Microprocessor Controlled Light Dimmer

with pushbutton control

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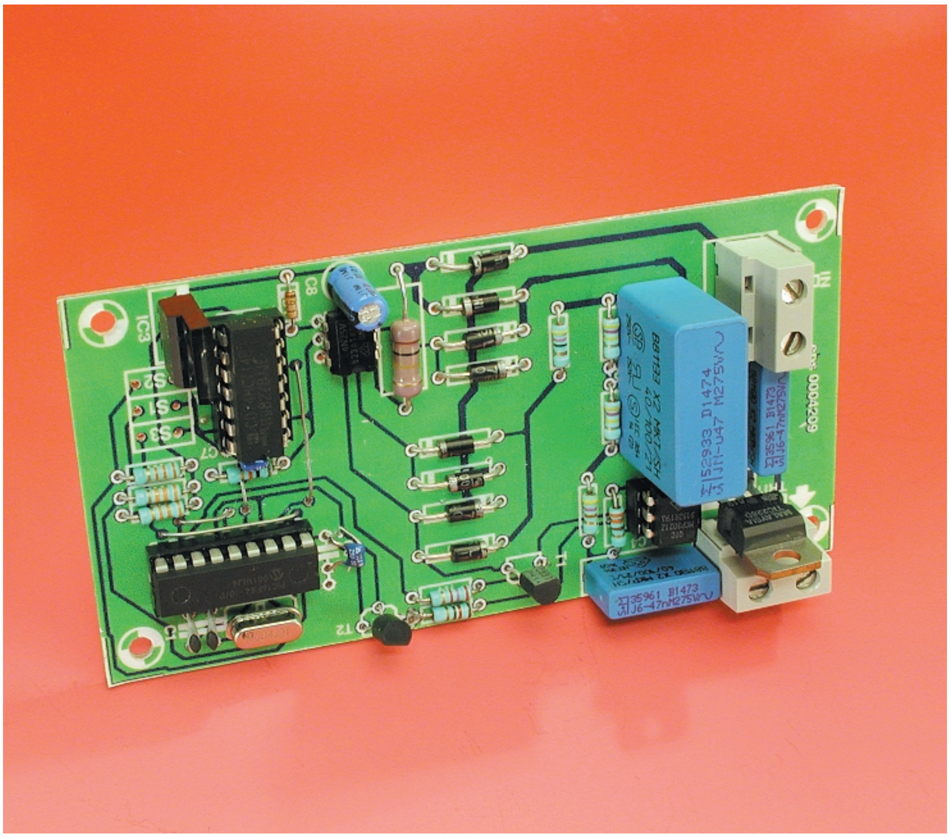
This easy to construct light dimmer is controlled by a PIC controller and can handle a maximum current of 6 A. Three pushbuttons ensure extremely user-friendly operation.



The light dimmer described here can be split into two parts. The light dimmer proper follows the familiar recipe. It is an analogue circuit, which uses a triac for phase control of the mains voltage. This is hardly a surprise. A little more striking is the fact that this dimmer circuit is not controlled with a simple potentiometer but with a programmed PIC16F84 processor. The processor is operated with the aid of three pushbuttons: a combined on/off button, an up and a down button.

Usage Instructions

The microprocessor is programmed in such a way that the dimmer will be in the 'off' position when first powered up, while at the same time the control circuit starts off in the

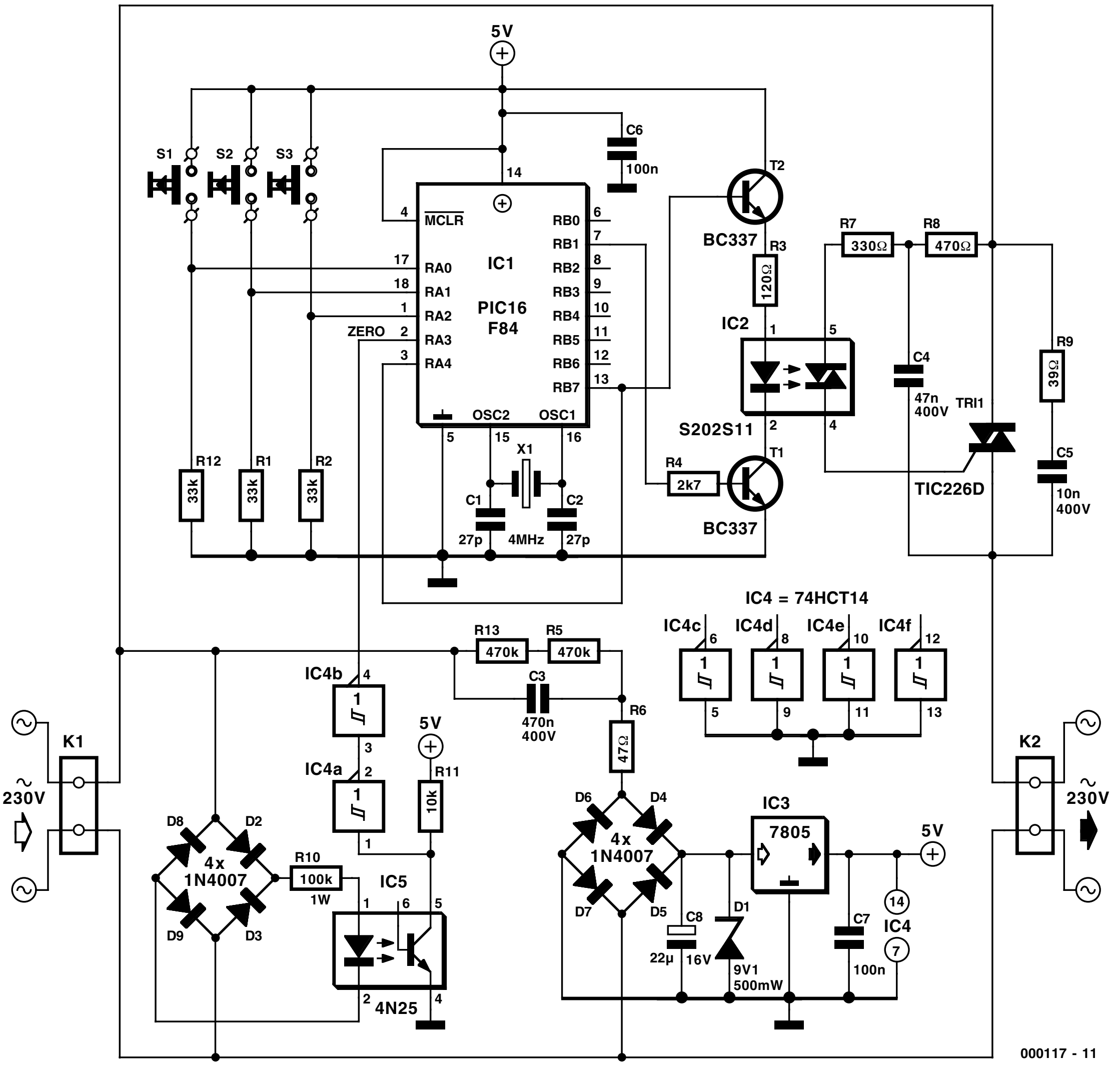


Figure 1. The classic triac light dimmer is driven from a programmed PIC16F84 processor.

'fully open' position. Pushing the on/off button activates the dimmer, only then will current be supplied to the attached lamp. However, it is also possible to adjust the control circuit before the dimmer is activated; in other words, it makes no difference whether the dimmer is activated or not.

Operation

The dimmer schematic is shown in **Figure 1**. It is immediately obvious that the amount of hardware required is quite small. The various functional blocks will be easily recognised by most of you. At top centre is the PIC-processor, to its right is the triac circuit, at bottom left is the zero-crossing detector and at bottom right is the power supply.

The **processor circuit** is a textbook example and requires no further explanation. The three input pushbuttons are connected to RA0, RA1 and RA2, while the triac circuit is driven from RB1 and RB7. The connection that has been drawn between RB7 and RA4 is now actually superfluous. Initially, the software used this connection to sense if the dimmer was on or off. Later on this was changed to enable the processor to keep track if this itself.

Now to the **triac circuit**. This is also a textbook example, with the exception that the triac (TRI1) is driven by a triac-driver (IC2). This provides separation between the low voltage and the high voltage circuitry. This is required because ground of the 5 V power supply has a different potential with respect to the high voltage circuit. T1 and T2 control the triac driver. These two transistors together perform an AND-function. The drive signal is applied only when both transistors conduct (RB1 and RB7 high). Snubber network R9/C5 protects the triac from inductive loads.

In order to determine the exact trigger point, a **zero-crossing detector** is indispensable. IC5 (optocoupler 4N25) is the most important part in this sub-circuit. A separate bridge rectifier drives the light source in the optocoupler. This is because the other bridge rectifier does not provide phase information of the mains, due to the presence of C3. The 100 Hz voltage applied to the input of IC5 causes the transistor in the optocoupler to block briefly at every zero crossing of the mains voltage. As a consequence, at every zero crossing there is a short 5-V pulse at the collector of this transistor. This signal is applied to the processor via the double Schmitt-trigger IC4a/IC4b. This makes it possible for the software to synchronise itself to the mains.

Finally, **the power supply**. As can be observed, the required 5 V supply voltage is derived directly from the mains, without the use of a transformer. 'AC resistor' C3 reduces the mains voltage to an acceptable level. This reduced voltage is rectified by a bridge rectifier (D4-D7) and regulated by a 7805. Diode D1 prevents the input voltage of IC3 from exceeding safe limits. Two 100 nF capacitors are used for power supply decoupling.

Because a 5 V power supply appears harmless, we would like to stress that this voltage in this instance is everything but safe! The reason is that this power supply is not electrically isolated from the mains. Be very careful!

Construction

Figure 2 depicts the layout for the PCB designed for the project. The construction of the light dimmer is a relatively simple task, because the number of components required is very modest, and the PCB and programmed PIC are available from the *Elektor Electronics* Readers Services (the source code files as well, for that matter).

We again urge all prospective constructors to take the utmost caution. The entire circuit is directly connected to the mains! Despite the presence of an optical triac driver and an optocoupler, the entire low voltage circuit is **not** electrically isolated from the mains. Keep this in mind while testing and making measurements on this circuit.

Another important practical matter is that for C3, C4 and C5, Class-X2 capacitors must be used. These are short-circuit proof and are guaranteed never to cause a short circuit in the event that they develop a defect. If you intend to fit the circuit into a typical enclosure, it may be better to mount voltage regulator IC3 horizontally. This can be achieved by bending IC3 over the top of IC4; do not trim the leads too short, otherwise this will not be possible.

Because of the compact dimensions of the PCB, finding a suitable enclosure should not be an issue. Use plastic screws and standoffs to fasten the PCB, in order to maintain the required insulation spacing between mains voltage and parts that may be touched. Our prototype was built into a plastic case from Bopla. The PCB fitted nicely, but it was necessary to shorten the internal stand-offs by some 3 mm for the cover to be fitted properly.

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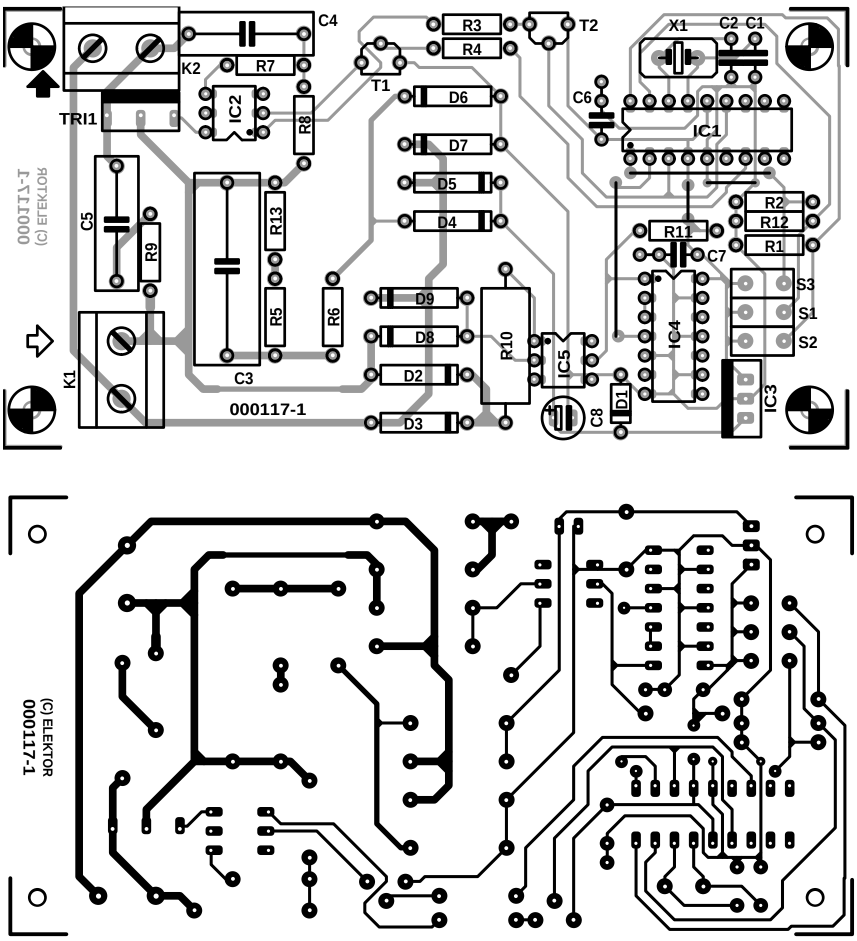

Figure 2. The PCB has everything clearly arranged and is compact. Keep in mind that the entire circuit is connected to the mains!

COMPONENTS LIST

Resistors:
R1,R2,R12 = 33 kΩ
R3 = 120 Ω
R4 = 2kΩ7
R5,R13 = 470 kΩ
R6 = 47 Ω
R7 = 330 Ω
R8 = 470 Ω
R9 = 39 Ω
R10 = 100 kΩ 1 W
R11 = 10 kΩ

Capacitors:
C1,C2 = 27 pF
C3 = 0.47µF 400 V (Class X2)
C4 = 47 nF 400 V (Class X2)
C5 = 10 nF 400 V (Class X2)
C6,C7= 100 nF
C8 = 22 µF 16 V radial

Semiconductors:
D1 = zener diode 9.1V 500mW
D2-D9 = 1N4007
T1,T2 = BC337
Tri1 = TIC226D
IC1 = PIC16F84-04, programmed, order code **000117-41** (see Readers Services page)
IC2 = MOC3021
IC3 = 7805
IC4 = 74HCT14
IC5 = 4N25

Miscellaneous:
S1,S2,S3 = pushbutton with make contact, safety Class 2
X1 =4 MHz quartz crystal
K1,K2 = 2-way PCB terminal block, lead pitch 7.5 mm
Case: e.g. Bopla (Conrad-Electronics order code 52 22 52-11)
PCB, order code **000117-1** (see Readers Services page)
Project disk (PIC source code files), order code **000117-11**