30 SOLDERLESS BREADBOARD PROJECTS

BOOK 2

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PREFACE

The aim of this book is basically the same as its predecessor, Book No. BP107: *30 Solderless Breadboard Projects – Book 1*, which provided a range of simple projects primarily intended for the newcomer to the hobby of electronics construction. Solderless breadboard component layouts (based on the "Verobloc" breadboard) are provided for each project, and with only a limited number of inexpensive components it is possible to build each project in turn. This has obvious appeal to the experimenter, but the designs are mostly proper projects which can be built as permanent and useful units if desired. Notes on the construction of designs as permanent units are given where appropriate.

There are two main areas of difference between this publication and its predecessor. One is that the projects in this book are based on CMOS logic integrated circuits, whereas the circuits in Book 1 were all designed using linear devices. The second is that the information given about identifying components and the use of breadboards given in Book 1 is not repeated here, and complete beginners at electronics construction would be advised to study the opening chapter of Book 1 before proceeding with the construction of the projects described in this publication.

R. A. Penfold

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Chapter 1

INTRODUCTION

Before proceeding to the projects one or two points concerning the components used in the projects, and not covered in Book No. BP107: *30 Solderless Breadboard Projects – Book 1*, will be dealt with.

The first point to bear in mind is that the circuits are all based on CMOS logic ICs, and these devices are vulnerable to damage by static charges. High voltage static charges are by no means uncommon, and the use of plastics in clothes, furniture, and other everyday items means that there is a real risk of CMOS devices being damaged if left unprotected in a normal environment. These devices are normally supplied in some form of protective packaging such as conductive foam, metal foil, or a plastic tube, incidentally.

Ideally CMOS logic devices should be left in the protective packaging until they are to be plugged into circuit, and they should be the last components to be fitted into place. The leadout wires should be handled as little as possible. When using CMOS devices in a breadboarded circuit they should be the first components to be removed when dismantling the project and should be returned immediately to their protective packaging. Once again, the pins of the devices should be handled as little as possible.

From the above you could get the impression that a CMOS device is almost certain to be destroyed if it is removed from its protective packaging for more than a few seconds, or if you merely touch the pinouts. In fact this is not really true, and all modern CMOS devices have built-in protection circuitry which reduces the risk of damage. However, this circuitry does only reduce the risk, and does not totally eliminate it. While a CMOS device is removed from its protective packaging and not connected into a circuit (which would normally be expected to provide complete protection against static charges) the device is vulnerable to damage. The risk is probably not very large, and many electronics experimenters (including the author) use CMOS devices like any other semiconductor devices without running into problems with damaged devices. The obvious disadvantage of doing this is that you cannot really return a faulty device under guarantee if you have not taken the necessary handling precautions, even if the fault probably has nothing to do with the lack of handling precautions. Whether you put up with the inconvenience of taking the handling precautions or run the risk of damaging the devices concerned is something you have to decide for yourself.

Many of the projects utilize the ICM7555 device (which is sometimes just referred to as a 7555), and this is a CMOS version of the popular 555 timer device and is not strictly speaking a CMOS logic device. However, it is a very useful device which is compatible with CMOS logic ICs and it is for these reasons that it has been used in many of the projects. The ICM7555 has built-in static protection circuitry which, unlike ordinary CMOS logic devices, does make special handling precautions unnecessary, and this integrated circuit can be handled and used like any normal semiconductor device.

Some of the designs use a transistor which is not the normal bipolar type (as used in the designs featured in Book 1), but is a VMOS type. The three leadout wires of a VMOS transistor (like other field effect types) are called the drain, gate, and source, and *not* the collector, base, and emitter (as used for bipolar types). Although some VMOS transistors, like CMOS logic ICs, are vulnerable to damage by high voltage static charges, the device specified for the projects in this book has an internal zener diode which gives complete protection against static charges, and special handling precuations are not required.

Note that if you construct any of the circuits as permanent projects it is advisable to use IC sockets for any CMOS logic ICs used. With the cheaper CMOS devices you may feel that the cost of a socket (which could be more than that of the integrated circuit) is not justified, and the device should then be soldered into circuit using a soldering iron having an earthed bit. Of course, the handling precautions mentioned earlier apply whether the device is to be used in a bread-boarded circuit or a parmanent one.

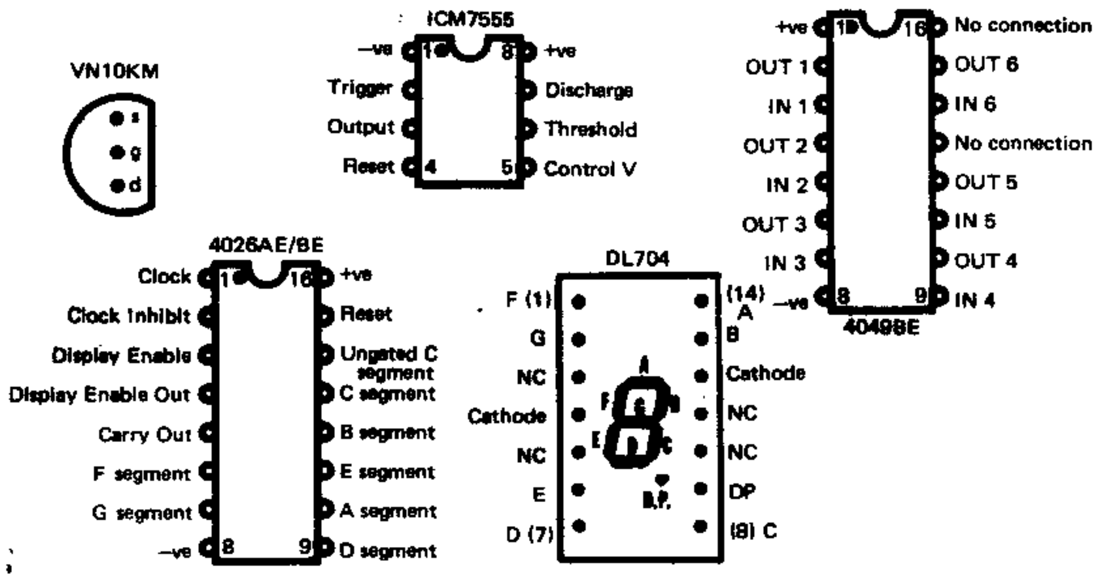

Figure showing transistor base view, IC top views and display front view

Chapter 2

THE PROJECTS

Project 1 – Simple Burglar Alarm

Burglar alarm systems can be very complex with radar, infra-red, or ultrasonic detectors, but for most purposes a simple design triggered via switches fitted to doors and windows is perfectly adequate and the cost of a more expensive system is unjustified. The switches used can either be microswitches which are operated mechanically by the door or window to which they are fitted, or reed switches which are operated by magnets fitted to the protected doors and windows.

It is not satisfactory to simply wire these switches so that an electric bell or other alarm generator is switched on when one of the doors or windows is opened, since this would enable an intruder to enter the premises with the alarm only sounding briefly. The switches must be taken to a simple latching circuit that continues to sound the alarm once the unit has been triggered, even if the switch which triggered the unit is reset to its original state.

The Circuit

Refer to Figure 1 for the full circuit diagram of the Simple Burglar Alarm.

IC1 is a 4049BE hex inverter, but only three of the six inverters are employed in this circuit. The inputs of the other three inverters are connected to the positive or negative supply rail to avoid spurious operation and possible damage. In logic circuits inputs and outputs can either be at logic 1 ("high", or at virtually the positive supply voltage), or at logic 0 ("low", or at virtually the negative supply rail potential). Normally intermediate states are only produced during transitions from one logic level to the other (although some logic devices, including the 4049BE and some other CMOS types, can be biased to operate more as linear devices than true logic circuits if desired). In this circuit though, the inverters are used as true logic devices.

An inverter is the most simple of logic circuit elements, and as its name implies it simply gives an output state that is the opposite of the input logic level.

Under stand-by conditions R2 and R3 bias the input of IC1a to a very low voltage, or logic 0 in other words. This gives logic 1 at the output of IC1a, logic 0 at the output of IC1b due to the coupling through R4, and logic 1 at the output of IC1c as this inverter is driven from the output of IC1b. Tr1 is therefore cut off and the relay coil plus LED indicator which form its drain load are both switched off.

The circuit can be used with normally open (NO) or normally closed (NC) switches, or both. Normally closed types are the more commonly used variety, and probably give better reliability than the normally open type. It is also usually much easier to instal the normally closed type as well.

If one of the normally closed switches is opened, due to the extremely high impedance of CMOS logic devices R2 takes the input of IC1a to almost the full positive supply voltage, or logic 1 in other words. If one of the normally open switches should close, R1 is switched into circuit in parallel with R2 and this also results in the input of IC1a being taken to logic 1.

With the input of IC1a changed to logic 1, its output plus the inputs and outputs of the other two inverters also change logic levels. Tr1 is therefore switched on, and it in turn switches on the relay and LED indicator D2. A pair of normally open relay contacts are used to connect a suitable power source to an electric bell or some other form of alarm generator.

If the switches at the input of the circuit are returned to their original states the output of IC1a will go to logic 1 again, but with the output of IC1c at logic 0 this simply results in D1 becoming forward biased and the voltage at the input of IC1b is limited to only about 0.65 volts (which is logic 0). Once triggered the circuit therefore latches in this state, and can only be reset by returning the input switches to their original positions and briefly switching off the unit using S1.

Although in normal use the circuit will be left switched on for long periods of time, a battery is still a perfectly adequate power source since the current consumption of the circuit in

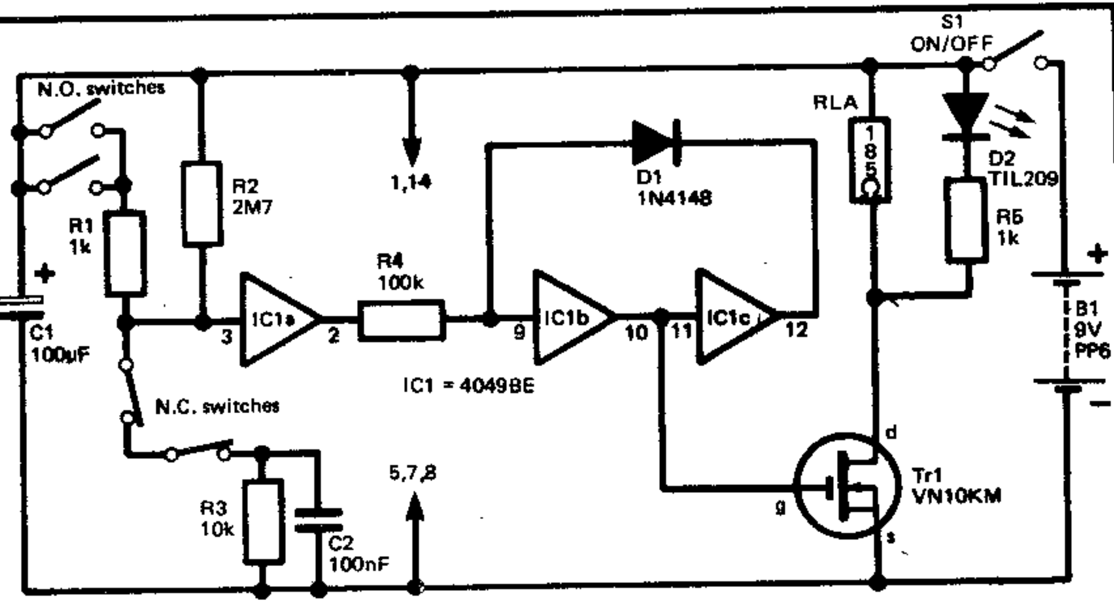

Fig. 1. The circuit diagram of the Simple Burglar Alarm

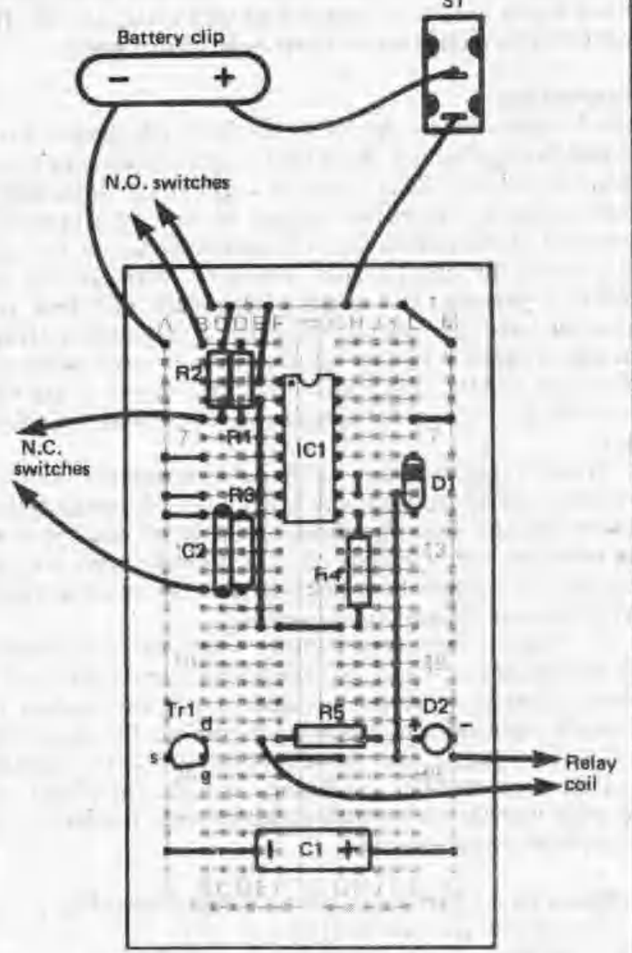

Fig. 2. Constructional details of the Simple Burglar Alarm

the stand-by mode is only a few microamps. This is not sufficient to significantly reduce the operating life of the battery which consequently has virtually its shelf life. Once triggered the current consumption of the unit is, of course, much higher due to the current drain of the relay and D2. The current consumption is then likely to be around 40mA.

Construction

The Verobloc component layout for the Simple Burglar Alarm is provided in Figure 2. When built experimentally on a breadboard S1 can be a SPST miniature toggle switch. If the unit is constructed as a permanent project S1 must be a keyswitch mounted on the exterior of the protected premises so that you can switch the unit on after leaving the premises, and off before re-entering. This avoids a false alarm each time you enter or leave the building. Of course, a keyswitch is needed in this application so that intruders cannot easily switch off the alarm, and the switch should be fitted in such a way that it would not be easy for someone to tamper with the wiring to it.

When trying out the circuit on a breadboard the NC switches can be replaced with a link wire. Momentarily disconnecting this link wire should result in D2 and the relay switching on and remaining on. The normally open switches can also be replaced by a link wire and the unit will trigger when this wire is connected into circuit.

In Figure 1 only two normally open and two normally closed switches are shown, but any desired number of normally closed types in series can be used, as can any number of normally open switches connected in parallel. The circuit will function properly if the normally open switches are omitted, and R1 then becomes unnecessary as well. The circuit can function without the normally closed switches, but these must be replaced with a link wire.

Components for Project 1 – Simple Burglar Alarm (Fig.1)

Resistors, all 1/3 watt 5% (10% over 1M)

R1 1k (brown, black, red, gold)

R2 2M7 (red, violet, green, silver)

R3 10k (brown, black, orange, gold)
R4 100k (brown, black, yellow, gold)
R5 1k (brown, black, red, gold)

Capacitors

C1 100μF 10V electrolytic
C2 100nF polyester (brown, black, yellow, black, red)

Semiconductors

Tr1 VN10KM
IC1 4049BE
D1 1N4148
D2 TIL209 (3mm red LED)

Miscellaneous

Verobloc
NO and NC switches (see text)
Key switch (S1, see text)
Panel holder for D2
PP6 size battery and connector to suit
Relay having a 6 volt coil with a resistance of 185 ohms or more and at least one normally open contact set of adequate rating
Wire

Project 2 – Exit Delay Burglar Alarm

This is a modified version of the Simple Burglar Alarm, and it is designed for use with one of the three alarm generator circuits described in subsequent sections of this book. The combination of this circuit and one of the alarm generator units gives a burglar alarm with both exit and entry delays (the advantage of having these delays is covered in the section dealing with the Simple Alarm Generator unit – see p. 14).

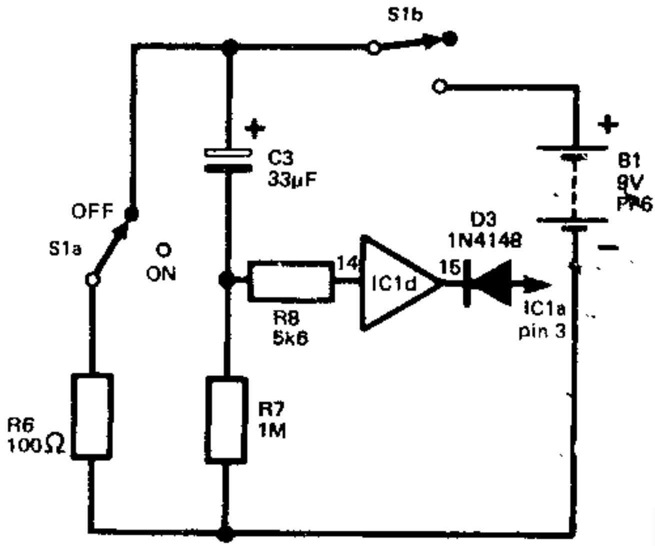

Fig. 3. The additional circuitry needed to add an exit delay to the Simple Burglar Alarm

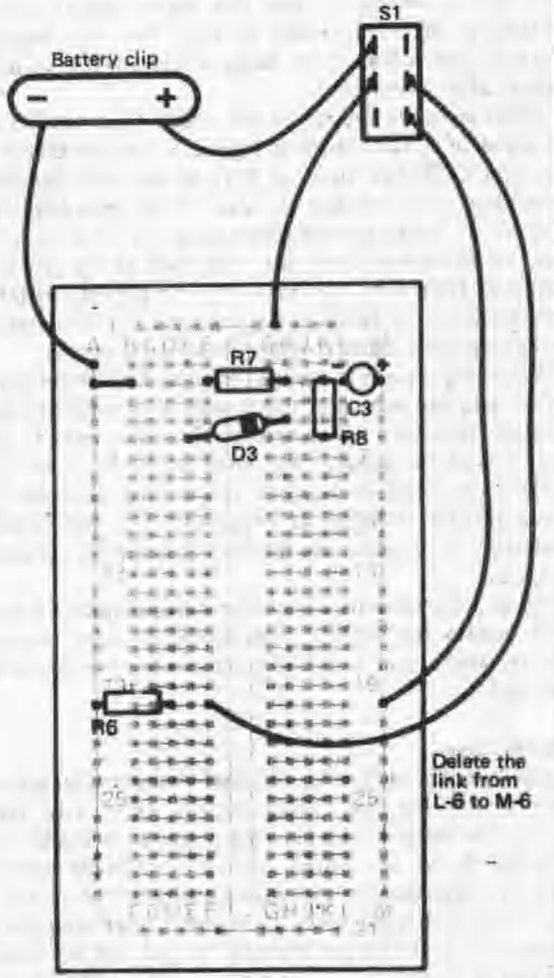

Fig. 4. The additional wiring needed to give the Simple Burglar Alarm an exit delay

The Circuit
The additional circuitry needed to give the exit delay facility is shown in Figure 3, and this makes use of one of the previously unused inverters in IC1. The exit delay simply prevents the alarm from being triggered for about thirty seconds after switch-on.

When power is applied to the circuit C2 is not charged and the input of IC1d is taken to logic 1. Its output therefore goes low, and holds the input of IC1a in the main burglar alarm circuit low. This prevents the alarm from being triggered until after about thirty seconds the charge on C3 is such that the input of IC1d goes from the high state to the low one. The output of IC1d then goes high, but the polarity of D3 is such that this does not result in the input of IC1 being taken high. Instead the main alarm is able to function normally.

The on/off switch is changed from an SPST type to a DPDT switch, and one section of this is used to connect or disconnect the positive supply rail as before. The other section is used to short circuit the supply rails when the switch is in the "off" position, and this is done to ensure that capacitors in the circuit rapidly discharge at switch-off. This was found to be necessary to prevent the circuit occasionally triggering at switch-on.

R6 and R8 are both current limiting resistors. C3 must be a good quality low leakage component in order to give satisfactory results, and a tantalum component has therefore been specified.

Construction
The component layout for the Exit Delay burglar alarm is the same as that for the Simple Burglar Alarm (see Figure 2) except that the link wire between points L–6 and M–6 on the Verobloc should be omitted. Also, it is obviously necessary for the extra components and wiring to be added to the breadboard, and this is all shown in Figure 4 (including the revised wiring to S1). If you are building the unit on the breadboard and not as a permanent project you can simply use an SPST switch for S2 if preferred, and use a link wire to provide a brief discharge path through R6 when the unit is switched off.