

# STANDALONE DIGITAL CLOCK

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**H**ere 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.

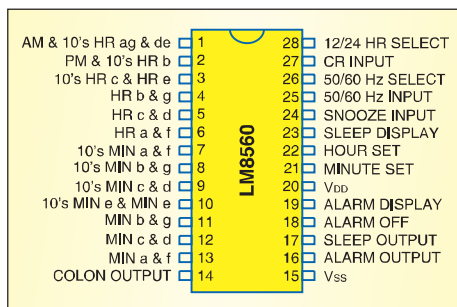
The AC mains is stepped down by transformer X1 to deliver a secondary output of 15V at 500 mA. The transformer output is rectified by full-wave bridge rectifier BR1, filtered by capacitor C3 and regulated by IC3. 12V battery is used for backup. Piezobuzzer PZ1, used for alarm, is driven by transistor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

## 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



## PARTS LIST

### Semiconductors:

IC1	- LM8560 clock
IC2	- CD4541 programmable timer
IC3	- 7812 12V regulator
T1	- BC558 npn 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 1/4-watt, $\pm 5\%$ 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

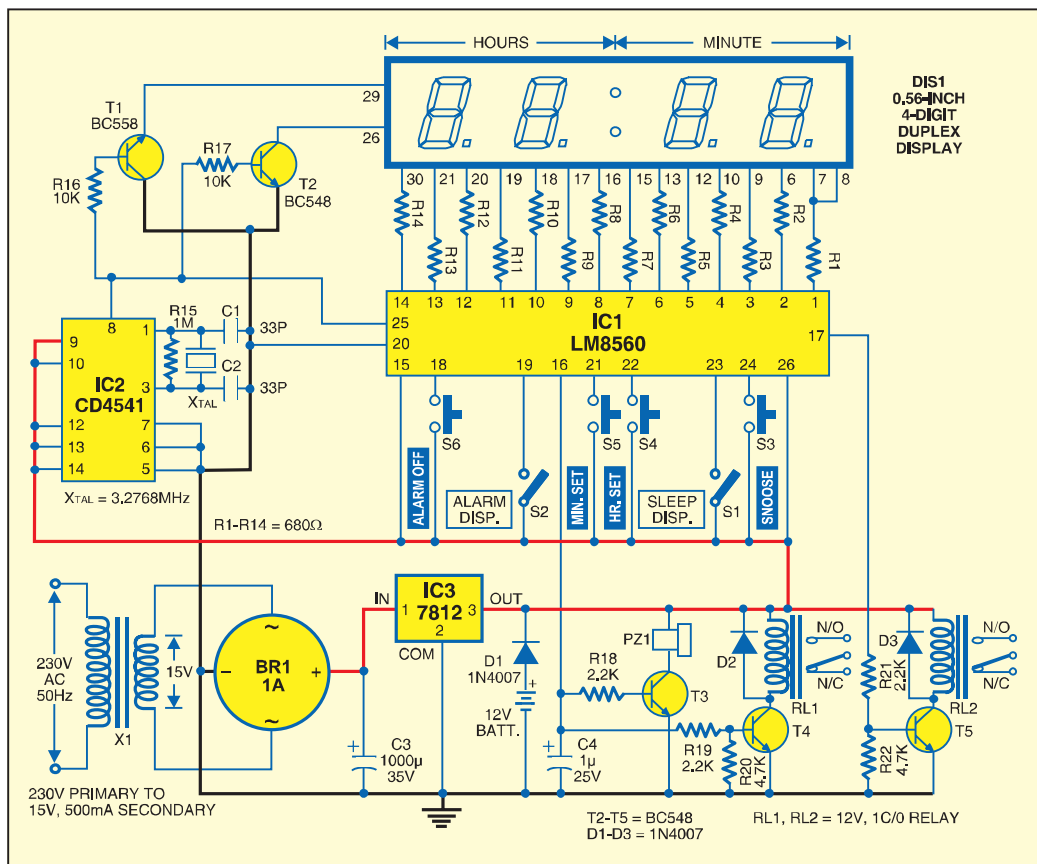
### Capacitors:

C1, C2	- 33pF ceramic disk
C3	- 1000 $\mu$ F, 35V electrolytic
C4	- 1 $\mu$ F, 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 <sub>TAL</sub>	- 3.2768MHz crystal

# CONSTRUCTION



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-

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

# CONSTRUCTION

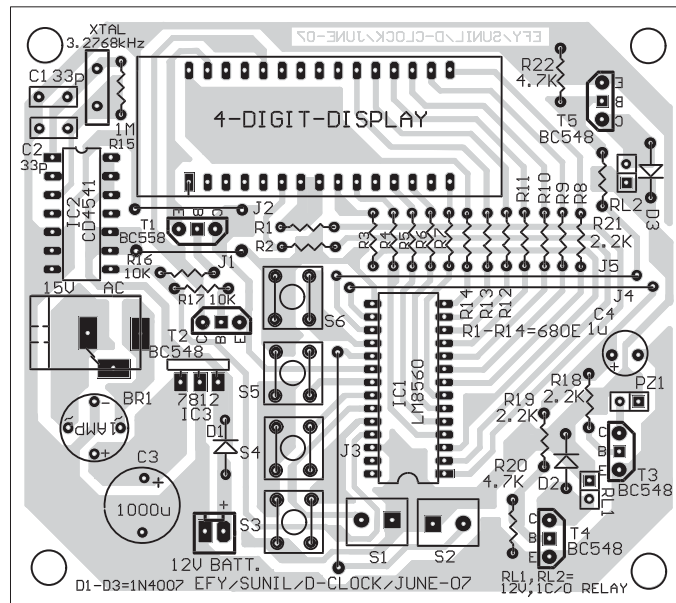
mal time is shown. However, the display blinks if the battery backup is not available or if batteries have discharged.

## 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

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.

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