TOSHIBA CMOS DIGITAL INTEGRATED CIRCUIT SILICON MONOLITHIC

JT9692A-AS

CMOS DIGITAL LSI FOR ANALOG DIGITAL WATCH

This product is a single-chip CMOS LSI to directly drive a six-digit LCD. As well as basic watch time display functions, the LSI provides alarm, calendar, and stopwatch functions.

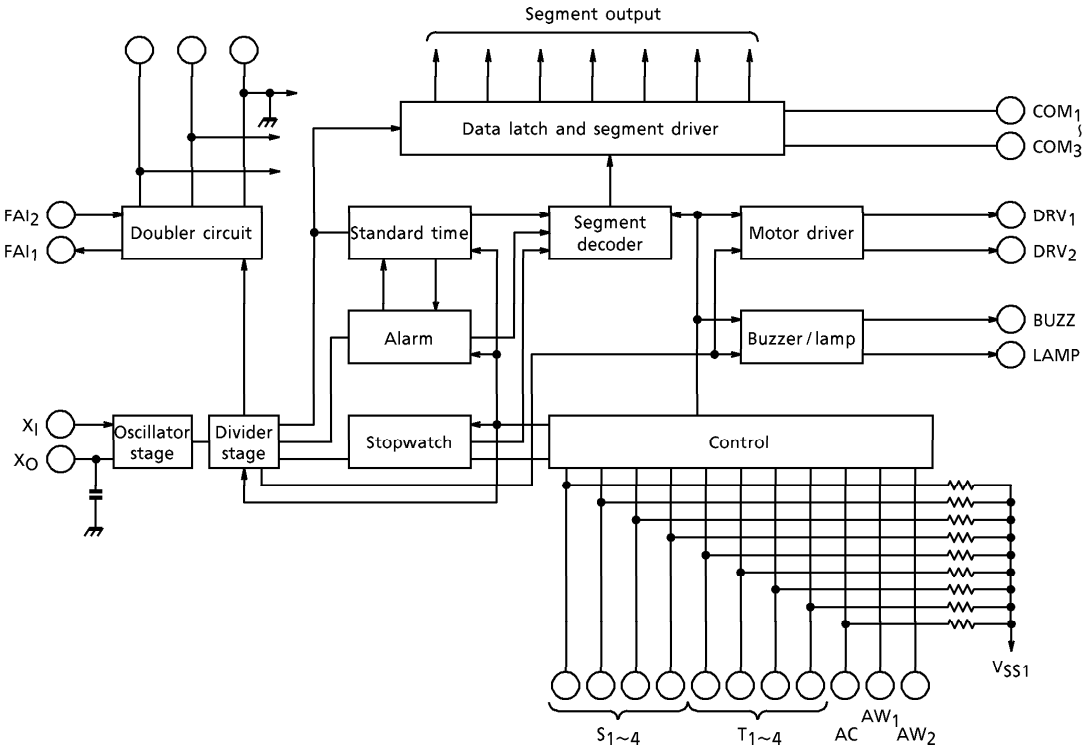
APPLICATIONS

- Watches

FEATURES

- LCD display output and analog drive pulse output
- Analog drive pulse width : 3.4ms, 3.9ms, 4.4ms, 4.9ms selectable
- Stopwatch with lap function
- Buzzer signal output alarm function
- Switch for 12 / 24-hour clock switching
- On-the-hour chime function that outputs buzzer sound
- 1 / 3-duty direct LCD drive
- Four-year automatic calendar
- Stopwatch accurate to the 100th of a second.
- Alarm time settable in one-minute units (buzzer output : 2kHz)
- Low current consumption ($|I_{sup}| \fallingdotseq 0.5\mu A$ Typ.)
- 1.55V single power supply
- Built-in voltage doubler circuit (uses external capacitor)
- All-lit function at reset ($S_2 \times S_3 \times S_4$)
- Alarm output time of 20s

BLOCK DIAGRAM



PIN DESCRIPTION (44PINS)

PIN NAME	SYMBOL	No. OF PINS
Power Supply Pins	V_{DD}, V_{SS1}, V_{SS2}	3
Oscillator Pins	X_I, X_O	2
Input Pins	$S_{1\sim4}$, AC, AW_1, AW_2	7
Output Pins	DRV_1, DRV_2, BUZZ, LAMP	4
Display Pins	$COM_{1\sim3}$, SEG (19)	22
Test Pins	$T_{1\sim4}$	4
Voltage Doubler Pins	FAI_1, FAI_2	2

DESCRIPTION OF FUNCTIONS

X_I : CG is trimmer capacitor, crystal $f_O = 32768Hz$

X_O : (Built-in CD)

V_{DD} :
V_{SS1} : Power supply voltage (Uses 1.57V silver battery)

FAI_1 :
FAI_2 : } Voltage doubler circuit pin $C_1 = C_2 = 0.1\mu F$
V_{SS2} :

(FAI_1 is the amplitude waveform between $V_{DD} \sim V_{SS1}$,
FAI_2 is the amplitude waveform between $V_{SS1} \sim V_{SS2}$
Clock signal for voltage doubling is 512Hz (50% duty))

$S_{1\sim4}$: Switches

$T_{1\sim4}$: Test pins

AC : All clear pin

BUZZ : Buzzer drive pin
LAMP : Lamp drive pin } Connected to NPN transistor base

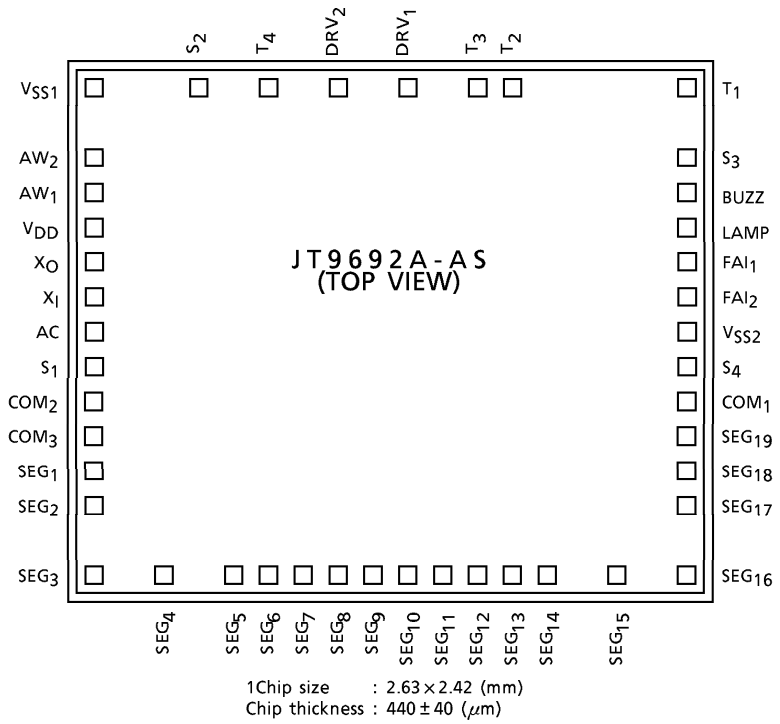
$DRV_{1, 2}$: Motor drive (Step motor drive output) pin

$COM_{1, 2, 3}$: Common output pins for multiplex LCD

SEG : Segment output pins for multiplex LCD

$AW_{1, 2}$: Step motor drive output pulse width selection pins

PAD LAYOUT



1Chip size : 2.63 × 2.42 (mm)
Chip thickness : 440 ± 40 (μm)

PAD LOCATION TABLE

PIN NAME	X POINT	Y POINT	PIN NAME	X POINT	Y POINT
SEG_2	– 1179	– 792	FAI_1	1179	331
SEG_1	– 1179	– 632	FAI_2	1179	171
COM_3	– 1179	– 472	V_{SS2}	1179	11
COM_2	– 1179	– 312	S_4	1179	– 156
S_1	– 1179	– 151	COM_1	1179	– 316
AC	– 1179	9	SEG_{19}	1179	– 476
X_I	– 1179	169	SEG_{18}	1179	– 636
X_O	– 1179	329	SEG_{17}	1179	– 796
V_{DD}	– 1179	489	SEG_{16}	1179	– 1044
AW_1	– 1179	650	SEG_{15}	950	– 1044
AW_2	– 1179	810	SEG_{14}	721	– 1044
V_{SS1}	– 1179	1044	SEG_{13}	561	– 1044
S_2	– 841	1044	SEG_{12}	401	– 1044
T_4	– 570	1044	SEG_{11}	240	– 1044
DRV_2	– 282	1044	SEG_{10}	80	– 1044
DRV_1	33	1044	SEG_9	– 80	– 1044
T_3	284	1044	SEG_8	– 240	– 1044
T_2	495	1044	SEG_7	– 401	– 1044
T_1	1179	1044	SEG_6	– 561	– 1044
S_3	1179	812	SEG_5	– 721	– 1044
BUZZ	1179	651	SEG_4	– 950	– 1044
LAMP	1179	491	SEG_3	– 1179	– 1044

FUNCTION SPECIFICATIONS

1. Analog block functions

1.1 Step motor drive output

(1) As Fig.3 shows, the step motor drive signals DRV_1 and DRV_2 are output in one-second cycles alternately.

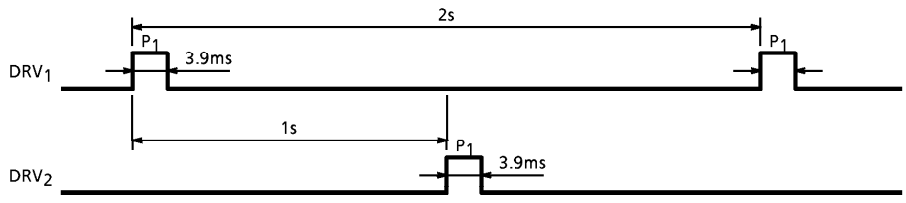


Fig.3 Step motor drive output

The pulse width P_1 can be set by the bonding option. Settings of 3.9ms, 4.9ms, 4.4ms, and 3.4ms are available. Four types of pulse width P_1 can be selected by combining the two pads (AW_1 and AW_2). The following table shows the pulse widths and the pad combinations.

STEP MOTOR DRIVE OUTPUT PULSE WIDTH

AW_1	1	1	0	0
AW_2	1	0	1	0
P_1	4.9ms (10*1 / 2048Hz)	4.4ms (9*1 / 2048Hz)	3.9ms (8*1 / 2048Hz)	3.4ms (7*1 / 2048Hz)

$1 = V_{DD}$
$0 = V_{SS1}$

(2) The step motor drive output takes precedence over other drive outputs (except for the LCD drive output signal).

- When the step motor drive output and the buzzer drive output overlap, the step motor drive output takes precedence and the buzzer drive output is delayed about 62.5ms. Fig.4 shows the timing.
- When the operating confirmation sound output timing and the step motor drive output timing overlap, the step motor drive output takes precedence. The operating confirmation sound is output after a 1 / 32-second delay.

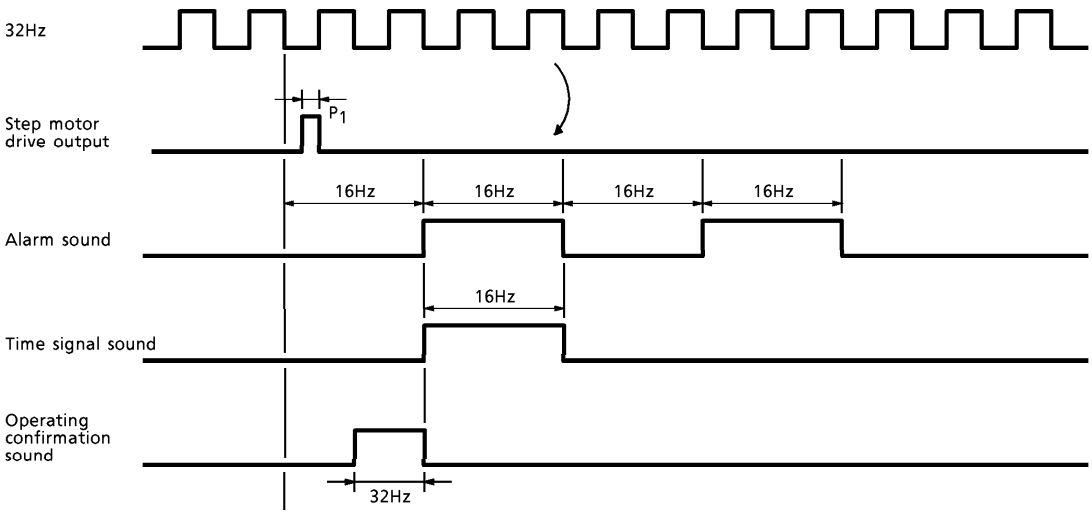


Fig.4 Step motor drive output and buzzer drive output timing

- When the step motor drive output and the lamp ON output overlap, about 3.9ms before the step motor drive output, the lamp goes OFF for around 9.8ms and the step motor drive output functions, as shown in Fig.5.

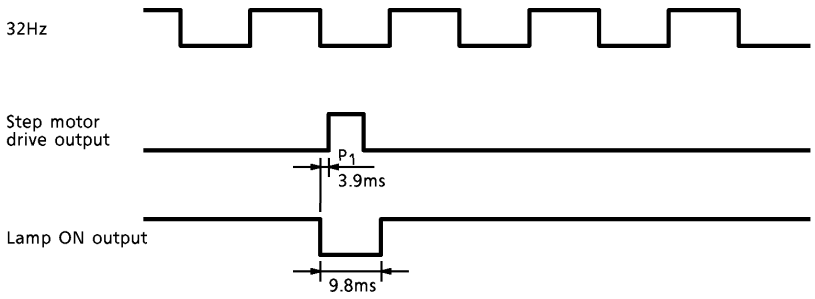


Fig.5 Step motor drive output and lamp ON output timing

1.2 Switch S_1 functions

(1) Switch S_1 only stops the step motor drive output. S_1 does not reset the time. Fig.6 shows the timing. The digital block is operates normally.

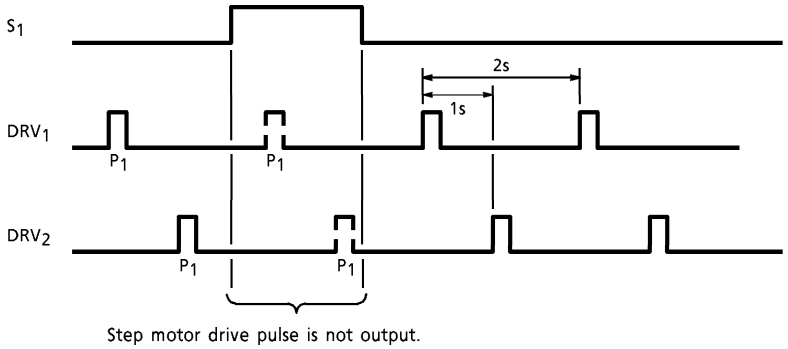


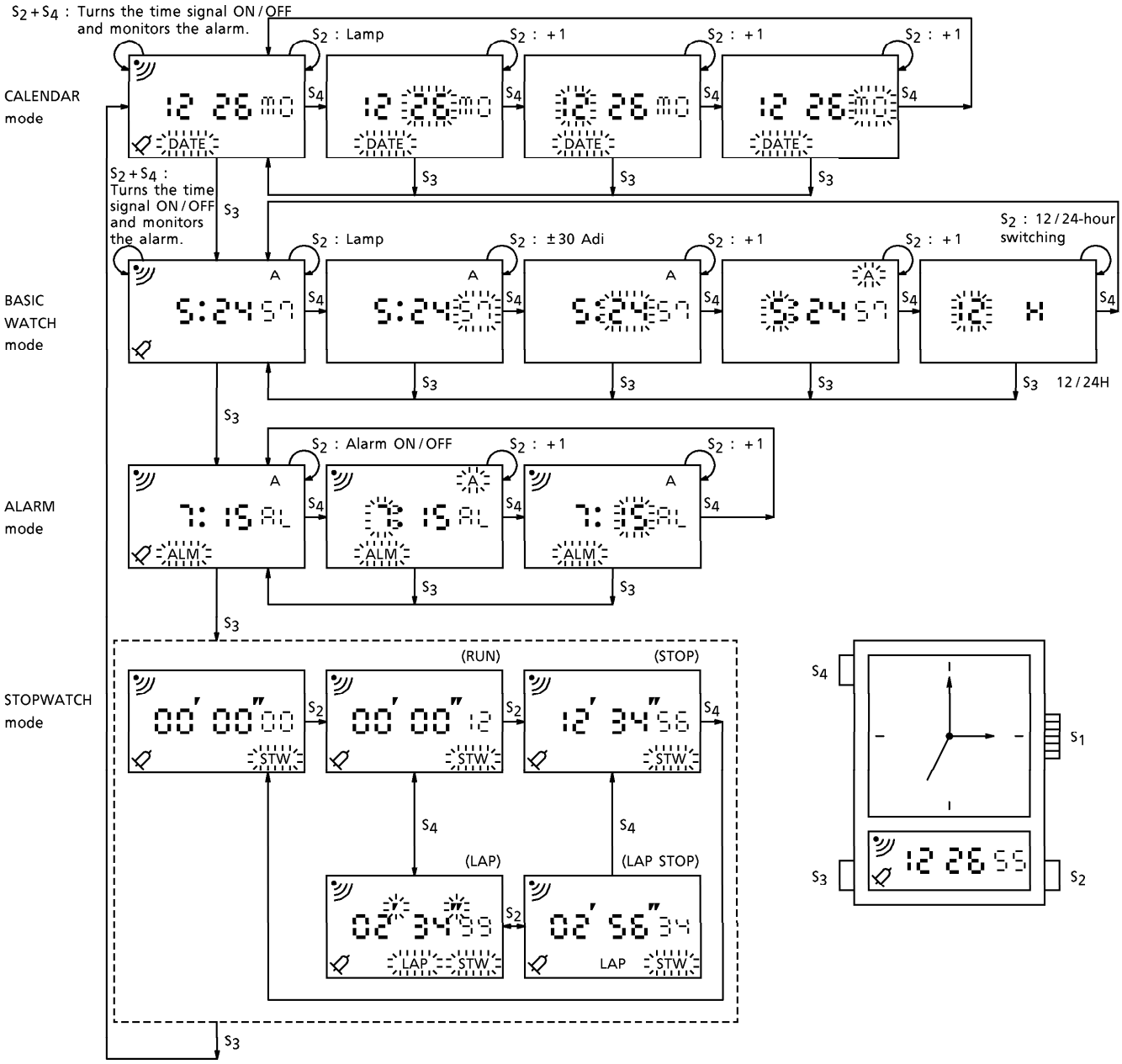
Fig.6 Switch S_1 and step motor drive output timing

(2) During step motor drive, the output halt function based on S_1 is disabled.

(3) If before S_1 was turned off, the step motor drive pulse was DRV_1, after S_1 is released, the step motor drive pulse is DRV_2.
If, on the other hand, before S_1 was turned off, the step motor drive pulse was DRV_2, after S_1 is released, the step motor drive pulse is DRV_1.

(4) The step motor drive output is linked to the digital seconds count, except when S_1 is ON.

1.3 Switch operation diagram



(Note 1) The ☼ setting columns and the marks flash at 2Hz with 50% duty. (The setting columns come ON during the 8Hz fast-wind used for setting.)

(Note 2) Pressing S_4 for 2~3 seconds or longer in NORMAL mode switches the device to SETTING mode. (In ALARM mode, a momentarily pressing S_4 sets to SETTING mode.)

(Note 3) In all setting modes except for the SECONDS RESETTING and 12/24-HOUR SWITCHING modes, depressing S_2 for 2~3 seconds starts the fast winding at 8Hz.

2. Digital block functions

2.1 Display example

(1) Names of digits and segments

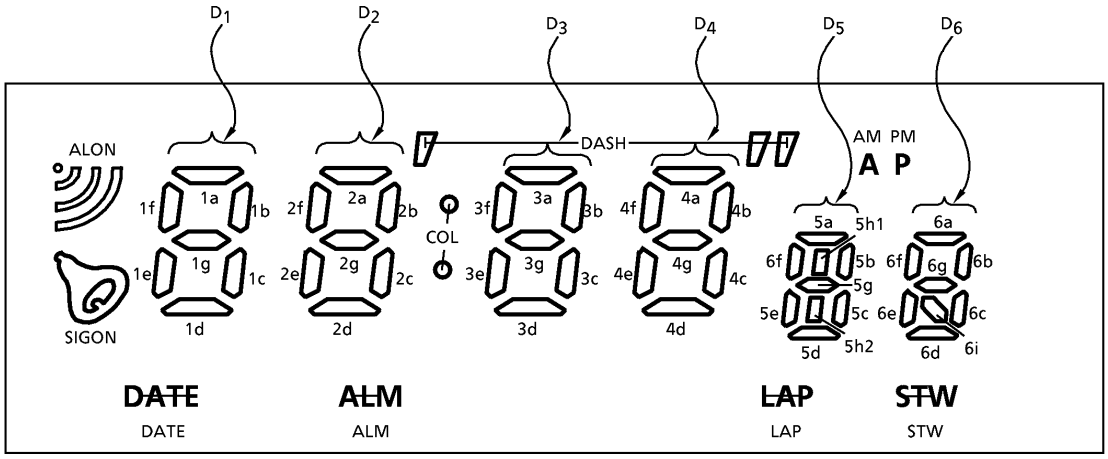


Fig.7

(2) Digit display

DIGIT			0	1	2	3	4	5	6	7	8	9
Display example			0	1	2	3	4	5	6	7	8	9
Lit segments	D_1~D_6	a	○		○	○		○	○	○	○	○
		b	○	○	○	○	○			○	○	○
		c	○	○		○	○	○	○	○	○	○
		d	○		○	○		○	○		○	○
		e	○		○				○		○	
		f	○				○	○	○		○	○
		g			○	○	○	○	○		○	○

Fig.8

(3) Text for days of the week, ALARM mode, and time control displays

STATE			SUN.	MON.	TUES.	WED.	THURS.	FRI.	SAT.	ALARM MODE	H
Display example			SU	MO	TU	WE	TH	FR	SA	AL	H
Lit segments	D_5	a	○	○	○		○	○	○	○	
		b		○		○				○	○
		c	○	○		○			○	○	○
		d	○			○			○		
		e		○		○		○		○	○
		f	○	○		○		○	○	○	○
		g	○					○	○	○	○
		h1		○	○	○	○				
		h2		○	○	○	○				
	D_6	a		○		○		○	○		
		b	○	○	○		○	○	○		
		c	○	○	○		○		○		
		d	○	○	○	○				○	
		e	○	○	○	○	○	○	○	○	
		f	○	○	○	○	○	○	○	○	
		g				○	○	○	○		
		i						○			

Fig.9

(4) Display flashing

- The display flashing is at 50% duty, alternating between coming ON and going OFF.

2.2 Switch functions in each mode

SWITCH \ MODE		DATE MODE	TIME MODE	ALARM MODE	STOPWATCH MODE
S_1	NORMAL mode	Motor drive halted	Motor drive halted	Motor drive halted	Motor driver halted
	SETTING mode				
S_2	NORMAL mode	Lamp ON	Lamp ON	ALARM ON / OFF	● RUN / STOP
	SETTING mode	One press increments (8Hz fast-wind for setting)	One press increments (8Hz fast-wind for setting)***	One press increments (8Hz fast-wind for setting)	
S_3	NORMAL mode	Switch to TIME mode	Switch to ALARM mode	Switch to STOPWATCH mode	● Switch to DATE mode
	SETTING mode	SETTING mode release	SETTING mode release	SETTING mode release	
After 2~3 seconds	NORMAL mode	To DAY SETTING mode	To SECONDS RESETTING mode		
S_4	NORMAL mode			Alarm time setting	LAP / RESET
	SETTING mode	Setting column selection	Setting column selection	Setting column selection	
S_2·S_4	NORMAL mode	● Time signal ON / OFF ● Sound demo	● Time signal ON / OFF ● Sound demo		**RUN / STOP LAP / RESET
S_2·S_3·S_4	NORMAL mode	AC / all lit	AC / all lit	AC / all lit	AC / all lit
	SETTING mode				

Fig.10

** To set S_2 and S_4 simultaneously ON in STOPWATCH mode, turn them ON in the correct sequence.

*** When setting the time in TIME mode, S_2 :

Sets the seconds ..... Resets the seconds (If the seconds display is 0-29, the seconds are simply set to "00". If the seconds display is 30-59, the seconds are simply set to "00" and one minute is incremented.)

Switching between 12-hour and 24-hour clocks ..... Switching between a 12-hour clock and a 24-hour clock is supported

**** In all modes, when the alarm starts sounding, S_2~S_4 function exclusively to turn the alarm OFF. However, in STOPWATCH mode, S_2 and S_4 also have stopwatch functions.

***** In DATE mode or TIME mode, immediately S_2 and S_4 both come ON, the time signal turns ON / OFF. The sound demo starts up immediately to one second later.

2.3 Current time function

(1) TIME (hour, minute, seconds) DISPLAY mode

- With the 12-hour clock, morning or afternoon is indicated by the AM / PM sign.
- With the 24-hour clock, AM and PM both remain OFF.
- For the operation of the time signal set sign (SIG ON), see 2.8 Time Signal Function.
- For the operation of the alarm set sign (ALON), see 2.4 Alarm Function.
- The other signs (DATE, ALM, STW, LAP, DASH) are OFF.

(2) CALENDAR (month, day of the month, day of the week) DISPLAY mode

- For long months, the day of the month is displayed in the range 1~31 ; for short months (except for February), the day of the month is in the range 1~30. For February, the day of the month is in the range 1~28. (See 2.9 Auto-calendar function.)
- The date mode sign (DATE) flashes at 2Hz.

2.4 Alarm function

(1) Alarm report function

- The alarm is set in units of one minute (set by switch in ALARM SETTING mode). Any time in the 24-hour range can be set.
- Switching between alarm set and set release is supported. Pressing S_2 in ALARM NORMAL mode releases the set if the alarm is set, and sets the alarm is the alarm is not set.
- When the set time and the current time match and the alarm is set (ON), a buzzer drive signal for the alarm sound is output. Note that the alarm does not sound while in TIME mode.
- While the buzzer drive signal is output, pressing any one of S_2, S_3, or S_4 stops the output.
- Even if S_2, S_3, or S_4 are not pressed, 20 seconds after a match between the alarm set time and the current time, the buzzer drive signal is automatically stopped.
- When output has been stopped by pressing a switch or by the elapse of 20 seconds, the signal is not output until the next match between the set time and the current time. Note that this excludes the SOUND DEMO function described in 2.7.
- When a switch is used to stop the buzzer drive signal as described above, the original function of the switch is disabled. However, in STOPWATCH mode, S_2 and S_4 also have stopwatch functions.

(2) ALARM SET TIME DISPLAY mode

- The alarm set time display is linked to the TIME mode. When TIME mode is a 12-hour clock mode, the alarm set time is 12-hour clock time ; when TIME mode is a 24-hour clock mode, the alarm set time is 24-hour clock time.
- The alarm set time display is the same as the TIME mode display, including the AM and PM signs. However, there is no seconds display and AL is displayed in columns D_5 and D_6.
- The alarm set sign (ALON) indicates whether the alarm is set or released. When the alarm is set (ON), the sign is lit ; when the set is released (OFF), the sign is not lit.
- The alarm set sign (ALON) functions as above in all modes except for time setting, date setting, and when all the columns are lit.
- The ALARM mode sign flashes at 2Hz.

2.5 Stopwatch function

(1) Time clocking function

- Time is clocked in units of 1 / 100-second.
- The maximum clock-able time is 59 minutes, 59 seconds, and 99 hundredths of a second. When the count reaches 60 minutes, the display returns to 00 : 00 : 00 and continues the count.
- Stopwatch time clocking operates independently of TIME mode time counting.

(2) Five stopwatch states

S_2 and S_4 are used to select the following five states.

- Reset state

  Stops time clocking and displays 00 minutes, 00 seconds, 00.
  The minutes and seconds sign (DASH) comes ON, and the lap sign (LAP) goes OFF.
  Pressing S_2 starts the clocking.

- Run state

  Time clocking continues and the clocked time is displayed while it is being recorded.
  Continues to record from the clocked time reached when this state was selected.
  The minutes and seconds sign (DASH) comes ON and the lap sign goes OFF.
  Pressing S_2 stops time clocking.
  Pressing S_4 switches to LAP or RUN state.

- STOP state

  Time clocking stops and the time reached when the clocking stopped is displayed.

- LAP / RUN state

  Time clocking continues.
  The minutes and seconds sign (DASH) flashes at 2Hz.
  The lap sign (LAP) is lit.
  Pressing S_2 switches to LAP / STOP state.
  Pressing S_4 releases LAP state.

- LAP / STOP state

  Time clocking stops in LAP or STOP state.
  The minutes and seconds sign (DASH) and the lap sign (LAP) are lit.
  Pressing S_2 switches to LAP / RUN state.
  Pressing S_4 switches to STOP state.

(Note) If the alarm sounds while the stopwatch is functioning, S_2 and S_4 can be used to stop the alarm sound. At this time they can simultaneously perform stopwatch functions.

(3) STOPWATCH DISPLAY mode (ST)

- The STOPWATCH mode sign (STW) flashes at 2Hz.
- Pressing S_2 or S_4 outputs a buzzer drive signal for the operating confirmation sound.
- When the output timing of this buzzer drive signal for the operating confirmation sound overlaps with the step motor drive signal output, the latter takes priority and delays the buzzer drive signal by 1 / 32 second.
- Pressing S_3 in any stopwatch display mode switches to DATE mode.
- Whichever mode is entered (apart from the initial setting), the clocking or stop status of the stopwatch is saved. When you again return to the stopwatch display mode, the stopwatch returns to the saved clocking or stop status.
- When entering DATE mode from the LAP state, the LAP state is released. When returning again to STOPWATCH DISPLAY mode, the RUN or STOP state is selected. (If the state was LAP / RUN, the RUN state is selected. If the state was LAP / STOP, the stop state is selected.)
- The minutes and seconds sign (DASH) is lit when in the RESET, RUN, STOP, LAP, or LAP / STOP states. In LAP / RUN state, the minutes and seconds sign flashes at 2Hz.

2.6 SETTING state

(1) Basic setting function

- In TIME DISPLAY or CALENDAR DISPLAY mode, depressing S_4 for 2~3 seconds or longer accesses the corresponding SETTING modes. (In ALARM mode, S_4 is pressed momentarily.)
- In ALARM SET TIME DISPLAY mode, press S_4 to enter SETTING mode.
- In SETTING mode, S_4 selects the setting column. At each press, S_2 increments the column selected for setting by one. (Depressing S_2 for 2~3 seconds or longer fast-winds at 8Hz.)
  Note that this does not include switching between the 12- and 24-hour clock, or resetting the seconds. (If the seconds display is 0-29, the seconds are simply set to "00". If 30-59, the seconds are simply set to "00" and one minute is incremented.)
- The column selected for setting (except for the seconds column) cannot normally accept a carry from a lower column.
- If a carry results from the setting, it cannot be output to a higher column. However, a carry from the seconds column can increment the minutes column by one minute if the seconds were 30-59.

(2) TIME (hours, minutes, seconds) SETTING mode

The selected columns flash at 2Hz.
The alarm set sign (ALON) and the time signal set sign (SIG ON) go OFF.
The colon (COL) comes ON.
If a match with the alarm time occurs during the setting, the alarm signal is not output.

- SECONDS RESETTING state

  The seconds columns flash at 2Hz.
  If S_2 is pressed when the seconds columns display 00-29, the columns change to "00".
  At that time, no carry is output to the minutes columns.
  If the seconds columns read 30-59, pressing S_2 changes the columns to "00". At the same time, a carry is output to the minutes columns.
  Pressing S_4 switches to minute setting state.

- MINUTES SETTING state

  The minutes columns flash at 2Hz.
  Pressing S_2 increments the minutes by one.
  Pressing S_4 switches to hours setting state.

- HOURS SETTING state

  Zero suppression is applied to the hours columns and the AM or PM signs (if the 12-hour clock is selected) flash at 2Hz.
  Pressing S_2 increments the hours by one.
  Pressing S_4 switches to 12-hour / 24-hour clock setting state.

- Setting the 12-/24-hour clock

  In column #1 or #2, "12" or "24" flash at 2Hz.
  "H" is displayed in the fifth column. (See the display example item.)
  Pressing S_2 switches the 12/24-hour clock.
  Pressing S_4 switches to STANDARD TIME (non-setting) mode.

(3) DATE (month, day of month, day of week) SETTING mode

The column selected for setting flashes at 2Hz.
The alarm set sign (ALON), the time signal set sign (SIG ON), and the colon (COL) are OFF.
The other displays are the same as for DATE NORMAL mode.

- Setting the day of the month

  The day of the month columns (zero suppressed) flash at 2Hz.
  Pressing S_2 increments the day of the month by one.
  The day of the month can be set in the range 1~31.
  (See 2.9 Auto-calendar function.)
  Pressing S_4 switches to the month setting state.

- MONTH SETTING state

  The month columns (zero suppressed) flash at 2Hz.
  Pressing S_2 increments the month by one.
  Pressing S_4 switches to the day of the week setting state.

- DAY OF THE WEEK SETTING state

  The day of the week column flashes at 2Hz.
  Pressing S_2 increments the day of the week by one.
  Pressing S_4 switches to DATE NORMAL mode.

(4) ALARM TIME SETTING mode

The column selected for setting flashes at 2Hz.
The alarm set sign (ALON) is lit when set (ON).
The time signal set sign (SIG ON) is OFF.
The colon (COL) is lit.
The other displays are the same as for ALARM NORMAL mode.
While setting the alarm time, if a match occurs with the TIME mode current time, the seconds are in the range 00-20, and the alarm is ON, the alarm signal is output.

- ALARM HOUR SETTING state

  The hours columns (zero suppressed) and the AM or PM signs (if the 12-hour clock is selected) flash at 2Hz.
  Pressing S_2 increments the hour for the alarm setting by one.
  Pressing S_4 switches to alarm minute setting state.

- ALARM MINUTE SETTING state

  The minutes columns flash at 2Hz.
  Pressing S_2 increments the time for the alarm setting by one minute.
  Pressing S_4 switches to ALARM NORMAL mode.

(5) Release from setting modes

Pressing S_3 in any state in any setting mode, forcibly switches to the normal mode.
In all settings of all modes, after 60~70 seconds has elapsed without S_2, S_3, or S_4 being pressed, the device automatically switches to the standard display mode.

2.7 Sound demonstration function

- In the standard states of DATE DISPLAY or TIME DISPLAY modes, while S_2 and S_4 are simultaneously ON, the buzzer drive signal for the alarm sound is output. If either S_2 or S_4 go OFF, the output stops.
- If one of S_2 or S_4 is ON before the other, the function of the switch first turned ON operates, and when the second switch is turned ON, the buzzer drive signal output starts. At the same time, the SET RELEASE state of the time signal is switched.
  (See 2.8 Time signal function.)
- During the sound demonstration, if a match occurs between the alarm set time and the current time, the buzzer drive signal output is as below.

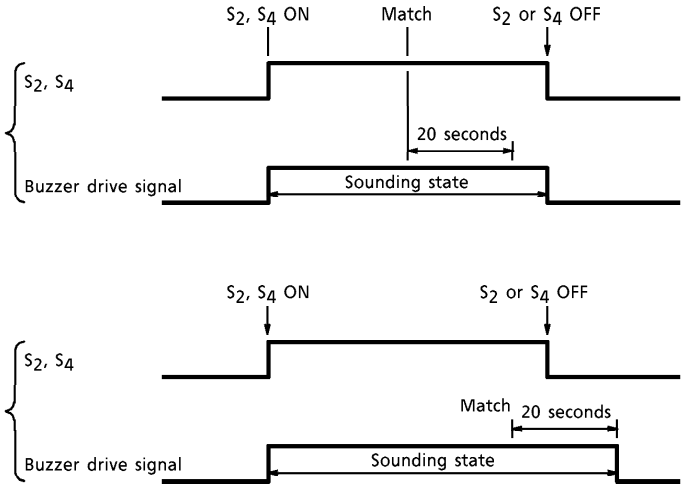


Fig.11

- The time signal ON / OFF switching and sound demonstration functions operate off the same switch. The time signal is switched ON / OFF immediately S_2 and S_4 both come ON. SOUND DEMO mode starts to output the alarm sound within one second of S_2 and S_4 both coming ON.

2.8 Time signal function

- In STANDARD TIME (current time) mode, the buzzer drive signal for the time signal sound is output on the hour.
- Time signal set and set release switching is supported.
  If the time signal is set, when the sound demo starts after pressing S_2 and S_4 in date and time normal modes, the set is released. If the time signal is released, when the sound demo starts after pressing S_2 and S_4 in date and time normal modes, the time signal is set.
- With the time signal set released, the buzzer drive signal is not output on the hour.
- The time signal set and set released states are indicated by the time signal set sign (SIG ON).
  In all modes except setting modes, the time signal set sign (SIG ON) comes ON when the time signal is set, and goes OFF when the set is released.

2.9 Auto-calendar function

(1) This function automatically controls the count for the days of the month to avoid the need to set the 1st of each month by detecting short months, long months, or February. Note that the days of the week are not related to this function.

Long months (with 31 days) : January, March, May, July, August, October, December
Short months (with 30 days) : April, June, September, November
Short months (with 28 days) : February

(2) The auto-calendar is effective only when a standard carry is input from the hours columns.

(3) If months and days that do not actually exist are set (the 31st of short months and the 30th and 31st of February), when the device returns to the standard (non-setting) state, it automatically sets the 1st of the following month.
Note that the days of the week are not related to this function.

(4) In standard states, when a standard carry is input from the hours columns at February 28, the display changes to March 1.
If February 29 is set, the display does not show March 1 on returning to the normal mode. Instead, the display shows March 1 when a standard carry is input from the hours column.

2.10 Lamp lighting function

The lamps are only lit in the standard states of the DATE and TIME modes while S_2 is ON.

(1) When the step motor drive is output while lamps are lit, the lamps turn OFF for 9.8ms.

(2) If buzzer drive output is generated while the lamps are ON :

- If the buzzer drive output is for the alarm, the lamps turn OFF only while the alarm sound is output.
  The waveform output for lighting the lamps is as in Fig.12.
- When the buzzer drive output is for the time signal sound, the lamps turn OFF only while the time signal sound is output.
  The waveform output for lighting the lamps is as in Fig.12

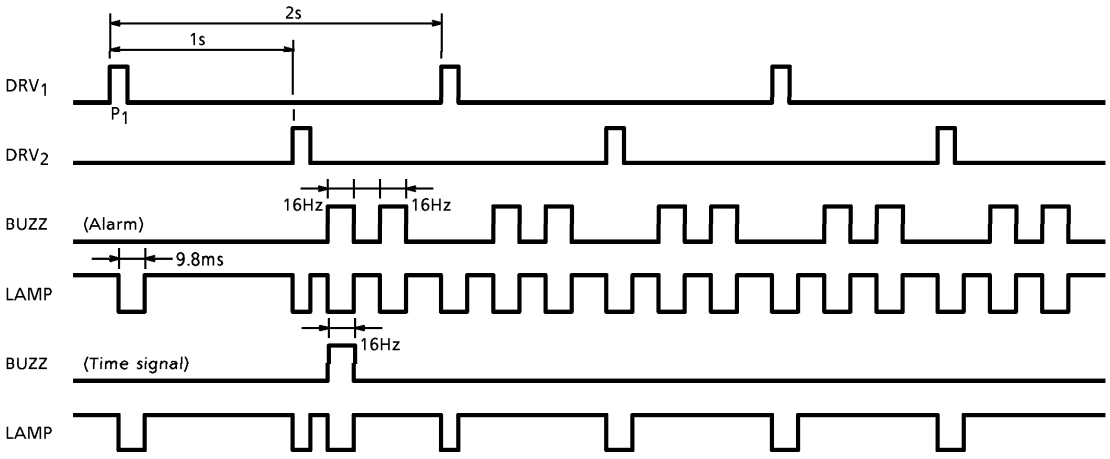
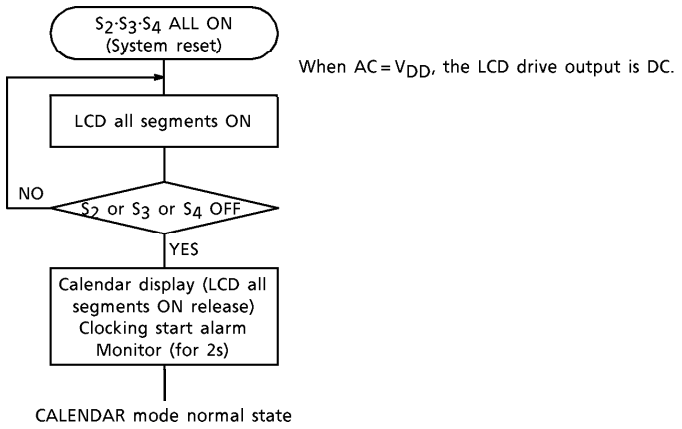


Fig.12 Lamp lighting output waveform (Includes the step motor drive output timing)

2.11 Initial value setting function (System reset)

When S_2, S_3, and S_4 are all at the V_{DD} level, the initial values are set (system reset), and the device functions as in the figure below.



2.12 Initial settings for each mode

Calendar	: January 1, Sunday
Time	: AM, 12 o'clock, 00 minutes, 00 seconds
Alarm	: AM, 12 o'clock, 00 minutes OFF state
Stopwatch	: 00 minutes, 00 seconds, 00 RESET state
Time signal function	: OFF state

2.13 All segments lit waveform

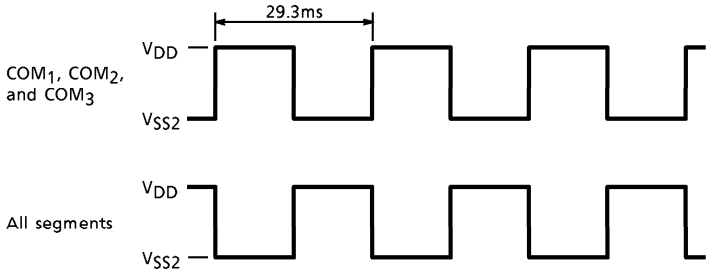


Fig.13

2.14 Buzzer drive signal

(1) The buzzer drive signals are : the alarm sound, the time signal sound, and the operating confirmation sound. The sound demo outputs the alarm sound.

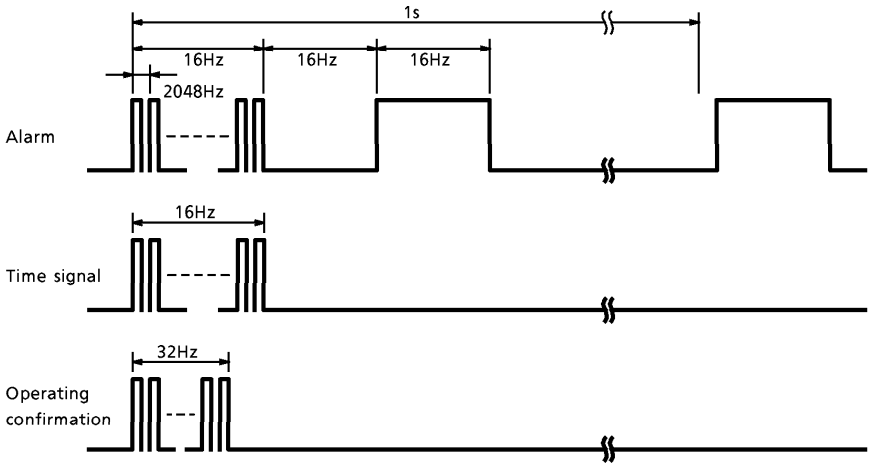


Fig.14 Buzzer drive waveform

2.15 LCD drive waveform

(1) The drive method is a multiplex drive with three commons and 1/2 bias

(2) The drive power supply has a reference voltage of V_{SS1} and uses doubled voltage V_{SS2}.

(3) The drive frequency is 34Hz/frame.

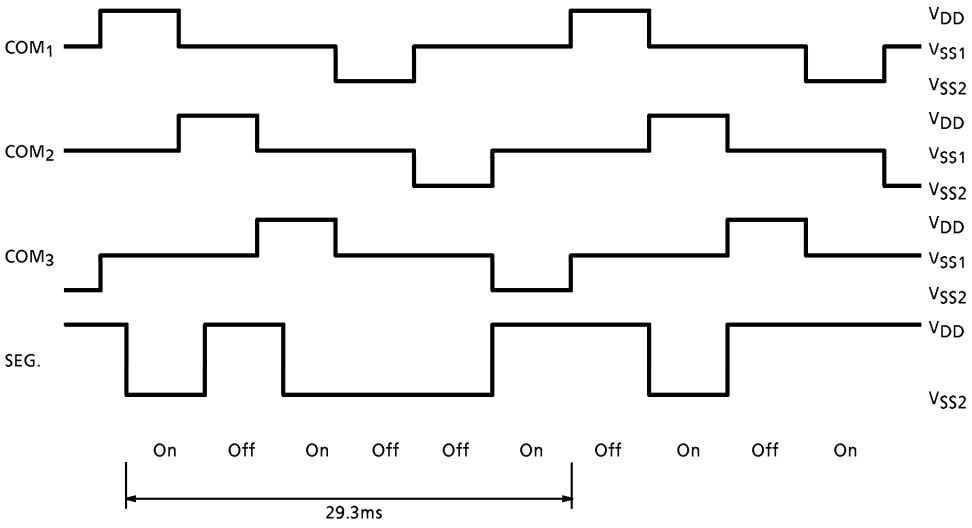
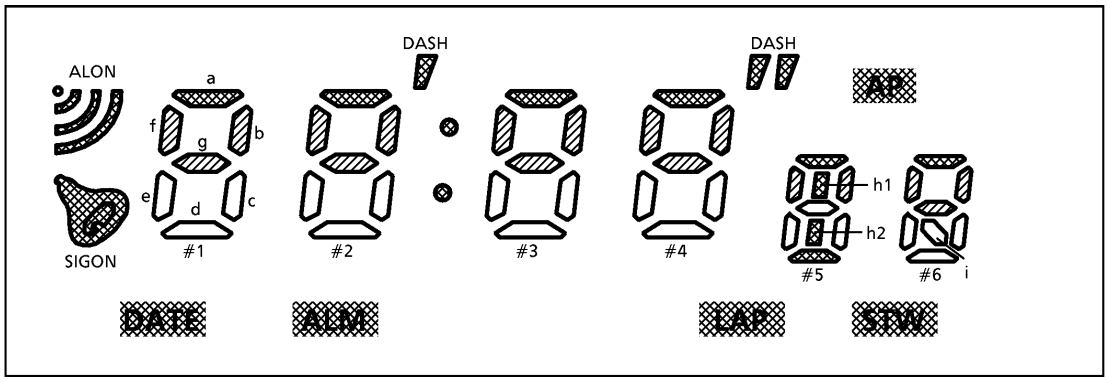


Fig.15 LCD drive waveform

3. LCD segment combinations



: COM_1 : COM_2 : COM_3

PAD NAME	COM_1	COM_2	COM_3
SEG_1	d5	—	d6
SEG_2	STW	b6	c6
SEG_3	a6	g6	i6
SEG_4	P	f6	e6
SEG_5	A	b5	c5
SEG_6	a5	5h1	g5
SEG_7	5h2	f5	e5
SEG_8	DASH	b4	c4
SEG_9	a4	g4	d4
SEG_{10}	LAP	f4	e4
SEG_{11}	SIGON	b3	c3
SEG_{12}	a3	g3	d3
SEG_{13}	COL	f3	e3
SEG_{14}	DASH	b2	c2
SEG_{15}	a2	g2	d2
SEG_{16}	ALM	f2	e2
SEG_{17}	DATE	b1	c1
SEG_{18}	a1	g1	d1
SEG_{19}	ALON	f1	e1

4. Switch input acceptance

(1) Switches S_1, S_2, S_3, and S_4 are all pulled down to the V_{SS1} level by pull-down resistance. Pulling the level up to the V_{DD} level turns the switch ON.

(2) The timing for reading the switches is on the rising edge of the switch pins from the V_{SS1} to the V_{DD} (⌐‾).

(3) The chattering prevention period for each switch is as follows.
Fig.16 shows the switch inputs.

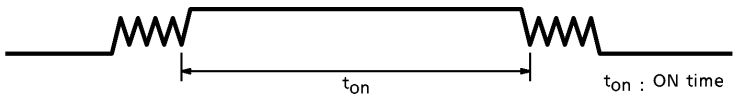


Fig.16 Switch input

- Switches S_2, S_3, and S_4

  $0 < t_{on} \leqq 31.25ms$: Not interpreted as ON
  $31.25ms \leqq t_{on} \leqq 62.5$: Interpreted as ON depending on the timing
  $62.5ms \leqq t_{on}$: Definitely read as ON

  The conditions for ON chattering ON and OFF chattering are the same.

- Switch S_2 and S_4 in STOPWATCH mode, and S_1 :

  ON chattering : None (Reads the beginning of the rising edge)
  OFF chattering : Same as above.

(4) Operations begin after two or three seconds, the period taken from the switch reading timing until the switch ON timing (between two and three seconds).

5. Test function

Test pins T_1~T_4 and AC are pulled down to V_{SS1} by internal resistance.

(1) T_1 pin

External clock input pin

(2) T_2 pin

When T_2 pin is at the V_{DD} level, a ϕT_1 clock is input from T_1 pin.

(3) T_4 pin

Column acceleration pin, input pin

(4) T_3 pin

When T_3 pin is at the V_{DD} level, the column count can be accelerated using the T_4 pin ϕT_4 clock at 128Hz, 64Hz, or 32Hz.
When T_3 is at the V_{SS} level, the seconds column count can be accelerated using the T_4 pin ϕT_4 clock.

6. 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 (Unless otherwise stated, 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}	− 5.0~0.2	V
Operating Temperature	T_{opr}	− 10~60	°C
Storage Temperature	T_{stg}	− 40~125	°C

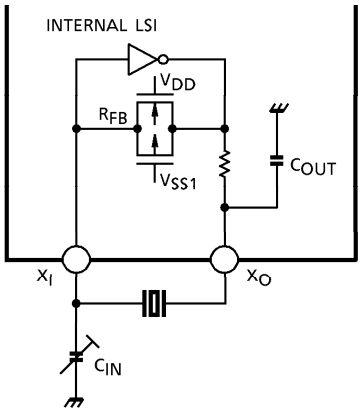
ELECTRICAL CHARACTERISTICS

(Unless otherwise stated, V_{DD} = 0V, V_{SS1} = − 1.55V, V_{SS2} = − 3.0V, Ta = 25°C)

PARAMETER	SYMBOL	TEST CIR-CUIT	TEST CONDITIONS		MIN.	TYP.	MAX.	UNIT
Operating Voltage	$\|V_{SS1}-V_{DD}\|$	3	—		1.20	1.55	1.80	V
Operating Current Consumption	$\|I_{SUP}\|$	2	—		—	—	1.00	μA
Oscillation Start Voltage	$\|V_{STA}\|$	3	—		—	—	1.40	V
Doubler Output Voltage	$\|V_{UCO}\|$	2	V_{SS1} = 1.55V $C_1 = C_2$ = 0.1μF, R_L = 3MΩ		—	—	2.9	V
Input Current (1) (S_1)	I_{IH1}	4	V_{SS1} = − 1.55V	V_{IH1} = 0V	0.04	—	0.27	μA
	I_{IL1}	4		V_{IL1} = − 1.55V	− 0.1	—	—	
Input Current (2) (S_2, S_3, S_4)	I_{IH2}	4	V_{SS1} = − 1.55V	V_{IH2} = 0V	3.0	—	60	μA
	I_{IL2}	4		V_{IL2} = − 1.55V	− 0.1	—	—	
Input Current (3) (T_1~T_4, AC)	I_{IH3}	4	V_{SS1} = − 1.55V	V_{IH3} = 0V	—	150	—	μA
	I_{IL3}	4		V_{IL3} = − 1.55V	− 0.1	—	—	
Output Current (1) (Segment)	I_{OH1}	4	V_{SS1} = − 1.55V	V_{OH1} = − 0.2V	—	—	− 0.5	μA
	I_{OL1}	4	V_{SS2} = − 3.0V	V_{OL1} = − 2.8V	0.5	—	—	
Output Current (2) (Common)	I_{OH2}	4	V_{SS1} = − 1.55V	V_{OH2} = − 0.2V	—	—	− 3.0	μA
	I_{OL2}	4	V_{SS2} = − 3.0V	V_{OL2} = − 2.8V	3.0	—	—	
Output Current (3) (BUZZ)	I_{OH3}	4	V_{SS1} = − 1.30V	V_{OH3} = − 0.6V	− 1000	—	− 100	μA
	I_{OL3}	4	V_{SS2} = − 2.00V	V_{OL3} = − 1.2V	3	—	60	
Output Current (4) (LAMP)	I_{OH4}	4	V_{SS1} = − 1.30V	V_{OH4} = − 0.3V	− 1000	—	− 100	μA
	I_{OL4}	4	V_{SS2} = − 2.00V	V_{OL4} = − 1.2V	3	—	60	
Output Current (5) (DRV_1, DRV_2)	I_{OH5}	4	V_{SS1} = − 1.55V	V_{OH5} = − 0.05V	—	—	− 0.8	mA
	I_{OL5}	4	V_{SS2} = − 3.0V	V_{OL5} = − 1.5V	0.8	—	—	

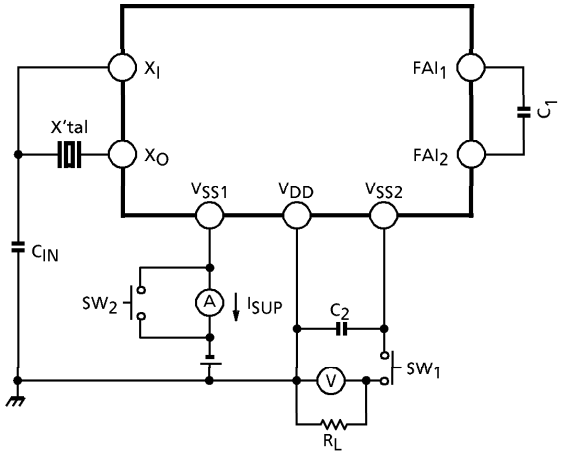
TEST CIRCUIT

1. Standard oscillation circuit



X'tal : f_O = 32.768kHz
R_S = 30kΩ
C_{OUT} = 10pF (Typ.)
C_{IN} = 33pF

2. I_{SUP}, V_{UCO} test circuit



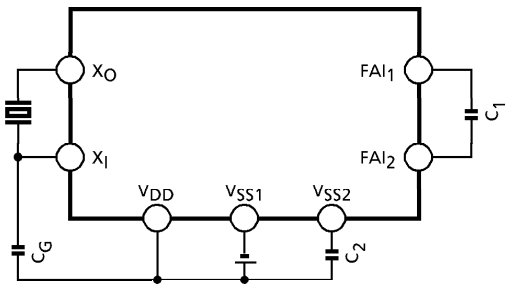
C_{IN} = 33pF
$C_1 = C_2 = 0.1\mu F$

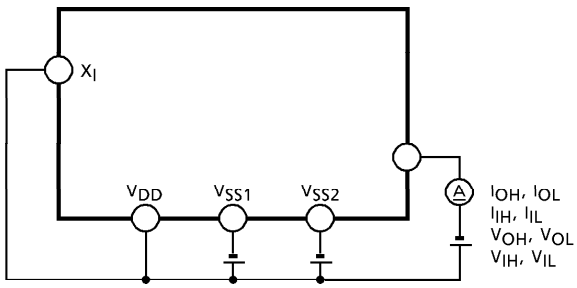
SWITCH OPERATION TABLE

	SW_1	SW_2
I_{SUP}	Open	Open
V_{UCO}	Short	Short

(In the I_{SUP} test circuit, R_L is disconnected.)

3.





APPLICATION CIRCUIT EXAMPLE