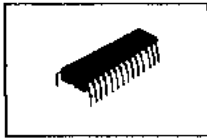




No.1543



LM8560

P MOS LSI  
DIGITAL ALARM CLOCK

**Applications**

- . Alarm clock
- . Clock radio

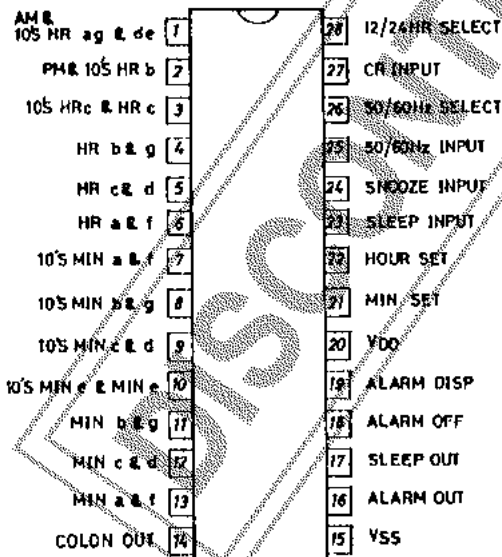
**Functions**

- . Real time display
- . Alarm with snooze
- . Sleep timer (max. 59 minutes or 1 hour 59 minutes)

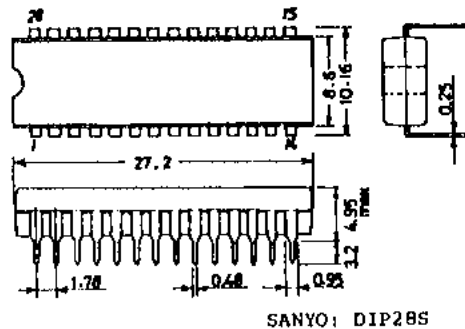
**Features**

- (1) Single-chip ED MOS LSI
- (2) LED direct drive by time-sharing (duplex)
- (3) Wide operating voltage range
- (4) Alarm on a 24-hour basis
- (5) Two selections of time format: AM/PM 12-hour basis and 24-hour basis.
- (6) On-chip CR oscillator for battery backup.
- (7) 50Hz or 60Hz is usable as the reference frequency.
- (8) Possible to automatically advance "hours", "minutes"
- (9) Sleep timer (max. 59 minutes or 1 hour 59 minutes)
- (10) Repeatedly usable snooze
- (11) Power failure indicator
- (12) 900Hz output for alarm tone

**Pin Assignment**



Case Outline 3029A-D28SIC (unit:mm)



These specifications are subject to change without notice.

TOKYO SANYO ELECTRIC CO. LTD. SEMICONDUCTOR DIVISION  
15-13 6-CHOME SOTOKANDA, CHIYODA KU, TOKYO 100 JAPAN

### Operation Description

- 50Hz/60Hz input: The on-chip Schmitt trigger circuit allows a simple RC filter at the input to remove possible line voltage transients. An internal pull-up resistor is provided.
- CR input: When AC power-down occurs, the time counter enters the "hold" mode and the on-chip clock oscillator starts operating immediately. If there is no input at "50/60Hz input" during 3-clock period, this oscillator controls the time counter advance instead of "50/60Hz input". The values of CR determine the frequency of the on-chip clock oscillator. All segment outputs are off during backup oscillator operation.  
(Note) If the backup OSC is used at the power-down mode, "50/60Hz input" must be open or at  $V_{SS}$  level.
- 50/60 select input: Connecting "50/60Hz select" to  $V_{SS}$  enables 50Hz operation. For 60Hz operation, "50/60Hz select" is left unconnected. Pull-down to  $V_{DD}$  is provided by the internal pull-down resistor.
- Display mode select input (alarm display/sleep display)  
The internal pull-down resistor allows the use of 2 SPST (single-pole single-throw) switches to select 4 display modes listed in Table 1.

Table 1. Display Mode

Select Input		Display Mode	Digit No.1	Digit No.2	Digit No.3	Digit No.4
Alarm	Sleep					
NC	NC	Time display	10's hour, AM/PM	hour	10's minute	Minute
$V_{SS}$	NC	Alarm display	10's hour, AM/PM	hour	10's minute	Minute
NC	$V_{SS}$	Sleep display	Blanked	hour	10's minute	Minute
$V_{SS}$	$V_{SS}$	Seconds display	Blanked	Minute	10' second	Second

(Note) If  $V_{SS}$  is applied to 2 input of "alarm display" and "sleep display" simultaneously, the seconds display mode is entered.

Time setting input: Two setting inputs for 'hours' and 'minutes' are provided. The application of  $V_{SS}$  causes the time setting in Table 2 to occur. An internal pull-down resistor each is provided.

Table 2. Setting Contents

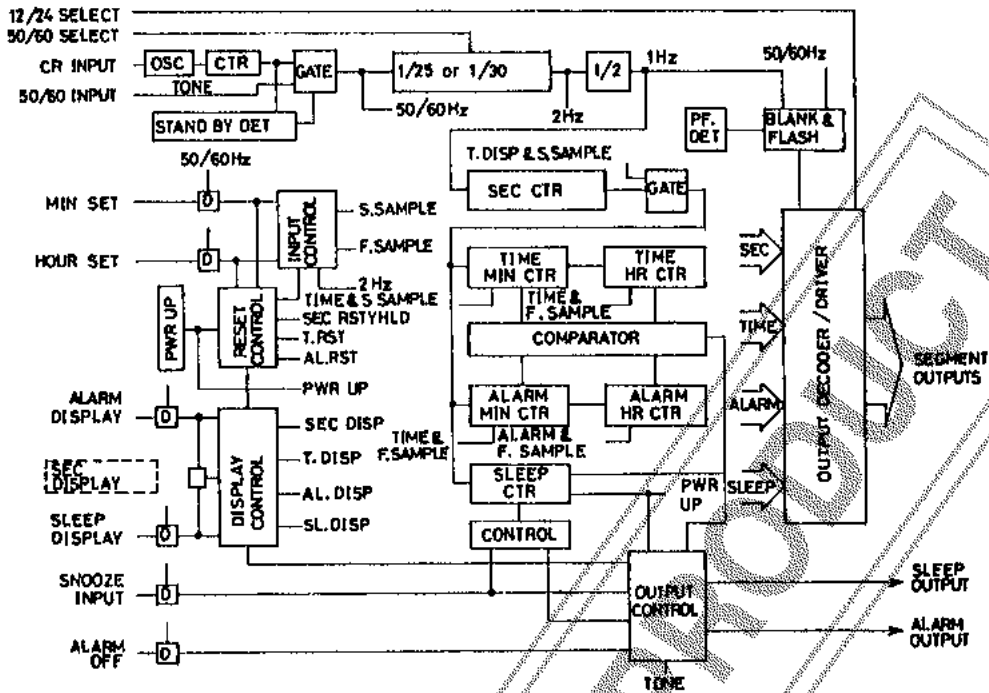
Display Mode	Set Input	Functions
Time	HOUR	'Hours' are incremented +1 immediately and advance at a 2Hz rate 1/4 to 3/4 second later.
	MIN	'Minutes' are incremented +1 immediately and advance at a 2Hz rate 1/4 to 3/4 second later.
	BOTH	'Seconds' are reset. Both operations shown above are performed.
Seconds (Alarm & Sleep)	HOUR(Note)	'Seconds' are cleared to [00].
	MIN	"Hold" mode.
	BOTH*	'Hours' and 'minutes' are reset to [0:00] (24-hour basis) or [12:00] (12-hour basis).

Display Mode	Set Input	Functions
Alarm	HOURL	'Hours' are incremented +1 immediately and advance at a 2Hz rate 1/4 to 3/4 second later.
	MIN	'Minutes' are incremented +1 immediately and advance at a 2Hz rate 1/4 to 3/4 second later.
	BOTH	'Hours' and 'Minutes' are reset to [0:00] (24-hour basis) or [12:00] (12-hour basis).
Sleep	HOURL	The moment $V_{DD}$ is applied to "sleep display", the sleep counter is set to [0:59].
	MIN	The moment $V_{DD}$ is applied to "sleep display" and "hour set" simultaneously, the sleep counter is set to [1:59].
	BOTH	The sleep counter counts down at a 2Hz rate.

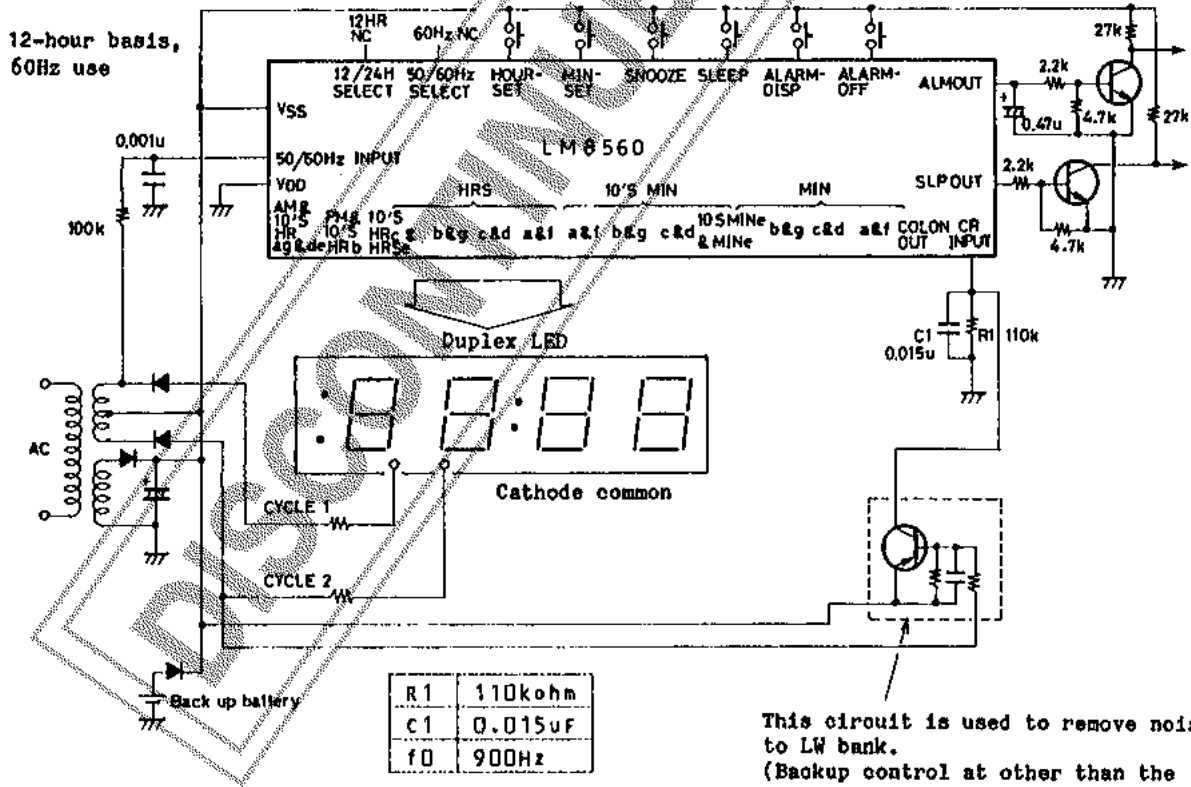
\* Once the reset mode or hold mode is entered, another function input is locked until both "hour set" input and "minute set" input are released.  
 (Note) When "seconds" display is at 50 to 59, "seconds" are reset to [00] and a carry occurs to increment "minutes" +1.

- 12/24-hour select input: Leaving this pin unconnected ( $V_{DD}$ ) causes the 12-hour basis to be selected; connecting this pin to  $V_{SS}$  causes the 24-hour basis to be selected. An internal pull-down resistor is provided.
- Power failure indication: If the power supply voltage drops and is applied again, all the on-segments flash and the power failure indication mode is entered. The power failure indication mode is released by applying  $V_{SS}$  to "hour set" or "minutes set".
- Alarm operation and alarm output: When the alarm set time is reached, the alarm signal is delivered. This signal continues to be delivered for 1 hour 59 minutes unless reset by "alarm off" or "snooze input". This signal is provided for the tone-signal of 900Hz with 50% duty of 2Hz gated. A simple LPF can be used to turn this alarm signal into DC signal as required.
- Snooze input: By momentarily connecting this pin to  $V_{SS}$  at the alarm on-state, the alarm output is inhibited for 8 to 9 minutes, after which the alarm signal is delivered again. The snooze function can be used repeatedly for 1 hour 59 minutes. An internal pull-down resistor is provided. By connecting "snooze input" to  $V_{SS}$  at the alarm off-state, the sleep timer counter is reset to [0:00]. (The sleep timer is reset with one touch.)
- Alarm off input: Connecting this input pin to  $V_{SS}$  inhibits the alarm output momentarily. An internal pull-down resistor is provided.
- Sleep timer and sleep output: The sleep output can be used to keep the radio turned on for any period of time up to 59 minutes or 1 hour 59 minutes. Table 2 shows how to select the period (59 minutes or 1 hour 59 minutes). This sleep timer uses a down counter. When the counter contents reach [00], the output stops being delivered, turning off the radio. By connecting "snooze input" to  $V_{SS}$  at the sleep output on-state, the sleep output is inhibited.

Block Diagram



Sample Application Circuit for Clock Radio Use (+ power supply)

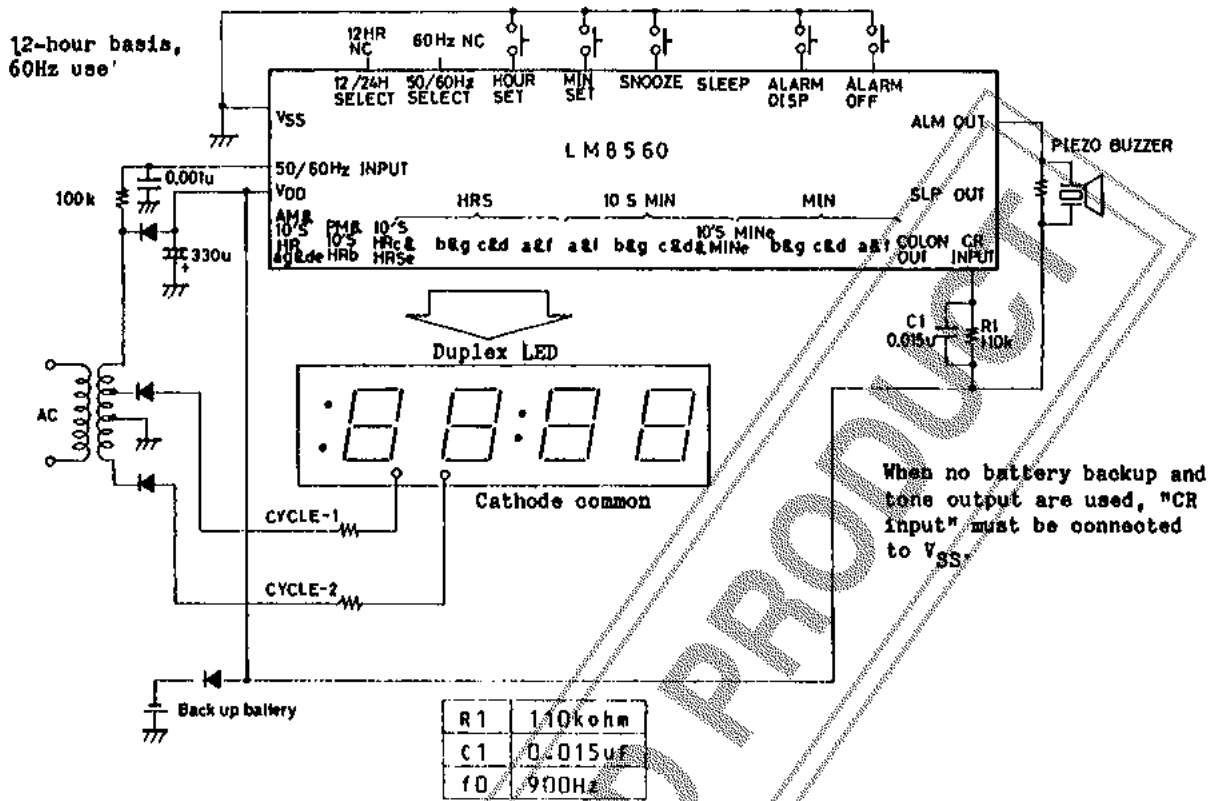


R1	110k $\Omega$
C1	0.015 $\mu$ F
f0	900Hz

This circuit is used to remove noise to LW bank.  
(Backup control at other than the battery backup mode)

LM8560

Sample Application Circuit for Clock Use (- power supply)



LM8560B

Absolute Maximum Ratings at Ta=25°C, VSS=0V

			unit
Maximum Supply Voltage	V <sub>DD max</sub>	-17.0 to +0.3	V
Input Voltage (1)	V <sub>IN(1)</sub> 50/60Hz INPUT	-17.0 to +0.3	V
Input Voltage (2)	V <sub>IN(2)</sub> Other than 50/60Hz INPUT	-17.0 to +0.3	V
Output Voltage	V <sub>OUT</sub>	-17.0 to +0.3	V
Input Clamp Current	I <sub>IN</sub> 50/60Hz INPUT	-0.4 to +0.4	mA
Allowable Power Dissipation	P <sub>dmax</sub> Ta=70°C	0.7	W
Operating Temperature	T <sub>opg</sub>	-30 to +70	°C
Storage Temperature	T <sub>stg</sub>	-55 to +125	°C

Allowable Operating Ranges at Ta=25°C, VSS=0

		min	typ	max	unit
Supply Voltage	V <sub>DD</sub>	-14.0		-6.5	V
Input "H" Level Voltage(1)	V <sub>IH(1)</sub> 50/60Hz INPUT	-1.0			V
Input "L" Level Voltage(1)	V <sub>IL(1)</sub> 50/60Hz INPUT, V <sub>DD</sub> ≤ -8V			V <sub>DD</sub> +2	V
	" V <sub>DD</sub> > -8V			V <sub>DD</sub> +1	V
Input "H" Level Voltage(2)	V <sub>IH(2)</sub> Other than 50/60Hz INPUT, V <sub>DD</sub> ≤ -8V	-1.5			V
	Other than 50/60Hz INPUT, V <sub>DD</sub> > -8V	-1.0			V
Input "L" Level Voltage(2)	V <sub>IL(2)</sub> Other than 50/60Hz INPUT, V <sub>DD</sub> ≤ -8V			V <sub>DD</sub> +2	V
	Other than 50/60Hz INPUT, V <sub>DD</sub> > -8V			V <sub>DD</sub> +1	V
Input Voltage on 50/60Hz INPUT Pin	V <sub>AC-IN</sub> (Note 1)			V <sub>LED</sub> (Note 1)	V

LM8560

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 50/60Hz INPUT, $V_{IN}=V_{DD}$			20	$\mu\text{A}$
Input "L" Level Current(2)	$I_{IL}(2)$ Input pins other than 50/60Hz INPUT, $V_{IN}=V_{DD}$			2	$\mu\text{A}$
Output "H" Level Current(1)	$I_{OH}(1)$ ALM OUT, SLP OUT $V_{OH}=V_{SS}-1\text{V}$				$\text{mA}$
Output Leakage Current(1)	$I_{OF}(1)$ ALM OUT, SLP OUT $V_{OUT}=V_{DD}$			10	$\mu\text{A}$
Output "H" Level Current(2)	$I_{OH}(2)$ 10's HR ag & de (24Hmode), $V_{OUT}=V_{SS}-1\text{V}$	36			$\text{mA}$
Output Leakage Current(2)	$I_{OF}(2)$ 10's HR ag & de (24Hmode), $V_{OUT}=V_{DD}$			20	$\mu\text{A}$
Output "H" Level Current(3)	$I_{OH}(3)$ Segment outputs other than above, $V_{OUT}=V_{SS}-1\text{V}$	18			$\text{mA}$
Output Leakage Current(3)	$I_{OF}(3)$ " " $V_{OUT}=V_{DD}$			20	$\mu\text{A}$
Power Failure Detect Voltage	$V_{DD}$	-6.5	-5.0		V
Current Dissipation	$I_{CC}$ Output: Off, input with pull-down resistor: Open		5	7	$\text{mA}$
Stability of Oscillator for Backup	$F_S$ Typical value, 900Hz, $V_{DD}=-9\text{V}\pm 10\%$	-10		10	%
Accuracy of Oscillator for Backup	$F_A$ Typical value, 900Hz, $V_{DD}=-9\text{V}$	-10		10	%

LM8560D

Absolute Maximum Ratings at $T_a=25^{\circ}\text{C}$ , $V_{SS}=0\text{V}$					unit
Maximum Supply Voltage	$V_{DD, \text{max}}$	-15.0	to	+0.3	V
Input Voltage (1)	$V_{IN}(1)$ 50/60Hz INPUT	-15.0	to	+0.3	V
Input Voltage (2)	$V_{IN}(2)$ Other than 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	$\text{mA}$
Allowable Power Dissipation	$P_{d\text{max}}$ $T_a=70^{\circ}\text{C}$			0.7	W
Operating Temperature	$T_{opg}$	-30	to	+70	$^{\circ}\text{C}$
Storage Temperature	$T_{stg}$	-55	to	+125	$^{\circ}\text{C}$

Allowable Operating Ranges at $T_a=25^{\circ}\text{C}$ , $V_{SS}=0$		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)	$V_{IH}(2)$ Other than 50/60Hz INPUT	-1.5			V
Input "L" Level Voltage(2)	$V_{IL}(2)$ Other than 50/60Hz INPUT			$V_{DD}+2$	V
Input Voltage on 50/60Hz INPUT Pin	$V_{AC-IN}$ (Note 1) Referenced to $V_{SS}$	$2V_{LED}$ (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 50/60Hz INPUT, $V_{IN}=V_{DD}$			20	$\mu\text{A}$
Input "L" Level Current(2)	$I_{IL}(2)$ Input pins other than 50/60Hz INPUT, $V_{IN}=V_{DD}$			10	$\mu\text{A}$

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			min	typ	max	unit
Output "H" Level Current(1)	$I_{OH}(1)$	ALM OUT, SLP OUT	5			mA
Output Leakage Current(1)	$I_{OF}(1)$	ALM OUT, SLP OUT $V_{OH}=V_{SS}-1V$			10	$\mu A$
Output "H" Level Current(2)	$I_{OH}(2)$	10's HR ag & de (24Hmode), $V_{OUT}=V_{DD}$	32			mA
Output Leakage Current(2)	$I_{OF}(2)$	10's HR ag & de (24Hmode), $V_{OUT}=V_{SS}-1V$			20	$\mu A$
Output "H" Level Current(3)	$I_{OH}(3)$	Segment outputs other than above, $V_{OUT}=V_{DD}$	16			mA
Output Leakage Current(3)	$I_{OF}(3)$	" $V_{OUT}=V_{SS}-1V$			20	$\mu A$
Power Failure Detect Voltage	$V_{DD}$		-7.5	-5.0		V
Current Dissipation	$I_{CC}$	Output: Off, input with pull-down resistor: Open		5	7	mA
Stability of Oscillator for Backup	$F_S$	Typical value, 900Hz, $V_{DD}=-9V \pm 10\%$	-10		10	%
Accuracy of Oscillator for Backup	$F_A$	Typical value, 900Hz, $V_{DD}=-9V$	-10		10	%

LM8560N

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

				unit
Maximum Supply Voltage	$V_{DDmax}$		-15.0 to +0.3	V
Input Voltage (1)	$V_{IN}(1)$	50/60Hz INPUT	-15.0 to +0.3	V
Input Voltage (2)	$V_{IN}(2)$	Other than 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	$P_{dmax}$	$T_a=70^\circ C$	0.7	W
Operating Temperature	$T_{opg}$		-30 to +70	$^\circ C$
Storage Temperature	$T_{stg}$		-55 to +125	$^\circ C$

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

			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)	$V_{IH}(2)$	Other than 50/60Hz INPUT	-1.5			V
Input "L" Level Voltage(2)	$V_{IL}(2)$	Other than 50/60Hz INPUT			$V_{DD}+2$	V
Input Voltage on 50/60Hz INPUT Pin	$V_{AC-IN}$ (Note 1)	Referenced to $V_{SS}$ (Note 2)		$V_{LED}$ (Note 1)		V

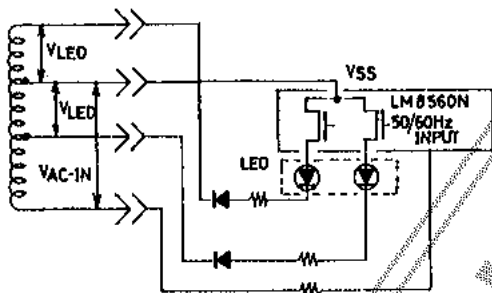
**Electrical Characteristics at  $T_a=25^\circ C, V_{DD}=-12V$**

			min	typ	max	unit
Input "H" Level Current(1)	$I_{IH}(1)$	50/60Hz INPUT, $V_{IN}=V_{SS}$			10	$\mu A$
Input "L" Level Current(1)	$I_{IL}(1)$	50/60Hz INPUT, $V_{IN}=V_{DD}$			10	$\mu A$
Input "H" Level Current(2)	$I_{IH}(2)$	Input pins other than 50/60Hz INPUT, $V_{IN}=V_{DD}$			20	$\mu A$
Input "L" Level Current(2)	$I_{IL}(2)$	Input pins other than 50/60Hz INPUT, $V_{IN}=V_{DD}$			10	$\mu A$
Output "H" Level Current(1)	$I_{OH}(1)$	ALM OUT, SLP OUT $V_{OH}=V_{SS}-1V$	5			mA
Output Leakage Current(1)	$I_{OF}(1)$	ALM OUT, SLP OUT $V_{OUT}=V_{DD}$			10	$\mu A$

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			min	typ	max	unit
Output "H" Level Current(2)	$I_{OH(2)}$	10's HR ag & de (24Hmode), $V_{OUT}=V_{SS}-1V$	36			mA
Output Leakage Current(2)	$I_{OF(2)}$	10's HR ag & de (24Hmode), $V_{OUT}=V_{DD}$			20	uA
Output "H" Level Current(3)	$I_{OH(3)}$	Segment outputs other than above, $V_{OUT}=V_{SS}-1V$	18			mA
Output Leakage Current (3)	$I_{OF(3)}$	" $V_{OUT}=V_{DD}$			20	uA
Power Failure Detect Voltage	$V_{DD}$		-7.5	-5.0	0	V
Current Dissipation	$I_{CC}$	Output:Off,input with pull-down resistor: Open		5	7	mA
Stability of Oscillator for Backup	$F_S$	Typical value, 900Hz, $V_{DD}=-9V \pm 10\%$	-10		10	%
Accuracy of Oscillator for Backup	$F_A$	Typical value, 900Hz, $V_{DD}=-9V$	-10		10	%

(Note 1)



$V_{AC-IN}$  --- Input voltage(average) on 50/60Hz INPUT pin  
 $V_{LED}$  ----- Supply voltage(average) for LED  
 These are the values at no load mode.

[Fig. 1]

(Note 2)



[Fig. 2]

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