LED Bedside Lamp
with turn-off delay

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If you are not lucky enough to have access to expensive test gear then lamp circuits using LEDs offer a good chance of success and allow a little bit of electronic experimentation.

One of our readers has come up with this simple but useful addition to the bedside table. The lamp is activated either by pressing a push button or automatically when the in-built microphone detects a noise. Once lit the LED remains on for a predetermined time. The circuit has quite modest power requirements and four rechargeable NiMH cells (BT1) will be sufficient to power the circuit for a couple of months of intermittent use before they need to be topped up. The complete circuit takes around 400 μA in standby and 24 mA with the LED burning.

The microphone requires a connection to the positive supply via R1 and the circuit diagram (Figure 1) shows it AC coupled to IC1.C. The microphone sensitivity is to some extent governed by the value of R1.

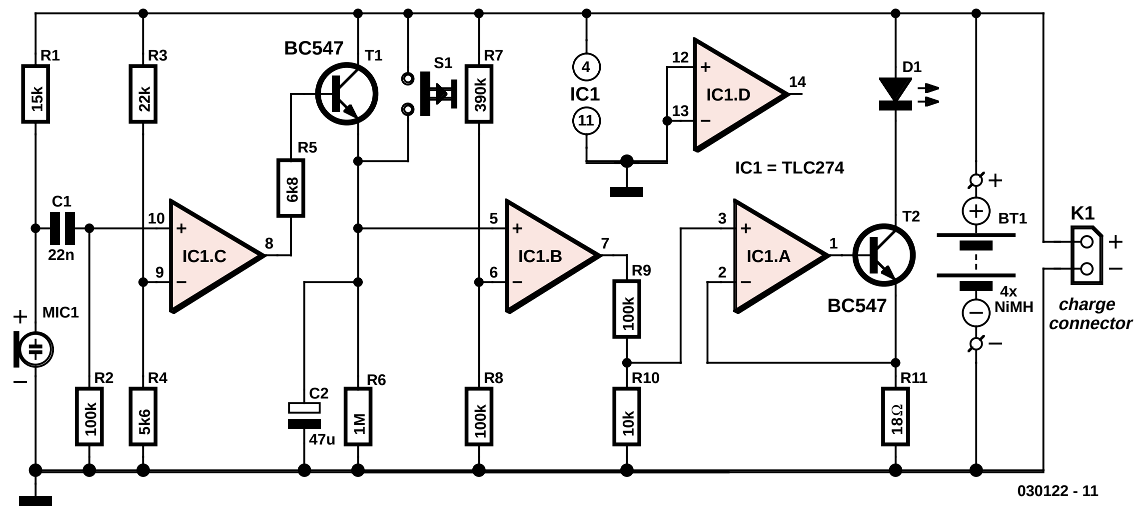

Figure 1.

A value of 15 kΩ is recommended but it may need to be changed to suit the sensitivity of your particular microphone capsule. At maximum sensitivity the LED was triggered by pressure on the microphone diaphragm from a draft of air produced when the bedroom door was opened!

Capacitor C1 is used to remove the DC component of the microphone signal while R2 ensures the resultant AC signal is referenced to earth potential. Resistors R3 and R4 form a potential divider to provide the voltage threshold at the negative input of comparator IC1.C. Whenever the signal level produced by the noise exceeds this threshold value the output will go high and switch on T1. Capacitor C2 will then be charged and the voltage level on the positive input of IC1.B will rise exponentially. Pressing pushbutton S1 will have the same effect because it is wired in parallel with T1. The charging path of C2 has no series resistor so even a very short duration sound will be sufficient for C2 to fully charge. IC1.B is configured as a comparator with resistors R7/R8 forming a potential divider defining the threshold voltage of 20 % of the supply voltage (about 1 V) at the inverting input. When C2 is fully charged it takes around 1.5 min for the voltage to fall to this level while discharging through resistor R6.

The last opamp IC1.A is configured as an amplifier together with transistor T2. The LED current (and hence brightness) can be altered by changing the value of R11 (I_{LED} = 0.44 V/R11). The voltage developed across R11 is used by IC1.A to control the conduction of T2 in a classic feedback configuration. This ensures that the light intensity of D1 remains constant even when the battery output voltage sinks to the sharp 'knee' in its characteristic. Connector K1 allows an external charger to recharge the cells.

The PCB component placement (including a socket for IC1) is shown in Figure 2. It is not necessary to fit any wire links and apart from the semiconductors there is only one polarised component (C2). It may be tempting fate but there is hardly any opportunity to fit any component incorrectly! The LED is soldered in place once the PCB is fitted into its enclosure and the LED

Turn off delay calculations

The LED turn-off delay time is relatively simple to calculate or change if required. The output of comparator IC1.B remains high as long as the signal on the non-inverting input (pin 5) is above the voltage on the inverting input (pin 6). The voltage level at pin 6 is given by:

$$U_{PIN\ 6} = U_{BT1} \times R8 / (R7+R8)$$

The voltage across C2 discharges according to the natural logarithm function:

$$U_{C2} = U_{BT1} \times e^{-t / R6C2}$$

Rearranging the equation for t:

$$U_{C2} / U_{BT1} = e^{-t / R6C2}$$

$$\ln (U_{C2} / U_{BT1}) = -t / R6C2$$

$$t = -R6C2 \times \ln (U_{C2} / U_{BT1})$$

U_{C2} and $U_{PIN\ 6}$ should be equal so substituting:

$$t = -R6C2 \times \ln (U_{BT1} \times R8 / (R7+R8)) / U_{BT1})$$

The battery voltage can be cancelled from the equation so that the turn off delay time is only dependant on the resistor and capacitor values!

$$t = -R6C2 \times \ln (R8 / (R7+R8))$$

Substituting actual component values we get:

$$t = -10^6 \times 47{\times}10^{-6} \times \ln (10^5 / 4.9{\cdot}10^5) \approx 75 \text{ s}$$

positioned through an opening. A reflector can be fitted to help concentrate the LED light.
Wire connections to the PCB can be made via solder pins. It may be possible to connect the charging socket and pushbutton directly to the relevant pins without the need for wire but this will depend on the type of enclosure that you use. The microphone capsule can be mounted inside the case but don't forget to provide an opening to allow sound waves to reach the microphone.

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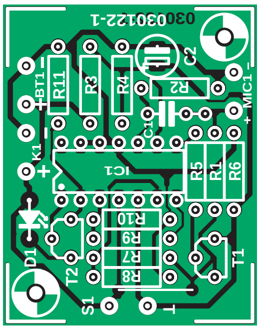

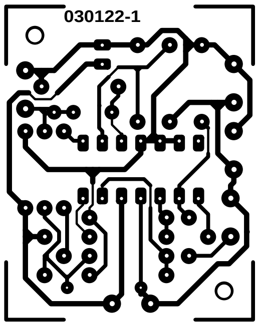

Figure 2.

COMPONENTS LIST

Resistors:
R1 = 15kΩ
R2,R8,R9 = 100kΩ
R3 = 22kΩ
R4 = 5kΩ6
R5 = 6kΩ8
R6 = 1MΩ
R7 = 390kΩ
R10 = 10kΩ
R11 = 18Ω

Capacitors:
C1 = 22nF
C2 = 47µF 16V radial

Semiconductors:
D1 = LED, white, e.g., Conrad Electronics # 153867
IC1 = TLC274
T1,T2 = BC547B

Miscellaneous:
Bt1 = battery holder for 4 NiMH cells
K1 = charge socket for batteries
MIC1 = electret microphone capsule
S1 = pushbutton, 1 make contact
PCB, ref. 030122-1 from The PCBShop
Enclosure