The materials and works contained within EPE Online — which are made available by Wimborne Publishing Ltd and TechBites Interactive Inc. — are copyrighted.

TechBites Interactive Inc and Wimborne Publishing Ltd have used their best efforts in preparing these materials and works. However, TechBites Interactive Inc and Wimborne Publishing Ltd make no warranties of any kind, expressed or implied, with regard to the documentation or data contained herein, and specifically disclaim, without limitation, any implied warranties of merchantability and fitness for a particular purpose.

Because of possible variances in the quality and condition of materials and workmanship used by readers, EPE Online, its publishers and agents disclaim any responsibility for the safe and proper functioning of reader-constructed projects based on or from information published in these materials and works.

In no event shall TechBites Interactive Inc or Wimborne Publishing Ltd be responsible or liable for any loss of profit or any other commercial damages, including but not limited to special, incidental, consequential, or any other damages in connection with or arising out of furnishing, performance, or use of these materials and works.

READERS’ TECHNICAL ENQUIRIES

We are unable to offer any advice on the use, purchase, repair or modification of commercial equipment or the incorporation or modification of designs published in the magazine. We regret that we cannot provide data or answer queries on articles or projects that are more than five years’ old. We are not able to answer technical queries on the phone.

PROJECTS AND CIRCUITS

All reasonable precautions are taken to ensure that the advice and data given to readers is reliable. We cannot, however, guarantee it and we cannot accept legal responsibility for it. A number of projects and circuits published in EPE employ voltages that can be lethal. You should not build, test, modify or renovate any item of mains-powered equipment unless you fully understand the safety aspects involved and you use an RCD adaptor.

COMPONENT SUPPLIES

We do not supply electronic components or kits for building the projects featured; these can be supplied by advertisers in our publication Practical Everyday Electronics. Our web site is located at www.epemag.com

We advise readers to check that all parts are still available before commencing any project.

To order you copy for only $18.95 for 12 issues go to www.epemag.com
GLOBAL warming in relation to our use of energy is a subject that is heavily debated. A major use of energy is the consumption of electricity in our homes and industries. Perhaps the most obvious waste of electricity in our homes (although certainly not the largest) is caused by lights being left on in areas when the occupants have left. Nowhere, perhaps, is this more common than in halls and stairways.

Fitting switches which turn off automatically after a preset time in these locations can reduce the electricity consumed quite significantly. A single 100W bulb left burning all night (say eight hours) would consume 800Whrs. The same bulb fitted with a switch which turned off automatically after say five minutes would consume only 83Whrs, even in the unlikely event that it were to be activated ten times during this period.

MECHANICAL DELAYS

Commercial time delay switches for stairs and halls are generally mechanical devices which work on the basis of a leaky cylinder. When the button is pressed, air is expelled from the cylinder and a contact is made, so switching on the light. A spring now slowly pushes the cylinder back to its rest position at the limited rate at which air can re-enter. This causes sufficient voltage drop so that after rectification a 3V to 4V d.c. supply is available for the control circuits. The Neutral wire from the lamp is left inaccessible in the ceiling. Thus it is not possible to simply reduce and rectify the mains to provide d.c. voltage for the triac control circuit, which must therefore be powered through the lamp, i.e. from the voltage across the triac.

An adequate d.c. voltage can be derived by delaying the point at which the triac is triggered in a mains half-cycle. This allows a higher voltage to develop across it which can be rectified and used to power the rest of the circuit.

The disadvantage is that it gives rise to EMI (electromagnetic interference) which can interfere with radio reception and computer systems. As a result, bulky and expensive chokes and capacitors have to be fitted to suppress it. This is unavoidable in light dimmers where we have to delay the triggering so that the power to the lamp can be controlled. For an on/off control, though, triggering should occur as early as possible so that full power is available to the lamp and without interference being generated.

TRIAC CONTROL

There are two major problems to solve when designing a touch switch to replace a conventional mechanical light switch and these concern the power supply and noise immunity.

The main switching element used to control the light is a semiconductor a.c. switch. This is normally in its off or non-conducting state but can be switched into conduction by means of a small trigger current fed to its gate terminal. Once triggered it will remain conducting until the current through it drops below a certain value (known as the holding current). This occurs normally on a.c. supplies when the voltage drops to zero at the end of every mains half-cycle, and the triac must be re-triggered again if the light is to remain on.

As with any switch, the voltage across a triac when it is in its off state will be the supply voltage (in this case 230V a.c.). When the triac is on, the voltage across it will be around 1V a.c., depending on the current. The triac therefore dissipates very little power so no heatsink is required.

With normal house wiring, only the Live wire and its feed to the lamp are accessible at the wall-mounted light switch. The Neutral wire from the lamp is left inaccessible in the ceiling. Thus it is not possible to simply reduce and rectify the mains to provide d.c. voltage for the triac control circuit, which must therefore be powered through the lamp, i.e. from the voltage across the triac.

The circuit provides sufficient current to enable the triac to be triggered by d.c. pulses instead of the short a.c. trigger pulses normally used. As a result, the triac does not turn off between half-cycles, and so does not cause interference to the mains supply. This point is important as it also enables the circuit to

**Constructional Project**

**TIME DELAY TOUCH SWITCH**

**BART TREPAK**

Automatically turns off lights after a preset period

This circuit overcomes these problems by having no moving parts. It is activated by touch and has the added bonus of a small neon light which enables it to be easily located in the dark. The finished unit is mounted on a standard electrical blanking plate and can replace any conventional light switch.

Although intended primarily for conventional incandescent light bulbs, the circuit has also been found to work with low energy fluorescent types.

The disadvantage is that it gives rise to EMI (electromagnetic interference) which can interfere with radio reception and computer systems. As a result, bulky and expensive chokes and capacitors have to be fitted to suppress it. This is unavoidable in light dimmers where we have to delay the triggering so that the power to the lamp can be controlled. For an on/off control, though, triggering should occur as early as possible so that full power is available to the lamp and without interference being generated.

IN CONTROL

In this circuit, a small Zener diode is connected in series with the triac. This causes sufficient voltage drop so that after rectification a 3V to 4V d.c. supply is available for the control circuits. The Zener has the load (light) current flowing through it during operation and therefore dissipates power, but for the kind of currents used in lighting this only amounts to a few hundred milliwatts, a value well within the ratings of small wire-ended Zener diodes.

The circuit provides sufficient current to enable the triac to be triggered by d.c. pulses instead of the short a.c. trigger pulses normally used. As a result, the triac does not turn off between half-cycles, and so does not cause interference to the mains supply. This point is important as it also enables the circuit to
be used with low power fluorescent lamps if required.

**TOUCH CONTROL**

Touch control circuits, by their very nature, tend to be prone to spurious switching in response to the many glitches and pulses which normally occur on the mains supply due to other equipment being switched on or off. This is often difficult to overcome, but it can be very much reduced by building a delay into the circuit so that short pulses, which characterise most of the interference, are ignored and the circuit only responds to longer inputs. By fitting a delay of a few hundred milliseconds, users will not notice any delay in switching, and interference, which rarely lasts for more than a few tans of milliseconds, will be largely ignored by the circuit. This is not a complete solution to the problem, but in this case there is also the advantage that even if the circuit should switch on accidentally, it will only remain on for a few minutes anyway.

The circuit diagram for the Time Delay Touch Switch is shown in Fig.1. Triac CSR1 and Zener diode D4 are connected in series with the lamp as previously discussed. The voltage appearing across the Zener is rectified and smoothed by diode D3 and capacitor C4 to provide a d.c. supply of around 4V.

As this voltage only appears when the triac is on, capacitor C5 is connected as a capacitive mains dropper to provide a small current to the Zener to maintain the d.c. supply when the triac is off. Resistor R6 is included to limit the Zener current should the circuit be powered when the capacitor is discharged (very likely) and also to limit the discharge current which could destroy the triac when it switches on (also very likely).

The rest of the circuit is quite conventional and is based on a quad CMOS Schmitt trigger NAND gate, although the gates are used as logic inverters by having both inputs connected together. This type of gate has the advantage of switching clearly once the input threshold voltage has been exceeded.

The input sensor is formed by placing a conducting foil behind the insulating front plate. Resistor R2 discharges the capacitor when the hand is removed.

When the input threshold of gate IC1a is exceeded, the output switches low causing a standard light switch blanking plate. The foil forms one plate of a capacitor, which is the human body is a fairly good conductor and exhibits a capacitance to earth of around 100pF, depending on size and area!)

Since the emitter circuit of npn transistor TR1 is connected via resistor R2 to the live rail, which is at 230V a.c. with respect to earth, this is equivalent to a 230V input to the base of TR1 via the combined capacitance of the body plus that the hand and foil.

Not surprisingly, transistor TR1 turns on when the input polarity is correct and charges capacitor C1. Resistor R1 and preset resistor VR1 set the sensitivity of the circuit, allowing it to be activated by placing one finger or the whole hand on the plate. Resistor R2 discharges the capacitor when the hand is removed.

When the input threshold of gate IC1a is exceeded, the output switches low causing time for which the triac remains triggered and the lamp turned on.

With the components specified, the turn-on time can be made variable from around 20 seconds to ½ minutes. This may be increased if required by increasing either R4 or C3, or both.

---

**COMPONENTS**

<table>
<thead>
<tr>
<th>Component</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resistors</td>
<td></td>
</tr>
<tr>
<td>R1, R3</td>
<td>2M2 (2 off)</td>
</tr>
<tr>
<td>R2</td>
<td>680k</td>
</tr>
<tr>
<td>R4</td>
<td>330k</td>
</tr>
<tr>
<td>R5</td>
<td>390Ω</td>
</tr>
<tr>
<td>R6</td>
<td>1k</td>
</tr>
<tr>
<td>R7</td>
<td>150k</td>
</tr>
<tr>
<td>VR1, VR2</td>
<td>2M2, min preset, vertical (2 off)</td>
</tr>
<tr>
<td>Potentiometers</td>
<td></td>
</tr>
<tr>
<td>See SHOP</td>
<td></td>
</tr>
<tr>
<td>TALK page</td>
<td></td>
</tr>
</tbody>
</table>

**Capacitors**

- C1, C2: 100n ceramic, 5mm pitch
- C3, C4: 10µF radial elect, 16V
- C5: 100n class X2, 250V a.c. (see text)

**Semiconductors**

- D1 to D3: 1N4148 signal diode
- D4: 4V7 BZX85, or 1N5337 Zener diode (see text)
- CSR1: TIC206D 400V 4A triac
- TR1: 2N3904 npn transistor
- TR2: BC558 pnp transistor
- IC1: 4093 quad Schmitt trigger NAND gate

**Miscellaneous**

- LP1: neon, wire-ended

---

Printed circuit board, available from the EPE PCB Service, code 331; 2-way p.c.b.-mounting terminal block; plastic electrical blanking plate; aluminium foil; insulating materials; connecting wire, solder, etc.

---

*Approx. Cost* Guidance Only excluding elec. plate £9

---

Everyday Practical Electronics, January 2002
Note also that the time can easily be extended by touching the plate during the on period. This will recharge C5 so that if you stop on the stairs for a chat, you need not be plunged into darkness half way through the conversation!

In any event, even if this should happen, with the triac turned off 230V a.c. will appear across it and the small neon lamp LP1 will light. This is arranged to shine through a hole in the printed circuit board, illuminating the touch area so that it should be an easy matter to find the switch in the dark. Resistor R7 limits the current through the neon, which generally strikes at about 90V.

**CONSTRUCTION**

As this circuit is always live at mains voltage, its construction should only be undertaken by those who are suitably experienced or qualified.

The circuit should not be constructed on stripboard, and it must not be earthed, either intentionally or accidently as this will cause the instant destruction of many of the components.

The recommended printed circuit board (p.c.b.) component and tracking layouts are shown in Fig.2, together with the triac and transistor pinouts in Fig.3. This board is available from the EPE PCB Service, code 331.

Care should be taken to ensure that the correct orientation of all polarity-conscious components is observed. The use of a socket is recommended for IC1, which is a CMOS device, and you should discharge static electricity from your body before handling it.

The neon should be mounted slightly above the p.c.b. to enable it to be bent to lie directly above the central hole. Insulating sleeving should be fitted over the leads to prevent them touching other components.

The triac should be a 400V a.c. sensitive-gate device and the type specified has a maximum gate current requirement of 5mA. Any substitute should have a similar specification.

Zener diode D4 will dissipate about 1W with a 100W lamp so a 1W type, such as the BZX85 series, should suffice. For higher lamp powers a 5W device such as the IN5337B should be used.

The choice of capacitor for C5 is very important as this device must be rated for connection across the mains. On the face of it, a 400V rating would appear suitable but this is not usually the case as this is often a d.c. rating and many such capacitors have only a 200V a.c. specification. It is essential that a Class X2 type should be used as these are guaranteed for operation up to 275V a.c.

**TESTING**

Before testing, ensure that there are no solder splashes or short circuits on the board and the soldering is of a good standard.

As the circuit operates at mains potential, do not touch any part of the p.c.b. when it is powered and ensure that the mains supply is off when fitting or adjusting it. Under no circumstances should any part of it be connected to earth.

Having said that, the circuit is safe to use once it is mounted in its wall box. There is, however, the problem of testing it safely and to do this it is best to use a temporary d.c. supply and not fit the triac at this stage. For this testing an i.e.d. should be connected between the two holes adjacent to the terminal block where the triac will be mounted, with the i.e.d. earthed (i.e. usually denoted by a shorter lead) nearest to the edge of the board.

Solder a temporary lead to the junction of components C5 and R6 and connect this to the positive terminal of a 9V d.c. power supply or battery. Secure another lead to the L terminal and connect this to the negative terminal of the power supply. The circuit can now be tested at low voltage and should work as described.

It will probably not be possible to switch the circuit on by touching the plastic front panel but it should switch when the transistor base is touched directly. If not, a 1MΩ resistor connected from the supply positive to the transistor base should cause the i.e.d. to light.

The operation of the circuit can easily be followed by monitoring the outputs of the gates with a multimeter or oscilloscope and the status of the triac will be displayed by the i.e.d. In this way the time delay and to a certain extent the sensitivity, can be set up by adjusting the i.e.d. replaced by the triac. This will probably need to be mounted as shown in Fig.4 to ensure that its height does not exceed 1.5cm from the board. This is important if the unit is to be mounted in a plaster-depth wall-box but is not so vital if a deeper box is available.

The triac leads will need to be bent to suit and this should be carried out carefully by holding each lead in a pair of pliers at the point where the bend is required. Do not bend the leads too close to the body of the device or bend them repeatedly as they may break.

To stop the device from moving and placing further strain on the leads, it may be a good idea to glue the triac tab to capacitor C5 with epoxy adhesive. Many triacs (including the device specified) have the heatsink tab internally connected to the centre pin and in these cases, this must be insulated by means of insulating tape or suitable plastic sheet as to ensure that it cannot touch the wall box.

**TOUCH PLATE**

The touch plate assembly is made by using a piece of aluminium kitchen foil about 4cm square stuck behind the centre of an electrical blanking plate, as shown in Fig.5.

Most blanking plates have a central area made of thinner plastic than the surrounding plate. This forms an ideal area for the completed circuit board. Note the neon has been bent over to lie directly over the centre hole in the p.c.b.
neon light to shine through. (Do not make a hole in the blanking plate.) The aluminium foil should be removed from this area as shown in Fig.5. The surface of the foil should then be covered with strips of insulating tape.

A short piece of wire with about 1 cm of insulation removed should be trapped beneath the insulation to enable the foil to be connected to the transistor on the circuit board. A small knot tied in the wire under the insulating tape may help to prevent the wire from being pulled out during final assembly.

After soldering the other end of the wire to the base of transistor TR1, the p.c.b. should be mounted on the back of the touch plate. Double-sided self-adhesive pads are ideal for this but as these grip immediately on contact, care should be taken to ensure that the board is situated to the centre of the plate. The position of the neon should be adjusted so that it shines directly over the central hole in the foil.

**INSTALLATION**

Once this has been completed, the unit can be mounted in the wall box. The mains must be switched off before the existing switch is removed, and when making any adjustments. The two cables inside the wall box should be connected to the terminal block on the unit. Because of the way the circuit operates, it is important that the Live wire is connected to the L terminal on the p.c.b. as shown in Fig.2.

This wire is normally coloured red but it may not be, depending on the installation. If you are not sure which of the two wires is the Live one, connect them either way around. If you have chosen the wrong one no damage will result but the circuit will not switch on and the preset fully anticlockwise and reverse the wires to the terminal block before repeating the procedure.

Do not increase the sensitivity beyond the point at which it switches on easily as this can make it more susceptible to random switching, or even prevent the unit from switching off at the end of the preset period. The latter can be increased by turning VR2 clockwise.

Should you wish to use the unit with a two-way switching circuit, to enable the lights to be switched on and off from two locations, this can be done quite easily with no re-wiring being involved. Fig.6 shows a typical two-way switching arrangement and the new switches may be used to replace the existing switches as shown.

The wire colours stated in Fig.6 are those normally used although they may be different depending on the installer. In any event, one of the existing wires will not be required and the touch switches should be wired in parallel as shown. It is important to ensure that the mains Live is connected to the correct terminal on each switch.