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 ~ 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 (Ta = 25°C)

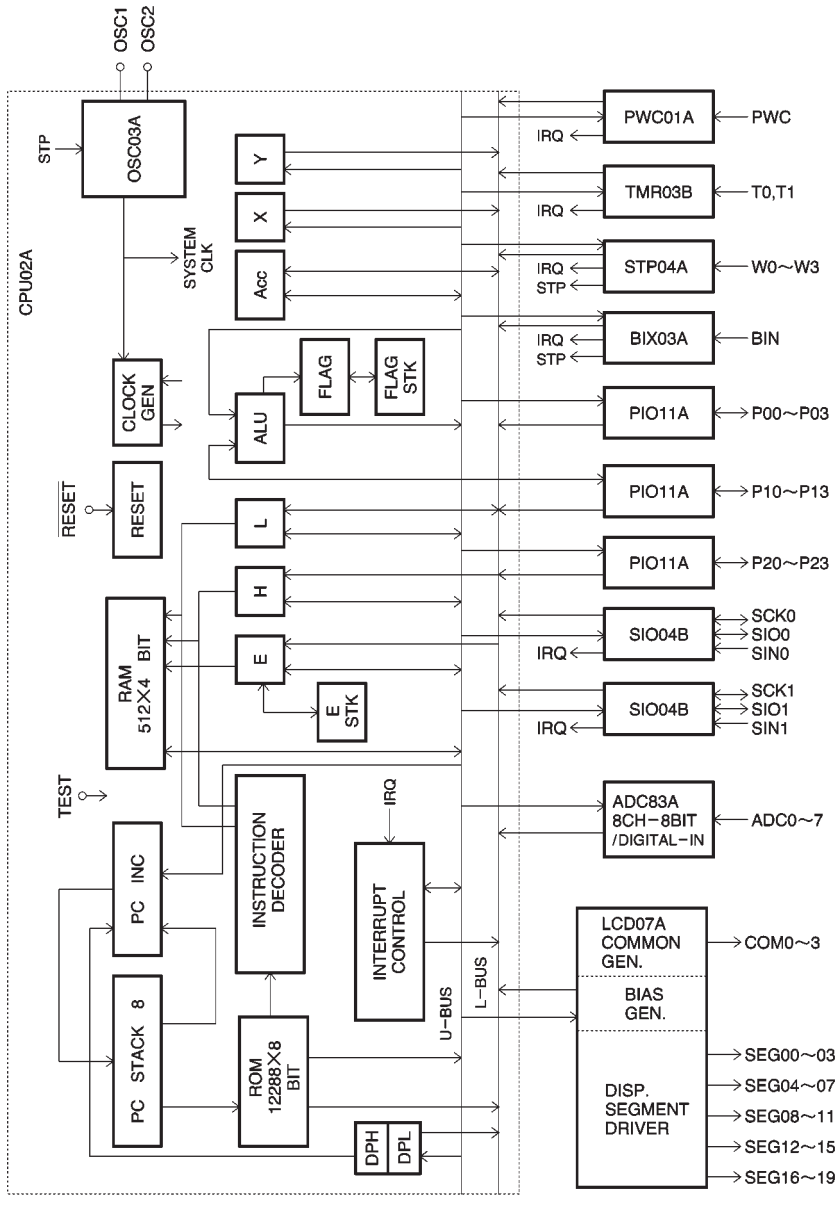
Parameter	Symbol	Limits	Unit
Applied voltage	V_{DD}	−0.3~+7.0	V
Power dissipation	Pd	500*	mW
Operating temperature	Topr	−25~+75	℃
Storage temperature	Tstg	−55~+125	℃

* Reduced by 5.0 mW for each increase in Ta of 1℃ over 25℃.

●Recommended operating conditions (Ta = 25°C)

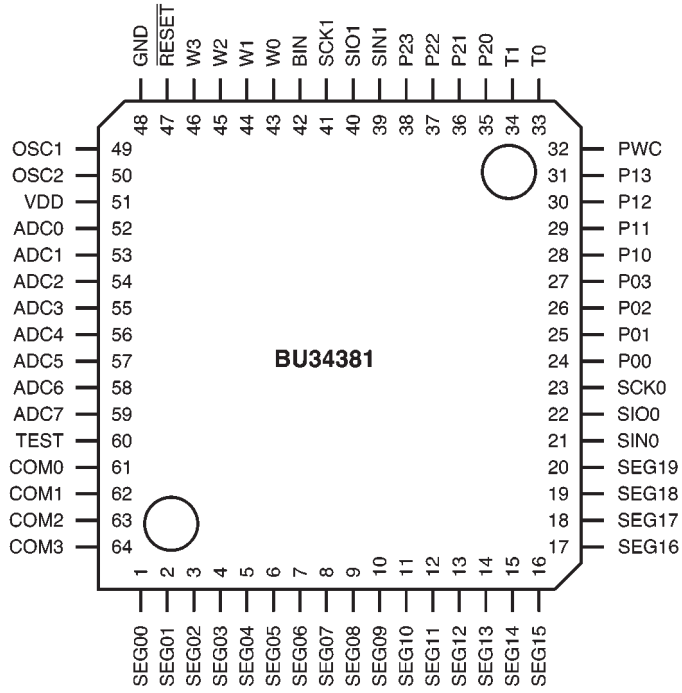
Parameter	Symbol	Min.	Typ.	Max.	Unit
Power supply voltage	V_{DD}	2.7	—	5.5	V
Input high level voltage (without hysteresis)	V_{IH}	0.7V_{DD}	—	V_{DD}	V
Input low level voltage (without hysteresis)	V_{IL}	0	—	0.3V_{DD}	V
Input high level voltage (with hysteresis)	V_{IHS}	0.75V_{DD}	—	V_{DD}	V
Input low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

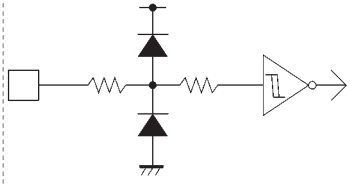
Pin No.	Pin name	I / O	Function	Type
24～27 28～31 35～38	P00～P03 P10～P13 P20～P23 （PI011A block）	I / O	・4-bit input and output ・Each bit is programmable for input or output (open drain output N-channel) ・Pull-up resistor ON/OFF operation is programmable (each bit can be set separately). ・Resetting turns the pull-up resistors off via input. *1	D
43～46	W0～W3 （STP04A block）	I	・Standard 4-bit input ・Programmable for stop cancel input or interrupt request signal output (each bit can be set separately). ・Pull-up resistor ON/OFF operation is programmable (each bit can be set separately). ・Resetting turns the pull-up resistors off.	C
42	BIN （BIX03A block）	I	・Standard 1-bit input ・Programmable for stop cancel input or interrupt request signal output. ・Pull-up resistor ON/OFF operation is programmable. ・Resetting turns the pull-up resistors off.	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	$\overline{\text{RESET}}$	I	• Reset input (Setting this pin to LOW resets the CPU.)	A
51	V_{DD}	—	• Power supply	—
48	GND	—	• Ground	—

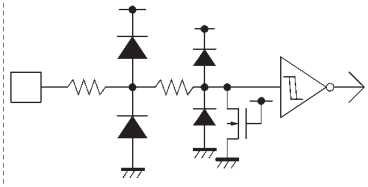
●Input / output circuits

TYPE A



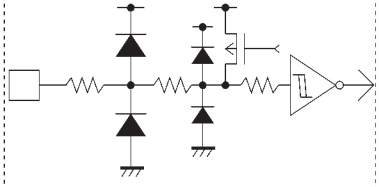
・Hysteresis input

TYPE B



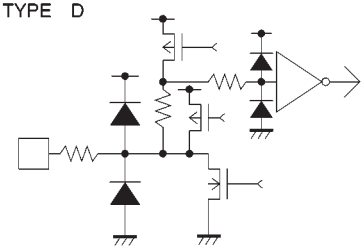
・Hysteresis input of internal pull-down resistor

TYPE C



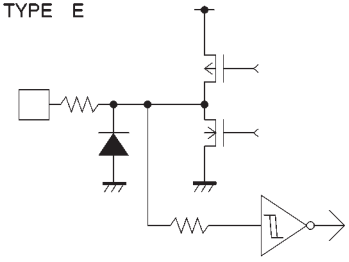
・Hysteresis input for programmable ON/OFF operation of pull-up resistor

TYPE D



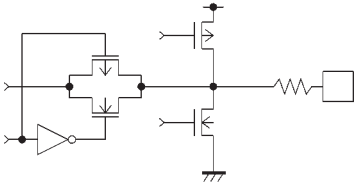
・Pull-up resistor with programmable ON/OFF operation and normal input/output with Nch open drain output

TYPE E



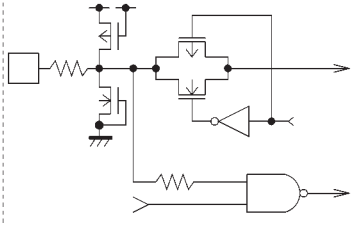
・Hysteresis input with programmable control of CMOS output

TYPE F



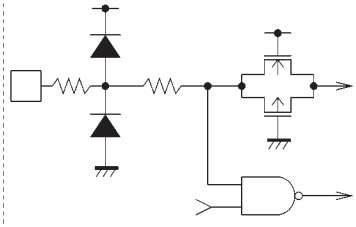
・LCD driver output
(CMOS output possible for SEG only)

TYPE G



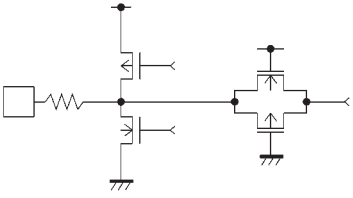
・Programmable control of AD input with digital input

TYPE H



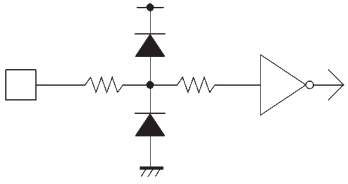
・Input in feedback resistor with STOP control

TYPE I

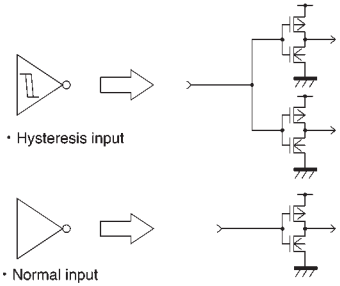


・CMOS output in feedback resistor

TYPE J



・Normal input



・Hysteresis input

・Normal input

●Electrical characteristics (at 5V) (unless otherwise noted, Ta = 25°C, V_{DD} = 5V)

Parameter	Symbol	Pin	Min.	Typ.	Max.	Unit	Conditions
STOP circuit current	I_{DDST}		—	—	1	μA	• STOP mode
HALT circuit current	I_{DDHT}		—	1	—	mA	• HALT mode • f_{OSC} = 4.4MHz
Operating supply current	I_{DDOP}		—	4	—	mA	• f_{OSC} = 4.4MHz
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 = input • ADC = digital input
Input high level voltage 2	V_{IH2}	W0～W3, BIN, SIN0, SIN1, SIO0, SIO1, SCK0, SCK1, PWC, TEST, $\overline{\text{RESET}}$	3.75	—	—	V	• Hysteresis input • SIO, 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 = input • ADC = digital input
Input low level voltage 2	V_{IL2}	W0～W3, BIN, SIN0, SIN1, SIO0, SIO1, SCK0, SCK1, PWC, TEST, $\overline{\text{RESET}}$	—	—	1.25	V	• Hysteresis input • SIO, 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, SIN0, SIN1, SIO0, SIO1, SCK0, SCK1, ADC0～ADC7, PWC, T0, T1, $\overline{\text{RESET}}$	—	—	1	μA	• No pull-down resistor • P, SIO, SCK = input • V_{IN} = V_{DD}
Input high level current 2	I_{IH2}	TEST	35	70	140	μA	• 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, $\overline{\text{RESET}}$, TEST	—	—	−1	μA	• No pull-down resistor • P, SIO, SCK = input • V_{IN} = GND
Input low level current 2	I_{IL2}	P00～P03, P10～P13, P20～P23, W0～W3, BIN	−90	−125	−160	μA	• Internal pull-down resistor • V_{IN} = GND
Output high level voltage 1	V_{OH1}	SIO0, SIO1, SCK0, SCK1	4.5	—	—	V	• SIO, SCK = output • I_{OH} = −500 μA
Output high level voltage 2	V_{OH2}	SEG00～SEG19, COM0～COM3	4.5	—	—	V	• I_{OH} = −250 μA
Output low level voltage 1	V_{OL1}	P00～P03, P10～P13, P20～P23, SIO0, SIO1, SCK0, SCK1	—	—	0.4	V	• P,SIO,SCK = output • I_{OL} = 1.6mA
Output low level voltage 2	V_{OL2}	SEG00～SEG19, COM0～COM3	—	—	0.7	V	• I_{OL} = 1.0mA
Output leakage current	I_L	P00～P03, P10～P13, P20～P23	—	—	1	μA	• P = high -impedance output
OSC feedback current	I_{FO}	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 ＊
A/D conversion linearity error	E_L	ADC0～ADC7	—	—	±3	LSB	
LCD 2 / 3 level output voltage	V_1	COM0～COM3 SEG00～SEG19	—	2	—	V	
LCD 2 / 3 level output voltage	V_2	COM0～COM3 SEG00～SEG19	—	1	—	V	

＊ 1 machine cycle = 1/6 oscillation frequency

●Electrical characteristics (at 3V) (unless otherwise noted, Ta = 25°C, V_{DD} = 3V)

Parameter	Symbol	Pin	Min.	Typ.	Max.	Unit	Conditions
STOP circuit current	I_{DDST}		—	—	1	μA	• STOP mode
HALT circuit current	I_{DDHT}		—	0.4	—	mA	• HALT mode • f_{OSC} = 4.4MHz
Operating supply current	I_{DDOP}		—	1.5	—	mA	• f_{OSC} = 4.4MHz
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 = input • ADC = digital input
Input high level voltage 2	V_{IH2}	W0～W3, BIN, SIN0, SIN1, SIO0, SIO1, SCK0, SCK1, PWC, TEST, $\overline{RESET}$	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 = input • ADC = digital input
Input low level voltage 2	V_{IL2}	W0～W3, BIN, SIN0, SIN1, SIO0, SIO1, SCK0, SCK1, PWC, TEST, $\overline{RESET}$	—	—	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, $\overline{RESET}$	—	—	1	μA	• No pull-down resistor • P, SIO, SCK = input • V_{IN} = V_{DD}
Input high level current 2	I_{IH2}	TEST	10	20	35	μA	• 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, $\overline{RESET}$, TEST	—	—	−1	μA	• No pull-down resistor • P, SIO, SCK = input • V_{IN} = GND
Input low level current 2	I_{IL2}	P00～P03, P10～P13, P20～P23, W0～W3, BIN	−20	−40	−60	μA	• Internal pull-up resistor • V_{IN} = GND
Output high level voltage 1	V_{OH1}	SIO0, SIO1, SCK0, SCK1	2.5	—	—	V	• SIO, SCK = output • I_{OH} = −500 μA
Output high level voltage 2	V_{OH2}	SEG00～SEG19, COM0～COM3	2.5	—	—	V	• I_{OH} = −250 μA
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} = 1.6mA
Output low level voltage 2	V_{OL2}	SEG00～SEG19, COM0～COM3	—	—	0.7	V	• I_{OL} = 0.8mA
Output leakage current	I_L	P00～P03, P10～P13, P20～P23	—	—	1	μA	• P = high-impedance output
OSC feedback current	I_{FO}	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 ＊
A/D conversion linearity error	E_L	ADC0～ADC7	—	—	±3	LSB	
LCD 2 / 3 level output voltage	V_1	COM0～COM3 SEG00～SEG19	—	2	—	V	
LCD 2 / 3 level output voltage	V_2	COM0～COM3 SEG00～SEG19	—	1	—	V	

＊ 1 machine cycle = 1/6 oscillation frequency

●Hardware descriptions

(1) Operates on a single power supply (V_{DD} = 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

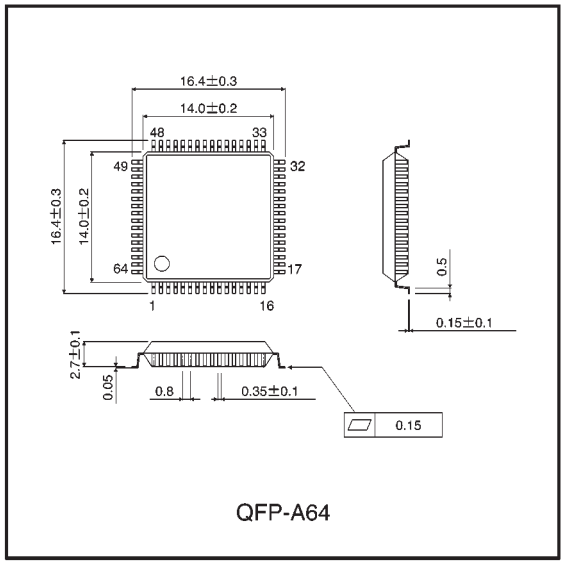
(13) Internal 8-bit timer counter (also used as event counter)

(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)



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