ULTRASONIC SWITCH

Two-board design forms basis for a wide range of applications from door-bells to data transmission!

THE USE OF an invisible beam to transmit information or to act as an alarm system has always been fascinating. We have described light operated systems of the infra-red (invisible), normal light and laser beam types. We have also published a radar alarm system. This unit uses a high frequency acoustical beam, well above the range of human hearing, which can be used simply as a door monitor, i.e. to give an alarm if the beam is broken, or can be modulated at up to several hundred Hz. This will allow information to be transmitted – details of how to do this will be given in future issues.

Construction

The construction of the units is not

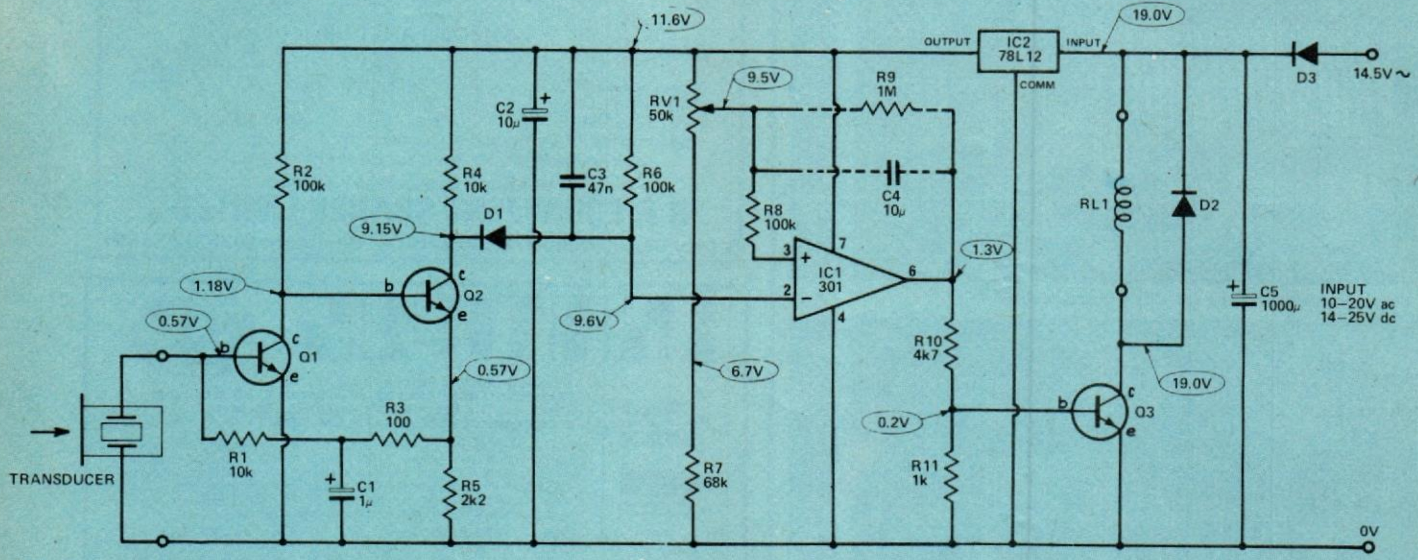


Fig. 1. Circuit diagram of the receiver.

NOTES:
VOLTAGES MEASURED WITH NO INPUT SIGNAL USING A VOLTMETER WITH 10 MEG OHM INPUT IMPEDANCE.
Q1–Q3 ARE BC548
D1 IS 1N914
D2,D3 ARE 1N4001
C4 IS USED INSTEAD OF R9 IF A MONOSTABLE ACTION IS REQUIRED.

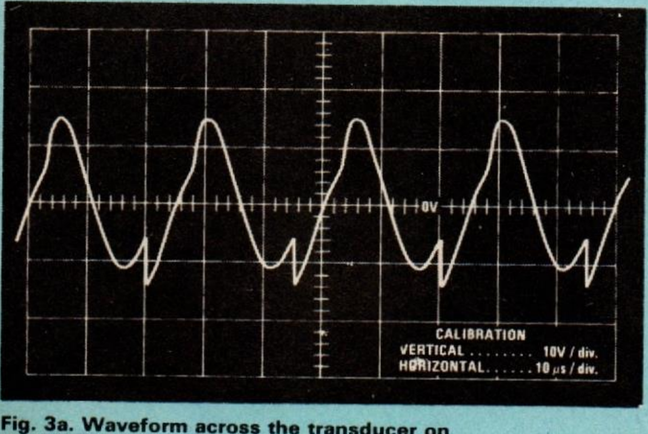


Fig. 3a. Waveform across the transducer on the transmitter.

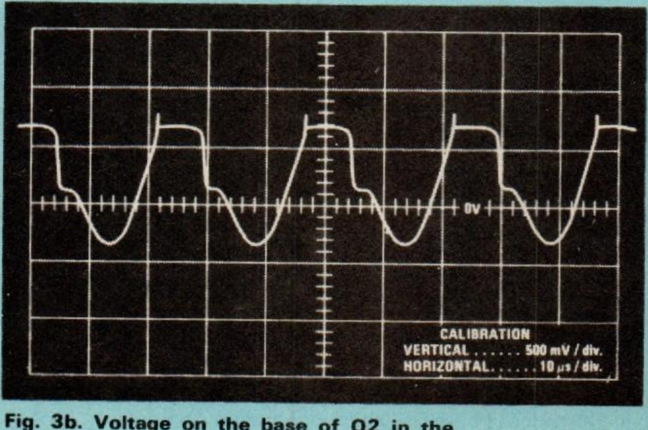


Fig. 3b. Voltage on the base of Q2 in the transmitter.

critical — any method may be used although the PC boards are recommended. We didn't mount the relay on the PCB as it can vary in size and if the unit is later used with a modulated beam, the relay will not be needed.

The only adjustment on the unit is the sensitivity control and this should be set to give reliable operation. The transmitter needs a supply voltage of 8 V to 20 V at about 5 mA. This could come from the regulated supply on the receiver board.

If it is required to extend the effect of a quick break in the beam or a quick burst from the transmitter, the resistor R9 can be replaced by C4 and this will give a minimum operation time of about 1 second.

ETI

HOW IT WORKS

Transmitter

This is an oscillator the frequency of which is determined by the transducer characteristics. The impedance curve of the transducer is similar to that of a crystal with a minimum (series resonance) at 39.8 kHz followed by a maximum (parallel resonance) just above it at 41.5 kHz.

In the circuit the two transistors are used to form a non-inverting amplifier and positive feedback is supplied via the transducer, R6 and C3. At the series resonant frequency this feedback is strong enough to cause oscillation.

Capacitors C1 and C4 are used to prevent the circuit oscillating at the third harmonic or similar overtones while C5 is used to shift the series resonant point up about 500 Hz to better match the receiver.

Receiver

The output from the transducer is an a.c. voltage proportional to the signal being detected (40 kHz only). As it is only a very small level it is amplified by about 70 dB in Q1 and Q2. D C stabilization of this stage is set by R1 and R3 while C1 closes this feedback path to the 40 kHz A C signal.

The output of Q2 is rectified by D1 and the voltage on pin 2 of IC1 will go more negative as the input signal increases. If the input signal is strong the amplifier will simply clip the output, which on very strong signals will be a square wave swinging between the supply rails.

IC1 is used as a comparator and checks the voltage on pin 2, i.e. the sound level, to that on pin 3 which is the reference level. If pin 2 is at a lower voltage than pin 3, i.e. a signal is present, the output of IC1 will be high (about 10.5 volts) and this will turn on Q3 which will close the relay. The converse occurs if pin 2 is at a higher voltage than pin 3.

A small amount of positive feedback is provided by R9 to give some hysteresis to prevent relay chatter. If R9 is replaced by the capacitor C4 the IC becomes a monostable and if the signal is lost for only a short time the relay will drop out for about 1 second. If the signal is lost for more than 1 s the relay will be open for the duration of the loss of signal.

We used a voltage regulator to prevent supply voltage fluctuations triggering the unit. The relay was not included on the regulated supply, allowing a cheaper regulator to be used.

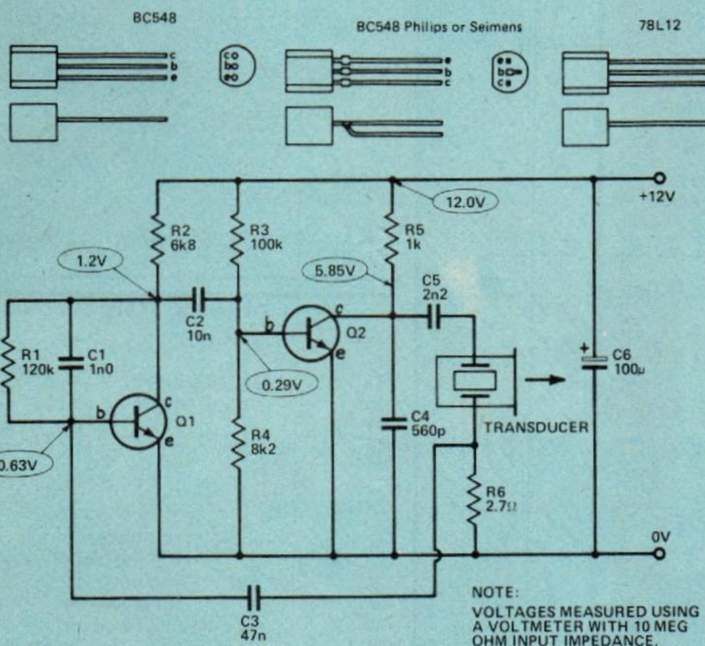


Fig. 2. Circuit diagram of the transmitter.

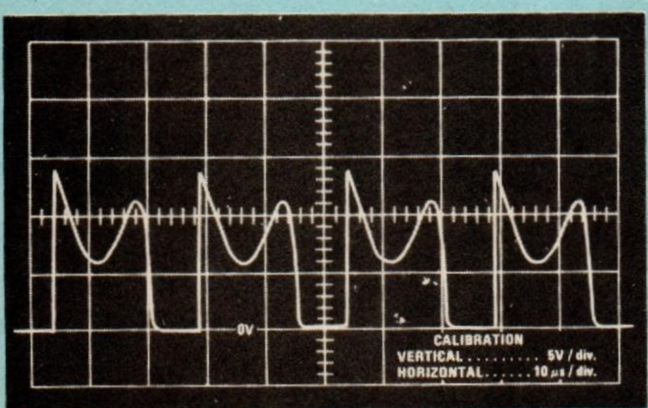
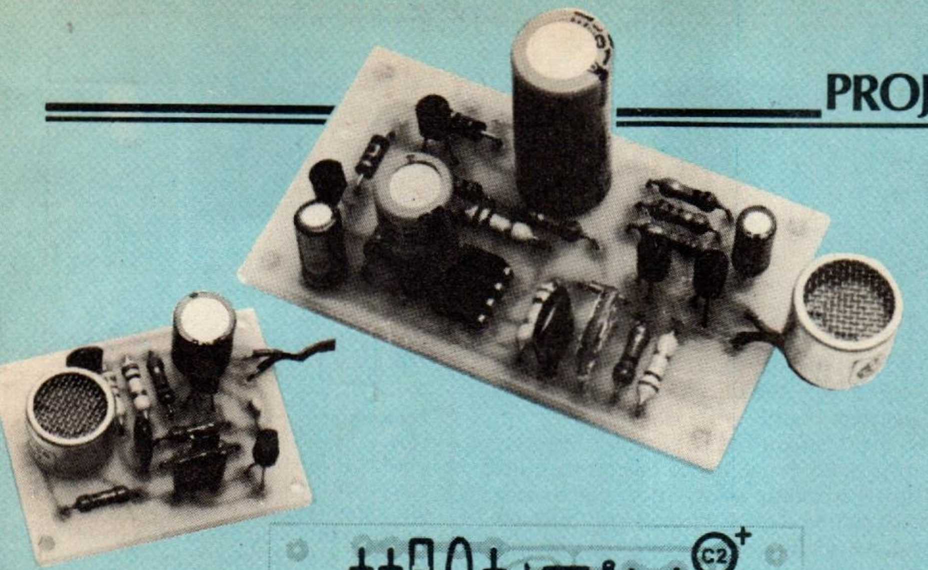


Fig. 3c. Voltage on the collector of Q2.



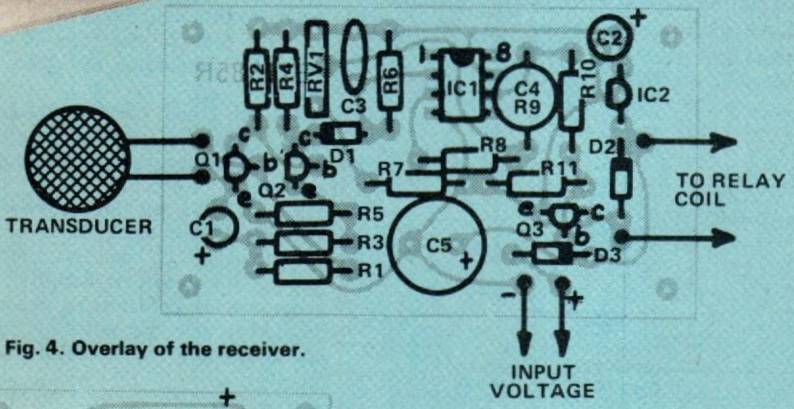


Fig. 4. Overlay of the receiver.

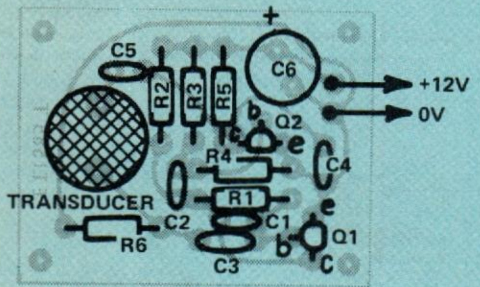
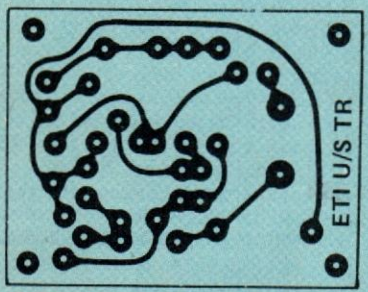


Fig. 5. Overlay of the transmitter.



7. Printed circuit board of transmitter. size 46 x 36mm.

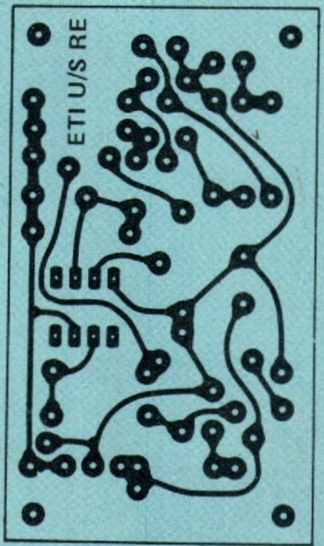


Fig. 6. Printed circuit board of receiver. Full size 70 x 40mm.

PARTS LIST

RECEIVER

RESISTORS all ½ W 5%

R1,4	10k
R2,6,8	100k
R3	100R
R5	2k2
R7	68k
R9	1M
R10	4k7
R11	1k

POTENTIOMETER

RV1	50k preset

CAPACITORS

C1	1u 25 V electrolytic
C2	10u 25 V electrolytic
C3	47n polyester
C4	10u non polarised electrolytic
C5	1000u 16 V electrolytic

SEMICONDUCTORS

Q1–Q3	BC548
IC1	LM301A
IC2	78L12
D1	1N914
D2,3	1N4001

MISCELLANEOUS

PCB as pattern, 40 kHz receiver, 12 V relay, case to suit

TRANSMITTER

RESISTORS all ½ W 5%

R1	120k
R2	6k8
R3	100k
R4	8k2
R5	1k
R6	2R7

CAPACITORS

C1	1n polyester
C2	10n polyester
C3	47n polyester
C4	560p cetamic
C5	2n2 polyester
C6	100u 25 V electrolytic

TRANSISTORS

Q1,2	BC548

MISCELLANEOUS

PCB as pattern, 40 kHz transmitter, case to suit.

BUYLINES

This project was designed with simplicity in mind and as a result uses components that should be available from most suppliers of electronic components. The only items likely to be difficult to obtain are the transmitter and receiver. In case of difficulty however these can be purchased from Audio Electronics at 301 Edgware Road, London.

SPECIFICATION

FREQUENCY	40 kHz
RANGE	5 metres
MAXIMUM MODULATION FREQUENCY (NOT WITH RELAY OUTPUT)	250 Hz
OUTPUT	relay, closed when beam is made
POWER SUPPLY	14–25 V DC
TRANSMITTER	10–20 V DC
RECEIVER	8–20 V DC, 4 mA