

TOSHIBA CMOS DIGITAL INTEGRATED CIRCUIT SILICON MONOLITHIC

**JTMP0350-0011S****LSI FOR LCD WATCHES**

The JTMP0350-0011S is a low-power LSI for watches with chronograph functions. This LSI features a chronograph, lap memory, an alarm function, and a built-in LCD driver.

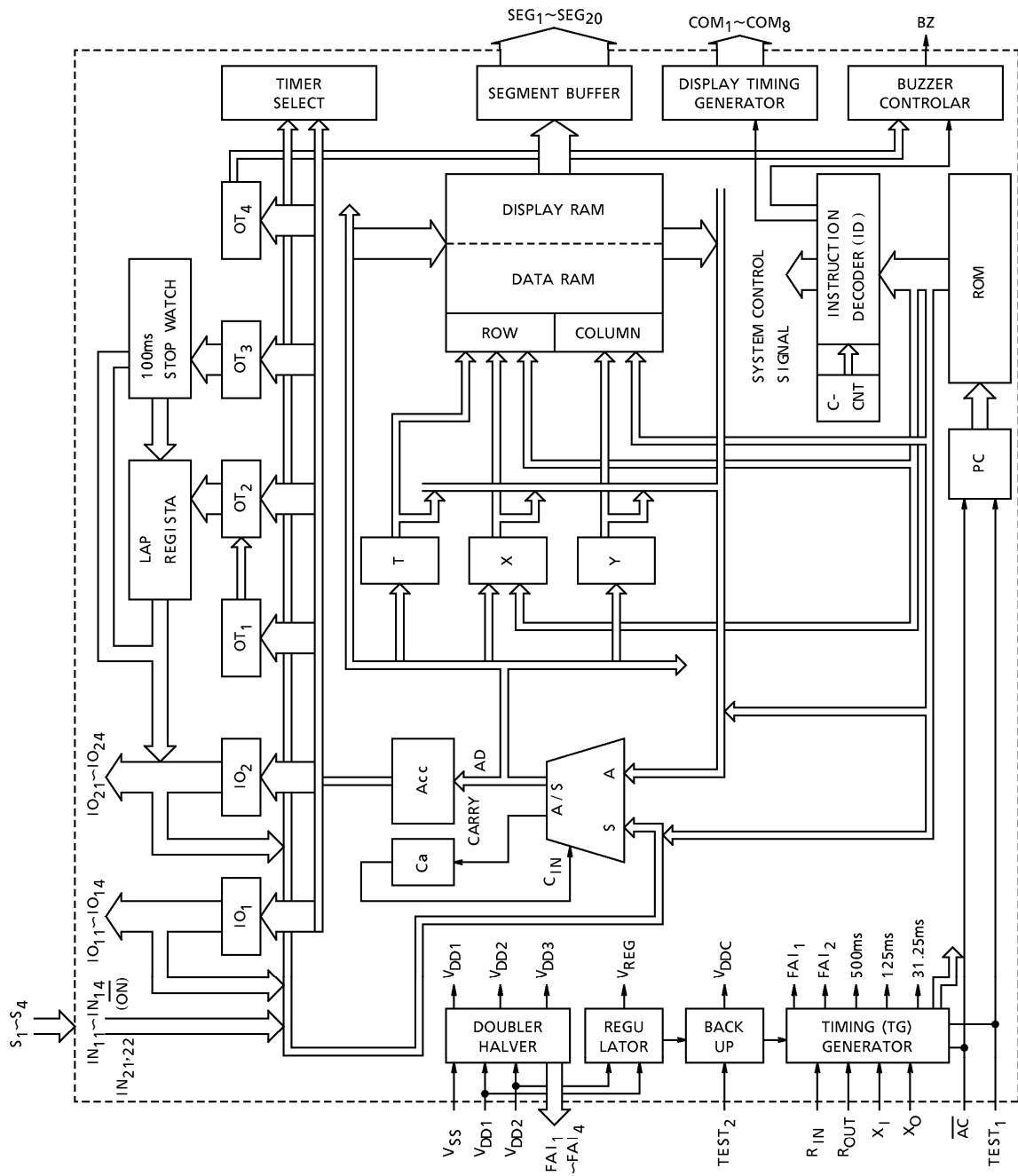
**FEATURES**

- Bar graph chronograph and elapsed time displays
- Lap memory (MAX. 10 laps)
- Lap /split time selectable
- 3.0V single power supply
- Alarm /time signal function
- 12 /24-hour display selectable

980910EBA1

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BLOCK DIAGRAM



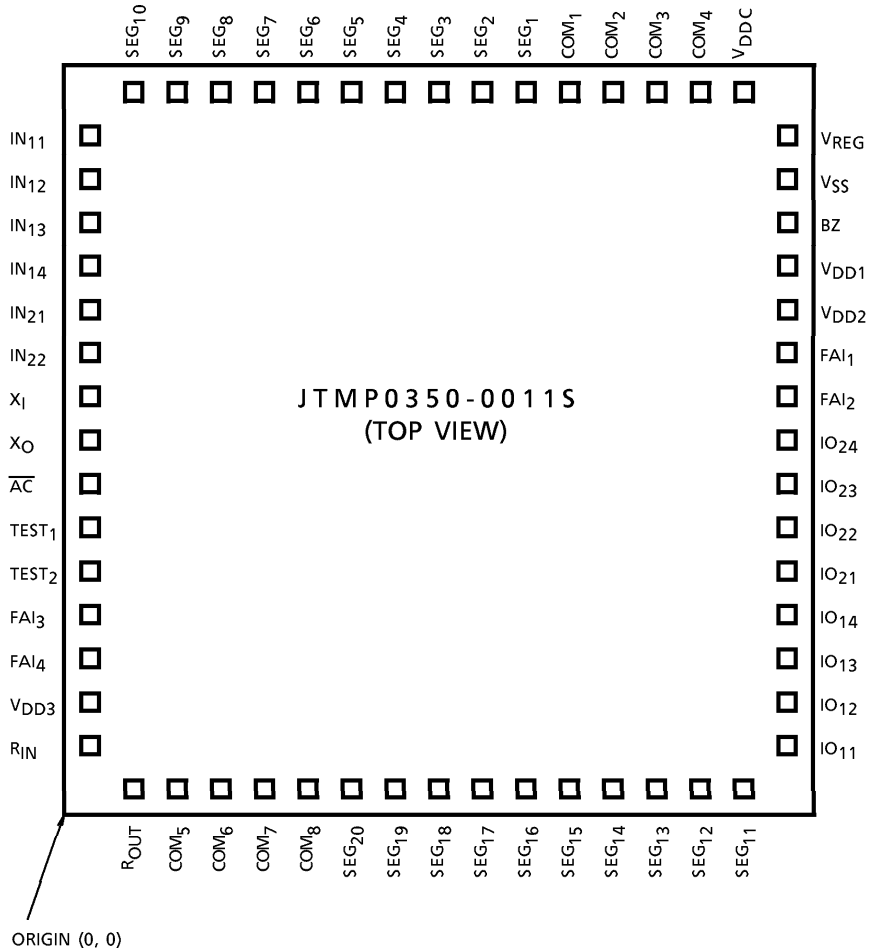
## PIN DESCRIPTION (60PINS)

PIN NAME	SYMBOL	No. OF PINS
Power Supply Pin	VDD1, VDD2, VDD3, VDDC, VSS, VREG	6
Oscillator Pin	XI, XO, ROUT, RIN	4
Input Pin	IN11~14, IN21, IN22, $\overline{AC}$	7
Output pin	BZ	1
Display Pin	COM1~8, SEG1~20	28
Input/Output Pin	IO11~14, IO21~24	8
Test Pin	TEST1, TEST2	2
Voltage Doubler/Halver Pin	FAI1~4	4

## DESCRIPTION OF FUNCTIONS

PIN NAME	FUNCTION
XI, XO ROUT, RIN	Connects low-speed clock oscillator crystal
IN11~IN14 IN21, IN22	6-bit input pin. When input to the accumulator, only four bits can be read simultaneously.
IO11~IO14 IO21~IO24	Input/output ports with output latch
BZ	Mainly for buzzer, alarm, and time signal output
FAI1~FAI4	For 0.1 $\mu$ F voltage doubler/halver capacitor connection
VREG	—
TEST1, TEST2	For testing (by Toshiba) at shipping. Fix to LOW.
$\overline{AC}$	For system setting
VSS	0V (GND)
VDD1	Connects to VSS via 0.1 $\mu$ F capacitor (1.5V at voltage step-down)
VDD2	3V
VDD3	Connects to VSS via 0.1 $\mu$ F capacitor (3.0V at voltage step-down)
VDDC	Connects to VSS via 0.1 $\mu$ F capacitor
SEG1~20	Outputs segment signals
COM1~8	Outputs common signals

PAD LAYOUT



Chip size : 3.52 × 3.33 (mm)  
 Chip thickness : 440 ± 40 (μm)

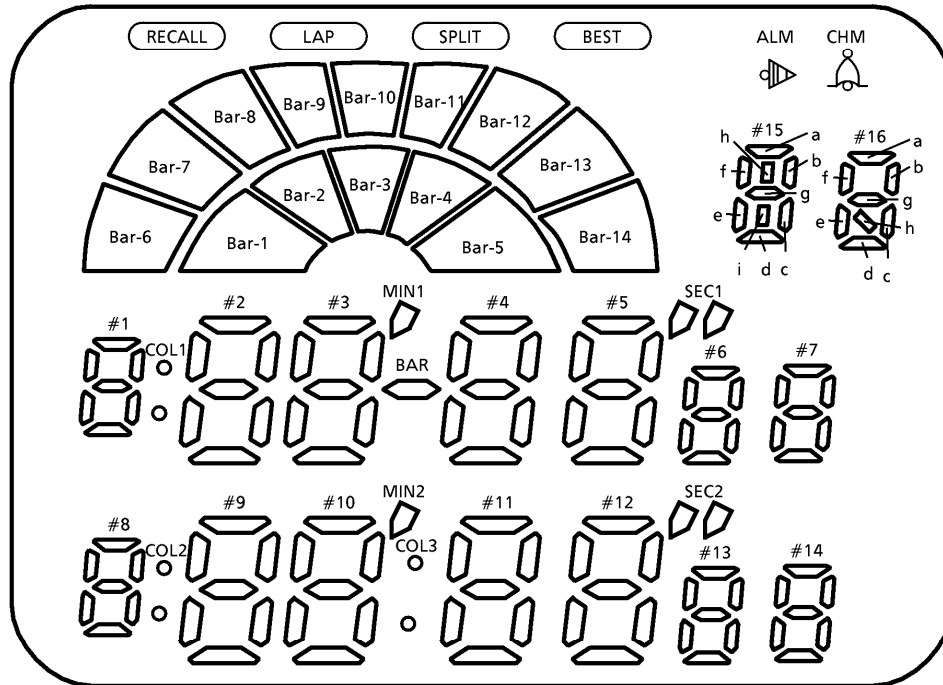
PAD LOCATION TABLE

( $\mu\text{m}$ )

PIN NAME	X POINT	Y POINT	PIN NAME	X POINT	Y POINT
IN <sub>11</sub>	168	2784	IO <sub>11</sub>	3270	435
IN <sub>12</sub>	168	2624	IO <sub>12</sub>	3270	595
IN <sub>13</sub>	168	2439	IO <sub>13</sub>	3270	755
IN <sub>14</sub>	168	2279	IO <sub>14</sub>	3270	915
IN <sub>21</sub>	168	2119	IO <sub>21</sub>	3270	1075
IN <sub>22</sub>	168	1959	IO <sub>22</sub>	3270	1235
X <sub>I</sub>	168	1799	IO <sub>23</sub>	3270	1395
X <sub>O</sub>	168	1639	IO <sub>24</sub>	3270	1555
$\overline{\text{AC}}$	168	1479	FAI <sub>2</sub>	3270	1715
TEST <sub>1</sub>	168	1319	FAI <sub>1</sub>	3270	1875
TEST <sub>2</sub>	168	1159	VDD <sub>2</sub>	3270	2035
FAI <sub>3</sub>	168	966	VDD <sub>1</sub>	3270	2195
FAI <sub>4</sub>	168	806	BZ	3270	2355
VDD <sub>3</sub>	168	646	VSS	3270	2515
RIN	168	403	VREG	3270	2784
ROUT	444	168	VDDC	2873	3015
COM <sub>5</sub>	654	168	COM <sub>4</sub>	2713	3015
COM <sub>6</sub>	864	168	COM <sub>3</sub>	2528	3015
COM <sub>7</sub>	1074	168	COM <sub>2</sub>	2368	3015
COM <sub>8</sub>	1283	168	COM <sub>1</sub>	2183	3015
SEG <sub>20</sub>	1443	168	SEG <sub>1</sub>	2023	3015
SEG <sub>19</sub>	1603	168	SEG <sub>2</sub>	1851	3015
SEG <sub>18</sub>	1763	168	SEG <sub>3</sub>	1691	3015
SEG <sub>17</sub>	1923	168	SEG <sub>4</sub>	1531	3015
SEG <sub>16</sub>	2083	168	SEG <sub>5</sub>	1371	3015
SEG <sub>15</sub>	2243	168	SEG <sub>6</sub>	1211	3015
SEG <sub>14</sub>	2403	168	SEG <sub>7</sub>	1051	3015
SEG <sub>13</sub>	2563	168	SEG <sub>8</sub>	891	3015
SEG <sub>12</sub>	2723	168	SEG <sub>9</sub>	731	3015
SEG <sub>11</sub>	2883	168	SEG <sub>10</sub>	571	3015

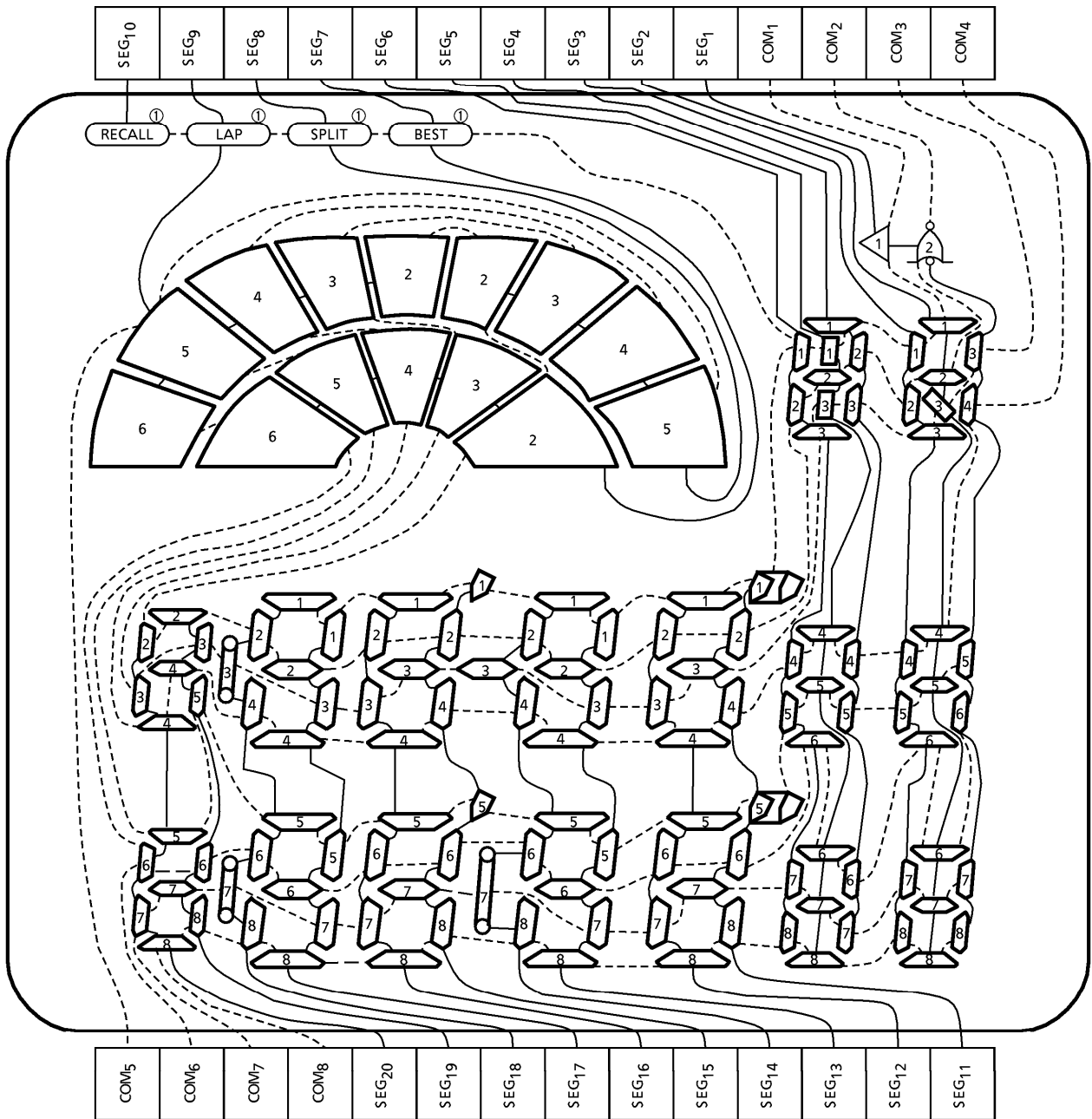
FUNCTION SPECIFICATIONS

1. Display configuration and segment symbols



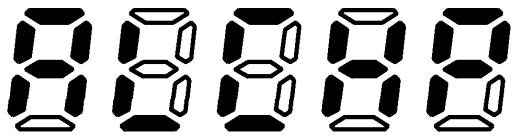
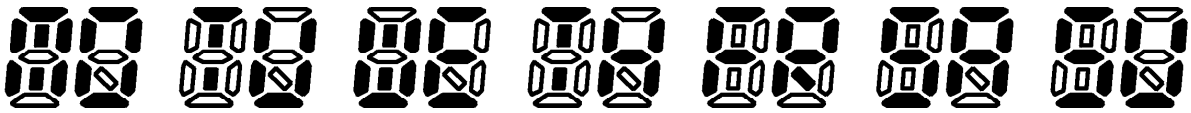
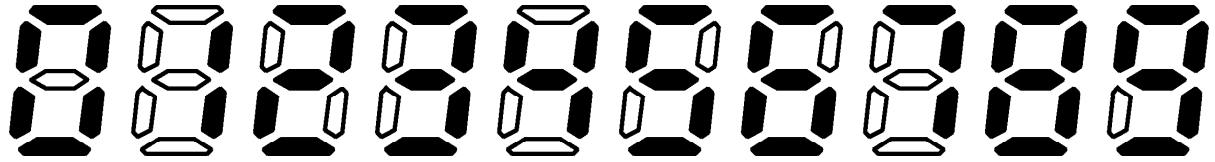
	COM <sub>1</sub>	COM <sub>2</sub>	COM <sub>3</sub>	COM <sub>4</sub>	COM <sub>5</sub>	COM <sub>6</sub>	COM <sub>7</sub>	COM <sub>8</sub>
SEG <sub>1</sub>	ALM	CHM	#16-b	#16-c	#7-b	#7-c	#14-b	#14-c
SEG <sub>2</sub>	#16-a	#16-g	#16-h	#7-a	#7-g	#14-a	#14-g	#14-d
SEG <sub>3</sub>	#16-f	#16-e	#16-d	#7-f	#7-e	#7-d	#14-f	#14-e
SEG <sub>4</sub>	#15-a	#15-b	#15-c	#6-b	#6-c	#13-b	#13-c	—
SEG <sub>5</sub>	#15-h	#15-g	#15-i	#6-a	#6-g	#13-a	#13-g	#13-d
SEG <sub>6</sub>	#15-f	#15-e	#15-d	#6-f	#6-e	#6-d	#13-f	#13-e
SEG <sub>7</sub>	BEST	Bar-5	Bar-4	Bar-3	Bar-2	Bar-1	—	—
SEG <sub>8</sub>	SPLIT	Bar-11	Bar-12	Bar-13	Bar-14	—	—	—
SEG <sub>9</sub>	LAP	Bar-10	Bar-9	Bar-8	Bar-7	Bar-6	—	—
SEG <sub>10</sub>	RECALL	—	—	—	—	—	—	—
SEG <sub>11</sub>	SEC1	#5-b	#5-g	#5-c	SEC2	#12-b	#12-g	#12-c
SEG <sub>12</sub>	#5-a	#5-f	#5-e	#5-d	#12-a	#12-f	#12-e	#12-d
SEG <sub>13</sub>	#4-b	#4-g	#4-c	#4-d	#11-b	#11-g	#11-c	#11-d
SEG <sub>14</sub>	#4-a	#4-f	BAR	#4-e	#11-a	#11-f	COL3	#11-e
SEG <sub>15</sub>	MIN1	#3-b	#3-g	#3-c	MIN2	#10-b	#10-g	#10-c
SEG <sub>16</sub>	#3-a	#3-f	#3-e	#3-d	#10-a	#10-f	#10-e	#10-d
SEG <sub>17</sub>	#2-b	#2-g	#2-c	#2-d	#9-b	#9-g	#9-c	#9-d
SEG <sub>18</sub>	#2-a	#2-f	COL1	#2-e	#9-a	#9-f	COL2	#9-e
SEG <sub>19</sub>	—	#1-a	#1-b	#1-g	#1-c	#8-b	#8-g	#8-c
SEG <sub>20</sub>	—	#1-f	#1-e	#1-d	#8-a	#8-f	#8-e	#8-d

2. LCD connection diagram



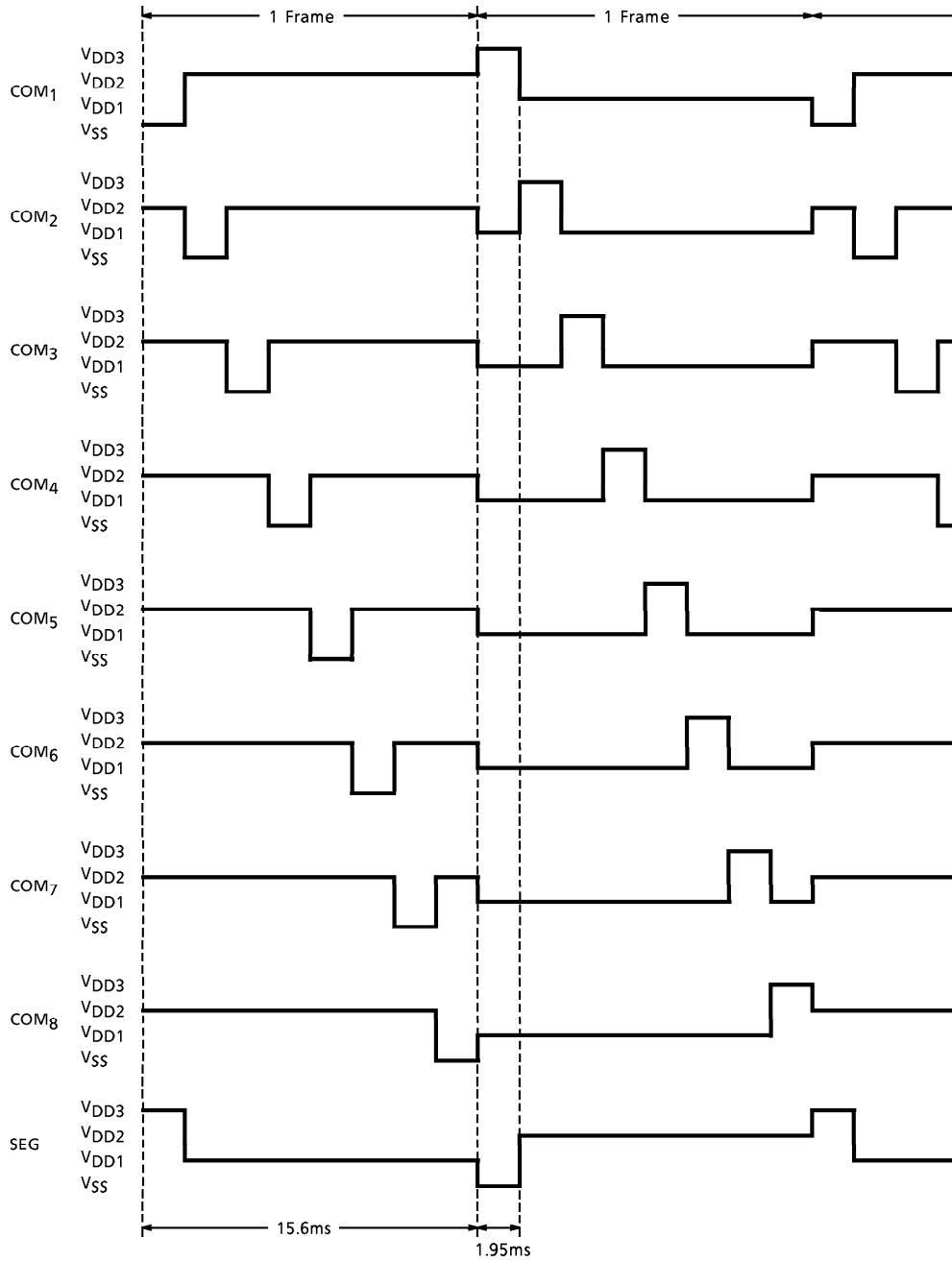
(\*Note) The figures in the display are common numbers.  
 — Segment  
 - - - Common

3. Liquid crystal display



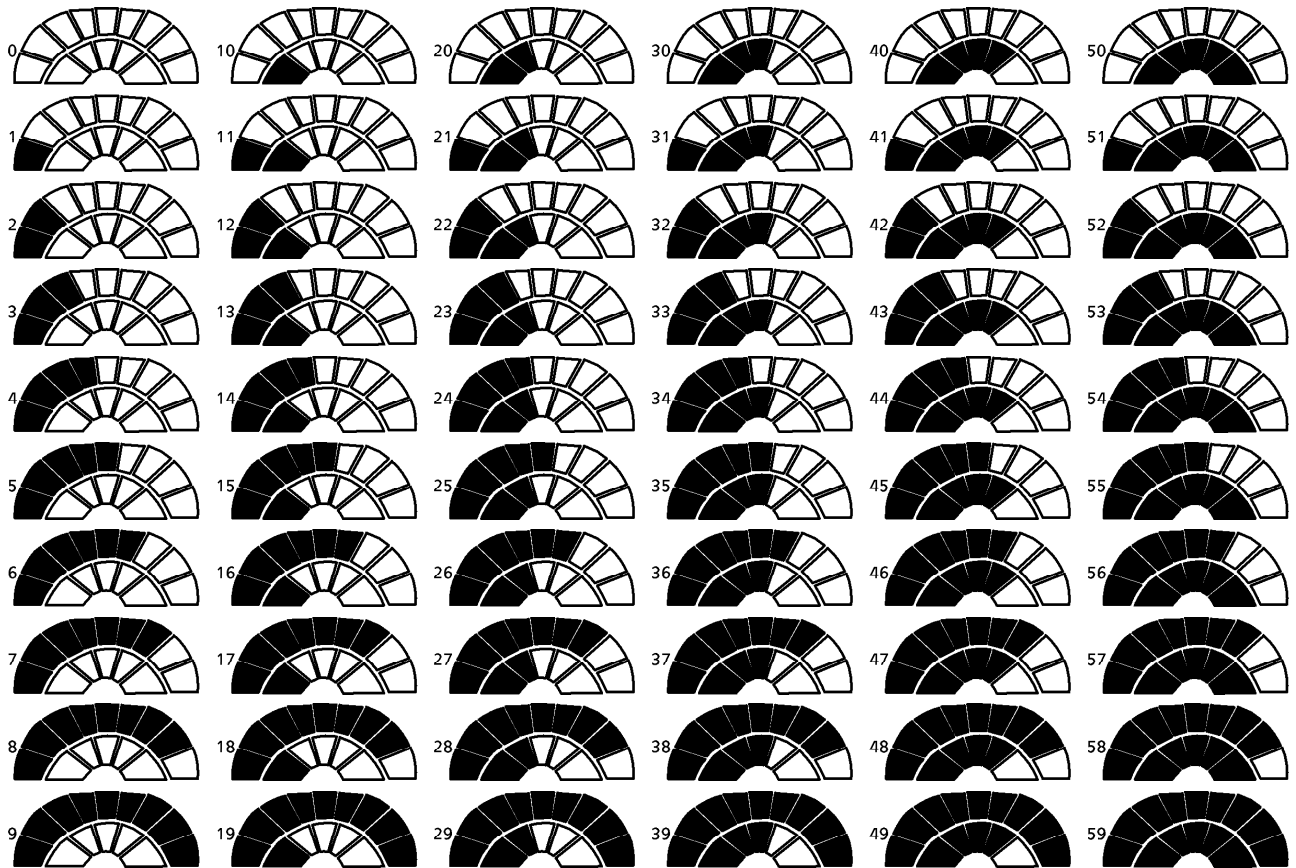
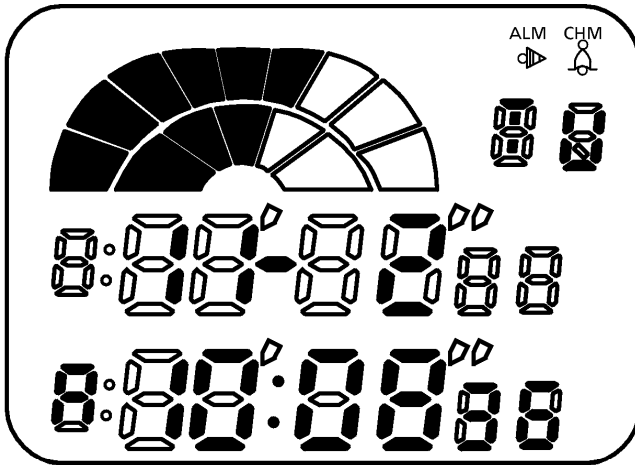


4. Liquid crystal drive wave forms

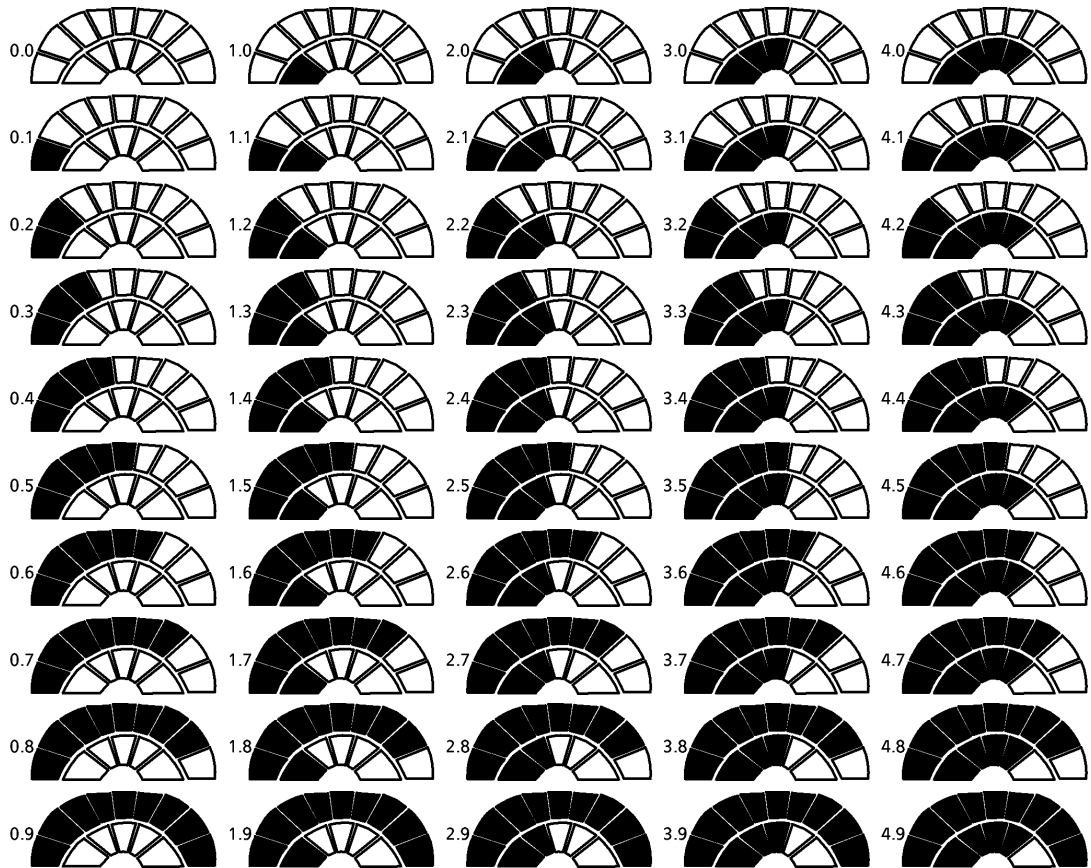
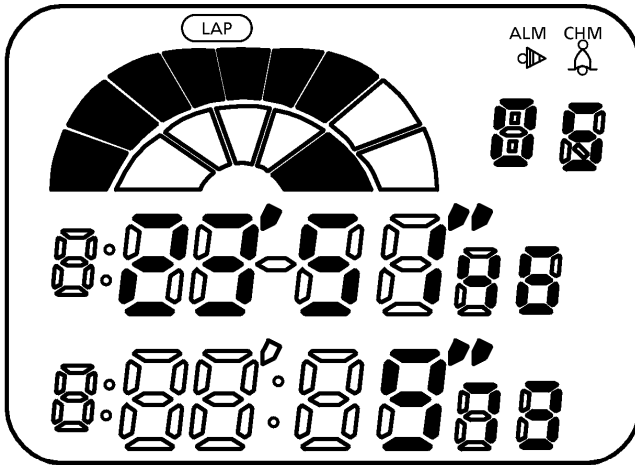


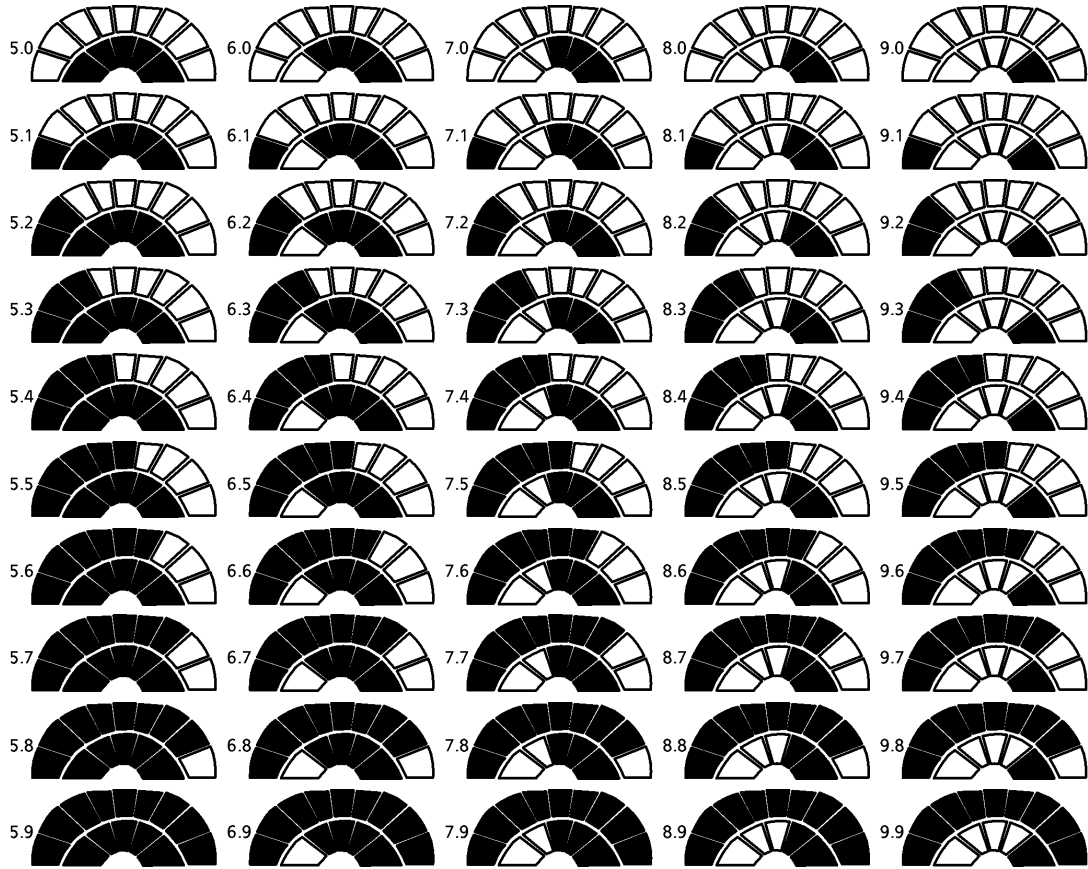
5. Display

5.1 TIME mode display

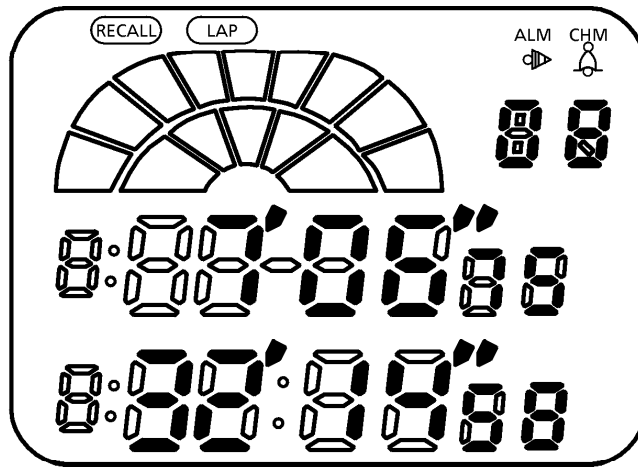


5.2 CHRONO mode display



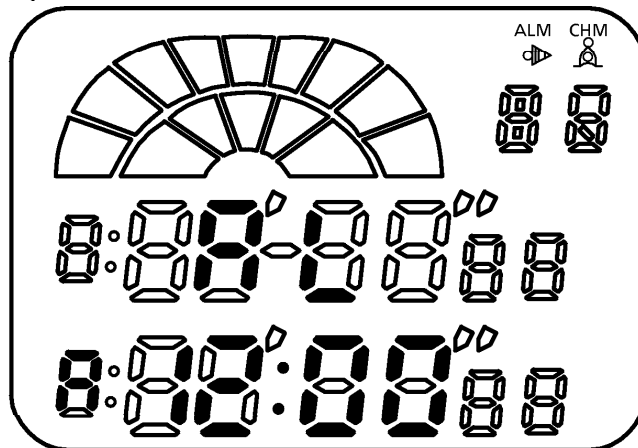


5.3 MEMORY RECALL mode display

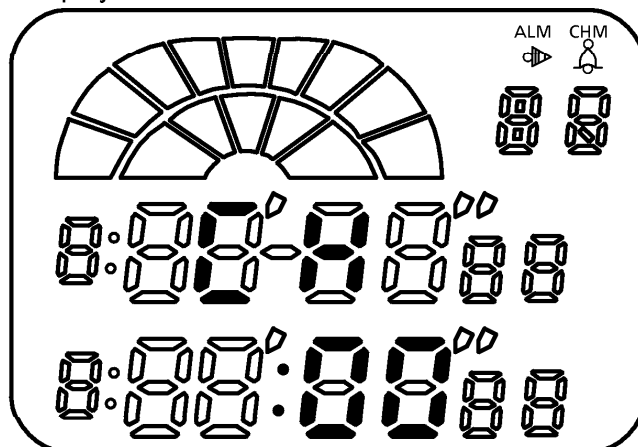


5.4 ALARM mode display

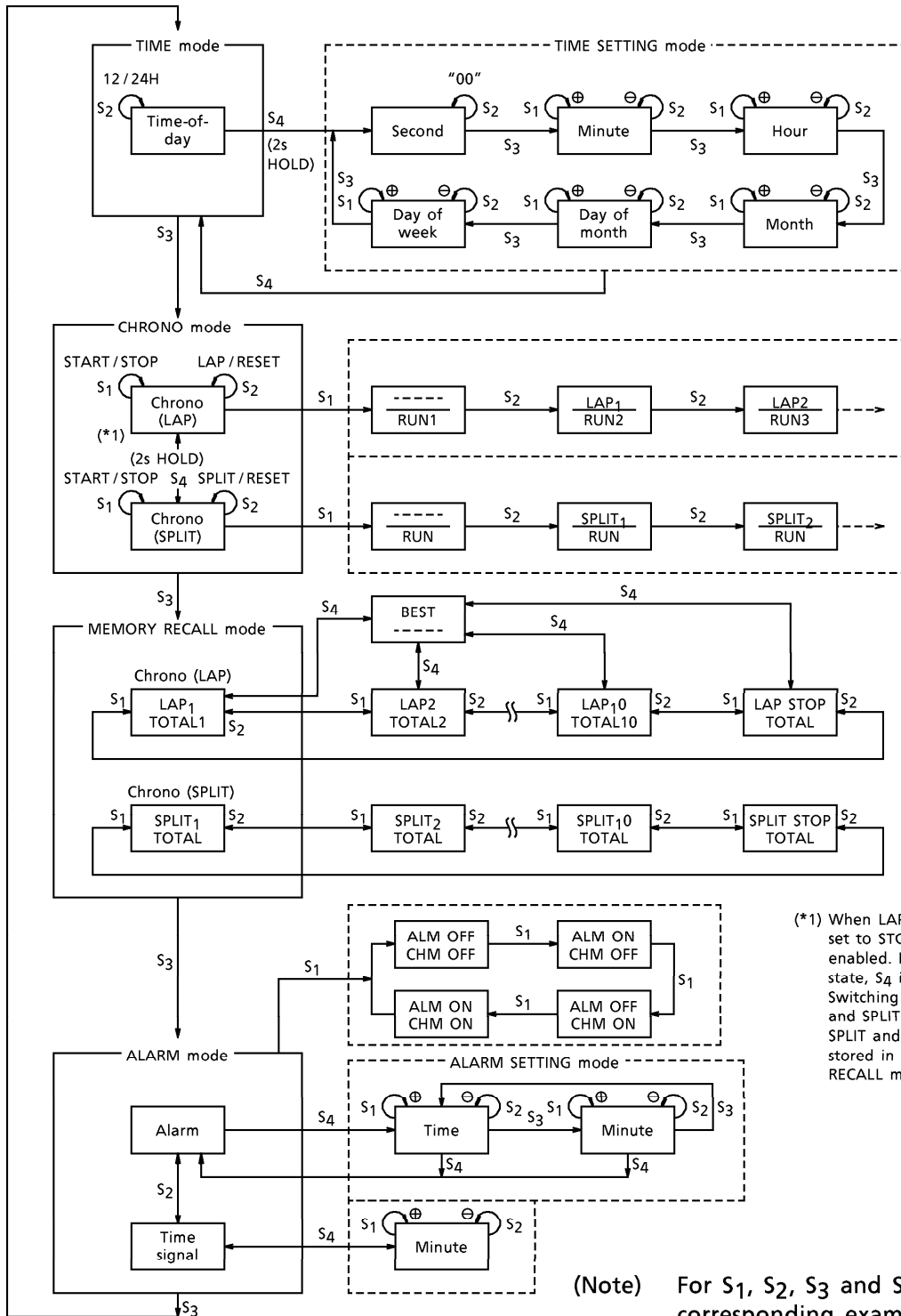
1) Alarm display



2) Time signal display



6. Mode transition diagram



(\*1) When LAP or SPLIT are set to STOP, S4 is enabled. In the RUN state, S4 is disabled. Switching between LAP and SPLIT resets LAP or SPLIT and the data stored in MEMORY RECALL mode.

(Note) For S1, S2, S3 and S4, see the corresponding example circuit.

7. Mode description

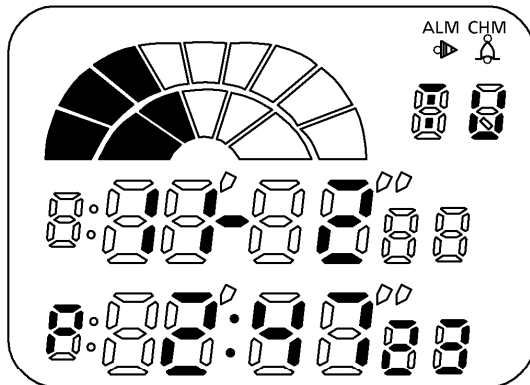
7.1 TIME mode

TIME mode is used to display the current time and make time settings.

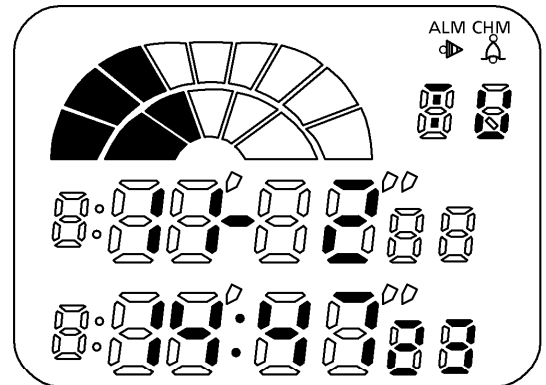
- Middle row columns #2 and #3 display the month, columns #4 and #5 display the day of the month with unnecessary zeros suppressed.
- Upper row columns #15 and #16 display the day of the week.
- Lower row column #8 displays AM/PM.
- Lower row columns #9 and #10 display the hour, columns #11 and #12 display minutes, and #13 and #14 display seconds.
- The ON/OFF states of the time signal and alarm are displayed in the upper right corner.
- When the alarm or time signal is set, the alarm or time signal sign in the top row flashes. When the LAP or SPLIT functions are running in CHRONO mode, the LAP or SPLIT signs flash.
- Pressing multiple switches simultaneously invalidates the switches pressed.
- Pressing a second switch while still pressing the first invalidates both switches.
- S<sub>2</sub> can be used to switch between a 12- and 24-hour clock. Such switching can only be performed in TIME mode.

<Display example>

(a) 12-hour clock



(b) 24-hour clock

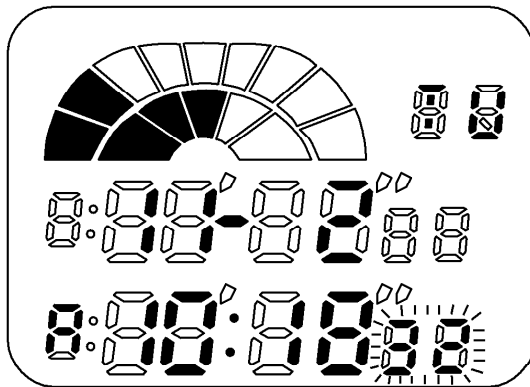


7.2 TIME SETTING mode

- Access TIME SETTING mode by pressing S<sub>4</sub> for two seconds in TIME mode.
- Pressing S<sub>3</sub> in TIME SETTING mode displays in turn the seconds, the minutes, the hour, the month, the day of the month, the day of the week, then the seconds again. Set each while it is flashing.
- In TIME SETTING mode, the ALM/CHM signs turn OFF and the sound is disabled even if they were set ON before entering TIME SETTING mode. When returning from TIME SETTING mode to TIME mode, the ALM/CHM sign returns to the status before the switch to TIME SETTING mode.
- In TIME SETTING mode, pressing S<sub>4</sub> switches to TIME mode. S<sub>4</sub> can be pressed from the second, minute, month, day of the month, or day of the week displays.
- If any switch is not pressed for one minute in TIME SETTING mode, the device automatically switches to TIME mode.
- Pressing multiple switches simultaneously invalidates the switches pressed.
- Pressing a second switch while still pressing the first invalidates both switches.

<Display example>

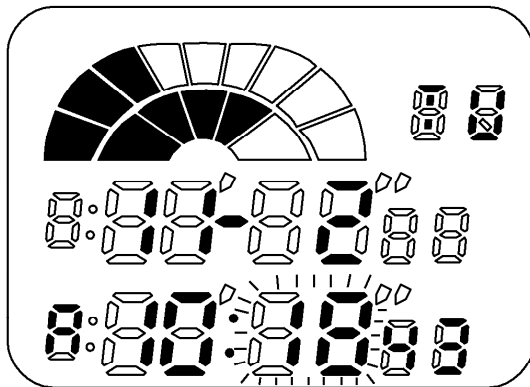
(a) Setting the seconds



- Pressing S<sub>2</sub> switch 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.

(\* ) S<sub>1</sub> is invalid.

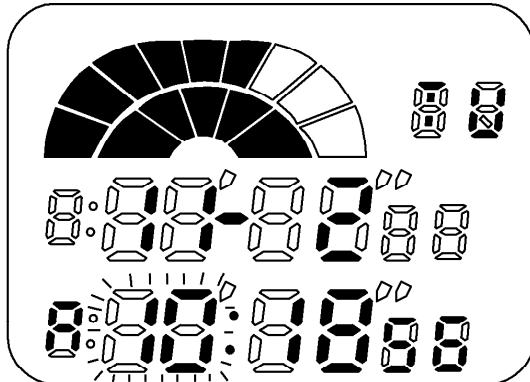
(b) Setting the minutes



- Use S<sub>1</sub> or S<sub>2</sub> to set the minutes. Each press of S<sub>1</sub> increments the time by one minute. Pressing S<sub>2</sub> decrements the time by one minute. Pressing either S<sub>1</sub> or S<sub>2</sub> for two seconds fast-winds the time at a speed of 4Hz for as long as the switch is depressed. Pressing another switch during the fast winding immediately cancels the fast winding. To return to fast winding, press S<sub>1</sub> or S<sub>2</sub> as above after releasing all other switches.
- The count range is 0~59.



(c) Setting the hour



- Use S<sub>1</sub> and S<sub>2</sub> to set the hour as in "Setting the minutes".

Displays the range :

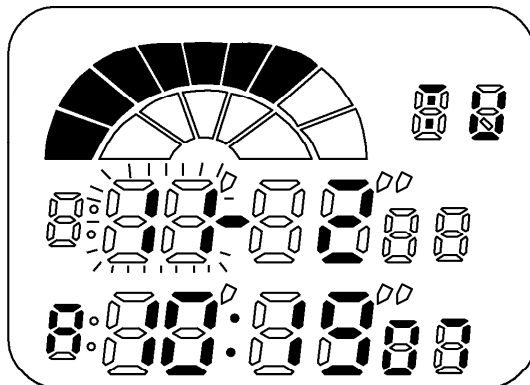
For 12-hour clock

→ AM12~11 ← PM12~11 ←

For 24-hour clock

→ 0~23 ←

(d) Setting the month

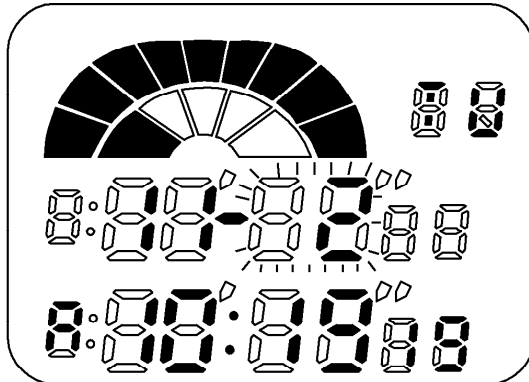


- Use S<sub>1</sub> or S<sub>2</sub> to set the month as in "Setting the minutes".

Displays the range :

→ 1~12 ←

(e) Setting the day of the month



- Use S<sub>1</sub> and S<sub>2</sub> to set the day of the month as in "Setting the minutes".  
For January, March, May, July, August, October, and December, the range displayed is :

→ 1~31 ←

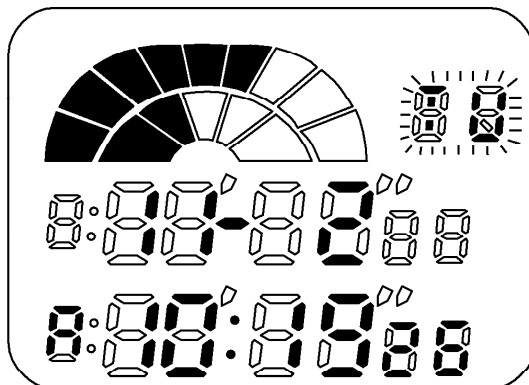
- For April, June, September, and November, the range displayed is :

→ 1~30 ←

- For February, the range displayed is :

→ 1~29 ←

(f) Setting the day of the week



- Use S<sub>1</sub> or S<sub>2</sub> to correct the month as in "Correcting the minutes".

Displays the range :

→ SU~SA ←

(\*) TIME SETTING mode can display some days of the month that do not actually exist (February 30, February 31, April 31, June 31, September 31, November 31). When switching from TIME SETTING mode to TIME mode, the first day of the following month is displayed.

(Example) February 30 in TIME SETTING mode,

S<sub>4</sub> ↓

becomes March 1 in TIME mode.

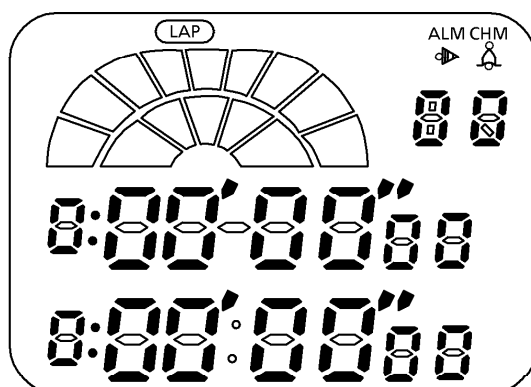
## 7.3 CHRONO mode

CHRONO mode displays lap and split time.

- Middle and lower row columns #1 and #8 display the hour ; columns #2 and #3, and #9 and #10 display the minutes ; columns #4 and #5, and #11 and #12 display the seconds ; columns #6 and #13 display tenths of seconds ; and columns #7 and #14 display hundredths of seconds.
- The middle row displays lap and split time.
- Upper row columns #15 and #16 display the lap or split count number.
- The lower row displays the RUN time.
- Clocking is up to 9 hours, 59 minutes, 59 seconds, 99 hundredths of seconds.
- In the RUN state, after 9 hours and 59 minutes, 59 seconds, and 99 hundredths of seconds, the count-up returns to 0, but because of zero suppression, the counting starts from display of a single zero.
- Displays the ALM/CHM ON/OFF status.
- In CHRONO mode, a switch-push sound is generated when  $S_1$  or  $S_2$  are pressed. In the case of  $S_4$ , the sound is generated after  $S_4$  is held for two seconds.
- To switch between lap and split, depress  $S_4$  for two seconds. This resets the lap or split display. (Switching is indicated by the switch-push sound. Lap/split switching also resets the data stored in MEMORY RECALL mode.  
During the RUN state,  $S_4$  is invalid and cannot be used for switching.
- The lap/split count number starts from 01. When 99 is reached, the count returns to 00. This cycle is repeated indefinitely.
- After an ALL CLEAR in CHRONO mode, the LAP mode reset state is displayed.
- If other switches are pressed at the same time as  $S_1$ ,  $S_1$  takes precedence.
- Pressing switches other than  $S_1$  at the same time invalidates the switches pressed.
- Pressing a second switch while still pressing the first, unless the first switch is  $S_1$ , invalidates both switches.

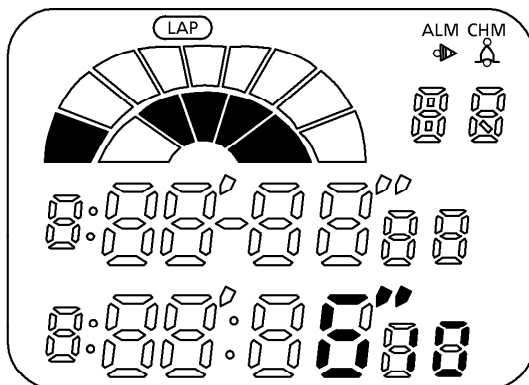
## (1) LAP mode display

## (a) Reset state



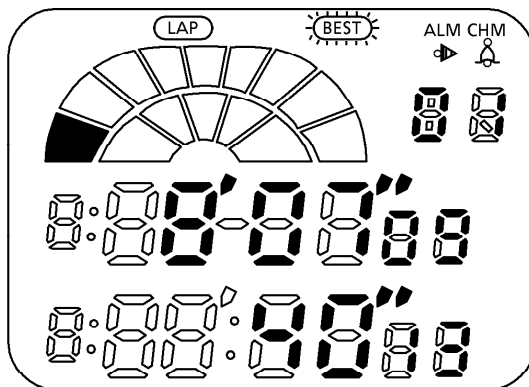
- ① In LAP mode, after a reset and in a state other than RUN, the display is as at left.
- ② The LAP sign at the top of the display is lit.

(b) RUN 1 state Lap 0



- ① Pressing S<sub>1</sub> sets the watch to RUN. The RUN state is displayed (zero suppressed) in the lower row. The graphic display in the upper row functions at the same time.
- ② As long as lap time is not recorded, the middle row display is blank.
- (\*) Once a digit is displayed in this column, the digit will not be zero suppressed. However, pressing S<sub>2</sub> (lap) resets and zero suppresses the lower row.

(c) RUN 2 state Lap 1



- ① In lap 0, RUN 1 state, pressing S<sub>2</sub> displays the lap time in the middle row, and the lap number at the far right of the upper row. Also, pressing S<sub>2</sub> in lap 0, RUN 1 state resets the time display in the lower row and starts the count from 0.
- ② If lap time is measured when no other lap time is recorded, the lap time recorded is the "best lap" time, and the best lap function is activated.

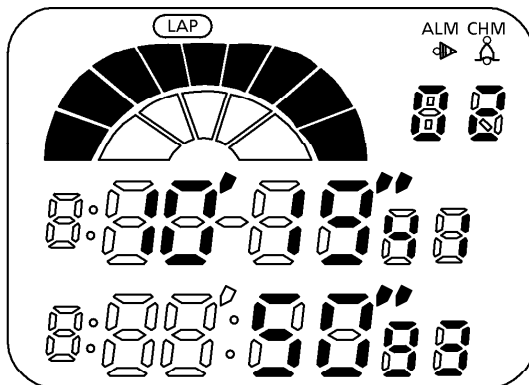
If another lap time is recorded, it is compared to the current best time. If the lap time is shorter than the current best lap time, the best lap function is activated. If the lap time is longer than the current best lap time, the best lap function is not activated. If the lap time is the same as the current best lap time, the lap time recorded first remains the best lap time. Therefore, where same lap times are recorded, the best lap function is not activated.

(\*) Best lap function

The best lap is the fastest lap.

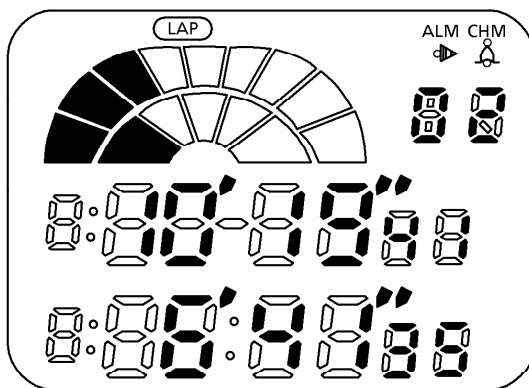
When a best lap time occurs, the BEST sign in the top row flashes at 2Hz, and the best time sound is output. While the best lap time remains displayed in the middle row, the BEST sign in the top row continues flashing.

(d) RUN 3 state Lap 2



- ① Compares the best lap time with the current lap. Because the current lap time is longer, the BEST sign is not lit.

(e) RUN 3 stop state



- ① Pressing S<sub>1</sub> stops the RUN state.  
 ② Even if the time to when the count stops is shorter than the best time, that time is ignored because it is not a full lap time.

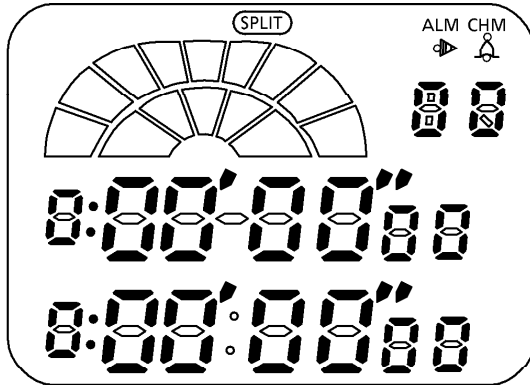
(\*) Even if the count is stopped with the BEST sign still flashing, the BEST sign continues to flash. If the count is restarted, the BEST sign continues flashing because the best lap time is displayed in the middle row.

(\*) During best time sound output (during RUN state)

- If the count is stopped by pressing S<sub>1</sub>, the S<sub>1</sub> switch-push sound takes precedence. If the best time sound is ON, it stops immediately.
- If the lap is recorded using S<sub>2</sub>, the S<sub>2</sub> switch-push sound takes precedence. If the best time sound is ON, it stops immediately.
- If the lap is recorded using S<sub>2</sub> and that lap time is a best time, the S<sub>2</sub> switch-push sound takes precedence. If the best time sound is ON, it stops immediately, then starts again after the S<sub>2</sub> switch-push sound ends.
- If the mode is switched using S<sub>3</sub>, the switch-push sound is not output. However, the best time sound stops immediately and the device switches to MEMORY RECALL mode.
- Except for pressing S<sub>4</sub> and S<sub>1</sub> together, pressing more than one switch at the same time invalidates both switches. Therefore, the best time sound continues.

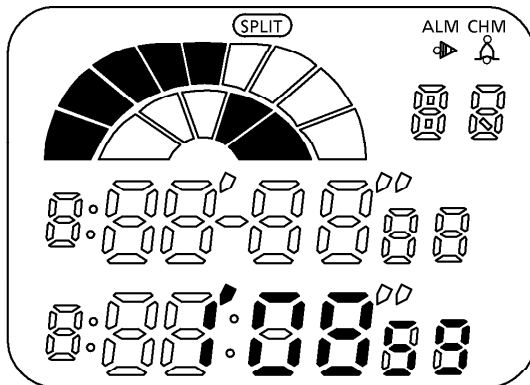
(2) SPLIT mode display

(a) Reset state



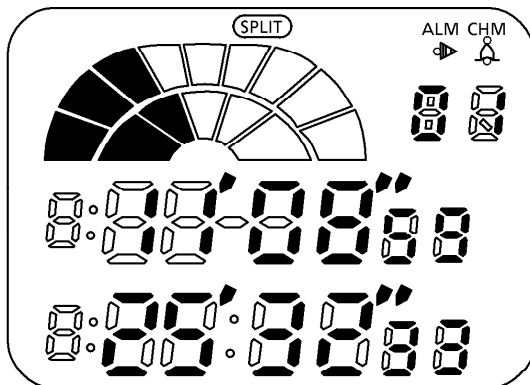
① Executing a reset in SPLIT mode produces the display shown at left.

(b) RUN state Split 0



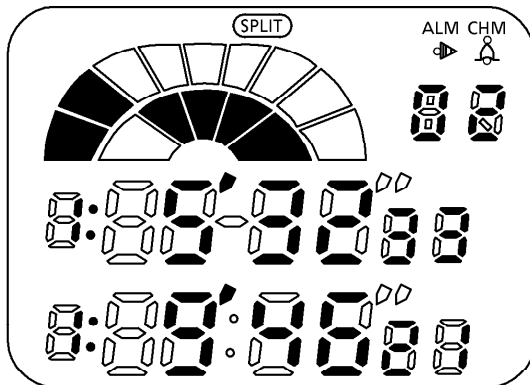
① Pressing S<sub>1</sub> sets the device to RUN and displays the RUN count in the lower row. The upper row graphic display comes on at the same time. (The lower row RUN count display is zero suppressed.)

(c) RUN state Split 1



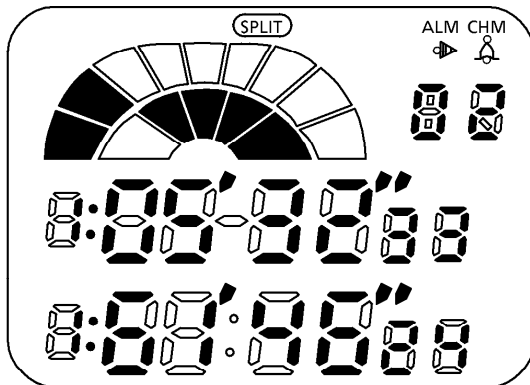
① Pressing S<sub>2</sub> in RUN split 0 state displays the time elapsed as split time in the middle row, and displays the split number at the right end of the upper row.

(d) RUN state Split 2



- ① Split 2 functions the same as RUN split 1. Pressing  $S_2$  updates the time displayed in the middle row with the time elapsed from start, which becomes the new split time, and displays the split number at the right end of the upper row.

(e) RUN stop state



- ① Pressing  $S_1$  stops the RUN count.
- ② Pressing  $S_2$  after stopping the RUN count displays the reset state.
- (\*) The RUN time displayed in the lower row in SPLIT mode is not reset when split data is recorded. Once a digit is displayed in this column the digit will not be zero suppressed.

#### 7.4 MEMORY RECALL mode

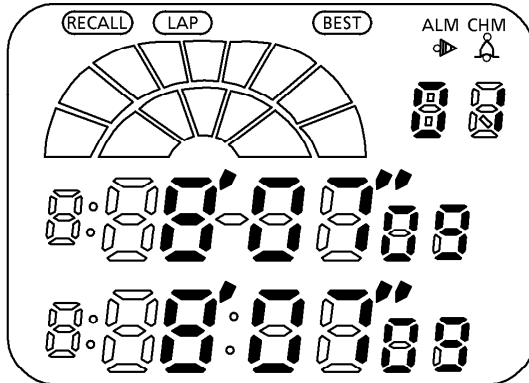
MEMORY RECALL mode stores and displays the lap or split data recorded in CHRONO mode.

- Middle and lower row columns #1 and #8 display the hour ; columns #2 and #3, and #9 and #10 display the minutes ; columns #4 and #5, and #11 and #12 display the seconds ; columns #6 and #13 display tenths of seconds ; and columns #7 and #14 display hundredths of seconds. Upper row columns #15 and #16 display the lap or split number.
- The upper row displays the lap or split numbers. The middle row displays the data of the lap or split numbers. The lower row display varies according to which of split or lap data is displayed. For lap time, the lower row shows the time elapsed from the start time to the lap number, in accordance with the lap number at that time. For split time, the lower row shows the total time elapsed irrespective of the split number.
- This mode does not support a graphic display.
- Up to 10 units of data in addition to time data can be stored and displayed.
- MEMORY RECALL mode cannot include both lap data and split data. Either lap or split data is displayed immediately before switching out of CHRONO mode. MEMORY RECALL mode can include one but not both.
- In CHRONO mode, performing lap /split switching by depressing  $S_4$  for two seconds clears the MEMORY RECALL data. If lap is selected for CHRONO mode, the LAP sign is displayed in MEMORY RECALL mode and lap data is displayed. If split is selected for CHRONO mode, the SPLIT sign is displayed in MEMORY RECALL mode and split data is displayed.
- If 10 or fewer units of data are recorded, all the data and stop times are displayed continuously. If over 10 units of data are recorded, only the latest ten units of data are stored and older data is deleted.
- The lap /split numbers start from 01 and continue to 99. After 99, the count returns to 00, 01, 02 up to 99 again, then repeats.
- After switching from MEMORY RECALL mode with lap or split data displayed to another mode, then returning to MEMORY RECALL mode, MEMORY RECALL mode displays the lap or split data from the lowest number, regardless of the number at the time the previous mode was switched. (As long as you did not start in CHRONO mode or did not switch between lap and split after leaving MEMORY RECALL mode.)
- MEMORY RECALL mode simultaneously displays the ON/OFF status of both ALM/CHM (alarm and chime).
- Pressing multiple switches simultaneously invalidates the switches pressed.
- Pressing a second switch while still pressing the first invalidates both switches.



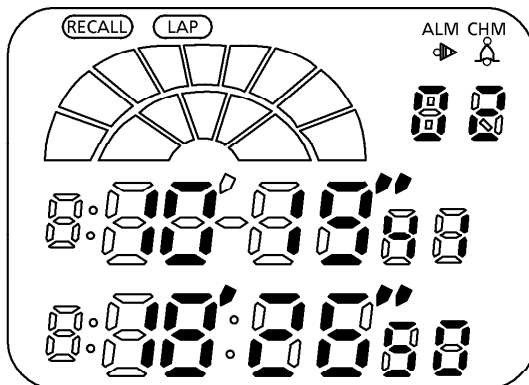
(1) LAP mode

(a) Lap n



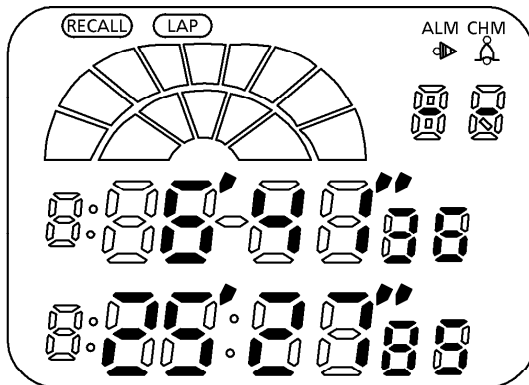
- ① After lap data is recorded in CHRONO mode, switching to MEMORY RECALL mode displays the data in the middle row starting from the lowest lap number.
- ② The lower row displays the total time from the start to the applicable lap number.
- ③ Where a best lap is stored in memory, the BEST sign is lit while the data of that lap is displayed.

(b) Lap n + 1



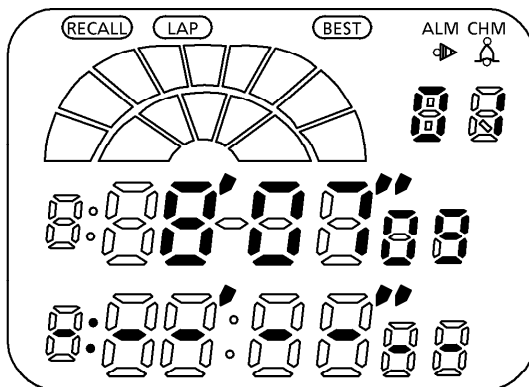
- ① Pressing S<sub>1</sub> displays the next lap data. Pressing S<sub>2</sub> displays the previous lap data.
- ② For the applicable lap number, the lower row displays the total time from the start.

(c) Lap stop



- ① The data at the point the count was stopped is displayed in the middle row. The lower row displays the total time from start to stop. The upper row shows " - - " as at left.

(d) Best lap



- ① Whatever data is displayed in MEMORY RECALL mode, while S<sub>4</sub> is depressed, the best lap time is displayed. (If another switch is pressed while S<sub>4</sub> is depressed, the display returns to the lap or stop data displayed before switching to the best lap time display.)
- ② When S<sub>4</sub> is released, the display returns to the lap or stop data displayed before switching to the best lap time display.
- ③ In the best lap time display, the lap number appears in the upper row. The best lap time is displayed in the middle row, as at left.
- ④ The best time is the fastest time among all the lap times recorded. Where a lap number n (100 < n) is the same as the best time number n (100 > n), the BEST sign is not lit even though lap number n, which is not the best time, is displayed.

- When S<sub>3</sub> is pressed with LAP mode only selected in CHRONO mode, the display is as at left when MEMORY RECALL mode is entered. The best lap time is as in Fig.2.

(\*) When an ALL CLEAR is executed and reset MEMORY RECALL mode is executed (when switching from split to lap in CHRONO mode), the display is as in Fig.1.

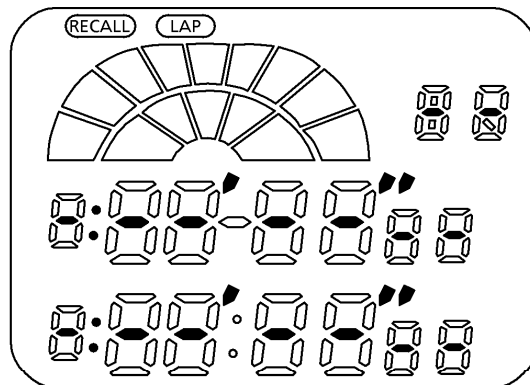


Fig.1

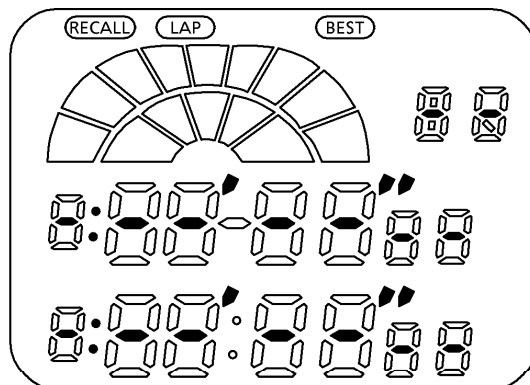
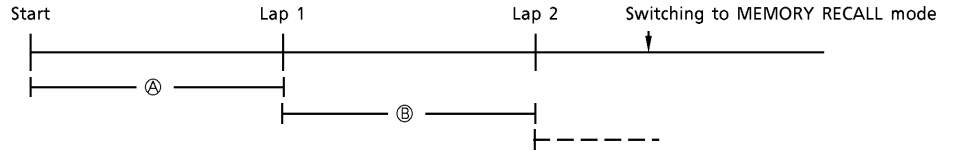


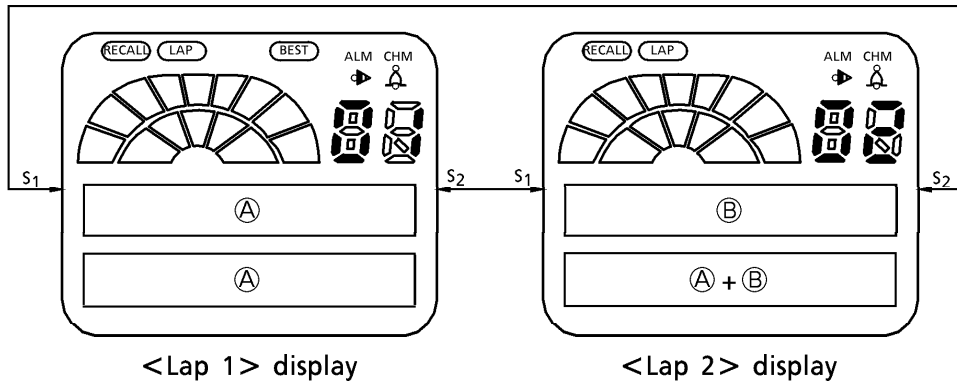
Fig.2

- When recording lap n in LAP mode and pressing S<sub>3</sub> with the count running to switch into MEMORY RECALL mode, the data up to lap n is displayed.  
(Lap 1 < lap 2)

<Example>

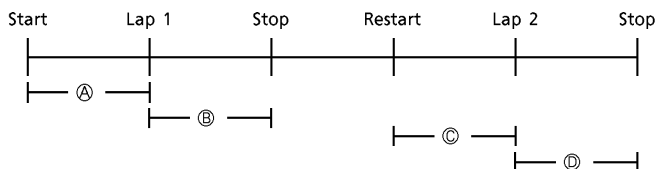


(MEMORY RECALL mode display)

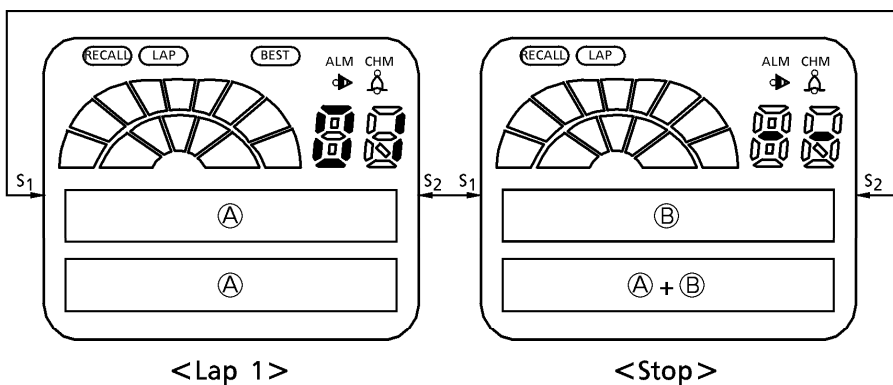


- In CHRONO mode, if you start a lap n, record, then stop and restart, the count starts from the stop time. The data following lap n + 1 continues from the stop time.  
 (The counting from the previous stop time continues until a reset.)  
 (\*) Lap 1 < lap 2.

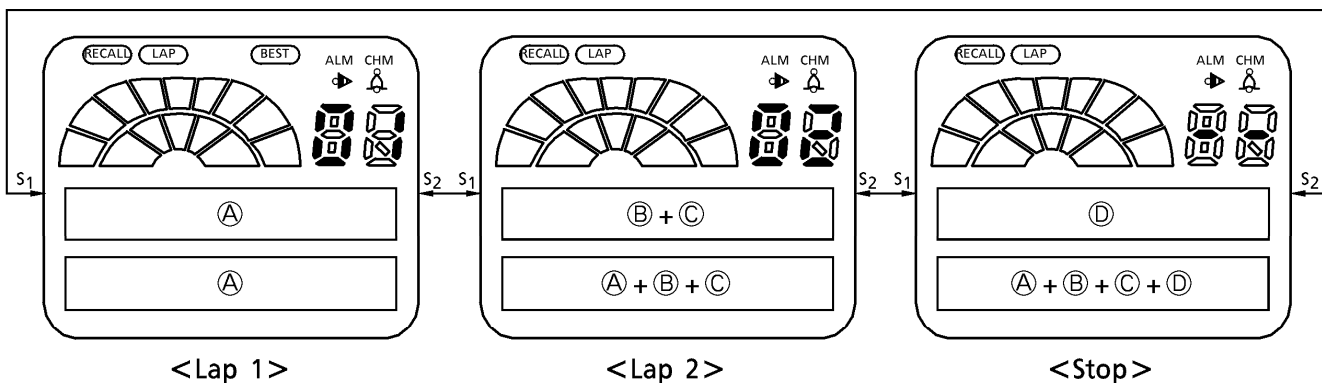
<Example>



(MEMORY RECALL mode display when start → lap 1 → stop.)

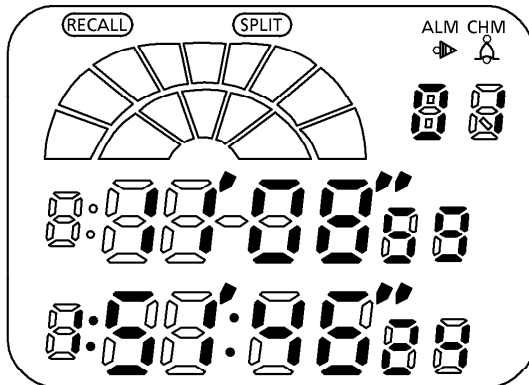


(MEMORY RECALL mode display when start → lap 1 → stop → restart → lap 2 → stop.)



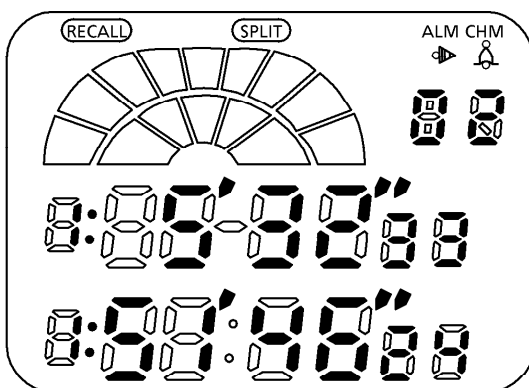
(2) Split mode display

(a) Split n



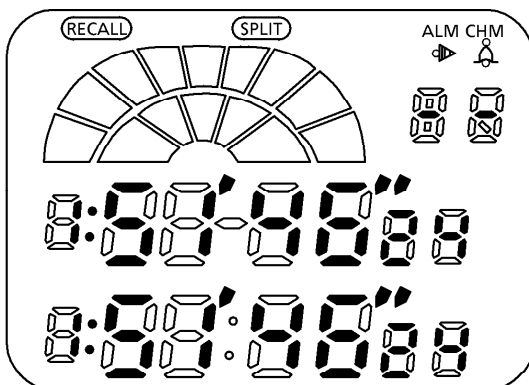
- ① When entering MEMORY mode after recording split data in CHRONO mode, data is displayed in the middle row starting from the lowest split number.
- ② The lower row displays the total time, irrespective of the split number.

(b) Split n + 1



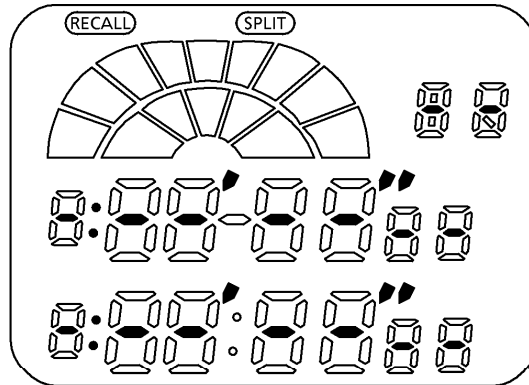
- ① Each press of S<sub>1</sub> displays the next split data. Each press of S<sub>2</sub> displays the previous split data.
- ② The lower row displays the final (at STOP) total time.

(c) Split stop



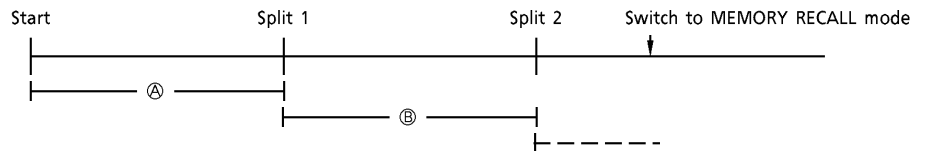
- ① As the middle row displays the data for when the count was last stopped, this is the same data as in the lower row. The upper row shows " -- " as at left.

- With only the split mode activated in CHRONO mode, pressing S<sub>3</sub> to enter MEMORY RECALL mode produces a display as below. Resetting MEMORY RECALL mode (switching from lap to split) also produces a display as below.

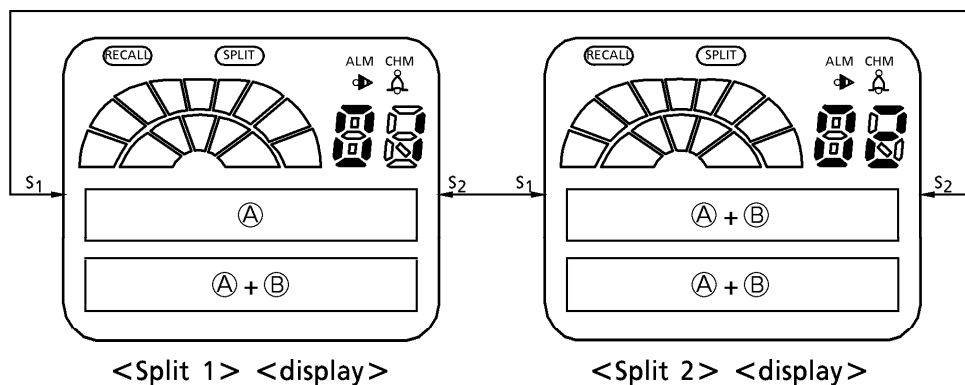


- When recording split n in SPLIT mode and pressing S<sub>3</sub> with the count running to switch into MEMORY RECALL mode, the data up to split n is displayed.

<Example>

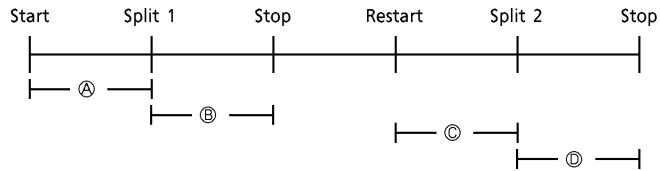


(Display in MEMORY RECALL mode)

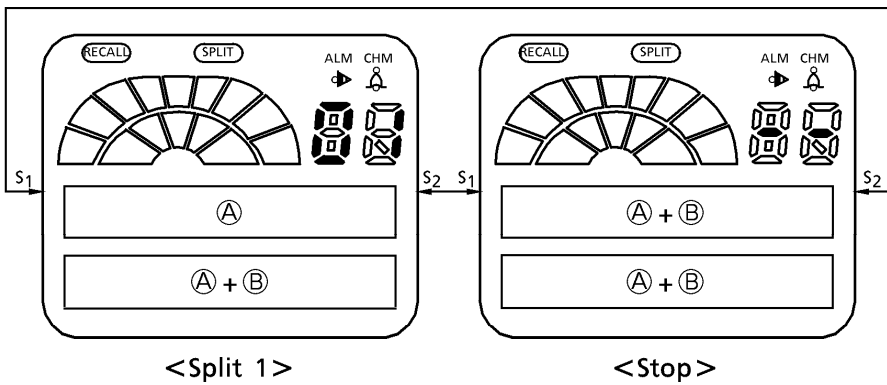


- In CHRONO mode, if you start a split n count, record, then stop and restart, the count from the stop time. The data following split n + 1 continues from the stop time. (The data continues until a reset.)

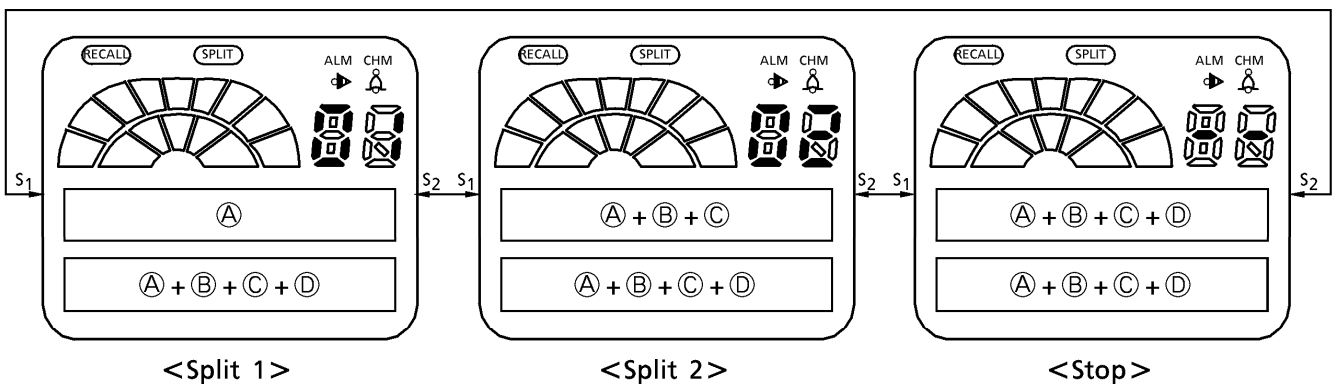
<Example>



(MEMORY RECALL mode display when start→split 1→stop.)



(MEMORY RECALL mode display when start→split 1→stop→restart→split 2→stop.)





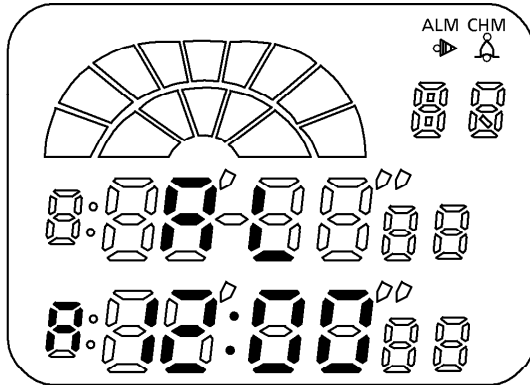
## 7.5 ALARM mode

ALARM mode is used to set and display the alarm and time signal.

- In this mode, the graphic display and upper row columns #15 and #16 go OFF.
- In MEMORY RECALL mode, press S<sub>3</sub> to switch to ALARM mode.
- The alarm and time signal ON/OFF states are displayed by the upper right sign. (Lit : ON, unlit : OFF)
- In ALARM mode, each press of S<sub>1</sub> turns the alarm ON, time signal OFF→alarm OFF, time signal ON→alarm/time signal ON→alarm/time signal OFF→alarm ON, time signal OFF...
- In ALARM mode, depressing S<sub>1</sub> for two seconds sounds a test alarm. While S<sub>1</sub> is depressed, the alarm continues sounding. (When the alarm is sounding, pressing another switch turns the alarm sound OFF. If the test alarm is sounding when the preset alarm or time signal are due to come ON, the test alarm tone takes precedence and the set alarm or time signal chime do not sound.)
- If the settings for the alarm and time signal are for the same time, the alarm takes precedence.
- The ALARM mode does not allow 12-hour/24-hour clock switching. (Such switching is supported only in TIME mode.) The 12-hour and 24-hour clocks conform to TIME mode.
- Press S<sub>2</sub> to switch between the alarm and time signal displays.
- After ALL CLEAR, the alarm display shows "AM12:00" if the 12-hour clock is selected, and "0:00" if the 24-hour clock is selected. After the ALL CLEAR, the time signal display shows "00".
- Pressing multiple switches simultaneously invalidates the switches pressed.
- Pressing a second switch while still pressing the first invalidates both switches.

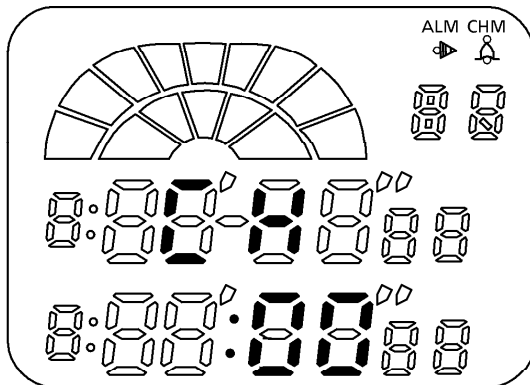
Alarm / time signal <Display configuration >

(a) Alarm display



- ① The middle row displays "AL". The bottom row displays the set time-of-day.
- ② Press S<sub>2</sub> to switch between the alarm and time signal.

(b) Time signal display



- ① The middle row displays "CH". The bottom row displays the set minutes of the hour.

## 7.6 ALARM SETTING mode

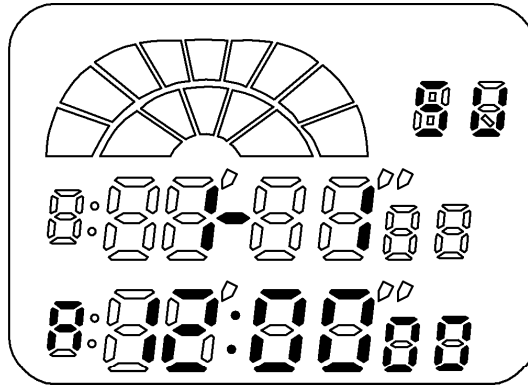
- Press S<sub>4</sub> while the alarm or time signal is displayed to switch to ALARM SETTING mode for the alarm or time signal.
- If a switch is not pressed for one minute while in ALARM SETTING mode, the device automatically switches to ALARM mode.
- When switching to ALARM SETTING mode from ALARM mode, even if the alarm / time signal are set, the ALM or CHM sign goes OFF and the alarm and chime (time signal) sounds are disabled.
- In ALARM SETTING mode, press S<sub>4</sub> to switch to ALARM MODE.  
When switching to ALARM MODE from ALARM SETTING mode,  
the alarm is set and the ALM sign is lit. The CHM sign returns to the status prevailing before switching to ALARM SETTING mode.  
When switching to ALARM MODE from ALARM SETTING mode for the time signal, the time signal is set and the CHM sign is lit. The ALM sign returns to the status prevailing before switching to ALARM SETTING mode.
- The method of correcting the alarm hour and minutes, and the method of correcting the time signal minutes is the same as for correcting the hour and minutes in TIME SETTING mode. Press S<sub>3</sub> to switch between the alarm hours and minutes to be set.
- Pressing multiple switches simultaneously invalidates the switches pressed.
- Pressing a second switch while still pressing the first invalidates both switches.

## 7.7 Alarm functions

- With the ALM sign lit, when the current time matches the set alarm time, the alarm sounds for 20 seconds.
- In ALARM SETTING mode, even if the set alarm time matches the current time, the alarm will not sound.
- To stop the alarm sound in any mode except ALARM SETTING mode, press any one of switches S<sub>1</sub>~S<sub>4</sub>.
- If the alarm sound comes on while you are depressing a switch in any mode except SETTING mode, release the switch then press it again to stop the alarm sounding.
- While switching from TIME mode to TIME SETTING mode by depressing S<sub>4</sub> for two seconds (in TIME mode), the alarm will sound if the set alarm time matches the current time. However, keep S<sub>4</sub> depressed. As soon as the mode is switched, the alarm sound and the ALM sign go off.

7.8 ALL CLEAR

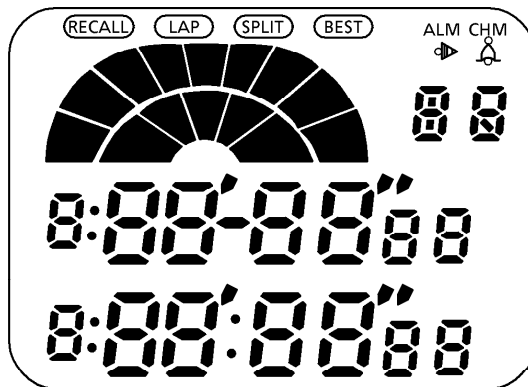
After an ALL CLEAR, TIME mode is selected. The count starts from January 1 (Sunday) AM12 hours, 0 minutes, 0 seconds. After an ALL CLEAR, the display is as below.



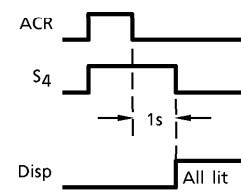
7.9 All segments lit

Immediately after an ALL CLEAR, press S<sub>4</sub> (until the display comes ON) to light all segments (the display is as below). Then, to switch from all segments being lit to TIME mode, push any one of S<sub>1</sub>~S<sub>4</sub>.

(\*) After an ALL CLEAR, TIME mode starts counting. Therefore, when you return to TIME mode, the time count has advanced.

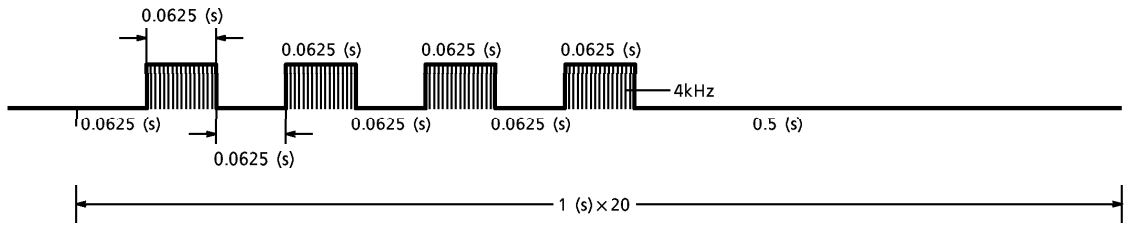


Timing flow chart

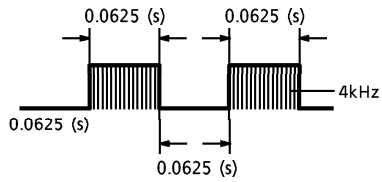


7.10 Alarm waveform

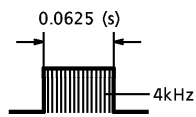
<Alarm sound>



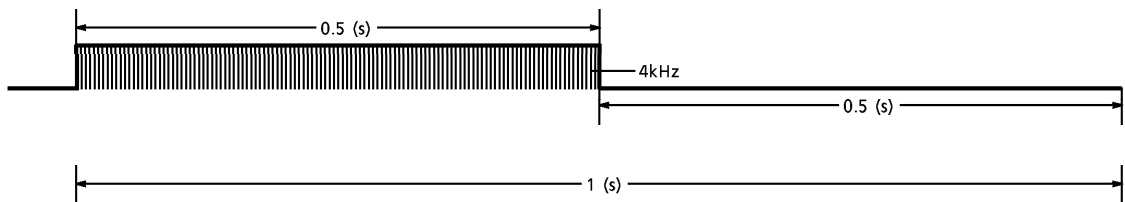
<Chime sound (Time signal)>



<Switch-push sound>



<Best lap time sound>



**MAXIMUM RATINGS**(Unless otherwise stated,  $V_{SS} = 0V$ ,  $V_{DD1} = 1.5V$ ,  $V_{DD2} = 3.0V$ ,  $V_{DD3} = 4.5V$ ,  $T_a = 25^\circ C$ )

PARAMETER	SYMBOL	RATING	UNIT
Power Supply Voltage (1)	$V_{SS} - V_{DD1}$	-0.2~3.0	V
Power Supply Voltage (2)	$V_{SS} - V_{DD2}$	-0.2~5.0	V
Power Supply Voltage (3)	$V_{SS} - V_{DD3}$	-0.2~6.5	V
$V_{DD1}$ System Input Voltage	$V_{IN1}$	$V_{SS} - 0.2 \sim V_{DD1} + 0.2$	V
$V_{DD2}$ System Input Voltage	$V_{IN2}$	$V_{SS} - 0.2 \sim V_{DD2} + 0.2$	V
$V_{DD3}$ System Input Voltage	$V_{IN3}$	$V_{SS} - 0.2 \sim V_{DD3} + 0.2$	V
$V_{DD1}$ System Output Withstanding Voltage	$V_{OUT1}$	$V_{SS} - 0.2 \sim V_{DD1} + 0.2$	V
$V_{DD2}$ System Output Withstanding Voltage	$V_{OUT2}$	$V_{SS} - 0.2 \sim V_{DD2} + 0.2$	V
$V_{DD3}$ System Output Withstanding Voltage	$V_{OUT3}$	$V_{SS} - 0.2 \sim V_{DD3} + 0.2$	V
Operating Temperature	$T_{opr}$	-10~60	$^\circ C$
Storage Temperature	$T_{stg}$	-40~125	$^\circ C$

**RECOMMENDED OPERATING CONDITIONS**(Unless otherwise stated,  $V_{SS} = 0V$ ,  $V_{DD1} = 1.5V$ ,  $V_{DD2} = 3.0V$ ,  $V_{DD3} = 4.5V$ ,  $T_a = 25^\circ C$ )

PARAMETER	SYMBOL	TEST CIRCUIT	APPLICABLE PIN	TEST CONDITIONS	MIN.	TYP.	MAX.	UNIT
$V_{DD1}$ System Operating Voltage Range	$ V_{DD1} $	—	$V_{DD1}$	No load	1.20	1.50	1.80	V
$V_{DD2}$ System Operating Voltage Range	$ V_{DD2} $	6	$V_{DD2}$	No load (Note 1)	2.40	3.00	3.60	V
$V_{DD3}$ System Operating Voltage Range	$ V_{DD3} $	—	$V_{DD3}$	No load	3.60	4.50	5.40	V
Low-Speed Clock Crystal Oscillator Frequency	$f_{XT}$	1	$X_I$ , $X_O$	$V_{DD} = 3.0V$	—	32.768	—	kHz
High-Speed Clock CR Oscillator Frequency	$f_{CR}$	1	$R_{IN}$ , $R_{OUT}$	$V_{DD} = 3.0V$	—	400	—	kHz

## ELECTRICAL CHARACTERISTICS

## DC CHARACTERISTICS

(Unless otherwise stated,  $V_{SS} = 0V$ ,  $V_{DD1} = 1.5V$ ,  $V_{DD2} = 3.0V$ ,  $V_{DD3} = 4.5V$ ,  $T_a = 25^\circ C$ )

PARAMETER	SYMBOL	TEST CIRCUIT	APPLICABLE PIN	TEST CONDITIONS	MIN.	TYP.	MAX.	UNIT
$V_{DD1}$ System Leak Current	$I_{DD1L}$	4	$V_{DD1}$	—	—	—	0.1	$\mu A$
$V_{DD2}$ System Leak Current	$I_{DD2L}$	4	$V_{DD2}$	—	—	—	0.1	$\mu A$
$V_{DD3}$ System Leak Current	$I_{DD3L}$	4	$V_{DD3}$	—	—	—	0.1	$\mu A$
$V_{DD1}$ System Step-Down Voltage	$V_{DCO1}$	5	$V_{DD1}$	$R_L = 3M\Omega$	1.4	—	—	V
$V_{DD3}$ System Step-Up Voltage	$V_{UCO3}$	5	$V_{DD3}$	$R_L = 3M\Omega$	4.3	—	—	V
Oscillation Start Voltage	$V_{STA}$	3	$X_I$ , $X_O$	(Note 6)	2.6	—	—	V
Oscillation Hold Voltage	$V_{HOLD}$	3	$X_I$ , $X_O$	—	2.4	—	—	V
CR Oscillator Voltage Dependency	$V_{CR}$	3	$R_{IN}$ , $R_{OUT}$	$V_{DD2} = 2.4 \sim 3.6V$	-30	—	30	%
Low Oscillation Frequency $V_{TH}$ Dependency	$\Delta\epsilon I_C$	3	$X_I$ , $X_O$	(Note 9)	—	—	8	ppm
Low Oscillation Frequency $V_{DD2}$ Dependency	$\Delta\epsilon V_{DD2}$	3	$X_I$ , $X_O$	$V_{DD2} = 2.4 \sim 3.6V$ (Note 8)	—	—	4	ppm
Low Oscillation Frequency $C_G$ Dependency	$\Delta\epsilon C_G$	3	$X_I$ , $X_O$	$C_G = 5 \sim 20pF$ (Note 7)	30	—	—	ppm
Oscillator Feedback Resistance (1)	$R_{FB1}$	—	$X_I$ , $X_O$	—	—	25	—	$M\Omega$
Oscillator Feedback Resistance (2)	$R_{FB2}$	—	$X_I$ , $X_O$	Backup time	—	25	—	$M\Omega$
Oscillator Output Resistance	$R_{OUTX}$	—	$X_I$ , $X_O$	—	—	250	—	$k\Omega$
Built-In CD Capacitance	$C_D$	—	$X_I$ , $X_O$	—	—	8	—	pF

DC CHARACTERISTICS (Current dissipation)  
CPU block ( $V_{DD}$ - $V_{SS}$  system)

PARAMETER	SYMBOL	TEST CIRCUIT	APPLICABLE PIN	TEST CONDITIONS	MIN.	TYP.	MAX.	UNIT
High-Speed Operation Mode Current Dissipation	$I_{DD}$ (OPH)	1	—	$V_{DD} = 3.0V$ $f_{CR} = 400kHz$ (Note 2)	—	100	200	$\mu A$
Low-Speed Operation Mode Current Dissipation	$I_{DD}$ (OPL)	1	—	$V_{DD} = 3.0V$ $f_{XT} = 32.768kHz$ (Note 3)	—	1.6	2.0	$\mu A$
STOP Mode Current Dissipation	$I_{DD}$ (STOP)	1	—	$V_{DD} = 3.0V$ $f_{XT} = 32.768kHz$ (Note 4)	—	0.9	2.0	$\mu A$
OFF Mode Current Dissipation	$I_{DD}$ (OFF)	1	—	$V_{DD} = 5.0V$ (Note 5)	—	0.01	1.0	$\mu A$

(\*) The entire device current dissipation is : (CPU current dissipation + built-in LCD driver current dissipation)



## DC CHARACTERISTICS (Pin capacities)

(Unless otherwise stated,  $V_{SS} = 0V$ ,  $V_{DD1} = 1.5V$ ,  $V_{DD2} = 3.0V$ ,  $V_{DD3} = 4.5V$ ,  $T_a = 25^\circ C$ )

PARAMETER	SYMBOL	TEST CIRCUIT	APPLICABLE PIN	TEST CONDITIONS	MIN.	TYP.	MAX.	UNIT
Output Current High	$I_{OH1}$	2	OUT, IO	$V_{DD2} = 2.5V$ $V_{OH1} = 2.0V$	—	—	- 250	$\mu A$
Output Current Low	$I_{OL1}$	2	OUT, IO	$V_{DD2} = 2.5V$ $V_{OL1} = 0.5V$	10	—	90	$\mu A$
Output Current High	$I_{OH2}$	2	BZ	$V_{DD2} = 2.5V$ $V_{OH2} = 2.0V$	—	—	- 250	$\mu A$
Output Current Low	$I_{OL2}$	2	BZ	$V_{DD2} = 2.5V$ $V_{OL2} = 0.5V$	250	—	—	$\mu A$
Output Current High	$I_{OH3}$	2	SEG, COM	$V_{SS}-V_{DD3}$ system $V_{OH3} = 4.0V$	—	—	- 80	$\mu A$
Output Current Low	$I_{OL3}$	2	SEG, COM	$V_{SS}-V_{DD3}$ system $V_{OL3} = 0.5V$	80	—	—	$\mu A$
Output Current High	$I_{OH4}$	2	SEG, COM	$V_{SS}-V_{DD1}$ system $V_{OH4} = 1.0V$	—	—	- 80	$\mu A$
Output Current Low	$I_{OL4}$	2	SEG, COM	$V_{SS}-V_{DD1}$ system $V_{OL4} = 2.0V$	80	—	—	$\mu A$
Output Current High	$I_{OH5}$	2	SEG, COM	$V_{SS}-V_{DD2}$ system $V_{OH5} = 2.5V$	—	—	- 80	$\mu A$
Output Current Low	$I_{OL5}$	2	SEG, COM	$V_{SS}-V_{DD2}$ system $V_{OL5} = 3.5V$	80	—	—	$\mu A$
Input Current High	$I_{IH1}$	2	$\overline{AC}$	$V_{IH1} = 3.0V$	- 0.5	—	0.5	$\mu A$
Input Current Low	$I_{IL1}$	2	$\overline{AC}$	$V_{IL1} = 0V$	- 85.0	—	—	$\mu A$
Input Current High	$I_{IH2}$	2	TEST <sub>1</sub> , TEST <sub>2</sub> IN <sub>1</sub> , IN <sub>2</sub>	$V_{IH2} = 3.0V$	—	—	8.5	$\mu A$
Input Current Low	$I_{IL2}$	2	TEST <sub>1</sub> , TEST <sub>2</sub> IN <sub>1</sub> , IN <sub>2</sub>	$V_{IL2} = 0V$	- 0.5	—	0.5	$\mu A$

- (Note 1) The voltage range, the oscillation, and the voltage step-up are maintained and internal circuits operate without fault.
- (Note 2) Current consumed in high-speed operating mode after an ALL CLEAR.
- (Note 3) Current consumed in low-speed operating mode, set by the FXT command after an ALL CLEAR.
- (Note 4) Current consumed in CPU stop mode, set by the STOP command after an ALL CLEAR.
- (Note 5) Current consumed in OFF mode, set by the OFF command after an ALL CLEAR.
- (Note 6) The V<sub>SS2</sub> voltage when the period between applying step voltage to V<sub>SS2</sub> and the output of a normal waveform to  $\phi 1$  is ten seconds or less.
- (Note 7)  $\Delta\epsilon C_G$  is determined by the following formula. Note that T<sub>0</sub> = 1000ms.

$$\Delta\epsilon C_G = \frac{T (C_G = 20\text{pF}) - T (C_G = 5\text{pF})}{T_0} \times 10^6 \quad [\text{ppm}]$$

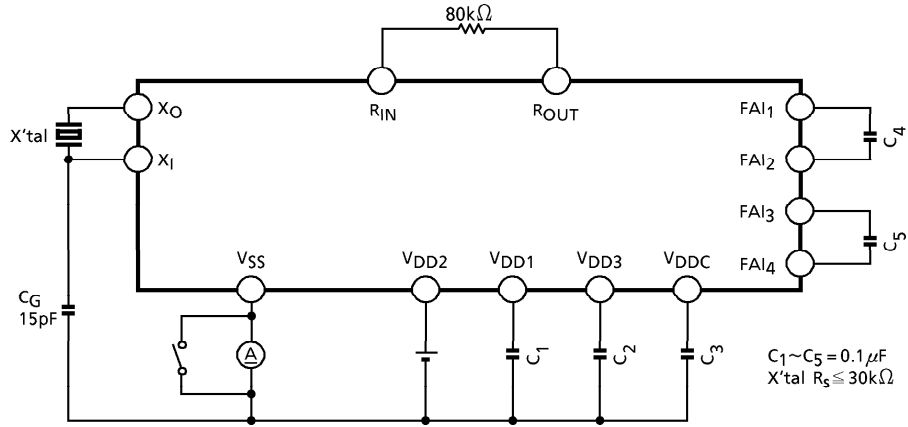
- (Note 8)  $\Delta\epsilon V_{SS1}$  is determined by the following formula.

$$\Delta\epsilon V_{SS1} = \left| \frac{T (V_{SS1} = 3.6\text{V}) - T (V_{SS1} = 2.4\text{V})}{T_0} \right| \times 10^6 \quad [\text{ppm}]$$

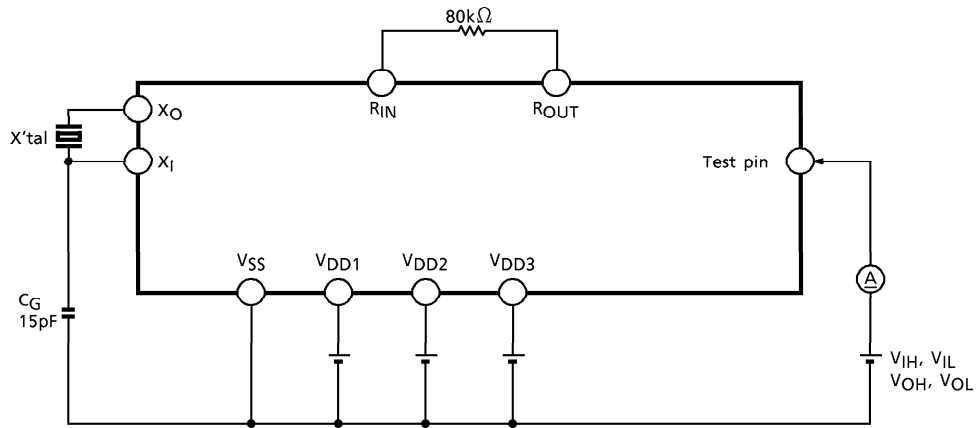
- (Note 9) Where the average value of the periodic deviation of all samples is t, and the standard deviation is  $\sigma = \sqrt{\sum (t_i - t)^2 / (n - 1)}$   
 $\Delta\epsilon C = \pm 3\sigma$

TEST CIRCUITS

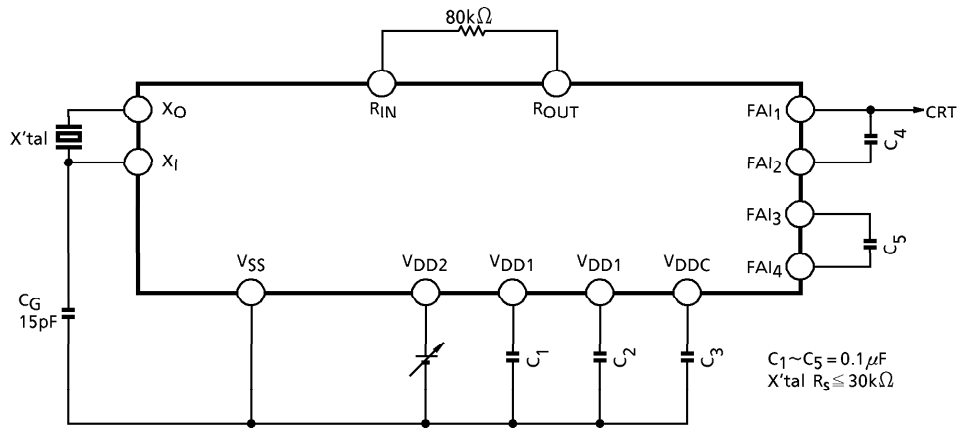
1. Current dissipation, oscillation frequency test



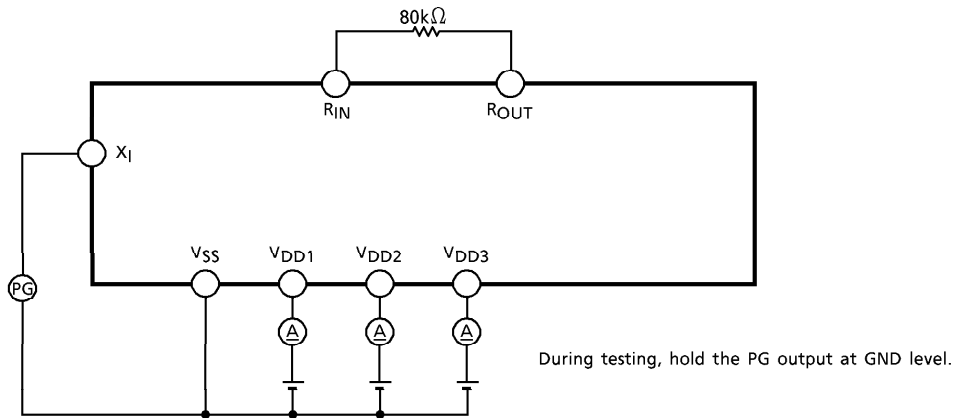
2. Input/output current test



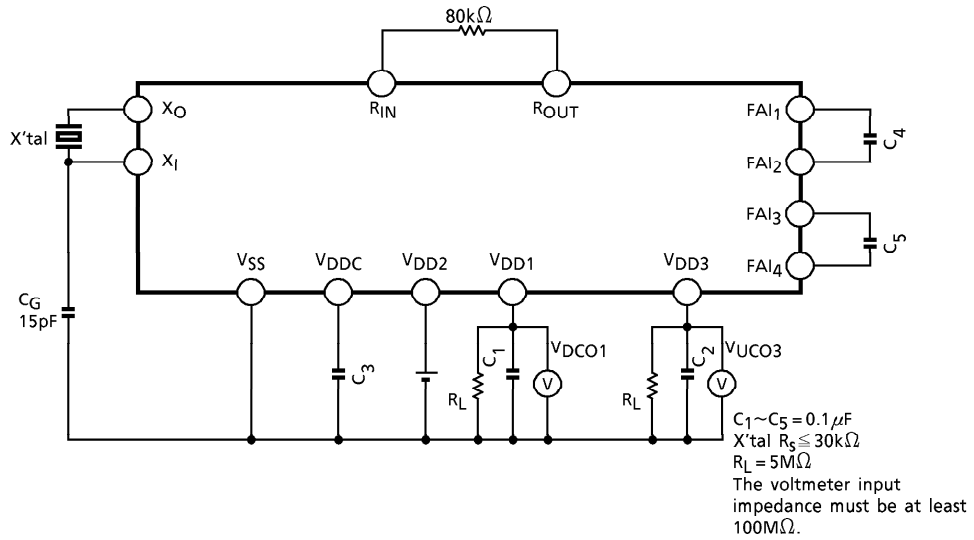
3.  $V_{STA}$ ,  $V_{HOLD}$  test



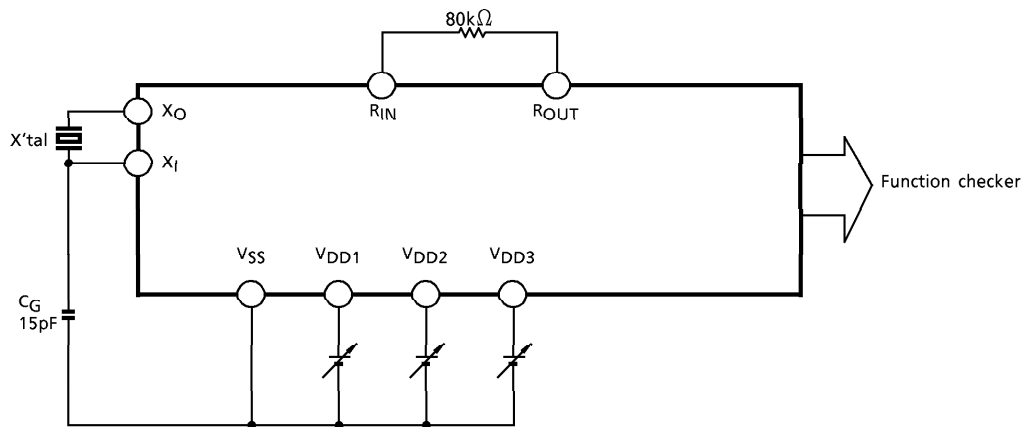
4.  $V_{DD1}$ ,  $V_{DD2}$ ,  $V_{DD3}$  system leak current tests



5.  $V_{DCO}$ ,  $V_{UCO}$  test



6.  $V_{DD1}$  system,  $V_{DD2}$  system,  $V_{DD3}$  system operating voltage range tests



APPLICATION CIRCUIT EXAMPLE

