

# 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 ( $T_a = 25^\circ C$ )

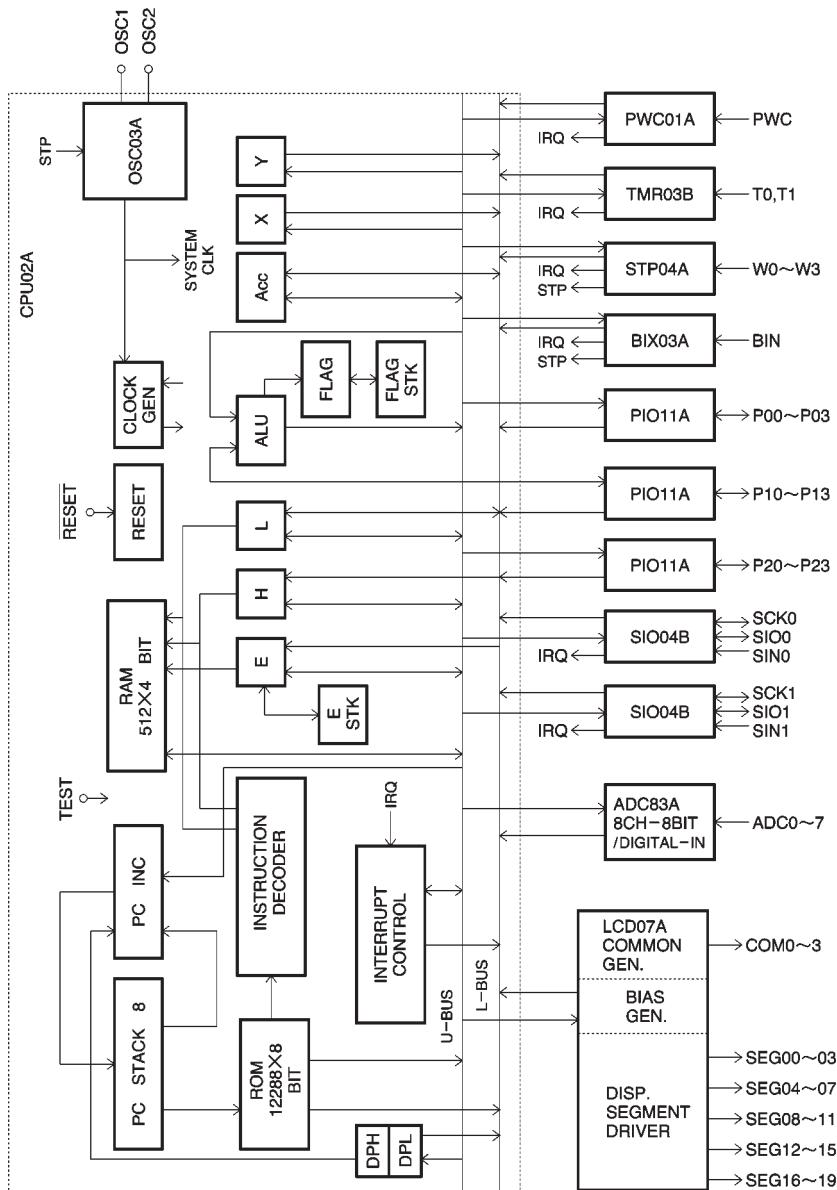
Parameter	Symbol	Limits	Unit
Applied voltage	$V_{DD}$	$-0.3 \sim +7.0$	V
Power dissipation	$P_d$	500 *	mW
Operating temperature	$T_{opr}$	$-25 \sim +75$	°C
Storage temperature	$T_{stg}$	$-55 \sim +125$	°C

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

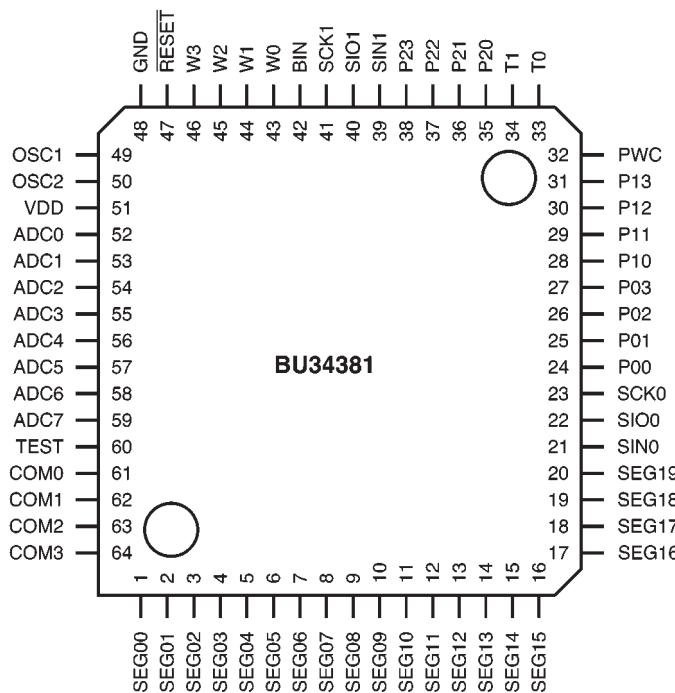


\* No internal PROM

\* The address bus and data bus do not output externally (addressing to external memory is not possible).

\* 4-bit ALU

## ● Pin assignments



## ● Pin descriptions

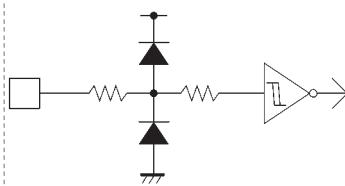
Pin No.	Pin name	I/O	Function	Type
24~27 28~31 35~38	P00~P03 P10~P13 P20~P23 (PI011A block)	I/O	<ul style="list-style-type: none"> <li>• 4-bit input and output</li> <li>• Each bit is programmable for input or output (open drain output N-channel)</li> <li>• Pull-up resistor ON/OFF operation is programmable (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 (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 (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 • Programmable for input or output	E
23, 41	SCK0, SCK1 (SIO04B block)	I / O	• Clock input/output for serial data transmission and reception • Programmable selection from among 3 internal clocks and 1 external clock	E
52~59	ADC0~ADC7 (ADC83A block)	I	• Analog data input • Each bit programmable for digital data input • Resetting returns all pins to analog input.	G
1~4 5~8 9~12 13~16 17~20	SEG00~03 SEG04~07 SEG08~11 SEG12~15 SEG16~19	O	• Programmable for LCD segment output or CMOS small-current output (set in 4-pin groups) • Resetting returns all pins to CMOS small-current output (LOW polarity output)	F
61~64	COM0~COM3 (LCD07A block)	O	• LCD common output • During 1/3 duty, COM3 outputs the ground level	F
32	PWC (PWC01A block)	I	• Pulse input	A
33, 34	T0, T1 (TMR03B block)	I	• External count clock input • Usable for 1-bit input	J
49	OSC1	I	• Oscillator input • External clock input	H
50	OSC2 (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	RESET	I	• Reset input (Setting this pin to LOW resets the CPU.)	A
51	V <sub>DD</sub>	—	• Power supply	—
48	GND	—	• Ground	—

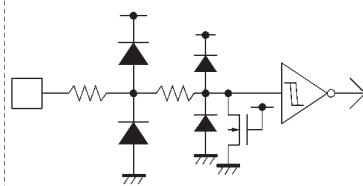
## ● Input / output circuits

TYPE A



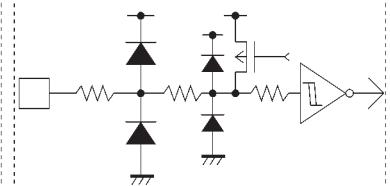
• Hysteresis input

TYPE B



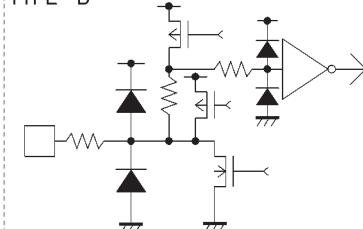
• Hysteresis input of internal pull-down resistor

TYPE C



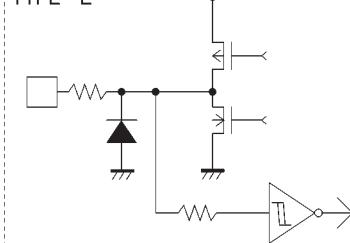
• Hysteresis input for programmable ON/OFF operation of pull-up resistor

TYPE D



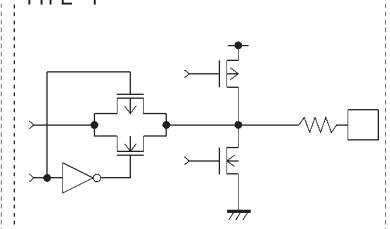
• Pull-up resistor with programmable ON/OFF operation and normal input/output with Nch open drain output

TYPE E



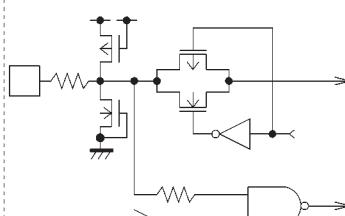
• Hysteresis input with programmable control of CMOS output

TYPE F



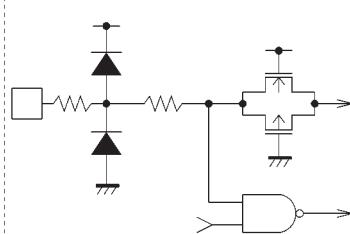
• LCD driver output (CMOS output possible for SEG only)

TYPE G



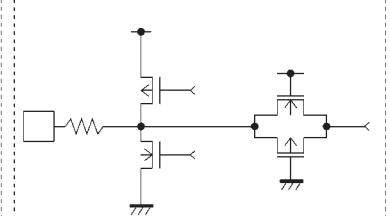
• Programmable control of AD input with digital input

TYPE H



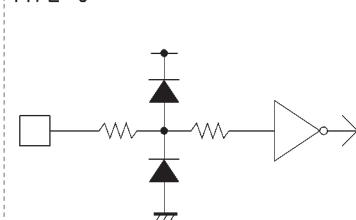
• Input in feedback resistor with STOP control

TYPE I

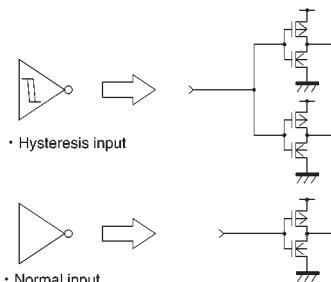


• CMOS output in feedback resistor

TYPE J



• Normal input



● Electrical characteristics (at 5V) (unless otherwise noted,  $T_a = 25^\circ\text{C}$ ,  $V_{DD} = 5\text{V}$ )

Parameter	Symbol	Pin	Min.	Typ.	Max.	Unit	Conditions
STOP circuit current	$I_{DDST}$		—	—	1	$\mu\text{A}$	• STOP mode
HALT circuit current	$I_{DDHT}$		—	1	—	mA	• HALT mode • $f_{osc} = 4.4\text{MHz}$
Operating supply current	$I_{DDOP}$		—	4	—	mA	• $f_{osc} = 4.4\text{MHz}$
Clock frequency	$f_{osc}$	OSC1, OSC2	2	—	4.4	MHz	
Input high level voltage 1	$V_{IH1}$	P00~P03, P10~P13, P20~P23, T0, T1, ADC0~ADC7	3.5	—	—	V	• $P = \text{input}$ • ADC = digital input
Input high level voltage 2	$V_{IH2}$	W0~W3, BIN, S1N0, S1N1, S1O0, S1O1, SCK0, SCK1, PWC, TEST, RESET	3.75	—	—	V	• Hysteresis input • S1O, SCK = input
Input high level voltage 3	$V_{IH3}$	OSC1	3.9	—	—	V	• External clock input
Input low level voltage 1	$V_{IL1}$	P00~P03, P10~P13, P20~P23, T0, T1, ADC0~ADC7	—	—	1.5	V	• $P = \text{input}$ • ADC = digital input
Input low level voltage 2	$V_{IL2}$	W0~W3, BIN, S1N0, S1N1, S1O0, S1O1, SCK0, SCK1, PWC, TEST, RESET	—	—	1.25	V	• Hysteresis input • S1O, SCK = input
Input low level voltage 3	$V_{IL3}$	OSC1	—	—	1.1	V	• External clock input
Input high level current 1	$I_{IH1}$	P00~P03, P10~P13, P20~P23, W0~W3, BIN, S1N0, S1N1, S1O0, S1O1, SCK0, SCK1, ADC0~ADC7, PWC, T0, T1, RESET	—	—	1	$\mu\text{A}$	• No pull-down resistor • P, S1O, SCK = input • $V_{IN} = V_{DD}$
Input high level current 2	$I_{IH2}$	TEST	35	70	140	$\mu\text{A}$	• Internal pull-down resistor • $V_{IN} = V_{DD}$
Input low level current 1	$I_{IL1}$	P00~P03, P10~P13, P20~P23, W0~W3, BIN, S1N0, S1N1, S1O0, S1O1, SCK0, SCK1, ADC0~ADC7, PWC, T0, T1, RESET, TEST	—	—	-1	$\mu\text{A}$	• No pull-down resistor • P, S1O, SCK = input • $V_{IN} = \text{GND}$
Input low level current 2	$I_{IL2}$	P00~P03, P10~P13, P20~P23, W0~W3, BIN	-90	-125	-160	$\mu\text{A}$	• Internal pull-down resistor • $V_{IN} = \text{GND}$
Output high level voltage 1	$V_{OH1}$	S1O0, S1O1, SCK0, SCK1	4.5	—	—	V	• S1O, SCK = output • $I_{OH} = -500\ \mu\text{A}$
Output high level voltage 2	$V_{OH2}$	SEG00~SEG19, COM0~COM3	4.5	—	—	V	• $I_{OH} = -250\ \mu\text{A}$
Output low level voltage 1	$V_{OL1}$	P00~P03, P10~P13, P20~P23, S1O0, S1O1, SCK0, SCK1	—	—	0.4	V	• P, S1O, SCK = output • $I_{OL} = 1.6\text{mA}$
Output low level voltage 2	$V_{OL2}$	SEG00~SEG19, COM0~COM3	—	—	0.7	V	• $I_{OL} = 1.0\text{mA}$
Output leakage current	$I_L$	P00~P03, P10~P13, P20~P23	—	—	1	$\mu\text{A}$	• P = high-impedance output
OSC feedback current	$I_{fO}$	OSC1, OSC2	-4.0	-10	-14	$\mu\text{A}$	• Approx. 500 k $\Omega$

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 *
A/D conversion linearity error	EL	ADC0~ADC7	—	—	±3	LSB	
LCD 2 / 3 level output voltage	V <sub>1</sub>	COM0~COM3 SEG00~SEG19	—	2	—	V	
LCD 2 / 3 level output voltage	V <sub>2</sub>	COM0~COM3 SEG00~SEG19	—	1	—	V	

\* 1 machine cycle = 1/6 oscillation frequency

● Electrical characteristics (at 3V) (unless otherwise noted,  $T_a = 25^\circ\text{C}$ ,  $V_{DD} = 3\text{V}$ )

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

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 *
A/D conversion linearity error	EL	ADC0~ADC7	—	—	±3	LSB	
LCD 2 / 3 level output voltage	V <sub>1</sub>	COM0~COM3 SEG00~SEG19	—	2	—	V	
LCD 2 / 3 level output voltage	V <sub>2</sub>	COM0~COM3 SEG00~SEG19	—	1	—	V	

\* 1 machine cycle = 1/6 oscillation frequency

### ●Hardware descriptions

(1) Operates on a single power supply (V<sub>DD</sub> = 2.7 ~ 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)

