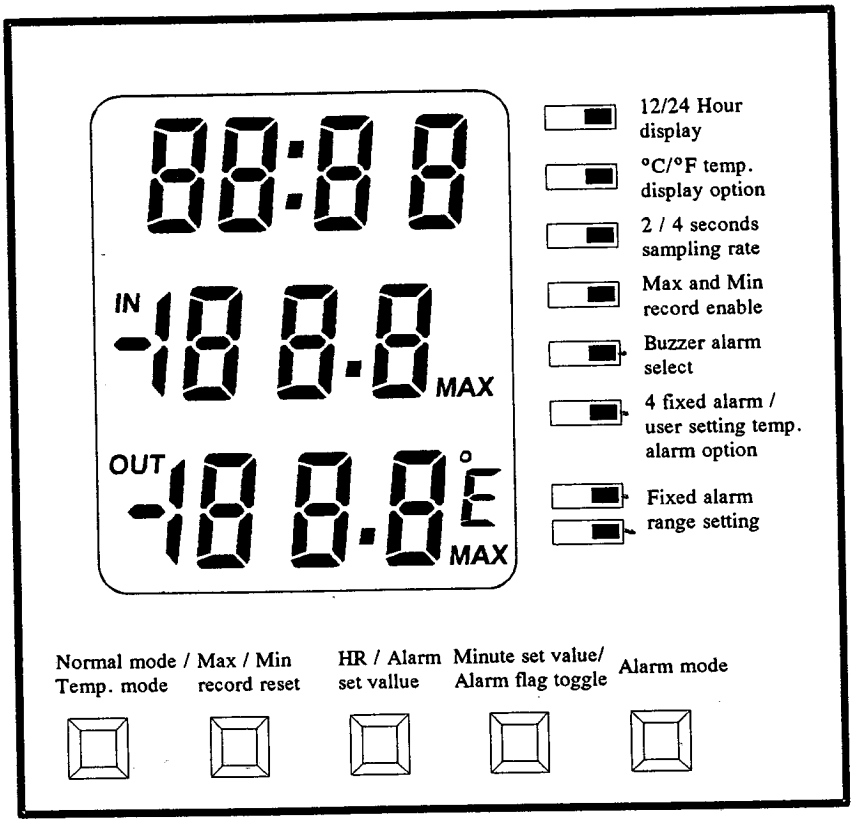
SS0110

DUAL THERMOMETER WITH CLOCK
-50°C(-58°F) ~ +70°C(+158°F)



Features:

1. 1.5 Volts battery power supply
2. Display clock, indoor and outdoor temperature simultaneously.
3. 12 / 24 Hour clock option.
4. ±0.1 °C / °F resolution
5. ±1 °C accuracy for 0°C to 50°C, otherwise ±2°C
6. °C / °F temperature display option.
7. 2 / 4 seconds temperature sensing rate option.
8. Max and Min temperature record. *NOTE
9. High and low temperature alarm.
10. 4 Fixed / User setting temperature alarm option.
11. beeps 4 times every minute / one minute continuous alarm sound option.

*NOTE: The max and min. record are invalid when user changes between °C and °F or after power on. User need to clear the Max/Min record.

I. General Description

SS0110 is a low power CMOS IC that displays the clock, indoor and outdoor temperature simultaneously from -50°C (-58°F) to +70°C (+158°F). It has 12/24 hr option, high / low temperature alarm and can record max and min temperature. A standard LCD LC-VCD0110 is available from VSL.

II. Function of Terminals

Terminal	Level	Function
P2.0	V_{SS1} OPEN	4 sec. sampling rate (User option) 2 sec. sampling rate
P2.1	V_{SS1} OPEN	12 Hour display (User option) 24 Hour display
P2.2	V_{SS1} OPEN	°F temperature display (User option) °C temperature display
P2.3	V_{SS1} OPEN	User setting for High and Low temperature alarm 4 Fixed setting for Hi / Low temp. alarm (refer to P0.0 & P0.1)
P0.2	V_{SS1} OPEN	Max and Min record enable (User option) Max and Min record disable
P0.3	V_{SS1} OPEN	Continues for one minute buzzer alarm Beeps 4 times every minute buzzer alarm

Table 1.

For P2.3 = OPEN only :

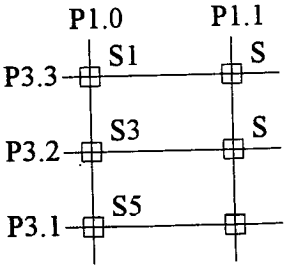
P0.0	P0.1	Alarm on condition
0	0	temp. < 38°C (30°F) or temp. > 41°C (33°F)
0	1	temp. < 22°C (14°F) or temp. >26°C (18°F)
1	0	0°C (-8°F) > temp > 5°C (-3°F)
1	1	temp. < 24°C (16°F) or temp. > 28°C (20°F)

Table 2.

III. Key Description

There can be a maximum of 5 keys (no sliding switch)

S1 : Display mode
S2 : Max / Min record reset
S3 : HR / Alarm set value
S4 : Minute set value / Alarm disable
S5 : Alarm mode



IV. Mode Description

At first power up, all the LCD segments and the alarm sound are turned on for 2 seconds. The IC then enters normal mode after the 2 seconds testing.

4.1 Normal Mode

Normal mode displays HOUR in digit 1 and 2, MINUTE in digit 3 and 4, with a colon sign (it blinks all the time except in Time Setting Mode.), the current inside temperature in digit 5, 6, 7 and 8 with a decimal point P1 and IN flag, the current outside temperature in digit 9, 10, 11, and 12 with a decimal point P2 and OUT flag, the unit of the temperature will display in °C or °F depend on the setting of P2.2.

4.2 Time Setting Mode

Time setting mode is entered by pressing either S3 or S4 and hold for 2 seconds in Normal Mode. The display is the same as the Normal Mode excepts the frozen colon sign. It indicates that time setting is enabled. HOUR is increment by 1 by pressing S3. MINUTE is increment by 1 by pressing S4. Time setting is disabled if S1 is pressed or neither S3 nor S4 is pressed for 10 seconds. The colon sign will blink again.

4.3 Indoor / Outdoor Temperature Mode (P0.2 = V_{SS1} Only)

Outdoor Temperature Mode is entered by pressing S1 in Normal Mode. Outdoor Temperature Mode displays the current outdoor temperature in digit 1, 2 and 3. The maximum outdoor temperature is shown in digit 5, 6, 7 and 8 with the decimal point P1 and MAX flag. The minimum outdoor temperature is shown in digit 9, 10, 11 and 12 with the decimal point P2 and MIN flag. The unit of the temperature will display in °C or °F depended on the setting of P2.2.

The maximum and minimum outdoor temperature records are reset to current indoor temperature by pressing S2 in Outdoor Temperature Mode.

Indoor Temperature Mode is entered by pressing S1 in Outdoor Temperature Mode. Indoor Temperature Mode displays the current indoor temperature in digit 1, 2 and 3. The maximum indoor temperature displays in digit 5, 6, 7 and 8 with the decimal point P1 and MAX flag. The minimum indoor temperature displays in digit 9,10,11 and 12 with the decimal point P2 and MIN flag. The unit of the temperature will display in °C or °F depended on the setting of P2.2.

The maximum and minimum indoor temperature records are reset to current indoor temperature by pressing S2 in Indoor Temperature Mode.

The display returns to Normal Mode when S1 is pressed in Indoor Temperature Mode.

4.4 User Alarm Setting Mode (P2.3 = Vss1 Only)

Alarm Setting Mode is entered by pressing S5 in Normal Mode. Alarm Setting Mode displays HOUR in digit 1 and 2, MINUTE in digit 3 and 4 with the blinking colon sign, the **High Temperature Alarm** in digit 5, 6, 7 and 8 with decimal point P1 and High alarm flag s and the **Low Temperature Alarm** in digit 9, 10, 11 and 12 with decimal point P2 and Low Temperature Alarm flag t. The unit of the temperature displays in °C or °F depended on the setting of P2.2, and alarm enable flag displays by **AL** flag.

By pressing S5, the High Temperature Alarm flag s will blink. That means the **High Temperature Alarm** can be reset. The temperature is increment by 1 by pressing S3. The figure changes to the lowest limit (-50°C / -58°F) when increment is over the highest limit (+70°C / +158°F). By pressing S5 again, the Low Temperature Alarm flag t will blink. That means the **Low Temperature Alarm** can be reset, and the operation is the same as the **High Temperature Alarm** setting. Pressing S4 will toggle the alarm enable flag **AL** at any time. When the alarm enable flag is on, if the outdoor temperature is 8 **High Temperature Alarm** or 7 **Low Temperature Alarm**, then the alarm will be activated.

The display returns to Normal Mode when S1 is pressed.

4.5 Fixed Alarm Setting Mode (P2.3 = OPEN)

The operation is the same as the user alarm setting except the HI / LOW temperature alarm cannot be changed by users. Please refer to table 2 for the fixed temperature alarm range.

4.6 Alarm function

When the alarm is activated, the buzzer will be on for one minute continuously or beeps 4 times every minute, which depends on the setting of P0.3 (refers to table 1). The alarm buzzer will be turned off when anyone of the keys is pressed. There is a output port P1.3 will be turned on until the outdoor temperature is outside the temperature alarm range.

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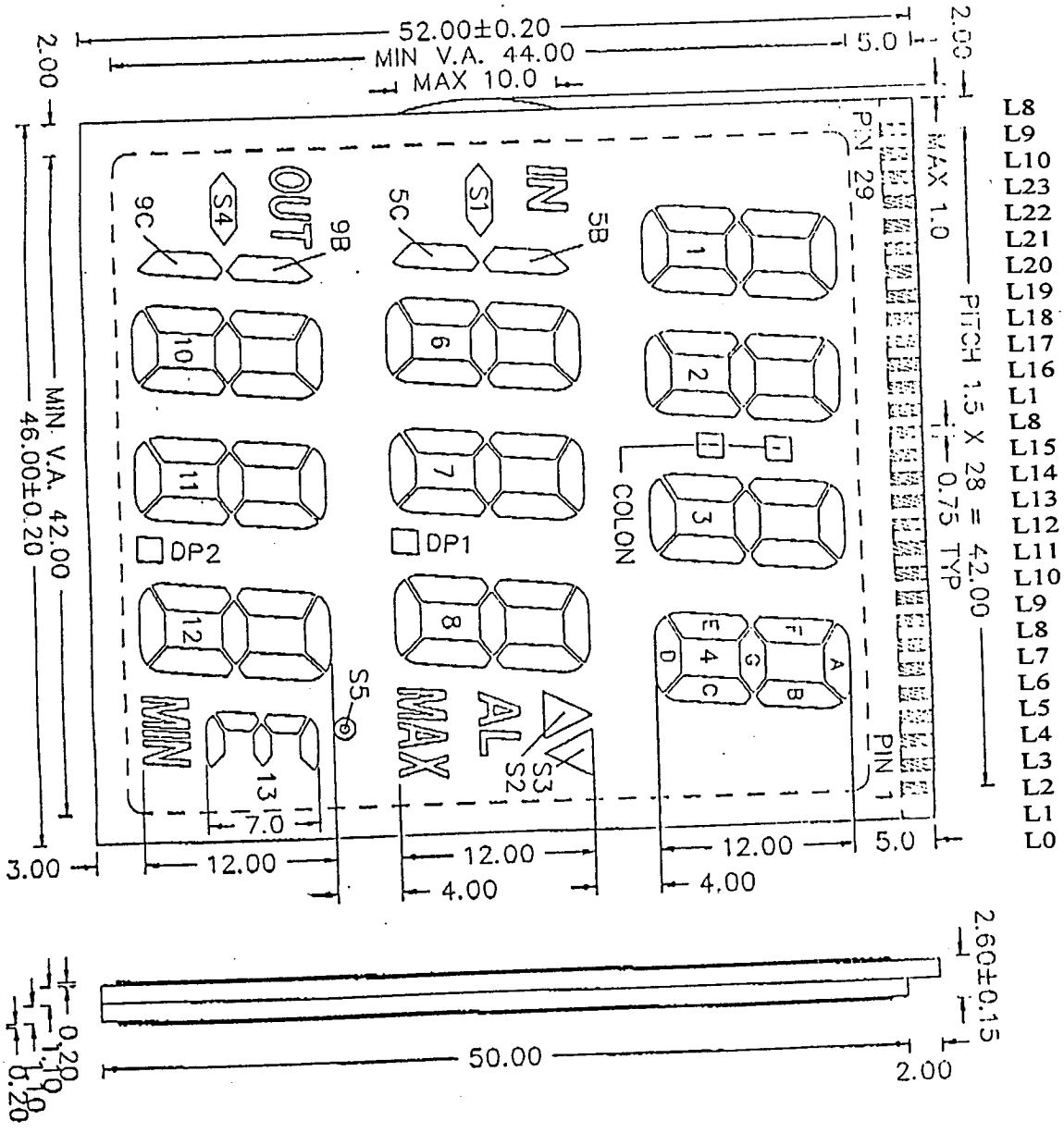
V. LCD Format (LC-VCD0110)

DISPLAY TYPE	TN POSITIVE
CONNECTOR TYPE	ELASTOMER
VIEWING DIRECTION	12 O'CLOCK
DRIVING IC	
DRIVING SCHEME	1/4 DUTY, 1/3 BIAS
DRIVING VOLTAGE	4.5V @ 20°C
OPERATION TEMPERATURE	-10°C ~ 60°C
STORAGE TEMPERATRE	-20°C ~ 65°C
POLARIZERS ---- FRONT	STD. TRANSMISSIVE
---- BACK	STD. REFLECTIVE



VI. LCD segment Layout

PIN	COM1 Group	COM2 Group	COM3 Group	COM4 Group
L0	MAX, MIN	13G	13D	S5, 13AEF, DP1, DP2
L1	AL	S2	S3	COLON
L2	8D	8C	8B	8A
L3	7D	8E	8G	8F
L4	IN	7C	7B	7A
L5	S1	7E	7G	7F
L6	6D	6C	6B	6A
L7	5BC	6E	6G	6F
L8	---	---	---	COM4
L9	---	---	COM3	---
L10	---	COM2	---	---
L11	COM1	---	---	---
L12	4A	4B	4C	4D
L13	4F	4G	4E	3D
L14	3A	3B	3C	1ADEG
L15	3F	3G	3E	1C
L16	2A	2B	2C	2D
L17	2F	2G	2E	1B
L18	12A	12B	12C	12D
L19	12F	12G	12E	11D
L20	11A	11B	11C	OUT
L21	11F	11G	11E	S4
L22	10A	10B	10C	10D
L23	10F	10G	10E	9BC

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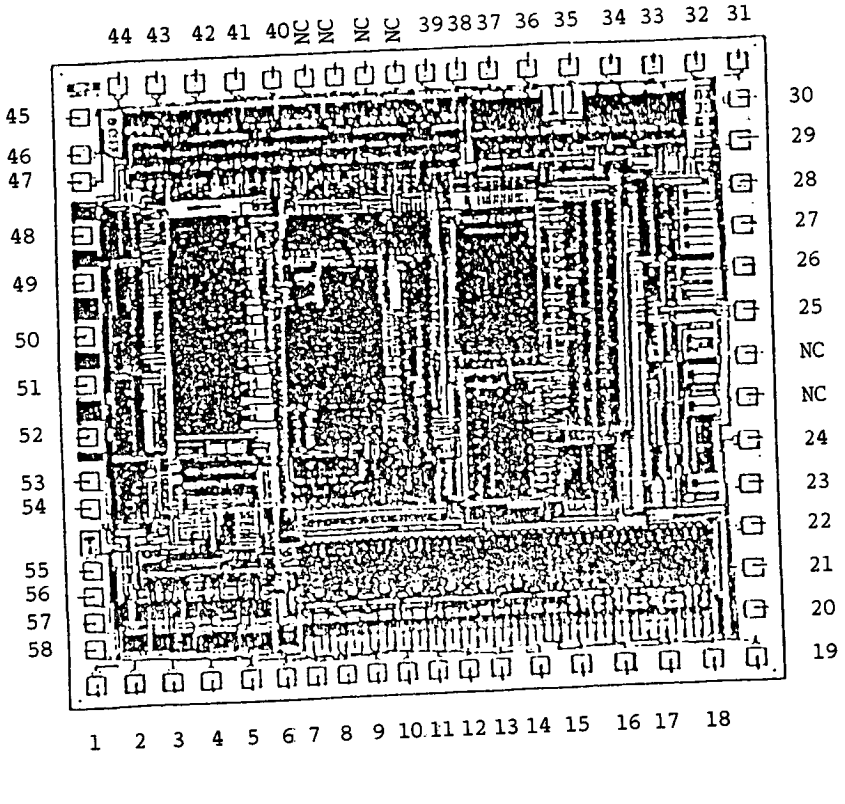
VII. Pad Layout and Pad No.

Chip size :4.69mm x 4.41mm
350 micron in thickness



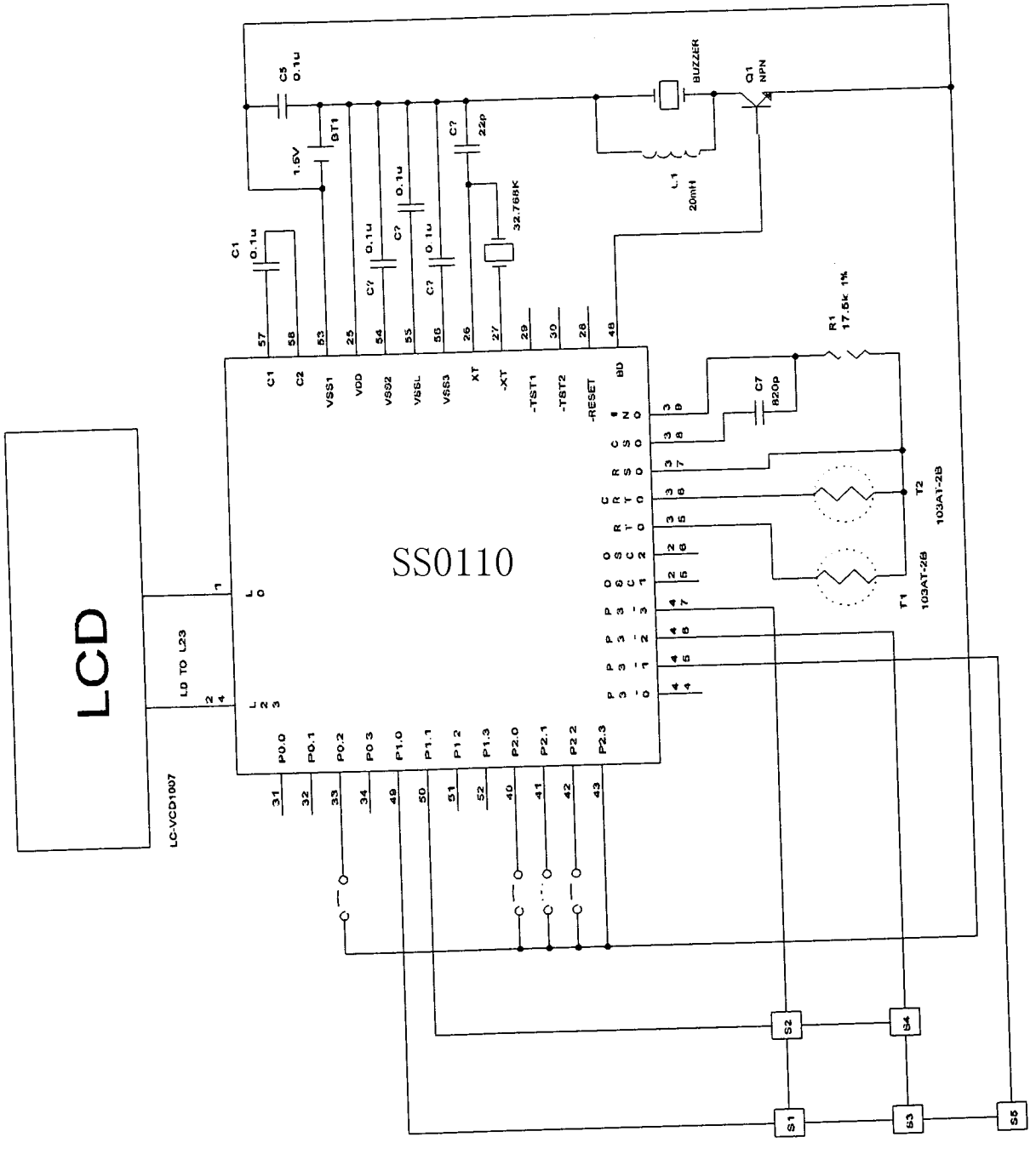
VIII. Pad Coordinates

Center of chip : X=0, Y=0

Pad No.	Pad Name	(μm) X	(μm) Y	Pad No.	Pad Name	(μm) X	(μm) Y	Pad No.	Pad Name	(μm) X	(μm) Y	Pad No.	Pad Name	(μm) X	(μm) Y
1	L0	-2168	-2042	19	L18	2168	-2042	31	P0.0	2168	2042	45	P3.1	-2168	1829
2	L1	-1918		20	L19		-1714	32	P0.1	1899		46	P3.2		1563
3	L2	-1669		21	L20		-1424	33	P0.2	1628		47	P3.3		1382
4	L3	-1426		22	L21		-1134	34	P0.3	1364		48	BD		1017
5	L4	-1170		23	L22		-844	35	RTO	1100		49	P1.0		688
6	L5	-934		24	L23		-554	36	CRTO	829		50	P1.1		328
7	L6	-727		25	VDD		316	37	RSO	565		51	P1.2		6
8	L7	-519		26	XT		606	38	CSO	349		52	P1.3		-353
9	L8	-312		27	XT		896	39	INO	141		53	VSS1		-645
10	L9	-104		28	RESET		1186	40	P2.0	-911		54	VSS2		-826
11	L10	104		29	TST1		1476	41	P2.1	-1160		55	VSSL		-1254
12	L11	311		30	TST2		1766	42	P2.2	-1416		56	VSS3		-1435
13	L12	527						43	P2.3	-1666		57	C1		-1616
14	L13	791						44	P3.0	-1916		58	C2		-1796
15	L14	1062													
16	L15	1340													
17	L16	1618													
18	L17	1897													

Substrate VDD level

Substrate VDD level



X. Electrical characteristics

Electrical Characteristics of the SS0110 are shown in the following :

10.1 Absolute Maximum Ratings

(VDD = 0V)

Item	Symbol	Condition	Rating	Unit
Power supply voltage 1	V_{SS1}	Ta = 25°C	-2.0 ~ +0.3	V
Power supply voltage 2	V_{SS2}	Ta = 25°C	-4.0 ~ +0.3	V
Power supply voltage 3	V_{SS3}	Ta = 25°C	-5.5 ~ +0.3	V
Power supply voltage 4	V_{SSL}	Ta = 25°C	-2.0 ~ +0.3	V
Input voltage 1	VIN1	V_{SS1} Input, Ta = 25°C	V_{SS1} -0.3 ~ +0.3	V
Input voltage 2	VIN2	V_{SS1} Input, Ta = 25°C	V_{SSL} -0.3 ~ +0.3	V
Output voltage 1	VOUT1	V_{SS1} Input, Ta = 25°C	V_{SS1} -0.3 ~ +0.3	V
Output voltage 2	VOUT2	V_{SS2} Input, Ta = 25°C	V_{SS2} -0.3 ~ +0.3	V
Output voltage 3	VOUT3	V_{SS13} Input, Ta = 25°C	V_{SS3} -0.3 ~ +0.3	V
Output voltage 4	VOUT4	V_{SSL} Input, Ta = 25°C	V_{SSL} -0.3 ~ +0.3	V
Storage temperature	TSTG	---	-55 ~ +125	°C

10.2 Recommended operating conditions

(VDD = 0V)

Item	Symbol	Condition	Rating	Unit
Operating temperature	TOPE	---	-40 ~ +85	°C
Operating voltage	V_{SS1}	---	-1.7 ~ -1.25	V

10.3 DC Chatacteristics

(VDD = 0V, VSS1 = -1.5V, Ta = -40 ~ +85°C unless otherwise mentioned)

Item	Symbol	Condition		Specification MIN	TYPE	MAX	Unit	Measurement circuit
V_{SS2} voltage	V_{SS2}	Ca, Cb, C12 = 0.1μF +100% / -50%		-3.2	-3.0	-2.8	V	
V_{SS3} voltage	V_{SS3}	Ca, Cb, C12 = 0.1μF +100% / -50%		-4.7	-4.5	-4.3	V	
V_{SSL} voltage	V_{SSL}	—		-1.5	-1.3	-0.6	V	
Power consumption 1	IDD1	CPU in halt state	Ta = -40 ~ +40°C	—	2	5	μA	
			Ta = -40 ~ +80°C	—	2	30		
Power consumption 2	IDD2	CPU in operation state	Ta = -40 ~ +40°C	—	5	15	μA	
			Ta = -40 ~ +80°C	—	5	40		
Power consumption 3	IDD3	CPU in halt state , A/D converter in oscillation state	RTO = 10kΩ	—	150	230	μA	
			RTO = 2kΩ	—	600	900		
Power consumption 4	IDD4	Battery check in operation state, CPU in operatin state		—	25	125	μA	
XTOSC Oscillation start voltage	VSTA	Less than 5 seconds for oscillation starts		—	—	-1.45	V	1
XTOSC Oscillation maintaining voltage	VHOLD	—		—	—	-1.25	V	
XTOSC stop delection time	TSTOP	—		0.1	—	1000	mS	
XTOSC Internal capacitance	CG	—		10	15	20	pF	
XTOSC external capacitance	CGEX	CG external option		10	—	30	pF	
XTOSC internal capacitance	CD	—		10	15	20	pF	
POR generation voltage	VPOR 1	VSS2 is within VPOR 1 ~ -1.5V and POR generated		-0.4	—	0	V	
POR non-generation voltage	VPOR 2	VSS1 is within VPOR ~ -1.5V and no POR		-1.5	—	-1.2	V	
Battery check reference voltage	VRB	Ta = 25°C		-0.73	-0.63	-0.53	V	2
VRB temperature variation	ΔVRB	—		—	-2	—	mV/°	

Notes :

- "XTOSC" refers to the 32.768kHz crystal oscillation circuit.
- "POR" refers to Power-On-Reset.
- "TSTOP" refers to the generation of system when XTOSC stops oscillation for more than this duration.

(VDD = 0V, VSS1 = VSSL = -1.5V, VSS2 = -3.0V, VSS3 = -4.5V, Ta = -40 ~ +85°C unless otherwise mentioned)

Item (pin name)	Symbol	Condition	Specification MIN	TYP	MAX	Unit	Measurement circuit
Output current 1 (P1.0)	IOH1	VOH1 = -0.5V	-2.1	-0.7	-0.2	mA	2
	IOL1	VOL1 = VSS1 + 0.5V	1	3	9	mA	
Output current 2 (P1.1 ~ P1.3) (P2.0 ~ P2.3) (P3.0 ~ P3.3)	IOH2	VOH2 = -0.5V	-2.1	-0.7	-0.2	mA	
	IOL3	VOL2 = VSS1 + 0.5V	0.2	0.7	2.1	mA	
Output current 3 (BD)	IOH3	VOH3 = -0.7V	-1.8	-0.8	-0.2	mA	
	IOL3	VOL3 = VSS1 + 0.7V	0.2	0.6	1.8	mA	
Output current 4 (RT0,RS0,CRT0,CS0)	IOH4	VOH4 = -0.1V	-1.1	-0.6	-0.3	mA	
	IOL4	VOL4 = VSS1 +0.1V	0.3	0.6	1.1	mA	
Output current 5 (When L16 - L23 are output ports)	IOH5	VOH5 = -0.5V	-1.5	-0.5	-0.1	mA	
	IOL5	VOL5 = VSS1 + 0.5V	0.1	0.5	1.5	mA	
Output current 7 (L0 ~ L23)	IOH7	VOH7 = -0.2V (VDD level	---	---	-4	µA	
	IOMH	VOMH7 = VSS1 + 0.2V (VSS1 level	4	---	---	µA	
	IOMH7	VOMH7S = VSS1 - 0.2V (VSS1 level	---	---	-4	µA	
	IOML7	VOML7 = VSS2 + 0.2V (VSS2 level	4	---	---	µA	
	IOML7S	VOML7S = VSS2 - 0.2V (VSS2 level	---	---	-4	µA	
	IOL7	VOL7 = VSS3 + 0.2V (VSS3 level	4	---	---	µA	
Output Leak (P1.0 ~ P1.3) (P2.0 ~ P2.3) (P3.0 ~ P3.3) (RT0,RS0,CRT0,CS0)	IOOH	VOH = VDD	---	---	0.3	µA	
	IOOL	VOL = VSS1	-0.3	---	---	µA	

Item (pin name)	Symbol	Condition	Specification MIN	TYP	MAX	Unit	Measurement circuit
Input current 1 (P0.0 ~ P0.3) (P2.0 ~ P2.3) (P3.0 ~ P3.3)	IIH1	VIH1 = VDD (pull down)	5	18	60	µA	3
	IIL1	VILK1 = VSS1 (pull-up)	-60	-18	-5	µA	
	IIH1Z	VIH1 = VDD (high-impedance)	0	--	1	µA	
	IIL1Z	VIL1 = VSS1 (high-impedance)	-1	---	0	µA	
Input curnet 2 (IN0)	IIH2	VIH2 = VDD (pull-down)	5	18	60	µA	
	IIH2Z	VIH2 = VDD (high impedance)	0	---	1	µA	
	IIL2Z	VIH2 = VSS1 (high impedance)	-60	-22	-6	µA	
Input current 4 (RESET, TST1, TST2)	IIH4	VIH4 = VDD	0	---	1	µA	
	IIL4	VIL4 = VSS1	-1.5	-0.75	-0.3	mA	
Input voltage 1 (P0.0 ~ P0.3) (P2.0 ~ P2.3) (P3.0 ~ P3.3)	VIH1	---	-0.3	---	0	V	4
	VIL1	---	-1.5	---	-1.2	V	
Input voltage 2 (IN0)	VIH2	---	-0.3	---	0V	V	
	VIL2	---	-1.5	---	-1.2	V	
Input voltage 2 (RESET, TST1, TST2)	VIH3	---	-0.3	---	0	V	
	VIL3	---	-1.5	---	-1.2	V	

Item (pin name)	Symbol	Condition	Specification MIN	TYP	MAX	Unit	Measurement circuit
Hysteresis width (P0.0 ~ P0.3) (P2.0 ~ P2.3) (P3.0 ~ P3.3)	ΔVT1	---	0.05	0.1	0.3	V	4
Hysteresis width (RESET, TST1, TST2)	ΔVT1	---	0.05	0.1	0.3	V	
Input pin capacitance (P0.0 ~ P0.3) (P2.0 ~ P2.3) (P3.0 ~ P3.3)	CIN	---	---	---	5	pF	1

XI. AD Converter Characteristics

(unless otherwise noted, VDD = 0V, VSS1 = -1.5V, Ta = -40 ~ +85°C)

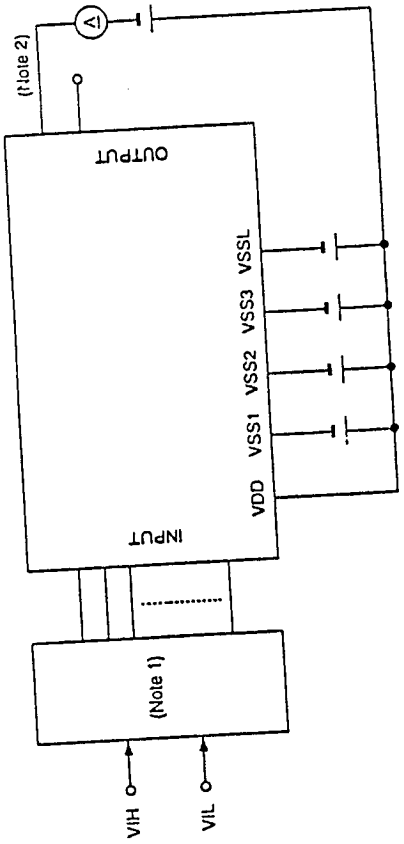
Parameter	Symbol	Condition	Specification			Unit	Measurement circuit
			MIN	TYP	MAX		
Resistor for oscillation	RS0,RT0 RTO-1	CS0,CT0 8 740pF	2	—	—	kΩ	5
Input current limiting resistor	RI0		1	10	—	kΩ	
Oscillation frequency	fOSC1	Resistor for oscillation = 2 kΩ	165	221	256	kHz	
	fOSC2	Resistor for oscillation = 10 kΩ	41.8	52.2	60.6	kHz	
	fOSC3	Resistor for oscillation = 200 kΩ	2.55	3.04	3.53	kHz	
RS·RT oscillation frequency ratio (Note)	Kf1	RT0, RT0-1 = 2 kΩ	3.89	4.18	4.35		
	Kf2	RT0, RT0-1 = 10 kΩ	0.990	1	1.010		
	Kf3	RT0, RT0-1 = 200 kΩ	0.0561	0.0584	0.0637		

(Note : Kfx is the ratio of the oscillation frequency by a sensor resistor and the oscillation frequency by a reference resistor in the same condition.)

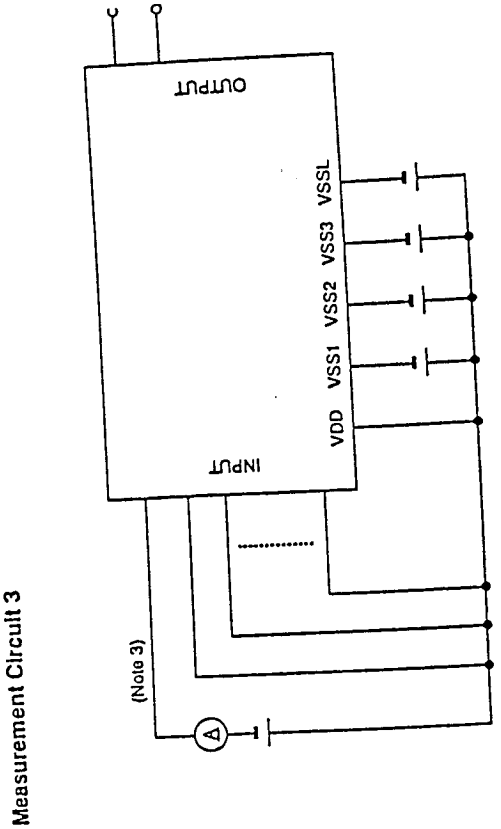
$$Kfx = \frac{fOSCx(\text{ RT0-CS0 Oscillation })}{fOSCx(\text{ RS0-CS0 Oscillation })} \ , \ \frac{fOSCx(\text{ RT0-1-CS0 Oscillation })}{fOSCx(\text{ RS0-CS0 Oscillation })}$$

(x = 1, 2, 3)

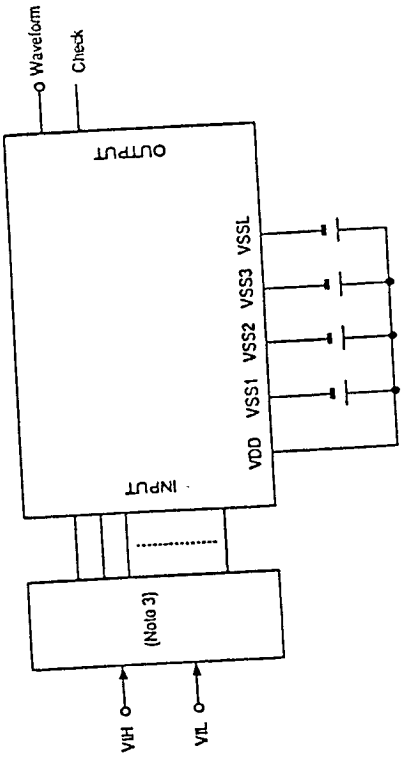
Measurement Circuit 2



Measurement Circuit 3



Measurement Circuit 4



Note 1: Input logic to select a specified state.
Note 2: To be repeated for the specified output pin.
Note 3: To be repeated for the specified input pin.

Measuring circuit 5