

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.

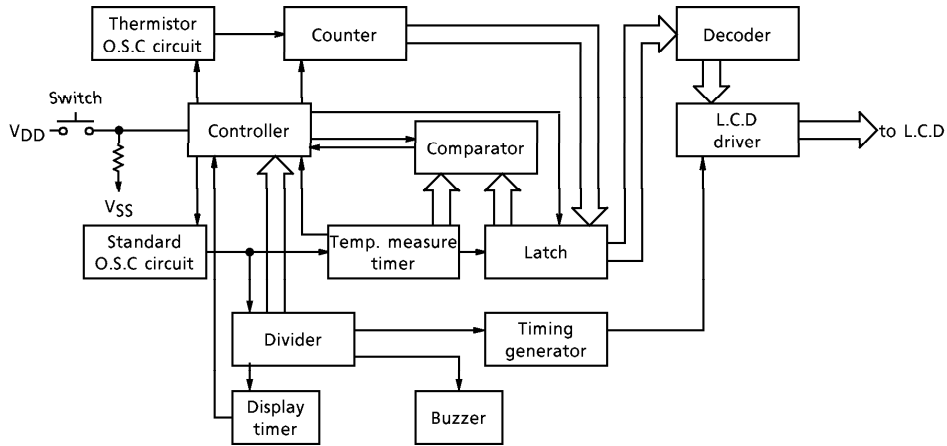
### FEATURES

- Display temperature range : 32.00°C to 43.00°C (90.00 to 110.00°F)
- Resolution : 0.01°C (0.01°F)
- Accuracy :  $\pm 0.1^\circ\text{C}$  (35.0°C~38.0°C,  $V_{SS1} = -1.55\text{V} \sim -1.40\text{V}$ ,  $T_a = 25^\circ\text{C}$ )
- 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 1.5V 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

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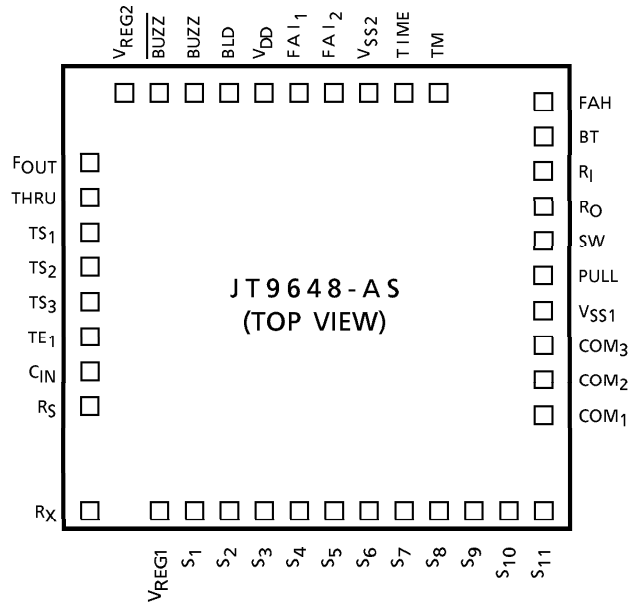
**BLOCK DIAGRAM**



**PIN DESCRIPTION**

PIN NAME	SYMBOL	No. OF PINS
Power Pin	VDD, VSS1, VSS2, VREG1, VREG2, PULL	6
Oscillator Pin	RS, RX, CIN, RI, RO	5
SW Pin	SW	1
Function selectional Pin	FAH, TM, BT, TIME	4
Test Pin	TE1, TS1, TS2, TS3, THRU, FOUT	6
Display Pin	COM1, COM2, COM3, SEG1~11	14
Buzzer Pin	BUZZ, BUZZ	2
Doubler Pin	FAI1, FAI2	2
BLD Pin	BLD	1

**PAD LAYOUT**



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

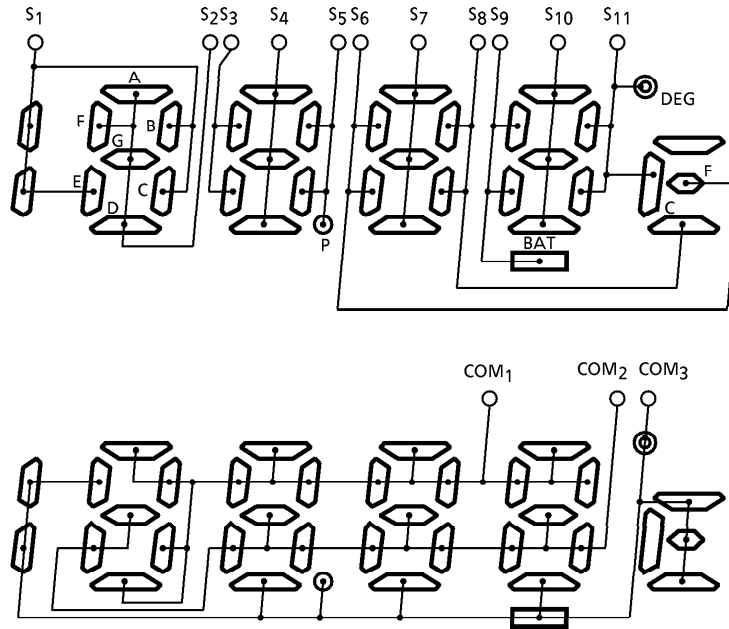
PAD LOCATION TABLE

( $\mu\text{m}$ )

PIN NAME	X POINT	Y POINT	PIN NAME	X POINT	Y POINT
R <sub>X</sub>	- 1222	- 1069	R <sub>I</sub>	1222	636
R <sub>S</sub>	- 1222	- 578	R <sub>O</sub>	1222	456
C <sub>IN</sub>	- 1222	- 398	SW	1222	276
TE <sub>1</sub>	- 1222	- 218	PULL	1222	96
TS <sub>3</sub>	- 1222	- 38	V <sub>SS1</sub>	1222	- 84
TS <sub>2</sub>	- 1222	142	COM <sub>3</sub>	1222	- 264
TS <sub>1</sub>	- 1222	322	COM <sub>2</sub>	1222	- 444
THRU	- 1222	502	COM <sub>1</sub>	1222	- 624
F <sub>OUT</sub>	- 1222	682	S <sub>11</sub>	1150	- 1069
V <sub>REG2</sub>	- 819	1069	S <sub>10</sub>	970	- 1069
BUZZ	- 639	1069	S <sub>9</sub>	790	- 1069
BUZZ	- 459	1069	S <sub>8</sub>	610	- 1069
BLD	- 279	1069	S <sub>7</sub>	430	- 1069
V <sub>DD</sub>	- 99	1069	S <sub>6</sub>	250	- 1069
FAI <sub>1</sub>	81	1069	S <sub>5</sub>	70	- 1069
FAI <sub>2</sub>	261	1069	S <sub>4</sub>	- 110	- 1069
V <sub>SS2</sub>	441	1069	S <sub>3</sub>	- 290	- 1069
TIME	621	1069	S <sub>2</sub>	- 470	- 1069
TM	801	1069	S <sub>1</sub>	- 650	- 1069
FAH	1222	996	V <sub>REG1</sub>	- 830	- 1069
BT	1222	816			

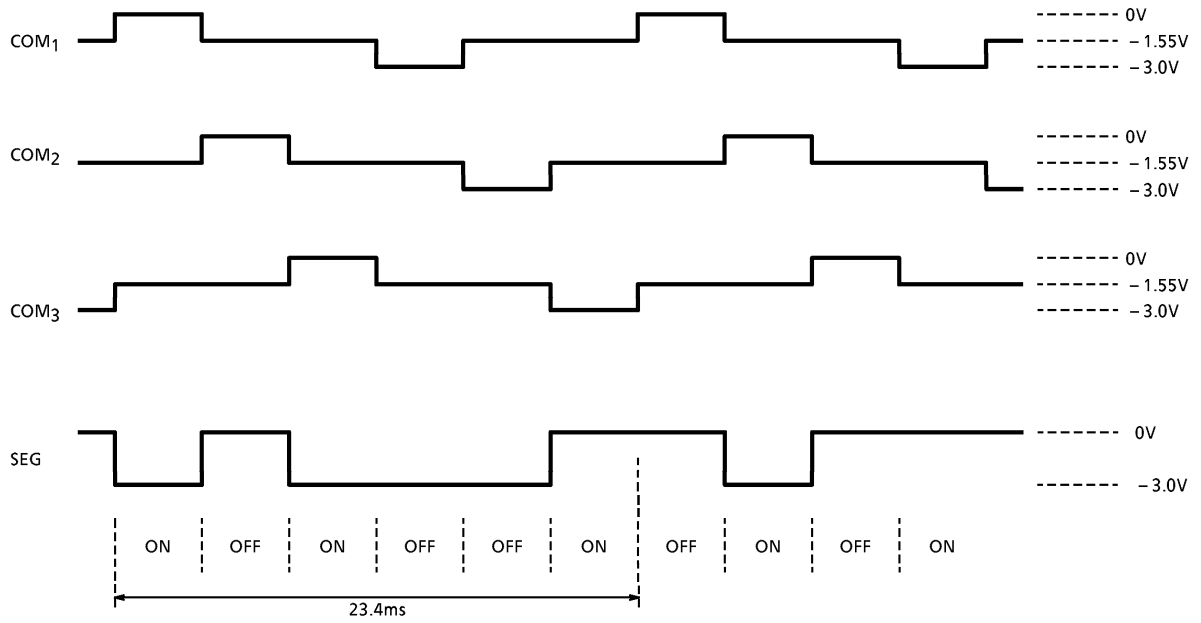
FUNCTIONAL SPECIFICATIONS

1. Display configuration



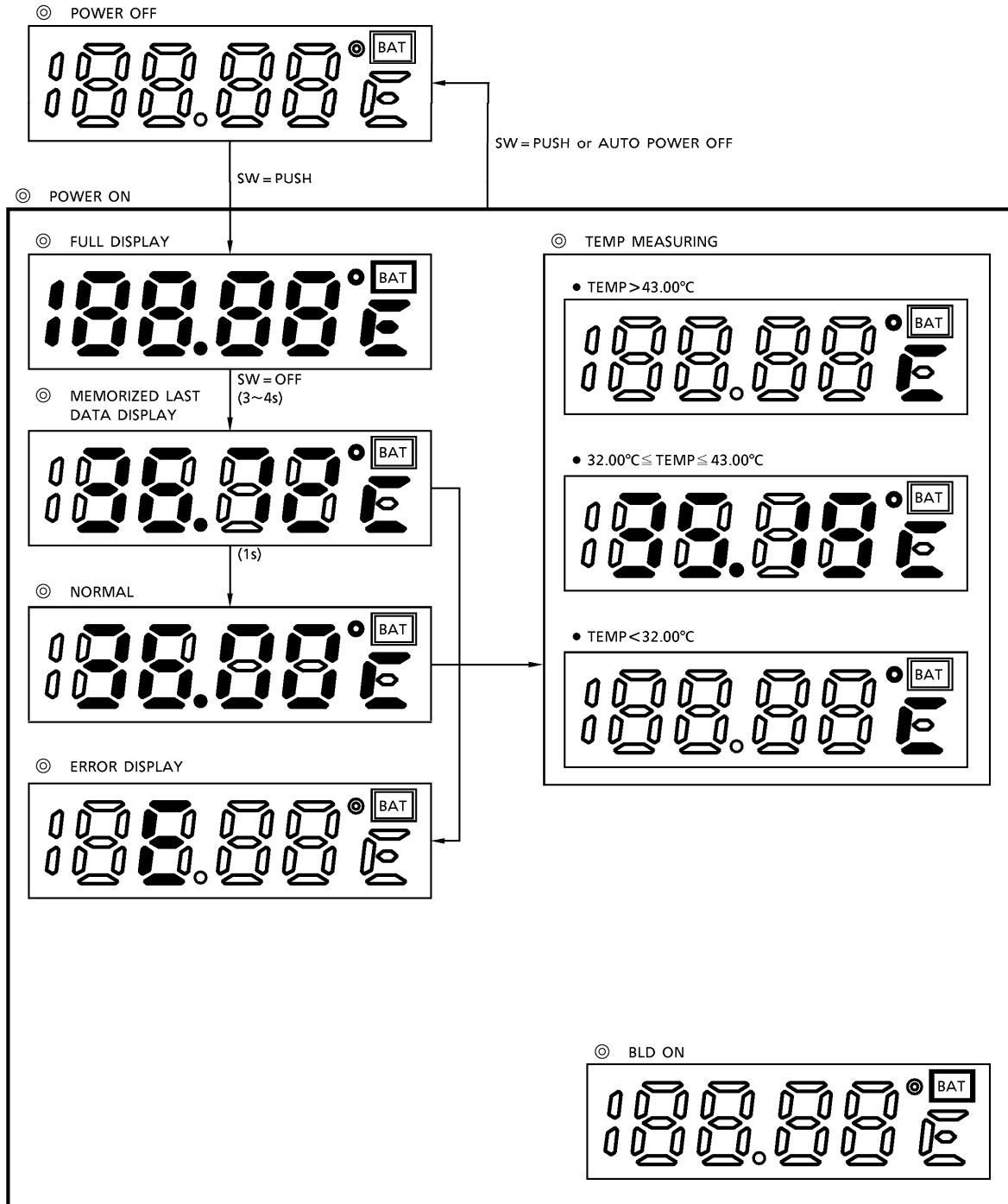
PAD NAME	COM <sub>1</sub>	COM <sub>2</sub>	COM <sub>3</sub>	PAD NAME	COM <sub>1</sub>	COM <sub>2</sub>	COM <sub>3</sub>
S <sub>1</sub>	2B 2C	2E	1B 1C	S <sub>7</sub>	4A	4G	4D
S <sub>2</sub>	2A 2D	2G	2F	S <sub>8</sub>	4B	4C	C
S <sub>3</sub>	3F	3E		S <sub>9</sub>	5F	5E	BAT
S <sub>4</sub>	3A	3G	3D	S <sub>10</sub>	5A	5G	5D
S <sub>5</sub>	3B	3C	P	S <sub>11</sub>	5B	5C	DEG
S <sub>6</sub>	4F	4E	F				

2. Liquid crystal drive waveform

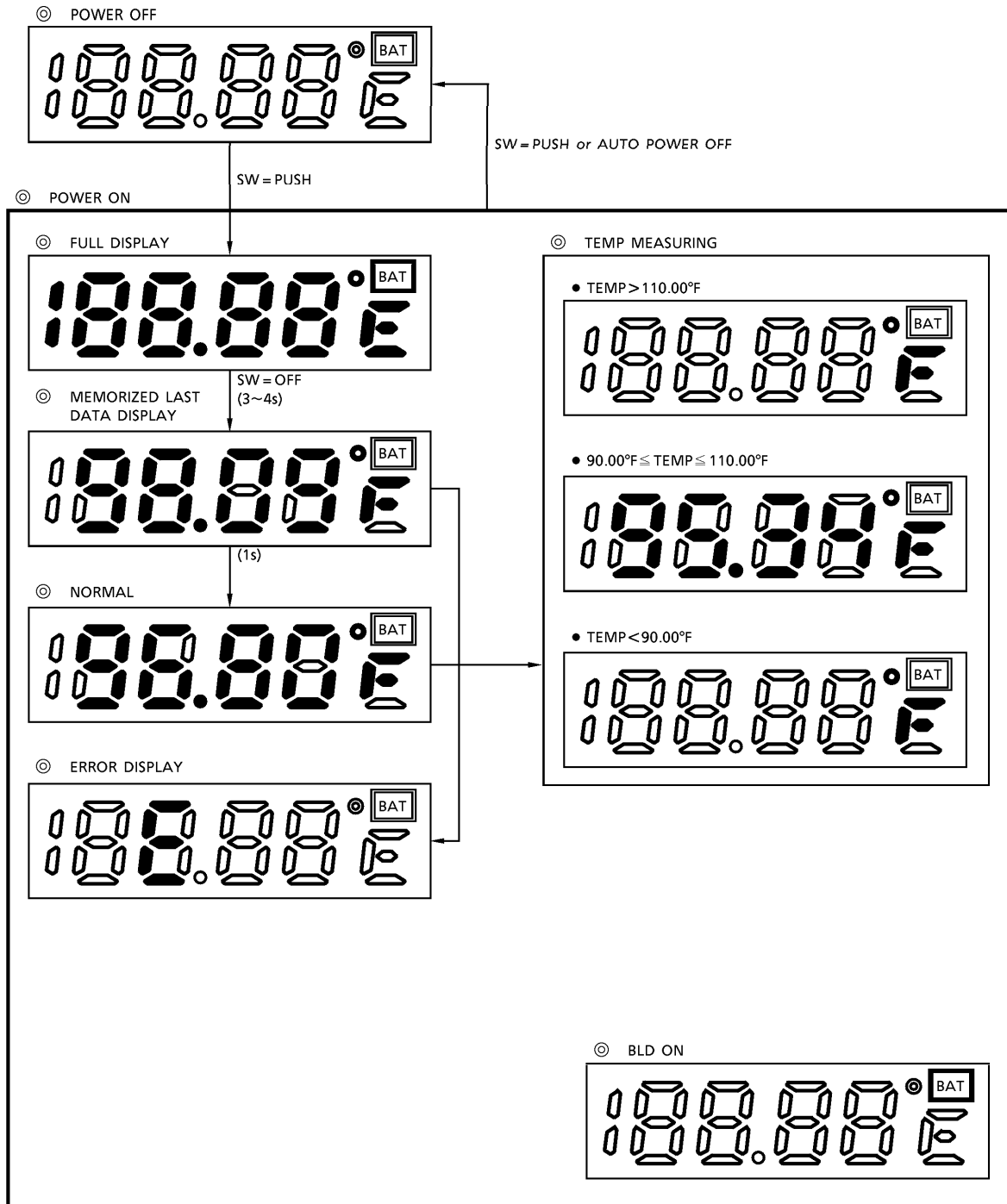


DISPLAY

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

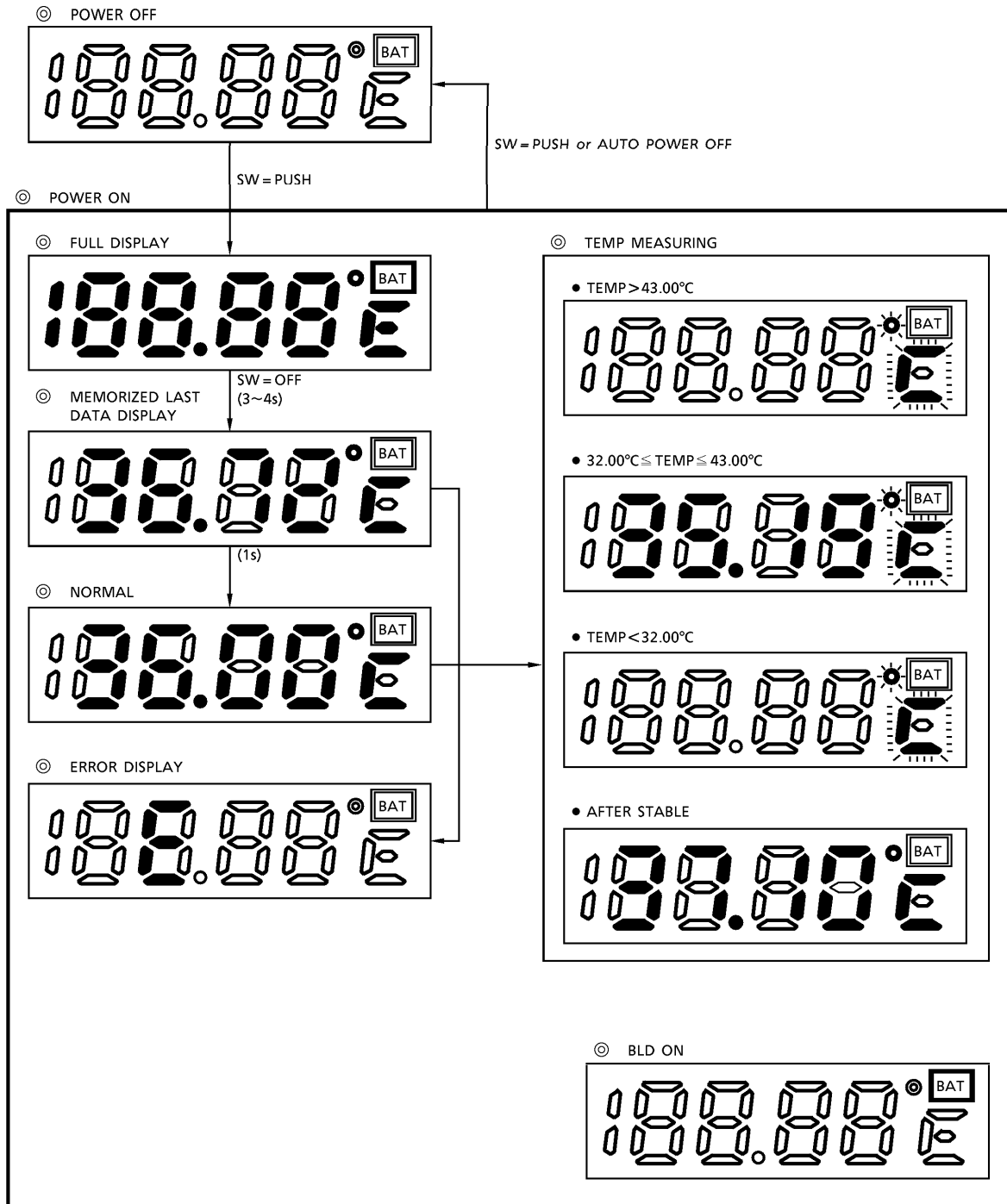


2. Switch operation (In case of the elapsed time informing function, unit : °F)

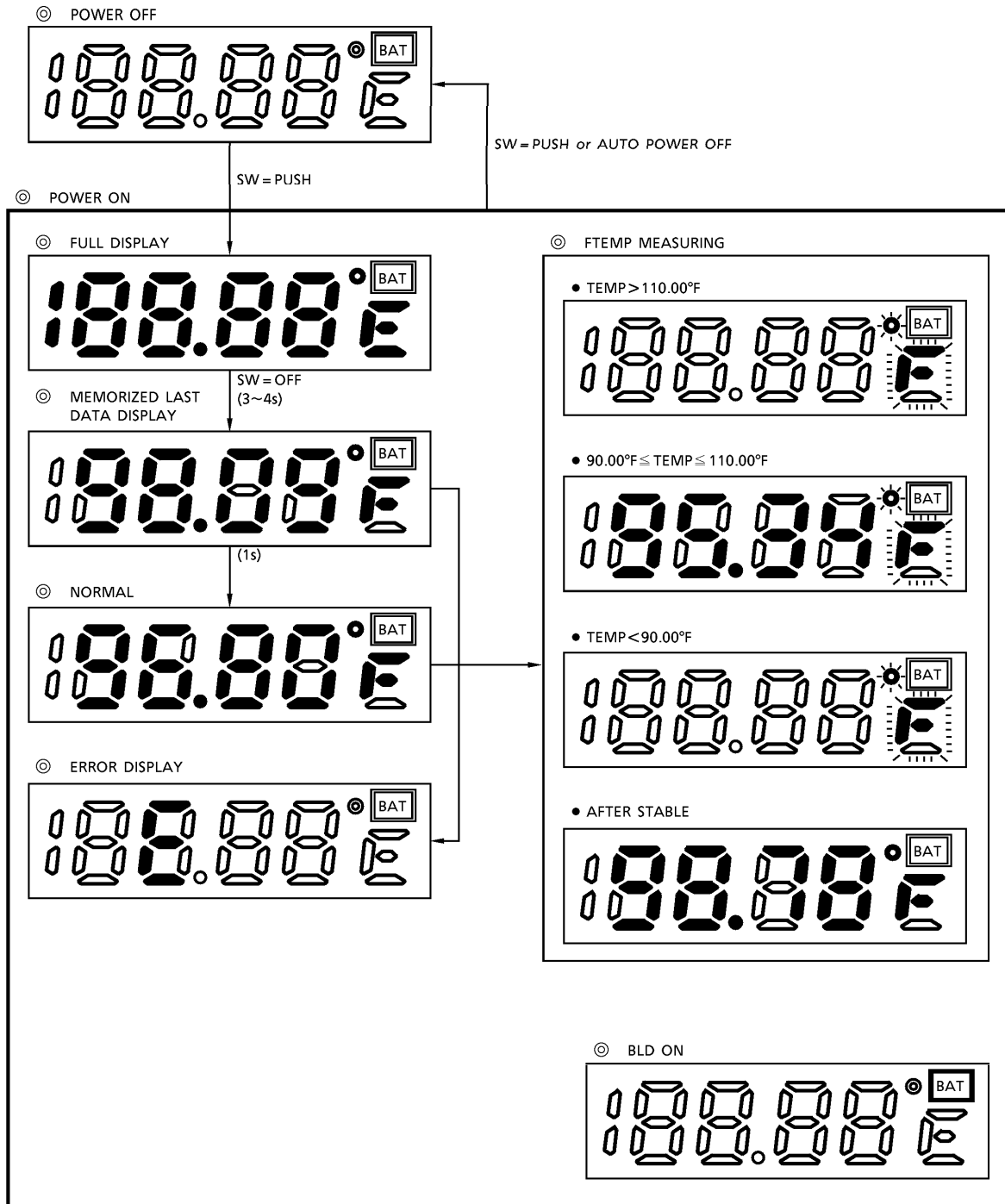




3. Switch operation (Stable detection informing function, unit : °C)

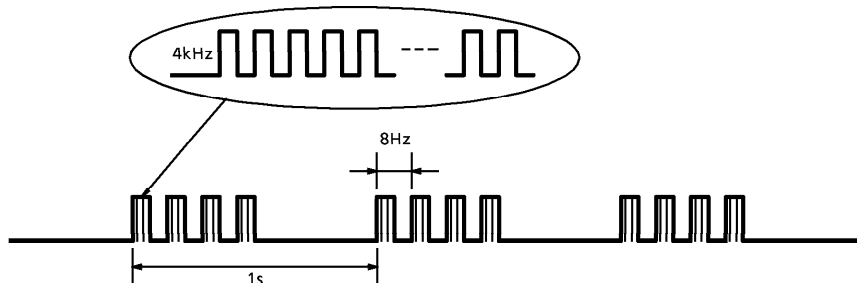


4. Switch operation (Stable detection informing function, unit : °F)



### 5. Full display and BZ demonstration

When power SW is on the display keep the FULL DISPLAY and after 1~2s 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 16s (8s 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<sub>SS1</sub> : Time informing function (1 min, 2 min, 3 min, 5 min)  
       V<sub>DD</sub> : Stable detection informing function

2. Selection of °C/°F measurement

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

FAH { V<sub>SS1</sub> or OPEN : °C  
       V<sub>DD</sub> : °F

3. Selection of auto power off function

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

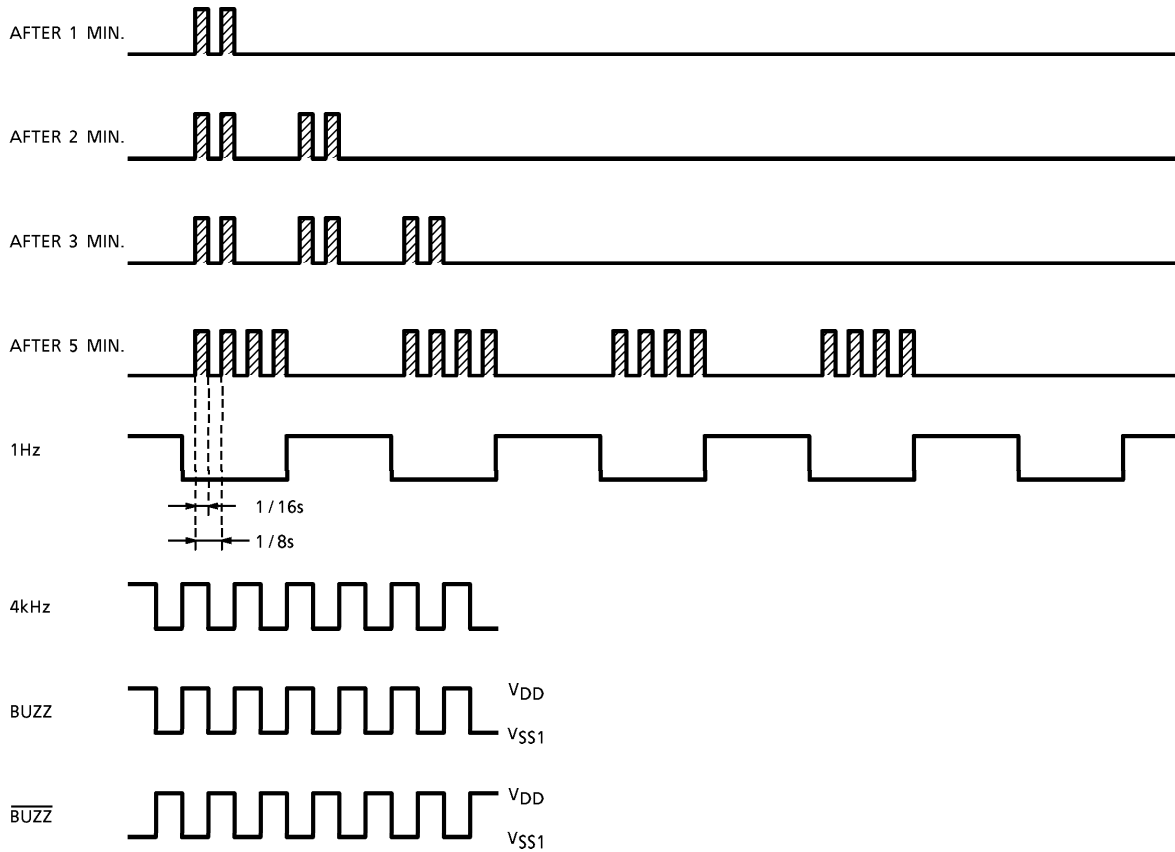
TM	TIME	
V <sub>SS1</sub> or OPEN	V <sub>SS1</sub> or OPEN	AUTO POWER OFF AFTER 16 min (FROM POWER ON)
	V <sub>DD</sub>	AUTO POWER OFF AFTER 64 min (FROM POWER ON)
V <sub>DD</sub>	—	NO AUTO POWER OFF FUNCTION

“—” DON'T CARE

**TIME INFORMING FUNCTION**

1. In case of the elapsed time informing system

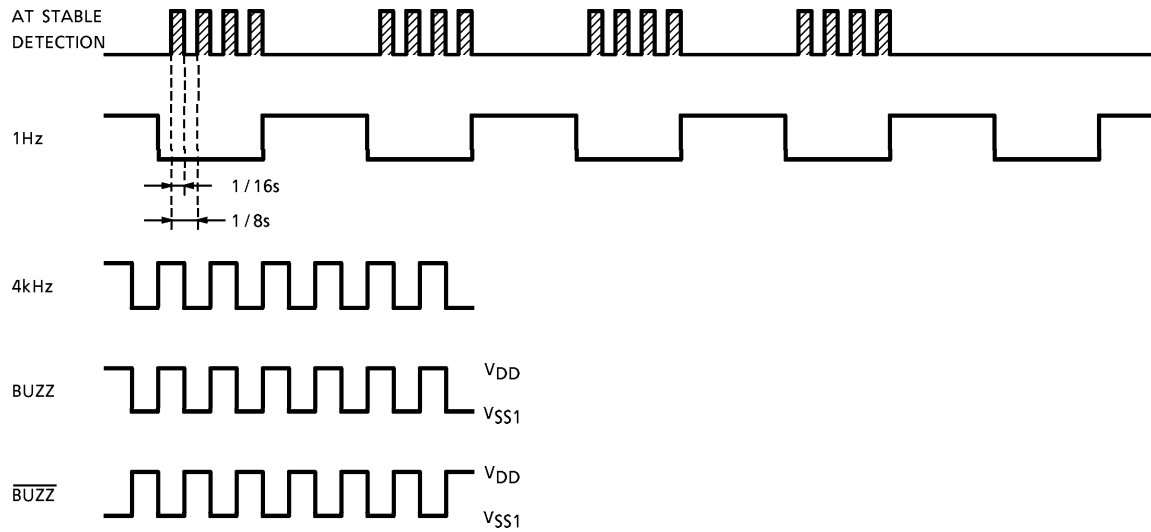
In order to inform time elapsed after power ON, when 1, 2, 3, and 5 minutes have elapsed after times are informed by the buzzer sounding. The buzzer waveforms are shown below.



2. In case of the stable detection informing system

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

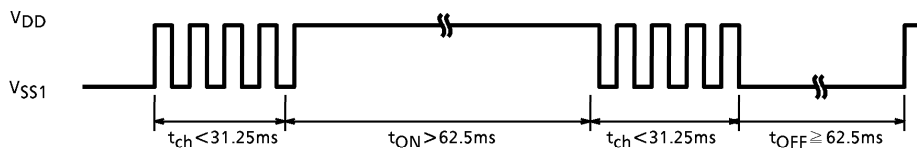


## INPUT PINS

### 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.

$$\text{THRU} \begin{cases} = V_{SS1} \text{ or OPEN} & : \text{Max. value holding function Available} \\ = V_{DD} & : \text{Not available} \end{cases}$$

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

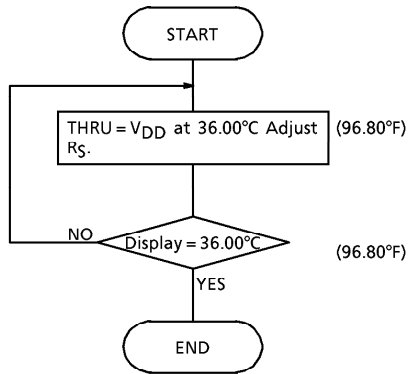
1. With a body thermometer immersed in a water tank (Always maintain water temperature at 36.00°C), connect the THRU pin to  $V_{DD}$ .  
Adjust  $R_S$  until the display on the body thermometer becomes 36.00°C.

Method 2

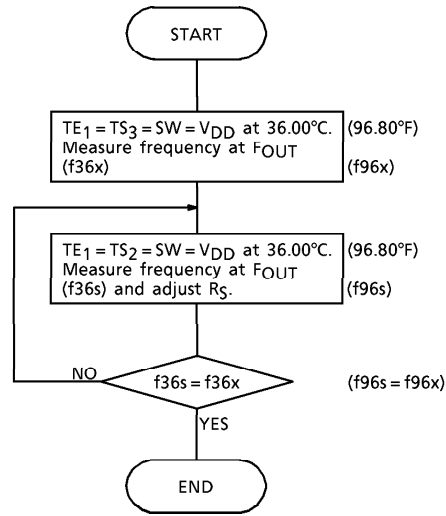
1. With a body thermometer immersed in a water tank (Always maintain water temperature at 36.00°C), connect the TE1, TS3 and SW pin to  $V_{DD}$ , set a frequency counter and then, measure frequency at the FOUT pin. (f36x)
2. Connect the TE1, TS2 and SW pins to  $V_{DD}$ . Measure frequency at the FOUT pin. (f36s)  
Adjust  $R_S$  until frequency f36s and frequency f36x become same with each other.



Method 1



Method 2



EXAMPLE OF USING THERMISTOR

THERMISTOR	833ET	503ET
VENDOR	ISHIZUKA ELECTRONICS	ISHIZUKA ELECTRONICS
RESISTANCE (32°C)	61.56kΩ	36.94kΩ
RESISTANCE (36°C)	52.10kΩ	31.26kΩ
RESISTANCE (43°C)	39.24kΩ	23.55kΩ
B-VALUE	3953 ± 1% (B30 / 45)	3953 ± 1% (B30 / 45)
RS	22.12kΩ~23.23kΩ	11.83kΩ~12.42kΩ
R1	40.15kΩ	19.81kΩ
R2	10kΩ	3.5kΩ
C	700pF	1100pF
RO	150kΩ ± 2%	150kΩ ± 2%

MAXIMUM RATINGS (Ta = 25°C)

PARAMETER	SYMBOL	RATING	UNIT
Supply Voltage (1)	VSS1-VDD	- 3.0~0.2	V
Supply Voltage (2)	VSS2-VDD	- 6.0~0.2	V
Operating Temperature	Topr	0~50	°C
Storage Temperature	Tstg	- 40~125	°C

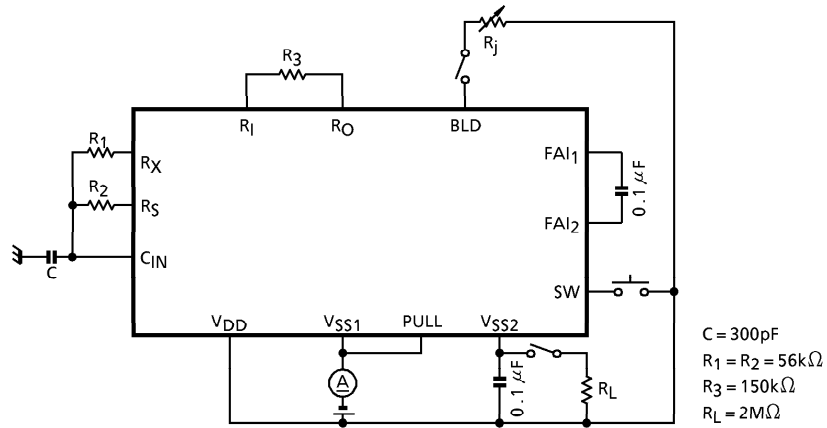
## ELECTRICAL CHARACTERISTICS

(Unless otherwise specified,  $V_{DD} = 0V$ ,  $V_{SS1} = -1.55V$ ,  $V_{SS2} = -3.00V$ ,  $f_o = 64.0kHz$ ,  $T_a = 25^\circ C$ )

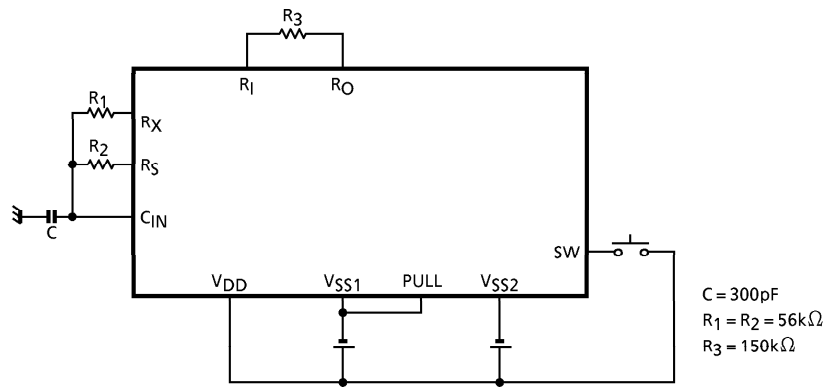
PARAMETER	SYMBOL	TEST CIRCUIT	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
$V_{SS1}$ Operating Voltage	$ V_{SS1} $	2	—	1.25	1.55	2.00	V
$V_{SS2}$ Operating Voltage	$ V_{SS2} $	2	—	2.00	3.00	4.00	V
Full Consumption Current (1)	$ I_{SUP1} $	1	FAH, TM = OPEN Power ON, no load	—	—	50	$\mu A$
Full Consumption Current (2)	$ I_{SUP2} $	1	FAH, TM = OPEN Power OFF, no load	—	—	0.20	$\mu A$
Doubler Output Voltage	$ V_{UCO} $	1	$R_L = 2M\Omega$	2.90	—	—	V
Built-in Capacitance	$C_o$	1	—	—	30	—	pF
Oscillation Frequency (1)	$f_o$	1	$R_O = 140k\Omega$ $C_o =$ built-in	—	64	—	kHz
Oscillation Frequency (2)	$f_{xs}$	1	$R_X = R_S = 53.9k\Omega$ $C = 300pF$	—	25	—	kHz
Detecting Resistor Range	$R_j$	—	1 detected voltage 1.30V	200	—	1700	$k\Omega$
Input Current (1) (SW, TE <sub>1</sub> , TS <sub>1</sub> , 2, 3)	$I_{IH1}$	3	$V_{IH1} = 0.00V$	1.0	—	10.0	$\mu A$
	$I_{IL1}$		$V_{IL1} = -1.55V$	-0.1	—	—	
Input Current (2) (SW, TE <sub>1</sub> , TS <sub>1</sub> , 2, 3)	—	3	—	—	—	—	$\mu A$
	$I_{IL2}$		$V_{IL2} = -1.25V$	50	—	250	
Input Current (3) (FAH, THRU, TM, BT, TIME)	$I_{IH3}$	3	POWER ON $V_{IH} = 0V$	0.04	—	0.28	$\mu A$
	$I_{IL3}$		$V_{IL} = -1.55V$	-0.1	—	—	
Input Current (4) (FAH, THRU, TM, BT, TIME)	—	3	—	—	—	—	$\mu A$
	$I_{IL4}$		Power ON state $V_{IL4} = -1.25V$	0.4	—	8.0	
Input Current (5) (FAH, THRU, TM, BT, TIME)	$I_{IH5}$	3	Power OFF state $V_{IH5} = -0.00V$	—	—	0.1	$\mu A$
	$I_{IL5}$		Power OFF state $V_{IL5} = -1.55V$	-0.1	—	—	
Output Current (1) (Segment)	$I_{OH1}$	3	$V_{OH1} = -0.3V$	—	—	-4.00	$\mu A$
	$I_{OL1}$		$V_{OL1} = -2.7V$	4.00	—	—	
Output Current (2) (COM $V_{SS2}$ )	$I_{OH2}$	3	$V_{OH2} = -0.3V$	—	—	-60.0	$\mu A$
	$I_{OL2}$		$V_{OL2} = -2.7V$	60.0	—	—	
Output Current (3) (COM $V_{SS1}$ )	$I_{OH3}$	3	$V_{OH3} = -1.75V$	—	—	-60.0	$\mu A$
	$I_{OL3}$		$V_{OL3} = -1.35V$	60.0	—	—	
Output Current (4) (BZ, $\bar{BZ}$ )	$I_{OH4}$	3	$V_{OH4} = -0.5V$ $V_{SS2} = -2.5V$ $V_{SS1} = -1.25V$	—	—	-200	$\mu A$
	$I_{OL4}$		$V_{OL4} = -0.75V$ $V_{SS2} = -2.5V$ $V_{SS1} = -1.25V$	200	—	—	
Output Current (5) (FOUT)	$I_{OH4}$	3	$V_{OH5} = -0.2V$	—	—	-30.0	$\mu A$
	$I_{OL4}$		$V_{OL5} = -1.35V$	30.0	—	—	

TEST CIRCUIT

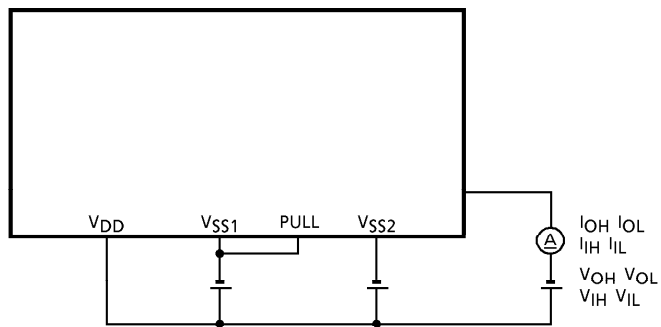
1.



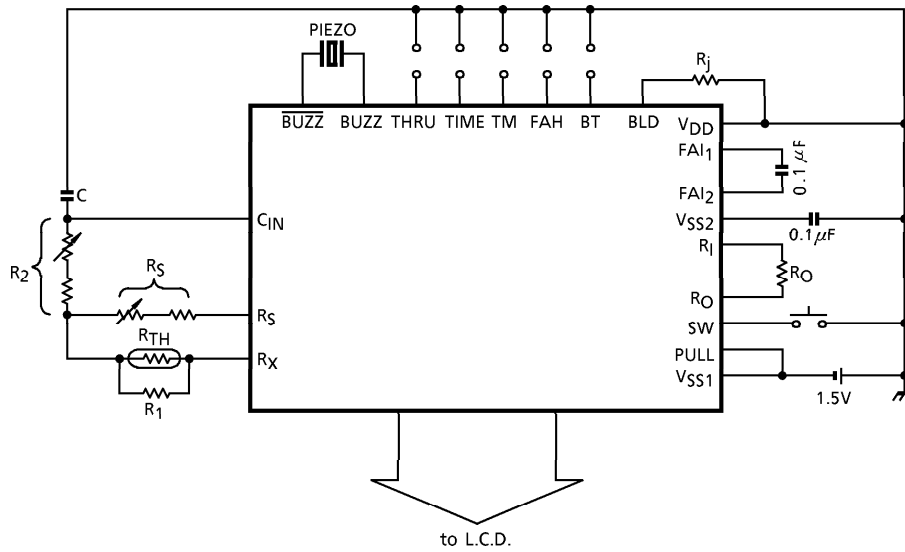
2.



3.



APPLICATION CIRCUIT



It is desirable to use C, R<sub>1</sub>, R<sub>2</sub> and R<sub>S</sub> having the satisfactory temperature characteristic.  
 It is desirable to minimize the range of variable resistance of R<sub>2</sub> and R<sub>S</sub> could as possible.