

**SANYO**

No.3490B

**LM8560N, 8560B****Digital Alarm Clock**

## Overview

Both the LM8560N and LM8560B are alarm equipped digital clock ICs with built-in drivers capable of directly driving LED display equipment. As ICs themselves, the  $V_{DD}$  pin for the LM8560N is graded to withstand a voltage of 15V while the LM8560B  $V_{DD}$  is graded for up to 17 V.

## Applications

- Alarm clocks
- Clock-radios

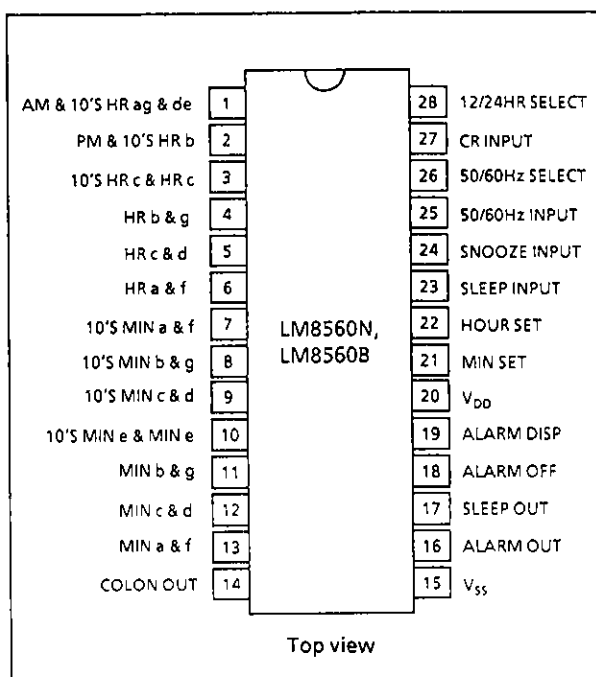
## Functions

- Current time display
- Snooze alarm function
- Sleep timer function (maximum intervals of 59 minutes or 1 hour and 59 minutes)

## Features

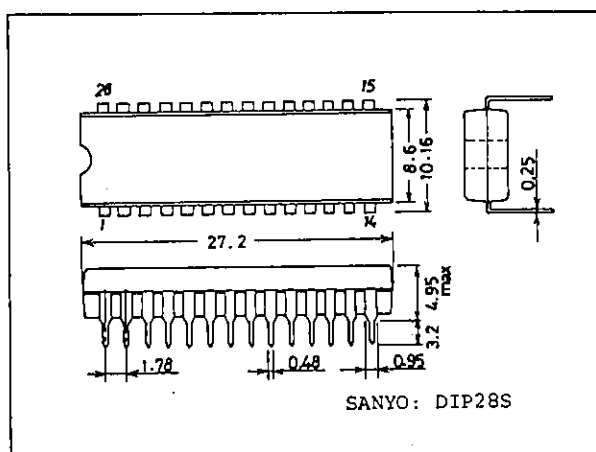
- Single chip P-channel ED MOS LSI
- LED direct drive using time division (duplex configuration)
- Wide operating power supply voltage range
- Built-in alarm function with 24-hour control
- Supports changeover between 12-hour AM/PM and 24-hour displays
- Built-in battery backup CR oscillator
- Uses 50Hz or 60Hz as standard frequency
- Built-in automatic fast forward function for hour and minute settings
- Built-in sleep timer function (maximum intervals for 59 minutes or 1 hour and 59 minutes)
- Built-in snooze function supporting repeat use
- Equipped with power failure display function
- 900Hz output for alarm tone

## Pin Assignment



## Package Dimensions

unit : mm

**3029A-DIP28S**

## Description of Operations

- 50/60 Hz Input : Built-in Shmidt circuit enables noise elimination at 50/60Hz commercial frequencies with use of a simple CR filter. Built-in pull-up resistor.
- CR Input : When the AC power supply is interrupted, the time counter switches to a holding state and a built-in oscillator promptly begins operation. If 50/60Hz input continues for 3 clocks without arriving, this oscillator's output is activated and functions as the time counter clock in place of 50/60Hz input. The frequency level of this clock oscillator is determined according to the CR value. While the above mentioned oscillator is operating using backup mode, all segment output is switched to OFF.  
(Note) When the backup oscillator is in use due to an AC power supply interruption, the 50/60Hz input pin must be maintained open or at a  $V_{SS}$  level.
- 50/60 Selective Input : When 50/60 selective input is connected to  $V_{SS}$ , 50Hz use is enabled. When 50/60 selective input is left open,  $V_{DD}$  is activated using an internal pull-down resistor and the setting is switched to enable use at 60Hz.
- Display Mode Selective Input (Alarm Select/ Sleep Select):  
Since the pull-down resistor is built-in, selection from four display modes is possible using two SPST switches (single-pole and single-throw switches). Table 1 shows these display mode selections.

**Table 1 Display Modes**

| Selective Input |          | Display Mode   | Digit No. 1                | Digit No. 2 | Digit No. 3           | Digit No. 4 |
|-----------------|----------|----------------|----------------------------|-------------|-----------------------|-------------|
| Alarm           | Sleep    |                |                            |             |                       |             |
| NC              | NC       | Time display   | 10's place for hour, AM/PM | Hour        | 10's place for minute | Minute      |
| $V_{SS}$        | NC       | Alarm display  | 10's place for hour, AM/PM | Hour        | 10's place for minute | Minute      |
| NC              | $V_{SS}$ | Sleep display  | Clear                      | Hour        | 10's place for minute | Minute      |
| $V_{SS}$        | $V_{SS}$ | Second display | Clear                      | Minute      | 10's place for second | Second      |

Note: Activating  $V_{SS}$  using two inputs simultaneously (alarm select and sleep select), the display mode is switched to display seconds.

- Time Setting Input : There are two setting inputs for use with "hour" and "minute". Time content settings shown in Table 2 are possible by activating  $V_{SS}$  to these pins. A pull-down resistor is built-in.

**Table 2 Setting Contents**

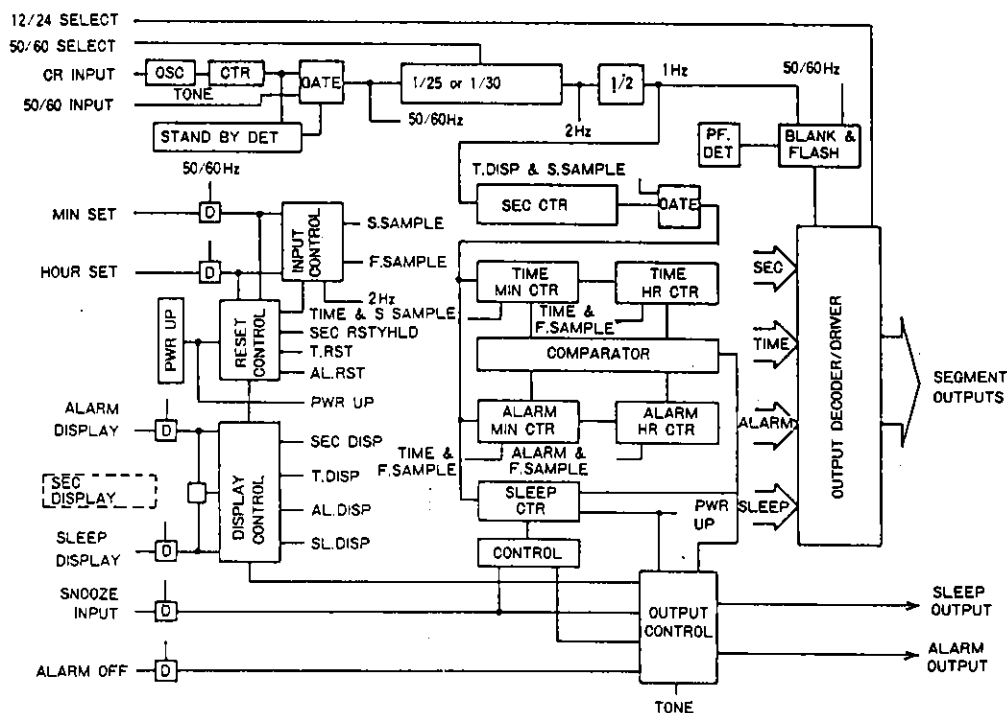
| Display Mode           | Set Input                    | Functions                                                                                                                                                                                                                                                                                    |
|------------------------|------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Time                   | HOURL                        | Immediately adds 1 to hour digits and then assigns an additional 1, at a speed of 2 Hz, after each 1/4 to 3/4 second.                                                                                                                                                                        |
|                        | MIN                          | Immediately adds 1 to minute digits and then assigns an additional 1, at a speed of 2 Hz, after each 1/4 to 3/4 second.                                                                                                                                                                      |
|                        | BOTH                         | Seconds are reset.<br>Operates both as outline above.                                                                                                                                                                                                                                        |
| Second (Alarm & Sleep) | HOURL (Note)<br>MIN<br>BOTH* | Second digits are cleared to [00].<br>Time holds.<br>Resets hour and minute digits as [0:00] when operating in 24-H mode or [12:00] when operating in 12-H mode.                                                                                                                             |
| Alarm                  | HOURL                        | Immediately adds 1 to hour digits and then assigns an additional 1, at a speed of 2 Hz, after each 1/4 to 3/4 second.                                                                                                                                                                        |
|                        | MIN                          | Immediately adds 1 to minute digits and then assigns an additional 1, at a speed of 2 Hz, after each 1/4 to 3/4 second.                                                                                                                                                                      |
|                        | BOTH                         | Resets hour and minute digits to [0:00] when operating in 24-hour mode or [12:00] when operating in 12-hour mode.                                                                                                                                                                            |
| Sleep                  | —<br>HOURL<br>MIN<br>BOTH    | Sets sleep counter to [0:59] instantly when $V_{DD}$ is activated to sleep select.<br>Sets sleep counter to [1:59] instantly when $V_{DD}$ is activated to sleep select and hour at the same time.<br>Sleep counter loses 1 at a speed of 2 Hz.<br>Sleep counter loses 1 at a speed of 2 Hz. |

\* Once conditions have been switched to reset or hold, input of other functions is locked until both HOURL and MIN input have been separated.

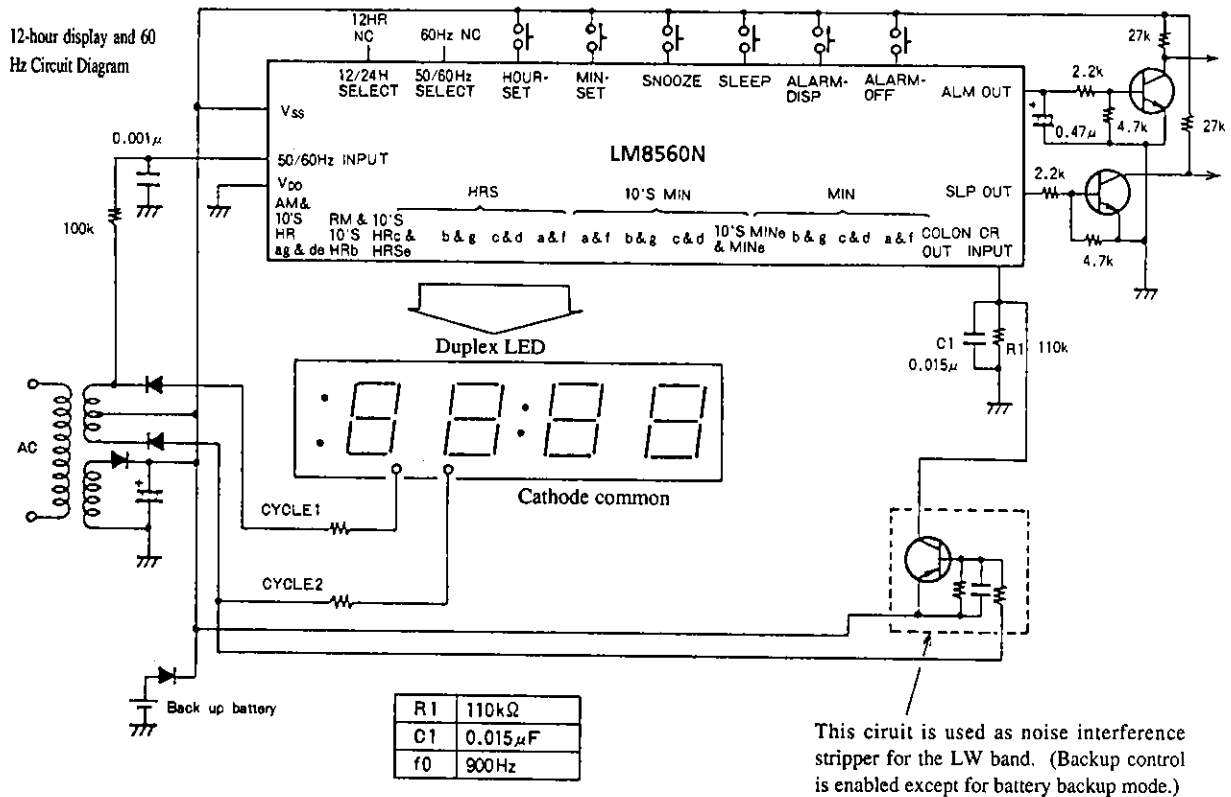
Note: When the digital reading for seconds is between 30 and 59 seconds, 1 is added to the digits for minutes as the digital reading for seconds resets to [00].

- **12/24H Select Input** : When this pin is set open ( $V_{DD}$ ), a 12-hour display is enabled whereas connecting this pin to  $V_{SS}$  enables the 24-hour display. A pull-down resistor is built-in.
- **Power Failure Detection Display** :  
When activated by drop in power supply, all segments which are lit begin to blink and the unit switches to a power failure detection display.  
The power failure detection display is canceled by activating  $V_{SS}$  to HOUR SET or MIN SET.
- **Alarm Operation and Alarm Output** :  
The alarm signal outputs when alarm content matches the content of current time. When not reset by either snooze input or alarm off input, output continues after 1 hour and 59 minutes. This output signal consists of 900 Hz 2 Hz intermittent (50% duty) modulation signals. When the need arises, a filter can be applied to alter the alarm signal to a DC signal.
- **Snooze Input** :  
When the alarm is sounding and instantly activating  $V_{SS}$  to this pin, alarm output is set to OFF for a period between 8 and 9 minutes after which time the alarm signal is once again output. The snooze function can be used repeatedly in 1 hour and 59 minutes intervals. A pull-down resistor is built-in. Activating  $V_{SS}$  to the snooze pin when the alarm is OFF resets the sleep timer counter to [0:00]. (This is known as the one-touch sleep timer reset function.)
- **Alarm Off Input** :  
Activating this input pin to  $V_{SS}$  instantly sets alarm output to OFF. A pull-down resistor is built-in.
- **Sleep Timer and Sleep Output** :  
Sleep output can turn on the radio and can be set for time intervals of 59 minutes or 1 hour and 59 minutes. Refer to Table 2 for the proper selection procedure (59 minutes or 1 hour and 59 minute selection). This sleep timer is constructed using a down counter and when the counter content arrives at [00], output is set to off and the radio turns off. Adding  $V_{SS}$  to snooze input turns sleep output off. When sleep output is on.

## Block Diagram

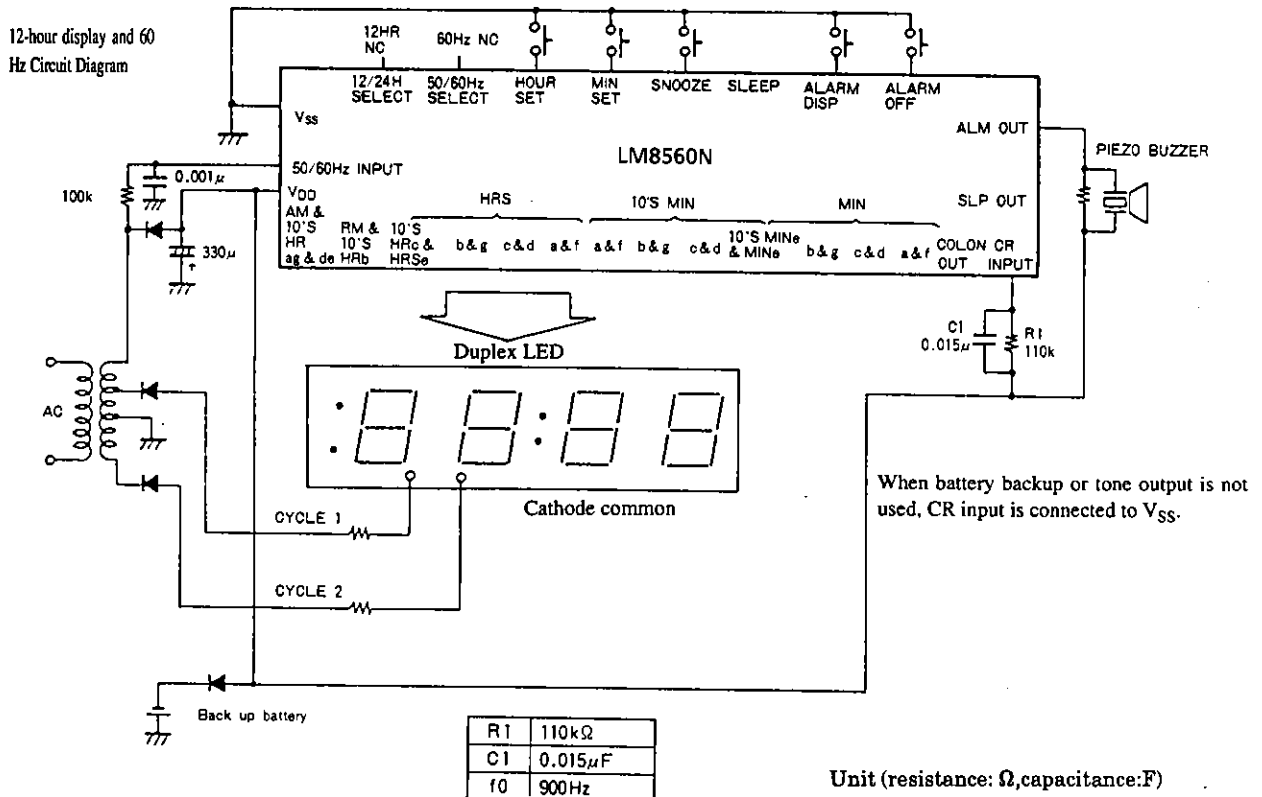


## Clock-radio Applied Circuit Diagram (+ power supply)



## Clock Applied Circuit Diagram (- power supply)

Unit (resistance: Ω, capacitance: F)



Unit (resistance: Ω, capacitance: F)

## [LM8560N]

## Specifications

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

|                             |              |                          |               | unit             |
|-----------------------------|--------------|--------------------------|---------------|------------------|
| Maximum supply voltage      | $V_{DD}$ max |                          | -15.0 to +0.3 | V                |
| Input voltage (1)           | $V_{IN}$ (1) | 50/60Hz INPUT            | -15.0 to +0.3 | V                |
| Input voltage (2)           | $V_{IN}$ (2) | Except 50/60Hz INPUT     | -15.0 to +0.3 | V                |
| Output voltage              | $V_{OUT}$    |                          | -15.0 to +0.3 | V                |
| Input clamp current         | $I_{IN}$     | 50/60Hz INPUT            | -0.4 to +0.4  | mA               |
| Allowable power dissipation | $P_d$ max    | $T_a = 70^\circ\text{C}$ | 0.7           | W                |
| Operating temperature       | $T_{opr}$    |                          | -30 to +70    | $^\circ\text{C}$ |
| Storage temperature         | $T_{stg}$    |                          | -55 to +125   | $^\circ\text{C}$ |

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

|                                 |                         |                                     | min                   | typ | max          | unit |
|---------------------------------|-------------------------|-------------------------------------|-----------------------|-----|--------------|------|
| Supply voltage                  | $V_{DD}$                |                                     | -14.0                 |     | -7.5         | V    |
| Input "H" level voltage (1)     | $V_{IH}$ (1)            | 50/60Hz INPUT                       | -1.0                  |     |              | V    |
| Input "L" level voltage (1)     | $V_{IL}$ (1)            | 50/60Hz INPUT                       |                       |     | $V_{DD} + 2$ | V    |
| Input "H" level voltage (2)     | $V_{IH}$ (2)            | Except 50/60Hz INPUT                | -1.5                  |     |              | V    |
| Input "L" level voltage (2)     | $V_{IL}$ (2)            | Except 50/60Hz INPUT                |                       |     | $V_{DD} + 2$ | V    |
| 50/60Hz input pin input voltage | $V_{AC-IN}$<br>(Note 1) | Sets $V_{SS}$ as reference (Note 2) | $V_{LED}$<br>(Note 1) |     |              | V    |

Electrical Characteristics at  $T_a = 25^\circ\text{C}$ ,  $V_{DD} = -12\text{V}$ 

|                                    |              |                                                                                 | min  | typ  | max | unit          |
|------------------------------------|--------------|---------------------------------------------------------------------------------|------|------|-----|---------------|
| Input "H" level current (1)        | $I_{IH}$ (1) | 50/60Hz INPUT, $V_{IN} = V_{SS}$                                                |      |      | 10  | $\mu\text{A}$ |
| Input "L" level current (1)        | $I_{IL}$ (1) | 50/60Hz INPUT, $V_{IN} = V_{DD}$                                                |      |      | 10  | $\mu\text{A}$ |
| Input "H" level current (2)        | $I_{IH}$ (2) | Input pins other than 50/60 Hz input<br>$V_{IN} = V_{SS}$                       |      |      | 20  | $\mu\text{A}$ |
| Input "L" level current (2)        | $I_{IL}$ (2) | Input pins other than 50/60 Hz input<br>$V_{IN} = V_{DD}$                       |      |      | 10  | $\mu\text{A}$ |
| Output "H" level current (1)       | $I_{OH}$ (1) | Alarm output and sleep output<br>$V_{OH} = V_{SS} - 1\text{V}$                  | 5    |      |     | mA            |
| Output leakage current (1)         | $I_{OF}$ (1) | Alarm output and sleep output<br>$V_{OUT} = V_{DD}$                             |      |      | 10  | $\mu\text{A}$ |
| Output "H" level current (2)       | $I_{OH}$ (2) | AM & 10'S HR ag & de<br>(24Hmode), $V_{OUT} = V_{DD} - 1\text{V}$               | 36   |      |     | mA            |
| Output leakage current (2)         | $I_{OF}$ (2) | AM & 10'S HR ag & de<br>(24Hmode), $V_{OUT} = V_{DD}$                           |      |      | 20  | $\mu\text{A}$ |
| Output "H" level current (3)       | $I_{OH}$ (3) | Segment output other than those<br>listed above, $V_{OUT} = V_{SS} - 1\text{V}$ | 18   |      |     | mA            |
| Output leakage current (3)         | $I_{OF}$ (3) | Segment output other than those<br>listed above, $V_{OUT} = V_{DD}$             |      |      | 20  | $\mu\text{A}$ |
| Power failure detection voltage    | $V_{DD}$     |                                                                                 | -7.5 | -5.0 |     | V             |
| Consumption current                | $I_{CC}$     | Output set to off and pull-down<br>attached input set open                      |      | 5    | 7   | mA            |
| Backup oscillator stability factor | $F_s$        | Standard value, 900Hz, $V_{DD} = -9\text{V} \pm 10\%$                           | -10  |      | 10  | %             |
| Backup oscillator accuracy         | $F_a$        | Standard value, 900Hz, $V_{DD} = -9\text{V}$                                    | -10  |      | 10  | %             |

## [LM8560B]

## Specifications

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

|                             |              |                          |               | unit             |
|-----------------------------|--------------|--------------------------|---------------|------------------|
| Maximum supply voltage      | $V_{DD}$ max |                          | -17.0 to +0.3 | V                |
| Input voltage (1)           | $V_{IN}$ (1) | 50/60Hz INPUT            | -17.0 to +0.3 | V                |
| Input voltage (2)           | $V_{IN}$ (2) | 50/60Hz INPUT            | -17.0 to +0.3 | V                |
| Output voltage              | $V_{OUT}$    |                          | -17.0 to +0.3 | V                |
| Input clamp current         | $I_{IN}$     | 50/60Hz INPUT            | -0.4 to +0.4  | mA               |
| Allowable power dissipation | $P_d$ max    | $T_a = 70^\circ\text{C}$ | 0.7           | W                |
| Operating temperature       | $T_{opr}$    |                          | -30 to +70    | $^\circ\text{C}$ |
| Storage temperature         | $T_{stg}$    |                          | -55 to +125   | $^\circ\text{C}$ |

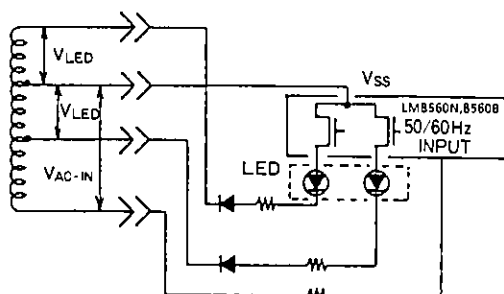
Allowable Operating Ranges at  $T_a = 25^\circ\text{C}$ ,  $V_{SS} = 0\text{V}$ 

|                                 |                         |                                                | min   | typ                   | max          | unit |
|---------------------------------|-------------------------|------------------------------------------------|-------|-----------------------|--------------|------|
| Supply voltage                  | $V_{DD}$                |                                                | -14.0 |                       | -6.5         | V    |
| Input "H" level voltage (1)     | $V_{IH}$ (1)            | 50/60Hz INPUT                                  | -1.0  |                       |              | V    |
| Input "L" level voltage (1)     | $V_{IL}$ (1)            | 50/60Hz INPUT, $V_{DD} \leq -8\text{V}$        |       |                       | $V_{DD} + 2$ | V    |
|                                 |                         | 50/60Hz INPUT, $V_{DD} > -8\text{V}$           |       |                       | $V_{DD} + 1$ | V    |
| Input "H" level voltage (2)     | $V_{IH}$ (2)            | Except 50/60Hz INPUT, $V_{DD} \leq -8\text{V}$ | -1.5  |                       |              | V    |
|                                 |                         | Except 50/60Hz INPUT, $V_{DD} > -8\text{V}$    | -1.0  |                       |              | V    |
| Input "L" level voltage (2)     | $V_{IL}$ (2)            | Except 50/60Hz INPUT, $V_{DD} \leq -8\text{V}$ |       |                       | $V_{DD} + 2$ | V    |
|                                 |                         | Except 50/60Hz INPUT, $V_{DD} > -8\text{V}$    |       |                       | $V_{DD} + 1$ | V    |
| 50/60Hz input pin input voltage | $V_{AC-IN}$<br>(Note 1) | Sets $V_{SS}$ as reference (Note 2)            |       | $V_{LED}$<br>(Note 1) |              | V    |

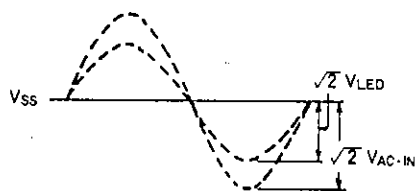
Electrical Characteristics at  $T_a = 25^\circ\text{C}$ ,  $V_{DD} = -12\text{V}$ 

|                                    |              |                                                                                 | min  | typ  | max | unit          |
|------------------------------------|--------------|---------------------------------------------------------------------------------|------|------|-----|---------------|
| Input "H" level current (1)        | $I_{IH}$ (1) | 50/60Hz INPUT, $V_{IN} = V_{SS}$                                                |      |      | 2   | $\mu\text{A}$ |
| Input "L" level current (1)        | $I_{IL}$ (1) | 50/60Hz INPUT, $V_{IN} = V_{DD}$                                                |      |      | 10  | $\mu\text{A}$ |
| Input "H" level current (2)        | $I_{IH}$ (2) | Input pins other than 50/60 Hz input<br>$V_{IN} = V_{SS}$                       |      |      | 20  | $\mu\text{A}$ |
| Input "L" level current (2)        | $I_{IL}$ (2) | Input pins other than 50/60 Hz input<br>$V_{IN} = V_{DD}$                       |      |      | 2   | $\mu\text{A}$ |
| Output "H" level current (1)       | $I_{OH}$ (1) | Alarm output and sleep output<br>$V_{OH} = V_{SS} - 1\text{V}$                  | 5    |      |     | mA            |
| Output leakage current (1)         | $I_{OF}$ (1) | Alarm output and sleep output<br>$V_{OUT} = V_{DD}$                             |      |      | 10  | $\mu\text{A}$ |
| Output "H" level current (2)       | $I_{OH}$ (2) | AM & 10'S HR ag & de<br>(24Hmode), $V_{OUT} = V_{SS} - 1\text{V}$               | 36   |      |     | mA            |
| Output leakage current (2)         | $I_{OF}$ (2) | AM & 10'S HR ag & de<br>(24Hmode), $V_{OUT} = V_{DD}$                           |      |      | 20  | $\mu\text{A}$ |
| Output "H" level current (3)       | $I_{OH}$ (3) | Segment output other than those<br>listed above, $V_{OUT} = V_{SS} - 1\text{V}$ | 18   |      |     | mA            |
| Output leakage current (3)         | $I_{OF}$ (3) | Segment output other than those<br>listed above, $V_{OUT} = V_{DD}$             |      |      | 20  | $\mu\text{A}$ |
| Power failure detection voltage    | $V_{DD}$     |                                                                                 | -6.5 | -5.0 |     | V             |
| Consumption current                | $I_{CC}$     | Output set to off and pull-down<br>attached input set open                      |      | 5    | 7   | mA            |
| Backup oscillator stability factor | $F_s$        | Standard value, 900Hz, $V_{DD} = -9\text{V} \pm 10\%$                           | -10  |      | 10  | %             |
| Backup oscillator accuracy         | $F_a$        | Standard value, 900Hz, $V_{DD} = -9\text{V}$                                    | -10  |      | 10  | %             |

(Note 1)



(Note 2)



[Fig. 2]

$V_{AC-IN}$  represents the average value for input voltage of the 50/60 Hz input pin.

$V_{LED}$  represents the average value for power supply voltage for LED usage.

The above values represent those gained under no-load conditions.

[Fig. 1]

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