

# Single-chip 4-bit microcontroller for CD-DA

## BU34381

The BU34381 is a 4-bit microcomputer designed for CD-DA players, and has a wide array of internal I / O components, including an 8-bit, 8-channel AD converter, pulse width counter (PWC), two serial I / O, and an LCD controller / driver capable of displaying up to 80 segments. All LCD segments are programmable for CMOS output. These I / O components allow for multifunction applications with a low number of pins.

### ●Applications

Portable CD-DA players, portable CD stereos

### ●Features

- 1) High speed operations and low voltage. ( $V_{DD}=2.7 \sim 5.5V$  at 4.4MHz)
- 2) Internal 8-bit, 8-channel AD converter.
- 3) Internal pulse width counter.
- 4) Two internal serial input / outputs.
- 5) Internal 20-segment, 4-common LCD controller / driver. (usable with 3 commons)
- 6) All segments output by the LCD controller / driver are programmable for CMOS output.

### ●Absolute maximum ratings ( $T_a = 25^\circ C$ )

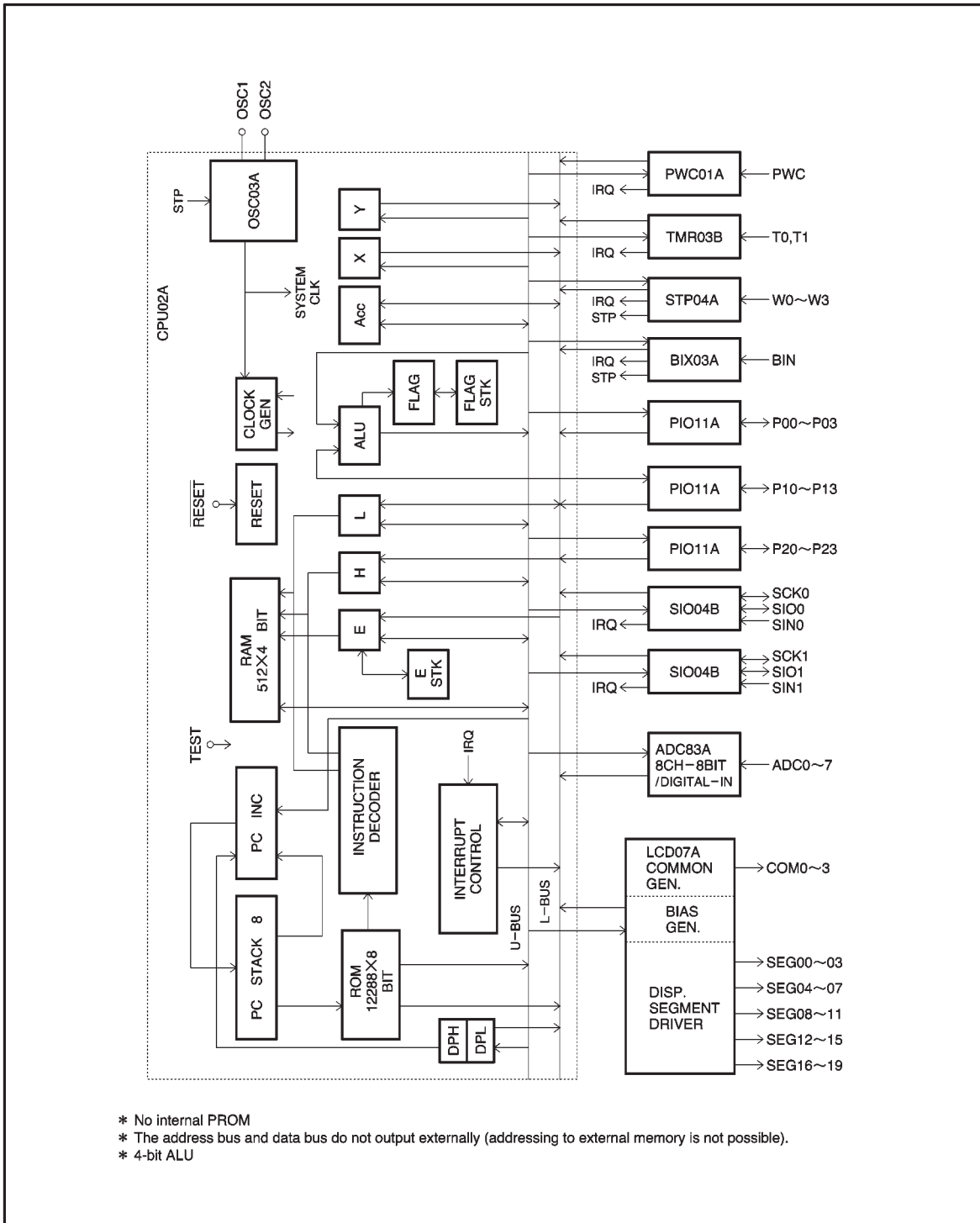
| Parameter             | Symbol    | Limits           | Unit       |
|-----------------------|-----------|------------------|------------|
| Applied voltage       | $V_{DD}$  | $-0.3 \sim +7.0$ | V          |
| Power dissipation     | $P_d$     | 500*             | mW         |
| Operating temperature | $T_{opr}$ | $-25 \sim +75$   | $^\circ C$ |
| Storage temperature   | $T_{stg}$ | $-55 \sim +125$  | $^\circ C$ |

\* Reduced by 5.0 mW for each increase in  $T_a$  of  $1^\circ C$  over  $25^\circ C$ .

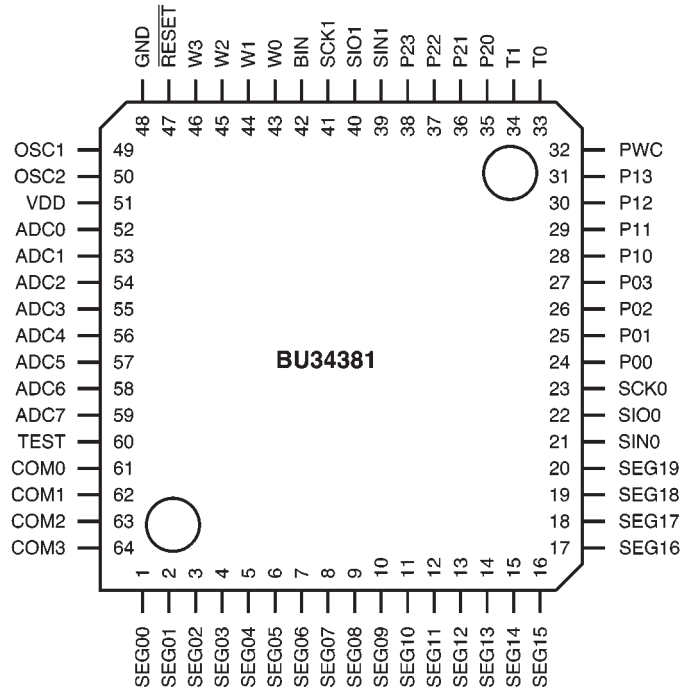
### ●Recommended operating conditions ( $T_a = 25^\circ C$ )

| Parameter                                     | Symbol    | Min.         | Typ. | Max.         | Unit |
|---|-----------|--------------|------|--------------|------|
| Power supply voltage                          | $V_{DD}$  | 2.7          | —    | 5.5          | V    |
| Input high level voltage (without hysteresis) | $V_{IH}$  | $0.7V_{DD}$  | —    | $V_{DD}$     | V    |
| Input low level voltage (without hysteresis)  | $V_{IL}$  | 0            | —    | $0.3V_{DD}$  | V    |
| Input high level voltage (with hysteresis)    | $V_{IHS}$ | $0.75V_{DD}$ | —    | $V_{DD}$     | V    |
| Input low level voltage (with hysteresis)     | $V_{ILS}$ | 0            | —    | $0.25V_{DD}$ | V    |

● Block diagram



● Pin assignments



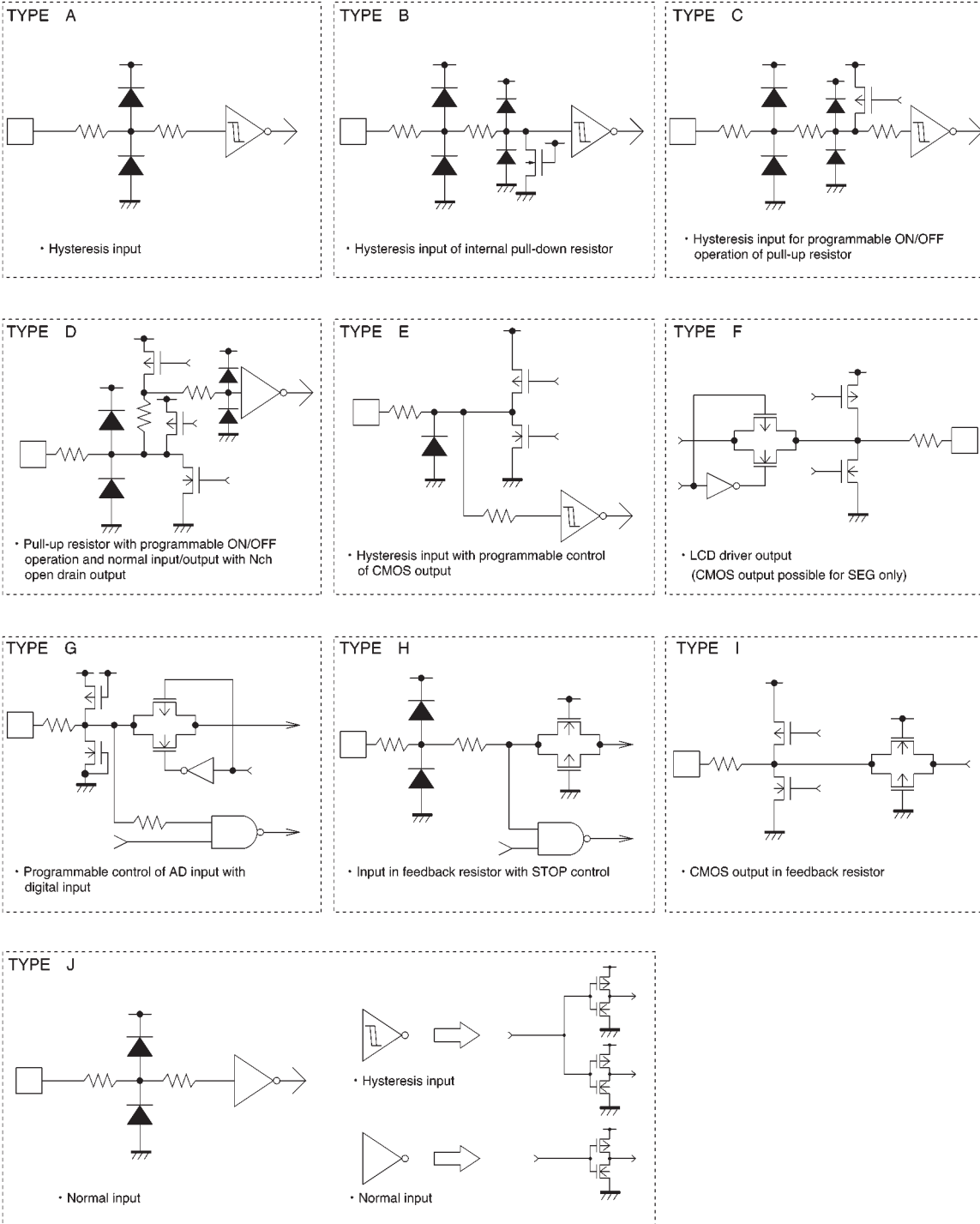
● Pin descriptions

| Pin No.                 | Pin name  | I / O | Function   | Type |
|-------------------------|---|-------|--|------|
| 24~27<br>28~31<br>35~38 | P00~P03<br>P10~P13<br>P20~P23<br>(PI011A block) | I / O | <ul style="list-style-type: none"> <li>• 4-bit input and output</li> <li>• Each bit is programmable for input or output (open drain output N-channel)</li> <li>• Pull-up resistor ON/OFF operation is programmable (each bit can be set separately).</li> <li>• Resetting turns the pull-up resistors off via input. *1</li> </ul>               | D    |
| 43~46                   | W0~W3<br>(STP04A block)                         | I     | <ul style="list-style-type: none"> <li>• Standard 4-bit input</li> <li>• Programmable for stop cancel input or interrupt request signal output (each bit can be set separately).</li> <li>• Pull-up resistor ON/OFF operation is programmable (each bit can be set separately).</li> <li>• Resetting turns the pull-up resistors off.</li> </ul> | C    |
| 42                      | BIN<br>(BIX03A block)                           | I     | <ul style="list-style-type: none"> <li>• Standard 1-bit input</li> <li>• Programmable for stop cancel input or interrupt request signal output.</li> <li>• Pull-up resistor ON/OFF operation is programmable.</li> <li>• Resetting turns the pull-up resistors off.</li> </ul>   | C    |

\*1 Because these pins reach high impedance immediately after resetting, some applications may require pin processing.

| Pin No.                              | Pin name   | I/O | Function  | Type |
|--------------------------------------|--|-----|---|------|
| 21, 39                               | SIN0, SIN1   | I   | • 8-bit serial data input   | A    |
| 22, 40                               | SIO0, SIO1   | I/O | • 8-bit serial data input/output<br>• Programmable for input or output  | E    |
| 23, 41                               | SCK0, SCK1<br>(SIO04B block)                             | I/O | • Clock input/output for serial data transmission and reception<br>• Programmable selection from among 3 internal clocks and 1 external clock                               | E    |
| 52~59                                | ADC0~ADC7<br>(ADC83A block)                              | I   | • Analog data input<br>• Each bit programmable for digital data input<br>• Resetting returns all pins to analog input.  | G    |
| 1~4<br>5~8<br>9~12<br>13~16<br>17~20 | SEG00~03<br>SEG04~07<br>SEG08~11<br>SEG12~15<br>SEG16~19 | O   | • Programmable for LCD segment output or CMOS small-current output (set in 4-pin groups)<br>• Resetting returns all pins to CMOS small-current output (LOW polarity output) | F    |
| 61~64                                | COM0~COM3<br>(LCD07A block)                              | O   | • LCD common output<br>• During 1/3 duty, COM3 outputs the ground level   | F    |
| 32                                   | PWC<br>(PWC01A block)                                    | I   | • Pulse input   | A    |
| 33, 34                               | T0, T1<br>(TMR03B block)                                 | I   | • External count clock input<br>• Usable for 1-bit input  | J    |
| 49                                   | OSC1   | I   | • Oscillator input<br>• External clock input  | H    |
| 50                                   | OSC2<br>(OSC03A block)                                   | O   | • Oscillator output   | I    |
| 60                                   | TEST   | I   | • Test input (This is a chip test pin that contains an internal pull-down resistor and so should normally remain open.)   | B    |
| 47                                   | $\overline{\text{RESET}}$                                | I   | • Reset input (Setting this pin to LOW resets the CPU.)   | A    |
| 51                                   | V <sub>DD</sub>  | —   | • Power supply  | —    |
| 48                                   | GND  | —   | • Ground  | —    |

● Input / output circuits



●Electrical characteristics (at 5V) (unless otherwise noted, Ta = 25°C, V<sub>DD</sub> = 5V)

| Parameter                   | Symbol            | Pin   | Min. | Typ. | Max. | Unit | Conditions  |
|-----------------------------|-------------------|---|------|------|------|------|---|
| STOP circuit current        | I <sub>DDST</sub> |   | —    | —    | 1    | μA   | • STOP mode   |
| HALT circuit current        | I <sub>DDHT</sub> |   | —    | 1    | —    | mA   | • HALT mode<br>• f <sub>osc</sub> = 4.4MHz  |
| Operating supply current    | I <sub>DDOP</sub> |   | —    | 4    | —    | mA   | • f <sub>osc</sub> = 4.4MHz   |
| Clock frequency             | f <sub>osc</sub>  | OSC1, OSC2  | 2    | —    | 4.4  | MHz  |   |
| Input high level voltage 1  | V <sub>IH1</sub>  | P00~P03, P10~P13,<br>P20~P23, T0, T1,<br>ADC0~ADC7  | 3.5  | —    | —    | V    | • P = input<br>• ADC = digital input  |
| Input high level voltage 2  | V <sub>IH2</sub>  | W0~W3, BIN, SIO0,<br>SIO1, SIO0, SIO1,<br>SCK0, SCK1, PWC, TEST,<br>RESET   | 3.75 | —    | —    | V    | • Hysteresis input<br>• SIO, SCK = input  |
| Input high level voltage 3  | V <sub>IH3</sub>  | OSC1  | 3.9  | —    | —    | V    | • External clock input  |
| Input low level voltage 1   | V <sub>IL1</sub>  | P00~P03, P10~P13,<br>P20~P23, T0, T1,<br>ADC0~ADC7  | —    | —    | 1.5  | V    | • P = input<br>• ADC = digital input  |
| Input low level voltage 2   | V <sub>IL2</sub>  | W0~W3, BIN, SIO0,<br>SIO1, SIO0, SIO1,<br>SCK0, SCK1, PWC, TEST,<br>RESET   | —    | —    | 1.25 | V    | • Hysteresis input<br>• SIO, SCK = input  |
| Input low level voltage 3   | V <sub>IL3</sub>  | OSC1  | —    | —    | 1.1  | V    | • External clock input  |
| Input high level current 1  | I <sub>IH1</sub>  | P00~P03, P10~P13,<br>P20~P23, W0~W3,<br>BIN, SIO0, SIO1, SIO0,<br>SIO1, SCK0, SCK1,<br>ADC0~ADC7, PWC, T0,<br>T1, RESET       | —    | —    | 1    | μA   | • No pull-down resistor<br>• P, SIO, SCK = input<br>• V <sub>IN</sub> = V <sub>DD</sub> |
| Input high level current 2  | I <sub>IH2</sub>  | TEST  | 35   | 70   | 140  | μA   | • Internal pull-down resistor<br>• V <sub>IN</sub> = V <sub>DD</sub>                    |
| Input low level current 1   | I <sub>IL1</sub>  | P00~P03, P10~P13,<br>P20~P23, W0~W3,<br>BIN, SIO0, SIO1, SIO0,<br>SIO1, SCK0, SCK1,<br>ADC0~ADC7, PWC, T0,<br>T1, RESET, TEST | —    | —    | -1   | μA   | • No pull-down resistor<br>• P, SIO, SCK = input<br>• V <sub>IN</sub> = GND             |
| Input low level current 2   | I <sub>IL2</sub>  | P00~P03, P10~P13,<br>P20~P23, W0~W3,<br>BIN   | -90  | -125 | -160 | μA   | • Internal pull-down resistor<br>• V <sub>IN</sub> = GND                                |
| Output high level voltage 1 | V <sub>OH1</sub>  | SIO0, SIO1, SCK0,<br>SCK1   | 4.5  | —    | —    | V    | • SIO, SCK = output<br>• I <sub>OH</sub> = -500 μA                                      |
| Output high level voltage 2 | V <sub>OH2</sub>  | SEG00~SEG19,<br>COM0~COM3   | 4.5  | —    | —    | V    | • I <sub>OH</sub> = -250 μA   |
| Output low level voltage 1  | V <sub>OL1</sub>  | P00~P03, P10~P13,<br>P20~P23, SIO0, SIO1,<br>SCK0, SCK1   | —    | —    | 0.4  | V    | • P, SIO, SCK = output<br>• I <sub>OL</sub> = 1.6mA                                     |
| Output low level voltage 2  | V <sub>OL2</sub>  | SEG00~SEG19,<br>COM0~COM3   | —    | —    | 0.7  | V    | • I <sub>OL</sub> = 1.0mA   |
| Output leakage current      | I <sub>L</sub>    | P00~P03, P10~P13,<br>P20~P23  | —    | —    | 1    | μA   | • P = high impedance output   |
| OSC feedback current        | I <sub>FO</sub>   | OSC1, OSC2  | -4.0 | -10  | -14  | μA   | • Approx. 500 kΩ  |

| Parameter                      | Symbol         | Pin                      | Min. | Typ. | Max. | Unit | Conditions             |
|--------------------------------|----------------|--------------------------|------|------|------|------|------------------------|
| A/D conversion resolution      | RES            | ADC0~ADC7                | —    | 8    | —    | bits |                        |
| A/D conversion settling time   | ts             | ADC0~ADC7                | —    | 25   | —    | MC   | MC: machine cycle<br>* |
| A/D conversion linearity error | EL             | ADC0~ADC7                | —    | —    | ±3   | LSB  |                        |
| LCD 2 / 3 level output voltage | V <sub>1</sub> | COM0~COM3<br>SEG00~SEG19 | —    | 2    | —    | V    |                        |
| LCD 2 / 3 level output voltage | V <sub>2</sub> | COM0~COM3<br>SEG00~SEG19 | —    | 1    | —    | V    |                        |

\* 1 machine cycle = 1/6 oscillation frequency

●Electrical characteristics (at 3V) (unless otherwise noted, Ta = 25°C, V<sub>DD</sub> = 3V)

| Parameter                   | Symbol            | Pin   | Min. | Typ. | Max. | Unit | Conditions  |
|-----------------------------|-------------------|---|------|------|------|------|---|
| STOP circuit current        | I <sub>DDST</sub> |   | —    | —    | 1    | μA   | • STOP mode   |
| HALT circuit current        | I <sub>DDHT</sub> |   | —    | 0.4  | —    | mA   | • HALT mode<br>• f <sub>osc</sub> = 4.4MHz  |
| Operating supply current    | I <sub>DDOP</sub> |   | —    | 1.5  | —    | mA   | • f <sub>osc</sub> = 4.4MHz   |
| Clock frequency             | f <sub>osc</sub>  | OSC1, OSC2  | 2    | —    | 4.4  | MHz  |   |
| Input high level voltage 1  | V <sub>IH1</sub>  | P00~P03, P10~P13,<br>P20~P23, T0, T1,<br>ADC0~ADC7  | 2.1  | —    | —    | V    | • P = input<br>• ADC = digital input  |
| Input high level voltage 2  | V <sub>IH2</sub>  | W0~W3, BIN, SIN0,<br>SIN1, SIO0, SIO1,<br>SCK0, SCK1, PWC, TEST,<br>RESET   | 2.25 | —    | —    | V    | • Hysteresis input<br>• SIO, SCK = input  |
| Input high level voltage 3  | V <sub>IH3</sub>  | OSC1  | 2.4  | —    | —    | V    | • External clock input  |
| Input low level voltage 1   | V <sub>IL1</sub>  | P00~P03, P10~P13,<br>P20~P23, T0, T1,<br>ADC0~ADC7  | —    | —    | 0.9  | V    | • P = input<br>• ADC = digital input  |
| Input low level voltage 2   | V <sub>IL2</sub>  | W0~W3, BIN, SIN0,<br>SIN1, SIO0, SIO1,<br>SCK0, SCK1, PWC, TEST,<br>RESET   | —    | —    | 0.75 | V    | • Hysteresis input<br>• SIO, SCK = input  |
| Input low level voltage 3   | V <sub>IL3</sub>  | OSC1  | —    | —    | 0.65 | V    | • External clock input  |
| Input high level current 1  | I <sub>IH1</sub>  | P00~P03, P10~P13,<br>P20~P23, W0~W3,<br>BIN, SIN0, SIN1, SIO0<br>SIO1, SCK0, SCK1,<br>ADC0~ADC7, PWC, T0<br>T1, RESET       | —    | —    | 1    | μA   | • No pull-down resistor<br>• P, SIO, SCK = input<br>• V <sub>IN</sub> = V <sub>DD</sub> |
| Input high level current 2  | I <sub>IH2</sub>  | TEST  | 10   | 20   | 35   | μA   | • Internal pull-down resistor<br>• V <sub>IN</sub> = V <sub>DD</sub>                    |
| Input low level current 1   | I <sub>IL1</sub>  | P00~P03, P10~P13,<br>P20~P23, W0~W3,<br>BIN, SIN0, SIN1, SIO0<br>SIO1, SCK0, SCK1,<br>ADC0~ADC7, PWC, T0<br>T1, RESET, TEST | —    | —    | —1   | μA   | • No pull-down resistor<br>• P, SIO, SCK = input<br>• V <sub>IN</sub> = GND             |
| Input low level current 2   | I <sub>IL2</sub>  | P00~P03, P10~P13,<br>P20~P23, W0~W3,<br>BIN   | —20  | —40  | —60  | μA   | • Internal pull-up resistor<br>• V <sub>IN</sub> = GND                                  |
| Output high level voltage 1 | V <sub>OH1</sub>  | SIO0, SIO1, SCK0,<br>SCK1   | 2.5  | —    | —    | V    | • SIO, SCK = output<br>• I <sub>OH</sub> = —500 μA                                      |
| Output high level voltage 2 | V <sub>OH2</sub>  | SEG00~SEG19,<br>COM0~COM3   | 2.5  | —    | —    | V    | • I <sub>OH</sub> = —250 μA   |
| Output low level voltage 1  | V <sub>OL1</sub>  | P00~P03, P10~P13,<br>P20~P23, SIO0, SIO1,<br>SCK0, SCK1   | —    | —    | 0.6  | V    | • P, SIO, SCK = output<br>• I <sub>OL</sub> = 1.6mA                                     |
| Output low level voltage 2  | V <sub>OL2</sub>  | SEG00~SEG19,<br>COM0~COM3   | —    | —    | 0.7  | V    | • I <sub>OL</sub> = 0.8mA   |
| Output leakage current      | I <sub>L</sub>    | P00~P03, P10~P13,<br>P20~P23  | —    | —    | 1    | μA   | • P = high-impedance output   |
| OSC feedback current        | I <sub>FO</sub>   | OSC1, OSC2  | —1.5 | —3   | —5   | μA   | • Approx. 1 MΩ  |



| Parameter                      | Symbol         | Pin                      | Min. | Typ. | Max. | Unit | Conditions             |
|--------------------------------|----------------|--------------------------|------|------|------|------|------------------------|
| A/D conversion resolution      | RES            | ADC0~ADC7                | —    | 8    | —    | bits |                        |
| A/D conversion settling time   | ts             | ADC0~ADC7                | —    | 25   | —    | MC   | MC: machine cycle<br>* |
| A/D conversion linearity error | EL             | ADC0~ADC7                | —    | —    | ±3   | LSB  |                        |
| LCD 2 / 3 level output voltage | V <sub>1</sub> | COM0~COM3<br>SEG00~SEG19 | —    | 2    | —    | V    |                        |
| LCD 2 / 3 level output voltage | V <sub>2</sub> | COM0~COM3<br>SEG00~SEG19 | —    | 1    | —    | V    |                        |

\* 1 machine cycle = 1/6 oscillation frequency

#### ● Hardware descriptions

- (1) Operates on a single power supply ( $V_{DD} = 2.7 \sim 5.5V$ )
- (2) Memory size
  - ROM : 12288 × 8 bits
  - RAM : 512 × 4 bits
  - LCD display RAM: 20 × 4 bits
- (3) Instruction execution time (1 cycle instruction)  
1.5μsec: (at 4MHz)
- (4) Subroutine nesting : 8 levels
- (5) Interrupts : 6 factors
  - External : 3 factors
  - Internal (time counter, serial I / O) : 3 factors
- (6) ROM data table function (data table area: 12KB)
- (7) Two energy-saving modes (STOP / HALT)
- (8) Internal 20-segment LCD driver adaptable for various types of displays
  - Bias : 1 / 3
  - Duty settings : 1 / 3, 1 / 4 (programmable)
  - Internal bias resistor (3 stages, approx. 50kΩ)
- (9) LCD segment output is program-switchable to CMOS output
  - All 20 segments can be selected in 4-bit groups
  - Resetting: CMOS small-current output port, LOW polarity
- (10) Internal remote control receiver (pulse width counter)
- (11) Internal 8-channel, 8-bit A / D converter
- (12) A / D input is programmable in 1-bit units as digital input
- (13) Internal 8-bit timer counter (also used as event counter)
- (14) Two internal serial input / outputs (LSB fast) that simplify interface with external LSI chips
- (15) 12 input / outputs (programmable pull-up)
- (16) 5 inputs (programmable pull-up)

● External dimensions (Units: mm)

