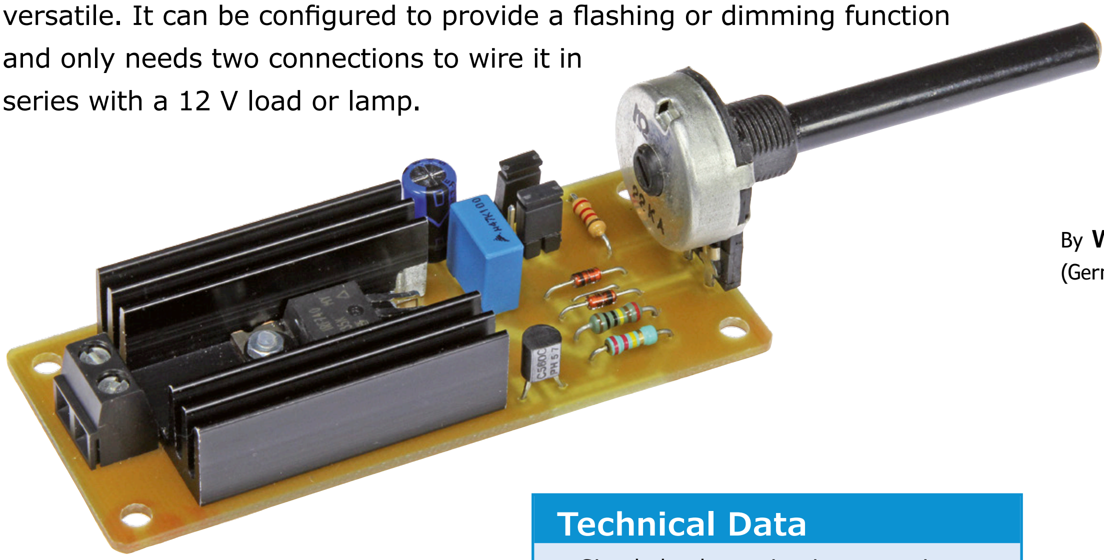
In-line Lamp Flasher/ Dimmer

Two connections are enough

This circuit looks relatively simple at first sight but it is nevertheless quite versatile. It can be configured to provide a flashing or dimming function and only needs two connections to wire it in series with a 12 V load or lamp.



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A while back the author found a circuit 'Somewhere on the Net' for a flashing turn indicator circuit that was wired in series with the load lamp. It was just what he was after; normal lamp flasher circuits have at least three connections (Supply, ground and output). He studied the circuit, made some improvements and came up with this design which can be easily incorporated into existing vehicle wiring without the need for extra cabling. The circuit can be used to replace a broken hot-wire flasher unit used in the turn-indicator circuit of a vintage car (wired in series with the lamp).

It seemed obvious that the circuit could also be modified to provide another function: Increase the flashing frequency to a rate faster than the eye's flicker-fusion frequency and the circuit could now work as a lamp dimming device wired in series with lamp. Classic car owners will find this an ideal substitute for a faulty wire-wound pot normally used in series with the dashboard instrument lights to control brightness.

Technical Data

- Simple hookup using just two wires
- Configurable for flashing or dimming mode
- 12 V operation
- Load maximum 21 W at 12 V
- Flash frequency 0.5 to 2 Hz
- Mark / Space ratio 1 to 99 %
- Reverse polarity protection

The circuit

Looking at the flasher/dimmer schematic shown in **Figure 1** you would probably agree that there is nothing complicated about its operation but don't let the low component count and its simplicity fool you, this apparently minimal circuit has a trick up its sleeve. To begin the description, configure the circuit in flashing mode with a jumper fitted between pins 2 and 3 of JP1 and another at JP2.

Flashing Mode

When power is first applied to the circuit T2 is off and the source and drain path is high impedance because the gate voltage is zero. The voltage on C1 (and C2) is initially zero, the emitter of T1 will be at ground potential

and its base will be at 10 V derived from the supply voltage and voltage divider network R1 and R3. T1 is therefore not conducting and the voltage across R4 is zero. C1 (and C2) are now charging up from the supply via R2 and P1. Eventually T1's emitter voltage exceeds the value of 10 V at its base plus the 0.6 V base-emitter voltage drop so that it begins to conduct. The high impedance of R4 ensures that the voltage across it rises rapidly and switches T2 on to light lamp LA1.
Now that T2 is conducting supply voltage to the circuit is effectively short-circuited so the circuit will shut down? Well that's not quite true; the trick is that the supply to the divider network R1 and R3 is now at zero but C1 (and C2) are still charged so T1 remains conducting while the voltage on C1 and C2 discharges through the emitter-base path down to ground via R1 and R3. This ensures that T2 remains conducting and only when the falling voltage across R4 drops below the voltage threshold of T2 will it begin to turn off. Now the voltage between the terminals of K1 starts to rise which in turn increases the voltage across the divider network R1 and R3 and the base of T1, producing a positive feedback effect to quickly turn off both transistor T1 and T2. The lamp now extinguishes and the process repeats from the start.
The feedback effect via R1 and R3 ensures that the T2 switches quickly so that even at high load currents there is very little energy dissipated in T2 during switching. The flash frequency is given by the charge and discharge times of C1 (and C2) which are governed by the capacitor values and the resistor values of R2 and P1. The values of R1, R3 and R4 do not play any part in the flash rate and are chosen to ensure fast switching. The value of P1 given in the parts list produces an approximate flash range between 0.5 to 2 Hz.

Dimming Mode

The circuit works so well that it seemed worthwhile looking for other applications. It can also be used as a dimmer for filament lamps. For this application it's not quite as simple as raising the flashing frequency by removing the jumper on JP2 so that C1 is disconnected from the circuit. With JP2 removed the switching frequency of T1 and T2 is about 100 times faster than in the previous configuration but twiddling P1 only affects the operating frequency not the mark/space ratio of the output which remains at about 50 % power.
To make the circuit function as an adjustable dimmer, pot P1 needs to control the on/off ratio of the output waveform. The jumper at JP1 is now repositioned to short pins 1 and 2 so that R2 is effectively out of the circuit. Now only the values of C2 and P1 affect the switching rate. Diodes D1 and D2 connected to the track ends of pot P1 are now used in order to define the on and off times of the switching waveform. When T2 is turned off, the charge time of C2 is determined (via D2) by the resistance of the portion of P1's track to the left of the wiper position. When T2 is conducting, C2 discharge time is governed (via D1) by the resistance of P1's track to the right of the wiper position. This arrangement allows the mark/space ratio of the output waveform to be varied from around 1 to 99 % as the pot's control shaft is turned from one end of its travel to the other. The operating frequency of the dimmer is approximately 100 Hz.

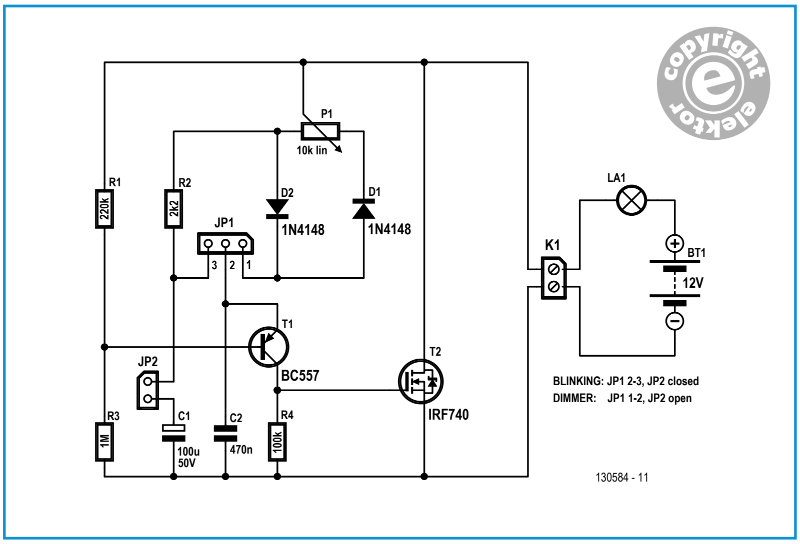

Figure 1.
The flasher/dimmer circuit looks simple at first glance.

Construction

Construction of the unit is not at all complicated; all components use through-hole leads so you can easily assemble them on a small square of prototyping perf board. Make sure that the conducting paths connecting the Drain and Source of T2 to connector K1 are thick enough to handle the load current if you are using high-wattage lamps. The turn-signal, lamp dimmer circuit has such a wide potential application that Elektor have developed a small single-sided PCB which makes

Component List

(All through-hole components)

Resistors
R1 = 220kΩ
R2 = 2.2kΩ
R3 = 1MΩ
R4 = 100kΩ
P1 = 10kΩ potentiometer

Capacitors
C1 = 100µF 25V, radial, 0.1” pitch
C2 = 470nF, foil, 5mm or 7.5mm pitch

Semiconductors
D1,D2 = 1N4148
T1 = BC557
T2 = IRF740

Miscellaneous
K1 = 2-way PCB screw terminal block, 5mm pitch
Heatsink for TO220 case
PCB # 130584-1 [1]

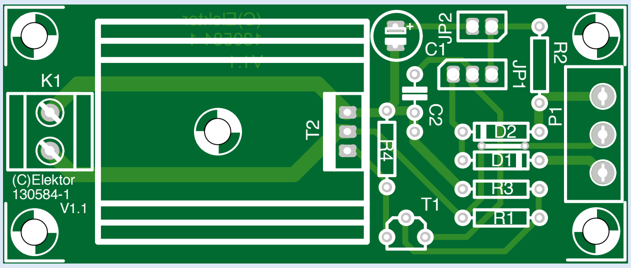

Figure 2.
Component placement using the Elektor PCB.

construction really simple and produces a neat result (see **Figure 2**). Details of the PCB layout and ordering the PCB itself are available on the web page for this project [1]. The PCB has space for a small heatsink to reduce the temperature rise produced by the low level of energy dissipated in T2.

The recommended transistor type specified for T2 is suitable for a load current up to 2 A. This would therefore allow a standard 12-V 21-W lamp, commonly used in cars, to be used as a load. To switch higher loads it will be necessary to use a power FET with lower $R_{DS(on)}$. In this case the use of a heat sink is essential. The circuit works well and is stable with an input voltage between 10 and 15 V and is ideal for operation from the 12 V supply used on cars and motorbikes. It is worth noting that the circuit does not provide any high voltage protection at the gate of T2. Caution is advised when the circuit is used to drive highly inductive loads even though capacitors C1 and C2 will provide some level of spike suppression. Standard filament lamps however do not cause a problem in this respect. It is not necessary to wire the circuit with the load in the positive lead from the battery as shown in Figure 1; the circuit works just as well if the load is placed in the negative lead from the battery. The circuit has built-in protection from accidental reverse polarity connection; if the circuit is incorrectly wired, T2’s parasitic diode conducts and the load becomes permanently powered.

When the circuit is to be installed as a permanent solution in either flashing or dimming mode the jumpers can be replaced with soldered wire bridges and any superfluous components can be left out of the build. To build a flasher leave out D1, D2 and C2 and for a dimmer leave out R2 and C1. A suitably rated fuse should be provided in the BATT+ line.

(130584)

Web Link

[1] www.elektor-magazine.com/post