MOS DIGITAL INTEGRATED CIRCUIT
µPD832G, µPD833G

8-CHANNEL DIGITAL LIQUID CRYSTAL DISPLAY, TIMEPIECES AND TIMER CIRCUIT WITH 4MHz OR 32kHz CRYSTAL OSCILLATOR OPERATION.

GENERAL DESCRIPTION

The µPD832G and µPD833G are CMOS LSI operating at the reference frequency of either 4.2 MHz or 32 kHz crystal oscillation, for use as multi-purpose electronic timepieces (clock & watch) and timers of 4-digit liquid crystal display type.

Composition of 8-Channel Digital Timepieces (clock & watch) and Timer

1. Standard time
2. Alarm timer
3. Snooze timer
4. Sleep timer
5. Control timer
6. Dual time
7. Stopwatch
8. Counter

FEATURES

1. Hours, minutes, seconds, AM and PM can be displayed.

2. Selection of either 12-hour or 24-hour display format is possible.

3. Instantaneous second correction is possible within an error of ±30 seconds.

4. Minutes and hours can be set independently. (at 1 pps or one push per one word step.)

5. That the tens digit of minutes, AM and PM can be set independently for alarm time (or control time) or dual time is very convenient.

6. Provided with a fine alarm tone.

7. Alarm timer offers the 4-minute duration alarm. By using the SNZ (snooze) terminal, the timer can offer the alarm every four minutes through the CANCEL-REFRESH method.

8. The trial sounding of alarm can be made.

9. The duration of control timer and sleep timer can be set in four ways at 15 minutes, 30 minutes, 60 minutes and 120 minutes.

10. The application as an multi-timer is possible with its two-phase control timer signal.

11. Since the dual time is available, it can be used as displaying second time zone or elapsed time.

12. The stopwatch can count up to 24 min.

13. The counter can count up to 1440 counts.

14. All memory sections excluding the LCD driver section with V_{SH} series (3.0 to 6.0 V) are composed of V_{SS} series. Thus, the system design is very simple with this device.

15. The source voltage for the alarm out, control out and sleep out terminals is variable from 1.5 to 6.0 V through the employment of open drain P-channel transistor.

16. (i) Standard time, dual time, and sleep timer or (ii) Standard time, stopwatch and sleep timer can be used in parallel independently.

APPLICATIONS

○ Digital alarm clock

○ Sleep timer

○ Snooze timer

○ Traveller's watch

○ Appliance timers

○ Measuring timer for the distance covered

○ Clock and watch displaying different time zone (World time)

○ Sequential controller

○ Desk timer

○ Portable timer for miscellaneous controls

TYPES

Type No.	Frequency of the crystal
µPD832G	4.194304 MHz
µPD833G	32.768 kHz

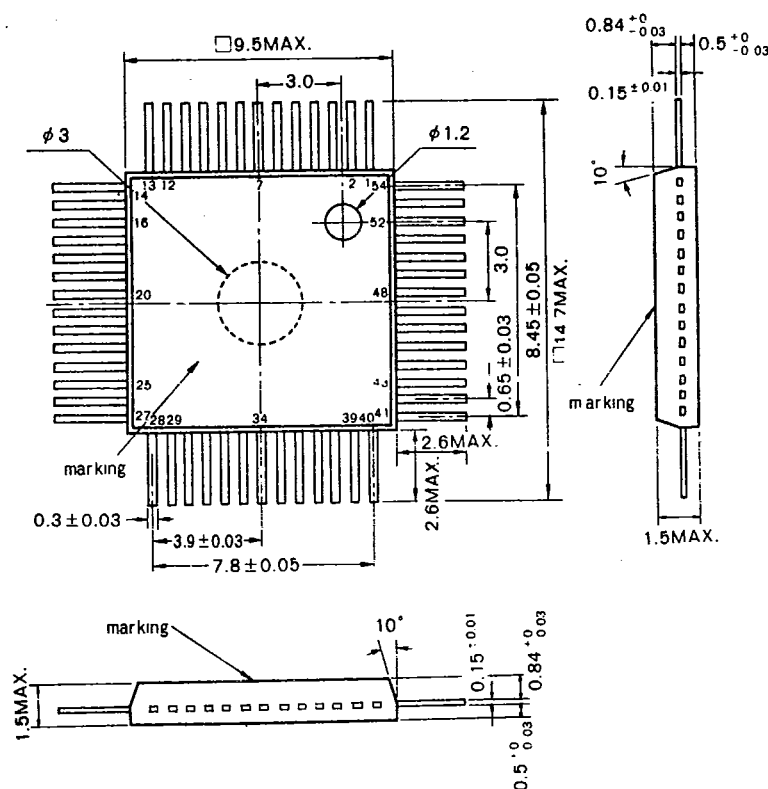## BLOCK DIAGRAM
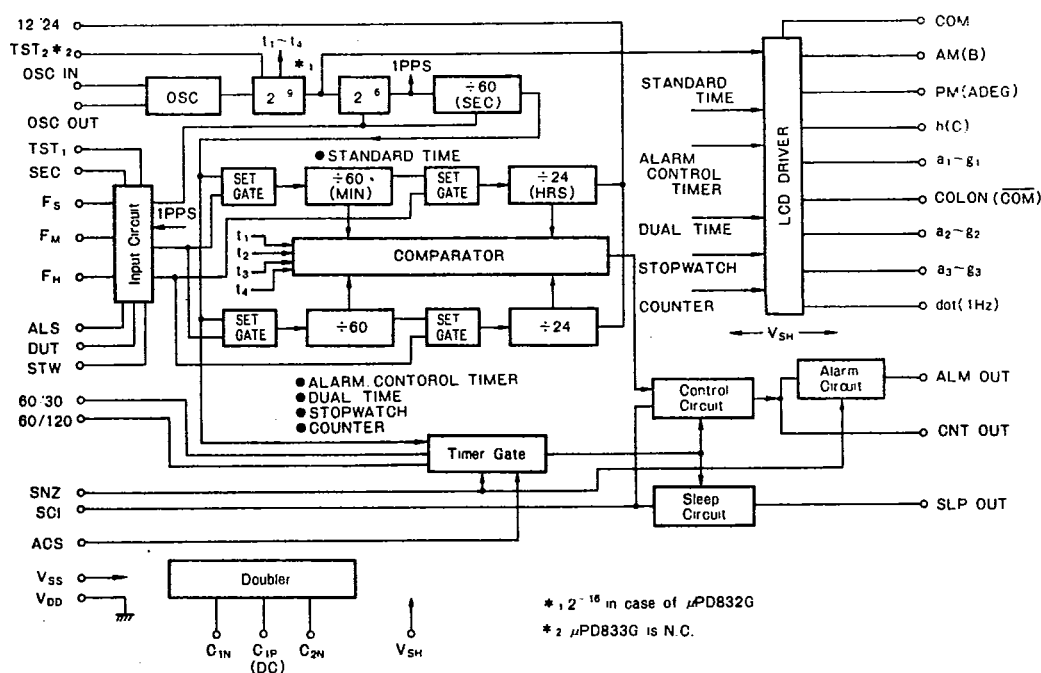
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PACKAGE DIMENSIONS (Unit: mm)

PIN CONNECTION

PIN NO.	Designation	PIN NO.	Designation
1	AM & B	28	c_3
2	g_1	29	d_3
3	f_1	30	e_3
4	a_1	31	c_2
5	b_1	32	d_2
6	g_2	33	e_2
7	f_2	34	dot(1Hz)
8	a_2	35	c_1
9	b_2	36	d_1
10	g_3	37	e_1
11	f_3	38	h & C
12	a_3	39	PM & ADEG
13	b_3	40	COM
14	CNT OUT	41	60/30
15	SLP OUT	42	60/120
16	F_S	43	V_{SS}
17	F_M	44	OSC IN
18	F_H	45	OSC OUT
19	DUT	46	V_{DD}
20	V_{DD}	47	V_{SH}
21	STW	48	COLON(COM)
22	ALS	49	C_{2N}
23	SEC	50	TST_2 *
24	SNZ	51	C_{1P} & DC
25	ACS	52	C_{IN}
26	ACI	53	TST_1
27	ALM OUT	54	12/24

CONNECTION DIAGRAM
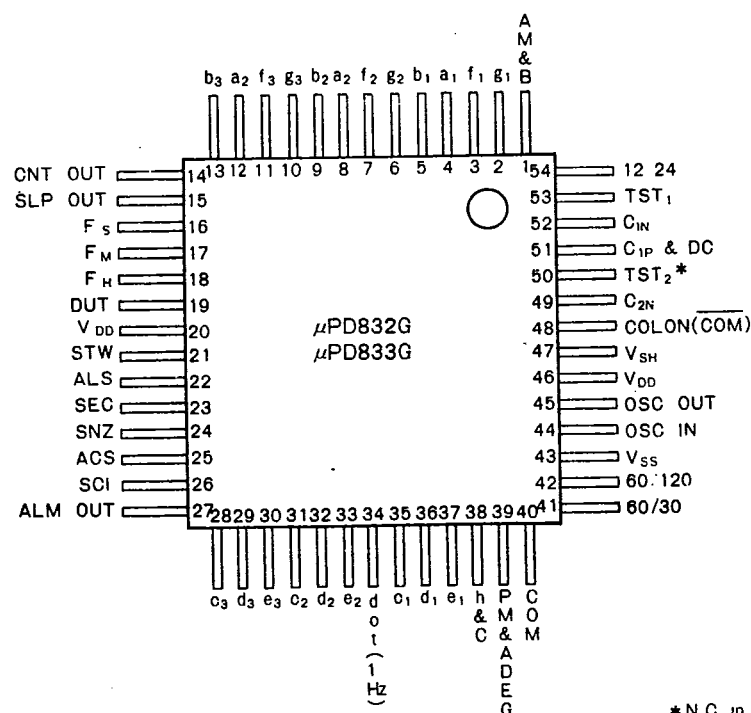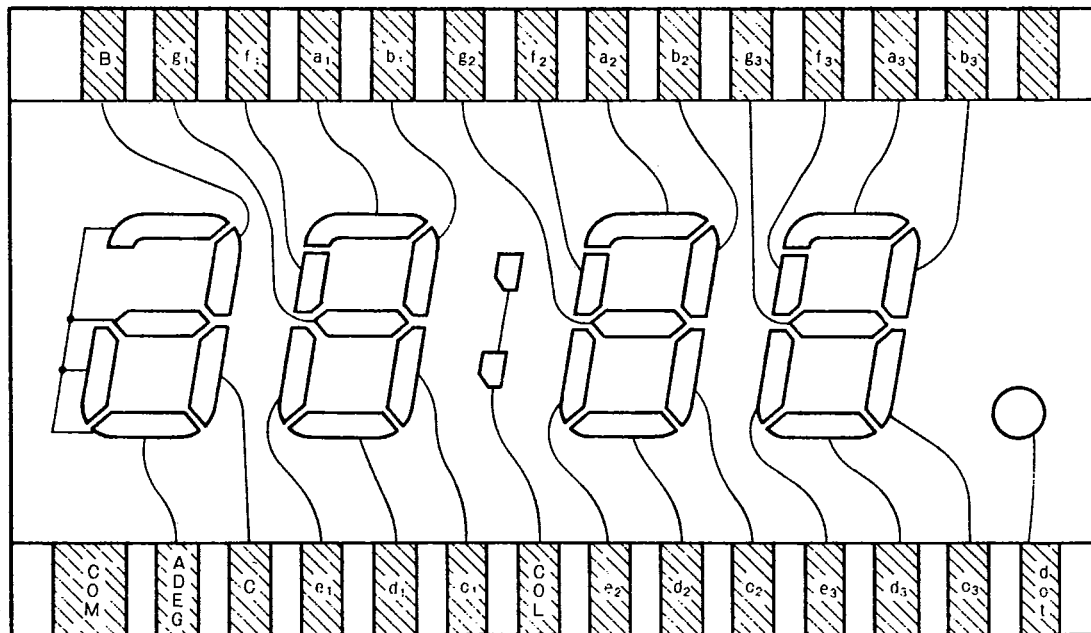

*N.C. in case of μPD833G

FIELD EFFECT LCD

12 hour display format

24 hour display format

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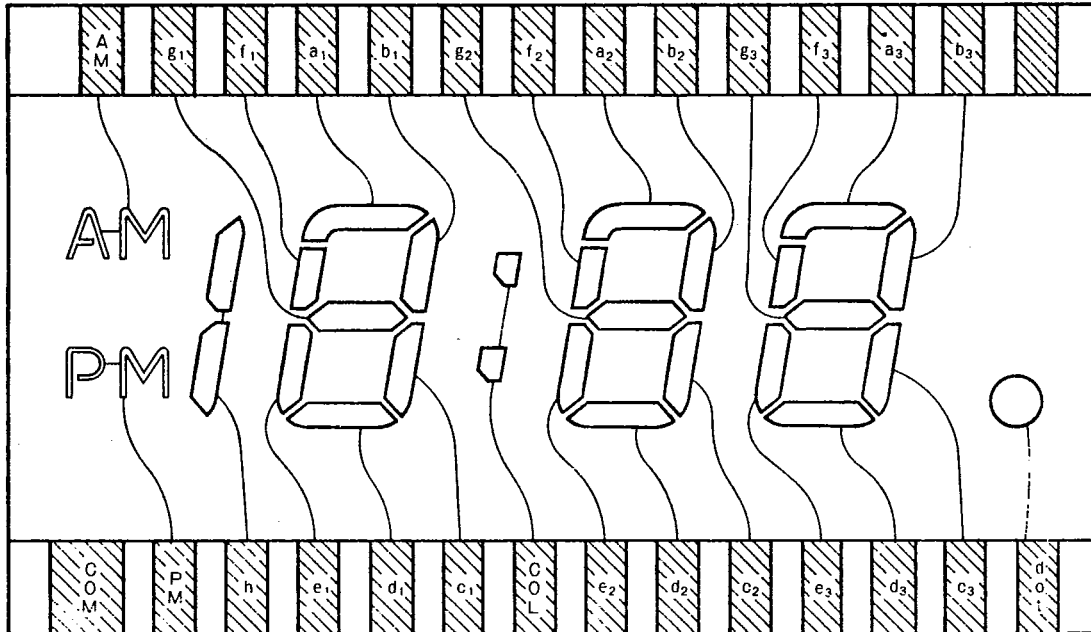
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ABSOLUTE MAXIMUM RATINGS (Ta = 25°C)

CHARACTERISTIC	SYMBOL	RATINGS	UNIT
Operating Voltage	V_{SS}	− 3.0	V
Operating Voltage	V_{SH}	− 7.0	V
Operating Temperature	Topt	−20 to +75	°C
Storage Temperature	Tstg	−40 to +125	°C

ELECTRICAL CHARACTERISTICS (Ta = 25°C)

μPD832G (f=4.194304 MHz, V_{DD}=Common, $V_{DD}-V_{SS}$=1.5 V, $C_G=C_D$=15 pF)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNIT	TEST CONDITIONS
Supply Voltage	$V_{DD}-V_{SS}$	1.2	1.5	1.9	V	Ta =−20~+75°C
Current Consumption	ISST		30	90	μA	$C_1=C_2$=0.1 μF, NO DISPLAY

μPD833G (f=32.768 kHz, V_{DD}=Common, $V_{DD} - V_{SS}$=1.5 V, C_D=5~40 pF, C_G=5~30 pF)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNIT	TEST CONDITIONS
Supply Voltage	$V_{DD}-V_{SS}$	1.1	1.5	2.0	V	Ta = −20~+75°C
Current Consumption	ISST		2.0	5.0	μA	$C_1=C_2$=0.1 μF, NO DISPLAY

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CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNIT	TEST CONDITIONS
Supply Voltage	$V_{DD}-V_{SH}$	2.2	3.0	6.5	V	Ta = −20 ~ +75°C
LCD Common Output Current	I_n & I_p	30			μA	$V_{DD}-V_{SH}$=2 V, V_{DS}=0.1 V
LCD Segment Output Current	I_n & I_p	5			μA	$V_{DD}-V_{SH}$=2 V, V_{DS}=0.1 V
DC,$\overline{DC}$ Output Current	I_n & I_p	100			μA	$V_{DD}-V_{SS}$=1.5 V, V_{DS}=0.5 V
ALARM/CONTROL/SLEEP Output Current	I_p	100			μA	$V_{DD}-V_{SS}$=1.5 V, V_{DS}=0.5 V
Doubler	V_{SHD}	3.0			V	$V_{DD}-V_{SS}$=1.55 V, RL=3 MΩ $C_1=C_2$=0.1 μF

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PULL DOWN RESISTANCES (Internally connected to −VSS)

TERMINALS	$V_{DD}-V_{SS}$	RESISTANCE	UNIT
FS	1.5 V	0.01 ~ 1.0	MΩ
FM	1.5 V	0.01 ~ 1.0	MΩ
FH	1.5 V	0.01 ~ 1.0	MΩ
SNZ	1.5 V	0.01 ~ 1.0	MΩ
ACS	1.5 V	0.01 ~ 1.0	MΩ
SCI	1.5 V	0.01 ~ 1.0	MΩ
TST	1.5 V	0.01 ~ 1.0	MΩ
DUT	1.5 V	OPEN	
STW	1.5 V	OPEN	
ALS	1.5 V	OPEN	
SEC	1.5 V	OPEN	
60/30	1.5 V	OPEN	
60/120	1.5 V	OPEN	
12/24	1.5 V	OPEN	

FUNCTIONAL DESCRIPTION

1. Segment Terminal

The frequency antiphase to 64 MHz frequency at COMMON terminal is present at the segment terminal displayed. At the segment terminal not displayed, the frequency is inphase to 64 MHz frequency at Common terminal. (Refer to Fig. 1)
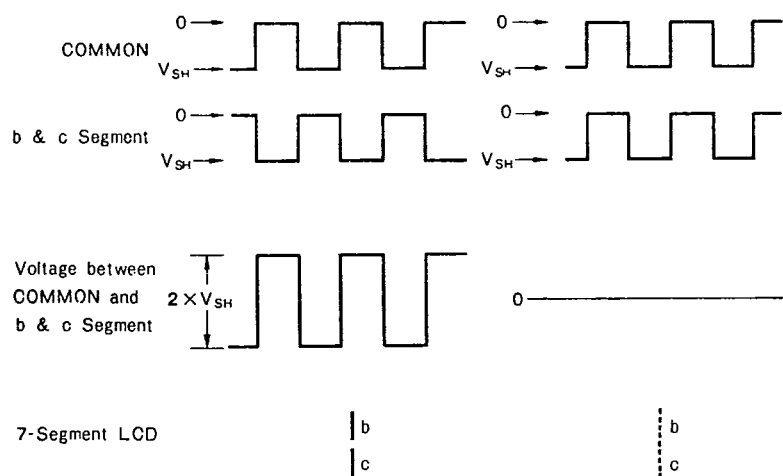
Fig. I

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2. Display Format

(1) Standard Time

DISPLAY MODE	12-Hour Format	24-Hour Format	ACTIVE terminal
① NORMAL	AM/PM 10:53 (HRS MIN)	22:53 (HRS MIN)	
② SECOND	3:26 (MIN SEC)	3:26 (MIN SEC)	S E C

(2) Memory

DISPLAY MODE	12-Hour Format	24-Hour Format	ACTIVE terminal
① ALARM / CONTROL Timer	AM/PM 2:30 (HRS MIN)	14:30 (HRS MIN)	A L S
② DUAL TIME	AM/PM 2:30 (HRS MIN)	14:30 (HRS MIN)	D U T / A L S
③ STOPWATCH	AM/PM 0:00 (MIN SEC)	0:00 (MIN SEC)	S T W / A L S
④ COUNTER	0:00 (Count)	0:00 (Count)	S T W / A L S

C means flashing dot.

● means dot "on" cont'ly.

means colon "on" cont'ly

Active Terminal: Sets the designated input terminal to V_{cc} level.

Fig.2

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3. Designation and Definition of Every Input and Output Terminal (Excluding Segment)

(1) Input Terminal

Normally every input terminal is set to the V_{SS} level (−1.5 V). An input terminal with internal pull-down resistors allow use of simple SPST switches to select the functional Mode. (Refer to the table for Pull-down resistor incorporated for input terminal.)

Therefore, when operating an input terminal, set it to the ACTIVE "H" ie V_{DD} level (0 V).

F_S (Fast Second)

The second setting terminal which, with respect to K minutes, discards the gain of 01 to 29 seconds to 00 second and carries the delay of 00 to 30 seconds to the succeeding minutes K minutes. This terminal operates instantaneously. In other words, by connecting the terminal F_S to V_{DD} in accordance with the time signal, the second is reset to "00". The second digit starts working. When the second counts "30" to "59" and F_S is connected to V_{DD} one minute and the second instantaneously return to "00". The error for this adjustment is smaller than 31 ms to K minutes 00 second.

On the other hand, when using this input terminal at V_{DD} level for an alarm/control time (ALS) or dual time (DUT, ALS), the function with respect to the setting is changed service of shifting digit to be called as F_S (Fast Shift). In other words, if the terminal F_M is connected to V_{DD} after setting the terminal F_S to V_{DD} level, only the tens of minutes is independently advanced fast at 1 pps.

When the terminal F_H is connected to V_{DD} after setting the terminal F_S to V_{DD} level, the AM or PM indication is shifted independently at 1 pps. rate. The repeated ON (at V_{DD} level)⇌OFF operation of minutes or the display of AM or PM at the speed of hand-operating.

F_M (Fast Minute)

The terminal for the setting of minutes which advances the minutes independently at 1 pps when connects to V_{DD} (later called set to ON). When this terminal is repeatedly on and off, the minutes can be advanced the speed of hand-operating.

In case of stopwatch (STW, ALS), the ON operation of this terminal resets the display to 0 min, 00 sec.

F_H (Fast Hour)

The terminal for the setting of hours which advanced the hours independently at 1 pps when set to V_{DD} level. The repeated ON-OFF operation of this switch is advanced the hours at the speed of hand's movement.

In case of stopwatch (STW, ALS), if this terminal is on, the function is shifted Start-Stop (Hold).

SNZ (SNooZe)

The SNOOZE terminal which stops the alarm tone when it is on. Alarm tone starts again after 4^{+0}_{-1} minutes after the terminal SNZ is off.

This terminal is operated on the basis of cancel-refresh method in which the alarm tone starts 3 or 4 minutes after setting the terminal to ON.

The effective period of cancel-refresh method is extended with every cancellation of alarm tone with the terminal SNZ.

On the other hand, the control output (CNT OUT) and the sleep output (SLP OUT) is not off with the on operation of SNZ terminal but, the duration of control output and sleep output is reset. Therefore, the terminal SNZ is provided with a function as snooze timer with respect to the alarm output, in addition to the above function, it has the function to extend the time interval with respect to the control output and sleep output.

ACS (Alarm Control Sleep Stop)

This terminal is used for the cancellation of the alarm, control and sleep terminals. When this terminal is on, all output the alarm, control and sleep are off immediately.

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SCI (Sleep Control Input)

This terminal is used for the sleep setting or two-phase control setting. When this terminal is on, the sleep output can be obtained from the terminal SLP OUT. In this case, the control output can be also obtained through the terminal CNT OUT. Therefore, if the control time is set after the duration of control time, the 2-phase control output can be obtained.

The SCI signal is converted into a single pulse of approximately 8-ms pulse width inside the LSI.

TST (TeST)

This terminal is used for the test. This terminal, when set to V_{DD} level, permits the high speed test of LSI in combination with the aforementioned terminals F_S, F_M and F_H set to ON.

All of above-mentioned input terminals has their own built-in resistor for the prevention of floating.

DUT (DUal Time)

This terminal is used to set the dual time and normally set to V_{DD} level. Moreover, when the terminal ALS in on, the display of dual time can be observed. Thus, this terminal is operated in combination with the terminal F_S, F_M and F_H to form a world timer (dual zone time) r timer to be used for the measurement of elapsed time.

STW (STop Watch)

This terminal is used to set the stopwatch and is normally set to V_{DD} level. With the terminal ALS set to ON, the display of a stopwatch is available. Thus, this terminal is on in combination with the F_M and F_H terminals.

ALS (Alarm controL Set)

This terminal is used for the alarm or control setting. When this terminal is on, the hours subjected to the alarm tone and control operation can be displayed. This terminal is used in combination with the terminals F_S, F_M and F_H.

On the other hand, if this terminal is used with the DUT terminal, the dual time can be set. This terminal can be used to set a stopwatch when operated in combination with the STW terminal (Refer to Fig. 2.)

SEC (SECond)

This terminal is used to set the seconds. When this terminal is on, the seconds of the standard time can be displayed.

60/30 (60 minutes/30 minutes)

This terminal is used for the switching over between 60-minutes duration and 30-minutes duration to set the duration of control or sleep signal. This terminal is normally set to V_{SS} level (−1.5 V) for the 60-minutes duration. When this terminal is connected to V_{DD}, the time interval is changed to 30 minutes. The 60-minutes duration is exactly the time interval of up to 64-minutes and the 30-minutes duration is exactly 32-minutes duration.

60/120 (60 minutes/120 minutes)

This terminal is used for the switching over between 60-minutes duration and 120-minutes duration to set the duration of control or sleep signal. This terminal is normally set to V_{SS} level (−1.5 V) for 60-minutes duration. When this terminal is connected to V_{DD}, the time interval is change to 120 minutes (exactly to 128 minutes). When both terminals 60/30 and 60/120 are connected to V_{DD}, the 15-minutes duration can be obtained. This is exactly the time interval of up to 16-minutes.

12/24 (12 hours/24 hours)

This terminal is used for the switching over between 12-hour indication and 24-hour indication to set the standard time, alarm timer and control timer. This terminal is also used to determine the switching over of the hour display format of dual time. This terminal is normally set to V_{SS} level (-1.5 V) for 12-hour indication. When this terminal is connected to V_{DD}, the indication is shifted to 24-hour.

* Since the above-mentioned input terminals (DUT-12/24) are open ones, be sure to set the signal pole double throw switches (snap switches).

When single pole single throw pushbutton switches are used, be sure to insert the pull-down resistor into every terminal. In this case, note that if every terminal is connected to V_{DD}, the current at (1.5 (V)/Rpd(MΩ)) A is present in accordance with Ohm's law from $V_{DD} - V_{SS} = 1.5$ V and pull-down resistance Rpd.

The pull-down resistance Rpd should be determined on the basis of the grounding capacity of clocks or watches and the capacity of battery.

(2) Output Terminal

Every output terminal is provided with P channel open drain transistor.

CNT OUT (CoNTrol Out)

This is the control output terminal and is set to V_{DD} level (0 V) when it is on. The selection of one of four durations, 15-minute, 30-minute, 60-minute and 120-minute is possible as explained before.

SLP OUT (SLeeP Out)

This is the sleep output terminal and is set to V_{DD} level (0 V) when it is on. The selection of one of four durations, 15-minute, 30-minute, 60-minute and 120-minute is possible as explained above.

ALM OUT (ALarM Out)

This is the alarm output terminal. When it is on, 2,048 kHz signal modulated by 8 Hz frequency is produced every other second. The alarm signal stops automatically after four minutes from the beginning.

However, if the terminal SNZ (snooze) is on, the alarm signal stops immediately. Then, the alarm signal starts again after 4^{+0}_{-1} minutes from the disconnection of the terminal SNZ. This operation is called Cancel-Refresh system.

4. Power Supply Circuit

The integral parts (memory and control circuits) of this LSI is composed of the components of V_{SS} system. The V_{SS} system supplies $V_{DD} - V_{SS} = 1.5$ V. The V_{SH} system for the liquid crystal driver voltage supplies $V_{DD} - V_{SH} = 2.2 \sim 6.5$ V. The LSI is provided with voltage doubler circuit in its inside.

The application of those circuits are as follows:

○ Voltage Doubler Circuit

To establish the voltage doubler circuit, connect the capacitor C_1 between the terminals C_{1N} and C_{1P} and the capacitor C_2 between the terminals C_{2N} and V_{DD}. Then, the voltage approximately twice as large as $V_{DD} - V_{SS} = 1.5$ V is present at the C_{2N} terminal.

Finally, connect the terminals C_{2N} and V_{SH}.

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* Capacitors C_1, C_2 are of 0.1 to 0.68 µF with small leak and of favorable temperature characteristics. The liquid crystal driver voltage (C_{2N}) from the voltage doubler circuit permits the direct operation of liquid crystal whose letter height is up to approximately 1 inch (2.54 cm).

It can be introduced another supply voltage (2.2 ~ 6.5 V) into V_{SH}.

5. Oscillator Circuit

This oscillator circuit has its built-in feedback bias resistor.

In case of µPD833G connect the quartz oscillator of the particular frequency of 32.768 kHz between the terminals OSC IN and OSC OUT. Connect OSC IN to V_{DD} or V_{SS} through capacitor C_G (5~30 pF) and OSC OUT to V_{DD} or V_{SS} through capacitor C_D (20~40 pF). Although the temperature characteristics and voltage drop characteristics differ with the type of quartz oscillator they are favorable with exact oscillator frequency of 32.768 kHz when C_G is between the values CD/5 and CD/2.

In case of µPD832G connect the quartz oscillator of particular frequency of 4.194304 MHz between the terminals OSC IN and OSC OUT. Then, connect OSC IN and V_{DD} through C_G and OSC OUT and V_{DD} or V_{SS} through C_D. ($C_G = C_D = 10$ to 20 pF)

Quartz oscillators of around 4 MHz frequency are of AT cut with favorable temperature characteristics.

6. Operation of each Terminal

6-1. Standard Time

1. Indication

With each input terminal set to V_{SS} level, the normal display is made on the standard time as shown in Fig. 2, (1), ①. The indication is for hours and minutes, and AM and PM are displayed for 12-hour indication.

When the display of seconds is required, connects the terminal SEC to V_{DD} (later this operation is referred simply to "on"). Then, the units digit of minutes and seconds can be obtained as shown in Fig. 2, (1), ②. To reset the display of seconds, set the terminal SEC to OFF.

2. Setting of Time

To set the time, use the terminals F_S, F_M and F_H. Normally the standard time is set to the present time. First, set seconds with the terminal F_S. When the gain is between 01 to 29 seconds, it is discarded to 00 seconds through the ON operation of F_S terminal and when the indication is between 30 to 59 seconds (delay in 01 to 30 seconds), it is set to be added one minute, and to 00 second. Then the second digit starts working immediately.

The accuracy in setting the time is within ±31 ms excluding the error in hand-operating. The correction of seconds is applicable to the normal display (Fig. 2, (1), ①) and the second display (Fig. 2, (1), ②). The correction of seconds is not applicable to the displays other than above.

Next, set minutes with the terminal F_M. While the minutes are set, the overflown seconds are carried to minutes, but the overflown minutes are not carried to hours.

Last, set hours with the terminal F_H. While hours are set, overflown minutes are carried to hours. Only in case of 12-hour indication, overflown hours are shifted from AM to PM and vice versa. From both the terminals F_M and F_H, when kept on, the advancing signal is sent at 1 pps. But the repeated ON-OFF operation of those terminals offers setting of hours and minutes at the speed of hand-operating.

The setting of minutes and hours is effective for the normal display (Fig. 2, (1), ①), and no setting of minutes and hours is applicable for the displays other than above.

* In case of using the quartz as an oscillator signal frequency source, the loss/gain at normal temperature range is within ±0.1 to ±0.5 seconds a day. Therefoe, the standard time is convenient for use through the instantaneous operation of the terminal F_S to make the correction.

The terminals F_S, F_M and F_H should usually be in non-sensitive status for the displays for minutes and seconds (Fig 2, (1), ⓘ and ⓘⓘ).

6—2. Alarm Timer

6—3. Control Timer

1. Display

With every input terminal set to the V_{SS} level, the memory offers the operation of alarm timer or control timer.

When setting the alarm time or control time for an electronic instrument, set the terminal ALS ON. Then the alarm or control time (Fig. 2, (2), ⓘ) is displayed even if represented the standard time (Fig. 2, (1), ⓘ and ⓘⓘ).

* Note that alarm time and control time are displayed in same way.

2. How to set the alarm time (or control time)

To set the alarm (or control) time, first set the terminal ALS on. Then, with the terminals F_M, F_H and F_S, set the alarm time (or control time), to obtain the display of alarm or control time as shown in Fig. 2, (2), ⓘ. accoriding to same methods to set the present time.

2.1 Setting of minutes

① With the terminal F_M set to ON, the minutes can be automatically set to the desired figures at 1 pps. If you are required to set it faster, repeat the ON-OFF operation of the terminal F_M. Then, minutes can be set at the speed of hand-operating. (one push one word method).

As shown in the Fig. 3, the minutes are not to be carried to hours when minutes are overflown.
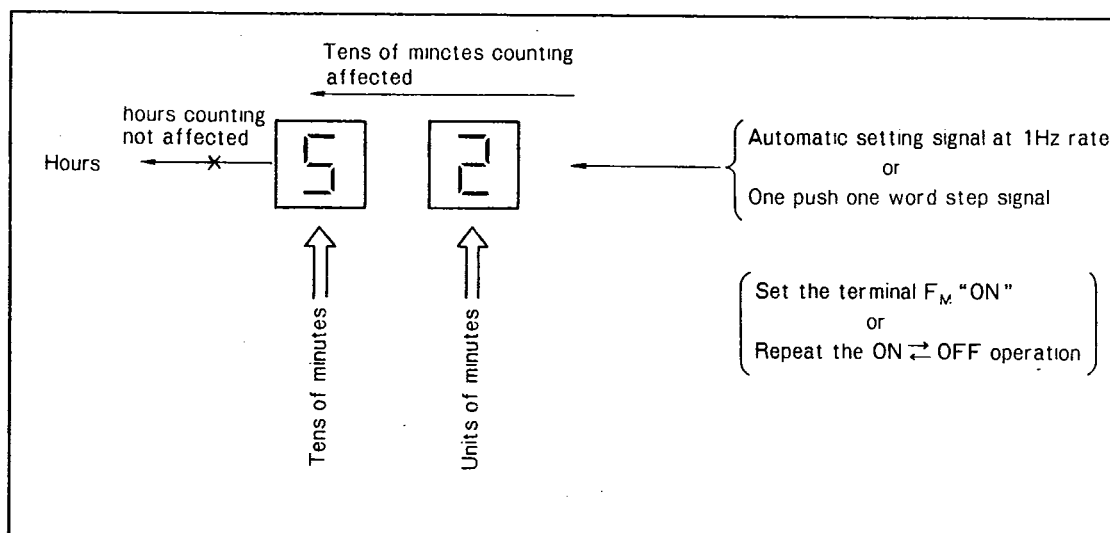

Fig.3

② When you are required to set the minutes faster, proceed with the following steps.

First, set the terminal F_S on, and set the terminal F_M on. Then, the tens digit of minutes can be set at 1 pps. Thus, the tens digit of minute can be set faster.

If you want to set minutes faster than above, keep the terminal F_S set to on, and repeat ON-OFF

operation of the F_M terminal. Then, the tens digit of minutes can be set at the speed of hand-operating. As shown in the Fig. 4, the display of minutes is not to be carried to hour when the minutes are over-flown.
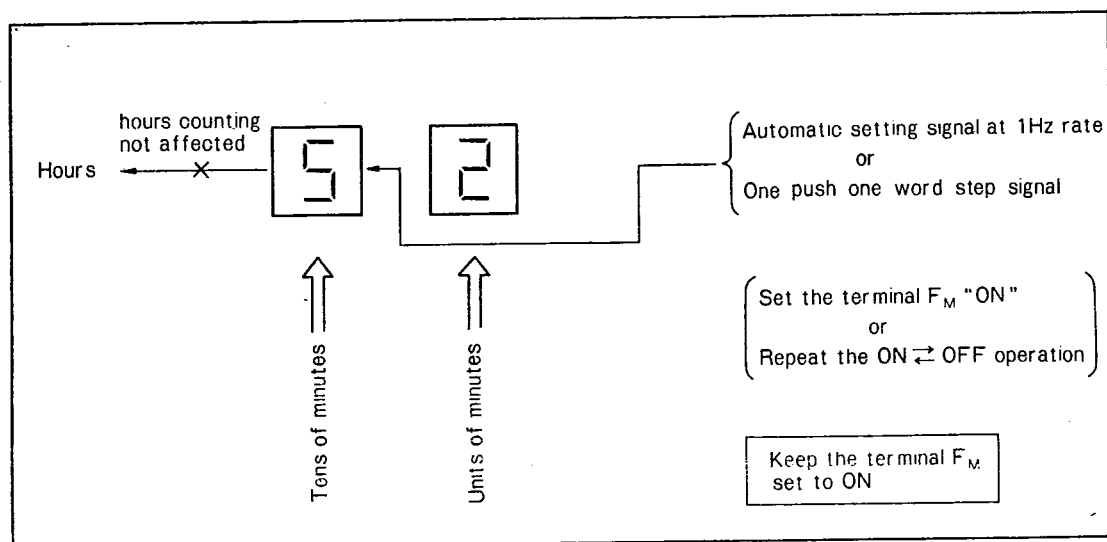

Fig.4

* Let us give an explanation of how to set minutes. Presuppose the display of minutes is 52. And you want to correct it to 41. First following the method 1 above, set the units digit to 1. In this case, the units digit is carried to tens digit due to the overflowing of the untis digit. This can be ignored. Then, set tens digit to 4. According to this method 2, the automatic setting at 1 pps completes within 14 seconds in case where there is no erroneous setting. The setting of minutes with one push one word signal completes within four seconds.

2.2   How to set Hours

① Set the terminal F_H on, then, the setting can be made to the desired figures at 1 pps.
   When you are required to set hours faster, repeat the ON-OFF operation of the terminal F_H. Then, hours can be set at the speed of hand-operating. Refer to the Fig. 5.
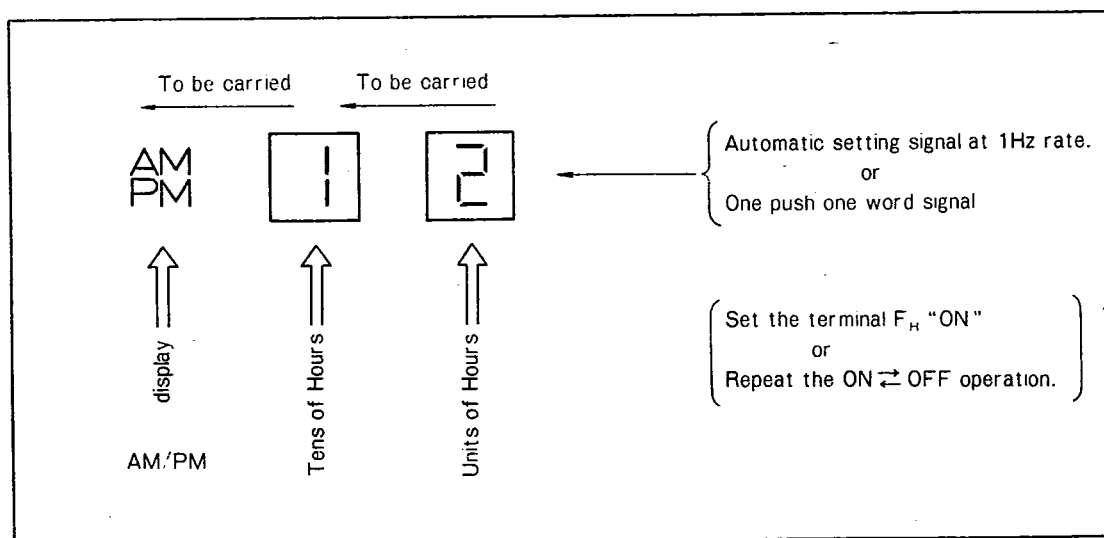

Fig.5

* The shifting of AM to PM and vice versa is made at 12 hours for the 12-hour indication.

② If you want to set hours faster for 12-hour indication, proceed with the following methods.
First, set the terminal F$_S$ on and the terminal F$_H$ on. Then, the AM/PM display can be set automatically at 1 pps. In other words, is shifted to PM and vice versa automatically.
If you are required to set AM/PM display faster than above, repeat the ON-OFF operation of the F$_M$ terminal set to ON. Then, AM/PM display can be set at the speed of hand-operating.
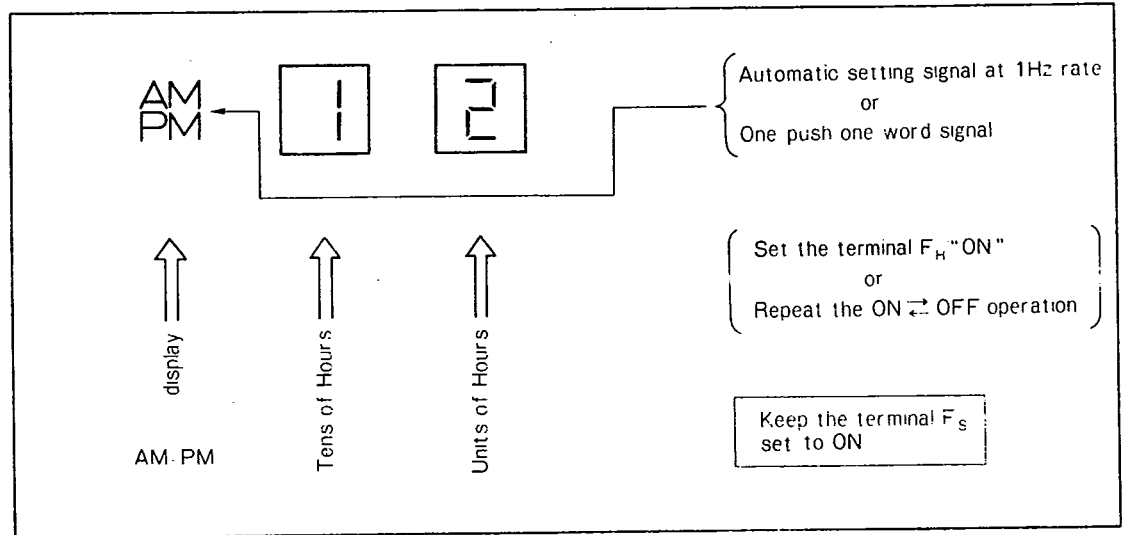Refer to the Fig. 6.

Fig.6

* An example of the setting of hours is given below for 12-hour indication.
Presuppose the display of hours is AM 11 and you want to correct it to AM 10. Fist, make the setting so that the display of hours becomes 10 in accordance with method 1 above. In this case, the display AM is shifted to FM with the overflown hours. This can be neglected. Then, set the display to AM in accordance with method 2 above. Through this operation with automatic setting signal at 1 pps, hours can be set within 13 seconds, in case where there is no erroneous setting. With the one push one word signal, hours can be set to the desired figure within 3 seconds.
As explained above, the setting of alarm time or control time for an electronic instrument requires only 7 seconds to complete even in the case of the longest set span.

3. Relationship between Ordinary Expression of Time and Expression of Time for μPD832G Series

The time can be displayed with μPD832G series either by 22-hour indication or by 24-hour indication. Table 1 shows the relationship between ordinary expression of time and expressions of times in 1-hour indication and 24-hour indication of μPD832G series.

Relationship between ordinary expression of time and
Expressions of times in 12-hour and 24 hour Indication

Ordinary expression of time	Forenoon	Afternoon
12 hours format	12 : 00AM~11 : 59AM	12 : 00PM~11 : 59PM
24 hours format	0 : 00 ~11 : 59	12 : 00 ~23 : 59

Ordinary expression of time	Twelve O'clock midnight	One O'clock in the morning	Two O'clock in the morning		Eleven O'clock in the morning	Twelve noon
12 hours format	12 : 00AM	1 : 00AM	2 : 00AM		11 : 00AM	12 : 00PM
24 hours format	0 : 00	1 : 00	2 : 00		11 : 00	12 : 00

One O'clock in the afternoon	Two O'clock in the afternoon	Three O'clock in the afternoon	Eight O'clock in the afternoon	Eleven O'clock in the afternoon	Twelve O'clock midnight
1 : 00PM	2 : 00PM	3 : 00PM	8 : 00PM	11 : 00PM	12 : 00AM
13 : 00	14 : 00	15 : 00	20 : 00	23 : 00	0 : 00

Table. I

4 Trial Sounding of Alarm Tone

Since the alarm time is set in accordance with methods 1 through 3 above, the alarm tone begins to be generated immediately from the terminal ALM OUT when the display corresponds to the present time of standard time in the course of setting of the hours with the terminals F_M, F_H and F_S. At this time, control signal (V_{DD} level) is also present at the CONT OUT terminal. But, in the course of further setting, if the display is deviated from the present time, the alarm tone stops sounding, and, at the same the control signal is also off.

On the contrary, with alarm time (or control time) fixed, if the standard time is set through the operation of the terminals F_M, F_H and F_S, the alarm tone begins to sound when the display corresponds to the alarm time fixed, and stops sounding when the display deviates from the alarm time fixed. This operation can be applied also to the control signal.

Such sounding of alarm tone as explained above may be called a very convinient trial sound of alarm.

* In other words, when the alarm is generated (at the same time, the control signal is also generated,) the alarm output (or control signal output) can be cancelled before the duration ends through the ON operation of the terminal F_M or F_H.

The cancellation of alarm tone is effective with the terminals F_M and F_H of either standard time or alarm timer.

The terminals F_S can generate alarm tone (or control signal) when the two hours correspond, but can not cancell the alarm tone (or control signal). There are the cases where the alarm tone (or control signal is off at the end of the duration brought by the carried minutes display when the time is between 30 and 50 minutes.

5. Setting of Alarm Time (or Control Time)

The alarm time (or control time) can be set to the any hours at an interval of one minute (resolusion: 1 minute). Once the alarm time is set, the alarm tone (or control signal) can be obtained every 24 hours at the preset time.

6. Durations of Alarm Tone or Control Signal

When the time of the alarm tone (or control signal) corresponds to the hours of standard time, the alarm tone of 2048 Hz frequency modulated by 8 Hz frequency is emitted every other second. The duration of alarm tone is 4 minutes. The alarm tone stops automatically at the end of duration and starts again at the same hours after 24 hours. The output waveform of the alarm tone is shown in Fig. 7.
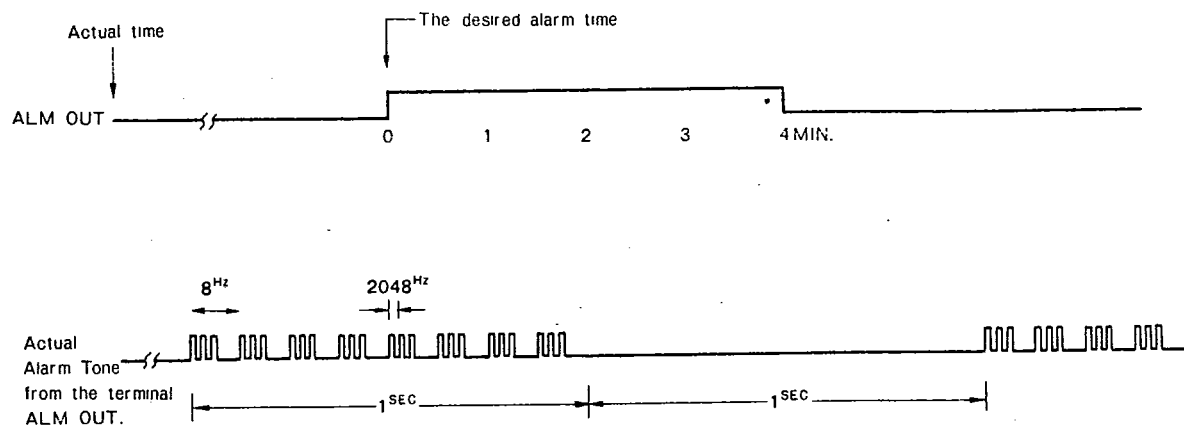
Fig.7

On the other hand, the control signal is present at the terminal CNT OUT. As shown in Table 2, there are four types of control duration, 16-minute, 32-minute, 64-minute and 128-minutes-durations. One of the four control durations can be selected in combination with the input terminals 60/30 and 60/120. Therefore, with those control signals, the recording is possible for 15-minute audio cassette tape to 2-hour video tape.

Terminal 60/30	L	H	L	H
Terminal 120/30	L	L	H	H
Duration (MIN)	64	32	128	16

L = V$_{SS}$ level

H = V$_{DD}$ level

Table 2

The relationship between the output waveforms at the ALM OUT and CONT OUT is shown in Fig. 8. In this case, the terminal SNZ is not operated. When the duration of control signal ends, the control signal stops and does not start again until the pre-set time reaches after 24 hours.
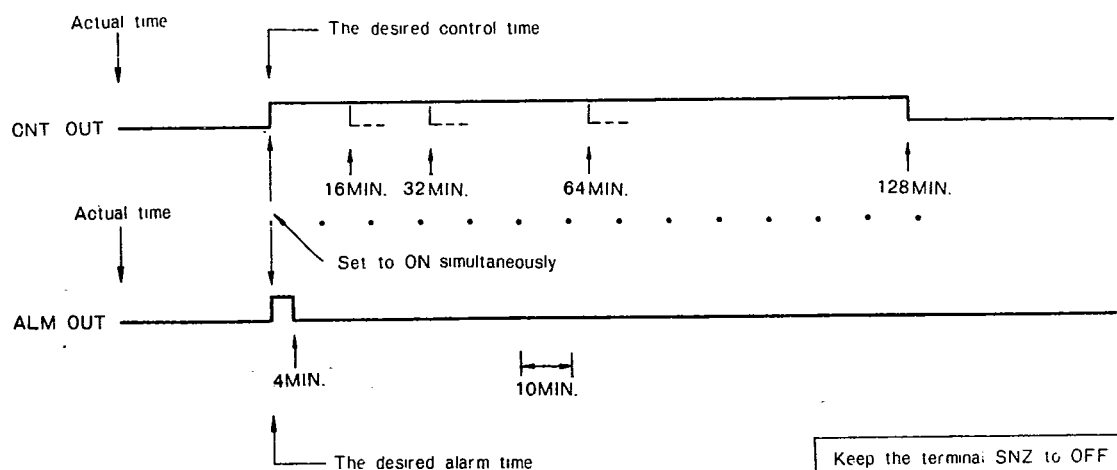

Keep the terminal SNZ to OFF

Fig.8

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7. Relationship between SNZ Terminal and Alarm Tone (Control Signal)

When the hours of standard time corresponds to the pre-set hours for the alarm time, the alarm tone (or control signal) is generated. The alarm is automatically off in four minutes. The control signal is off at the end of pre-set duration (15 minutes, 30 minutes, 60 minutes and 120 minutes). If you want to take a snooze while the alarm tone is on, set the terminal SNZ to on, then, the alarm is simultaneously off. The alarm tone is on again after 4^{+0}_{-1} minutes from the OFF operation of the terminal SNZ. The operation of the terminal SNZ to stop the alarm tone and start it again three or four minutes later as explained above is referred to as the cancel-refresh method.

The duration of cancel-refresh operation of alarm tone is extended every terminal SNZ operation. Even though the cancel-refresh method is employed, the alarm tone is not on again if it is lasts fully for four minutes.

The cancel-refresh method is to be applied to the protable alarm timer (or traveller's watch) with its built-in μPD832G series which is expected to be commercialized in feature for the purpose of preventing the battery from discharging uselessly while the user keeps the timer away, levaing it on.

The relationship in operation between the terminals ALM OUT and SNZ is shown in Fig. 9.
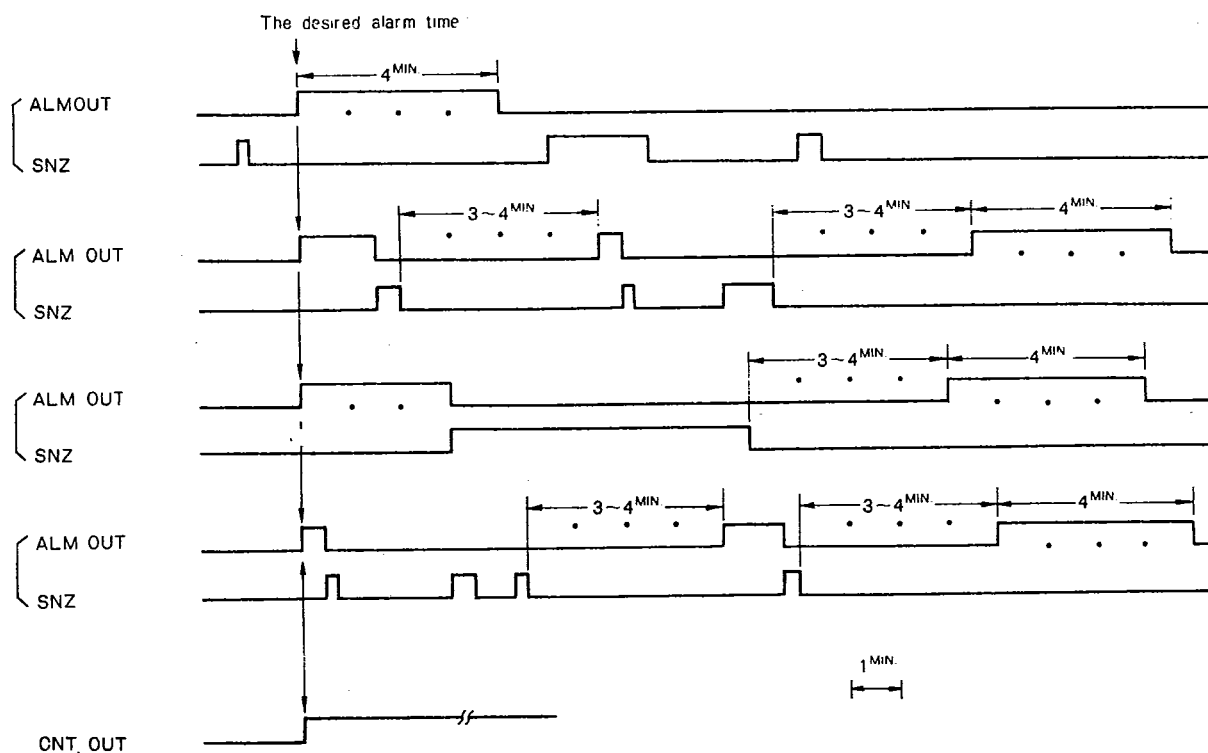

Fig 9. Relationship in operation between
the terminals ALM OUT and SNZ.

Even though the control signal from the terminal CNT OUT is not off through the ON operation of the terminal SNZ, the duration of control-signal is extended. In other words, the ON operation of the terminal SNZ resets the duration circuit for the control signal. From the instance the terminal SNZ is off, the counting of control signal duration starts. The counting is effective up to 16^{+0}_{-1} minutes for the 15-minute duration, 32^{+0}_{-1} minutes for the 30-minute duration, 64^{+0}_{-1} minutes for the 60-minute duration and 128^{+0}_{-1} minutes for the 120-minute duration.

Fig. 10 shows the relationship in operation between the terminals CNT OUT and SNZ on the basis of 32-minute duration. As can be understood from the figure, the duration of control signal can be extended through the ON operation of the terminal SNZ.
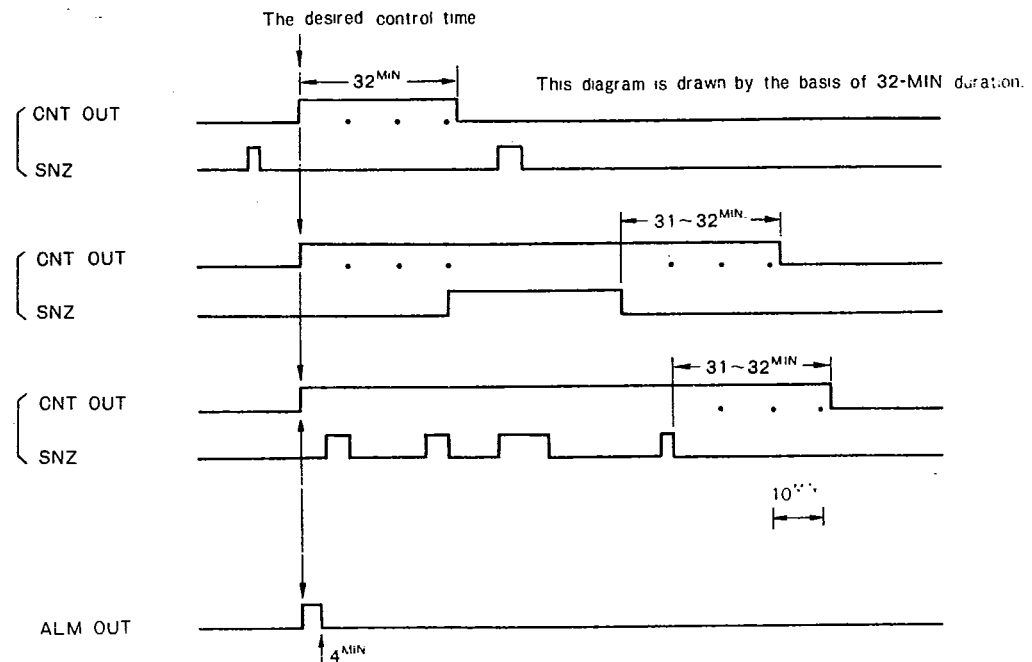
The desired control time

Fig. 10. Relationship in between the terminals
CNT OUT and SNZ.

8. Stopping the Alarm Tone (or Control Signal)

When you need to stop and clear the alarm tone (or control signal) completely, set the terminal ACS to ON.

If the terminal ACS is off after clearing the alarm tone (or control signal), it is on again at the pre-set hours after 24 hours.

* If the alarm tone (or control signal) is not required every 24 hours, proceed with the following steps.

1. Disconnect the terminal ALM OUT from the alarm tone source.

2. Set the volume of alarm tone to the minimum.

3. Disconnect the terminal CNT OUT from the controlled electronic instrument.

4. Keep the terminal DUT set to V_{DD} level.
    .... In this case, the memory operates as dual time.

5. Keep the terminal STW set to V_{DD} level.
    .... In this case, the memory operates as stopwatch.

* While the sleep timer is in use, the alarm timer can not be used. (In this time, the control signal is also on from the terminal CNT OUT.) In other words, while the sleep timer is in operation, the alarm timer does not emit the alarm tone even though the pre-set time corresponds to present hours.

6—4. Snooze Timer

When you want to take a snooze a little longer after the alarm tone starts, set the terminal SNZ to ON. Then, you can take a snooze for three to four minutes.

In addition to the application and operation previously explained in the preceeding paragraph for the alarm timer, the snooze timer is applicable to the follwings.

By making the oscillator frequency programable with µPD833G a notifying tone (or calling bell) can be produced at a regular interval. When the notifying tone is heard, set the terminal

SNZ ON and OFF.

The main oscillator signal frequencies and duration of notifying tone are as shown in Table below.

Oscillator Frequency	Interval of Notifying Tone	Pulse at ALM OUT Terminal
65.536 kHz	Every 2 minutes	8-burst pulse every 0.5 Sec
32.768 kHz	Every 4 minutes	8-burst pulse every other Sec
16.384 kHz	Every 8 minutes	8-burst pulse every2.0 Sec
8.192 kHz	Every 16 minutes	8-burst pulse every 4.0 Sec
4.906 kHz	Every 32 minutes	8-burst pulse every 8.0 Sec
2.048 kHz	Every 53 minutes (Approx. 1 hrs.)	8-burst pulse every 16 Sec
1.024 kHz	Every 128 minutes (Approx. 2 hrs.)	8-burst pulse every 32 Sec
512 kHz	Every 256 minutes (Approx. 4 hrs.)	8-burst pulse every 64 Sec
256 Hz	Every 512 minutes (Approx. 8.5 hrs.)	8-burst pulse every 128 Sec
.	.	.
.	.	.
.	.	.
.	.	.

Be sure to set the terminal SNZ ON and OFF. Then, the notifying tone stops immediately. In this case, the notifying tone can be heard again after the specified interval. (In case of 1.024 signal frequency, the notifying tone is heard again after two hours.)

The snooze timer is effective for use as a timer to notify such regular interval of hours as required for the application of drops to a patient, the sackling of an infant, the medication to a patient, etc.

6—5. Sleep Timer

The sleep timer offers such conveniecnes that the user can sleep listening in mood music or classic music, or appreciating a theatrical performance through the radio or television.

1. How to set Sleep Timer

To set the sleep timer, connect the terminal SLP OUT to such electronic instrument as television, radio, etc. Then, switch the electronic instrument on. Next, set the terminal SCI to ON. The sleep timer automatically controls the electronic instrument at the end of pre-set duration (15 minutes, 30 minutes, 60 minutes or 120 minutes).

Even though the terminal SCI is kept to ON, the SCI signal inside the LSI is driven by the single pulse of approximately 8-ms width. Thus, the button switch (single pole single through switch) should be used. The duration is similar to that of control signal. When determining the duration, use the 60/30 and 60/120 terminals as shown in Table 3.

Terminal 60/30	L	H	L	H
Terminal 60/120	L	L	H	H
Duration with the use of the terminal SCI (MIN)	63~64	31~32	127~128	15~16

Table 3.

L = V$_{SS}$ level

H = V$_{DD}$ level

The available durations ranging from 15 to 120 minutes offers the conveniences so much to the users.

The sleep timer has the priority in setting the hours over the alarm timer. Thus, the alarm tone stops immediately after the ON operation of the terminal SCI, and the sleep signal is emitted instead from the terminal SLP OUT. At the same time, the control signal (one phase control signal) is emitted from the terminal CNT OUT. Refer to Fig. 11 for the time chart of the signals to be emitted.
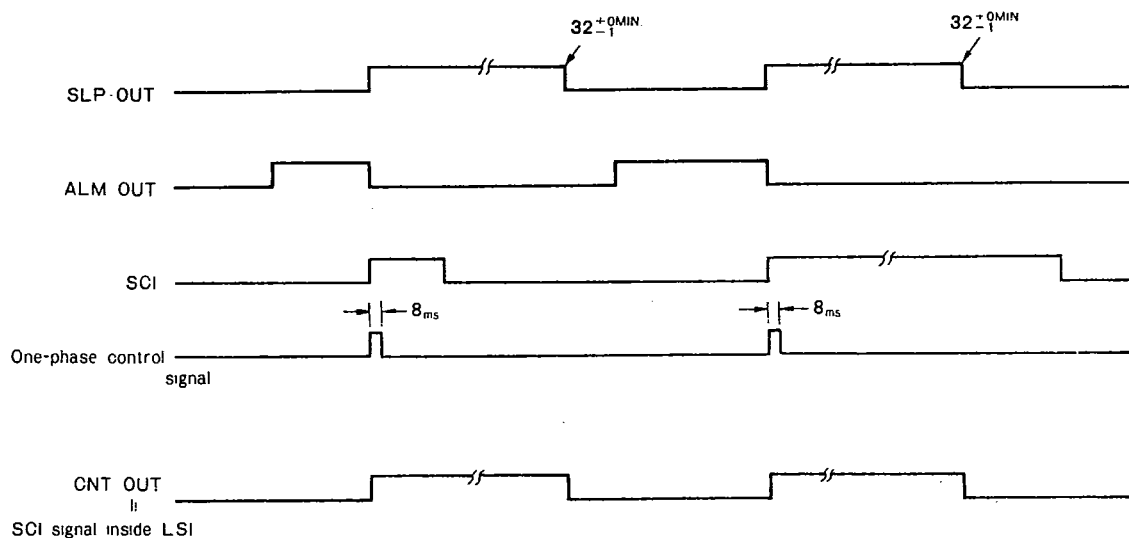

This diagram is drawn by the basis of 32MIN duaration

Fig. 11

If you want to stop and clear the sleep timer completely, during the application, set the terminal ACS to ON.

* The sleep timer has no display for the lapse of hours. If the memory is set so that the time is used as dual time or stopwatch and let it start counting instanteneously after the terminal SCI is on, the lapse of hours can be displayed for the sleep timer.

* When the alarm timer is used, it should be set to the time one minute or more later than the end of duration for the sleep timer. Then, the sleep timer and alarm timer can be set together.

* When the alarm timer is set to a certain hours in the duration of sleep timer, if the standard time corresponds to the alarm time, the alarm is not on until it reaches again at same hours after 24 hours. The sleep timer does not operate, unless the terminal SCI is set to ON, whenever using the sleep timer.

* The sleep timer is effective, when the memory is not used as alarm timer (or control timer for electronic instrument), as dual timer (with the terminal DUT set to V_{DD} level) or stopwatch (with the terminal STW set to V_{DD} level). In other words, the sleep timer can be used as independent 3-channel timer in parallel with the combinations of 1 standard time, dual timer and sleep timer, and 2 standard time, stopwatch and sleep timer.

2.   Applications of Sleep Timer

In addition to its proper applications as sleep timer, it can be used for slot machines to determine the duration of service with the coin or the equivalent in shape. Among those slot machines are massaging machine, cooler, gas range, game machine, telescope, etc. of coin timer type.

3.   Relationship between Terminal SNZ and Sleep Signal

The ON operation of the terminal SNZ does not disconnect the sleep signal, but it extends its duration. In other words, the ON operation of the terminal SNZ resets the duration circuit for the sleep signal.

From the instance the sleep signal is off, the duration for the control signal is counted. The counting is effective for 16^{+0}_{-1} minutes for 15-minute duration, 32^{+0}_{-1} minutes for 30-minute, 60^{+0}_{-1} minutes for 60-minute and 128^{+0}_{-1} minutes for 120-minute. This operation of terminal SNZ is quite similar to that of terminal CNT OUT explained in the preceeding paragraph. Fig. 12 shows the relationship in operation between the terminals SLP OUT and SNZ on the basis of 32-minute duration.
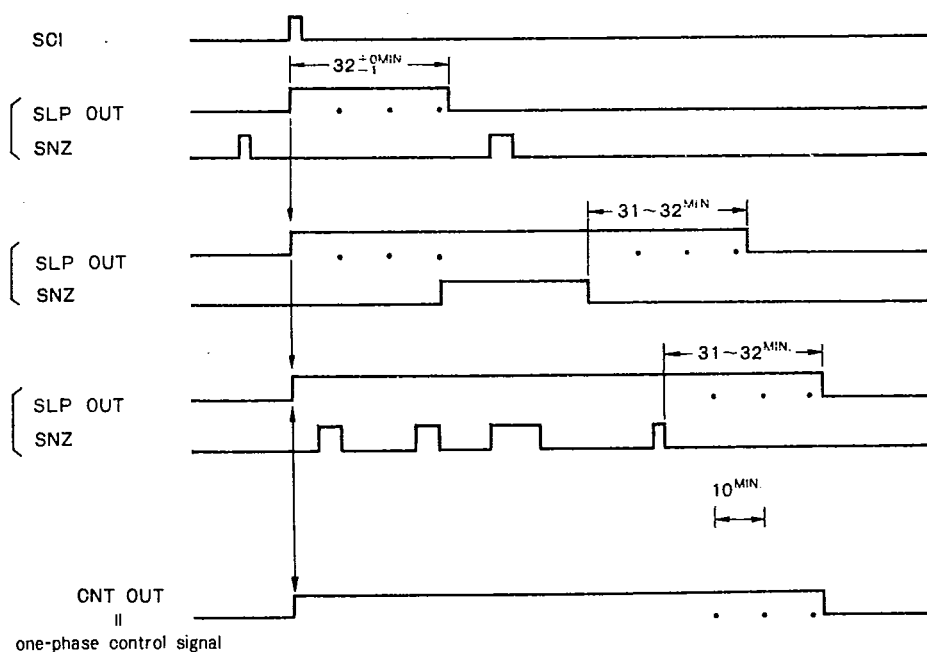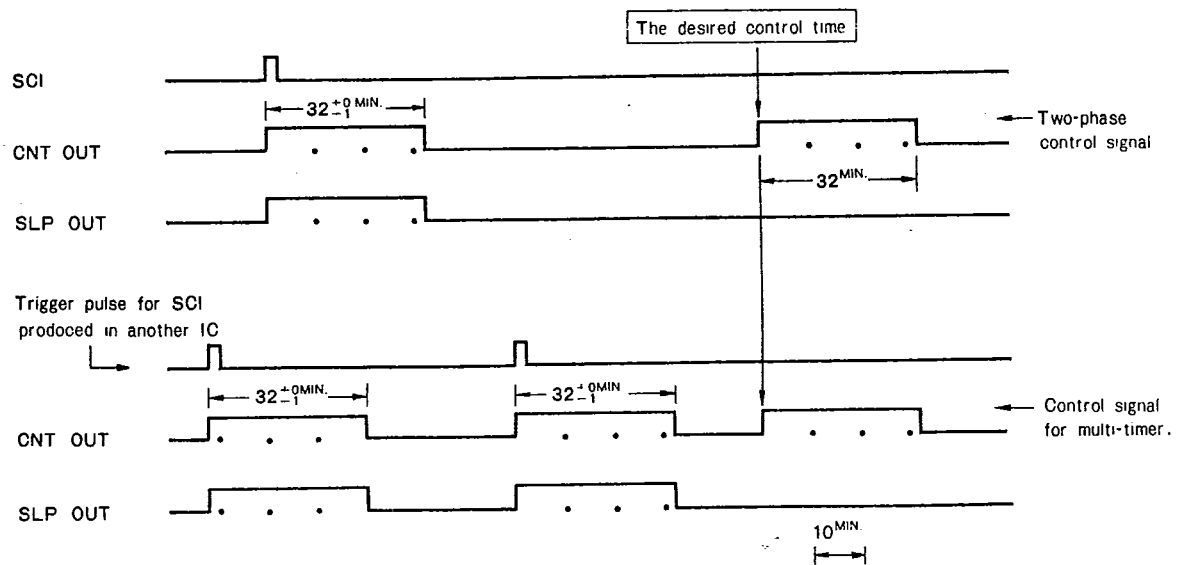

This diagram is drawn by the basis of 32MIN duration

Fig. 12

4.   2-Phase Control Signal

The ON operation of the terminal SCI produces the sleep signal from the terminal CNT OUT. In addition to the sleep signal, the control signal (one-phase control signal) is also obtained from the terminal CNT OUT. Therefore, if the control time is set to the hours out of the duration of the one-phase control signal, the two-phase control signal can be obtained as shown in Fig. 13. Thus, a multitimer can be established. In this case, sleep signal, one-phase control signal and two-phase control signal are same in duration. In other words, the duration is determined in combination with terminals 60/30 and 60/120. Refer to Table 2 and 3.

The multi-timer which can be obtained by triggering the terminal SCI with the trigger pulse signal produced by the separate IC is shown in Fig. 13.

The desired control time

SCI

CNT OUT — Two-phase control signal

32^{+0}_{-1} MIN.

$32^{MIN.}$

SLP OUT

Trigger pulse for SCI prodoced in another IC

CNT OUT — Control signal for multi-timer.

32^{+0}_{-1} MIN. 32^{+0}_{-1} MIN.

SLP OUT

$10^{MIN.}$

This diagram is drawn by the basis of 32MIN duration

Fig. 13

* The durations of one-phase control signal and 2-phase control signal are extended when the terminal SNZ is set to ON. This is same in operation as explained in the preceeding paragraph.

6—6.   Dual Time

1.   Display

With the terminal DUT set to V_{DD} level, the memory is used as dual time. If you want to see the ALS terminal to ON. Then, the dual time (Fig. 2, (2), ii) is displayed regardless of the displays for Normal and seconds (Fig. 2, (1), i and ii).

In case of alarm timer (or control timer), a statical display of hours are presented with the dot illuminating. But the dot flashing every other second for the dual time. The dual timer has no display for seconds. The resolution as the dural time is one minute.

2.   How to set the Dual Time

The method of time setting is similar to that of alarm timer (or control timer as explained in Item 2 of Paragraph 6—3).

3.   Applications of Dual Time

(1.)   Dual time is an optimum traveller's watch when it is used as a time for displaying the time differential (or as a part of world timer).

It can be used to constitute an independent 3-channel timer in combination with standard timer and sleep timer.

(2.)   Dual time can be used as a time to measure the lapse of hours. In case of 12-hour indication, AM 12 hours are interpreted as 0 (zero) hour. If the display on the dual time is AM 3 hours 25 minutes, the amount of lapse of time is 3 hours and 25 minutes, and if the dual time displays PM 12 hours 40 minutes, it indicates that 12 hours and 40 minutes have passed.

The display succeeding PM 1 should be added 12 hours for the counting of the amount of laspe of time. For examle, it the display on the dual time is PM 3 hours 58 minutes, the amount of laspe of time is 15 hours 58 minutes (3 hours 58 minutes +12 hours).

In case of 24-hour indication, the counting is made from 0 hour as the cardinal point. Thus, no addition is required to obtain amount of lapse of time. Table 4 shows the relationship between 12-hour indication and 24-hour indication for the display of amount of laspe of time.

μPD832G, μPD833G

12-hour format (HRS)	AM 12	AM 1	AM 2	AM 3	AM 4	AM 5	AM 6	AM 7	AM 8	AM 9	AM 10	AM 11
24-hour format (HRS)	0	1	2	3	4	5	6	7	8	9	10	11

PM 12	PM 1	PM 2	PM 3	PM 4	PM 5	PM 6	PM 7	PM 8	PM 9	PM 10	PM 11
12	13	14	15	16	17	18	19	20	21	22	23

Table.4

6-7. Stopwatch

1. Display

When the terminal STW is set to V_{DD} level, the memory is provided with the function of stopwatch. To see the display of stopwatch, set the terminal ALS to ON. Then, the stopwatch (Fig. 2, (2), iii) is displayed regardless of displays on the standard time (Fig. 2, (1), i and ii). The stopwatch is provided with displays of seconds and minutes. The minutes is displayed on the space for hours and the seconds, on the space for minutes.

The dot flashing every other second for the display of seconds on the standard time. But the colon is illuminated for the stopwatch.

2. Application of Stopwatch

When using the stopwatch, keep the terminal STW set to V_{DD} level and set the terminal ALM to ON. Then, the stopwatch is ready for operation. At this time, if the F_M terminal is set to ON, the display is reset to 00 minute 00 seconds and hold as it is. The start-stop operation is made through the use of the terminal F_H. The stopwatch can count up to 23 minutes 59 seconds.

In case of 12-hour indication, the display succeeding to 9 minutes 59 seconds is ^{AM}10 minutes 00 second, and AM indicates that the count reaches 10 minutes. The display $^{AM}_{FM}$ 0 minute 00 second comes next to ^{AM}19 minutes 59 seconds. In this case, $^{AM}_{PM}$ represents 20 minutes. Fig. 14 will help you understand the method of display explained above.

In case of 24-hour indication, the display is made in digit from 0 minute 00 second to 23 minutes 59 seconds.
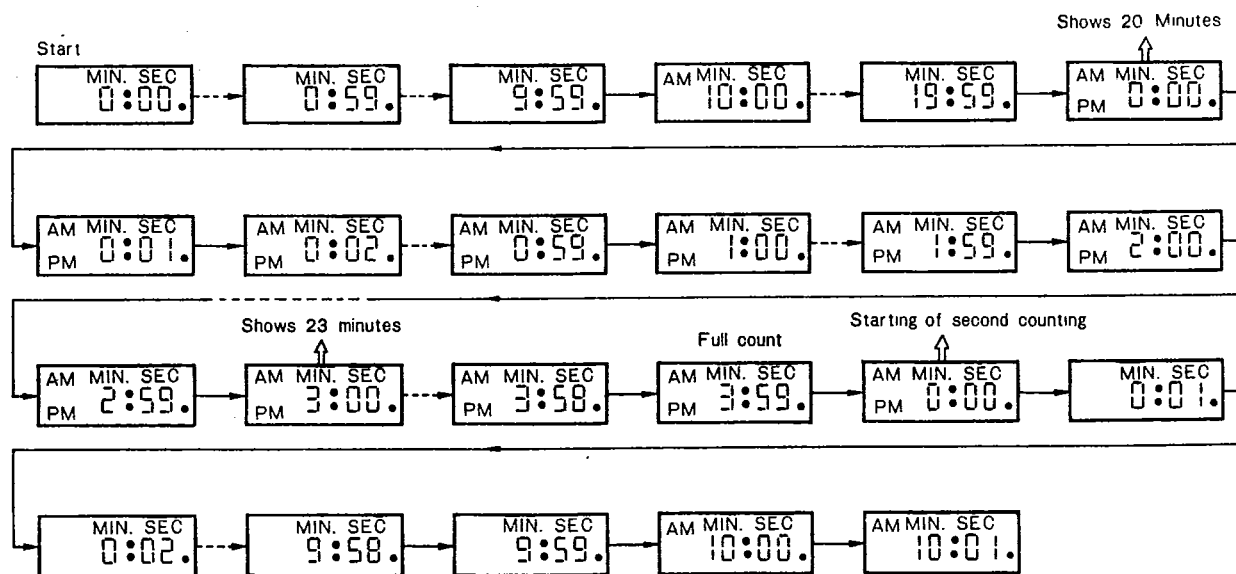

Fig. 14

* Since the terminal F_H offers the start-stop (hold) operation of stopwatch, the measurement can be made without counting the time wasted.

6—8. Counter

Counter is an article used in reckoning and can keep counting the number of people entered in a certain place, quantity of items unloaded, amount of traffic at the specific place, calling a roll of pupils, etc.

The function of counter is not designed independently, but is incidentally produced from the stopwatch explained in Paragraph 6—7. Therefore, its capacity is 720 counts (12 x 60) for 12-hour indication and 1440 counts (24 x 60) for 24-hour indication.

The counter for 24-hour indication which is provided with re-cycle count mechanism may be more convinient to use than that for 12-hour indication.

1. Application

First keep the terminal ALS set to V_{DD} level. In this case, the alarm (or control) time is displayed for any hours.

Then, set the terminal STW to ON to obtain the display of stopwatch, and perform ON-OFF operation of the terminal F_M to obtain indication shown in Fig. 2, (2), iv. Finally, set the terminal STW to OFF. The counter is ready for use.

The terminal STW is set to ON for every counting. The stopwatch starts operating when the terminal STW is switched over from OFF to ON. Thus, the terminal STW should be set to the OFF when the stopwatch is not in use.

Be sure to insert the circuit for preventing the terminal STW from chattering into its input circuit as shown in Fig. 15. The use of common terminal for the signal to drive the liquid crystal is required for the synchronization on the LSI circuit to shift the display from 19:59 to 20:00 count for 24-hour indication.
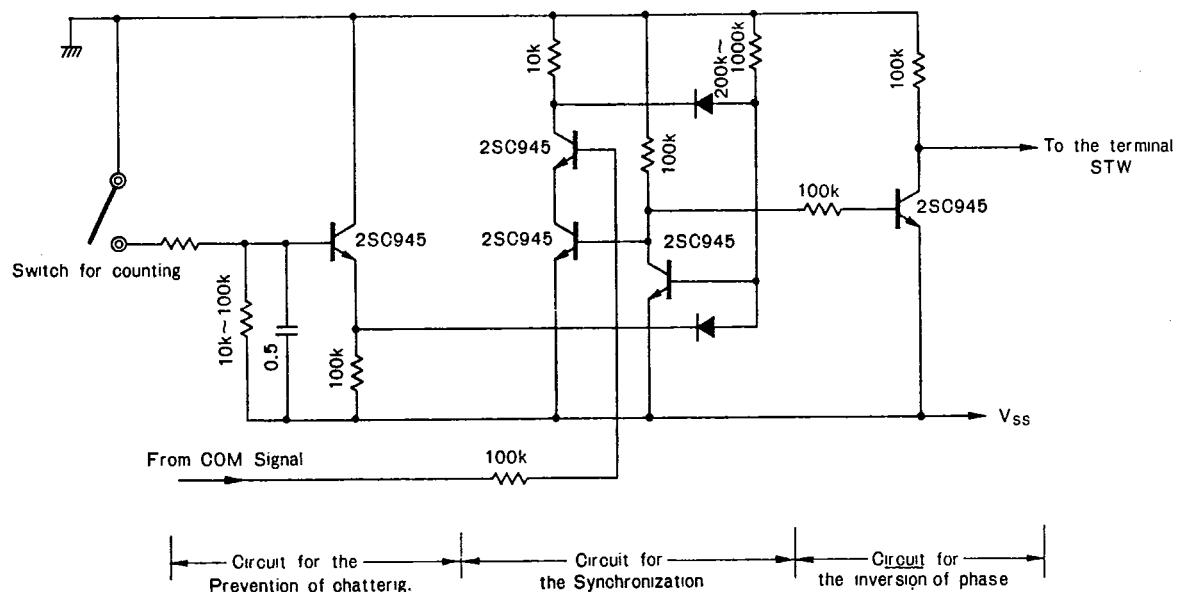

Fig. 15

As the summary to the explanation for every channel, Fig. 16 shows the relationships between the terminal DUT and dual time, that terminal STW and stopwatch, the terminal ALS and alarm (or control) timer, and the terminal SEC and standard time.

μPD832G, μPD833G

6427525 N E C ELECTRONICS INC   72C 09004   D T-49-15-02

| Input terminal		Memory								
		Alarm timer or Control timer		Dual time					Stopwatch	
	DUT	L	L	H	H	H	H	L	L
	STW	L	L	L	H	L	H	H	H
	ALS	L	H	L	L	H	H	L	H
	SEC	L H	L H	L H	L H	L H	L H	L H	L H
The state of Display		MIN•HRS / MIN•SEC — Standard Time	Alarm or Control Time	MIN•HRS / MIN•SEC — Standard Time	MIN•HRS / MIN•SEC — Standard Time	Another Time	Another Time	MIN•HRS / MIN•SEC — Standard Time	Stopwatch

H = V$_{DD}$ level
L = V$_{SS}$ level

Fig. 16

7. Test

Set the every inpt terminal to V$_{SS}$ level and insert the specified oscillator frequency into OSC IN, (42 MHz for μPD832G and 32 kHz for μPD833G), and set the terminal TST$_1$ to ON. Then, the LSI is ready for test.

① Set the terminal F$_S$ to ON. Then, the standard time and memory are reset (completely cleared). In this case, standard time and alarm timer display 1 hour 00 minute (00 second) for 12-hour indication and 0 hour 00 minute (00 second) for 24 hour indication.

② Set the terminal F$_S$ to OFF and the terminal F$_M$ to ON. Then, the frequency 32 kHz is directly applied to the divider (5-th stage) whose proper input signal is 2.048 kHz. As a result, the second counter of standard time is carried fast at approximately 16 Hz for test.

③ Set the terminal F$_M$ OFF and the terminal F$_H$ ON. Then, the second counter of standard timer can be tested at a high speed at approximately 2.048 kHz and the fast shifting of minute counter can be tested at approximately 30 Hz. In this case, if the terminals DUT and ALT are set to ON. The minute counter of memory can be tested fast with 30 kHz frequency. Then, the hour counter is tested at approximately 0.57 Hz.

④ When the terminals F$_M$ and F$_H$ are on, the high speed test of second counter can be tested at 32.768 kHz the high speed test of minute counter tested at approx. 500 Hz and the high speed test of hour counter test at about 9 Hz. In this case, if the terminals DUT and ALS are on, the high speed test of minute counter of memory can be made at approximately 500 Hz. The high speed test of hour counter of memory can be made at approx. 9 Hz.

⑤ In case of μPD832G the output is available the frequency 32.768 kHz from the terminal TST$_2$ that it is one cycle of the oscillator frequency divided by 27.
And then, the terminal TST$_2$ is provided which facilitates high-speed testing too. High-frequency pulses driving the TST$_2$ input allow for high-speed testing of the seconds, minutes and hours counters.
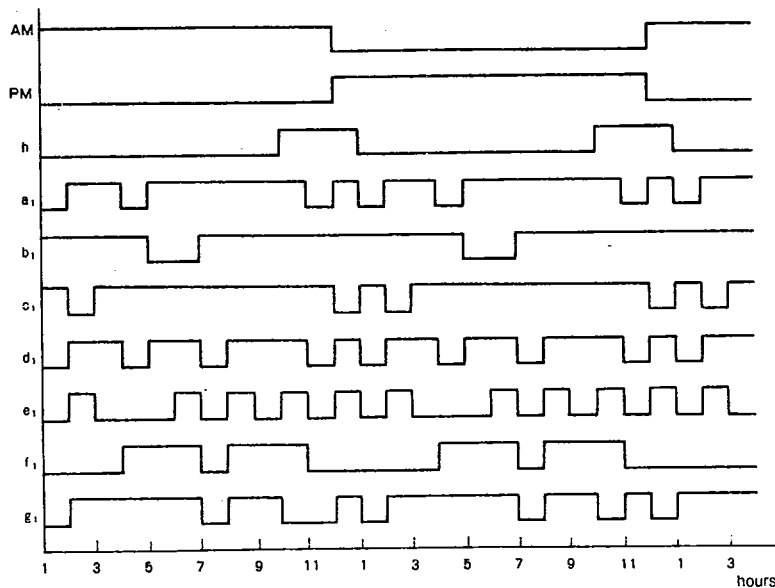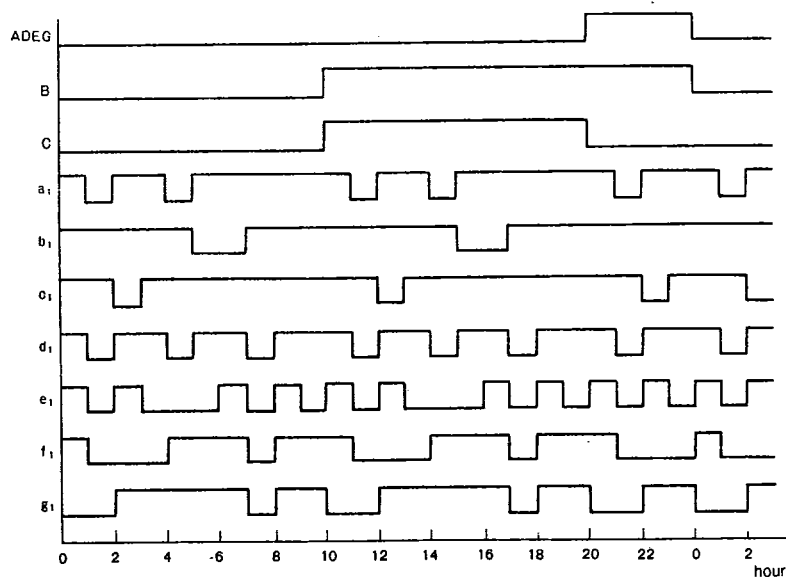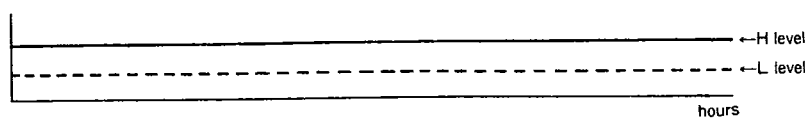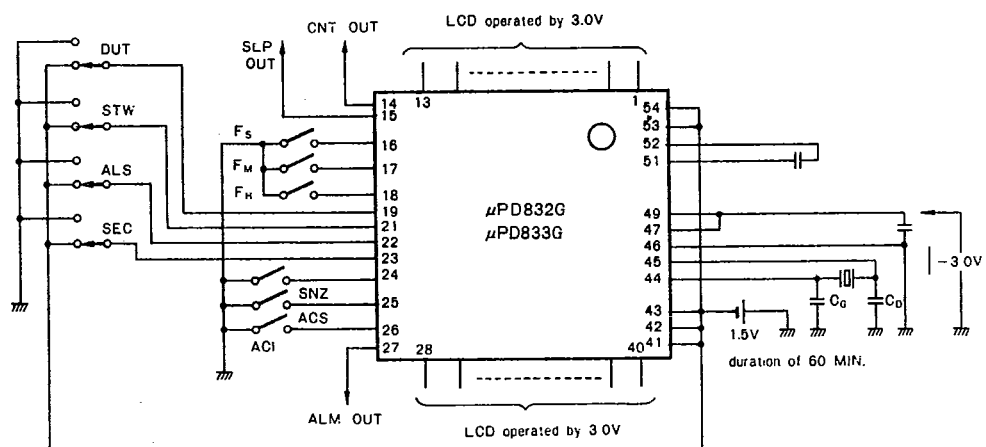
Minute & Second Display
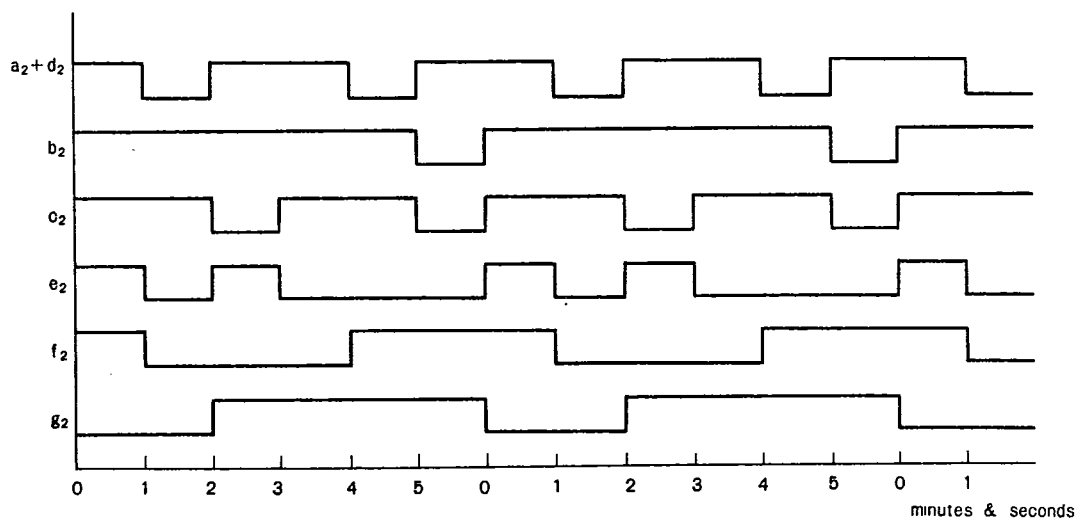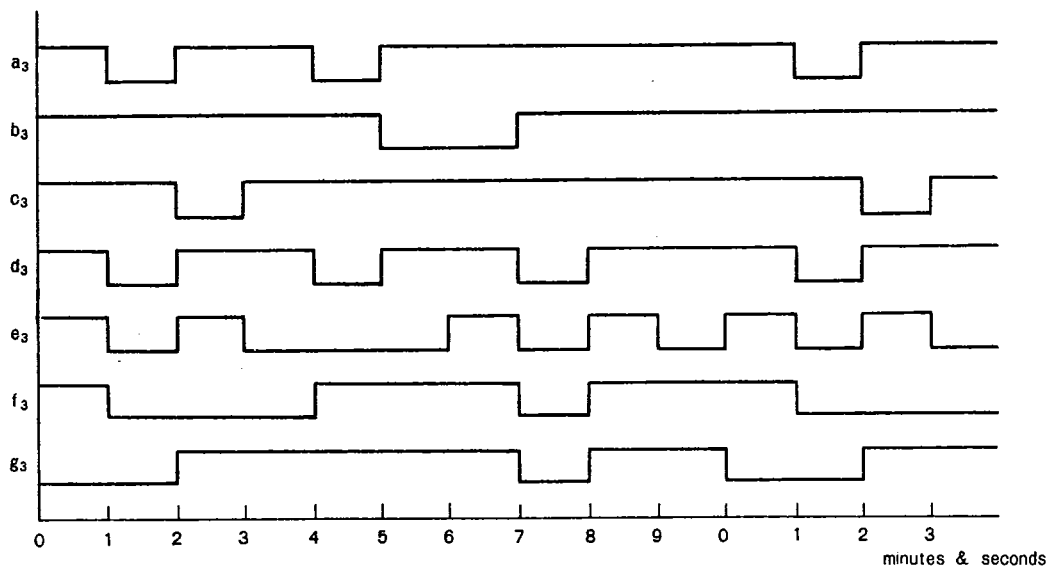
Output waveforms of segments

(When the level is "H", 32Hz of opposite phase to COMMON is outputed for the segments, and when the level is "L", 32Hz of the same phase is outputed.)
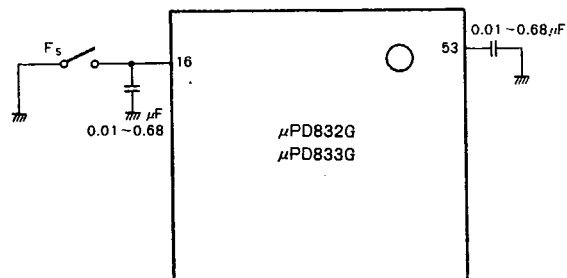
Hours Display of 12 Hour Format

AM
PM
h
a₁
b₁
c₁
d₁
e₁
f₁
g₁

1   3   5   7   9   11   1   3   5   7   9   11   1   3
hours

Hours Display of 24 Hour Format

ADEG
B
C
a₁
b₁
c₁
d₁
e₁
f₁
g₁

0   2   4   6   8   10   12   14   16   18   20   22   0   2
hours

Dot(1 Hz)

0   1   2   3   4   5   Seconds

COLON(COM)
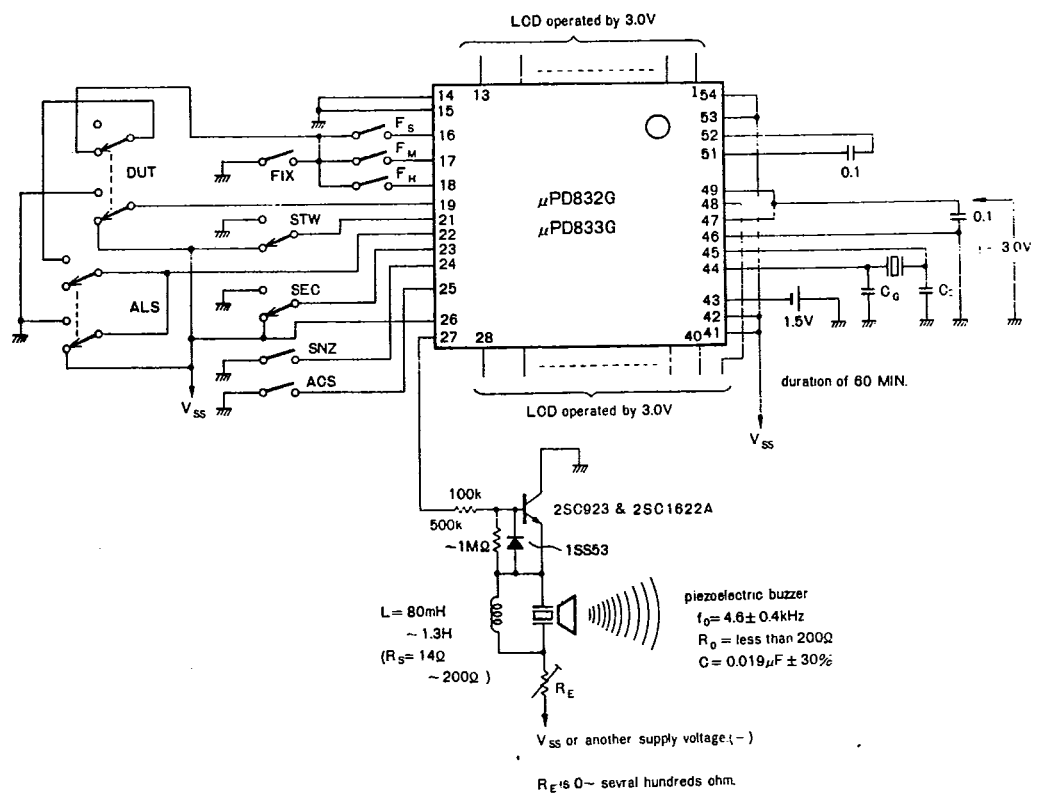
←H level
←L level
hours

634

APPLICATION

1. Application circuit for doubler

2. How to operate auto clear

3. Application circuit for alarm clock with dual time and stopwatch

piezoelectric buzzer
$f_0 = 4.6 \pm 0.4$ kHz
$R_0 =$ less than 200Ω
$C = 0.019\mu F \pm 30\%$

$L = 80$mH
~ 1.3H
$(R_S = 14\Omega$
~ 200Ω)

V_{SS} or another supply voltage (−)

R_E is 0~ sevral hundreds ohm.

2SC923 & 2SC1622A
1SS53

4 Application circuit for 8 channel function
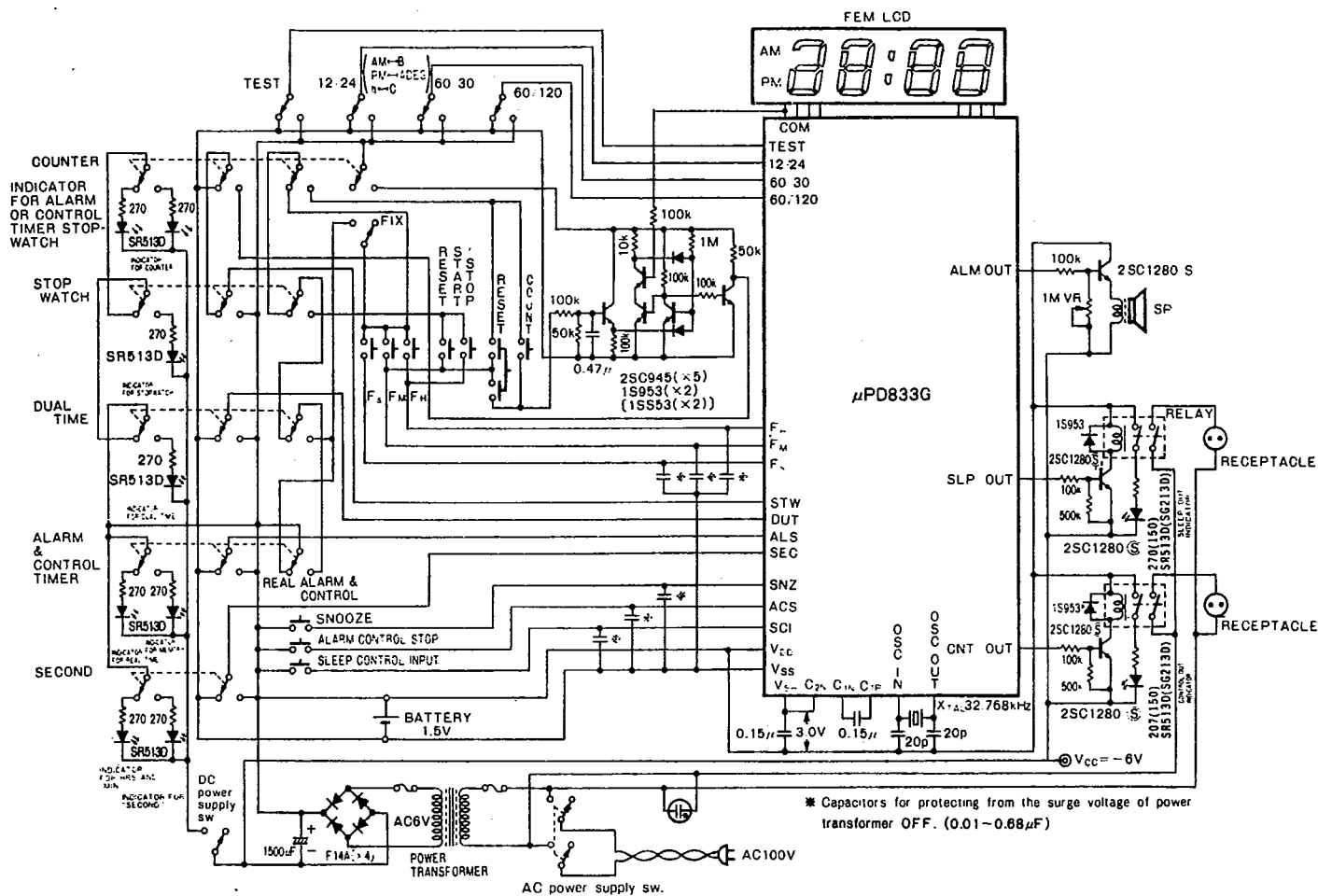
MATTERS DEMAND SPECIAL ATTENTION!

① Make μPD832G and μPD833G pack by aluminum foil certainly when be carred or be kept.

② The input terminals be unused connect to V_{SS} always.