

Long Delay Timer with Real-Time Clock Display



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Often we forget to switch-off the water pump on time and it results in overflow of water from the overhead tank. Fortunately, there are many solutions available for switching-off the motor automatically. Most water-level controllers require a level monitoring system for the tank, which is not so easy to install due to complicated electrical connections.

One of the simplest alternatives is a countdown timer circuit described here. This circuit shows the real-time clock in hours, minutes and seconds, with AM/PM on LCD display. It eliminates the use of additional peripherals like DS1307 RTC and I²C bus programming. Thus, cost of the circuit is reduced significantly as compared to other real-time clock circuits.

Circuit and working

The circuit diagram of a long delay timer with real-time clock display is shown in Fig. 1. The circuit consists of three push-button switches (S1, S2 and S3), one on/off switch (S4) and LCD display. The heart of the circuit is AT89C51 microcontroller (IC2).

AT89C51 microcontroller. AT89C51 is a CMOS 8-bit microcontroller having 4kB Flash memory, 128 bytes of RAM, 32 I/O lines, five-vector two-level interrupt architecture, two 16-bit timers/counters, full duplex serial port, on-chip oscillator and clock circuitry.

It is used to run both the real-time clock and countdown timer. One of its internal timers is used to configure the countdown timer. The four ports of the microcontroller are used as I/O pins. The push-button switches are connected to port pins P1.0, P1.1 and P1.2, respectively. The buzzer is connected to port pin P3.0 through transistor T1 (BC547). On/off switch S4 is connected to port P1.3 for controlling the timer and buzzer. Pins 18 and 19 of IC2 are connected to a 12MHz crystal oscillator and capacitors C1 and C2 (22pF each).

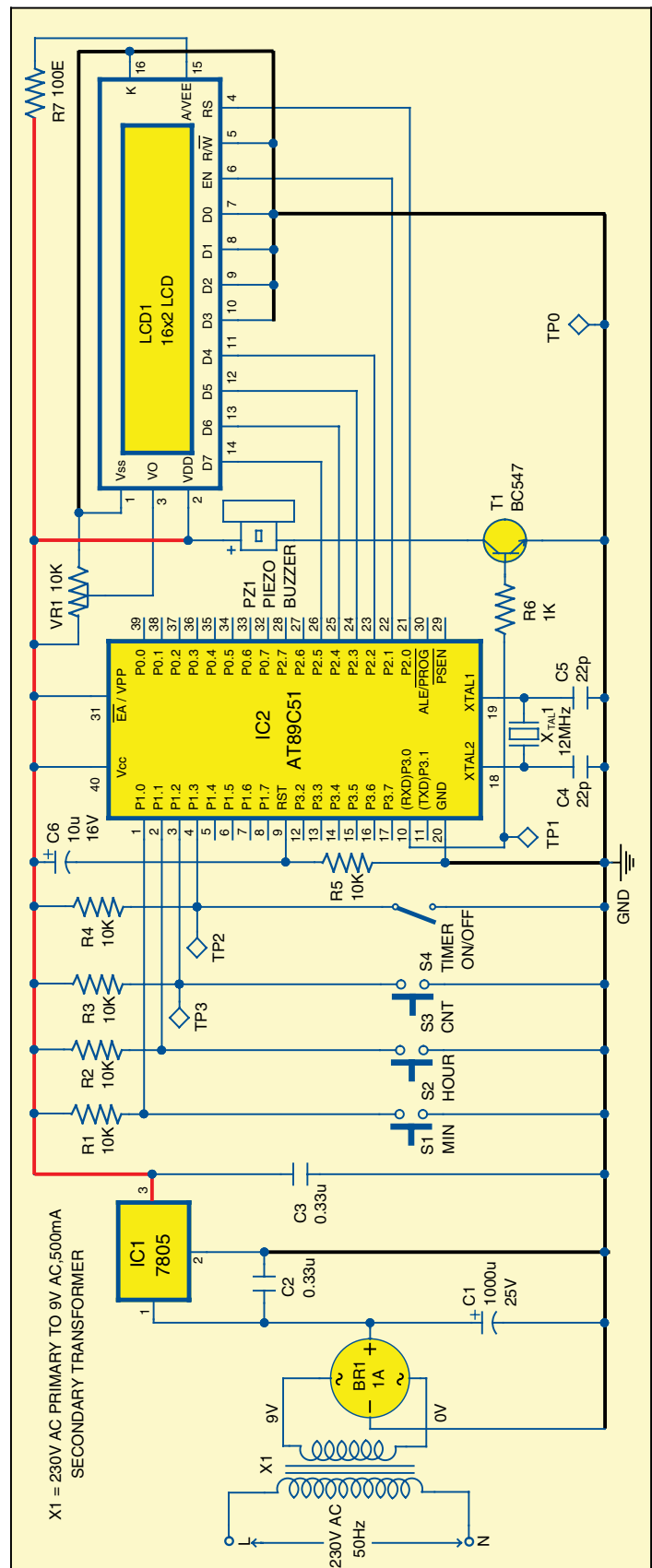


Fig. 1: Circuit of the long delay timer with real-time clock display

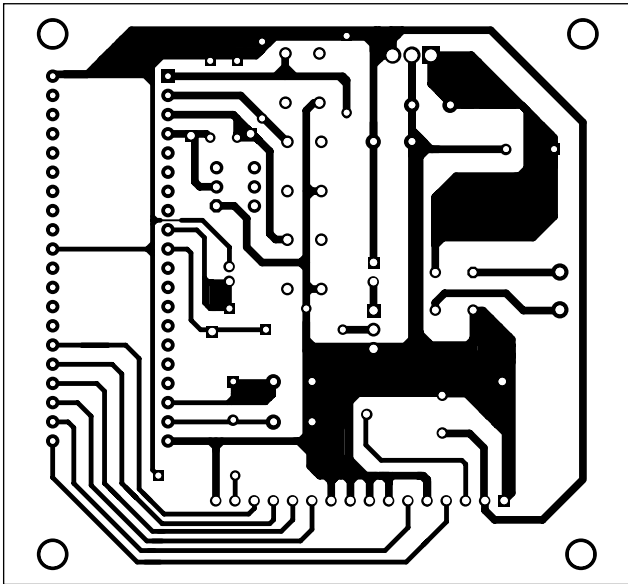


Fig. 2: Actual-size PCB layout of the long delay timer with real-time clock display

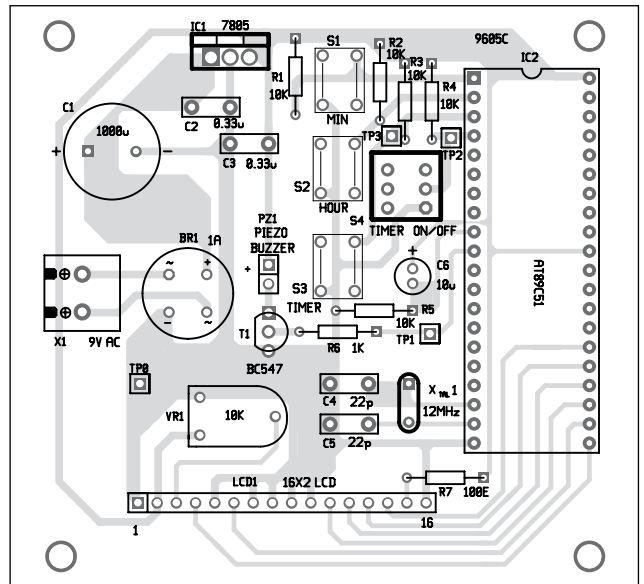


Fig. 3: Component layout of the PCB

LCD display. In this application, LCD library function is used to display the time and countdown timer on a 16x2 LCD, controlled by an HD44780 LCD controller. RS and EN control pins of LCD are connected to port pins P2.0 and P2.1 of IC2, respectively. IC2 pins 23, 24, 25 and 26 are connected to data pins (11-14) of the LCD. Pins 7, 8, 9, 10 and 16 of the LCD are connected to ground and pin 15 is connected to Vcc through a 100-ohm resistor. Since the data is read from the microcontroller, R/W pin 5 of LCD is also grounded.

The LCD displays real-time in hours : minutes : seconds format with AM or PM, and the countdown timer with on/off status. In this circuit, the LCD is programmed in 4-bit mode, so it needs only four data bits. By using switch S1, you can vary the minutes from zero to 59 and switch S2 to set the hour from one to 12. Similarly, switch S3 is used for changing the countdown timer. Initially, the countdown timer is at zero. When it is set to a value more than zero, it will start decrementing based on the status of seconds in real-time clock. That is, whenever the seconds reach zero after crossing 59, the timer decrements by one count.

Switch S4 not only controls the buzzer but also controls the countdown timer display on the LCD.

Initially, switch S4 is set to off position.

Power supply. The circuit requires a 5V supply for driving the LCD and microcontroller. Here, the power supply is derived from 230V AC primary to 9V, 500mA secondary transformer. IC 7805 converts the 9V supply to a regulated 5V DC supply.

Software program

The program for the microcontroller is written in C language and compiled using MikroC compiler. The compiler is used to convert the C program into a hex file for burning into the Flash memory of AT89C51 microcontroller using a suitable programmer. MikroC compiler is available for various microcontrollers like 8051, PIC, AVR and ARM. Here, MikroC compiler for 8051 is chosen that has a code limit of 2kB.

The program uses timer 0 interrupt as given below.

```
void Timer0InterruptHandler() org IVT_
ADDR_ET0{
```

It is programmed in mode 1 as a 16-bit timer. The interrupt enable bit and timer 0 interrupt bit are enabled initially. Then, timer 0 is programmed to give an interrupt every 50ms, accurately. Timer run bit TR0 is set to one to run timer 0 of AT89C51 in 16-bit mode. A 12MHz crystal oscillator is used for giving a base frequency

Test Points

Test point	Details
TP0	0V
TP1	High when timer becomes zero
TP2	High when switch S4 is opened
TP3	Low when switch S3 is pressed

of 1ms. Timer registers TH0 and TL0 are loaded with values 3CH and B0H, respectively.

The time delay value is calculated by $(65,536 - 50,000) = 15,536 = 3CB0H$, where 50,000 indicates the required time delay in milliseconds and $2^{16} = 65,536$. The interrupt program is used to increment seconds, minutes and hours every one second (50ms \times 20 iterations). The LCD is used to display seconds, minutes and hours after the conversion of values into ASCII characters since LCD controller HD44780 only accepts ASCII characters. When the real-time clock shows the time 12:00:00 seconds, session AM will change to PM, and vice versa. The microcontroller has a reset circuit to reset the clock to 01:00:00.

Construction and testing

An actual-size, single-side PCB for the long delay timer with real-time clock display is shown in Fig. 2 and its component layout in Fig. 3. Assemble

PARTS LIST

Semiconductors:

IC1	- 7805, 5V regulator
IC2	- AT89C51 microcontroller
T1	- BC547 npn transistor
BR1	- 1A bridge rectifier
LCD1	- 16x2 LCD

Resistors (all 1/4-watt, $\pm 5\%$ carbon):

R1-R5	- 10-kilo-ohm
R6	- 1-kilo-ohm
R7	- 100-ohm
VR1	- 10-kilo-ohm preset

Capacitors:

C1	- 1000 μ F, 25V electrolytic
C2-C3	- 0.33 μ F ceramic
C4-C5	- 22pF ceramic
C6	- 10 μ F, 16V electrolytic

Miscellaneous:

S1, S2, S3	- Tactile switch
S4	- On/off toggle switch
X _{CRY} 1	- 12MHz crystal oscillator
PZ1	- Peizo buzzer
X1	- 230V AC primary to 9V, 500mA secondary transformer

the circuit on the PCB to save time and minimise assembly errors. Carefully assemble the components and double-check for any overlooked errors.

Initially, the user has to set the timer in off mode using switch S4. To start the timer, switch on S4 and use switch



Fig. 4: Timer on message on the LCD when switch S4 is closed

EFY Note

The source code of this project is included in this month's EFY DVD and is also available for free download at source.efymag.com

S3 to set the countdown timer (CNT). You can set the timer from one to 59. Fig. 4 shows the display settings with real-time clock as 07 hours, 10 minutes and 38 seconds in AM and the countdown timer (CNT) is set to one. When the timer is set, you can switch on the

electrical appliance such as a motor pump.

The real-time seconds keep on incrementing from 38 till these reach zero. As soon as the seconds reach zero (after 59), the minutes will increase to 11 and, at the same time, the count-down timer will be zero. When the countdown timer reaches zero, a buzzer

alerts the user to switch-off the electrical appliance. The buzzer continues to beep till switch S4 is switched-off. For troubleshooting, ensure that the voltages at test points are as per test points table.

This timer can also be used as an appliance timer or kitchen timer. You can even replace the buzzer with a relay for switching on/off the appliance through it. ●

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