electronics today

NOVEMBER 1977

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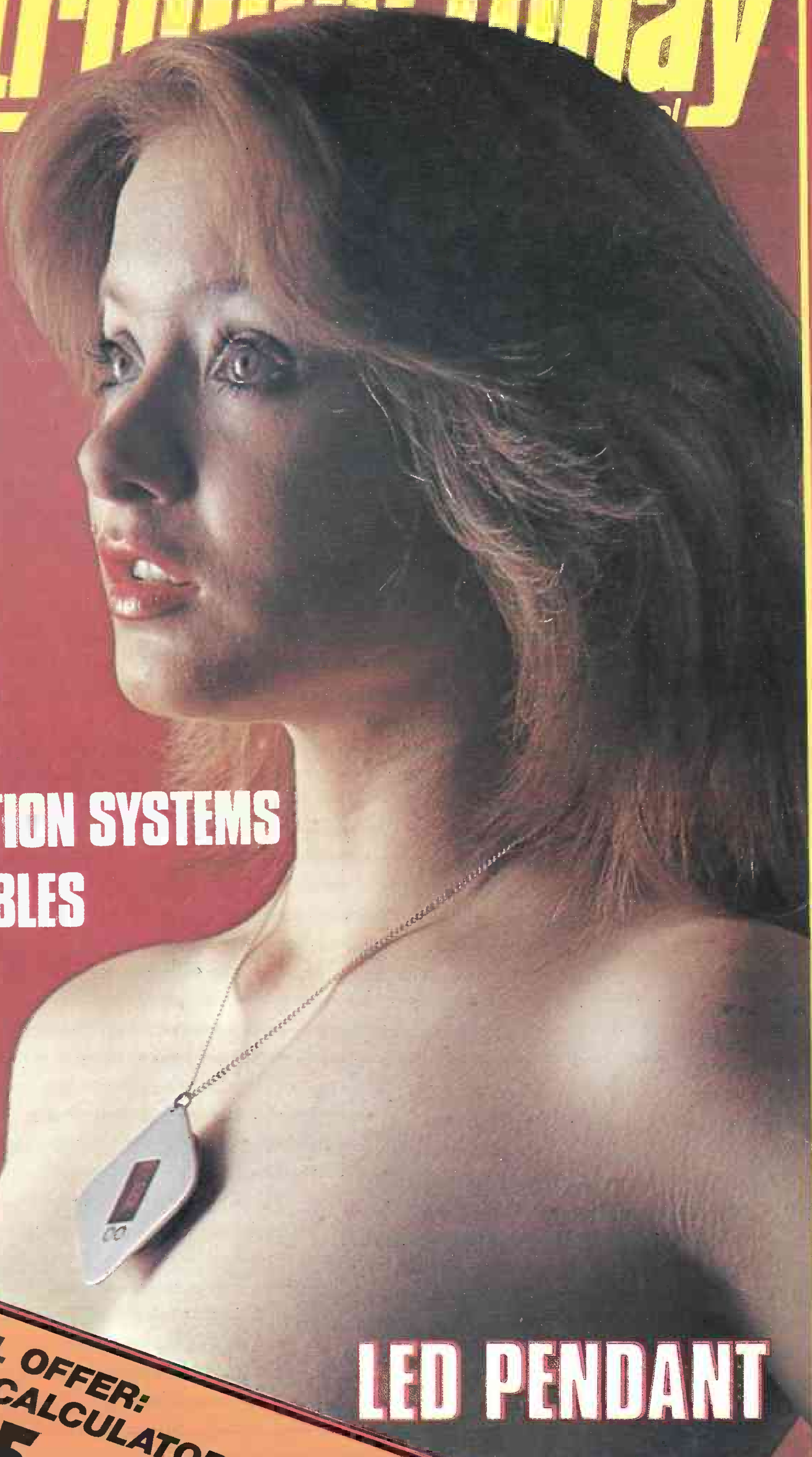

SKEET GAME

MULTI-OPTION CLOCK

NOISE REDUCTION SYSTEMS

PROGRAMMABLES REVIEWED

SINGLE CHIP COMPANDER

LED PENDANT

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NOVEMBER 1977 Vol. 6 No. 10

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Electronics Today International is normally published on the first Friday of the month prior to the cover date.

PUBLISHED BY
Modmags Ltd,
25-27 Oxford Street, W1R 1RF

DISTRIBUTED BY
Argus Distribution Ltd (British Isles)
Gordon & Gotch Ltd (overseas)

PRINTED BY
QB Limited, Colchester

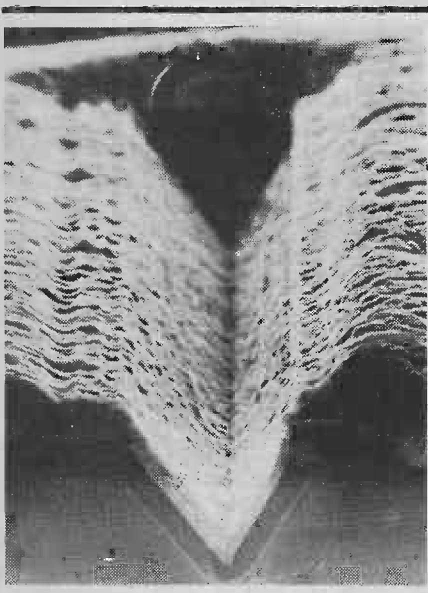
..news...news...news

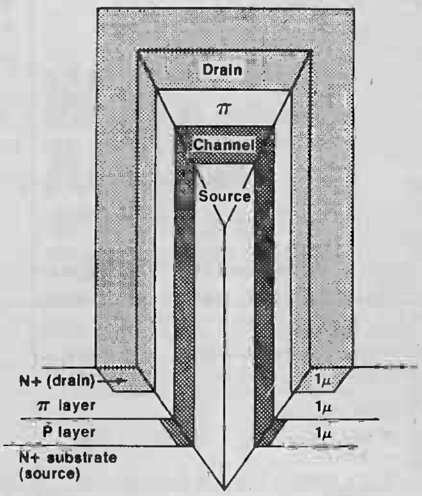
meet our new sales manager.....

This is the German Leopard 2 medium tank, one of the first types to employ laser ranging in front-line situations. Many countries, including Britain have been experimenting with the system and the U.S is shortly to adopt it also.

The standard British system at present remains the 'sighting machine-gun'. This is heavy calibre (0.50 usually) and mounted co-axially with the main gun, firing tracer rounds which are literally used to find the target by hitting it! Sounds crude, but it's very effective.

The advantage of the new system is one of range. With the laser the tank has a first-round hit capability at about 8000yds. This distance is, incidentally, somewhat beyond the 'killing range' of modem ballistic ammunition.





Scanning electron microscope photograph of a VMOS transistor on the left and a drawing on the right with the transistor elements labeled. Channel width is measured around the entire circumference of the V-Groove, to give a high power speed product. The pi-layer is lightly P-doped as a space charge region to lower capacitance and increase breakdown voltage at the drain-substrate junction. The transistor is formed inside the line connector width and does not require enlargement as in older N-channel integrated circuits..

MOS gets the v sign!..

A new technology for processing integrated circuits is yielding high-performance low-cost ICs for memory application.

Known as VMOS, the proprietory technology developed by American Microsystems, Inc. (AMI) has produced the first of a series of memory products with a new 1K bit static RAM.

The new S4015-3 RAM, has an access time of 45 nanoseconds and is the first VMOS product.

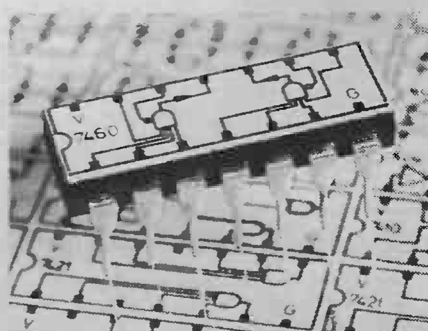
Planned for release during the autumn are: faster versions of the S4015-3, two 4K static RAMs (One 1K x 1), a 16K (2K x 8) ROM (Read Only Memory), and a unique 65K (8K x 8) ROM.

VMOS memory circuits gain their advantages because of their unusual three-dimentional circuit geometry. Electrical current flow in the IC is vertical from the sub-strate to the transistor drain, so more of the silicon chip is utilized; the critical transistor channel width is measured around the entire circumference of the V-groove instead of merely across a single planar area, and no space is wasted for grounding and source connections, since these are made from the substrate itself at the bottom of the groove.

AMI Microsystems Ltd., 108A, Commercial Road, Swindon, Wiltshire.

stick it!.............

Concept Electronics of Sevenoaks, Kent, have a useful low-cost aid for users of TTL IC's. Their STICKIES are IC-size self-adhesive printed labels showing pin-outs for the 61 most popular 14- and 16-pin IC's. Details from Concept Electronics, 8 Bayham Rd., Sevenoaks, Kent.



RMSLCDDMM-OK?.........

The latest digital multimeter from Gould Advance Ltd., known as Gamma, is a low-cost 0.1%-accuracy instrument using a large liquid-crystal display and incorporating a novel sensing circuit for the measurement of true root-mean-square (RMS) voltages.

The electronic method of RMS measurement used in the Gamma involves squaring, averaging and square-rooting the input voltage, and gives a dynamic range greater than 1000:1. Feedback techniques allow the r.m.s. function to be synthesised with a single square-low device.

The Gamma multimeter offers 29 measurement ranges, including a facility for temperature measurement with an optional probe. A purpose-built C-MOS integrated circuit in--corporates all analogue and digital functions, including an on-chip oscillator, high-impedance output, automatic zeroing and multiplexed digital outputs.

Gould Advance Limited, Roebuck Road, Hainault, Essex. IG6 3UE.

masterDIDmind!.........

Our apologies are due to Invicta Plastics for our use of their registered trademark "Mastermind" on our electronic game published in ETI, June 1977. At the time we were unaware that the name was registered by them. Sorry!

I'm sorry I'll print that again..........

September 1977:- Stereo Simulator Reverse the position of R12 and R13 on the component overlay shown with the article. (The circuit diagram is correct.)

all together now......

New from Tektronix, the 851 "digital service instrument" represents a new 'concept' in test gear. Consisting of a 35MHz counter-timer, digital multimeter and logic probe, the 851 provides functions necessary for front-line servicing of digital systems, accurate measurement of physical system parameters, digital signal checks and simple digital signature analysis.

The counter-timer part of the 851 instrument produces an autoranged 5-digit display from as many as three inputs. Measurements carried out include frequencey, period, pulse width, transition time, totalise, duty factor, frequency ratio, event count, transition count, time interval and coincidence time.

The digital-multimeter function of the 851 provides an autoranged 4½-digit display and uses floating inputs. In addition to the basic multimeter measuring capabilities it measure peak voltage, temperature, input thresholds and line voltage. The multimeter also senses and displays the polarity of the input signal.

Tektronix U.K. Ltd., Beaverton House, P.O.BOX 69, Harpenden, Herts.

screening some facts..

We have received the following statement from Videomaster Ltd., concerning the recent adverse publicity T.V. games have received with respect to damage caused to T.V. tubes:-

"There is no evidence to show that television sets can be harmed by electronic games. Videomaster has checked with the Independent Broadcasting Authority and Radio Rentals - both of whom have been quoted recently in the press - *and both now say they cannot now account for the comments which have been attributed to them.* They both now admit they have *no evidence whatsoever* to show that T.V. games can harm the television set, and they have certainly not had any complaints to that effect from customers.

In one story, it was stated that leaving an image on a T.V. screen for more than a minute could do permanent damage to the tube. But as one IBA engineer said: "You only have to look at any electrical retailer's window and see the test-card showing for hours on end to see that no damage occurs". This might have been a danger some years ago with old black and white 405 line sets, where a bright object left on the screen for a great length of time might leave a permanent mark on the screen. But with modern vacuum techniques of tube manufacture, there is no danger of this happening."

Videomaster Limited,
36-44 Tabernacle Street, LONDON.
EC2A 4DT.

EXPANDER COMPRESSOR

NOISE REDUCTION SYSTEMS ARE COMPLEX IN THEORY — AND USUALLY VERY COMPLICATED FOR THE HOME CONSTRUCTOR TO TACKLE. HERE IS ETI'S ANSWER TO THIS — AN EXPANDER COMPRESSOR WHICH IS EASILY CONSTRUCTED AND YET GIVES A FINAL PERFORMANCE EQUAL TO — AND IN MOST CASES SUPERIOR TO — COMMERCIAL UNITS COSTING MANY TIMES THE PRICE OF THIS ETI PROJECT TEAM DESIGN.

ONE LINGERING ADVANTAGE remains with reel-to-reel recorders and discs in their battle against the ever encroaching cassette - dynamic range.

As narrow-gap heads and special tapes i.e. TDK, SA and the rest, improve the frequency response and the linearity of that response, noise reduction systems are working to improve the dynamic range, which can be simply expressed as the difference between the loudest and quietest 'sound' in the music.

If the quietest piece gets lost in the noise, then the range is down to that between the NOISE and the loudest passage. And if the peaks are limited either by the studio when recording an LP, or your machine when taping, down comes the range yet again.

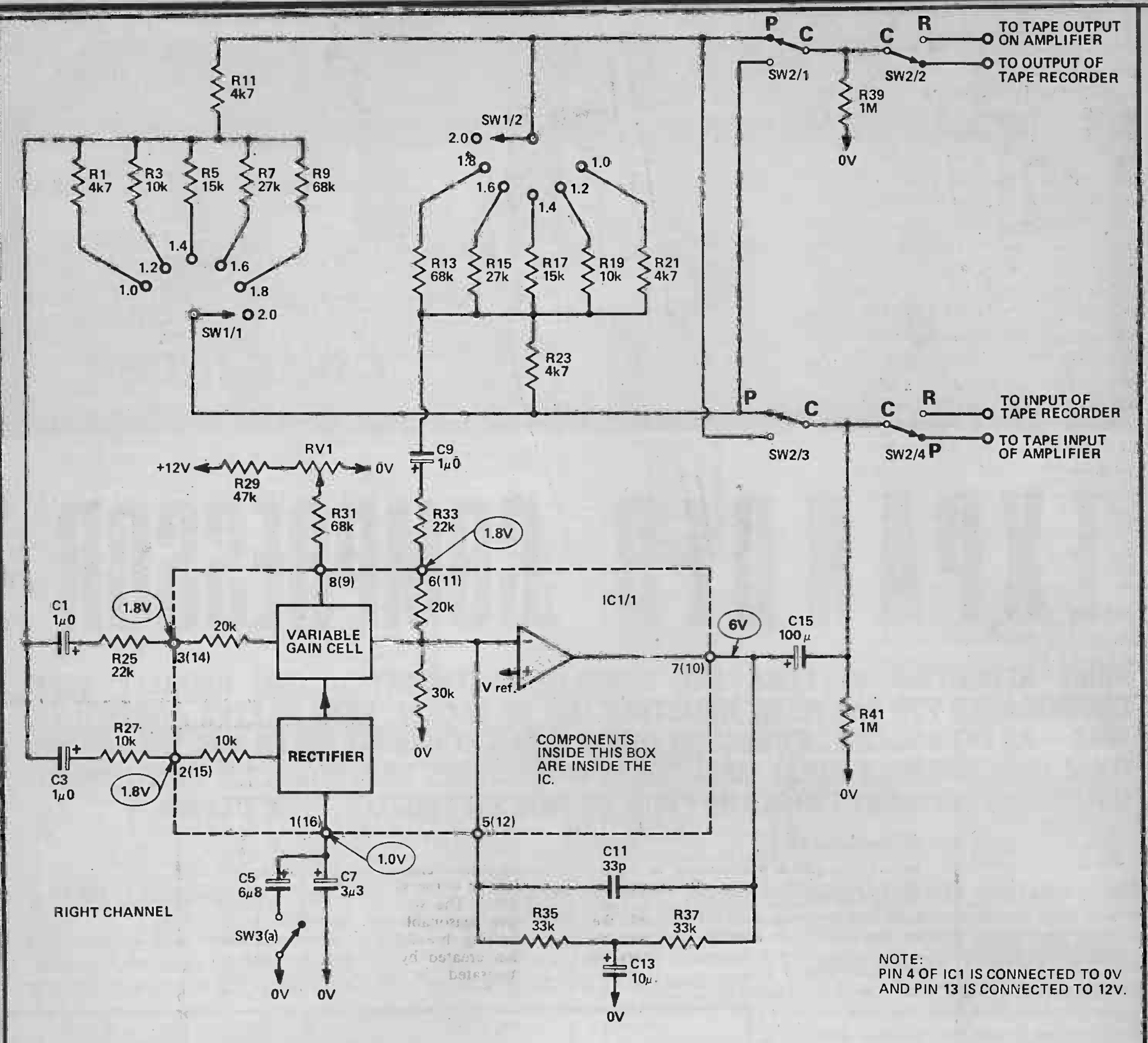
When recording tapes there has to be a compromise between signal to noise ratio and clipping the peaks of the music due to tape saturation. Many systems have been devised to help alleviate this problem with the most commonly known one being the Dolby system. This effectively gives an additional 10 dB or so of dynamic range. Limiters are used on a lot of recorders to prevent tape saturation but these reduce the dynamic range which is not acceptable to the hi-fi listener.

Another system used professionally and increasingly so in the domestic situation is the compressor expander.

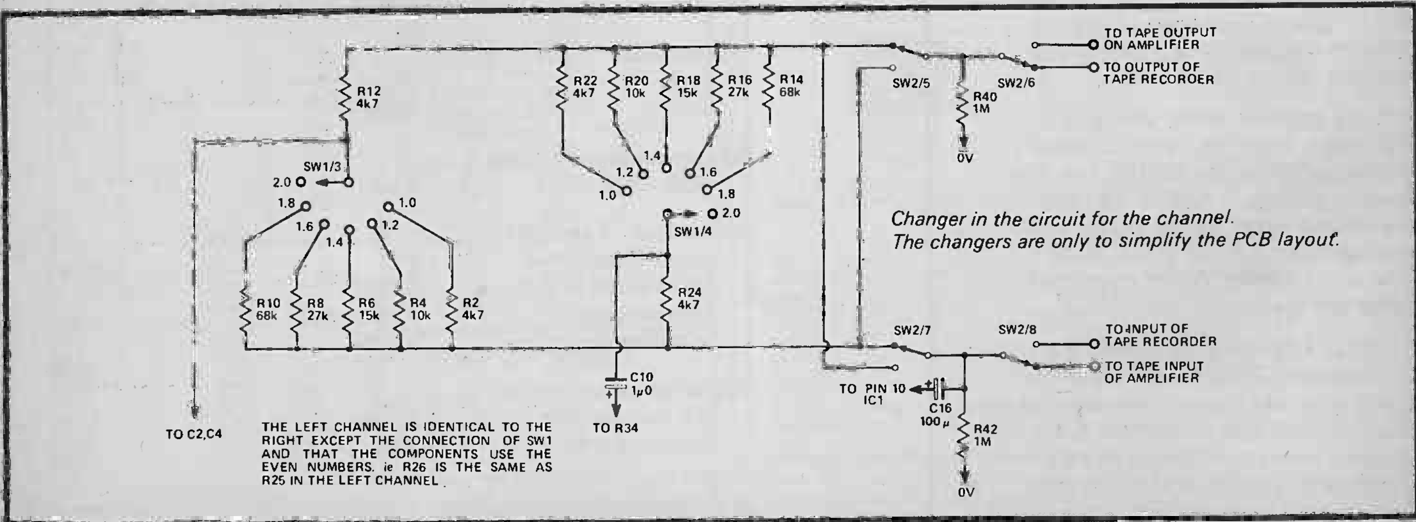
SPECIFICATION

Compression ratio	1.0, 1.2, 1.4, 1.6, 1.8, 2.0
Expansion ratio	1.0, 1.2, 1.4, 1.6, 1.8, 2.0
Attack time	
fast	10ms
slow	40ms
Maximum input voltage *	
R25—R28 = 0Ω	1 volt
Distortion 1 volt out	
untrimmed max.	2%
untrimmed prototype	0.25%
trimmed max.	0.2%
trimmed prototype	0.09%
Signal to noise ratio re 1V	
2.0 compression	45dB
2.0 expansion	90dB

* The max. input voltage can be increased to 3 volts using R25,26 = 22k and R27,28 = 10k

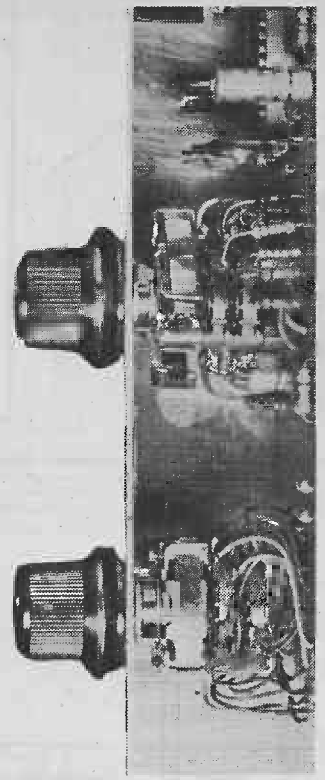


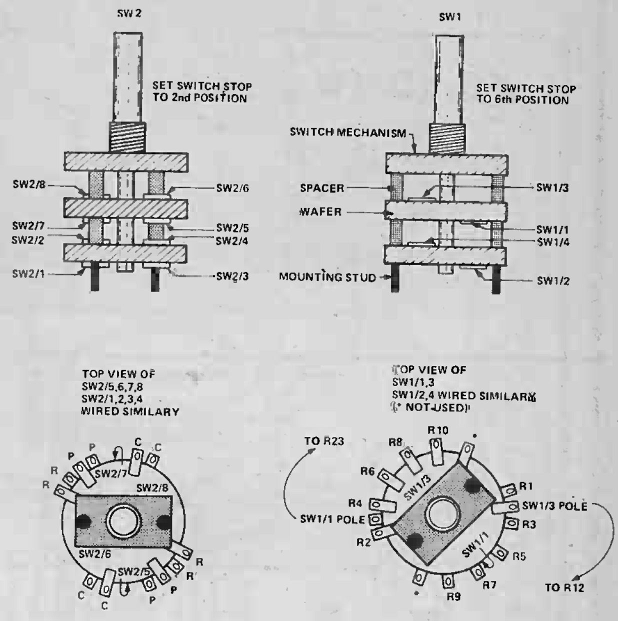
Circuit diagram of the right channel.



Changer in the circuit for the channel. The changers are only to simplify the PCB layout.

The best known unit here must be the DBX unit. With this type of system the full dynamic range, say 80 dB, is compressed to perhaps 40 dB (compression ratio of 2), then it is recorded. If the signal to noise ratio of the recorder is 50 dB and our peak recording level is 5 dB below maximum our minimum level is still 5 dB above the noise. On replay we now expand by the same factor giving us our full 80 dB dynamic range with the noise 10 dB lower. We have already published the design of a compressor expander (in ETI, May 1976) which worked well but was complex and used a double sided printed circuit board with eight ICs and four dual transistors. This new design is simplified by the use of a special IC which takes the place of all these separate components reducing the cost and complexity.





Construction

Commence assembly with all the components which are mounted flat

HOW IT WORKS

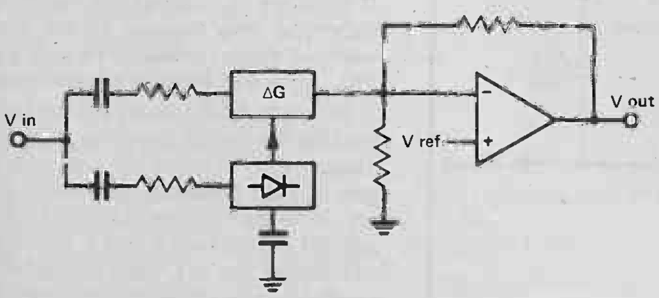
As most of the work is done inside the IC we must look inside the IC to explain the operation. The IC contains a rectifier circuit which is used to measure the actual signal level, a variable gain block which is controlled by the output of the rectifier so that the gain is proportional to the input signal, and an amplifier. By connecting the IC in various ways either a compressor or expander can be formed. We can do either by switching and also by mixing the two by a series of resistors we obtain ratios other than the preset 2. However due to the mixing being done before the logarithmic control of the variable gain cell the ratio is only true in the top 30-40 dB range reverting to a ratio of 1 below this level. Both compressor and expander however follow the same curve and compensate for each other.

We have provided two release times in the unit. With a fast release time there is distortion created at low frequency while if it is too slow the unit appears to 'breathe'. The slow time is slow enough to give reasonable low distortion while minimising breathing. However the distortion created by a fast release time is compensated in the expansion mode provided it is recorded and played back at the same settings.

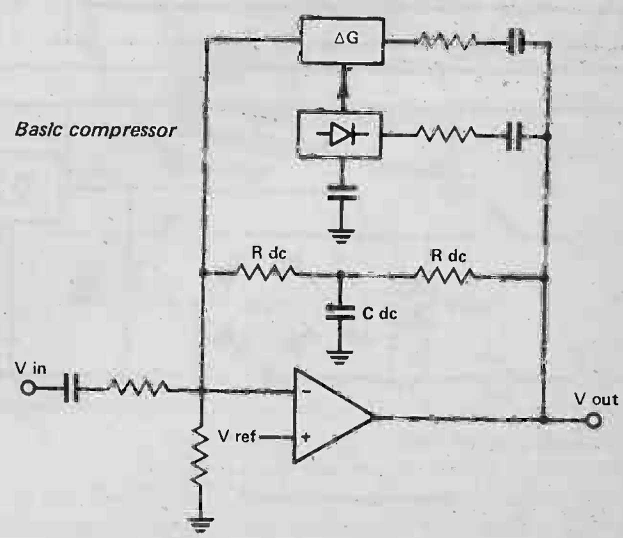
Expander or Compressor

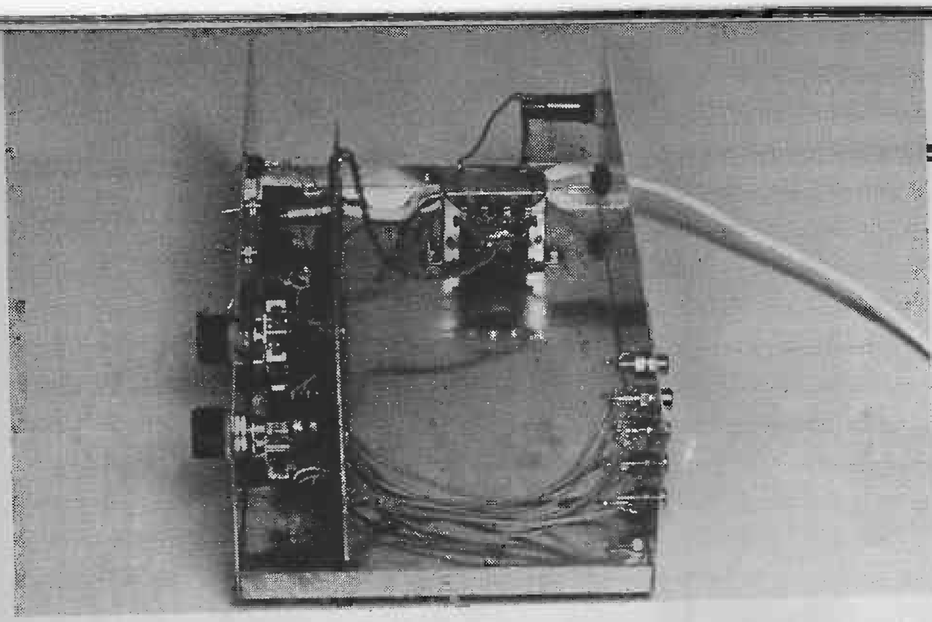
These diagrams show how the IC is connected to operate as either a compressor or expander with a fixed ratio of 2.0.

Basic expander.



Basic compressor





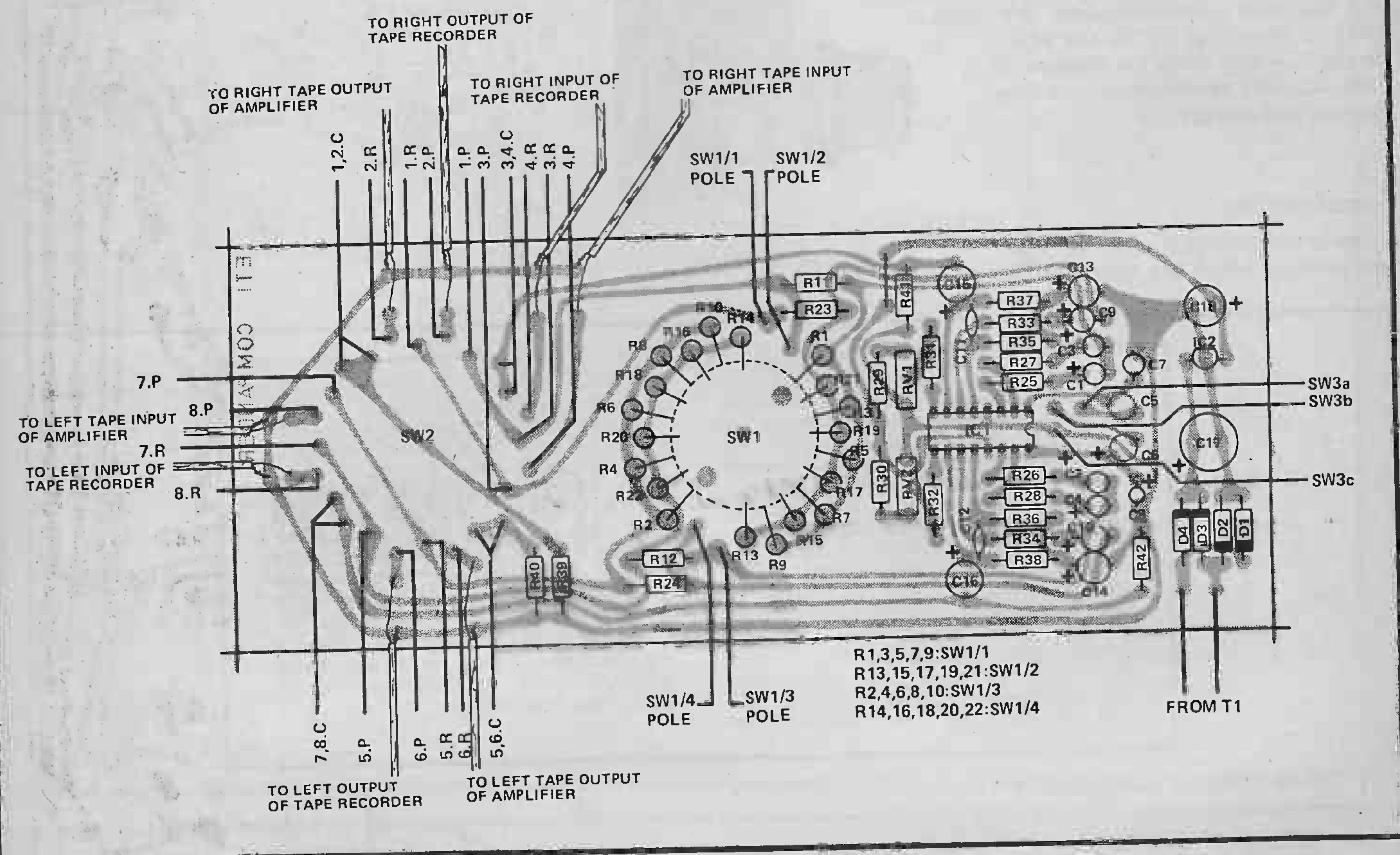
BUY LINES

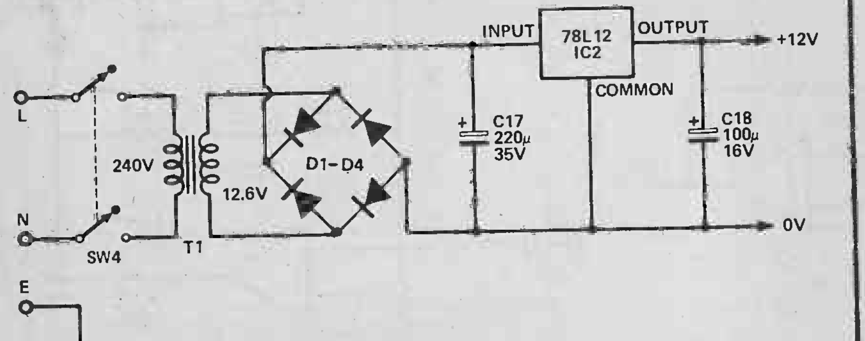
IC1 is now available from Marshalls 42, Cricklewood Broadway at around £4.75. SW1,2 are available from several sources ie. Maplin, Doram and R. S. Stockists as "Mini Maker" switches.

SW1 is made up from two 2 pole 6 way wafers and a switch mechanism (stopped at the sixth position).

SW2 is made up from two 4 pole 3 way wafers and a switch mechanism (stopped at the second position, thus giving only a two way action. See text.

The case is a new addition from the Norman range, a WB4.





Power supply of the unit.

on the printed circuit board. If, and only if, you have distortion measuring equipment add RV1, 2 and R29–R32. If these are not adjusted correctly the distortion may well be higher than without them (it should be less than 2%). Now add to each rotary switch ½ inch long 6BA spacers on the bolts holding the switch together. It may be necessary to remove the rear nuts to give enough thread to hold these spacers. Now bolt the switches onto the printed circuit board (the 6 pos. one is the nearest the IC). Take note of which contact is the wiper on each of the switches.

PARTS LIST

RESISTORS all ¼W 5%

R1,2,11,12,21,22,23,24	4k7
R3,4,19,20,27,28	10k
R5,6,17,18	15k
R7,8,15,16	27k
R9,10,13,14,31,32	68k
R25,26,33,34	22k
R29,30	47k
R35-38	33k
R39-42	1M
R43	1k5

CAPACITORS

C1-4,9,10	1uO 63V electrolytic
C5,6	6u8 16V tantalum
C7,8	3u3 35V tantalum
C11,12	33p ceramic
C13,14	10u 16V electrolytic
C15,16,18	100u 16V electrolytic
C17	220u 35V electrolytic

POTENTIOMETERS

RV1,2	25k vertical trim type

SEMICONDUCTORS

IC1	NE 571
IC2	78 L12
D1-4	1N 4001
LED1	.2" type

SWITCHES

SW1	4 pole 6 way rotary (2 sec, 2 pole 6 way) * see text and "Buy-Lines".
SW2	8 pole 2 way rotary (2 sec, 4 pole 3 way) * see text and "Buy-Lines".
SW3,4	D.P.D.T toggle.

TRANSFORMER

T1	240 - 12V 100mA

CASE

Norman type WB4 or similar (280mm x 150mm x 80mm approx.)

MISCELLANEOUS
Phono sockets or din sockets, knobs to suit, 3 core mains flex, connecting wire, screened wire, nuts, bolts, mounting-spacer pillars, grommets etc. P.C. Board as shown. Mounting feet. Fuse holder and fuse to suit.

Printed circuit layout.

The release time switch can now be wired and the printed circuit board mounted into the chasis. The transformer input sockets etc. can now be mounted and wired.

Distortion Adjustment

Distortion can only be adjusted with a meter. Set the ratio switch to 2 and feed about 1 to 1.5 V at about 1 kHz into the socket marked 'to tape output on amplifier' and measure the distortion at the socket marked 'to tape recorder input'. By adjusting RV1 and RV2 depending on which channel you are measuring it should be possible to adjust the distortion to under 0.2%. This can be repeated with the second channel.

Input Levels

The maximum input level the IC can handle is 2 volts peak. However by using the resistors R25 — R28 the maximum level is increased to 4 volt peak. They also affect the unity gain voltage and as signals higher than 2V will not be used these resistors should be replaced by links. Resistors R33 and R34 should also be replaced by links if R25 — R28 are. ETI

NOISE REDUCTION SYSTEMS

There is a lot which appears on records and tapes that shouldn't be there. How do you go about getting rid of it, or at least reducing it? William King investigates.

OVER THE PAST FEW decades, the standard of reproduction of audio equipment has increased at an astounding rate; so much so that the public is beginning to demand programme material of very high technical quality.

One of the major problems in fulfilling this need is being able to recreate the full dynamic range of a live performance, of say, an orchestral concert. The heart of the problem is noise, and this is most likely to be worst in the audio link between the studio or concert and the listener at home, whether it be a disc, tape or FM radio link.

For most people a quality tape system with a good signal to noise ratio is far too expensive, and of those people who have FM tuners claiming a signal to noise ratio of 70dB, how many live close enough to a transmitter to have the required 1mV or so available at the front end?

Royal noise

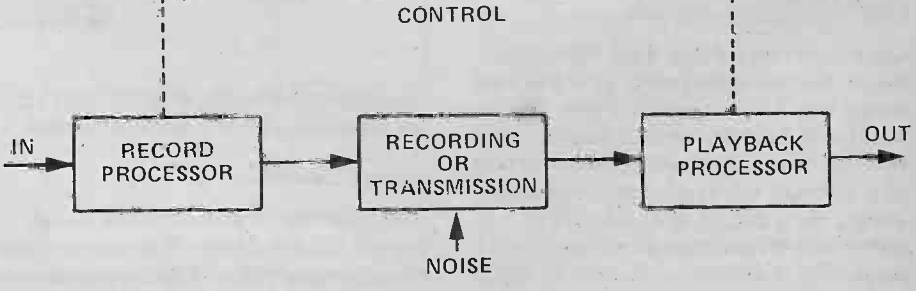
In the early days of sound broadcasting and recording, when the noise problem was much worse than today, attempts were made to reduce its effect by turning up the gain manually for quiet passages of music, thus in effect compressing the dynamic range so that even quiet passages would be above the noise floor. The BBC today still use this technique, in orchestral concerts relayed from the Royal Albert Hall.

The level of quiet passages can be raised by as much as 16dB, thus allowing listeners in poor reception areas who are listening to AM transmissions to be able to receive the entire programme without quiet passages being drowned in noise.

The average usable dynamic range of the domestic listening environment allows a usable dynamic range of a mere 65dB. This is about the same as the noise figure introduced between the studio and the listener at home. What use then are noise reduction systems?

Once a master tape has been finished copies will be made, and maybe later even copies made of the copies — but with each successive copying the tape noise will have increased by 6dB (roughly doubled). At home, the now popular 'compact cassette' system, due to its slow tape speed and narrow track width, has a noise figure of —50dB which is noticeable in any listening environment.

A block diagram of a complementary noise reduction system, showing the need for the overall control between input and output.



Being uncomplementary

Noise reduction systems are then a real necessity in the studio and can be justified in the home, and there are at present a number of systems in use, varying in complexity and effectiveness.

The broadest categories into which noise reduction systems fall, are complementary (two pass) units and non-complementary (single pass) types.

Complementary systems, such as the dolby and dbx systems, consists of two units, a processor and a deprocessor. Before being recorded, or transmitted, the audio signal is passed through the processor and on reproduction through the deprocessor.

Above the floor

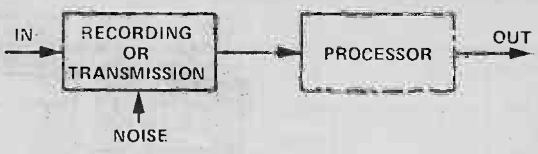
The simplest type of system is the compressor/expander type. In the dbx 122, the processor consists of an audio compressor, which will produce a change in output level of 1dB for a change in input level of 2dB. Thus, an orchestral concert with a dynamic range of 80dB when processed will have a dynamic range of only 40dB, giving the unit a compression ratio of 2:1.

The compressed signal is then recorded on a tape recorder as normal, and now, even the quietest passages (at —40db) will still be well above the noise floor of the tape.

On replay, the recorded signal is played back through the deprocessor, an expander, which restores the original dynamic range of 80dB.

When using a system like this with a tape recorder, the tape recorder must be accurately set up beforehand. If the machine has a frequency response accurate to within ±3dB, when the processed signal is replayed and expanded the frequency response will drop to within only ±6dB. Any defects in the tape will also be more noticeable — a drop out will sound twice as bad when expanded.

Noise reduction with this sort of system can be as much as 40dB, and because it works over the entire audio frequency range, will provide 'wideband' noise reduction. Unlike the dolby system, because the compression ratio is independent of relative levels, the dbx system requires no complicated setting up or calibration tapes.



Basic functioning of a non-complementary noise reduction system.

Dolby et al

Perhaps the widest known of all noise reduction systems is the dolby system. There are two versions of this system available, dolby 'A' for use in recording studios, and dolby 'B' a simpler version designed for consumer use.

The dolby A system also works on the principle of compression and expansion, but does not have a fixed compression ratio. The incoming audio signal is filtered into four bands, below 80Hz, 80 to 3kHz, above 3kHz, and above 5kHz.

As can be seen from the diagram, identical filter and compressor networks are used in the processor and deprocessor; — the only difference being the use of an adder in the processor and a subtractor in the deprocessor.

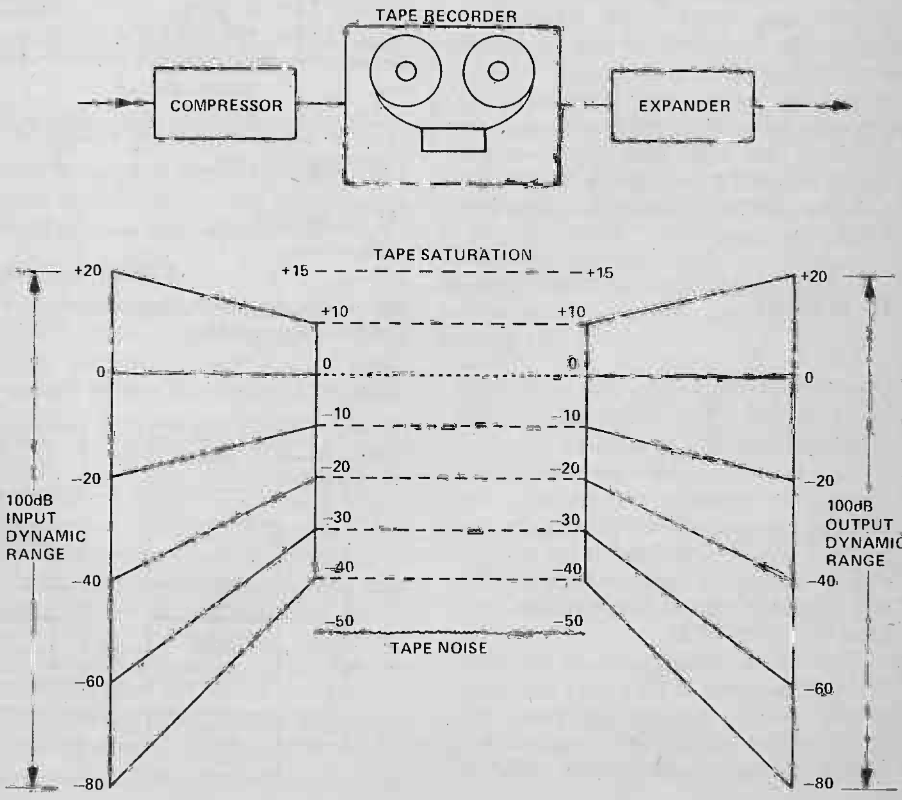
The dolby A system processor works only on high and medium level signals. If individual frequency components less than —40dB down on the operating level, they will pass through their particular band side chain without undergoing any form of compression. As signals increase in level, so does the amount by which they are compressed, varying from 0 for low level signals to up to 15dB compression for high level signals.

Banding together

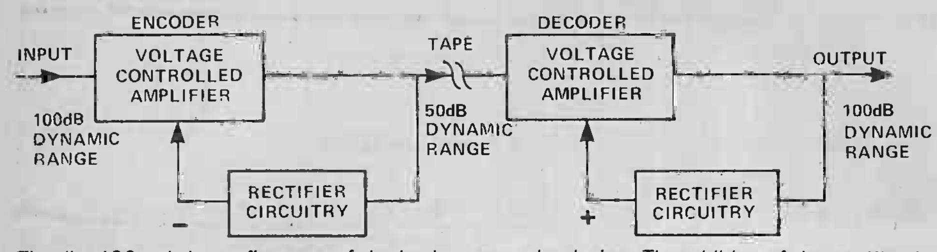
Being a multi-frequency band system, the system minimises some of the problems associated with wideband systems such as the dbx, one particular advantage being that each band can have operating characteristics (such as attack and delay times) optimised reducing gain overhand and modulation products caused by too slow or too rapid gain changes.

The fact that the compression and

A compander circuit expander-compressor showing how a 2:1 compressor ratio functions in practise to give, in theory, a 100dB S/N ratio from a tape with a 50dB noise 'floor'.



NOISE REDUCTION SYSTEMS



The dbx 122 unit is a refinement of the basic compander design. The addition of the rectification circuitry can be seen from the block diagram.

expansion ratios vary with the audio signal level means that in order to function properly, a tape machine using the dolby system will have to be accurately calibrated with level tapes, before use. Due to the difference in sensitivity and output level of different tapes it also is necessary to recalibrate the system when a different type of tape is used. From dolby A, the typical noise reduction figure which can be expected is 10dB up to 5kHz, rising to 15dB at 15kHz.

The simpler version, dolby B, is intended for consumer applications, and fitted as standard to many makes of cassette deck divides the audio signal into two audio bands. The system is based on the assumption that high frequency hiss will be far more noticeable than low frequency noise, and so does not process the low frequency content of an audio signal.

The compressor in the processor boosts low level high frequency signals by amounts of up to 10dB depending on the input level, giving on replay and deprocessing a reduction in noise of up to 10dB in the high frequency range. This increases the dynamic range of a cassette system from around 50dB to a max of over 60dB.

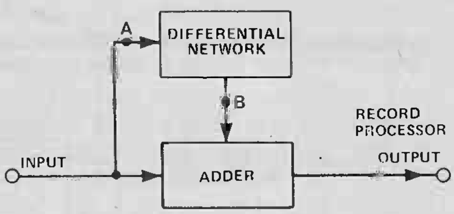
To B or A?

Dolby B, uses a non linear dynamic compression ratio and so must be carefully adjusted for the tape recorder and tape with which it is used; very few external user serviceable controls are found most on most cassette decks fitted with the dolby B system, for fear that people might incorrectly calibrate the device and produce worse results than if it were not used at all.

One of the drawbacks of complementary systems is that they will only reduce noise induced between the compressor and the expander. Complementary systems also offer no help with noisy tapes and discs recorded without being first processed, and of course, the various systems available are all incompatible so the engineer with a nice dolby system and a dbx tape is still at square 1!

A fillip to NRS

Single pass non-complementary systems offer some hope for non-encoded material. Philips DNL (dynamic noise limiter) has been around for a few years now, and was specifically designed to reduce noise in unprocessed cassette recordings (but is now also fitted in addition to the dolby system on some Philips reel-to-reel tape decks).



Top Simplified diagram of a Dolby A deprocessor circuit.

Right: The processor circuit to match that shown above.

Bottom: Diagram of the Dolby A differential networks.

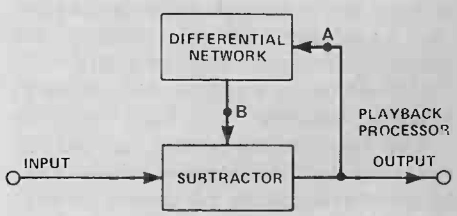
The DNL consists of a dynamic low-pass filter; noise is most noticeable in quiet passages of music (such as piano music), when most of the higher frequency signal is noise, and it is at this time that the DNL operates.

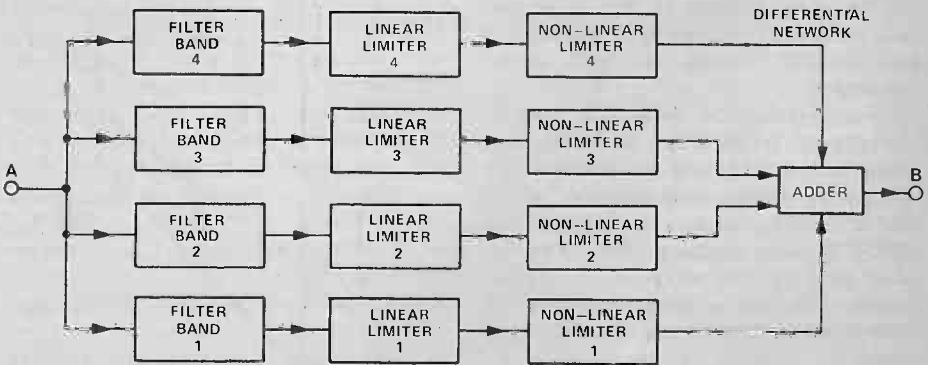
When the signal's high frequency component is strong, and sufficient to mask the high frequency noise, the cut off frequency of the filter increases and allows all the high frequency signal to pass unattenuated. When the level of the high frequency component is low, it is assumed that the noise will be dominant, and the cut off frequency of the filter is reduced, attenuating the noise, and, unfortunately some of the wanted signal.

Burwens DNF (dynamic noise filter) works on a similar principle but is much more flexible. The system senses the high frequency content of the signal. If there is a lot of high frequency energy present, the filter cut off frequency rises to 30kHz, and all the signal is passed, the high signal level masking the noise. When the signal reduces in level, so does the cut off frequency which falls to 500Hz when no signal at all is present, giving a very substantial noise reduction on blank gaps between pieces of music on tape.

Correlations!

Phase linears Auto correlator is an example of a very sophisticated non-complementary systems. It consists of a series of bandpass filters

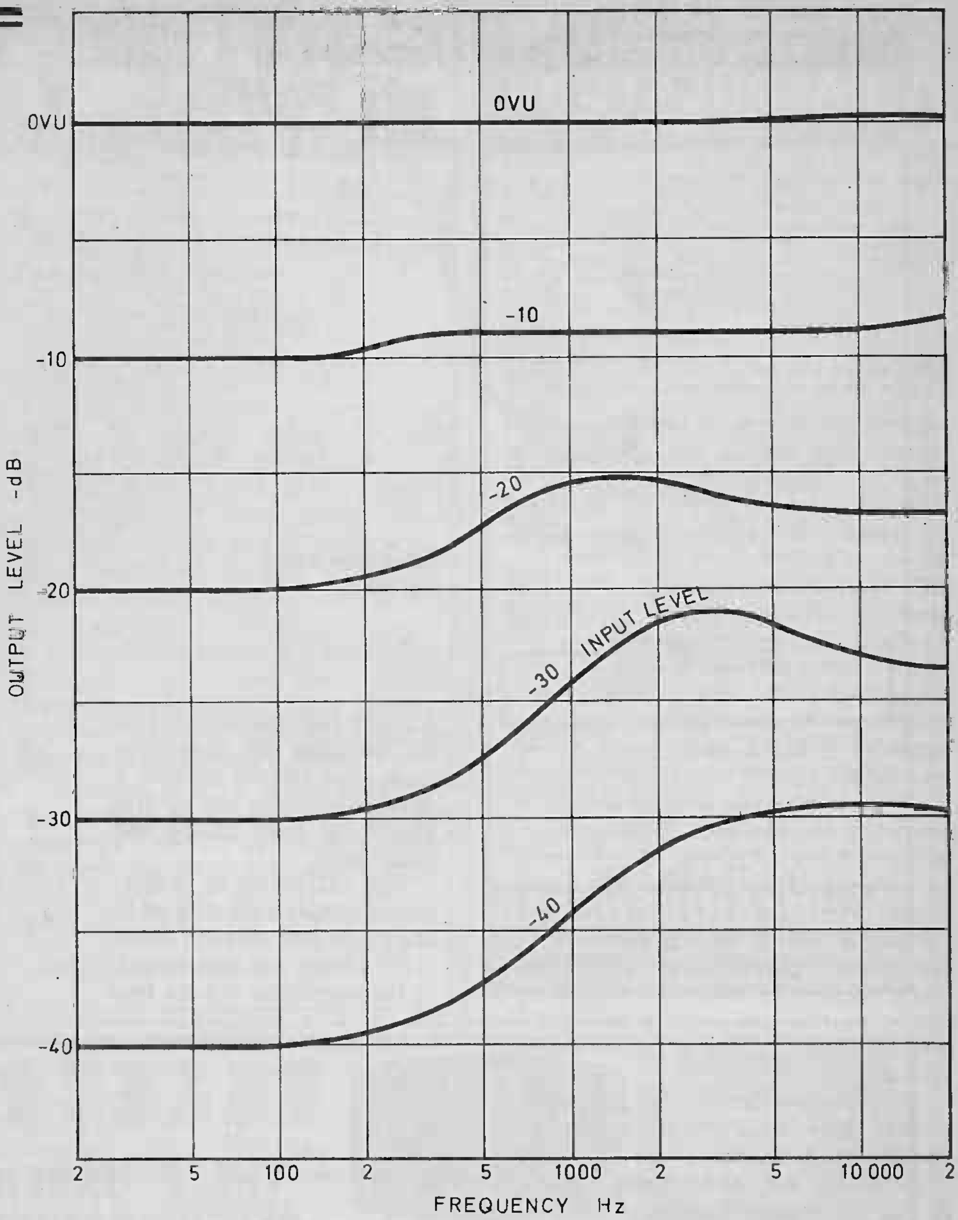




that can be opened, to allow signal in the frequency range of the filter through, or closed down to remove noise. The filters are controlled by the Auto correlation circuitry. Music contains mathematically related tones and is highly coherent (or correlated) in nature, whilse noise tends to be random and has a low correlation coefficient. What the Auto correlator does is to calculate the correlation coefficient, and use it to determine whether a signal is noise or music. If a particular signal is determined to be musical in nature, the appropriate filters are opened up to allow it, and its harmonics and overtones through.

If the correlation is low, the signal is treated as noise and the appropriate filters are activated preventing noise to pass through.

These three non-complementary systems, because of the way they operate will inevitably have an effect on the wanted audio signal, but if carefully set up can give a substantial reduction in noise with only a minor effect on the program content, and it must not be forgotten, that while two-pass systems only reduce noise induced between the processor and deprocessor, a non complementary one pass system can effectively reduce noise generated anywhere in the audio chain, from the studio to device itself.



Variable compression ratio of Dolby B system; note how frequencies below 100Hz are unaffected.

Snip the crackle and pop!

One recently developed type of noise reduction system is the SAE model 500 Impulse Noise Reduction System has been designed to remove unwanted clicks and pops caused by scratches in discs.

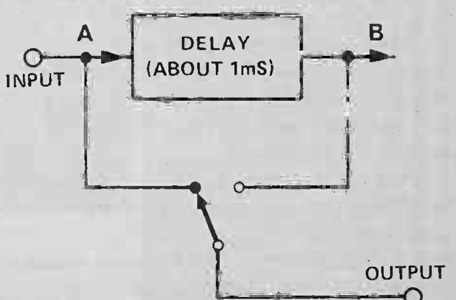
The SAE device recognises clicks and pops by their fast rise and fall times. If a signal has a fast rise and fall time, it is thus assumed to be an unwanted 'click', the click is removed and to prevent a period of silence disturbing the continuity, a small section of the preceding music is inserted in its place. This feat is accomplished using an analogue delay unit providing a delay of a few milliseconds, as the pop 'click' transient is about to enter the delay, the output of the device switches from the input of the delay to the output. Then, just before the click is about to leave the delay, the output of the unit again switches back to the input of the delay, thus removing the click. The typical click only has a duration of about a milliseconds, and so the switching to the delay goes unnoticed, but the click vanishes.

Studious future

What the future holds in store for "noise" is anyones guess; within a decade we may see digital tape-recorders as the standard in studios — using digital recording techniques will, if the sampling rate is high enough, eliminate noise induced in tape systems (or in broadcasts if we ever see pulse code modulation for broadcast stations) altogether, and will allow tapes to be copied any number of times without any extra noise being introduced. Already, today it is possible to buy add on units for video recorders to enable audio signals to be digitally recorded onto tape!

For the moment, however, for the engineers in recording studios using multi-track machines where track width is small, and for the hifi enthusiast at home with his cassette system, noise reductions systems are a necessity, and will remain so for some time. ETI

Simplified diagram of the workings of the SAE Impulse Noise Reducer. The 'switch' is the actual unit, which transfers the output connection from A to B when a click is present to eliminate the sound.



MULTI~OPTION CLOCK

KEEP AN EYE ON THE TIME DATE AND WHEN THINGS ARE GOING TO TURN ALARMING WITH THIS VERSATILE DESIGN. THIS MONTH WE GIVE DETAILS OF A PROJECT USING LED DISPLAY, AND NEXT ISSUE A FLUORESCENT DISPLAY VERSION WILL BE DESCRIBED.

THE MOSTEK MK50362, upon which this project is based, is perhaps the most versatile clock chip yet to emerge for the home constructor. It has two independant alarm times, four year calendar, the ability to drive either LED or flourescent displays directly, and a surprising insensitivity to surrounding electrical conditions.

In order to exploit the chip as fully as possible we are in fact presenting TWO clocks, with LED and flourescent displays respectively. Both can be built up as alarm or lounge clocks on PCBs which caters for all possible options with either diplay format.

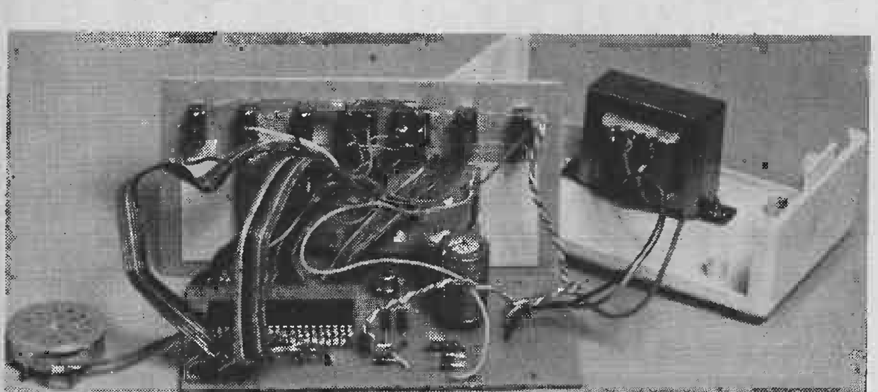
LED in

This month we give full details of the LED version of the clock, however for those of you who may prefer the flourescent display types, next month we go onto the description of that circuit. The display employed is the Futaba 5LT02 (non-mpx) type, and is available now from Pronto Electronics (See Buy Lines) who can also supply the chip, should you wish to order in advance.

Back to our common cathodes. Since the IC is handling all the display current itself, care must be taken to make sure that its capability is not exceeded. This is around 10mA per segment, and for safety this figure should not be tested to the limit.

The options offered by the 50362 are all brought out to switch pads on our PCB - simply pick the ones you want, and forget those you don't want.

If there is any of the possible modes that you don't wish to have switchable, then just wire the pad to that supply rail which gives the result you require.



Time for a date

There is a difference of opinion surrounding the Atlantic Ocean, and the manner in which the date should be presented on digital clocks and watches. The Americans favour a month-day format, whilest the intransigent British set it at day-month. Well this is the British ETI and we're gonna do it our way.

Figure 1 is the main circuit diagram for the unit, and this is of a 24hr format unit, with UK date order. The component overlay fig. 2 is also of this circuit configuration. However only a minor change is needed to produce a 12hr time showing. Fig. 3 shows how to rewire the board, omitting D4-7 and connecting in a PM indicator.

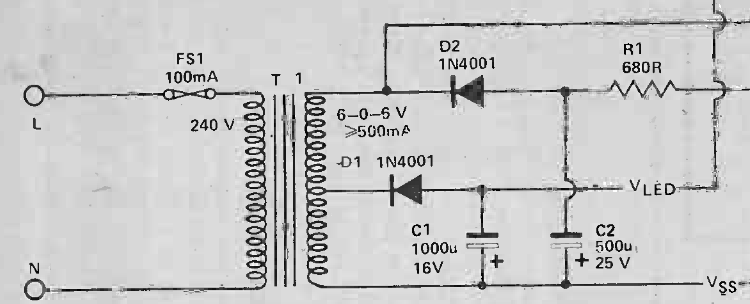
In 12hr mode, the UK date display is not possible, since to produce a figure three in the MSB is impossible with only two segments connected!

However should you wish to add in more switches, take a look at figure five, which will show you how to add the facility of switchable 12/24hr display, and date format. Don't forget to arrange pin 12 correctly if the mode IS made switchable, and to get US format, pin 14 must go to VSS in the 'date' position.

Construction

Using the recommended PCB and display module, the job of build up reduces to a ribbon cabling bonanza - if you can afford the stuff! Mounting the board on the top half of the box may look cracked - but it shortens the run to the display considerably, and

MULTI-OPTION CLOCK



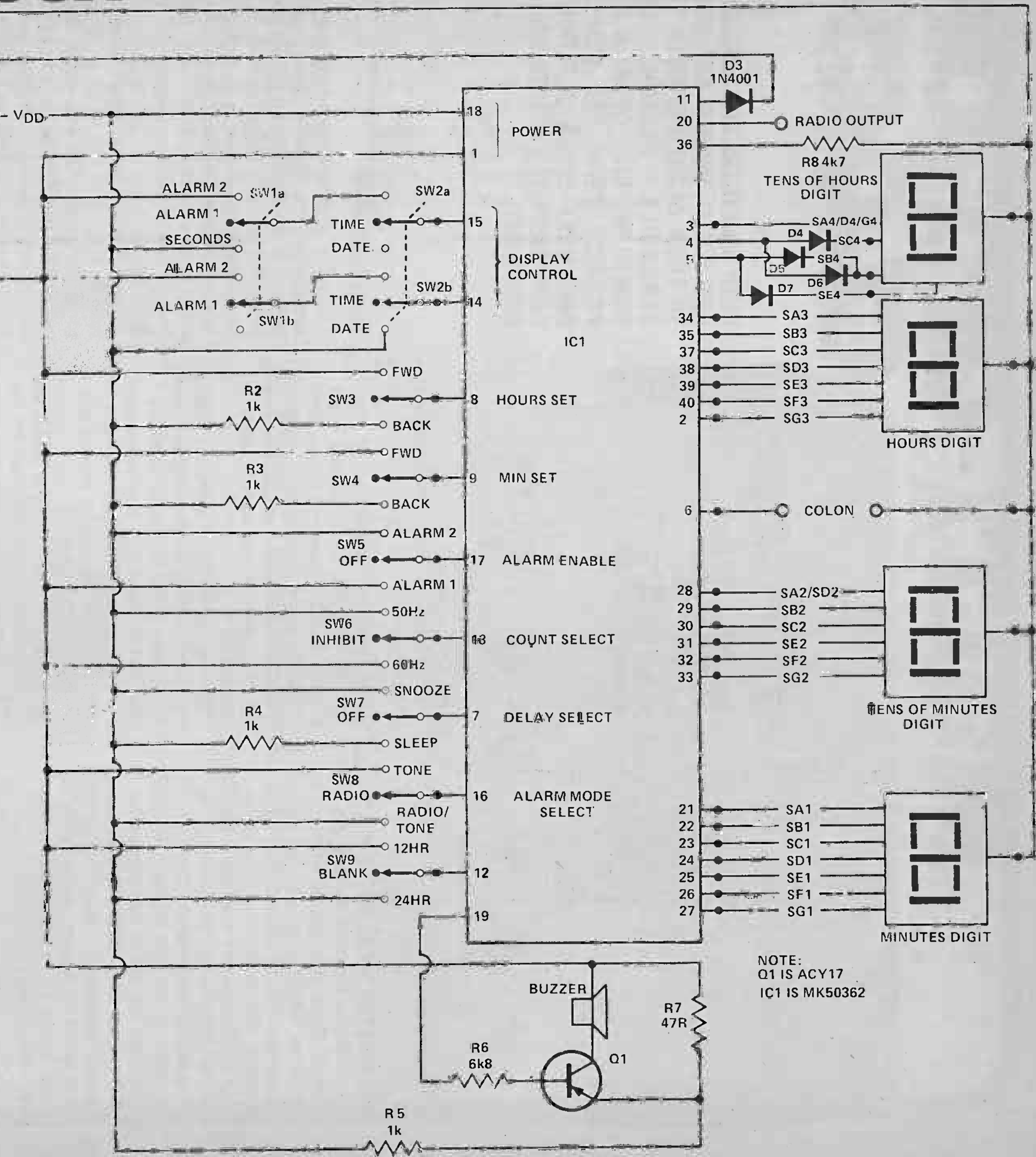


Fig 1. Full circuit diagram for the LED clock. Note that the switches shown can be replaced by links to the appropriate supply rail when the particular function they control is not required. If you use a metal box, the case, should, of course, be earthed.

HOW IT WORKS

Power supply smoothing is provided by C1 and C2. Higher values afford no benefits, and occupy much greater space. D1 and D2 are to partly rectify the supply to both chip and display. The IC supply is further decoupled, and the voltage lowered, by R1. The 50362 should draw about 10mA, and have a VDD of between 11 and 16V. Experimentation with the value of this resistor may well be beneficial in some cases where the transformer voltage is somehow high.

Timing pulses for the chip are derived from VDD, before rectification, by D3 - no shaping or attenuation components are needed, and the 50Hz is fed in at pin 11.

All the switches simply select either VDD or VSS for each pin of the 'mode select'. When left open internal resistors set the level present.

R8 is the intensity control resistor. Lower values raise the current through each segment, the minimum allowable value being 3k. At this level care should be taken to ensure that the chip is not overun, and under normal conditions we do not advise lowering R8 to less than 3k3.

Moving into the alarm circuit, R6 is used to limit the current into the base of Q1, the transducer drive component. R7 and R5 hold the transistor 'off' when pin 19 is low. Experimenting with values will give a louder tone, but possibly at the expense of a certain degree of background 'noise' when the alarm is off. The type of Q1 is not important, as long as the one selected can take the 15V rail, and about 10mA current.

PARTS LIST

RESISTORS all ½W 5%

R1	680R
R2,3,4,5	1k
R6	6k8
R7	47R
R8	4k7

CAPACITORS

C1	1000u 16V
C2	500u 25V

SEMICONDUCTORS

Q1	ACY 17 or similar
D1-7	1N4001 or similar
IC1	MK 50362N

SWITCHES

SW1,2	DPDT with centre off position
SW3,4	DPDT with centre off position, biased both directions
SW5-9	SPST with centre off position

DISPLAYS

Common cathode 7-segment LED, requiring no more than 10mA per segment. Alternatively: MCD 461 display module (see Buy Lines)

MISCELLANEOUS

T1	240/6-0-6 at 500mA or greater
FS1	100mA mains fuse (type to suit)
PCB	ETI clock board A
Verobox	(75-1239-K)
Crystal insert	

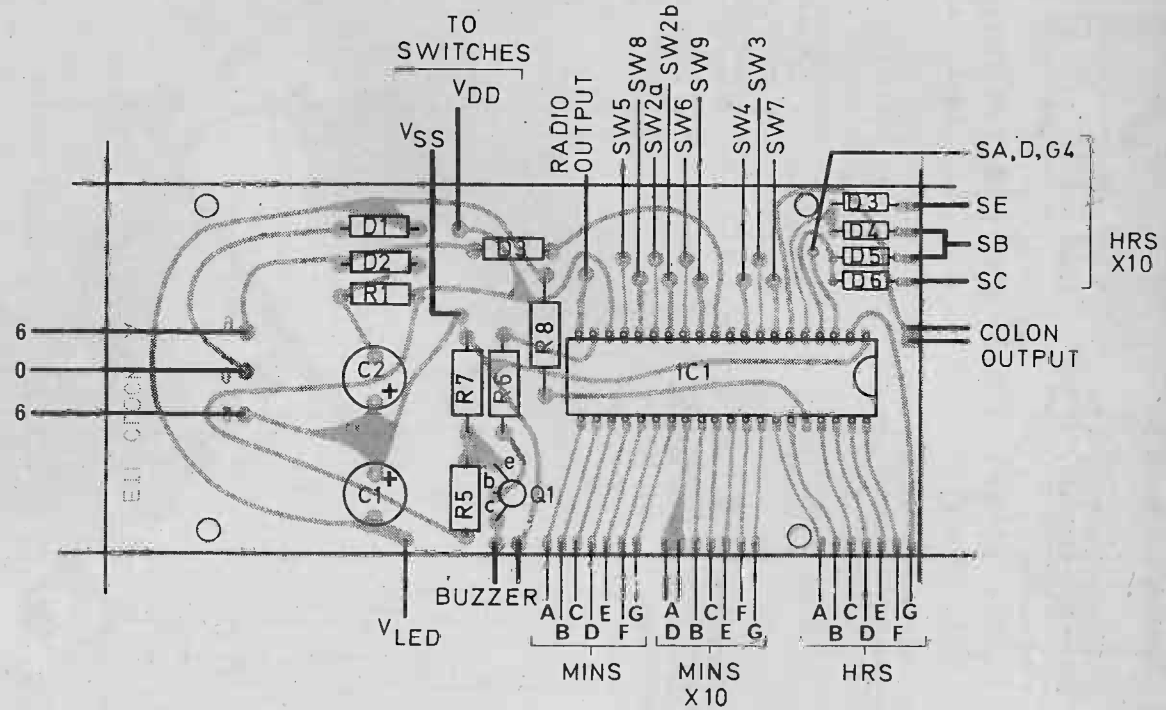


Fig 2. Component Overlay to produce a 24 hr display format, with British date display. See text for details of how to modify date display format.

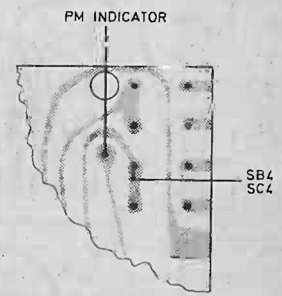


Fig 3. Modifying the above PCB to give 12 hr display. Diodes D4-D7 are omitted in this configuration. Note that British date format is not possible here, unless fig 5 is followed.

BUY LINES

A 'package deal' of chip and display can be had from Pronto Electronics Systems Ltd., 645-647 High Road, Seven Kings, Essex. IG3 8RA. For the MK50362N and Futaba 5LTO2 flourescent display (constructional details next month) the price is £12.96 all inclusive. For the chip and the four FND 35F common cathode LED's they want £11.96 all inclusive. Parts are available seperately, but the price will be higher.

Maplin are the largest supplier of the MCD 461 display module shown on our LED prototype. The price is £3.95 all inclusive. They CANNOT supply the 50362. See ad in back cover for address etc.

MULTI-OPTION CLOCK

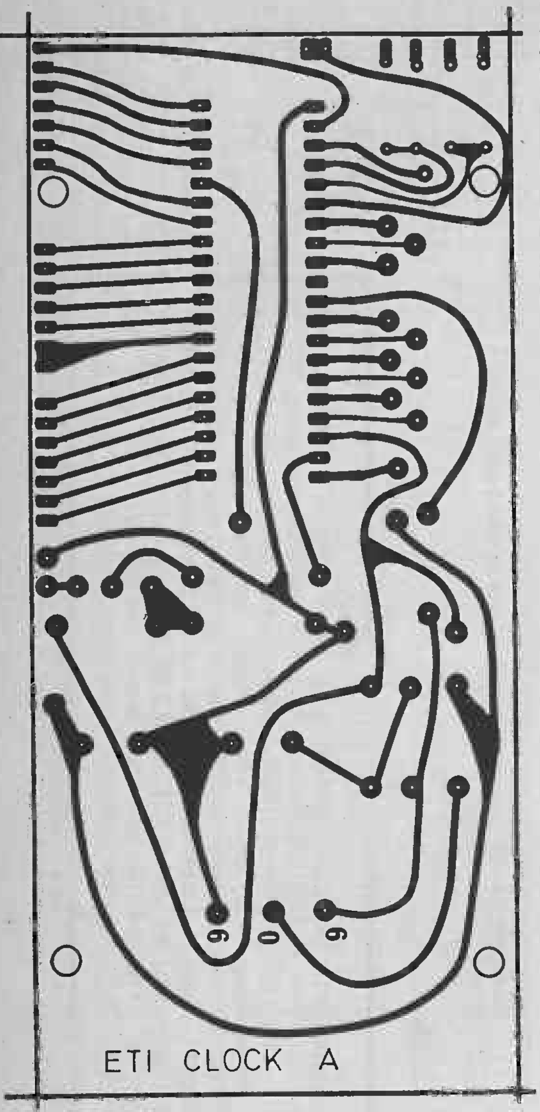
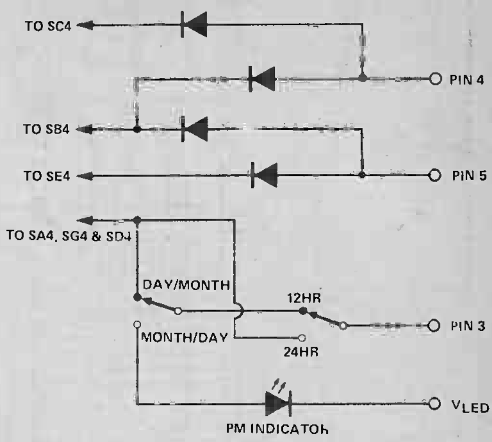
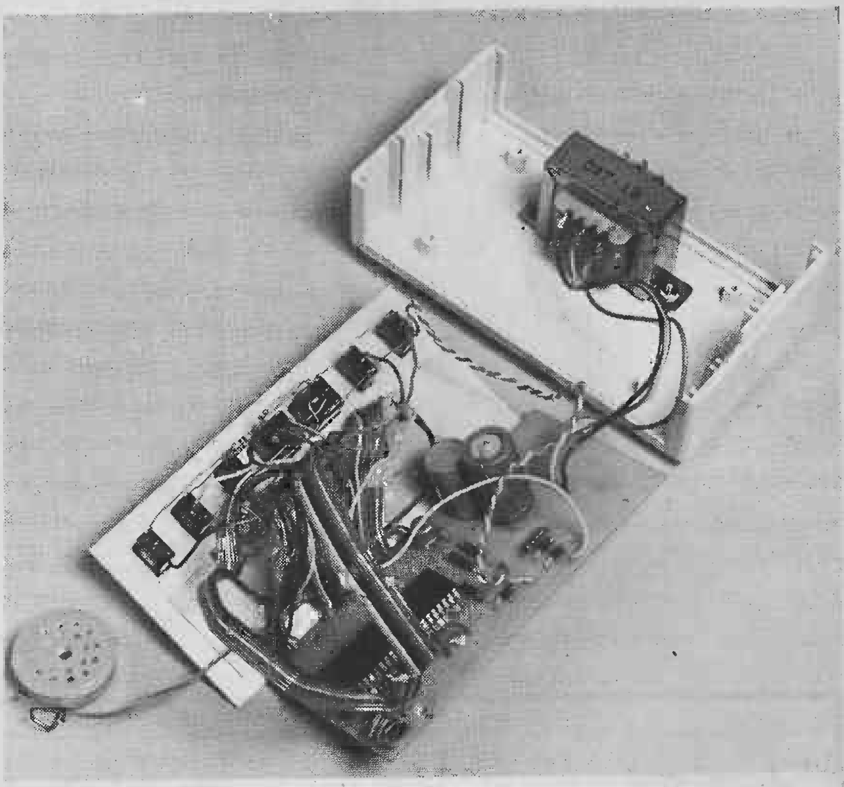


Fig 4. Full size foil pattern for LED clock. The mounting holes are given as a guide. In some cases the transformer will mount over the two nearest the 6-0-6 markings.

Fig 5. Right — how to modify the basic circuit to give a selectable 12-24 hr display and/or US/UK date format. Remember pin 12 if you do this!



Below — Internal shot of the works. No springs or levers, just yards of ribbon cable! Note that the board mounts on the top of the Verobox upside down!



allows the transformer to be placed centrally in the bottom of the box to aid stability.

Employing the Verobox shown the board will fit over the mounting pillars neatly and it is possible the transformer will mount across them at one end. Room has been allowed to fit a minature 6-0-6 type from Maplin, and others should be available.

Slide switches could be used instead of the more expensive 'centre off' types shown in use here. (But they won't look as good) Fit the wires to the board first, since the display module is easier to manipulate than is a complete PCB.

When assembling that board USE A HOLDER for the chip, it really is just not worth the risk - honest!

The alarm output on the 50362 is a three-mode facility, selected by pin 16. When radio/tone is chosen, radio output - pin 20 - will go to VSS at alarm time, and eight minutes later the tone sounds. Both will remain on until disabled. Sleep through the lot if you can!

The tone is somewhere between 200Hz and 1kHz, and conducts to VSS at a 1Hz rate for 8.3% of the cycle. Alarm 1 will shut-off after one hour of operation, alarm two does not, but both will reset the snooze when disabled.

In the sleep mode, the display will show the time as it counts down to shut off time. Once the required time has elapsed, the radio output turns off.

Right. You've built the clock and switched on. The display is flashing on and off at 1Hz, and is reading the wrong time. Good-all is well! Switch on and off again at which point all noughts will appear on the display, and the colon is hard on.

Once 'mins set' is advanced, the clock begins to count. On power up all the noughts may well be there to start with. Don't look at gift digit in the cathode, just set the time up.

NEXT MONTH: Constructional details of the flourescent version.

MICROFILE

VISUALLY INTERESTING GARY EVANS LOOKS AT AN INTERESTING VISUAL DISPLAY CHIP.

ANY COMPUTER SYSTEM be it a large ICL installation or a small home system based upon an MPU, can be divided into four distinct blocks.

Firstly there is the section that allows the user to input data to the system. Another section deals with the processing of this data, a third with the long or short term storage of this data and, finally, the section that deals with the output of the processed material.

One of the most popular methods of performing this last function in a home MPU system is the VDU terminal.

2513 VDU

Now in days of old, when knights were bold, and LSI was incredibly expensive, being asked to design a low cost, easy to build, VDU would have made even the most hardened of electronic engineers wish that he had listened to mum and become a brain surgeon after all.

Then the 2513 made an appearance at a price that made it acceptable to the amateur market. This 2513 character generator chip was adopted as the standard device in low cost VDU systems and many designs have been based on this device, including our own 560 VDU.

The 2513 is however a character generator pure and simple. When presented with a six bit ASCII code it responds with a five bit output code which, when serialised and processed, will provide the video signal required. We also have to provide the 2513 with a three bit row address signal.

In addition to these control signals for the 2513, we also require a fair amount of additional devices to take care of the many other signals that any VDU must produce, sync pulses, video blanking etc.

CAB VDU

The arrival of the DM8678 CAB earlier this year has meant that VDUs with a lower package count have started to appear, notably the System 68 VDU.

The DM8678 has an on chip parralel-in-serial-out shift register together with a line counter and various latches. These facilities are a vast improvement over the 2513 but designs based on the DM8678 still require a lot of support devices leaving us still some way from the ideal of a single chip VDU.

VTAC VDU

This ideal is brought one step nearer with the arrival of the CRT 5027 Video Timer And Controller (VTAC) from SMC Micro Systems.

This device, as its title suggests, handles the generation of the various control signals for the presentation and formatting of interlaced and non-interlaced video displays on a CRT moniter.

With the exception of the dot counter all frame formatting (such as horizontal, vertical and composite sync), characters per row and data rows per frame is taken care of by the chip and are totally user programmable.

Programming of the various user options described above is achieved by loading seven 8 bit control registers from the chip's 8 bit bi-directional data bus. Four register address lines and a chip select line provide complete microprocessor compatibility for program controlled set up.

For example the chip allows for 20, 32, 40, 64, 72, 80, 96 and 132 characters per row the selection being made by loading the appropriate register with a three bit binary code.

The chip also provides a cursor video signal, in fact the only major section of a VDU missing from this device is the character generator.

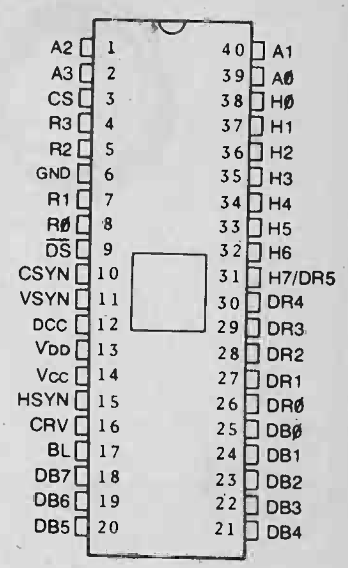
Coupling this VTAC with devices like the DM8678, while not providing the ideal signal chip VDU, should enable VDU designs of about four or five chips to be realised.

Quite an improvement on those early 2513 efforts.

I²L RAM

Texas instruments have announced a 4K static RAM built using Integrated Injection Logic. The S400 will retain data even when the supply rail sinks to 2 volts and dissipates only 500 mW and 25 mW on standby.

PIN CONFIGURATION



PIN FUNCTIONS

Pin No.	Symbol	Name
25-18	DBØ-7	Data Bus
3	CS	Chip Select
39,40,1,2	AØ-3	Register Address
9	$\overline{DS}$	Data Strobe
12	DCC	DOT Counter Carry
38-32	HØ-6	Character Counter Outputs
7, 5, 4	R1-3	Scan Counter Outputs
31	H7/DR5	H7/DR5
8	RØ	Scan Counter LSB (Odd/Even Field)
26-30	DRØ-4	Data Row Counter Outputs
17	BL	Blank
15	HSYN	Horizontal Sync
11	VSYN	Vertical Sync
10	CSYN	Composite Sync
16	CRV	Cursor Video
14	VCC	Power Supply
13	VDD	Power Supply

BATTLE OF THE KEYS

IN THE SPACE OF A FEW MONTHS KEY PROGRAMMABLE CALCULATORS HAVE COME DOWN IN PRICE SUFFICIENTLY TO MAKE THEM COMPETITIVE WITH MANY ORDINARY SCIENTIFICS. MANY PEOPLE FEEL THEY WILL EVENTUALLY TAKE OVER THE MARKET COMPLETELY.

IN ORDER TO INVESTIGATE THE MERITS, OR OTHERWISE, OF THIS NEW BREED, RON HARRIS TAKES FOUR POPULARLY PRICED MACHINES AND PUTS THEM THROUGH THEIR PACES.

A YEAR HAS PASSED since our last calculator review, in which time the market has been comparatively quiet. Prices have continued to wend their way downward, seemingly to approach zero in some cases.

Scientific machines have reached somewhat of an impasse - a where do we go from here situation. With the advent of machines like the CBM 4190R every conceivably useful function stands ready behind its own little key amid the ranks massed beneath the display.

The calculating power of these machines is frightening. In general use most of the capability will never be exercised except in idle moments of 'key doodling' - rather like doing the shopping in a Rolls, and deciding to do 70 up the drive just for the hell of it.

Improvements are still being made of course - the advent of LCD display, for example, with the attendant extension of battery life is to be highly praised - but aside from more keys where else is there to go? Well, manufacturers all seem to agree that their next step is into programmability.

Power To The People

Basically all this means is that the calculator is capable of storing a number of keystrokes and repeating with these with new sets of data upon request. The request always takes the form of a 'RUN' key which causes the machine to cycle throught the stored sequence in order, and (hopefully) display the result.

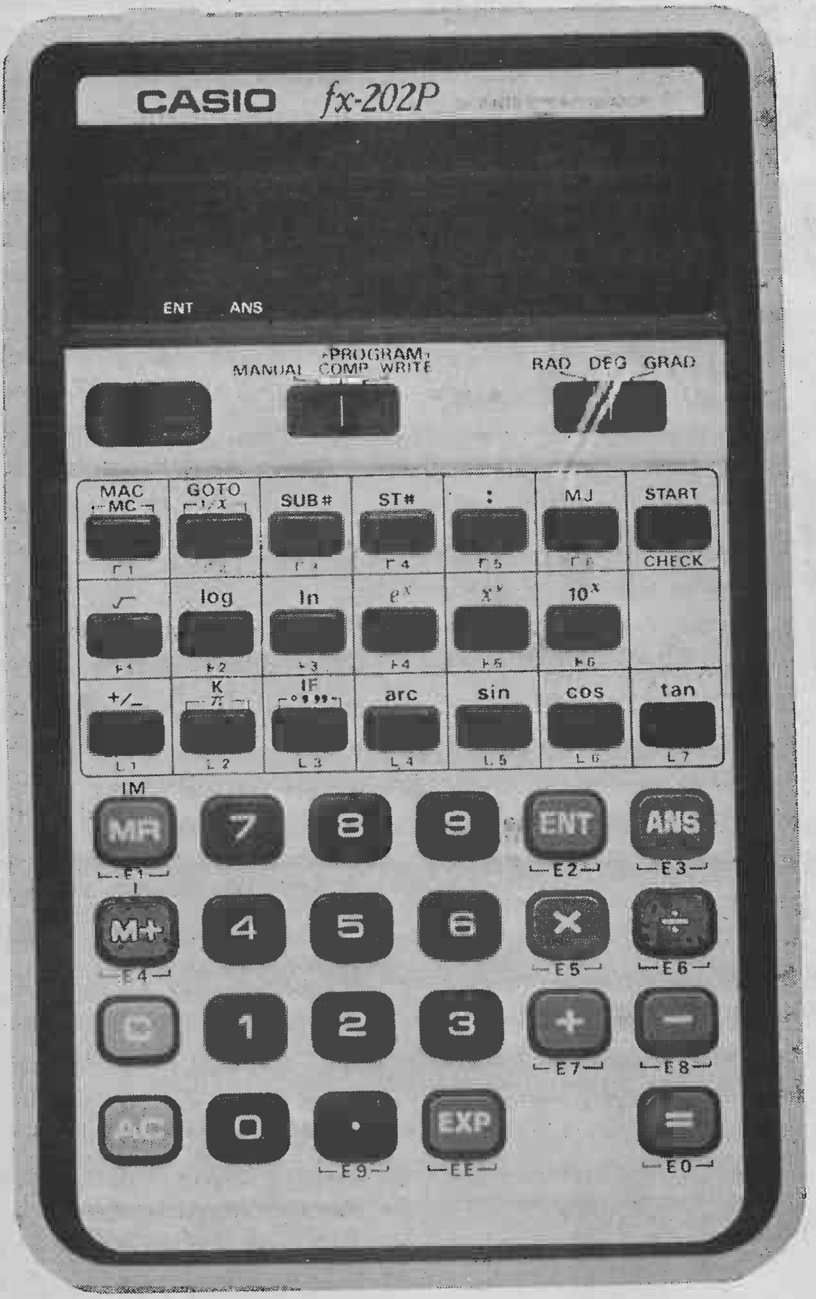
Up until recently this facility was a very expensive addition indeed, a typical programmable costing around £150-£200 mark. Now however a vertiable flood of programmable machines has burst upon us, with the cheapest (Sinclair) available for around £15.

Not surprisingly the more powerful of the breed still costs somewhat more, but the same £150 which last year bought you membership of the elite programming brigade will now get you such power as to make last years snobs look more than a little silly.

Putting Your Cards On The Table

There are two types of this calculator on the market with card and key programming facilities respectively.

CASIO fx-202P



ACTUAL SIZE

KEY FUNCTIONS

Memories clear: Goto/1/x: Subroutine: Step nos: Manual jump: Start/Check: $\sqrt{x}$: log: ln: e^x: x^y: 10^x: +/-: k/π: IF/HMS: arc: sin: cos: tan: Memory Read: 7:8:9: Enter: Answer: Memory Add: 4:5:6: X : ÷ : C: 1:2:3: + : - : AC:O:.:EXP:=

Notes. All upper case functions are for use in program mode, which means that some functions like 1/x and π cannot be used in a program.

Nos. of memories: 11 plus one 'indirect'
Nos. of program step: 127 (= key-strokes).
Non-rechargeable. Adapter extra.
Program memory data retained on switch off.
Typical Price: £80.
Software extra £3.50.

FX202P Poor Manual, no check codes listed with programs, no games software (spoilsports!). Good sized keyboard, but key action met with widely varying reception from "nice" to "bloody awful!" The display was unamimously acclaimed as was the 202's use on a desktop. However only poachers could pocket the machine comfortably, we feel.

As a non-programed machine there are too few functions on the keys to make it praiseworthy. Quite surprising this in view of its (relatively) high price.

As a programmable however, the 202 was unsurpassed - once you got used to its unique system. This is based on "statements" and subroutines rather than individual key-strokes of which it stores 127.

Comprehensive branching facilities exist - the machine will test against numbers or registers, and branches according to greater, less or equal conditions.

Cards are a nice permanent form of software, and once set up are much quicker to use. You just run the card through - and the programme is loaded ready for use. Naturally these are the more expensive animal.

Key programmables are the breed we are concerning ourselves with here, as they are more numerous, cheaper and more likely to be that which the tyro first encounters.

Here the program is entered by placing the machine into a 'learn' mode and entering the sequences of keystrokes you wish the machine to store.

Various levels of checking ability are present in the different machines to ensure that no 'bugs' are lurking, so that in theory at least the 'RUN' key will cause the operation to be performed correctly.

Getting Keyed Up

This article looks at four of the 'new' programmables ranging in price from

COMMODORE PR100

KEY FUNCTIONS

Backstep: Step: Run: GoTo: Skip: Clear: sinh/sin: cosh/cos: tanh/tan: AC/CE: Inv: e^x/ln: 10^x/log: $x\sqrt{y}/y^x$: $1/x/\sqrt{x}$: C→s/R→polar: Deg→Rad/hours: slope/c: intcp/c_s: n!/π: Frac/M: Int/MR: del x_n/x_n: Δ%/%: x→m/x→y: P^n_m/7: C^n_m/8: s/9: x/(: S /): deg/4: rad/5 Grad/6: MX/X: M÷/÷: scientific/1: Fix pt/2: Engineering/3: M+/+: M-/- $^oF\to{}^oc$/o: inches→cm/.: gal→litres/EE: lb→kg/chs: 9M/=.

Notes. First row of keys operate only in program mode. Conversions are into American units, not Imperial.

Nos. of memories: 9
Nos. of program steps: 72 (= keystrokes)
Rechargeable - adapter supplied
Data not retained
Typical Price: £35
Software supplied.

ACTUAL SIZE

PR 100 Let down by the manual, and rather heavily too. The machine itself received high praise, but the manual was continually cited as the villain of the piece. Software was free, but very poorly presented and too specialised.

The PR 100 is easy to program and to check routines on, but has a limited branching ability. Desk use is not bad at all, the display is sloped up to make things easier.

As a scientific the PR 100 is superb! Every function you could wish for (and a few you'll never think of!) are on the keys.

One comment was "If the HP is the Rolls Royce, the PR 100, is a Mercedes - it's as good on most things and better on some ... but somehow it ain't got the class".

£15 - £100, to give some idea of the advantages, or otherwise, of this new approach. We have not actually tested the accuracy of the machines in question, as all four possessed an accuracy more than adequate for any possible task. It should be noted though that the Sinclair is an order of magnitude less accurate than the rest, although still MORE than good enough.

We had hoped to include the new Texas machine in our group, which on paper anyway looks the most power-ful yet to emerge, but time ran out on us. So if you're listening Texas - we're still here and still interested!

In order to avoid individual bias one way or the other, we had our entire editorial team evaluate all four calculators and then prepared the review on the basis of all their comments. The table shows the marks each machine received in each category - averaged out- and the standard deviation on that mark. This is a measure of consistency, and the lower the better here.

HEWLETT-PACKARD 25C

ACTUAL SIZE

KEY FUNCTIONS

Fix pt/single step: scientific notation/ Backstep: Engineering not/Goto: x/x→y/%: S/Roll stack/1/x: Store: Recall: Σ-/Σ+: Enter: clear prgm/CHS/ Degree mode: clear register/EXP/Rad: Clear stack/Clear x/Grad: x<y/-/x<o: ln/7/e^x: log/8/10^x: →R/9/→P: x≥y/+/ x≥o: sin/4/$\sin^{-1}$: cos/5/$\cos^{-1}$: tan/6/ $\tan^{-1}$: x≠y/X/x≠o: int/1/Frac: √x/2/ x^2: y^x/3/ABS.
x=y/÷/x=0: →HMS/O/→H: Last x/./π: Pause/Run/Nop.

Note. Upper case fncs. accessed by F button, and lower case by G button. Upper and lower case notation on four function keys (+, -, X, ÷) are branching and lower.

Facilities for use within a program.

Nos. of memories: 10.
Nos. of program steps : 49 (147 key-strokes max.)
Rechargeable - adapter supplied.
Memory data (inc. program) retained on switch off.
Typical Price: £118.
Software supplied.

HP 25C Excellent literature. The manual is an object lesson in how such things should be done, and the supplied programs are well documented although very involved in places and consequently not simple to follow.

Ergonomically the HP 25C scored well, but the 3 function keys and complexity of RPN operation were disliked by some. Display is well positioned, and can be clearly seen over a surprising angle. Desk use is very possible.

Programming is straightforward enough, but relies on RPN again which can make it tricky at first. Checking is easy, and one could not wish for more branching than is possible here!

As a normal calculator the range of functions is very wide, and should cover most requirements. Two years old now - perhaps the age is reflected in the very high price.

CONCLUSIONS

In making our comparisons we have avoided any question of price or 'value for money'. - this is simply because we don't feel it is in the slightest applicable! All four machines can be unreservedly recommended, and which one you choose will depend upon the use to which it is to be put, and how much you can afford to spend.

Games are great fun in programmable calculators, with the 'moon landing' being the most popular. Hewlett Packard and Sinclair provide a listing for this, although the latter is limited by the fewer steps available.

One universal gripe is that the manufacturers don't give enough games software with the calculators.

These things aren't for calculating they're for PLAYING WITH!

The table on the right gives a good summary of our results on these machines. The first column shows those parameters we looked at which could be assigned numerical ratings. Each reviewer then scored each parameter on each machine (out of a maximum of 10) and the table is a compliation of all the reams of paper this generated.

Standard Deviation, s, is given on each as a measure of consistency of mark. The lower the better. Overall totals are marks out of a hundred possible, but should be taken with a large dose of price and usage considerations!

SINCLAIR CAMBRIDGE PROGRAMMABLE

ACTUAL SIZE

KEY FUNCTIONS

./EE/-: Shift: Step/Clear: sin/7/$\sin^{-1}$: cos/8/$\cos^{-1}$: tan/9/$\tan^{-1}$: Learn/Run: In/4/e^x: rcl/5/memory ex: ( )/6/R→Deg: ÷/: $\sqrt{x}$/1/go if neg: sto/2/go to: CLN or /3/D→Rads: X: stop/O/CHS: =: +: -

Notes: Some keys perform differently in a program. Key '3' works as change notation if shifted normally, or as 'introduce number' in program mode. In a program upper case functions are normally assumed.

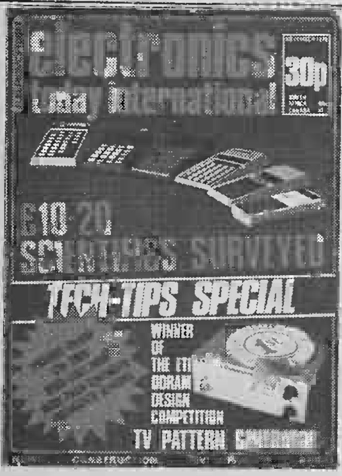
Nos. of memories: 1
Nos. of program steps: 36 (=keystrokes)
Non rechargeable. Adaptor extra.
Data not retained.
Typical price: £16.
Software Extra £4.95.

SINCLAIR Good clear manual with extensive program library available as an extra - and a very worthwhile one too. The keyboard is too small however and the key action was condemed by all. It was the only machine however that can be operated in one hand! The size means that it is easily pocketed, and the plastic 'thing' supplied fits it for desk use which is then limited by the restricted viewing angle of the display.

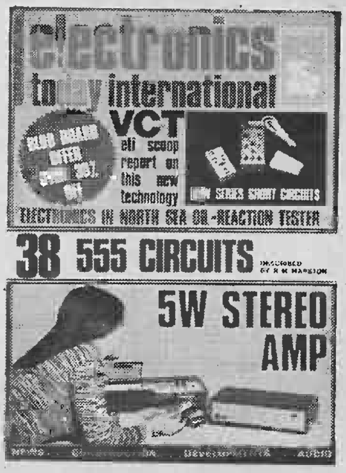
Getting into the program node is a chore, but once there the Cambridge is easy to program, and the 36 step limit is less of a drawback than you might suppose. Branching ability and checking facilities are highly limited.

As a normal scientific the Sinclair is good, the only 'beef' being the number of shift key operations required.

		CASIO FX 202P		CBM PR 100		HP 25C		SINCLAIR CAMBRIDGE	
		X̄	S	X̄	S	X̄	S	X̄	S
INSTRUCTION MANUAL	LITERATURE	4.500	0.577	5.000	1.000	9.700	0.500	8.000	1.000
SOFTWARE	LITERATURE	4.732	1.155	5.333	1.155	8.778	1.527	8.667	1.154
KEYBOARD	ERGONOMICS	8.000	0.0(!)	7.333	0.517	8.000	1.732	6.000	1.000
DISPLAY	ERGONOMICS	9.770	0.577	7.333	1.527	7.667	0.577	6.333	1.155
DESK USE!	ERGONOMICS	8.000	0.0(!)	8.333	0.577	8.000	1.000	4.666	1.528
POCKETABILITY	ERGONOMICS	6.333	1.537	7.667	0.573	7.000	0.0(!)	9.778	0.500
EASE OF PROGRAMMING	PROGRAM MODE	7.667	1.732	9.000	1.000	7.677	1.527	7.667	0.577
CHECKING EASE	PROGRAM MODE	8.000	2.341	8.337	1.157	8.000	1.000	7.000	1.000
BRANCHING ABILITY	PROGRAM MODE	9.777	1.34	5.333	1.340	8.667	0.577	4.333	1.528
KEY FUNCTIONS	NON PROGRAM USAGE	3.677	0.577	10.000	0.00	8.000	1.000	7.333	0.577
	TOTALS	71.44%		73.67%		81.47%		69.78%	



Gaps?



Gaps?

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PLAY THE GAME — BUILD

SKEET

AN EXCITING GAME OF LUCK AND SKILL FROM OUR PROJECT TEAM

GAMES, BE THEY electronic or otherwise, may, in general, be divided into two broad categories. There are those which entertain by stimulating the mind and those that involve the more mechanical of skills. In general all games will involve a mixture of these two elements.

The game described here cannot claim to tax the grey matter to any great extent, unlike the chancellor and our green matter, but certainly provides a test of hand/eye coordination.

We have also introduced an element of luck which helps the game meet, perhaps, the most important requirement of any game — it is fun play!

Game Bird

Before going on to describe the game it might be best to explain just why we called it Skeet.

Skeet is the term used in the USA to describe the sport we know as Clay Pigeon Shooting. We thought that a title like "Clay Pigeon Shoot" would be too much of a mouthful, and nobody wants a mouthful of clay pigeon. We therefore chose the American name for the sport that our game attempts to emulate — hence Skeet.

Flight Of Fancy

The line of LEDs, seen in the photographs of the game, represent the flight path of the Skeet. The "gun" of our game is permanently aimed at the last LED of the flight path. This means that there is no aiming involved, the object of the game being to correctly estimate the delay between "firing" the "gun" and the "shot" reaching the Skeet. This delay represents the time of flight for a real shot.

When the firing button is pressed the "shot" LED lights and the time that this remains on indicates the travel time of the "shot."

At the instant that the LED turns off, if the Skeet has just reached the end of its flight, a "hit" is registered and the "hit" LED lit.

Whether or not a "hit" was scored the LEDs representing the flight path will stay off until pressing the skeet release button starts another "bird" on its way.

Score With A Bird

The game is made more interesting because the speed of the Skeet varies from one flight to the next, this is where the luck, and skill come in. You cannot become used to firing the gun at the same position in the flight path as the "bird's" speed

HOW IT WORKS

IC1 is a one of ten decoded counter. The "Zero" output from this IC is not used while the next eight outputs are connected to LEDs 1-8, these LEDs represent the flight of the Skeet. The "nine" output (Pin 11) is coupled to the enable input (Pin 13). This means that the counter will be disabled after it has completed one count cycle.

Pressing the skeet release button PB1 resets the counter, removing the inhibit and allows another cycle to take place.

The pulses which clock IC1 through its count cycle are derived from the CMOS oscillator formed by IC3a and IC3b.

This oscillator has the resistor which forms one of the elements in the timing chain split into five sections. Four of these sections are shunted by the transmission gates of IC5 so that they may be bypassed as required and so control the frequency of the oscillator. The remaining resistor, R1, ensures that there is always some resistance in the oscillator circuit.

The oscillator is running at all times when power is applied to the circuit.

Three of the transmission gates of IC5 are coupled to the outputs of IC2b. IC2b is one half of a dual BCD counter and is clocked by the CMOS oscillator. As IC2b clocks through its count sequence the resistance of the timing element changes altering the frequency of the oscillator.

The enable line of IC2b is tied to that of IC1, and since the enable lines of these counters require signals of opposite logic level, when one is running, the other is halted.

This enable line is also tied to the fourth gate in IC5. This straddles the largest resistor in the timing chain and so has the greatest effect on oscillator frequency.

The sequence of events during play is as follows.

PB1 is operated and so disables IC2b and latches its output. This sets the "random" speed of the skeets flight as IC1 is now enabled and is clocked by the oscillator's output.

When IC1 reaches the count of nine, it is disabled and IC2b in turn enabled. IC2b then cycles through its count sequence changing the oscillator's frequency ready for the next skeet flight.

The fact that IC5d is tied to the enable line means that the oscillator runs much faster when performing its "random" frequency selection function than when controlling the flight of the skeet.

The "gun" consists of two CMOS monostables in series (IC4). The first one has a time constant representing the time of the shot travel to the target. It drives a LED via buffer IC6a to allow timing judgements during play.

The second one shot provides a short pulse after the first is complete. This is the "shot" pulse.

This pulse is AND-ed (IC6c) with that from the "eight" output of IC1 to produce the "hit" pulse.

This pulse is applied to the score counter (IC7) and, via a pulse stretcher (IC3c, IC3d), to the hit LED (LED 9).

IC2a is the other section of the BCD counter and is clocked from the "eight" output of IC1. This IC is used to count the total number of skeet flights.

This BCD counter is arranged to blank the score display, via the enable display pin of IC7, until it reaches a count of eight. At this stage the Q3 output will enable the display and inhibit further clocking of the counter.

Lighting of the score display signals the end of a game.

The buffers (IC6a, IC6b and IC6d) are required because while a CMOS output will drive a LED directly, as LEDs 1-8 are driven from IC1 the load that the LED presents brings the CMOS output to below an acceptable "1" level.

Thus if the output is not used elsewhere in the circuit we can drive a LED directly, but where the signal is required to drive other gates we have used a buffer.

The photograph shows the completed Skeet unit. This shows the layout of the various front panel controls.

BUY LINES

Most of the components used in the Skeet game should be readily available from the larger of electronic component suppliers.

R10 (10M) might prove difficult to obtain, but is certainly available from some of the large mail order firms advertising in this issue.

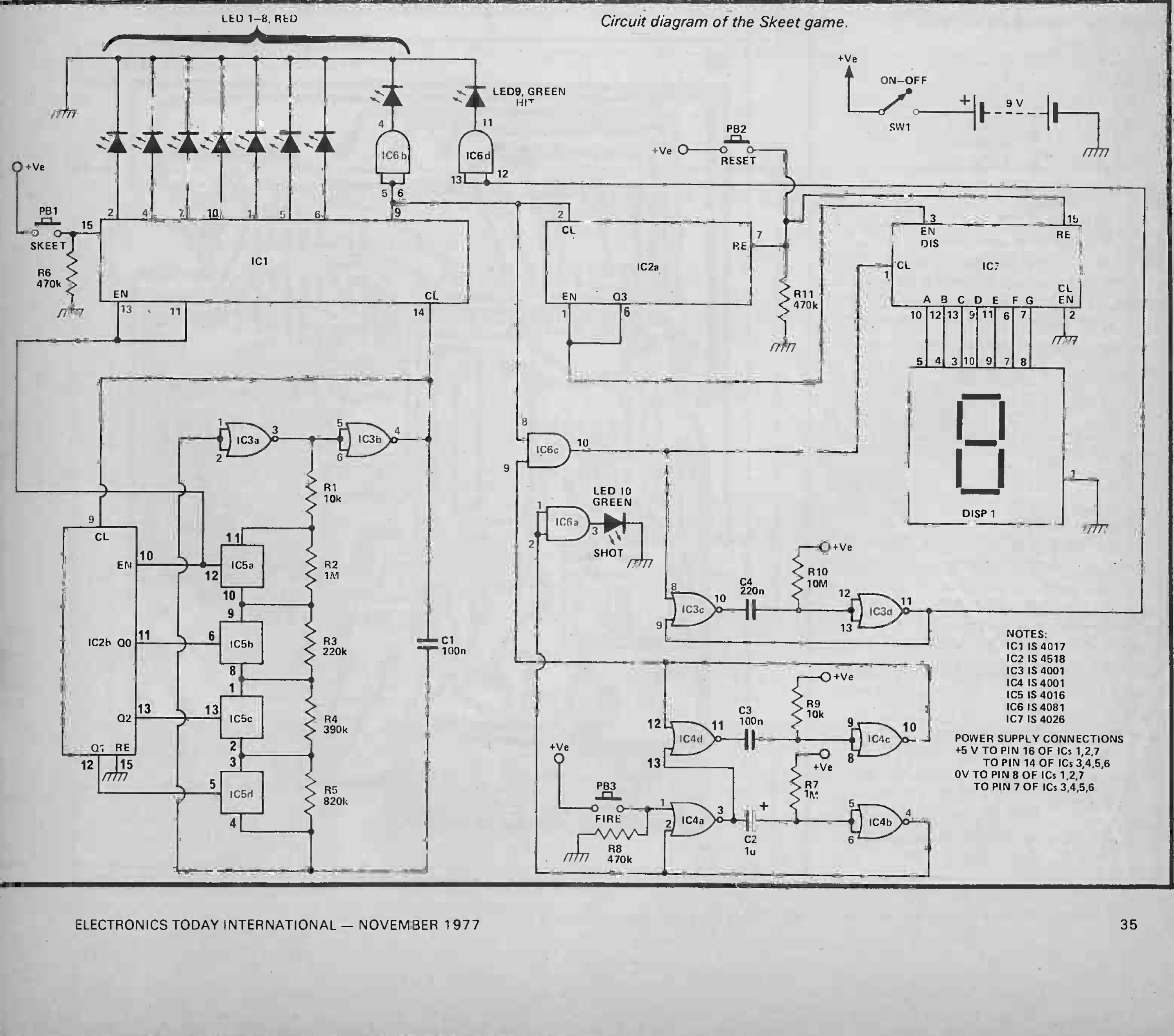
Of the ICs, most are common enough, but the 4081 and 4026 types might prove ellusive. In case of difficulty try Marshalls for the former and Maplin for the 4026.

The case we used is available from Vero stockists.

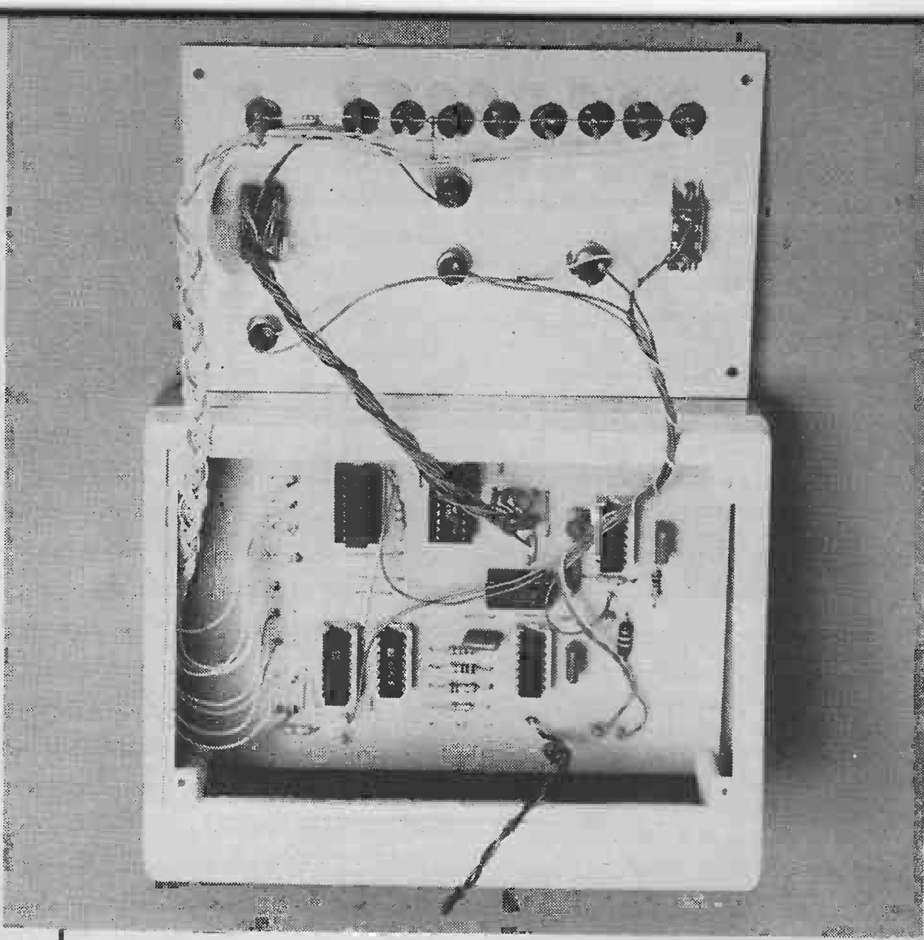
can be any one of eight different values determined randomly.

After eight shots the score display, blanked until now, lights up with your score out of eight. This signals the end of a round. In a competitive game, make a note of your score, press the reset button and pass the game to the "hot shot" competing against you. For practice games, the score need not be reset, the counter continuing to register.

Circuit diagram of the Skeet game.



SKEET

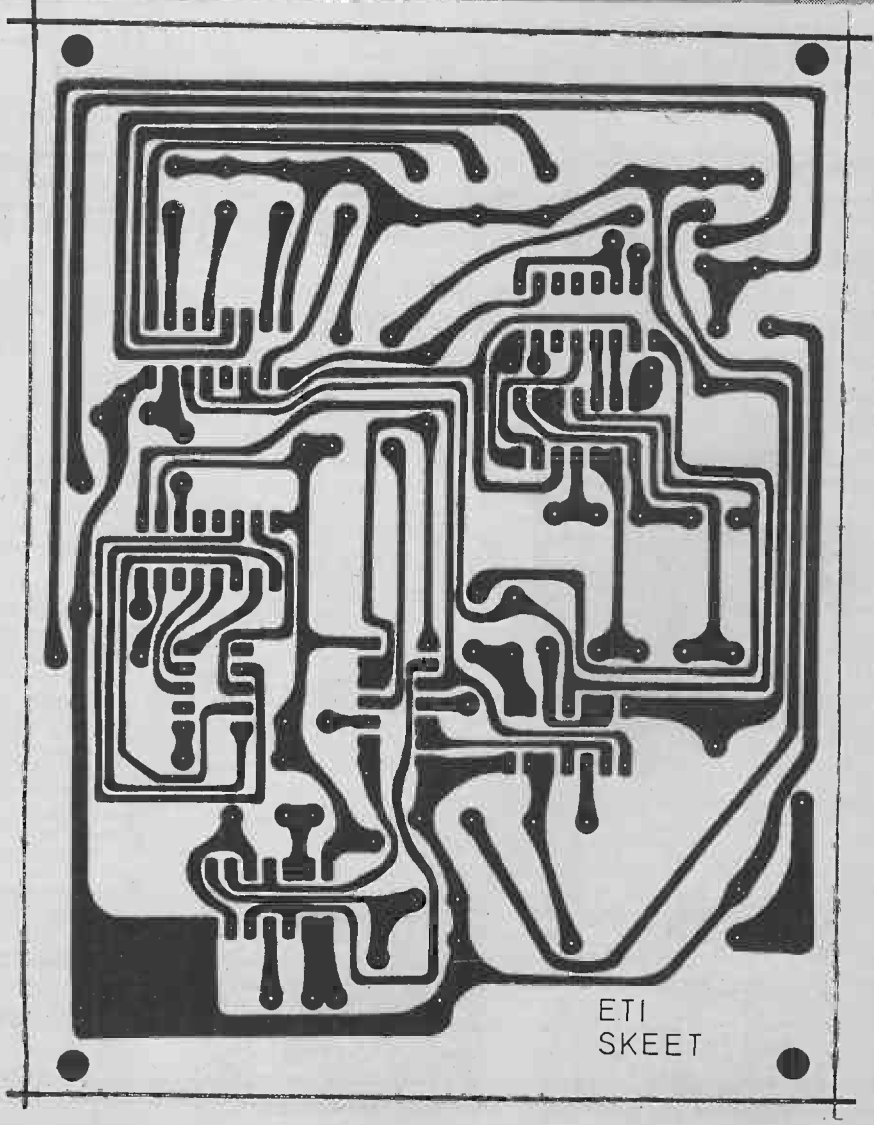


Building Birdie

The majority of parts are mounted on the PCB and should be assembled according to the overlay shown. We recommend that sockets are used for mounting all of the ICs as this makes the task of any fault finding that may be necessary far easier than would be

An internal view of completed unit. The wiring of the front panel switches and display to the PCB board can be seen. Note the insulated sleeve from IC1 pin 16 to IC2 pin 16 and the insulation on the wires to the display.

Below right we show the full size PCB foil pattern (140 x 105mm).



PARTS LIST

RESISTORS all ¼W 5%

R1,9	10k
R2,7	1M
R3	220k
R4	390k
R5	820k
R6,8,11	470k
R10	10M

CAPACITORS

C1,3	100n polyester
C2	1u0 35V tantalum
C4	220n polyester

SEMICONDUCTORS

LED 1-9	.2" type red
LED 10	.2" type green
DIS 1	DL704 common cathode or similar
IC1	4017
IC2	4518
IC3,4	4001
IC5	4016
IC6	4081 - see "Buy-lines"
IC7	4026 - see "Buy-lines"

SWITCHES

PB1-3	Push to make push type
SW1	Single pole on/off type

CASE

VERO Sloping front type: 75-1798k

MISCELLANEOUS

PCB as per pattern, PP6 battery and clip, flexible connecting wire.

the case if the ICs were soldered directly to the PCB.

Note that the link from IC1 pin 16 to IC2 pin 16 is insulated.

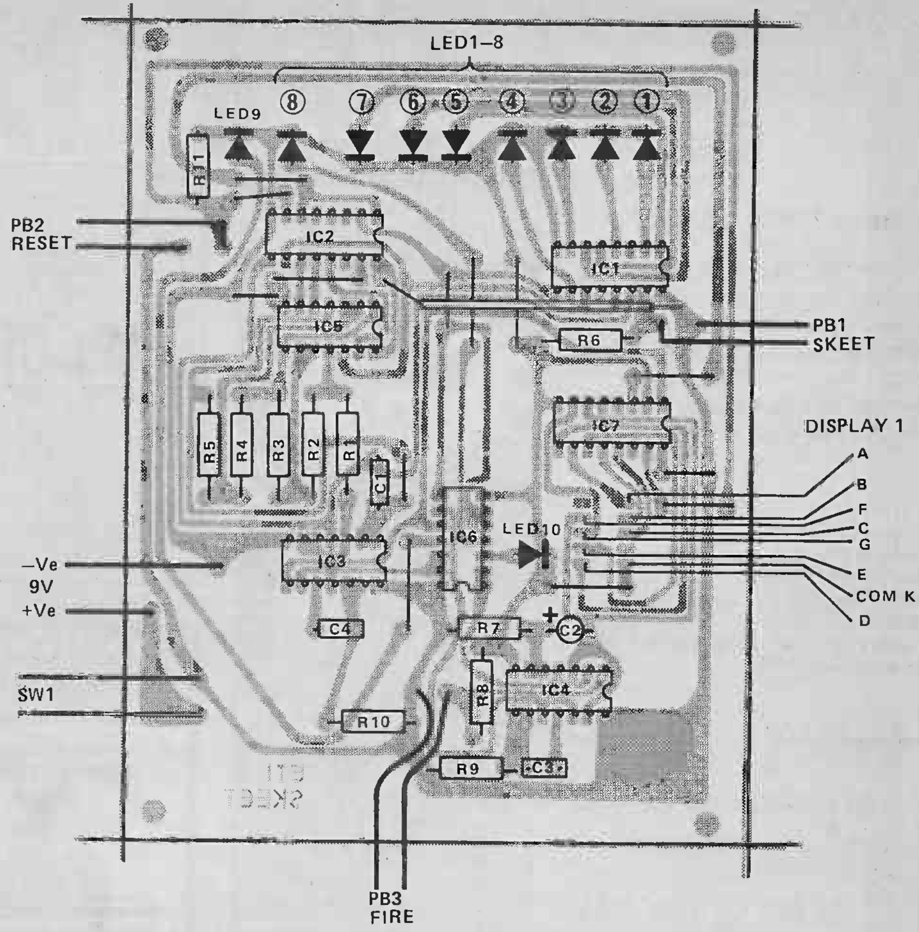
The switches, seven segment display and LEDs are all mounted off-board on the front panel and wired to pins on the PCB. The layout of our game can be seen in our pictures.

Space inside the box was, as is usual in our designs, at a premium and the PP6 battery was squeezed into the back of the case, insulated from the PCB by a piece of foam rubber.

The first pull

When power is first applied the condition of the various counters is undetermined. To start a game, press the skeet release button first and allow the skeet to complete one cycle. Press the reset button and you're ready to begin shooting Skeet.

ETI



Right: the component overlay for the skeet game. All the links but for that between IC1 pin 16 and IC2 pin16 may be made from uninsulated wire.

LED PENDANT

FIND YOUR PARTNER IN THE DARK WITH THIS ATTRACTIVE FLASHER

WANTING TO IMPRESS upon one's women folk that electronics is not a boring useless occupation, has inspired many an electronic engineer to build egg-timers and liquid overflow indicators, etc, for their loved ones.

However, these sort of devices, appreciated though they may be, cannot be exhibited at parties and pubs where they achieve maximum admiration (sought after not only by females) so the obvious solution is electronic jewellery.

Before LEDs

Before LEDs became commonly available it was possible to build illuminated jewellery using miniature catheter bulbs. But the current drain still involved the inelegant strapping-on of bulky power supplies and the concealment of switches.

Nowadays by using LEDs and CMOS 'chips' it is possible to build a piece of self-contained jewellery that doesn't even need an on/off switch.

The LED pendant

The LED pendant, as can be seen from the cover photograph, is sufficiently small to be worn comfortably around the neck or it could be made into a badge.

The operation is as follows. Upon touching the contact plates the seven-segment LED flashes between two initials for about eight seconds and then switches off again.

The pendant is not limited to those letters that the seven segment display can handle because there is nothing to stop the reader from hard-wiring LEDs into a dot pattern to produce Ms and Ks etc.

The prototype was designed to flash the initials BJ.

Mechanical construction

This project, although the circuit is not very complicated, will separate the skilful from the hamfisted. As can be seen the pendant measures approximately 1½in in diameter, yet only standand components were employed.

Because one of the design aims was to keep the width to a minimum a PCB could not be used. Therefore the components were hard wired, and we do mean *hard* wired.

To begin with, the front panel was cut from 16 SWG aluminium with a window for the seven-segment display and two holes below, with sufficient clearance for the heads of 8 BA cheesehead screws, filed smooth, the red perspex window and the 8 BA screws were fixed in to the front panel using epoxy resin. Then the front was sanded down and polished. The epoxy insulating the contacts from the aluminium and also providing mechanical anchorage.

HOW IT WORKS

The prototype was designed with the initials BJ in mind, which was very convenient as the segments b, c, d and e remain on for the monostable period and segments a, f and g flash at 1 Hertz to complete the letter B (Fig. 1 a, b).

To illustrate the technique involved in obtaining different combinations of letters, a further circuit (Fig 1 c) was designed to accommodate the letters A, L. This requires a further transistor Q3 and resistors R9 and R10 to give an inverse function. This circuit will be described in detail.

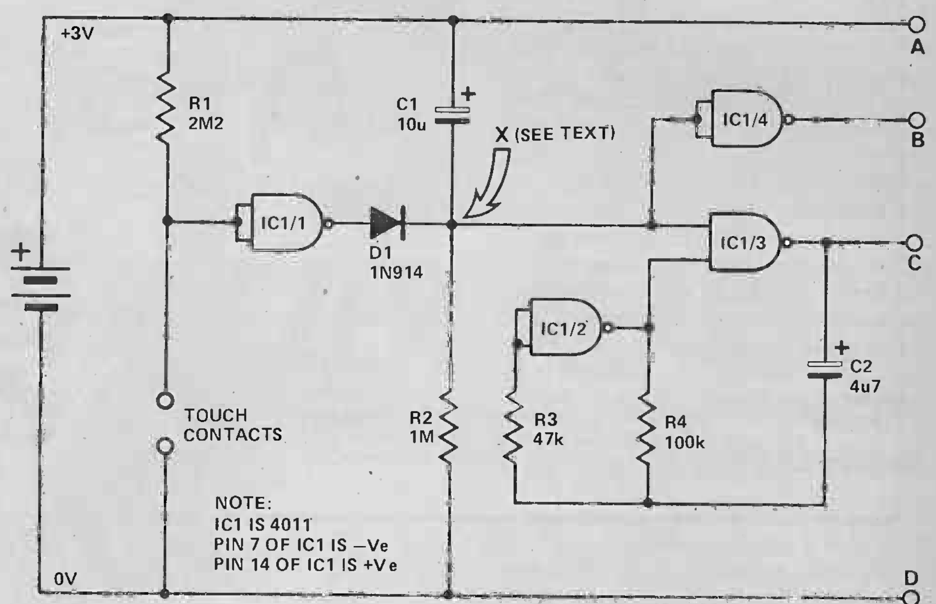
Under quiescent conditions no measurable current is drawn. When the touch plates are joined by a finger, inverter 1 discharges C1, thus point X goes high for about 8 seconds, as C1 charges down. Then, via inverter 4, Q1 turns on and lights LED segments e and f. These remain on for the monostable period.

The output from the astable (gates 2 and 3) is initially low after the beginning of the monostable period, so that Q2 is switched on. This lights segments a, b, g and c, but Q3 is switched off via Q2, so that segment d is off. Thus the letter A is formed.

When the astable changes over Q2 is switched off, turning Q3 on, and lighting segment d. Thus with segments e and f on, the letter L is lit up.

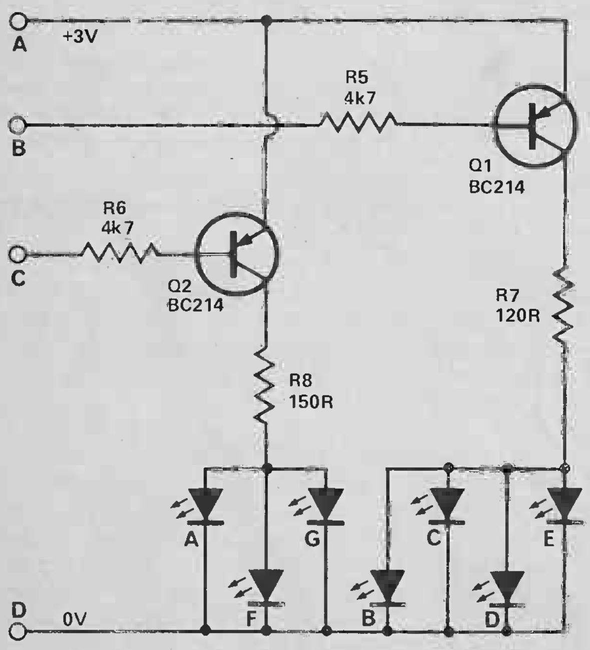
Resistors 7, 8, 11 and 12 are chosen so that all segments have the same current and thus the same intensity. In this case about 2mA per segment forms a compromose between battery drain and visibility.

The batteries are mallory MS76H 1.5 volt cells and in the prototype a life of two months was typical, with approx two minutes usage a day.

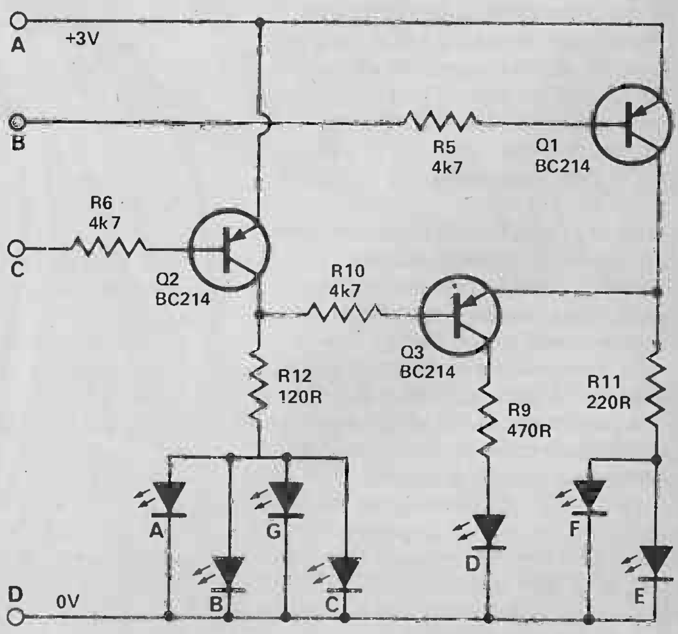


1a

Fig. 1a is the monostable and astable multivibrator which is the basic circuit. Fig. 1b and 1c show alternative circuits for BJ and AL respectively.



1b



1c

PARTS LIST

RESISTORS all 1/8W 5% or smaller

R1	2M2
R2	1M
R3	47k
R4	100k
R5,6	4k7
R7	120R
R8	150R

CAPACITORS

C1	10u 6V3 tantalum
C2	4u7 16V tantalum

SEMICONDUCTORS

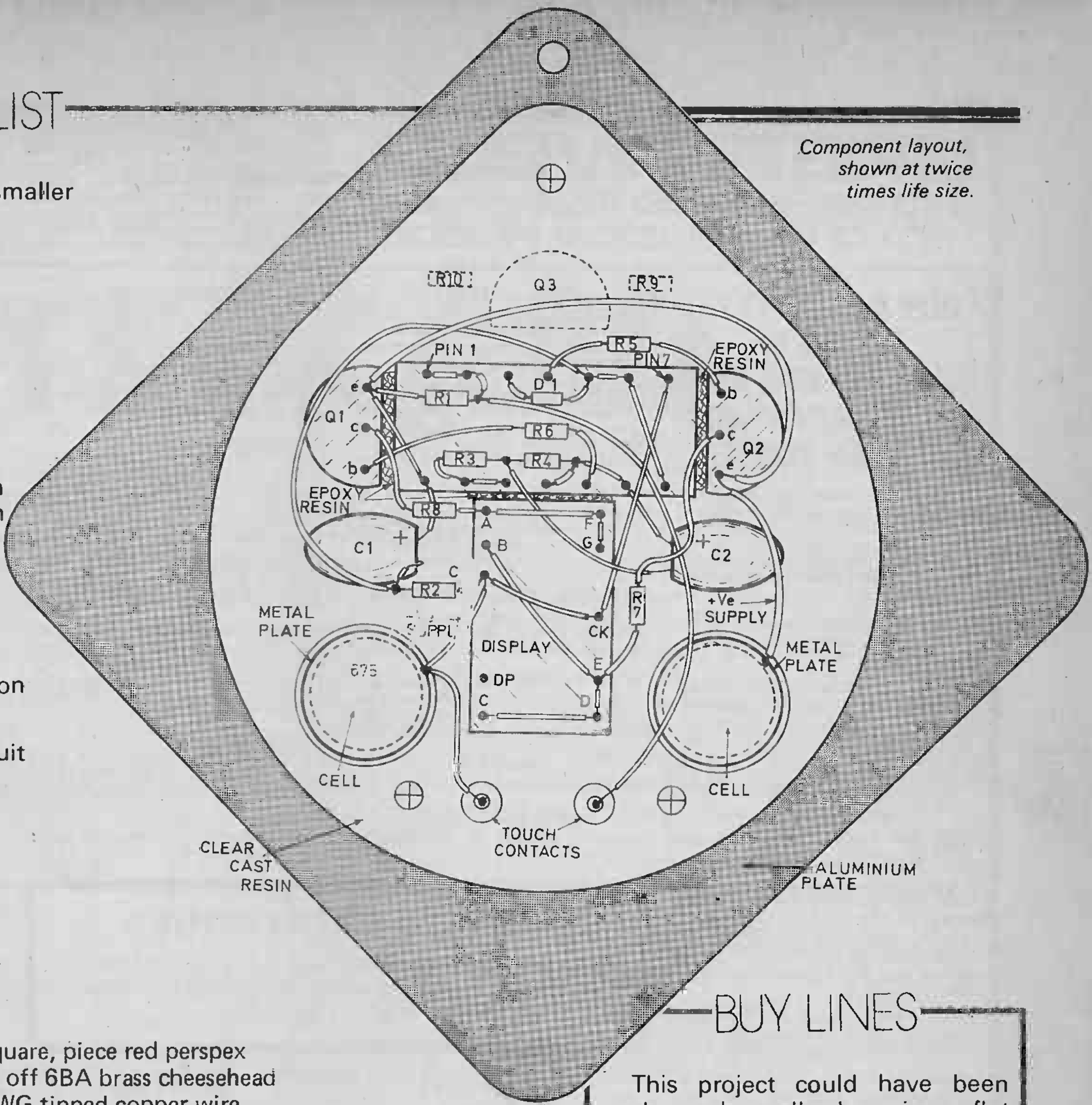
IC1	4011
D1	1N914
Q1,2	BC214
DISPLAY	7-segment common cathode type

additional components for circuit shown in fig. 1C

R9	470R
R10	4k7
R11	220R
R12	120R
Q3	BC214

MISCELLANEOUS

Piece aluminium 16 SWG 2" square, piece red perspex 7/8ths" X ½". Epoxy resin, 2 off 6BA brass cheesehead bolts. 20 SWG tin plate. 30 SWG tinned copper wire. PTFE sleeving. 2 off mallory MS76M.

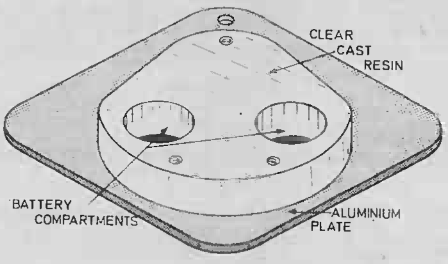


Component layout, shown at twice times life size.

BUY LINES

This project could have been made much smaller by using a flat pack version of the 4011 and miniature hearing aid type transistors, and 1/20th watt resistors. This would reduce the size to almost the display and battery dimensions. But by using commonly available components a respectable size has been achieved.

Twentieth watt resistors are available from Electrovalue and the display from Maplin. The Mallory MS76H cells are available from chemists or photographic shops.



LED Pendant as seen from rear after potting, note battery compartments.

Electronic construction

The front facia finished, the electronics can be mounted with super glue or epoxy resin having centralised the display over the window.

Great care must be taken in positioning the components when wiring to prevent shorts. Thirty-two SWG tinned coppper wire and PTFE sleeving to suit, was used to hard wire the circuit, as in the wiring diagram. Small pieces of tin plate were stuck down with double sided sticky pads for the battery contacts.

The sticky pads serve a dual purpose. They insulate the contacts from the front panel and also provide the tension to ensure good electrical contact.

Finishing it off

When all the wiring is complete the battery compartments need to be constructed. Make up two tubes of the same external diameter as the batteries, out of cellophane and position them on the facia over the battery contacts, then pour quick set epoxy or clear cast around the tubes. When the epoxy has set remove the tubes and you have two battery compartments.

Make up another cellophane tube about 1½in in diameter. Place this around the finished electronics and battery compartments and pour more clear cast over to cover everything to the depth of the battery compartments. When this has set, a thin sheet of aluminium can be screwed down with countersunk self-tappers. (This sheet forms the common connection for the two cells.)

Presentation

Having built the device, and given it to your loved one, all that remains is for you to reap your just rewards, preferably in dimly lit surroundings where the pulsating red glow will produce the desired effect.

TTY CARD

Designed by John Miller-Kirkpatrick

THIS MONTH WE begin the description of the optional boards which may be added to the basic System 68 to extend its capabilities.

The board we have chosen to describe first allows for two UARTS plus a 20mA loop I/O interface to give two parallel to serial/serial to parallel devices which may be run at different speeds.

Why TTY

Why a TTY I/O interface card for a VDU based system I hear you ask. The reasoning behind it is quite simple.

First there are many people who will want to use their VDU for the majority of their development work but use a TTY as a hard copy output for the final result. The second reason is to allow the use of other I/O devices which expect TTY configured signals. An example of such a device is the MP-40 printer described in last month's Microfile (for microphilliacs?) The final reason for adding a TTY interface is to pave the way for a CUTS cassette interface which uses a UART, the principle component of the TTY card, at 300 baud for the majority of its I/O timing.

Getting A Bit Baud

Before beginning a description of the TTY card we thought that a brief description of some of the terms associated with serial transmission in general would not go amiss.

Serial transmission may commonly be divided into two distinct types. These are referred to as Asynchronus and Synchronous.

In Synchronous transmission all timing and control of the data is undertaken by a clock that is common to both transmitter and receiver. Synchronous transmission is used only when high speed is a prime requirement.

Almost all low speed circuits use an Asynchronous system. In this type of transmission there is no common clock, the timing and control being performed by control bits appended to the transmitted signal.

The other terms that crop up when dealing with serial orientated machines are Baud and Bits Per Second (BPS).

Bits per second is a term used to define the number of data bits sent down a line in one second.

As mentioned above, however, most serial signal have a number of control bits appended. This means that a group of eight data bits will have, say, three control bits added. This makes a total of eleven bits in each transmitted group.

Baud is the term used for the total number of bits (data plus control) sent in one second.

Thus TTY which transmits an eight bit data signal plus three control bits as a group of data in 9.09mS has a baud rate of 110 but a BPS rate of 80.

Thou Art, No, UART

Having stated that a UART forms the major part of the design now is the time to go into some details of this device. UART stands for Universal Asynchronous Receiver/Transmitter. Its specification states that it is an LSI sub-system that accepts binary data from a terminal or MPU and receives/transmits this character with parallel-serial or serial-parallel conversion as appropriate.

The UART also both adds control and error detecting bits when transmitting and strips a recieved serial signal of these same bits.

It might be easiest to consider a UART as an intelligent parallel/serial/parallel shift register.

Why UART Needed

A PISO (Parallel Input Serial Output) shift register could be loaded from a data bus with eight bits and then present these bits one at a time in sequence at a single output pin as requested by an external clock. If these serial bits were now input to a SIPO (Serial Input, Parallel Output) shift register driven by the same clock then the bits would become available at its eight output pins in the form in which they were originally input to the PISO.

To understand the need for the apparent complexity of a UART, consider attempting conversion/transmission together with associated reception using simpler PISOs and SIPOs.

I Sync, Therefore UART

The problem of synchronization appears immediatly, what happens if a clock signal is missed or mis-interpreted by either the PISO or the SIPO? Answer, not only is that 8 bit word mutilated but all subsequent words will be similarly mutilated.

The way to get over this is to send a special code which indicates that a new 8 bit word is just starting and another code to indicate that an 8 bit word is just finished. Now instead of 8 bits we need to transmit about 10 or 11 bits to include our START and STOP bits.

If we do have reception problems we can have several error conditions.

1. Parity error, if a bit has been lost or misread then a parity check will show this, we need an output to indicate that the last data received contained a parity error. We also need to generate and transmit the parity bit.

2. Framing error, if too few bits were received or if a valid stop bit was not received.

3. Over-run, data is being received for a second word before the first word has been cleared from the receiver.

Art Of Control

We also need some other controls to indicate to the transmitter that the

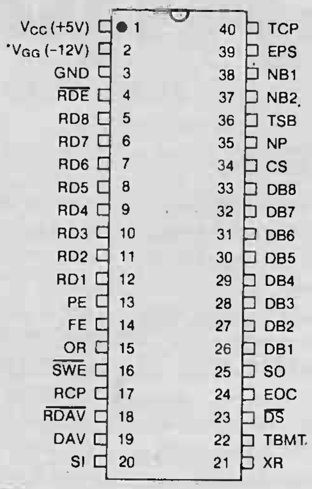
DATA SHEET

UAR/T UNIVERSAL A SYNCHRONOUS RECEIVER/TRANSMITTER

PIN CONFIGURATION

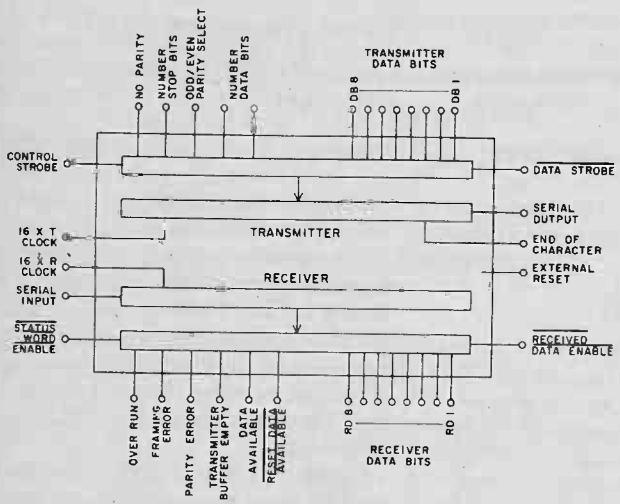
40 LEAD DUAL IN LINE

Top View



*Pin 2: AY-3-1014A/1015
— No Connection.

BLOCK DIAGRAM



Pin No.	Name (Symbol)
1	V_{CC} Power Supply (V_{CC})
2	V_{GG} Power Supply (V_{GG})
3	Ground (V_{GI})
4	Received Data Enable (RDE)
5-12	Received Data Bits (RD8-RD1)
13	Parity Error (PE)
14	Framing Error (FE)
15	Over-Run (OR)
16	Status Word Enable (SWE)
17	Receiver Clock (RCP)
18	Reset Data Available (RDAV)
19	Data Available (DAV)
20	Serial Input (SI)
21	External Reset (XR)
22	Transmitter Buffer Empty (TBMT)
23	Data Strobe (DS)
24	End of Character (EOC)
25	Serial Output (SO)
26-33	Data Bit Inputs (DB1-DB8)
34	Control Strobe (CS)
35	No Parity (NP)
36	Number of Stop Bits (TSB)
37-38	Number of Bits/Character (NB2, NB1)
39	Odd/Even Parity Select (EPS)
40	Transmitter Clock (TCP)

FEATURES

- DTL and TLL compatible—no interfacing circuits required—drives one TTL load.
- Fully Double Buffered—eliminates need for system synchronization, facilitates high-speed operation.
- Full Duplex Operation—can handle multiple bauds. (receiving-transmitting) simultaneously.
- Start Bit Verification—decreases error rate with center sampling.
- Receiver center sampling of serial input; 46% distortion immunity.
- High Speed Operation.
- Three-State Outputs—bus structure capability.
- Low Power-minimum power requirements.
- Input Protected—eliminates handling problems.

Function

+5V Supply

−12V Supply (Not connected for AY-3-1014A/1015)

Ground

A logic "O" on the receiver enable line places the received data onto the output lines.

These are the 8 data output lines. Received characters are right justified: the LSB always appears on RD1. These lines have tri-state outputs; i.e., they have the normal TTL ouput characteristics when $\overline{RDE}$ is "O" and a high impedance state when $\overline{RDE}$ is "1". Thus, the data output lines can be bus structure oriented.

This lines goes to a logic "1" if the received character parity does not agree with the selected parity. Tri-state.

This line goes to a logic "1" if the received character has no valid stop bit. Tri-state.

This line goes to a logic "1" if the previously received character is not read (DAV line not reset) before the present character is transferred to the receiver holding register. Tri-state.

A logic "O" on this line places the status word bits (PE, FE, OR, DAV, TBMT) onto the output lines. Tri-state.

This line will contain a clock whose frequency is 16 times (16X) the desired receiver baud.

A logic "O" will reset the DAV line. The DAV F/F is only thing that is reset.

This line goes to a logic "1" when an entire character has been received and transferred to the receiver holding register. Tri-state. Fig.12,34.

This line accepts the serial bit input stream. A Marking (logic "1") to spacing (logic "O") transition is required for initiation of data reception. Fig.11,12,33,34.

Resets all registers (except that the received data register is not reset in the AY-5-1013/1013A and AY-6-1013). Sets SO, EOC, and TBMT to a logic "1". Resets DAV, and error flags to "O". Clears input data buffer. Must be tied to logic "O" when not in use.

The transmitter buffer empty flag goes to a logic "1" when the data bits holding register may be loaded with another character. Tri-state. See Fig.18,20,40,42.

A strobe on this line will enter the data bits into the data bits holding register. Initial data transmission is initiated by the rising edge of $\overline{DS}$. Data must be stable during entire strobe.

This line goes to a logic "1" each time a full character is transmitted. It remains at this level until the start of transmission of the next character. See Fig.17,19,39,41.

This line will serially, by bit, provide the entire transmitted character. It will remain at a logic "1" when no data is being transmitted. See Fig.16.

There are up to 8 data bit input lines available.

A logic "1" on this lead will enter the control bits (EPS, NB1, NB2, TSB, NP) into the control bits holding register. This line can be strobed or hard wired to a logic "1" level.

A logic "1" on this lead will eliminate the parity bit from the transmitted and received character (no PE indication). The stop bit(s) will immediately follow the last data bit. If not used, this lead must be tied to a logic "O".

This lead will select the number of stop bits, 1 or 2, to be appended immediately after the parity bit. A logic "0" will insert 1 stop bit and a logic "1" will insert 2 stop bits. For the AY-3-1014A/1015, the combined selection of 2 stop bits and 5 bits/character will produce 1½ stop bits.

These two leads will be internally decoded to select either 5, 6, 7 or 8 data bits/character.

NB2	NB1	Bits/Character
0	0	5
0	1	6
1	0	7
1	1	8

The logic level on this pin selects the type of parity which will be appended immediately after the data bits. It also determines the parity that will be checked by the receiver. A logic "O" will insert odd parity and a logic "1" will insert even parity.

This line will contain a clock whose frequency is 16 times (16X), the desired transmitter baud.

previous word has been sent and the next word can be loaded and a similar signal to inform the receiver that a valid word has been received and is now available in the parallel output buffer.

A UART performs all these functions, plus a few more; this single LSI chip, selling for about £62 can replace the 30 or so MSI TTL chips that would be needed to do the job with TTL.

Many IC manufacturers make UARTS and most are fully pin and function compatible, two examples are the National MM5303 and General Instrument's AY-5-1013. The pinout and pin functions of these are shown in the System 68 data sheet in this issue.

MPUs Like UARTs

Before we leave UARTs in general there is one useful point to note and that is that the data inputs are internally latched and that they are in a tri-state mode if not selected by the appropriate strobe. This means that the input and output data lines be connected directly to an MPU bus, it would thus be possible to produce a UART in a much smaller package (perhaps 14 pin) if this type of operation was always to be used. Quite a difference from our 30+ package original design!

S 68 Loves UARTS

As you can see from the above, connecting a UART to System 68 is very easy and takes up little space which is why we have allowed for two units on the same PCB. The basic circuitry for both halves is identical except that component values may be changed to give, for instance, two different Baud rates from the two 555 timers. It is not necessary to install both circuits initially and it is not necessary to install the 20mA interface if the UART will only be used for our CUTS interface. If you intend to use System 68 to talk to another MPU or similar I/Os where you can get at the other unit's UART you can go directly from UART to UART with no TTY interface In this case keep interconnecting leads short, screened and watch out for any mis match on power supplies, ie if you have earthed chassis then one may not be the same as the other relative to ground — could be a bye-bye system.

Apart from these simple tests it is best to use MPU software to check the operation of the unit, more about this next month.

TTY CARD

The Continuing Story

Next month we shall deal with the construction of the TTY. card and the test procedures needed to verify its operation.. We shall also cover the software necessary to ''drive'' the card.

And Now For Something

Having dealt with hardware up until now, its here that software gets its turn.

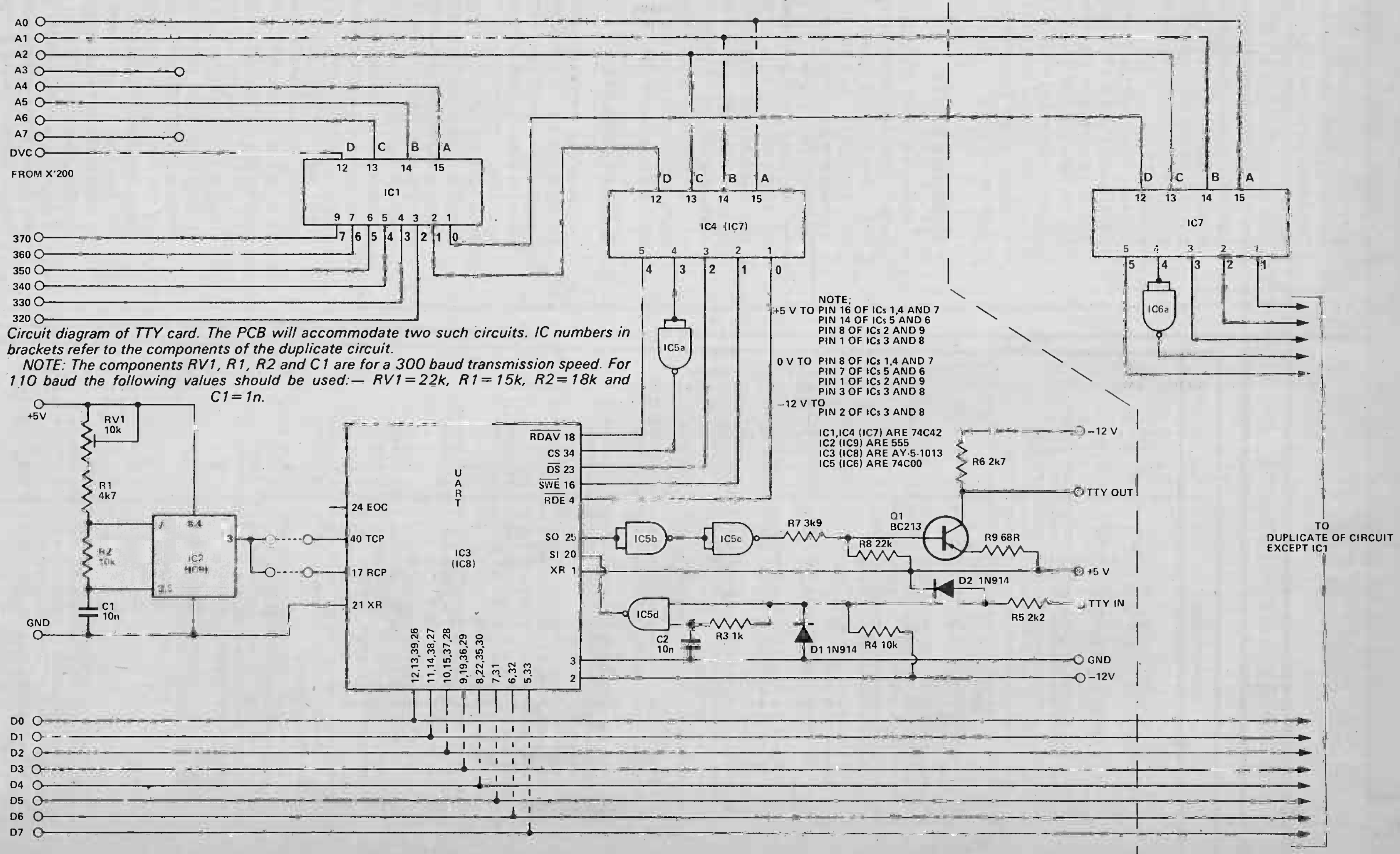
This month we publish the first of, what we hope, will be a regular series of software tips.

We developed this month's routine but hope that in the future we will be able to publish reader's ideas.

So if you have any interesting ideas for small routines, or an 8K BASIC if you will, send them to us. We will be glad to see ideas, flow diagrams, assembly codes, object codes or anything.

Do not even worry if your program is not in 6800 code, if its interesting enough we will modify it to run on System 68.

So get writing that software.



Circuit diagram of TTY card. The PCB will accommodate two such circuits. IC numbers in brackets refer to the components of the duplicate circuit.

NOTE: The components RV1, R1, R2 and C1 are for a 300 baud transmission speed. For 110 baud the following values should be used:— RV1 = 22k, R1 = 15k, R2 = 18k and C1 = 1n.

A glance at the circuit diagram will show that most of the activity on the TTY card occurs within the confines of the UART.

We shall therefore begin this description of circuit operation with a detailed look at this device.

The following sections should be read in conjunction with the circuit diagram and the UART data sheet.

UART TRANSMITTER

In order to operate the UART, in addition to the +5V and −12V power supplies, requires a number of control and data signals.

The first of these that we shall look at is the transmit clock. This should be a signal that is sixteen times the required transmit frequency (if 4800Hz for 300 baud per second or 1760Hz for 110 baud per second). This clock frequency is input to the Transmitter Clock (TCP) input at pin 40.

The UART, when provided with this clock input, will respond with a series of MARKS at the Serial Output (SO) at pin 25.

MARK is a logical "1" bit of a serial data stream (a SPACE is the term used to describe a logical "0" bit).

At this stage the parity, number of stop bits and word length can be set up on the control lines (Odd/Even Parity Select — EPS — Pin 39, number of Stop Bits — TSB — Pin 36, Number of Bits/character — NB1, NB2 — pins 37 and 38) and strobed into internal latches by the control Strobe (CS Pin 34). Once these parameters are set they need not be re-entered before each word transmission.

The data to be transmitted should now be set up on the Data Bit Inputs (DP1—DB8 pints 26-33) and latched internally by the Data Strobe ($\overline{DS}$ pin 23).

This signal also indicates to the UART that a new word is ready for transmission. The UART will respond by setting the Transmitter Buffer empty signal (TBMT pin 22) to zero in order to indicate that a new data word may not be entered yet.

The UART now begins to output the data by setting the Serial output (SO pin 25) to zero — start bit — and then shifts out the data bits with appropriate parity and stop bits.

During transmission the End Of Character output (EOC pin 24) goes to logic "1" to indicate that the transmitter is busy. EOC returns low when transmission is complete.

Note — the data is transferred from the transmitter buffer to the transmitter shift register as soon as the latter is empty.

This means that the UART can hold two data words for transmission, one in the input buffer and one in the shift register.

The MPU can, by testing the TBMT signal, decide when the input buffer is empty and thus ready for the next word.

The only signal concerned with transmission not yet mentioned is the No Parity NP Pin 35) which if set at "1" will eliminate parity bits. In most applications it will be hardwired to "0".

UART RECEIVER

The receiver, as might be expected, operates in a manner opposite to that of the transmitter. It should be noted that the same UART parameters are used for both transmission and reception. Thus, while if these were set up for transmission there is no need to set them up again, there is no reason why different parameters cannot be used for transmission and reception. So, for example, a UART can input five bit, no parity words at 30 baud/second and output eight bit, parity words at 300 baud/second by changing UART

Data reception starts when the Serial Input (SI pin 20) changes from MARKING (Logic "1") to SPACING. (Logic "0") which represents a start bit. The start bit is valid if, after transition from "1" to "0", the SI line is still "0" when centre sampled eight clock pulses later. Note this clock time can be different from that used in the transmission section. The receive clock is input to the Receiver Clock (RCP pin 17).

After receiving a valid start bit the input proceeds until valid stop bits are recognised.

As the parity and stop bits are entered they are checked against the UART parameters and the appropriate error flip-flop set is an error is detected (Parity Error — PE pin 13 or Framing Error — FE pin 14).

Once a complete word has been received the Data Available (DAV — pin 19) flip-flop will be set to indicate to any external device that data is available.

The data is output to the Received Data bus (RD1-RD8 pins 5-12). These outputs have tri-state outputs so that they may be used in bus structure orientated systems. The tri-state outputs are controlled by the Received Data Enable ($\overline{RDE}$ pin 4) line.

The external device must accept the data and signal that it has done so, by resetting the data available flip-flop by pulsing the Reset Data Available line ($\overline{RDAV}$ pin 18).

If a second complete character is received before the first has been read out, the Over-Run (OR pin 15) is set.

Before resetting the data available flip-flop any errors indicated by the status word buffer, contents placed on data bus by taking Status Word Enable ($\overline{SWE}$ pin 16) low, and if serious indicate so to the external device.

Apart from the power supplies applied to pins 1-3, the only pin not mentioned so far is the EXTernal Reset (XR pin 21) which may be used to reset all registers.

This completes a fairly detailed look at the operation of a UART and should make the operation of the TTY card easier to follow.

The support components on the TTY card can be split into three sections; clock generator, address decoding and 20mA interface.

CLOCK GENERATOR

The clock generator is based on IC2, a 555 timer. With the component values shown the clock frequency is 4800 Hz, suitable for 300 baud/second transmission and reception.

20mA INTERFACE

The output from the UART is buffered by two sections of IC5 which in turn drives Q1 which acts as both an inverter and 20mA loop driver. This is fed to the TTY output.

TTY input is passed via a filtering and level shifting network before being passed to one section of IC5 to be inverted and input to the UART.

ADDRESS DECODING

Decoding is carried out using 74C42 BCD-Decimal decoders. Of the ten outputs provided on this chip we shall at most use only the first eight (0-7).

In operation one of the outputs of the device will adopt an active (low) state depending upon the specific BCD code applied to the four input lines (A-D; D=MSB).

Our application uses the D input as a form of chip enable line. We can do this because if D is high, the output line enabled must be greater than decimal seven and hence the chip is effectively disabled.

Taking D low will cause one of the lines 0-7 to go low, the specific line depending upon the binary code applied to the A-C inputs.

The whole card is enabled by the X'200 output from the CPU card. This active low signal is applied to the D input of IC1 and this enables this device's output.

The particular output required is selected by three of the systems address lines, $A_4 A_5$ and A_6. This means that the eight outputs from ICI become decodes for the addresses X' 2x0 to X' 2xF where the X in each case represents the binary value of address lines A_4-A_6.

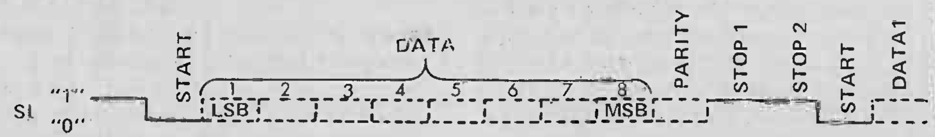
Thus we have eight outputs each of which uniquely decodes a block of sixteen sequential addresses (selected by A_0-A_3).

Six of these lines are used to enable units off the TTY card. The other two enables are used to similarly enable the outputs of ICs 4 and 7 which in turn control the operation of the UARTS (ICs 3 and 8).

Five of the potential eight outputs of IC4(7) are used to enable functions of the appropriate UART as shown in table 1.

TABLE 1

Function	Signal	IC4(7)	Address
Read from UART	$\overline{RDE}$	0	X' 2 x 0
Check for errors	$\overline{SWE}$	1	X' 2 x 1
Load UART	$\overline{DS}$	2	X' 2 x 2
Load parameters	$\overline{CS}$	3	X' 2 x 3
Reset DAV F/F	$\overline{RDAV}$	4	X' 2 x 4



Typical configuration of serial data. The initial transition from logic "1" to "0" indicates the start of the data chain. Next follow eight data bits a parity bits and two stop bits. The UART allows for many different configurations but all follow this basic pattern.

CPU CARD CORRECTIONS

Link 1C pin 11 to 1C2 pin 5
Link 1C8 to D7

Link from 1C to pin 17 should go to 1C5 pin 7

Links D0 to D7 are shown reversed on overlay (ie D0 to D7, D1 to D6 etc).

SOFT WARE

FORMATTED HEXADECIMAL DUMP

This program will print any 128 byte section of system memory as a formatted hexadecimal dump starting at the top of the VDU screen.
The dump is formatted as 16 lines with 16 bytes per line, each line starting with the low address of its 16 bytes.

The routine assumes that upon entry the X Reg holds the address from which the dump is to start.

0080	FFA016	STX TEMP2	Save value of X at TEMP 2
0083	CE8800	LDX X '8800	Load X with X '8800 (Point to top of screen)
0086	FFA014	STX VDULOC	Save X at VDULOC (Next VDU position)
0089	C600	LDA B, O	Set counter to 0
008B	CEA016	LDX X 'A016	Point X at TEMP 2
008E	BDEEC8	JSR OUT4HS	Print Address
0091	BDEECC	OUT2S	Print space
0094	FEA016	LDX TEMP2	Restore original value of X
0097	BDEECA	JSR OUT2HS	Print data pointed to by X
009A	18	INVALID	Just to show invalid codes are ignored
009B	5C	INCR B	Add 1 to counter
009C	C50F	BIT B, X 'OF	Are all low order bits '1'? (Count = 15 + N * 16)
009E	26F7	BNE 0091	Print next data until 16 per line
00A0	860D	LDA A, X 'OD	Load CR character to Acc A
00A2	BDEE75	JSR OUTCH	Print CR
00A5	FFA016	STX TEMP2	Store current X for printing on next line
00A8	C180	CMP B, X '80	Is count =128?
00AA	26DF	BNE 008B	No - go to print address
00AC	3F	SWI	Return to ETIBUG.

This program illustrates the use of some of ETIBUG's internal routines.
The functions of these routines, together with their starting address, are given below.

ROUTINE	LOCATION	FUNCTION
OUT4HS	EEC8	To output two succesive memory locations, the first pointed to by X Reg, as 4Hex characters followed by a space. To increment X Reg. so that on exit this points to the memory location following the last location output.
OUT2HS	EECA	As OUT4HS except that 2 characters are output (one memory location).
OUT2S	EECC	Output one space character.
OUTCH	EE75	Output contents of Acc. A.

ETI DATA SHEET

NSL 4944 UNIVERSAL LED — NATIONAL

THE NSL4944 IS A simple two-lead device normally used as an AC or DC indicator whch can also be used as a rectifier and constant current source at the same time in associated circuitry. Further, most of the regulating circuitry is not in series with the LED. This allows the complete regulated LED to operate at only about 300 mV more than a standard red LED. Thus the NSL4944 operates on half the voltage needed by previously available regulated or resistor LEDs. The device is rated for a maximum of 18 V forward and reverse.

These characteristics provide several advantages. Unloaded TTL gates provide enough voltage, in either high or low states, to directly drive the universal indicator. Size and weight can be saved in instruments with a number of indicator lights by reducing the size of filter capacitors or voltage regulators. The NSL4944 can operate on unfiltered DC or at somewhat reduced intensity on 3 to 12 VAC. Since the IC within the regulated LED blocks reverse voltage, the device can be used as a low voltage rectifier or polarity indicator.

Equivalent Circuit

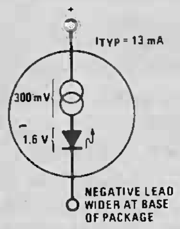


FIGURE 1: Equivalent Circuit

The LED and its current source, as illustrated in Fig. 1, both fit within a standard LED package. The typical operating voltages shown allow the device to operate with lower supplies and take up less room than an LED and resistor.

Schematic

Figure 2 shows how some of the operating features of the device are achieved. The rectifying characteristic occurs because the only input to the device passes through the IC's PNP emitters. These have a high reverse voltage in standard linear processing. The voltage reference and comparison amplifier operate from the same low voltage that the LED does. The big PNP transistor which passes both I_{LED} and I_{REF} can be operated almost in saturation since the comparison amplifier can pull the PNP base down to only one volt from common.

Features

- Supply range 2 V to 18 V
- Reverse polarity protection
- Constant light output over 3 V
- No larger than normal LED
- 12mA to 14 mA current
- 300 mW dissipation
- Low cost per unit

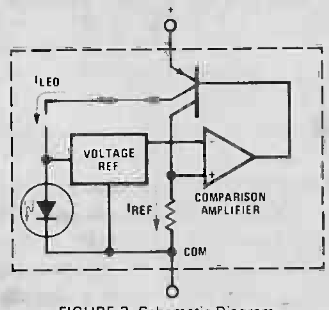


FIGURE 2. Schematic Diagram.

Unfiltered AC

Power and parts count is minimized by powering the indicator from a low voltage transformer winding as shown in Fig. 3. This method, however, provides only half intensity light, but the apparent visual decrease is not as great. Some flicker occurs if the observer moves his head rapidly. The supply of Fig. 4 will provide up to 87% of maximum light output. The bulk of a filter capacitor is still not needed, and at 12 VAC in, flicker will be almost imperceptible since the LED "off" periods will be less than a millisecond. In both situations, the indicator may be switched a number of ways, including bipolar transistors, since only DC can pass through the indicator.

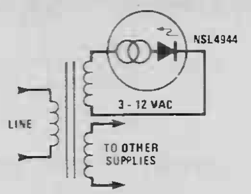


FIGURE 3. AC Power

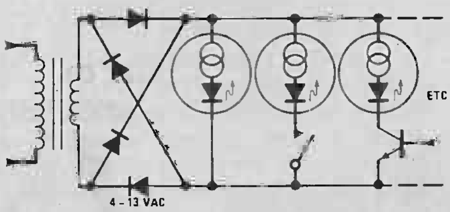


FIGURE 4. Unfiltered DC Power

Full Intensity

As shown in Fig. 5, full intensity and zero possible flicker are achieved by minimal DC filtering. The small capacitor shown operates with 10 V p-p ripple and only about 8 V average DC, while the constant current drain characteristics of the NSL 4944 allow only a few percent change in light intensity. If a system or instrument with a regulated supply has a number of LED indicators, regulator size and dissipation can be minimized by powering the regulated LEDs from the unregulated voltage.

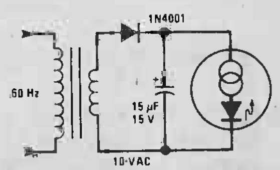


FIGURE 5. Minimizing DC Filtering

Reduced Intensity

The low operating voltage and constant current characteristics make the regulated LED an ideal status indicator for digital circuitry. An interesting fact to keep in mind is that full regulator current is not needed to light the LED. If, for example, only 8 mA is available (from a voltage of 1.6 to 1.9 V) the LED will light at a somewhat reduced intensity. The regulator will be switched full on instead of current limiting . . . but in such a situation it doesn't matter.

TTL Drive

Any circuit capable of supplying 10 to 20 mA and a voltage swing of at least 1 V can switch the NSL4944 from an off to an on state Fig 6a, b. Within 25°C of room temperature, an input voltage of 1.3V will produce little or no light, and 2.3 V will produce 70% to 90% of full output. However, with a small signal change, the pre-existing biases must be correct. The output swing of a TTL stage goes much closer to ground than to the 5 V supply.

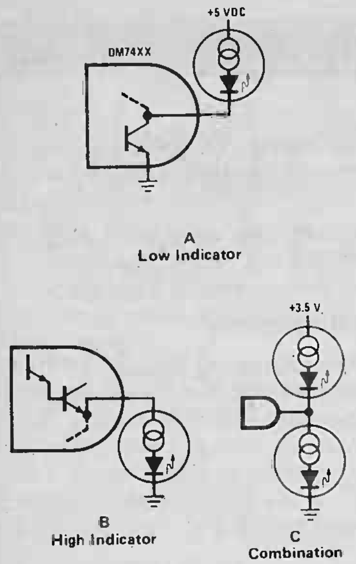


FIGURE 6. TTL Indicators

Therefore, Fig. 6-C requires a 3.5 V supply for the indicators to have complete off-on switching.

Replacing FETs

In many circuits or small instruments the need for a constant current source or current limiter arises. FETs can generally only be used as low current sources, so for 10 mA or more parts. If an indicator or pilot light is also needed, the regulated LED may be a very economical source of the needed constant current.

The examples below illustrate all three characteristics of the NSL4944. It is a combined rectifier, constant current source, and pilot light.

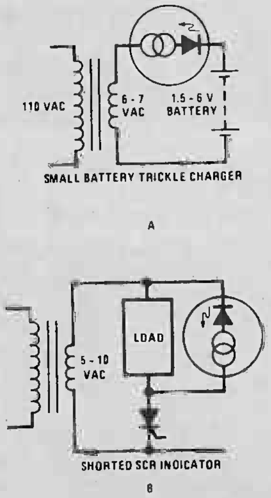


FIGURE 7.

Shortproof Circuit

A current source can also be a current limiter. Fig. 8 shows an NSL4944 put in the collector of an emitter follower such as might be used in a pre-amp or mike mixer cable driver.

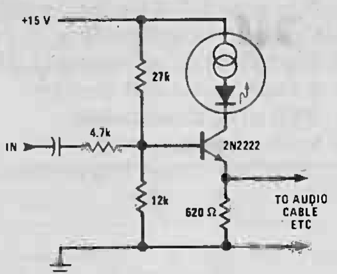


FIGURE 8. Current Limiting and Short Protection

Normally voltage across the LED is only 2 V, allowing almost full supply-to-supply swing of the emitter follower output. In comparison a limiting resistor would either greatly increase output impedance, or severely limit output swing. However, if the output cable is accidentally shorted, only a little more than the rated current of the LED will flow. Output transistor dissipation actually decreases under emitter short conditions.

Delay Tactics

Logically, a constant current source is helpful in designing time delay circuits. If the circuit of Fig. 9 were built with a resistor, the timing period would only be half the amount shown, and timing would vary over 50% with the supply variations shown.

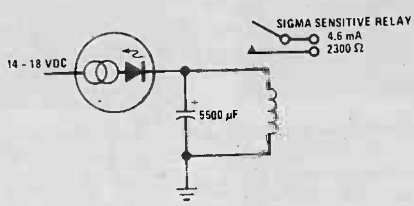


FIGURE 9. Six Second Time Delay

Instead, the current regulated LED is still drawing within 10% of full current when the relay reaches its 11 V pull-in voltage. The 14 to 18 V supply variation will produce only about a 3% timing variation, a considerable improvement. Variations due to temperature and electrolytic capacitor tolerances will remain however.

A number of LEDs can "share" a single constant current LED. Further, any of the ordinary LEDs can be turned on and off by a shunting switch without affecting operation of any of the others.

Active Loads

The lamp-driver Schmitt of Fig 10 illustrates a still further use of the NSL4944's constant current source. Substituting a current source for the collector resistor increases the useful voltage gain of Q_1. Further, almost full base current remains available to Q_2, even when supplying 12 V output, which would not be possible using a resistor. When the lamp and Q_2 are off, most of the LED current flows in

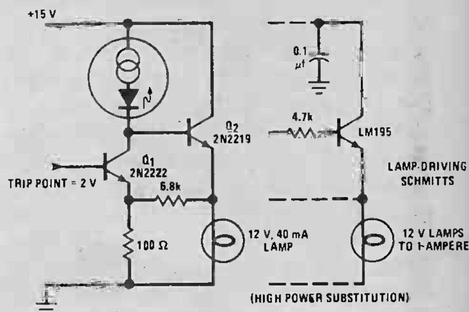


FIGURE 10. Use as Active Load

the 100 R resistor, thus determining the circuit's switching or trip point of 2 V.

With Q_1 saturated, Q_2 still provides a volt to the bulb, contributing some preheating and reducing the bulb's starting current surge. On, Q_2 provides the bulb with 12 V due to the minimum voltage drop in the constant current LED. The 6k8 feedback resistor sets hysteresis at a measured 50 mV at the input. This can be varied without having to change the rest of the circuit. 10k provides almost "0" hysteresis (undesirable and unstable) while 2k sets a hysteresis of 0.5 V.

The NSL4944 is available from National stockists, all branches of Marshalls should have stocks. Price is 62p including VAT.

DIGITAL ELECTRONICS BY EXPERIMENT PART 2

THE IC WE HAVE CHOSEN to introduce TTL is the SN7414 Schmitt inverter, placed at the top left hand side of the blob-board. (As all the TTL series start with the letters SN, we shall omit these in future, and refer, for example, to the 7414.)

The circuit of an inverter is that of a high-gain inverting d.c. amplifier (Fig. 1), with the input at the emitter of a transistor and the output from a single-ended push-pull stage which is capable of passing of up to 16mA in either direction (to + 5 V or to earth). This type of design, typical of TTL circuits, has several important implications for us.

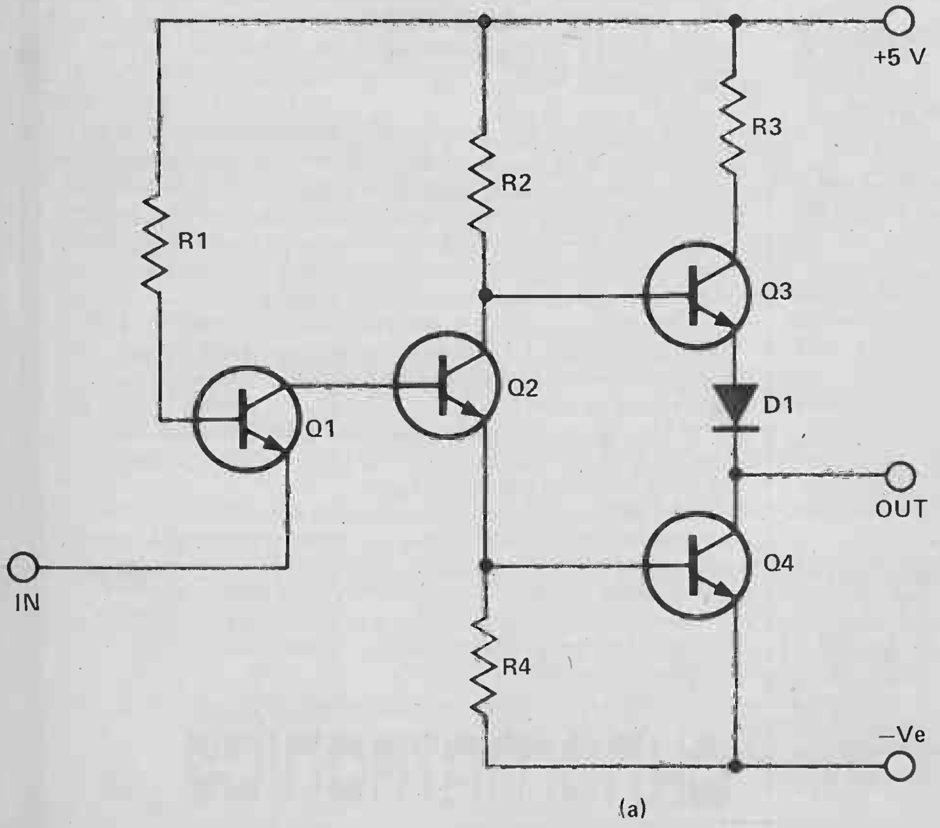
Source or sink

One important result is that the input impedance is fairly low when the input stage is conducting. If the input is left floating, the connection of the base of the first transistor to + 5 V will ensure that the emitter terminal will also be at high (+5V) voltage: The first transistor will be cut off in this state. The normal action of an inverter is that a high (or "1") input produces a low ("0) output, so that Q_2 is switched on by the high voltage at the collector of Tr_1 and connects the output terminal to earth through Q_4. As mentioned above, this will allow a current of up to 16mA to pass from a positive source; in TTL language, the output stage will sink a current of up to 16mA.

Thank you fans

When we connect the input of the inverter to earth (0), what we are doing is to earth the emitter of Q_1, with the base still connected, through its current limiting resistor, to + 5 V. When this is done, a current of about 1.6 mA (set by the value of the limiting resistor) will flow from base to emitter, and it is very important that any resistance between the emitter (input) and earth should be small enough to prevent the emitter voltage rising above about 0.5V in normal use. This is ensured when we drive a TTL input from the output of another TTL device, since a TTL output can sink a current of up to 16 mA, the current from ten inputs, without the emitter voltages rising too high for reliable operation. This is referred to as a "fan-out" of ten at the output.

Since in these circuits we are interested only in high and low signal levels, we must make sure that there is no uncertainty about either of these



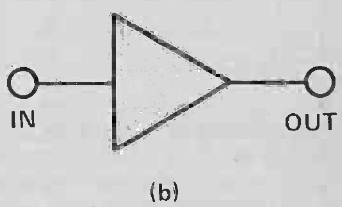


Fig. 1. A typical TTL inverter circuit (a). The value of R1 is about 3k, to limit the base current to 1.6mA. (b) Symbol.

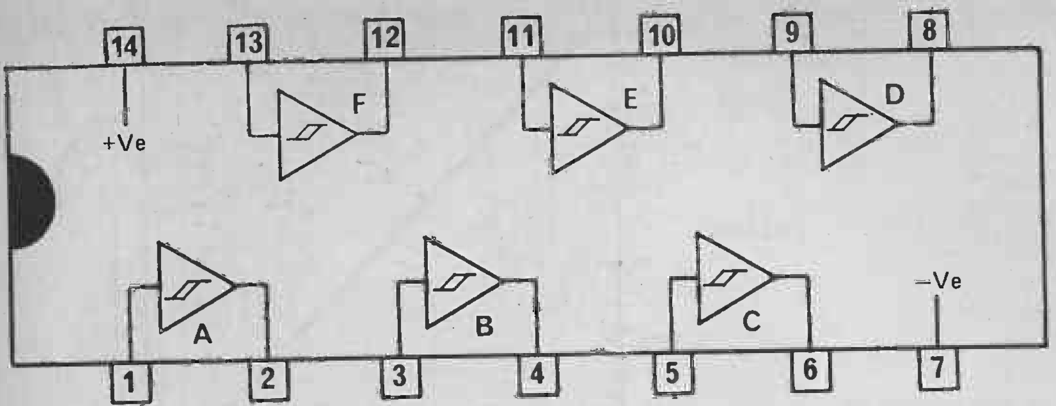


Fig. 2. Pin-out of the SN7414N Hex Schmitt inverter.

levels, and the usual TTL limits are: maximum of 0.8V for the low; minimum of 2.2 V for the high. We prefer if possible not to approach these limits too closely, and if we drive a TTL input from any other type of output, we must be sure that the source impedance of the driver output will be low enough to allow a current of 1.6mA to be sunk at a voltage level of 0.5V or less; this corresponds to an output impedance of 300R or less.

Starting work

Ensure that the 1 and 0 lines on your blob-board are fully linked up and, if you are using it, connected to the stabilised supply. Join + and – leads to the power supply. If you have a separate stabilised supply, these leads, which should be colour coded, will connect directly to the 1 and 0 lines on the board. If you are using the built on stabiliser, the leads should run to the stabiliser input.

With no other connections made (none of the ICs wired to 1 or 0 lines) ensure that the voltage between lines 1 and 0 is between 4.75 V and 5.25 V with the supplies on. Switch off again. This check should be repeated whenever the board is used from a variable voltage supply, since TTL circuits will be damaged if any input is taken to 0 with the applied voltage too high.

Four for four uses

Connect the supplies to the 7414, pin 14 to +5V, pin 7 to earth. These connections, like all the connections which follow, are made by soldering short lengths of insulated wire between pads on the blob-board, as shown in Fig. 3. These connections, once made, can be left permanently.

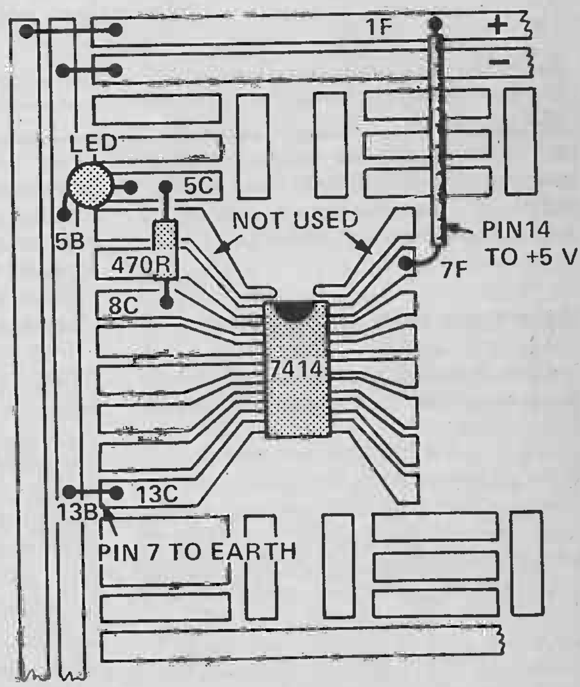


Fig. 3. Connections to + and – lines using wires. This also shows the LED and its limiting resistor (Fig. 4) in place.

(With no other connections made, the IC will draw a current of about 85 mA.)

Now connect a 470R resistor and an LED to form the circuit of Fig. 4. This is done by tinning each end of the resistor and LED leadout wires, and then butting these tinned wires, in turn, against the blob-pad and touching wire and pad with a hot iron until the lead "blobs" into place. For this particular joint, we can use a spare pad, as shown in Fig. 3, with the resistor connected from pin 2 of the 7414 to the spare pad, and the LED connected from the spare pad to the 0 line. Note that the LED case is usually marked with a flat section at the wire which should be connected to the 0 line.

The LED will now light when the output of No 1 inverter (there are six inverters in the pack) is high. Switch on — the LED should remain unlit, since with the input, at pin No 1, floating high, the output will be low. Now check what happens when pin 1 is temporarily earthed through a wire link (no need to solder) placed with one end on the pin 1 blob-pad and the other end on the 0 line.

Bridge over troubled pads

Remove the wire, and try bridging between the blob-pad for pin 1 and

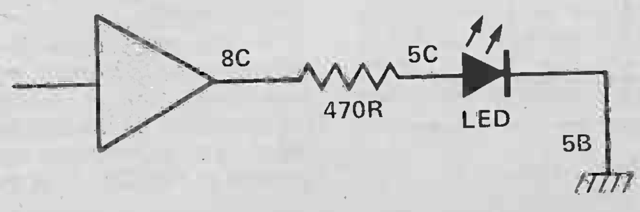
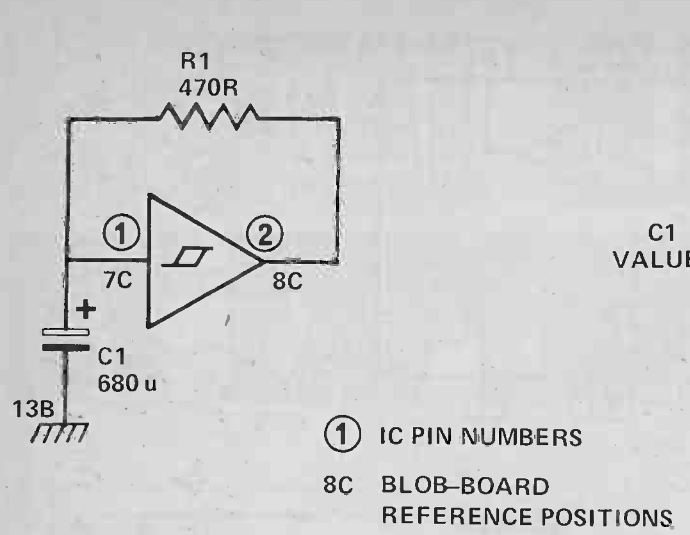


Fig. 4. LED indicator circuit.



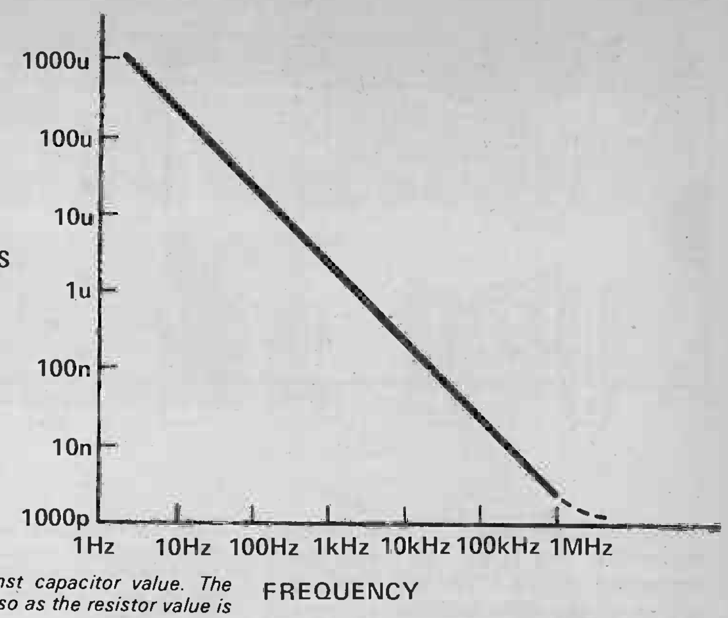


Fig. 6. Oscillator circuit, with a graph of approximate frequency against capacitor value. The frequency changes considerably when the operating voltage is changed, also as the resistor value is varied.

the 0 line with low value resistors, starting with 220R and working up. What is the maximum value of resistance which will allow the LED to light?

Schmitten with complexity

The actual circuit of the 7414 is more elaborate than the outline which has been shown in Fig. 1. These inverters are Schmitt trigger inverters, indicated by the symbol of Fig. 5(a), in which some positive feedback is used to make the changeover between 1 and 0 very much more rapid than that of an amplifier alone.

A simple discrete Schmitt trigger circuit as shown in Fig. 5(b), with the positive feedback applied by using a common load, R_2, for the two emitters. With the base of Q_1 at ?, the collector of Q_1 will be at 1, and Q_2 will be conducting, with its base voltage at a level decided by the values of R_1 and R_2, say 1.3V for the sake of an example.

The emitter voltage will be about 0.6V (since we are using silicon transistors) less than the base voltage of Q_2. If we now slowly increase the voltage at the base of Tr_1, nothing will happen until we reach a level of 1.3V in our example, at which level Q_1 will start to conduct.

When this happens, the voltage at the collector of Tr_1 starts to drop, reducing the base voltage of Q_2. Since every 80 mV drop on base voltage causes collector current to reduce to one tenth of its previous value (a useful rule and true for all silicon transistors), Q_2 will rapidly cut off, with the current now switching to Q_1 because of the positive feedback through the emitters.

If the base voltage of Q_1 is reduced again, it must be to a value less than the base voltage of Q_2 before Q_2 can conduct again.

In this way, there is a voltage difference or *hysteresis* between the switchover voltages in either switching direction, which is indicated on a graph of output voltage against input voltage in Fig. 5(c). It is the shape of this graph which is used as the symbol for a Schmitt stage.

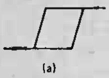
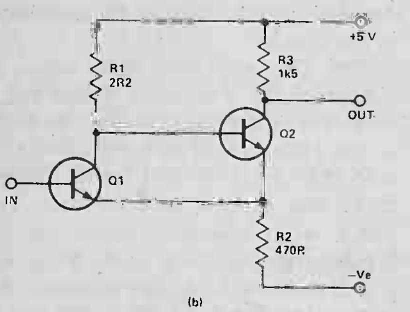
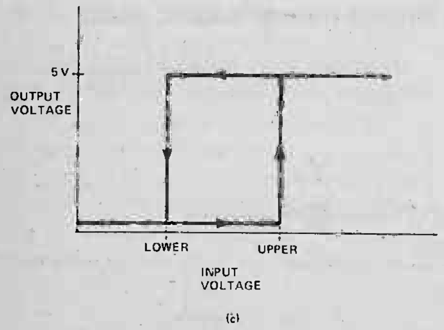


Fig. 5. Schmitt Trigger. (a) Symbol. (b) Typical circuit. (c) Graph of output voltage plotted against input voltage.



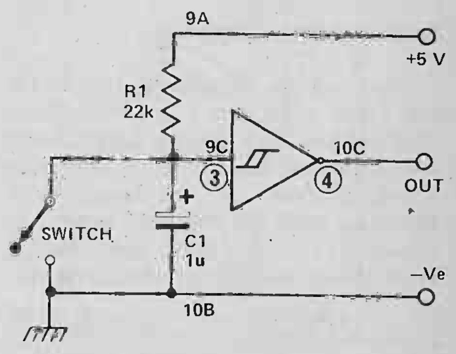


Slow, slow, quick quick . . .

Since the normal type of TTL circuit consists of a very high gain d.c. amplifier, there is a risk of positive feedback, causing high frequency oscillations, if the amplifier is ever operated, even momentarily, in a linear region, that is with the input biased so that the output voltage is between 1 and 0, or slowly changing. There is no problem if the change between 1 and 0 is fast, 30 ns or so, but slow in this context can mean 1 μs!

Slowly changing waveforms are most likely to be found when other circuits such as photocell amplifiers, microswitches or tacho-generators are connected to TTL inputs. This is an interface problem. Using a Schmitt stage at the input solves this, assuming we have a low enough impedance to drive the Schmitt, since the Schmitt action will give a 30 ns rise or fall time at its output for any

Fig. 7. Switch de-bouncing circuit.



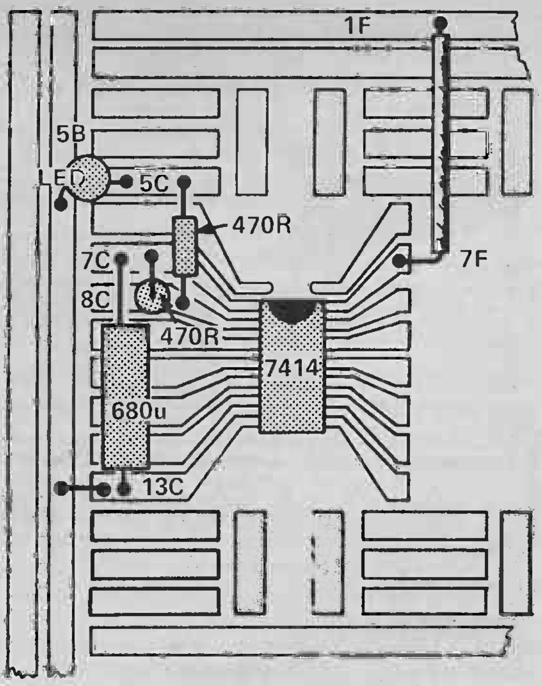


Fig. 8. Layout of the oscillator circuit on the Blob-board.

type of input, however slowly changing. Once the Schmitt has triggered, a comparatively large voltage swing is needed to make it change back. A Schmitt stage with high input impedance is also available (SN72560).

They call it de bounce

One of the unique features of this type of stage is that it can very simply act as an oscillator or as a switch de-bouncer. Oscillator action is achieved by connecting a resistor of between 330R and 820R between output and input, with a capacitor between input and earth. The circuit is shown in Fig.6. The output waveform is a square wave with very short rise and fall times, and unequal mark and space times.

When mechanical switches are used to provide waveforms for TTL circuits, contact bounce may cause problems. It occurs as contacts close, and cause a TTL input to be left briefly floating during the time of the bounce.

The effect of this can be to cause several output pulses from the switch where only one is intended. This is harmless if the switch is simply setting d.c. levels, but causes errors if the pulses are being counted. To *de*-bounce a switch, the circuit of Fig.7 can be used. The principle is that the time constant is longer than the bounce time of the switch, so that the voltage change when the contacts bounce is small, less than the hysteresis of the Schmitt circuit, hence no change in the trigger output when the bounce occurs.

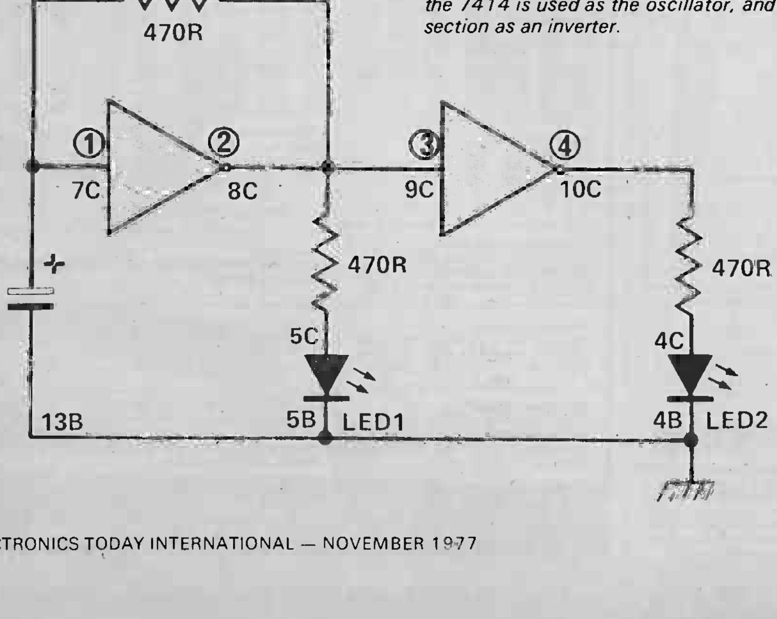


Fig. 9. Showing inverter action. One section of the 7414 is used as the oscillator, and the next section as an inverter.

Back to the Blob-Board

Using unit 1 of the 7414, make up an oscillator using a 680R resistor and a 680 µF capacitor as shown. Keep the connections previously made to the LED, since this can now be used to check that the oscillator is working.

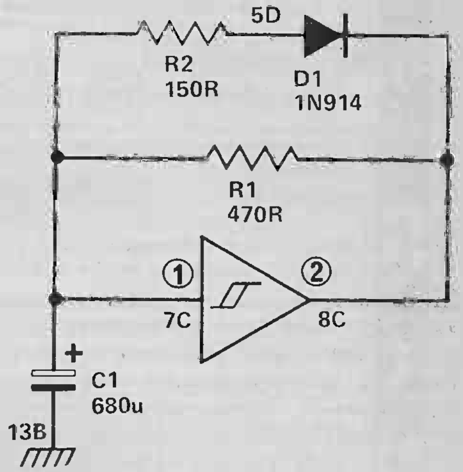


Fig. 10. Modification of the oscillator circuit for equal mark-space ratio. This is not needed for any of the applications in this series.

Estimate the frequency by counting the number of LED flashes in one minute, and then dividing the number counted by 60. Demonstrate the inverter action by using unit 2 as shown in Fig. 9. Wire a connection from pin 2 to pin 3 of the IC, and a 470R resistor from pin 4 to a spare pad. Connect another LED between this pad and earth to indicate when unit 2 output is high. Switch on again, and the two LEDs should blink alternately.

The oscillator can be modified for equal mark-space ratio by using the circuit of Fig.10. Some trial and error is needed to find the correct resistor value.

Organ Bank

Note that the 7414, with its six separate inverter circuits, can be used as the oscillator for an electric organ. Two 7414s will give a basic twelve note scale, and dividers can be used to produce lower frequencies.

Later in this series, the 7414 units will be used as oscillators to provide slow clock pulses, as inverters, and as switch de-bouncers. The connections made during this month's experiments can be left in place. ETI

To be continued

AUDIOPHILE

This page will be aimed at those of our readers interested in the mystical art of hi-fi. Each month we will try to bring you items of interest within that sphere.
If you have any problems relating to hi-fi, choosing equipment, compatibility between units, weird occurances etc. we might be able to help. Audiophile is to have its own readers queries service, for which there will be no charge - just an SAE please - and mark the envelope 'AUDIOPHILE' so that it gets to where it should be.
Replies may take up to two weeks, especially near the end if the month when things have a habit of getting hectic for us. Try and include anything and everything which may have any relevence to the query, and always give details of the COMPLETE system you're using.

It would appear that four channel sound might not be quite the flock of dead ducks we took it for. Over in our largest colony a new (1974!) system of enhancing matrix quad is causing no little stir.

The system is called the Tate Directional Enhancement System, hereafter reffered to as TDES to save our printers ink, and was originally launched at the Consumer Electron--ics Show in 1974 for dealing with SQ more kindly. It promises 30 dB MINIMUM seperation - and that's better than most pick-ups between ANY two of the four channels you care to pick. THD less than 0.05% and S/N ratio exceeds 70 dB.

Specifications won't get a system adopted, however, no matter how good. Compatability and cost, on the other hand, certainly will. One big advantage of the TDES is that National Semi are producing it as a chip set, LM1852 and LM1853, which will make the cost realistic to manu--facturers, recording studios and us mugs at the end of the chain.

Using their loaf

The two and a half years since TDES first appeared have been spent compressing the original breadboard design of 2ft by 3ft into these nice little National ICs, so that com--mercial companies can sell you a box you don't have to live in to use.

To get TDES to do its stuff a signal is fed in from a basic NON-LOGIC decoder, and the chip set than provides volume, balance and dimension control with four power amp feeds. A ready built board is being marketed in the USA for about £120, although prices must inevitably fall if volume sales begin to materialise.

National themselves estimate they'll sell 25 million units over the next five years. Either someone somewhere is very optimistic, or they know something we don't!

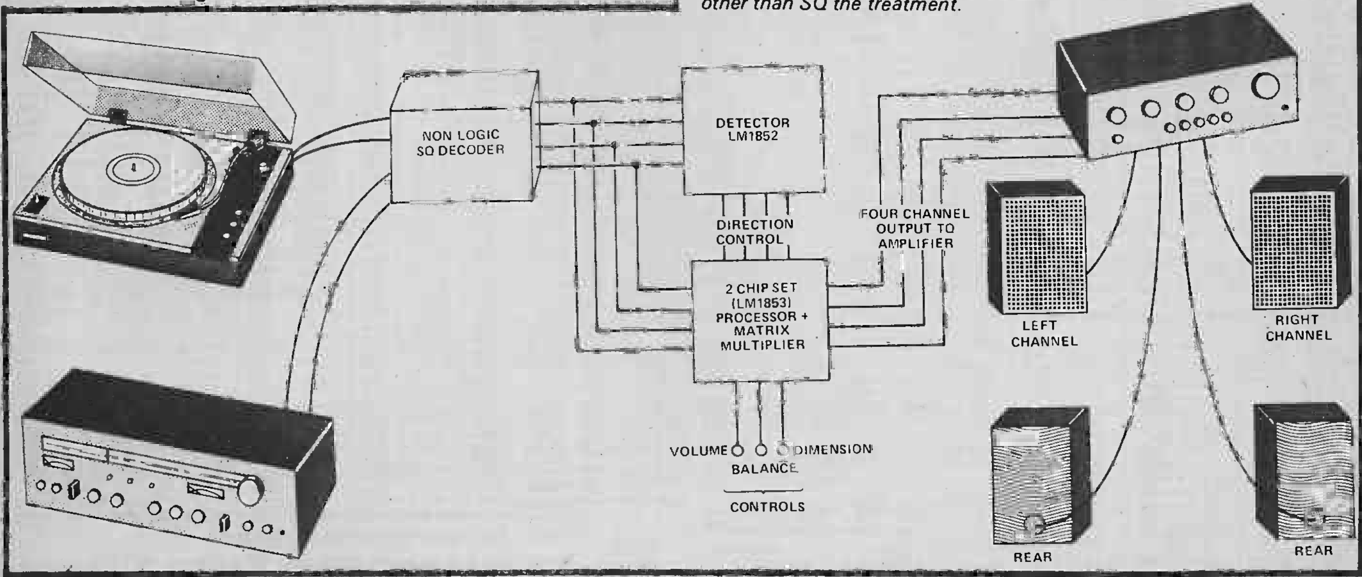
Household cavalry

Tates inventors naturally look upon their system as being the saving grace of quad, the hero arriving in the nick of time to the sound of bugles and dying Indjuns etc, but whether or not it can perform this almost divine act of ressurection will depend on the public - us.

Certainly the TDES is streets ahead of any of the present methods of getting four channels of sound from a stereo compatible disc or FM broadcast. It is relatively cheap, and leaves the present logic enhancement systems stand--ing. With those the only way to get 30 dB seperation was to play the speakers in four different rooms using four different pieces of music. And non-matrix quad i.e CD4 requires special cartridges and suffers from greater distort--ion and surface noise susceptibility. In fact TDESs inventor, one Wesley Ruggles, gets most upset at attempts to compare his baby with CD4.

For all this it looks like too little, too late. I hope we're wrong and the best of luck to Tate, but first let's get an industry standard, if it's Tate SQ - fine. So long as the vinyl starts to appear for us to use our new toy with, I think the uncommitted masses won't care which system it is, they'll just be glad to get off that fence safe in the knowledge that the clever orientals aren't going to invent something better tomorrow,

Below: Schematic diagram of the Tate Directional Enhancement System. By changing the front end it will be possible to give systems other than SQ the treatment.



ELECTRONICS TOMORROW

by John Miller-Kirkpatrick

RECENTLY I WAS thinking along the lines of persuading any standard seven segment multiplexed device, such as a calculator, clock or DVM chip to communicate happily with a microprocessor.

Telling time for MPUs

I had puzzled over this problem for some time before the obvious (or at least an obvious) answer occurred to me. Whatever logic is used to select the digit information, the seven segment data has to be latched for the MPU to be able to read it and also has to be capable of being attached to the data bus and thus has to have an optional tri-state output. The 74173, or for lower loading, the 74LS173 or 74C173 are four bit tri-state latchs suitable for latching data from an external source for eventual loading onto an MPU bus. If you imagine that the seven segment information (plus decimal point if needed) is input to two 74173s and then output to a data bus you can see that this is a very convenient way to hold and transfer the information between the clock, calculator or DVM chip to the MPU.

The problem of latching the information at the appropriate digit time is simply solved with another standard TTL package, the 74151. This is a data selector/multiplexer for up to eight lines. The idea is that you select the digit required by inputting the appropriate binary code on the three input lines and wait for a signal to indicate that the seven segment data is available in the latch. This signal and the latching strobe come from either of the 74151's outputs depending on the active state of the digit drive. Most multiplexed displays chips use an active high output on the digit drives ie the digit drive is normally low and goes high during its data display time. By connecting the digit drives to the inputs of the 74151 the status of each digit drive can be read off one at a time at the outputs. One output gives the TRUE representation of the input while the other output gives the INVERSE.

In order to latch the seven segment data into the 74173s we need a negative strobe and thus if the original device has active high outputs we need to use the INVERSE output, for an active low output device we would use the TRUE output. The output is connected to the clock input of the 74173 and will normally be in a high state. When a digit is selected on the inputs of the 74151 the outputs will reflect the status of the digit drive selected, this output will normally be at logic 1 and will thus allow the seven segment data to enter the 74173s without hindrance and without destroying any data already latched into the devices. When the selected digit drive goes active then the output to the latches will go to logic 0 and thus latch the data on the seven segment outputs into the latches. This output could also set a flip-flop which indicates a 'data available' signal to the MPU.

The MPU can now read out the data in the latches at leisure without having to worry about the timing of the clock/calculator/DVM. When the data has been read out and a new set of digit information set up at the inputs of the 74151 then the flip-flop can be reset.

Anchors away

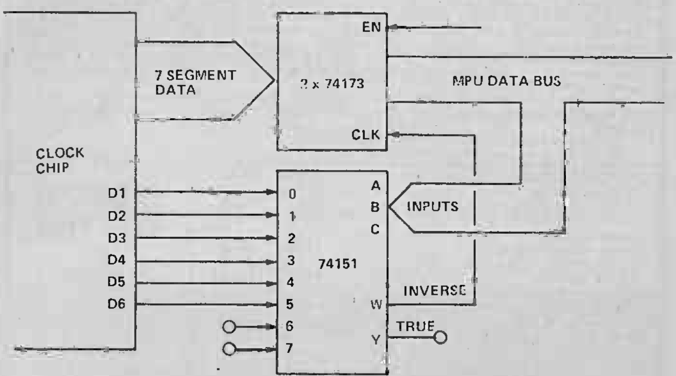
To return once more to the problem of a low cost direct-access device for amateur MPU users it was pointed out to me recently that once again Electronics Tomorrow came up with the answer first. The issue was so long ago that it had completely disappeared from my memory, October 1973 to be correct.

It put forward an idea which now appears to have been developed by the BBC. The system is designed to allow fast access to pre-recorded messages for use as sub-titles, presumably with video generated characters. It seems they used magnetic recording media to coat (oxide face down) a Garrard turntable revolving at the good old 78RPM. A single Read Write head is carried across the disk on an arm controlled by a small stepping motor. This head has sixteen positions across the disk thus giving sixteen tracks or 'grooves'. Each track is further sub-divided into sixteen sectors giving a total of 256 logical record spaces on each disk. The sensing for each sub-track is controlled by LEDs and sensors using a hole drilled in the disk near the perimeter, thus by activiating the stepper motor and a LED sensor the data in one of the 256 logical records can be accessed in less than one second.

Each logical record is capable of storing about 400 bits or about one row of data for display on a 32 character wide VDU including start and finish codes, line return codes etc. It works out in total to about 12K bytes of data storage at reasonable access speeds with a built in sync clock (the Garrard 701 has a sync strobe painted around the side). Perhaps any of our readers who work at the BBC and have experience of this equipment (called "Anchor") could tell us how well it works?

Perhaps we should re-title this column 'Electronics Four years hence'?

Block diagram of the MPU/clock interface described in the text. It is assumed that the MPU can perform the seven segment to BCD conversion "in its head".



The Tape Recorder Controller in Tech-Tips October 1977 was incorrectly credited. It was in fact designed and submitted by P. B. Cordes of Bishop Auckland.

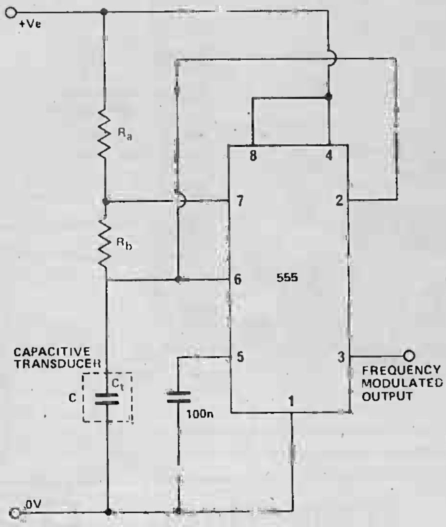
tech

Low Cost Transducer Amplifier

T. Barnett

Capacitative tranducers are often used to measure displacement or pressure. The versatility of the low-cost 555 intergrated circuit timer can be utilis--ed with these types of tranducer to provide a frequency modulated output. This output, fed into a frequency-to-voltage converter, will give an analog output voltage proportional to the capacitance of the tranducer.

The 555 module is connected with the tranducer C_t substituted for the external timing capacitor. Precise setting of the duty cycle is obtained with resistors R_a and R_b and with pins 2 and 6 connected together, the device will trigger itself and thus free-run as a multivibrator. As the output will source or sink current up to 200 mA or drive TTL circuitry, it can be fed directly into most types of frequency-to-voltage converter.



Seven Segment Decoder

Yap Sue-Ken

As not all of the possible seven segment codes are used, only 5 lines are required to define the ten numerals without ambiguity. The logic circuitry required to recover the other two segments are as shown in the figure.

In the case of microprocessor controll--ed displays this can save two valuable I/o pins.

DECIMAL DIGIT	INPUT SEGMENTS a	b	e	f	g	OUTPUT SEGMENTS c	d
0	1	1	1	1	0	1	1
1	0	1	0	0	0	1	0
2	1	1	1	0	1	0	1
3	1	1	0	0	1	1	1
4	0	1	0	1	1	1	0
5	1	0	0	1	1	1	1
6	1	0	1	1	1	1	1
7	1	1	0	0	0	1	0
8	1	1	1	1	1	1	1
9	1	1	0	1	1	1	1

Metal Detector

J. P. Macaulay

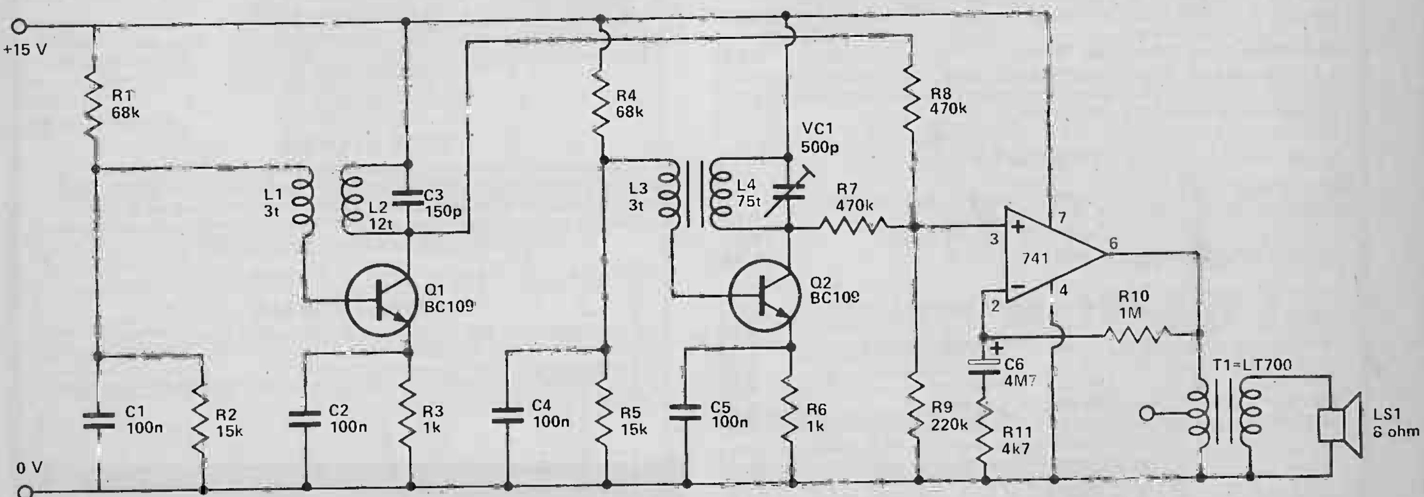
In common with most simple detectors, this circuit uses the fact that the in--ductance of the search coil changes when it nears a metallic object.

The search coil, L2, is 12 turns wound on a 6 inch diameter non magnetic former, using 26 SWG wire.

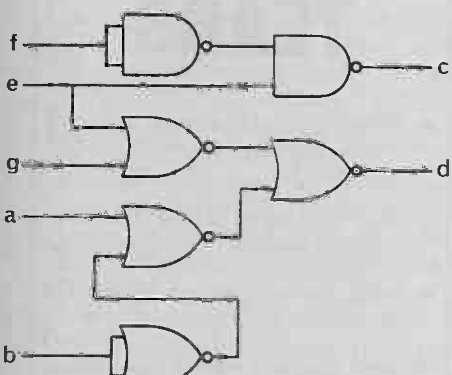
The pickup coil, L1, consists of 3 turns of similar wire wound next to L2 on the former. C3 tunes L2 to approximately 700 kHz and L2 and L1 are connected in the collector and base circuits of Q1 to form, with the associated components, a simple oscillator.

The local oscillator, built around Q2 is essentially the same as the search oscillator. L4 and L5 are however close wound on a .375 inch diameter ferrite rod, 3 inches long. Output from both oscillators is fed via a passive mixer, R7 and R8, to the non-inverting input of IC1. R9 in con--junction with R7 and R8 provide the IC with the required bias voltage.

Because of the IC's internal roll off it will not amplify the RF, but will pass the audio beat frequency. T1 interfaces the output of the IC to the speaker, LS1.



Tech-Tips is an ideas forum and is not aimed at the beginner. We regret we cannot answer queries on these items.
ETI is prepared to consider circuits or ideas submitted by readers for this page. All items used will be paid for. Drawings should be as clear as possible and the text should preferably be typed. Circuits must not be subject to copyright. Items for consideration should be sent to ETI TECH-TIPS, Electronics Today International, 25-27 Oxford St., London W1R 1RF.



NOR GATE = CD4001 OR SN7402
NAND GATE = CD4011 OR SN7400
POSITIVE LOGIC: '1' = ON

$c = \overline{e.f}$

$d = \overline{(g+e)} + \overline{(a+b)}$

Talk Timer

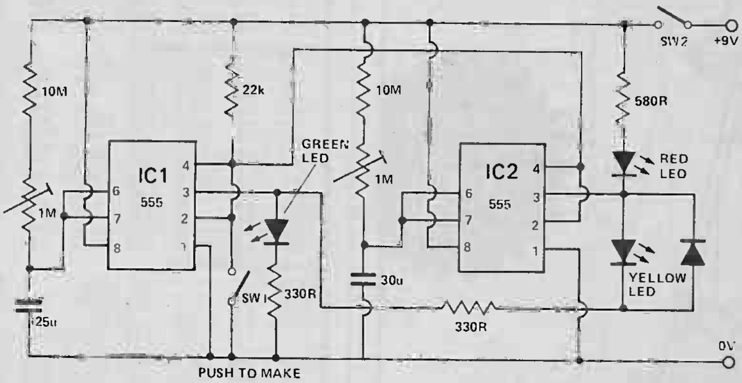
A. G. Mitchell

This circuit was designed for use as a timer for educational talks, providing a timing period of 5 minutes. During the talk, a green LED is turned on, but half a minute before the end, the green LED is extinguished and the yellow LED lit, giving a warning that only half a minute remains. At the end of the 5 minutes, the yellow LED turns off and the red LED turns on.

The circuit is simply two one-shot monostables connected together, the first with a timing period of 4½ minutes, and the second ½ minute.

Timing is started by momentarily closing S1, pin 3 of both ICs go high turning on the green LED and off the red and yellow LEDs.

At the end of the first timing period, pin 3 of IC1 goes low turning the green LED off and the yellow LED on. When at the end of the second timing period, pin 3 of IC2 goes low, the yellow LED is turned off and the red LED lit.



Bite Detector

David Chivers

Since there are over three million fishermen in the country, there must be many, who like myself, try to combine their hobby with electronics.

This circuit is for a simple bite detector, and construction of such a unit represents a considerable saving over the buying of a commercial instrument, while at the same time offering many additional advantages.

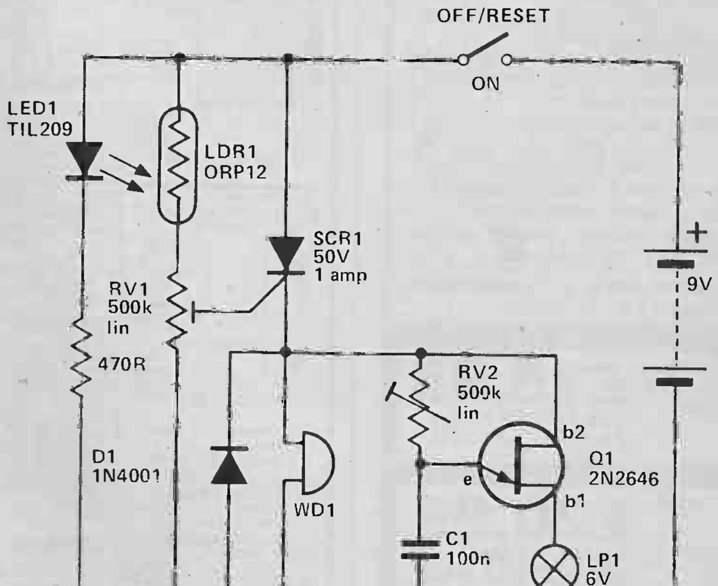
In operation, a piece of silver foil is folded over the line, and placed between the LED and the LDR. When a fish pulls on the line, the foil will jump up, and light will shine on the LDR, causing the resistance to go low, firing the SCR. Even if the foil drops again, due to its latching action, the SCR will remain on. WD1 will now emit a loud note, and the unijunction transistor, Q1, acts as a relaxation oscillater making LP1 flash (the rate of flashing being dependant on the setting of RV2). SW1 is the on/off reset switch.

The setting of RV1 will depend on the amount of light reaching the LDR under quiescent conditions. The circuit is, if anything, too sensitive and in strong winds or heavy currents, additional weighting of the line may be necessary, in this case lead foil should be used.

WD1 and LP1 may be taken from the unit via an extension lead, and kept by the anglers tent or sleeping bag. The unit may be built onto a rod rest and should be fully waterproofed.

The devise has other applications; it may be used as a burglar alarm with a "trip wire" type detector, or perhaps even as a devise to tell you when the cat has come in!

WD1 should be the type of device that draws a continuous current once energised.



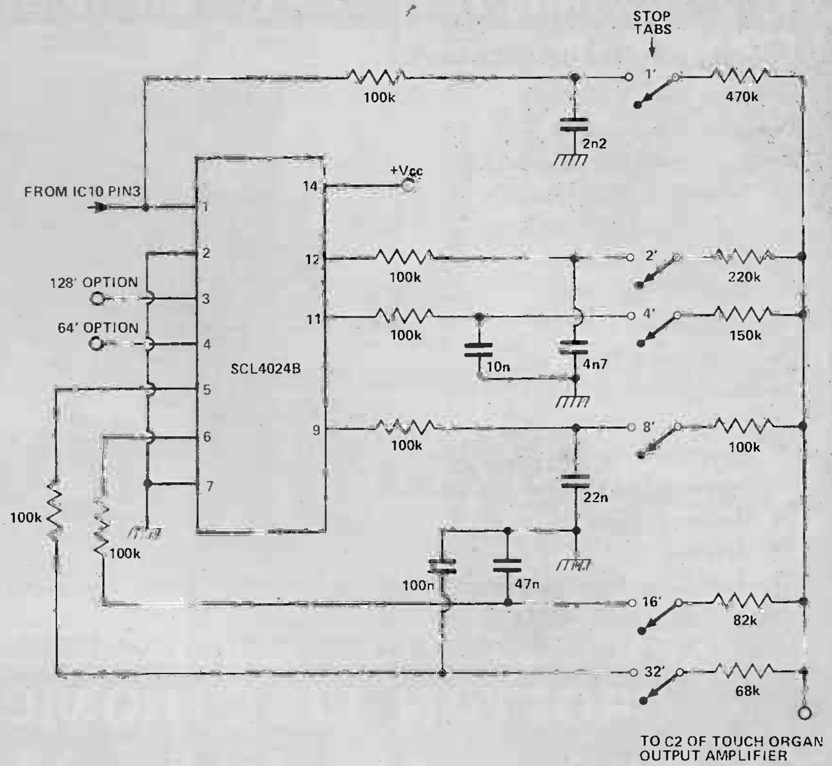
tech-tips

Electronic Organ Divider

J. L. Errington

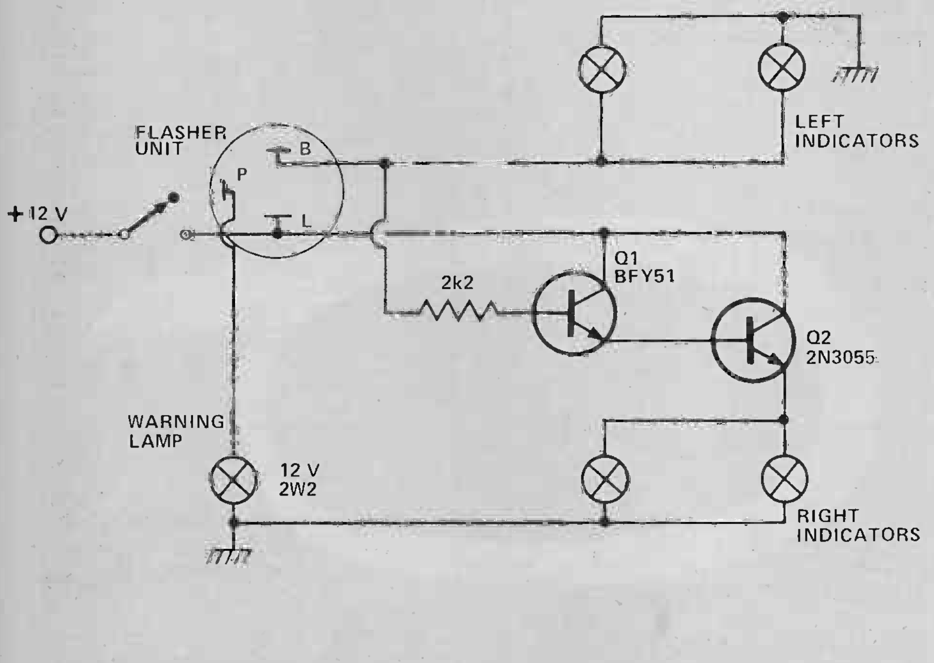
In order to improve the versatility of the ETI Touch Organ it proved de--sirable to enable further octaves to be used. The circuit shown uses a CMOS divider IC to produce up to seven octaves below the fundamental. To increase the upper limit of the range, the original value of C1 in the touch organ was reduced to 5n6, so that the basic two octaves were from 699Hz to 2796Hz.

This was designated as the 1' pitch, and the first five divided outputs from the 4024 were 2', 4', 8', 16', and 32' pitches. All these were then fed via separate RC filters to stop switches, then through a resistive mixer to the existing audio amplifier. The values used in the mixer may be adjusted to suit individual requirements. The input to the divider is fed directly from the output (pin 3) of the 555. Although designed specifically to complement the Touch Organ, this circuit is also suitable for many other simple organ circuits.



Hazard Warning Flasher

D. Warren



Hazard warning lights can be a life--saver in motor vehicles. But the high cost of commercial units prevents some people from fitting them. The circuit I have devised is both simple and inexpensive to install.

A flasher unit is used to operate the left hand indicators. At each flash a current of 5mA is supplied to the base of Q1, switching it on. The emitter now goes high switching on Q2 which connects the right hand indicators. If more lamps are to be lit (ie. when a trailer is being towed) a more power--ful flasher unit is required. As Q2 carries the full current of the right hand indicators (3.5A to 5.25A) it must be mounted on a suitably large heatsink. This can be achieved by fitting the circuit in an alluminium case 4" x 3" x 1¼" and mounting Q2 directly using a mica shim and rubber bushes to isolate it from earth. The flasher unit should be mounted on the out--side of the case for ease of replacement.

The circuit shown is for negative earth, but is easily adapted for positive earth vehicles.