TOSHIBA CMOS DIGITAL INTEGRATED CIRCUIT SILICON MONOLITHIC

JT9673-AS

LCD DISPLAY STOPWATCH LSI

This product is a single-chip CMOS LSI for stopwatches capable of directly driving a 7-digit LCD with four signs.

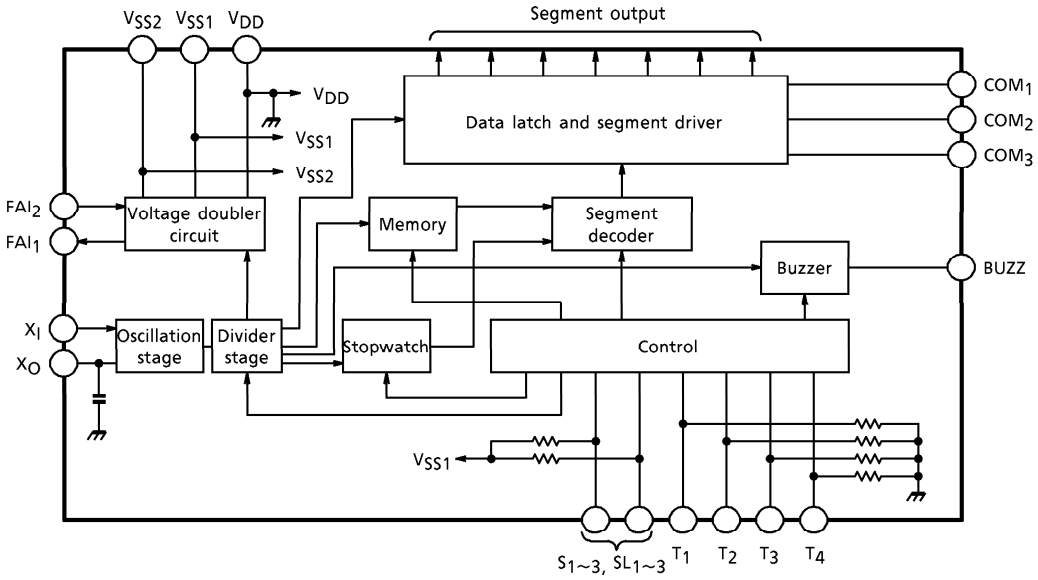
APPLICATIONS

- Stopwatches

FEATURES

- 32.768kHz crystal oscillator
- Displays hour, minute, second, and hundredths of seconds
- Four-sign, 7-digit display, 1/3-duty LCD drive
- 5 Display modes (RESET, RUN, STOP, LAP, LAP STOP) and optional display modes (NORMAL LAP, SECTION LAP) are selectable by bonding option.
- Counting by 9 hours, 59 minutes, 59 seconds, 99 hundredths of second (units : 1/100 second)
- Power supply : 1.55V-single power supply
- Built-in voltage doubler circuit
- Low current consumption (I_{sup} = 3.0μA Max.)

BLOCK DIAGRAM

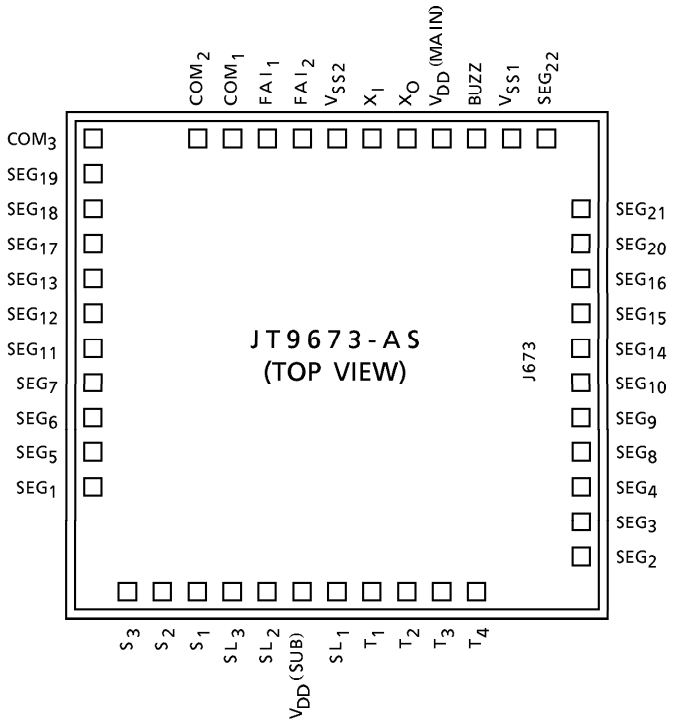


980910EBA2

PIN DESCRIPTIONS (44PINS)

PIN NAME	SYMBOL	No. OF PINS
Power Supply Pins	V_{DD} (2), V_{SS1}, V_{SS2}	4
Oscillator Pins	X_I, X_O	2
Input Pins	$S_{1\sim3}$, $SL_{1\sim3}$	6
Output Pin	BUZZ	1
Display Pins	$COM_{1\sim3}$, SEG (22)	25
Test Pins	$T_{1\sim4}$	4
Voltage Doubler Pins	FAI_1, FAI_2	2

PAD LAYOUT



Chip size : 2.39×2.39 (mm)
Chip thickness : 440±40 (μm)

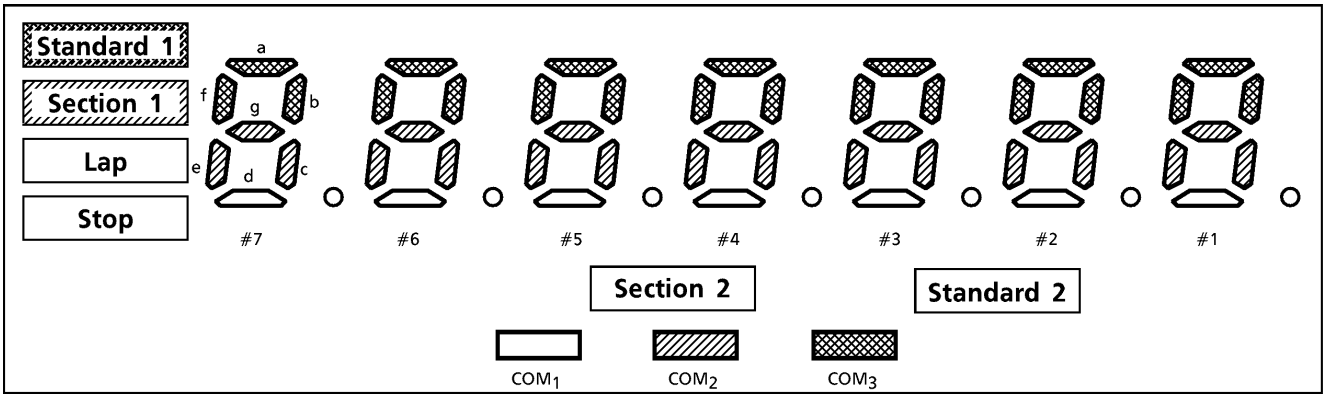
(Note) Be sure to connect the V_{DD} (MAIN).

PAD LOCATION TABLE (μm)

PIN NAME	X POINT	Y POINT	PIN NAME	X POINT	Y POINT
SEG_1	– 1067	– 618	SEG_{21}	1067	618
SEG_5	– 1067	– 455	SEG_{20}	1067	455
SEG_6	– 1067	– 292	SEG_{16}	1067	292
SEG_7	– 1067	– 129	SEG_{15}	1067	130
SEG_{11}	– 1067	33	SEG_{14}	1067	– 33
SEG_{12}	– 1067	196	SEG_{10}	1067	– 196
SEG_{13}	– 1067	359	SEG_9	1067	– 359
SEG_{17}	– 1067	522	SEG_8	1067	– 522
SEG_{18}	– 1067	684	SEG_4	1067	– 684
SEG_{19}	– 1067	847	SEG_3	1067	– 847
COM_3	– 1067	1010	SEG_2	1067	– 1010
COM_2	– 618	1067	T_4	618	– 1067
COM_1	– 455	1067	T_3	455	– 1067
FAI_1	– 292	1067	T_2	292	– 1067
FAI_2	– 129	1067	T_1	130	– 1067
V_{SS2}	33	1067	SL_1	– 33	– 1067
X_I	196	1067	V_{DD} (SUB)	– 196	– 1067
X_O	359	1067	SL_2	– 359	– 1067
V_{DD} (MAIN)	522	1067	SL_3	– 522	– 1067
BUZZ	684	1067	S_1	– 684	– 1067
V_{SS1}	847	1067	S_2	– 847	– 1067
SEG_{22}	1010	1067	S_3	– 1010	– 1067

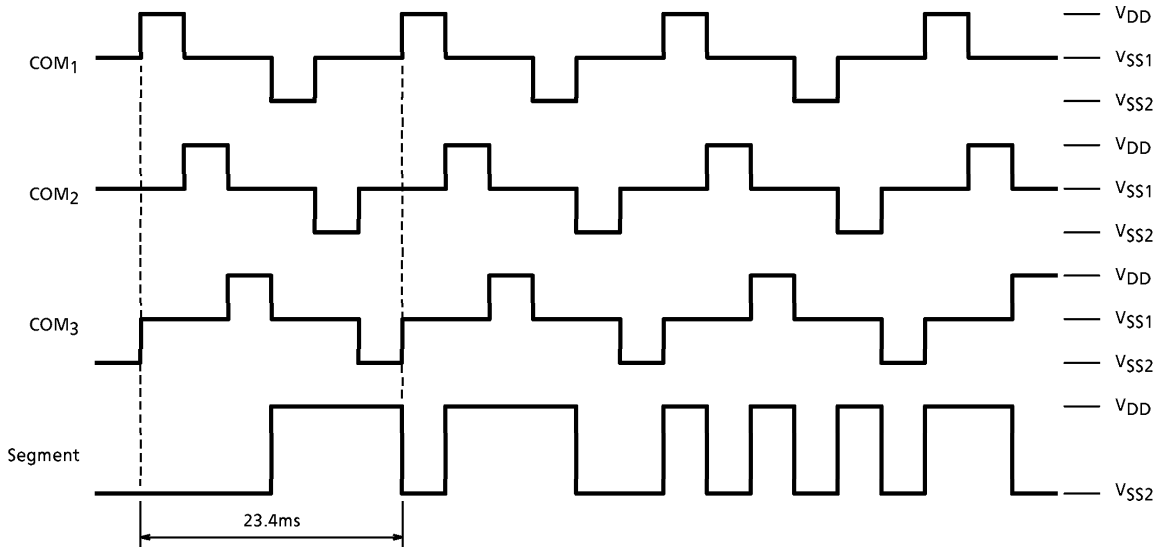
FUNCTION SPECIFICATIONS

1. LCD segment pattern



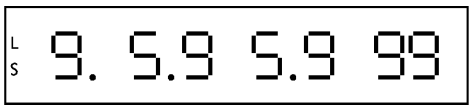
	COM_1	COM_2	COM_3		COM_1	COM_2	COM_3
SEG_1	Lap	Section 1	Standard 1	SEG_{12}	4d	4g	4a
SEG_2	Stop	7e	7f	SEG_{13}	4p	4c	4b
SEG_3	7d	7g	7a	SEG_{14}	—	3e	3f
SEG_4	7p	7c	7b	SEG_{15}	3d	3g	3a
SEG_5	—	6e	6f	SEG_{16}	3p	3c	3b
SEG_6	6d	6g	6a	SEG_{17}	Standard 2	2e	2f
SEG_7	6p	6c	6b	SEG_{18}	2d	2g	2a
SEG_8	—	5e	5f	SEG_{19}	2p	2c	2b
SEG_9	5d	5g	5a	SEG_{20}	—	1e	1f
SEG_{10}	5p	5c	5b	SEG_{21}	1d	1g	1a
SEG_{11}	Section 2	4e	4f	SEG_{22}	1p	1c	1b

2. LCD drive waveform

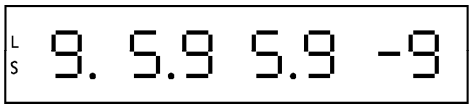


3. Display modes

Ⓐ 1 / 100 second display



Ⓑ 1 / 10 second display



Selected by SL_1. (See 7. Type Selection Function below.)

4. Display sequence

A TYPE

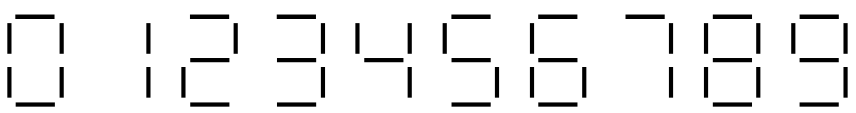
0 hours	00 minutes	00 seconds	00
0	00	00	09
0	00	00	10
0	00	00	99
0	00	01	00
0	00	09	99
0	00	10	00
0	00	59	99
0	01	00	00
0	09	59	99
0	10	00	00
0	59	59	99
1	00	00	00
9	59	59	99

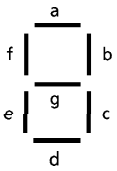
B TYPE

0 hours	00 minutes	00 seconds	– 0
0	00	00	– 9
0	00	01	– 0
0	00	09	– 9
0	00	10	– 0
0	00	59	– 9
0	01	00	– 0
0	09	59	– 9
0	10	00	– 0
0	59	59	– 9
1	00	00	– 0
9	59	59	– 9

The display returns from 9 hours, 59 minutes, 59 seconds, 99 1 / 100 seconds, to 0 hours, 00 minutes, 00 seconds 00 and counting continues.

5. Display example





6. Input setting

S_1, S_2, S_3 : Normally all pulled down to the V_{SS1} level by IC internal pull-down resistance. S_1, S_2, and S_3 perform their specified functions when connected to the V_{DD} by an external switch.

SL_1, SL_2, SL_3 : Normally, all pulled down to the V_{SS1} level by IC internal pull-down resistance. Setting the level of the pins externally allows functions to be selected

T_1, T_2, T_3, T_4 : Normally, all pulled up to the V_{DD} level by IC internal pull-up resistance. Used for IC testing.

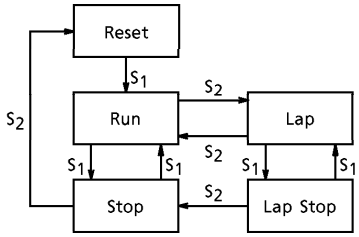
7. Type selection function

SL_1	SL_2	SL_3	TYPE	
0	—	—	A Type (1 / 100 seconds display)	
1	—	—	B Type (1 / 10 seconds display)	
—	0	0	C Type	See 8. Mode Sequence.
—	1	0	D Type	
—	0	1	E Type	
—	1	1	F Type	

(Note) '0' indicates input is OPEN or connect to V_{SS1}.
'—' indicates don't care.

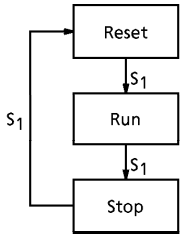
8. Mode sequence

(1) C type

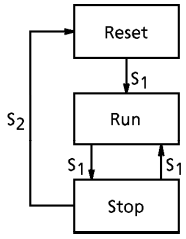


Starts functioning on the rising edge of S_1 and S_2

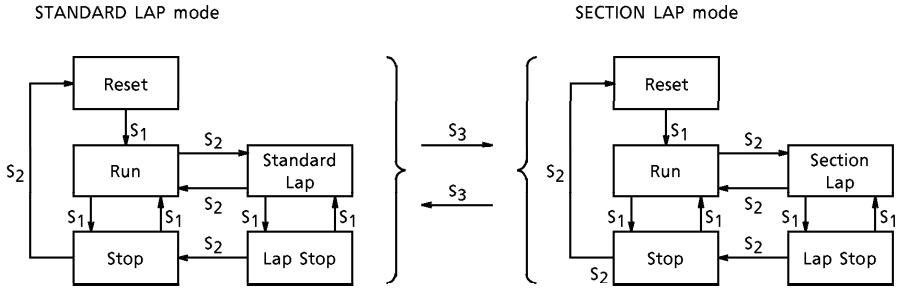
(2) D type



(3) E type



(4) F type



- S_3 toggles between STANDARD LAP mode and SECTION LAP mode.
- In SECTION LAP mode, when switched from RUN to LAP, the counter is immediately reset to '0'.
- When switched from SECTION LAP mode to NORMAL LAP mode by pressing S_3, the counter is not reset to '0'.

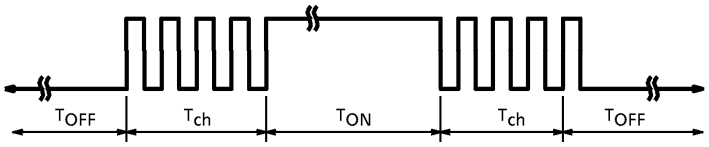
9. Display column table

DISPLAY / COLUMN / MODE	DIGIT SEGMENT							DOT SEGMENT							SIGN			
	7	6	5	4	3	2	1	7P	6P	5P	4P	3P	2P	1P	LAP	STOP	STAN-DARD	SEC-TION
Reset	□	□	□	□	□	(–)	□ (□)	●	①		⚠1						①	⚠1
Run	Hour	10 min-utes	1 min-ute	10 sec-onds	1 sec-ond	1 / 10 second	1 / 100 second	●	①		⚠1						①	⚠1
Stop	Hour	10 min-utes	1 min-ute	10 sec-onds	1 sec-ond			●	①		⚠1					●	①	⚠1
Lap	Hour	10 min-utes	1 min-ute	10 sec-onds	1 sec-ond	(–)	(1 / 10 second)	●	①		⚠1				◉		①	⚠1
Lap Stop	Hour	10 min-utes	1 min-ute	10 sec-onds	1 sec-ond			●	①		⚠1				●	●	①	⚠1

(Note 1) When 1 / 10s type is selected, only the first and second column displays are different. The display is as in the parentheses ( ).
(Note 2) '●' indicates 'lit'. (7P always lit)
(Note 3) '◉' indicates flashing at 1Hz.
(Note 4) In the F type only, '①' flashes at 1Hz when STANDARD LAP mode is selected.
(Note 5) In the F type only, '⚠1' flashes at 1Hz when SECTION LAP mode is selected.
(Note 6) 1P, 2P, 3P, and 5P do not light.

10. Chattering prevention function

A chattering prevention circuit is provided for the S_1, S_2, and S_3 inputs. The input waveform shown below does not cause malfunction.



T_{ch}<31.25ms
$T_{ON, OFF} \geqq$ 31.25ms

11. Buzzer drive function

Pressing S_1 or S_2 turns the buzzer drive circuit ON for around 30~60ms. The drive frequency is 4kHz.

12. Autoclear circuit

An autoclear circuit is incorporated for when the power supply is switched ON, at which time the counter reads "0" and RESET mode is selected. (To operate the autoclear circuit more dependably, externally attach a capacitor between T_2 and V_{SS1}.)

13. Input circuit setting error

The S_1, S_2 switch input circuit operates on the first rising edge of the input. The error for one switching is a maximum of 1 / 100 second.

14. Test functions

T_1	T_2	T_3	T_4	S_1	S_2	FUNCTION
1	1	1	1	0	0	Normal
1	0	—	—	—	—	All clear
0	ϕT_2	—	—	—	—	Acceleration from the 256Hz stage using ϕT_2
—	—	0	0	1	0	Output 100Hz to BUZZ pin
—	—	0	0	0	1	+1 h by S_2
—	—	1	0	1	—	+10 mins by S_1
—	—	1	0	—	1	+1 min by S_2
—	—	0	1	1	—	+10s by S_1
—	—	0	1	—	1	+1s by S_2
—	—	0	0	1	1	LCD all lit, BUZZ output (H level)

(Note 1) When $T_3 = 0$ or $T_4 = 0$, the normal functions of S_1 and S_2 are disabled.
(Note 2) An ALL CLEAR sets to RESET mode (0 hours, 00 minutes, 00 seconds, 00 1/100 seconds).

15. All clear function

When power is applied or when the supply of power is interrupted (e.g. if the battery is changed), the internal state of the IC may become unstable, even though it appears to be operating normally. For this reason it is vital to verify that the crystal oscillation circuit is oscillating normally ant stably (at 32 kHz) and then to use the system reset pin to initialize the IC (i.e. clear it) before use.
Note that a clear operation using the built-in power-on clear circuit should not be used in this case.

MAXIMUM RATINGS (If no temperature stipulations, Ta = 25°C)

PARAMETER	SYMBOL	RATING	UNIT
Power Supply Voltage (1)	V_{SS1}-V_{DD}	−3.0~0.2	V
Power Supply Voltage (2)	V_{SS2}-V_{DD}	−4.5~0.2	V
Input Voltage (1)	V_{IN1}	V_{SS1} − 0.2~V_{DD} + 0.2	V
Input Voltage (2)	V_{IN2}	V_{SS2} − 0.2~V_{DD} + 0.2	V
Output Voltage (1)	V_{OUT1}	V_{SS1} − 0.2~V_{DD} + 0.2	V
Output Voltage (2)	V_{OUT2}	V_{SS2} − 0.2~V_{DD} + 0.2	V
Operating Temperature	T_{opr}	−10~60	°C
Storage Temperature	T_{stg}	−40~125	°C

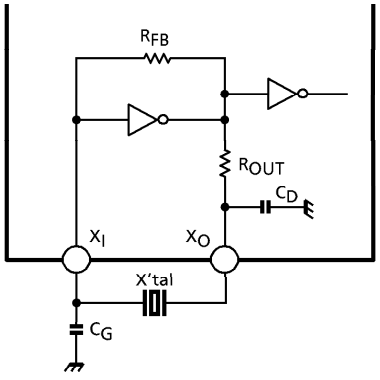
ELECTRICAL CHARACTERISTICS

(Unless otherwise stated, V_{DD} = 0.00V, V_{SS1} = − 1.55V, V_{SS2} = − 3.00V, C_G = 20pF, C_D = built-in (10pF), C_{IMAX} = 21kΩ, F_o = 32768Hz)

PARAMETER	SYMBOL	TEST CIR-CUIT	TEST CONDITIONS		MIN.	TYP.	MAX.	UNIT
Operating Voltage	$\|V_{SS1}-V_{DD}\|$	3	—		1.25	1.55	1.80	V
Operating Current Consumption	$\|I_{sup}\|$	2	No LCD Load		—	—	3.0	μA
Oscillation Start Voltage	$\|V_{STA}\|$	3	t_{STA} 10s		—	—	1.40	V
Output Current (1) Segment	I_{OH1}	4	V_{OH1} = − 0.2V		—	—	− 0.5	μA
	I_{OL1}	4	V_{OL1} = − 2.8V		0.5	—	—	
Output Current (2) Common	I_{OH2}	4	V_{OH2} = − 0.2V		—	—	− 4.0	μA
	I_{OL2}	4	V_{OL2} = − 2.8V		4.0	—	—	
Output Current (3) Buzzer	I_{OH3}	4	V_{SS1} = − 1.25V	V_{OH3} = − 0.5V	—	—	− 100	μA
	I_{OL3}	4	V_{SS2} = − 2.8V	V_{OL3} = − 0.75V	100	—	—	
Input Current (1) S_3, SL_1, SL_2, SL_3	I_{IH1}	4	V_{IH1} = 0V		1.55	—	20.0	μA
	I_{IL1}	4	V_{IL1} = − 1.55V		− 0.1	—	—	
Input Current (2) T_1, T_3, T_4	I_{IH2}	4	V_{IH2} = 0V		—	—	0.1	μA
	I_{IL2}	4	V_{IL2} = − 1.55V		—	− 50	—	
Input Current (3) T_2	I_{IH3}	4	V_{IH3} = 0V		—	—	0.1	μA
	I_{IL3}	4	V_{IL3} = − 1.55V		− 15.5	—	—	
Input Current (4) S_1, S_2	I_{IH4}	4	V_{IH4} = 0V		15.5	—	150	μA
	I_{IL4}	4	V_{IL4} = − 1.55V		− 0.1	—	—	
Voltage Doubler Output	$\|V_{UCO}\|$	2	C_1 = C_2 = 0.1μF, R_L = 3MΩ		3.0	—	—	V

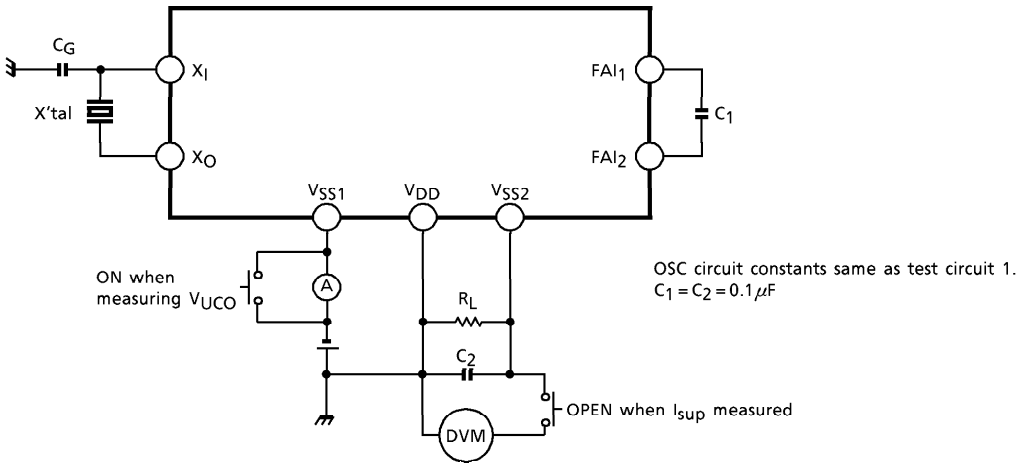
TEST CIRCUIT

1. Oscillation circuit



X'tal
R_S = 21kΩ
F_O = 32.768kHz
C_G = 20pF
C_D = 10pF built in

2. Measuring I_{sup} and V_{UCO}



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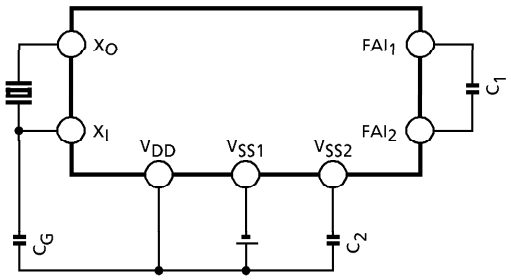

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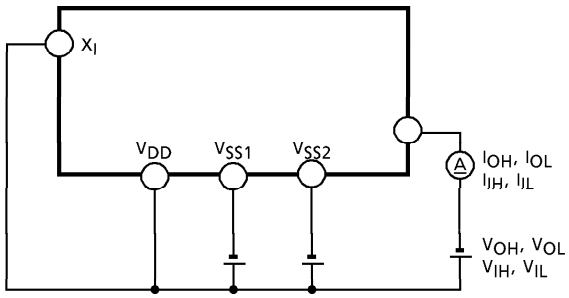
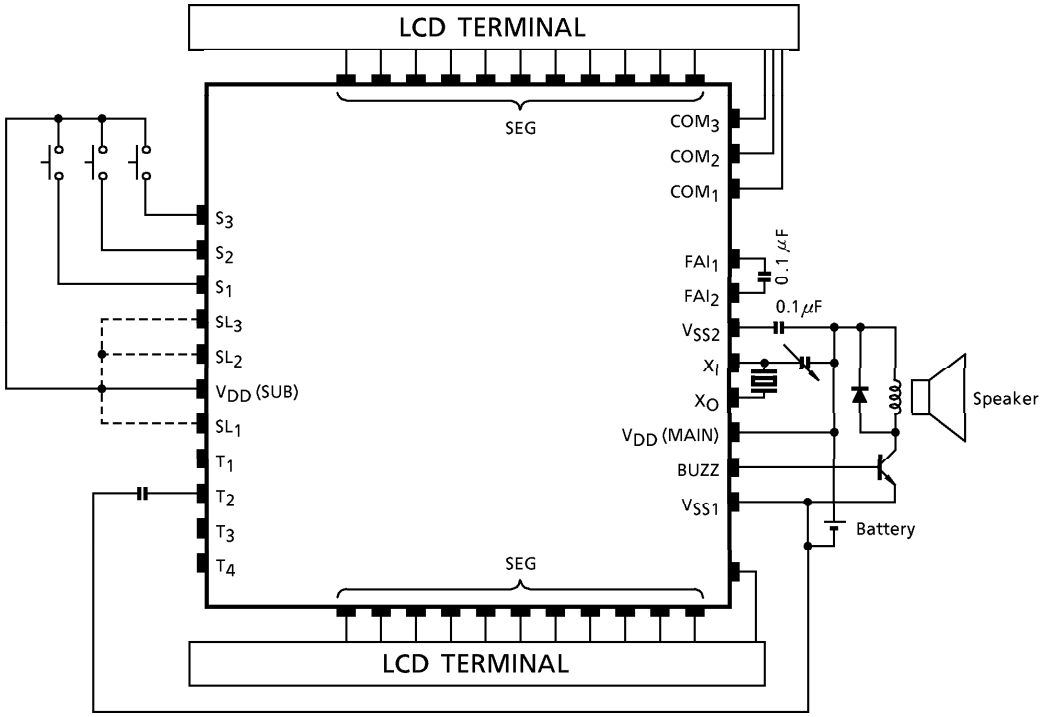


When measuring SL_1, SL_2, SL_3, set T_2 to V_{SS1}.

APPLICATION CIRCUIT EXAMPLE



(Note) Be sure to connect the V_{DD} (MAIN).