No.864B

LM8363

PMOS LSI

Dual - Alarm Digital Clock

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

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

Functions

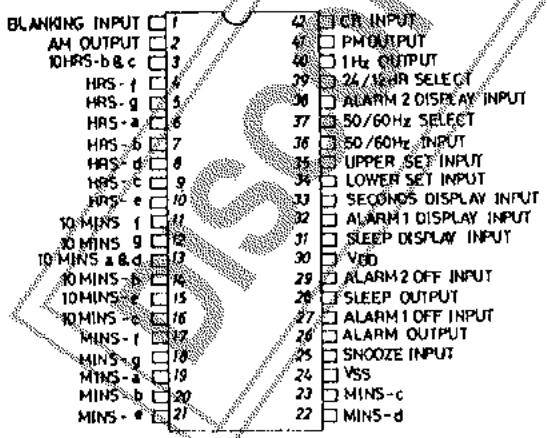
- Current time display function and month/date display function
- Dual-alarm output function with snooze function
- Sleep timer function (max. 59 minutes)

Features

1. P channel ED MOS LSI on a single chip
2. Possible to direct drive LED (5mA or more, red LED) : LM8363D
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-alrm function.
6. Battery backup function (On-chip backup CR oscillator)
7. Month/data 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. 50Hz or 60Hz 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

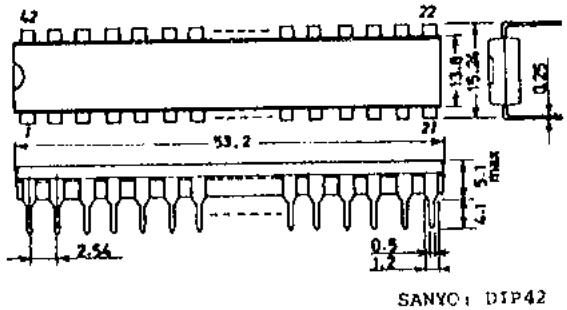
Related Products : LM8361, LM8362, LM8364, LM8365

Pin Assignment



Case Outline 3014A-D42IC

(unit : mm)



SANYO : DIP42

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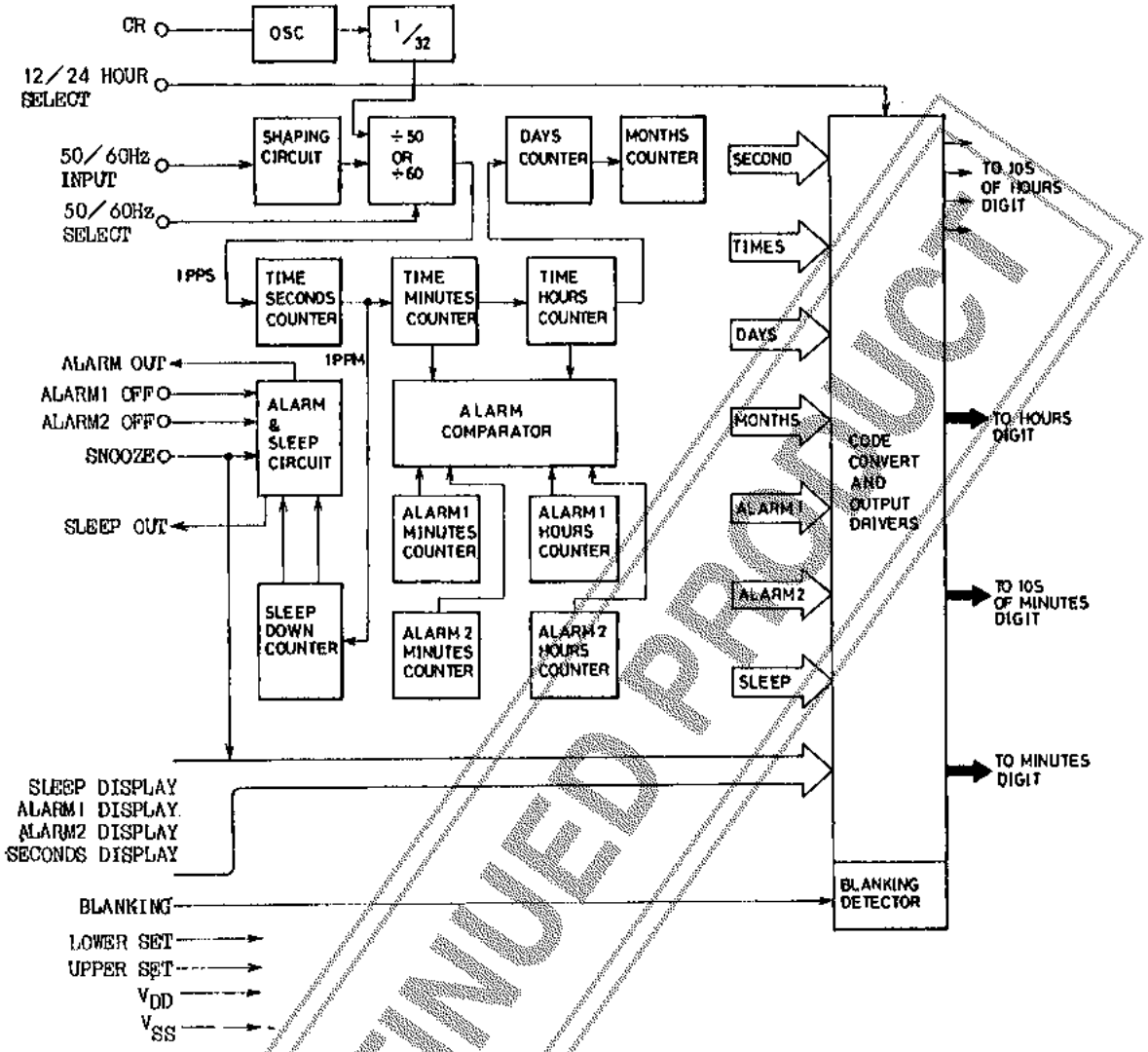
Equivalent Circuit Block Diagram



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

Absolute Maximum Ratings at Ta = 25°C, V_{SS} = 0

				unit
Maximum Supply Voltage	V_{DD} max		−18 to +0.3	V
Input Voltage	V_{IN}		V_{DD} − 0.3 to +0.3	V
Output Voltage	V_{OUT}	Output OFF	V_{DD} − 0.3 to +0.3	V
Allowable Power Dissipation	Pd max	Ta = 65°C	0.9	W
Operating Temperature	Topg		−30 to +65	°C
Storage Temperature	Tstg		−55 to +125	°C

Allowable Operating Conditions at Ta = 25°C, V_{SS} = 0V

			min	typ	max	unit
Supply Voltage	V_{DD}		−16	−12	−6.5	V
Input 'H'-Level Voltage	V_{IH}	V_{DD} = −6.5 to −16V	−1		0	V
Input 'L'-Level Voltage	V_{IL}	V_{DD} = −8.0 to −16V	V_{DD}		V_{DD}+2	V
		V_{DD} = −6.5 to −8V	V_{DD}		V_{DD}+1	V

Electrical Characteristics at Ta = 25°C, V_{SS} = 0V, V_{DD} = −9 to −15V			min	typ	max	unit
Output 'H'-Level Current						
ALARM OUT,SLEEP OUT	$I_{OH(1)}$	$V_{OH} = V_{SS} - 2.5V$	1.5			mA
b & c,a & d	$I_{OH(2)}$	$V_{OH} = V_{SS} - 2.5V$	10		※	mA
1Hz	$I_{OH(3)}$	$V_{OH} = V_{SS} - 2.5V$	15		※	mA
Other than above	$I_{OH(4)}$	$V_{OH} = V_{SS} - 2.5V$	5		※	mA
Output Leak Current						
ALARM OUT,SLEEP OUT	$I_{OL(1)}$	$V_{OL} = V_{DD}$			5	μA
Other than above	$I_{OL(2)}$	$V_{OL} = V_{DD}$			50	μA
Input Leak Current						
ACIN	$I_{IH(1)}$	$V_{IH} = V_{SS}$			5	μA
	I_{IL}	$V_{IL} = V_{DD}$	−5			μA
Input Current (Other than ACIN)	$I_{IH(2)}$	$V_{IH} = V_{SS}$	10		200	μA
Input Pin Open Voltage (Ohter than ACIN)	$V_{IL\,open}$	Pin open	V_{DD}		$V_{DD}+1$	V
Power Failure Detect Voltage	V_{Det}		−6.5	−4.5		V
Current Dissipation	I_{DD}	$V_{DD} = -10V$		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, V_{SS} = 0				unit
Maximum Supply Voltage	V_{DD} max		−23 to +0.3	V
Input Voltage	V_{IN}		V_{DD} −0.3 to +0.3	V
Output Voltage	V_{OUT}	Output OFF	V_{DD} −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, V_{SS} = 0V			min	typ	max	unit
Supply Voltage	V_{DD}		−21	−12	−6.5	V
Input 'H'-Level Voltage	V_{IH}	V_{DD} = −6.5 to −21V	−1		0	V
Input 'L'-Level Voltage	V_{IL}	V_{DD} = −8.0 to −21V	V_{DD}		$V_{DD}+2$	V
		V_{DD} = −6.5 to −8.0V	V_{DD}		$V_{DD}+1$	V

Electrical Characteristics at Ta = 25°C, V_{SS} = 0V, V_{DD} = −9 to −21V			min	typ	max	unit
Output 'H'-Level Current						
ALARM OUT,SLEEP OUT	$I_{OH(1)}$	$V_{OH} = V_{SS} - 2.5V$	1.5			mA
b & c,a & d	$I_{OH(2)}$	$V_{OH} = V_{SS} - 1.0V$	2			mA
1Hz	$I_{OH(3)}$	$V_{OH} = V_{SS} - 1.0V$	3			mA
Other than above	$I_{OH(4)}$	$V_{OH} = V_{SS} - 1.0V$	1			mA
Output Leak Current						
ALARM OUT,SLEEP OUT	$I_{OL(1)}$	$V_{OL} = V_{DD}$			5	μA
Other than above	$I_{OL(2)}$	$V_{OL} = V_{DD}$			2	μA
Input Leak Current						
ACIN	$I_{IH(1)}$	$V_{IH} = V_{SS}$			5	μA
	I_{IL}	$V_{IL} = V_{DD}$	−5			μA
Input Current (Other than ACIN)	$I_{IH(2)}$	$V_{IH} = V_{SS}$	10		200	μA
Input Pin Open Voltage (Ohter than ACIN)	$V_{IL\,open}$	Pin open	V_{DD}		$V_{DD}+1$	V
Power Failure Detect Voltage	V_{Det}		−6.5	−4.5		V
Current Dissipation	I_{DD}	$V_{DD} = -10V$		6	10	mA

1. Display

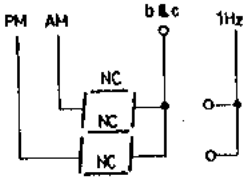
1-1 4-digit 7-segment static lighting format.

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

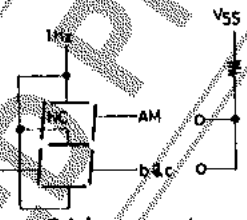
1-2 Display mode

· 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/data 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.

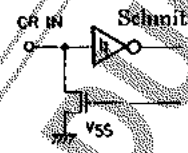
2. Input Configuration

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 1MΩ.
- 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 Schimtt 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.	
	LOWER	Minutes advance at a 2Hz rate.	No carry to hours occurs.
	BOTH	Minutes advance at a 5Hz rate.	Seconds are cleared to 00.
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 5Hz rate.	

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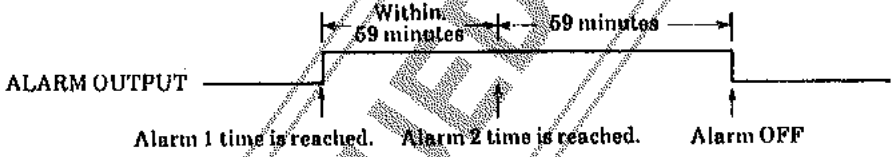
Display mode	Setting	Operation contents
Month/date display	UPPER	Month (date) advances at a 2Hz rate. ( ) : 24-hour system.
	LOWER	Date (month) advances at a 2Hz rate. No carry occurs from the low-order digit
	BOTH	Date (month) advances at a 5Hz rate. to the high-order digit.
Sleep display	UPPER	No operation.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

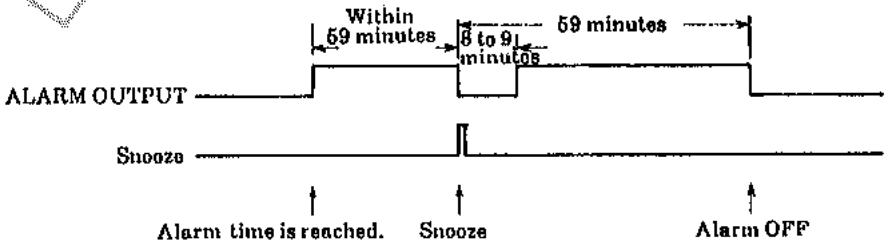
The following alarm operation is available corresponding to the level setting of ALARM 1 OFF INPUT and ALARM 2 OFF INPUT.

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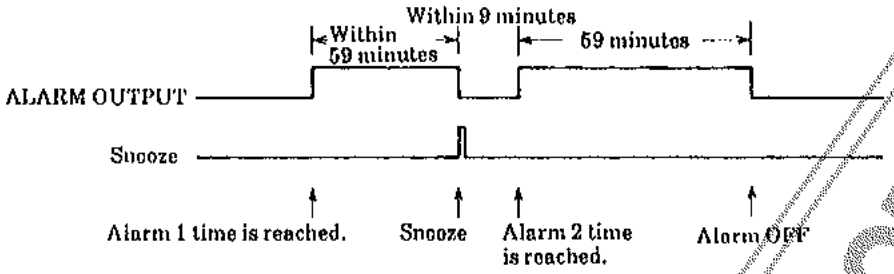
When the alarm 2 time is reached during the snooze operation, the snooze operation will be released at this point of time and ALARM 2 OUTPUT will be turned ON.



(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 lapes 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

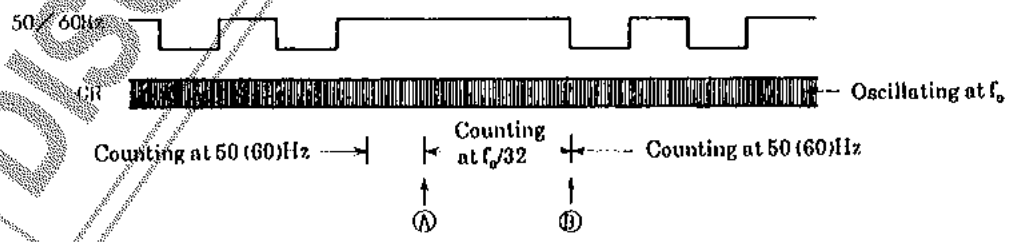
(1) $|V_{DD}|$ min. for the normal operation of LSI system is 6.5V

(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 $\frac{1}{f_o} \times 64$ (sec.), the reference frequency will be changed-over from 50/60Hz to f_o/32Hz.

Ⓑ : The moment 50/60Hz INPUT receives the input, the reference frequency will be changed-over from f_o/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 Ⓐ to Ⓑ 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.

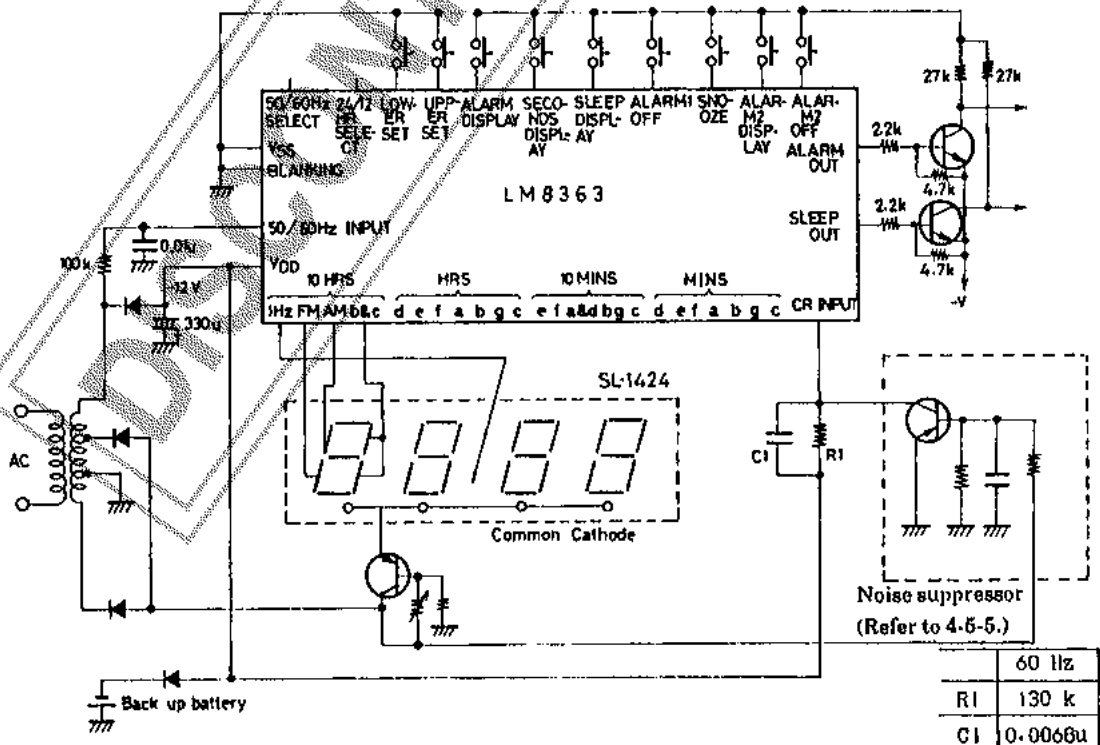
4-7 12/24-hour system selection
The display content is selected as follows by use of 24/12 HRS SELECT.

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

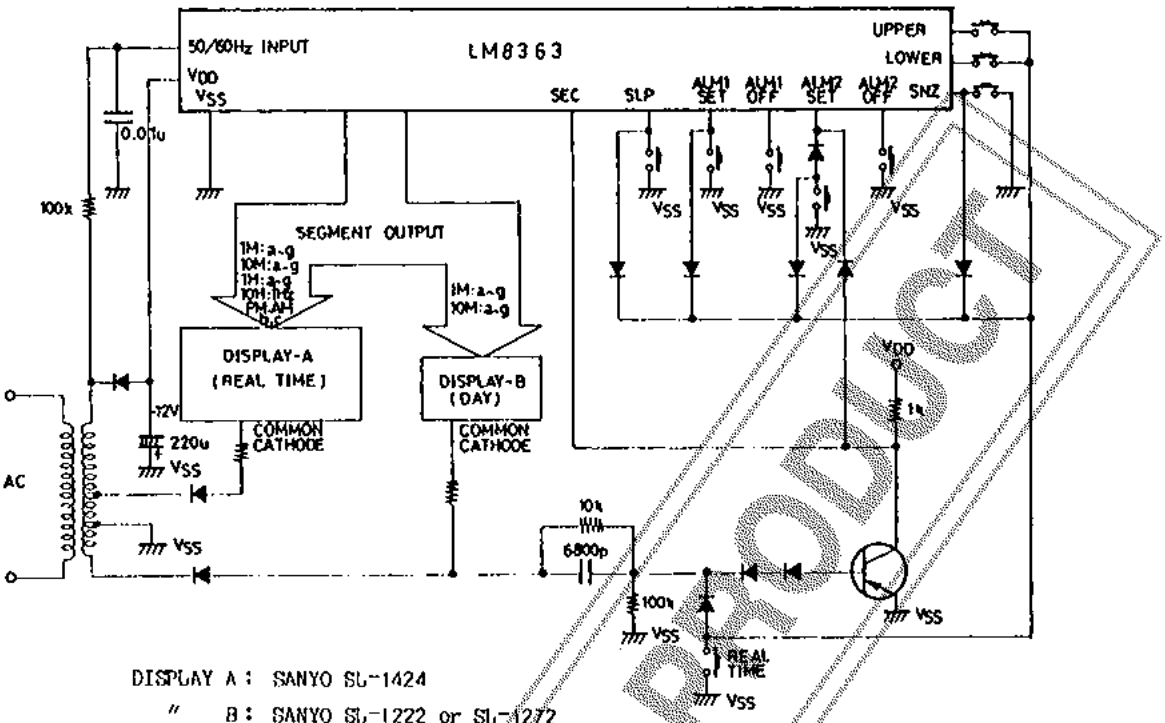
Rank	Display tube		Remarks
	LED (red)	Fluorescent display tube	
LM8363D	○		
LM8363DH		○	
LM8363N	○	○	
LM8363S	○	○	For use in industrial applications

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



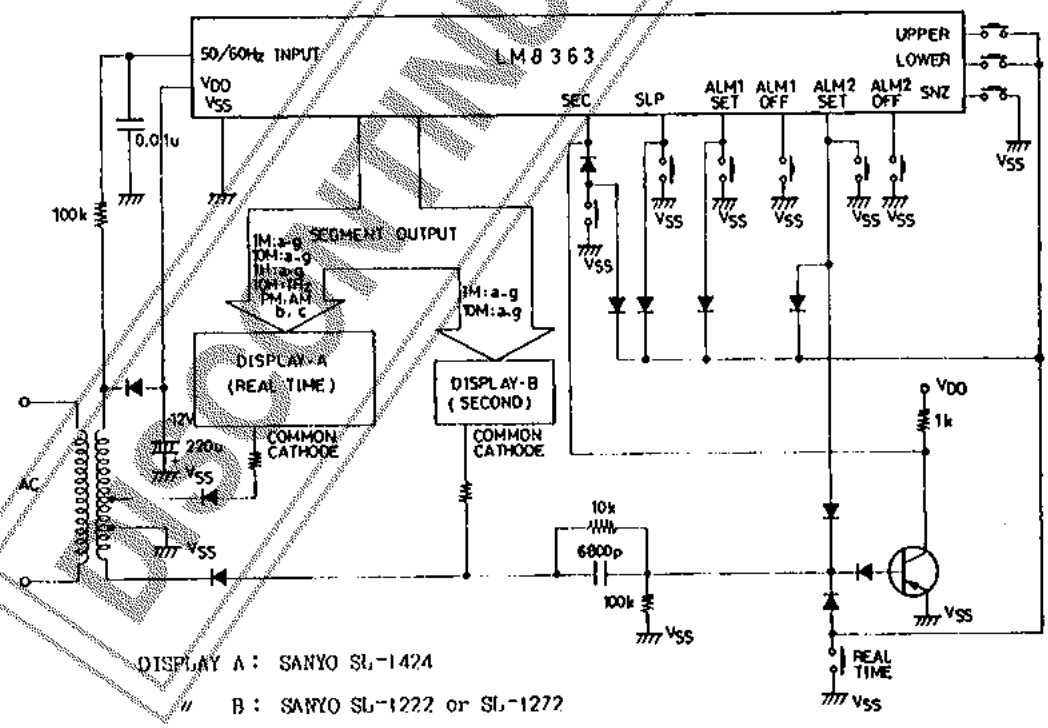
	60 Hz	50 Hz
R1	130 k	150 k
C1	0.0068u	0.0068u
f_O	1.92 k	1.6 k

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



DISPLAY A : SANYO SL-1424
" B : SANYO SL-1222 or SL-1272

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



DISPLAY A : SANYO SL-1424
" B : SANYO SL-1222 or SL-1272