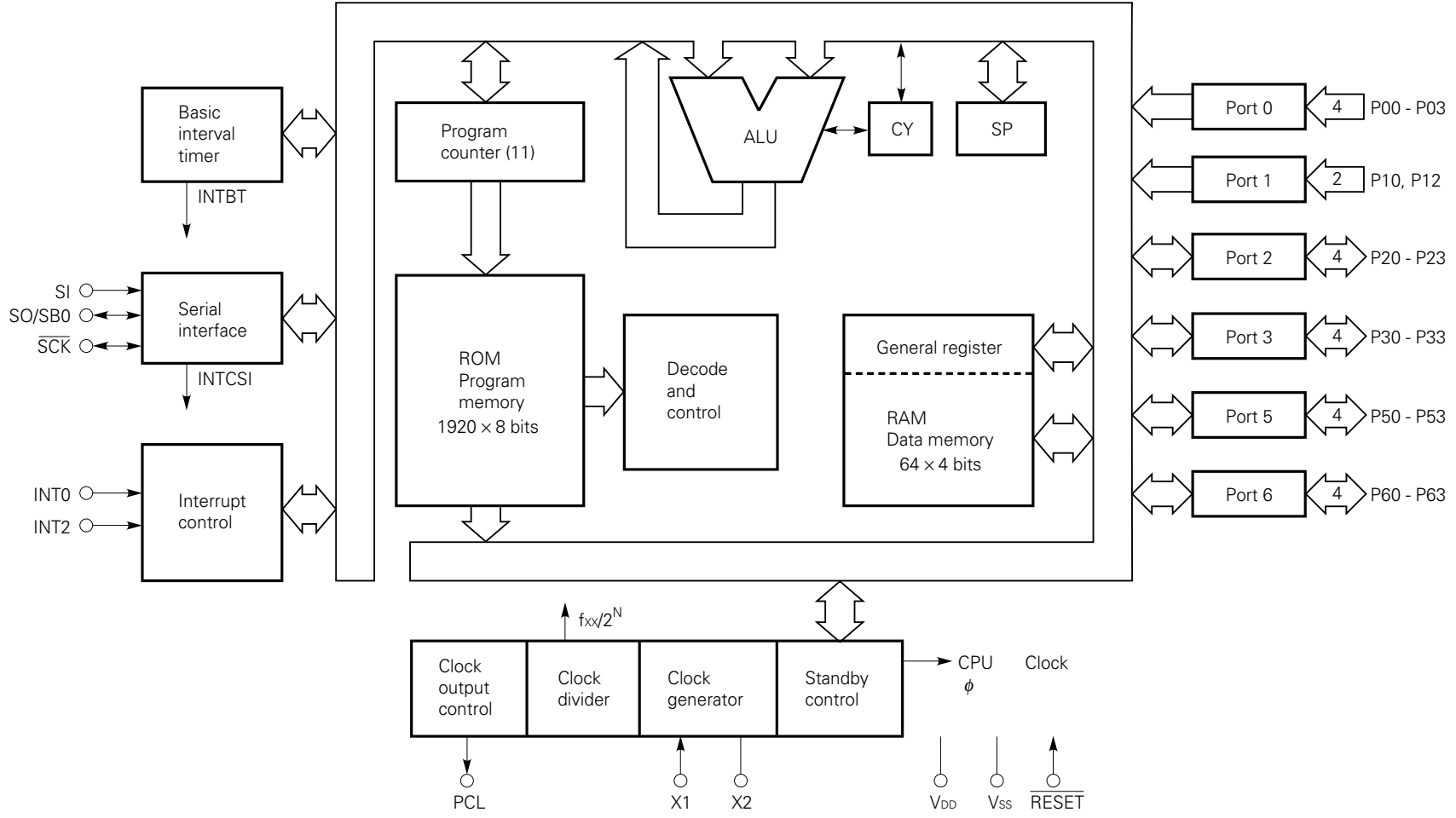
SCK : Serial clock I/O
 SO/SB0 : Serial output/input-output
 SI : Serial input
 PCL : Clock output
 INT0 : External vectored interrupt input
 INT2 : External test input
 X1 and X2: Oscillating pins
 RESET : Reset input
 VDD : Power supply
 Vss : Ground
 NC : No connection

Note When the μPD75402A(A) shares the printed circuit board with the μPD75P402, connect the NC pin directly to the Vss pin.

44-pin plastic QFP (10 × 10 mm)



Note When the μPD75402A(A) shares the printed circuit board with the μPD75P402, connect the NC pin (pin 30) directly to the Vss pin.



2. BLOCK DIAGRAM

3. PIN FUNCTIONS

3.1 PORT PINS

| Pin | I/O | Dual-function pin | Function |
|-----------|-------|-------------------|---|
| P00 | Input | – | 4-bit input port (port 0) P01 to P03 allow the connection of built-in pull-up resistors to be specified in units of three bits by software. |
| P01 | I/O | SCK | |
| P02 | I/O | SO/SB0 | |
| P03 | Input | SI | |
| P10 | Input | INT0 | 2-bit input port (port 1) P10 connects with the built-in noise eliminator using a sampling clock. P12 connects with the built-in noise eliminator using an analog delay. P12 allows the connection of built-in pull-up resistor to be specified by software. |
| P12 | | INT2 | |
| P20 | I/O | – | 4-bit I/O port (port 2) Allow I/O specification in units of four bits. Allow the connection of built-in pull-up resistors to be specified in units of four bits by software. |
| P21 | | – | |
| P22 | | PCL | |
| P23 | | – | |
| P30 - P33 | I/O | – | Programmable 4-bit I/O port (port 3) Allow I/O specification bit by bit. Allow the connection of built-in pull-up resistors to be specified in units of four bits by software. Can directly drive LED. |
| P50 - P53 | I/O | – | 4-bit N-ch open-drain I/O port (port 5) Allow I/O specification in units of four bits. Allow the connection of built-in pull-up resistors to be specified bit by bit by mask option. Can directly drive LED. |
| P60 - P63 | I/O | – | 4-bit I/O port (port 6) Allow I/O specification in units of four bits. Allow the connection of built-in pull-up resistors to be specified in units of four bits by software. Can directly drive LED. |

- Remarks 1.** The μPD75402A(A) cannot perform 8-bit I/O with two ports as a pair.
2. See Chapter 8 for each pin status during resetting.

3.2 NON-PORT PINS

| Pin | I/O | Dual-function pin | Function |
|---------------------------|-------|-------------------|--|
| INT0 | Input | P10 | Edge detection vectored interrupt request input pin (A detected edge can be selected by the mode register.) Connects with the built-in noise eliminator using a sampling clock. |
| INT2 | Input | P12 | Edge detection external test input pin (A rising edge is detected.) |
| SI | Input | P03 | Serial data input pin |
| SO | I/O | P02/SB0 | Serial data output pin |
| $\overline{\text{SCK}}$ | I/O | P01 | Serial clock I/O pin |
| SB0 | I/O | P02/SO | Serial bus I/O pin |
| PCL | I/O | P22 | Clock output pin |
| X1, X2 | Input | - | Pin for connection to a crystal/ceramic resonator for system clock generation. An external clock is applied to X1, and its reverse phase to X2. |
| $\overline{\text{RESET}}$ | Input | - | System reset input pin, which connects with the built-in noise eliminator using an analog delay. |
| V _{DD} | - | - | Positive power supply pin |
| V _{SS} | - | - | Ground potential pin |
| NC Note | - | - | No connection |

Remark See Chapter 8 for each pin status during resetting.

Note Connect the NC pin directly to the V_{SS} pin when the μPD75402A(A) shares the printed circuit board with the μPD75P402 in emulation.

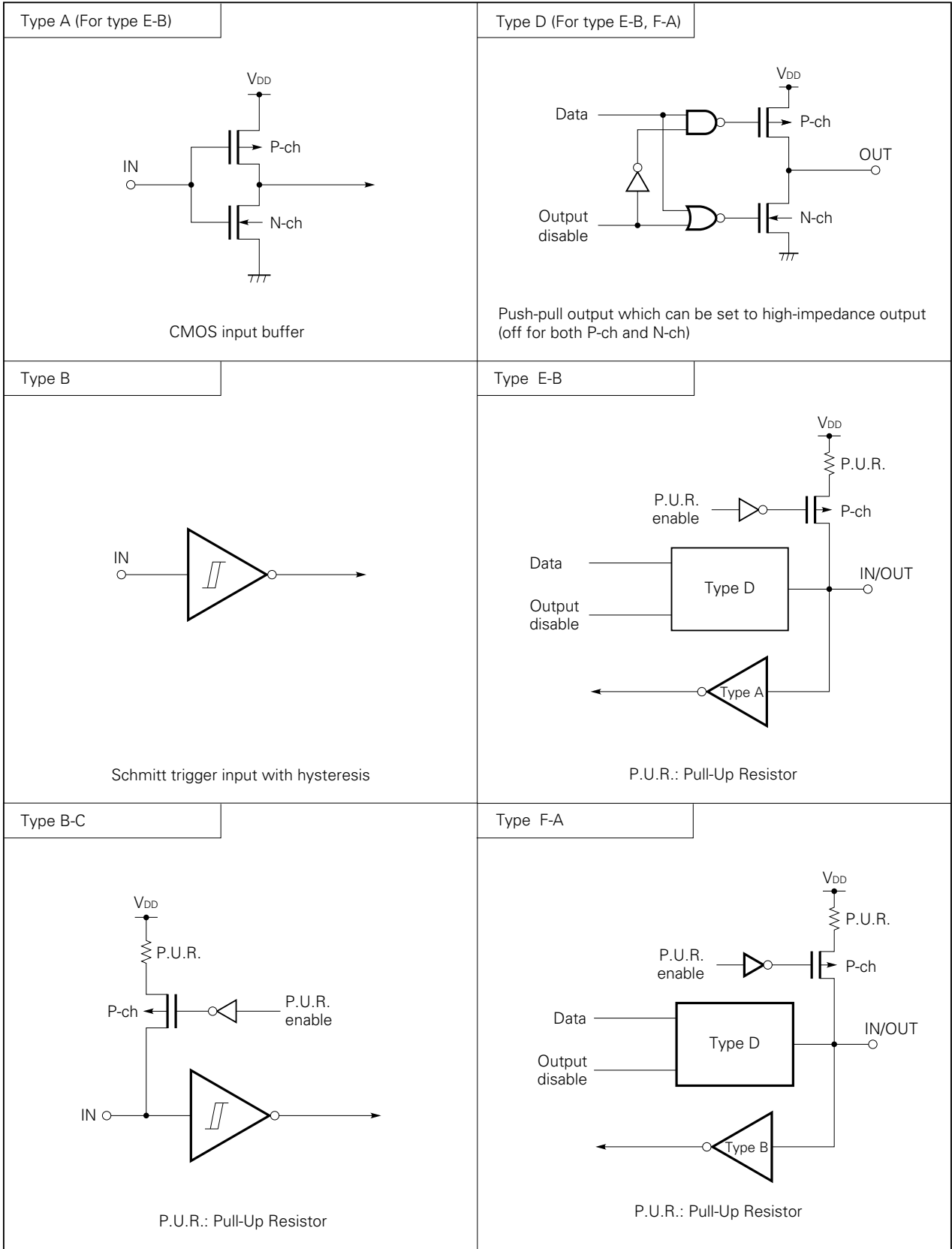
3.3 PIN INPUT/OUTPUT CIRCUITS

The I/O circuits of the μPD75402A(A) are roughly shown on the next and subsequent pages.

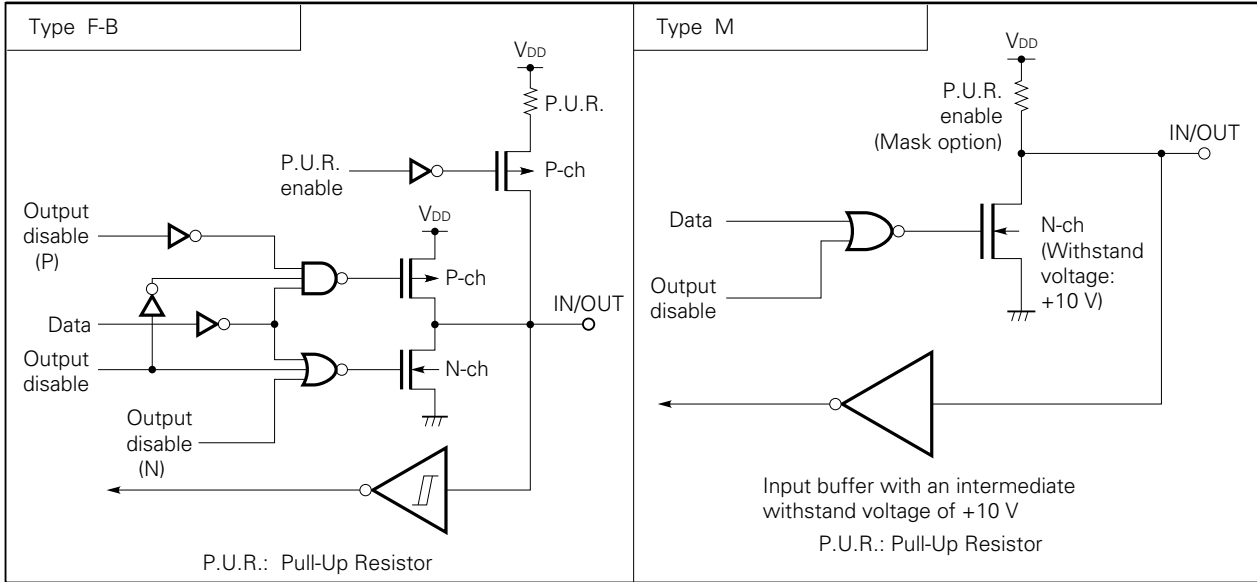
Table 1-1 I/O Circuit Type of Pin

| Pin | I/O type | Pin | I/O type |
|------------------------------|----------|---------------------------|----------|
| P00 | Ⓑ | P20, P21, and P23 | E-B |
| P01/ $\overline{\text{SCK}}$ | Ⓕ-A | P22/PCL | |
| P02/SO/SB0 | Ⓕ-B | P30 - P33 | E-B |
| P03/SI | Ⓑ-C | P50 - P53 | M |
| P10/INT0 | Ⓑ | P60 - P63 | E-B |
| P12/INT2 | Ⓑ-C | $\overline{\text{RESET}}$ | Ⓑ |

Remark The types in circles have a Schmitt-triggered input.



(2/2)



3.4 SELECTION OF A MASK OPTION

The following mask options are provided for pins:

| | | |
|-----------|--|----------------------------------|
| P50 - P53 | ① Pull-up resistors connected (Either can be specified bit by bit.) | ② No pull-up resistors connected |
|-----------|--|----------------------------------|

3.5 HANDLING UNUSED PINS

| Pin | Recommended connection method |
|-----------|--|
| P00 | Connected to the V _{SS} pin |
| P01 - P03 | • When a pull-up resistor is contained Connected to the V _{DD} pin |
| P10, P12 | • When a pull-up resistor is not contained Connected to the V _{SS} or V _{DD} pin |
| P20 - P23 | • When a pull-up resistor is contained Input mode : Connected to the V _{DD} pin |
| P30 - P33 | Output mode : Open |
| P50 - P53 | • When a pull-up resistor is not contained Input mode : Connected to the V _{SS} or V _{DD} pin |
| P60 - P63 | Output mode : Open |
| NC | Open or directly connected to the V _{SS} pin Note |

Note When the μPD75402A(A) shares the printed circuit board with the μPD75P402, connect the NC pin directly to V_{SS} pin.

3.6 NOTES ON USING THE P00 AND RESET PINS

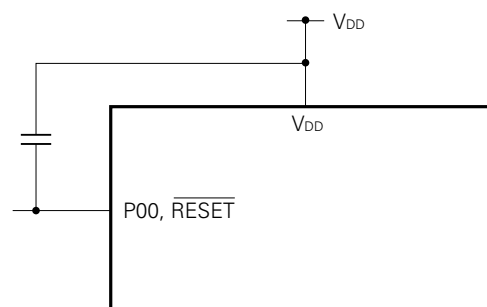
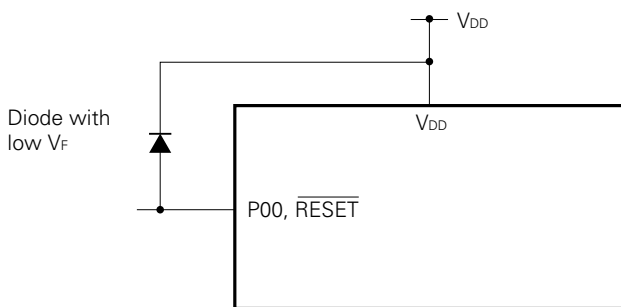
The P00 and RESET pins have the test mode selecting function for testing the internal operation of the μPD75402A(A) (IC test), besides the functions shown in Sections 3.1 and 3.2.

Applying a voltage exceeding V_{DD} to the P00 and/or RESET pin causes the μPD75402A(A) to enter the test mode. When noise exceeding V_{DD} comes in during normal operation, the device is switched to the test mode.

For example, when the wiring from the P00 or RESET pin is too long, noise voltage induced on the wiring is applied to the pin, driving the voltage at the pin above V_{DD}, which may cause malfunction.

When installing the wiring, lay the wiring in such a way that noise is suppressed as much as possible. If noise yet arises, use an external part to suppress it as shown below.

- Connect a diode with low V_F (0.3 V or lower) between the pin and V_{DD}.
- Connect a capacitor between the pin and V_{DD}.



4. MEMORY CONFIGURATION

- Program memory (ROM): 1920 × 8 bits (000H to 77FH)
 - 000H and 001H: Vector table which contains the program start address after reset
 - 002H to 009H : Vector table which contains the program start addresses when interrupts occur
- Data memory
 - Data area : 64 × 4 bits (000H to 03FH)
 - Peripheral hardware area: 128 × 4 bits (F80H to FFFH)

Fig. 4-1 Program Memory Map

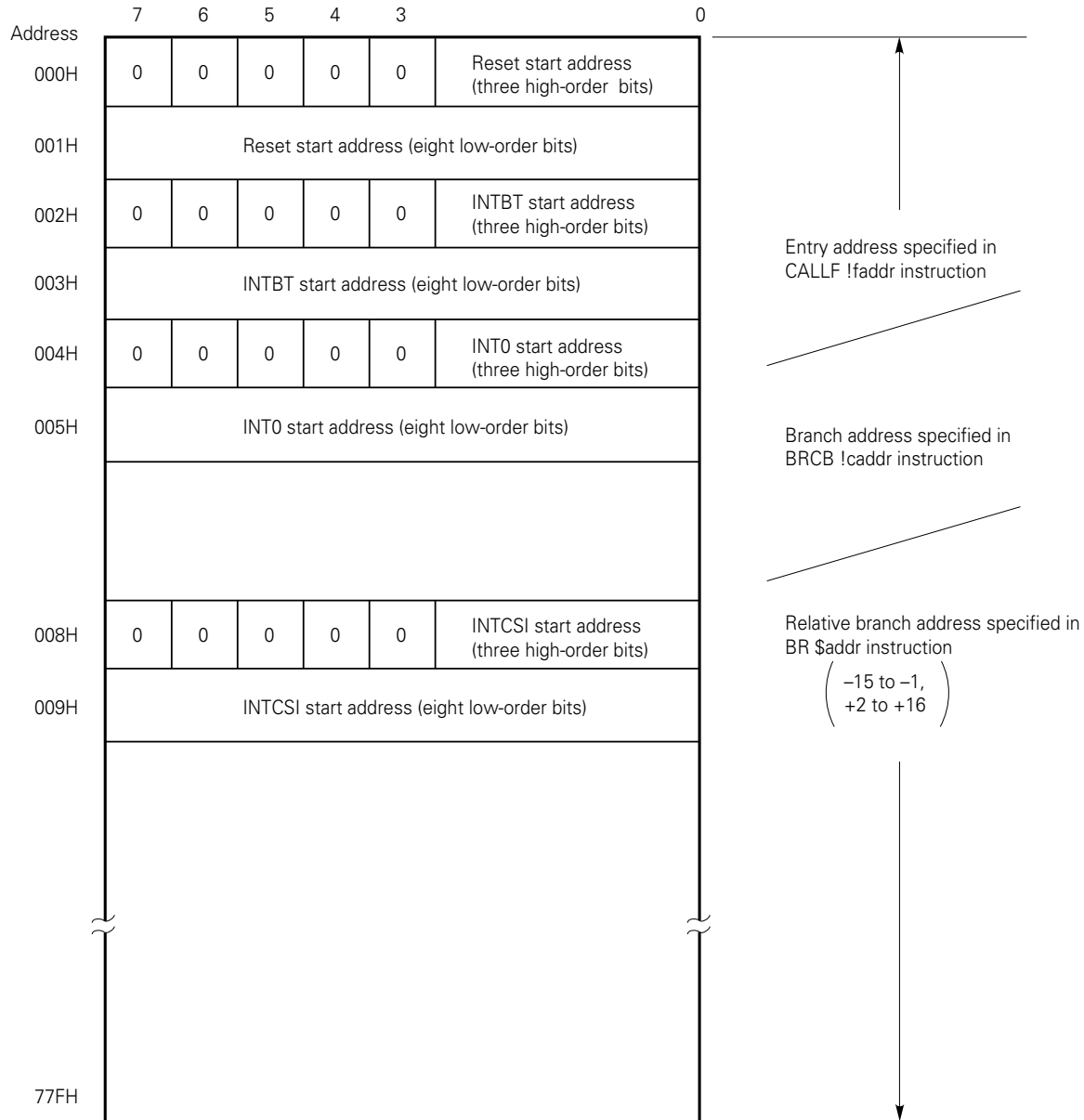
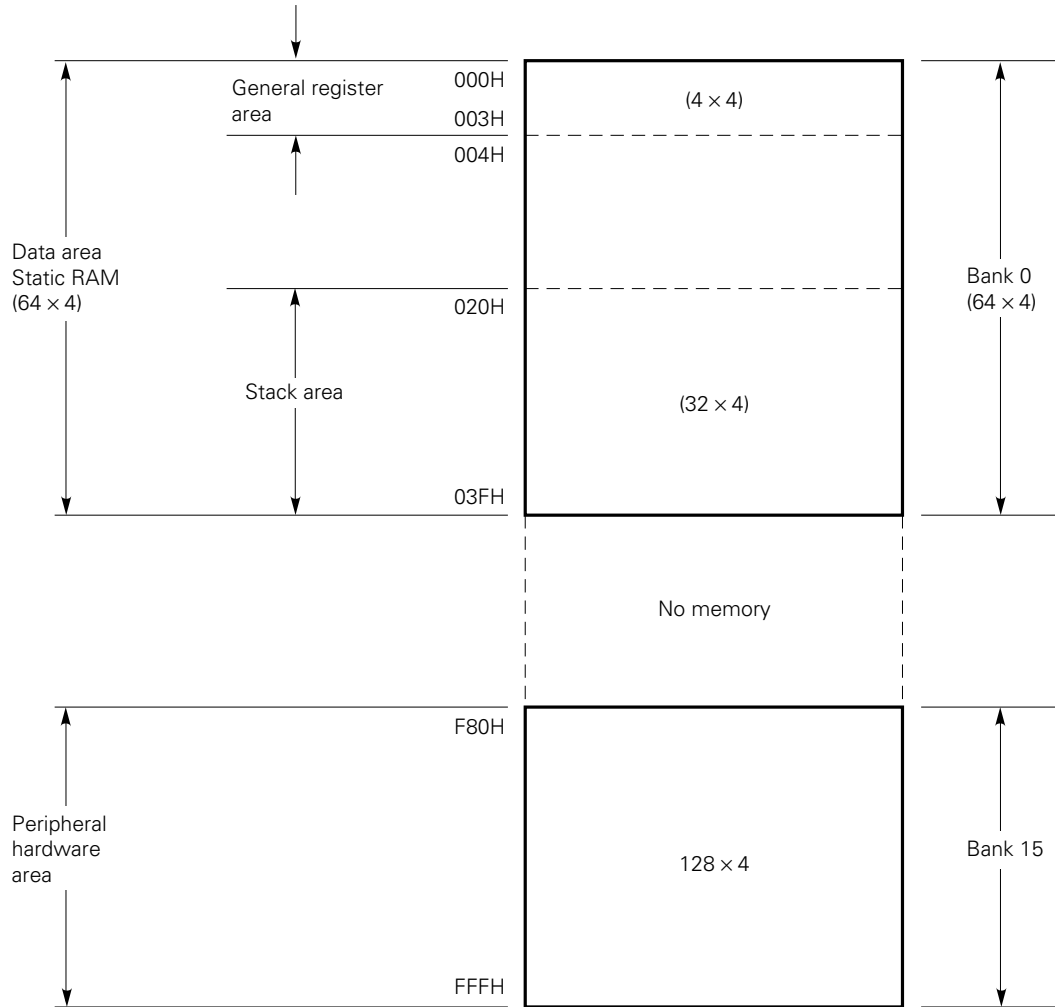


Fig. 4-2 Data Memory Map



5. PERIPHERAL HARDWARE FUNCTIONS

5.1 PORTS

The μPD75402A(A) has the following three types of I/O port:

- 6 CMOS input pins (PORT0 and PORT1)
- 12 CMOS I/O pins (PORT2, PORT3, and PORT6)
- 4 N-ch open-drain I/O pins (PORT5)

Total: 22 pins

Table 5-1 Functions of Ports

| Port name | Function | Operation and feature | Remarks |
|----------------------------|--|---|---|
| PORT0 PORT1 | 4-bit Input | Allows read and test at any time regardless of the operation modes of dual function pins. | Also used for SO/SB0, SI, \overline{SCK} , INT0, and INT2. |
| PORT3 Note | 4-bit I/O | Allows input or output mode setting bit by bit. | — |
| PORT2 PORT6 Note | | Allows input or output mode setting in units of 4 bits. | Port 2 is also used for PCL. |
| PORT5 Note | 4-bit I/O (N-ch open-drain I/O with a withstand voltage of 10 V) | Allows input or output mode setting in units of 4 bits. | This port can incorporate a pull-up resistor as a mask option bit by bit. |

Note PORT3, PORT5, and PORT6 can directly drive the LED.

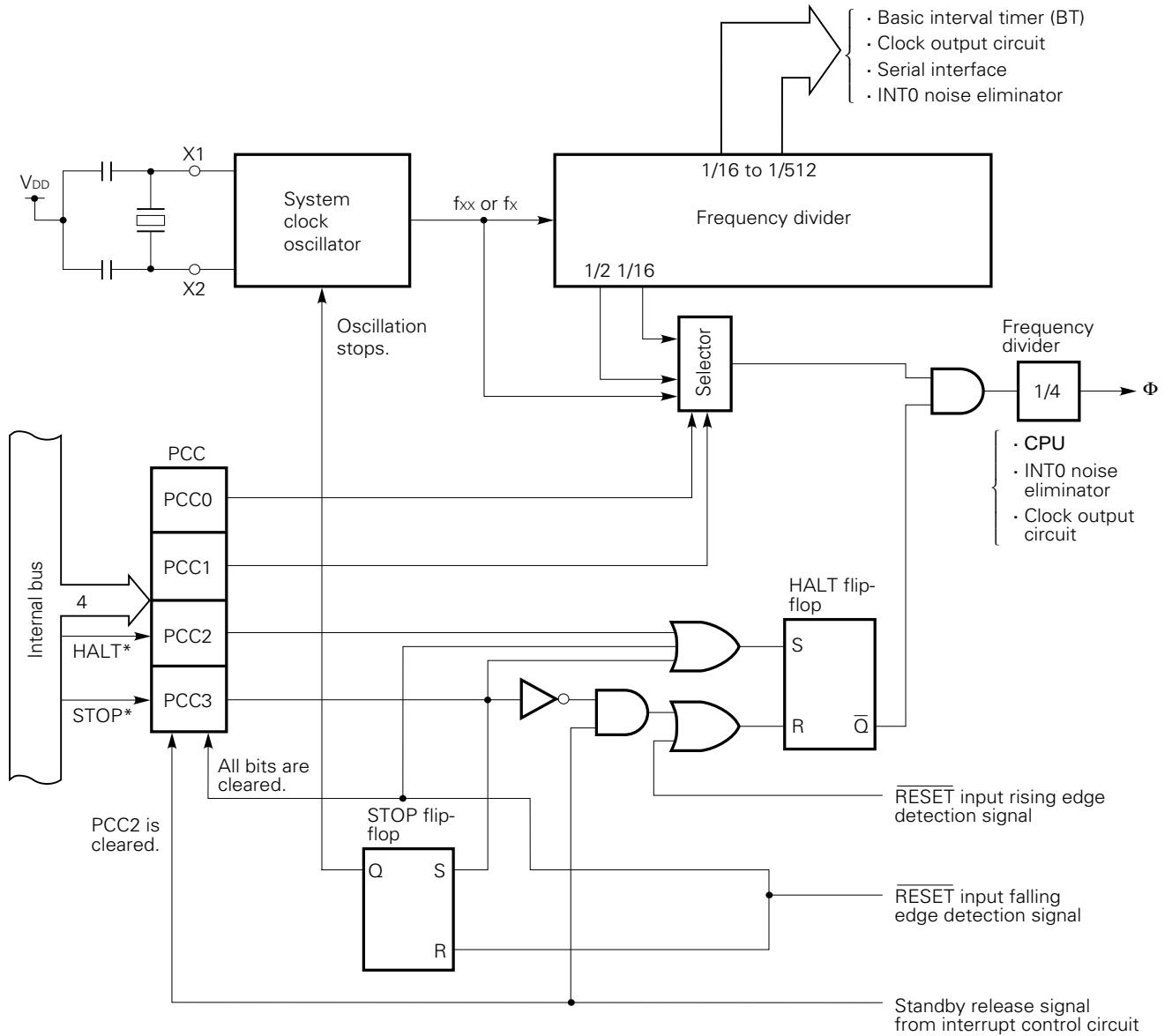
5.2 CLOCK GENERATOR

Operation of the clock generator is specified by the processor clock control register (PCC).

The instruction execution time is variable.

- 0.95 μs, 1.91 μs, 15.3 μs (when fxx is 4.19 MHz.)

Fig. 5-1 Block Diagram of the Clock Generator



- Remarks**
1. f_{xx} = Crystal/ceramic oscillated frequency
 2. f_x = External clock frequency
 3. Φ = CPU clock
 4. An asterisk (*) indicates instruction execution.
 5. PCC: Processor clock control register
 6. One clock cycle (t_{cv}) of Φ is equal to one machine cycle of an instruction. See AC characteristics of **Chapter 10** for details of t_{cv} .

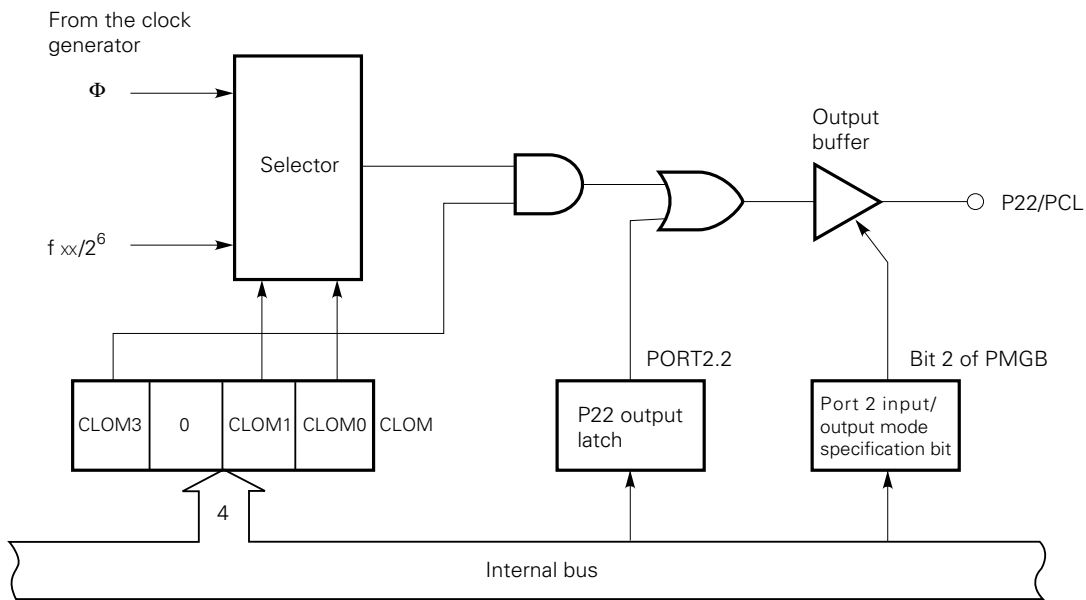
5.3 CLOCK OUTPUT CIRCUIT

The clock output circuit, which outputs clock pulses from pin P22/PCL, is used for supplying clock pulses for peripheral LSIs or for remote control output.

- Clock output (PCL): 1.05 MHz, 524 kHz, 65.5 kHz (when f_{xx} is 4.19 MHz).

Fig. 5-2 shows the configuration of the clock output circuit.

Fig. 5-2 Configuration of the Clock Output Circuit



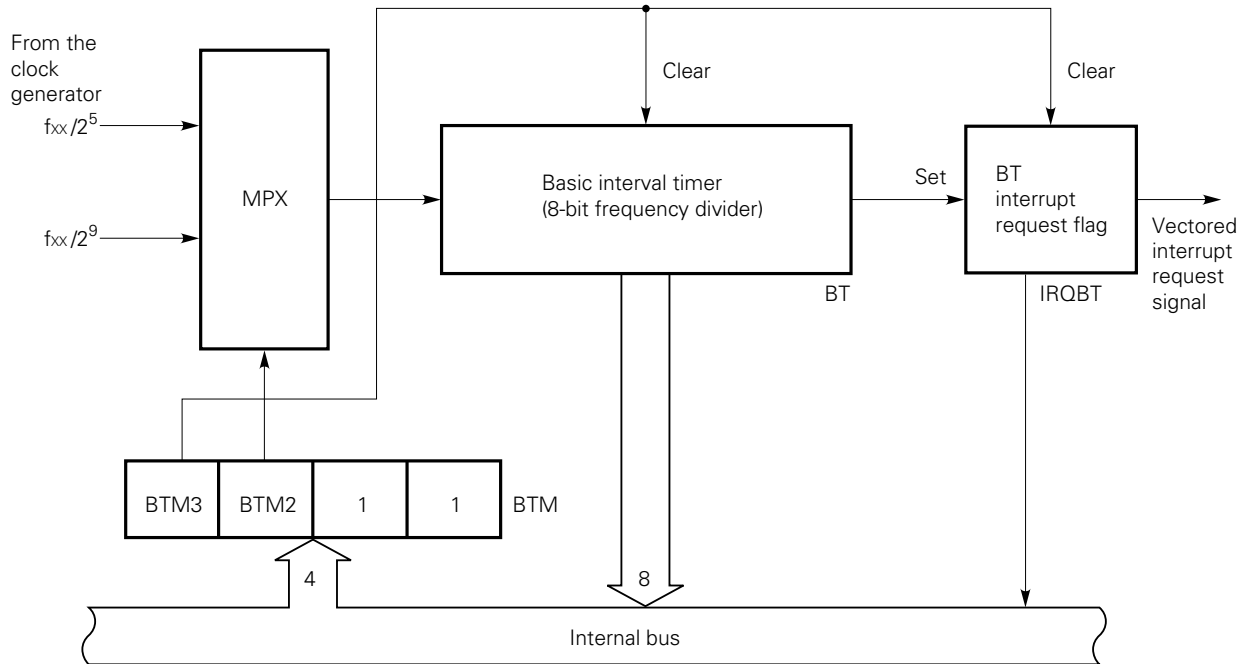
Remark The clock output circuit is designed not to output high-frequency pulses when clock output is switched between the enable and disable states.

5.4 BASIC INTERVAL TIMER

The basic interval timer provides the following functions:

- Interval timer operation that generates a reference time interrupt
- Can be used as a watchdog timer for detecting program crashes
- Reading the count value

Fig. 5-3 Configuration of the Basic Interval Timer



5.5 SERIAL INTERFACE

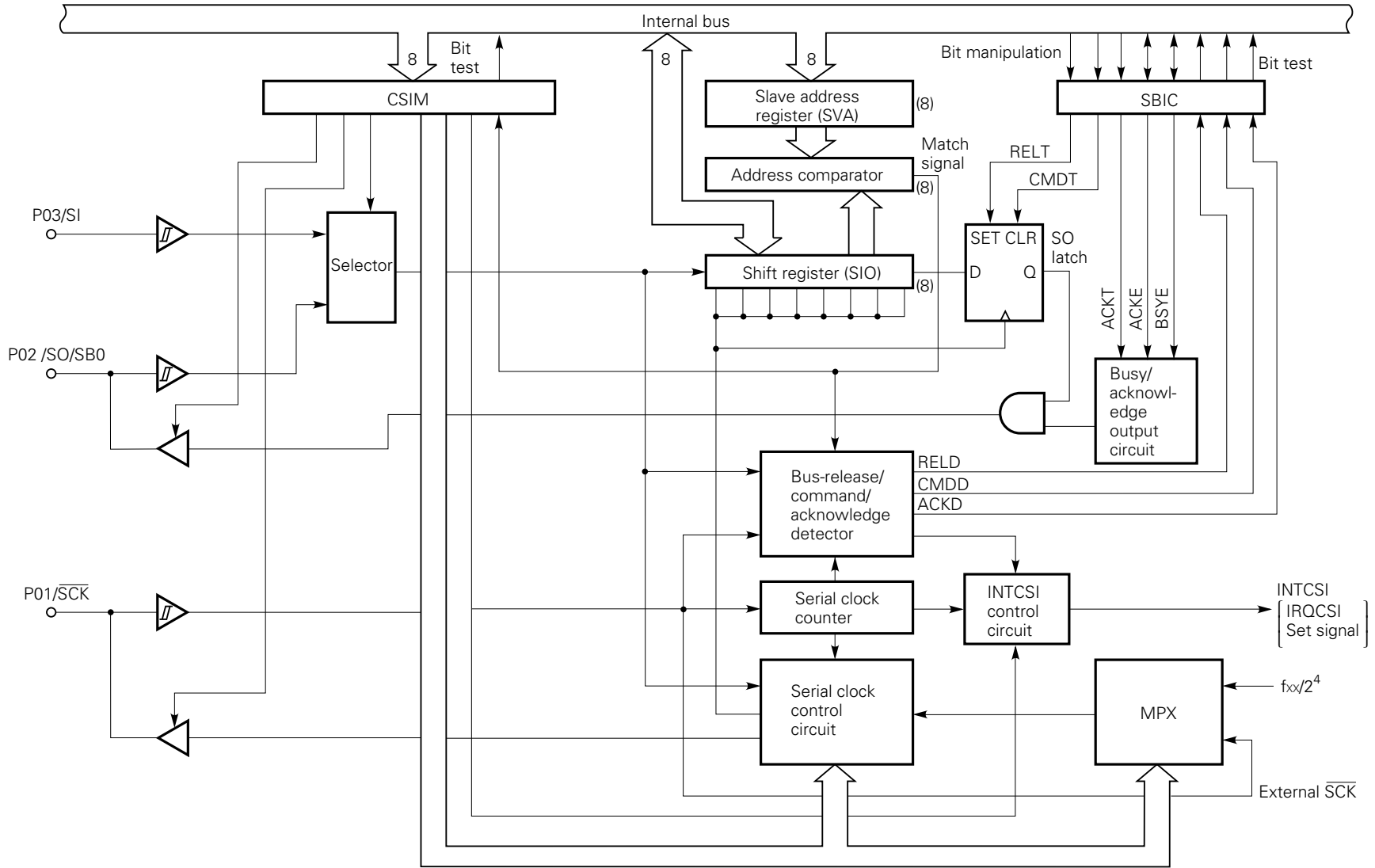
The serial interface has the following modes:

- Three-wire serial I/O mode (MSB is transferred first.)
- SBI mode (MSB is transferred first.)

The three-wire serial I/O mode enables connections to be made with the 75X series, 78K series, and many other types of peripheral I/O devices.

The SBI mode enables communication with two or more devices.

Fig. 5-4 Block Diagram of the Serial Interface



6. INTERRUPT FUNCTION

The μ PD75402A(A) has three interrupt sources and each of them has the interrupt vector table.

The μ PD75402A(A) is also provided with one edge-sensitive testable input signal.

When a vectored interrupt request is issued, the PC and PSW are saved in the stack, and the contents of the vector table which corresponds to the issued vectored interrupt are set in the PC as a start address. The program branches to the interrupt service routine. These operations are performed automatically by the hardware.

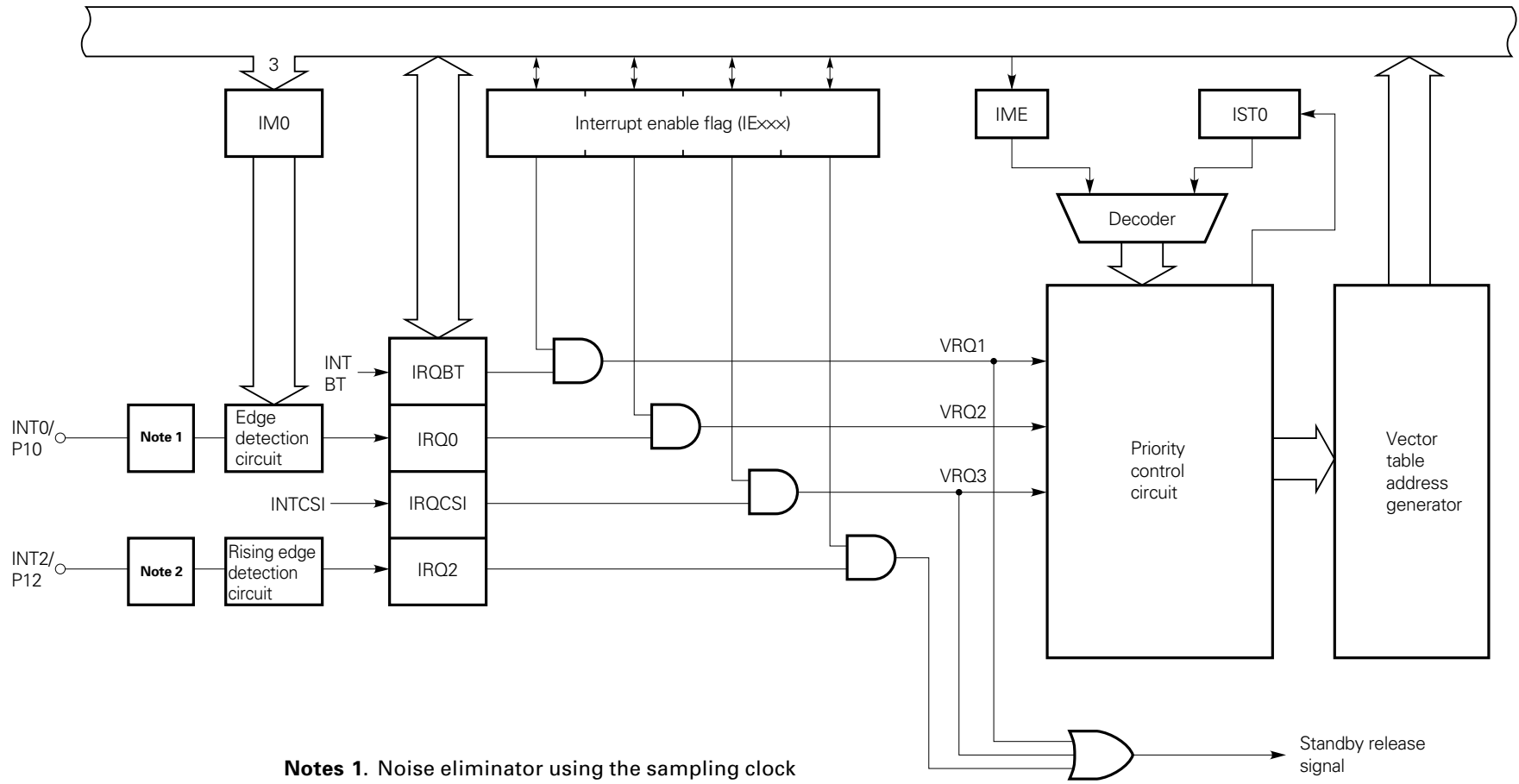
The flag is set by detecting the edge of the testable input signal, but a vectored interrupt request is not issued.

During execution of the interrupt service routine, the μ PD75402A(A) does not accept the other interrupt requests. Unlike the other 75X series, the μ PD75402A(A) cannot handle multiple interrupts.

The interrupt control circuit of the μ PD75402A(A) has the following functions.

- Vectored interrupt function under hardware control which can determine whether to accept an interrupt by an interrupt enable flag (IE_{xxx}) and an interrupt master enable flag (IME).
- Any interrupt start address can be set.
- Test function of an interrupt request flag (IRQ_{xxx}) (Software can confirm that an interrupt occurs.)
- Release of the standby (HALT) mode (An interrupt to be released by an interrupt enable flag can be selected from interrupts other than INT0.)

Fig. 6-1 Block Diagram of Interrupt Control Circuit



Notes 1. Noise eliminator using the sampling clock
2. Noise eliminator using analog delay

7. STANDBY FUNCTION

To reduce the power consumption when the program is in the wait state, the μPD75402A(A) has two standby modes, STOP and HALT.

Table 7-1 Operation Statuses in the Standby Mode

| | | STOP mode | HALT mode |
|------------------------------------|----------------------|--|---|
| Instruction to be used to set mode | | STOP instruction | HALT instruction |
| Operation status | Clock generator | Oscillation of the system clock stops. | Only the CPU clock (Φ) stops, but oscillation continues. |
| | Basic interval timer | Operation stops. | Operates. (IRQBT is set at every reference time interval.) |
| | Serial interface | Operable only when the external \overline{SCK} input is selected for the serial clock. | Operable |
| | Clock output circuit | Operation stops. | Clocks other than CPU clock (Φ) can be output. |
| | External interrupt | INT2 pin is usable. INT0 pin cannot be used. | INT2 pin is usable. INT0 pin cannot be used. |
| | CPU | Operation stops. | |
| Release signal | | \overline{RESET} input | \overline{RESET} input or interrupt request signals enabled by the interrupt enable flags |

8. RESET FUNCTION

When a low level signal is input to the $\overline{\text{RESET}}$ input pin, the state changes to the system reset. Table 8-1 shows the statuses of the hardware.

When the $\overline{\text{RESET}}$ signal rises from the low level to the high level, the reset state is released. The three low-order bits of the reset vector table whose address is 000H is set in bits 10 to 8 of the program counter (PC) and the contents of the reset vector table whose address is 001H is set in bits 7 to 0 of the PC. The program branches to that address and starts execution, i.e., the reset start address is programmable.

Initialize contents of registers in a program if necessary.

The $\overline{\text{RESET}}$ pin connects to the Schmitt-trigger circuit whose threshold level has hysteresis in the chip. This pin is also connected to the noise eliminator using an analog delay to eliminate narrow noise and prevent errors caused by noise. (See Fig. 8-1.)

For the power-on reset operation, be sure to allow sufficient time for oscillation to settle between power on and acceptance of the reset signal (see Fig. 8-2).

Fig. 8-1 Acceptance of the Reset Signal

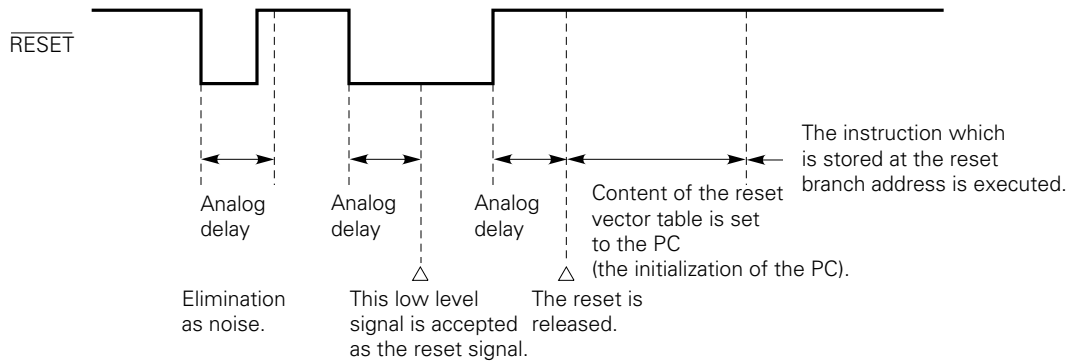


Fig. 8-2 Power-On Reset Operation

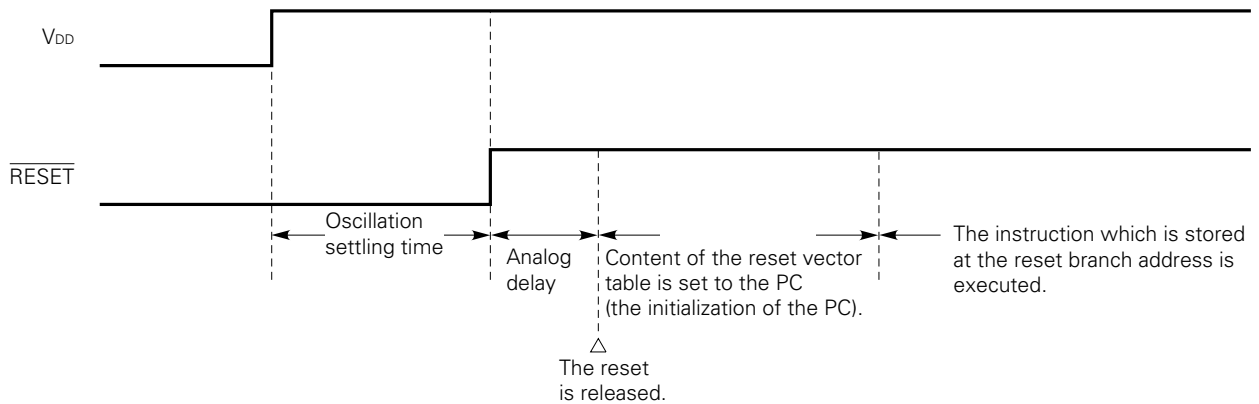


Table 8-1 Hardware Statuses after Reset Operations

| Hardware | | $\overline{\text{RESET}}$ input in standby mode | $\overline{\text{RESET}}$ input during operations |
|--|--|--|--|
| Program counter (PC) | | Set the three low-order bits of address 000H in program memory in PC bits 10 to 8 and set the contents of address 001H in PC bits 7 to 0. | Set the three low-order bits of address 000H in program memory in PC bits 10 to 8 and set the contents of address 001H in PC bits 7 to 0. |
| PSW | Carry flag (CY) | Retained | Undefined |
| | Skip flag (SK0 - SK2) | 0 | 0 |
| | Interrupt status flag (IST0) | 0 | 0 |
| Stack pointer (SP) | | Undefined | Undefined |
| Data memory (RAM) | | Retained Note | Undefined |
| General register (X, A, H, L) | | Retained | Undefined |
| Basic interval timer | Counter (BT) | Undefined | Undefined |
| | Mode register (BTM) | 0 | 0 |
| Serial interface | Shift register (SIO) | Retained | Undefined |
| | Operation mode register (CSIM) | 0 | 0 |
| | SBI control register (SBIC) | 0 | 0 |
| | Slave address register (SVA) | Retained | Undefined |
| Clock generator and clock output circuit | Processor clock control register (PCC) | 0 | 0 |
| | Clock output mode register (CLOM) | 0 | 0 |
| Interrupt | Interrupt request flag (IRQ _{xxx}) | Reset (0) | Reset (0) |
| | Interrupt enable flag (IE _{xxx}) | 0 | 0 |
| | Interrupt master enable flag (IME) | 0 | 0 |
| | INT0 mode register (IM0) | 0 | 0 |
| Digital I/O port | Output buffer | Off | Off |
| | Output latch | Cleared (0) | Cleared (0) |
| | I/O mode register (PMGA, PMGB) | 0 | 0 |
| | Pull-up resistor specification register (POGA) | 0 | 0 |
| States of pins | P00 - P03, P10, P12, P20 - P23, P30 - P33, P60 - P63 | Used as inputs | Used as inputs |
| | P50 - P53 | <ul style="list-style-type: none"> • High level when pull-up resistor is built in • High impedance when open drain is used in the internal circuit | <ul style="list-style-type: none"> • High level when pull-up resistor is built in • High impedance when open drain is used in the internal circuit |

Note Data in the data memory whose addresses are 38H to 3DH is not defined when the standby mode is released by the $\overline{\text{RESET}}$ input signal.

9. INSTRUCTION SET

(1) Representation format and description method of operands

An operand is described in the operand field of each instruction according to the description method corresponding to the operand representation format of the instruction refer to "RA75X Assembler Package User's Manual, Language" (EEU-1363) for details. When two or more elements are described in the description method field, select one of them. Upper-case letters, a number sign (#), and at mark (@), an exclamation mark (!), and a dollar sign (\$) are keywords, so they can be used without alteration.

Specify an appropriate numeric value or label for immediate data.

The symbols of registers and flags can be used as labels instead of mem, fmem, and bit (refer to the "μPD75402A User's Manual" (IEU-644) for details). Some labels, however, cannot be specified in fmem.

| Representation format | Description method |
|-----------------------|---|
| reg | X, A, H, L |
| reg1 | X, H, L |
| rp | XA, HL |
| n4 | 4-bit immediate data or label |
| n8 | 8-bit immediate data or label |
| mem | 8-bit immediate data or label Note |
| bit | 2-bit immediate data or label |
| fmem | FB0H - FBFH/FF0H - FFFH immediate data or label |
| addr | 11-bit immediate data or label |
| caddr | 11-bit immediate data or label |
| faddr | 11-bit immediate data or label |
| PORTn | PORT0 - PORT3, PORT5, PORT6 |
| IExxx | IEBT, IECSI, IE0, IE2 |

Note Only an even address can be written in mem when 8-bit data is processed.

(2) Legend

- A : A register, 4-bit accumulator
- H : H register
- L : L register
- X : X register
- XA : Register pair (XA), 8-bit accumulator
- HL : Register pair (HL)
- PC : Program counter
- SP : Stack pointer
- CY : Carry flag, bit accumulator
- PSW : Program status word
- PORTn: Port n (n = 0 to 3, 5, 6)
- IME : Interrupt master enable flag
- IExxx : Interrupt enable flag
- PCC : Processor clock control register
- : Address/bit delimiter
- (xx) : Contents addressed by xx
- xxH : Hexadecimal data

(3) Explanation of the symbols in the addressing area field

| | | |
|----|--|--|
| *1 | MB = 0 | |
| *2 | MB = 0 (00H - 3FH) MB = 15 (80H - FFH) | |
| *3 | MB = 15, fmem = FB0H - FBFH or FF0H - FFFH | |
| *4 | addr = 000H - 77FH | |
| *5 | addr = (Current PC) - 15 to (Current PC) - 1 or (Current PC) + 16 to (Current PC) + 2 | |
| *6 | caddr = 000H - 77FH | |
| *7 | faddr = 000H - 77FH | |

- Remarks**
1. MB indicates an accessible memory bank.
 2. *4 to *7 indicate each addressable area.

(4) Explanation of the machine cycle field

S indicates the number of machine cycles required for a skip instruction to perform skipping. The following shows the values of S.

- When the next instruction is not skipped, S is 0.
- When the next instruction is skipped, S is 1.

A machine cycle is equal to one cycle (= t_{cy}) of CPU clock Φ. A PCC setting determines the machine cycle. It can be set to one of three different periods.

| Instruction group | Mnemonic | Operand | Number of bytes | Machine cycle | Operation | Addressing area | Skip condition |
|--------------------------------------|-----------|----------|-----------------|--|--|-----------------|----------------|
| Transfer instruction | MOV | A, #n4 | 1 | 1 | $A \leftarrow n4$ | | String A |
| | | XA, #n8 | 2 | 2 | $XA \leftarrow n8$ | | String A |
| | | HL, #n8 | 2 | 2 | $HL \leftarrow n8$ | | String B |
| | | A, @HL | 1 | 1 | $A \leftarrow (HL)$ | *1 | |
| | | @HL, A | 1 | 1 | $(HL) \leftarrow A$ | *1 | |
| | | A, mem | 2 | 2 | $A \leftarrow (mem)$ | *2 | |
| | | XA, mem | 2 | 2 | $XA \leftarrow (mem)$ | *2 | |
| | | mem, A | 2 | 2 | $(mem) \leftarrow A$ | *2 | |
| | | mem, XA | 2 | 2 | $(mem) \leftarrow XA$ | *2 | |
| | XCH | A, @HL | 1 | 1 | $A \leftrightarrow (HL)$ | *1 | |
| | | A, mem | 2 | 2 | $A \leftrightarrow (mem)$ | *2 | |
| | | XA, mem | 2 | 2 | $XA \leftrightarrow (mem)$ | *2 | |
| | | A, reg1 | 1 | 1 | $A \leftrightarrow reg1$ | | |
| MOVT | XA, @PCXA | 1 | 3 | $XA \leftarrow (PC_{10-8} + XA)_{ROM}$ | | | |
| Arithmetic/ logical instruction | ADDS | A, #n4 | 1 | 1 + S | $A \leftarrow A + n4$ | | carry |
| | | A, @HL | 1 | 1 + S | $A \leftarrow A + (HL)$ | *1 | carry |
| | ADDC | A, @HL | 1 | 1 | $A, CY \leftarrow A + (HL) + CY$ | *1 | |
| | AND | A, @HL | 1 | 1 | $A \leftarrow A \wedge (HL)$ | *1 | |
| | OR | A, @HL | 1 | 1 | $A \leftarrow A \vee (HL)$ | *1 | |
| | XOR | A, @HL | 1 | 1 | $A \leftarrow A \nabla (HL)$ | *1 | |
| Accumulator manipulation instruction | RORC | A | 1 | 1 | $CY \leftarrow A_0, A_3 \leftarrow CY, A_{n-1} \leftarrow A_n$ | | |
| | NOT | A | 2 | 2 | $A \leftarrow \overline{A}$ | | |
| Increment/ decrement instruction | INCS | reg | 1 | 1 + S | $reg \leftarrow reg + 1$ | | reg = 0 |
| | | mem | 2 | 2 + S | $(mem) \leftarrow (mem) + 1$ | *2 | (mem) = 0 |
| | DECS | reg | 1 | 1 + S | $reg \leftarrow reg - 1$ | | reg = FH |
| Comparison instruction | SKE | reg, #n4 | 2 | 2 + S | Skip if reg = n4 | | reg = n4 |
| | | A, @HL | 1 | 1 + S | Skip if A = (HL) | *1 | A = (HL) |
| Carry flag manipulation instruction | SET1 | CY | 1 | 1 | $CY \leftarrow 1$ | | |
| | CLR1 | CY | 1 | 1 | $CY \leftarrow 0$ | | |
| | SKT | CY | 1 | 1 + S | Skip if CY = 1 | | CY = 1 |
| | NOT1 | CY | 1 | 1 | $CY \leftarrow \overline{CY}$ | | |

| Instruction group | Mnemonic | Operand | Number of bytes | Machine cycle | Operation | Addressing area | Skip condition |
|--------------------------------------|--------------|-----------------------|-----------------|----------------------|--|-----------------|-----------------|
| Memory bit manipulation instruction | SET1 | mem.bit | 2 | 2 | (mem.bit) ← 1 | *2 | |
| | | fmem.bit | 2 | 2 | (fmem.bit) ← 1 | *3 | |
| | CLR1 | mem.bit | 2 | 2 | (mem.bit) ← 0 | *2 | |
| | | fmem.bit | 2 | 2 | (fmem.bit) ← 0 | *3 | |
| | SKT | mem.bit | 2 | 2 + S | Skip if (mem.bit) = 1 | *2 | (mem.bit) = 1 |
| | | fmem.bit | 2 | 2 + S | Skip if (fmem.bit) = 1 | *3 | (fmem.bit) = 1 |
| | SKF | mem.bit | 2 | 2 + S | Skip if (mem.bit) = 0 | *2 | (mem.bit) = 0 |
| | | fmem.bit | 2 | 2 + S | Skip if (fmem.bit) = 0 | *3 | (fmem.bit) = 0 |
| | SKTCLR | fmem.bit | 2 | 2 + S | Skip if (fmem.bit) = 1 and clear | *3 | (fmem.bit) = 1 |
| | AND1 | CY, fmem.bit | 2 | 2 | CY ← CY ∧ (fmem.bit) | *3 | |
| OR1 | CY, fmem.bit | 2 | 2 | CY ← CY ∨ (fmem.bit) | *3 | | |
| XOR1 | CY, fmem.bit | 2 | 2 | CY ← CY ⊕ (fmem.bit) | *3 | | |
| Branch instruction | BR | addr | - | - | PC ₁₀₋₀ ← addr (The assembler selects an appropriate instruction from the BRCB !caddr and BR \$addr instructions.) | *4 | |
| | | \$addr | 1 | 2 | PC ₁₀₋₀ ← addr | *5 | |
| | BRCB | !caddr | 2 | 2 | PC ₁₀₋₀ ← caddr | *6 | |
| Subroutine stack control instruction | CALLF | !faddr | 2 | 2 | (SP - 4)(SP - 1)(SP - 2) ← 0, PC ₁₀₋₀ (SP - 3) ← 0000 PC ₁₀₋₀ ← faddr, SP ← SP - 4 | *7 | |
| | RET | | 1 | 3 | ×, PC ₁₀₋₀ ← (SP)(SP + 3)(SP + 2) SP ← SP + 4 | | |
| | RETS | | 1 | 3 + S | ×, PC ₁₀₋₀ ← (SP)(SP + 3)(SP + 2) SP ← SP + 4, then skip unconditionally | | Unconditionally |
| | RETI | | 1 | 3 | ×, PC ₁₀₋₀ ← (SP)(SP + 3)(SP + 2) PSW ← (SP + 4)(SP + 5), SP ← SP + 6 | | |
| | PUSH | rp | 1 | 1 | (SP - 1)(SP - 2) ← rp, SP ← SP - 2 | | |
| | POP | rp | 1 | 1 | rp ← (SP + 1)(SP), SP ← SP + 2 | | |
| Interrupt control instruction | EI | | 2 | 2 | IME (IPS.3) ← 1 | | |
| | | IE _{xxx} | 2 | 2 | IE _{xxx} ← 1 | | |
| | DI | | 2 | 2 | IME (IPS.3) ← 0 | | |
| | | IE _{xxx} | 2 | 2 | IE _{xxx} ← 0 | | |
| Input/output instruction | IN | A, PORT _n | 2 | 2 | A ← PORT _n (n = 0 - 3, 5, 6) | | |
| | OUT | PORT _n , A | 2 | 2 | PORT _n ← A (n = 2, 3, 5, 6) | | |
| CPU control instruction | HALT | | 2 | 2 | Set HALT mode (PCC.2 ← 1) | | |
| | STOP | | 2 | 2 | Set STOP mode (PCC.3 ← 1) | | |
| | NOP | | 1 | 1 | No operation | | |

10. ELECTRICAL CHARACTERISTICS

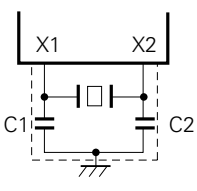
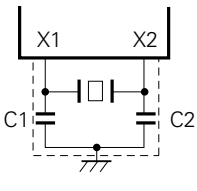
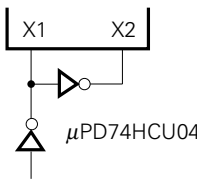
ABSOLUTE MAXIMUM RATINGS (T_a = 25 °C)

| Parameter | Symbol | Conditions | | Rated value | Unit |
|---------------------------|-----------------------------|--|---------------------------|-------------------------------|------|
| Supply voltage | V _{DD} | | | -0.3 to +7.0 | V |
| Input voltage | V _{I1} | Ports other than port 5 | | -0.3 to V _{DD} + 0.3 | V |
| | V _{I2} | Port 5 | Built-in pull-up resistor | -0.3 to V _{DD} + 0.3 | V |
| | | | Open drain | -0.3 to +11.0 | V |
| Output voltage | V _O | | | -0.3 to V _{DD} + 0.3 | V |
| High-level output current | I _{OH} | Each pin | | -15 | mA |
| | | Total of all output pins | | -30 | mA |
| Low-level output current | I _{OL} Note | One pin of port 0, 3, 5, or 6 | Peak value | 30 | mA |
| | | | rms | 15 | mA |
| | | One pin of port 2 | Peak value | 20 | mA |
| | | | rms | 10 | mA |
| | | Total of all pins of ports 0, 3, and 5 (excl. P33) | Peak value | 100 | mA |
| | | | rms | 60 | mA |
| | | Total of all pins of ports 2, 6, and P33 | Peak value | 100 | mA |
| | | | rms | 60 | mA |
| Operating temperature | T _{opt} | | | -40 to +85 | °C |
| Storage temperature | T _{stg} | | | -65 to +150 | °C |

Note Calculate rms with [rms] = [peak value] × √duty.

Caution Absolute maximum ratings are rated values beyond which some physical damages may be caused to the product; if any of the parameters in the table above exceeds its rated value even for a moment, the quality of the product may deteriorate. Be sure to use the product within the rated values.

CHARACTERISTICS OF THE OSCILLATION CIRCUIT ($T_a = -40$ to $+85$ °C, $V_{DD} = 2.7$ to 6.0 V)

| Resonator | Recommended constant | Parameter | Conditions | Min. | Typ. | Max. | Unit |
|-------------------|---|---|--|------|------|-------------------|------|
| Ceramic resonator |  | Oscillator frequency (f_{XX}) Note 1 | $V_{DD} =$ oscillation voltage range | 2.0 | | 5.0 Note 3 | MHz |
| | | Oscillation settling time Note 2 | After V_{DD} reaches MIN. of the oscillation voltage range | | | 4 | ms |
| Crystal |  | Oscillator frequency (f_{XX}) Note 1 | | 2.0 | 4.19 | 5.0 Note 3 | MHz |
| | | Oscillation settling time Note 2 | $V_{DD} = 4.5$ to 6.0 V | | | 10 | ms |
| External clock |  | X1 input frequency (f_x) Note 1 | | 2.0 | | 5.0 Note 3 | MHz |
| | | X1 input high/low level width (t_{XH} , t_{XL}) | | | 100 | | 250 |

- Notes**
- The oscillator frequency and X1 input frequency indicate only the oscillator characteristics. See the item of AC characteristics for the instruction execution time.
 - The oscillation settling time means the time required for the oscillation to settle after V_{DD} is applied or after the STOP mode is released.
 - When $4.19 \text{ MHz} < f_x \leq 5.0 \text{ MHz}$, do not select $PCC = 0011$ as the instruction execution time. When $PCC = 0011$, one machine cycle falls short of $0.95 \mu\text{s}$, the minimum value for the standard.

- ★ **Caution** When the clock oscillator is used, conform to the following guidelines when wiring at the portions surrounded by dotted lines in the figures above to eliminate the influence of the wiring capacity.
- The wiring must be as short as possible.
 - Other signal lines must not run in these areas.
 - Any line carrying a high fluctuating current must be kept away as far as possible.
 - The grounding point of the capacitor of the oscillator must have the same potential as that of V_{SS} . It must not be grounded to ground patterns carrying a large current.
 - No signal must be taken from the oscillator.

CAPACITANCE ($T_a = 25$ °C, $V_{DD} = 0$ V)

| Parameter | Symbol | Conditions | Min. | Typ. | Max. | Unit |
|--------------------|-----------|---|------|------|------|------|
| Input capacitance | C_{IN} | $f = 1 \text{ MHz}$ | | | 15 | pF |
| Output capacitance | C_{OUT} | 0 V for pins other than pins to be measured | | | 15 | pF |
| I/O capacitance | C_{IO} | | | | 15 | pF |

DC CHARACTERISTICS (T_a = -40 to +85 °C, V_{DD} = 2.7 to 6.0 V)

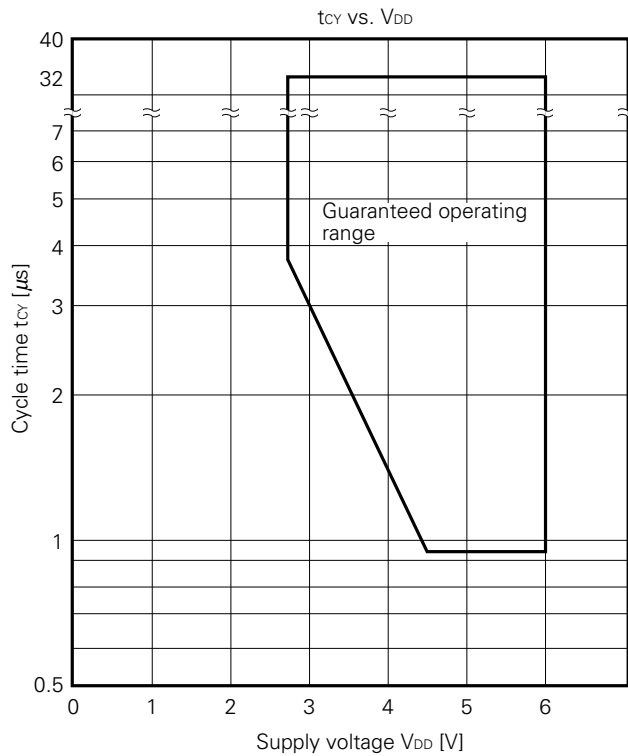
| Parameter | Symbol | Conditions | | Min. | Typ. | Max. | Unit | |
|------------------------------------|-------------------|---|--|--|---------------------|--------------------|--------------------|----|
| High-level input voltage | V _{IH1} | Ports 2, 3, and 6 | | 0.7V _{DD} | | V _{DD} | V | |
| | V _{IH2} | Ports 0 and 1, and $\overline{\text{RESET}}$ | | 0.8V _{DD} | | V _{DD} | V | |
| | V _{IH3} | Port 5 | Built-in pull-up resistor | 0.7V _{DD} | | V _{DD} | V | |
| | | | Open drain | 0.7V _{DD} | | 10 | V | |
| V _{IH4} | X1 and X2 | | V _{DD} - 0.5 | | V _{DD} | V | | |
| Low-level input voltage | V _{IL1} | Ports 2, 3, 5, and 6 | | 0 | | 0.3V _{DD} | V | |
| | V _{IL2} | Ports 0 and 1, and $\overline{\text{RESET}}$ | | 0 | | 0.2V _{DD} | V | |
| | V _{IL3} | X1 and X2 | | 0 | | 0.4 | V | |
| High-level output voltage | V _{OH} | Ports 0, 2, 3, and 6 | V _{DD} = 4.5 to 6.0 V, I _{OH} = -1 mA | V _{DD} - 1.0 | | | V | |
| | | | I _{OH} = -100 μA | V _{DD} - 0.5 | | | V | |
| Low-level output voltage | V _{OL} | Ports 3, 5, and 6 | V _{DD} = 4.5 to 6.0 V, I _{OL} = 15 mA | | 0.6 | 2.0 | V | |
| | | | Ports 0, 2, 3, 5, and 6 | V _{DD} = 4.5 to 6.0 V, I _{OL} = 1.6 mA | | | 0.4 | V |
| | | SB0 (Open drain) | Pull-up resistor : 1 kΩ or more V _{DD} = 4.5 to 6.0 V | I _{OL} = 400 μA | | | 0.5 | V |
| | | | | | | | 0.2V _{DD} | V |
| High-level input leakage current | I _{LIH1} | V _{IN} = V _{DD} | Other than X1 and X2 | | | 3 | μA | |
| | | | X1 and X2 | | | 20 | μA | |
| | I _{LIH3} | V _{IN} = 10 V | Port 5 (open drain) | | | 20 | μA | |
| Low-level input leakage current | I _{LIL1} | V _{IN} = 0 V | Other than X1 and X2 | | | - 3 | μA | |
| | | | X1 and X2 | | | - 20 | μA | |
| High-level output leakage current | I _{LOH1} | V _{OUT} = V _{DD} | Other than port 5 | | | 3 | μA | |
| | | | I _{LOH2} | V _{OUT} = 10 V | Port 5 (open drain) | | | 20 |
| Low-level output leakage current | I _{LOL} | V _{OUT} = 0 V | | | | - 3 | μA | |
| Built-in pull-up resistor | R _{L1} | Ports 0, 1, 2, 3, and 6 (excl. P00 and P10) V _{IN} = 0 V | V _{DD} = 5.0 V ± 10 % | 15 | 40 | 80 | kΩ | |
| | | | V _{DD} = 3.0 V ± 10 % | 30 | | 300 | kΩ | |
| | R _{L2} | Port 5 V _{OUT} = V _{DD} - 2.0 V | V _{DD} = 5.0 V ± 10 % | 15 | 40 | 70 | kΩ | |
| | | | V _{DD} = 3.0 V ± 10 % | 10 | | 60 | kΩ | |
| Power supply current Note 1 | I _{DD1} | 4.19 MHz crystal resonance C1 = C2 = 22 pF | V _{DD} = 5.0 V ± 10 % Note 2 | | 2.5 | 8 | mA | |
| | | | V _{DD} = 3.0 V ± 10 % Note 3 | | 0.5 | 1.5 | mA | |
| | I _{DD2} | HALT mode | V _{DD} = 5.0 V ± 10 % | | 500 | 1500 | μA | |
| | | | V _{DD} = 3.0 V ± 10 % | | 150 | 450 | μA | |
| | I _{DD3} | STOP mode | V _{DD} = 5.0 V ± 10 % | | 0.5 | 20 | μA | |
| | | | V _{DD} = 3.0 V ± 10 % | | 0.1 | 10 | μA | |
| | | | T _a = 25 °C | 0.1 | 5 | μA | | |

- Notes**
1. This current excludes the current which flows through the built-in pull-up resistors.
 2. Value when the processor clock control resistor (PCC) is set to 0011 and the μPD75402A(A) is operated in the high-speed mode
 3. Value when the PCC is set to 0000 and the μPD75402A(A) is operated in the low-speed mode

AC CHARACTERISTICS (T_a = -40 to +85 °C, V_{DD} = 2.7 to 6.0 V, V_{SS} = 0 V)

| Parameter | Symbol | Conditions | Min. | Typ. | Max. | Unit |
|--|---------------------------------------|--------------------------------|---------------|------|------|------|
| CPU clock cycle time Note 1 (minimum instruction execution time = one machine cycle) | t _{cy} | V _{DD} = 4.5 to 6.0 V | 0.95 | | 32 | μs |
| | | | 3.8 | | 32 | μs |
| Interrupt input high/low level width | t _{INTH} , t _{INTL} | INT0 | Note 2 | | | μs |
| | | INT2 | 10 | | | μs |
| RESET low-level width | t _{RSL} | | 10 | | | μs |

- Notes 1.** The cycle time of the CPU clock (Φ) (minimum instruction execution time) depends on the connected resonator frequency and the setting of the processor clock control register (PCC). The figure on the right side shows the cycle time t_{cy} characteristics for the supply voltage V_{DD}.
- 2.** This value is 2t_{cy} or 128/f_{xx} according to the setting of the interrupt mode register (IM0).



Serial transfer operation

Three-wire serial I/O mode ($\overline{\text{SCK}}$... Internal clock output):

| Parameter | Symbol | Conditions | Min. | Typ. | Max. | Unit | |
|---|-------------------|---|--------------------------------|------|------|------|----|
| $\overline{\text{SCK}}$ cycle time | t _{KCY1} | V _{DD} = 4.5 to 6.0 V | 1600 | | | ns | |
| | | | 3800 | | | ns | |
| $\overline{\text{SCK}}$ high/low level width | t _{KL1} | V _{DD} = 4.5 to 6.0 V | t _{KCY1} /2 - 50 | | | ns | |
| | t _{KH1} | | t _{KCY1} /2 - 150 | | | ns | |
| SI setup time (referred to $\overline{\text{SCK}}\uparrow$) | t _{SIK1} | | 150 | | | ns | |
| SI hold time (referred to $\overline{\text{SCK}}\uparrow$) | t _{KSI1} | | 400 | | | ns | |
| Delay from $\overline{\text{SCK}}\downarrow$ to SO output | t _{KSO1} | R _L = 1 kΩ, C _L = 100 pF Note | V _{DD} = 4.5 to 6.0 V | 0 | | 250 | ns |
| | | | | 0 | | 1000 | ns |

Note R_L and C_L are the resistance and capacitance of the SO output line load respectively.

Three-wire serial I/O mode ($\overline{\text{SCK}}$... External clock input):

| Parameter | Symbol | Conditions | Min. | Typ. | Max. | Unit | |
|---|-------------------|---|--------------------------------|------|------|------|----|
| $\overline{\text{SCK}}$ cycle time | t _{KCY2} | V _{DD} = 4.5 to 6.0 V | 800 | | | ns | |
| | | | 3200 | | | ns | |
| $\overline{\text{SCK}}$ high/low level width | t _{KL2} | V _{DD} = 4.5 to 6.0 V | 400 | | | ns | |
| | t _{KH2} | | 1600 | | | ns | |
| SI setup time (referred to $\overline{\text{SCK}}\uparrow$) | t _{SIK2} | | 100 | | | ns | |
| SI hold time (referred to $\overline{\text{SCK}}\uparrow$) | t _{KSI2} | | 400 | | | ns | |
| Delay from $\overline{\text{SCK}}\downarrow$ to SO output | t _{KSO2} | R _L = 1 kΩ, C _L = 100 pF Note | V _{DD} = 4.5 to 6.0 V | 0 | | 300 | ns |
| | | | | 0 | | 1000 | ns |

Note R_L and C_L are the resistance and capacitance of the SO output line load respectively.

SBI mode ($\overline{\text{SCK}}$... Internal clock output (master)):

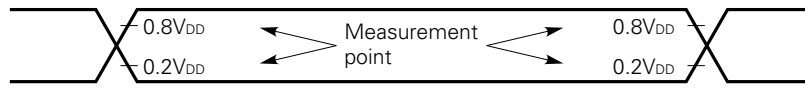
| Parameter | Symbol | Conditions | Min. | Typ. | Max. | Unit |
|--|--------------------------------------|--------------------------------|----------------------------|------|------|------|
| $\overline{\text{SCK}}$ cycle time | t _{KCY3} | V _{DD} = 4.5 to 6.0 V | 1600 | | | ns |
| | | | 3800 | | | ns |
| $\overline{\text{SCK}}$ high/low level width | t _{KL3} t _{KH3} | V _{DD} = 4.5 to 6.0 V | t _{KCY3} /2 - 50 | | | ns |
| | | | t _{KCY3} /2 - 150 | | | ns |
| SB0 setup time (referred to $\overline{\text{SCK}}\uparrow$) | t _{SIK3} | | 150 | | | ns |
| SB0 hold time (referred to $\overline{\text{SCK}}\uparrow$) | t _{KSI3} | | t _{KCY3} /2 | | | ns |
| Delay from $\overline{\text{SCK}}\downarrow$ to SB0 output | t _{KSO3} | V _{DD} = 4.5 to 6.0 V | 0 | | 250 | ns |
| | | | 0 | | 1000 | ns |
| Delay from $\overline{\text{SCK}}\uparrow$ to SB0 \downarrow | t _{KSB} | | t _{KCY3} | | | ns |
| Delay from SB0 \downarrow to $\overline{\text{SCK}}$ | t _{SBK} | | t _{KCY3} | | | ns |
| SB0 low-level width | t _{SBL} | | t _{KCY3} | | | ns |
| SB0 high-level width | t _{SBH} | | t _{KCY3} | | | ns |

SBI mode ($\overline{\text{SCK}}$... External clock input (slave)):

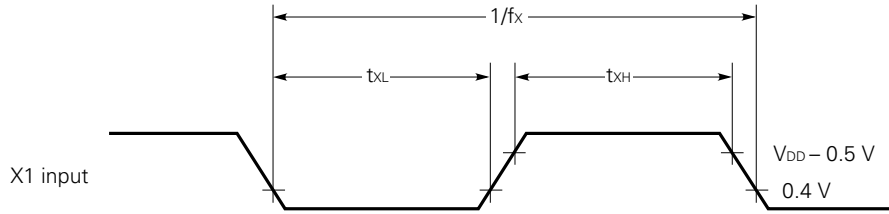
| Parameter | Symbol | Conditions | Min. | Typ. | Max. | Unit |
|--|--------------------------------------|---|--------------------------------|------|------|------|
| $\overline{\text{SCK}}$ cycle time | t _{KCY4} | V _{DD} = 4.5 to 6.0 V | 800 | | | ns |
| | | | 3200 | | | ns |
| $\overline{\text{SCK}}$ high/low level width | t _{KL4} t _{KH4} | V _{DD} = 4.5 to 6.0 V | 400 | | | ns |
| | | | 1600 | | | ns |
| SB0 setup time (referred to $\overline{\text{SCK}}\uparrow$) | t _{SIK4} | | 100 | | | ns |
| SB0 hold time (referred to $\overline{\text{SCK}}\uparrow$) | t _{KSI4} | | t _{KCY4} /2 | | | ns |
| Delay from $\overline{\text{SCK}}\downarrow$ to SB0 output | t _{KSO4} | R _L = 1 kΩ, C _L = 100 pF Note | V _{DD} = 4.5 to 6.0 V | | 300 | ns |
| | | | | 0 | | 1000 |
| Delay from $\overline{\text{SCK}}\uparrow$ to SB0 \downarrow | t _{KSB} | | t _{KCY4} | | | ns |
| Delay from SB0 \downarrow to $\overline{\text{SCK}}\downarrow$ | t _{SBK} | | t _{KCY4} | | | ns |
| SB0 low-level width | t _{SBL} | | t _{KCY4} | | | ns |
| SB0 high-level width | t _{SBH} | | t _{KCY4} | | | ns |

Note R_L and C_L are the resistance and capacitance of the SO output line load respectively.

AC Timing Measurement Points (Excluding X1 Input)

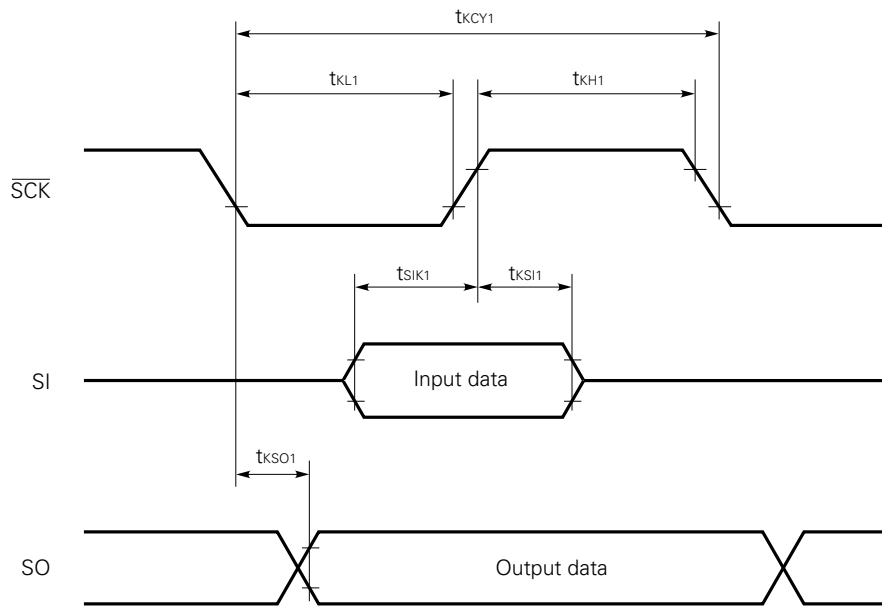


Clock Timing



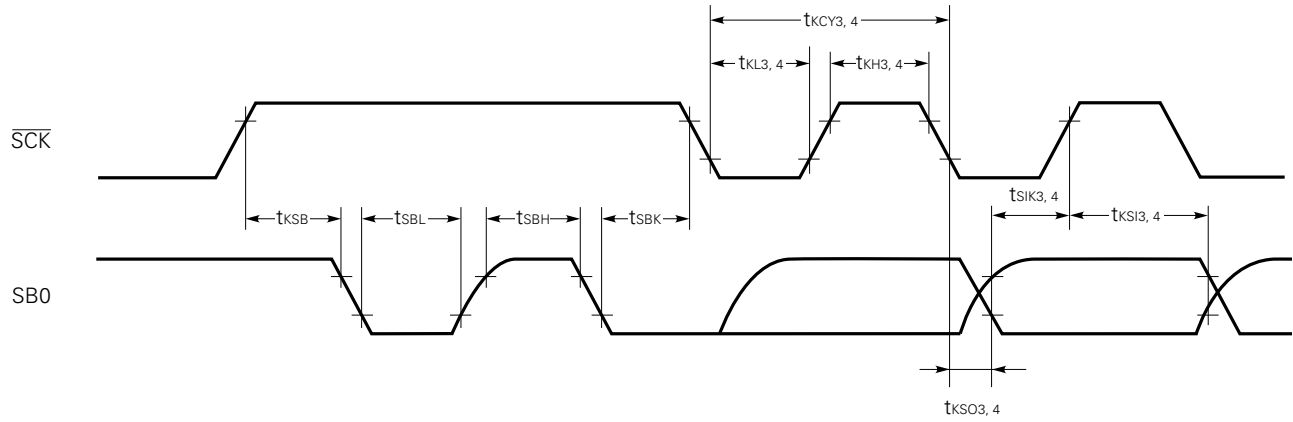
Serial Transfer Timing

Three-wire serial I/O mode:

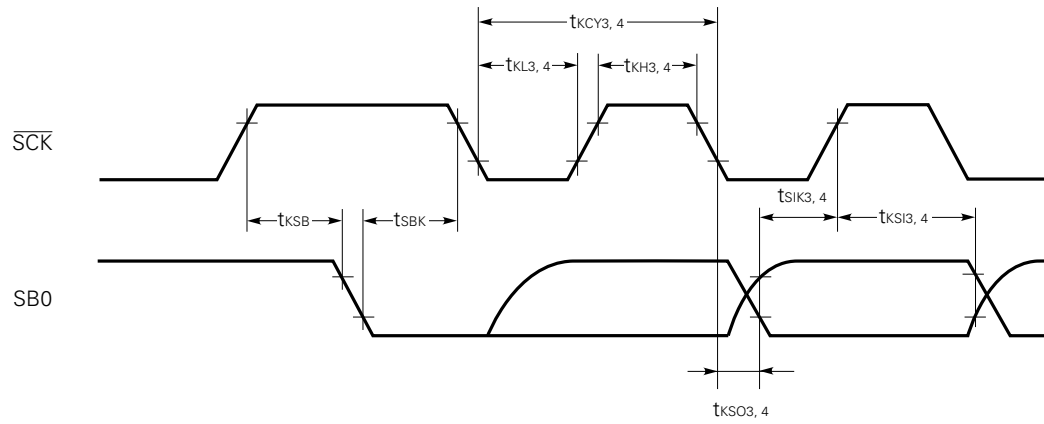


Serial Transfer Timing

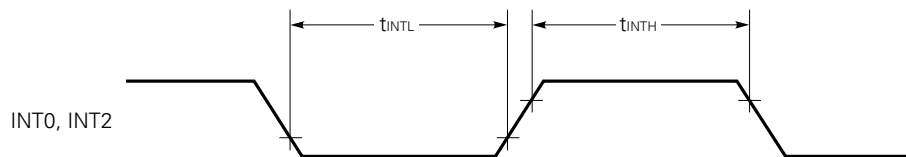
Bus release signal transfer:



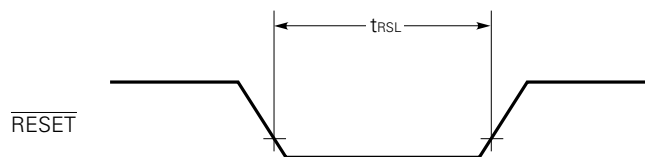
Command signal transfer:



Interrupt Input Timing



RESET Input Timing

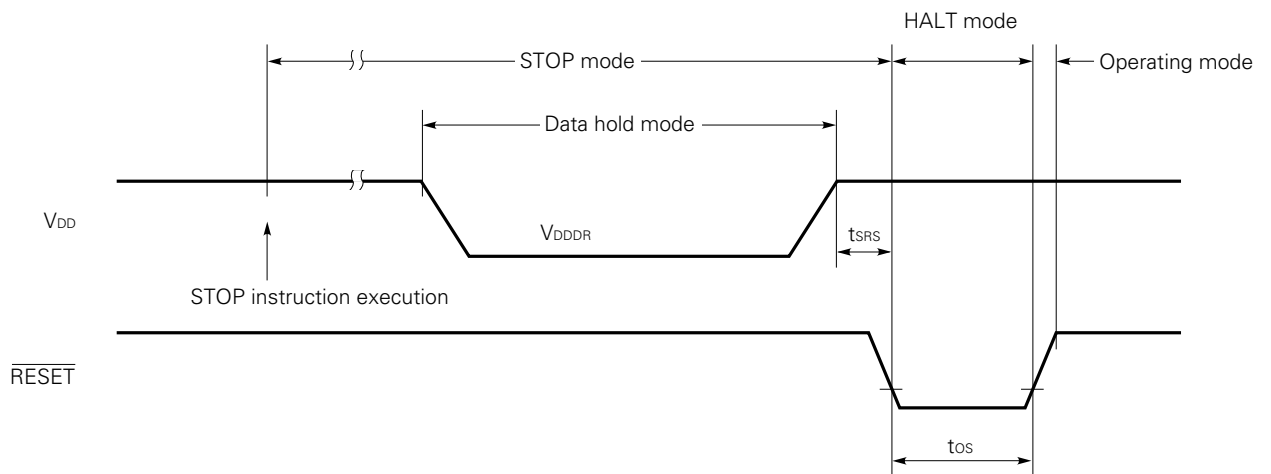


DATA HOLD CHARACTERISTICS AT LOW SUPPLY VOLTAGE IN DATA MEMORY STOP MODE

($T_a = -40$ to $+85$ °C)

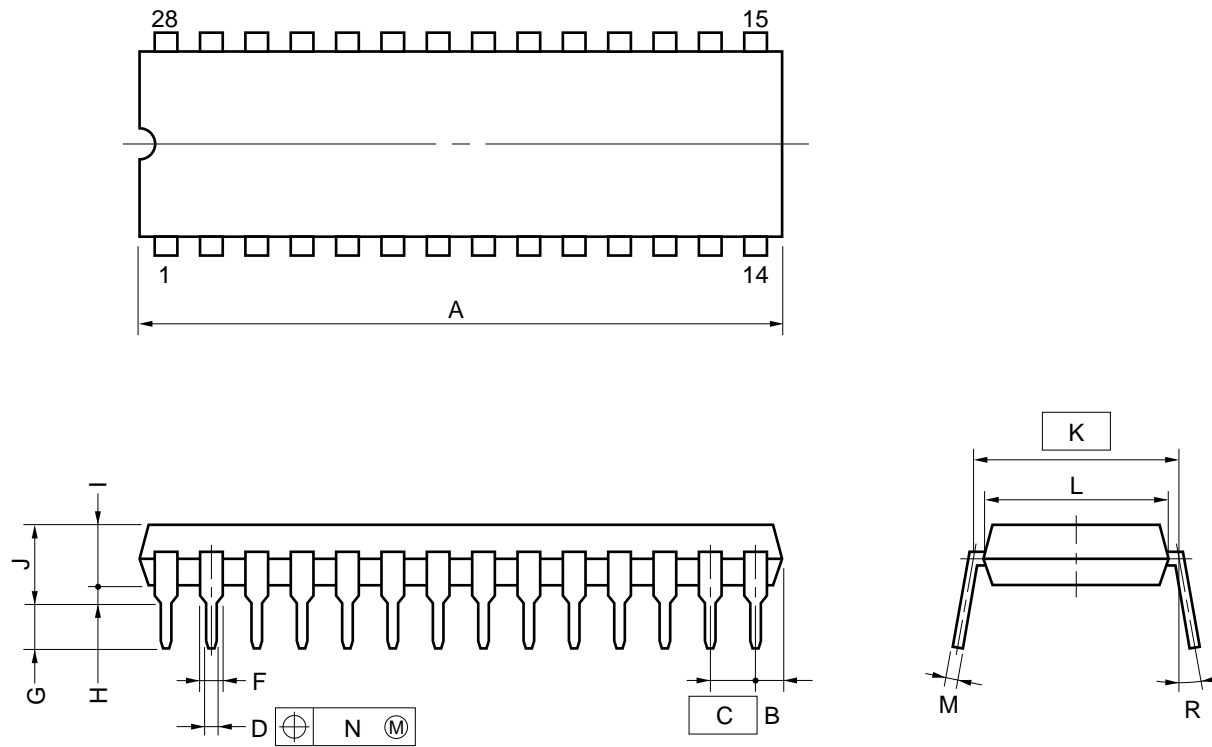
| Parameter | Symbol | Conditions | Min. | Typ. | Max. | Unit |
|---------------------------|------------|--|------|------|------|------|
| Data hold supply voltage | V_{DDDR} | | 2.0 | | 6.0 | V |
| Data hold supply current | I_{DDDR} | $V_{DDDR} = 2.0$ V | | 0.1 | 10 | μA |
| RESET setup time | t_{SRS} | | 0 | | | μs |
| Oscillation settling time | t_{OS} | After V_{DD} reaches the oscillation voltage range when the ceramic resonator is connected | | | 4 | ms |
| | | After V_{DD} reaches the oscillation voltage range when the crystal is connected | | | 10 | ms |

Data Hold Timing (STOP Mode Release by RESET)



11. PACKAGE DIMENSIONS

28 PIN PLASTIC DIP (600 mil)



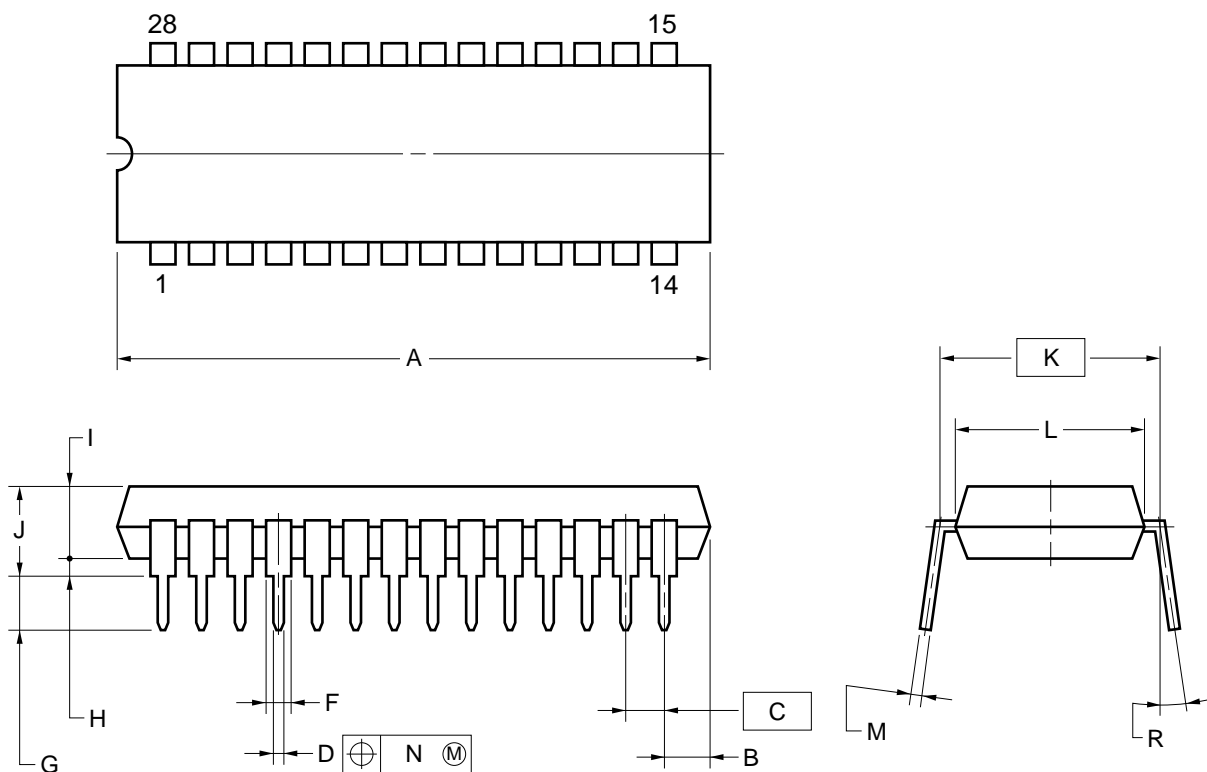
NOTES

- 1) Each lead centerline is located within 0.25 mm (0.01 inch) of its true position (T.P.) at maximum material condition.
- 2) Item "K" to center of leads when formed parallel.

| ITEM | MILLIMETERS | INCHES |
|------|--|---|
| A | 38.10 MAX. | 1.500 MAX. |
| B | 2.54 MAX. | 0.100 MAX. |
| C | 2.54 (T.P.) | 0.100 (T.P.) |
| D | 0.50±0.10 | 0.020 ^{+0.004} _{-0.005} |
| F | 1.2 MIN. | 0.047 MIN. |
| G | 3.6±0.3 | 0.142±0.012 |
| H | 0.51 MIN. | 0.020 MIN. |
| I | 4.31 MAX. | 0.170 MAX. |
| J | 5.72 MAX. | 0.226 MAX. |
| K | 15.24 (T.P.) | 0.600 (T.P.) |
| L | 13.2 | 0.520 |
| M | 0.25 ^{+0.10} _{-0.05} | 0.010 ^{+0.004} _{-0.003} |
| N | 0.25 | 0.01 |
| R | 0 °15° | 0 °15° |

P28C-100-600A1-1

28PIN PLASTIC SHRINK DIP (400 mil)



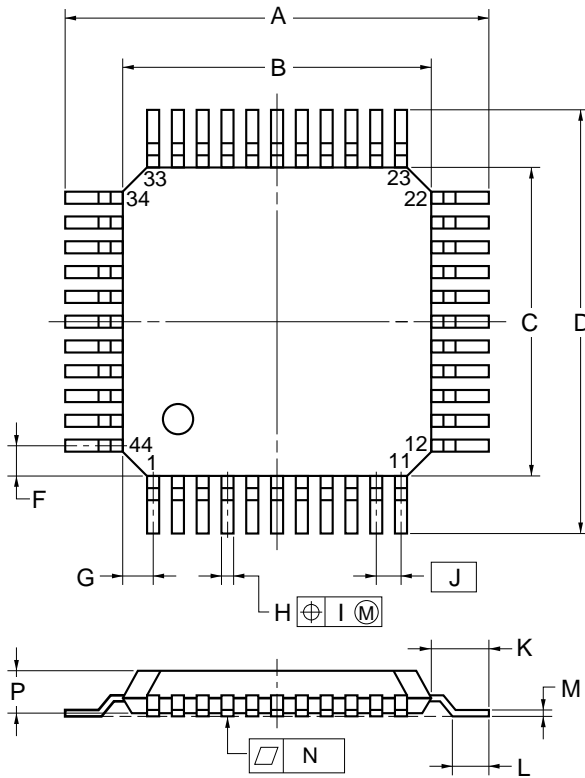
NOTES

- 1) Each lead centerline is located within 0.17 mm (0.007 inch) of its true position (T.P.) at maximum material condition.
- 2) Item "K" to center of leads when formed parallel.

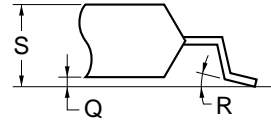
| ITEM | MILLIMETERS | INCHES |
|------|--|---|
| A | 28.46 MAX. | 1.121 MAX. |
| B | 2.67 MAX. | 0.106 MAX. |
| C | 1.778 (T.P.) | 0.070 (T.P.) |
| D | 0.50±0.10 | 0.020 ^{+0.004} _{-0.005} |
| F | 0.9 MIN. | 0.035 MIN. |
| G | 3.2±0.3 | 0.126±0.012 |
| H | 0.51 MIN. | 0.020 MIN. |
| I | 4.31 MAX. | 0.170 MAX. |
| J | 5.08 MAX. | 0.200 MAX. |
| K | 10.16 (T.P.) | 0.400 (T.P.) |
| L | 8.6 | 0.339 |
| M | 0.25 ^{+0.10} _{-0.05} | 0.010 ^{+0.004} _{-0.003} |
| N | 0.17 | 0.007 |
| R | 0~15° | 0~15° |

P28C-70-400A-1

44 PIN PLASTIC QFP (□10)



detail of lead end



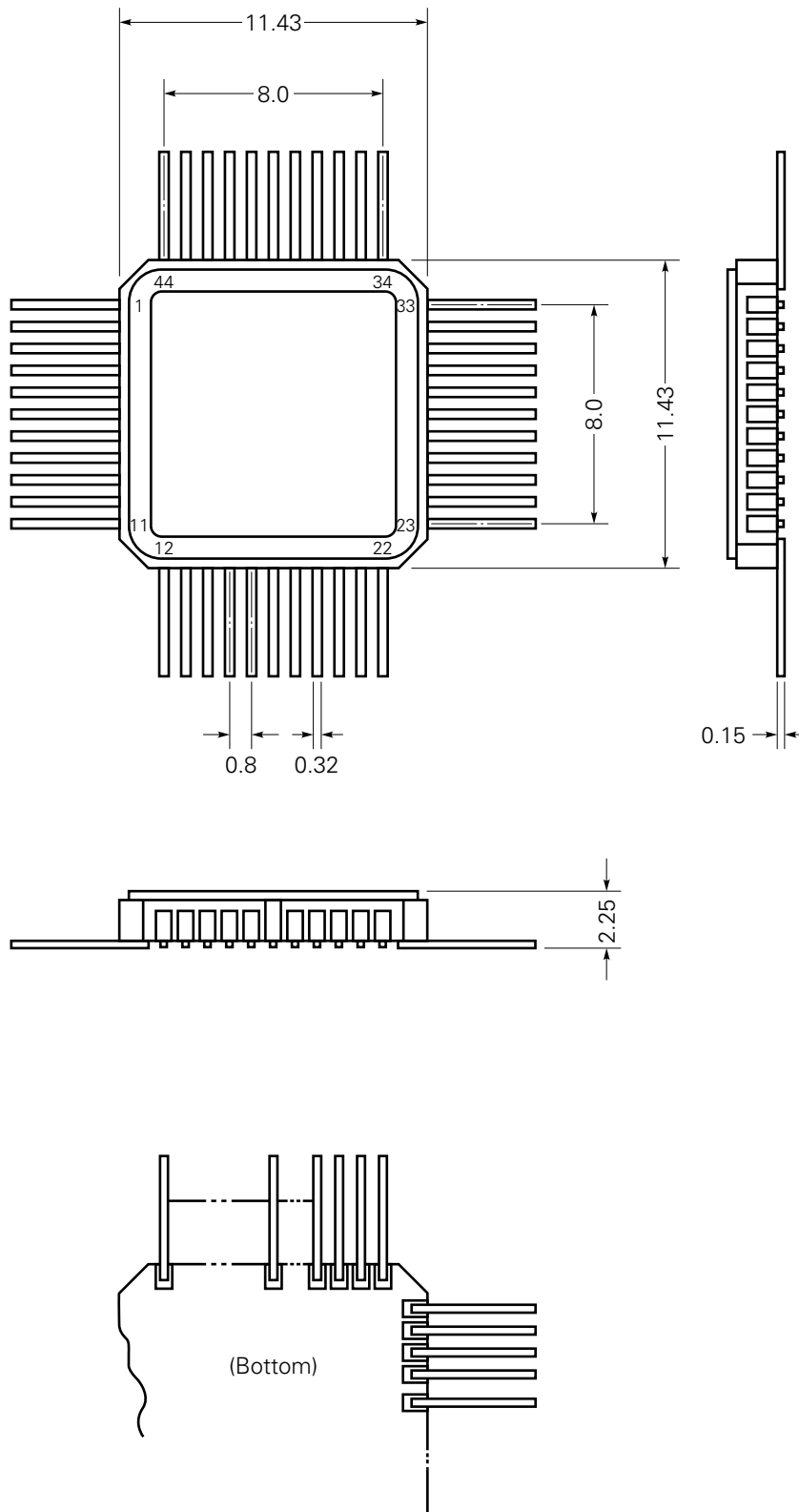
NOTE

Each lead centerline is located within 0.15 mm (0.006 inch) of its true position (T.P.) at maximum material condition.

| ITEM | MILLIMETERS | INCHES |
|------|--|---|
| A | 13.6±0.4 | 0.535 ^{+0.017} _{-0.016} |
| B | 10.0±0.2 | 0.394 ^{+0.008} _{-0.009} |
| C | 10.0±0.2 | 0.394 ^{+0.008} _{-0.009} |
| D | 13.6±0.4 | 0.535 ^{+0.017} _{-0.016} |
| F | 1.0 | 0.039 |
| G | 1.0 | 0.039 |
| H | 0.35±0.10 | 0.014 ^{+0.004} _{-0.005} |
| I | 0.15 | 0.006 |
| J | 0.8 (T.P.) | 0.031 (T.P.) |
| K | 1.8±0.2 | 0.071 ^{+0.008} _{-0.009} |
| L | 0.8±0.2 | 0.031 ^{+0.009} _{-0.008} |
| M | 0.15 ^{+0.10} _{-0.05} | 0.006 ^{+0.004} _{-0.003} |
| N | 0.10 | 0.004 |
| P | 2.7 | 0.106 |
| Q | 0.1±0.1 | 0.004±0.004 |
| R | 5°±5° | 5°±5° |
| S | 3.0 MAX. | 0.119 MAX. |

P44GB-80-3B4-3

PACKAGE DIMENSIONS OF THE 44-PIN CERAMIC QFP FOR ES (REF. DWG.) (UNIT: MM)



- Cautions**
1. Find the location of pin 1 by checking the location of pin 17, which is connected to the metal cap.
 2. The metal cap is connected to pin 17. The electrical level of the metal cap is V_{SS} (GND).
 3. The lead length has not been specified because leads are cut without any detailed specifications.

12. RECOMMENDED SOLDERING CONDITIONS

The following conditions shall be met when soldering the μPD75402A(A).

For details of the recommended soldering conditions, refer to our document "SMD Surface Mount Technology Manual" (IEI-1207).

Please consult with our sales offices in case other soldering process is used, or in case soldering is done under different conditions.

Table 12-1 Soldering Conditions for Surface-Mount Devices

μPD75402AGB(A)-xxx-3B4: 44-pin plastic QFP (10 × 10 mm)

| Soldering process | Soldering conditions | Symbol |
|------------------------|---|-----------|
| Infrared ray reflow | Peak package's surface temperature: 230 °C Reflow time: 30 seconds or less (210 °C or more) Number of reflow processes: 1 | IR30-00-1 |
| VPS | Peak package's surface temperature: 215 °C Reflow time: 40 seconds or less (200 °C or more) Number of reflow processes: 1 | VP15-00-1 |
| Wave soldering | Solder temperature: 260 °C or less Flow time: 10 seconds or less Number of flow processes: 1 Preheating temperature: 120 °C max. (measured on the package surface) | WS60-00-1 |
| Partial heating method | Terminal temperature: 300 °C or less Flow time: 3 seconds or less (for each side of device) | — |

Caution Do not apply more than a single process at once, except for "Partial heating method."

Table 12-2 Soldering Conditions for Insertion-Mount Devices

μPD75402AC(A)-xxx: 28-pin plastic DIP (600 mil)

μPD75402ACT(A)-xxx: 28-pin plastic shrink DIP (400 mil)

| Soldering process | Soldering conditions |
|------------------------------------|---|
| Wave soldering (Only for leads) | Solder temperature: 260 °C or less Flow time: 10 seconds or less |
| Partial heating method | Terminal temperature: 260 °C or less Flow time: 10 seconds or less |

Caution In wave soldering, apply solder only to the lead section. Care must be taken that jet solder does not come in contact with the main body of the package.

Notice

Other versions of the products are available. For these versions, the recommended reflow soldering conditions have been mitigated as follows:

Higher peak temperature (235 °C), two-stage, and longer exposure limit.

Contact an NEC representative for details.

APPENDIX A DIFFERENCES BETWEEN THE μPD75402A(A) AND μPD75P402

| Product | | μPD75402A(A) | | μPD75P402 | |
|--|--------------------------|--|----|---|--|
| Item | | | | | |
| ROM | | Masked ROM | | One-time PROM | |
| I/O ports | Input | 22 | 6 | 16 (Pull-up resistors can be connected by software.) | |
| | I/O | | 12 | | |
| | N-ch I/O | 4 (Pull-up resistors can be connected by mask option.) | | 4 (No pull-up resistors can be connected.) | |
| V _{PP} , PROM programming pin | | Not provided | | Provided | |
| Electrical characteristics | Operating supply voltage | 2.7 to 6.0 V | | 5 V ±10 % | |
| | Operating temperature | -40 to +85 °C | | -10 to +70 °C | |
| Quality grade | | Special | | Standard | |

APPENDIX B DEVELOPMENT TOOLS

The following development tools are provided for developing systems including the μPD75402A(A)

| | | |
|----------|--|--|
| Hardware | IE-75000-R ^{Note 1} IE-75001-R | In-circuit emulator for the 75X series |
| | IE-75000-R-EM ^{Note 2} | Emulation board for the IE-75000-R and IE-75001-R |
| | EP-75402C-R | Emulation probe for the μPD75402AC(A) and μPD75402ACT(A) |
| | EP-75402GB-R EV-9200G-44 | Emulation probe for the μPD75402AGB(A). A 44-pin conversion socket, the EV-9200G-44, is attached to the probe. |
| | PG-1500 | PROM programmer |
| | PA-75P402CT | PROM programmer adapter for the μPD75P402C and μPD75P402CT. Connected to the PG-1500. |
| | PA-75P402GB | PROM programmer adapter for the μPD75P402GB. Connected to the PG-1500. |
| Software | IE control program | Host machine <ul style="list-style-type: none"> • PC-9800 series (MS-DOS™ Ver. 3.30 to Ver. 5.00A^{Note 3}) • IBM PC/AT™ (PC DOS™ Ver. 3.1) |
| | PG-1500 controller | |
| | RA75X relocatable assembler | |

Notes 1. Maintenance service only

2. Not contained in the IE-75001-R

3. These software cannot use the task swap function, which is available in MS-DOS Ver. 5.00 and Ver. 5.00A.

Remark Refer to "75X Series Selection Guide" (IF-1027) for development tools manufactured by third parties.

APPENDIX C RELATED DOCUMENTS



Documents related to the device

| Document name | Document No. |
|----------------------------|--------------|
| User's manual | IEU-644 |
| Application note | IEA-638 |
| 75X series selection guide | IF-1027 |

Documents related to development tools

| Document name | | Document No. | |
|---------------|---------------------------------------|--------------|----------|
| Hardware | IE-75000-R/IE-75001-R User's Manual | | EEU-1416 |
| | IE-75000-R-EM User's Manual | | EEU-1294 |
| | EP-75402C-R User's Manual | | EEU-701 |
| | EP-75402GB-R User's Manual | | EEU-702 |
| | PG-1500 User's Manual | | EEU-1335 |
| Software | RA75X Assembler Package User's Manual | Operation | EEU-1346 |
| | | Language | EEU-1363 |
| | PG-1500 Controller User's Manual | | EEU-1291 |

Other related documents

| Document name | Document No. |
|---|--------------|
| Package Manual | IEI-1213 |
| SMD Surface Mount Technology Manual | IEI-1207 |
| Quality Grades on NEC Semiconductor Devices | IEI-1209 |
| NEC Semiconductor Device Reliability/Quality Control System | IEI-1203 |
| Electrostatic Discharge (ESD) Test | IEI-1201 |
| Guide to Quality Assurance for Semiconductor Devices | MEI-1202 |

Caution The above documents may be revised without notice. Use the latest versions when you design an application system.

Cautions on CMOS Devices

① **Countermeasures against static electricity for all MOSs**

Caution When handling MOS devices, take care so that they are not electrostatically charged.

Strong static electricity may cause dielectric breakdown in gates. When transporting or storing MOS devices, use conductive trays, magazine cases, shock absorbers, or metal cases that NEC uses for packaging and shipping. Be sure to ground MOS devices during assembling. Do not allow MOS devices to stand on plastic plates or do not touch pins.

Also handle boards on which MOS devices are mounted in the same way.

② **CMOS-specific handling of unused input pins**

Caution Hold CMOS devices at a fixed input level.

Unlike bipolar or NMOS devices, if a CMOS device is operated with no input, an intermediate-level input may be caused by noise. This allows current to flow in the CMOS device, resulting in a malfunction. Use a pull-up or pull-down resistor to hold a fixed input level. Since unused pins may function as output pins at unexpected times, each unused pin should be separately connected to the V_{DD} or GND pin through a resistor.

If handling of unused pins is documented, follow the instructions in the document.

③ **Statuses of all MOS devices at initialization**

Caution The initial status of a MOS device is unpredictable when power is turned on.

Since characteristics of a MOS device are determined by the amount of ions implanted in molecules, the initial status cannot be determined in the manufacture process. NEC has no responsibility for the output statuses of pins, input and output settings, and the contents of registers at power on. However, NEC assures operation after reset and items for mode setting if they are defined.

When you turn on a device having a reset function, be sure to reset the device first.

[MEMO]

[MEMO]

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Application examples recommended by NEC Corporation

Standard: Computer, Office equipment, Communication equipment, Test and Measurement equipment, Machine tools, Industrial robots, Audio and Visual equipment, Other consumer products, etc.

Special: Automotive and Transportation equipment, Traffic control systems, Antidisaster systems, Anticrime systems, etc.

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