TOSHIBA CMOS Digital Integrated Circuit Silicon Monolithic

JT9648-AS

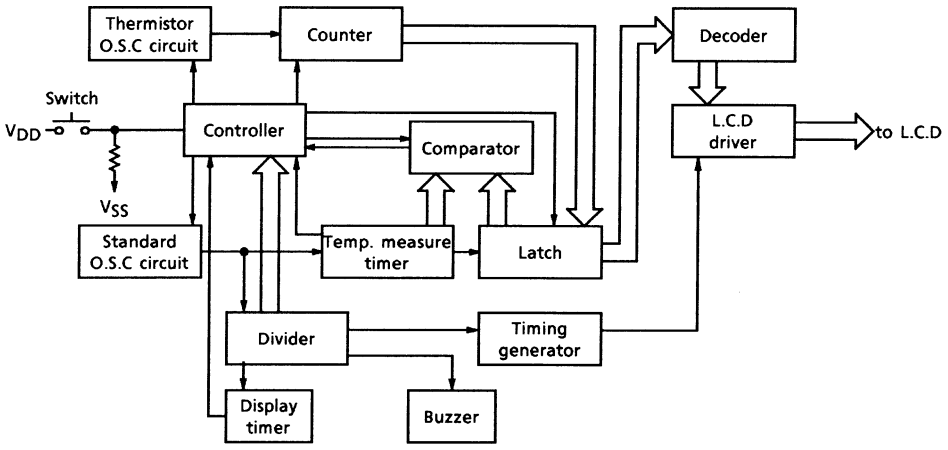
Liquid Crystal Display Body Thermometer LSI

The JT9648-AS is a single chip CMOS LSI for electrical body thermometer capable of directly driving a 4-1/2 digit liquid crystal using a thermistor as a body heat sensor.

Features

- Display temperature range: 32.00°C to 43.00°C (90.00 to 110.00°F)
- Resolution: 0.01°C (0.01°F)
- Accuracy: ±0.1°C (35.0°C~38.0°C, V_{SS1} = −1.55 V~−1.40 V, Ta = 25°C)
- Max value holding function
- Memorize last value
- Voltage drop detecting function
- Measured temperature stable detecting function
- Power ON/OFF operation by a single switch
- Automatic power OFF function (approx. 16 min)
- Full display function
- A single 1.5 V silver oxide battery
- 4-1/2 digit, 1/3 duty, 1/2 bias liquid crystal direct driving
- Buzzer output (time elapsed or stable detection reporting)
- °C/°F measurements selectable by bonding option

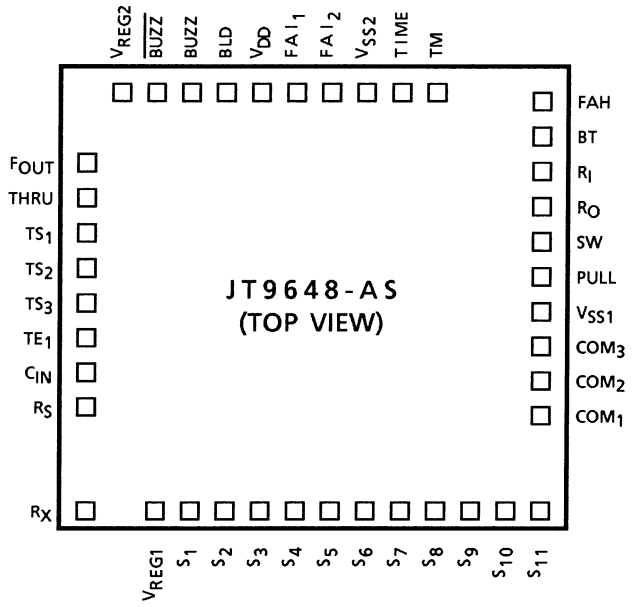
Block Diagram



Pin Description

Pin Name	Symbol	No. of Pins
Power Pin	V_{DD}, V_{SS1}, V_{SS2}, V_{REG1}, V_{REG2}, PULL	6
Oscillator Pin	R_S, R_X, C_{IN}, R_I, R_O	5
SW Pin	SW	1
Function selectional Pin	FAH, TM, BT, TIME	4
Test Pin	TE_1, TS_1, TS_2, TS_3, THRU, F_{OUT}	6
Display Pin	COM_1, COM_2, COM_3, $SEG_{1\sim11}$	14
Buzzer Pin	BUZZ, $\overline{BUZZ}$	2
Doubler Pin	FAI_1, FAI_2	2
BLD Pin	BLD	1

Pad Layout



Chip size : 2.72×2.41 (mm)
Chip thickness : 440±30 (μm)

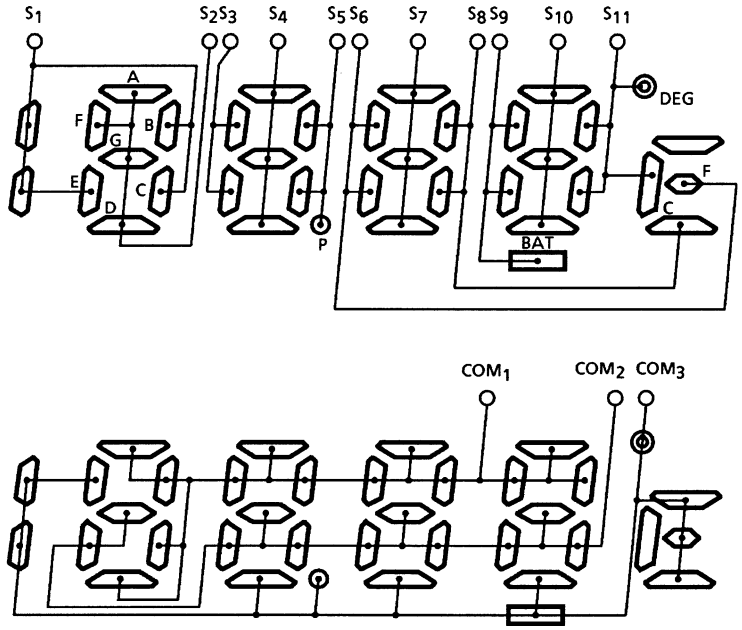
Pad Location Table

(μm)

Pin Name	X Point	Y Point	Pin Name	X Point	Y Point
R_X	–1222	–1069	R_I	1222	636
R_S	–1222	–578	R_O	1222	456
C_{IN}	–1222	–398	SW	1222	276
TE_1	–1222	–218	PULL	1222	96
TS_3	–1222	–38	V_{SS1}	1222	–84
TS_2	–1222	142	COM_3	1222	–264
TS_1	–1222	322	COM_2	1222	–444
THRU	–1222	502	COM_1	1222	–624
F_{OUT}	–1222	682	S_{11}	1150	–1069
V_{REG2}	–819	1069	S_{10}	970	–1069
$\overline{BUZZ}$	–639	1069	S_9	790	–1069
BUZZ	–459	1069	S_8	610	–1069
BLD	–279	1069	S_7	430	–1069
V_{DD}	–99	1069	S_6	250	–1069
FAI_1	81	1069	S_5	70	–1069
FAI_2	261	1069	S_4	–110	–1069
V_{SS2}	441	1069	S_3	–290	–1069
TIME	621	1069	S_2	–470	–1069
TM	801	1069	S_1	–650	–1069
FAH	1222	996	V_{REG1}	–830	–1069
BT	1222	816			

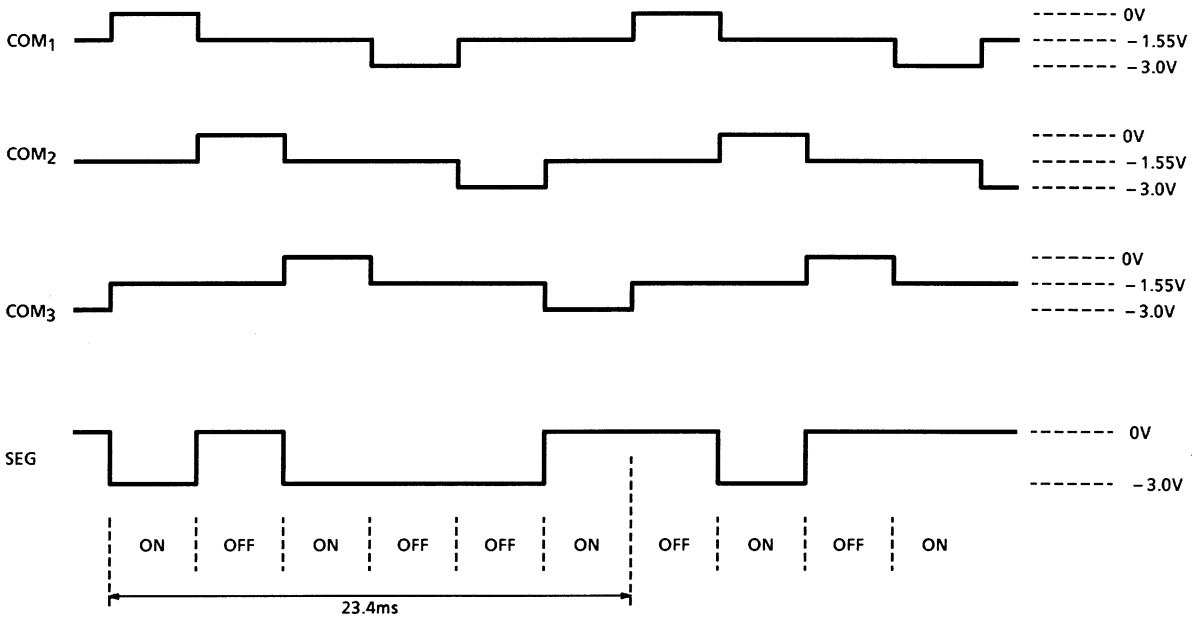
Functional Specifications

1. Display Configuration



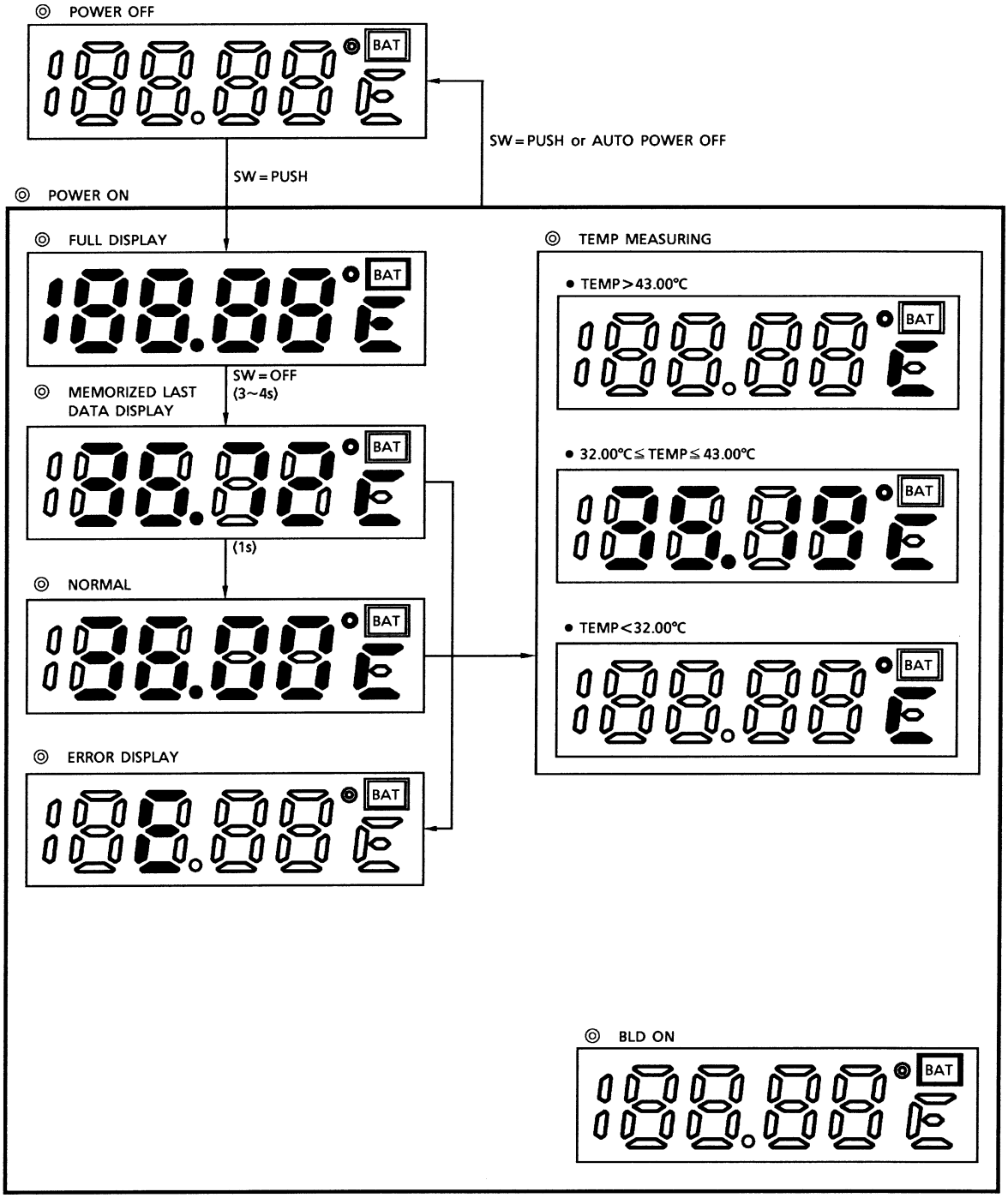
Pad Name	COM_1	COM_2	COM_3	Pad Name	COM_1	COM_2	COM_3
S_1	2B 2C	2E	1B 1C	S_7	4A	4G	4D
S_2	2A 2D	2G	2F	S_8	4B	4C	C
S_3	3F	3E		S_9	5F	5E	BAT
S_4	3A	3G	3D	S_{10}	5A	5G	5D
S_5	3B	3C	P	S_{11}	5B	5C	DEG
S_6	4F	4E	F				

2. Liquid Crystal Drive Waveform

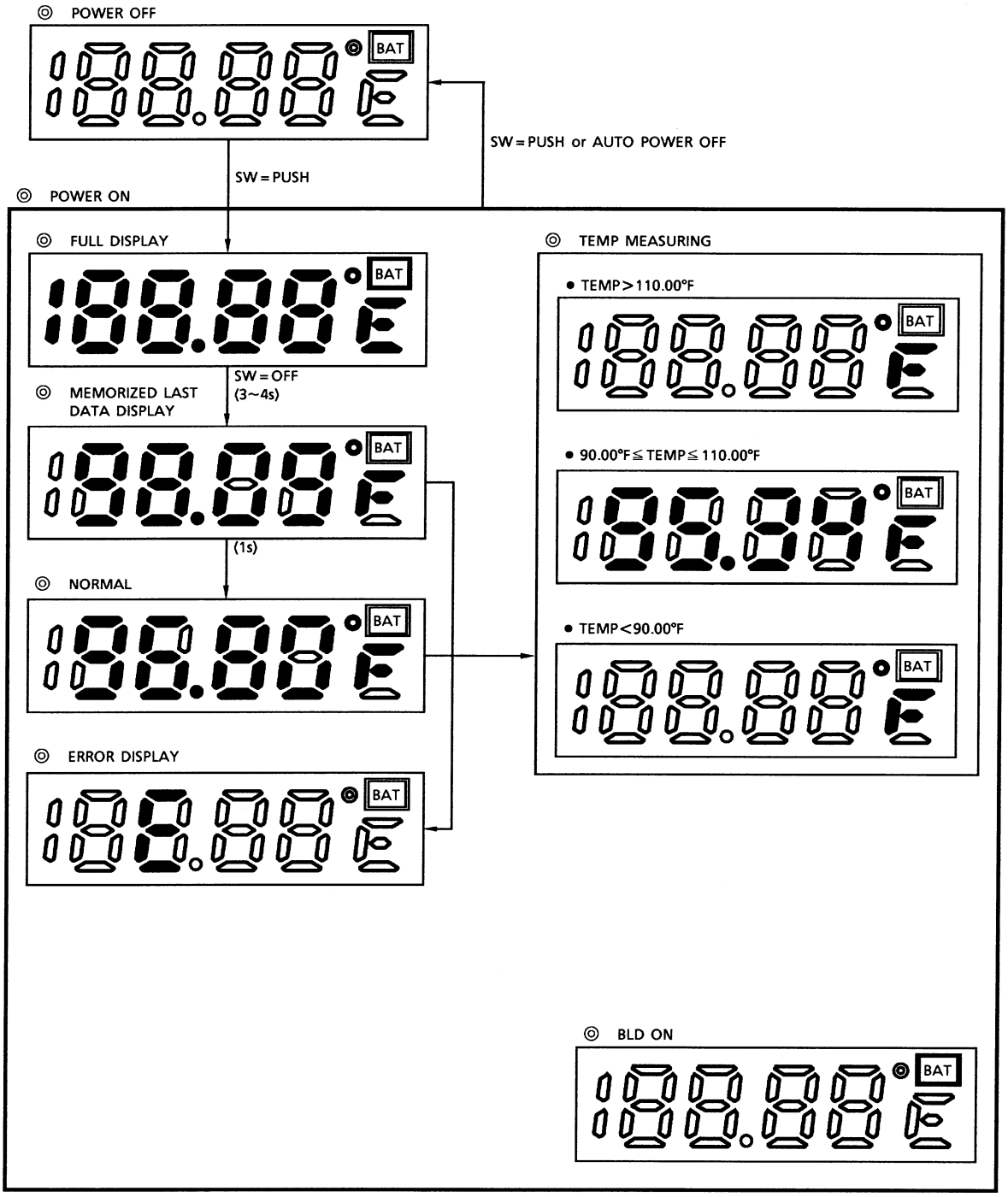


Display

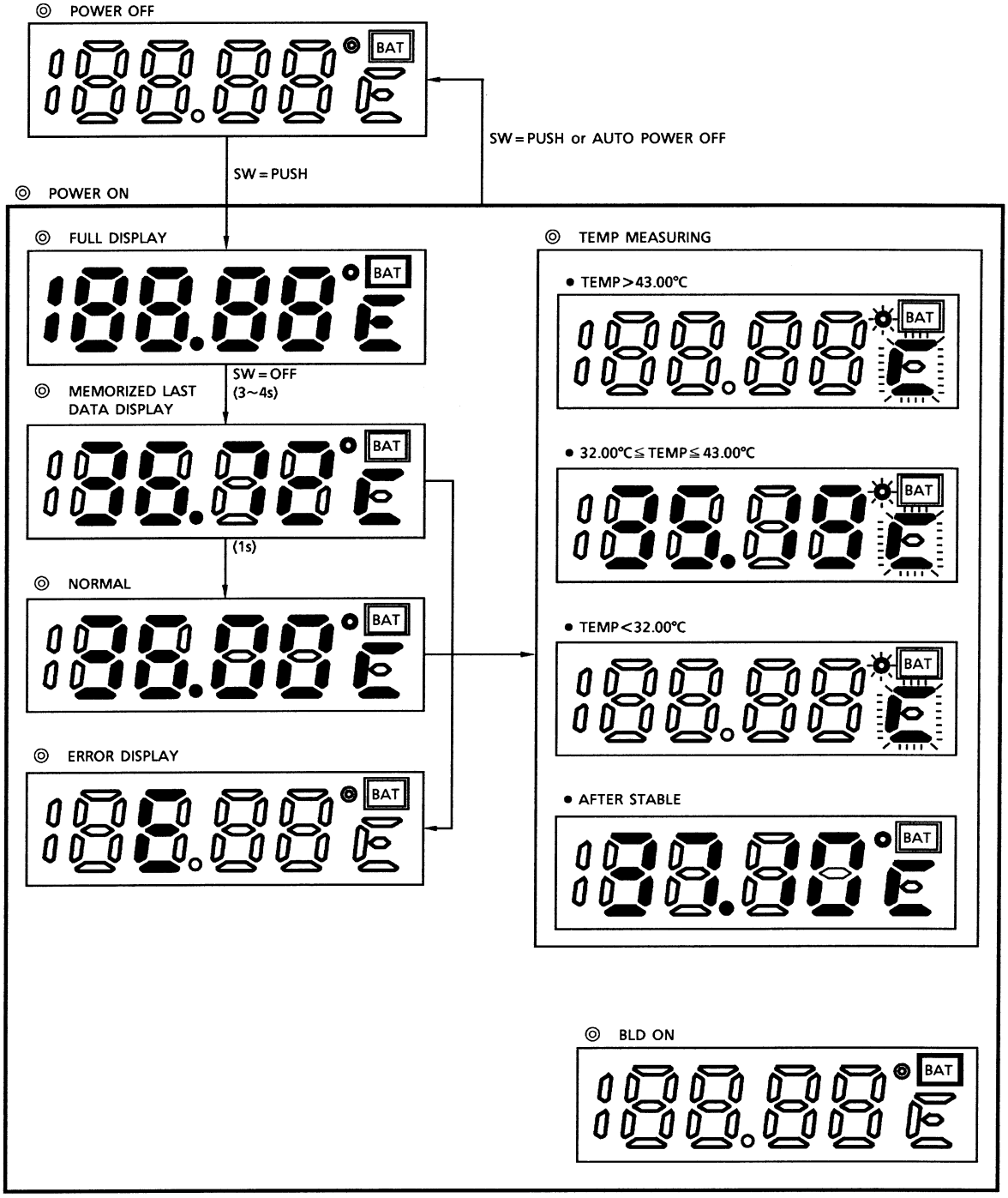
1. Switch Operation (in case of the elapsed time informing function, unit: °C)



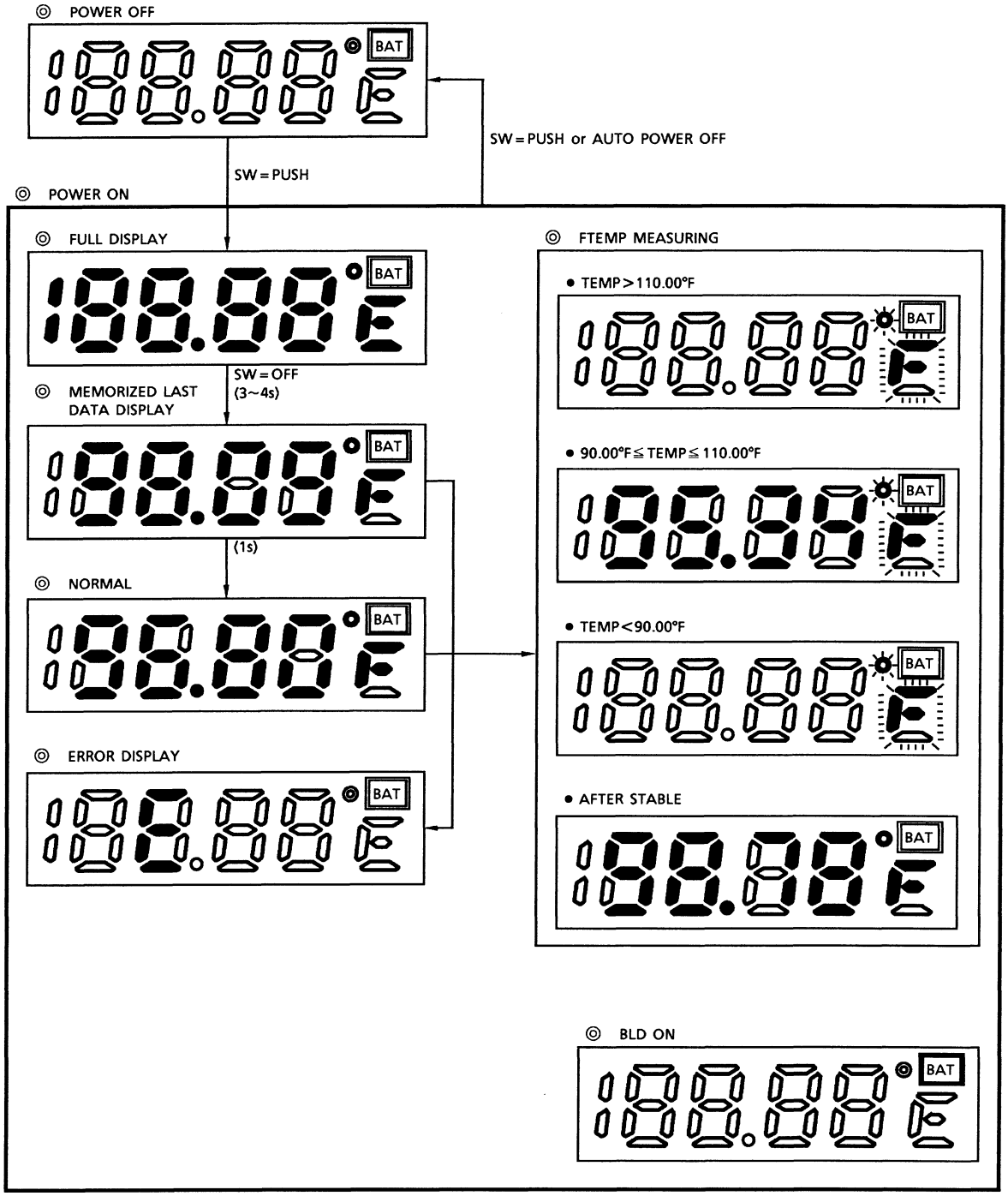
2. Switch Operation (in case of the elapsed time informing function, unit: °F)



3. Switch Operation (stable detection informing function, unit: °C)

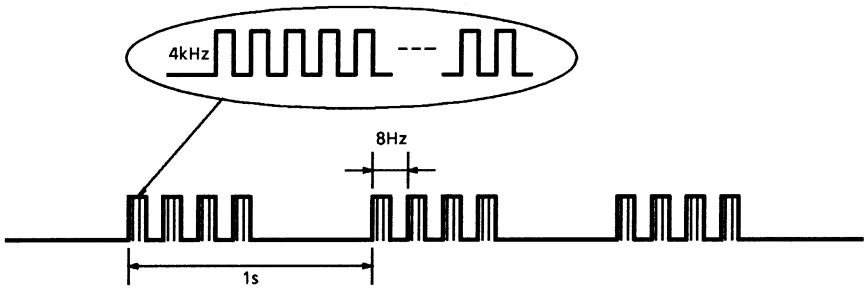


4. Switch Operation (stable detection informing function, unit: °F)



5. Full Display and BZ Demonstration

When power SW is on the display keep the FULL DISPLAY and after 1~2 s BZ is out during SW holding, as follows.



6. Memorized Last Data Display

After full display (releasing SW), the display show the memorized last data and at the same time TEMP oscillation circuit is tested. If the measuring is error, the display show ERROR DISPLAY.

7. Low Temp Display

When measured TEMP is below 32°C (90°F), all digits are off and only UNIT (°C/°F) is on.

8. High Temp Display

When measured TEMP is over 43°C (110°F), all digits are off and only UNIT (°C/°F) is on.

9. Stable Detection Display

In case of the stable detection informing system, the °C or °F mark is flashing during the temperature measurement. The stable detection is performed by checking the 0.1°~10° digits for °C (0.1°~100° digits for °F). If the 0.1°~10° digits (0.1°~100° digits for °F) do not change for 16 s (8 s for °F), it is judged that temperature is stable and the flashing is stopped, and the °C or °F mark is kept on to inform the stable.

The stable display is held even when a value of measured temperature dropped. If, however, temperature rises again and the 0.1°~10° digits (0.1°~100° digits for °F) changed after stable detection, the °C or °F mark starts to flash again.

10. Voltage Drop Detection Display

If battery voltage drops, a display is made to inform the time to exchange the battery. When voltage drop is detected, "BAT" mark is only displayed, but the others are disappeared.

The indicating is kept till power off.

Voltage is detected when SW is pushed and every one minute after power on.

Selection of Function

1. Selection of Elapsed Time Informing/Stable Detection Informing Functions

The elapsed time informing/stable detection informing function is selectable by the BT pin.

BT { OPEN or V_{SS1}: Time informing function (1 min, 2 min, 3 min, 5 min)
   { V_{DD}: Stable detection informing function

2. Selection of °C/°F Measurement

°C/°F measurement is selectable by the FAH pin.

FAH { V_{SS1} or OPEN: °C
    { V_{DD}: °F

3. Selection of Auto Power Off Function

Auto power off function can be set by TM and TIME pin.

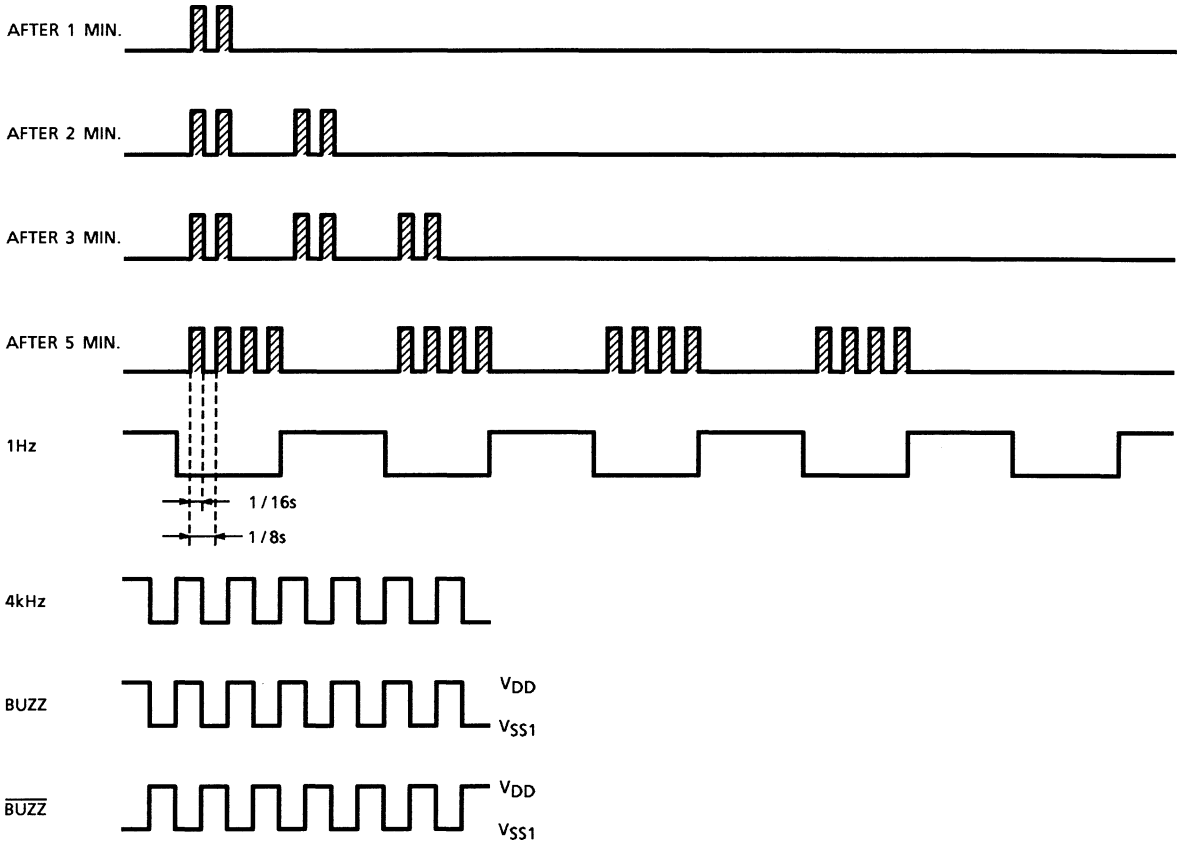
TM	TIME	
V_{SS1} or OPEN	V_{SS1} or OPEN	AUTO POWER OFF AFTER 16 min (from power ON)
	V_{DD}	AUTO POWER OFF AFTER 64 min (from power ON)
V_{DD}	—	NO AUTO POWER OFF FUNCTION

"—" Don't care

Time Informing Function

1. In Case of The Elapsed Time Informing System

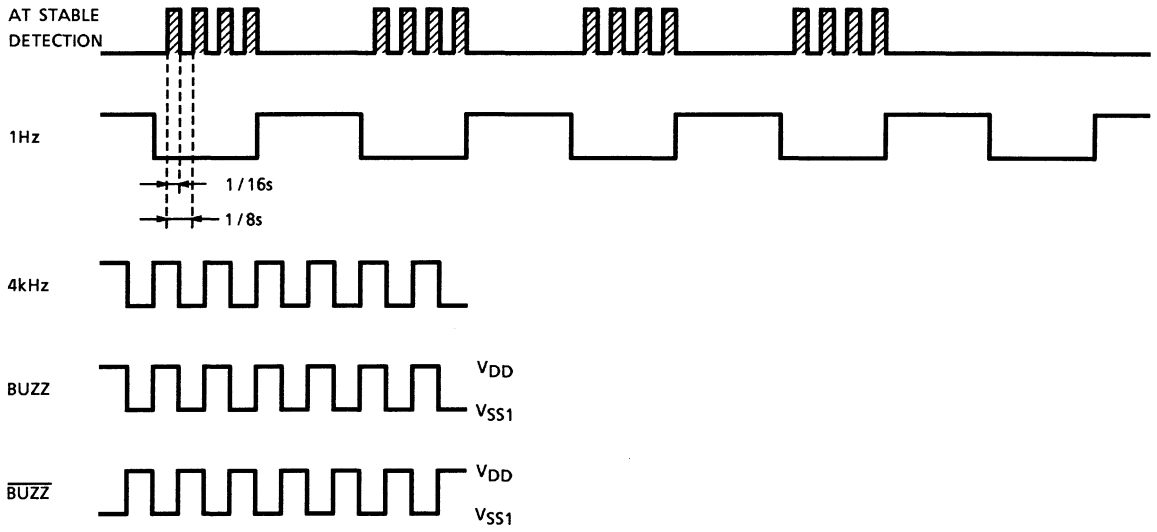
In order to inform time elapsed after power ON, when 1, 2, 3, and 5 minutes have elapsed after times are informed by the buzzer sounding. The buzzer waveforms are shown below.



2. In Case of The Stable Detection Informing System

When temperature is judged as the stable, the buzzer sounds for 4 s. to inform.

Even when temperature rises thereafter and stable temperature is detected again, the buzzer does not sound. The buzzer waveforms in this system are shown below.

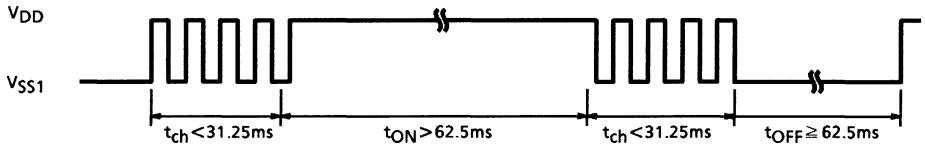


Input Pins

1. SW Pin

The SW pin has a built-in pull-down resistor and the power supply is repeatedly turned ON/OFF whenever the SW pin is connected to V_{DD}.

In this case, in order to prevent malfunction, the chattering of this switch must satisfy the following requirements:



2. Function Selecting Pins

There are 3 function selecting pins; FAH, TM, TIME and BT pins, which select respective functions. (refer to SELECTION OF FUNCTION)

Each of these 3 pins has a built-in pull-down resistor.

3. Test Pins

There are 5 test pins; TE_1, TS_1, TS_2, TS_3 and THRU pins.

Each of these 5 pins has a built-in pull-down resistor.

For the functions of these test pins, refer to TEST FUNCTIONS, CALIBRATION METHODS.

Test Functions

1. All Clear Function

Connection of the TE1 pin to V_{DD} clears all system. After cleared, the mode is POWER OFF.

2. Max Value Holding Stop Function

When connect THRU to V_{DD}, the display show the measured temperature every time. Max doesnot be held.

THRU { = V_{SS1} or OPEN: Max value holding function Available
= V_{DD}: Not available

3. Output Pin Selecting Function

TE1	SW	TS2	TS3	FOUT
1	1	0	0	BLD CONDITION
1	1	0	1	R_S OSCILLATION CLOCK
1	1	1	0	R_X OSCILLATION CLOCK
1	1	1	1	SYSTEM OSCILLATION CLOCK

Calibration Methods

Method 1

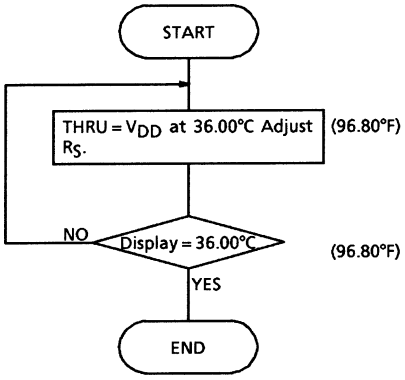
(1) With a Body Thermometer Immersed in a Water Tank (always maintain water temperature at 36.00°C), Connect the THRU Pin to V_{DD}.
Adjust R_S Until the Display on the Body Thermometer Becomes 36.00°C.

Method 2

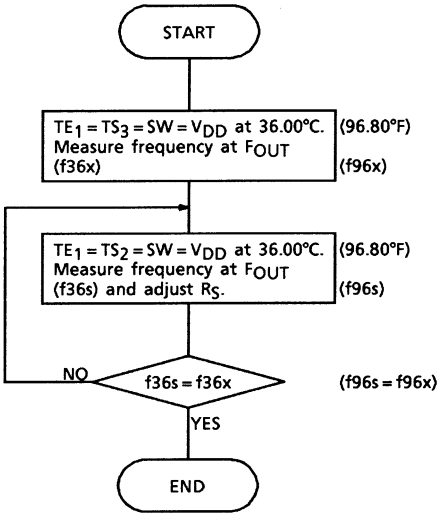
(1) With a Body Thermometer Immersed in a Water Tank (always maintain water temperature at 36.00°C), Connect the TE_1, TS_3 and SW Pin to V_{DD}, Set a Frequency Counter and Then, Measure Frequency at the F_{OUT} Pin. (f36x)

(2) Connect the TE_1, TS_2 and SW Pins to V_{DD}. Measure Frequency at the F_{OUT} Pin. (f36s)
Adjust R_S Until Frequency f36s and Frequency f36x Become Same with Each Other.

Method 1



Method 2



Example of Using Thermister

Thermistor	833ET	503ET
VENDOR	ISHIZUKA ELECTRONICS	ISHIZUKA ELECTRONICS
RESISTANCE (32°C)	61.56 kΩ	36.94 kΩ
RESISTANCE (36°C)	52.10 kΩ	31.26 kΩ
RESISTANCE (43°C)	39.24 kΩ	23.55 kΩ
B-VALUE	3953 ± 1% (B30/45)	3953 ± 1% (B30/45)
R_S	22.12 kΩ~23.23 kΩ	11.83 kΩ~12.42 kΩ
R_1	40.15 kΩ	19.81 kΩ
R_2	10 kΩ	3.5 kΩ
C	700 pF	1100 pF
R_O	150 kΩ ± 2%	150 kΩ ± 2%

Maximum Ratings (Ta = 25°C)

Characteristics	Symbol	Rating	Unit
Supply voltage (1)	V_{SS1}-V_{DD}	–3.0~0.2	V
Supply voltage (2)	V_{SS2}-V_{DD}	–6.0~0.2	V
Operating temperature	T_{opr}	0~50	°C
Storage temperature	T_{stg}	–40~125	°C

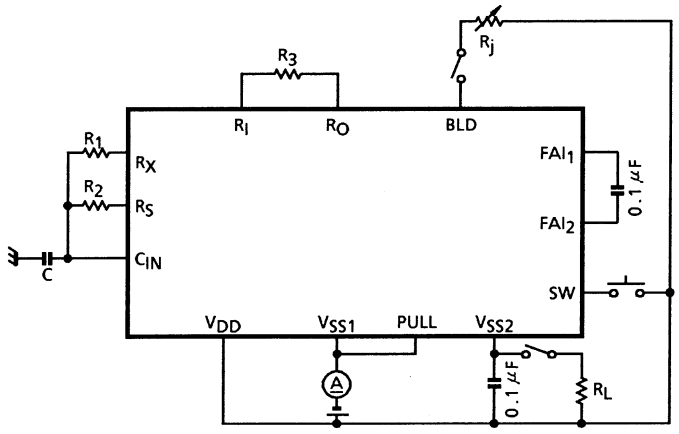
Electrical Characteristicse
(unless otherwise specified, V_{DD} = 0 V, V_{SS1} = –1.55 V, V_{SS2} = –3.00 V, f_o = 64.0 kHz, Ta = 25°C)

Characteristics	Symbol	Test Circuit	Test Condition	Min	Typ.	Max	Unit
V_{SS1} operating voltage	$\|V_{SS1}\|$	2	—	1.25	1.55	2.00	V
V_{SS2} operating voltage	$\|V_{SS2}\|$	2	—	2.00	3.00	4.00	V
Full consumption current (1)	$\|I_{SUP1}\|$	1	FAH, TM = OPEN Power ON, no load	—	—	50	μA
Full consumption current (2)	$\|I_{SUP2}\|$	1	FAH, TM = OPEN Power OFF, no load	—	—	0.20	μA
Doubler output voltage	$\|V_{UCO}\|$	1	R_L = 2 MΩ	2.90	—	—	V
Built-in capacitance	Co	1	—	—	30	—	pF
Oscillation frequency (1)	f_o	1	R_O = 140 kΩ Co = built-in	—	64	—	kHz
Oscillation frequency (2)	fxs	1	R_X = R_S = 53.9 kΩ C = 300 pF	—	25	—	kHz
Detecting resistor range	Rj	—	1 detected voltage 1.30 V	200	—	1700	kΩ
Input current (1)	I_{IH1}	3	V_{IH1} = 0.00 V	1.0	—	10.0	μA
(SW, TE_1, $TS_{1, 2, 3}$)	I_{IL1}		V_{IL1} = –1.55 V	–0.1	—	—	
Input current (2)	—	3	—	—	—	—	μA
(SW, TE_1, $TS_{1, 2, 3}$)	I_{IL2}		V_{IL2} = –1.25 V	50	—	250	
Input current (3)	I_{IH3}	3	POWER ON, V_{IH} = 0 V	0.04	—	0.28	μA
(FAH, THRU, TM, BT, TIME)	I_{IL3}		POWER ON, V_{IL} = –1.55 V	–0.1	—	—	
Input current (4)	—	3	—	—	—	—	μA
(FAH, THRU, TM, BT, TIME)	I_{IL4}		Power ON state V_{IL4} = –1.25 V	0.4	—	8.0	
Input current (5)	I_{IH5}	3	Power OFF state V_{IH5} = –0.00 V	—	—	0.1	μA
(FAH, THRU, TM, BT, TIME)	I_{IL5}		Power OFF state V_{IL5} = –1.55 V	–0.1	—	—	
Output current (1)	I_{OH1}	3	V_{OH1} = –0.3 V	—	—	–4.00	μA
(segment)	I_{OL1}		V_{OL1} = –2.7 V	4.00	—	—	
Output current (2)	I_{OH2}	3	V_{OH2} = –0.3 V	—	—	–60.0	μA
(COM V_{SS2})	I_{OL2}		V_{OL2} = –2.7 V	60.0	—	—	
Output current (3)	I_{OH3}	3	V_{OH3} = –1.75 V	—	—	–60.0	μA
(COM V_{SS1})	I_{OL3}		V_{OL3} = –1.35 V	60.0	—	—	

Characteristics	Symbol	Test Circuit	Test Condition	Min	Typ.	Max	Unit
Output current (4) (BZ, $\overline{BZ}$)	I_{OH4}	3	V_{OH4} = −0.5 V, V_{SS2} = −2.5 V, V_{SS1} = −1.25 V	—	—	−200	μA
	I_{OL4}		V_{OL4} = −0.75 V, V_{SS2} = −2.5 V, V_{SS1} = −1.25 V	200	—	—	
Output current (5) (F_{OUT})	I_{OH5}	3	V_{OH5} = −0.2 V	—	—	−30.0	μA
	I_{OL5}		V_{OL5} = −1.35 V	30.0	—	—	

Test Circuit

1.



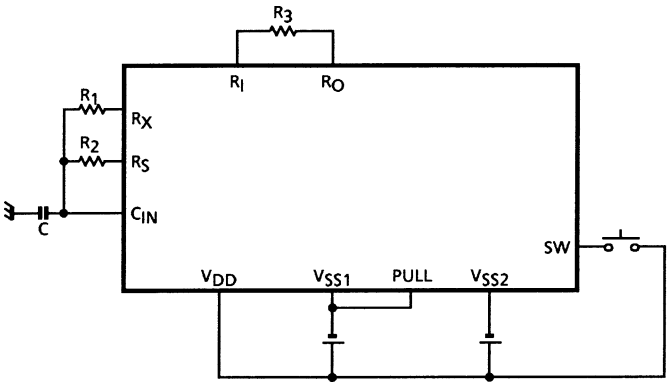
C = 300 pF

$R_1 = R_2 = 56\ k\Omega$

$R_3 = 150\ k\Omega$

$R_L = 2\ M\Omega$

2.

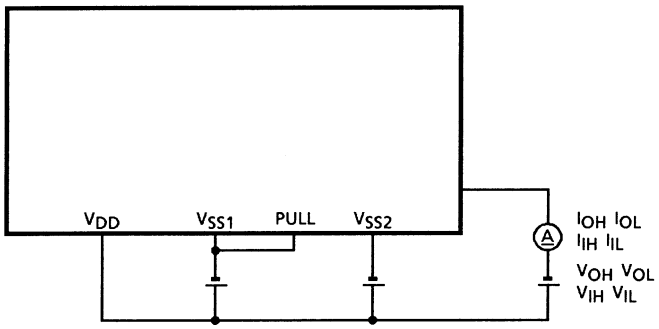


C = 300 pF

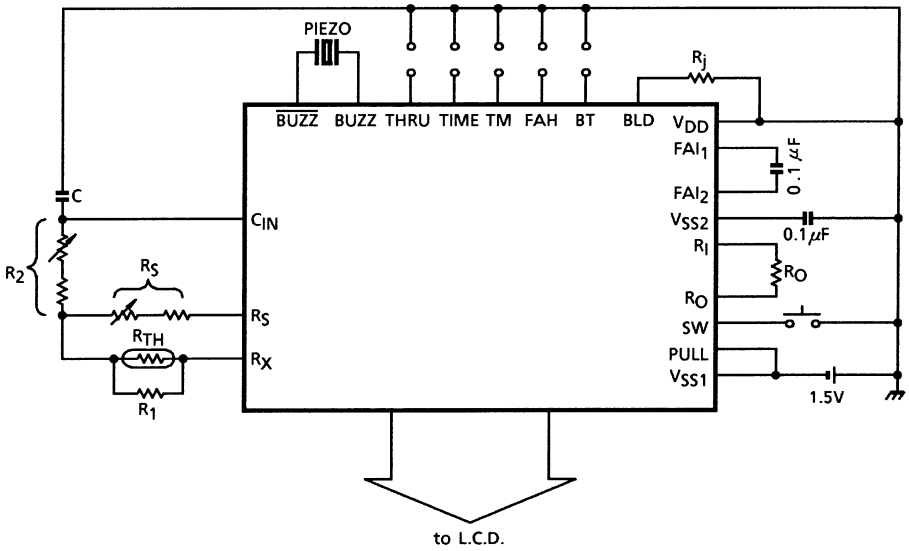
$R_1 = R_2 = 56\ k\Omega$

$R_3 = 150\ k\Omega$

3.



Application Circuit



It is desirable to use C, R_1, R_2 and R_S having the satisfactory temperature characteristic.
It is desirable to minimize the range of variable resistance of R_2 and R_S could as possible.

RESTRICTIONS ON PRODUCT USE

000707EBA

- TOSHIBA is continually working to improve the quality and reliability of its products. Nevertheless, semiconductor devices in general can malfunction or fail due to their inherent electrical sensitivity and vulnerability to physical stress. It is the responsibility of the buyer, when utilizing TOSHIBA products, to comply with the standards of safety in making a safe design for the entire system, and to avoid situations in which a malfunction or failure of such TOSHIBA products could cause loss of human life, bodily injury or damage to property.
  In developing your designs, please ensure that TOSHIBA products are used within specified operating ranges as set forth in the most recent TOSHIBA products specifications. Also, please keep in mind the precautions and conditions set forth in the “Handling Guide for Semiconductor Devices,” or “TOSHIBA Semiconductor Reliability Handbook” etc..
- The TOSHIBA products listed in this document are intended for usage in general electronics applications (computer, personal equipment, office equipment, measuring equipment, industrial robotics, domestic appliances, etc.). These TOSHIBA products are neither intended nor warranted for usage in equipment that requires extraordinarily high quality and/or reliability or a malfunction or failure of which may cause loss of human life or bodily injury (“Unintended Usage”). Unintended Usage include atomic energy control instruments, airplane or spaceship instruments, transportation instruments, traffic signal instruments, combustion control instruments, medical instruments, all types of safety devices, etc.. Unintended Usage of TOSHIBA products listed in this document shall be made at the customer’s own risk.
- The products described in this document are subject to the foreign exchange and foreign trade laws.
- The information contained herein is presented only as a guide for the applications of our products. No responsibility is assumed by TOSHIBA CORPORATION for any infringements of intellectual property or other rights of the third parties which may result from its use. No license is granted by implication or otherwise under any intellectual property or other rights of TOSHIBA CORPORATION or others.
- The information contained herein is subject to change without notice.