Project 257

'Universal' relay driver board

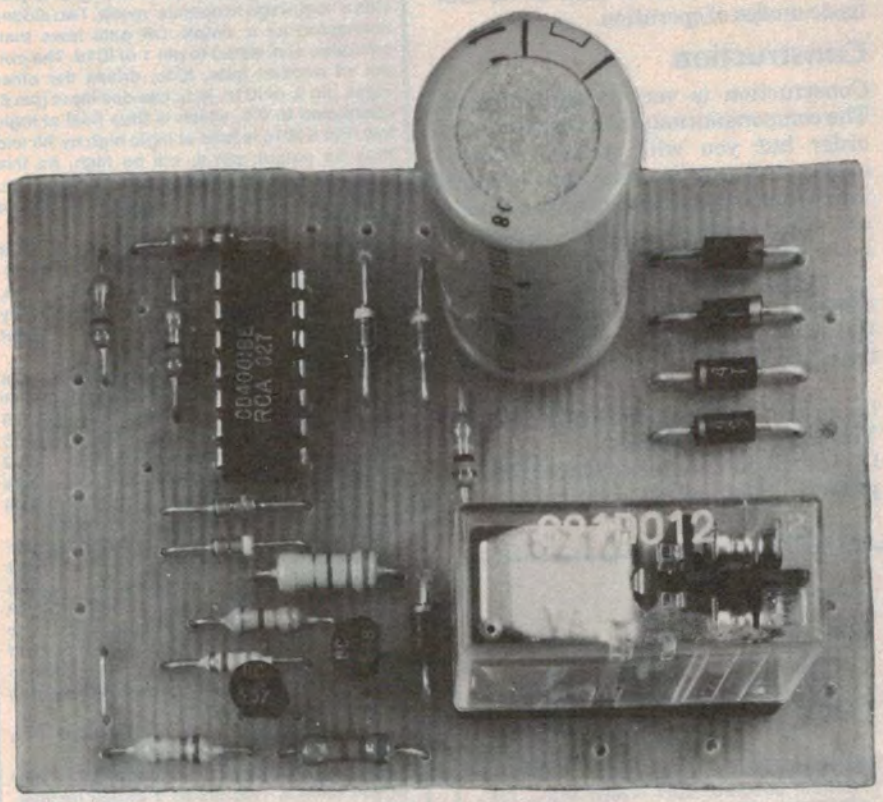
Operating a relay to switch heavy current or mains voltages is a common requirement in electronic control applications. This project permits a relay to be switched in a variety of ways and from a variety of inputs.

Graeme Teesdale

THIS VERSATILE relay driver unit is intended to be used with projects or devices not normally providing a switched relay output. In addition, power for external circuitry can be obtained from the board.

The unit has three groups of 'logic' inputs and a direct input. The relay itself is driven by two transistors, Q1 and Q2, and the direct input goes to the base of Q1 via a resistor (R7). Linking this input to the unit's 0 V rails — via a switch, a transistor which is turned on by a signal (open-collector logic) or a logic gate output — will operate the relay.

The logic circuitry on the board can be implemented by installing Link 1, which connects the output of the logic circuitry to the direct input. There are two "logic high to operate" inputs (pins 1 and 2). A logic high level — i.e: voltage level above about 2 V — on either of these inputs will operate the relay. There are also two "logic low to operate" inputs (pins 7 and 8). Pulling either of these inputs below logic low — about ▶



The relay driver board is simple, yet versatile. The external input/output pins are located around the edges of the board.

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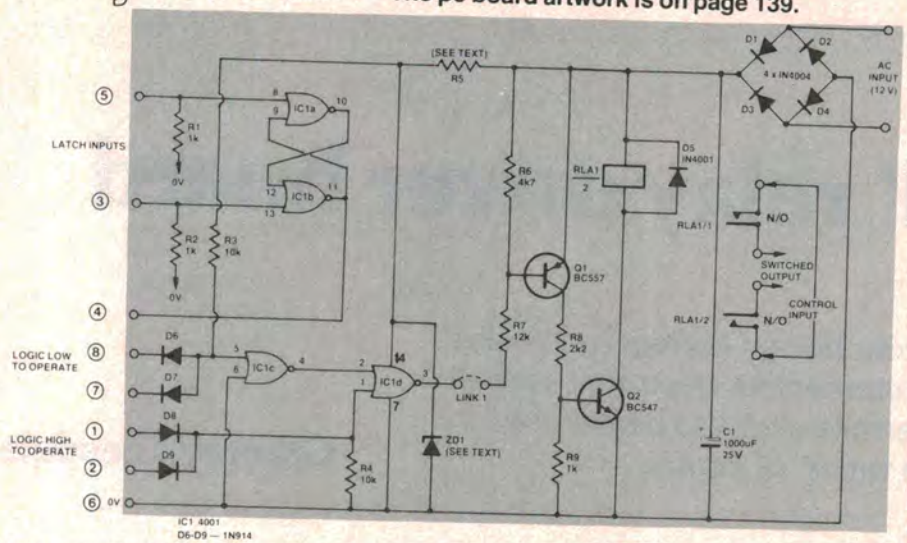
The pc board artwork is on page 139.



Circuit diagram of the relay driver board. Note that the rectifier diodes may be any of a range of types, such as 1N4001-2-4, etc, or EM401, EM402, etc. A variety of common relays will fit the pc board.

0.5 V — will operate the relay. Note that these input pairs are ORed with diodes and can be linked so that one input inhibits the other. In addition there are two "latch" inputs, pins 3 and 5. Pin 4 is the output of the latch circuitry and latch operation is implemented by linking this pin to one of the other inputs. All the logic inputs are high impedance and can be driven from CMOS circuitry.

This unit is powered from a 12 to 15 Vac source such as a plugpack or 5 VA transformer. Supply for IC1 (and perhaps any off-board circuitry) is obtained from a simple zener regulator circuit. This can be chosen to suit individual requirements. We used a BZY96/8V2 zener (1N4738) to provide an 8.2 V rail for IC1. We used a 220 ohm, 1 W resistor for R5. You can use any convenient zener from 5.1 V to 15 V — but no higher, and we recommend 1 W types run at around 50-60 mA current. You will have to work out the value of R5 according to your choice of zener. For a 15 V zener, R5 could be 47 ohms, for a 5.1 V zener, 270 ohms, or for a 12 V zener, say 100 ohms. There's plenty of latitude and these values are only given as a guide.

The logic circuitry (i.e: IC1) can be supplied from an off-board source if you wish. To do so, remove R5 and use a 15 V zener for ZD1 to prevent spikes on the external supply line causing damage to IC1. Note also that the logic levels on inputs 1, 2, 3 and 5 should also be no higher than 15 V.

The accompanying drawings illustrate how the unit is used in its four basic modes of operation.

Construction

Construction is very straightforward. The components may be mounted in any order but you will probably find it easiest to leave the relay and C1 until last. Watch the polarity of all the diodes, the transistors and the IC. However, leave out link 1 at this stage.

Once you've got it together and have checked everything, apply 12 V ac to the ac input and check various modes of operation as follows:

(1) Bridge the free end of R7 to ground. The relay should operate.
(2) Install link 1, then bridge pin 7 to ground. The relay should operate. Likewise for pin 8.
(3) Bridge pin 1 to the cathode of the zener. The relay should operate. Likewise for pin 2.
(4) Connect pin 4 to pin 1 or 2. The relay may operate. Apply a pulse to pin 3 or 5 and see that it latches on. A pulse on the other input will drop it out again.

If all is well, your unit is ready for installation! ●

PARTS LIST — ETI 257

Resistors — all ½W, 5% unless noted

R1, R2, R9	1k
R3, R4	10k
R5	220R, 1W (see text)
R6	4k7
R7	12k
R8	2k2

Capacitors

C1	1000 u/25 V electrolytic

Semiconductors

IC1	4001B
Q1	BC557
Q2	BC547
D1-D5	1N4001, 1N4002 etc
D6-D9	1N914, 1N4148 etc
ZD1	400 mW or 1 W zener, see text

Miscellaneous

ETI-257 pc board; RLA1 — relay, Fujitsu FRL-621D012 or Takamisawa VB 12STAN or Pye 265/12/G2V.

HOW IT WORKS — ETI 257

The best place to start is right in the middle of the circuit — because that's the 'business' end!

Transistor Q2 has relay RLA1 as its collector load. Diode D5 provides protection for Q2 when the coil current is cut off whenever Q2 is turned off. The base of Q2 is driven by the collector of Q1 via R8 and R9. Base bias for Q1 is obtained from the resistor network of R6 and R7. The 'free' end of R7 can be linked to on-board logic circuitry (IC1) or driven by an external source.

If the free end of R7 is connected to 0 V then base current will flow in Q1, which will turn on. This will turn on Q2 and the relay will operate. In fact, all that is required to turn Q1 on is to 'pull' the free end of R7 about 1 V below the positive supply rail to overcome the 0.6 V base-emitter turn-on voltage of Q1.

Effectively, a 'low' level on the free end of R7 will operate the relay.

Two groups of logic circuitry built around IC1 are included to provide a variety of operating 'modes'. IC1 is a quad NOR gate package. One gate, IC1d, is arranged to provide a 'logic high to operate' mode. Two diodes connected as a simple OR gate have their cathodes connected to pin 1 of IC1d. The output of another gate, IC1c, drives the other input, pin 2, of IC1d. IC1c has one input (pin 6) connected to 0 V, which is thus held at logic low. Pin 5 IC1c is held at logic high by R3 and thus its output, pin 4, will be high. As this drives pin 2 IC1d its output, pin 3, will be high. With Link 1 fitted, Q1 will normally be off and the relay not operated.

When a high logic level is applied to either input pin 1 or 2, or both, the diode(s) will conduct driving pin 1 IC1d high. The output, pin 3, will go low and the relay will operate. The relay will remain operated only while the input remains high.

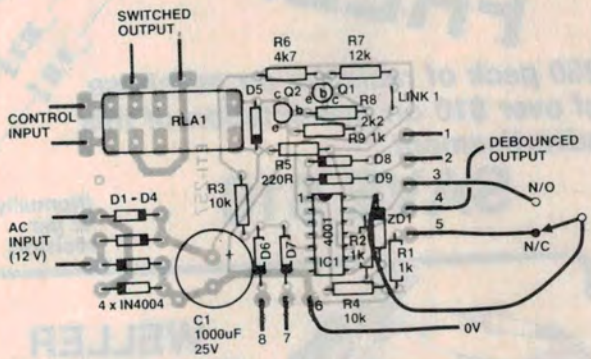
Two diodes (D6, D7) are connected as a simple OR gate with their anodes connected to pin 5 IC1c. A logic low on either input pin 7 or 8 ('logic low to operate') or both will pull pin 5 IC1c low and its output, pin 4, will go low. Pin 2 IC1d will go low and thus pin 3 IC1d will go low and the relay will operate. The relay will remain operated only while the input remains low.

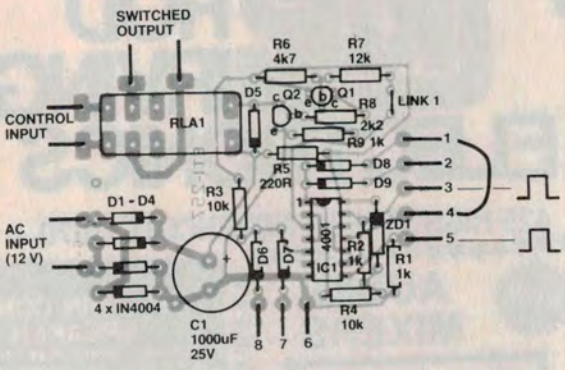
The remaining two gates from IC1 are connected as a set-reset (SR) flip-flop. Pin 4 on the pc board provides an output which may be coupled to the other inputs. Assume the SR flip output is initially low. A pulse applied to input pin 3 or 5 will cause pin 4 (pins 9, 11 of IC1a, b) to 'latch' high. A pulse then applied to the opposite input pin will cause the output to go low again, and remain low.

This part of the circuit can be used as a 'switch debouncer' as illustrated.

Power is derived from an off-board 9 Vac or 12 Vac source. This drives a bridge rectifier, diodes D1 to D4, smoothing being provided by C1. A zener diode, ZD1, is used to provide a regulated supply to the logic circuitry (IC1).

universal relay driver



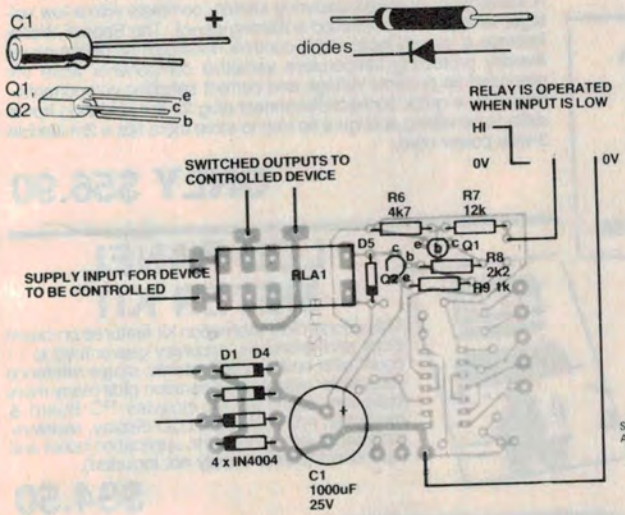


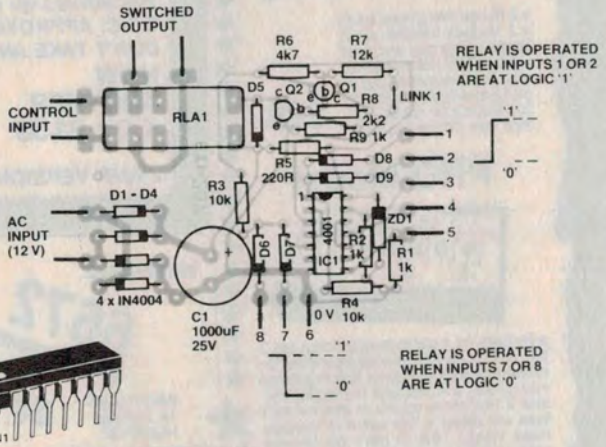
SWITCH DEBOUNCING

The SR flip-flop (IC1a and b) is not electrically connected to the rest of the circuit and may be used in external circuitry — for example, as a switch debouncing circuit.

LATCH OPERATION

Pin 4, the output of the set-reset (SR) flip-flop, must be linked to either pin 1 or pin 2, or pins 7 or 8. A positive-going pulse on pin 3 or pin 5 will cause the relay to latch. A positive-going pulse on the opposite latch input will then cause the relay to unlatch.





DIRECT INPUT

The relay will operate when the input is low (i.e: 0 V) or 'pulled' about 1 V lower than the positive supply rail. Only those components shown are necessary for this mode of operation.

LOW OR HIGH TO OPERATE

The relay will be operated when pins 1 or 2 are held at logic high. To operate the relay from a logic low, pins 7 or 8 must be held at logic low. The inputs are ORed so that up to two input signals can be employed to operate the relay in each mode.