Constructional Project

DOORBELL DELAY

STEVEN HOLLAND

A simple timer that prevents misuse of the doorbell. Can also be used as a "doorbell" for the deaf.

HOW MANY times does somebody ring your doorbell, and while you are on the way to answering, they keep on pressing the bellpush three or four times which can be quite annoying. Sometimes having to shout "I'm coming" to stop them pressing the bellpush even more.

Well, all your problems are over with this little circuit design for a Doorbell Delay that connects to your existing doorbell unit. When the caller rings the bell, it will only ring for "X" seconds and then cancels. The bellpush will remain inoperative for a further "X" mins/secs.

These times can be adjusted by two small presets. The circuit uses two common timer i.c.'s and just a few external components. All the unit needs is a 9V to 12V power supply.

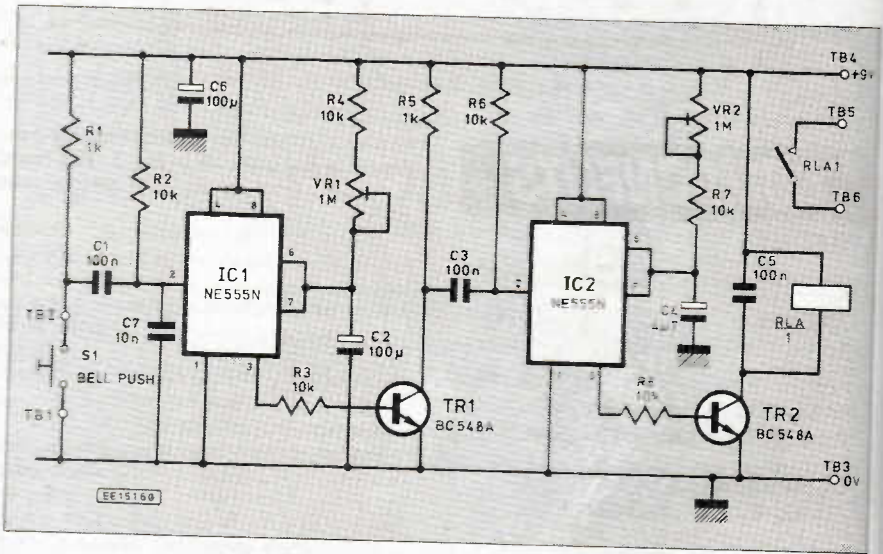


Fig. 1. Circuit for the Doorbell Delay

CIRCUIT DESCRIPTION

The complete circuit diagram for the Doorbell Delay is shown in Fig. 1.

The basic operation of this circuit is easy to understand and should pose no problems even to the beginner.

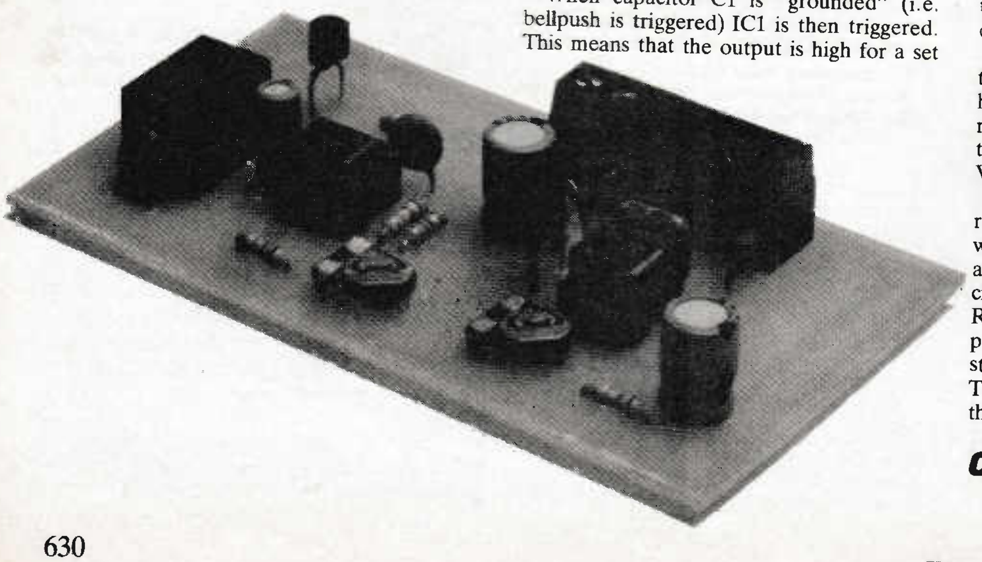
The two 555 timer i.c.s (IC1 and IC2) are designed to operate as "one shot multivibrators" which are linked in series, consequently when the first timer is triggered the second timer also triggers–which in turn operates the relay RLA.

When capacitor C1 is "grounded" (i.e. bellpush is triggered) IC1 is then triggered. This means that the output is high for a set period. No matter how many times it is triggered during this period the timer will not start again but will finish its time period and then allow another trigger pulse to be received.

Transistor TR1 allows a negative pulse to trigger IC2 and the same operation happens here, but the timing components are different. The time periods are dependent on the timing components, VR1 and C2 for IC1 and VR2 and C4 for IC2.

IC1 sets the time between each successive relay operation and IC2 sets the time for which the relay is energised. Capacitors C5 and C6 provide suitable suppression for the circuit.

Resistors R1, R2, R5 and R6 provide the pull-up voltage required for the change in state voltage at the trigger pins on each i.c. Transistor TR2 is used simply as a switch for the relay RLA.



CONSTRUCTION

The circuit for the *Doorbell Delay* is built

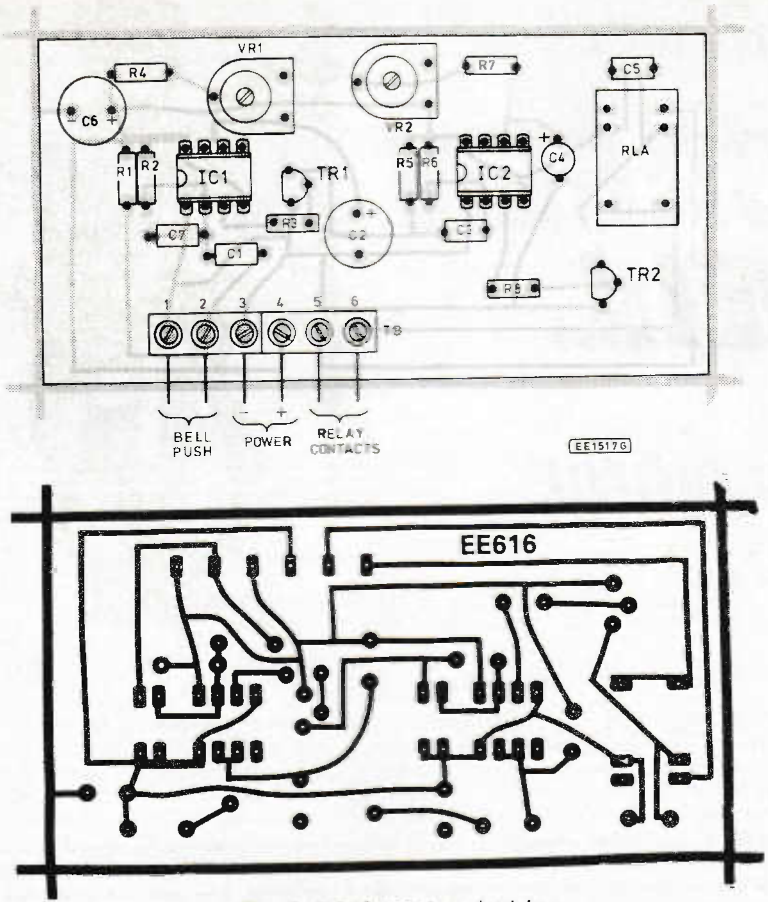


Fig. 2. PCB layout and wiring

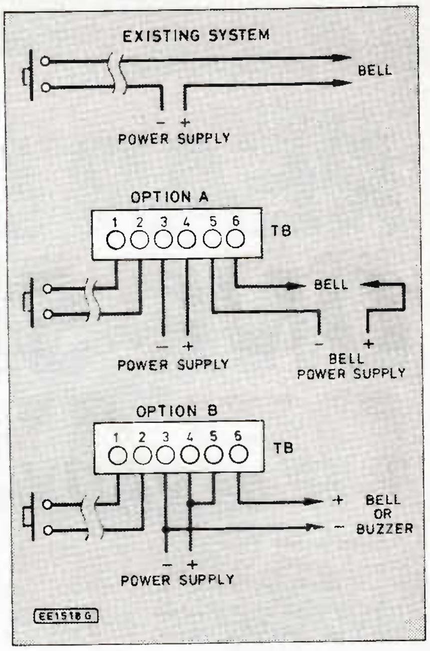


Fig. 3. Connecting to the existing doorbell

COMPONENTS

Shop Talk
See page 660

Resistors
R1 1k
R2,R3,R4 10k (3 off)
R5 1k
R6,R7,R8 10k (3 off)
All 0.25W 10% carbon

Potentiometers
VR1,VR2 1M skeleton preset (2off)

Capacitors
C1 100n poly.
C2 100µ radial elec.
C3 100n poly.
C4 4µ7 radial elec.
C5 100n poly.
C6 100µ radial elec.
C7 10n

Semiconductors
IC1,IC2 NE555N timer (2off)
TR1,TR2 BC548A *npn* gen. purpose (2 off)

Miscellaneous
RLA 6V miniature d.i.l. p.c.b. mounting relay; Printed circuit board, available from *EE PCB Service*, code EE616; 3-way screw terminal block (2 off); 8-pin i.c. socket (2 off); connecting wire and solder etc.

Approx. cost Guidance only £5.50

on a small printed circuit board and the component layout is shown in Fig. 2. This board is available from the *EE PCB Service*, code EE616.

The construction of this project is not difficult at all, as long as the main guide lines are followed. If you wish to construct this project on stripboard you will have to figure out the component layout for yourself. However, as a guide, it could follow a similar layout as the p.c.b. version with the copper strips running from top to bottom, with breaks in the copper as necessary.

Referring to the printed circuit board, first insert the two 8-pin d.i.l. sockets and solder them in position. Next place and solder the two preset potentiometers in their correct position, don't force them into their holes because they could break, so widen the holes a little to allow for this.

Insert the three electrolytic capacitors, making sure the polarity is correct, and solder in position. Now proceed to solder the two transistors, remaining capacitors and resistors on the board. This should be followed by the p.c.b. terminals and the miniature p.c.b. mounting relay RLA.

Finally, examine the board for any dry joints, illegal solder blobs, joint tracks or indeed any breaks in the copper tracks. When satisfied–insert the two i.c.s and power up.

TESTING AND USING

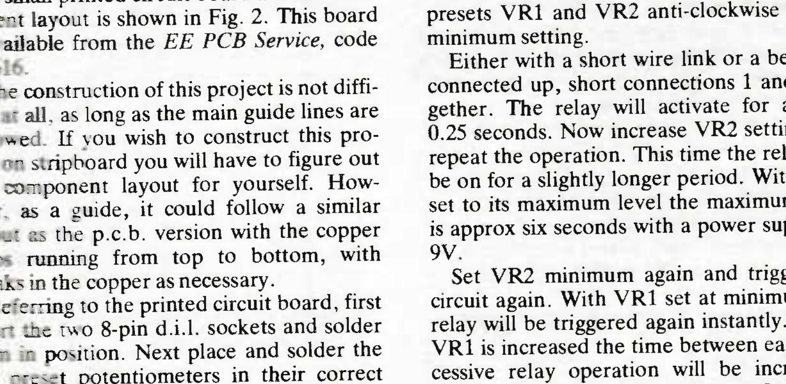
Apply a 9V to 12V power supply to connections 3 and 4 on the terminal block. You should hear the relay click on–then after a few seconds it should click off. Turn both presets VR1 and VR2 anti-clockwise to the minimum setting.

Either with a short wire link or a bellpush connected up, short connections 1 and 2 together. The relay will activate for approx 0.25 seconds. Now increase VR2 setting and repeat the operation. This time the relay will be on for a slightly longer period. With VR2 set to its maximum level the maximum time is approx six seconds with a power supply of 9V.

Set VR2 minimum again and trigger the circuit again. With VR1 set at minimum the relay will be triggered again instantly. But if VR1 is increased the time between each successive relay operation will be increased. The maximum time here is approx 2 mins 30 seconds with a 9V power supply.

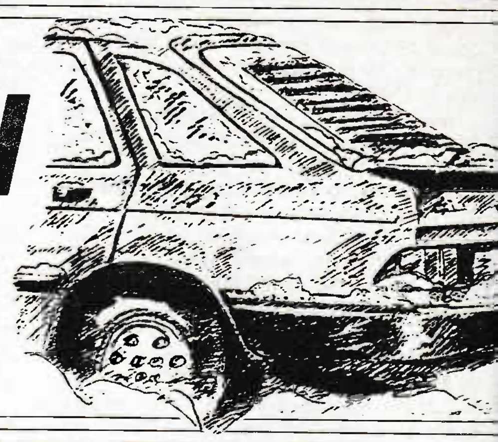
The reason for the bell length time being up to six seconds is to prevent any misunderstanding whether the doorbell was heard or not. The method of connecting the unit into the existing doorbell system is shown in Fig. 3.

This module can also double up as a doorbell for the deaf, with the relay used to activate a bulb or some other type of indicator. □



Constructional Project

REAR SCREEN ONE-SHOT



T. R. de VAUX-BALBIRNIE

Avoid a flat battery—use timed control

A HEATED rear windscreen is very effective in keeping the glass free from condensation and improving visibility. Unfortunately, it is easy to leave it switched on once it has done its job. In some cases it is even possible to leave the heater on continuously while the ignition is switched on and this imposes an unnecessary and unacceptable load on the vehicle battery.

The heating element of a typical car rear windscreen requires 5A to 8A. On a large car this may exceed 12A. When this is added to the current requirements of headlights, fog lights, windscreen wipers and other accessories being used in the winter, an overall current drain may result.

The battery will then discharge since the current supplied by the generator is less than the total requirement. The problem is alleviated by putting the heated rear windscreen under timed control.

The circuit design presented here is a "one-shot" system. That is, on pressing the Start button for an instant, the windscreen heater operates for a preset time then switches off automatically. Normal operation is also possible (depending on the way in which the circuit is connected to the existing system) so that the heater may be switched on continuously if required.

The Start button may also be pressed at intervals to re-start the timing cycle. The circuit draws no current with the ignition off. With the ignition switched on, it requires 15mA approximately with the windscreen heater off and 120mA with it on. In either case the additional load is negligible.

The circuit is contained in a small plastic box placed out of sight—behind the dashboard, for example. External connections are made to a 5-way terminal block mounted on the side. The Start button is sited at any convenient place on the dashboard.

The Heated Rear Windscreen One-Shot could find applications in putting other 12V appliances in the car or elsewhere under timed control.

CIRCUIT DESCRIPTION

The circuit diagram for the complete Heated Rear Windscreen One-Shot is shown in Fig. 1. IC1 is an integrated circuit timer whose period depends on the values of preset potentiometer VR1 and capacitor C2.

With preset VR1 adjusted for maximum resistance this is approximately 30 minutes and any operating time from 30 seconds up to this figure may be chosen. IC1 is a digital device which counts 4095 charge/discharge cycles of C2 before switching off. This minimises the value of capacitor C2.

With the ignition switched on, the circuit draws current through fuse FS1 and diode, D2. Capacitor C4 smooths the rather "noisy" output from the vehicle generator which could otherwise cause false triggering.

off switch contacts. At the end of the preset timing period, pin 3 reverts to low. Transistor TR1, the relay and the heating element then switch off.

Capacitor C3 provides internal stability for IC1 and resistor R2 increases the nominal timing period by a factor of about two, so reducing the value required for C2 still further. Capacitor C1 prevents possible false triggering due to pin 1 (trigger input) being left unconnected while S1 is not being pressed—this would leave the circuit

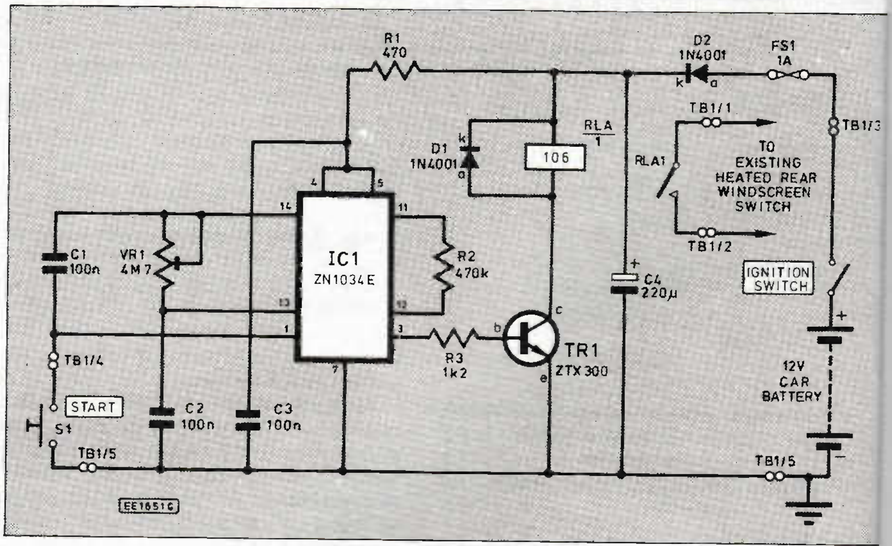


Fig. 1. Circuit diagram of the one-shot timer.

Current flows to IC1 via resistor R1 and voltage stabilisation then takes place on the chip.

The internal timing (counting) of IC1 does not begin until switch S1 (Start) is pressed to make pin 1 low (supply negative voltage) momentarily. This initiates the i.c. and the output, pin 3, changes state from low to high. This supplies current through R3 to transistor TR1 base which, in turn, operates relay, RLA in the collector circuit.

The "make" contacts of the relay direct current to the heated rear windscreen element usually by bypassing the existing on-

vulnerable to stray signal pick-up. The protection diode D1 bypasses the potentially harmful high-voltage pulse which appears when the magnetic field in the relay coil collapses (back e.m.f.).

The specified relay has 16A contacts which are more than sufficient for all heated rear windscreens checked by the author. Sometimes the heater is already operated through a relay to relieve the existing on-off switch contacts of the high current drawn. This is unimportant as far as the present circuit is concerned.

CONSTRUCTION

The component layout of the prototype circuit board is shown in Fig. 2. This uses a piece of 0.1in. matrix stripboard, size 12 strips×37 holes.

Begin construction by cutting the board a little larger than required and filing it to fit the slots in the plastic box. File out the small section at matrix position 13*A* to accommodate the wires passing below the panel later.

Make all underside copper track breaks and solder in the topside inter-strip link wires. This should be followed by all the on-board components, but do not insert IC1 into its socket until the end of construction.

Pay particular attention to the polarities of diodes D1, D2 and capacitor C4. A check should also be made to ensure that no copper tracks have been "bridged" with solder.

Solder 15cm pieces of light-duty stranded connecting wire to copper strips *C*, *D* and *J*, along the left-hand side of the circuit panel as indicated. Solder 15cm pieces of auto-type wire of 7A rating minimum (or as appropriate for the particular windscreen heater) direct to the relay "make" contact terminals–**do NOT connect these wires through the copper tracks.**

Drill two small holes in the case near terminal block TB1 position for the wires to pass through from the circuit panel. Use one hole for the wiring to terminals TB1/1 and TB1/2 and the other for TB1/3, 4 and 5. Drill two small holes in the bottom of the case for mounting it in position later. Drill holes and mount the five-way terminal block and the fuse FS1.

Referring to Fig. 3, complete the internal wiring shortening any wires as necessary but

COMPONENTS

Shop Talk

See page 660

Resistors
- R1 470
- R2 470k
- R3 1k2

All 0.25W 5% carbon

Potentiometer
- VR1 4M7 sub-min enclosed preset (horizontal).

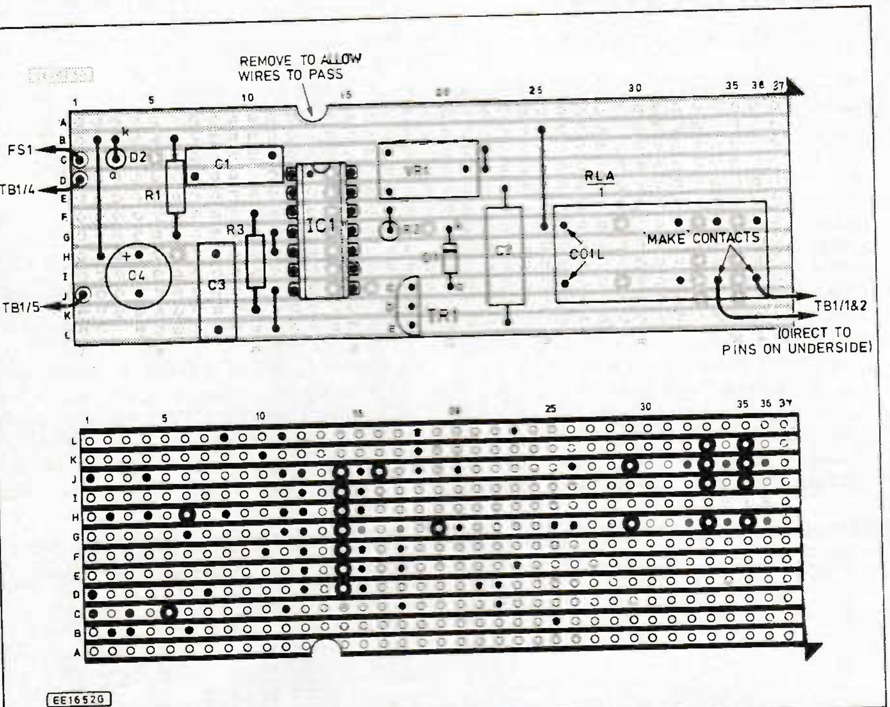
Capacitors
- C1, C2, C3 100n (3 off)
- C4 220μ radial elec. 16V

Semiconductors
- D1, D2 1N4001 1A 50V diodes (2 off)
- TR1 ZTX300 *npn* silicon
- IC1 ZN1034E precision counter/timer

Miscellaneous
- S1 Miniature push-to-make switch
- RLA/1 Miniature relay with 12V 106 ohm coil and 16A changeover or "make" contacts.

Plastic case, size 100×76×41mm external; stripboard, 0.1in matrix size 12 strips×37 holes; TB1 15A terminal block–5 sections required; FS1 20mm chassis fuse-holder with 1A fuse to fit; 14-pin d.i.l. i.c. socket; 3A auto-type wire; 7A auto-type wire; auto-type connectors; small fixings; etc.

Approx. cost Guidance only **£12.50**



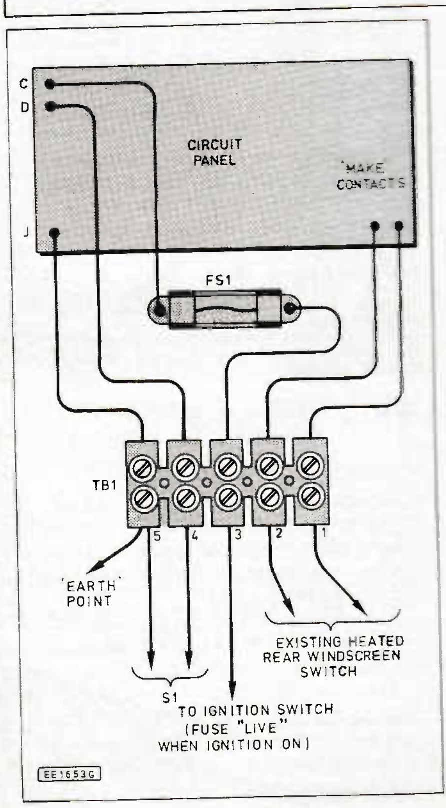
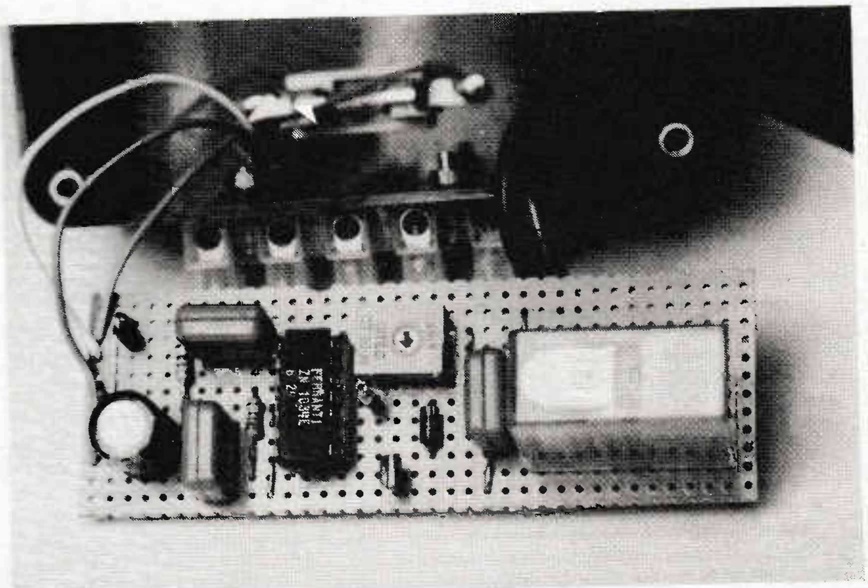
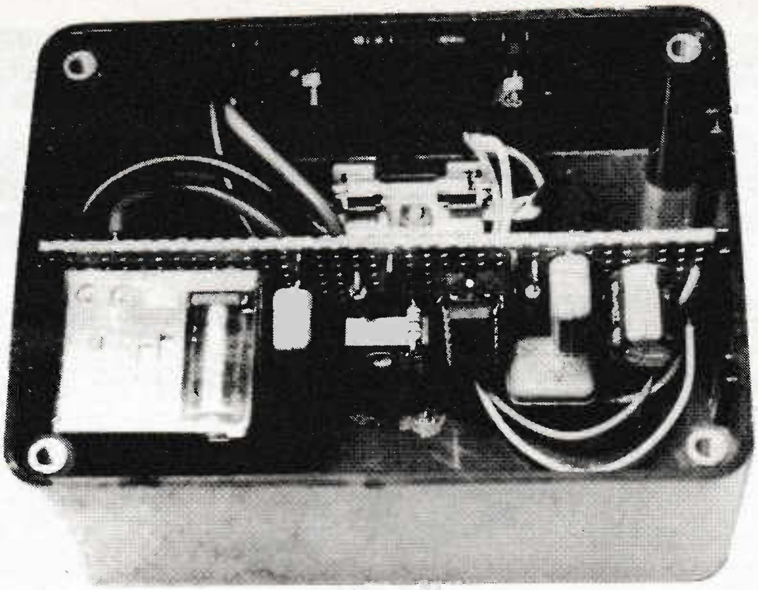


Fig. 2. P.C.B. layout and wiring.

Fig. 3 (left). Internal wiring and car connections.





leaving some slack. Adjust preset VR1 sliding contact fully clockwise then anticlockwise by one sixteenth turn approximately. Insert the fuse. Place IC1 carefully into its socket with the correct orientation and slide the circuit panel into position.

INSTALLATION AND TESTING

Before starting external wiring, remove the car battery positive connection, or safer still disconnect the battery completely. Remember that where a wire passes through a hole in metal, a rubber grommet must be used.

Note that all external wiring to the terminal block TB1 MUST be made with auto-type wire. Also, heavy-duty wire appropriate to the heater MUST be used for TB1/1 and TB1/2 connections but light-duty wire of 3A rating may be used for the others.

There are two ways of proceeding. The first involves connecting terminals TB1/1 and TB1/2 direct (in parallel with) the windscreen heater switch contacts–existing wires being left in position. For automatic use, this switch will be left off. To override the timer, the switch may be used in the usual way.

If the connections to the windscreen heater switch are difficult to reach, there is an alternative way of connecting the unit. This involves breaking into one of the heater feed wires and connecting the free ends to terminals TB1/1 and TB1/2. This can usually be done most easily at the rear of the car with the unit mounted in the boot. Proper insulated auto-type connectors MUST b used for this.

Carefully remove one of the heated re windscreen "spade" connectors and exten the free wire to reach terminal TB1/1 on th unit. Connect a piece of wire between th now free heater connector and termin TB1/2 . Using this method means that th existing on-off switch will need to be left o for the unit to work.

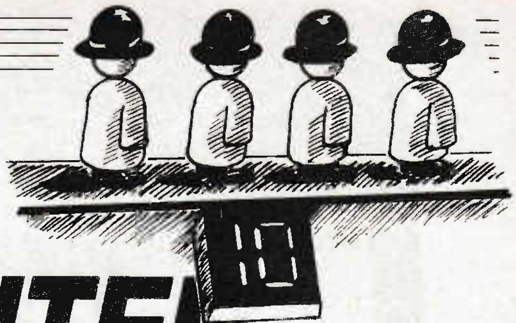
Connect terminal TB1/3 to a fuse which live only when the ignition is switched o Decide on a position for S1 on the dashboar and connect this to terminals TB1/4 an TB1/5. Terminal TB1/5 should also b connected to a nearby "earth" point on th car metalwork. Mount the unit in positio using two self-tapping screws through th holes drilled for the purpose.

Re-connect the car battery and switch th ignition on. Press S1 (Start) momentarily relay RLA should be heard to click. After short while depending on the setting of pres VR1, it should click off again.

If it remains on continuously, it is possib that the preset has been adjusted too f clockwise (near-zero resistance). Und these conditions it latches on and VR1 shoul be re-adjusted accordingly.

If all is well, the unit may be put int permanent service. Over a trial period, th operating time may be adjusted to best effe by rotating VR1 slider anti clockwise using small screwdriver. When doing this, the ign tion **MUST** be switched off.

If the heater needs to be switched o before the timing period ends, this may b done by switching off the ignition for a instant. If the unit has been connected series with the existing wiring, the unit ma be cancelled by switching off at the on-o switch.



INFRA RED OBJECT COUNTER

ROGER PARSELL

This neat, programmable object counter uses an infra-red beam to sense the passing objects. It can be preset to count "one" for any number of beam interrupts up to 255.

MOST object counters around today implement a mechanical method of counting and those that don't, use some very sophisticated and expensive methods of determining the presence of an object. These may take the form of magnetic induction or single ended optical detection both of which have some major drawbacks.

I required an object counter that could count objects of different size, shape, composition and orientation as they pass the sensor.

I decided that an optical method was best suited to the task. For this reason I used an infra-red transmitter and receiver, this was superior to the mechanical method because there is no physical contact made between the object and the sensor. I also had the problem that the object might break the beam more than once during the pass, e.g. a car has two sets of wheels as seen from the side, if you count the wheels as they pass you will have counted two but only one car has passed. So a programmable divider was included to count once when every (X) number of times the beam was broken, (X being the number the divider is set to divide by), then the numerical value of the objects that have passed the sensor is displayed on a seven segment display.

HOW IT WORKS

As can be seen in the block diagram (Fig. 1) an oscillator generates pulses of infra-red light at a predetermined frequency, in this case 5kHz. This light is then detected by the receiver and amplified. The amplified signal is then fed through a filter that only allows a signal of 5kHz to pass, following this is a pulse shaping circuit which outputs one pulse every time the beam is broken, this is sent to the programmable divider or directly to the counters which ever is required.

The counters are decade counters and directly drive the displays from their decoded outputs, thus eliminating the need for counters, decoders and drivers as they are all on board the chips.

CIRCUIT

The transmitter is based on the NE555 timer i.c. configured in the astable multivibrator mode (Fig. 2). The advantages of using a pulsed beam in preference to a continuous beam are as follows:-

By using the pulsed beam method the beam can be encoded in a way that the receiver can differentiate from any other light source. This allows the system to be used in so called optically noisy environments e.g., environments that are prone to lights being turned on and off or even the transition from day to night. These environmental changes can cause the receiver to trigger a false count.

There is also a power saving when using the encoded system, this is because the output diodes are flashed on and off many times a second so the output is only on for half the time, therefore, only half the power is used.

The timing components VR1, R1, R2, and C1 are selected to produce 5kHz at the output. VR1 is incorporated so that the transmitter can be fine tuned to the optimum for the environment.

The output of the NE555 can only sink loads up to 200mA so transistor TR1 is used

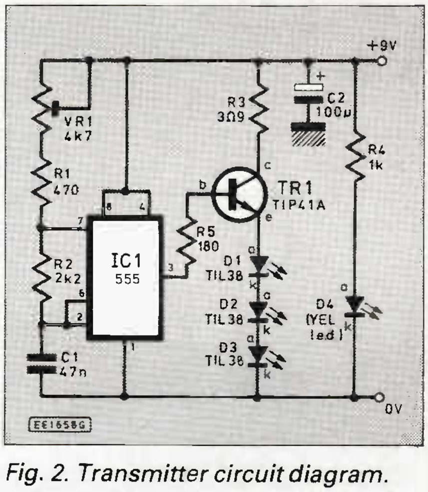
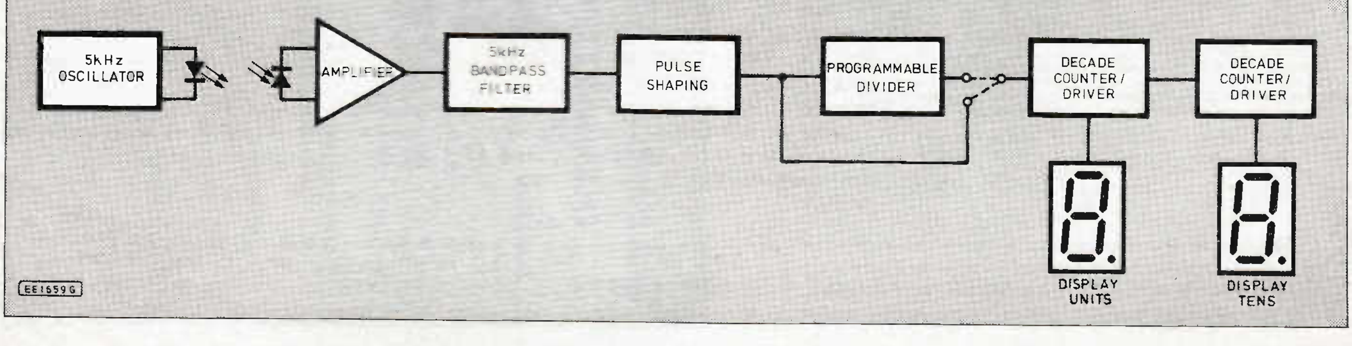


Fig. 2. Transmitter circuit diagram.

Fig. 1. Block diagram of the I.R. Object Counter.



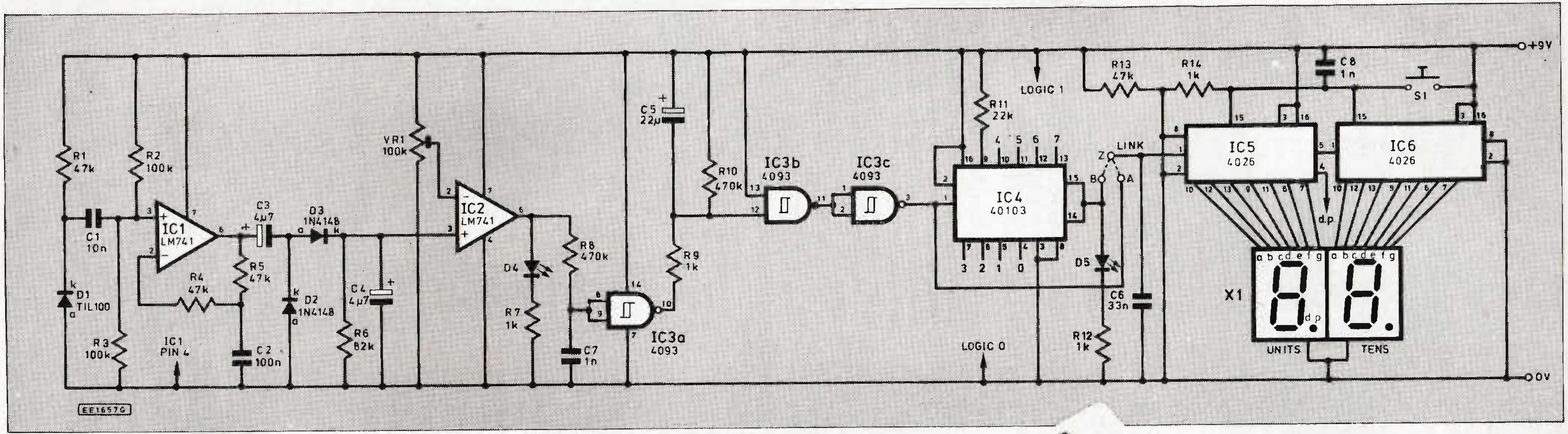
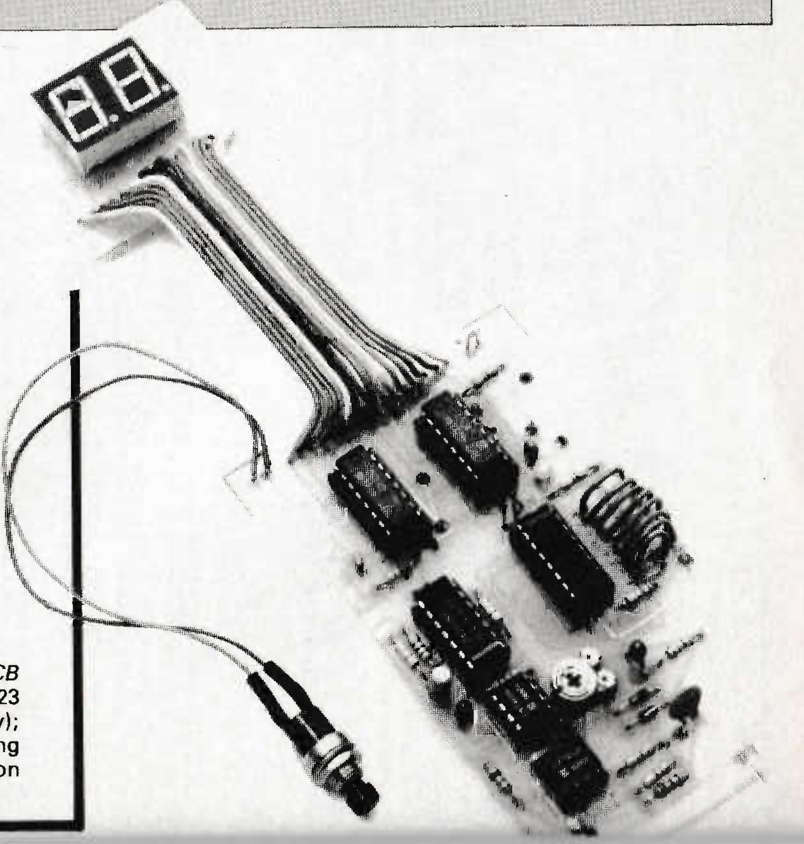


Fig. 3. Receiver and counter circuit.



COMPONENTS £21

Approx. cost Guidance only

TRANSMITTER

Shop Talk
See page 660

Resistors

R1	470
R2	2k2
R3	3Ω9
R4	1k
R5	180

All ¼W± 10% carbon

Potentiometer

VR1 4k7 horizontal preset

Capacitors

C1	47n polyester layer
C2	100µ axial elect. 16V

Semiconductors

IC1	NE555 timer
TR1	TIP41A *npn*
D1, D2, D3	TIL38 infra-red diode (3 off)
D4	3mm. l.e.d.

Miscellaneous

P.C.B. available from the *EE PCB Service,* order code EE622; connecting wire; solder etc.

RECEIVER

Resistors

R1, R4, R5, R13	47k (4 off)
R2, R3	100k (2 off)
R6	82k
R7, R9, R12, R14	1k (4 off)
R8, R10	470k (2 off)
R11	22k

All ¼W± 10% carbon

Potentiometer

VR1 100k horizontal preset

Capacitors

C1	10n ceramic
C2	100n ceramic
C3, C4	4µ7 tant. 16V (2 off)
C5	22µ min. elect. 16V
C6	33n ceramic
C7, C8	1n ceramic (2 off)

Semiconductors

IC1, IC2	LM741 op-amp (2 off)
IC3	4093 quad NAND Schmitt
IC4	40103 programmable divider
IC5, IC6	4026 counter driver (2 off)
D1	TIL100 photo diode
D2, D3	1N4148 (2 off)
D4, D5	3mm l.e.d. (2 off)
X1	Double 7 segment display (commom cathode)

Miscellaneous

P.C.B.s available from the *EE PCB Service,* order codes EE623 (receiver) and EE624 (display); single core insulated connecting wire; short length of 16 way ribbon cable; solder etc.

to drive the output diodes as these diodes take 100mA each.

Resistor R3 should not be replaced by a lower value than 3Ω 9 or this might damage the transistor TR1. R4 and D4 are only incorporated to indicate the connection of power to the transmitter as the output diodes do not emit any visible light.

RECEIVER DRIVER UNIT

The receiver driver unit can be split into four separate parts; these are, Receiver and Filter, Pulse Shaping, Pulse Dividing, and Counter Drivers.

RECEIVER AND FILTER

The device used to receive the infra-red signal is the TIL100 photo diode (Fig. 3.), this diode works best when light in the infra-red spectrum falls upon it. When the light falls upon the sensor the current flowing through it increases. If this diode is connected in reverse bias across the supply through a pull up resistor, we can get a change in potential at the point where they meet which is proportional to the light falling upon the sensor. This potential is also oscillating at the same frequency as the transmitter so we can a.c. couple the signal to the amplifier via C1.

The amplifier is designed so that only a signal of 5kHz can pass easily, this is due to the feedback arrangement of R4, R5 and C2. At low frequency the gain of the amplifier is approximately 1:1, but at 5kHz the impedance of C2 decreases so that the gain of the amplifier increases to several thousand.

The 5kHz frequency at the output of the amplifier is then sent through a voltage doubler circuit D2, D3, and smoothed by R6, C4, it then reaches the pulse shaping stage.

PULSE SHAPING

Pulse shaping is required to shape the smoothed signal into a pulse with fast attack and fast decay, this eliminates the risk of false reading by unwanted noise spikes. Noise spikes can occur by the switching on and off of light switches etc., in the close proximity of the receiver.

The first stage of the pulse shaping is to compare the input pulses with a known potential, this is done by a comparator circuit. A 741 operational amplifier (IC2) is used to compare the potential set at pin two by the potentiometer VR1—this is known as the reference potential. The input signal is connected to pin three and this is then compared with the reference potential. If the signal is greater than the reference then the output goes high. If the signal potential does not reach the reference potential then the output will remain low. By using a comparator all the noise spikes less than the reference potential are eliminated.

The output of the comparator then feeds R7 and D4. This diode then emits light when the beam remains unbroken and stops emitting when the beam is broken.

The next stage is formed by IC3 which consists of four 2-input NAND gates, which can be used as Schmitt triggers, this simplifies the task of pulse shaping. (As the Schmitt trigger is a dedicated pulse shaping device it is an obvious choice). The input pulse is fed into the first two gates for shaping and the third is incorporated as an inverter to invert the output of IC3b ready to be fed through the dividing circuit.

PULSE DIVIDING

As described previously the pulse divider was incorporated to enable the use of the system in applications where the beam might be broken more than once by the object. By calculating how many times the beam will be broken by the object, this number can then be programmed into the divider so the output will only pulse once for every predetermined number of times the beam is broken, or once every time the object passes.

The programmable divider is virtually self contained as IC4. The input pulse is fed to pin one of IC4, from there it is divided by the value set by the programme inputs.

The programming inputs are pins, 4, 5, 6, 7, 10, 11, 12, 13. As can be seen there are 8 inputs and these must be programmed in binary, with a binary 1 equal to +ve and binary 0 equal to 0V, this combination of 1's and 0's is connected to the programming inputs of IC4 to give the numnber to be divided by.

Resistor R12 and D5 indicate the output pulses from IC4. IC4 can divide the input pulses from 2 to 256, if a 1:1 count is required then the link should be made to bypass the counter, otherwise connect a link from divider to counters. The link should never go from the output of the divider to the bypass as the Schmitt triggers cannot drive the l.e.d. and IC3 would be destroyed.

COUNTER DRIVING

Again in the counter driver section most of the circuits are self contained in the chips and very few external connections are necessary. IC5 and IC6 are both decade counter drivers, this means that they can only count from 0 to 9 and reset to 0, also contained on the chips are seven segment decoders and drivers, allowing seven segment displays to be driven directly from the decoded outputs.

The few components that are associated with these i.c.s consist of capacitor C8 and switch S1. These are both connected to the reset pin 15. When this pin is connected to the +ve supply via S1 the counters will reset. The capacitor C8 holds pin 15 high at switch on for a short while in order to reset the counters to zero each time the unit is turned on.

CONSTRUCTION

The circuits are constructed on the p.c.b.s as shown in Figs. 4, 5 and 6. It is advisable to use the p.c.b. method of construction, rather than Veroboard, as this would not be easy even for the experienced constructor. It would also be possible to severely damage or totally destroy one of the chips with an incorrect connection.

Before commencing construction take a careful look at the photographs of the prototypes and diagrams. On the receiver driver board (Fig. 4) the wire links on the top of the

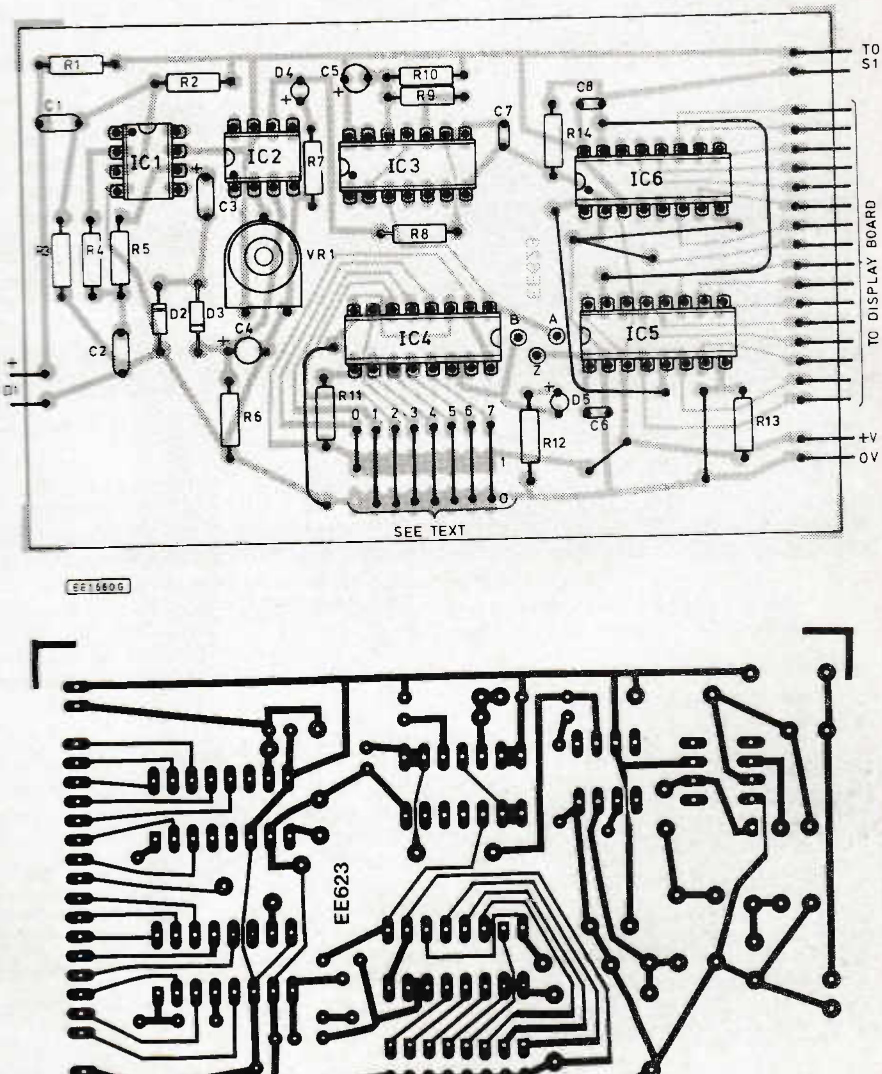


Fig. 4. Main p.c.b. for the I.R. Object Counter.

board should be connected first using insulated connecting wire (these replace the double sided p.c.b. used in the prototype). Then all resistors should be connected. The resistors should then be followed by inserting the signal diodes D2, and D3 ensuring the correct orientation. Then connect the remaining capacitors and l.e.d.'s also ensuring the correct orientation.

The i.c.'s should be connected using i.c. sockets as it is very difficult to remove them once they have been soldered in place. Components IC3, IC4, IC5 and IC6 are all CMOS devices and should be handled with all static handling precautions. D1 could be connected to the p.c.b. or connected remotely via two connecting wires, but pay particular attention to the orientation of this device. The long lead should be connected to the positive and the short lead connected to the 0V line.

The transmitter board (Fig. 6) is assembled in much the same way with the resistors and capacitors connected in place first. This should then be followed by D1, D2, D3 and D4 connected in forward bias with the long lead to the positive. Finally IC1 and TR1 should be connected in, observing the right orientation. The display board should cause no problem in construction but make sure that the display is the correct way around.

SETTING UP

Before testing the board the programmable divider should be set up using solder links. All eight programming presets or IC4 must be connected to either positive for logic 1 or the 0V rail for logic 0. Any count can be made between 1 and 255 and is set in binary using solder links to the supply rails as shown in the connection diagram. Having worked out the number of times the object will break the beam, the number can be set up as an eight bit binary code.

Each preset input of IC4 corresponds to a single bit of an eight bit binary number as follows:-

0	1	2	3	4	5	6	7
1	2	4	8	16	32	64	128

Thus any number can be programmed up to 255 by connecting the appropriate input to either positive input or ground. For example, if you require one count for every 122 times the beam was broken.

$$122=0\times128+1\times64+1\times32$$
$$+1\times16+1\times8+0\times4+1\times2+0\times1$$

Which is 01111010 in binary, this number is set by connecting the programming inputs in the following way.

Preset 7 goes to 0V
Preset 6 goes to +ve
Preset 5 goes to +ve
Preset 4 goes to +ve
Preset 3 goes to +ve
Preset 2 goes to 0V
Preset 1 goes to +ve
Preset 0 goes to 0V

A word of caution: the preset inputs 0–7 do not correspond to the i.c. pin numbers (see Fig. 3), so do check before you start.

TESTING

The transmitter may be powered by any voltage source of eight or nine volts. When powered up you will not be able to see anything being emitted as infra-red is invisible to the human eye, however, checking pin three of the NE555, with either a high impedance earphone or an oscilloscope should confirm the presence of high frequency oscillation.

The receiver is best checked by powering up, and then bringing the transmitter close to D1 of the receiver at which point the l.e.d. D4 should light. If it does not do this then try rotating VR1, a result should be obtained when it is set to a central position. If the diode still stays unlit then check that photo diode D1 is connected the right way around, also check that C3, D2, D3, are the right way around.

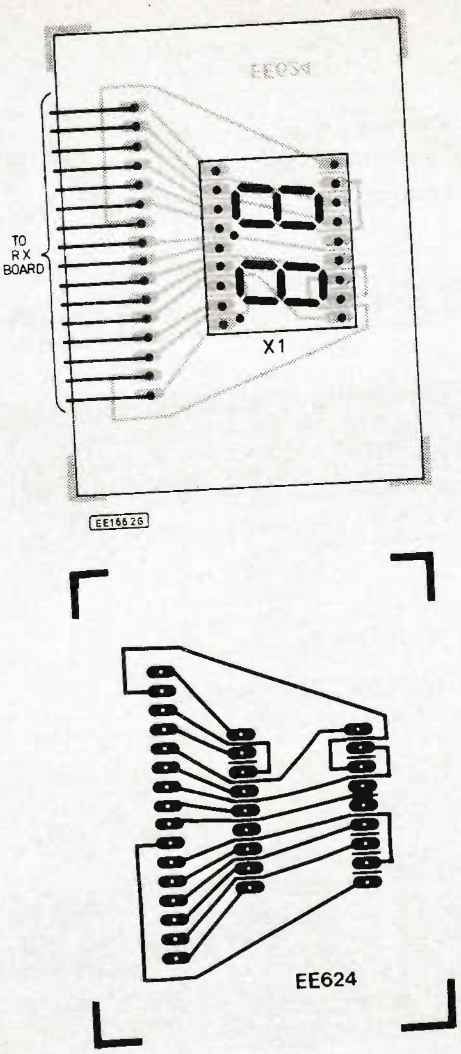


Fig. 5. Display p.c.b.

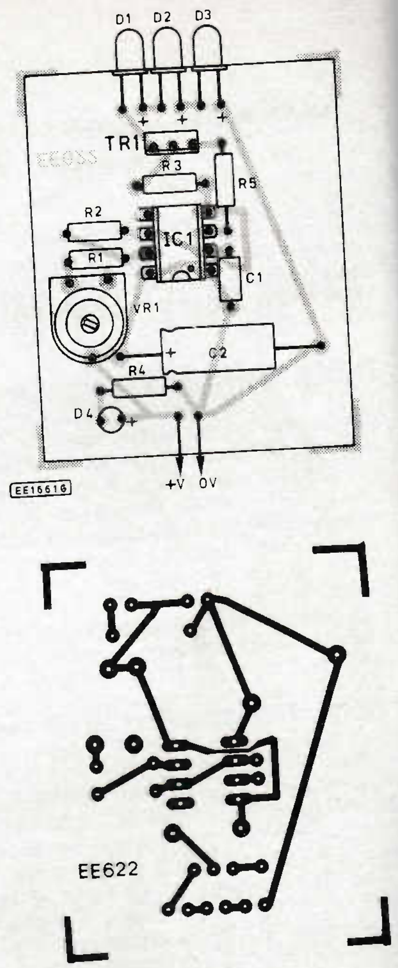
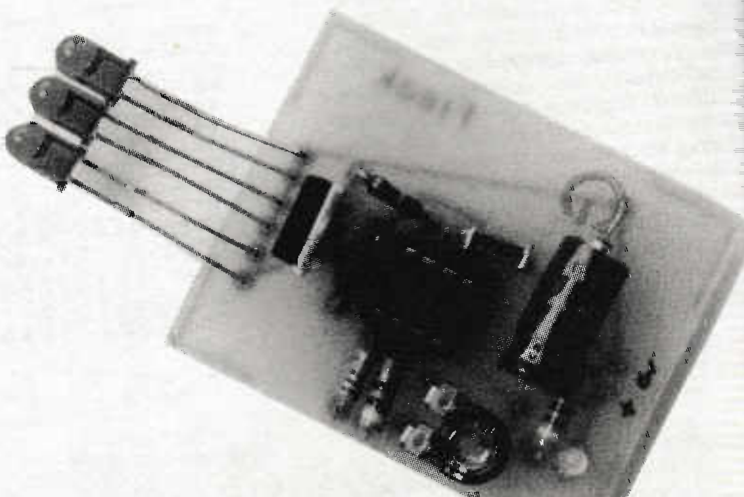


Fig. 6. Transmitter p.c.b. for the I.R. Object Counter.

In use the receiving diode should be covered by a light guide, thus making it more directional and less sensitive to stray pickup. A small piece of rubber sleeving is ideal for this.

An operational range of up to 3.5m is possible, the only adjustment required is to alter VR1 on the transmitter and VR1 on the receiver for optimum operation. It is also necessary to set the programming of the divider and the link to count pulses or count the output of the divider, as described earlier.



REALISTIC®

PROGRAMMABLE SCANNING RECEIVERS

THE BEST CHOICE FOR YOUR HOME OR CAR

[A] **Realistic® PRO-2004.** The ultimate in today's solid-state high-technology scanners! Delivers a wide range of frequencies not found on most scanners. Search mode finds new channels, selectable scan and search speeds, two-second scan delay. Lock-out key for temporarily bypassing channels. Squelch control and priority function. Continues tuning from 25-520 MHz and 760-1300 MHz. 300 channels for storing frequencies. Large LCD channel/frequency display with electroluminescent back lighting, built-in speaker, telescoping aerial. Jacks for external aerial, headphone, external speaker, tape record and DC power supply. Measures: 2³/₁₆ x 10¹¹/₁₆ x 8¹¹/₁₆". Mains operation (or 13.8 VDC neg. gnd. power cord, extra). Memory back-up requires 9v battery. **20-9119** **£329.95**

[B] **Realistic PRO-2021.** Features direct keyboard entry, search and scan in two speeds and two-second scan delay. Priority function will automatically switch to the priority channel when a call is received on it and individual lock-outs for temporarily bypassing channels. Scan up to 200 channels in these bands: VHF Lo 68-88 MHz, VHF AIR 108-136 Mhz, VHF Hi 138-174 MHz, UHF Lo 380-470 MHz and UHF Hi 470-512 MHz. Easy-to-read LCD channel/frequency display with electroluminescent back-lighting, squelch control and built-in speaker, telescoping aerial. Jacks for external speaker, external aerial, tape recorder and DC power supply. Size: 3⅛ x 10¼ x 8". Includes mounting bracket for mobile use and DC power cord. Mains operation (or 13.8 VDC neg. gnd.). Memory back-up requires 9v battery. **20-9113** **£199.95**

Tandy®

Over 400 Stores And Dealers Nationwide

Prices may vary at Dealers. Offers subject to availability.

Tandy, Tandy Centre, Leamore Lane, Bloxwich, Walsall, West Midlands. WS2 7PS

City and Guilds

Certificate Course

Introducing DIGITAL ELECTRONICS

Part 2: Component Identification and Coding

By Michael J. Cockcroft
Training Manager, Peterborough ITeC

This series of twelve articles has been designed as a complete course for the City and Guilds Introductory Digital Electronics syllabus (726 301). Full details on registering for C&G assessment, details of assessment centres, and information on the course in general were given in a booklet provided free with the October issue.

WE will cover the following City and Guilds objectives in this part:

1.1 Components

1.1.1 Identify at least ten commonly available components (selected from Appendix A of the City and Guilds "Introductory Electronics Modules Resource Document") and determine costs and component reference numbers from suppliers catalogues.

1.1.2 State and apply the pin numbering convention associated with common integrated circuit packages including 8-pin, 14-pin, and 16-pin d.i.l.

1.1.3 State and apply standard colour coding to identify resistor values and tolerances (Appendix J of the Resource Document).

1.1.4 State and apply standard colour coding to identify capacitor values, tolerances, and working voltages (Appendix K of the Resource Document).

1.1.5 State and apply commonly used alternative methods employed for marking capacitor and resistor values (Appendix J and K of the Resource Document).

1.1.6 Identify the correct orientation of polarised components including selected capacitors and diodes.

Circuit Building

Electronic components are the variables that are combined with voltage sources and conductive paths (e.g. wires) to produce electronic systems, they help us manipulate electrons in any way we like to produce useful functions. We have already used a few electronic components in our experiment with the "torch", in Part 1: first, using a battery as a voltage source and wires as a path for electrons, we directed an electric current through a bulb to illuminate it; then we added a switch to the circuit to provide control over when the bulb was on or off.

Rarely, though, are electronic systems quite as simple as this torch circuit, and the method by which it was assembled is far from typical. Most electronic components are designed to be **printed circuit board** mounted. Printed circuit boards (p.c.b.'s) are thin boards made fr[...] insulating material (usually gl[...] reinforced plastic like the one in F[...] 2.1) with metal conductive pa[...] representing wires, printed onto [...] surface. The components are usu[...] connected to the metal paths by s[...]dering.

Mostly, as in the examples of F[...] 2.2, holes are drilled into the boar[...] accommodate components; [...] more and more, these days, a re[...] development called **surface mo[...] technology** is being adopted by e[...]tronic equipment manufactur[...] This technology requires spe[...] components called **surface mo[...] devices** (SMD's) as shown in Fig. [...]

Stripboard

Both of these types of p.c.b. [...] used for large scale production[...] the purpose of this course [...] **stripboard** form of p.c.b. of Fig[...] and conventional components [...] not SMDs) are what we will be us[...] Stripboard is intended only for [...] assembly of prototype (trial mo[...] circuits and very small scale [...]duction. It has uniform strips [...] copper on one side and many h[...] so that the user may place com[...]nents to any layout. If m[...] components are to be mounted [...] small area it may be necessar[...] make breaks in the copper strip[...] isolate components from each o[...] this is easily done by twisting an [...]nary drill bit (about ¼ inch) by h[...] in one of the holes until the co[...] strip separates.

Polarity

When constructing a circui[...] physical parts of the compon[...] need to be tallied with their sym[...] representations in circuit diagra[...]

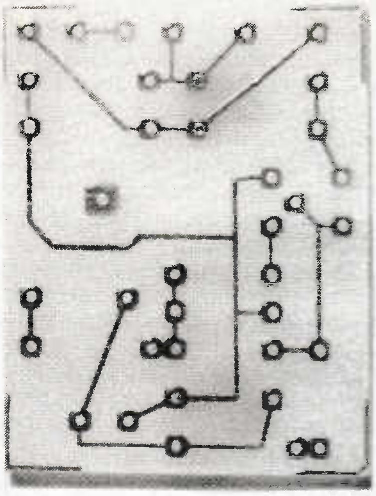
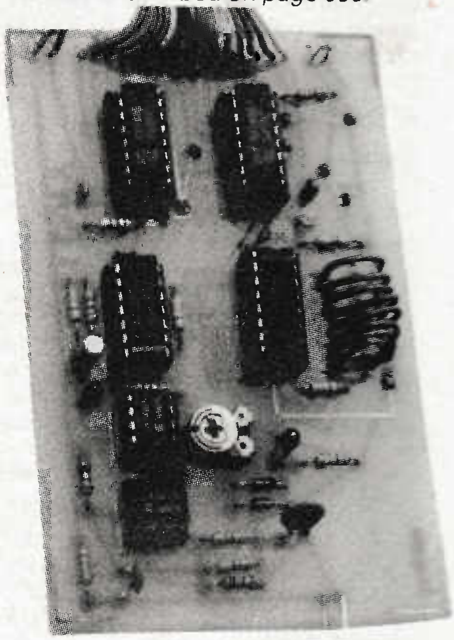


Fig. 2.1 (above). The underside of a p.c.b. before the components are inserted.

Fig. 2.2 (below). A completed p.c.b. This one is for the Infra-Red Object Counter described on page 635.



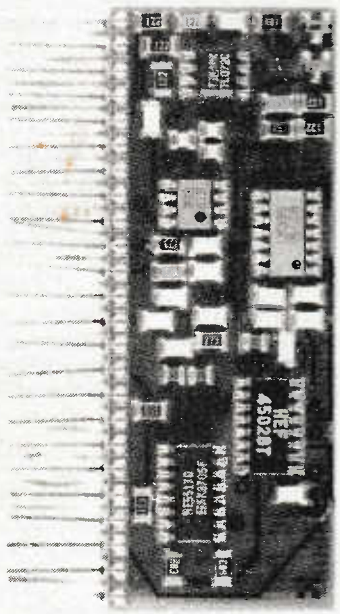


Fig. 2.3. An example of surface mount technology. (Photo courtesy of CorinTech.)

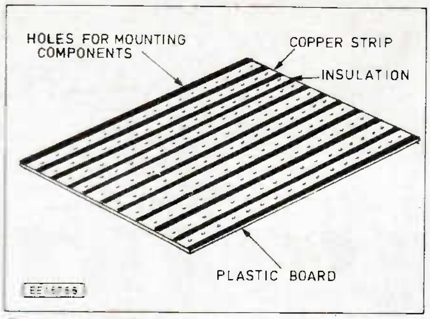


Fig. 2.4. Stripboard form of p.c.b.

light emitting diode, for instance, has two parts and we need to be able to distinguish which is which from both the circuit diagram and from the physical device itself if we are to build a physical system; Fig. 2.5a, for example, shows how the circuit symbol for the light emitting diode (LED) relates to the physical component in Fig. 2.5b so that one may interpret the circuit diagram of Fig. 2.5c to construct the physical system on stripboard as shown in Fig. 2.5d. The other component in the circuit is a resistor and it is not polarised, therefore, it may be connected either way round on the stripboard.

An important point to note about this example is that the power supply (battery) is not actually mounted on the p.c.b. nor is it included on the circuit diagram. This is typical of the way in which it is usually done: power supplies (particularly battery supplies) are almost always physically separate from the p.c.b.s and only included on circuit diagrams as a straight line marked with the appropriate voltage.

Components

Components are the building blocks of electronic systems and in order to be able to start building we need to know a number of things about them: what do they look like?, how do we determine their values?, how are they connected within a circuit?, and how are they symbolically represented in circuit diagrams? We are not concerned, at this point, how the components work; we leave that for later issues. For the present, we need to know how to use them in our experiments and exercises.

Although there are many, many electronic components, the following are some of the most important and are the subject of this part of the course:

(a) Resistors
(b) Capacitors
(c) Diodes
(d) Transistors
(e) Integrated Circuits

Resistors

Resistors are probably the most common electronic component and almost every circuit will contain at least one of them. Each resistor has a resistance value and a power rating; when connecting them into a circuit it is important to ensure that both values correspond with what is specified on the circuit diagram. If a resistor of the wrong resistance is placed in a circuit, the circuit will not function properly; if the resistor's power rating is too low it will overheat and eventually fail (perhaps burning to a cinder in the process!).

Resistors are simply pieces of conducting material with leads or legs which allow them to be soldered or otherwise connected into a circuit. They are made from a variety of conductors (poor conductors, of course, otherwise the component would require excessive material for the job) using a variety of manufacturing processes depending on the application for which they are intended.

Some resistors are of fixed resistance value—a number of these are shown in Fig. 2.6a—and others are manufactured so that their value can be manually adjusted with the fingers or a special tool, like a screwdriver, called a pot' trimmer. Variable resistors are called potentiometers (often shortened to pots) and a few of the available types are depicted in Fig. 2.6b. Fig 2.6c shows the circuit symbols for both fixed and variable resistors.

Resistor Colour Coding

Since resistors are never manufactured to be *exactly* the marked value, there are two things to consider

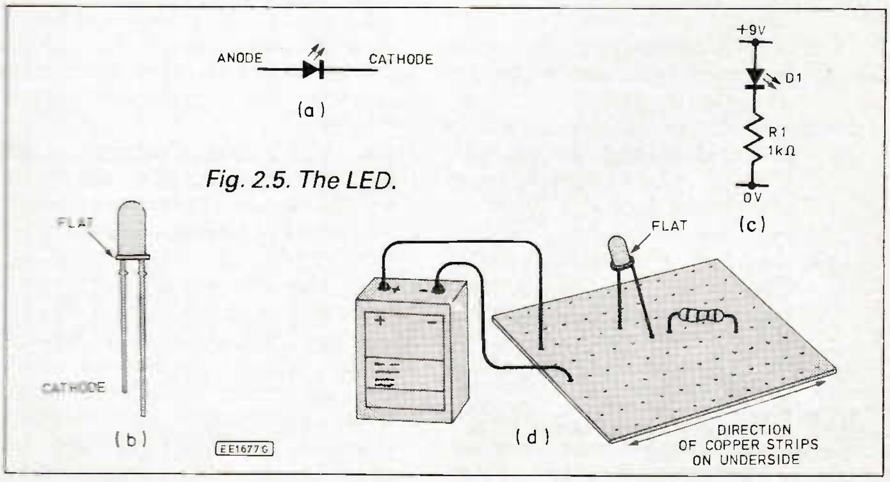
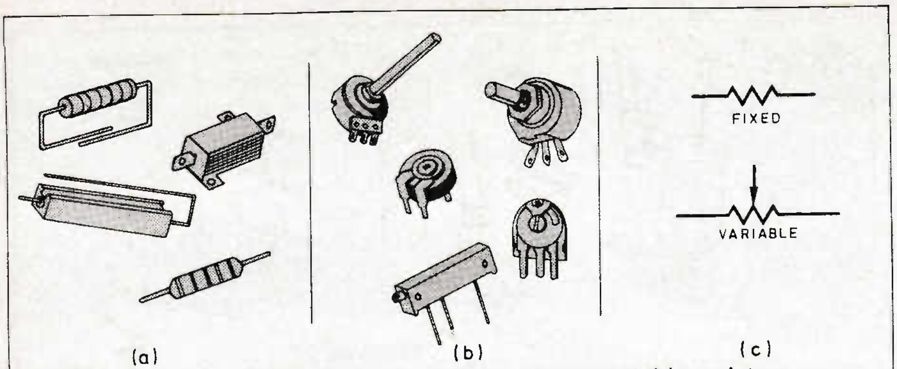


Fig. 2.5. The LED.



EE1678G *Fig. 2.6. Fixed and variable resistors.*

when selecting one for use: the actual resistance value in **ohms** (symbol Ω) and the **tolerance** rating which is the guaranteed degree of accuracy to which the resistor is manufactured.

Some resistors have their value of resistance and tolerance (as a percentage of the value) printed onto the body of the resistor, but most small types use a colour coded representation of the value and tolerance. Resistor coding is given in Table 2.1, but the system may require some explanation as follows:

Each number, zero to nine, is represented by a colour which is printed around the body of the resistor. There are usually four colour bands per resistor (also shown is the less popular five band system). In the four band system three of the bands give the value of the resistor and the fourth gives the tolerance. The position of the bands is given in Table 2.1.

When reading the resistor value, orientate the resistor such that the three "clustered together" bands (1, 2, and 3) are to the left. Read the bands from left to right. (If the bands are equally spaced you can usually identify the gold or silver "tolerance" band–this is the last band.) The first two bands (1 and 2) represent the first two digits in the resistance value, and the third band (3) represents the number of zeros that follow the first two numbers. If, for example, the resistor shown has these colours:

Band 1=Yellow
Band 2=Violet
Band 3=Orange
Band 4=Silver

Yellow makes the first digit 4, violet makes the second digit 7, and orange means that three zeros must be placed after these two digits like this:

yellow	violet	orange
4	7	000

The resistor has the resistance value of forty seven thousand ohms (47,000Ω), plus or minus the tolerance indicated by the fourth band.

The tolerance is a value indicated by the silver fourth band which, according to Table 2.1, is 10%. The actual value of the resistor, then, can be any value between 42,300 ohms (47,000 less 10%) and 51,700 ohms (47,000 plus 10%).

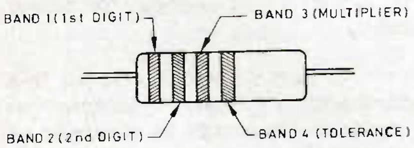
These large numbers are cumbersome (and much larger numbers are common in electronics) and it is conventional to substitute zeros in multiples of three for letters of the alphabet, as shown in Table 2.2. So, in place of three zeros we can put k, six zeros M, nine zeros G, and twelve zeros T. The value for our resistor becomes 47k. This is easier to say and it is also less to write–the Ω sign is not normally written.

Note that some manufacturers use the silver and gold bands in both value and tolerance coding. This is expressed in Table 2.1 as a division by ten for gold and a division by one hundred for silver, look at Table 2.3 for examples of this using both colour and letter coding.

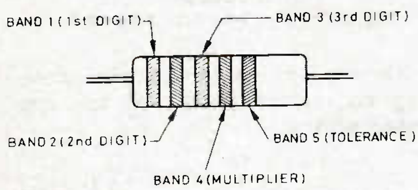
Power Rating

There is also an unmarked rating which must be considered when selecting a resistor for a job–the power rating. This rating relates to the highest amount of current that can pass through the resistor without damaging it. The power rating is measured in Watts which is a measure of the amount of energy expended for the amount of current

RESISTOR AND CAPACITOR IDENTIFICATION



EE236G

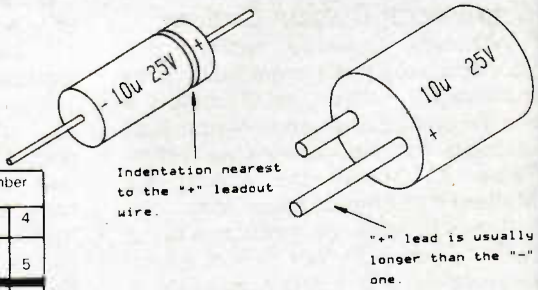


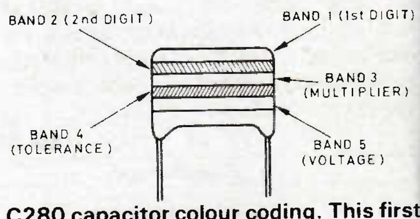
EE237G

TABLE 2.1

Four and five band resistor colour codes. Do not assume that a resistor having a similar code to the one you require will have a similar value. If the "multiplier" is wrong the value will be wrong by a factor of at least ten.

		Band Number				
	4 Band Codes	1	2		3	4
	5 Band Codes	1	2	3	4	5
Colour	Silver				0·01	10%
	Gold				0·1	5%
	Black	0	0	0	1	
	Brown	1	1	1	10	1%
	Red	2	2	2	100	2%
	Orange	3	3	3	1000	
	Yellow	4	4	4	10000	
	Green	5	5	5	100000	
	Blue	6	6	6	1000000	
	Violet	7	7	7		
	Grey	8	8	8		
	White	9	9	9		
	None					20%





C280 capacitor colour coding. This first three bands gave the value (in pF) using the same system as for the four band resistor coding.

		Band	
		4	5
Colour	Black	20%	
	White	10%	
	Green	5%	
	Orange	2·5%	
	Red	2%	250V
	Brown	1%	
	Yellow		400V

Table 2.2. Resistor Letter Codes

Letter	Represents
R	Units
k	Thousands
M	Millions
G	Thousands of millions
T	Millions of millions

passing through the resistor in a given time.

The physical size of the resistor is usually an indication of the power rating (the bigger the resistor the higher the wattage) but, to be certain about it, consult the supplier's catalogue or the packet in which it was despatched. If the wattage rating of a particular resistor is not specified on the circuit diagram it usually means that it expends less energy than the smallest resistor one can buy; in which case any convenient one *of the correct resistance* may be used.

Capacitors

The physical appearance of a particular capacitor depends on its method of construction and the type of material used in its manufacture. Some capacitors are polarised (you will recall that polarised components must be correctly orientated when placed in a circuit) and some are not. Also, like resistors, capacitors may be fixed or variable. Fig. 2.7 illustrates some polarised (a), non-polarised (b), and variable (c) capacitors. Capacitor circuit symbols are given in Fig. 2.7d.

Capacitor Colour Coding

Although capacitor coding conventions vary from manufacturer to manufacturer, they usually follow a similar coding arrangement to that of resistors for the capacitance value. Table 2.1 shows the coding for Mullard C280 Series capacitors.

The basic unit of capacitance is the Farad (symbol F), but this is a very large value—a one Farad capacitor is far too large for most practical applications, so capacitor values are expressed in microFarad (symbol μ), nanoFarad (symbol nF), and picoFarad (symbol pF):

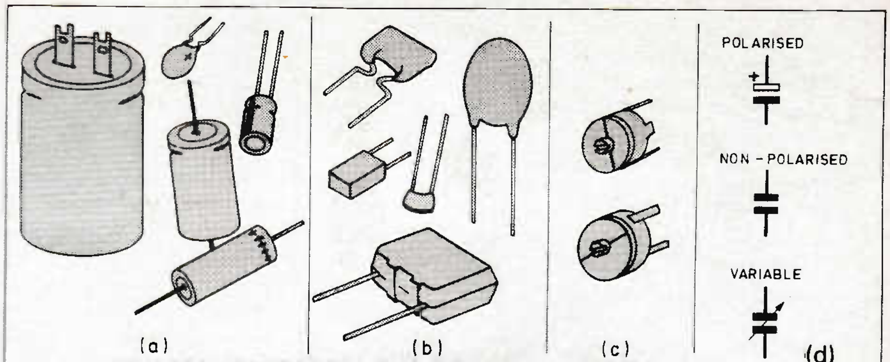


Fig. 2.7. Fixed and variable capacitors.

$1\mu F = 0.000001F = 10^{-6}$
$1nF = 0.000000001F = 10^{-9}$
$1pF = 0.000000000001F = 10^{-12}$

These are the most common symbols used for representing very small values of capacitance. The whole range of symbols for large and small values of any kind is given in Table 2.4.

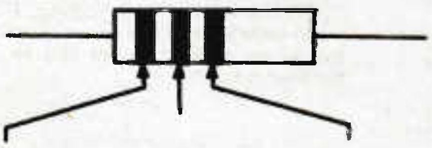
Voltage Rating

Capacitors have a working voltage rating. This rating is the greatest voltage that the capacitor can withstand without physically breaking down and failing to operate. There are only two working voltage variations in the C280 series, these are 250V (this means any voltage up to 250 volts) and (up to) 400V, as shown in the table.

Capacitor tolerance values are expressed as a percentage of the component value in exactly the same way as resistor tolerances, although they do seem to be coded somewhat arbitrarily which doesn't make it easy to memorise. It helps, though, that 1%, 2% and 5% are according to the standard colour code.

Fig. 2.8 gives an example of the use of Table 2.1 in evaluating a $0.47\mu F$ capacitor. The top two bands (tens and units), yellow (4) and violet (7), mean that the capacitance value is 47 multiplied by the value represented by the yellow third band (10,000pF) in the "multiplier" column of the table. $47 \times 10{,}000$ evaluates to 470,000pF which is $0.47\mu F$ (by shifting the decimal point six places to the left). This capacitor has a 20 per cent (black fourth band) tolerance and a maximum working voltage of 250V represented by the red fifth band.

Table 2.3. Examples



Colour Code			Resistance in ohms	Letter Code
Yellow	Violet	Silver	0.47	R47
Yellow	Violet	Gold	4.7	4R7
Yellow	Violet	Black	470	470R
Red	Red	Red	2.2k	2k2
Yellow	Violet	Yellow	470k	470k
Brown	Grey	Green	1.8M	1M8
Brown	Black	Blue	10M	10M

If you have had any difficulty in understanding the number representations above (e.g. 10^{-6}), the following passage and the one on scientific notation should help.

Powers of Ten

Very large numbers (say, greater than 1000) and very small numbers (say, less than 0.001) are very common in electronics and become an annoyance to write and use because of all the zeros. There is a particularly tidy way of abbreviating such large and small quantities; for example, 1000000 may be abbreviated to 10^6 (pronounced ten to the power of six or just ten to the sixth) and 0.000001 may be abbreviated to 10^{-6} (pronounced ten to the power of minus six or just ten to the minus six).

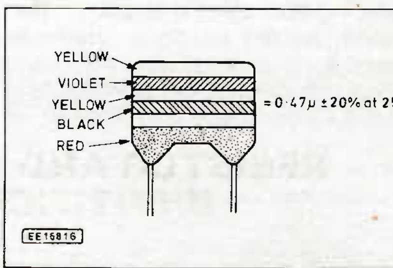


Fig. 2.8. Example of capacitor colour coding.

There is nothing special about this shorthand notation, it simply expresses the quantity as a power of ten, meaning a representation which states how many times ten is multiplied by itself:

$$1000000 = 10\times10\times10\times10\times10\times10 = 10^6.$$

Here is a range of numbers showing equivalent power of ten representations:

$1 = 1\times10^0$	
$10 = 10^1$	$0.1 = 10^{-1}$
$100 = 10^2$	$0.01 = 10^{-2}$
$1000 = 10^3$	$0.001 = 10^{-3}$
$10000 = 10^4$	$0.0001 = 10^{-4}$
$100000 = 10^5$	$0.00001 = 10^{-5}$
$1000000 = 10^6$	$0.000001 = 10^{-6}$

Multiplication and division of large and small numbers can be done much more quickly using power

Table 2.4. Multiples and submultiples

Name	Symbol	Multiplying Factor
Tera	T	10^{12}
Giga	G	10^{9}
Mega	M	10^{6}
Kilo	k	10^{3}
Hecto		10^{2}
Deca		10^{1}
Deci		10^{-1}
Centi		10^{-2}
Milli		10^{-3}
Micro	u or μ	10^{-6}
Nano	n	10^{-9}
Pico	p	10^{-12}
Femto		10^{-15}
Atto		10^{-18}

Electrical Quantities (S.I. Units)

Term	Symbol	Unit	Abbreviation of Unit After Numerical Values
Current	I	Ampere Milliampere Microampere	A mA μA
Difference of Potential	V	Volt Millivolt Kilovolt	V mV kV
Power	W	Watt Kilowatt Megawatt	W kW MW
Resistance	R	Ohm Microhm Megohm	Ω $\mu\Omega$ MΩ

notation. When multiplying numbers in this form we simply *add* the powers; for example, 10000×100 as powers of ten is $10^4 \times 10^2$.
$10^4 \times 10^2 = 10^6$ (4+2=6).

When dividing the same two powers of ten we *subtract* the second power from the first:
$10^4 \div 10^2 = 10^2$ (4−2=2).

Scientific Notation

It is possible to express any number in a form such that this easy method of multiplying and dividing can be applied: any number can be written as a number between one and ten multiplied by a power of ten; for example:

$$1500 = 1.5 \times 10^3$$
$$325 = 3.25 \times 10^2$$
$$6.2 = 6.2 \times 10^0$$
$$0.47 = 4.7 \times 10^{-1}$$

This form of representing numbers is called scientific notation. Any decimal number can be converted to scientific notation by:

(a) Shifting the decimal point until all the zeros plus one non-zero digit are to one side of it (e.g. 0.000526 becomes 00005.26, in fact 5.26).

(b) Counting how many places the decimal point was shifted (in the above case it was 4→ 0.0005.26). This gives the "power" of the number.

(c) Observing as to whether the decimal point needed to be shifted left or shifted right to get all the zeros and a non-zero digit to one side of it.

(d) Compiling the number in scientific notation: write down the number obtained from the first operation (a), above, followed by "×10" and a small superscripted digit representing the power of the number (the count obtained from (b)). If the decimal point was shifted right (c) the superscripted number must be preceded by a minus sign; for example:
$0.0005.26 = 5.26 \times 10^{-4}$

To convert the numbers back from scientific notation, shift the decimal point the number of times indicated by the power. If the power is positive–shift right, if the power is negative shift left, thus:

$$5.26 \times 10^{-4} = 0.000526$$

and $18 \times 10^6 = 18000000$

For addition and subtraction of numbers in scientific notation, convert all numbers to the same power of ten by shifting the decimal point, the result will then be to the same power of ten.

Numbers in scientific notation can be used in formulae, but component values should be written using the mega, kilo, micro, pico etc. prefixes shown in Table 2.4.

Diodes

We have already met one particular type of diode, the l.e.d. As we progress through the course it will become apparent that diodes are named according to their particular application; for the time-being, we only consider l.e.d.s (LEDs), Zener diodes, and general purpose diodes.

Diodes are packaged in many ways, as can be seen from Fig. 2.9a, but the most common types are those which look like resistors with a single colour band. They are polarised devices and the band indicates the connecting terminal called the cathode. The unmarked side of the diode is called the anode. Fig. 2.9b identifies the cathodes of the various types of diode with regard to the symbol.

Some example diode identification numbers are 1N4002, OA90, BY127, and UF4001.

Transistors

There are literally hundreds of varieties of transistor, a number of which are depicted in Fig. 2.10a. Like diodes, transistors are identified by code numbers; some examples are BC182, 2N5447, BD377, and ZTX107. The transistors of interest to us are **bipolar** which are of two general types: *n-p-n* and *p-n-p* whose circuit symbols are given in Fig. 2.10b.

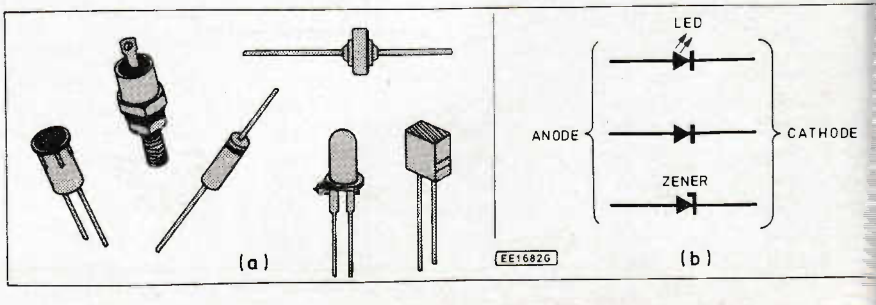
There are three parts to the transistor, hence the three connecting leads. The three leads are known as **base**, **collector** and **emitter** and are marked b, c, and e, on the symbols. The only difference in the two symbols is the direction of the arrow on the emitter of each type. Fig. 2.11 shows examples of the position of these leads in some different packages, but it is important to realise that the lead positions for a particular transistor cannot be known simply by looking at the transistor.

So how does one learn the pin-out of a particular transistor? Component manufacturers and distributors supply hand-books or catalogues containing look-up charts and tables similar to the one in Fig. 2.12. We simply look up the package number for the transistor indexed by the designated transistor code; for example if the catalogue states that a BC108 transistor has a package (sometimes called the case rather than package) number TO18, we find the lead designation picture for that package (this is ringed in the figure).

Integrated Circuit Pin-Outs

An integrated circuit (i.c.) is a com-

Fig. 2.9. Diodes.



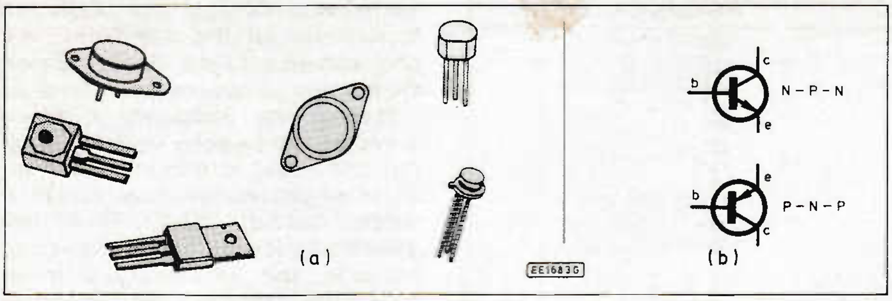


Fig. 2.10. Transistors.

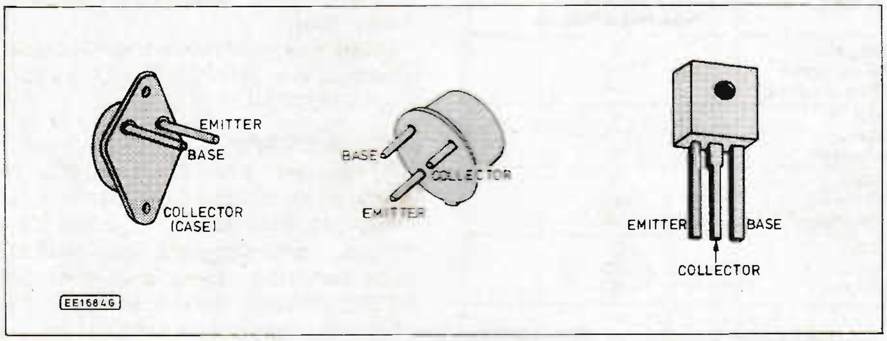


Fig. 2.11. Typical transistor leadouts.

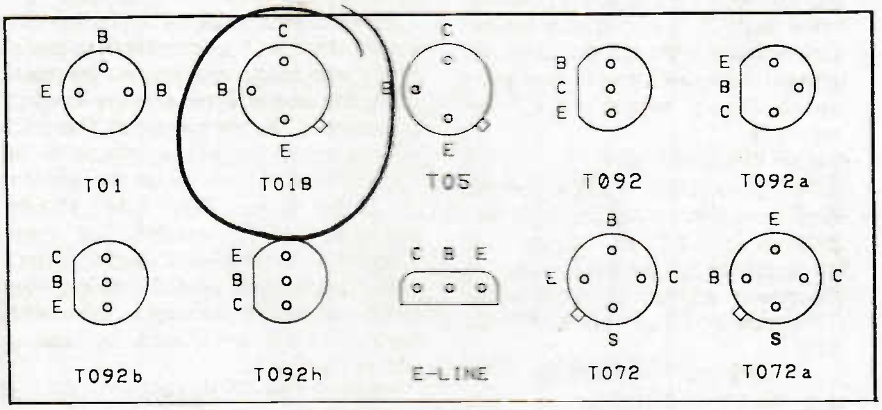


Fig. 2.12. Example of transistor base identification chart.
(Diagram taken from *Electronic Hobbyists Handbook* published by Babani)

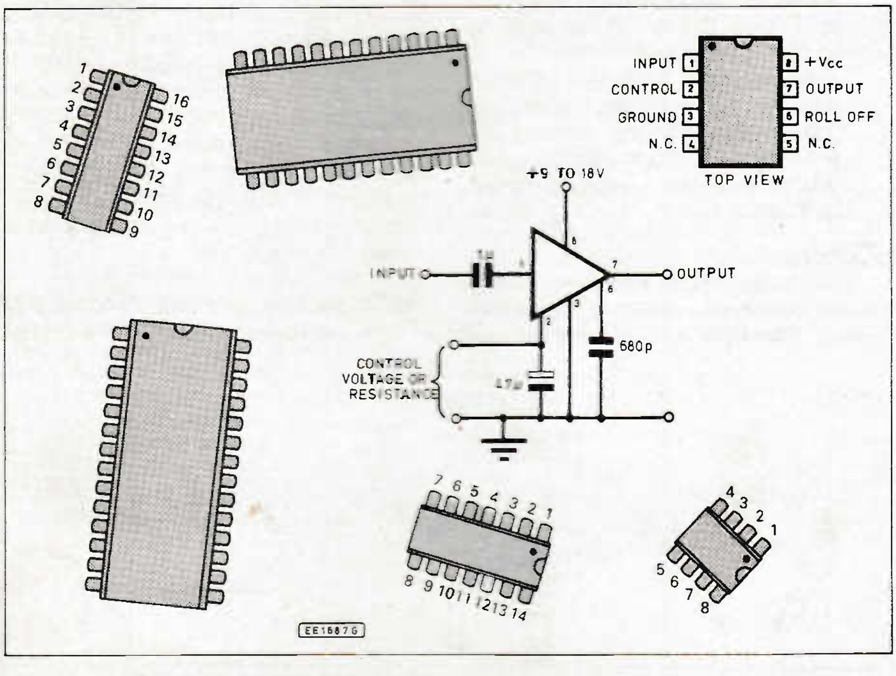


Fig. 2.13. Integrated circuits.

plete circuit containing transistors and, perhaps, diodes, resistors and capacitors all contained within a single package (see Fig. 2.13). I.C.s (often called chips) are available in many sizes with varying numbers of connecting pins (or legs), the most common of which are 8-pin, 14-pin, and 16-pin devices.

Manufacturers of integrated circuits apply standard conventions for packaging (encasing) their devices. Device "packaging" specifies the physical construction and pin numbering arrangement as well as the amount of connecting pins. Fig 2.13 shows the physical shape and pin numbering arrangement for 8, 14 and 16 pin d.i.l. (dual-in-line) packages. Notice that, on the diagram, the notch and the dot indicate the position of pin 1 and the last pin of the device, depending on the size of the package. The same arrangement applies to all d.i.l. chips.

Table 2.5 is a complete listing of the components and materials in appendix A of the Resource Document, it gives the following information about all of these components:

(a) The physical appearance of some types of each component.
(b) The symbolic representations used in circuit diagrams.
(c) Names given to some typical variations of each component.
(d) The number of connections required for many of the components and their respective names (e.g. a diode has two connections, the anode and the cathode).
(e) Whether a particular component is polarised or not.
(f) Each component's electrical unit of measure and corresponding symbol (e.g. the electrical unit of resistance is the ohm and its symbol is Ω).

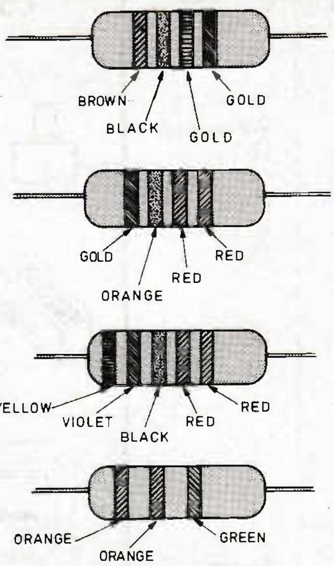
Take some time to look up each component in suppliers catalogues making sure that you can identify each one and discover the basic specification i.e. value or type number, rating etc.

This table serves as a convenient reference for this, and future parts of the series.

Questions

1. What is the tolerance of a resistor baring a fourth colour band of gold?
2. With the aid of a component suppliers catalogue or a data book, state the integrated circuit package and pin numbering convention of a 7400 i.c.
3. Is an electrolytic capacitor polarised?
4. A resistor is colour coded: band one blue; band two grey; band three orange; band four silver. What is the value and tolerance?

5. A ceramic capacitor has a value of 56pF; tolerance of 20%; and a working voltage of 400V. State the colour coding.
6. What is the working voltage of a polyester capacitor with a fifth band of red?
7. Wirewound resitors are not usually colour coded, how would its value be marked?
8. Convert 100mA into Amperes.
9. Draw the circuit symbols for the components listed below.
   1. l.e.d. 5. Zener diode
   2. switch 6. bulb
   3. capacitor 7. diode
   4. transistor 8. resistor
10. A p____ is a variable resistor.
11. A tantalum capacitor is marked:
    4.7
    35
    +
    What do these numbers and the symbol represent?



12. What is the value and tolerance of the resistors on the left?
13. For what is d.i.l. an abbreviation (in terms of i.c. packages)?
14. Identify the i.c. pin number to which the arrow in the diagram below points.
15. Convert 47,000pF to nanoFarads.

ANSWERS, PLUS "MATERIALS AND TOOLS", NEXT MONTH.

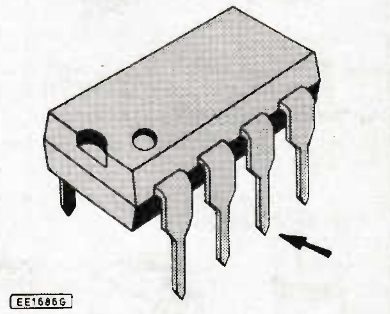
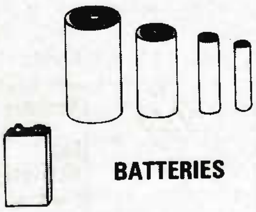
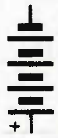
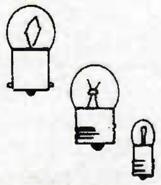
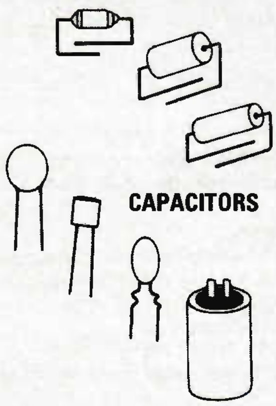
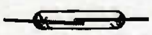
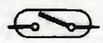
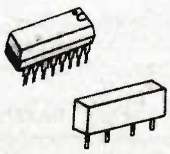
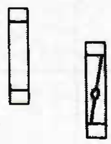
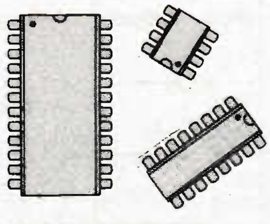
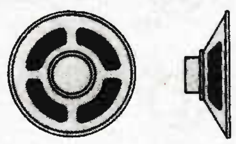
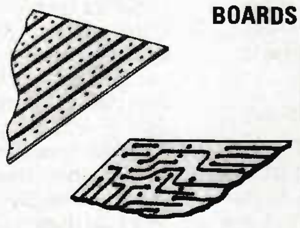
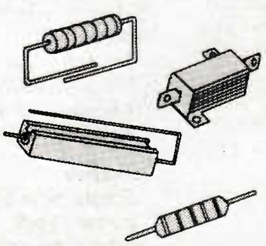
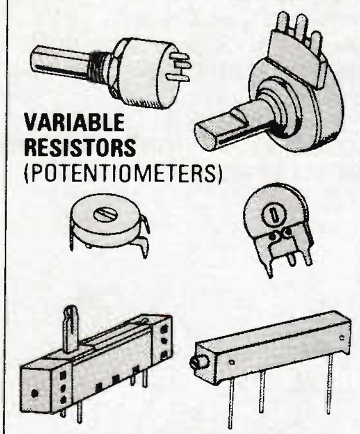
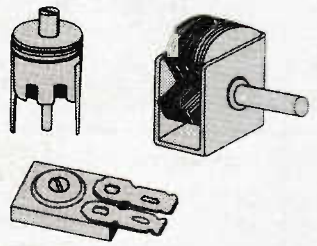
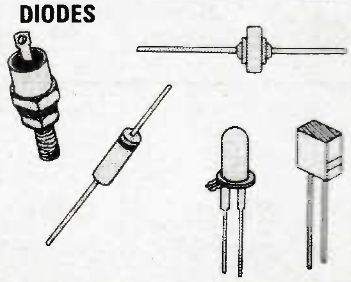
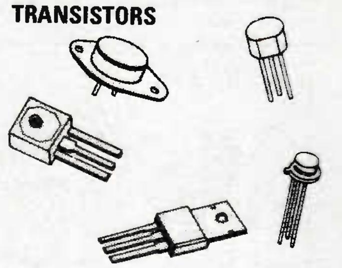
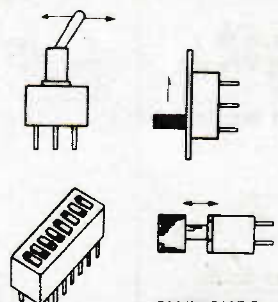
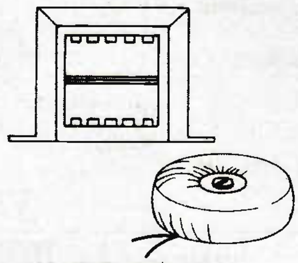
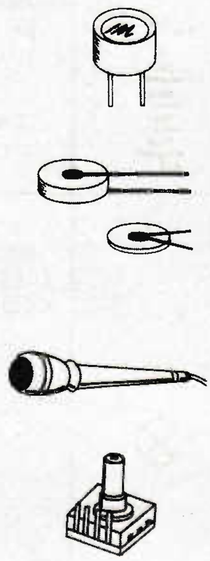


TABLE 2.5

COMPONENT	SYMBOL	TYPES POLARISED?
 BATTERIES	 Volt V 	Zinc Alkaline Nicad Yes
 BULB HOLDERS		MES LES MBC
 BULBS		No
 CAPACITORS	 Farad F 	Polystyrene Polyester Polycarbonate Ceramic Silver Mica No Tantalum Electrolytic Yes
 REED SWITCH		Open Encapsulated No
REED RELAYS 		DIL SIL

COMPONENT	SYMBOL	TYPES POLARISED?
 FUSES		Anti-surge Quick Blow No
 INTEGRATED CIRCUITS	Various	Various
LOUDSPEAKERS 		Not polarised but marked for phase
PRINTED CIRCUIT BOARDS 		Various
RESISTORS 	 ohm Ω	Carbon Wirewound Metal-Oxide No

COMPONENT	SYMBOL	TYPES POLARISED?
VARIABLE RESISTORS (POTENTIOMETERS) 	ohm Ω	Carbon Wirewound LOG LIN Preset Multiturn Slider No
VARIABLE CAPACITORS 	Farad F	Ceramic Airspaced Preset No
DIODES 	LED anode cathode ZENER	Various Yes
TRANSISTORS 		Various
 SWITCHES		Toggle Rocker Slide Pushbutton DIL Rotary PCB Mounting No
 TRANSFORMERS		Various
SENSORS 		Light Dependent Resistor Light Activated Switch Thermistor Thermocouple Dynamic Microphone Piezo Resistive Transducer

NOTE: The phone number given in the booklet for Mansfield Information technology Centre should have been 0623 650263.

RECOMMENDED BOOKS

Rather than provide a long list of recommended books at this stage (which readers may be tempted to rush out and buy!), we will simply suggest titles for background reading as the course progresses. To start the series off we would suggest the following title (which covers the whole range of electronics): **Electronics** by G. H. Olsen, £4.95 (one of the Heinemann "Made Simple" books). This book is available from the Direct Book Service —for full details on ordering see page 674.

COMPONENTS

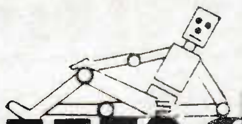
The following is a list of components required for the first six parts of the *Introducing Digital Electronics* course. These components are all readily available from companies advertising in the pages of *Everyday Electronics*. Readers will find that by obtaining a number of catalogues from various companies they will be able to fulfil their requirements for electronic components by mail order fairly easily. Most catalogues also carry illustrations of various components and other helpful data–they are in this way very useful for newcomers to electronics.

Resistors
- 10 ohm 0.5W 1 off
- 100 ohm 0.5W 1 off
- 1 kilohm 0.5W 1 off
- 10 kilohm 0.5W 1 off

Switches
- Single pole single throw push to make button, 1 off.
- Single pole single throw toggle switch, 1 off.

Semiconductors
- 2N3053 transistor 1 off
- ORP 12 light dependent resistor 1 off
- Light emitting diode (l.e.d.) 1 off

Miscellaneous
- 9 volt to 12 volt single pole changeover relay with low resistance (100ohm to 500ohm) coil 1 off
- 9 volt PP3 battery 1 off
- 12 volt MES bulb 1 off
- MES bulb holder with screw terminals 1 off
- Solderless breadboard–single plug-in, Vero or similar type
- Veroboard, 0.1 inch matrix 36 strips by 50 holes
- Crocodile clips, standard insulated, 6 off
- Insulated single core copper wire (1/0.6mm)–approx. 5 metres, various colours
- PP3 "press-stud" battery clip with red and black wires attached
- Solder–22 s.w.g. cored type, 10m



Robot Roundup

NIGEL CLARK

ANY robot which can answer the perennial question: "What can it do?" has an immediate advantage over the competition. This realisation has lead to a number of responses including specialist software and interfaces for the popular micros and large amounts of back-up documentation.

With robot arms the most visible form this has taken has been the development of the work-cell, giving the robot an environment in which it can show off its skills.

The usual cell includes a method of presenting objects to the arm—such as a gravity feeder, a conveyor, a method for testing the objects—for example for size—and a rotary table with bins in which the sorted objects can be placed. Variations include some way of working the objects, usually by a computer numerically controlled (CNC) lathe or drill.

Such cells have become increasingly popular and recent developments have left very few arms without a cell of some description. The latest additions include the EMU, Alfred, Teachmover and Scorbot. Meanwhile moving in the opposite direction is the Armtech which has been shorne of its companion peripherals.

FLEXIBLE MANUFACTURING

The EMU from LJ Electronics now forms part of the IRO 2 package, selling at about £850, which also includes two conveyor belts. The 4-axis EMU, under control from an IBM PC, moves parts between the two conveyors.

The company also plans to include the EMU in a flexible manufacturing system (FMS). Again controlled by the IBM PC the system will have a CNC drill and should be launched at the beginning of next year.

Research Development Associates is developing the Alfred work cell in response to an order from the States. The system allows three Alfreds to work together with usual work cell components.

The whole cell is again controlled by the IMB PC by way of RDA's Octopus intelligent controller. The price to the US will be about £2,500. Dave Doughty said that the price in the UK should be about the same and although orders were being taken it would not be possible to satisfy them immediately until the US order had been met.

Teachmover, the 5-axis articulated arm, has a work cell which includes a CNC lathe, and sells for a little more than £3,000. Scorbot, at about the same price, is now able to work with a variety of devices. Both Teachmover and Scorbot can also be used with vision systems.

NEW COMPANIES

The machines are now being supplied by a new company called Morgan Automation, having taken over from Syke Instrumentation, following the sale by Syke of its industrial machines.

Morgan is run by Vaughan Clark, a former Syke director. He felt there was a market in education for the Teachmover, which has been imported from the US for some time, and the Israeli Scorbot which has been available in the UK for about two years.

The decision by Shestotech to limit its output to the Armtech, its Armdroid look-a-like, followed slow sales. Richard Shestopal said that the company was concentrating on the basic 5-axis arm with toothed belt drive and seeing how sales went.

The work cell, with the usual items, was supplied with the more powerful 2000 Plus version.

Meanwhile Chris Magee, who bought the rights to the Colne Robotics products, is no longer supplying the up-dated Armdroid arm and the vision systems. His Cardiff-based company, Concorde Robotique has been closed and he has moved to Farnborough in Hampshire and set up a new company, MQ Electronics.

He blamed distributors for the problems at Concorde and added that he would not be considering returning to the robotics market until the problems had been sorted out.

EXPANDED WALLI

Back on the work cells Cybernetic Applications has expanded its Walli control program so that up to eight of its varied collection of arms can work together with the other items in the cell. The arms include the latest gantry device which has been named the Kestrel, and which is now available. The only limitation from the user's point of view is that the controlling computer needs 512K of memory.

Full specifications for the Kestrel reveal that it has four axes plus a gripper working in the X and Y directions, in the same way as a plotter, with the limb to which the gripper is attached being raised and lowered.

It is driven by stepper motors and with its gripper, which can be either two-fingered pneumatic type or vacuum, and can lift up to 2kg. It can move 50cm in the X direction, 35cm in the Y and 15cm in the Z with a further 15cm on the Z which can be preset in increments of 5cm.

The wrist can turn through 360 degrees.

Programming can be by push button and by the direct entry of the cartesian co-ordinates. All that for a little less than £4,000.

IMPROVEMENTS

Other manufacturers have also been making improvements to their ranges. LJ's Atlas can now be controlled by the IBM PC. An interface can be obtained for about £350. LJ is also looking to update its unusual X–Y plotter arm, the Placer.

UMI has made the vertical movement of its RTX Scara arm faster and more accurate. The company is offering to upgrade existing machines for about £750.

The plans it had for a smaller, simpler arm, based on the RTX technology have been dropped. Not sufficient interest was shown in the device, a prototype of which was shown at the Barbican show earlier this year. UMI is, therefore, concentrating on the main arm which, the company says, has attracted a lot of interest and sales in education and health care.

The Trekker buggy can now be controlled using Logotron Logo in addition to the built-in Basic commands. For £10, a chip will be supplied allowing the language to be used. Clwyd Technics, which makes the Trekker, is also looking to provide a version, with the necessary support material, to be used in primary schools. □

Cybernetic Applications' Kestrel robot.