IL8560
ЧАСОВАЯ СХЕМА

Область применения

- Часы со звуковой сигнализацией
- Радио - часы

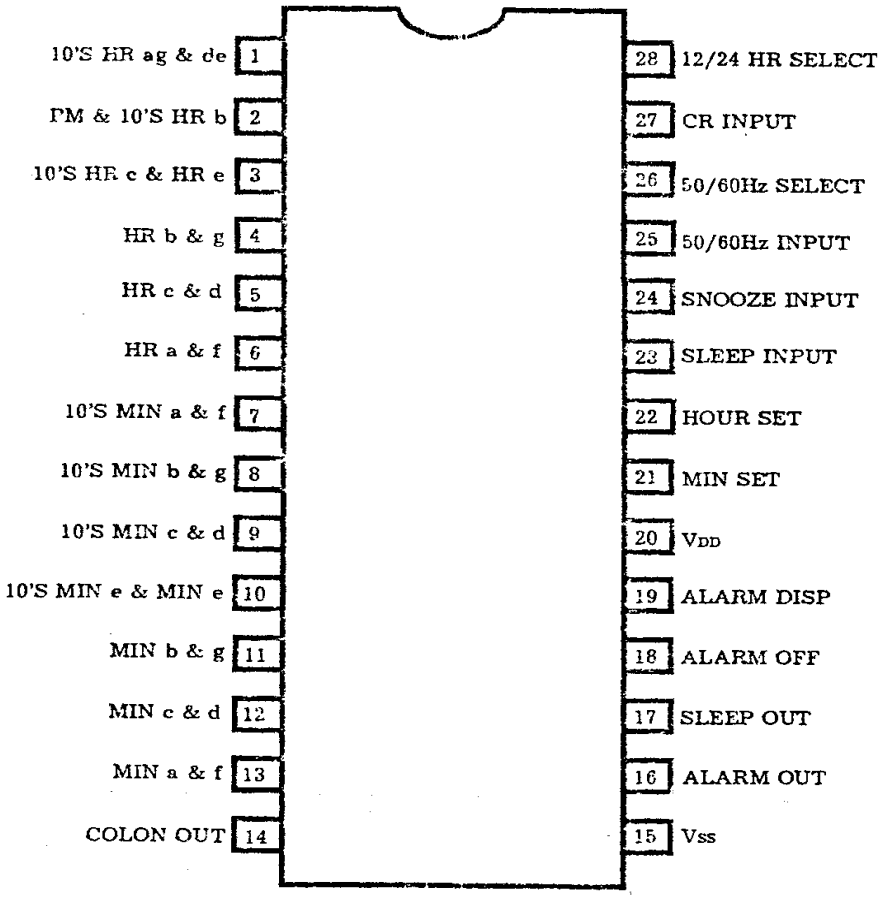
Функции

- Отображение текущего времени
- Звуковой сигнал с режимом плавного пробуждения
- Таймер сна (макс:59 минут или 1 час 59 минут)

Характеристики

(1) Однокристальная КМОП БИС
(2) Прямое управление светодиодным индикатором за счет временного разделения (дуплекс)
(3) Широкий диапазон рабочих напряжений
(4) Звуковой сигнал на базе 24-ти часовой шкалы
(5) Два формата шкалы времени; .AM/PM на базе 12-часовой и 24-часовой шкал
(6) Встроенный RC - генератор с батарейным питанием
(7) Возможность использования питания с частотой 50 и 60 Гц
(8) Возможность автоматического отображения «часы», «минуты».
(9) Таймер сна (макс:59 минут или 1 час 59 минут
(10) Повторное использование плавного пробуждения
(11) Индикатор отказа питания
(12) Выход звукового сигнала с частотой 900 Гц

Цоколевка



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Блок-схема

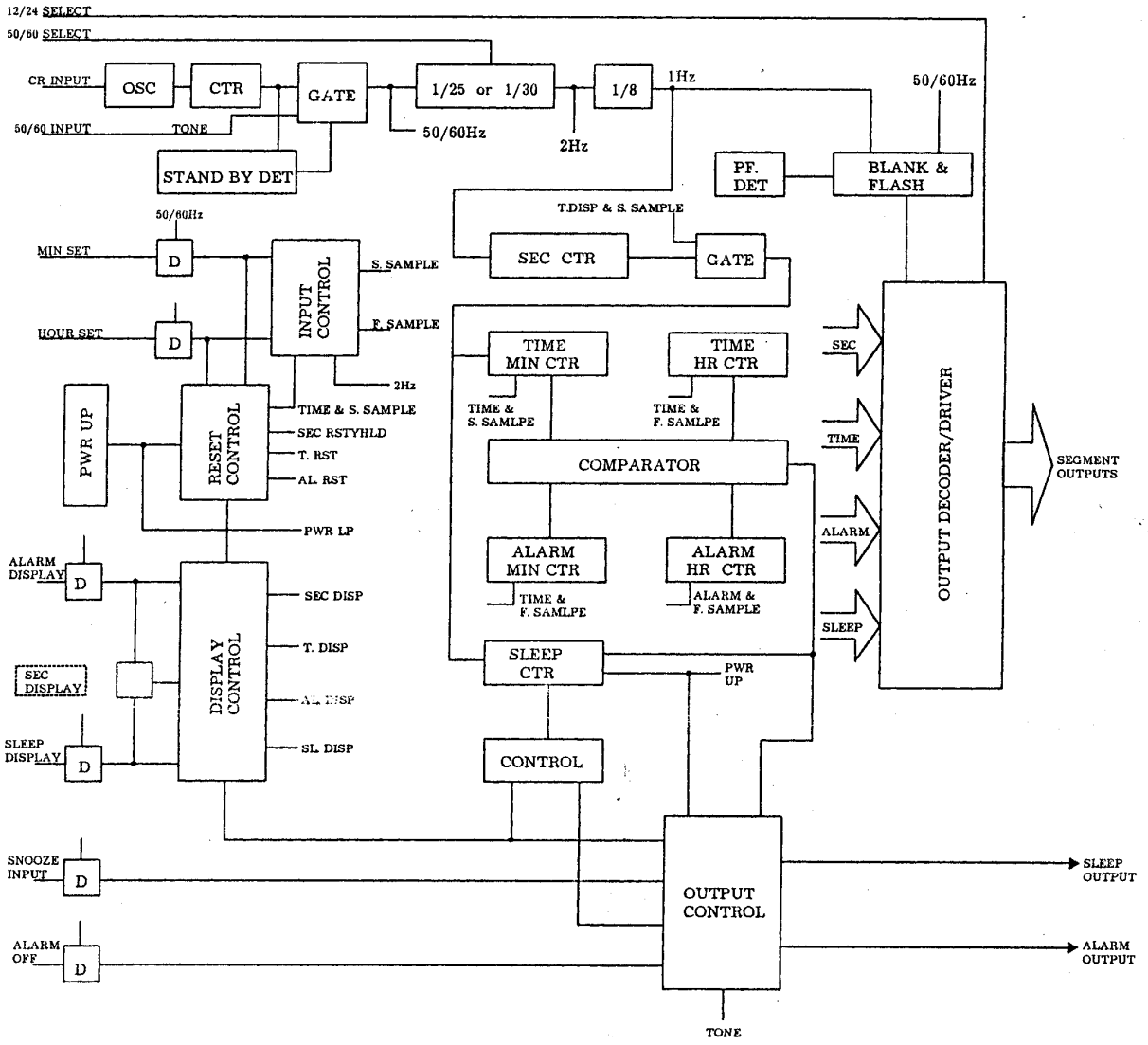

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Схема включения в применении в качестве часов

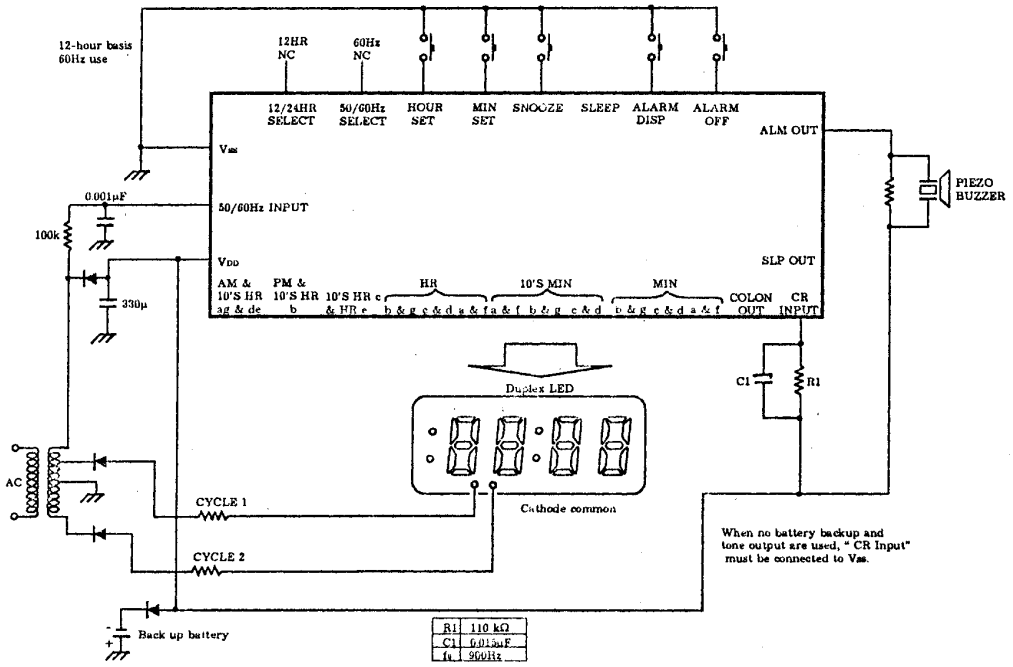
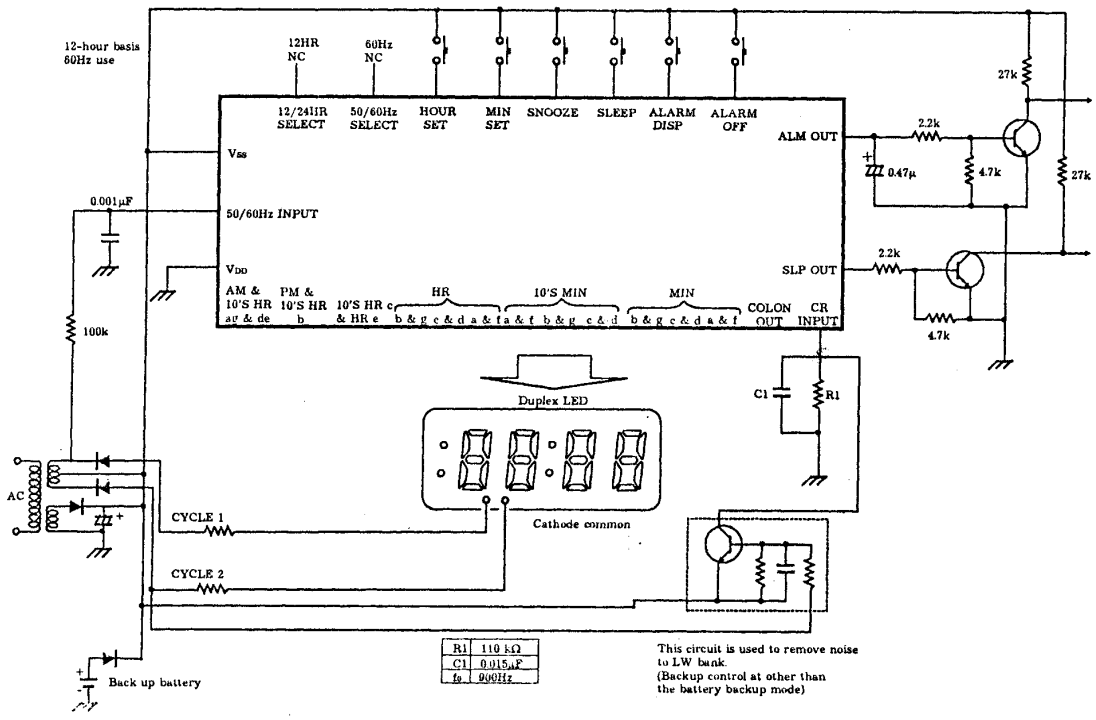


Схема включения в применении в качестве радио-часов



IL8560

Описание функционирования

Запуск от сигнала частотой 50/60Гц: Встроенный триггер Шмидтта представляет собой простейший RC-фильтр на входе для исключения возможных высокочастотных составляющих. Имеется встроенный резистор подброса.

Запуск от RC-генератора: При сбое питания по переменному току счетчик входит в режим удержания и сразу же начинает работать встроенный генератор. Если в течение трех периодов на входе "50/60Hz Input" отсутствует сигнал, то генератор подает управляющий сигнал вместо сигнала "50/60Hz input". Величины C и R определяют частоту встроенного генератора. Сегменты выключены при работе от генератора.

При использовании генератора при отключенном напряжении питания, вход "50/60Hz Input" должен находиться в открытом состоянии или в состоянии Vss.

Выбор входного сигнала 50/60 Гц: Подключение вход "50/60Hz select" к Vss обеспечивает работу от сигнала частотой 50 Гц. Для работы от сигнала частотой 60Гц, вход "50/60Hz select" остается не подсоединенным:

Подброс напряжения до уровня V_{DD} обеспечивается с помощью встроенного резистора подброса.

Вход выбора режима индикации (индикация времени звукового сигнала/индикация времени режима сна);

Встроенный резистор подброса позволяет использовать 2 переключателя типа « один полюс один переброс»для выбора 4 режимов индикации, приведенных в таблице 1.

Таблица 1. Режимы индикации

Вход выбора		**Режим индикации**	**Цифра No.1**	**Цифра No.2**	**Цифра No.3**	**Цифра No.4**
Сигнал	**Сон**					
NC	NC	Индикация времени	десятки часов,AM/PM	часы	десятки минут	минуты
Vss	NC	Индикация сигнала	десятки часов,AM/PM	часы	десятки минут	минуты
NC	Vss	Индикация сна	пустой	часы	десятки минут	минуты
Vss	Vss	Индикация секунд	пустой	минуты	десятки секунд	секунды

(Примечание) Если Vss подается одновременно на два входа "alarm display" и "sleep display", то будет действовать режим индикации секунд.

Вход установки времени: имеется два входа установки для часов и минут. Подача уровня Vss вызывает установку времени в соответствии с таблицей 2. На каждом входе имеется встроенный резистор подброса.

Таблица 2. Процедура установки

Режим индикации	**Вход установки**	**Функции**
	HOUR	'Часы' увеличиваются на 1 сразу и нарастают с частотой 2 Гц спустя 1/4. до 3/4 секунды.
Время	MIN	'Минуты' увеличиваются на 1 сразу и нарастают с частотой 2 Гц спустя 1/4. до 3/4 секунды. 'Секунды сбрасываются.
Секунды	BOTH HOUR (Note)	Обе операции, указанные выше, выполняются 'Секунды сбрасываются в [00].
Сигнал и сон	MIN BOTH*	Режим "Удержания". 'Часы' и 'минуты' сбрасываются в [0;00] (24-часовая шкала) или [12 00] (12-часовая шкала).
Сигнал	HOUR	'Часы' увеличиваются на 1 сразу и нарастают с частотой 2 Гц спустя 1/4. до 3/4 секунды.
	MIN	'Минуты' увеличиваются на 1 сразу и нарастают с частотой 2 Гц спустя 1/4. до 3/4 секунды
	- BOTH	Часы и минуты достигают значения 0:00 при 24 -часовой шкале или 12 при 12-часовой шкале
Сон	HOUR	В тот момент, когда на входы "sleep display" and "hour set' одновременно подается V_{DD}, счетчик сна устанавливается в [1;59].
	MIN	Счетчик сна считает в обратном направлении с частотой 2 Гц.
	BOTH	Счетчик сна считает в обратном направлении с частотой 2 Гц.

При входе в режим удержания или режим сброса, ввод другой функции блокируется, пока не будут сняты сигналы с обоих входов "hour set" и "minute set".

(Примечание) Если показания секунд лежат в диапазоне 50 -*53,* секунды переходят в [00] и происходит перенос в минуты.

•Вход выбора 12/24 : не подключение этого вывода выбирает 12-ти часовую шкалу; подключение этого вывода к Vss выбирает шкалу 24-часа. Имеется встроенный резистор подброса.

•Индикация сбоя питания: Если напряжения питания падает и подается снова, все включенные сегменты мигают и включается режим индикации сбоя по питанию. Режим индикации сбоя по питанию снимается подачей напряжения V_{DD} на "hour set" или "minutes set".

• Работа звукового сигнала и его выход:

При достижении установленного времени звуковой сигнализации, подается звуковой сигнал. Этот сигнал длится 1час 59 минут, если не подается сигнал «alarm off" и "snooze input". Этот сигнал подается с частотой 900 Гц с заполнением 50% при 2-х герцовом огибающим сигналом. Для преобразования этого сигнала в сигнал постоянного тока необходим простой низкочастотный фильтр.

• Вход плавного пробуждения: При включенном состоянии звукового сигнала при подключении этого вывода к V_{DD}, выход звукового сигнала отключается на 6 - 9 минут, после чего звуковой сигнал снова подается. Эта функция медленного пробуждения может повторно использоваться на продолжении 1 часа 59 минут. Имеется встроенный резистор подброса. При подключении входа "snooze input" к V_{DD} при отключенном звуковом сигнале, счетчик таймера плавного пробуждения сбрасывается в [0:00]. (Таймер медленного пробуждения сбрасывается по одному прикосновению)

• Вход выключения звукового сигнала: Подключение этого входа к V_{DD} сразу же выключает звуковой сигнал. Имеется встроенный резистор подброса.

Выход таймера и выход сна. Выход сна может использоваться для поддержания радиоприемника во включенном состоянии на время до 59 минут или 1 час 59. В таблице 2

показано, как производить выбор периода (59 минут или 1 час 59 минут). В этом таймере сна используется обратный счет. Когда содержимое счетчика достигает значения [00], на выходе исчезает сигнал, при этом радио выключается. Подключая вывод "snooze Input" к V_{DD} при включенном состоянии на выходе сна, выход сна переходит в закрытое состояние.

Абсолютно максимально значения параметров при Ta=25°C,V_{SS}=OV			**Величина**	**Ед. измерения**
Максимальное напряжение питания	Vmax		-17.0 - +0.3	В
Входное напряжение(1)	$V_{IN(1)}$	50/60 Гц вход	-17.0 - +0.3	В
Входное напряжение (2)	$V_{IN(2)}$	Вход, отличный от 50/60 Гц	-17,0 - +0.3	В
Выходное напряжение, Входной ток по выводу Допустимое рассеивание мощности	V_{OUT} I_{IN} Pdmax	50/60 Гц вход Ta=70°C	-17.0 - +0.3 -0.4 - +0.4 0.7	В нА Вт
Рабочая температура	Topg		-30 - +70	°C
Температура хранения	Tsbg		-55 - +125	°C

Допустимые рабочие диапазоны приTa=25°C, Vss=0			Min	Typ	Max	unit
Напряжение питания	V_{DD}max		-14.0		-6.5	В
Входной уровень напряжения"H"(1)	$V_{IH(1)}$	50/60Hz INPUT	-1.0			В
Входной уровень напряжения "L" (1)	$V_{IL(1)}$	50/60Hz INPUT V_{DD}≤-8В			V_{DD}+2	В
		V_{DD}>-8В			V_{DD}+1	
Входной уровень напряжения "H" (2)	$V_{IH(2)}$	Other than 50/60Hz V_{DD}>-8В	-1.5			В
		Other than 50/60Hz V_{DD}≤-8В	-1.0			
Входной уровень напряжения "L" (2)	$V_{IL(2)}$	Other than 50/60Hz V_{DD}≤-8В			V_{DD}+2	В
		V_{DD}>-8В			V_{DD}+1	
Напряжение на входе при 50/60Hz INPUT Pin	V_{AC-IN} (note1)	Referenced to Yet; (Note 2) ""	to Vss		V_{LED} (note1)	В

Электрические параметры приTa=25°C, V_{DD}=-12V			Min	Typ	Max	unit
Входной уровень тока"H" (1)	$I_{IH(1)}$	50/60Hz INPUT, V_{IN}=V_{SS}			2	мкА
Входной уровень тока "L" (1)	$I_{IL(1)}$	50/60Hz INPUT, V_{IN}=V_{DD}			10	мкА
Входной уровень тока "H" (2)	$I_{IH(2)}$	Input pins other than 50/60Hz INPUT,V_{IN}=V_{DD}			20	мкА
Входной уровень тока "L" (2)	$I_{IL(2)}$	Input pins other than 50/60Hz INPUT, V_{IN}=V_{DD}			2	мкА
Выходной уровень тока "H" (1)	$I_{OH(1)}$	ALM OUT,SLP OUT V_{OH}=V_{SS}-1В	5			мА
Утечка тока на выходе(1)	$I_{OF(1)}$	ALM OUT,SLP OUT V_{OUT}=V_{DD}			10	мкА
Выходной уровень тока"H" (2)	$I_{OH(2)}$	10 S HR ag & de (24 H mode) V_{OUT}=V_{SS}-1В	36			мА
Утечка тока на выходе (2)	$I_{OF(2)}$	10 S HR ag & de (24 H mode) V_{OUT}=V_{DD}			20	мкА
Выходной уровень тока "H" (3)	$I_{OH(3)}$	Segnent outputs other than above,V_{OUT}=V_{SS}-1В	18			мкА
Утечка тока на выходе (3)	$I_{OF(3)}$	Segnent outputs other than above,V_{OUT}=V_{DD}			20	мкА

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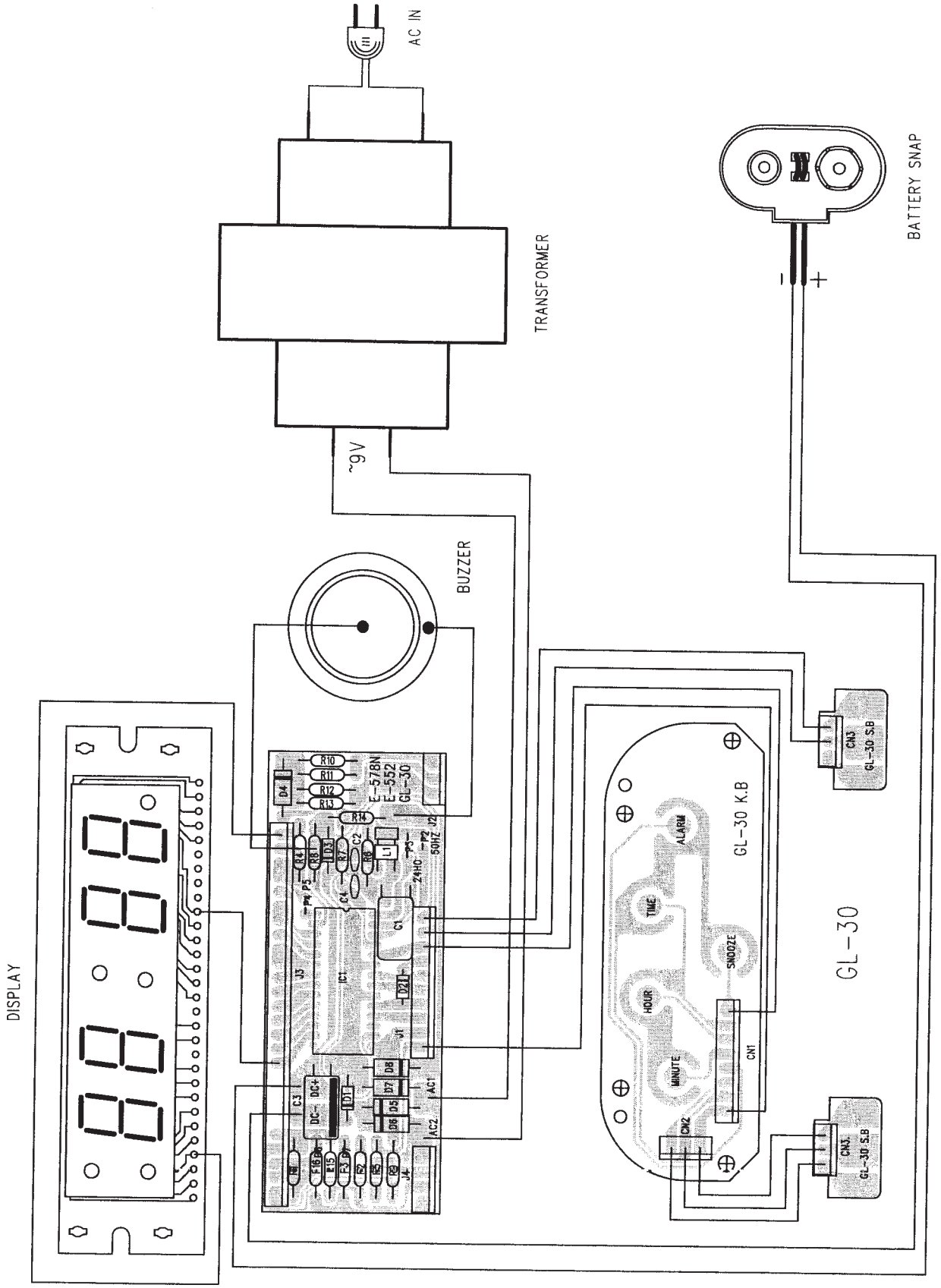
БЕЛМИКРОСИСТЕМЫ


AC IN
TRANSFORMER
~9V
BUZZER
BATTERY SNAP
-
+
DISPLAY
GL-30
GL-30 K.B
ALARM
TIME
SNOOZE
HOUR
MINUTE
CN1
CN2
CN3
GL-30 S.B
CN4
GL-30 S.B
E-578N
E-552
GL-30
50HZ
24HO
IC1
J3
J4
AC1
AC2
C1
C2
C3
C4
L1
D1
D2
D3
D4
D5
D6
D7
D8
D21
R4
R5
R6
R7
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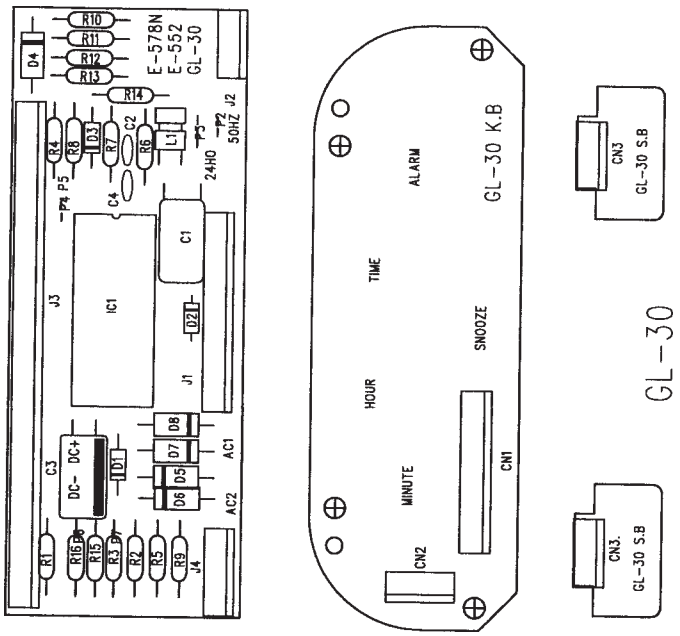
R15
R16
P1
P2
P3
P4
P5
V1


E-578N
E-552
GL-30
GL-30 K.B
ALARM
TIME
HOUR
MINUTE
SNOOZE
CN1
CN2
CN3
GL-30 S.B
CN3.
GL-30 S.B
GL-30

SC8560

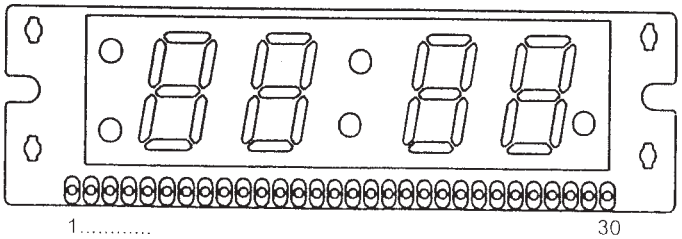
1	2	3	4	5	6	7	8	9	10	11	12	13	14
7.3	5.8	11.8	11.8	7.2	5.6	11.8	7.4	11.9	11.9	5.6	12	12	
15	16	17	18	19	20	21	22	23	24	25	26	27	28
12	3.4	11.8	0.01	0.01	0	0.01	0.01	0.01	0.01	8.2	0.01	12	0.01

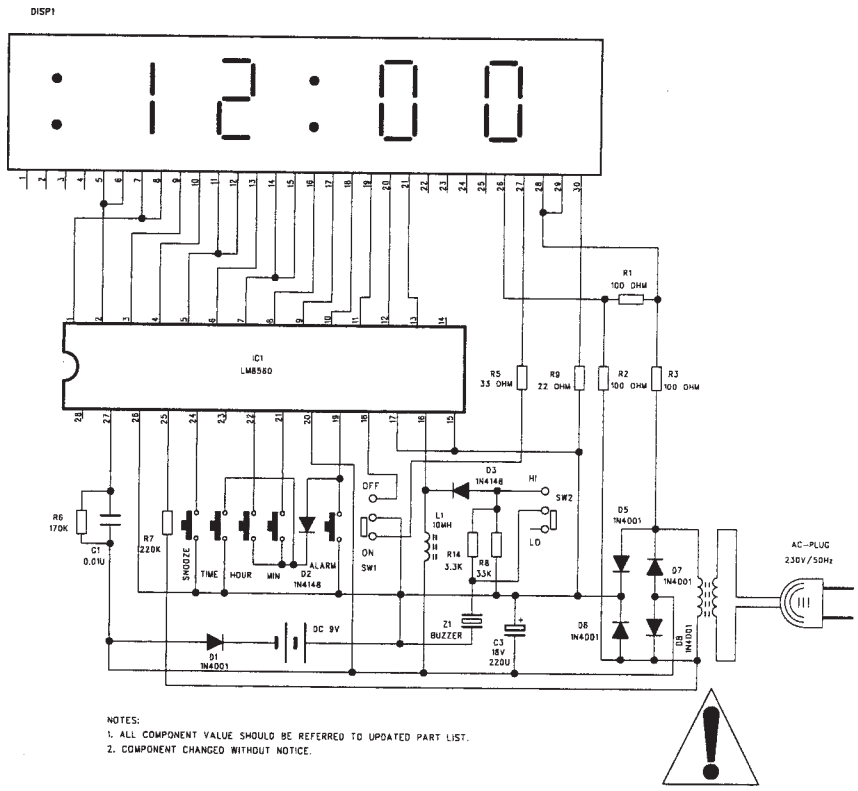
CLOCK I.C

SEMICONDUCTOR DEVICES

DIODE

0.6″ RED DISPLAY (Front view)




DISP1
: 12:00
IC1
LM8560
R1
100 OHM
R5
33 OHM
R9
22 OHM
R2
100 OHM
R3
100 OHM
D3
1N4148
HI
SW2
OFF
ON
SW1
LO
L1
10MH
R14
3.3K
R8
33K
D5
1N4001
D7
1N4001
D6
1N4001
D8
1N4001
AC-PLUG
230V/50Hz
R6
170K
C1
0.01U
R7
220K
SNOOZE
TIME
HOUR
MIN
D2
1N4148
ALARM
DC 9V
D1
1N4001
Z1
BUZZER
C3
16V
220U
NOTES:
1. ALL COMPONENT VALUE SHOULD BE REFERRED TO UPDATED PART LIST.
2. COMPONENT CHANGED WITHOUT NOTICE.

Ordering number : EN3490B

PMOS LSI

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

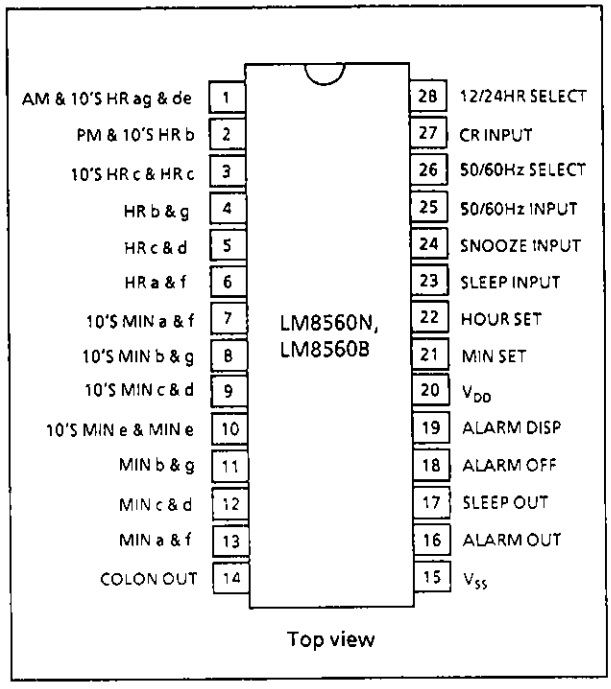
Functions

- 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

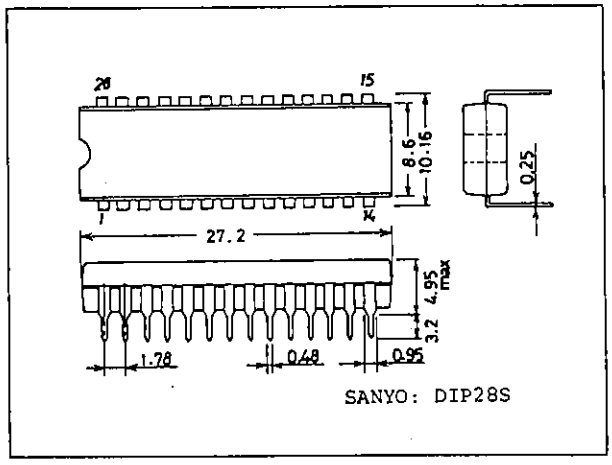
Pin Assignment



Package Dimensions

unit : mm

3029A-DIP28S



Description of Operations

- 50/60 Hz Input : Built-in Shumidt 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

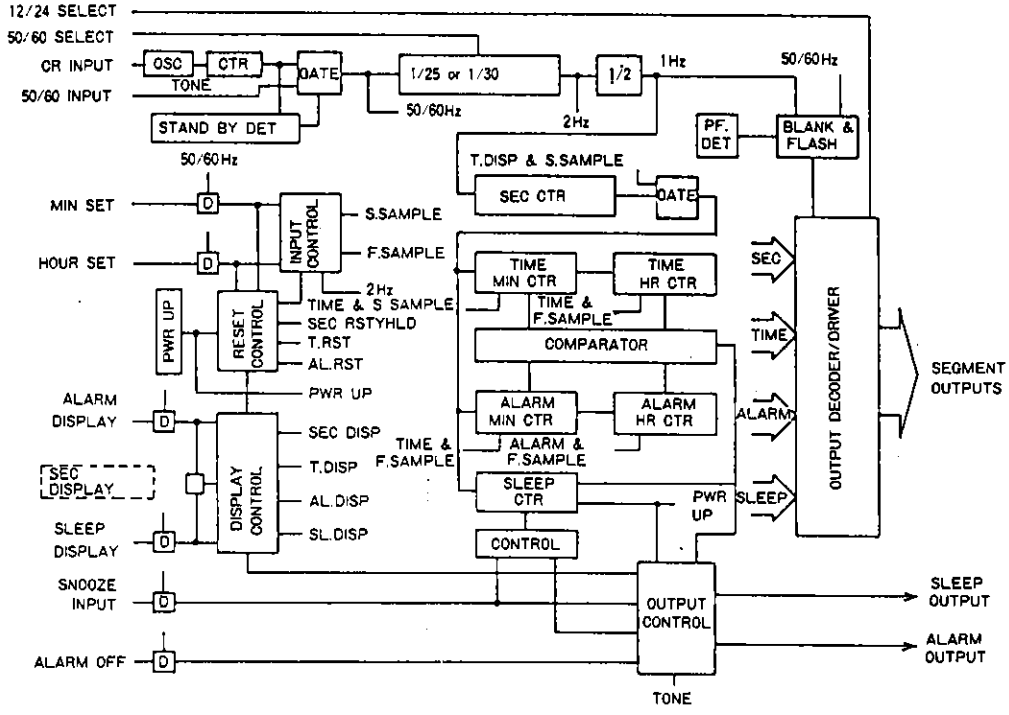
Display Mode	Set Input	Functions
Time	HOUR	Immediately adds 1 to hour digits and then assigns an additional 1, at a speed of 2 Hz, after each 1/4 to 3/4 second.
	MIN	Immediately adds 1 to minute digits and then assigns an additional 1, at a speed of 2 Hz, after each 1/4 to 3/4 second. Seconds are reset.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

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

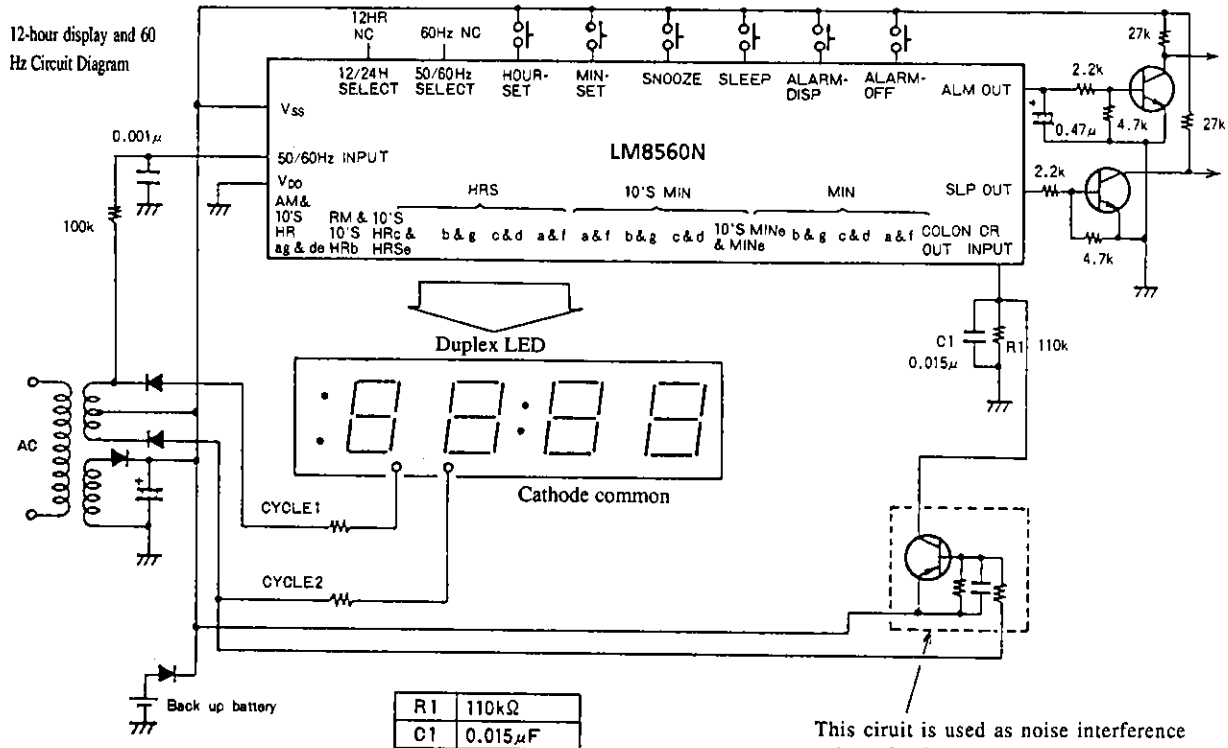
Note: When the digital reading for seconds is between 30 and 59 seconds, 1 is added to the digits for minutes as the digital reading for seconds resets to [00].

- 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 build-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

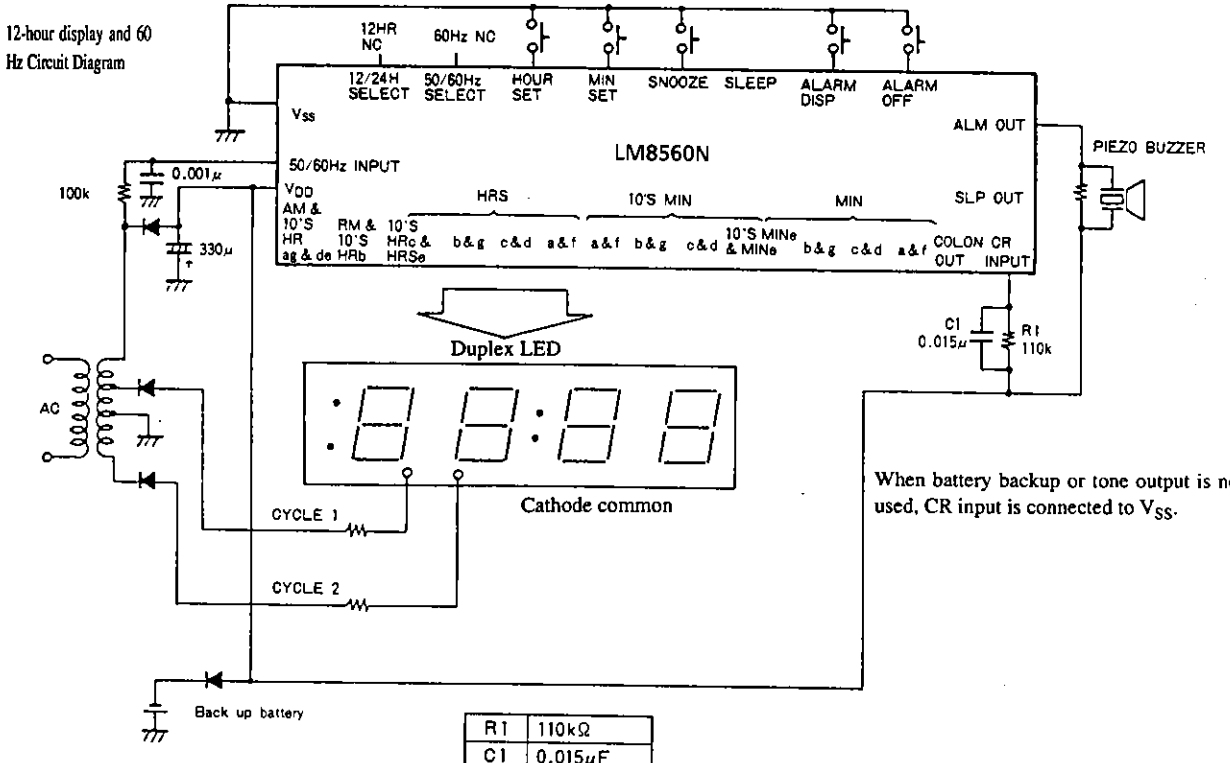


Clock-radio Applied Circuit Diagram (+ power supply)



Clock Applied Circuit Diagram (– power supply)

Unit (resistance: Ω,capacitance:F)



Unit (resistance: Ω,capacitance:F)

[LM8560N]

Specifications

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

					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 voltate (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	Pd max	Ta = 70°C	0.7	W	
Operating temperature	Topr		−30 to +70	°C	
Storage temperature	Tstg		−55 to +125	°C	

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

			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 (Note 1)	Sets V_{SS} as reference (Note 2)	V_{LED} (Note 1)			V

Electrical Characteristics at Ta = 25°C, V_{DD} = −12V

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

[LM8560B]

Specifications

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

				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 voltate (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	Pd max	Ta = 70°C	0.7	W
Operating temperature	Topr		−30 to +70	°C
Storage temperature	Tstg		−55 to +125	°C

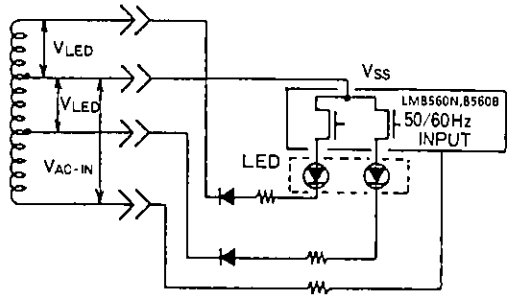
Allowable Operating Ranges at Ta = 25°C, V_{SS} = 0V

			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, $V_{DD} \leqq -8V$			V_{DD} +2	V
		50/60Hz INPUT, $V_{DD} > -8V$			V_{DD} +1	V
Input "H" level voltage (2)	V_{IH} (2)	Except 50/60Hz INPUT, $V_{DD} \leqq -8V$	−1.5			V
		Except 50/60Hz INPUT, $V_{DD} > -8V$	−1.0			V
Input "L" level voltage (2)	V_{IL} (2)	Except 50/60Hz INPUT, $V_{DD} \leqq -8V$			V_{DD} +2	V
		Except 50/60Hz INPUT, $V_{DD} > -8V$			V_{DD} +1	V
50/60Hz input pin input voltage	V_{AC}-IN (Note 1)	Sets V_{SS} as reference (Note 2)	V_{LED} (Note 1)			V

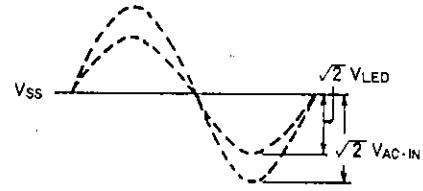
Electrical Characteristics at Ta = 25°C, V_{DD} = −12V

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

(Note 1)



(Note 2)



[Fig. 2]

$V_{AC\text{-}IN}$ 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]

STANDALONE DIGITAL CLOCK

Here is a standalone digital clock that does not require software and programming. The clock has many features like wide supply range, 12-hour/24-hour display modes, on-chip alarm output (900Hz tone), 50/60Hz frequency selection, snooze, on-chip battery backup oscillator sleep timer (maximum of 59 minutes or 1 hour 59 minutes).

Circuit description

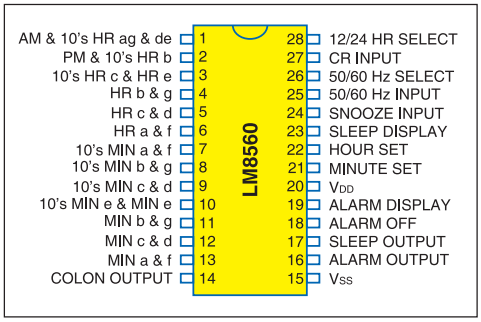
At the heart of this clock is IC LM8560. The user-selectable 50/60Hz AC frequency available from the secondary of the transformer can be clocked into the chip and it also has an on-chip oscillator to back up the clock in the case of power down. However, in this project, a crystal oscillator and divider IC (CD4541) **is** used for this precision job as the mains frequency in many countries is generally well below the 50Hz mark and is not that stable for an accurate clock application.

LM8560 supports duplex display. This time-shared duplexing has the advantage of reducing the number of display pins to 14 and the chip has only 28 pins. Pin-out of IC LM8560 is shown in Fig. 1.

Fig. 2 shows the circuit of the standalone digital clock. CD4541 is a programmable timer that consists of a 16-stage binary counter, an integrated oscillator to be used with external timing components, an automatic power-on reset and output control logic, which results in a division of 65,536 times. Frequency-division 8, 10, or 13 binary stages are also programmable with this IC. Frequency division is selected by input pins 12 and 13. When the mode input (pin 10) is held high, the output at pin 8 is continuous square wave.

It has a built-in oscillator controlled by external component. Nevertheless in the present schematic, an oscillator with a 3.2768MHz crystal is employed for more accuracy. With both pins 12 and 13 (A and B) held high, crystal frequency is divided by 65,536 and the output is available at pin 8.

This output has a dual role to play. It is directly fed to the 50Hz input of LM8560 at pin 25 as reference frequency. The internal circuitry in the clock divides this into minutes and hours and feeds the appropriate drivers. 50Hz frequency is used for display duplexing. 50Hz output signals from pin 8 of IC2 are fed to cathode 1 and cathode 2 of the display through transistors T1 and T2.



Regular seven-segment displays cannot be used with this IC as it supports only duplex display. Instead of making common connection of all the cathodes of the seven segments from all the four digits, here all the cathodes are divided into two and driven by alternate cycles of 50 Hz and anodes are driven by duplexing. One of the duplex displays is Sanyo's SL1498T.

The AC mains is stepped down by transformer X1 to deliver a secondary output of 15V at 500 mA. The transformer output is rectified by full-wave bridge rectifier BR1, filtered by capacitor C3 and regulated by IC3. 12V battery is used for backup. Piezobuzzer PZ1, used for alarm, is driven by transistor T3. Sleep timer pin drives relay RL2 with the help of transistor T5.

An actual-size, single-side PCB layout for the standalone digital clock is shown in Fig. 3 and its component layout in Fig. 4.

PARTS LIST

Semiconductors:

IC1	-	LM8560 clock
IC2	-	CD4541 programmable timer
IC3	-	7812 12V regulator
T1	-	BC558 pnp transistor
T2-T5	-	BC548 npn transistor
DIS1	-	0.56-inch, 4-digit duplex display
D1-D3	-	1N4007 rectifier diode
BR1	-	1A bridge rectifier

Resistors (all ¼-watt, ±5% carbon):

R1-R14	-	680-ohm
R15	-	1-mega-ohm
R16, R17	-	10-kilo-ohm
R18, R19, R21	-	2.2-kilo-ohm
R20, R22	-	4.7-kilo-ohm

Capacitors:

C1, C2	-	33pF ceramic disk
C3	-	1000µF, 35V electrolytic
C4	-	1µF, 25V electrolytic

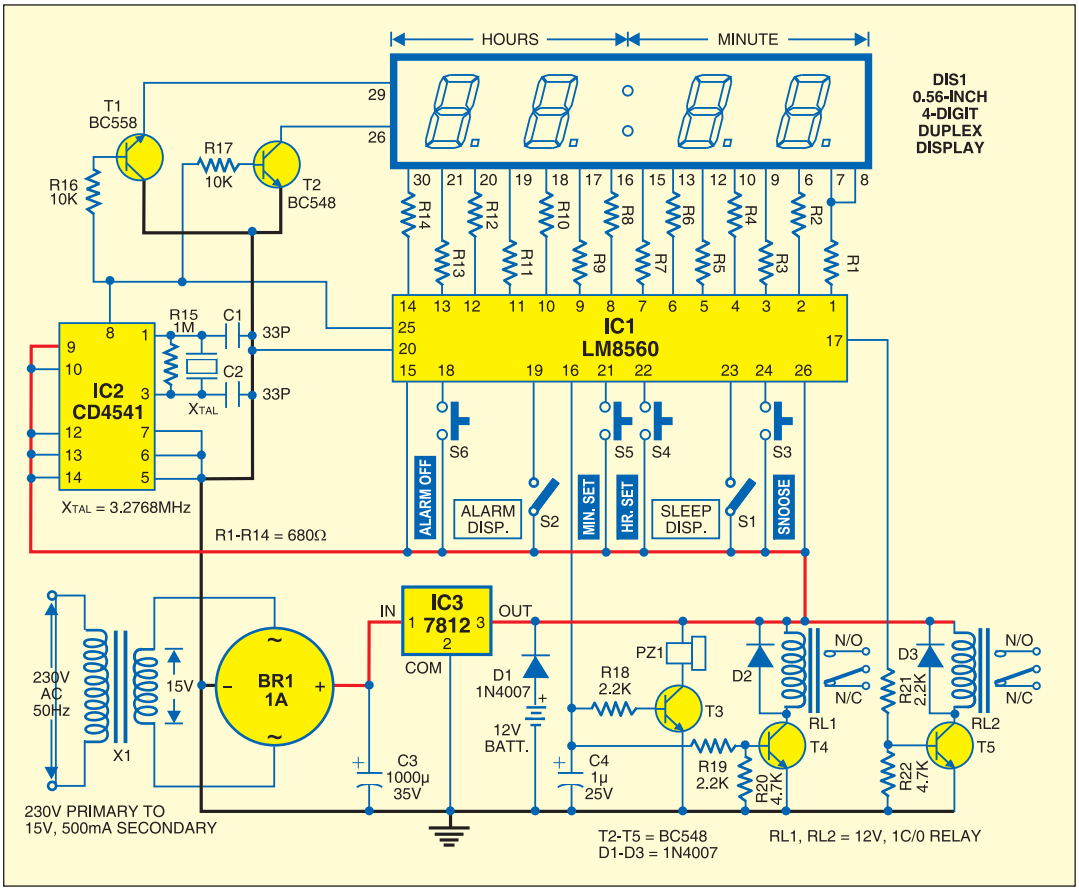
Miscellaneous:

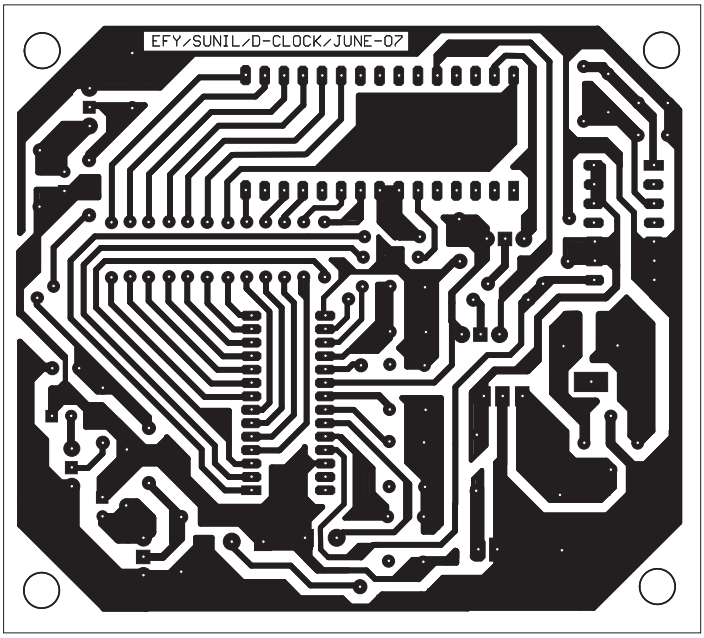
X1	-	230V AC primary to 15V, 500mA secondary transformer
RL1, RL2	-	12V, 1C/O relay
PZ1	-	Piezobuzzer
S1, S2	-	SPST or on/off switch
S3- S6	-	Push-to-on switch
X_{TAL}	-	3.2768MHz crystal

Settings and display modes

Display management of LM8560 is carried out with switches S1 and S2 (SPST switches), which provide all the four display functions such as real time, alarm time, and sleep timer and seconds display. 50Hz operation is enabled by connecting pin 26 to Vcc. If pin 26 is left unconnected, the clock shifts to 60Hz mode because this pin is internally pulled down.

If pin 28 is left unconnected, the clock stands in 12-hour mode and by pulling it to Vcc the clock shifts to 24-hour mode. In 12-hour mode, PM LED





lights up as and when appropriate.

Normal time display. With both S1 and S2 switches open, the display shows real time in hours and minutes. Pressing hour-set switch S4 makes the clock increment hours at 2Hz rate. Pressing minute-set switch S5 makes the clock increment minutes at 2Hz rate. Pressing both switches at the same time increments both hours and minutes at the same rate simultaneously.

When activated by a drop in power supply, all the lit segments begin to blink and the unit switches to a power-failure-detection mode. The power-failure-detection display is cancelled by activating Hours set S4 or Min set S5.

Alarm time display. When switch S2 is closed, the clock shifts to alarm display mode. In this mode, alarm time can be set in much the same way as the normal display with hours and minutes set switches (S4 and S5, respectively).

Pressing the hour-set switch S4 pulls pin 22 to Vcc and the clock increments hours at 2Hz rate. But in this mode, if both switches are pressed simultaneously, the alarm time is reset to 12:00 in the 12-hour mode or 00:00 in 24-hour mode.

Sleep display. When switch S1 is closed, the clock changes to sleep display mode. Ten's of hours display is blanked and sleep counters are set to 59 minutes. Pressing hour-set switch S4 while S1 is closed sets the display to 1:59 minutes in this mode. By pressing minutes set switch S5 now, the sleep display decrements at 2Hz rate.

Seconds display. When switches S1 and S2 are closed, the clock enters seconds display mode. If the minute switch S5 is pressed now, the clock changes to hold mode. Pressing hours and minutes switches (S4 and S5, respectively) simultaneously makes the clock to reset the time to 12:00 in the 12-hour mode or 00:00 in 24-hour mode.

Normal time setting. With S1 and S2 open, normal time is set with switches S4 for hours and S5 for minutes. If the power fails and resumes, nor-

mal time is shown. However, the display blinks if the battery backup is not available or if batteries have discharged.

Alarm operation

When the set alarm time synchronises with the real time, the clock delivers an alarm signal of 900 Hz gated at 2 Hz at pin 16. This signal drives a piezo buzzer. The alarm signal continues for 1 hour 59 minutes until stopped by alarm-off or suspended by snooze. The alarm can be switched off by pressing switch S6. It can also be snoozed or suspended for 8 or 9 minutes by pressing S3, while the alarm time is active. On the other hand, if snooze switch S3 is pulled up in alarm-off state, the sleep timer goes down to 00:00 hour. The 900Hz alarm signal can be turned to DC signal by a simple low-pass filter as shown in the schematic. This can drive a relay or switch a radio circuit.

Sleep timer

Sleep counter can be used to drive a relay or switch a radio or any other circuit for up to 1 hour 59 minutes. As soon as the sleep timer is activated with switch S1 closed, it is reset to 00:59 minutes and the down count starts. This fires a relay through T4.

If sleep display switch S2 is closed and hour-set switch S4 is pressed, the sleep counter is reset to 1 hour and 59 minutes. Pressing minute-set switch S5 makes the sleep counter to count down at 2Hz rate. The required sleep time is thus set in minutes with this switch and the counter counts down until 00:00 hour from the set time delay. Now even if hour-set switch S4 and minute-set switch S5 are pressed simultaneously, the timer still counts down at 2Hz rate, but if the snooze switch is pressed the sleep timer goes down to 00:00 hour. ●