

SANYO	No.864B	LM8363
		PMOS LSI Dual - Alarm Digital Clock

Use

- Alarm clock (Dual alarm)
- Clock radio (Dual alarm)
- ON/OFF timer for household electric appliances

Functions

- Current time display function and month/date display function
- Dual-alarm output function with snooze function
- Sleep timer function (max. 59 minutes)

Features

1. P channel ED MOS LSI on a single chip
 2. Possible to direct drive LED (5mA or more, red LED) : LM8363I
 3. Possible to direct drive fluorescent display tube (Light up voltage : 21V or less) : LM8363DII
 4. Wide range of operating voltages (Fluorescent display tube : -6.5 to -21V, LED : -6.5 to -16V).
 5. 24-hour mode dual-alm function.
 6. Battery backup function (On-chip backup CR oscillator)
 7. Month/date display function (Possible to read out by use of SNOOZE INPUT).
 8. Sleep timer function (On-chip presettable max. 59-minutes countdown timer)
 9. Repeatedly usable snooze function
 10. 50kHz or 60kHz is usable as reference frequency
 11. Possible to select 12-hour system with AM/PM display or 24-hour system.
 12. Power failure indicating function (All digits flashing)
 13. Blanking pin to blank display (Possible to parallel connect with other LSI of P channel open drain output type).
 14. Clock input noise suppressor
- Related Products : LM8361, LM8362, LM8364, LM8365

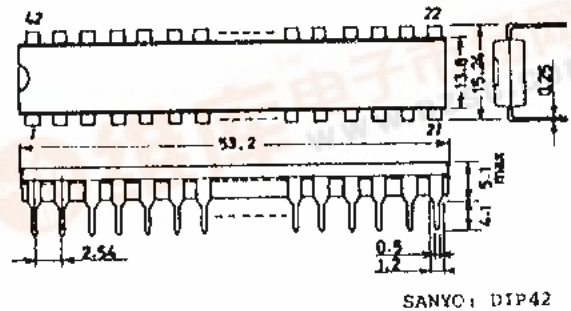
The application circuit diagrams and circuit constants herein are included as an example and provide no guarantee for designing equipment to be mass-produced.

The information herein is believed to be accurate and reliable. However, no responsibility is assumed by SANYO for its use, nor for any infringements of patents or other rights of third parties which may result from its use.

Pin Assignment

<table border="0" style="width: 100%;"> <tr><td>BLANKING INPUT</td><td>1</td></tr> <tr><td>AM OUTPUT</td><td>2</td></tr> <tr><td>10HRS-b & c</td><td>3</td></tr> <tr><td>HRS-f</td><td>4</td></tr> <tr><td>HRS-g</td><td>5</td></tr> <tr><td>HRS-a</td><td>6</td></tr> <tr><td>HRS-b</td><td>7</td></tr> <tr><td>HRS-d</td><td>8</td></tr> <tr><td>HRS-c</td><td>9</td></tr> <tr><td>HRS-e</td><td>10</td></tr> <tr><td>10 MINS-f</td><td>11</td></tr> <tr><td>10 MINS-g</td><td>12</td></tr> <tr><td>10 MINS-a & d</td><td>13</td></tr> <tr><td>10 MINS-b</td><td>14</td></tr> <tr><td>10 MINS-c</td><td>15</td></tr> <tr><td>10 MINS-e</td><td>16</td></tr> <tr><td>MINS-f</td><td>17</td></tr> <tr><td>MINS-g</td><td>18</td></tr> <tr><td>MINS-a</td><td>19</td></tr> <tr><td>MINS-b</td><td>20</td></tr> <tr><td>MINS-c</td><td>21</td></tr> </table>	BLANKING INPUT	1	AM OUTPUT	2	10HRS-b & c	3	HRS-f	4	HRS-g	5	HRS-a	6	HRS-b	7	HRS-d	8	HRS-c	9	HRS-e	10	10 MINS-f	11	10 MINS-g	12	10 MINS-a & d	13	10 MINS-b	14	10 MINS-c	15	10 MINS-e	16	MINS-f	17	MINS-g	18	MINS-a	19	MINS-b	20	MINS-c	21	<table border="0" style="width: 100%;"> <tr><td>CR INPUT</td><td>42</td></tr> <tr><td>PMO OUTPUT</td><td>47</td></tr> <tr><td>1Hz OUTPUT</td><td>48</td></tr> <tr><td>24/12HR SELECT</td><td>29</td></tr> <tr><td>ALARM 2 DISPLAY INPUT</td><td>36</td></tr> <tr><td>50/60Hz SELECT</td><td>37</td></tr> <tr><td>50/60Hz INPUT</td><td>38</td></tr> <tr><td>UPPER SET INPUT</td><td>35</td></tr> <tr><td>LOWER SET INPUT</td><td>34</td></tr> <tr><td>SECONDS DISPLAY INPUT</td><td>33</td></tr> <tr><td>ALARM 1 DISPLAY INPUT</td><td>32</td></tr> <tr><td>SLEEP DISPLAY INPUT</td><td>31</td></tr> <tr><td>VEE</td><td>30</td></tr> <tr><td>ALARM 2 OFF INPUT</td><td>29</td></tr> <tr><td>SLEEP OUTPUT</td><td>28</td></tr> <tr><td>ALARM 1 OFF INPUT</td><td>27</td></tr> <tr><td>ALARM OUTPUT</td><td>26</td></tr> <tr><td>SNOOZE INPUT</td><td>25</td></tr> <tr><td>VSS</td><td>24</td></tr> <tr><td>MINS-c</td><td>23</td></tr> <tr><td>MINS-d</td><td>22</td></tr> </table>	CR INPUT	42	PMO OUTPUT	47	1Hz OUTPUT	48	24/12HR SELECT	29	ALARM 2 DISPLAY INPUT	36	50/60Hz SELECT	37	50/60Hz INPUT	38	UPPER SET INPUT	35	LOWER SET INPUT	34	SECONDS DISPLAY INPUT	33	ALARM 1 DISPLAY INPUT	32	SLEEP DISPLAY INPUT	31	VEE	30	ALARM 2 OFF INPUT	29	SLEEP OUTPUT	28	ALARM 1 OFF INPUT	27	ALARM OUTPUT	26	SNOOZE INPUT	25	VSS	24	MINS-c	23	MINS-d	22
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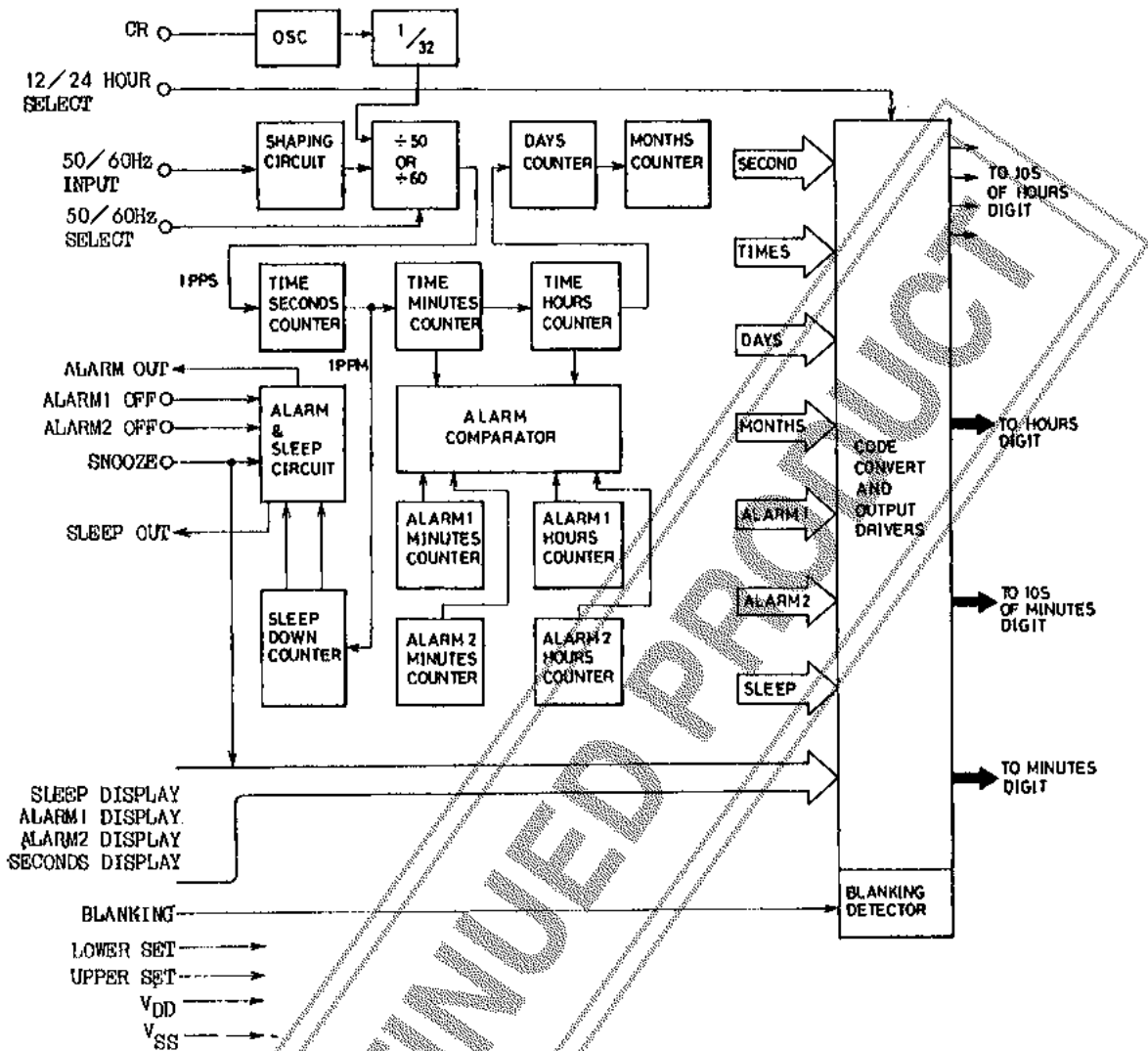
Case Outline 3014A-D42IC
(unit: mm)



Specifications and information herein are subject to change without notice.

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Equivalent Circuit Block Diagram



Main Characteristics : For LED (D, N, S) specifications

Absolute Maximum Ratings at $T_a = 25^\circ\text{C}$, $V_{SS} = 0$

Parameter	Symbol	Value	unit
Maximum Supply Voltage	$V_{DD \text{ max}}$	-18 to +0.3	V
Input Voltage	V_{IN}	$V_{DD} - 0.3$ to +0.3	V
Output Voltage	V_{OUT}	$V_{DD} - 0.3$ to +0.3	V
Allowable Power Dissipation	$P_d \text{ max}$	0.9	W
Operating Temperature	T_{op}	-30 to +65	$^\circ\text{C}$
Storage Temperature	T_{stg}	-55 to +125	$^\circ\text{C}$

Allowable Operating Conditions at $T_a = 25^\circ\text{C}$, $V_{SS} = 0\text{V}$

Parameter	Symbol	min	typ	max	unit
Supply Voltage	V_{DD}	-16	-12	-6.5	V
Input 'H'-Level Voltage	V_{IH}	-1		0	V
Input 'L'-Level Voltage	V_{IL}	V_{DD}	$V_{DD} + 2$	$V_{DD} + 1$	V
		V_{DD}	V_{DD}	$V_{DD} + 1$	V

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Electrical Characteristics at Ta = 25°C, VSS = 0V, VDD = -9 to -15V				min	typ	max	unit
Output 'H'-Level Current							
ALARM OUT, SLEEP OUT	IOH(1)	VOH = VSS - 2.5V	1.5				mA
b & c, a & d	IOH(2)	VOH = VSS - 2.5V	10		※		mA
1Hz	IOH(3)	VOH = VSS - 2.5V	15		※		mA
Other than above	IOH(4)	VOH = VSS - 2.5V	5		※		mA
Output Leak Current							
ALARM OUT, SLEEP OUT	IOL(1)	VOL = VDD				5	μA
Other than above	IOL(2)	VOL = VDD				50	μA
Input Leak Current							
ACIN	IiH(1)	ViiH = VSS				5	μA
	IiL	ViiL = VDD	-5				μA
Input Current (Other than ACIN)	IiH(2)	ViiH = VSS	10			200	μA
Input Pin Open Voltage (Other than ACIN)	ViiLopen	Pin open	VDD			VDD + 1	V
Power Failure Detect Voltage	VDet		-6.5	-4.5			V
Current Dissipation	IDD	VDD = -10V			6	10	mA

※ : The segment output current is allowed max. 22mA for pins 10HRS-b & c, 10MINS a & d, and max. 33mA for pin 1Hz OUTPUT, and max. 11mA for other than these pins in the range of 900mW of power dissipation.

Main Characteristics : For fluorescent display tube (DH, N, S specifications)

Absolute Maximum Ratings at Ta = 25°C, VSS = 0				unit			
Maximum Supply Voltage	VDD max			-23 to +0.3			V
Input Voltage	VIN			VDD - 0.3 to +0.3			V
Output Voltage	VOUT	Output OFF		VDD - 0.3 to +0.3			V
Allowable Power Dissipation	Pd max	Ta = 70°C				0.3	W
Operating Temperature	Topg					-30 to +70	°C
Storage Temperature	Tstg					-55 to +125	°C

Allowable Operating Conditions at Ta = 25°C, VSS = 0V				min	typ	max	unit
Supply Voltage	VDD			-21	-12	-6.5	V
Input 'H'-Level Voltage	ViiH	VDD = -6.5 to -21V		-1		0	V
Input 'L'-Level Voltage	ViiL	VDD = -8.0 to -21V		VDD		VDD + 2	V
		VDD = -6.5 to -8.0V		VDD		VDD + 1	V

Electrical Characteristics at Ta = 25°C, VSS = 0V, VDD = -9 to -21V				min	typ	max	unit
Output 'H'-Level Current							
ALARM OUT, SLEEP OUT	IOH(1)	VOH = VSS - 2.5V	1.5				mA
b & c, a & d	IOH(2)	VOH = VSS - 1.0V	2				mA
1Hz	IOH(3)	VOH = VSS - 1.0V	3				mA
Other than above	IOH(4)	VOH = VSS - 1.0V	1				mA
Output Leak Current							
ALARM OUT, SLEEP OUT	IOL(1)	VOL = VDD				5	μA
Other than above	IOL(2)	VOL = VDD				2	μA
Input Leak Current							
ACIN	IiH(1)	ViiH = VSS				5	μA
	IiL	ViiL = VDD	-5				μA
Input Current (Other than ACIN)	IiH(2)	ViiH = VSS	10			200	μA
Input Pin Open Voltage (Other than ACIN)	ViiLopen	Pin open	VDD			VDD + 1	V
Power Failure Detect Voltage	VDet		-6.5	-4.5			V
Current Dissipation	IDD	VDD = -10V			6	10	mA

LM8363

1. Display

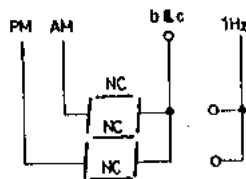
1-1 4-digit 7-segment static lighting format.

Display font 1 2 3 4 5 6 7 8 9 0

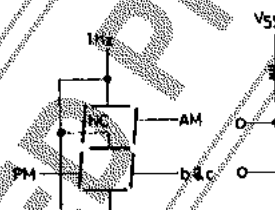
1-2 Display mode

- Time and alarm time display mode (12-hour system) 1:00AM to 12:59PM (10's digit of hours : 0 blanking)
(24-hour system) 0:00 to 23:59 (10's digit of hours : 0 blanking)
- Month/date display mode (12-hour system) 1 1 to 12 31 (10's digit of months, 10's digit of dates : 0 blanking)
(24-hour system) 1 : 1 to 31 : 12 (10's digit of months, 10's digit of dates : 0 blanking)
- Seconds display mode (12-hour system) 0 : 00 to 9 : 59 (Digit No.1 : Blanking)
(24-hour system) 0 : 00 to 9 : 59 (Digit No.1 : Blanking)
- Sleep display mode (12-hour system) : 00 to 59 (Digits No.1 and No.2 : Blanking)
(24-hour system) : 00 to 59 (Digits No.1 and No.2 : Blanking)

1-3 Connection for 10's digit of hours



12-hour system



24-hour system

1-4 1Hz output

- 24-hour system : Used for segments a, d, g of digit No.1.
- 12-hour system : Current time (hour/minutes) display mode and alarm time display mode
 ----- Flashing at a 1Hz rate
 Month/date display mode, sleep display mode, seconds display mode
 ----- OFF (Unlighted)

1-5 Month/data display mode

	Digits No.1 and No.2	Digits No.3 and No.4
24-hour system	Date	Month
12-hour system	Month	Date

1-6 Power failure indication

- All ON-state segments flash at a 1Hz rate at all display modes. ----- Power failure indication
- Flashing to indicate power failure is released by applying the input to UPPER SET INPUT or LOWER SET INPUT.

1-7 Display during backup operation

- When the count operation is performed (during backup operation) by CR-OSC oscillation frequency with no input applied to 50/60Hz INPUT, all ON-state segment outputs will be turned OFF.

2. Input Configuration

2-1 Logic level

- Logic 'L': V_{DD} level
- Logic 'H': V_{SS} level

2-2 AC INPUT

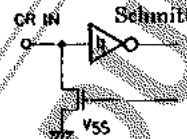
- With built-in Schmitt circuit, the input impedance is more than $1M\Omega$.
- The clamp circuit for a voltage being more minus than V_{DD} is built in.

2-3 BLANKING INPUT

- Input pin with pull-down resistor. If connected to V_{DD} or left open, all segments will be turned OFF; and if connected to V_{SS} , the normal ON-state will return.

2-4 CR INPUT

- This consists of a Schmitt circuit and an open drain driver



2-5 Input pins other than above

- Input pins with pull-down resistor

3. Output Configuration

All of segment output, alarm output, and sleep output are of P-channel open drain type.

4. Operation Description

4-1 Display mode selection

- The display mode is selected by using SLEEP DISPLAY INPUT, ALARM DISPLAY INPUT, ALARM 2 DISPLAY INPUT, and SECONDS DISPLAY INPUT. The order of priority given to these switch signals is as shown in Table 1.

Table 1. Order of priority given to switch signals

Switch input					Display mode
SLEEP DISPLAY	SNOOZE	ALARM 1 DISPLAY	ALARM 2 DISPLAY	SECOND	
H	-	-	-	-	Sleep display
L	H	-	-	-	Month/data display
L	L	-	H	H	Month/data display
L	L	H	L	-	Alarm 1 display
L	L	H	H	L	Alarm 1 display
L	L	L	H	L	Alarm 2 display
L	L	L	L	H	Seconds display
L	L	L	L	L	Current time display

Note: 'H': V_{SS} level is applied to input pin.

'L': V_{DD} level is applied to input pin. (Input pin may be left open.)

'-': V_{SS} level or V_{DD} level is applied to input pin or input pin may be left open.

4-2 Time setting

- Time setting is executed by applying V_{SS} level to UPPER SET INPUT and LOWER SET INPUT.
- When executing setting, no carry occurs from the low-order digit to the high-order digit.
- The operation contents at each display mode are as shown in Table 2.

Table 2. Operation contents

Display mode	Setting	Operation contents	
Current time display	UPPER	Minutes advance at a 2Hz rate.	No carry to hours occurs. Seconds are cleared to 00.
	LOWER	Minutes advance at a 2Hz rate.	
	BOTH	Minutes advance at a 6Hz rate.	
Alarm 1 display (Alarm 2 display)	UPPER	Hours of alarm 1 (alarm 2) advance at a 2Hz rate.	No carry to hours occurs.
	LOWER	Minutes of alarm 1 (alarm 2) advance at a 2Hz rate.	
	BOTH	Minutes of alarm 1 (alarm 2) advance at a 6Hz rate.	

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Display mode	Setting	Operation contents
Month/date display	UPPER LOWER BOTH	Month (date) advances at a 2Hz rate. (): 24-hour system. Date (month) advances at a 2Hz rate. No carry occurs from the low-order digit to the high-order digit. Date (month) advances at a 5Hz rate.
Sleep display	UPPER LOWER BOTH	No operation. Minutes of sleep timer subtract at a 2Hz rate. Minutes of sleep timer subtract at a 5Hz rate.
Seconds display	UPPER LOWER BOTH	Seconds counter stops running. Seconds are cleared to 00. Clearing continues until switch is released. Each counter is reset as follows: Current time ---- 12:00AM (For 24-hour system, 0:00) Alarm time ---- 12:00AM (For 24-hour system, 0:00) Month/date ---- 12 1 (For 24-hour system, 1:12)

Note: BOTH means that V_{SS} level signal is applied by pressing both switches of UPPER SET INPUT and LOWER SET INPUT.

4-3 Alarm operation

- (1) The 24-hour mode dual alarms of alarm 1 and alarm 2 are built in. The alarm outputs are each made available once in 24 hours. The time contents are displayed, read out, and set as shown in Table 1 and Table 2.
- (2) The alarm 1 time and alarm 2 time can be set independently. When the alarm 1 time (alarm 2 time) is reached, ALARM 1 OUTPUT (ALARM 2 OUTPUT) will be turned ON (H level) and will be turned OFF (L level) automatically 59 minutes later. When the alarm 2 time is reached within 59 minutes after the alarm 1 time is reached, ALARM 2 OUTPUT will be turned ON and will be turned OFF automatically 59 minutes after the time alarm 2 time is reached.



(3) ALARM OUTPUT release

When the alarm 1 time (alarm 2 time) is reached and ALARM 1 OUTPUT (ALARM 2 OUTPUT) is turned ON, ALARM 1 OUTPUT (ALARM 2 OUTPUT) can be turned OFF by applying H level to ALARM 1 OFF INPUT (ALARM 2 OFF INPUT).

(4) Alarm operation inhibit

The following alarm operation is available corresponding to the level setting of ALARM 1 OFF INPUT and ALARM 2 OFF INPUT.

ALARM 1 OFF INPUT	ALARM 2 OFF INPUT	Operation of alarm 1	Operation of alarm 2
L	L	○	○
H	L	×	○
L	H	○	×
H	H	×	×

'L': V_{DD} level or open

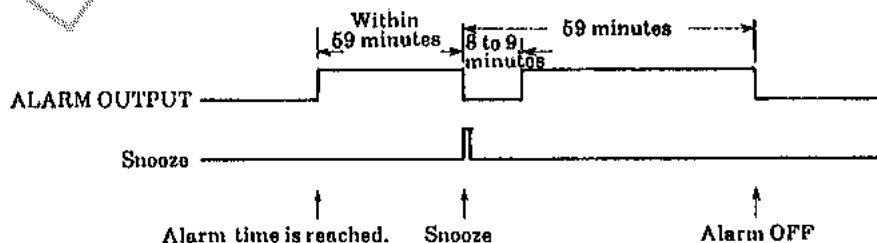
'H': V_{SS} level

'○': Normal operation

'×': Operation inhibit. Even if the alarm time is reached, ALARM OUTPUT will not be turned on.

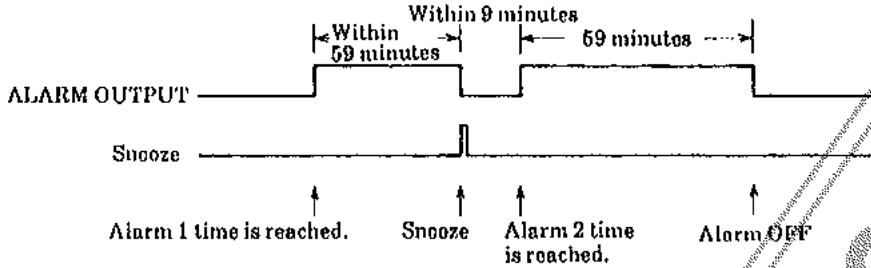
(5) Snooze operation

If 'H' level is applied to SNOOZE INPUT while ALARM OUTPUT is turned ON, ALARM OUTPUT will be turned OFF temporarily and will be turned ON 8 to 9 minutes later. The snooze operation is available as often as you like.



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When the alarm 2 time is reached during the snooze operation, the snooze operation will be released at this point of time and ALARM 2 OUTPUT will be turned ON.



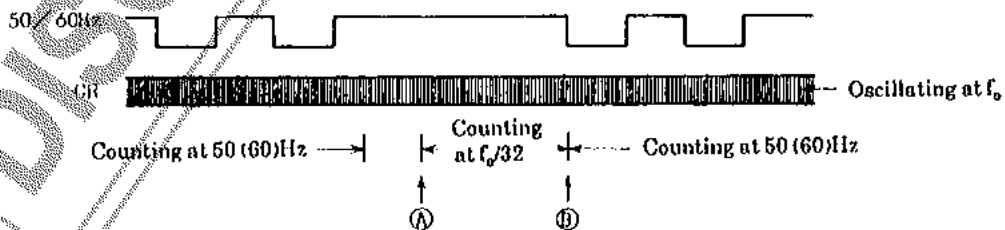
- (6) Relation between alarm operation and sleep operation
 - SLEEP OUTPUT is not turned ON while ALARM OUTPUT is turned ON (including the period of snooze operation).
 - Contrary to this, even if the alarm time is reached while SLEEP OUTPUT is turned ON, ALARM OUTPUT will not be turned ON.

4-4 Sleep operation

- (1) If 'H' level is applied to SLEEP DISPLAY INPUT when all of ALARM 1 OUTPUT, ALARM 2 OUTPUT, and SLEEP OUTPUT are turned OFF, the sleep timer will be set to 59 minutes and SLEEP OUTPUT will be turned ON. When the sleep timer reaches 0 minute and a lapses of 59 minutes, SLEEP OUTPUT will be turned OFF.
- (2) If 'H' level is applied to SLEEP DISPLAY INPUT while SLEEP OUTPUT is turned ON, the sleep timer will not be set to 59 minutes, but will display the remaining period of time.
- (3) The sleep timer can be subtracted fast as shown in Table 2.
- (4) Sleep timer release
If 'H' level is applied to SNOOZE INPUT at other display modes than sleep display mode while SLEEP OUTPUT is turned ON, SLEEP OUTPUT will be turned OFF. If 'H' level is applied to SNOOZE INPUT at the sleep display mode, the sleep timer will be preset to 59 minutes. (A simple touch of the switch permits 59 minutes to be set.)
- (5) Relation between alarm operation and sleep operation
Refer to 4-3-6.

4-5 Backup operation

- (1) |V_{DD}| min. for the normal operation of LSI system is 6.5V
- (2) For the backup operation during power failure, the following actions are required.
 - 1. A voltage of more than 6.5V must be applied across V_{DD} and V_{SS}.
 - 2. CR INPUT must be oscillated with a frequency 32 times as high as 50Hz (or 60Hz).
 In case of power failure, these 1 and 2 cause the internal reference clock to be chaged-over automatically to the oscillation frequency at CR INPUT.
- (3) When restored to normal from power failure, the reference clock will be changed-over automatically to 50/60Hz.
- (4) Changeover operation time chart



- Ⓐ : When there is no input applied to 50/60Hz INPUT for $\frac{1}{f_0} \times 64$ (sec.), the reference frequency will be changed-over from 50/60Hz to $f_0/32$ Hz.
- Ⓑ : The moment 50/60Hz INPUT receives the input, the reference frequency will be changed-over from $f_0/32$ to 50/60Hz.

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(5) Rejection of interference noise to radio

By stopping oscillation at CR INPUT during application of AC power supply and starting oscillation simultaneously with power failure, the interference noise to radio due to oscillation at CR INPUT can be rejected. (Refer to Sample Application Circuit 1.)

(6) Segment output during backup operation

During the period from (A) to (B) shown in the time chart in (4), all segment outputs are turned OFF automatically.

4-6 Commercial frequency and its selection

(1) The commercial frequency is input from 50/60Hz INPUT. This pin contains a Schmitt circuit to prevent malfunction due to external noise. It is necessary to use this pin in conjunction with a CR filter having 100 to 1000kΩ and 0.01μF to prevent LSI breakdown due to high-voltage impulse, etc. from the commercial power supply.

(2) 50Hz or 60Hz is selected by use of 50/60Hz SELECT.

50Hz : 50/60Hz SELECT is set at 'H' level (V_{SS}).

60Hz : 50/60Hz SELECT is set at 'L' level (V_{DD}) or is left open.

4-7 12/24-hour system selection

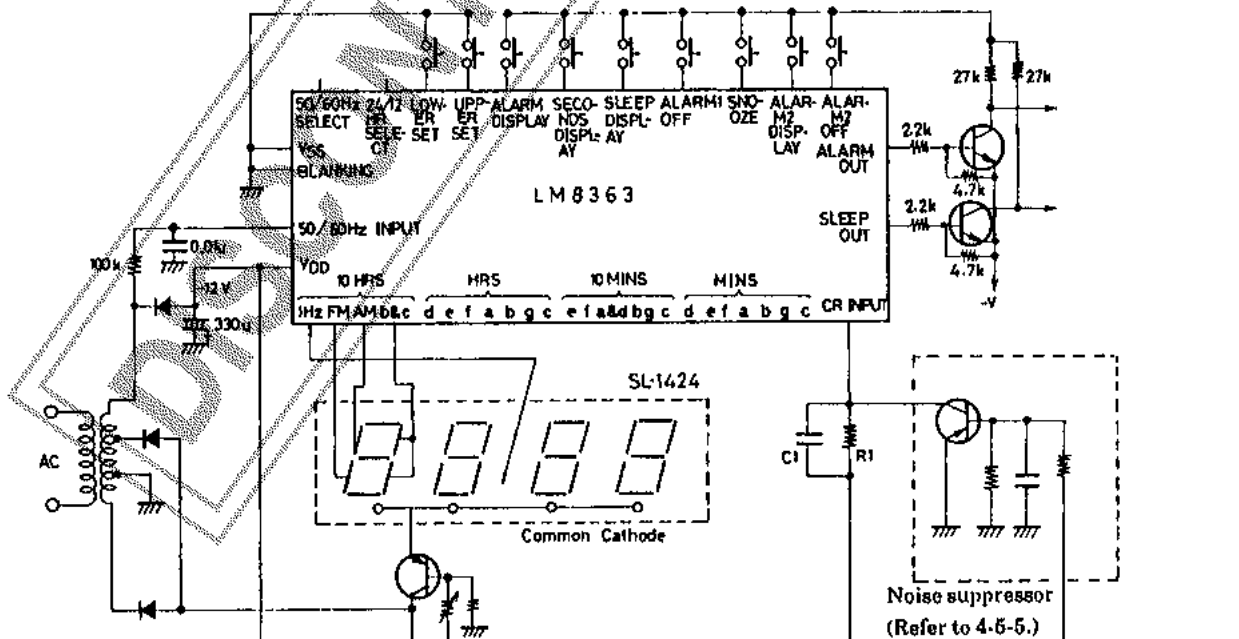
The display content is selected as follows by use of 24/12 HRS SELECT.

24/12 HRS SELECT	Current time and alarm time	Month/date	
		Digits No.1 and No.2	Digits No.3 and No.4
'H' level (V _{SS})	24-hour system	Date	Month
'L' level (V _{DD}) or open	12-hour system	Month	Date

5. Function Table of Rank Products

Rank	Display tube		Remarks
	LED (red)	Fluorescent display tube	
LM8363D	○		
LM8363DH		○	
LM8363N	○	○	
LM8363S	○	○	For use in industrial applications

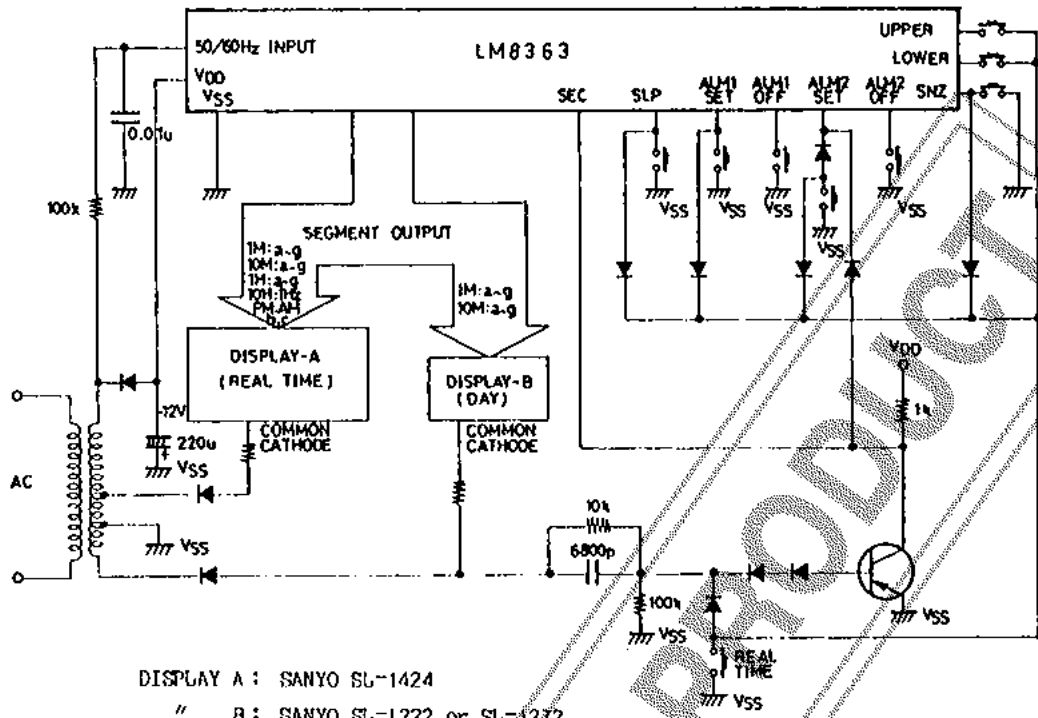
Sample Application Circuit 1. LED display (Common cathode), 12-hour system, Backup operation automatic changeover circuit (Suppression of interference noise to radio)



	60 Hz	50 Hz
R1	130 k	150 k
C1	0.0068μ	0.0068μ
C2	0.02 μ	0.02 μ

LM8363

Sample Application Circuit 2: 6-digit display (Current time + date, 12-hour system)



Sample Application Circuit 3: 6-digit display (Current time + seconds)

