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1. Overview

This manual explains the functional specifications, programming specifications, and operations of the standard clock program with built-in weather forecasting function, which uses the SS0204 GS-K/Chip (hereafter referred to as "MCU").

This MCU function is as follows.

(1) Time & calendar functions:
12-hour/24-hour clock, calendars for 1993 - 2023 and time signal output.

(2) Alarm function:

(3) Temperature, humidity, and atmospheric pressure measurement functions:
Temperature measurement:
-20.0~+70.0°C, displayed in increments of 0.1°C
-58.0~+158.0°F, displayed in increments of 0.1°F
Humidity measurement:
20~90%, displayed in increments of 1%
Atmospheric pressure measurement:
850~1050 hPa, displayed in increments of 1 hPa
Sensor measurement time: Selectable

(4) Uncomfortable index determination function:
Uncomfortable index levels: 6

(5) Weather forecasting function:
Weather forecast levels: 4 (Fine, Fine becoming cloudy, Cloudy, and Rain)

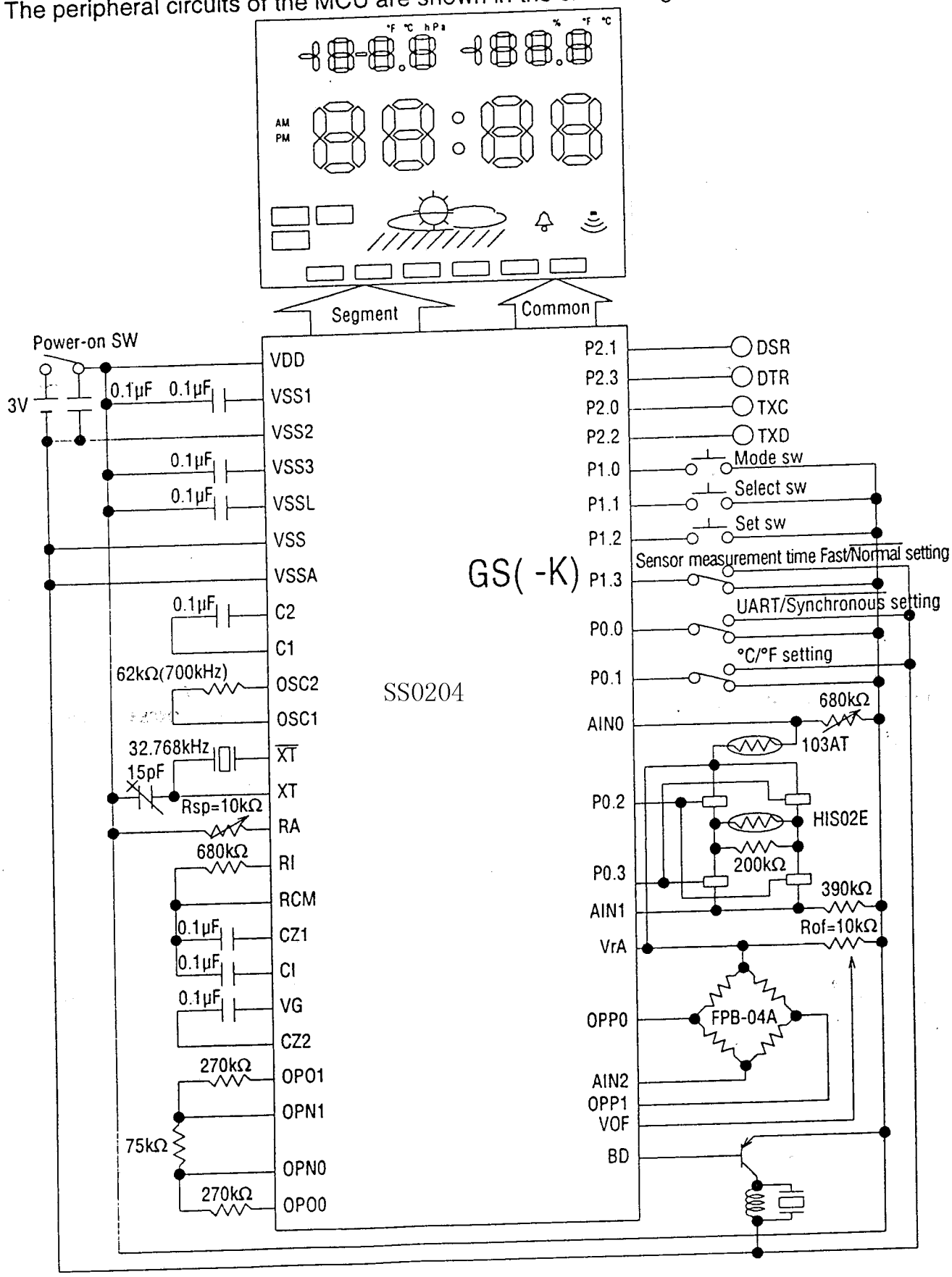
(6) Serial transmission function:
The data of calendar, time, temperature, humidity and atmospheric pressure are serially transmitted to the external.
11-bit UART system/clock synchronous system: Selectable

2. Hardware Specifications

The hardware specifications of the MCU are shown below.

2.1 Peripheral Circuit Diagrams

The peripheral circuits of the MCU are shown in the circuit diagram.



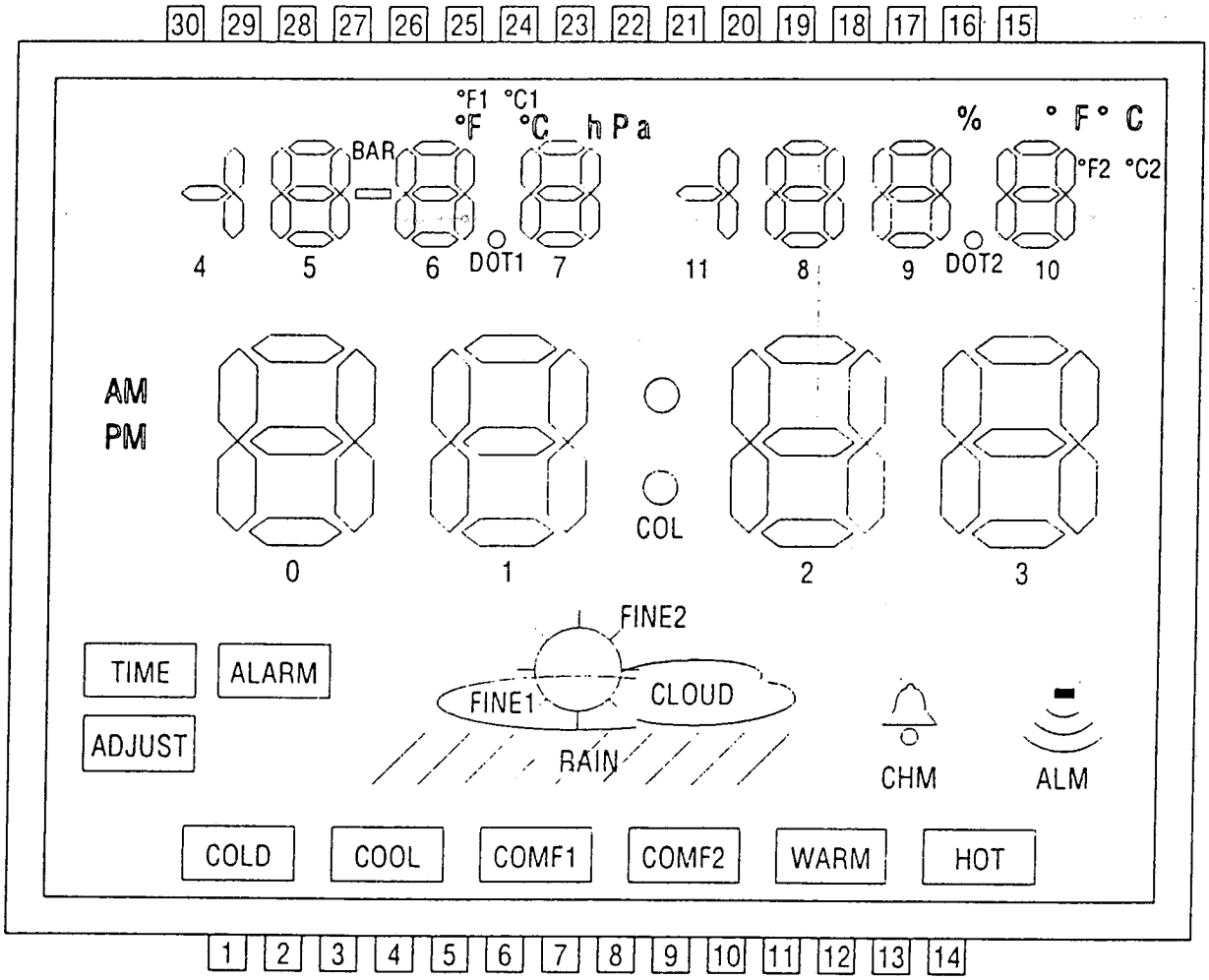
2.2 Pin Connection Table

The pin connections of the MCU are shown in the table below.

Pin No.	Pin Name	Description	I/O	Active Level	Pin No.	Pin Name	Description	I/O	Active Level
1	L2	Common 2 output	O	–	44	VSSL	Negative power supply for internal logic	–	–
2	L3	Common 1 output	O	–					
3	L4	Segment output	O	–	45	VOF	Connection to reference voltage adjustment resistor for atmospheric pressure sensor	–	–
4	L5	Segment output	O	–					
5	L6	Segment output	O	–					
6	L7	Segment output	O	–	46	VDDA	0V power supply for analog	–	–
7	L8	Segment output	O	–	47	VrA	Reference output for sensor	O	–
8	L9	Segment output	O	–	48	AIN0	Temperature sensor analog input	I	–
9	L10	Segment output	O	–	49	AIN1	Humidity sensor analog input	I	–
10	L11	Segment output	O	–	50	AIN2	Unused (open)	–	–
11	L12	Segment output	O	–	51	AIN3	Atomospheric pressure sensor analog input (internal)	I	–
12	L13	Segment output	O	–					
13	L14	Segment output	O	–	52	RA	Connection to constant current adjustment resistor for atmospheric pressure sensor	–	–
14	L15	Segment output	O	–					
15	L16	Segment output	O	–					
16	L17	Segment output	O	–	53	RI	Connection to resistor for integration		–
17	L18	Segment output	O	–	54	RCM	Resistor capacitor common for integration		–
18	L19	Segment output	O	–					
19	L20	Segment output	O	–	55	CZ1	Connection to capacitor for offset correction	–	–
20	L21	Segment output	O	–					
21	L22	Segment output	O	–	56	CI	Connetion to capacitor for integration	–	–
22	L23	Segment output	O	–	57	CZ2	Connection to capacitor for offset correction	–	–
23	L24	Segment output	O	–	58	VG		–	–
24	L25	Segment output	O	–	59	OPO0	Connection to voltage amplifier adjustment resistor for pressure sensor	–	–
25	L26	Segment output	O	–	60	OPN0		–	–
26	L27	Segment output	O	–	61	OPP0		–	–
27	L28	Segment output	O	–	62	OPO1		–	–
28	L29	Segment output	O	–	63	OPN1		–	–
29	L30	Unused (open)	O	–	64	OPP1		–	–
30	OSC2	High-speed oscillation output (700kHz)	O	–	65	VSSA	Analog power supply	–	–
31	OSC1	High-speed oscillation input (700kHz)	I	–	66	VSS	0V power supply for connecting external logic	–	–
32	VDD	0V power supply	–	–	67	P0.0	Switch for UART/Clock synchronous	I	"H/L"
33	$\overline{XT}$	Low-speed oscillation output (32.768kHz)	O	–	68	P0.1	Switch for ° C/° F	I	"H/L"
34	XT	Low-speed oscillation input (32.768kHz)	I	–	69	P0.2	Analog SW1 for humidity sensor AC	O	"H"
35	VSS2	–3V power supply	–	–	70	P0.3	Analog SW2 for humidity sensor AC	O	"H"
36	C2	Connection to capacitor for generating bias for LCD drive	–	–	71	P1.0	Mode SW	I	"H"
37	C1		–	–	72	P1.1	Select SW	I	"H"
38	VSS3	Bias output for LCD drive	–	–	73	P1.2	Set SW	I	"H"
39	VSS1	Bias output for LCD drive	–	–	74	P1.3	Switch for sensor measurement time Fast/Normal	I	"H/L"
40	BD	Buzzer driver output	–	"H"	75	P2.0	TXC (clock synchronous)	O	–
41	$\overline{TST1}$	Unused (open)	–	–	76	P2.1	DSR (Clock synchronous/UART)	I	"H"
42	$\overline{TST2}$	Unused (open)	–	–	77	P2.2	TXD (Clock synchronous/UART)	O	–
43	$\overline{RESET}$	Reset input (L→H)	I	"L"	78	P2.3	DTR (Clock synchronous)	I	"H"
					79	L0	Common 4 output	O	–
					80	L1	Common 3 output	O	–

2.3 LCD Layout

The LCD layout used in the MCU is shown below.



LCD panel
Maker: Citizen Watch Co., Ltd.
Type: LM-1240C

Segment Assign Table

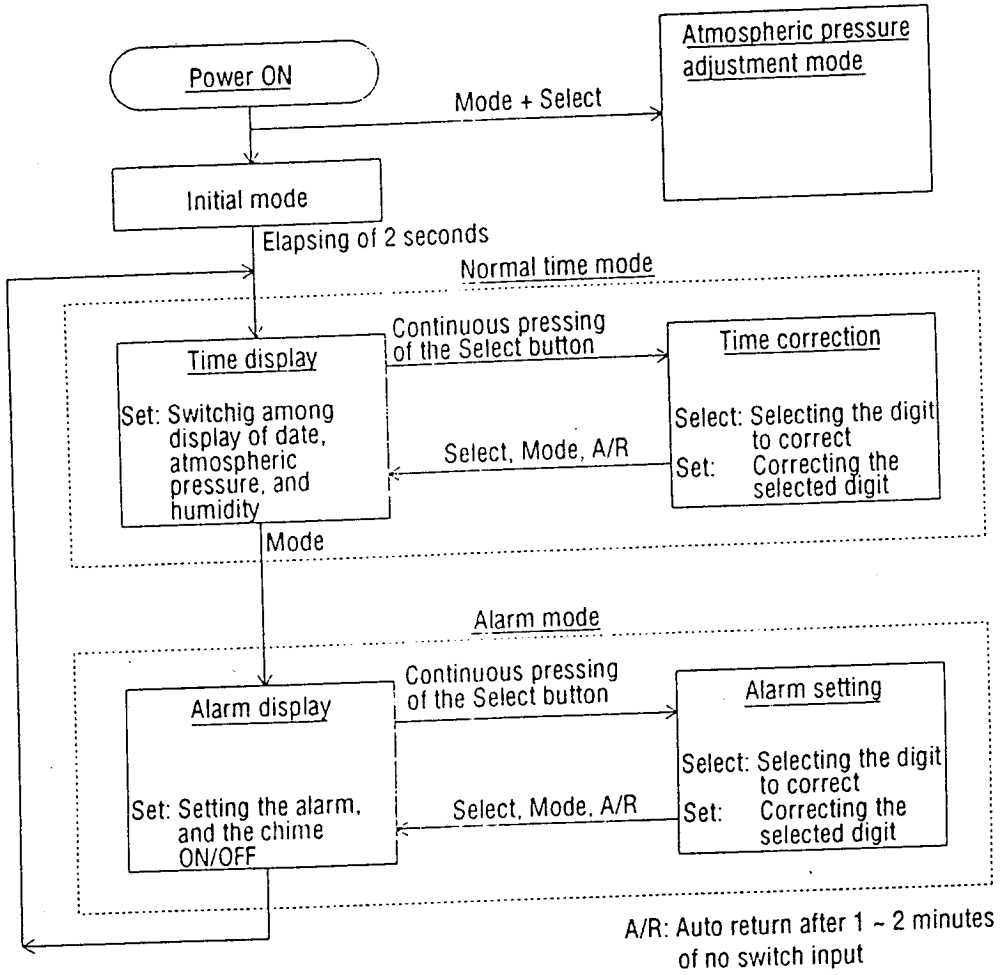
PIN No.	Signal				PIN No.	Signal				PIN No.	Signal			
	COM1	COM2	COM3	COM4		COM1	COM2	COM3	COM4		COM1	COM2	COM3	COM4
1	.	.	.	COM4	11	COMF2	2D	2G	2A	21	8F	8G	8E	1A
2	.	.	COM3	.	12	WARM	CHM	2C	2B	22	11A	11B	hPA	7D
3	.	COM2	.	.	13	HOT	.	3E	3F	23	°C1	7B	7G	7C
4	COM1	.	.	.	14	ALM	3D	3G	3A	24	°F1	7A	7F	7E
5	ADJUST	TIME	0D	0E	15	°F2	°C2	3C	3B	25	6A	6B	6C	DOT1
6	.	ALARM	0C	0G	16	10A	10B	10C	10D	26	6F	6G	6D	0B
7	COLD	1E	1G	1F	17	%	10F	10G	10E	27	5B	BAR	6E	0A
8	COOL	1D	1C	1B	18	9A	9B	9C	DOT2	28	5A	5G	5C	0F
9	COMF1	FINE2	COL	2F	19	9F	9G	9E	9D	29	5F	5E	5D	AM
10	RAIN	CLOUD	FINE1	2E	20	8A	8B	8C	8D	30	4A	4B	PM	.

3. Operation Specifications

The contents on the operation and display of the MCU are explained below.

3.1 Status Transition Diagram

The operation modes and status implemented by the MCU are shown in the transition diagram below.



(Items common to all modes)

- If the time coincides with the alarm time when the alarm has been set, the alarm will sound for 20 seconds.
- If the hour digit is updated through a carry of the minute digit when the chime has been set, the time signal will sound.
- If any switch is operated when the alarm is going off, the alarm will stop, and the previously-set function will be canceled.

3.2 Operation Table

The operations implemented with the MCU are listed in the table below.

Mode			No input	Mode	Select	Set
	Initial mode		–	Invalid	Invalid	Invalid
Normal time	Time display state	Atmospheric pressure & temperature	–	To alarm mode display state	Continuous pressing: Correction state is changed to correction of the second column.	To month, day, & temperature
		Month, day, & temperature				To temperature & humidity
		Temperature & humidity				To atmospheric pressure & temperature
	Time correction state	Second column correction	Changes to Time display state within 1~2 minutes	To hour dispaly state	To minute column correction	Second clearing
		Minute column correction			To hour column correction	(1 PUSH): +1 correction (Continuous pressing): 8Hz+ correction
		Hour column correction			To year column correction	
		Year column correction			To month column correction	
		Month column correction			To day column correction	
		Day column correction			To setting of 12 or 24	
		Setting of 12 or 24			To display state	12 ← → 24
Alarm	Alarm display state	Alarm/Chime OFF	–	To timer mode display state	Continuous pressing: to minute column setting state	Alarm ON
		Alarm ON				Chime ON
		Chime ON				Alarm/Chime ON
		Alarm/Chime ON				Alarm/Chime OFF
	Alarm-setting state	Minute digit setting	To alarm display state within 1~2 minutes	To alarm display state	To hour column setting	(1 PUSH): +1 correction (Continuous pressing): 8Hz+ correction
		Hour digit setting			To display state	
Atmospheric Pressure Adjustment			–	Invalid	Invalid	Invalid
Alarm sound being output			–	Alarm stopped	Alarm stopped	Alarm stopped

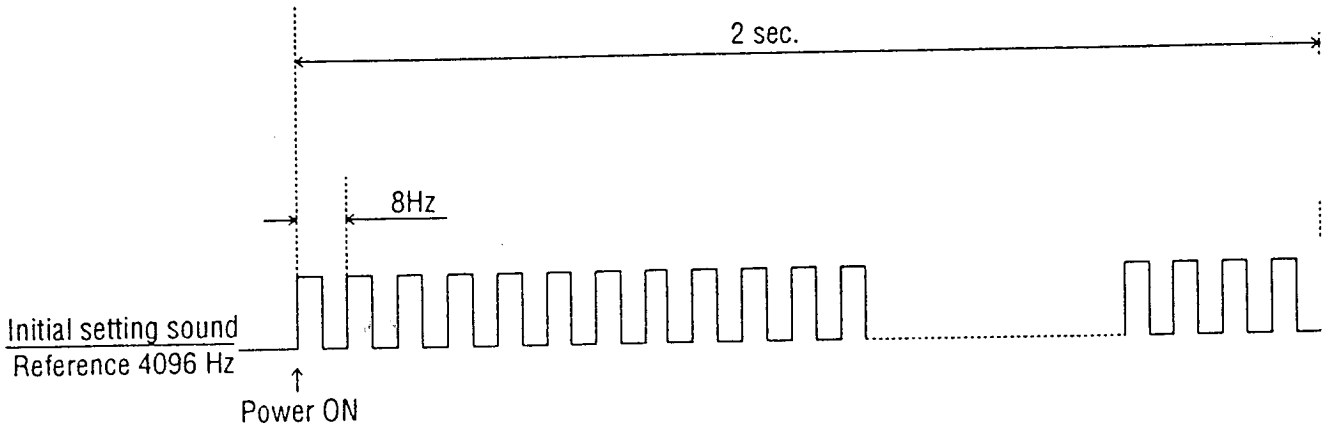
3.3 Initial Mode

After power-on, the mode is shifted to this mode.

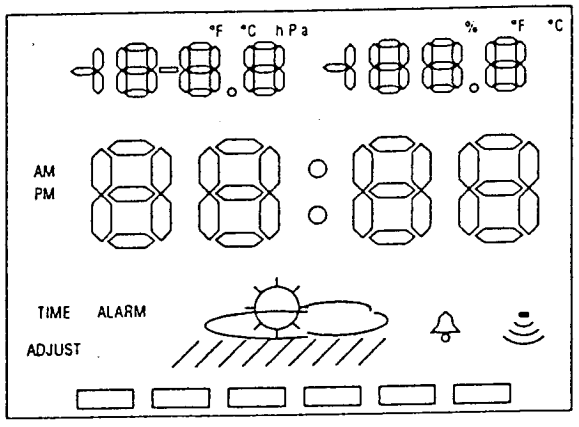
- All LCD segments display for 2 seconds
- Initial setting of respective data

[Initial Settings]
Normal time: AM 12:00:00
Calendar: 1-JAN-1993
Alarm: AM 12:00 (alarm/chime off)

- Temperature, humidity, and atmospheric pressure are measured. (for display)
- Output of the initial setting sound



After 2 seconds, the mode is shifted to a Normal time mode and time display state (atmospheric pressure and temperature).



All segment display

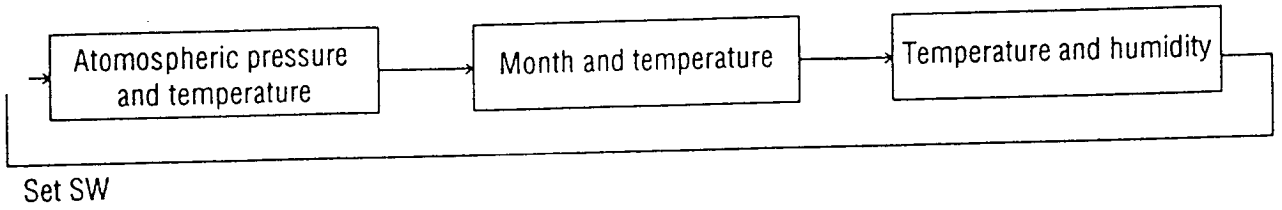
3.4 Normal Time Mode

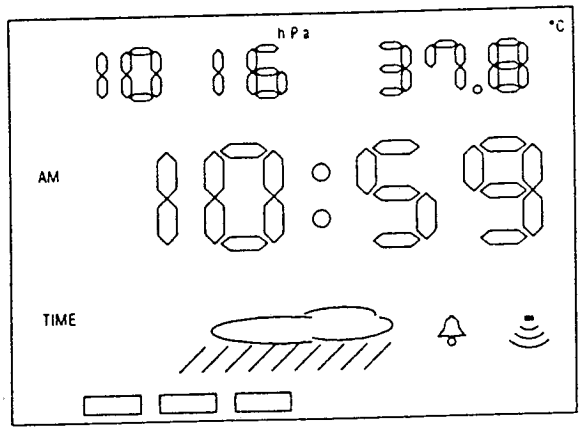
The normal time mode consists of the time display state and the time correction state.

- A colon (:) is flashed at 0.5 Hz frequency.
- If the normal time coincides with the alarm time when the alarm has been set, the alarm will sound for 20 seconds.
- If any switch is pressed while the alarm sound is being output, the alarm will stop, and the previously-set function will be canceled.

3.4.1 Time Display State

- The Mode SW is used to shift to the Alarm display state.
- Continuous pressing of the Select SW is used to shift to the second correction function of the time correction state.
- The Set SW is used to switch to the following displays.





Time display that shows the atmospheric pressure and temperature

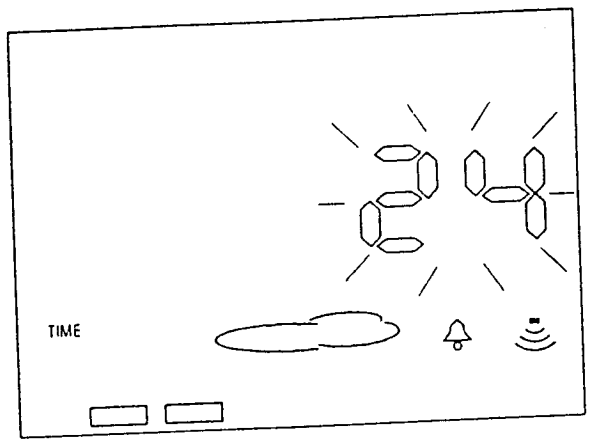
3.4.2 Time Correction State

The time correction state consists of the correction functions for second, minute, hour, day, month, and year.

- The time display state goes into effect through the use of the Mode SW, or through auto return after 1~2 minutes of no input.

(Second correction) The second digits flashes at 1 Hz frequency. Clock, month and day are displayed.

- Shift to the minute correction function using the Select SW.
- Clear the second digits using the Set SW.
  (1 PUSH: Second columns = 00) (Continuous pressing: Invalid)



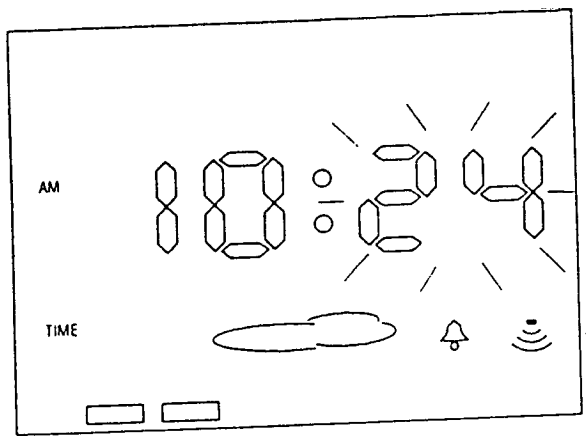
Second correction display

(Minute correction) The minute digits flash at 1 Hz frequency.

- Shift to the hour correction function using the Select SW.
- Correct the minute columns using the Set SW.
  (1 PUSH: Minute digits + 1) (Continuous pressing: Minute digits fast-forwarded at 8 Hz)
  00 through 59, 00 minutes: No carry.

(Hour correction) The hour digits flash at 1 Hz frequency.

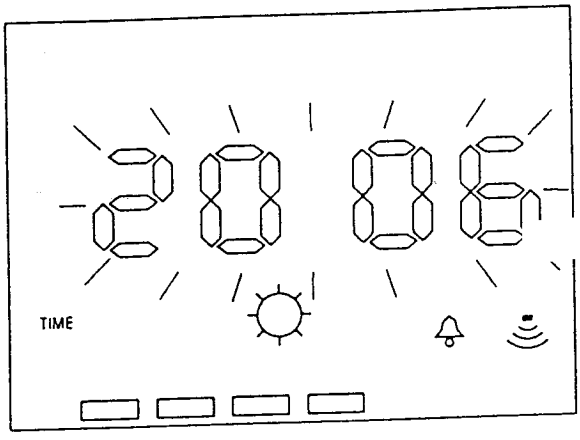
- Shift to the day correction function using the Select SW.
- Correct the hour columns using the Set SW.
  (1 PUSH: Hour digits + 1) (Continuous pressing: Hour digits fast-forwarded at 8 Hz)
  (24-hour system) 00 through 23, 00: No carry.
  (12-hour system) AM12, AM1 through AM11, PM12, PM1 through PM11, AM12: No carry.



Minute correction display

(Year correction) Year digits flash at 1 Hz frequency.

- Shift to the month correction function using the Select SW.
- Use the Set SW to move the year digits forward for correction.
  (1 PUSH: Year digits + 1) (Continuous pressing: Year digits fast-forwarded at 8 Hz)
  1993 through 2023, 1993



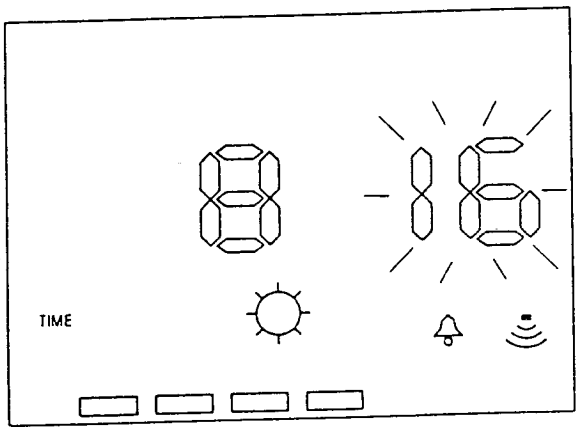
Year correction display

(Month correction) The month digits flash at 1 Hz frequency.

- Shift to the day correction function using the Select SW.
- Correct the month columns using the Set SW.
  (1 PUSH: Month digits + 1) (Continuous pressing: Month digits fast-forwarded at 8 Hz)
  1 through 12, 1: No carry.

(Day correction) The day digits flash at 1 Hz frequency.

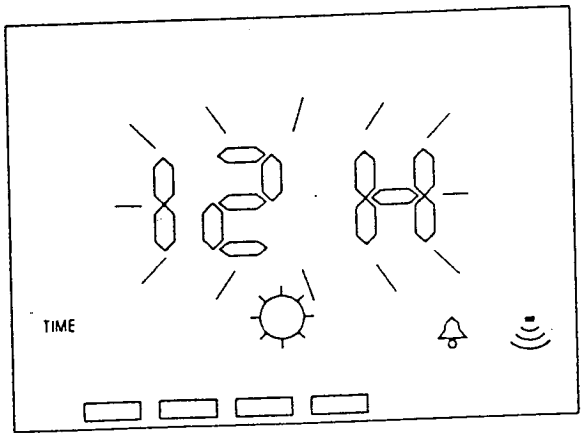
- Shift to the time display state using the Select SW.
- Correct the day columns using the Set SW.
  (1 PUSH: Day digits + 1) (Continuous pressing: Day digits fast-forwarded at 8 Hz)
  (Longer months) 1 through 31: No carry. No nonexistent days.
  (Shorter months) 1 through 30: No carry. No nonexistent days.
  (February in ordinary years) 1 through 28: No carry. No nonexistent days.
  (February in leap years) 1 through 29: No carry. No nonexistent days.



Day correction display

(12/24 hour system setting) 12H or 24H is set.

- Shift to the time display state using the Select SW.
- Correct the time system using the Set SW.
  (1 PUSH: 12H ⟷ 24H) (Continuous pressing: Invalid)



12H/24H setting display

3.5 Alarm Mode

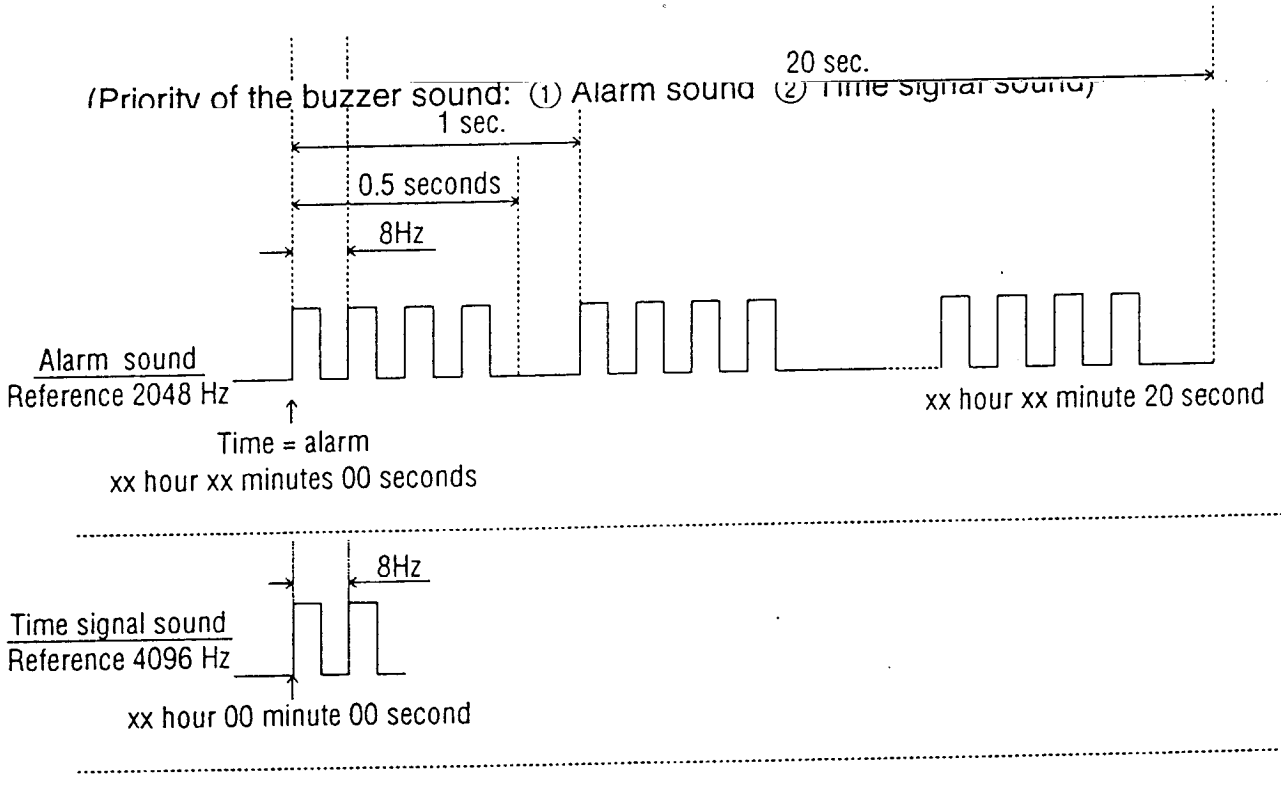
The alarm mode consists of the alarm display state and the alarm setting state.

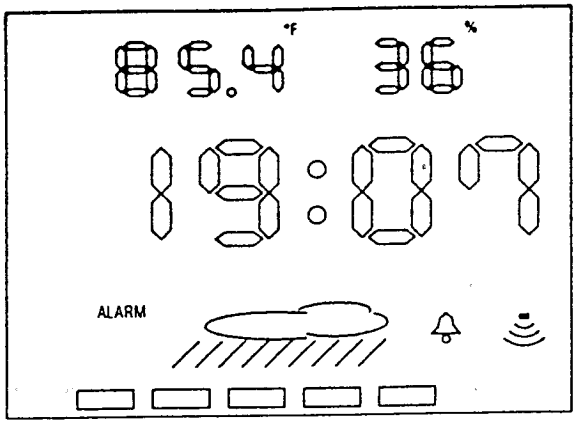
- If the Normal time coincides with the alarm time when the alarm has been set, the alarm will sound for 20 seconds.
- If any switch is pressed while the alarm sound is being output, the alarm will stop, and the previously-set function will be canceled.

3.5.1 Alarm Display State

- A colon (:) is lit.
- Shift to the time display state of the Normal time mode using the Select SW.
- Shift to the Minute setting function of the alarm setting state by continuously pressing the Select SW.
- Set the alarm/chime using the Set SW.
  (1 PUSH: ON/OFF setting) (Continuous pressing: Invalid)
  (Priority of the buzzer sound: ① Alarm sound ② Time signal sound)

Alarm	Chime
Off	Off
On	Off
Off	On
On	On





Alarm display that shows the temperature and humidity.

3.5.2 Alarm Setting State

The alarm setting state consists of the Hour setting and the minute setting functions.

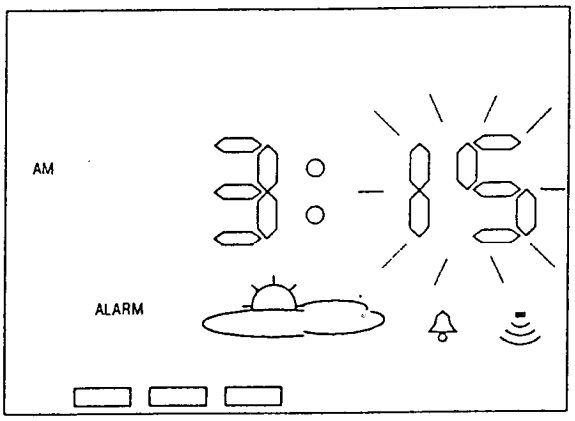
- The alarm display state goes into effect through the use of the Mode SW, or through auto return after 1~2 minutes of no input.

(Minute setting) The minute digits flash at 1 Hz frequency.

- Shift to the minute setting function using the Select SW.
- Correct the minute digits using the Set SW.
  (1 PUSH: Minute digits + 1) (Continuous pressing: Minute digits fast-forwarded at 8 Hz)
  00 through 59, 00 minutes: No carry.

(Hour setting) The hour digits flash at 1 Hz frequency, displaying the alarm time.

- Shift to the alarm display state using the Select SW.
- Set the hour digits using the Set SW.
  (1 PUSH: Hour digits + 1) (Continuous pressing: Hour digits fast-forwarded at 8 Hz)
  (24-hour system) 00 through 23, 00: No carry.
  (12-hour system) AM12, AM1 through AM11, PM12, PM1 through PM11, AM12: No carry.



Display of the alarm minute setting

3.6 Atmospheric pressure Adjustment Mode

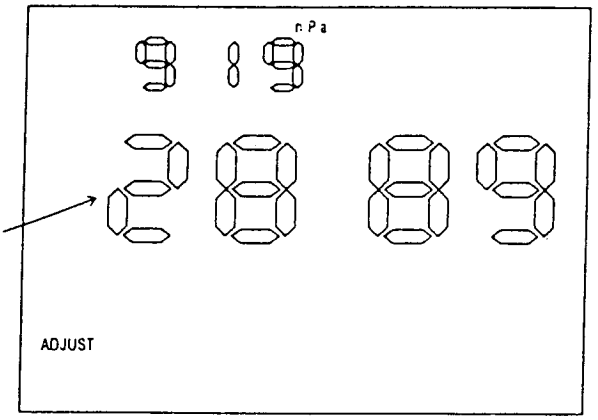
In the power-on, when the mode SW and select SW are simultaneously pressed, all the LCD segments light for one second and the mode is shifted to this mode.

- The atmospheric pressure is measured every one second.
- The key input is invalid.

The atmospheric pressure adjustment method is shown below.
The atmospheric pressure adjustment is performed by varying variable resistors Rsp and Rof.

1 Add the atmospheric pressure of 621hPa.
2 Fit the A/D count value to 3256 by varying the Rof value.
3 Add the atmospheric pressure of 1111hPa.
4 Fit the A/D count value to 2652 by varying the Rsp value.
5 When the A/D count value is 3256 after adding the atmospheric pressure of 621hPa, the atmospheric pressure adjustment finishes. When the A/D count value is different from 3256, readjust items from 1 to 4.

This mode finishes by the power-off.



A/D count value

Displays of the atmospheric pressure and A/D count

SUNSTAR 深圳市商斯达电子有限公司
SHENZHEN SUNSTAR ELECTRONICS CO.,LTD.
地址(Add):深圳福田区福华路福庆街鸿图大厦1602室
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传真(Fax):0755-3376182 E-mail:szsunstr@public.szptt.net.cn
网址: Http://www.sunstare.com/ 手机:(0)13902971329
西安办事处电话:(0)13609291696 191-8454356
北京办事处电话:(0)13501189838 191-8886650
上海办事处电话:(0)13701955389 191-3789221

4. Display Specifications

4.1 Display Table

The displays implemented with the MCU are listed in the table below.

Mode	Segment / State	Mark			7 segments				Mark				
		TIME	ALARM	ADJUST	0	1	2	3	AM	PM	COL	CHM	ALM
Initial mode		●	●	●	8	8	8	8	●	●	●	●	●
Normal time	Time display — Atmospheric pressure, temperature	●	Off	Off	10 o'clock	1 o'clock	10 minutes	1 minute	AM/PM		○		
	Month, day, temperature	↑	↑	↑	↑	↑	↑	↑	↑		↑		
	Temperature, humidity	↑	↑	↑	↑	↑	↑	↑	↑		↑		
	Time correction state — Second column	↑	↑	↑	Off	Off	10 seconds	1 second	Off	Off	Off		
	Minute column	↑	↑	↑	10 o'clock	1 o'clock	10 minutes	1 minute	AM/PM		●		
	Hour column	↑	↑	↑	10 o'clock	1 o'clock	10 minutes	1 minute	AM/PM		●		
	Year column	↑	↑	↑	1000	100	10 years	1 year	Off	Off	Off		
	Month column	↑	↑	↑	October	January	the 10th	the 1st	↑	↑	↑		
	Day column	↑	↑	↑	October	January	the 10th	the 1st	↑	↑	↑		
	12/24	↑	↑	↑	10 o'clock	1 o'clock	H	Off	↑	↑	↑		
Alarm	Alarm display — Alarm/Chime OFF	Off	●	Off	10 o'clock	1 o'clock	10 minutes	1 minute	AM/PM		●		
	Alarm ON/Chime OFF	↑	↑	↑	↑	↑	↑	↑	↑		↑		
	Alarm OFF/Chime ON	↑	↑	↑	↑	↑	↑	↑	↑		↑		
	Alarm/Chime ON	↑	↑	↑	↑	↑	↑	↑	↑		↑		
	Alarm setting state — Hour column	↑	↑	↑	10 o'clock	1 o'clock	↑	↑	AM/PM		↑		
	Minute column	↑	↑	↑	10 o'clock	1 o'clock	10 minutes	1 minute	AM/PM		↑		
Atmospheric pressure adjustment		Off	Off	●	1000AD	100AD	10AD	1AD	Off	Off	Off	–	–

*2 Goes on when the chime is ON; otherwise OFF

*3 Goes on when the alarm is ON; otherwise OFF

Note: The AM/PM mark will always be off in the 24 hour system.

Outlined characters indicate flashing at 1 Hz frequency.

● indicates ON

○ indicates flashing at 1 Hz frequency

Mode	State / Segment	3 segments	7 segments			Mark				
		4A4B	5	6	7	BAR	DOT 1	hPa	°C1	°F1
Initial mode		-I	8	8	8	●	●	●	●	●
Normal time	Time display — Atmospheric pressure, temperature	1000hPa	100hPa	10hPa	1hPa	Off	Off	●	Off	Off
	Month, day, temperature	10 months	1 month	10 days	1 day	●	↑	Off	↑	↑
	Temperature, humidity	100 degrees	10 degrees	1 degree	0.1 degrees	Off	●	↑	°C/°F	
	Time correction state — Second column	Off	Off	Off	Off	↑	Off	↑	Off	Off
	Minute column	↑	↑	↑	↑	↑	↑	↑	↑	↑
	Hour column	↑	↑	↑	↑	↑	↑	↑	↑	↑
	Year column	↑	↑	↑	↑	↑	↑	↑	↑	↑
	Month column	↑	↑	↑	↑	↑	↑	↑	↑	↑
	Day column	↑	↑	↑	↑	↑	↑	↑	↑	↑
	12/24	↑	↑	↑	↑	↑	↑	↑	↑	↑
Alarm	Alarm display — Alarm/Chime OFF	Follows the state set in clock display								
	Alarm ON/Chime OFF	↑								
	Alarm OFF/Chime ON	↑								
	Alarm/Chime ON	↑								
	Alarm setting state — Hour column	Off	Off	Off	Off	Off	Off	Off	Off	Off
	Minute column	↑	↑	↑	↑	↑	↑	↑	↑	↑
Atmospheric pressure adjustment		1000hPa	100hPa	10hPa	1hPa	Off	Off	●	Off	Off

● indicates ON

Mode	State / Segment	3 segments	7 segments			Mark			
		11A11B	5	6	7	DOT 2	%	°C 2	°F 2
Initial mode		–1	8	8	8	●	●	●	●
Normal time	Time display — Atmospheric pressure, temperature	100 degrees	10 degrees	1 degree	0.1 degrees	●	Off	°C/°F	
	Month, day, temperature	↑	↑	↑	↑	↑	↑	↑	
	Temperature, humidity	100%	10%	1%	Off	Off	●	Off	Off
	Time correction state — Second column	Off	Off	Off	Off	Off	Off	Off	Off
	Minute column	↑	↑	↑	↑	↑	↑	↑	↑
	Hour column	↑	↑	↑	↑	↑	↑	↑	↑
	Year column	↑	↑	↑	↑	↑	↑	↑	↑
	Month column	↑	↑	↑	↑	↑	↑	↑	↑
	Day column	↑	↑	↑	↑	↑	↑	↑	↑
	12/24	↑	↑	↑	↑	↑	↑	↑	↑
Alarm	Alarm display — Alarm/Chime OFF	Follows the state set in clock display							
	Alarm ON/Chime OFF	↑							
	Alarm OFF/Chime ON	↑							
	Alarm/Chime ON	↑							
	Alarm setting state — Hour column	Off	Off	Off	Off	Off	Off	Off	Off
	Minute column	↑	↑	↑	↑	↑	↑	↑	↑
Atmospheric pressure adjustment		Off	Off	Off	Off	Off	Off	Off	Off

● indicates ON

Mode	Segment	FINE2	FINE1	CLOUD	RAIN
Initial mode		●	●	●	●
Weather forecasting level in modes or states other than the above	Level 1	●	●		
	Level 2	●		●	
	Level 3			●	
	Level 4			●	●

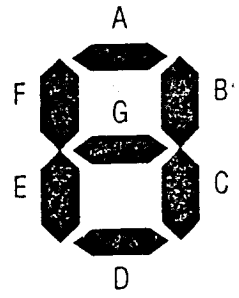
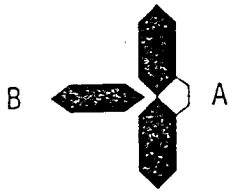
Mode	Segment	COLD	COOL	CONF1	CONF2	WARM	HOT
Initial mode		●	●	●	●	●	●
Discomfort index level in modes or states other than the above	Level 1	●					
	Level 2	●	●				
	Level 3	●	●	●			
	Level 4	●	●	●	●		
	Level 5	●	●	●	●	●	
	Level 6	●	●	●	●	●	●

4.2 Display RAM Map

The display RAM map which corresponds to the LCD layout is shown below.

Display register [SFR address]	bit3	bit2	bit1	bit0	Display register [SFR address]	bit3	bit2	bit1	bit0
DSPR00[40h]	8D	8C	8B	8A	DSPR16[50h]	0D	0C	0B	0A
DSPR01[41h]		8G	8F	8E	DSPR17[51h]		0G	0F	0E
DSPR02[42h]	9E	9C	9B	9A	DSPR18[52h]	1D	1C	1B	1A
DSPR03[43h]		9G	9F	9E	DSPR19[53h]		1G	1F	1E
DSPR04[44h]	10D	10C	10B	10A	DSPR20[54h]	2D	2C	2B	2A
DSPR05[45h]		10G	10F	10E	DSPR21[55h]		2G	2F	2E
DSPR06[46h]			%	11A	DSPR22[56h]	3D	3C	3B	3A
DSPR07[47h]	11B	° F2	° C2	DOT2	DSPR23[57h]		3G	3F	3E
DSPR08[48h]	5D	5C	5B	5A	DSPR24[58h]	ADJUST		ALARM	TIME
DSPR09[49h]		5G	5F	5E	DSPR25[59h]		PM	AM	COL
DSPR10[4ah]	6D	6C	6B	6A	DSPR26[5ah]	COMF2	COMF1	COOL	COLD
DSPR11[4bh]		6G	6F	6E	DSPR27[5bh]			HOT	WARM
DSPR12[4ch]	7D	7C	7B	7A	DSPR28[5ch]	FINE2	FINE1	CLOUD	RAIN
DSPR13[4dh]		7G	7F	7E	DSPR29[5dh]				
DSPR14[4eh]		hPa	BAR	4A	DSPR30[5eh]	CHM	ALM		
DSPR15[4fh]	4B	° F1	° C1	DOT1					

LCD Display Pattern

7 S E G		3 S E G	
– Applicable columns – 0, 1, 2, 3, 5, 6, 7, 8, 9, 10		– Applicable columns – 4, 11	

NO	7SEG										3SEG	
	0	1	2	3	4	5	6	7	8	9	minus	1
Pattern												

5. Functional Specifications

The functions implemented with the MCU are explained here.

5.1 Normal Time and Calendar Functions

The normal time is based on the AM/PM 12-hour system. The calendar covers 1993 through 2023 (with automatic calculation of leap years), and the time is updated every second.

Timing	Content	Range
Every second	Second column + 1	00 ~ 59 seconds → 00 seconds (second column carry)
Second column carry	Minute column + 1	00 ~ 59 seconds → 00 minutes (minute column carry)
Minute column carry	Hour column + 1	(12-hour system) AM12 → AM1 ~ AM11 → PM12 → PM1 ~ PM11 → AM12 (hour column carry)
		(24-hour system) 00 ~ 23 o'clock → 00 o'clock (hour column carry)
Hour column carry	Day column + 1	Long months: 1 ~31 → 1(day colum carry)
		Short months: 1 ~30 → 1(day colum carry)
		February in ordinary year: 1 ~ 28 → 1(day column carry)
		February in leap year: 1 ~ 29 → 1(day column carry)
Day column carry	Month column + 1	1 ~ 12 → 1(month column carry)
Month column carry	Year column + 1	1993 ~ 2023 → 1993

Individual columns of the normal time and calendar can be adjusted separately in the time correction mode.
Note that in the time signal setting, the time signal sound is output synchronously with a minute column carry.

5.2 Alarm Function

The alarm function checks every minute for a match between the hour and minute columns of the normal time and those of the alarm. When there is a match while the alarm is set, the alarm sound is output for 20 seconds (between 00 and 19 seconds of the normal time). This checking will not be performed while the clock is being adjusted or the alarm is being set.
The hour and minute columns of the alarm can be adjusted in the alarm mode. The alarm can also be set to ON or OFF in this mode.

5.3 Temperature, Humidity, and Atmospheric Pressure Measurement Functions

The analog readings of temperature, humidity, and atmospheric pressure are read by the A/D converters at specified time intervals. Those readings are then converted into appropriate temperature, humidity, and atmospheric pressure values, using certain calculation equations.

5.3.1 Temperature Measurement

- Temperature measurements are taken every 10 seconds(sensor measurement time=Normal) / 1 second(sensor measurement time=Fast).
- The temperature measurement range is -50.0~+70.0°C (-58.0~+158.0°F).
- When the temperature measurement exceeds, the temperature range flashes at 0.5 sec.
- The temperature unit increment is 0.1°C (0.1°F).

5.3.2 Humidity Measurement

- Humidity measurements are taken every 1 minute(sensor measurement time=Normal) / 10 seconds(sensor measurement time=Fast).
- The humidity measurement range is 20~90%.
- The humidity unit increment is 1%.
- When the measurement range exceeds, the humidity value flashes at 0.5 sec.
- When the temperature range to be used exceeds, the bar display (– – %) is shown.
- Humidity values are calculated using several linear approximation formulas, depending on temperature and humidity range.

5.3.3 Atmospheric Pressure Measurement

- Atmospheric pressure measurements are taken every 5 minutes(sensor measurement time=Normal) / 1 minute(sensor measurement time=Fast).
- The atmospheric pressure measurement range is 850~1050 hPa
- The atmospheric pressure unit increment is 1 hPa.
- When the atmospheric pressure range exceeds, the atmospheric pressure value flashes at 0.5 sec.
- When the measurement range to be used exceeds, the bar display (– – – – hPa) is shown.

5.4 Uncomfortable Index Determination Function

The uncomfortable index is a gauge for measuring the degree of heat or cold. The uncomfortable index is calculated based on temperature and humidity values, and one of the 6 levels is displayed after humidity measurement.

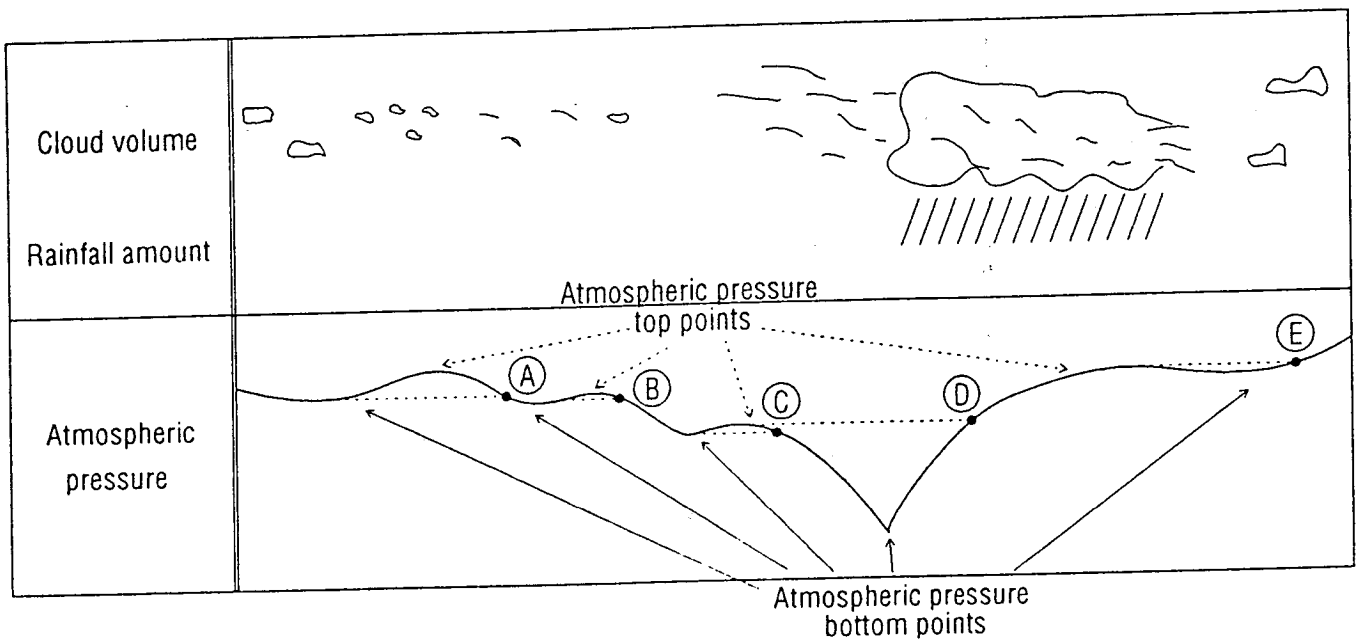
Uncomfortable index value = 0.81 • Temperature (°C) + 0.01 • Humidity (0.99 • Temperature (°C) - 14.3) + 46.3

Level	Uncomfortable index value (x)
1	$X \leq 60$
2	$60 < X \leq 65$
3	$65 < X \leq 70$
4	$70 < X \leq 75$
5	$75 < X \leq 80$
6	$80 < X$

5.5 Weather Forecasting Function

The weather forecasting function forecasts weather changes, based on changes in atmospheric pressure.

5.5.1 Weather Pattern (Atmospheric Pressure Changes and Approach to Weather)



When weather becomes good. ..... Atmospheric pressure value goes higher than its most recent top point.

When weather becomes bad. ..... Atmospheric pressure value goes lower than its most recent bottom point.

It is judged that the weathers at Ⓐ , Ⓑ and Ⓒ portions become bad.
It is judged that the weathers at Ⓓ and Ⓔ portions become good.

5.5.2 Initial Weather Display

After the power-on, all the weather display sections light. (atmospheric pressure top point = its bottom point)
As shown below, the weather displays vary with the changes in atmospheric pressure.

Atmospheric pressure change			Weather display
First	Second	Third	
↑	↑	↑	Fine
↑	↑	↓	Fine and cloud
↑	↓	↑	Fine
↑	↓	↓	Cloud
↓	↑	↑	Fine and cloud
↓	↑	↓	Rain
↓	↓	↑	Cloud
↓	↓	↓	Rain

↑: This shows that the atmospheric pressure value has gone higher than most recent atmospheric pressure top point.
↓: This shows that the atmospheric pressure value has gone lower than most recent atmospheric pressure bottom point.

5.6 Serial Transmission Function

The serial transmission function transmits through the serial port, the values for the calendar, time, temperature, humidity, and atmospheric pressure, at the time when the hour column is updated in the normal time.

5.6.1 Transmission Data

The calendar, time, temperature, humidity, and atmospheric pressure data are transmitted in this order.

(1) All data must be ASCII format 8-bit data.
(2) A space code is transmitted as a delimiter between each piece of data, and a CR code is transmitted after all data have been sent.
(3) The calendar months are expressed as three-digit alphanumeric characters.
January: JAN, February: FEB, March: MAR, April: APR, May: MAY, June: JUN, July: JUL, August: AUG, September: SEP, October: OCT, November: NOV, December: DEC
(4) If the tens column of the day, hour, and humidity values is "0", a blank space will be transmitted for that column. If the tens and/or hundreds columns of the temperature value are "0", a blank space will be transmitted for the empty column(s).
(5) "°C" or "°F" is transmitted as the unit of temperature.
(6) When the temperature exceeds the range to be used, the digits of humidity and temperature transmit respectively bar codes (–).
(Humidity: – – %, atmospheric pressure: – – – – hPa)

Transmission Example (December 31, 1999; 12:00 o'clock; Temperature of 8.6°C; Humidity of 40%; Atmospheric pressure of 1008 hPa)

31-DEC-1999 □ 12 : 00 □ □ □ 8.6° C □ 40 % □ 1008hPa △
Date Time Temperature Humidity Atmospheric pressure

□: Indicates a space △: Indicates a CR

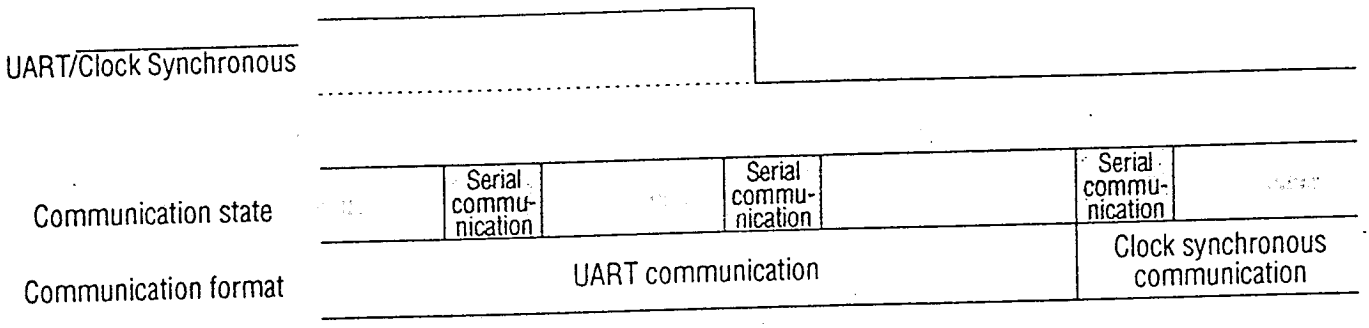
Transmission Data Code Table

Each piece of data is to be transmitted in ASCII-format 8-bit code, as shown below.

Special data		Numerical data		Character data			
Data	Code (hex)	Data	Code (hex)	Data	Code (hex)	Data	Code (hex)
Space	20h	0	30h	A	41h	O	4Fh
CR	0Dh	1	31h	B	42h	P	50h
:	3Ah	2	32h	C	43h	R	52h
BAR(–)	2Dh	3	33h	D	44h	S	53h
.	2Eh	4	34h	E	45h	T	54h
%	25h	5	35h	F	46h	U	55h
°	DFh	6	36h	G	47h	V	56h
		7	37h	J	4Ah	Y	59h
		8	38h	L	4Ch	a	61h
		9	39h	N	4Eh	h	68h

5.6.2 Serial Communication Specifications

The Serial Communication Format UART/$\overline{\text{Clock Synchronous}}$ setting switch (P0.0) sets a flag when a level change occurs, and switches to the next timing.

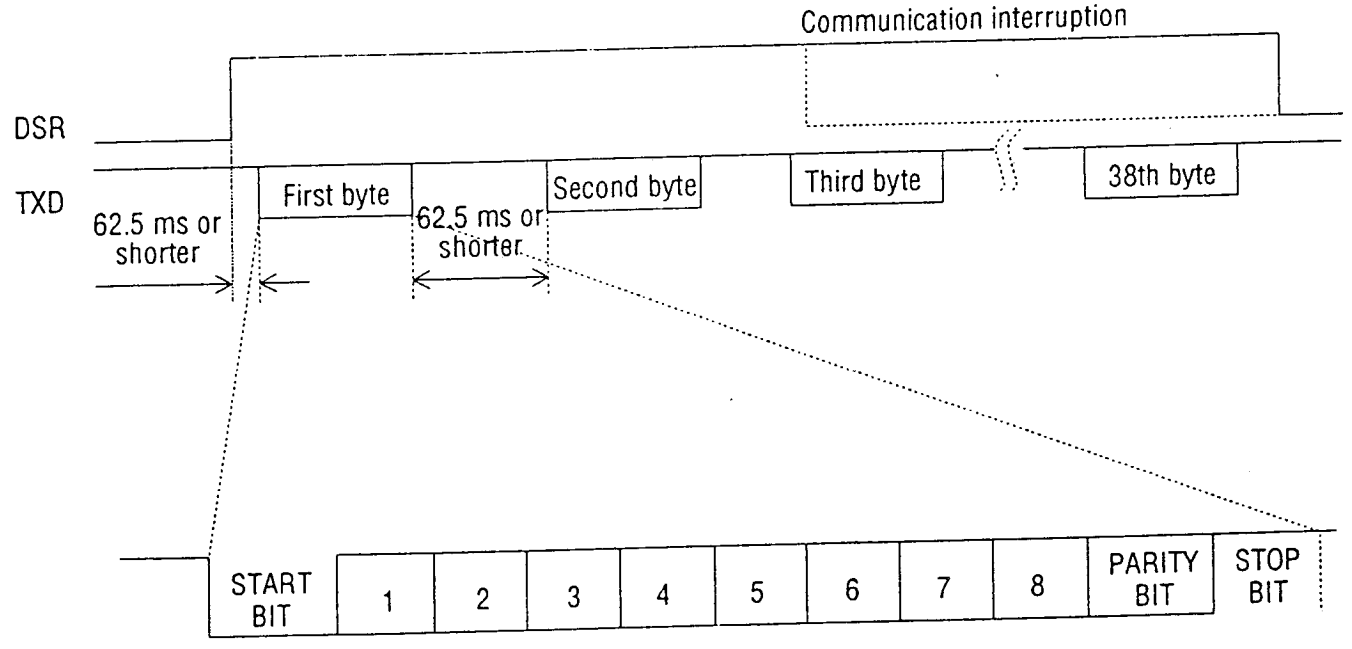


The 38 bytes of data containing the calendar, time, temperature, humidity, and atmospheric pressure taken when DSR rises, is serially transmitted to an outside destination, using the 11-bit UART format or clock synchronous.

11-Bit UART Format Communication

The 11-bit UART format is an asynchronous communication format in which one communication unit consists of "the start bit + 8 data bits + the parity bit + the stop bit", and the communication speed is fixed at 9600 bps.

UART Format Timing Chart



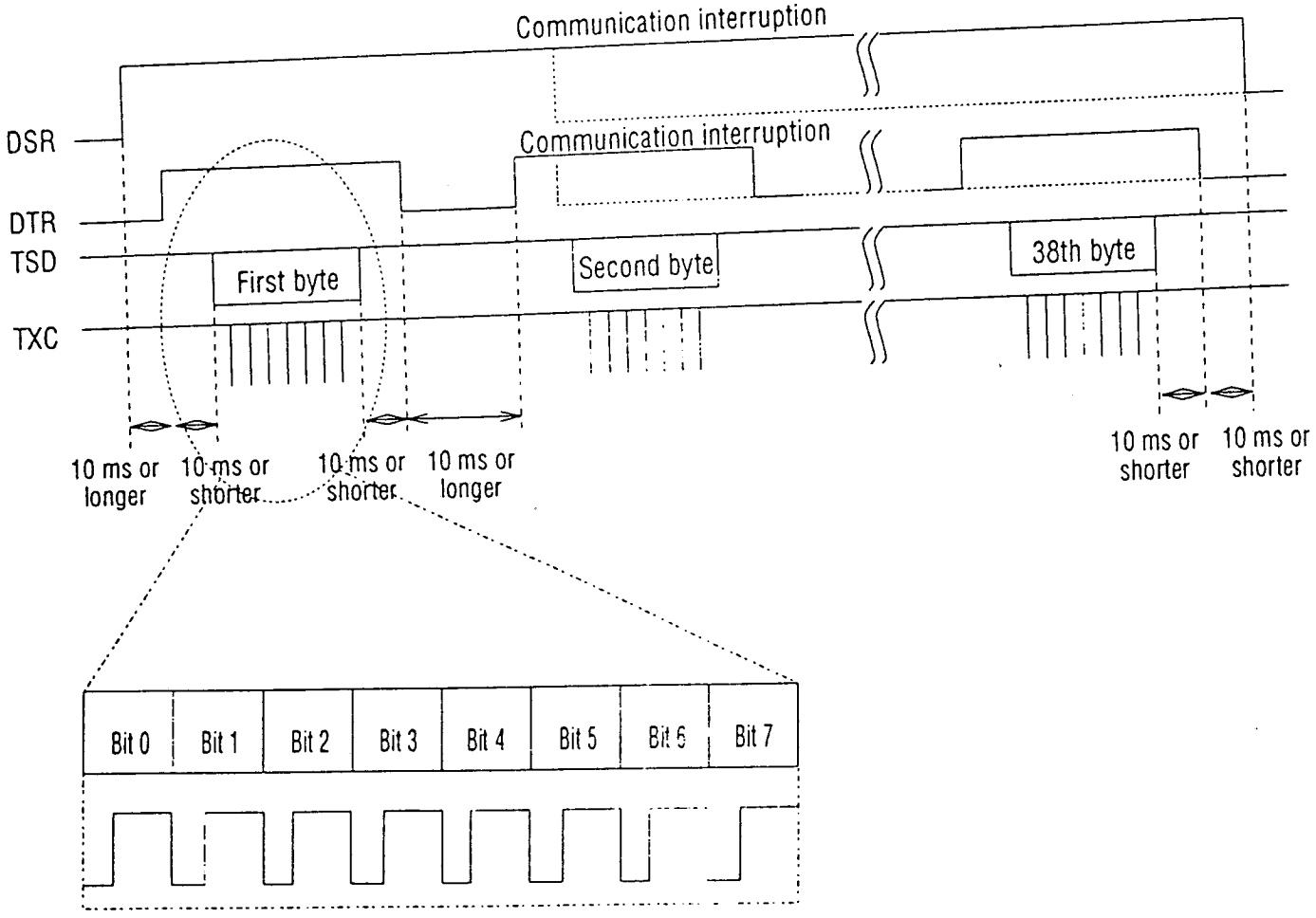
[UART Communication]

(1) Communication start:
Communication is considered to start when DSR rises.
(2) Data transmission:
11-bit UART format communication is performed for every byte.
(3) Normal termination of communication:
The point at which the 38 bytes have been transmitted is regarded as the end of communication.
(4) Abnormal termination of communication:
If DSR falls during communication, the communication will be abnormally terminated.

Clock Synchronous Format Communication

The clock synchronous format is a communication format in which one communication unit consists of "8 data bits", and clock-synchronized (TXC) data is transmitted using an external control signal (DSR, DTR). The communication speed of one bit is fixed at 32 KHz.

Clock Synchronous Format Transmission Timing Chart



[Clock Synchronous Communication]

(1) Communication start:
Communication is considered to start when DSR rises.

(2) 1-byte communication preparation 1:
Communication preparation is made before DTR rises(within 10 ms).

(3) 1-byte data communication:
1-byte clock synchronous communication is started when DTR rises.
If DTR does not rise within 10 ms, the result is abnormal termination.

(4) 1-byte communication termination:
After 1-byte is sent, DTR falls within 10 ms.
If DTR does not fall within 10 ms, the result is abnormal termination.

(5) 38-byte communication:
The processes in (2) through (4) are repeated for 38 bytes.

(6) Normal termination of communication:
When DSR falls within 10 ms after 38 bytes have been sent, communication terminates normally.

(7) Abnormal termination of communication:
If DSR falls before the end of communication, the communication is abnormally terminated.

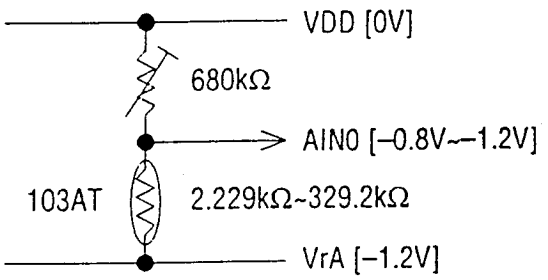
Note: For both normal and abnormal terminations, the system immediately ends the communication, and waits for DSR to rise.

6. Sensor Specifications

This section explains the sensors used by the MCU.

6.1 Temperature Sensor

The temperature sensor used is the Thermistor "103AT" made by Ishizuka Electronics.
Block Diagram



Temperature/Resistance Correspondence Table

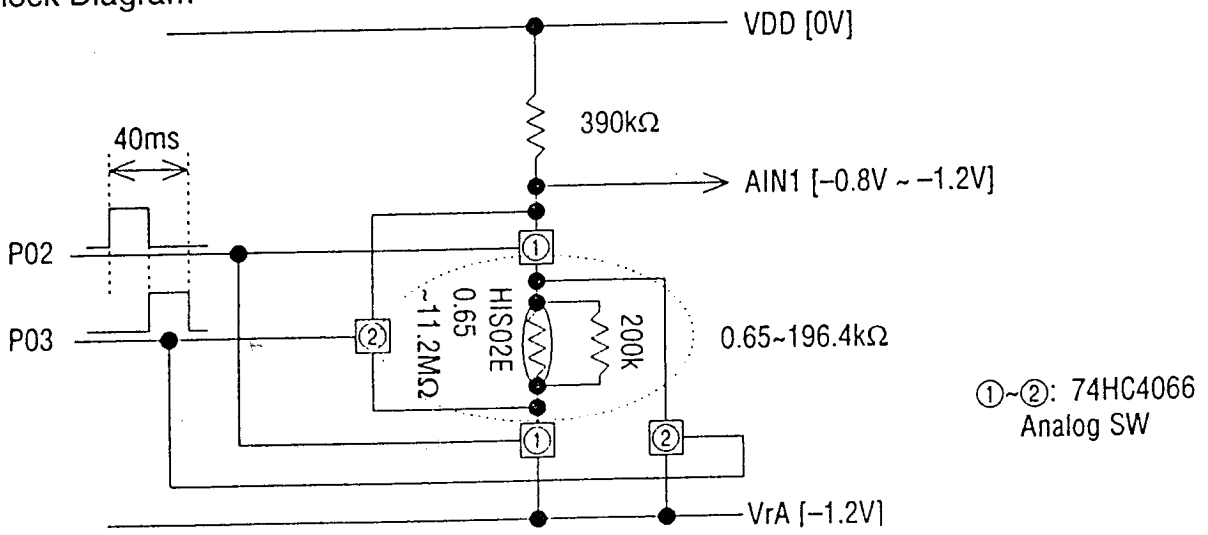
Temperature °C	Resistance kΩ	Temperature °C	Resistance kΩ	Temperature °C	Resistance kΩ	Temperature °C	Resistance kΩ
–50	329.2	–30	111.3	–10	42.45	10	17.96
–49	310.7	–29	105.7	–9	40.56	11	17.24
–48	293.3	–28	100.4	–8	38.76	12	16.55
–47	277.0	–27	95.47	–7	37.05	13	15.90
–46	261.8	–26	90.80	–6	35.43	14	15.28
–45	247.5	–25	86.39	–5	33.89	15	14.68
–44	234.1	–24	82.22	–4	32.43	16	14.12
–43	221.6	–23	78.29	–3	31.04	17	13.57
–42	209.8	–22	74.58	–2	29.72	18	13.06
–41	198.7	–21	71.07	–1	28.47	19	12.56
–40	188.4	–20	67.74	0	27.28	20	12.09
–39	178.3	–19	64.54	1	26.13	21	11.63
–38	168.9	–18	61.52	2	25.03	22	11.20
–37	160.1	–17	58.66	3	23.99	23	10.78
–36	151.8	–16	55.95	4	22.99	24	10.38
–35	144.0	–15	53.39	5	22.05	25	10.00
–34	136.6	–14	50.96	6	21.15	26	9.632
–33	129.7	–13	48.66	7	20.29	27	9.281
–32	123.2	–12	46.48	8	19.48	28	8.994
–31	117.1	-11	44.41	9	18.70	29	8.622

Temperature °C	Resistance kΩ	Temperature °C	Resistance kΩ	Temperature °C	Resistance kΩ
30	8.313	50	4.161	70	2.229
31	8.015	51	4.026		
32	7.729	52	3.897		
33	7.455	53	3.772		
34	7.192	54	3.652		
35	6.941	55	3.537		
36	6.699	56	3.426		
37	6.468	57	3.319		
38	6.246	58	3.216		
39	6.033	59	3.116		
40	5.828	60	3.021		
41	5.630	61	2.928		
42	5.439	62	2.838		
43	5.256	63	2.752		
44	5.080	64	2.669		
45	4.912	65	2.589		
46	4.749	66	2.512		
47	4.594	67	2.437		
48	4.444	68	2.365		
49	4.300	69	2.296		

6.2 Humidity Sensor

The humidity sensor used is the "HIS-02E" sensor made by Hokuriku Electric.
Rated voltage: AC 1 V
Rated power: 0.3 mW
Operating temperature range: 0~50°C
Frequency: 50 Hz~1 kHz

Block Diagram



The temperature sensor is used in AC. Therefore, the analog switch by switching the ON/OFF of P02 and P03 is operated and the AC is given to the sensor.

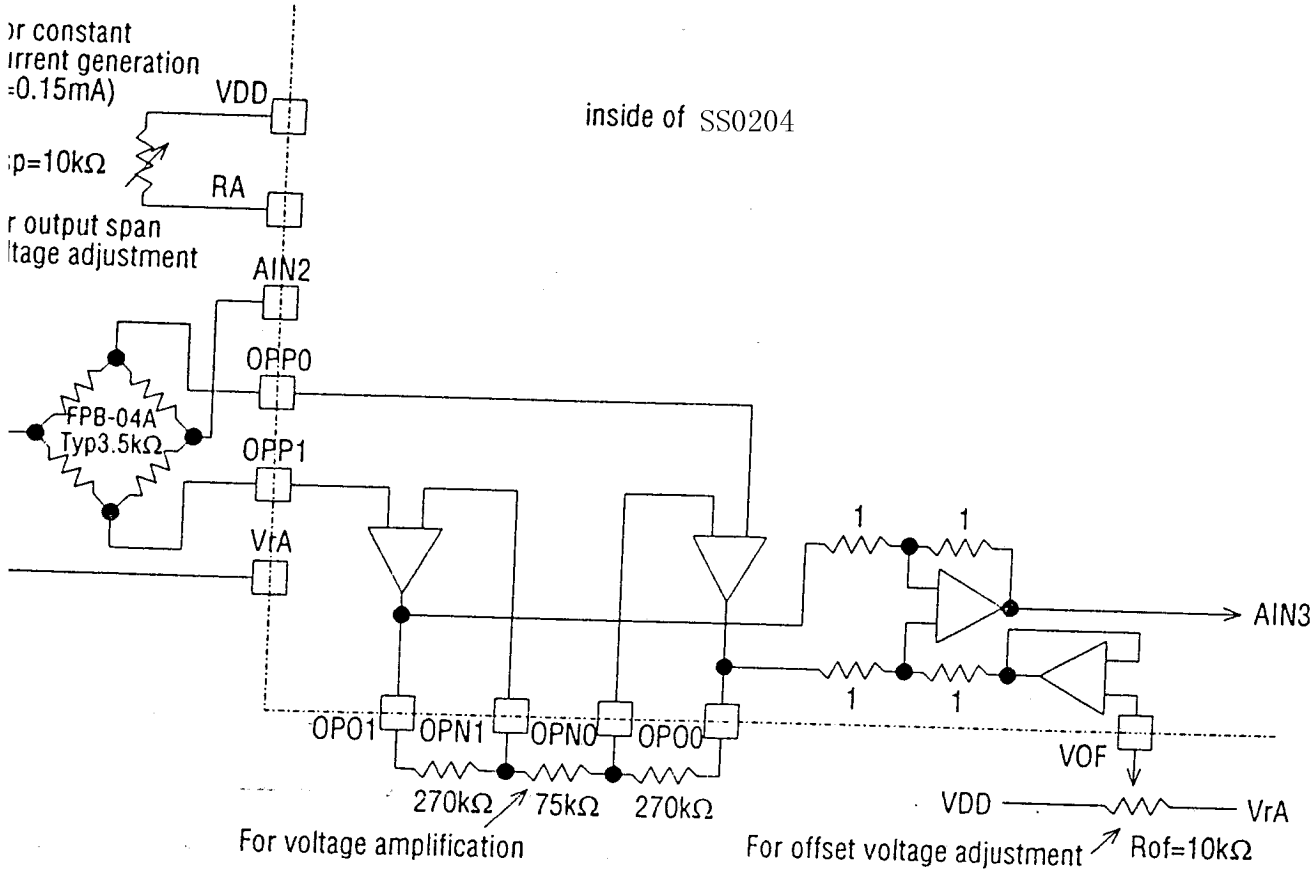
Humidity/Sensor/Resistance/TOTAL Resistance Correspondence Table at Specified Temperatures

5°C		15°C		25°C		35°C		45°C	
Humidity %	HIS resistance [TOTAL resistance] kΩ	Humidity %	HIS resistance [TOTAL resistance] kΩ	Humidity %	HIS resistance [TOTAL resistance] kΩ	Humidity %	HIS resistance [TOTAL resistance] kΩ	Humidity %	HIS resistance [TOTAL resistance] kΩ
30	11239[196.4]	30	3038[187.88]	30	888[163.64]	30	355[128.57]	30	132[78.79]
35	4200[190.91]	35	1300[173.33]	35	400[133.3]	35	170[91.89]	35	68[50.75]
40	1800[180.0]	40	550[146.67]	40	190[97.44]	40	85[59.65]	40	38[31.93]
45	820[160.78]	45	280[116.67]	45	100[66.67]	45	46[37.40]	45	22[19.82]
50	447[138.46]	50	140[82.35]	50	55.4[43.14]	50	26.8[24.56]	50	13.6[13.08]
55	230[106.98]	55	75[54.55]	55	32[27.59]	55	17[15.67]	55	8.5[8.15]
60	130[78.79]	60	45[36.73]	60	19[17.35]	60	10[9.52]	60	5.7[5.54]
65	75[54.55]	65	28[24.56]	65	12[11.32]	65	6.5[6.30]	65	3.8[3.73]
70	45.2[36.73]	70	17.7[16.51]	70	8.23[7.88]	70	4.54[4.50]	70	2.65[2.66]
75	28[24.56]	75	11[10.43]	75	5.4[5.26]	75	3.0[2.96]	75	1.9[1.88]
80	18[16.51]	80	7.1[6.86]	80	3.6[3.54]	80	2.0[1.98]	80	1.3[1.29]
85	11[10.43]	85	4.8[4.69]	85	2.4[2.37]	85	1.4[1.39]	85	0.9[0.9]
90	7.32[6.95]	90	3.09[3.05]	90	1.56[1.49]	90	0.944[0.95]	90	0.650[0.65]

3.3 Pressure Sensor

The pressure sensor used is the "FPB-04A" sensor made by Fujikura.
Pressure range: 633.2~1133.2 g/cm2
Drive current: 0.15 mA
Operating temperature: -10~65°C
Offset voltage: 2~10 mV
Bridge resistance: 2500~4500 Ω
Output span voltage: 2.4~7.2 mV (633.2~1133.2 g/cm2)

Block Diagram



The pressure-output voltage characteristics of the pressure sensor are different due to each sensor. Therefore, the pressure is adjusted by varying the offset voltage and output span voltage (the variable resistor shown in the above diagram) and make sure so that the pressure-output voltage characteristics of all the sensors can keep constant.

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