# Multiplexed alarm

## Remote sensing of up to 10 points with a two-wire system

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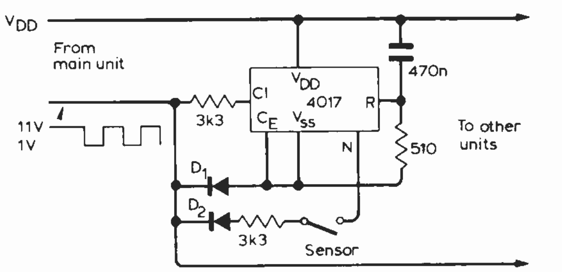
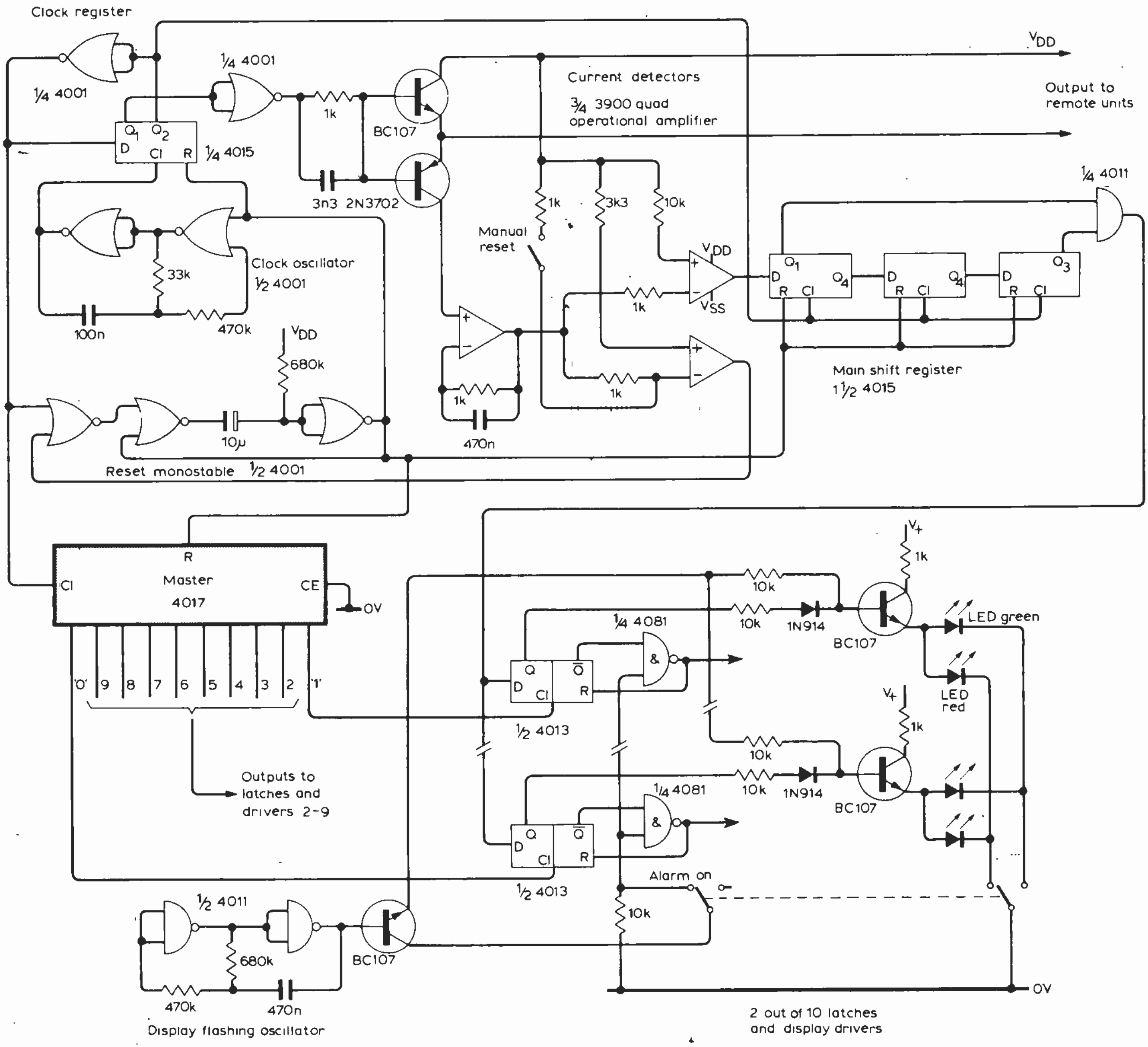
This multiplexed system is the result of improving a rather primitive burglar alarm. The redesigned circuit can detect the state of up to 10 sensors and give an immediate identification and location of an activated sensor. Because each sensor does not form part of an overall alarm loop, separate sensors or groups can activate different audible / visual signals. Installation is simplified because one pair of wires connects all of the sensors to a control unit.

BECAUSE wiring is the most inconvenient feature of an alarm system I felt that having around 10 sensors all wired separately to a central point would be unacceptable. Although time division multiplexing seemed to offer a solution where connections could be made from one site to the next, it appeared that

**Fig. 1.** *Remote multiplexer circuit. Each unit uses a different output from one to zero.*

**Fig. 2.** *Control circuit. The 10 channels can be individually turned on and off or switched in groups.*



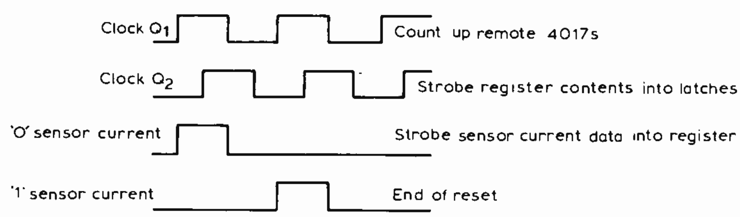



**Fig. 3.** *Circuit waveforms.*

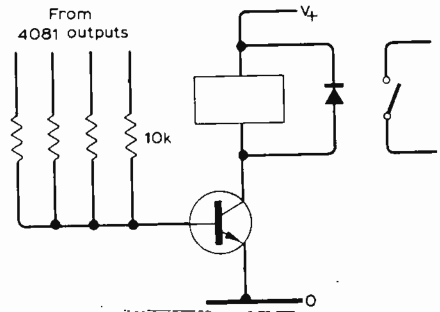



**Fig. 4.** *Transistor OR gate.*

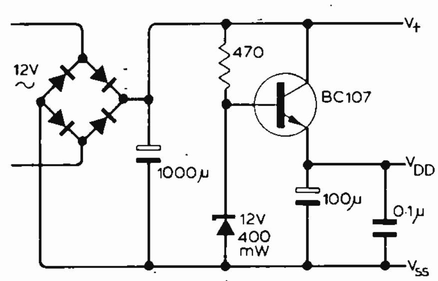



**Fig. 5.** *Power supply.*

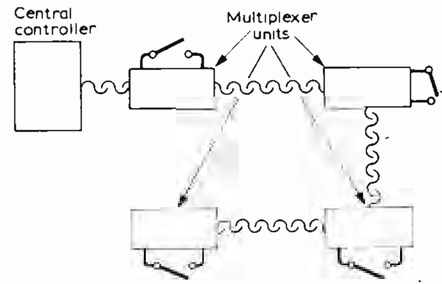



**Fig. 6.** *Interconnection of the remote alarm units.*

power supply lines, a reset line, clock line and a sensor state indication line would be necessary to supply the multiplexer circuit at each site. The present design has reduced this requirement to just 2 wires by making use of the low current and large power supply tolerance of c.m.o.s.

The multiplexer circuit is based on a 4017 decade counter with 10 individual outputs as shown in Fig. 1. Up to 10 of these can be used, each with a different output, to give signals in 10 time slots. A reset line has been avoided by using the power supply rail to reset the counter. When switched on, a CR time constant holds the reset line at $V_{DD}$ to make sure that counting starts from 0. A clock line has been eliminated by switching the supply line as a square wave. When this supply waveform is applied as shown, the capacitor charges through $D_1$ and the resistor. Because $V_{SS}$ is taken low before the reset pin, the 4017 is set to zero. When the square-wave input returns to $V_{DD}$ the 4017 is powered by the charge on the capacitor, and counting proceeds from zero as long as the square wave is present.

The sensor indication line has also been eliminated by detecting the power supply current drain. If a sensor such as a reed switch is connected via a limiting resistor and $D_2$, between one of the 10 counter outputs and the negative supply line as shown, the current drawn through the sensor switch can be detected by the control circuit. In this way one pair of wires can be used to supply 10 remote sensors.

The main circuit is shown in Fig. 2. An oscillator and shift register generate clocking waveforms as shown in Fig. 3, and a 3900 quad op-amp converts current flowing in the line to logic levels. A master 4017 clocks these logic levels, which correspond to the 10 time slots, into 10 output latches. This data is also stored in an 11 stage shift register which holds the state of the last 11 sensor checks.

An open sensor output produces a 1, so two consecutive sensor-open signals are detected by the 2 input NAND gate connected to the 1st and 11th stages of the shift register. Because the NAND gate requires two consecutive sensor open outputs to switch, this system prevents an interference pulse from activating the alarm. If a supply current of greater than normal is detected because, for example, the remote multiplexers are not in step, the circuit is reset by a monostable.

The output of the NAND gate is fed to the data inputs of 10 D-type flip flops which are used as latches. The output from the NAND gate is sequentially clocked into these latches by the 10 outputs of the master 4017. Ten 4018 AND gates connect the Q outputs to the reset pins of the latches. When the gates are enabled by the alarm-on switch, a latch will be held in the 0 state if corresponding sensor contacts are opened for two counting cycles of the multiplexer. The latch will remain in the 0 state even if the sensor contacts are closed again. Transistors drive l.e.ds from the flip flop Q outputs, and are switched between red and green types to indicate alarm-on or alarm-off. An oscillator pulses all of the display drivers to give a flashing l.e.d. for the sensor which has been interrupted.

The 10 alarm signals are available at the 4081 outputs, and the method of using them will depend on individual requirements. Although each output can be used to drive a separate bell or siren, it is much more likely that groups of these will need to be ORed to operate one alarm. The simplest way of achieving this is to drive a transistor from the required outputs as shown in Fig. 4. A relay in the transistor collector provides a contact closure that can switch mains or low voltage alarms. Although only one switch has been shown for the alarm on/off function, it is possible to use several so that some sensor sites can be activated while others are switched off. Alternatively, 10 switches can be used to give independent control of each site. Only a simple power supply is necessary as shown in Fig. 5. The l.e.ds are powered from the unstabilised supply and a simple regulator is provided for the c.m.o.s. logic.

Installation of the alarm is obviously an individual matter, but in my installation a twisted pair of wires was used for interconnection between remote units and the control box as shown in Fig. 6. Detectors for windows were made from a loop of fine enamelled copper wire glued to the surface of the glass. This is unobtrusive and easily broken if the glass is shattered. For doors, standard reed switches were mounted vertically in a slot cut in the door jamb. A ferrite bar magnet was horizontally mounted in a slot cut in the door opposite the reed switch. This arrangement gave satisfactory operation and enough latitude to ensure that wind rattling the door did not give a false alarm.

This system has been in use for nearly three years and has proved to be far superior to the simple alarms which are available. The ability to detect which doors or windows have been left open is particularly convenient when setting the alarm, and it is felt that this facility alone is worth the extra expense. The only trouble experienced over this time has been interference caused by a particularly bad motor on the same power line. Although the correct approach would have been to suppress the motor, fitting a mains interference filter to the burglar alarm immediately cured the trouble. In this connection, it may be of interest that a 100m drum of three core mains cable appears to be more effective than a commercial LC filter. □