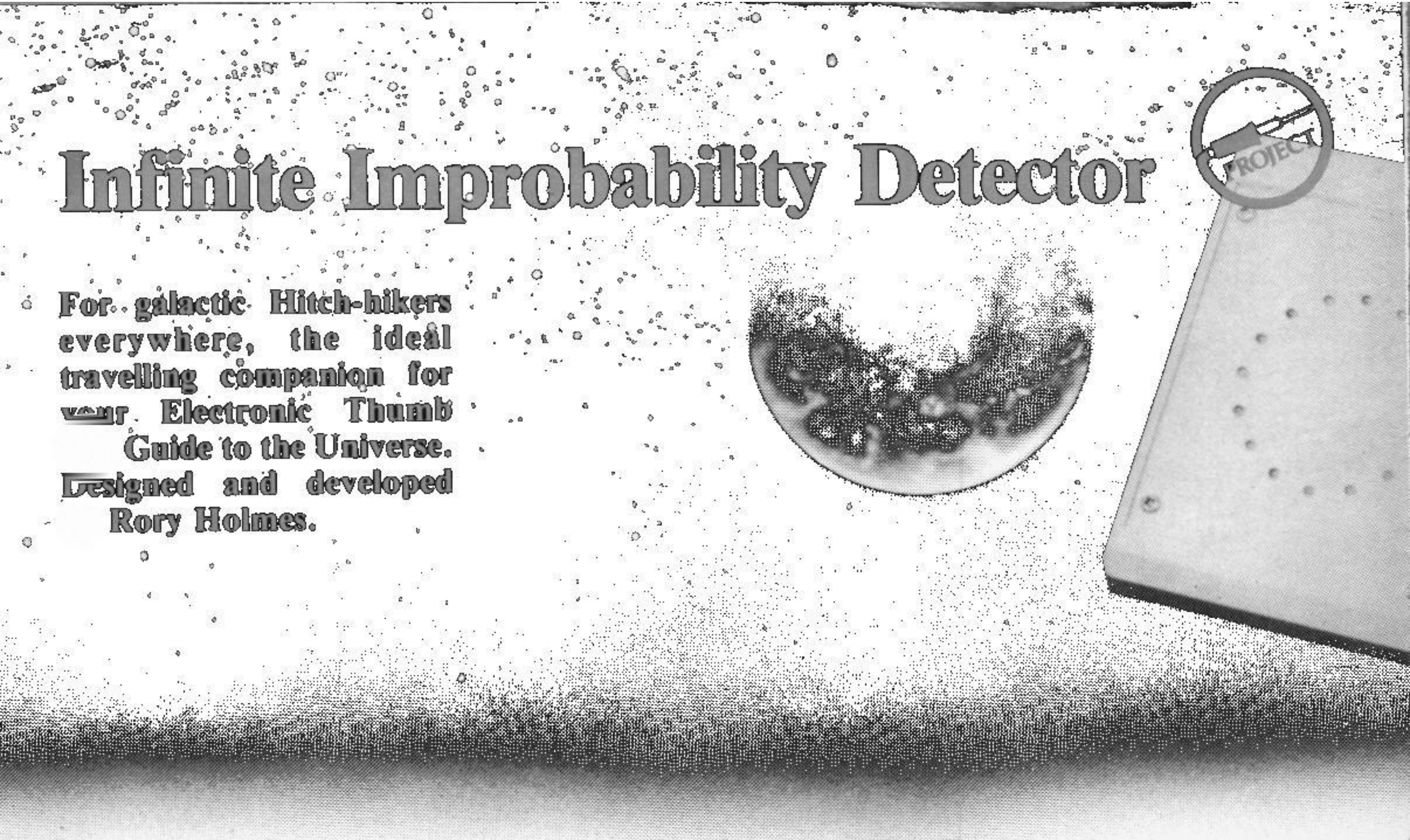


Infinite Improbability Detector

For galactic Hitch-hikers everywhere, the ideal travelling companion for your Electronic Thumb Guide to the Universe. Designed and developed Rory Holmes.

NOWADAYS THERE are many scientists of the paranormal who will assure us that a person is able to influence and control matter by the direct action of his mind alone. They call this effect psychokinesis; it's akin to the claims of the familiar ardent gambler who is convinced he can influence the throw of a dice, or the spin of a roulette wheel, to come up with his lucky number.

ETI, with an open mind, decided to design a machine which would give a clear indication of any such psychokinetic action directed on it. We thought that a 16 ton weight linked to a movement detector might perhaps give the skeptics an unfair advantage and so decided that the slightly smaller and rather more capricious nature of the electron might be more amenable to the delicate influences from the psyche. In fact, the electron itself does not have to be influenced, but rather those forces involved in producing the random movement of thermally and electrically excited electrons. These forces are completely unknown and unpredictable; that's why they're called random! It's this nature of randomness and its ultimate source which has fascinated people for years; hence the favourite pastimes of staring into the fire or watching the ocean waves.

In our machine, the random motions mentioned above are linked electronically to control the movement of a dot of light round a circle of LEDs. This dot of light obviously shouldn't rotate too far in any one direction, but should dither around — both clockwise and counter-clockwise — keeping the same position on average. The light moves at regular clock intervals and at every movement it has, theoretically, a 50-50 chance of going in either direction.

We called it the Infinite Improbability Detector for two reasons. First, in the absence of any assumed psychokinetic intervention from a lively mind, it is incredibly unlikely that it will rotate consistently in one direction. Second, we're Douglas Adams fans. The probability against continuous rotation is, in fact, two to the power of 16 to the power of the number of revolutions. Therefore, if this occurs, *don't panic* — we have proof of an external and paranormal force.

It is hoped that if psychokinetic ability *does* exist, then it should certainly be able to bias our machine to rotate in one direction or another.

In use the operation is simple — if a little indefinable. There is a rate control for setting the overall speed of movement of the light and an on-off switch. After switching on and setting the desired speed, the rest is really up to you. The idea is to concentrate on the moving dot of light in order to make it consistently rotate in one direction.

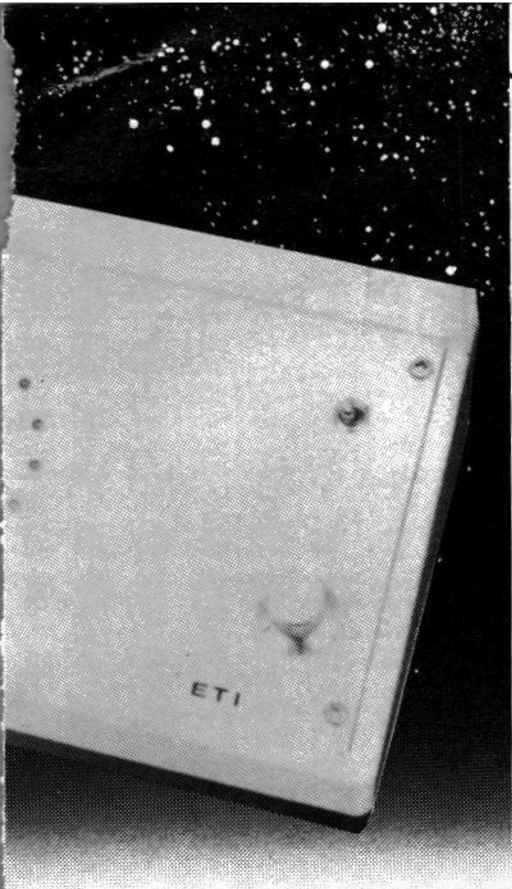
ETI would be delighted to hear from any readers who can demonstrate impressive results.

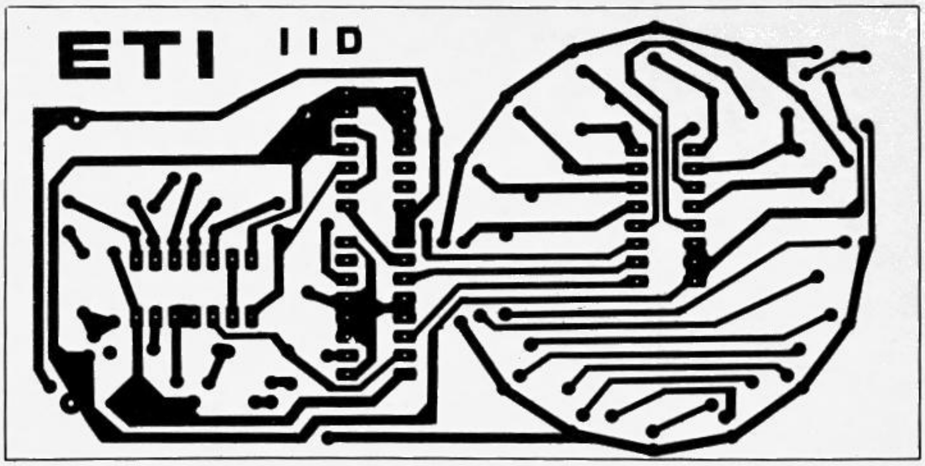
Construction

It isn't difficult to obtain a neat and smart appearance with this project (see the photos of our prototype). There are only two front panel controls, making interwiring and assembly completely straightforward. The only point to watch during construction is the mounting of the LEDs; these should be left until the rest of the PCB is assembled.

Solder in all the other components, following the overlay guide. It's easier to start with the links and sockets first, then the passive components. Leadout wires to the pot (RV1) and battery supply can also be connected at this stage.

After assembly, the LEDs (LED1 to 16) can be mounted with their anodes towards the centre of the circle, but do not solder them at this stage — the LEDs must be fitted into their front panel holes to provide the right uniform height above the PCB before they are soldered. Take a piece of tracing paper and mark the exact hole positions from the copper track pattern. This can then be transferred to the inside of the case front panel and the positions centre-punched before drilling the holes to a width exactly the same as the LEDs. The sloping front Vero box we used has a detachable aluminum front pane which makes this an easy process. Th LEDs are then fitted into the holes and correct board clearance height can found before they are soldered up.





The Infinite Improbability Detector board.

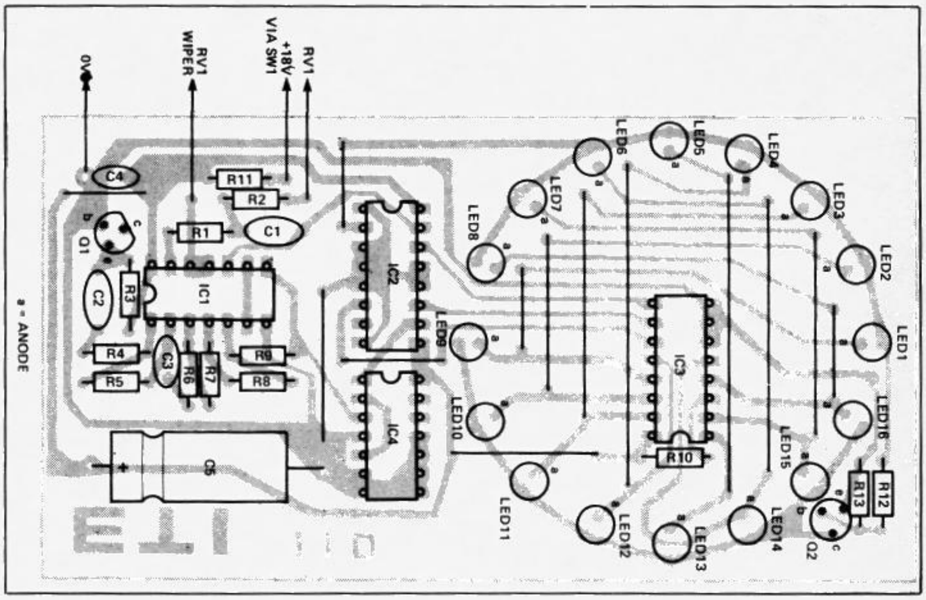


Fig. 1. Component overlay for the PCB. The LEDs are arranged in a circle with the anodes to the inside.

We found that after soldering, the good fit of the LEDs was quite enough to hold the PCB in place. Two 9V batteries were fixed inside the case with adhesive pads, and battery clips were used to connect them up to the switch and the PCB. The potentiometer and switch are mounted through two holes on the front panel, after wiring on the front panel, and after wiring them up from the overlay diagram the device can be tested.

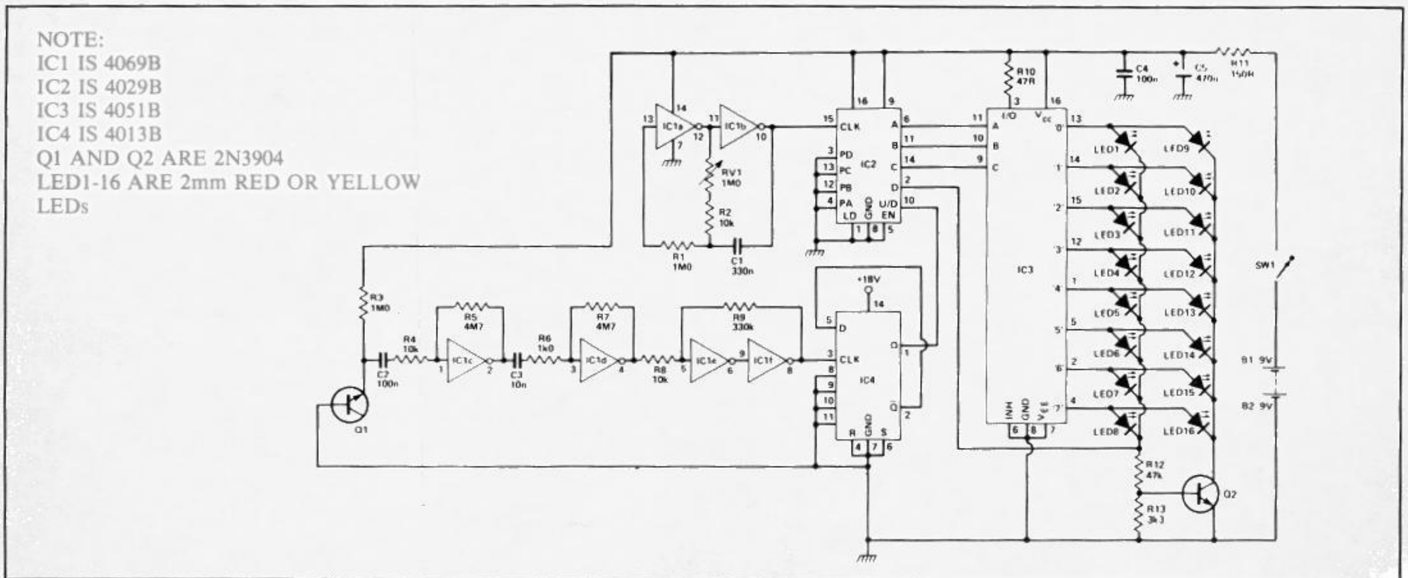


Fig. 2. Circuit diagram of the Infinite Improbability Detector.

Switch on and set the speed control to its lowest rate; if all is well the illuminated LED should move backwards and forwards round the circle in a random manner with no preferred direction. If it does rotate in only one direction, then there is either a construction blunder, or the portion of the Universe occupied by the detector has passed through a region of Infinite Improbability.

PARTS LIST

Resistor (all ¼W, 5%)	
R1,3	1M0
R2,4,8	10k
R5,7	4M7
R6	1k0
R9	330k
R10	47R
R11	150R
R12	47k
R13	3k3
Potentiometers	
RV1	1M0 logarithmic pot
Capacitors	
C1	330n polycarbonate
C2,4	100n ceramic
C3	10n ceramic
C5	470u 16 V axial electrolytic
Semiconductors	
IC1	4069B
IC2	4029B
IC3	4051B
IC4	4013B
Q1,2	2N3904
LED1-16	2 mm red or yellow LEDs
Miscellaneous	
SW1	miniature toggle switch

PCB; two 9V batteries plus clips; case.

HOW IT WORKS

IC2 is a four bit up/down counter, set to count in binary mode and thus having 16 count states provided on its four output lines. These binary output lines are decoded by IC3 and Q2 to give a one-of-16 output for driving LED1 through LED16.

IC3 is a CMOS one-of-eight analogue decoder, whose outputs are connected to the anodes of two sets of eight LEDs. The select lines on pins 9, 10 and 11 will take one pair of anodes to positive via R10 for each address. When the D output of IC2 is logic low the cathodes of LEDs 1 to 8 are held low, thus illuminating one of them and Q2 will be switched off. When D goes logic high the reverse takes place, with Q2 now turned on to provide a ground for the cathodes of LEDs 9 to 16. Thus each count state will correspond to one LED being illuminated.

Assume for the moment that the up/down control on pin 10 of IC2 is kept high (the 'up' mode); then, for each clock pulse applied to pin 15, IC2 will move to its next count state from 0 through to 15. Each LED in the circle will in turn illuminate to indicate that particular count, so producing the effect of a rotating dot of light.

However, the up/down control is made to continuously change in a random fashion and at a much faster rate than the clock period. The timing diagram of Fig. 2 shows the clock as a square wave. The CMOS counter IC2 only changes state as the clock moves from low to high and the direction of its counting can only be changed when the clock is high. Thus the state of the up/down control when the clock goes low will determine the count direction when it next goes high again. The dot of light will move randomly either clockwise or counterclockwise on each clock period. If, say, the light moves three places clockwise in succession, this is equivalent to getting three heads in a row from a coin toss.

The random logic level generator is based on Q1, a transistor selected to provide a good noise output when connected in its base-emitter breakdown mode. This produces genuine random noise due to the completely unknown and unpredictable movements of excited electrons in the semiconductor material. The noise voltage so generated is amplified by IC1c and d. These are unbuffered CMOS inverter gates which are biased into their linear amplifying mode by R5 and R7; the gain is determined by the ratio of R4 to R5 and R6 to R7. C2 and C3 provide AC signal coupling.

IC1e and f are configured as a Schmitt trigger, with R9 providing positive feedback for a sharp switching action. Those noise spikes which pass the switching threshold will produce clean logic level pulses at the output. These random pulses are applied to the clock input of IC4, a flip-flop wired as a divide-by-two circuit whose Q output is taken to the up/down control of IC2. Although the number of random pulses in each IC2 clock period will be pretty much the same, the state of the Q output is arbitrary and will be truly random with an equal chance of a 0 or 1 (or rather, not truly random if one allows that the mind can bias this in some way).

The clock used to drive IC2 is the usual CMOS astable using IC1a and b, withtiming components RV1, C1 and R2. Potentiometer RV1 is a front panel control which sets the frequency of the clock and makes available a large range of rotation speeds.

It was found necessary to limit the supply current with R11, since IC1 (the 4069B) is used in the linear mode as a noise signal amplifier and with too high a supply voltage it can start dissipating enough current to destroy itself!

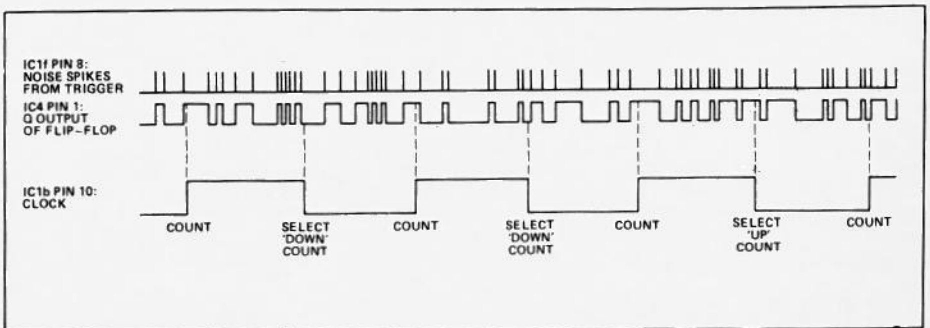


Fig. 3. Timing diagram of the circuit.

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