ANYONE WHO HAS SEEN THE NEWS ON TELEVISION WILL BE AWARE THAT FLOODING HAS POSED A SERIOUS THREAT IN LOW LYING AREAS OF BRITAIN DURING THE PAST YEAR, CAUSING SIGNIFICANT PROPERTY DAMAGE.

Flood ALARM

by Gavin Cheeseman

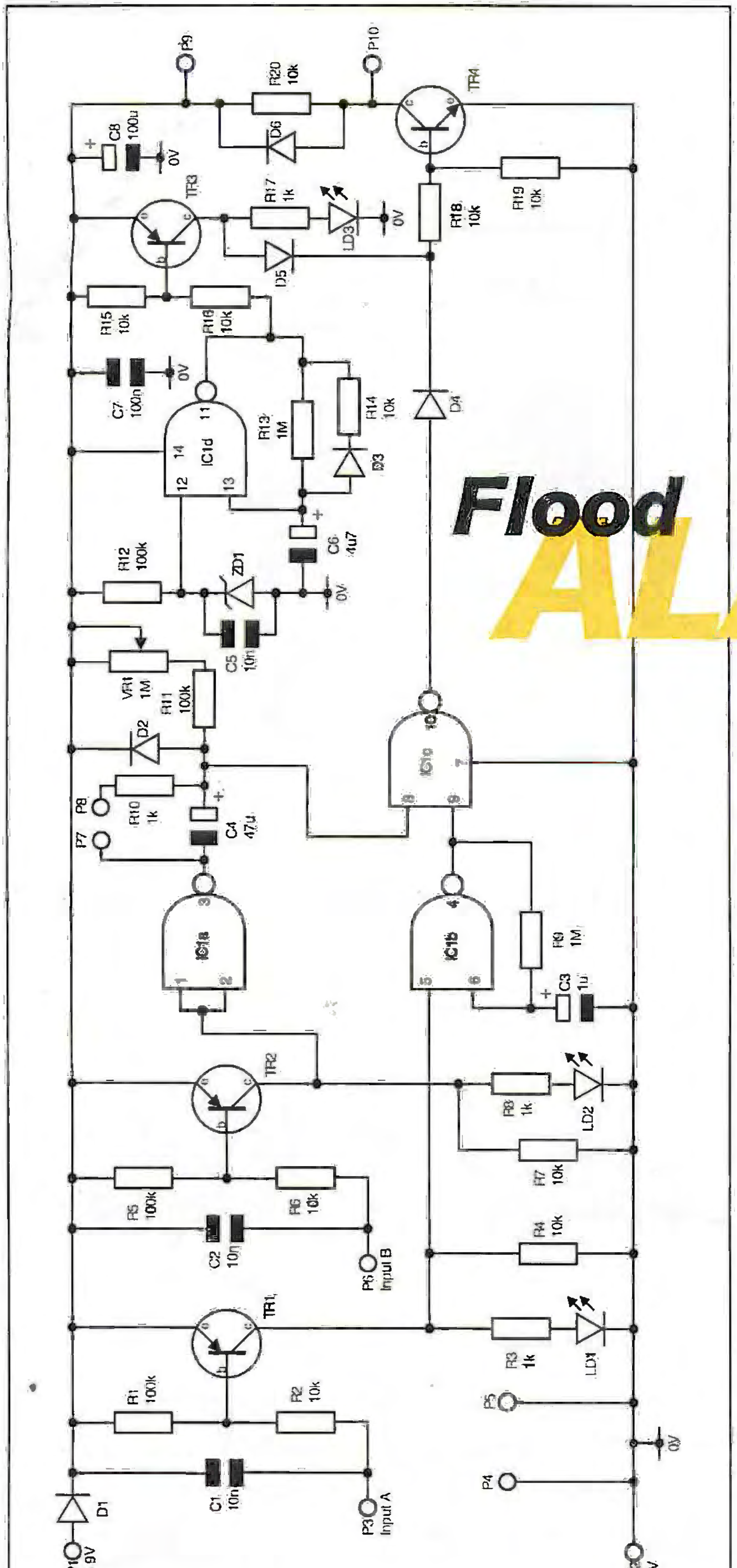

Figure 1. Circuit Diagram

Some will probably have been unfortunate enough to experience the effects of flooding first hand. If a house becomes flooded when the occupants are asleep or otherwise unaware of the situation, clearly the results can be catastrophic.

In this article we look at a simple circuit that will provide an audible indication when water is detected. When set up correctly, it can give advanced warning if flooding starts to take place. Unlike simple water alarms, the circuit features two inputs, allowing the coverage of two separate zones. There is also a low battery indicator to show when the battery requires replacement.

Operational Details

For ease of identification the two inputs have a different alarm sound. Input A is designed to pulse a buzzer when triggered. Conversely, if input B is triggered the buzzer sounds continuously. If both inputs are triggered, input B takes priority and the alarm produces a continuous sound from the buzzer. Whatever the case, LED's indicate if an input is active. Input B has an optional time-out. When set, the alarm will sound for a short period if input B is triggered, until the time-out is complete. After the timeout period has elapsed, the output condition is determined by the alarm status of input A. That is to say, if input A is not triggered the alarm will revert to silence. If input A is triggered the alarm buzzer will emit a pulsed sound.

The circuit diagram of the flood alarm is shown in Figure 1. Input A comprises terminals P3 and P4 and input B uses terminals P5 and P6. Each input is connected to a pair of conductive probes. If the resistance between the probes falls due to the presence of water, a small current flows and the associated transistor (TR1 or TR2) is turned on. Current flows in the collector circuit, illuminating either LD1 or LD2 depending which input has been triggered.

The alarm section of the circuit is based around a CMOS 4093 quad schmitt NAND IC. If the collector of TR1 switches high due to the presence of an alarm condition at input A, this results in a logic high condition at one of is an alarm condition at input A, in which case the output switches back to pulsing mode. VR1 allows the timeout period to be adjusted. If terminal P7 is connected to P8 the alarm timeout is disabled and the alarm will sound continuously until the cause of the alarm condition at input B is removed, or the battery is discharged.

IC1d and associated components form a 'low battery' indicator. The circuit pulses LD3 and TR4 when the supply voltage has dropped to a level where battery replacement should be considered. The output pulse from IC1d has been set to be narrow so as not to draw a high current from an already failing battery. Some buzzers may not respond to such a short pulse. If required, the length of the pulse can be extended without changing between manufacturers, refer to the manufacturer's data sheet if the polarity of the component is not absolutely clear. Details of the semiconductor pin-outs are shown in Figure 2.

Figure 3 shows off board wiring. If required, a switch may be connected between terminals P7 and P8 to allow the alarm time-out to be switched on or off. Please note: the time-out only applies to input B.

The circuit will switch a standard piezo buzzer with drive circuit (a piezo transducer alone is not suitable). The buzzer must be suitable for operation at supply voltages between about 4V and 9V to allow the alarm to operate correctly when the battery voltage is low. The buzzer supply current should not exceed 50mA.

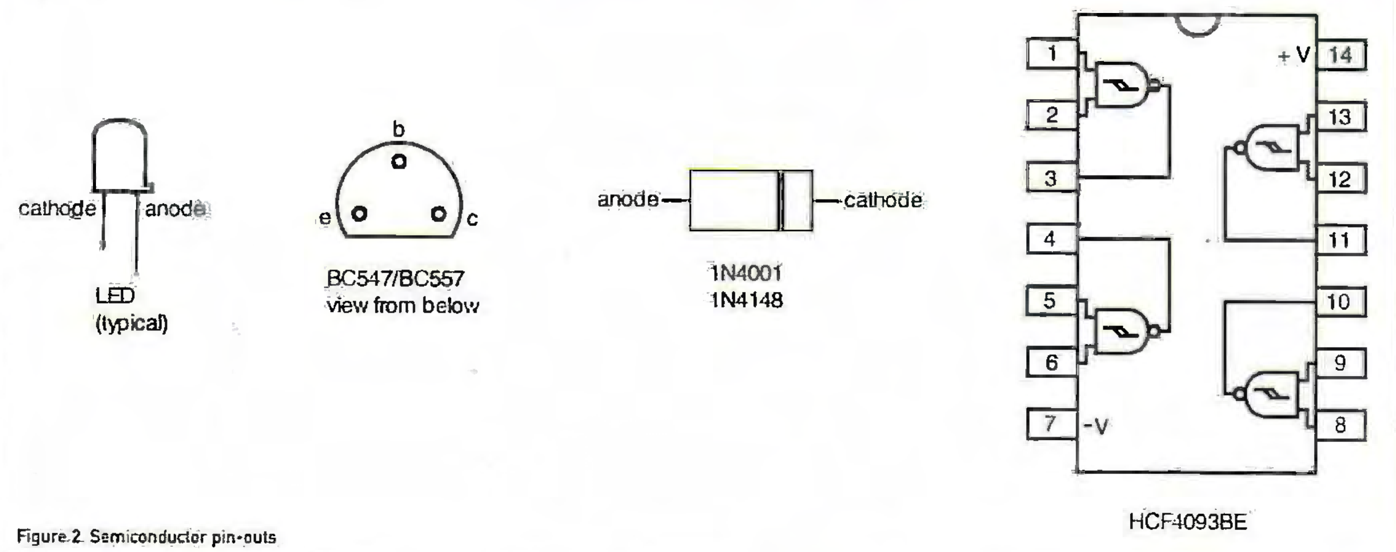

Figure 2. Semiconductor pin-outs

the inputs of IC1b (pin 5). IC1b is configured as a low frequency relaxation oscillator. The presence of a logic high condition at IC1 pin 5 enables the oscillator, which applies a low frequency square wave to one input of IC1c. The second input on IC1 pin 8 is normally high in the absence of an alarm condition at input B. In these circumstances, IC1c effectively acts as an inverter and the square wave signal is fed to output transistor TR4. As a result, the load connected between terminals P9 and P10 (normally a piezo buzzer) is switched on and off repetitively.

If an alarm condition occurs at input B, TR2 turns on applying a high condition to both inputs of IC1a (pins 1 and 2). IC1 pin 8 is pulled low by IC1 pin 3, via capacitor C4. This results in a continuously high output at IC1 pin 10 and TR4 is turned on applying current to the output load. C4 slowly charges and when the voltage at IC1 pin 8 reaches the switching threshold, the output of IC1c returns to low, switching off TR4 unless there the duty cycle by increasing the value of C6 to 10uF. The pulse will also repeat less regularly.

Construction

The circuit may be built using almost any construction medium. Matrix or strip board is a good choice. Start by fitting the lowest profile components such as the resistors and IC socket followed by larger parts such as the electrolytic capacitors. Do not insert IC1 into the IC socket until all soldering is complete. The layout of the circuit is not particularly critical but it is recommended that C7 is mounted as close as possible to IC1.

To avoid the risk of component damage as well as for safety reasons, the electrolytic capacitors and semiconductors must be fitted paying attention to the correct polarity. The negative lead of the capacitor is normally the shorter of the two and is also indicated by a minus (-) symbol marked on the component body. As marking conventions may vary

Testing the alarm

The circuit is designed to operate from a 9V PP3 type battery (or equivalent). A multimeter, set to read current, may be connected in series with the positive power supply rail. This allows the current to be measured during testing and can sometimes indicate if there is a problem with the circuit. Always set the meter to a high current range to start with, switching to a lower range once the approximate current consumption is known.

Connect the battery and set switch S1 to the 'on' position. When the input terminals are open circuit, all LED's should remain off and the output buzzer should be silent. Connect a link between terminals P3 and P4. The output buzzer should beep repetitively and LD1 should illuminate, indicating that input A has been triggered. Disconnect the link and the alarm should return to silence. Next connect the link between terminals P5 and P6 (input B). LD2 should light and the alarm should sound as before but the tone should be continuous. After a period of several seconds the buzzer should switch off. If a link is then connected to input A, the buzzer should pulse as normal. Disconnect the link and connect terminals P7 and P8 together. Reconnect the link at input B. This time the buzzer should sound continuously until the link is removed. After testing disconnect all links.

If you have access to a variable power supply, disconnect the battery and temporarily connect the power supply in its place between terminals P1 (+V) and P2 (0V). Both inputs should remain open circuit. When the voltage of the power supply is set to 9V, the circuit should remain silent. However, if the power supply voltage is slowly reduced, a point should be reached where the alarm buzzer starts to emit short beeps. This confirms that the battery low circuit is operating. Remove the connections to the power supply and replace the battery.

The current consumption of the circuit is in the region of 100uA in standby mode, so unless the alarm is continuously sounding, the battery should last many weeks before replacement is required. If the circuit is not in use for a very long period, the battery should be removed to avoid damage due to leakage etc.

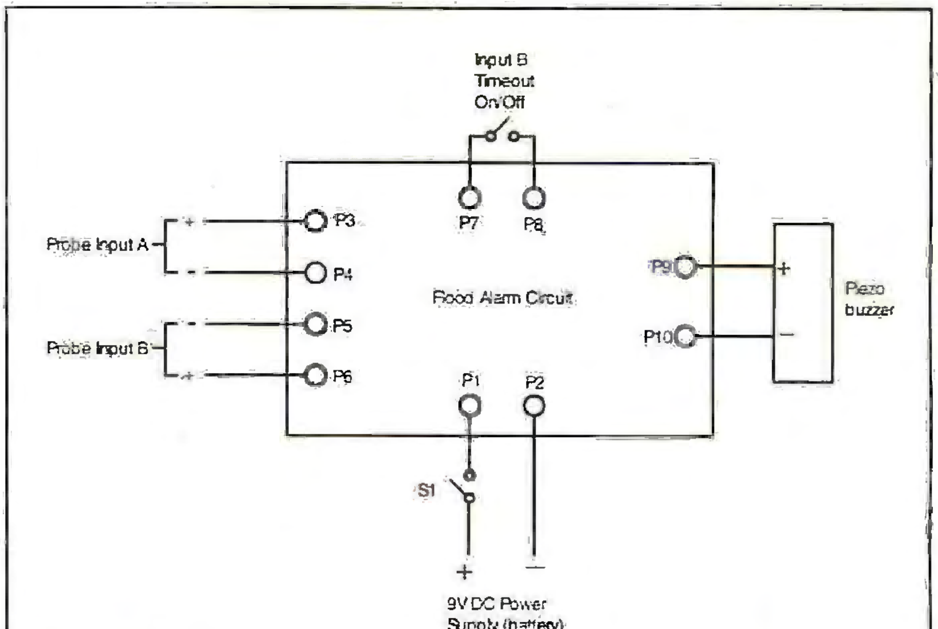

Figure 3. Wiring Diagram

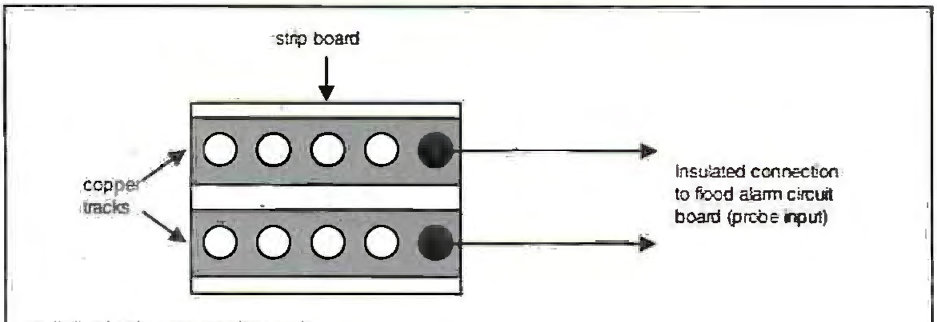

Figure 4. Typical probe arrangement

Probes

The shape and configuration of the probes is not particularly critical as long as there is enough contact area and the probes are not spaced too far apart. A length of bell wire with stripped ends can be used but steps must be taken to ensure that the ends do not accidentally short together, as this will result in a false alarm. A small piece of strip-board may be used as illustrated in Figure 4. The only disadvantage with this type of arrangement is that the alarm may continue to sound until the circuit board is completely dry. This is unlikely to present a serious problem in most applications but if required the effect can be reduced by using tracks that are spaced further apart. Similar considerations apply in areas subject to condensation etc. A larger area may be covered by running two bare parallel wires with insulating spacers. Under normal conditions the two contacts must be high resistance. Any leakage may trigger the alarm. Specially designed cables are available for use with flood alarms.

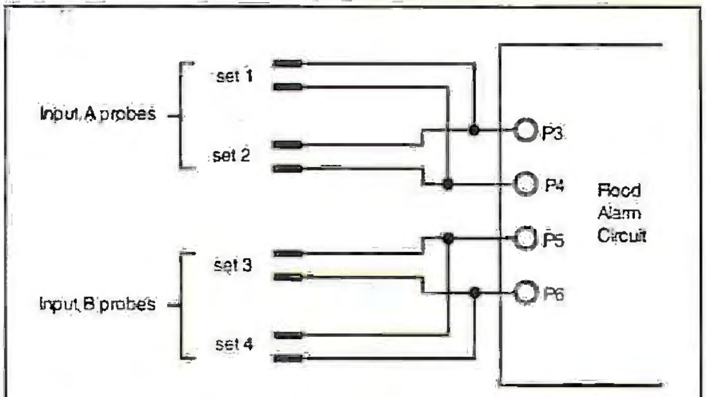

Figure 5. Connecting probes in parallel

Although the alarm has only two inputs, cables from several different sensors may be connected in parallel to each input allowing a larger area of coverage (see Figure 5). Try to avoid unnecessarily long cables as these will tend to couple high frequency noise to the input of the alarm. If RF pickup causes false triggering, it is often possible to rectify the problem by fitting suitable ferrite beads or rings to the inputs close to the alarm circuit.

Using the alarm

Where and how the alarm is installed depends on the specific circumstances. One point to remember is that water should not be allowed to come into contact with the alarm circuit board as this will usually result in irreparable damage. Therefore, it is sensible to mount the unit high up where it is less likely to come into contact with water, if a flood occurs. The unit should preferably be indoors but if it is mounted outside, it is essential to protect the circuit from the elements. It should be noted that CMOS IC's function poorly at temperatures below zero. The alarm buzzer must be audible. For example, there is little point in mounting the unit at the end of the garden or in an outbuilding if you cannot hear the buzzer when it sounds. However, if the alarm is used to protect an outbuilding situated some distance from the dwelling, it may be sensible to extend the buzzer lead rather than using very long probe leads.

If possible, the probes should be positioned so that an alarm condition occurs before the floodwater reaches a problem level. The two inputs can be used in different ways. For example, the alarm could be used to cover two entirely unrelated zones.

Alternatively, input B could be set to time-out mode with the probe positioned to give an early indication that the water level is rising. The probe for input A would be placed at a higher level to show when the water has reached a level where it poses a serious threat.

The unit may also be used to cover indoor areas such as kitchens and bathrooms where flooding may occur due to a tap being left on or a plumbing fault.

Finally...

As with most alarm systems, it should be remembered that the flood alarm is not foolproof and will not provide absolute protection against flooding. However, when correctly installed, the unit may provide an early warning of the occurrence of flooding that may otherwise go unnoticed until a much later stage.

Parts List

Resistors (minimum 0.5W metal film)		
R1, 5, 11, 12	100k	4
R2, 4, 6, 7,		
14-16, 18-20	10k	10
R3, 8, 10, 17	1k	4
R9, 13	1M	2
VR1	1M trimmer pot.	1
Capacitors (voltage rating 16V or greater)		
C1, 2, 5	10n Ceramic	2
C3	1u Electrolytic	1
C4	47u Electrolytic	1
C6	4µ7 Electrolytic	1
C7	100n Ceramic	1
C8	100u Electrolytic	1
Semiconductors		
TR1-3	BC557	3
TR4	BC547	1
IC1	4093BE	1
D1	1N4001	1
D2-6	1N4148	5
ZD1	BZY88C4V7 or equiv.	1
LD1-3	Red LED	3
Miscellaneous Items		
14 pin DIL socket		1
9V Battery (PP3 or equiv.)		1
PCB terminal pins		10
Buzzer		1

Suitable parts can be obtained from major component suppliers such as Farnell Components and Maplin Electronics