TENTATIVE TOSHIBA CMOS DIGITAL INTEGRATED CIRCUIT SILICON MONOLITHIC

JT6P21-AS

LIQUID CRYSTAL DISPLAY WATCH LSI

This is a directly driven, alarm / chronograph watch for liquid crystal display implemented in a single-chip CMOS LSI.

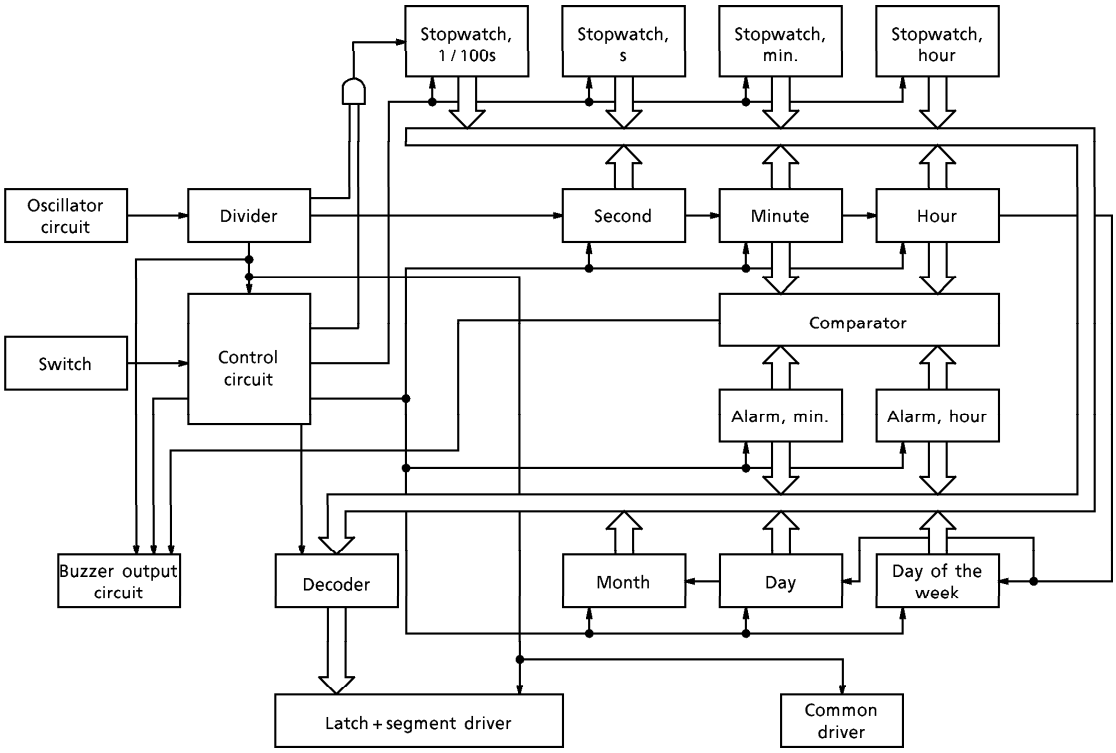
APPLICATIONS

- Alarm / chronograph watch

FEATURES

- Alarm function with buzzer drive.
- Chronograph function with lap.
- Comes with a time announcement function.
- Selectable 12 / 24-hour systems.
- 8-digit display, 12 marks, 1 / 2-duty liquid crystal drive.
- Comes with a timer function (s / min. / hour, day, day of the week, and month) and a 4-year auto calendar.
- The chronograph has a 1 / 100s / s / min. / hour counter. Furthermore, it comes with a lap function and can indicate time in up to 12 hours.
- The alarm and the time announcement buzzer (4kH) are directly driven.
- Low current consumption ($|I_{sup}| = 1.0\mu A$ Typ.)
- Single 1.55V power supply (Ago) or single 3.00V power supply can be selected by bonding.
- Built-in step-up / step-down circuits.
- Alarm and announcement time in 20 seconds.

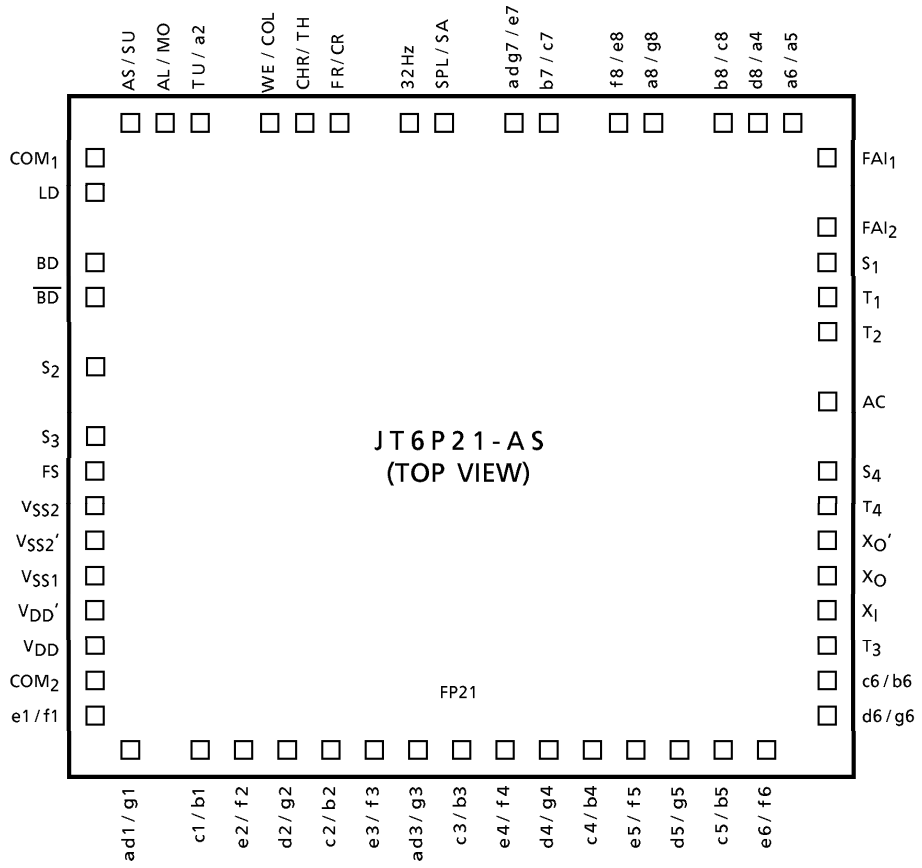
BLOCK DIAGRAM



PIN DESCRIPTION (58pins)

PIN NAME	SYMBOL	No. OF PINS
Power Supply Pins	V_{DD}, V_{DD}', V_{SS1}, V_{SS2}, V_{SS2}'	5
Oscillator Pins	X_I, X_O, X_O'	3
Input Pins	$S_{1\sim4}$, AC, FS	6
Output Pins	BD, $\overline{BD}$, LD, 32Hz	4
Display Pins	COM_1, COM_2, SEG (32)	34
Test pins	$T_{1\sim4}$	4
Step-up / Step-down Pins	FAI_1, FAI_2	2

PAD LAYOUT



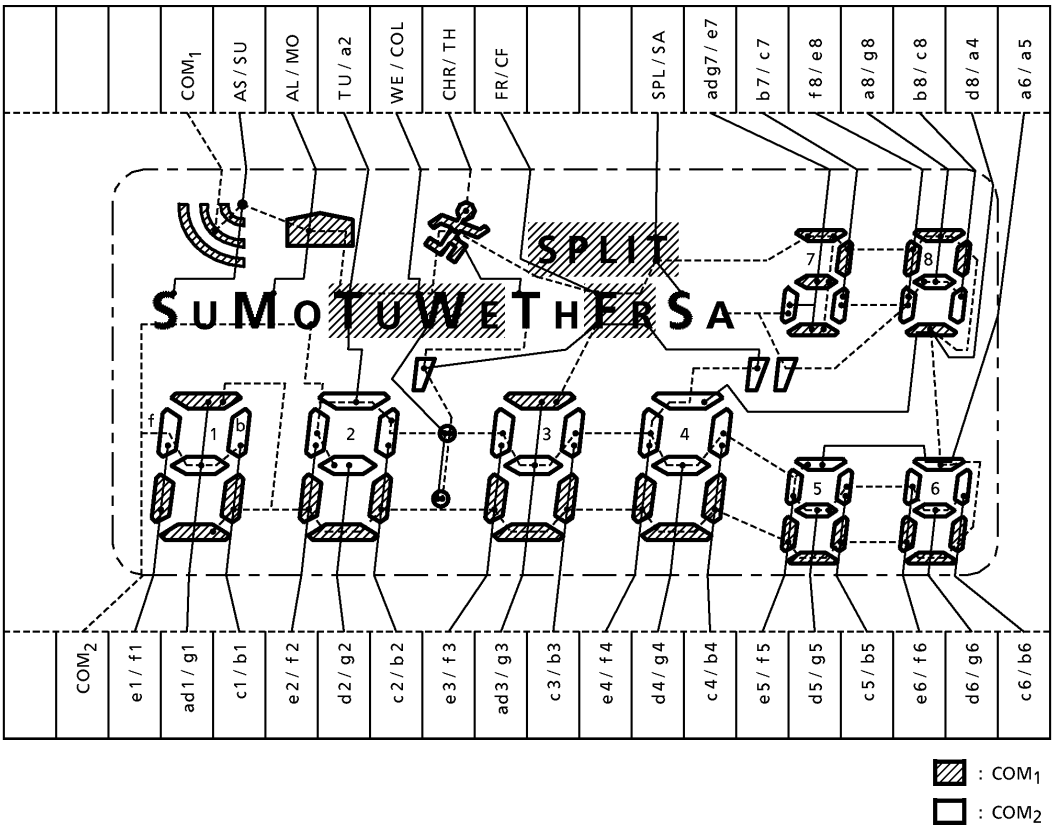
Chip size : 2.65 × 2.73 (mm)
Chip thickness : 440 ± 40 (μm)

PAD LOCATION TABLE

PIN NAME	X POINT	Y POINT	PIN NAME	X POINT	Y POINT
e1 / f1	– 1188	– 1040	d6 / g6	1185	– 1040
COM_2	– 1188	– 880	c6 / b6	1185	– 880
V_{DD}	– 1188	– 720	T_3	1185	– 720
V_{DD}'	– 1188	– 560	X_I	1185	– 560
V_{SS1}	– 1188	– 400	X_O	1185	– 400
V_{SS2}'	– 1188	– 240	X_O'	1185	– 240
V_{SS2}	– 1188	– 80	T_4	1185	– 80
FS	– 1188	80	S_4	1185	80
S_3	– 1188	240	AC	1185	240
S_2	– 1188	400	T_2	1185	400
$\overline{BD}$	– 1188	560	T_1	1185	560
BD	– 1188	720	S_1	1185	720
LD	– 1188	880	FAI_2	1185	880
COM_1	– 1188	1040	FAI_1	1185	1040
ad1 / g1	– 1122	– 1200	AS / SU	– 1122	1200
c1 / b1	– 962	– 1200	AL / MO	– 962	1200
e2 / f2	– 802	– 1200	TU / a2	– 802	1200
d2 / g2	– 642	– 1200	WE / COL	– 642	1200
c2 / b2	– 482	– 1200	CHR / TH	– 482	1200
e3 / f3	– 322	– 1200	FR / CR	– 322	1200
ad3 / g3	– 162	– 1200	32Hz	– 162	1200
c3 / b3	– 2	– 1200	SPL / SA	– 2	1200
e4 / f4	159	– 1200	adg7 / e7	159	1200
d4 / g4	319	– 1200	b7 / c7	319	1200
c4 / b4	479	– 1200	f8 / e8	479	1200
e5 / f5	639	– 1200	a8 / g8	639	1200
d5 / g5	799	– 1200	b8 / c8	799	1200
c5 / b5	959	– 1200	d8 / a4	959	1200
e6 / f6	1119	– 1200	a6 / a5	1119	1200

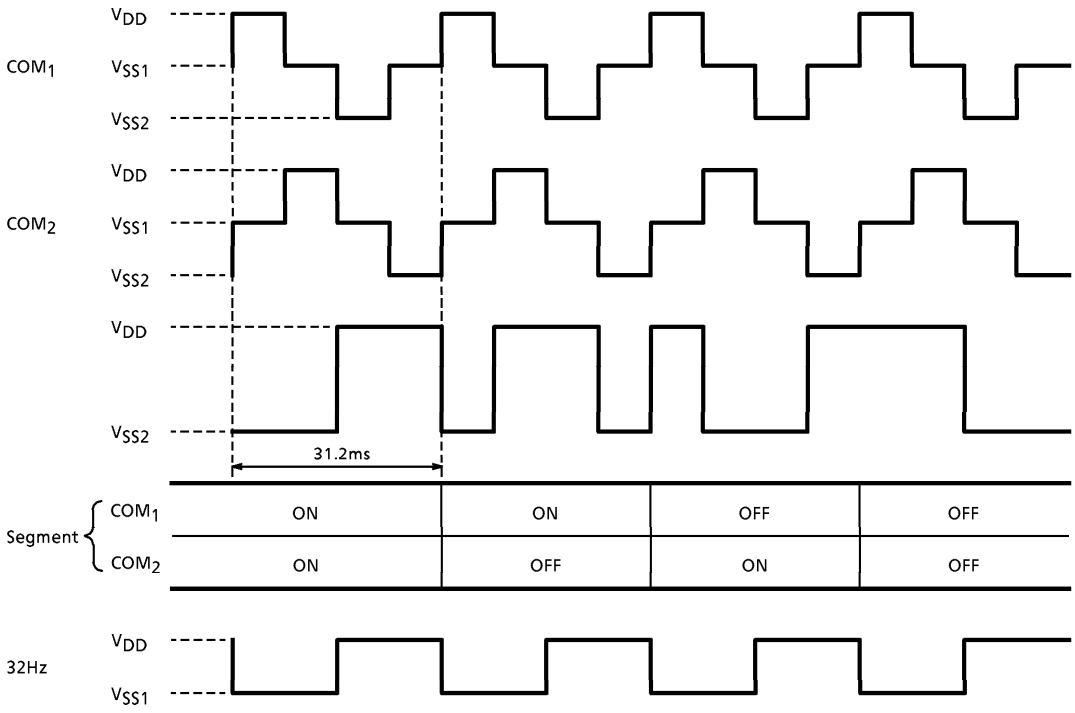
FUNCTIONAL SPECIFICATIONS

1. Liquid crystal layout

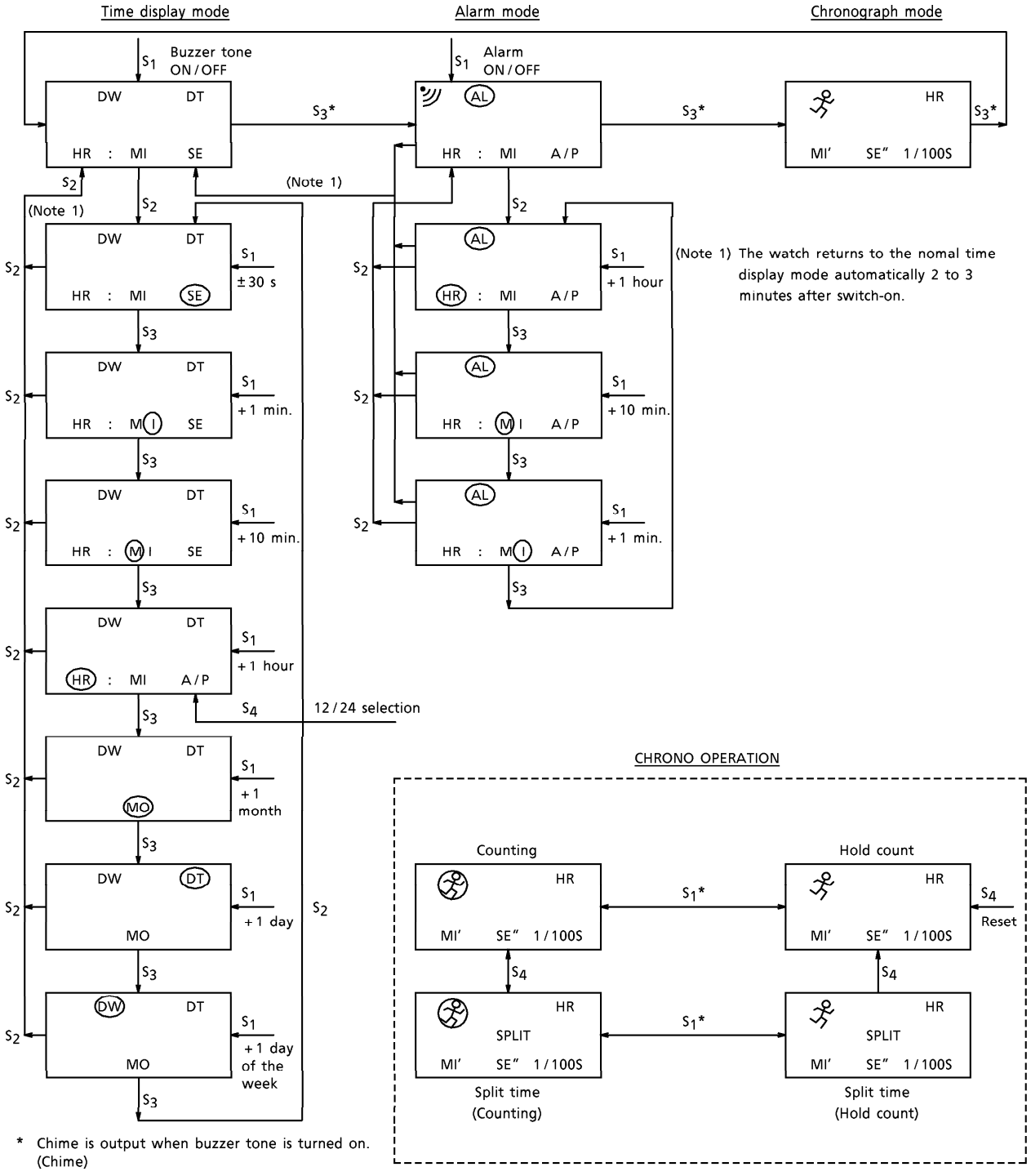


PAD NAME	COM_1	COM_2	PAD NAME	COM_1	COM_2	PAD NAME	COM_1	COM_2
e1 / f1	e1	f1	e5 / f5	e5	f5	adg7 / e7	adg7	e7
ad1 / g1	ad1	g1	d5 / g5	d5	g5	SPL / SA	SPL	SA
c1 / b1	c1	b1	c5 / b5	c5	b5	FR / CF	FR	CF
e2 / f2	e2	f2	e6 / f6	e6	f6	CHR / TH	CHR	TH
d2 / g2	d2	g2	d6 / g6	d6	g6	WE / COL	WE	COL
c2 / b2	c2	b2	c6 / b6	c6	b6	TU / a2	TU	a2
e3 / f3	e3	f3	a6 / a5	a6	a5	AL / MO	AL	MO
ad3 / g3	ad3	g3	d8 / a4	d8	a4	AS / SU	AS	SU
c3 / b3	c3	b3	b8 / c8	b8	c8			
e4 / f4	e4	f4	a8 / g8	a8	g8			
d4 / g4	d4	g4	f8 / e8	f8	e8			
c4 / b4	c4	b4	b7 / c7	b7	c7			

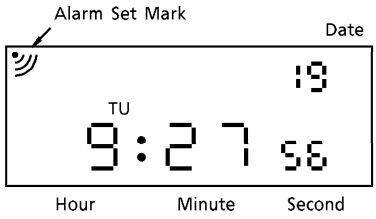
2. Liquid crystal drive waveform



3. Mode transition



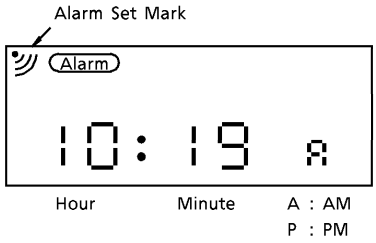
4. Time display mode



In the time display mode, the 1st and 2nd digits show hours, the 3rd and 4th digits show minutes, the 5th and 6th digits show seconds, the 7th and 8th digits show the date, with the day of the week indicated by one of seven marks.
When the chime is turned off, the colon stays steadily on ; when the chime is turned on, it blinks. If the alarm is set, the alarm set mark ( ) lights up. When the chronograph is in progress while the watch mode is the nomal time display mode, the chronograph mark ( ) blinks.

In the time correction mode, the digit to be corrected blinks at 0.25-second intervals. A single shot on S_1 causes the number to be incremented by 1. In the hour correction mode, you can use S_4 to choose between the 12 / 24-hour systems. Furthermore, the 4-year auto calendar in the correction mode allows you to find the last day of each particular month upon +1 increment). In February, however, transition to the 1st day occurs at the 29th day when correcting days : in other modes, it occurs at the 28th day.

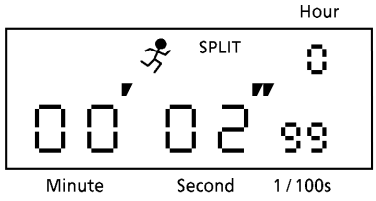
5. Alarm mode



In the alarm mode, the 1st and 2nd digits show hours, the 3rd and 4th digits show minutes, with the colon steadily on. The alarm mode indicator blinks. If you have selected the 12-hour system, the 6th digit shows A or P. A single shot on S_1 causes the alarm mark to be set. The digit to be corrected blinks at 0.25-second intervals. A single shot on S_1 causes the number to be incremented by 1. When the alarm time is reached, an alarm tone turns on ; it stops automatically 20 seconds later.

The alarm tone can be forcibly stopped by pressing one of switches S_1 to S_4 when the alarm tone is turned on. However, if you have stopped the alarm tone in this way in the chronograph mode, S_1 (START / STOP) and S_4 (SPLIT / RESET) are not disabled ; they function normally. The alarm tone basically is sounded once every 24 hours; but it does not sound when you are correcting time or alarm.

6. Chronograph mode



In the chronograph mode, time is indicated in eight digits for hours, minutes, seconds, and 1 / 100 seconds using the minute (') and the second (") marks.
The " " mark blinks when the chronograph is in the RUN state and stays steadily on when the chronograph is idle. The minute (') and the second (") marks stay steadily on when the chronograph is in the RUN state and blink when the chronograph is in a split state. In this case, furthermore, the SPLIT mark lights up and the hour / minute / second display is made to stop. However, the internal counter continues counting.

The maximum count is 11 hours, 59 minutes, 59 seconds 59. An operating tone is sounded when you press S_1.

7. Explanation of marks

* : AND + : OR

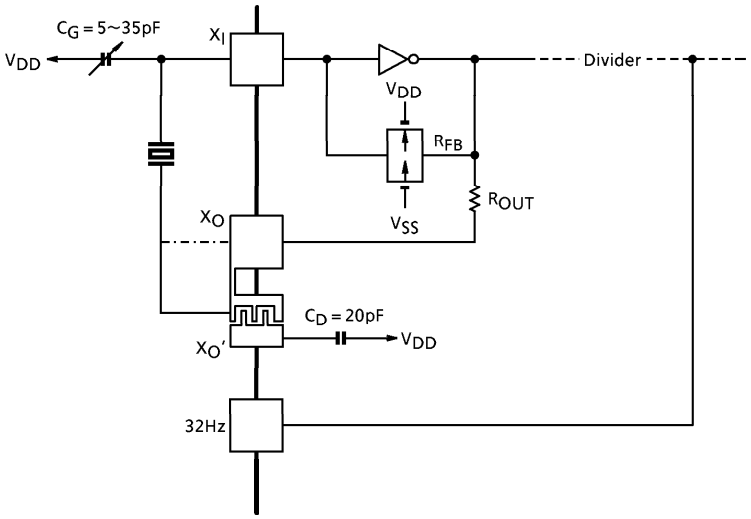
MARK	FORMAT	FUNCTIONAL DISPLAY
COL	ON	NM * [set + ($\overline{CSB}$ * $\overline{set}$)] AL
	0.25 / 0.25	NM * $\overline{set}$ * CSB
AL	0.25 / 0.25	AL
AS	ON	AL * ALARM STANDBY NM * $\overline{set}$ * ALARM STANDBY
CHR	ON	CHR * CHRONO STOP
	0.5 / 0.5	CHR * CHRONO START NM * $\overline{set}$ " CHRONO START
SPLIT	ON	CHR * SPLIT
CF	ON	CHR * [CHRONO STOP + (CHRONO START * $\overline{SPLIT}$)]
	0.5 / 0.5	CHR * CHRONO START * SPLIT

NM : Time display mode
AL : Alarm mode
CHR : Chronograph mode
set : Set mode

CSB : Chime standby
0.5 / 0.5 : Blink (0.5s ON, 0.5s OFF)
0.25 / 0.25 : Blink (0.25s ON, 0.25s OFF)

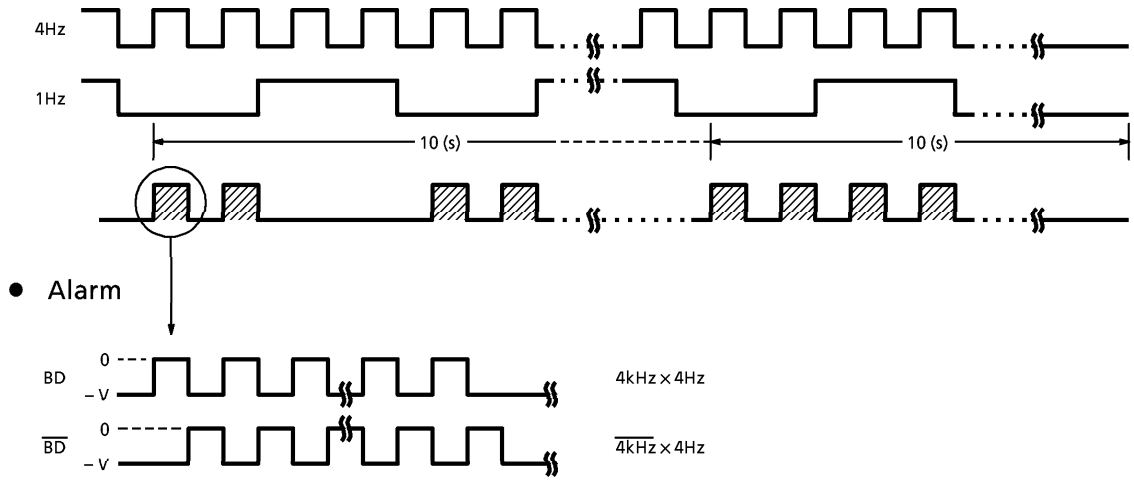
8. Basic oscillator circuit

An exact oscillating frequency can be obtained by connecting a crystal resonator to the device as shown below. To produce an exact watch, set the oscillating frequency to 32.768kHz. The frequency can be tuned by adjusting C_G and C_D. If you use an external C_D, use the X_O pin to connect the crystal. When using the internal C_D, use the X_O' pin. The RC network except C_G is built in the device. The output pins for FAI_1 (512Hz), COM_1, COM_2, and 32Hz can be used as monitor pins for frequency adjustment. Using these pins as a monitor does not affect the oscillator circuit.

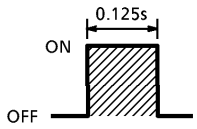


9. Output

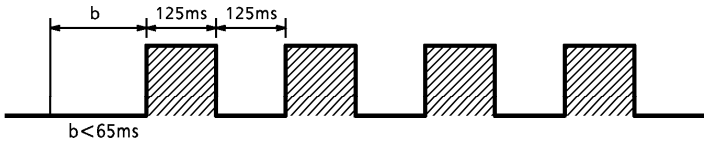
(1) Buzzer output (4kHz duty 50%)



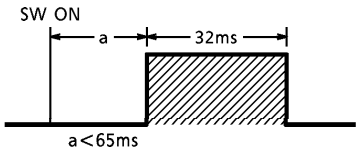
- Chime



- Alarm sound demonstration



- Chrono sta / stp (S_1), Mode change (S_3) (Chime set)



(Note) The buzzer output is disabled when you turn on S_4.

(2) Lamp output (LD)

This is a micro lamp output.
The lamp is turned on by S_4 except when in the clock set and chronograph modes.

10. Power supply

The device can be operated with 1.5 or 3.0V. It contains a voltage step-up / step-down circuit. The table below shows connections between the power supplies and bonding pads.

BATTERY / POWER SUPPLY	1.5V	3.0V
V_{DD}	V_{DD}'	V_{DD}
V_{SS1}	V_{SS1}	V_{SS1}
V_{SS2}	V_{SS2}	V_{SS2}'

11. 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

PARAMETER	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}	−10~60	°C
Storage Temperature	T_{stg}	−40~125	°C

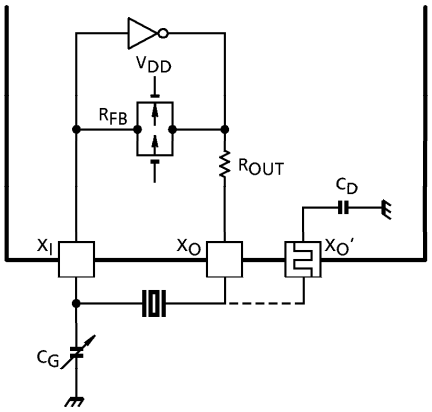
ELECTRICAL CHARACTERISTICS

(Referenced to V_{DD} = 0V, V_{SS1} = −1.55V, V_{SS2} = −3.0V, Ta = 25°C unless otherwise noted)

PARAMETER	SYMBOL	TEST CIR-CUIT	TEST CONDITIONS	MIN.	TYP.	MAX.	UNIT
Operating Voltage (1)	$\|V_{SS1}\|$	2	—	1.25	1.55	1.80	V
Operating Voltage (2)	$\|V_{SS2}\|$	3	—	2.00	3.00	3.60	V
Operating Current Consumption	$\|I_{SUP1}\|$	2	—	—	—	2.50	μA
	$\|I_{SUP2}\|$	3	—	—	—	1.50	
Oscillation Start Voltage	$\|V_{STA1}\|$	2	—	—	—	1.45	V
	$\|V_{STA2}\|$	3	—	—	—	2.70	
Output Current (1) (V_{SS2} Block Common)	I_{OH1}	4	V_{OH1} = −0.2V	—	—	−4.0	μA
	I_{OL1}		V_{OL1} = −2.8V	4.0	—	—	
Output Current (2) (V_{SS1} Block Common)	I_{OH2}	4	V_{OH2} = −1.75V	—	—	−4.0	
	I_{OL2}		V_{OL2} = −1.35V	4.0	—	—	
Output Current (3) (Segment)	I_{OH3}	4	V_{OH3} = −0.2V	—	—	−0.4	
	I_{OL3}		V_{OL3} = −2.8V	0.4	—	—	
Output Current (4) (BD, $\overline{BD}$, LD)	I_{OH4}	4	V_{OH4} = −0.4V	—	—	−150	
	I_{OL4}		V_{OL4} = −1.15V	100	—	—	
Input Current (1) (S_1, S_2, S_3, S_4)	I_{IH1}	4	V_{IH1} = 0V	1.0	—	100	
	I_{IL1}		V_{IL1} = −1.55V	−0.1	—	—	
Input Current (2) (T_1, T_2, T_3, T_4, AC)	I_{IH2}	4	V_{IH2} = 0V	—	—	0.1	
	I_{IL2}		V_{IL2} = −1.55V	−120	—	−5	
Oscillator Stage Feedback Resistance	R_{FB}	1	—	10	—	77.5	MΩ
Oscillator Stage Output Resistance	R_{OUT}	1	—	200	250	330	kΩ
Step-up Circuit Output Voltage	$\|V_{UCO}\|$	—	V_{SS1} = −1.25V	2.30	—	—	V
Step-down Circuit Output Voltage	$\|V_{DCO}\|$	—	V_{SS2} = −2.6V	1.25	—	—	V

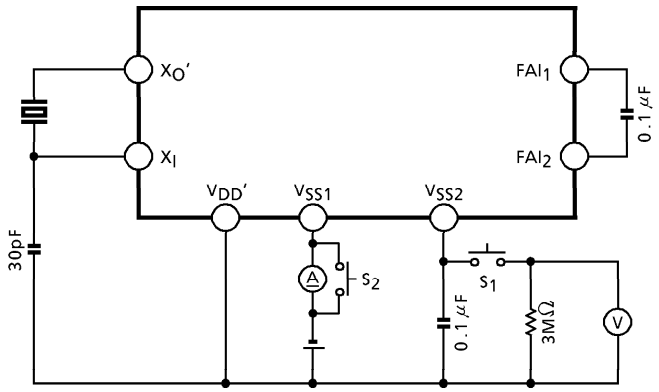
TEST CIRCUIT

(1) Oscillator circuit



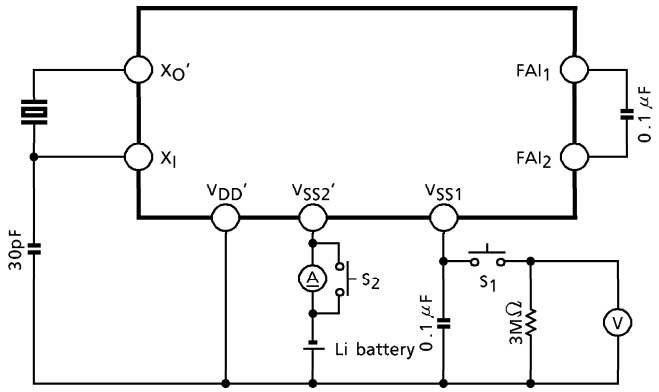
X'tal : f_O = 32.768kHz
C_I = 30kΩ (Typ.)
C_G = 5~35pF (external)
(30pF Typ.)
C_D = 20pF Typ. (built-in)

(2) I_{sup1} and V_{UCO} test circuit (when using silver oxide battery Ago)



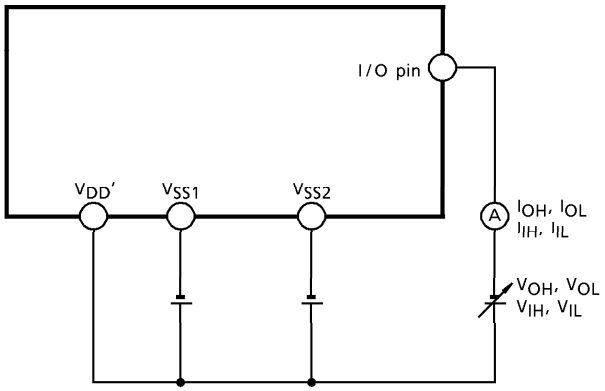
	S_1	S_2
I_{sup1}	Break	Break
V_{UCO}	Make	Make

(3) I_{sup2} and V_{DCO} test circuit (when using lithium battery Li)



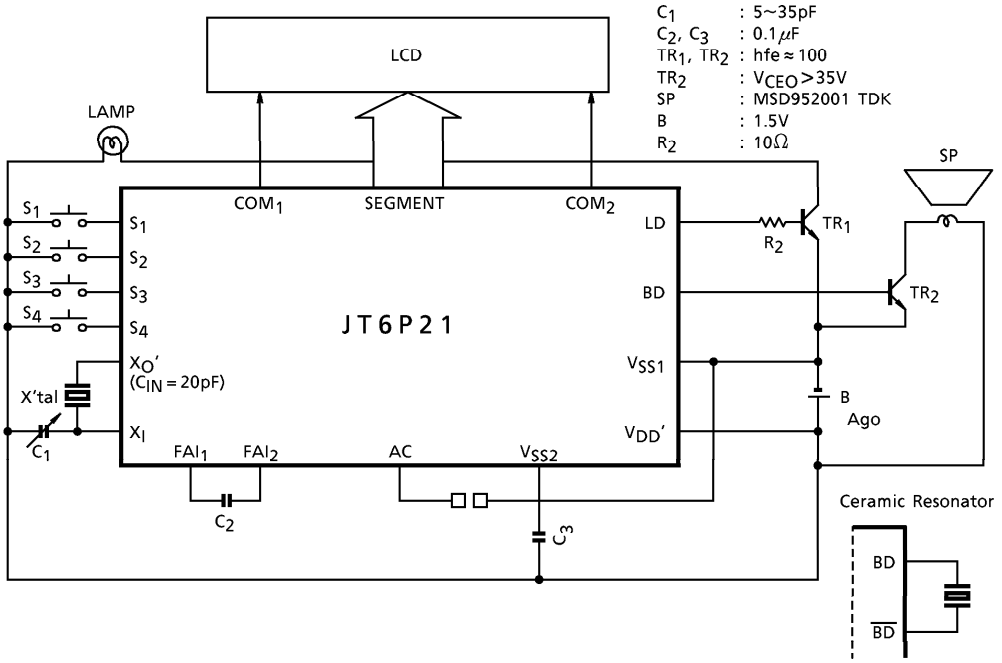
	S_1	S_2
I_{sup2}	Break	Break
V_{DCO}	Make	Make

(4) DC test circuit

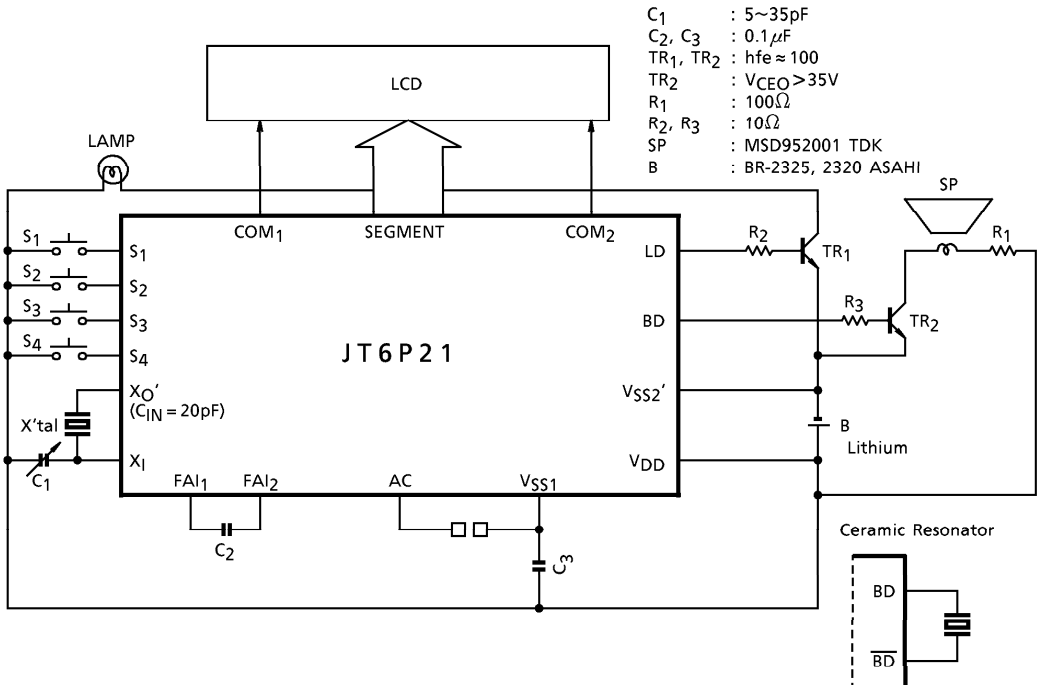


APPLICATION CIRCUIT

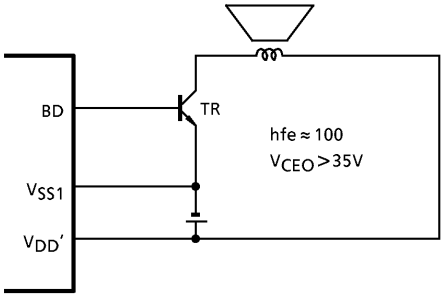
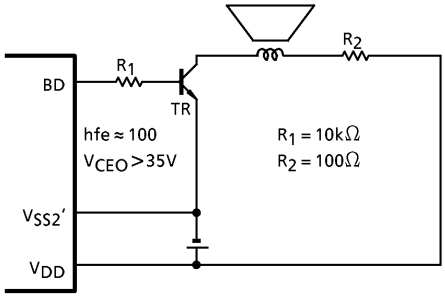
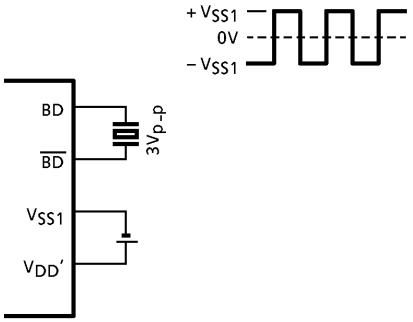
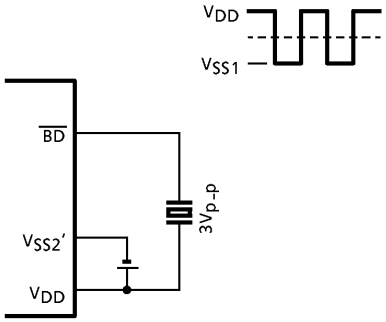
1. Silver oxide type



2. Lithium type



3. Typical application of buzzer output circuit

	1.5V SILVER OXIDE	3.0V LITHIUM
SP		
PIEZO		
High Power PIEZO