CAPACICOUPLING

A number of methods are known to permit isolation between separate but otherwise co-operating electric circuits. Perhaps the most familiar example is the ordinary transformer. A more recent development in this field is the optocoupler, but other systems using either magnetic or electrostatic coupling are also possible.

In this article an electrostatic system is described which can be used as part of a sophisticated light dimmer.

The magnetic coupling method has the disadvantage that it is difficult for the home constructor to make a neat job of the necessary transducers. Optocouplers have been used for various tasks in previous Elektor articles. The remaining approach, electrostatic coupling, can be accomplished very easily by etching a capacitive coupler on the printed circuit board. A design based on this approach is given here.

Circuit operation

Gates N2 and N3 form an oscillator which is enabled, or 'gated', when pin 5 is at logic level one (1). Since N1 is an inverter, pins 1 and 2 must be at a low logic level to enable the oscillator. If it is assumed that the 'enable' signal which is applied to pins 1 and 2 has a square wave shape, the gated oscillator will produce a burst of pulses during the time the input waveform is low.

The isolation between the transmitter and receiver section of the circuit is effected by two small capacitors C_{X_1} and C_{X_2}. These capacitors are etched on the p.c. board.

N5 is biassed to function as a normal amplifier, and when used in combination with the next amplifying stage (N6), it regenerates the burst being transmitted across the isolation capacitors. This burst is then detected by an envelope detector made up of components D1, R6 and C4. The output signal from gate N7 will now correspond to the original 'enable' signal.

This detected signal is differentiated by C5/D2/R7. It is also passed through inverter N8 and differentiated by C6/D3/R8. The pulses that result from both positive and negative differentiation are used to trigger the triac.

Triacs capable of currents up to about 1 A can be mounted on the printed circuit board. Others with higher current ratings must be 'out boarded' and will most likely need heat sinks.

The coupling capacitors

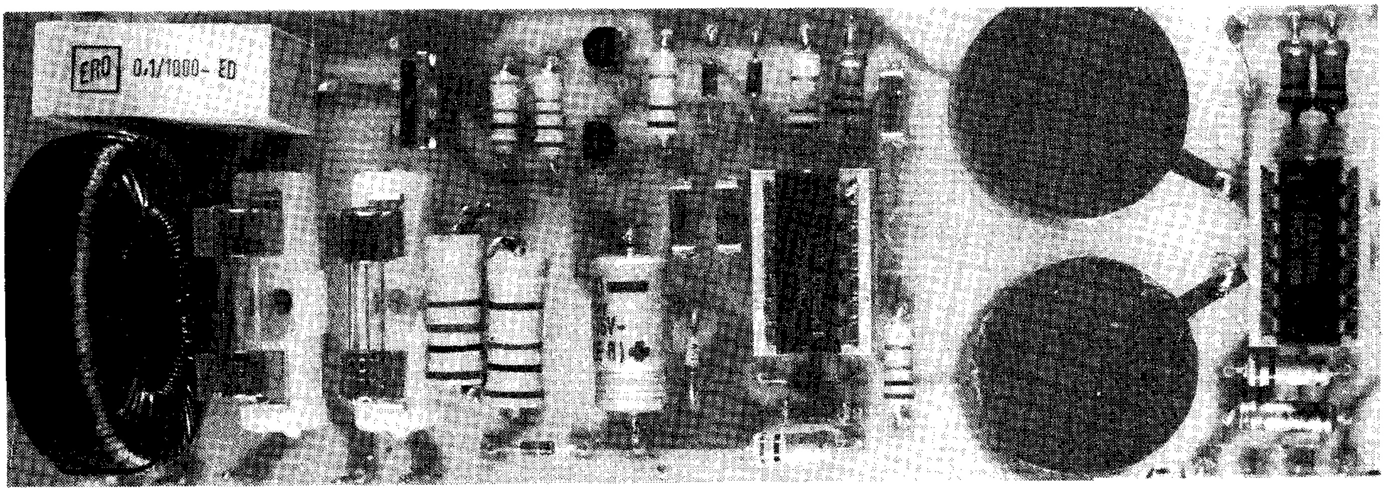
A stated earlier, the coupling capacitors can be etched on a p.c. board. An obvious choice would be a double-sided board, with one 'plate' etched on each side. However, since two-sided p.c.b.'s are expensive and hard to make at home, capacitors C_{X_1} and C_{X_2} are formed by using two separate boards. It is important to note that the two boards must be joined together in such a way that only one thickness of the fiberglass board is in between the copper areas that form the plates of the capacitors. If the plates are two board thickness apart, the resultant capacity will be too low and the circuit will not function properly. Also, the daughter board should be fitted directly against the mother board, with no gaps in between.

Tap sensor control

The circuit shown in figure 2 can be used as the interface between the triac controller shown in figure 1 and the 'outside world'.

The tap sensors control a set/reset flipflop constructed from two C-MOS NAND gates and a few resistors.

To prevent this FF from assuming an indeterminate state when the power is switched on, the FF is preset to the off state by C1. This can be particularly useful in areas where power cuts are frequent . . .



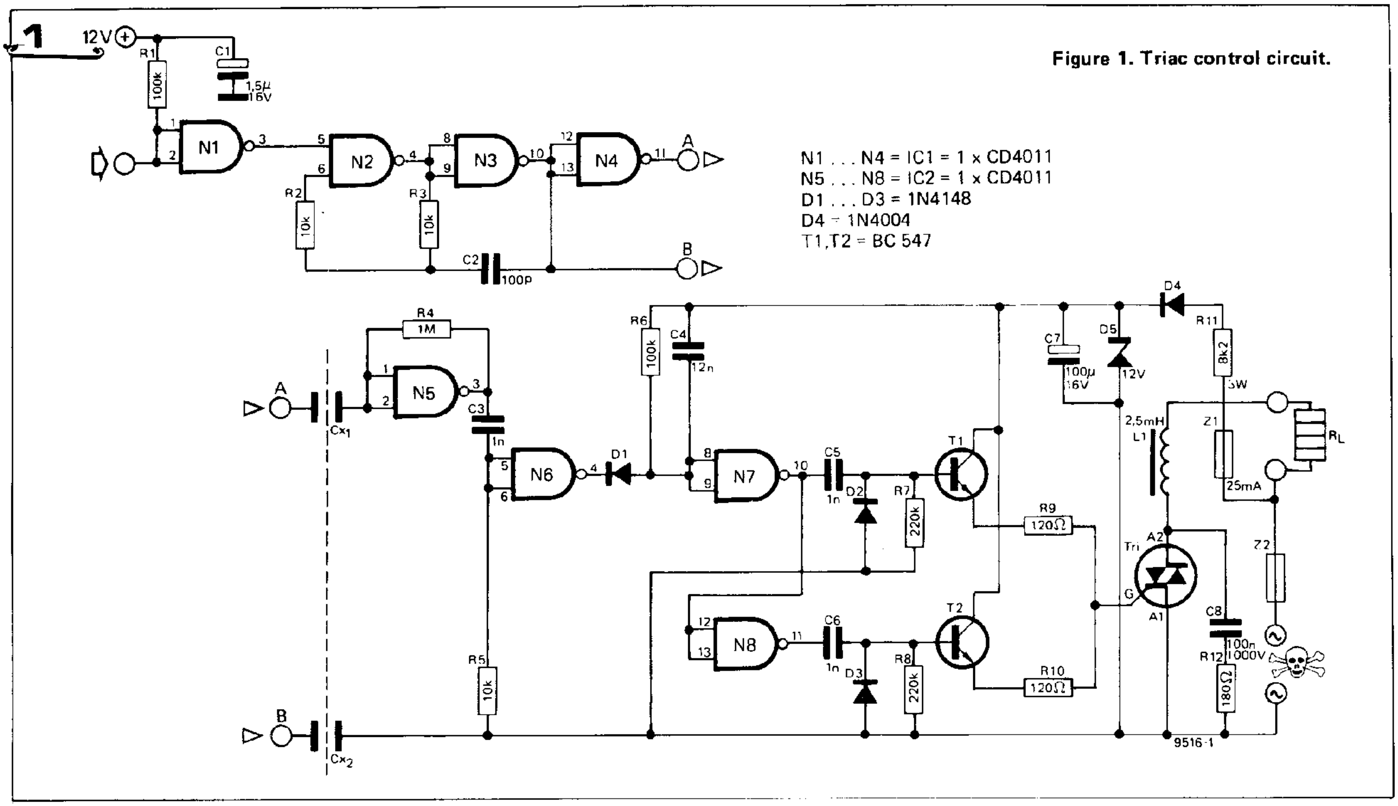


Figure 1. Triac control circuit.

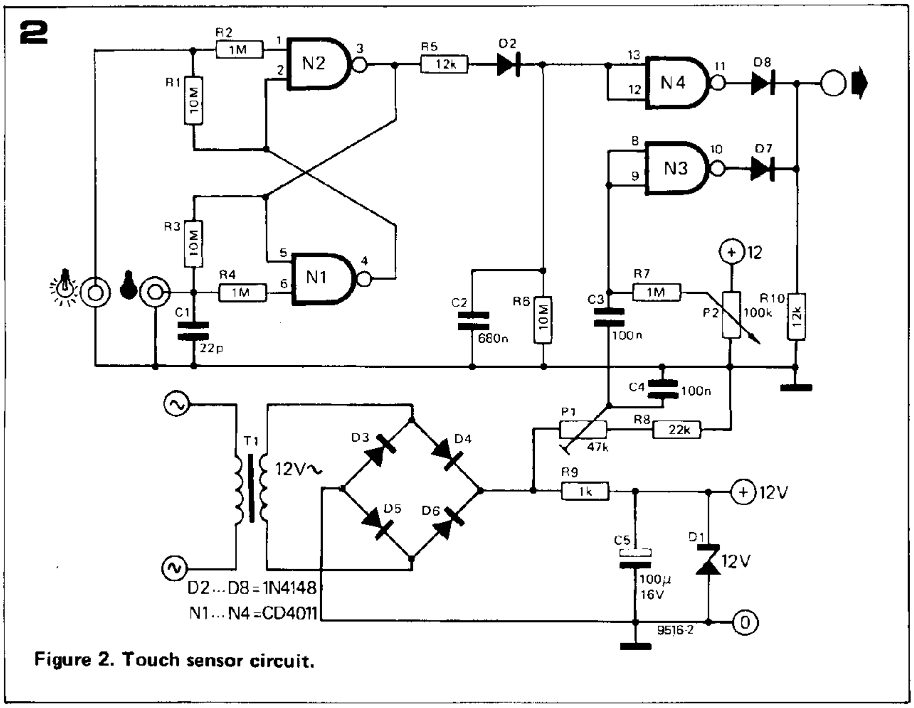
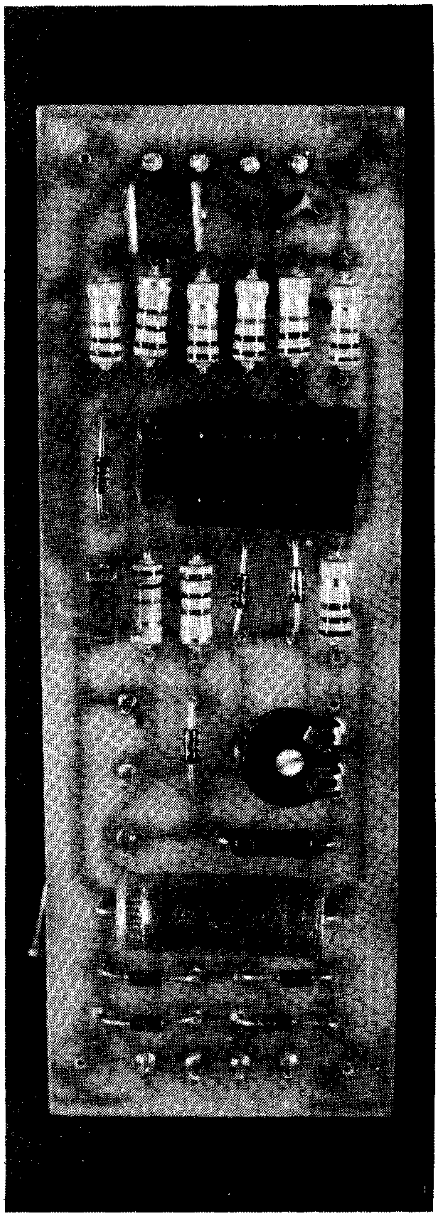


Figure 2. Touch sensor circuit.

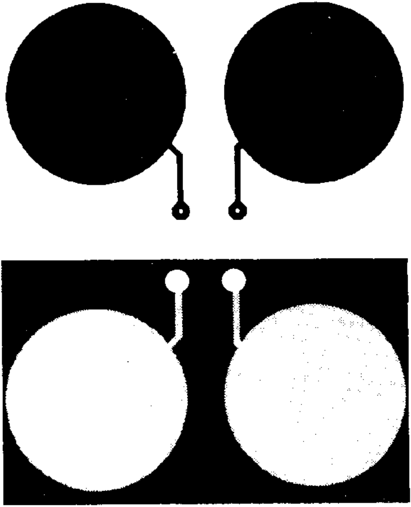


In the initial 'off' condition the output of N2 is 'low', and the output of N4 is 'high'. This effectively blocks the 'enable' input via diode D8. When the 'on' sensor is touched the output of N2 goes 'high', charging C2 and causing the output of N4 to go 'low'. This frees the output. When the 'off' sensor is touched, C2 discharges through R6. This provides a turn-off delay of about 7 seconds. This feature is great when the equipment is used to control room lighting: after the 'off' sensor has been activated, the lights will stay on to light the path of the last person leaving the room.

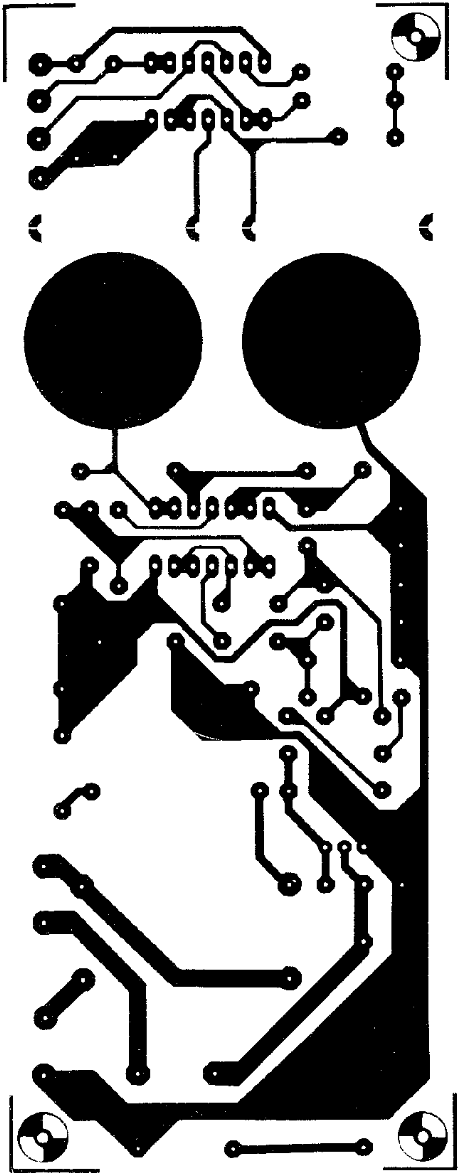
Since the actual triac drive must be synchronous with the mains supply, the gate signal supplied by the tap sensor board is picked off at the output of the bridge rectifier. This 100 Hz signal is phase shifted by P1 and C4. This phase shift is necessary to permit complete brightness control by P2.

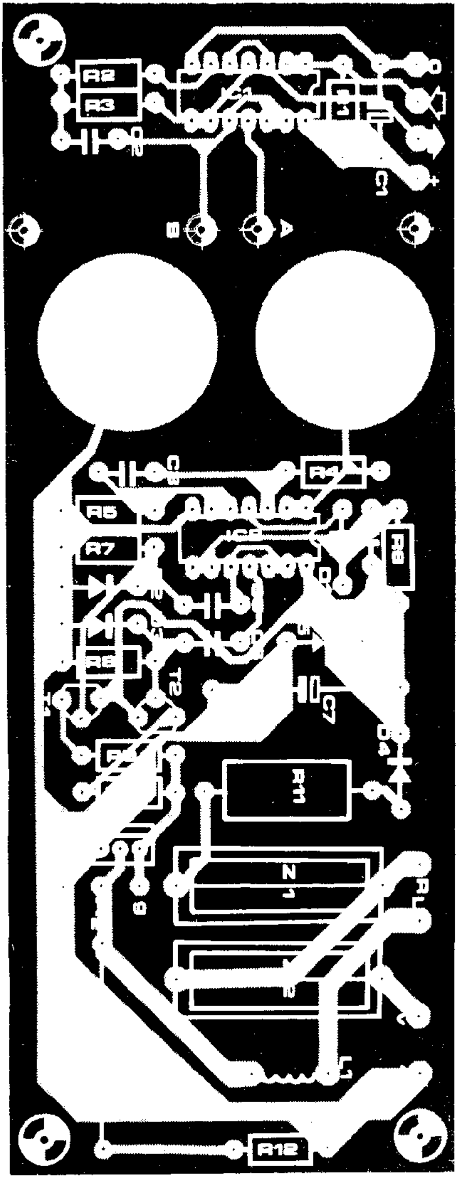
If, after P1 has been adjusted, P2 is still ineffective over a certain portion of its range, an additional resistor may be connected in series with P2. The value of this resistor must be found by trial. It should be selected to permit the entire range (light to dark) to coincide with a complete rotation of P2.

3a



3b




R2
R3
IC1
C2
C1
+
B
A
C3
R4
R5
R7
IC2
R8
R6
T2
T1
C7
D4
R11
Z1
Z2
L1
6
R12

Parts list for figure 1

resistors:
R1,R6 = 100 k
R2,R3,R5 = 10 k
R4 = 1 M
R7,R8 = 220 k
R9,R10 = 120 Ω
R11 = 8k2
R12 = 180 Ω

capacitors:
C1 = 1µ5/16 V
C2 = 100 p
C3,C5,C6 = 1 n
C4 = 12 n
C7 = 100 µ/16 V
C8 = 100 n/1000 V (ceramic)

semiconductors:
T1,T2 = BC547, 2N3904
IC1,IC2 = CD4011
D1 . . . D3 = 1N4148
D4 = 1N4004
Tri = 600 V, with adequate current rating.

misc:
noise suppression coil: 2.5 mH, wit
adequate current rating.
Z1 = fuse, 25 mA
Z2 = fuse, depends on load.

Figure 3. Printed circuit board and component layout for the triac control circuit. Note: large copper areas are C_{x1} and C_{x2}. (EPS 9516).

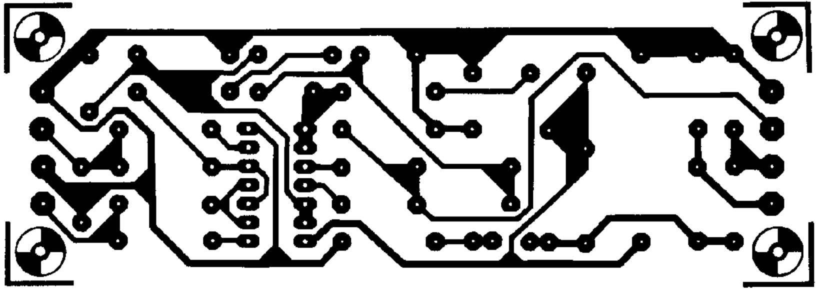
Figure 4. Tap sensor p.c. board and component layout (EPS 9707).

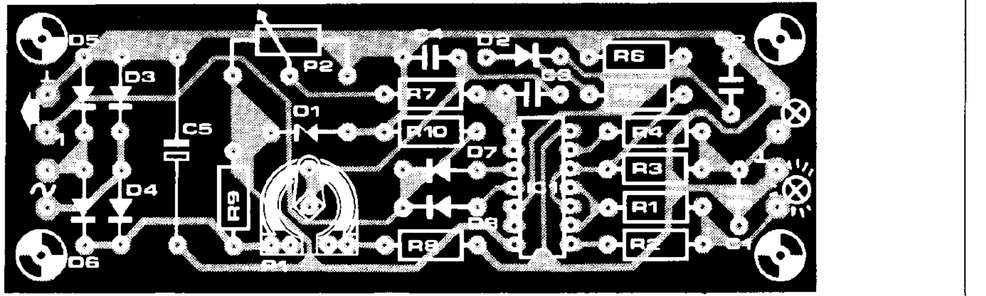
Parts list for figure 2

resistors:
R1,R3,R6 = 10 M
R2, R4,R7 = 1 M
R5,R10 = 12 k
R8 = 22 k
R9 = 1 k
P1 = 47 k (preset)
P2 = 100 k (lin.)

Capacitors:
C1 = 22 p
C2 = 680 n
C3,C4 = 100 n
C5 = 100 μ/16 V

semiconductors:
D1 = 12 V/400 mW zener
D2 . . . D8 = 1N4148
IC1 = CD4011




D5
D3
C5
D4
D6
R9
P1
D1
P2
C4
R7
R10
D7
D8
R8
D2
C3
R6
R5
C2
IC1
R4
R3
R1
R2
C1