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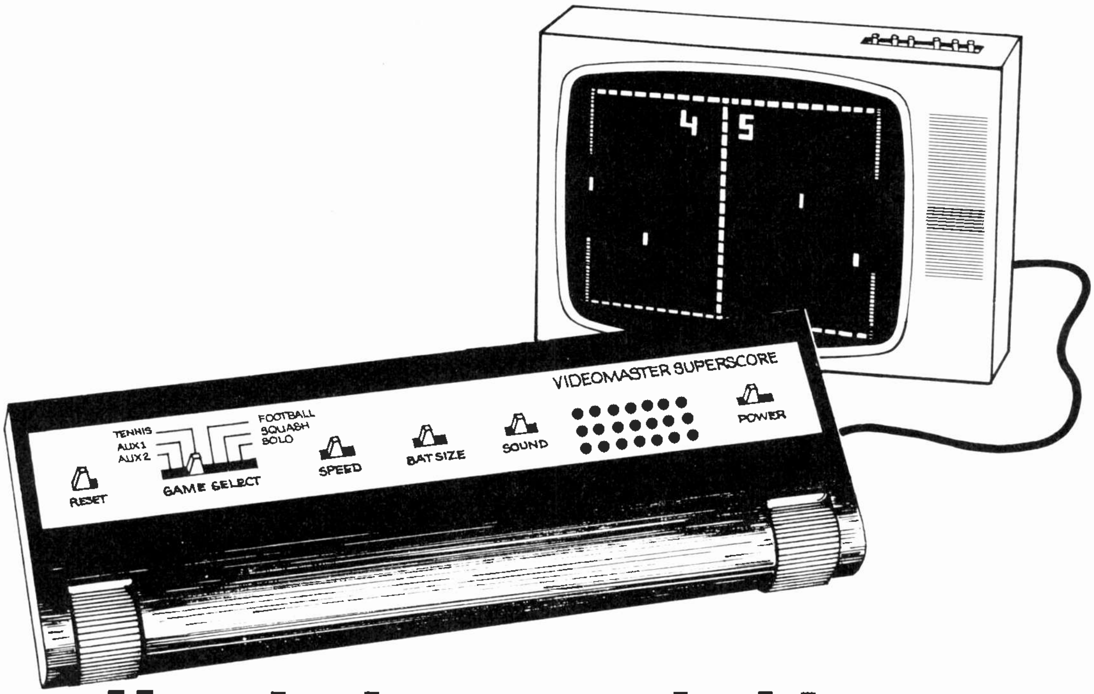
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OCTOBER 1976 VOL 5, No. 10

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Rushcutters Bay 2011
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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.
36 Ebury Street, London SW1W 0LW.

DISTRIBUTED BY
Argus Distribution Ltd. (British Isles)
Gordon & Gotch Ltd. (Canada and South Africa)

PRINTED BY
QB Newspapers Limited, Colchester.

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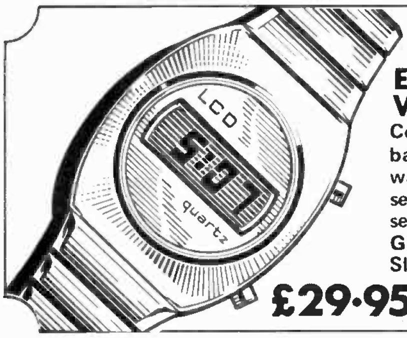

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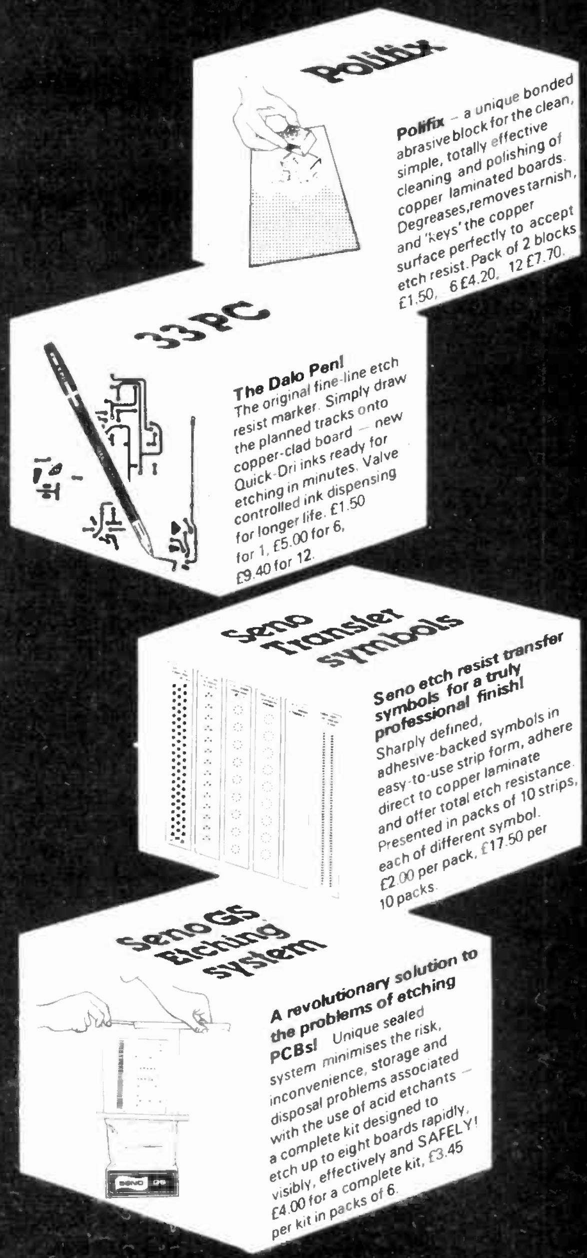

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2N698	0.82	2N3416	0.23	2N6027	0.45	BC115	0.19	BC547	0.12	BF259	0.49	ME0404	0.15	TBA810	1.16
2N699	0.55	2N3418	0.27	3N128	0.80	BC116	0.19	BC548	0.10	BF459	0.39	ME0412	0.20	TBA820	1.03
2N706	0.12	2N3440	0.57	3N139	1.45	BC116A	0.20	BC549	0.13	BFR39	0.24	ME4102	0.10	TBA920	1.79
2N706A	0.12	2N3441	0.78	3N140	1.00	BC117	0.22	BCY30	1.03	BFS21A	2.60	ME4104	0.10	TIL209	0.30
2N708	0.21	2N3442	1.20	3N141	0.85	BC118	0.16	BCY31	1.06	BFS28	1.04	MJ480	1.05	TIP29A	0.50
2N709	0.50	2N3638	0.16	3N200	2.60	BC119	0.30	BCY32	1.18	BFS61	0.30	MJ481	1.30	TIP30A	0.60
2N711	0.55	2N3638A	0.16	40361	0.45	BC121	0.45	BCY33	0.90	BFS98	0.27	MJ490	1.05	TIP31A	0.62
2N718	0.22	2N3639	0.30	40362	0.48	BC125	0.18	BCY34	0.98	BFX29	0.36	MJ491	1.55	TIP32A	0.75
2N718A	0.40	2N3641	0.20	40363	1.00	BC126	0.25	BCY38	2.00	BFX30	0.38	MJ2955	1.00	TIP33A	1.00
2N720	0.69	2N3702	0.17	40389	0.50	BC132	0.30	BCY42	0.60	BFX84	0.38	MJE340	0.58	TIP34A	1.20
2N914	0.22	2N3703	0.15	40394	0.60	BC134	0.15	BCY58	0.55	BFX85	0.41	MJE370	0.68	TIP35A	2.50
2N916	0.43	2N3704	0.15	40395	1.20	BC135	0.15	BCY59	0.32	BFX87	0.35	MJE371	0.81	TIP36A	3.35
2N918	0.34	2N)	0.15	40406	0.48	BC136	0.19	BCY70	0.25	BFX88	0.32	MJE520	0.65	TIP41A	0.70
2N929	0.25	2N3706	0.14	40407	0.38	BC137	0.14	BCY71	0.26	BFX89	0.95	MJE521	0.75	TIP42A	0.90
2N930	0.26	2N3707	0.18	40408	0.50	BC140	0.60	BCY72	0.24	BFY50	0.30	MJE2955	1.25	TIP29c	0.75
2N1302	0.37	2N3708	0.14	40409	0.55	BC141	0.65	BD115	1.20	BFY51	0.38	MJE3055	0.75	TIP30c	0.85
2N1303	0.37	2N3709	0.15	40410	0.55	BC142	0.30	BD116	1.20	BFY52	0.36	MP8111	0.35	TIP31c	0.85
2N1304	0.40	2N3710	0.14	40411	2.30	BC143	0.30	BD121	2.00	BFY53	0.34	MP8112	0.40	TIP32c	1.00
2N1305	0.40	2N3711	0.15	40594	0.75	BC147	0.10	BD123	2.00	BFY90	1.27	MP8113	0.45	TIP33c	1.45
2N1306	0.45	2N3712	1.20	40595	0.85	BC148	0.10	BD124	2.00	BRY39	0.50	MPF102	0.30	TIP34c	1.70
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2N1308	0.60	2N3714	2.45	40602	0.50	BC153	0.27	BD132	0.54	BSX21	0.32	MPSA06	0.20	TIP42c	1.20
2N1309	0.60	2N3715	2.45	40603	0.60	BC154	0.27	BD135	0.42	BU105	3.05	MPSA12	0.35	TIP2955	1.00
2N1671	1.80	2N3716	2.60	40604	0.60	BC157	0.12	BD136	0.42	BU205	2.40	MPSA55	0.20	TIP3055	0.50
2N1671A	1.92	2N3771	1.60	40636	1.15	BC158	0.11	BD137	0.45	CA3028A	0.85	MPSA56	0.20	TIS43	0.30
2N1671B	2.12	2N3772	1.70	40673	0.73	BC160	0.78	BD138	0.48	CA3030A	1.50	MPSU05	0.40	ZTX300	0.15
2N1711	0.27	2N3773	2.65	AC126	0.37	BC167	0.12	BD139	0.50	CA3035	1.35	MPSU06	0.40	ZTX301	0.15
2N1907	5.50	2N3779	6.00	AC127	0.44	BC168	0.12	BD140	0.50	CA3046	0.73	MPSU55	0.45	ZTX302	0.20
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2N2160	1.10	2N3794	0.20	AC153	0.40	BC172	0.12	BF115	0.36	CA3089E	2.00	NE560D	4.48	ZTX530	0.23
2N2218A	0.47	2N3819	0.26	AC153K	0.42	BC177	0.19	BF117	0.70	CA3090Q	4.25	NE561	4.48	ZTX531	0.22
2N2219	0.42	2N3820	0.29	AC154	0.45	BC178	0.18	BF121	0.55	CA3130	0.88	NE565	1.30		
2N2219A	0.52	2N3823	0.61	AC176	0.40	BC179	0.21	BF123	0.55	LM301A	0.47	OC28	2.00		
2N2220	0.35	2N3904	0.21	AC176K	0.45	BC182	0.11	BF152	0.25	LM308N	1.32	OC35	1.50		
2N2221	0.22	2N3906	0.22	AC187K	0.46	BC182L	0.14	BF153	0.25	LM309K	1.80	OC42	0.50		
2N2221A	0.26	2N4036	0.67	AC188K	0.45	BC183	0.11	BF154	0.25	LM380	0.98	OC45	0.75		
2N2222	0.25	2N4037	0.55	AD142	0.65	BC183L	0.14	BF159	0.35	LM381AN	2.07	OC71	0.45		
2N2222A	0.25	2N4058	0.20	AD143	0.75	BC184	0.12	BF160	0.30	LM702C	0.75	OC72	0.45		
2N2368	0.17	2N4059	0.15	AD149	0.74	BC184L	0.14	BF161	0.60	LM709TO99	0.40	OC81	0.75		
2N2369A	0.21	2N4060	0.20	AD150	1.20	BC207	0.11	BF166	0.40	LM741CAN	0.38	OC83	0.50		
2N2369	0.25	2N4061	0.17	AD161	0.75	BC208	0.10	BF167	0.33	8DIL	0.35	ORP12	0.60		
2N2646	0.55	2N4062	0.18	AD162	0.75	BC212	0.14	BF173	0.33	14DIL	0.40	R53	1.80		
2N2647	1.10	2N4126	0.17	AF106	0.45	BC212L	0.17	BF177	0.38	LM710	0.45	SL414A	2.35		
2N2904	0.36	2N4289	0.30	AF114	0.65	BC214L	0.17	BF178	0.45	LM3900N	0.55	SL610C	2.35		
2N2904A	0.37	2N4919	0.85	AF115	0.65	BC237	0.14	BF179	0.48	LM723C	0.60	SL611C	2.35		
2N2905	0.37	2N4920	0.90	AF116	0.65	BC238	0.12	BF180	0.45	LM733	0.88	SL612C	2.35		
2N2905A	0.38	2N4921	0.60	AF117	0.65	BC239	0.15	BF181	0.45	LM709CAN	0.40	SL620C	3.50		
2N2906	0.28	2N4922	0.65	AF118	0.65	BC251	0.15	BF182	0.45	8DIL	0.40	SL621C	3.50		
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2N2907	0.21	2N5190	0.70	AF125	0.65	BC257A	0.17	BF184	0.35	LM747	0.78	SL640C	4.00		
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2N2926	0.13	2N5195	1.10	AF139	0.69	BC261A	0.21	BF195	0.11	14DIL	0.41	SN76013N	1.50		
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2.5mm plug	10p
2.5mm socket	10p

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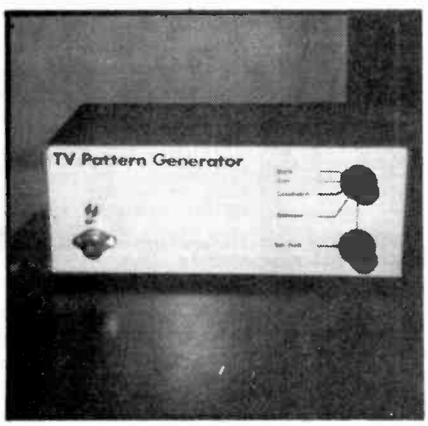
news digest

Mr. Ning receives his prize.

'SCOUSER' WINS THE DORAM COMPETITION

The results of our ETI/Doram design competition proved difficult to obtain – the standard was too high! The outright winner, shown above with our illustrious editor and his cheque for £50 and £50 worth of Doram vouchers, was a Mr. Garsing Ning from Huyton Liverpool. His TV pattern generator, shown below in the form Doram will market it as a kit was



considered by the judges one of the finest original design projects seen for years.

Category winners were:

BEST AUDIO PROJECT
S.B. Furber of Cambridge – FUZZ UNIT FOR A GUITAR.
BEST PHOTOGRAPHIC PROJECT
B.G. Greensides of Swansea – PHOTO NEGATIVE ANALYSER.
BEST HOUSEHOLD PROJECT
D. Aylwin of Brighton – FREEZALARM.
BEST CAR ELECTRONIC PROJECT
D.T.A. Jack of Bolton – WINDSCREEN "WASH-WIPE" DEVICE.
BEST ELECTRONICS GAME/TOY
E.G. Cawkwell of Lincoln – "BEAT THE ACE" SHOOTING GAME.
BEST PROJECT USING INTEGRATED CIRCUITS
I. Humphries of Liss Forest, Hampshire – SINGLE POINT TOUCH ON/OFF SWITCH.
BEST "OTHERS" PROJECT
J. Bruere of Rochdale – BLINDMAN'S TORCH.

CMOS UNITED

An American components company has opened the way to CMOS breeding at the two main CMOS logic families: 4000 and 74C00 series. They are making all the devices pin for pin compatible for any given function.

Inter-marriage of the two promises to bring down pack count, and combine special features indiginous to both. For example the 74C series is faster than the 4000, but has been limited in scope up to now by the small number of functions available.

SOFTLY SOFTLY 741

Motorola has introduced new ultra-low noise versions of the MC1741 and MC1458 (dual) op-amp. Many users of op-amps have trouble with 'burst' noise, and these new devices are guaranteed to have less than 20µ V peak noise referred to the input.

Special tests are run to identify burst noise. The devices are distinguished by the N suffix.

Motorola Ltd., York House, Empire Way, Wembley, Middlesex.

WHEREFORE ART THOU D3304A4?

We get many queries here at ETI concerning some weird and wonderful devices. Someone building a 50,0001 Watt Stereo food mixer up in the wilds of Inverness needs desperately a two billion amp bridge rectifier or something. Can we help? Apart from advising them to give up cooking and take up map reading in Siberia, one of the first things to do is consult the D.A.T.A books.

These are a largely un-sung band of paper heros, listing between their 16 volumes just about every semiconductor and device any warped designers mind has conjured forth from the primal soup. They are expensive, but if you need the information its all here. Details from – London Information Ltd., Index House, Ascot, Berks SL5 7EU.

CBM SOFTSHOE SHUFFLE

After a moving around of some top staff, CBM are about to increase calculator and watch activities in Korea, Japan and Eaglescliff UK.

The long awaited CBM watch range is finally set to put in an appearance, and if all goes as it should, we'll have details in next months News Digest. There is some talk too of a watch retailing at about £4.95, although precise dates are still obscured by clouds. The watch modules are assembled in Korea and Hong Kong.

CATS RECEIVED

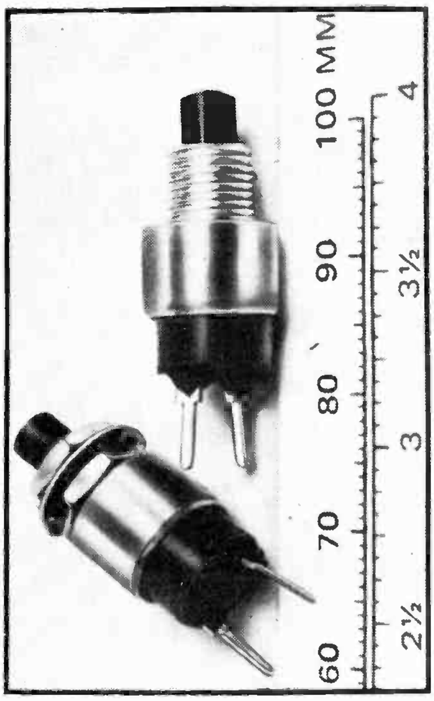
Chékits Ltd – We have the new Chromasonic catalogue to hand now, after it had suffered several set backs in production. It is a nicely thought out document, and contains, amongst other things, a design for a "Poor Mans Digital Tuner"! Very comprehensive, and would make a good addition to your component catalogue shelf. (What'd yer mean yer aint got one?) Price 35p from 56 Fortis Green Road, London N10 3HN.

Doram, Edition 3 – What can we say? Latest edition of the entirely comprehensive and superbly produced Doram (R.S.) catalogue. If what you want isn't in here, you don't really want it!

Price 60p from P.O. Box TR8, Wellington Road Industrial Estate, Wellington Bridge, Leeds LS12 2UF.

P.C.B.P.B.

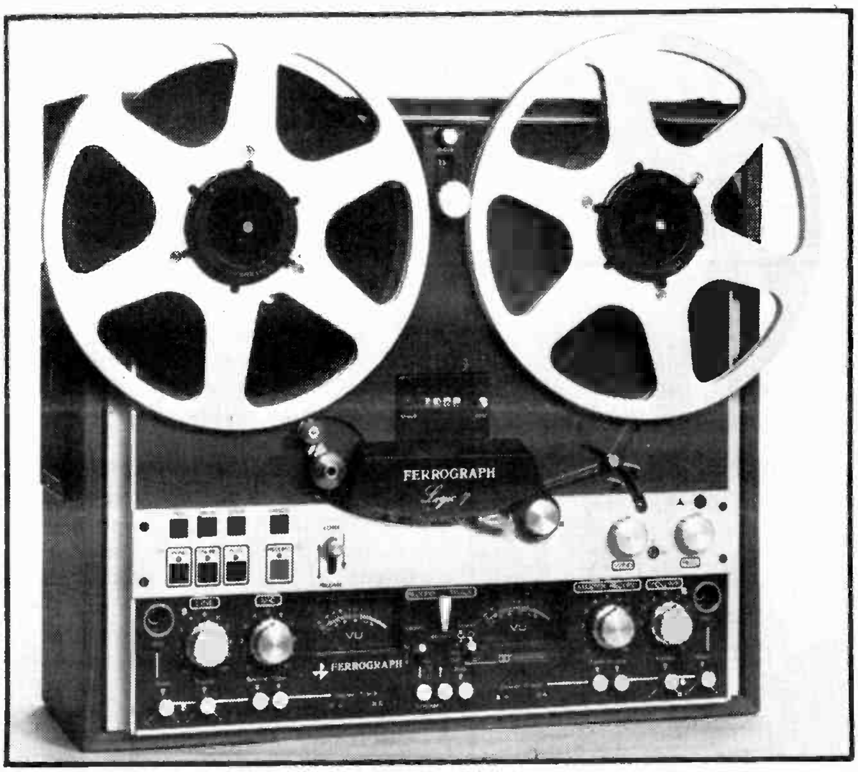
A subminiature push button designed for PCB usage has just been released by Roxburgh Electronics. The 8531 is only 1.1in x 0.375in diameter, and has a contact rating of 1A at 120V AC or 28V DC (0.5A at 250V AC).



For the fashion conscious five colours of cap are available!

Roxburgh Electronics Ltd., 22 Winchelsea Road, Rye, Sussex.

LOGICAL FERROGRAPH DEVELOPMENT



This new series of tape machines from Ferrograph incorporate logic control facilities. Spooling speed control is fitted, as are LED's to show the user what the machine thinks he wants it to do.

Tape motion sensing and a command memory are used in the control circuit. Switching arrangement allow for echo, 4 input mixing, track transfer and source monitoring.

Several versions are being produced as usual, power amps and/or speakers, with or without Dolby. Prices will run from £475 and gallop up to £615 ex. VAT. Wilmot Breedon, Durban Road, South Bersted, Bognor Regis, Sussex.

BANDING TOGETHER

The Editor,
Electronics Today International,
36 Ebury Street,
London SW1W 0LW.

Dear Sir,

We were most pleased to read the article "C.B. for Britain" in your July issue. The Citizens' Band Association is campaigning for the establishment of a VHF Citizens' Band in the UK and agrees with nearly all the points you make.

We have prepared a technical proposal for a VHF FM Citizens' Band which is being sent to the Home Office for discussion and contains a number of proposals to ensure that a British Citizens' Band suffers from few of the disadvantages of the American one. These proposals include:

1. Modulation shall be FM which avoids many problems of TVI, BCI and audio equipment break-in.
2. Each transceiver should contain an automatic identifying signal which is transmitted every time the transmit key is depressed. This means that anyone misusing Citizens' Band can easily be identified.
3. Transmission time should be limited to 75 seconds to prevent channels being monopolised.

Apart from the above, and a few purely technical proposals concerning standards which should be high enough to prevent interference to other services but not so unnecessarily high as to price Citizens' Band equipment out of the market, we believe that a British Citizens' Band should have a minimum of regulations.

Membership of the CBA is £1.50 p.a. for individuals and £5 for clubs.

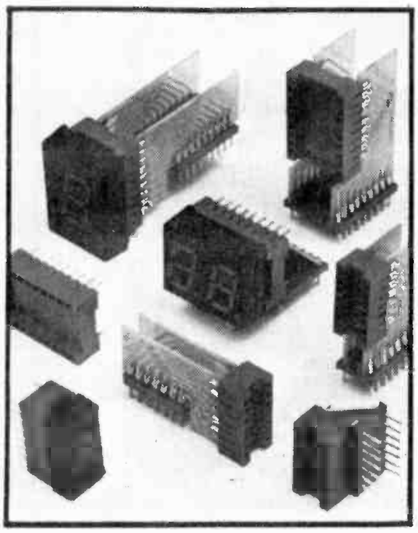
Yours faithfully,

James M. Bryant,
President, Citizens Band Association.

NEW TWIST (90°) TO DISPLAY SOCKET

A unique range of seven segment display sockets, specifically designed for 707, 727 and 747 type packages has recently been announced by Jermyn Manufacturing.

For each package type there are socket assemblies providing three 90° mounting options.



The right angle mounting versions are useful where a slim line appearance is required and obviate the need for a motherboard to be mounted at 90° to the main equipment PCB.

Alternatively, the 'side line' versions can be used either horizontally for mounting multi digit 707 or 727 format displays, or with the sockets standing vertically thus allowing 707 or 747 displays to be side connected into PCB's.

Jermyn, Sevenoaks, Kent.

THE END OF THE AMP?

A British invention (three cheers!) could well mark the end of the amplifier as a circuit block. A new device called a 'voltage-to-current transactor' can do everything an op-amp can — but better, Invented by Professor Gosling and Carl Brinker, the device contains no passive components at all, and consists of a network of transistors.

The advantages are that it integrates smoothly rather than as a series of steps, follows an input quicker and with a wider dynamic range, is smaller in chip form and uses less external components. A VCT can also double as a transformer!

These 'things from 2001' will be commercially available later this year from Texas Instruments who now hold all the patents. Prices will be no more than those of present (outdated?) op-amps.

THINGS THAT GO BRIGHT IN THE NIGHT

Monsanto have announced a new optoelectronic material with a 30 per cent increase in **minimum** brightness level.

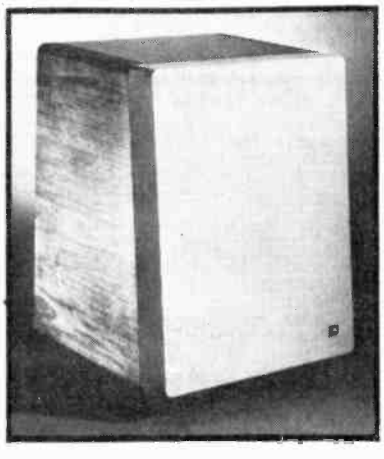
The new material, designated MON-MON-400, is gallium arsenide phosphide on gallium arsenide subtrate and has a minimum specified brightness of 400 foot-Lamberts.

The specific advantages are claimed to be the assurance of a higher level of brightness, and reduced current requirement for a given light output. It is expected the new material will help in applications such as digital watches, which have demonstrated an increasing need for better material definition.

Monsanto Europe SA, Avenue de Tervuren, 270-272, Letter Box No. 1, B-1150 Brussels, Belgium.

SUMMIT NEW FROM JBL

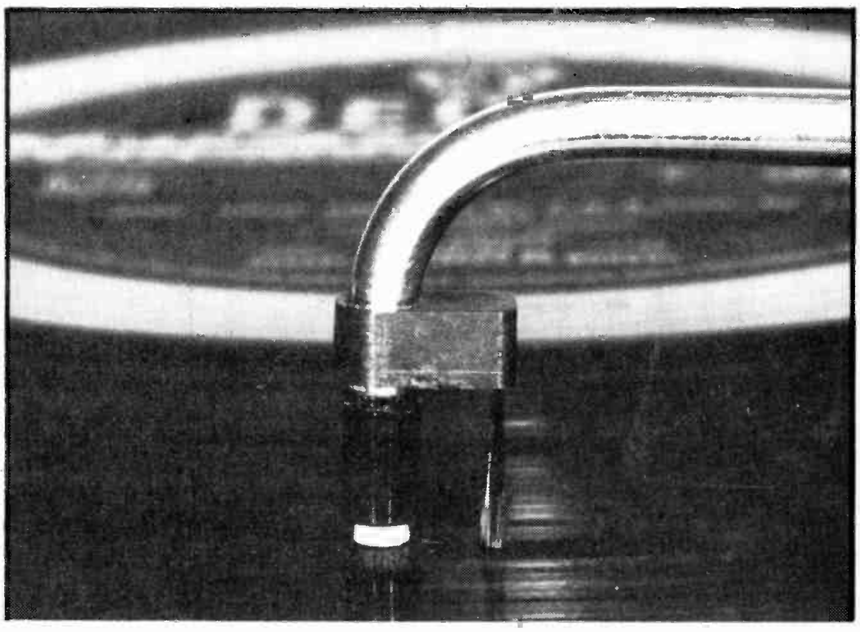
The JBL stable have let loose a 'domestic' (housed trained?) version of the 4333 studio monitor. Titled the L300 Summit, the new box takes its place at the head of JBL's line. Styling is fairly conventional, apart from the smoked glass top.



The box contains 3 drive units, two of them naturally horn drivers. The bass unit is a new design with a free air resonance at 16Hz. Crossover frequencies lie at 800Hz and 8k5Hz. One 'nice' feature is the trouble JBL have taken to make the enclosure as 'dead' as possible. One inch thick hardwoods are used for the sides, and internal bracing is present in all faces.

C.E. Hammond Ltd., 111 Chertsey Road, Byfleet, Surrey KT14 7LA.

A SUCKER FOR A GOOD GROOVE!



Since its introduction the Groovac record vaccuum cleaner has undergone several changes. The latest is the addition of a anti-static carbon fibre brush, tracking just ahead of the nozzle to loosen static attraction.

Great pains have now been expended to make the unit 'silent', suspension of the pump on springs inside a small sealed enclosure, and damping in the exhaust line.

Tracking force is also improved — to 0.5gms, achieved by improving the bearing and bias correction methods to a considerable degree.

Price: £17.95 + 80p p and p complete, from R.I. Audio, Kernick Road, Penryn, Cornwall.

ELECTRONICS IN PRINTING

A Special report by Peter Davis

ETI REGULARS PROBABLY KNOW Charles Babbage as the founding father of present day computers. You will probably know that his ideas were more than a hundred years ahead of the technology available to him. But did you know that, back in 1822, he used his "analytical engine" as the world's first computer typesetting machine? It's improbable but true; when he set out to compile log tables with his "engine" he decided to sidestep the expensive, error-prone and time-consuming process of hand typesetting by having his machine impress tabulated results direct onto moulds from which relief printing plates were later cast. The world had to wait 140 years until the early 1960s, before that link-up between printers and computers was successfully re-established.

Newspaper operations have more steps than ordinary commercial printing, so in looking at them a reasonable insight into other printers' operations can be gleaned.

Before we go into details, we'll review the traditional working methods of the newspaper industry. We'll take as an example your morning paper. What happens before it hits your doormat?

Let's trace a story on its journey into print. Suppose a London editor has decided to cover an important afternoon political meeting in a provincial town hundreds of miles from the capital, and has assigned a reporter to attend it. The reporter writes up his story on the spot, telephones London and dictates it over the phone to a specialist typist. The girl's typed sheets are sent up to the editorial department, where a team of journalists may rewrite the story, 'sub' it, and decide on headlines. It may be typed out again. When the News Editor has passed the story, the newly-typed sheets, probably with lots of handwritten alterations, are sent down to the Composing Room where it is assigned to operators who work semi-automatic linecasting machines. These highly-skilled men type out the copy, producing about three lines of lead type-slugs per minute. They work slowly because they have to decide where to end each line, and whether and where to hyphenate words. This process is called Hyphenation and Justification — "H & J". Meanwhile a different, and slower, machine is casting the large type slugs for the headlines.

After typesetting, a 'galley' proof is pulled. A 'reader' checks the proofs for errors, and if any are spotted (there are usually several) the faulty lines have to be replaced by correct ones. Often, a half-dozen lines need resetting, even if there was only, say, a single word omitted in one line. When the amended galley proof is passed, the slugs for the story are transported to the 'stone'. Here, working to a dummy prepared by an editor, a craftsman jiggles the stories together with headlines and photo blocks into their designated page positions under the watchful eye of a journalist who OKs each assembled page. The metal pages are wheeled off to another department (a tabloid page of type may weigh 40lb), where the raised surfaces of the flat typematter are converted to curved metal duplicate plates using the same principles as an ordinary rubber stamp, which are clamped onto the cylinders of the printing press. The raised image surface of the plate is inked by rollers, and then as the press runs, the image is transferred straight onto the moving 'web' of paper from a reel. Newspapers come off the machine folded and ready for dispatch.

Ambitious plans afoot in 'the Street' could sweep away the anachronistic components of this process, along, unfortunately, with many people's jobs. Our old friend the computer, aided by developments in lasers and digital transmission techniques, is destined to slew the newspaper industry away from mechanical techniques and toward electronic methods. Editors are making their plans with the long-term prospect of a 'paperless newspaper' at the back of their minds.

It would be misleading in the extreme to suggest that this is just round the corner; it is very many years in the future. Here, we shall look at what the state-of-the-art can offer to newspapermen right now.

Let's go back to our reporter on the beat. We've all heard of those briefcase-size portable data terminals insurance salesmen sometimes take out on the road with them. Well, something similar, called the Teleram is in everyday use with the New York Times. An NYT reporter can go to events armed with the Teleram, retire to a handy bar, and type out the story on the Teleram's keyboard where it is recorded in blocks on a Compact Cassette. He can edit it using cursor controls in conjunction with the midget CRT display. When he's happy with the final version, he moves over to a callbox, dials up his newspaper's data bank, and transmits the story in digital form at 30 c.p.s., using the Teleram's built-in modem and acoustic coupler. Our man's story will join the day's other stories on a big disc store. His deskbound colleagues, by the way, may have typed in their stories on their very own VDTs (the NYT has several hundred) in the office. Wire agency copy and pictures, instead of coming in on a teleprinter or Muirhead facsimile machine, are received over wideband private lines. Digitised pictures are stored for later electronic cropping and tone enhancement by the Picture Editor, while the agency news is sent in ten-second bursts containing the entire newswire repertory at the rate of several Megabits per second. Classified ads will be resident in the disc store, just as the tele-ad girls typed them in.

Now the editorial team, instead of using pencils and typewriters, have at their disposal a database little different from that you'd find in a large-scale on-line DP setup, except that it is probably resident on a network of minis rather than a mainframe. This scenario should hint at the benefits you can get when computers are applied to editorial operations. The rest of this article will focus, however, on computers in the *production* side of publishing.

WHAT COMPUTERS DO FOR PRINTERS

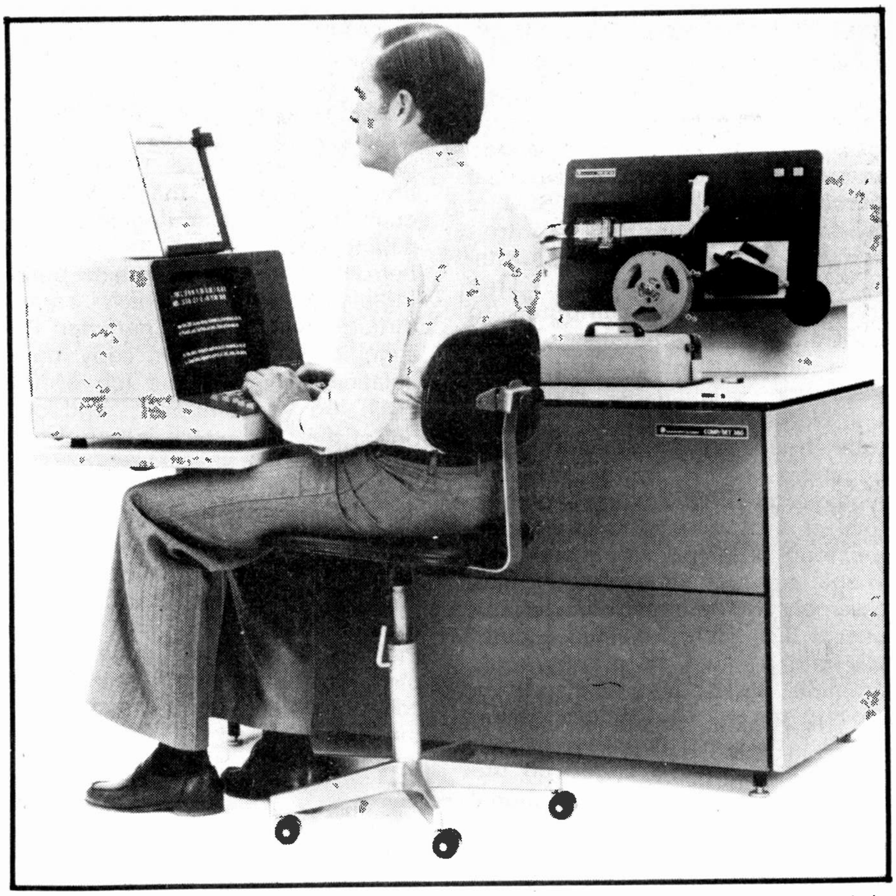
In printing, a computer *system* replaces a collection of isolated machines or manual operations each worked or overseen by one man and each accomplishing one narrow task.

The principal reason for using computers is to increase efficiency — and lower costs — by giving computers the boring routine jobs and leaving humans only with creative decisions to make. But computers offer an added incentive: speed. And in the newspaper world, faced with competition from the electronic mass media, speed is more vital than ever. To an editor, this acceleration may mean he can hold back his deadlines perhaps a further half-hour before 'putting the paper to bed'. The book publisher, in contrast, may get titles into print within weeks rather than months.

In the near future, computers will help save money by 'driving' huge newspaper presses, thereby cutting down wastage of paper, and minis are already very successfully employed in newspaper 'publishing rooms' (dispatch areas).

In the area of type composition, the computer has a lot of calculations to do. The snags arise in part from the awkward nature of printed type characters. Not only may individual letters be anything from one twelfth of an inch to 3½ inches high, but their relative widths vary too. They differ not only between different typefaces of the same size (e.g. condensed vs. bold) but also between letters of the same typeface. On a proportional-space typewriter like the IBM 'Executive', a letter may be either 1½, 2, or 3 units wide. But printed typefaces, for the sake of elegance, are usually designed on an 18-unit system. That is, the widest character of the alphabet, usually the capital 'M', is 18 units wide, while the narrowest, 'i' or 'l', may be only four or 5 units wide. So far, so good. But as you'll have noticed, printed matter is usually set in columns so that both the left and right margins align; this is known as justified setting. On mechanical linecasters, justification is easily achieved by driving wedges ('spacebands') between words so they fill out the full length or 'measure' of the line.

With computer-assisted typesetting the situation is not so simple and the software needed to produce justification and appropriate



hyphenation, although in continuous development since the first attempts back in 1961, has only become really good enough for top-class work over the last few years. A main memory size of 8K Bytes is the minimum which will allow reasonably good hyphenation and justification (H & J).

What happens during H&J is, in grossly oversimplified form, as follows.

The computer is told what typefaces, in which sizes, are to be used. The computer also needs to know the length of printed lines, and then it is ready to go into action. It works out how much width each character is allocated in these circumstances, looking up the information from disc or RAM memory. As characters are read in to a buffer store, the computer tots up a running total of width units used so far. When the running total is almost equal to the permitted line length, the computer looks ahead to see if it can squeeze in another word onto the line. If not, it attempts to hyphenate this next word according to logic rules (based on word structure in Britain, or pronunciation in the States) in software. It may also look up an 'exception dictionary' of up to 20,000 words on disc file to see whether this is a special case which must *not* be hyphenated according to the normal rules. Two common clangers are the words 'therapist' and 'arsenic'. Think about it!

When an acceptable point for breaking the line is found, the computer subtracts the width value of all the letters read so far — but ignoring the spaces — takes this sum away from the allotted line length, divides the remainder by the number of inter-word spaces, and uses the quotient to determine the width of spacing to be placed between each word in that particular line. If the CPU is built into a photo-typesetting unit, it will instruct the machine to expose the characters as soon as it has completed H & J on each line. Otherwise, if, for example, the computer is tucked away inside an editing terminal, it will merely output the characters onto paper tape, floppy disc or magnetic cassette with a 'Carriage Return' to mark the breakpoint at the end of each line, leaving the photo unit's onboard computer to work out the spaces between words again when the text is eventually typeset. This, then, is the basic H & J program. In modern typesetting systems, however, the computer does much more than just H&J, as we shall see. In the next section, we're looking at a series of devices or systems for the composition of type, starting with simpler machines and working up to a typical state-of-the-art newspaper system.

THE A-M COMP/SET 550: a pint-sized composing room

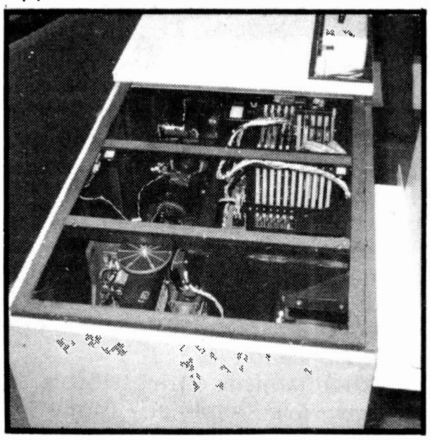
The £7500 A-M Comp/Set 550 is a direct-entry phototypesetting machine with built-in VDU, aimed at small in-house and commercial printers (see photo). The 550 is built round a custom 'Amtrol' computer at whose heart is an Intel 8080 microprocessor. This machine uses its computer to control the mechanics of the typesetting process and to perform justification calculations. The photo unit works by having a xenon flash tube 'freeze' characters carried as negatives on a rotating plastic type-master disc, which holds a total of 448 characters — enough for four different typefaces. The image is magnified by a zoom lens assembly to the intended size (any one of 33), then projected accurately into position on photographic bromide paper by means of a moving mirror. Width information for each character is garnered from optical bar codes arranged on the periphery of the disc. An optional paper tape pubch/reader module (soon to be supplanted by a floppy disc) allows the 550's VDu to be employed as an editing screen for updating and modifying previously-punched ASSII tapes, and one of the features which makes the machine extra-productive is the 'search' facility which allows it to locate and indicate specified sequences of letters punched on the paper tape.

System software is kept on ROM, and although it's pretty sophisticated, if you want hyphens when justifying you have to insert them manually from the keyboard. On the top two lines of the VDU display various status indicators appear, relating to line length, type style in use, etc., and the keyboard is locked until all these parameters have been entered. In the middle of the screen the operator sees the line that is currently being set in the photo unit (at 9 characters/second), and lower down on the display appears the line the operator is actually typing-in. The quality of the typographic output is astonishingly good and the unit is quite versatile. For example, it possesses considerable virtue when it comes to setting tabular work — usually a real headache for printers — and when finicky layouts have to be followed with meticulous care.

GOING ON THE SCALE: a medium-size composition system

This compact setup — it could fit comfortably in your living room — has a vast throughput potential. It could typeset a paperback book or a local newspaper in two hours, although the humans doing the paste-up would be gasping for breath! Whereas the A-M 550 combines input, editing and typesetting operations in the one unit, here there are three major building-blocks: input, which comes through an Optical Character Recognition (OCR) reader; copy manipulation, which is the job of the VDU, the Varicomposer; and output of the text, which is performed by a Pacesetter phototypesetter.

At one end typed sheets produced on fairly ordinary typewriters go in, and at the business end columns of latent type image emerge from the Pacesetter, go through a developing unit, and are then made up into pages by a paste-up artist who sticks the columns down onto layout sheets in the positions where they are to appear in the finished product.



WHY USE OCR?

OCR can help printers because it allows the banishment of anachronistic paper tape and lets them use £400 typewriters in place of £1500 perforating keyboards for entering copy. The medium — typed paper — is of course easily read by humans, in marked contrast to paper or mag tape. Someday, most copy for printing may be provided by publishers in the form of OCR-legible typed sheets, allowing appreciable savings in time and money to be realised because printers won't need to type it all out again. The OCR reader in this system is the American-made Compugraphic UniScan. Unlike earlier OCRs, it isn't too fussy about what kind of paper is dumped into its stack feeder. You may be agreeably surprised to see from the samples reproduced here that OCR typewriter faces don't look at all like 'computer writing'. Gobbling copy at the prodigious rate of 10,000 words per minute, the UniScan is quick enough to keep over 200 stenographers slaving over hot typewriters all day long! After scanning and recognition, the UniScan outputs the information as ASCII codes on-line to a floppy disc drive on the Varicomposer.

This is Courier 12, the U.S. standard OCR typeface for syndicated newspaper copy.

In Europe there's no such standard, but this OCR-B face is widely used in the UK.

NOT JUST A FLOPPY DISC!

The Varicomposer is a super-intelligent VDU or 'front-end' for merging, correcting, ordering, editing and formatting copy before it is actually set. In this particular system it also performs all H & J tasks, using an impeccable program to this end. To serve as grey matter it has a fast Varisystems-designed 8-bit TTL computer with 32K Bytes of MOS RAM backed by a further 300K Bytes of program or data store on each of two Shugart floppy disc drives. It uses TTL instead of a (cheaper) microprocessor because current-generation MPUs are far too slow for this demanding application, as in many others in typesetting. The Varicomposer is *multiprogrammed* to perform up to four tasks simultaneously. While accepting unjustified input from its own keyboard in foreground mode, it may be reading information from the on-line OCR machine, typing out a rough proof on a 55 c.p.s. daisy-wheel printer and punching out a paper tape in background mode.

Software — except for a bootstrap loader — is kept on reserved tracks of a floppy disc and loaded into RAM at the start of each working day. In case that sounds a bit onerous to anyone used to loading programs with paper tape, I hasten to reassure you that this takes just 8 seconds from floppy disc.

So it looks very nice. But what can it do? Its purpose is to present flawless information to the typesetter so that a perfect type image is obtained first time round, as well as to manipulate text while it's in digital form rather than waiting to carve up typematter on bromide paper *after* the photo unit has set it, as you'd otherwise need to do. In its editing mode, the Varicomposer's 70 function command keys include buttons for 'line kill', 'insert' and 'word delete' as well as other functions which make a Data Processing VDU look like a Model T Ford in comparison. Any mistakes spotted on the original typed sheets are best corrected here. The operator has the relevant typed sheets before him and can find the offending character string by striking a 'search' key, or if, say, a word has been consistently misspelt throughout an article, a 'search and alter' routine can replace each incorrect entry with the right spelling of the word.

Both floppy discs are exploited when a 'sort and merge' subroutine is run; for example, classified ads entered at random can be arranged automatically in alphabetical order, reading the originals off the first disc and writing them back onto the second. And just in case Varisystems' software doesn't do all you want it to, you can acquire an Assembler for a cool £2k and write your own, as software expert Mike Barnes is doing in the picture.

Efficient editing capabilities are essential for the smooth running of any but the very most basic typesetting system, and the Varicomposer neatly fits the bill. Just a few years ago, you'd have had to pay for a £50,000 minicomputer system to get comparable facilities. And since the Varicomposer is software-oriented, this product is not immutably cast in a mould when it leaves the factory; its character always remains amenable to radical change just by slotting-in a fresh floppy disc.

THE BUSINESS END

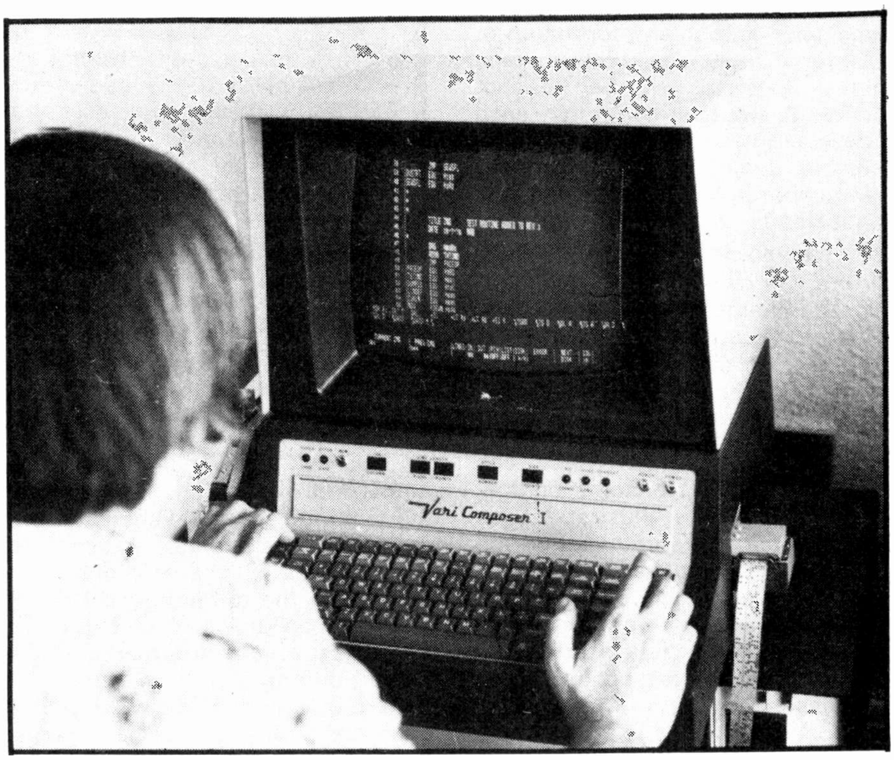
The Photon-Dymo Pacesetter actually sets the type. It is a versatile electro-mechanical photosetter, containing a dedicated 16K byte TTL computer, which exposes letters in much the same way as the A-M 550. Apart from being just an output machine, the Pacesetter differs from the 550 in that it works almost ten times faster, can mix up to 16 (as opposed to four) typestyles on-line, gives even better image quality and costs four times as much.

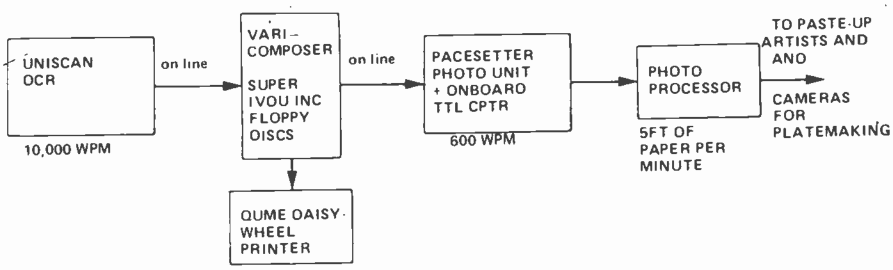
A STATE-OF-THE-ART NEWSPAPER COMPOSITION SYSTEM

We're into big money here: this composition system would cost something in the area of a half-million pounds. A similar system, which will doubtless differ in parts from the one described here, is to go live at London's *Daily Mirror* some time in 1977. It will be compositors, not journalists with VDTs, who type in the copy. Journalists are notoriously lousy one-finger typists and could put too many bodges into the system; and editorial VDTs are anyway rather a mixed blessing for the men who have to use them. Another reason for avoiding direct input from journalists is the human relations aspect. If all Fleet Street papers were to use direct editorial entry of copy, the majority of London's 2000 newspaper 'comps' might become redundant — with precious little prospect of finding alternative employment in printing — and both sides of the industry prudently regard the human costs and the major disruption that this would cause as outweighing the potential benefits of such a change.

The system, designed by Linotype-Paul in London, takes the form of a 'distributed intelligence' network. It is staked out around a host minicomputer (a Prime 100) while dedicated processors control VDTs and other system components such as the typesetters and Page View Terminals. The 'Linoscreen'' editing terminals incorporate microprocessors so that they call on the host computer only when requesting or despatching blocks of copy.

Since the breakdown of any component must not halt all work, everything appears in duplicate. The system is ~~amenable to~~ last-minute changes to the copy and can cope with up to, say, five editions during the course of an evening. And it eliminates as much handwork as the state-of-the-art permits.





INPUT

Most text is input via 90-key justifying keyboards with the same key arrangement as the old mechanical Linecasters had. As he types in the copy, each operator has to decide for himself, without any help from the computer, how and where to end the lines. He can check the accuracy of what he's just typed on a marching 'Self-Scan' display. This type of keyboard is used instead of one where the computer does all the hard work because it makes the job a more interesting one, since the 'comp' has to be actively involved all the time.

Headlines may be entered either from the justifying keyboards or on the 'Linoscreen' editing terminals. Linoscreens are configured in clusters, with four 'slaves' sharing the (microprocessor-endowed) intelligence of each 'master' terminal, and they are used both for correcting text, and for entering 'difficult' copy such as tabular information or text for display ads, where many stored 'formats' will be needed. On-line to the host computer, each Linoscreen has very similar capabilities to those of the stand-alone *Varicomposer;* but of course the Linoscreens can dip into that 60Megabyte disc for extra program or data information.

ILLUSTRATIONS

Pictorial copy has to be rephotographed onto 2¼in slides before it can be accepted by the Graphic Input Scanner (GIS), which can store up to 5000 pictures on-line. The GIS digitises illustrations so that they can be reproduced on the face of the CRT inside the typesetter. The object of the exercise is to further reduce hand-work, but again the use of a GIS could lead to the closure of an entire section — the process department — in a newspaper works. It is attractive to managements because it means fewer craftsmen need be employed, but is anathema to the unions for precisely the same reason; evidently the skills of the negotiators acting for both sides are going to be stretched to the limit while they strive for a settlement.

THE PAGE VIEW TERMINAL (PVT)

The PVT displays a detailed simulation of a tabloid newspaper page, full size, and allows the layout to be modified interactively. Thus it makes possible the total elimination of the paste-up stage in production. Each PVT comprises a Tektronix 4014 storage-tube terminal and associated display processor on-line to a dedicated 32K word *Prime 100.* Optional extras include a hard-copy printer and a graphics tablet. A daily newspaper group might well need a dozen or so PVTs (at $50,000 each) to cope with a total of perhaps 200 pages every day. Don't forget that some pages of a 'daily' may go through up to five editions during the night, each calling for fresh plates to be made.

The PVT's input is 'clean' text and headlines which have already been through H & J. When starting on a page, the operator first calls up the text for whichever story is to appear on the top left-hand side of the page; he knows which story is to go there because it is marked on a paper 'dummy'' already sent down to him by an editor. Now, shunting the text with a special cursor control, he 'picks up' the story and puts it in place. If it won't fit in the space allocated on the dummy, he can get it re-set in a different type size, or in shorter or longer lines. The text management computer will do this and almost immediately the story will come back onto the screen in its new format.

Once satisfied with this first story, the operator jigsaws the others into position in the same way, until he has filled the page. When the finished page has been approved, it is written onto disc to join the queue of other pages awaiting typesetting.

THE TYPESETTER

The Linotron 606 is among the world's fastest typesetting machines, operating at speeds of up to 3000 single-column lines per minute. Digital information concerning the shape of all type characters (on a matrix of not the familiar 5 x 7, but perhaps 200 x 200 dots) is held on disc and transferred to RAM when required. The Linotron's onboard computer reads a made-up page off the 60Mbyte disc as a set of specifications which say where each line is to go, together with information (in ASCII or TTS code) about the actual letters or words which have to be typeset. It reads 'raw' digitised information only on character formation and on illustration content.

The Linotron 'paints' the characters and/or illustrations on a 'window' as wide as the printed page, at a typical resolution of 650 scanned lines per vertical inch. But only one column — including the entire width of its associated headlines and illustrations — is set at a time. The image on the face of the CRT is projected through a lens system and onto roll-fed photographic paper or film. When the first column has been exposed, the photographic emulsion is wound back up again to its starting position and the next column is set, and so on until the page is done. The exposed film is automatically fed into an on-line photographic processor which develops and dries it. The page positives thus derived are used as masters for making printing plates.

DESTINATION 2000

Some day, the chances are that most of the copy which is now printed on paper will be sent from computer data banks to TV screens in the home, or better still, to pocket-size terminals with (liquid crystal?) screens. In this very long-term perspective, we can see that computer useage in print is still in its infancy.

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PIV	8A (TO92)	1A (3TO5)	3A (C106)	4A (TO220)	6A (TO220)	8A (TO220)	10A (TO220)	10A (TO220)	15A (TO220)
50	0.20*	0.25	0.35	0.32	0.41	0.42	0.42	0.47	0.96
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200	0.27*	0.35	0.45	0.40	0.58	0.60	0.60	0.68	1.14
400	0.30*	0.40	0.50	0.45	0.87	0.88	0.88	0.98	1.40
500	——	0.65	0.70	——	1.09	1.19	1.19	1.26	1.80

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	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)
110V	0.60	0.60	0.70	0.70	0.78	0.78	0.83	0.83	1.01	1.01
200V	0.64	0.64	0.75	0.75	0.87	0.87	0.87	0.87	1.17	1.17
400V	0.77	0.78	0.80	0.83	0.97	1.01	1.13	1.19	1.70	1.74
600V	0.96	0.99	0.87	1.01	1.21	1.26	1.42	1.50	2.11	2.17

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7442	0.65
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7447	0.81
7448	0.75
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7470	0.30
7472	0.25
7473	0.30
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7475	0.47
7476	0.32
7482	0.75
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7486	0.32
7489	2.92
7490	0.49
7491	0.65
7492	0.57
7493	0.45
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AC187	0.18	BC207B	0.12*	BF194	0.10*	BZX61	Series	ST2	0.20	2N3703	0.10*
AC187K	0.25	BC212	0.11*	BF195	0.10*	Zeners	0.20	TIP29A	0.44	2N3704	0.10*
AC188	0.18	BC213	0.12*	BF196	0.12*	BZX83 or		TIP30A	0.52	2N3705	0.10*
AC188K	0.25	BC213L	0.12*	BF197	0.12*	BZX88 Series		TIP31A	0.54	2N3706	0.10*
AD140	0.50	BC214	0.14*	BF224J	0.18*	Zeners	0.11			2N3707	0.10*
AD142	0.50	BC214L	0.14*	BF244	0.17*	C106A	0.40			2N3714	1.05
AD143	0.46	BC237	0.16*	BF257	0.30*	C106B	0.45	TIP32A	0.64	2N3715	1.15
AD149	0.45	BC238	0.16*	BF258	0.35	C106D	0.50	TIP34	1.05	2N3716	1.25
AD161	0.35	BC300	0.34	BF337	0.32	C106F	0.35	TIP41A	0.68	2N3771	1.60
AD162	0.35	BC301	0.32	BFW60	0.17*	CRS1 05	0.25	TIP42A	0.72	2N3772	1.60
AL102	0.95	BC323	0.60	BFX29	0.26	CRS1 10	0.25	IN2069	0.14	2N3773	2.10
AL103	0.93	BC327	0.18*	BFX30	0.30	CRS1 20	0.35	IN2070	0.16	2N3819	0.28*
AF114	0.20	BC328	0.16*	BFX84	0.23	CRS1 40	0.40	IN4001	0.04*	2N3904	0.16*
AF115	0.20	BC337	0.17*	BFX85	0.25	CRS1 60	0.65	IN4002	0.05*	2N3906	0.11*
AF116	0.20	BC338	0.17*	BFX88	0.20	CRS3 05	0.34	IN4003	0.06*	2N4124	0.14
AF117	0.20	BCY30	0.55	BFY50	0.20			IN4004	0.07*	2N4290	0.12
AF118	0.50	BCY31	0.55	BFY51	0.18			IN4005	0.08*	2N4348	1.20
AF139	0.36	BCY32	0.60	BFY52	0.19	CRS3 10	0.45	IN4006	0.09*	2N4870	0.35*
AF239	0.37	BCY33	0.55	BFY64	0.35	CRS3 20	0.50	IN4007	0.10*	2N4871	0.35*
BC107	0.09	BCY34	0.55	BFY90	0.65	CRS3 40	0.60	2N696	0.14	2N4919	0.70*
BC107B	0.09	BCY38	0.50	BR100	0.20	CRS3 60	0.85	2N697	0.12	2N4920	0.80*
BC108	0.09	BCY39	1.15	BFY39	0.40	MJ480	0.80	2N706	0.10	2N4922	0.58*
BC109	0.09	BCY70	0.12	BSX19	0.16	MJ481	1.05	2N929	0.14	2N4923	0.46*
BC109C	0.12	BCY71	0.18	BSX20	0.18	MJ490	0.90	2N930	0.14	2N5060	0.20*
BC117	0.19*	BCY72	0.12	BSX21	0.20	MJ491	1.15	2N1131	0.15	2N5061	0.25*
BC125	0.18*	BD115	0.55	BSY95A	0.12	MJE340	0.40*	2N1132	0.16	2N5062	0.27*
BC126	0.20*	BD131	0.36	BT106	1.00	MJE371	0.60	2N1304	0.20	2N5064	0.30*
BC141	0.28	BD132	0.40	BT107	1.60	MJE520	0.45	2N1305	0.20	2N5496	0.65
BC142	0.23	BD135	0.36	BT108	1.60	MJE521	0.55	2N1711	0.18		
BC143	0.23	BD136	0.39	BT109	1.00	OA5	0.50*	2N2102	0.44		
BC144	0.30	BD137	0.40	BT116	1.00	OA90	0.08	2N2369	0.14		
BC147	0.09*	BD138	0.48	BU105	1.80*	OA91	0.08	2N2369A	0.14		
BC148	0.09*	BD139	0.58	BU105/02	1.90*	OC41	0.15	2N2484	0.16		
BC149	0.09*	BD181	0.86	BU126	1.60*	OC42	0.15	2N2646	0.50		
BC152	0.25*	BD182	0.92	BU204	1.60*	OC44	0.12	2N2905	0.18		
BC153	0.18*	BD183	0.97	BU208	2.60*	OC45	0.10	2N2905A	0.22		
BC157	0.09*	BD232	0.60*	BY206	0.15	OC70	0.10	2N2926R	0.10*		
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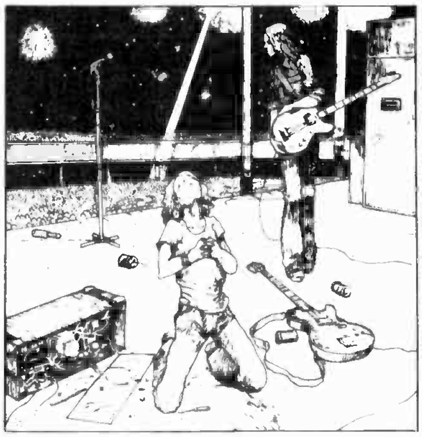

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There are some simple electronic dice circuits around but they generally display non-random results. Here is a project which overcomes this problem.

DOUBLE DICE

eti project 241

ELECTRONIC GAMES ARE VERY popular today and we have published quite a few which vary in complexity from simple switch logic games, like the Family Ferry, to very complex ones. We have had many requests for an electronic dice and several designs have been submitted by readers. However, all the circuits, submitted had a common failing. This was that, although they operated correctly, the distribution of numbers was not random. That is, if a few hundred 'rolls' were made it would be found that, for example, sixes ocurred far more frequently than they should do. In most cases this was due to the fact that currents in the logic modulated the power supply thus causing bias in the dice.

Bias. We had the same problem in our dice initially, even though CMOS logic was used. It had been intended to design dice which roll fast when the button is pressed, roll slowly when the button is released (for more realism) and then stop to display the result. We designed a system to this specification but found that it too was biased. The cause was current variations due to the differing number of LEDs being switched on and off during the slow roll. The resulting modulation of the power supply causes instability of the oscillator and also acceptable variations in the delay circuitry. This would have been cured but by increasing the complexity of the unit. It was decided instead to delete the slow roll feature and to blank the display during the fast roll. The resulting circuit has been thoroughly checked for randomness and is found to have no bias.

With the CMOS logic used the power consumption is so low that a power switch is not required. The circuit is activated simply by pressing the roll button. The roll result is displayed and after about seven seconds the display will switch off automatically. The current drawn from the battery in the off state was measured and found to be 600 nanoamps! And of that 500 nanoamps was due to leakage in the capacitor across the battery.

CONSTRUCTION

The CMOS devices used in this project should be handled with care as they may easily be damaged by static electricity. They should be the last components to be installed on the printed circuit board they should be left in the protective foam until installation and they should be handled as little as possible.

Begin assembly of the board by fitting the links (we regret that there are so many but it was unavoidable on a one-sided PCB) then resistors and other low-height components and then finally the IC's. Drill holes in the front panel for the LEDs and for the push button. The cathode terminal of the type of LED specified is marked by a small flat on the body flange and the cathode lead is also slightly shorter. Cut the leads of the LED so that they are 5–7mm long leaving the cathode just a little shorter so that it may be identified easily after installation. Mount the LEDs and position them so that the anode lead points towards the centre of the box (between the two dice groups) and

HOW IT WORKS ETI 241

The logic for each of the dice is basically a decade counter connected so that it divides by six. The output from the decade counter is decoded to drive the LEDs which are arranged in dice format. To make the decade counter (IC5, 4518) divide by six, the 'B' and 'C' outputs are taken to a two-input HAND gate and then through a second NAND gate to the reset te rminal of the decade counter. When the 'B' and 'C' outputs first both go to '1' (decimal count six) the reset terminal goes high which resets the counter outputs to '000' thus removing the high to the rest terminal. Thus as a result at the reset terminal of the decade counter a pulse about 100 nanoseconds wide is generated. This pulse from the first dice is used to clock the second one. The decoding of the output from the decade counter is performed by ICs 2/3, 3/3 and 3/4 together with some associated resistors and transistors the truth table of which is shown in Table 2.

The power required by the LEDs is more than can be supplied by the CMOS and the transistors are therefore required to buffer the outputs as well as forming part of the decoding process. Transistors Q3 and Q5 (Q6 and Q9 for dice 2) act as logic gates for decoding.

The counters are clocked by an oscillator constructed from ICs 2/1 and 2/2. The output from the oscillator, about 8 kHz, can be gated on and off by a control input as follows. The push button controls a flip-flop, constructed from the gates IC1/1 and IC1/ . The purpose of this flipflop is to remove any contact bounce from the operation of the push button. The flip-flop switches the oscillator on when the push button is pressed, removes the +6 volts from the LEDs, and charges C3 via D1. When the button is released the oscillator stops, the capacitor C3 slowly discharges via R3, and the output of IC1/4 switches on Q1 thus supplying power to LEDs 1 and 6. Power is supplied to the other LEDs by the switch. The LEDs now indicate the outputs of the decade counters. After about seven seconds the output o IC1/3 goes low which resets the decade counters. In addition the transistor Q1 is turned off. Power to the rest of the LEDs is left on but as the counters are reset to zero (to decimal count zero or display count '1') all LEDs will be off.

Parts List

Resistors

R1	1M	½W	5%
R2	10k	"	"
R3	1M	"	"
R4-R10	10k	"	"
R11-R14	330 ohms	"	"
R15, 16	10k	"	"
R17-R20	330 ohms	"	"
R21, 22	10k	"	"

Capacitors

C1	10μF 25V electrolytic
C2	4n7 polyester
C3	10μF 25V electrolytic

Semiconductors

D1	1N914 or similar
Q1,2,4,6,8	ZTX500 or BC178
Q3,5,7,9	BC108 or similar
IC1 – 4	4011 (CMOS)
IC5	4518 or 4520
LED 1-14	TIL 209 with clip

Miscellaneous

PB1 Push button SPDT
ETI 241 PC board
14 pc board pins
Front panel
2 battery holders
2 battery clips
4 batteries

wire them in accordance with the component overlay/wiring diagram. With the leads on the LEDs cut this short they may be damaged when soldering if precautions are not taken. To prevent this use a pair of long-nose pliers or similar as a heat sink on the lead of the LED when soldering.

Before wiring the switch check which terminal is common. Usually this is the centre terminal but sometimes, as with the switch we used, it is one of the outside terminals. When the unit is completed a piece of foam plastic should be used between the rear of the LEDs and the PCB so that there is no possibility of shorts ocurring.

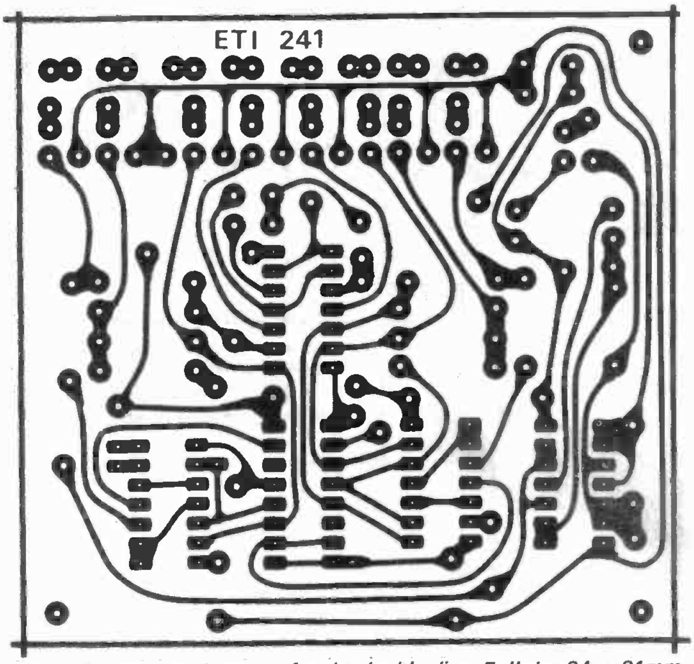
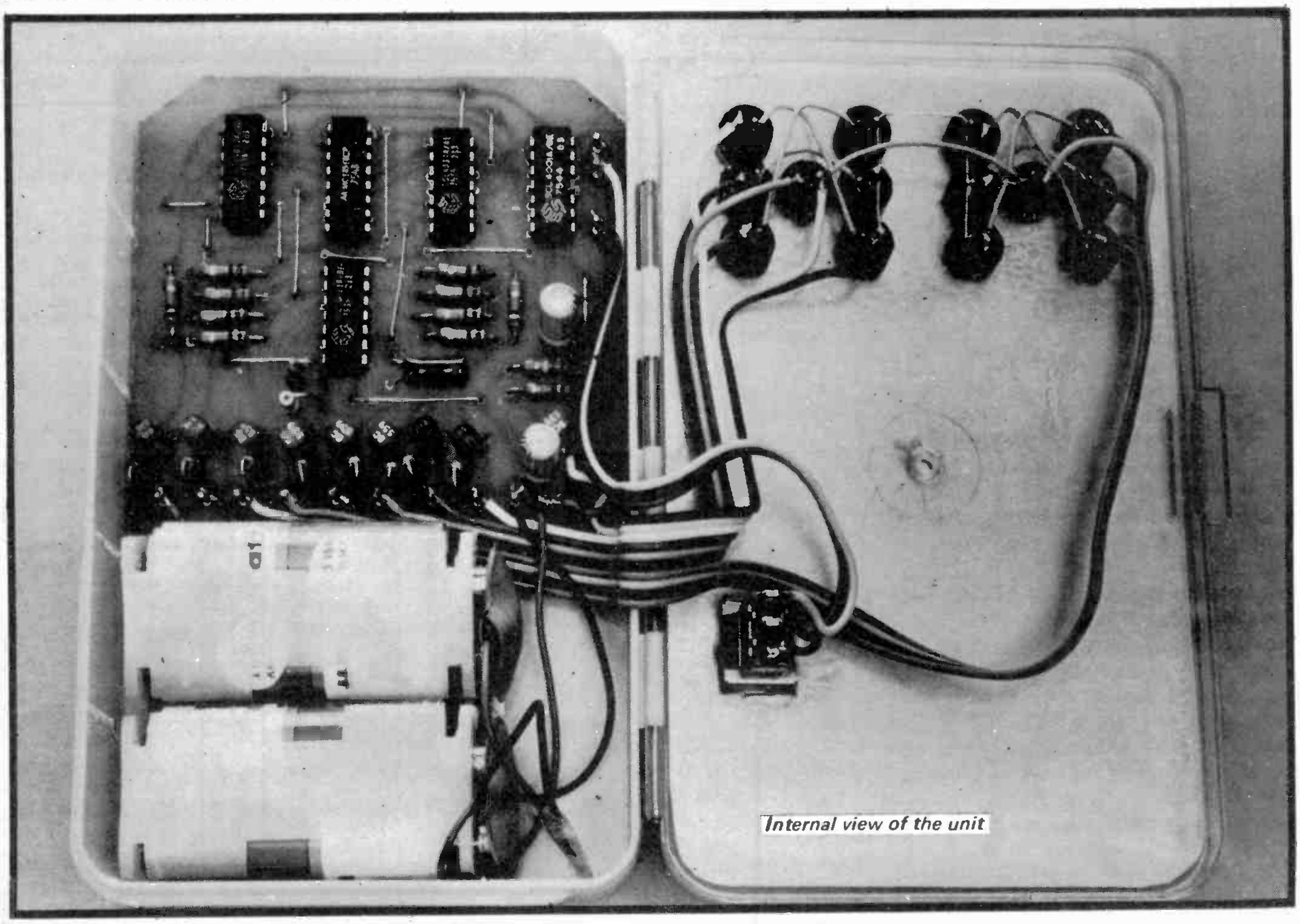


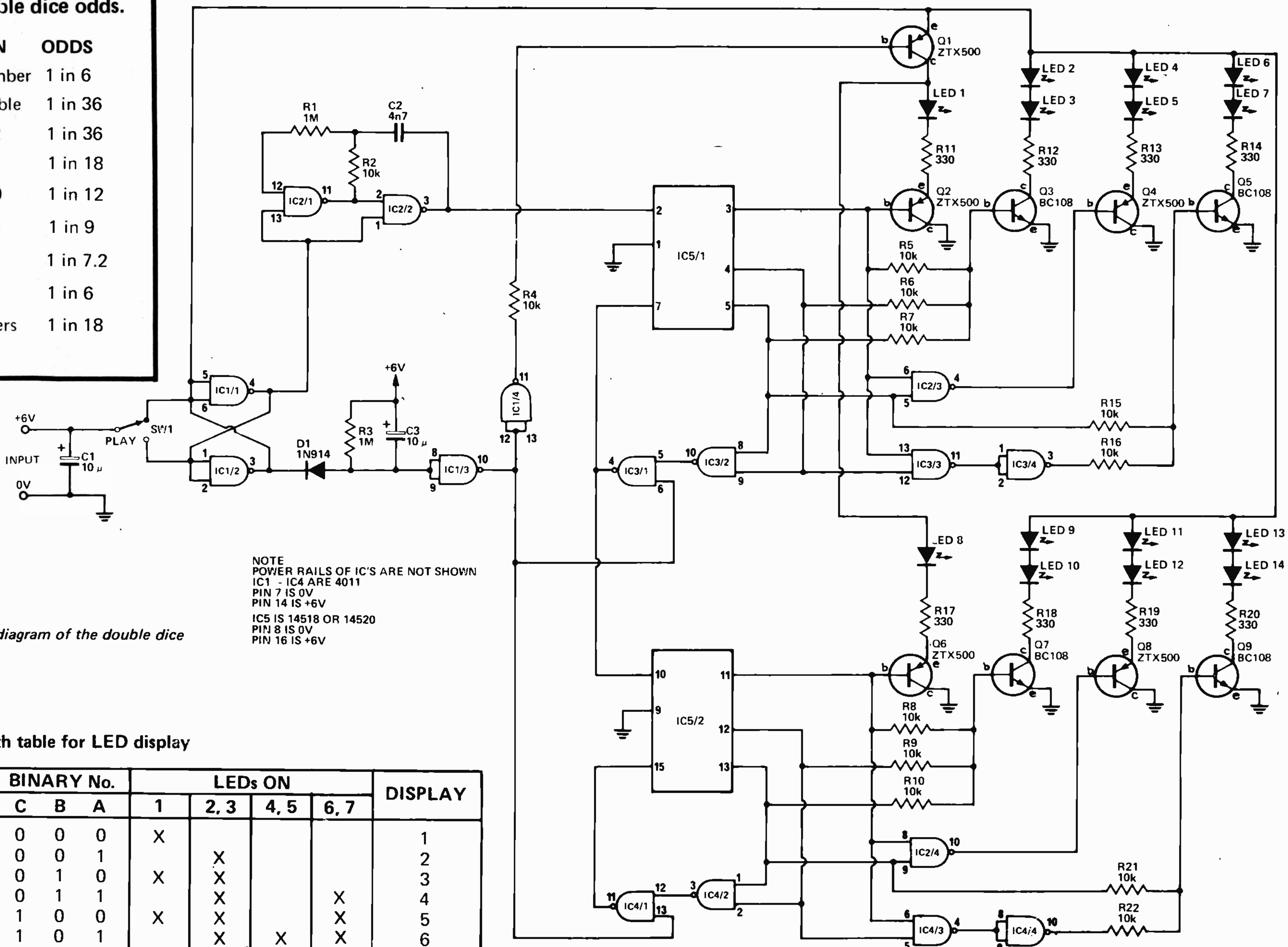
Fig. 1. Printed circuit layout for the double dice. Full size 84 x 81mm.



Internal view of the unit

TABLE 1 Double dice odds.

COMBINATION	ODDS
any double number	1 in 6
a specified double	1 in 36
total of 2 or 12	1 in 36
total of 3 or 11	1 in 18
total of 4 or 10	1 in 12
total of 5 or 9	1 in 9
total of 6 or 8	1 in 7.2
seven	1 in 6
any two numbers	1 in 18



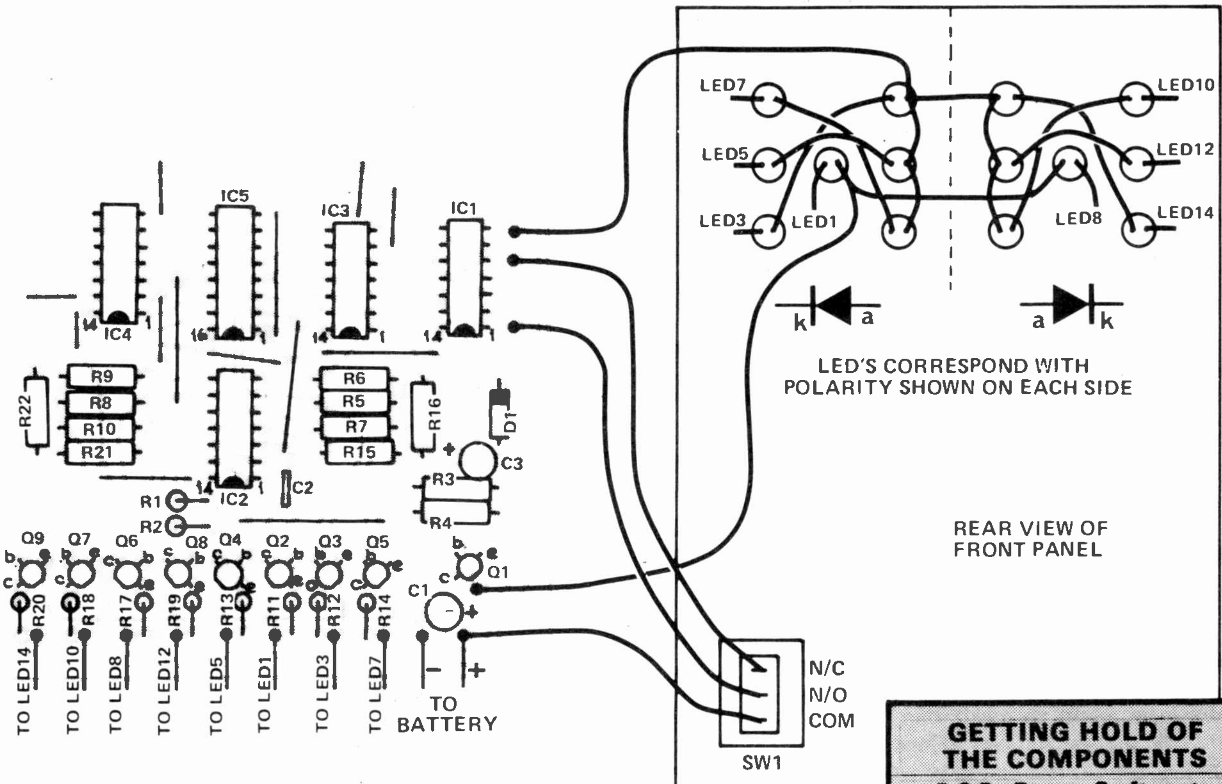
NOTE
POWER RAILS OF IC'S ARE NOT SHOWN
IC1 - IC4 ARE 4011
PIN 7 IS 0V
PIN 14 IS +6V

IC5 IS 14518 OR 14520
PIN 8 IS 0V
PIN 16 IS +6V

Fig. 2. Circuit diagram of the double dice

TABLE 2 Truth table for LED display

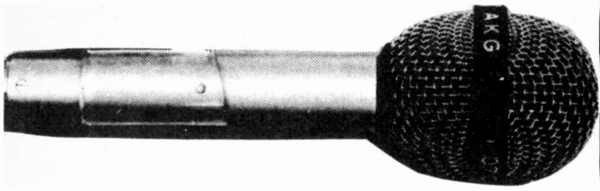
Decimal Count No.	BINARY No. C	B	A	LEDs ON 1	2, 3	4, 5	6, 7	DISPLAY
0	0	0	0	X				1
1	0	0	1		X			2
2	0	1	0	X	X			3
3	0	1	1		X		X	4
4	1	0	0	X	X		X	5
5	1	0	1		X	X	X	6
6	1	1	0	RESET TO 000				



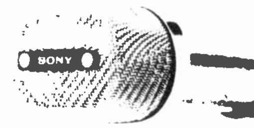
GETTING HOLD OF THE COMPONENTS

P.C.B.: Ramar, Crofton etc. There are no 'awkward' components in this project and most mail order suppliers will have all the pieces available

Fig. 3. Component overlay and interconnection diagram.



SELECTING MICROPHONES



MICROPHONE SPECIFICATIONS tend to be masterpieces of obscurity. The beginner faced with buying a microphone has to reconcile conflicting requirements between the equipment he already has, the recordings he wants to make, and the amount of money he can afford to pay. The literature he gets from manufacturers may or may not be very helpful.

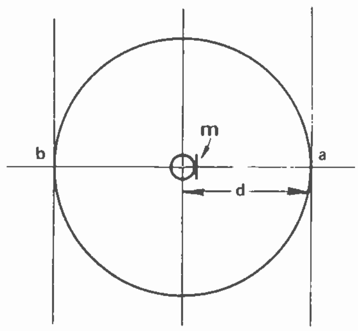
Microphones react differently to sounds coming from different directions. The most important direction, of course, is from the front. The directional response can be considered as a comparison between this front or 'on-axis' response and all other directions.

A polar plot or polar diagram, three of which are shown in Fig. 1, is a line joining all those points around the microphone which give the same output for a given sound level. In other words, if you were to move a sound all around the omnidirectional microphone shown at the top of Fig. 1 you would get the same output from the microphone without having to move closer to it. On the other hand, if you were to move a sound round the figure of eight microphone there would be no response from the microphone at the sides at right angles to its axis but the response would increase again towards the back.

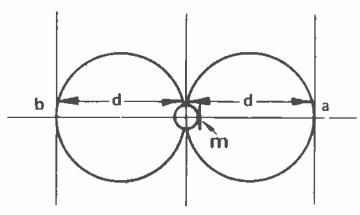
PRESSURE TRANSDUCER

The directional characteristics of the microphone depend on its construction. If, as in Fig. 2, the rear of the diaphragm is totally enclosed apart from an atmospheric pressure equalisation tube, then the diaphragm will react only to rapid changes in air pressure. If the diaphragm is not so big as to interfere with the sound waves it will respond to sound from any direction since these changes in pressure can approach from any direction. Thus it is a pressure transducer.

Another kind of operation is pressure gradient operation. The diaphragm (Fig. 3) is exposed on both sides. A sound wave coming from direction A strikes the front of the diaphragm first and then travels round to the back. In doing so it will have to move distance x, the path difference between front and back. In this time the pressure at the front of the diaphragm will have altered according to the pressure pattern of the incoming wave. If the wavelength of the sound is long compared with x (Fig. 4) the pressure change which occurs while the wave travels distance x will not be great. In the limit, when the sound pressure is constant, there will be no difference along the path length x at all. At low frequencies x will be small compared with the wavelength and it can be assumed that P_1 to P_2 is a linear portion of the pressure curve, so that $P_1 - P_2$ genuinely represents the pressure gradient. Here the force on the diaphragm is proportional to frequency, and this is roughly true until the distance is a quarter of the wavelength of the sound.



Omnidirectional response.



Bidirectional or figure of eight.

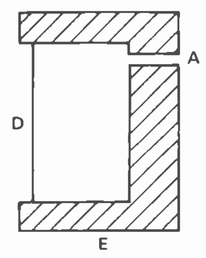


Fig. 2. Pressure operation. Diaphragm D reacts only to rapid pressure changes, which may come from any direction. A is a small aperture to avoid permanent diaphragm deflexions, E is the enclosure.

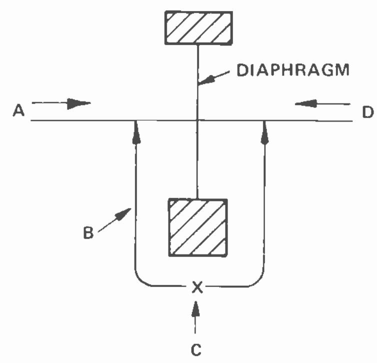


Fig. 3. Pressure gradient operation. Distance x is the path difference between the front and the back of the diaphragm.

CARDIOID PATTERNS

The pressure gradient microphone will only respond to sounds from the front. Sounds from position C in Fig. 3 will have no effect on the diaphragm since pressures on either side of it are equal. Sounds from D will have the same effect as those from A but will be phase reversed since they move the diaphragm in the opposite sense, so that although the microphone would give the same voltage output at B as at A, the output at A would be +V and the voltage at B would be –V. It is for this reason that if the omnidirectional and figure of eight characteristic are combined – as they can be by connecting an omnidirectional microphone element to a figure of eight element – then the responses of the two characteristics add at the front and subtract at the back, giving the cardioid characteristic by using a cardioid, which does not respond to sounds coming from behind it and will not be so affected by auditorium loudspeakers. Often auditorium loudspeakers are placed in front of the performers and have their own directional pattern which prevents their output reaching the stage microphones.

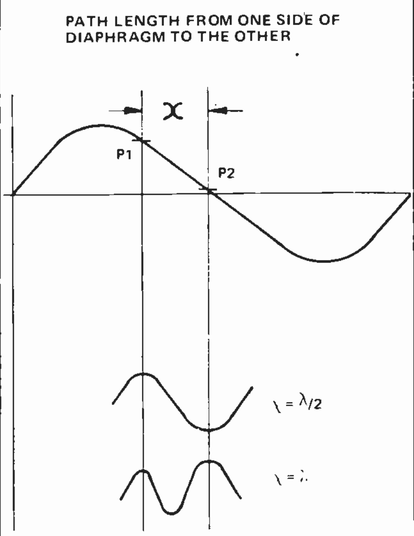


Fig. 4. Pressure gradient and frequency. As the wave travels distance x its amplitude (i.e. the pressure) changes and the diaphragm senses this differential.

HAND MICROPHONES

The omnidirectional microphone is best for use as a hand microphone. There is less handling noise and the user need not be on axis for the microphone to give full output. The omnidirectional microphone, is also less prone to a phenomenon known as 'proximity effect', which means that as the microphone gets nearer to the source of a sound it exaggerates the bass response. On the other hand an omnidirectional microphone is not easily used in public address work because it may pick up the sound from an audience loudspeaker and re-amplify it, causing howl-round or feedback. This is best eliminated

POPPING

Another problem is breath popping, which occurs when a performer sends a puff of hot steamy air into the internal organs of a microphone. Omnidirectional microphones are less sensitive to this kind of thing and cardioids can be protected from it by windshields. A ribbon might not recover. If a windshield is used on a cardioid with a port or aperture in the body of the microphone, as in the AKG series, the ports should be windshielded too.

The figure of eight combination overcomes disadvantages inherent in the omnidirectional and cardioid designs. The omnidirectional, while it has many advantages, responds to echoes and reverberations in a room as well as the direct sound. The cardioid responds, in general, to the direct sound, which is why it tends to be used in situations where an audience is present and it can therefore reduce the coughs, chair scrapes and, if you're unlucky, snoring that may occur on such occasions. On the other hand the cardioid tends to produce a very dry sound, particularly if used too close, and recordings made this way can often be said to need some reverberation. The figure of eight is a perfect compromise, on many occasions, introducing just the right amount of reverberation and keeping off unwanted noise.

REFLECTIONS

Figure 5 shows the common situation when recording. In Figure 5 the microphone receives a direct sound from the instrument as well as numerous indirect sounds reflected from walls, floor and ceiling. For a variety of reasons in a concert hall these tend to be predominantly sounds reflected from the side of the hall. The cardioid will tend to diminish its response to sounds as they come from a direction nearer the back of the microphone. So it will respond better to sounds at A than sounds at C, and B will be almost as well heard as the direct sound. The B reflection has much less far to go than those from the ceiling, which is why speakers sitting at tables can be difficult to record.

The omnidirectional microphone will record all these reflections faithfully and the trumpet will sound very distant indeed. A figure of eight will tend to record those sounds from the rear wall as well as the direct sound.

The ratio of indirect sound can also be varied by giving the direct sound a shorter path to the microphone.

This approach should be used if an omni has to be used, but as we shall see later, it is not suitable for ribbons.

TRANSDUCERS

The transducer is the element which converts the mechanical movements of the diaphragm into electrical signals. Three types of transducer are used to get these various response in quality microphone: the moving **coil**, which is suited to an omnidirectional response but can be modified to give a cardioid response, the **ribbon**, which is far more suited to figure of eight operation than other responses, and the **capacitor**, condenser or electrostatic microphone.

Both moving coil and ribbon microphones work on the same principle – that when a conductor moves in a magnetic field an electrical signal is induced in the conductor. The size of the signal depends on the rate at which the conductor moves across the field.

MOVING COIL

In Fig. 6 the moving coil is attached to a diaphragm, and when sound waves hit the diaphragm the coil moves and gives a signal across its ends. The same

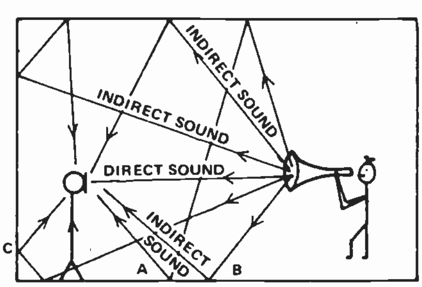
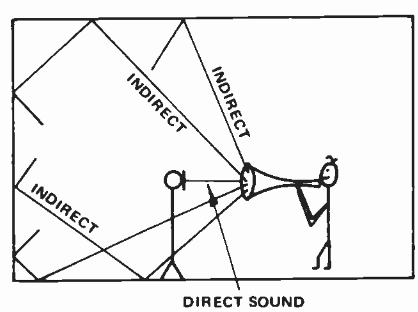


Fig. 5. If the mike is too far away the indirect sounds (echoes) drown the direct sounds.



Moving the mike closer in alters the direct/indirect sound ratio.

SELECTING MICROPHONES

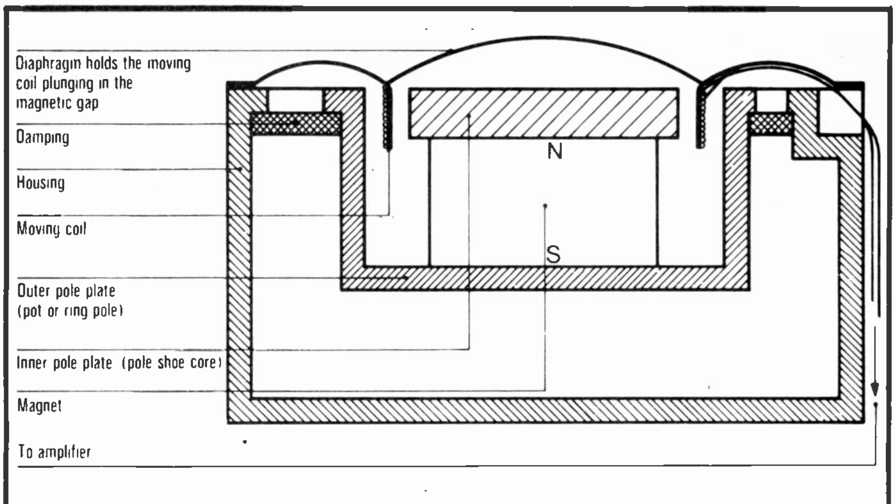


Fig. 6. Transducer principle of the moving-coil microphone.

happens in the ribbon microphone.

The moving coil is more widely used in studios and on stage than any other. It is robust, gives a good output level, has a good transient response and frequency response, and is reliable and inexpensive. It is best suited to omnidirectional work and can become rather complicated if used as a cardioid. Even as an omni the response becomes less omnidirectional at high frequencies because the case interferes and this has to be compensated for by making the microphone smaller – though as it gets smaller the output decreases.

The impedance of the moving coil microphone is low, between 20 and 30 ohms. Also, compared with the output of the lower quality crystal and ceramic types of microphones, the output is low, so a transformer may be needed to step up both impedance and output voltage for the input of the tape recorder, amplifier or mixer. Often the transformer is built into the case of the microphone and can be fitted with a number of secondary tappings, so that the microphone can be matched into a variety of impedances.

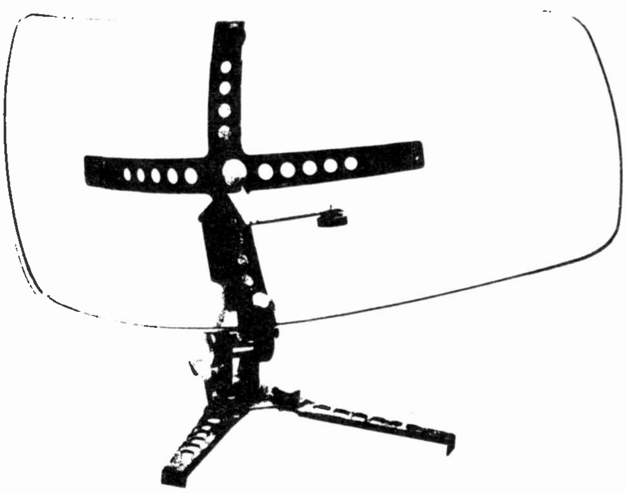
RIBBON

Figure of eight operation is usually achieved with a ribbon microphone. Much of the foregoing remarks about the need for a transformer apply here as they do with the moving coil microphone, except that the ribbon microphone has a far lower impedance and output than the moving coil microphone. The impedance might be as low as an ohm and a transformer is always needed, particularly since a ribbon microphone with a wide frequency response is likely to give a very low output. The ribbon microphone is an excellent choice for stereo, where two arranged may give excellent results for recording an orchestra.

Note that if two microphones are to be used for recording stereo the off-axis response is very important. Since they will not be pointed directly at the orchestra they need to reproduce high frequencies at an angle to the front of the microphone. Most manufacturers of repute give some idea of the off-axis response of a microphone by publishing a polar diagram plotted at various frequencies.

Orchestral recording is ideal for the ribbon microphone, since it is very prone to 'proximity effect', and should never be used near to loud bassy instruments. It is also very delicate and cannot be used outside, where a gust of wind may damage it permanently. It should never be used held in the hand, since it is more prone to handling noise than any other microphone. It may have a large stray magnetic field, so a ribbon microphone should be kept away from recording tapes.

Ribbon microphones can also be used to make small studios less dead without including reflections, particularly those from tables. A bi-directional microphone can be used for two persons speaking, one either side, and for drama it is very useful for an actor to be able to step 90° round the microphone to 'disappear' from the scene. For more speakers, as in a discussion, it is better to use an upward facing cardioid, which will, again, cut out those unwanted table reflections and paper shuffling sounds without making the discussion sound as though it is being held in a room lined with cotton wool or at night in the centre of the Simpson desert. Broadcasting studios often have a well in the middle of the table for placing such a microphone in and another advantage of this is that it tends to lower the microphone's prominence in the minds of those having to speak into it, particularly if they are not experienced broadcasters. Note that a ribbon microphone should be used at mouth level in such circumstances.



Another way to get a highly directional response: the parabolic reflector. The reflector on the JVC TL-E71 gives a 15 dB gain at 5 kHz.

CAPACITOR

The capacitor microphone can be arranged to have any of the three polar patterns and even any in between. It works on the principle that if the charge on a parallel plate capacitor is kept constant the voltage across the plates is proportional to the distance between the plates. One plate is kept fixed and the other is flexible and responds to sound, so that the sound varies the voltage across the plates, and gives an audio output signal. The charge on the plates is kept constant by polarising the plates via a large resistor, see Fig. 11, and the audio voltage is extracted via an isolating capacitor. The microphone has a flexible plate on either side of the fixed plate so that two outputs are obtained which can be added, subtracted or mixed in varying degrees to obtain various polar patterns.

Capacitor microphones undoubtedly exhibit the best frequency response, and can be flat up to 15 kHz or so, with a −3 dB point as high as 18 kHz or higher. In addition they have very high output level, can be very small and, as we have seen, can give various polar patterns.

The problem with a capacitor microphone is that its source is a small capacitance, which gives a very high value of source impedance at audio frequencies. Any signal source with a high source impedance may suffer from stray fields picked up by the cable connecting it to its amplifier and from a deterioration in frequency response along the cable. Thus a buffer amplifier has to be built close to the microphone cable. This means that the amplifier has to be powered but, on the other hand, the output can be as high as the amplifier designer requires.

All this means that for a capacitor microphone you may need an external power supply and an internal impedance convertor. Sometimes the diaphragm is made of metal-flashed plastic, which can distend in heat, such as found under television lighting. Even if the capacitor polarising voltage is supplied by an electret — a permanently polarised crystal — a battery is still needed to power the buffer amplifier because the electret cannot supply any current. The electret may be an uncertain proposition and perhaps susceptible to heat and moisture. Even an externally powered capacitor microphone is susceptible to an increase in noise in humid conditions.

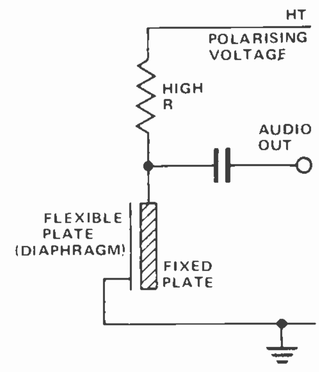
IMPEDANCE AND MATCHING

The next problem is that you have to match the microphone output to your amp or tape recorder input. There are two rules here: the output impedance should be a half or a third the input impedance of the device into which it is feeding, and the sensitivity of the microphone should be two to four times the maximum input sensitivity of the device into which it is feeding. This gives enough input from the microphone to avoid too low a signal, which would increase noise, and it also means that there will not be so much output from the microphone that the input to the recorder is overloaded.

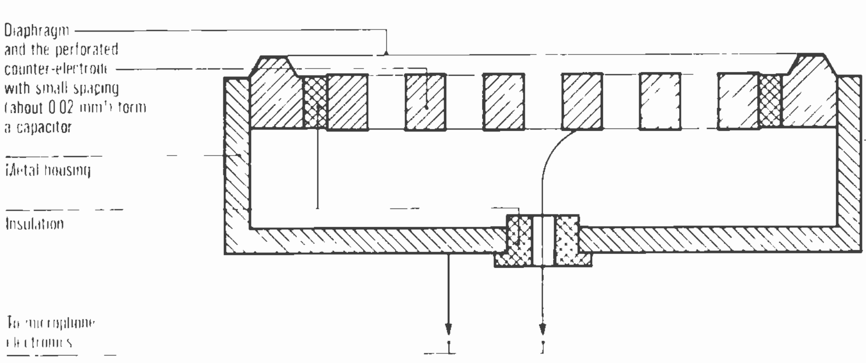
The Revox A77, for instance, quotes an input sensitivity of 0.15 mV at 6 kilohms. First, you're looking for a microphone with a maximum output impedance of around 2 k. Next you want an output from the microphone of between 0.3 and 0.6 mV. This means that the sensitivity will be between −70 dB and −64 dB. The reference is 1 V / microbar, or $10V/N/m^2$. Note that if the voltage is doubled the sensitivity increases by 6 dB. If the reference is 1 mW into 600 ohms the reference is 0.776 V and 1 mW into 1 kohm gives 1 V.

The self generated noise in the microphone varies with its source impedance, and the lower this is the better from the noise point of view. At any rate the noise should be between 20 and 30 dB measured to DIN standard 45405, or defined as between 0.2 and 0.3 Veff.

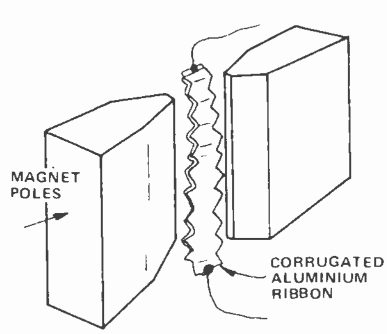
The dynamic range of a microphone is a measure of its ability to record the softest and the loudest sounds equally well. At the top end it will begin to distort once the sound reaches a certain loudness and the level at which the microphone distorts by, say, one per cent can be taken as the reference level. At the quiet end the microphone may give an output which is barely above its own noise level. The dynamic range should be between 120 and 130 dB. It should be noted that this quantity isn't all that significant since the limitations of the input amplifier are more likely to be dominant — if the microphone gives out more than $1mV/dyne/cm^2$ the output will be 0.1 V at a sound level of 114 dB or so, which can occur, and the amplifier is likely to distort.



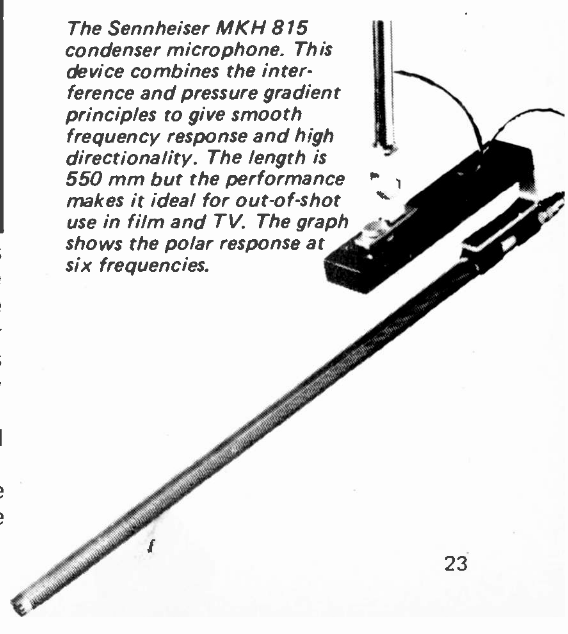
Some capacitor microphones have a flexible plate either side of a fixed plate. Each single diaphragm gives a cardioid response so that if the two outputs are added, the results is omnidirectional, and if subtracted is bi-directional or each cardioid can be used alone.



Transducer principle of the capacitor microphone.



Ribbon microphone.



The Sennheiser MKH 815 condenser microphone. This device combines the interference and pressure gradient principles to give smooth frequency response and high directionality. The length is 550 mm but the performance makes it ideal for out-of-shot use in film and TV. The graph shows the polar response at six frequencies.

MICROPROCESSORS

SC/MP Introkit (from 1 Aug. '76)	£62.50
ME680 Kit	£95.00
Mostek F8 Kit	£135.00
SC/MP TTY Kit (See Electronics Tomorrow, Sept. '76	£88.00
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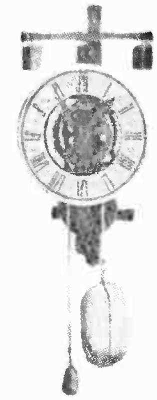

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SO-50253 Alarm, snooze	£12.50	£14.25
SO-5378 Car (xtal incl)	£17.00	
SO-50395 6 dec counter	£23.50	£25.00
SO-50396 HHMMSS Counter	£23.50	£25.00
SO-50396 HHMMSS Counter	£23.50	£25.00
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DL704E	.3	C	£0.60	£2.00	£4.50
DL707E	.3	A	£0.60	£2.00	£4.50
DL721E	.5	A	£1.50	£2.50	£6.00
DL728E	.5	C	£1.50	£2.50	£6.00
DL747E	.6	A	£0.90	£3.50	£8.00
DL746E	.6	A	£0.90	£3.50	£8.00
DL750E	.6	C	£0.90	£3.50	£8.00

BASIC KIT £7.50

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4x DL747E, Instr.
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THERMAL PRINTING

BY ARTHUR E. CRUMP*

IT IS QUITE REMARKABLE how a development in one field triggers off advances in others. In fact if often happens that an improvement in a particular product actually *demands* advances in related areas in order fully to exploit the original breakthrough.

IC's have developed to the stage where complex data logging systems can be fabricated on a single printed circuit board, yet until fairly recently the production of a hard-copy printout to accompany the miniaturised electronics meant the use of mechanically complicated printers. Such printers involved numerous moving parts which needed maintenance and lubrication, messy ink ribbons or rollers, or the use of pressure-sensitive paper, which has poor handling qualities. Drum-type printers went part way towards simplifying printer mechanisms, and these are still very popular, but have the disadvantage that they are not normally alphanumeric.

A truly microcircuit-compatible printer needs to be mechanically simple, have low power drain, and be alphanumeric. Silent operation and fade-free printout with high tolerance to handling, and the absence of ink, are further desirable features. Thermal printers fulfil these requirements admirably, and promise to be the accepted standard for the future.

Thermal printers form characters by the application of heat to heat-sensitive paper. The characters are constructed from a dot matrix which may be of any number of elements from 5 x 4 to 9 x 7 or greater. Micro-miniature solid-state heaters are fabricated into a matrix of the requisite size, the character being formed by applying power to the "dot" positions as appropriate.

A typical thermal head is shown in Fig. 1.

Typically, the heat-sensitive paper changes from white to dark blue at around 80° centigrade. The solid state heaters achieve a tem-

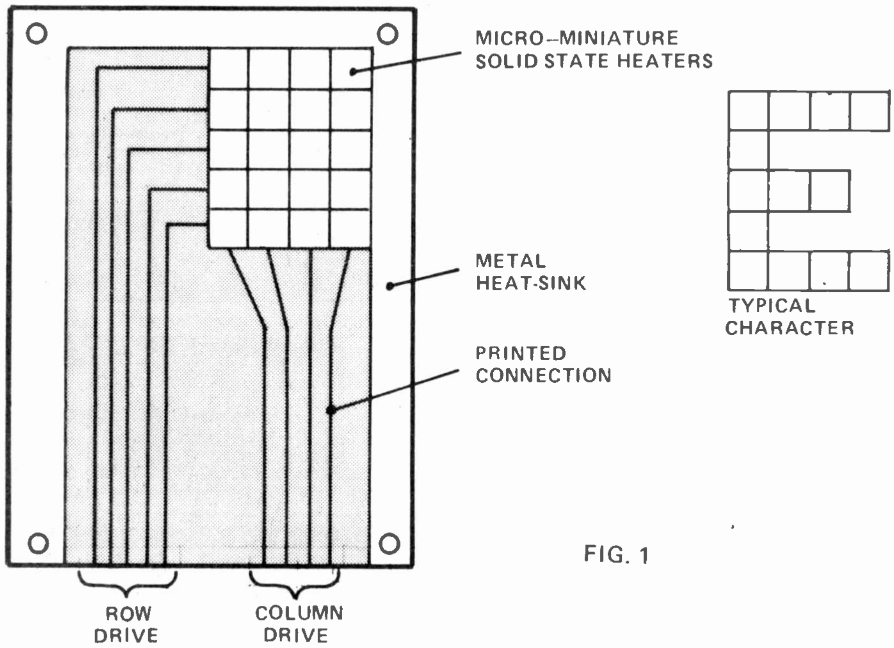


FIG. 1

Fig. 1. A typical thermal printing head.

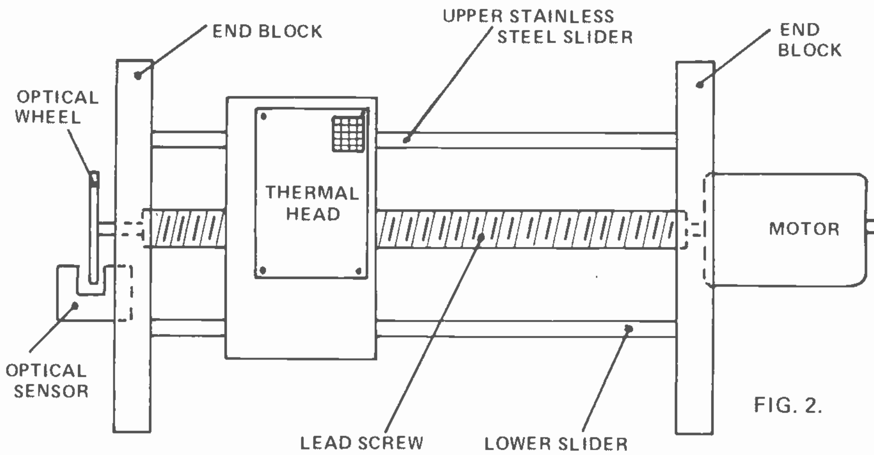


FIG. 2.

Fig. 2. The thermal matrix head is normally mounted on a moving carrier.

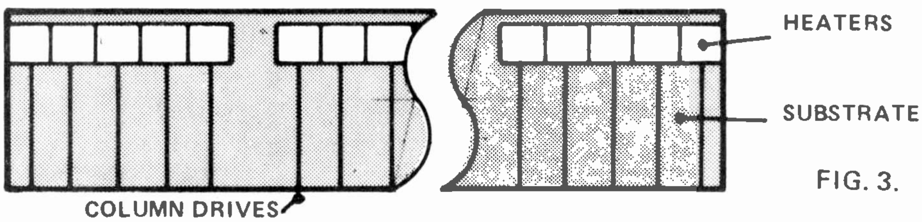


FIG. 3.

Fig. 3. A later development of the thermal print head is the in-line type.

* Managing Director, Spectronics Limited, Poole.

perature of over 200°C in 5-10 mS.

The thermal matrix head is normally mounted on a moving carrier, as shown in Fig. 2, and a pressure-bar keeps the head in pressure-contact with the paper to ensure adequate thermal conduction.

The result is a silent printer having very few moving parts and providing a stable printout. The heat sensitive paper produces a clean and clear printout which does not fade with time or when exposed to light. Certain types of thermal paper are also pressure-sensitive but these papers mark very easily when handled so the non pressure-sensitive types are preferred.

A further advantage of the thermal technique is that low voltages are used for driving the print head, 12 to 24V being typical, so that the power supply for the printer is compatible with that used for the associated electronics.

A later development of the thermal print head is the in-line type shown in Fig. 3. This is a fixed head which also uses the dot-matrix approach, but instead of moving a complete matrix across the paper, the paper is moved incrementally past a static head. This type of printer requires an electronic store which stores a complete line of printout and presents the character 'dots' to the head one row at a time, the paper being moved on after each row. The line is therefore built up rather like a television picture by means of row scanning. The in-line thermal printer is inherently faster than the moving head type as a complete line of dots can be energised simultaneously so that with say a 5 x 5 matrix format, only 5 paper shifts are needed per line.

In the case of the moving head, the entire character is printed but the head must be moved after each character. To printout a 20 character line would involve 20 head shifts, as opposed to 5 paper shifts in the case of the fixed head system. The moving head system is potentially cheaper than the fixed head system especially on line lengths greater than 30 characters, and has the advantage that the printout can be seen as the line progresses, whereas in the case of the fixed-head type nothing is seen until the line is completed.

There are many areas where the particular advantages of thermal printers can be exploited. The obvious application is of course printout for electronic calculators. Here more than almost any other product, the electronic integration and cost cutting techniques used in

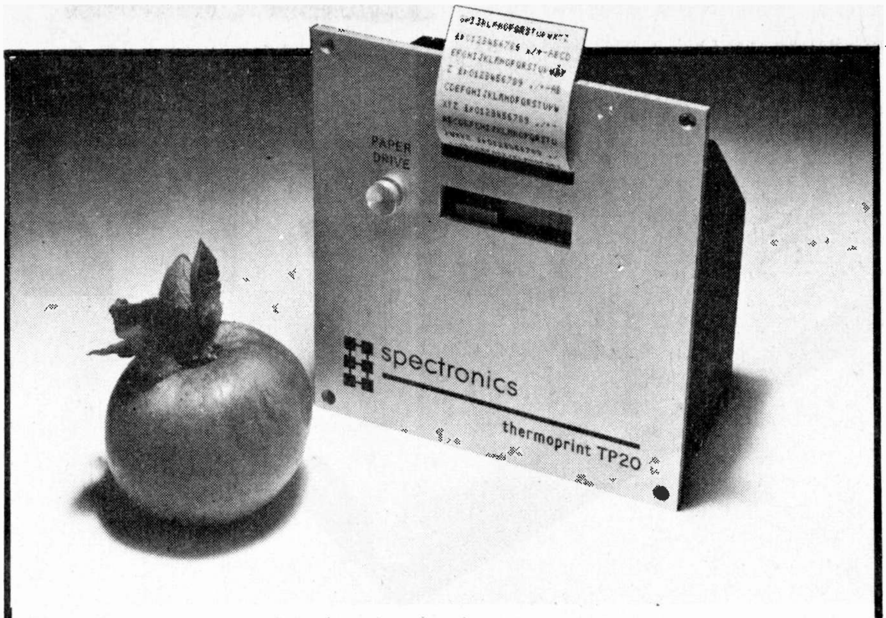


Fig. 4. Depicts a typical OEM thermal printer.

the basic product are exemplary, and the availability of miniature thermal printers allow a miniature printing calculator of high reliability to be produced. The small number of moving parts used have the added advantage of yielding a very rugged design which is ideal in portable and mobile situations.

The mobile application constitutes a fast-growing market for these

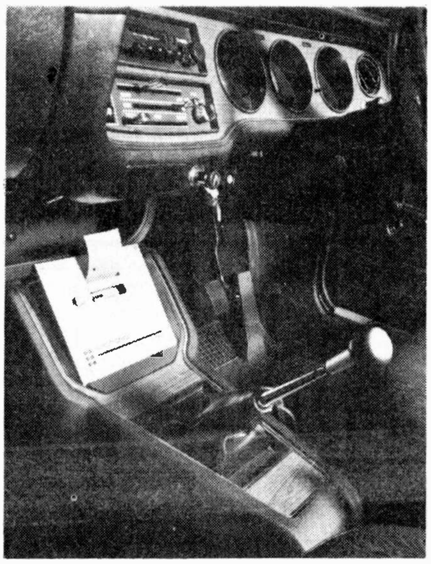


Fig. 5. A thermal printer fitted to a vehicle.

printers, which did not exist in the past. The police are finding numerous applications for thermal printers, particularly in the patrol car. Radio bands are becoming very congested, and it is not possible to allocate a special channel to each vehicle. This means that patrolmen have to listen to messages not intended for their vehicle, and the constant background of traffic makes it easy to miss a message of importance. The other problem is that even on a duplex system, there is very little security. The use of a printer, which runs from the vehicle battery, enables messages to be transmitted from headquarters in digital form, the transmitted signal also containing the vehicle identity code. The message can be transmitted very rapidly over the existing radio channel, with complete security, the message being printed out in the car. The ability to transmit messages rapidly (a 256 character message can be transmitted in a few milliseconds) enables many vehicles to operate on the same radio frequency, but each receives only the message intended. A built-in store captures the high-speed message and then passes it on to the printer at a slower speed. Similar applications occur in ambulance fleets, fire services, military vehicles, taxis, ships, aircraft, in fact vehicles of all kinds. Fig. 5 shows a thermal printer fitted to a vehicle.

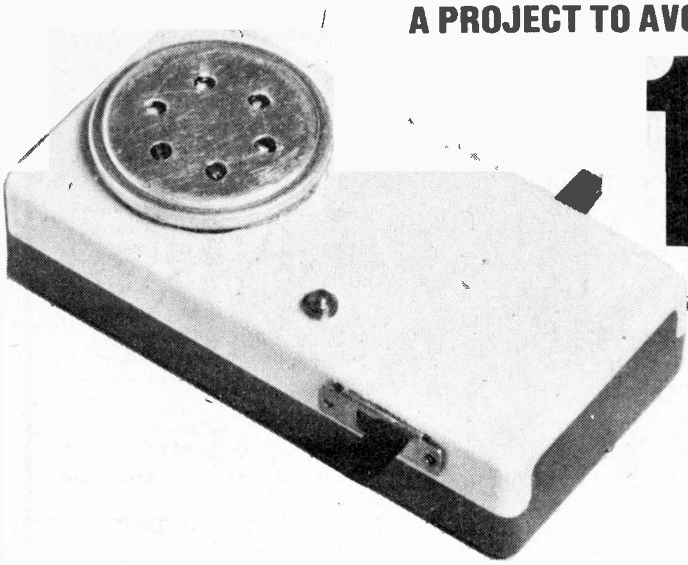
Another important area where the printer's small size and low cost score, is as an OEM product. It can be used rather as a digital panel-meter — as a digital panel printer. The photograph in Fig. 4 depicts a typical OEM thermal printer.

Moving-coil meters and pen records can now be replaced by miniature thermal printers with built-in analogue-to-digital converters, to provide permanent records of results. The silent operation is particularly useful in places such as hospitals where silence is important.

The light weight and small size of these printers make possible the construction of time-sharing computer terminals which can literally be built into a small briefcase.

Thermal printers can be made into sophisticated systems having in-built intelligence, as will be described in a future issue of ETI. ●

A PROJECT TO AVOID BURNT CAKES AND SMILING WARDENS



1-2 HOUR TIMER

ETI project 252

THE DESIGN CRITERIA to be satisfied by this timer are that it is simple to operate, reliable, pocket sized, has an audio output and is cheap to run.

IN PRACTISE

As figure 1 shows, the circuit consists of two parts: a precision digital timer and an audio oscillator. After the preset delay period, the timer circuit energises the audio oscillator. There are two operating controls.

Switch S1 is first set for the required period; switch S2, the on/off switch, then initiates the delay. At the end of the period, a rapid series of pips is heard from the speaker. The time period is simply reset by switching it on again. THe LED D1 is used to indicate that timing is in progress and goes out when the alarm sounds at the end of the delay period. The general appearance of the prototype timer is shown in Fig. 2.

Accurate timing is set by shunting VR1 and VR2 with a 2k2 resistor to obtain a time delay of 40 seconds.

IN THEORY

Firstly, the timer circuit based on IC1. This integrated circuit is a precision timer device, (Ferranti ZN1034E), in a 14 lead DIL package. The frequency of an 'on chip' oscillator is determined by an externally-connected capacitor and resistor. Pulses from this oscillator are fed through a 12 stage binary divider which switches the output stage after 4095 counts. During the count-out period the drain current is a low 5mA or so, and the oscillator frequency is independent of supply voltage in the range 5V to 450 V (an on-chip voltage regulator is used).

Capacitor C1 has a fixed value of 4.7µF and the resistors R1 and R2 are selected empirically to provide time intervals of 1 hour and 2 hours, respectively. Values of approximately 270 kΩ and 540 kΩ are required. Of course, great precision in the time intervals required is not necessary for the application in mind for the timer, but the great advantage of using this timer chip instead of the ubiquitous '555' IC is that large-value resistors and capacitors are not required for delays of an hour or so. For connections shown in the figure, the time delay in seconds is given by

$$T = 2736 C1 R1$$

At the end of the delay period, output pin 2 goes positive and output pin 3 goes negative. Thus, during the timing period, the positive voltage on pin 3 drives on the LED and the negative voltage on pin 2 keeps off transistor Tr1. When the timer counts out the positive voltage rise at pin 2 switches on Tr1 which provides current for the oscillator based on the integrated circuit IC2.

IC2 is the well known dual timer device, the '556' consisting of two '555' timers in the same chip. Each timer is wired as an astable multibrator which are cross-coupled by resistor R10. The low frequency oscillator based on R6, R7 and C3 modulates the high frequency audio oscillator based on R8, R9 and C4 to give a rapid series of 'pips' from the speaker LS. The values of these

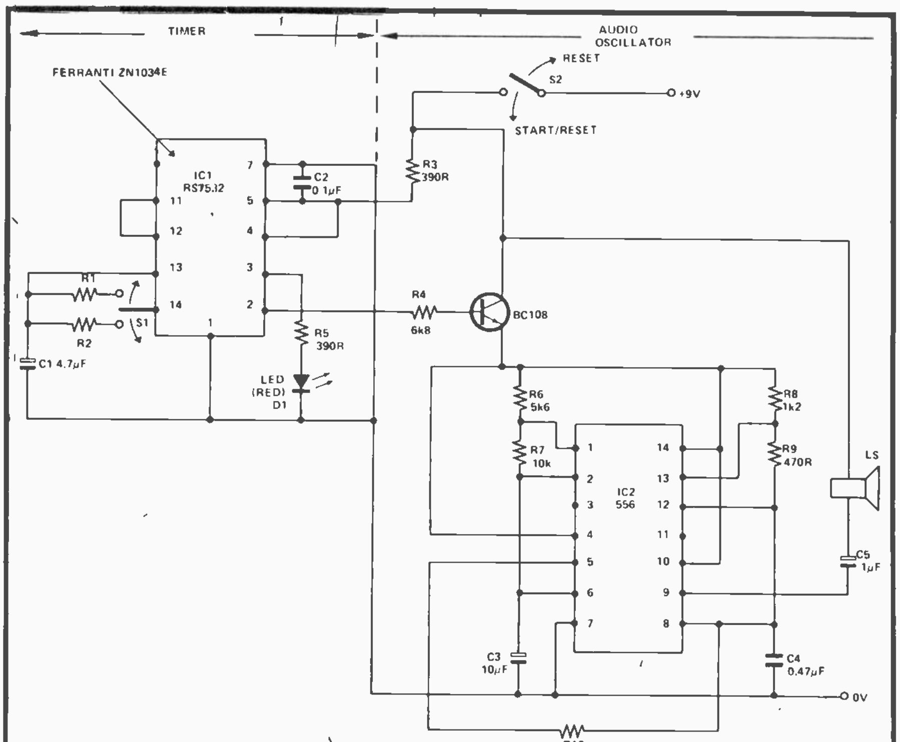
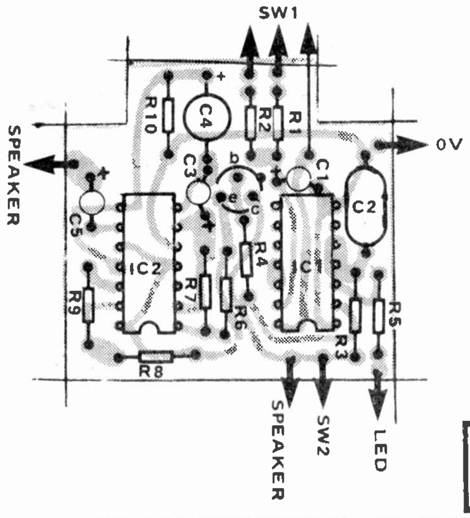
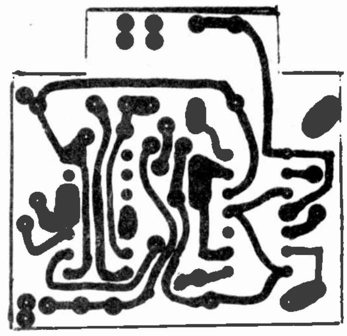


Fig. 1. Circuit Diagram of the Timer.

frequency determining resistors and capacitors, and the value of R10, can be experimented with to obtain the audio signal required. For instance, if the value of R10 is raised from 2.2 kΩ to 6.8 kΩ the audio note changes from a succession of pips to a two-tone alarm.

If it is intended to use this device as a parking timer, it might be best to set the period just short of 1/2 hours, say by 10 minutes or so, to give yourself time to get back and redeem the situation, before the dreaded piece of paper descends on your windscreen.





PARTS LIST ETI 252	
R1	270k (adjust to give 1hr)
R2	540k (adjust to give 2hr)
R3	390R
R4	6k8
R5	390R
R6	5k6
R7	10k
R8	1k2
R9	470R
R10	6k8
	All 5% ¼ watt metal oxide
C1	4.7μf 12v.w.
C2	0.1μf
C3	10μf 12v.w.
C4	0.47μf
C5	1μf 12v.w.
TR1	BC108 or similar
IC1	ZN 1034E (Doram—RS 7532)
IC2	556
D1	TIL 209 or similar
LS	Telephone insert
Verobox to suit, battery (PP3) and clips	

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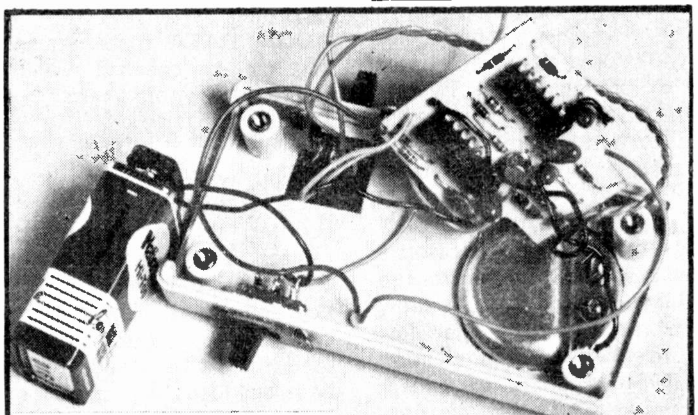


Fig. 2. Internal shot of the Timer.

Low Cost VDU

ETI Project 560 Part 3: Modifications & Interfacing

IN LAST MONTH'S ARTICLE we completed the building of the VDU and suggested some modifications for different applications. In a studio application external sync pulses may be required and we suggested such a modification, whether internal or external sync is used the video output is capable of driving several TV sets and thus the 560 VDU can be used as a message system where the usual 'Tannoy' system cannot be used. If a relatively simple serial-parallel-serial interface is added then the 560 VDU could input or output to a cassette recorder or an acoustic coupler for use with the telephone. This would allow recording of messages for later fast replay or telephone communication for the deaf if a keyboard was added. If using a cassette I/O then continuous tape could be used to present an ever changing message for supermarket special offers or similar applications.

The cassette could store 'pictures' made up from letters to provide a cartoon type display which would be animated by the input from the cassette. The easiest format to use for recording is ADDR, DATA, space, ADDR, DATA, space, etc so that any box can be changed without having to rewrite a whole screen.

KEYBOARD

If you wish to use a keyboard in place of switches you need a cursor counter, this is a ÷ 8 counter to replace the 8 address switches. These counters are incremented with each key depression or reset by CR or LF commands. If up/down counters are used then a backspace command can be included, a cursor position indicator can be included by disabling RCLK at COMP low time. This will produce an underscore at the selected box. An alternative method of connecting the keyboard is to connect the VDU to an MPU and the MPU to the keyboard, thus anything entered to the MPU will be reflected on the VDU.

MICROPROCESSORS

Fig. 11. shows a possible interface for an MPU chip and Fig. 12. shows the program flowchart required to drive it.

The MPU outputs the address of the required box on the screen as data on the data bus, this data is 'written' by the MPU to MPU address 'FFFE' which is a psuedo-address, i.e. there is no RAM storage at that address. The fact that the MPU has tried to access 'FFFE' is decoded by 7430s and 7400s and this decoded signal is used to latch the data bus containing the VDU address into a pair of 7475 latches. This information is connected in place of or in parallel to the 560 VDU address switches (and at high) and thus causes the VDU to access

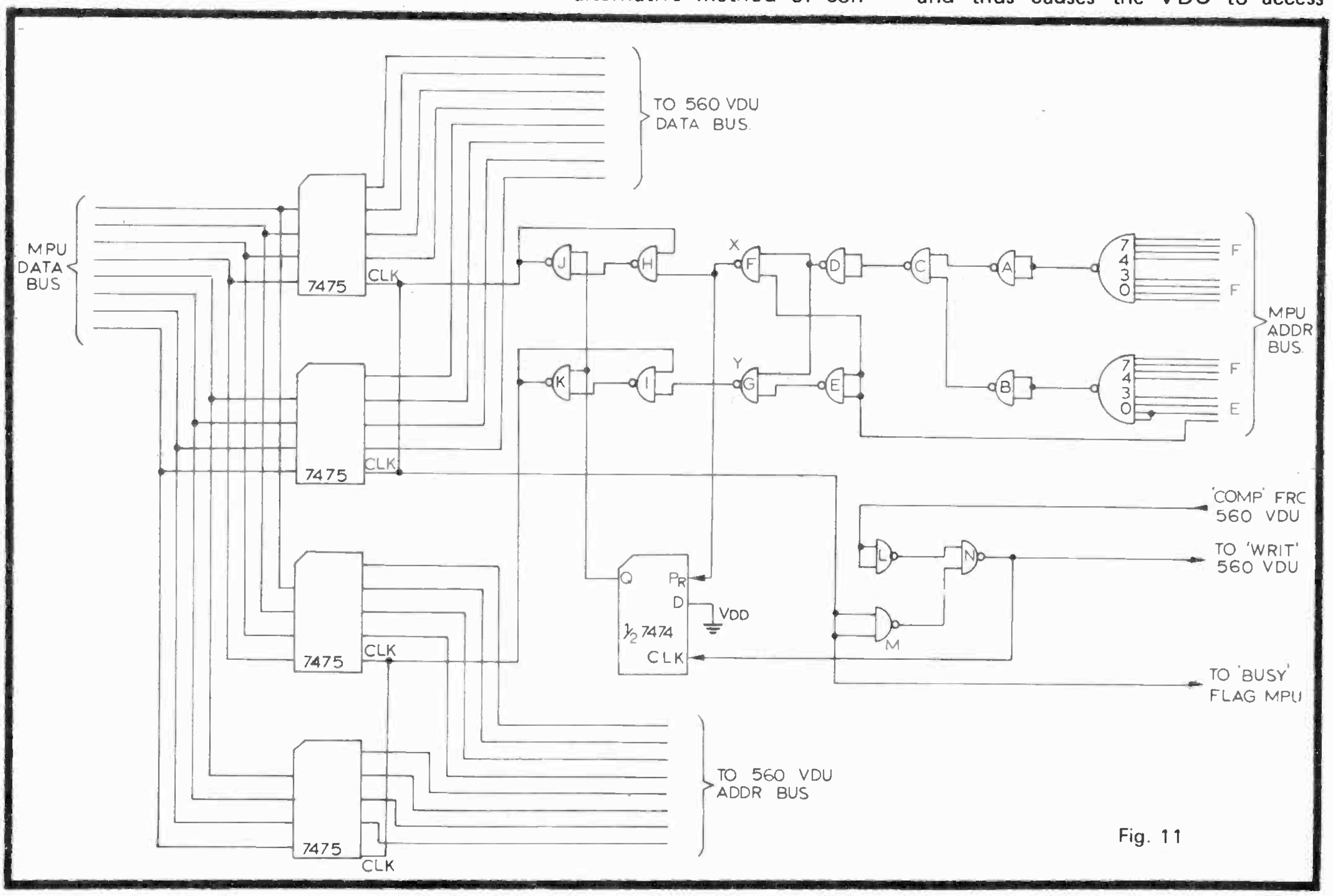
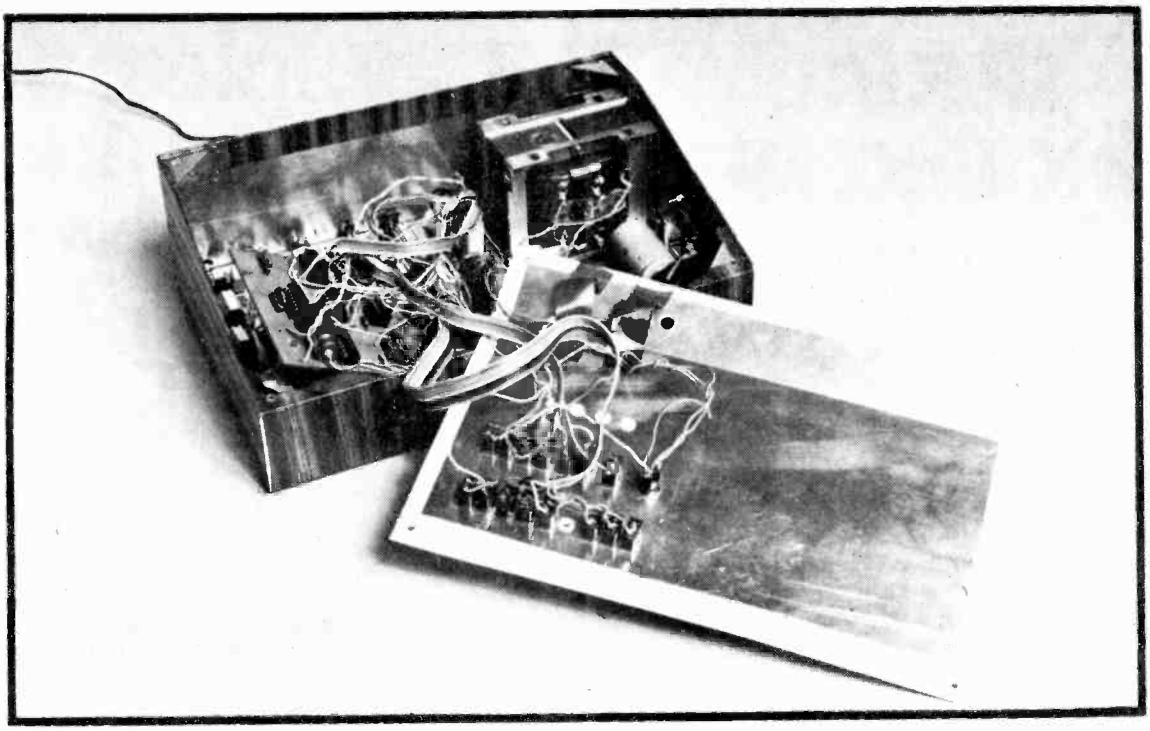
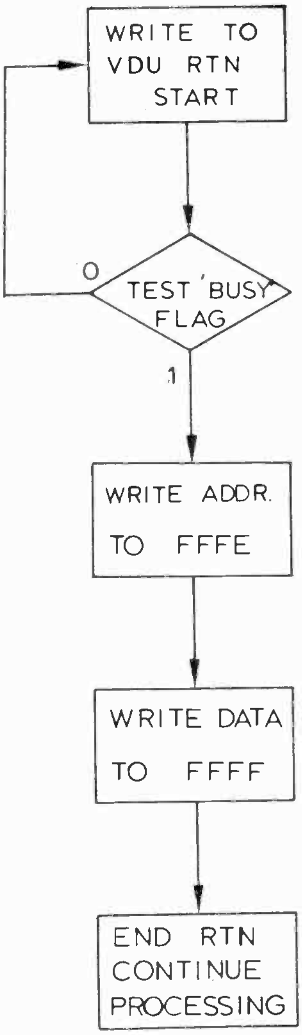


Fig. 11





DESCRIPTION

CLK'S on 7475 latches are at '1' ∴ latches are open but 'WRIT' is disabled.

If VDU is still writing last entry the 'BUSY' flag will be low wait until it goes high.

FFFE address is decoded by gates A,B,C,D,F,G and produces a low at Y. This low is latched by flip-flop I,K and in turn latches required VDU address to VDU.

FFFF address is decoded and produces a low at X which sets the flip-flop H,J and 7474. This latches the required data to the VDU and also acts as the output to the busy flag and enables the 'WRIT' gate.

MPU may now continue processing other work. When the VDU scans the required address 'COMP' will go low and produce a low to 'WRIT' thus putting data into memory. As 'WRIT' goes high after writing the 'D' of the 7474 is transferred to the Q output which clears flip-flops I,K and H,J and puts a high on the 'BUSY' flag to indicate that the VDU can now accept new data.

Fig. 12

that address and to produce a COMP output. The MPU now 'writes' the required data to MPU address 'FFFE', this is decoded and used to latch the data into another pair of 7475s and then on to the 560 VDU data bus. The decode for 'FFFE' is also used to trigger a flip-flop which sends a flag bit back to the MPU to show that the VDU is 'BUSY' and cannot yet accept any more inputs. When COMP goes low it is gated with the BUSY flag to enable the WRIT pulse to store the data in the VDU RAM. As this WRIT pulse ends the positive going edge is used to transfer the D input of the 7474 flip-flop to the output. As this D input is low the Q output reset the flip-flops controlling the latching and also resets the BUSY signal to the MPU.

Another approach allows the MPU to directly address the VDU RAM, i.e. the MPU busses, in this case the MPU would write to pseudo-address 'FFxx" where is the address in the VDU RAM, a 7430 detects the 'FF' and uses this to enable the WRIT signal as in the previous example. The latches and associated flip-flops are not required if the MPU has a facility for extending I/O times to cope with low speed devices. SC/MP for instance has a HOLD input which causes the address and data busses to stay active until hold is released, thus the 7474 flip-flop is triggered by the detection of 'FFxx' and reset by the end of WRIT. The Q output would be used for controlling HOLD. In the first example the MPU can process whilst waiting for VDU writing to complete and in the second example the MPU waits for completion and then goes on to the next instruction. ●

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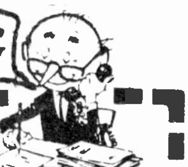

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117	.24p	557	.9p*	TIP 29A	.47p*	2646	.40p
124	.30p	BCY 71	.18p	30A	.50p*	2926G	.13p*
239	.37p	72	.14p	31A	.57p	2926	.15p*
AU 113	1.50p*	BD 123	.90p			3053	.18p
BC 107	.11p	124	.60p			3055	.60p
107B	.12p	131	.30p			3702	.11p*
108	.10p	132	.30p			3703	.10p*
ICL108	.9p	BD 139	.54p*			3704	.13p*
BC 109B	.11p	155	.75p*			3705	.10p*
109C	.12p	BF 158	.20p*			3707	.12p*
109	.11p	184	.25p			3819E	.25p*
109B	.12p	185	.20p				
109C	.13p	194	.10p*				
117	.10p*	196	.12p*				
142	.22p	197	.12p*				
143	.24p	199	.15p*				
147A	.9p*	200	.30p				
147B	.10p*	336	.34p				
148	.9p*	BFW11	.60p				
148B	.10p*	BFX 29	.20p				
149B	.11p*	84	.22p				
149C	.11p*	88	.22p				
154	.10p*	BFY 50	.17p				
157B	.12p*	51	.18p				
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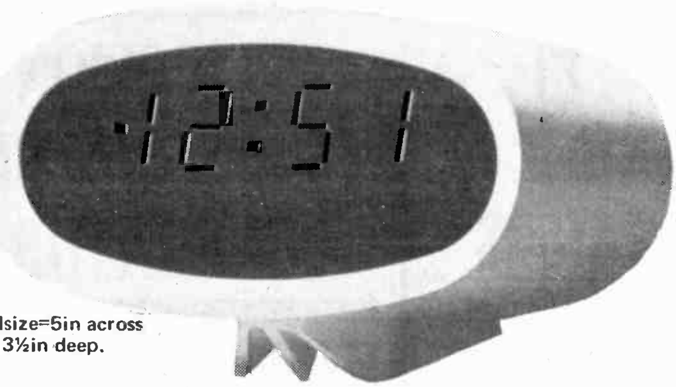

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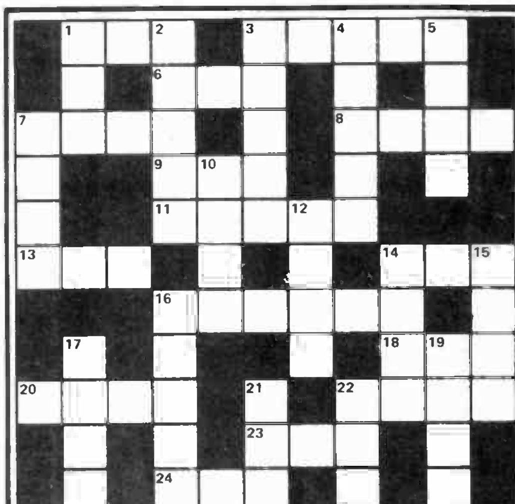
All numbers are rounded off to the number of spaces in the puzzle, and this is done in the standard manner, (1—4 round down, 5—9 round up).

The clues are not easy, but then again neither are they so obscure you'll need to burn the midnight oil. Good luck!

Competition closes 30th October, and the results will be announced in the January ETI.

Our digital clock has previously been marketed under the name Pulsar. At the time the name was chosen by us, we were unaware that a prior right to the name Pulsar existed. This has been drawn to our attention that this is in fact the case. We have been asked to point out that this clock is not, and never has been associated with Pulsar Watches and their accessories, Time Computer Inc, or Pulsar S.A.



DOWN

1. 1452.2°F in °C.
2. (6+sinh(1.00)).
3. Voltage across a 12k resistor with 4.856mA flowing in the circuit.
4. Links circles and apples, the most useful of numbers.
5. A national, if alarming, method of timekeeping.
7. Unlucky for some to a base of two.
10. Code breaker which displays its conclusions!
12. The capacitor value (in μF) to give a time constant of 100 secs if used with a resistor of 10.451k!
14. The two o'clock would be eleven minutes early if it turned up here!
15. The famous Motorola MPU!
16. One hundred and forty — based on three.
17. One more than a high impedance op-amp!
19. Handy for storing odd bits of information — 64 of 'em in fact!
21. As high as can be accounted for by 140 hands — less a finger!
22. A gross, understatement of one!

ACROSS

1. Display of great size?
3. Mostek six decade counter.
6. Ubiquitous prehistoric n-p-n!
7. It begins 141 days after 12-8-76.
8. With which to switch to CMOS?
9. $_{e}6.358$.
10. $(59029.5616)^{1/2}$.
13. $\sqrt[5]{2.3485\times10^{11}}$.
14. Sixty-nine to base seven.
16. $\int_1^3 e^x dx$.
18. tan 77.989°.
20. Pre-programmed scientific calculator — for a maritime ranking?
23. Commonly coupled with in to provide a one way flow.
24. A number to bring a small light to a circuit!

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We've done calculator surveys before but next month we're taking a different approach. We're looking very closely at scientific calculators in the most popular price bracket – that of £10 – £20.

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We've been swamped with orders but there's still time to take advantage but remember, the offer closes September 30th.

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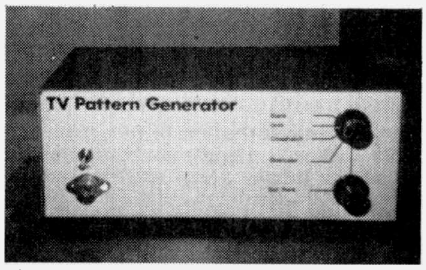
PLUS TECH-TIPS SPECIAL

A bumper supplement of our deservedly popular circuit ideas and other tips.

TELEVISION CROSS-HATCH GENERATOR



The winner of the ETI–Doram Competition – a Cross Hatch Generator (news of which is given in News Digest) will be featured next month. This includes its own UHF modulator avoiding the necessity to clip in on an unknown circuit. Full details next month.

GENERAL PURPOSE PREAMP

A general purpose stereo preamplifier using a single LM382 IC which can be tailored for use with magnetic pickups, tape recorders or microphones by changing a few components.

MODEL TRAIN CONTROLLER

Model trains have always been popular with the lads – and dads – with perhaps dads coming first! This project offers reverse (automatic), inertia, emergency brake and loop track facilities.

Features mentioned on this page are in an advanced state of preparation but circumstances, including late developments may affect the final contents.

CDI Systems

A CONSIDERATION OF THE THEORY INVOLVED

BY M. KALFUS

Capacitive-discharge ignition systems have already achieved nearly 100% penetration in the small-engine market, and as a result of economic and energy-conservation considerations are now making an impact on the automotive market. This article describes the requirement of small-engine ignition systems, automotive or battery-powered systems.

Capacitive-discharge ignition systems have been in use since the introduction of silicon controlled rectifiers or thyristors. The early recognition and application of the benefits of this system in limited areas of the small-engine market (single-cylinder, two and four cycle engines, and marine engines) has since expanded to nearly 100% of that market. Each day additional applications are added: chainsaws, lawnmowers, snowmobiles, motorcycles, mini-bikes, fence chargers and auxiliary power sources are relying on the virtually maintenance-free, high performance capacitive-discharge system.

Large-engine systems for automotive use have so far tended to remain a replacement-market product, primarily for economic reasons. However, expansion in this area is expected to increase because of the energy crisis, which has stimulated the demand for greater fuel economy with improved performance.

Basic considerations

It is important to start by considering the basic requirements of automotive ignition systems. Under worst-case conditions, about 22kV is required to ignite the combustible mixture of an automobile engine. In addition, a minimum energy of about 20mJ must be available in the spark to ensure the propagation of a stable 'flame front' originating at the spark. The exact values of voltage and energy required under all operating conditions depends on four main factors:

(i) Condition of spark plugs: Fouled plugs reduce both the voltage and the energy available for ignition. The plug gap also affects both the voltage and the energy required. As the plug gap is increased, the required voltage increases, but the required energy decreases.

(ii) Cylinder pressure: The cylinder pressure depends on both the compression at the point of ignition and the air/fuel mixture. The minimum breakover voltage in any gas is a function of the product of gas pressure and electrode spacing (Paschen's Law). In automobile engines, the minimum voltage increases as this product increases. Therefore, higher pressures also require higher voltages.

(iii) Spark plug polarity: The centre electrode of the spark plug is hotter than the outside electrode because of the thermal resistance of the ceramic sleeve that supports it. If the centre electrode is made negative, the effect of thermionic emission from this electrode can reduce the required ignition voltage by 20-50%.

(iv) Spark-plug voltage waveshape: The spark-plug voltage waveshape is shown qualitatively in Fig. 1. The voltage starts to rise at point A and reaches ignition at point B. The region from B to C represents the sustaining voltage for ionisation across the spark plug. When there is insufficient energy left to maintain the discharge (at point C), current flow ceases and the remaining energy is dissipated by ringing. The final small spike at point D occurs when the ignition coil again starts to pass current.

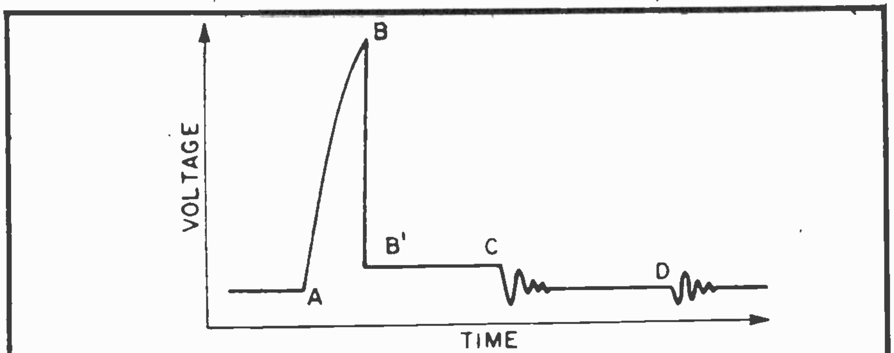


Fig. 1. Spark plug waveforms.

The two most important characteristics of the voltage waveshape are its rise time (from A to B) and the spark duration (from B to C). A rise time that is too long results in excessive energy dissipation with fouled plugs; a rise time that is too short can lead to loss by radiation through the ignition harness of the high-frequency components of the voltage. The minimum rise time should be about 10μs; a 50μs rise time is acceptable. Conventional systems have a typical rise time of about 100μs. At an engine speed of 5000 rev/min, one revolution takes 12ms. Engine timing accuracy is usually no better than 2°, which corresponds to 67μs. The error caused by the rise time is therefore comparable to normal timing errors. At normal cruising speeds (about 2000 rev/min), the 2° timing error corresponds to about 165μs, and rise-time effects are negligible.

(v) Energy storage: The energy delivered to the spark plug can be stored in either an inductor or a capacitor. Although the inductive storage method is the more common approach, both are used. One requirement common to both meth-

CDI Systems

ods is that, after the storage element is discharged by ignition, it must be recharged before the next spark is fired.

Capacitive-discharge

The basic capacitive-discharge system is illustrated in Fig. 2. It is important to note that the transformer serves simply as a pulse transformer, and the performance at high engine speeds is not affected by the transformer but is governed by the time required to charge capacitor C to the desired voltage level.

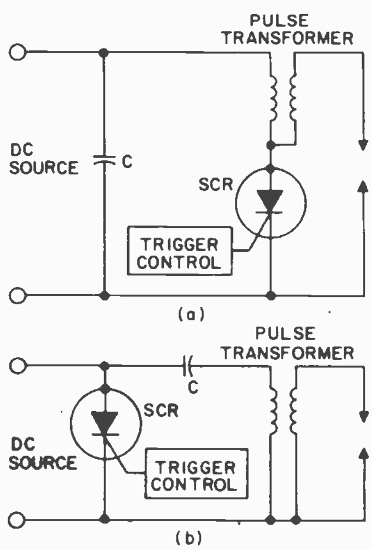


Fig. 2. The basic CDI system.

The trigger control circuit (which can be a transistor switch) is controlled by the distributor points. More sophisticated distributor control, such as that available from distributors in which the voltage pulses are derived magnetically or photo optically, can also be used to control the trigger circuit. The capacitor is charged to the d.c. voltage; the stored energy e is equal to $C V_c^2/2$, where V_c is the capacitor voltage.

At the appropriate time, the trigger control circuit fires the thyristor. The capacitor discharges through the transformer, which steps up the voltage to a value V_s equal to KNV_s (where N is the transformer turns ratio and K is a constant generally between 1 and 1.5). The stored energy is thus delivered to the spark plug in the form of a high voltage pulse. Typical values for V_c and C are about 350V and 1μ F, respectively so that the energy e is about 60mJ.

Because the energy dissipated in the spark gap is equal to the energy stored in the capacitor minus the losses in the transformer and thyristor the energy available in the system is relatively easy to calculate. Examination of the basic circuits shows that the energy is transformed only when the thyristor is forward-conducting with the gate biased on.

However, part of the energy is not available in the basic circuit because the capacitor and inductor form a tuned circuit when the thyristor is on, and the energy that would normally flow back from the inductor to the capacitor is stopped by the high reverse impedance of the thyristor. The duration of the spark is limited to approximately one half cycle of the natural LC frequency of oscillation.

Some of the energy lost can be regained and used to increase the spark duration by installing a diode in the basic circuit of Fig. 2 as shown in Fig. 3. The diode not only bypasses the reverse impedance of the thyristor but also eliminates the possibility that the thyristor might conduct in the reverse direction should the gate of the thyristor be biased on at this time.

In addition to improving the low-temperature performance of the system by increasing spark duration, the diode reduces the possibility of excessive heating and damage to the thyristor that could accompany reverse conduction, and thereby reduces the overall cost of the system by reducing the reverse blocking requirement of the thyristor.

Another important consideration

The ratio of spark duration to charging time decreases with increasing engine speed so that in some applications a speed limit may be reached which is below the desired maximum because of charging-time requirements.

A major operating point that must be considered in the capacitive-discharge system is when to charge the capacitor. In some systems the capacitor is charged soon after discharge; in others, just before discharge. The second method is the better in that it minimises the losses resulting from leakage, but this advantage is somewhat negated because of the precise timing required to institute the charge just prior to discharge.

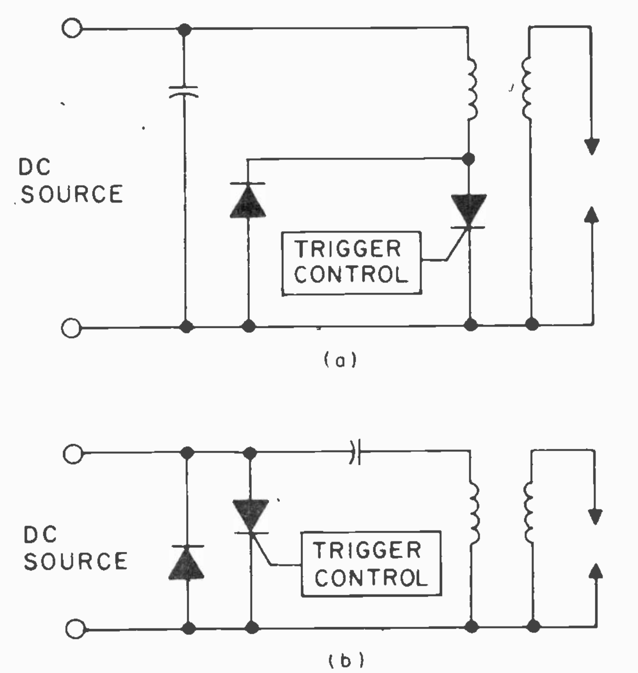


Fig. 3. Refinement of the basic system to include diode protections.

This requirement can result in complex mechanical or electrical arrangements.

A higher charging voltage may be considered to permit the use of a high-voltage regulator to compensate for leakage in both the capacitor and thyristor. A circuit designed to charge the capacitor just prior to discharge would also tolerate a higher level of leakage current in the thyristor.

However, the rate at which the capacitor is charged is limited by any capability of the thyristor to withstand practical amounts of static dv/dt at the worst-case temperature.

Low-temperature operating limits require consideration of gate-firing characteristics. The thyristor gate voltage and, to a greater degree, the gate current required, increase as the temperature decreases. Gate-current sensitivity must be kept to a low enough level at high-temperature extremes to avoid spurious or false turn-on. This sensitivity establishes the gate current requirement at the low-temperature extreme. In most capacitive-discharge applications, minimum and maximum gate-current requirements are specified at 25°C and are correlated with minimum and maximum limits at the temperature extremes of operation.

Invertor-charged systems

A system eliminating the need for flywheel magnetics is the invertor-charged system. This system is used where a battery is available, as in an automobile.

There are some practical considerations which limit the use of this system. The first is low temperature starting. At an ambient temperature of —40°C, the available battery voltage in a nominal 12V automotive system may be as low as 6V d.c. because of the starter current required at this temperature and the reduced battery capability. In addition, at this temperature, the fuel/air mixture is wet, particularly in a two cycle engine.

For reliable starting, the full spark energy must be available immediately. This means that the invertor must be capable of producing the full energy at low supply voltages. The voltage step-up ratio of the system transformer is constant and therefore cannot be increased as the temperature decreases; such an action would ensure sufficient voltage at low temperatures, but would subject the capacitor and thyristor to voltages higher than their ratings under normal conditions and after starting. The problem of starting at low temperature may be circumvented by regulating the voltage on the capacitor or by using a transformer with a higher step-up ratio than required and then shutting down or removing the invertor, with its transformer, from the circuit at a time that will prevent any voltages from becoming a problem. A typical example of an invertor-type ignition system with regulator ballasting is shown in Fig. 4. The trigger circuit shown in the figure is subject to the same variations in potential as the invertor circuit, in addition to others arising from the need to gate the thyristor with a high current at low temperature when the available voltage is low. This gating problem can only be solved by a compromise between overdriving of the gate at high temperature and maintaining only an adequate drive at low temperatures; there are many circuits that can be used to achieve this compromise. ●

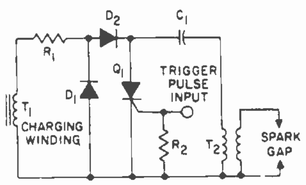
HOW IT WORKS – BASIC CDI

All these systems are operated in a similar way; energy stored in a capacitor is transferred to a spark gap through a transformer and thyristor; the thyristor ensures that the spark is short.

The circuit in Fig. 4 is typical that used in the three systems. The AC potential across transformer T_1 is rectified by diode D, and charges capacitor C, to the required voltage. Resistor R, which may be part of the charging-winding resistance, limits the current and prevents the thyristor from firing as a result of the imposition of a dv/dt value greater than the capability of the thyristor.

The combination of diodes D_1 and D_2 prevents the charging winding of transformer T_1 from impressing a high reverse voltage across the thyristor. Resistor R_2 damps variations in the input impedance of the thyristor. The thyristor is triggered at the appropriate time, and the energy stored in the capacitor is transferred into the primary of T_2 thus causing a spark at the gap.

The voltage required to break down the sparking gap is a function of the spacing of the electrodes and pressure in the cylinder in the vicinity of the gap. The spark in the gap lasts until the current passing through the thyristor stops conducting, D_1 and D_2 start conducting in the reverse direction and lengthen spark duration. After the thyristor turns off, C is discharged, and the circuit is ready to repeat the cycle.



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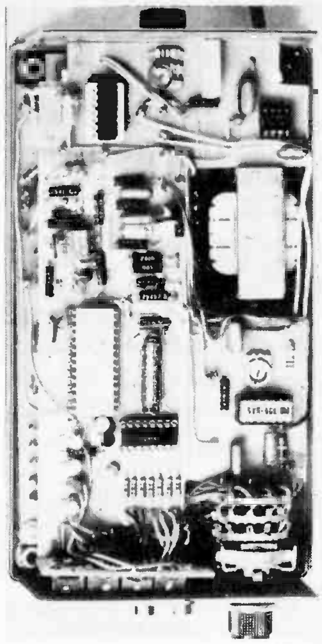
VOLTS AMPS AND OHMS TO 1% ACCURACY

DIGITAL MULTIMETER

ETI project 151



INTRODUCTION

THIS PROJECT DESCRIBES the construction of a low cost high performance digital multimeter, emphasis has been placed on simple construction, without sacrifice of the precision instrument. Anyone who has had some experience of soldering, and can distinguish one end of a diode from the other must (with a little care and patience) be able to build up this unit. The components are easy to get, but do not be tempted to use surplus or second grade components, as the precision of the multimeter relies heavily on the quality of its components.

We have arranged with B & H Components of Leighton Buzzard a supply of a first grade component kit.

The construction of the Multimeter is simplified by the use of the three printed circuit boards — one for the A/D Converter, Ohms Generator and DC Voltmeter, the second for Power Supply, Input Dividers and A/C Rectification. The third is for the Display.

No mounting procedure for the components is given, as it is straightforward, if you follow the components lay-out! Careful soldering is required, especially on the double sided board.

Extreme care should be taken when handling the GZF1200D, as it is M.O.S. technology, and despite its input protection vulnerable to static. The basic handling rule is that the pins should not come into contact with anything insulated from earth. *Do not alter the circuit with the GZF1200D in position, and most of all do not insert it with the power switched 'ON'.*

Most of the complexity of the circuit has been taken out of the hands of the constructor, but there is still a fair amount of interwiring involved, which means that if the Multimeter does not function when it has been completed, fault finding will be difficult. It is strongly suggested that all components *with the exception of the I/C* should be checked before assembly.

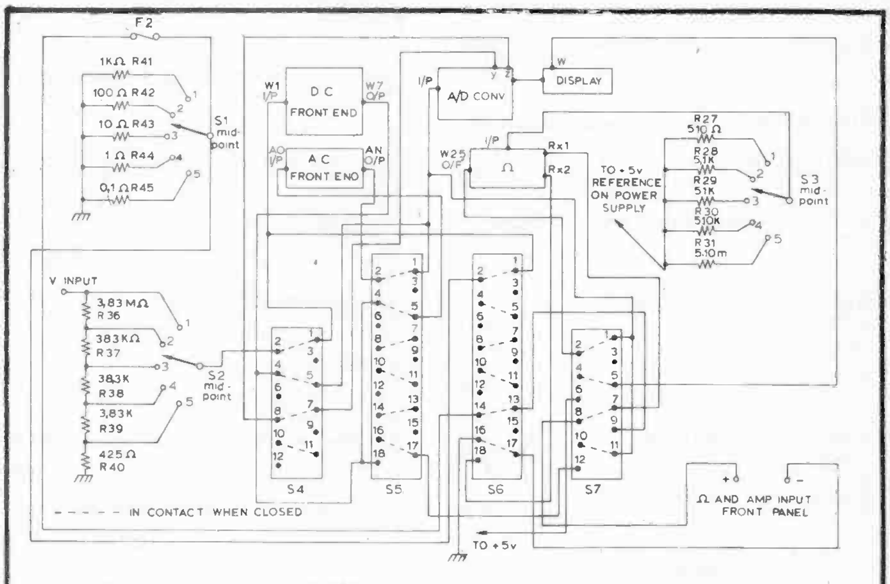
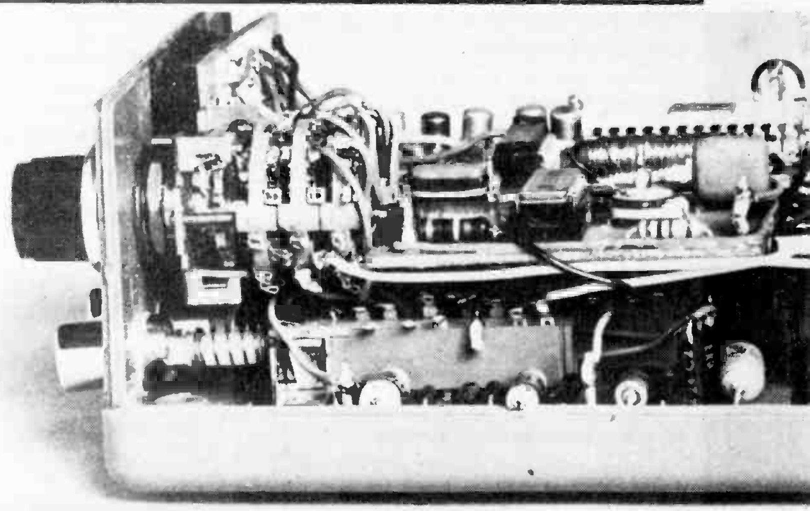


Fig. 1. Block diagram of the DMM system.



POWER GLORIOUS POWER

First assemble the power supply.

Connect the OV output of the 15-0-15 from the mains transformer to Pin A, the other 15V A/C Input to Pins B and C, the 8Volt A/C to pins BD and BC and the 15Volt A/C to pins G and H.

Connect to the mains and check that there exists
+5 to 7volt between D E
—15 to —17volts between F and J
+12 to 14volts between AD and D
—12 to 14volts between AR and D
+5 between I and J

HEARTY MATTERS

The second stage the construction of the heart of the Multimeter — the A/D Converter, once again pay special attention to the soldering. L1 will be glued in position between the two links.

DISPLAY OF WORK

The next stage is the display, insert the L.E.D. in place and connect to the A/D Converter as shown on the components lay-out. Do not forget the shorting links. For the time being connect PinW to +5 and short out PinY and PinZ and connect the A/D Converter Input to earth. (Note that Zero volts is *not* earth). Connect pinW3 to —15volt, W4 and +5V, W5 to —V, the leg of C2 nearest to R10 to earth and W6 to +5V. Switch on and check that the voltage did not drop too much.

If everything is okay, switch off and carefully insert IC1, IC2 and IC3 and switch on. The display should light up, and begin changing numbers in a random way. Adjust P1 until the display reads 000, the optimum setting up being when the polarity indicator keeps changing from negative to positive.

GENERATING AN OHM OR TWO

Fit R27 to R31, connect W10 to PinE and Pin AH, W16 to earth, W12 to +12Volt and W11 to —12volt. Disconnect A/d Converter input and connect it to W25 for the time being (W14 to middle point of S3). Connect W13 to middle point of S3). Connect W13 to positive input on front panel and W15 to negative input. Connect M to pin 1 of S3 (0.1 range), N to Pin 2 of S3 etc . . .

Switch on, short out positive and negative Input on front panel, switch range to position 10 and adjust P3 for 000 reading on display. Now connect a 100Ω 1% resistor in place of the short on positive and negative input on front panel (the display should read something round 1000), adjust P4 for a reading of just 1000.

If the input is open circuit, the resistance is going to be infinite, too high for the Multimeter to measure so it will display (the overload condition) 1048 with the condition top bar of the 1 only being displayed.

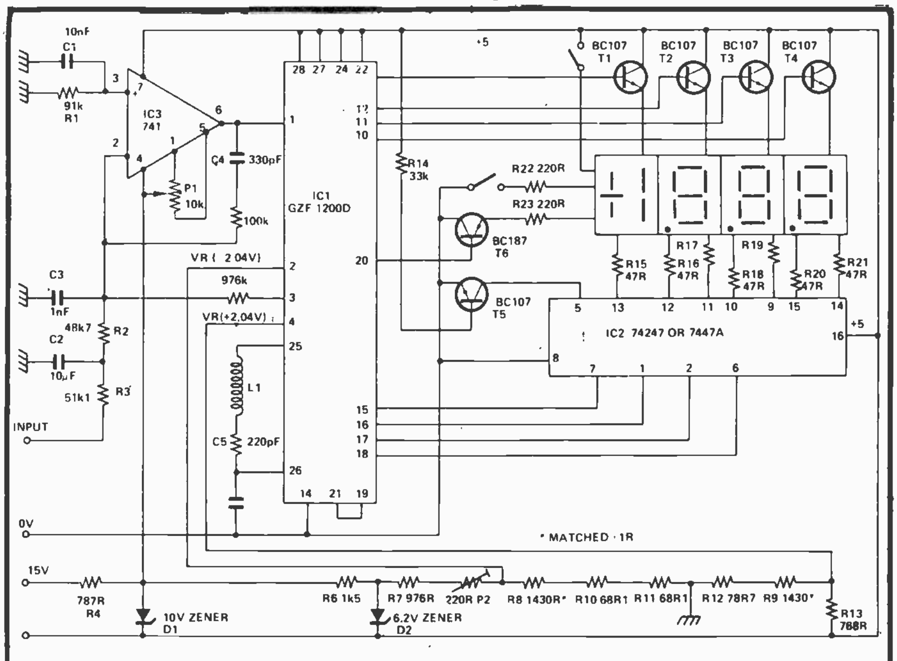
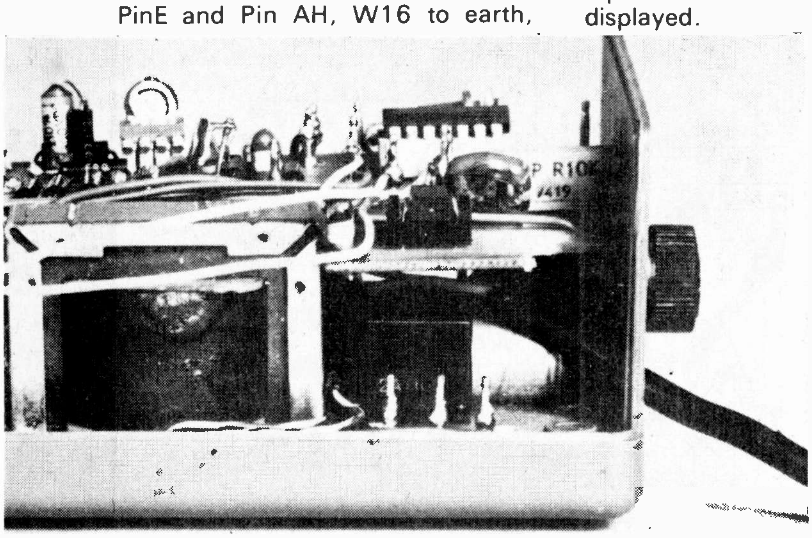


Fig. 2. Circuit of the A/D convertor section of the multimeter.



Use the ohmeter to make up R45 (0.1Ω). Switch the range switch to 0.1 and with the input probes measure the length of resistive wire for a reading of 0.1. Cut the wire to size and insert in position R45. You can now disconnect W25— W15 and W13.

VOLTS FOR OHMS

Now we come to the DC Voltmeter.

Temporarily connect A/D Converter input to W7, fit R36 to R40 and C13 to C17, and connect:
A1 to Pin 1 S2 (0.1range)
AJ to Pin 2 S2 (1 range)
AK to Pin 3 S2 (10 range)
AL to Pin 4 S2 (100range)
AM to Pin 5 S2 (1000range)
W1 to middle point S2, and (temporarily) middle point S2 to earth. Select range 1 and switch on, adjusting P5 for 000 reading. Switch OFF and disconnect the wire between earth and the middle point of S2. Also disconnect W1 from S2.

Since the ammeter circuitry is common with that of the voltmeter, it too is now set up.

Fit R41 to R45, connect AG to Pin D on power supply AB to Pin 1 S1 AC to Pin 2 S1 AD to Pin 3 S1 AE to Pin 4 S1 AF to Pin 5 S1 Pin J to middle point S1 Pin K to Pin 14 S6.

INTERWIRING

Put in place S4-S5-S6-S7, cutting off the unnecessary tags, and fit the latching assembly (see Fig. 10). Fit the volt input jack and by following the wiring diagram, interconnect boards and switch. (Do not forget to plug in the 16 D.I.L. module containing the protection

DIGITAL MULTIMETER

PARTS LIST

DC/AC VOLTMETER and AMMETER (front end):

R36 3.83mΩ
R37 383 KΩ
R38 38.3KΩ
R39 3.83 KΩ
R40 425Ω
R41 1KΩ
R42 100Ω
R43 10Ω
R44 1Ω
R45 0.1Ω (see text)
R46 1KΩ
R47 1KΩ
R48 5620Ω
R49 5620Ω
R50 2740Ω
R51 47Ω

All resistors ¼ to ½ watts 1% or better.
C13 1nF 250V sufflex or similar
C14 Variable capacitor 6 to 60pF submin (round) (alternative 3p to 40pF Radio Spare no. 124-027)
C15 220p sufflex
C16 2.2nF 250V sufflex
C17 22nF 250V sufflex if possible
C18 1nF 250V sufflex
C19 100nF C280 mullard
C20 100nF C280 mullard
C21 4.7µF 10V
C22 10µF 10V
C23 10µF 10V
D10 3.3V zener 400mW
D11 3.3V Zener 400mW
D12 IN4148
D13 IN4148
IC5 305-945 (F.E.T. input op Amp) Radio Spare
F2 100mA anti surge fuse (20mm) . . . . Printed circuit fuse holder (20mm)

OHMS GENERATOR

R27 510Ω 1%
R28 5.1KΩ 1%
R29 51 KΩ 1%
R30 510KΩ 1%
R31 5.1MΩ 1%
R32 47Ω 1%
R33 10KΩ 1%
R34 10KΩ 1%
R35 1KΩ 1%

P3 10KΩ multiturns cermet
P4 220Ω preset (submin)

C11 100nF 250V (C280 mullard)
C12 100nF 250V (C280 mullard)
3.3V zener 400mV (D7-D8)
5.1V zener 1W (D9)

POWER SUPPLY (MAINS)

Tx1	Special mains transformer (15-0-15)
	2 amp fuse
	Fuse holder 20mm panel mounting
BR1 and BR2	Bridge rect. (50V-2amp)
Reg 1	Regulator LM 7805 (Radio Spare)
C6 to C8	500 µf 25V
C9	1000 µf 15V
T7	TIP 42
D3	5.6V zener 400mW
D4-D5	12V zener 400mW
D6	IN4002
C10	100 µf 10V
R24	820Ω ½w 5%
R25-R26	430Ω ½w 5%

MISC

2 4 pole changeover switch (R.S. 338-636)
2 6 pole changeover switch (R S. 338-440)
1 Latching assembly (R.S. 338-254)
1 100Ω 10%
3 2 pole 6way miniature switch (R.S. 327-355)
1 Switch mechanism (R.S. 327-311)
4 Knobs to fit changeover switch
1 Knob to fit range switch
4 cin of constantan 4/10 wire
1 strip of soldercon pins (100)
50 Vero pin 0.1pitch
Input banana socket (1red — 1black)
1 Fuse holder (panel mounting) Dia. 20mm
1 lamp fuse
1 Jack socket 20mm
1 16 0.1 L. module case (R S. 401-841)
1 Vero box with handle (R.S. 509-383)

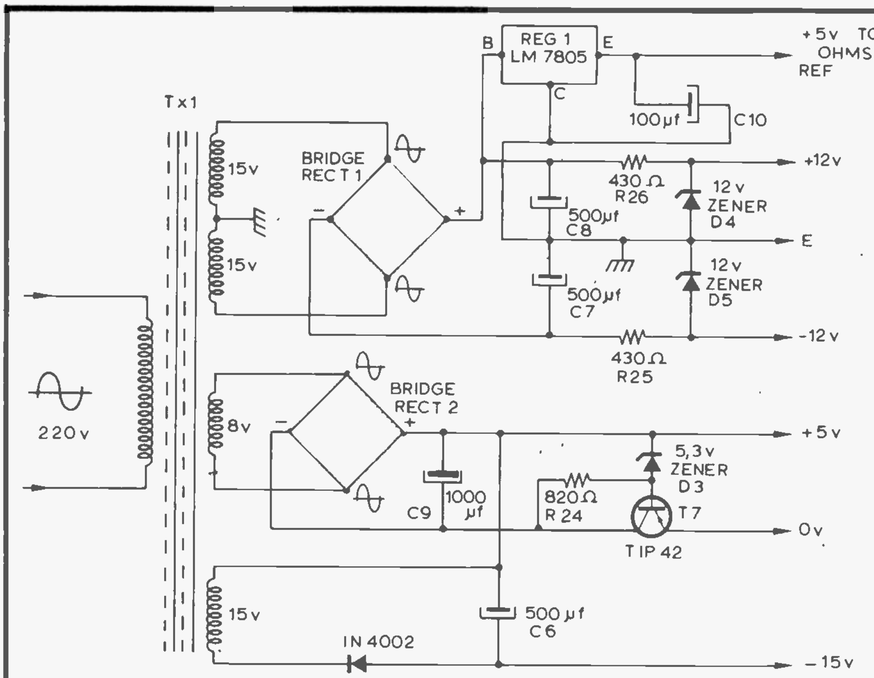
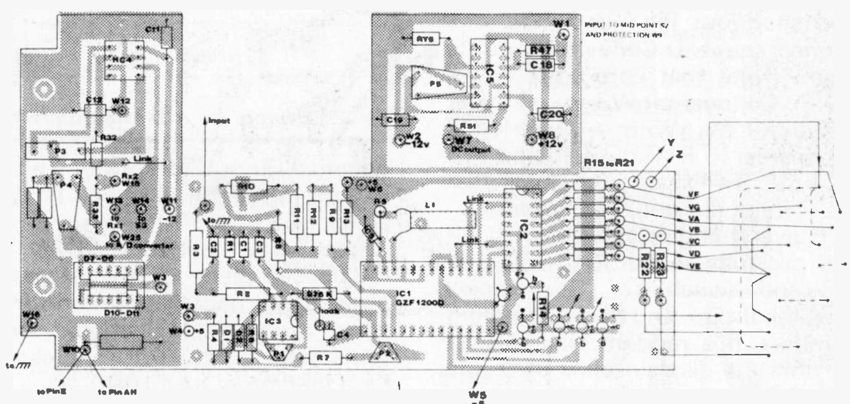
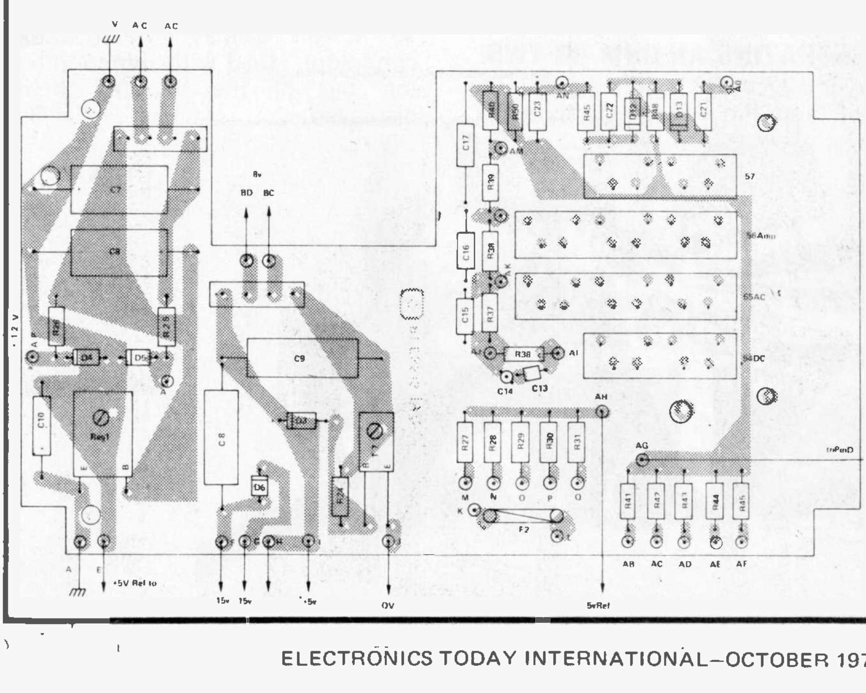
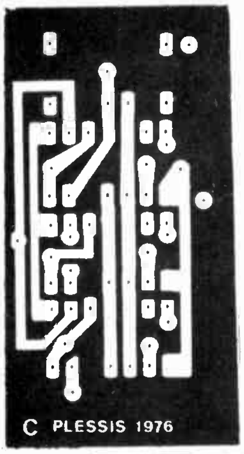


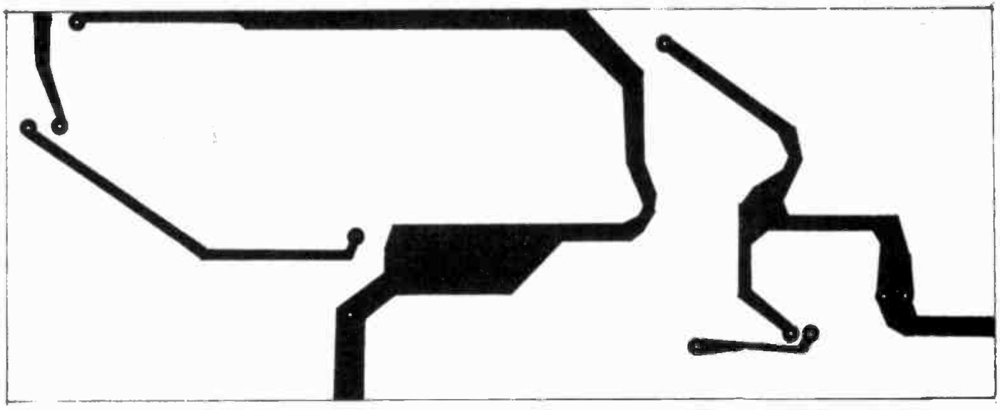
Fig. 3. Power supply circuit.

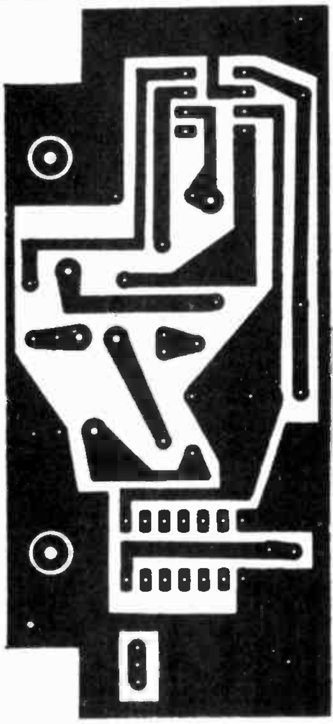


Component overlays.

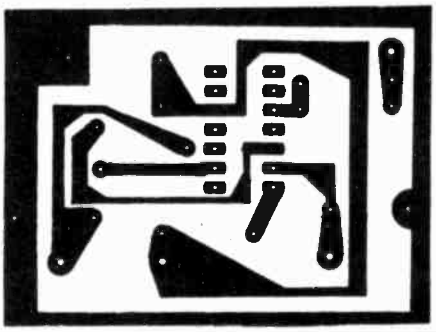


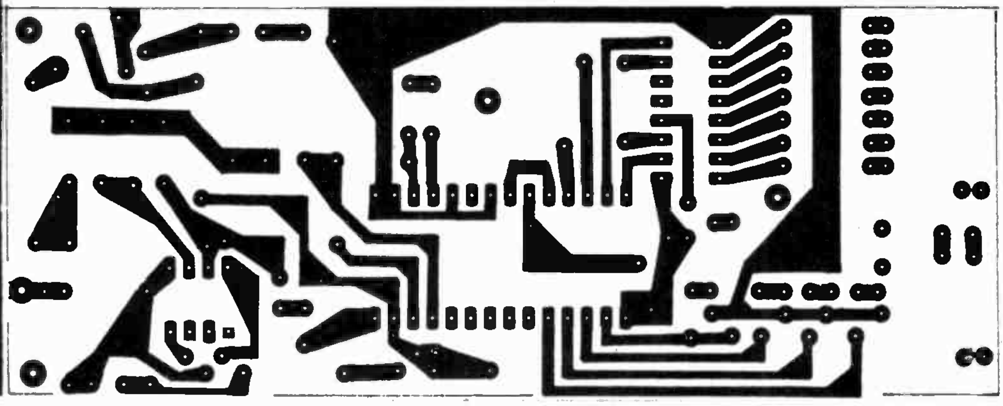


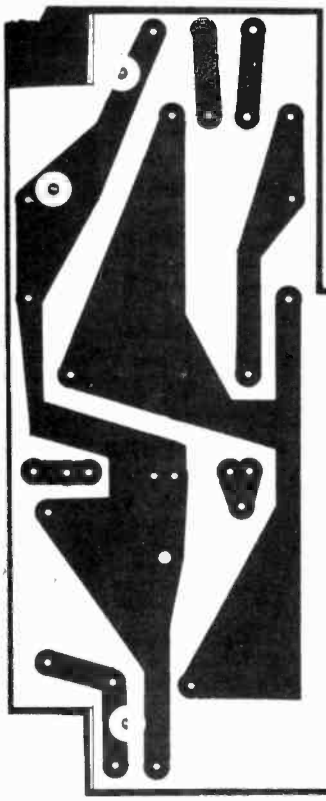




A full kit of parts for the meter is available from B.H.Components — see ad on page 71.







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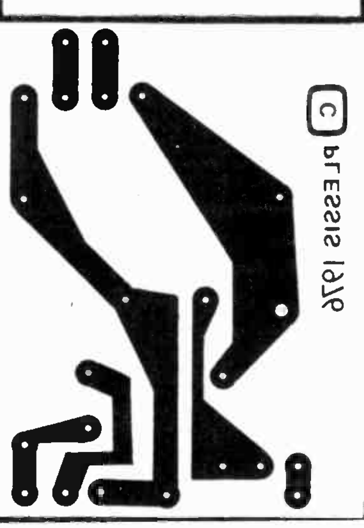
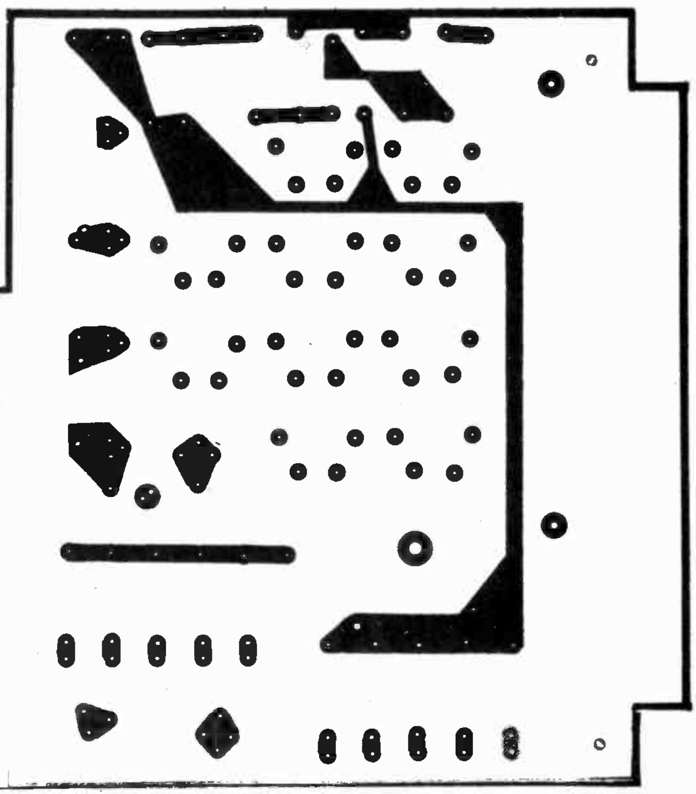




diodes). Due to wire resistance the zero set pre-sets P3 for ohms and P5 for volts may have to be slightly reset; if you want to check or reset the zero setting of the A/D Converter, remember to short its input to earth.

FINAL SETTING UP

A reference battery will be needed for a precise setting up (Weston type). Select D.C. range 1 and adjust P2 until the display reads 1.019, reverse the input lead and the reading should not change with the exception of the polarity indication.

For the ohmeter, simply connect a 1000-% or better resistor and adjust P4 for correct reading. On the 0.1 range setting it is almost impossible to obtain due to the resistance of the wiring and the internal noise generated by the 741 (IC4). The resolution should be around 1/10th. This setting up should be satisfactory for most uses, but if extra precision is required, select AC volt range 0.1 and inject a 1Khz sine wave of enough amplitude to Display 1999, change to range 1 and adjust C14 for a reading of 1/10 of the preceding one.

CONCLUSION

As described, this Multimeter should give you a general accuracy of ±1%. The danger with a digital machine is to believe that the displayed value is *absolutely* correct. Alas, there is always some inexactitude and no equipment in the world can escape this!

Acknowledgments are due to Mr C. Brown of Credshire Ltd, B H components of Leighton Buzzard — not forgetting M. Bellamie.

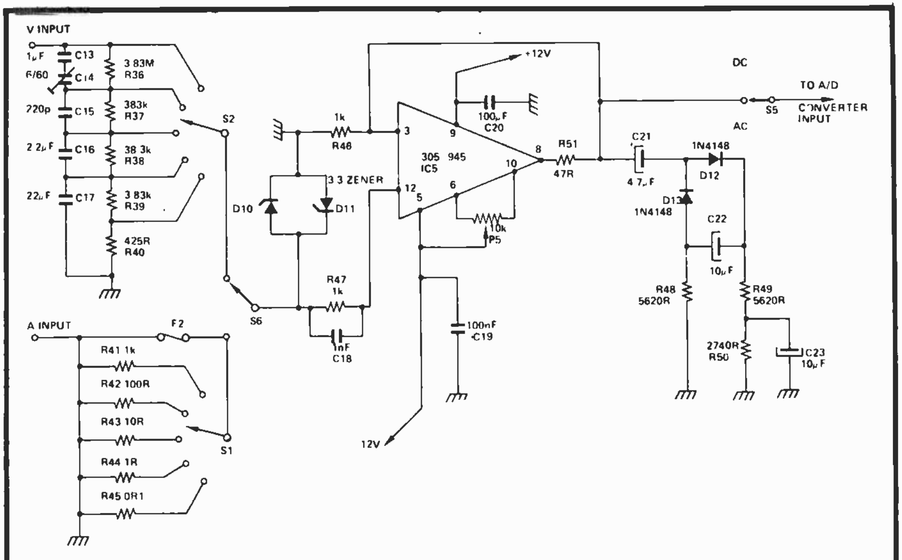


Fig. 4. Front end amplifier circuit.

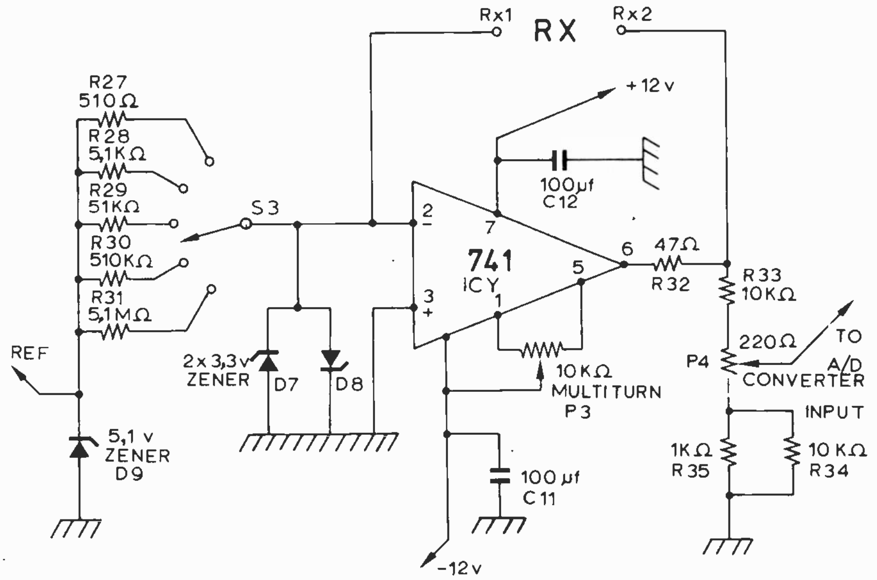


Fig. 5. Ohms generator circuit.

PARTS LIST

CONVERTER AND DISPLAY

BC 107 (T1 to T5)
8C 187 (T6)
DL 701 Display
DL 707 Display
74247 or 7447A (IC2)
741 (IC3)
GZF1200D (IC1)
10V Zener 400mW (D1)
6.2V Zener 400mW (D2)
10nF 250V (10%) C280 mullard. (C1 and C2)
1nF 250V (sufflex) 10% or better (C3)
330pf 250V (sufflex) 10% or better (C4)
220pf 250V (sufflex) 10% or better (C5)
choke 300 turns. 38swg. on 25 x 4 ferrite rod L1
91 KΩ 1% (R1)
48.7 KΩ 1% (R2)
51.1 KΩ 1% (R3)
15 KΩ 1% (R5)
787Ω 1% (R4)
1.5 Kr 1% (R6)
976Ω 1% (R7)
1430Ω 1% matched ± 1Ω (R8 and R9)
10.5Ω 1% (R10)
68.1Ω 1% (R11)
78.7Ω 1% (R12) (ALL RESISTORS ¼ to ½watt)
768Ω 1% (R13)
33 KΩ 1% (R14)
47Ω 10% (R15 to R21)
220Ω 5% (R22 to R23)
10 KΩ submin vertical preset (P1)
220Ω submin vertical preset (P2)

HOW IT WORKS

The heart of this meter is the A/D converter built around the GZF 1200F.

The supply voltage required for this is not critical. 8.75-10.6V with a current consumption of 10ma max. A precision divider chain establishes the various references needed in the circuit.

The initial voltage of —13 to —15 is held to −10V by a zener,and this feeds the input buffer 741. The remainder of the divider supplies the reference of + 2.04 and −2.04V

The input buffer is working as an inverter,and if its input is +, the output is −. The chopper output determines the system sensitivity(here about 10)

We only need 200mv for 2000 display points,equal to 0.1mv per point.The null for the 741 is set by the 10k pot.

In the D.C. mode the polarity indicator is on permanently, the vertical bar to indicate + is controlled by a transistor and a diode

When the input is + the polarity output is low, which allows a current flow in the vertical bar of the display.

A word of advice on the voltmeter, although the circuit allows measurement of voltage up to 1000V, the range switch will not like this too often, and so a probe resistor of 38.3M is suggested for voltages above 750V.

The ohm-meter circuit uses a 741 as a current generator, the reference coming from the PSU. This is fed to the op-amp input via the ranging resistors. The gain of the stage is set by the value of the ranging resistors, and the feedback resistor RX, which is that under measurement.

Since the output is clamped as 5V, the output is directly proportional to RX.

If the input is left open circuit, the effective resistance is infinite, and the meter goes to overload, displaying 1048, with only the top half of the one being displayed.

The LM389 is an array of three NPN transistors on the same substrate with an audio power amplifier similar to the LM386.

The amplifier inputs are ground referenced while the output is automatically biased to one half the supply voltage. The gain is internally set at 20 to minimize external parts, but the addition of an external resistor and capacitor between pins 4 and 12 will increase the gain to any value up to 200.

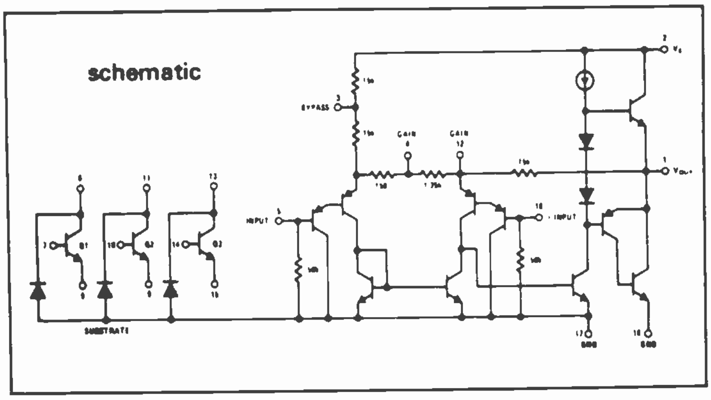
The three transistors have high gain and excellent matching characteristics. They are well suited to a wide variety of applications in dc through VHF systems.

To make the LM389 a more versatile amplifier, two pins (4 and 12) are provided for gain control. With pins 4 and 12 open, the 1.35 kΩ resistor sets the gain at 20 (26 dB). If a capacitor is put from pin 4 to 12, bypassing the 1.35 kΩ resistor, the gain will go up to 200 (46 dB). If a resistor is placed in series with the capacitor, the gain can be set to any value from 20 to 200. A low frequency pole in the gain response is caused by the capacitor working against the external resistor in series with the 150Ω internal resistor. If the capacitor is eliminated and a resistor connects pin 4 to 12, then the output dc level may shift due to the additional dc gain. Gain control can also be done by capacitively coupling a resistor (or FET) from pin 12 to ground.

Additional external components can be placed in parallel with the internal feedback resistors to tailor the gain and frequency response for individual applications. For example, we can compensate poor speaker bass response by frequency shaping the feedback path. This is done with a series RC from pin 1 to 12 (paralleling the internal 15 kΩ resistor). For 6 dB effective bass boost: R ≅ 15 kΩ, the lowest value for good stable operation is R = 10 kΩ if pin 4 is open. If pins 4 and 12 are bypassed then R as low as 2 kΩ can be used. This restriction is because the amplifier is only compensated for closed-loop gains greater than 9V/V.

The LM389 has excellent supply rejection and does not require a well regulated supply. However, to eliminate possible high frequency stability problems, the supply should be decoupled to ground with a 0.1μF capacitor. The high current ground of the output transistor, pin 18, is brought out separately from small signal ground, pin 17. If the two ground leads are returned separately to supply then the parasitic resistance in the power ground lead will not cause stability problems. The parasitic resistance in the signal ground can cause stability problems and it should be minimized. Care should also be taken to insure that the power dissipation does not exceed the maximum dissipation of the package for a given temperature. There are two ways to mute the LM389 amplifier. Shorting pin 3 to the supply voltage, or shorting pin 12 to ground will turn the amplifier off without affecting the input signal.

The schematic shows that both inputs are biased to ground with a 50 kΩ resistor. The base current of the input transistors is about 250 nA, so the inputs are at about 12.5 mV when left open. If the dc source resistance driving the LM389 is higher than 250 kΩ it will contribute very little additional offset (about 2.5 mV at the input, 50 mV at the output). If the dc source resistance is less than 10 kΩ, then shorting the unused input to ground will keep the offset low (about 2.5 mV at the input, 50 mV at the output). For dc source resistances between these values we can eliminate excess offset by putting a resistor from the unused input to ground, equal in value to the dc source resistance. Of course all offset problems are eliminated if the input is capacitively coupled.



The three transistors on the LM389 are general purpose devices that can be used the same as other small signal transistors. As long as the currents and voltages are kept within the absolute maximum limitations and the collectors are never at a negative potential with respect to pin 17, there is no limit on the way they can be used. For example, the emitter-base breakdown voltage of 7.1V can be used as a zener diode at currents from 1μA to 5 mA. These transistors make good LED driver devices, V_{SAT} is only 150 mV when sinking 10 mA. In the linear region, these transistors have been used in AM and FM radios, tape recorders, phonographs, and many other applications. Using the characteristic curves on noise voltage and noise current, the level of the collector current can be set to optimize noise performance for a given source impedance

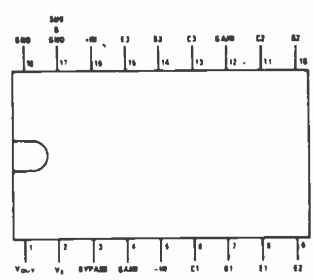
When using the LM389 with higher gains (bypassing the 1.35 kΩ resistor between pins 4 and 12) it is necessary to bypass the unused input, preventing degradation of gain and possible instabilities. This is done with a 0.1μF capacitor or a short to ground depending on the dc source resistance of the driven input.

ABSOLUTE MAXIMUM RATINGS

Supply Voltage	15V
Package Dissipation (Note 1)	825 mW
Input Voltage	±0.4V
Storage Temperature	-65°C to +150°C
Operating Temperature	0°C to +70°C
Junction Temperature	150°C
Lead Temperature (Soldering, 10 seconds)	300°C
Collector to Emitter Voltage, V_{CEO}	12V
Collector to Base Voltage, V_{CBO}	15V
Collector to Substrate Voltage, V_{CIO} (Note 2)	15V
Collector Current, I_C	25 mA
Emitter Current, I_E	25 mA
Base Current, I_B	5 mA
Power Dissipation (Each Transistor) $T_A \leq +70°C$	150 mW

ELECTRICAL CHARACTERISTICS $T_A = 25°C$

	PARAMETER	CONDITIONS	TYP	UNITS
AMPLIFIER				
V_S	Operating Supply Voltage		12	V
I_Q	Quiescent Current	$V_S = 6V$, $V_{IN} = 0V$	6	mA
P_{OUT}	Output Power (Note 3)	THD = 10% $V_S = 6V$, $R_L = 8Ω$	325	mW
		THD = 10% $V_S = 9V$, $R_L = 16Ω$	500	mW
A_V	Voltage Gain	$V_S = 6V$, f = 1 kHz	26	dB
		10μF From Pins 4 to 12	46	dB
BW	Bandwidth	$V_S = 6V$, Pins 4 and 12 Open	250	kHz
THD	Total Harmonic Distortion	$V_S = 6V$, $R_L = 8Ω$, $P_{OUT} = 125$ mW, f = 1 kHz, Pins 4 and 12 Open	0.2	%
PSRR	Power Supply Rejection Ratio	$V_S = 6V$, f = 1 kHz, $C_{BYPASS} = 10μF$, Pins 4 and 12 Open, Referred to Output	50	dB
R_{IN}	Input Resistance		50	kΩ
I_{BIAS}	Input Bias Current	$V_S = 6V$, Pins 5 and 16 Open	250	nA
TRANSISTORS				
V_{CEO}	Collector to Emitter Breakdown Voltage	$I_C = 1$ mA, $I_B = 0$	20	V
V_{CBO}	Collector to Base Breakdown Voltage	$I_C = 10μA$, $I_E = 0$	40	V
V_{CIO}	Collector to Substrate Breakdown Voltage	$I_C = 10μA$, $I_E = I_B = 0$	40	V
V_{EBO}	Emitter to Base Breakdown Voltage	$I_E = 10μA$, $I_C = 0$	7.1	V
H_{FE}	Static Forward Current Transfer Ratio (Static Beta)	$I_C = 10μA$	100	
		$I_C = 1$ mA	275	
		$I_C = 10$ mA	275	



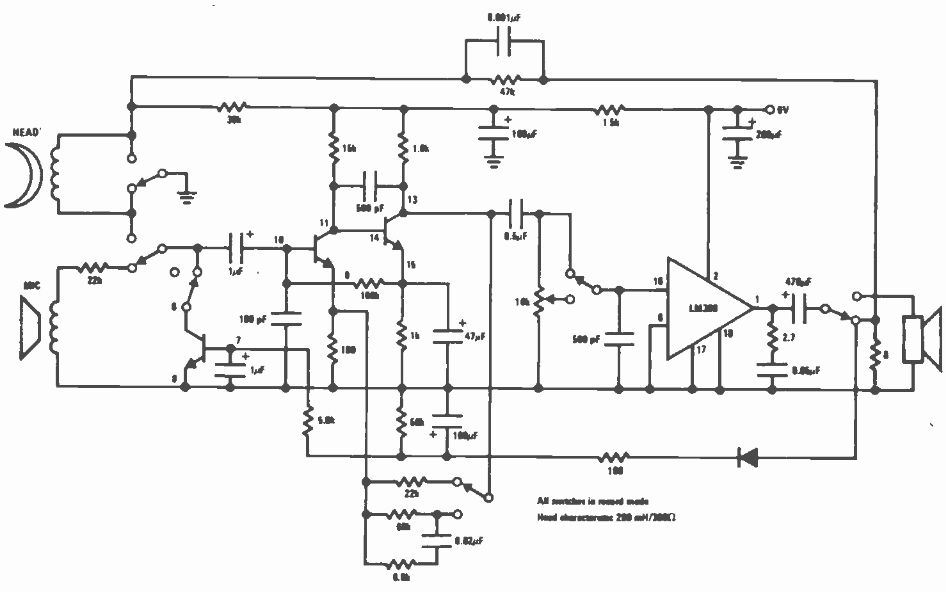


FIGURE 1 Tape Recorder

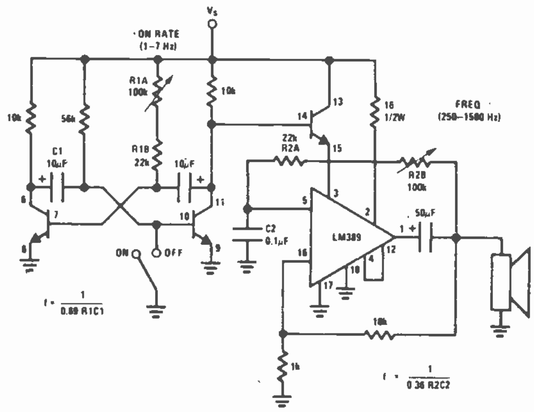


FIGURE 2 Siren

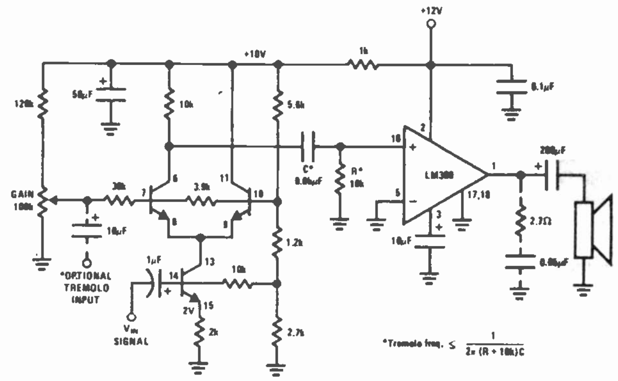


FIGURE 3 Voltage-Controlled Amplifier or Tremelo Circuit

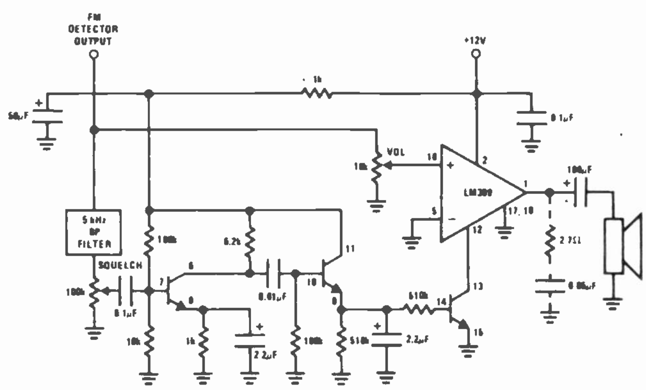


FIGURE 4 FM Scanner Noise Squelch Circuit

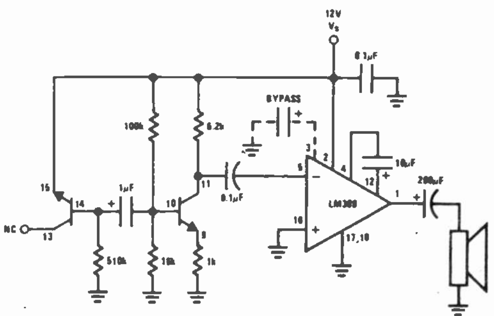


FIGURE 5 Noise Generator Using Zenor Diode

The MK 50395 is an ion-implanted, P-channel MOS six-decade synchronous up/down-counter/display driver with compare-register and storage-latches. The counter as well as the register can be loaded digit-by-digit with BCD data. The counter has an asynchronous-clear function.

The six-decade counter is synchronously incremented or decremented on the positive edge of the count input signal. A Schmitt trigger on this input provides hysteresis for protection against both a noisy environment and double triggering due to a slow rising edge at the count input.

The count inhibit can be changed in coincidence with the positive transition of the count input; the count input is inhibited when the count inhibit is high.

The counter will increment when up/down input is high (V_{ss}) and will decrement when up/down input is low. The up/down input can be changed .75 μs prior to the positive transition of the count input.

The clear input is asynchronous and will reset all decades to zero when brought high but does not affect the six digit latch or the scan counter.

As long as store input is low, data is continuously transferred from the counter to the display. Data in the counter will be latched and displayed when store input is high. Store can be changed in coincidence with the positive transition of the count input.

The counter is loaded with BCD data, digit by digit corresponding to the digit strobe outputs. BCD thumb-wheel switches with four diodes per decade connected between the digit strobe outputs and the BCD inputs will load the counter when the load counter input is taken high. Counter input is inhibited while the load counter input is high. The load counter input must remain high a minimum of six digit strobe output periods.

PARAMETER	MIN	MAX
Count Input Frequency	0	1 MHz
Scan Input Frequency	0	20 KHz
Count Pulse Width	400	ns
Store Pulse Width	2.0	μs
Store Setup Time	0	μs
Count Inhibit Setup Time	0	μs
Up/Down Setup Time	-.75	μs
Clear Pulse Width	2.0	μs
Clear Setup Time	0.5	μs
Zero Access Time		3.0 μs
Zero Hold Time		1.5 μs
Carry Access Time		1.5 μs
Carry Hold Time		0.9 μs
Equal Access Time		2.0 μs
Equal Hold Time		1.5 μs
Load Time	1/6 f_{si}	
Input Low Voltage, "0"	V_{DD}	$0.2V_{SS}$ V
Input High Voltage, "1"	$V_{SS}-1$	V_{SS} V
Output Voltage "0" @ 30μ A		$0.2V_{SS}$ V
Output Voltage "1" @ 1.5 mA	$0.8V_{SS}$	V
Output Current "1"		
digit strobes	3.0	mA
segment outputs	10.0	mA
Scan Input Pullup Current @ 0V		5.5 mA
Scan Input Pulldown Current @ 15V	2	40 μ A
$\overline{SET}$ Input Pullup Current @ 0V	5	60 μ A
Operating Temperature	0	70 C
Supply Voltage (V_{DD} = 0V)	10	15 V
Supply Current		40 mA
Break Down Voltage (Segment only @ 10 μA)		$V_{ss}-26$ V

The register is loaded with BCD data digit-by-digit corresponding to the digit strobe outputs. BCD thumbwheel switches with four diodes per decade connected between the digit strobe outputs and the BCD inputs will load the register when the load register input is taken high. The load register input must remain high a minimum of six digit strobe output periods.

This register is a static register and will not be cleared by the clear input.

BCD or seven segment outputs are available. Digit strobes are decoded internally by a divide by six Johnson counter. This counter scans from MSD to LSD. By bringing the SET input low, this counter will be forced to the MSD decade count. During this time the segment outputs are blanked to protect against display burn out.

Both the segment outputs and digit strobes are blanked during the interdigit blanking time. Leading zero blanking effects only the segment outputs. This option is disabled by bringing the LZB input high.

BCD output data changes at the beginning of the inter-digit blanking time. These outputs are CMOS compatible.

The MK 50395 has an internal oscillator. The frequency of the scan oscillator is determined by an external capacitor between V_{ss} and scan input. The wave form present on the scan oscillator input is triangular.

Typically, the scan oscillator will oscillate at the following frequencies with these nominal capacitor valves from V_{ss} to scan input.

	Min	Max
820 pF	1.4 KHz	4.9 KHz
470 pF	2.0 KHz	6.8 KHz
120 pF	7.0 KHz	20 KHz

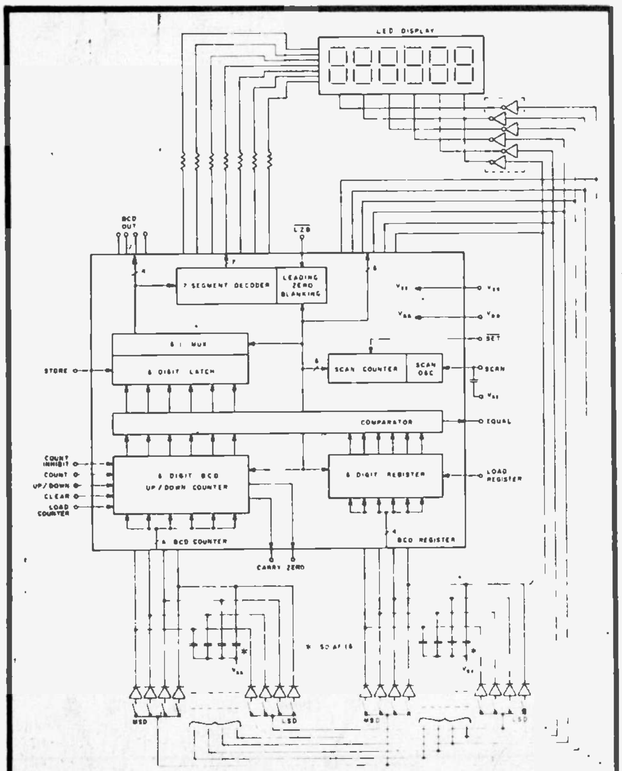
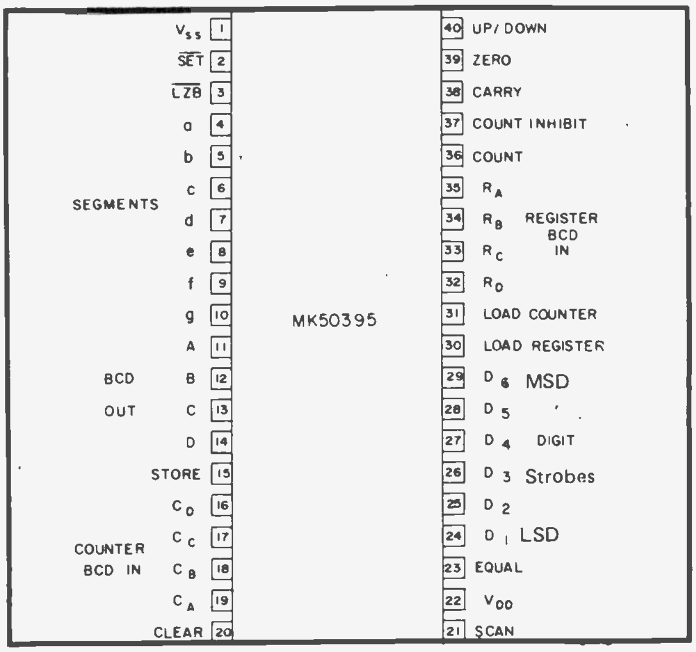


Fig 1. Functional diagram

This device is available from Bywood Electronics, 68 Ebberns Road, Hemel Hempstead Herts HP3 9QRC Price £14.50 inclusive



100W DISCO

PART TWO

ETI project 458

After testing the power amplifiers switch off and remove from both the wire connecting them to the power supply OV. When the disco is completed the power amplifiers will be earthed from the preamplifiers. To the wire joining the two capacitors C6 and C6 should be connected the centre tap of the transformer's 32-0-32V winding, the mains earth (which should also be connected to the chassis of the transformer), the negative connection from each loudspeaker and a wire from the tone control board.

BOARD ASSEMBLY

Fit the components to the front panel as shown in Fig. 19. The sliders should be fitted using ⅛in x 6BA spacers and 6mm countersunk screws to give the correct spacing for the knobs. Mount the mixer resistors on VR1, 2, 4 and 5 and the four resistors on VR16.

Fit wiring pins to the P.C.B.'s, and mount all components. The fader, pre-amp and tone control boards are to be mounted close to their controls, on the front panel. Whilst these boards could be bolted directly to the front panel, this would result in a disorderly arrangement of screwheads being visible. A better system is to glue a piece of wood (540 x 42 x 10mm) to the front panel and mount the P.C.B.'s by on this.

FRONT PANEL

A separate power distribution point of two 4-way tag strips is fixed close to the tone control board, ensuring that the front panel does not foul it when closing.

Fig. 9 shows the overlay for the P/U board, note that two of these boards are required (one for each deck) and the overlay shown is for Deck 1.

Use a low capacity screened cable for the connections between the boards and the turntables.

STABILITY AND KEEPING IT

Referring to Fig. 19 wire the PCB's and front panel components, all wires shown connected to "star" must be *individually* connected to the star point, a piece of wire on the slider of VR3. The braids of the screened leads must be earthed at one end only unless shown otherwise. All other wires should be twisted together in pairs (triples on tone controls and stereo/mono switch). If twisted wire is shown do not use screened wire as its high capacity is detrimental to stability).

Refer to the appropriate PCB overlay drawings for PCB pin numbers, and check the wiring carefully when completed. It is imperative that no part of the circuit be earthed more than once.

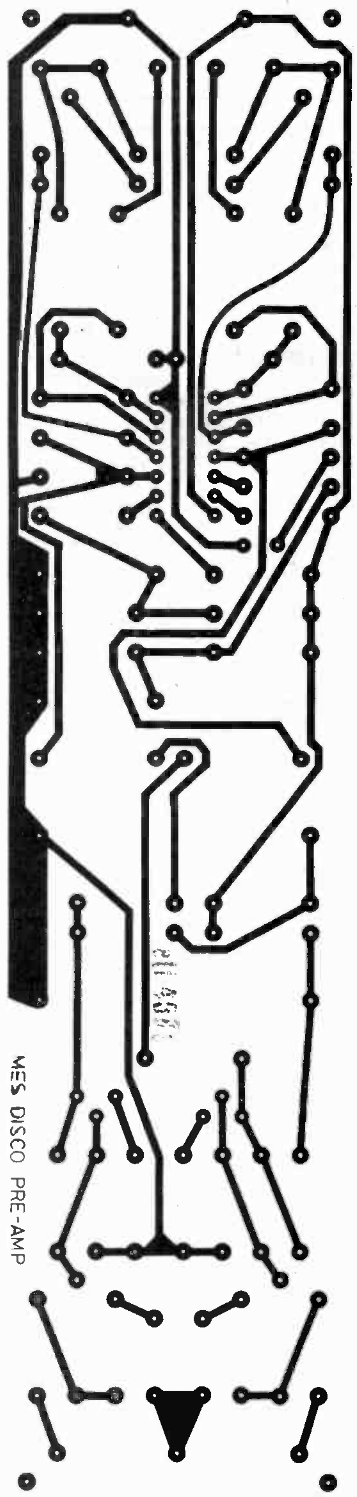
If at any time the amplifiers break into oscillation switch off immediately and check that all four fuses FS2, 3, 4 and 5 are intact. Under **no** circumstances should the power amplifiers be operated with one power rail connected to them. With the wiring details as shown in Fig. 7 the amplifiers are completely stable under all load conditions.

SETTING-UP: FADER

Set VR12, VR14 to centre position, turn fade sensitivity VR12 fully off, and faded level VR7 fully on. Turn VR1 on the power supply fully clockwise and play a record on either deck at normal volume.

Turn VR1 anticlockwise until the level becomes noticeably quieter then turn clockwise until both channels are *just* not faded — turn it a fraction more. Now with fade sensitivity (VR12) fully on check that the music fades when the microphone is spoken into.

VR13 adjusts the rate at which the music is faded and VR14 sets the speed of recovery after the speech ends.



100W STEREO DISCO

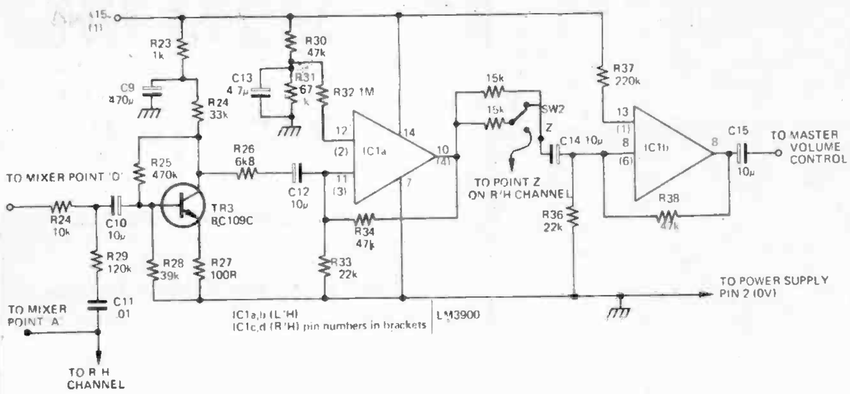


Fig. 7 — Circuit of Pre-amp Board.

Double all quantities for stereo except where marked *

R35, 35a	15K	R23	1K
R37	220K	R24	33K
	All ⅓w 5% carbon film	R25	470K
		R26	6K8
C9	470µF 25V	R27	100R
C10, 12, 14, 15	10µF 25V	R28	39K
C11	Polyester .01µF	R29	120K
C13	4.7µF 63V	R29a	10K
TR3	BC109C	R30, 31, 34, 38	47K
IC1*a, b, c, d	LM3900 (only 1 required)	R32	1M
		R33, 36	22K
SW2*	*1 x Sub Miniature DPDT Toggle SW	*1 x pcb "Disco Pre-Amp"	

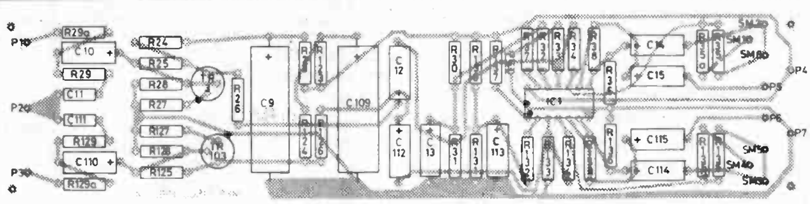


Fig. 8 — Overlay of Pre-amp Board.

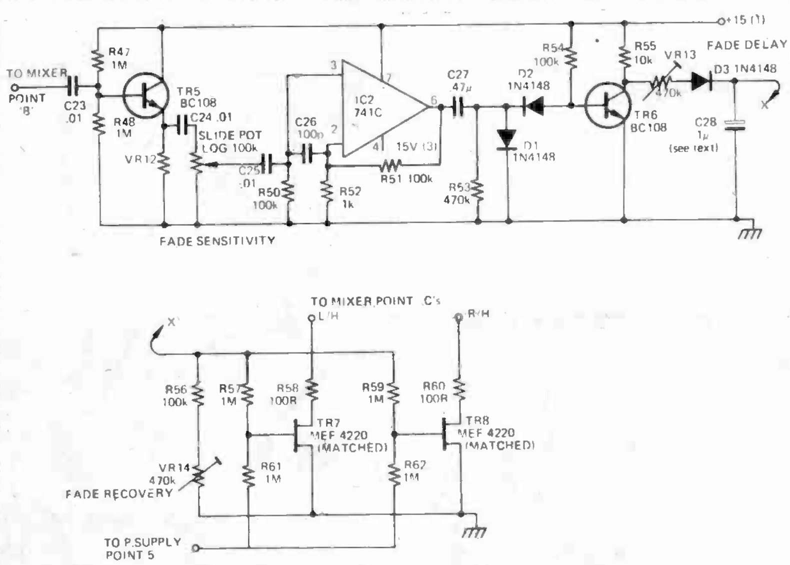


Fig. 10 — Circuit of Fader.

How It Works: Pre-amp

The FET P/U board has a very high input impedance to match the ceramic cartridges, and a medium output impedance. All the inputs (except mic) are mixed together after the FET P/U board to a common point (D), impedance 20k. The signals are then fed through 10k resistor to a sensitivie input on the pre-amp board.

After level adjustment at VR6 the microphone signals are mixed into both channels at the input on the pre-amp board so that the mic signals are not reduced by the fader. TR3 forms a 25dB gain stage (10k input impedance), the output of which is then fed through two elements of an LM3900 giving a further 33dB gain.

A fully mixing mono/stereo switch is provided between the elements. Thus a signal of 2.5mV rms at the input to the pre-amp gives an output of 2V rms.

Tone controls are a 'standard' Mullard circuit with an additional top cut control R44 is provided to prevent 'thuds' when SW1 is operated.

The output from the tone controls is taken directly to the power amps.

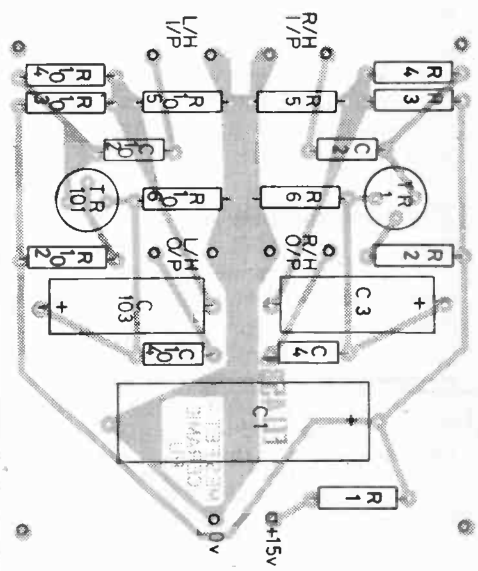
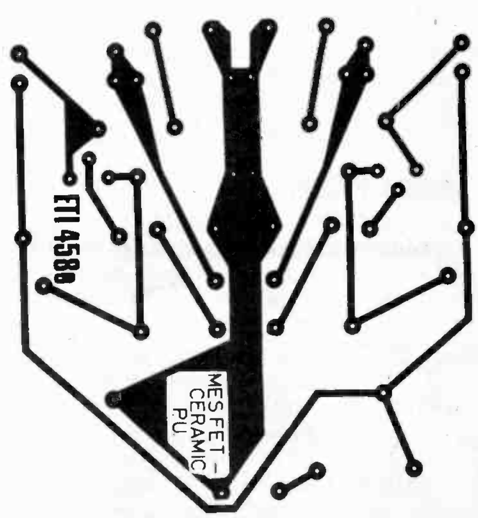


Fig. 9 — Overlay of P/U board and mixer.



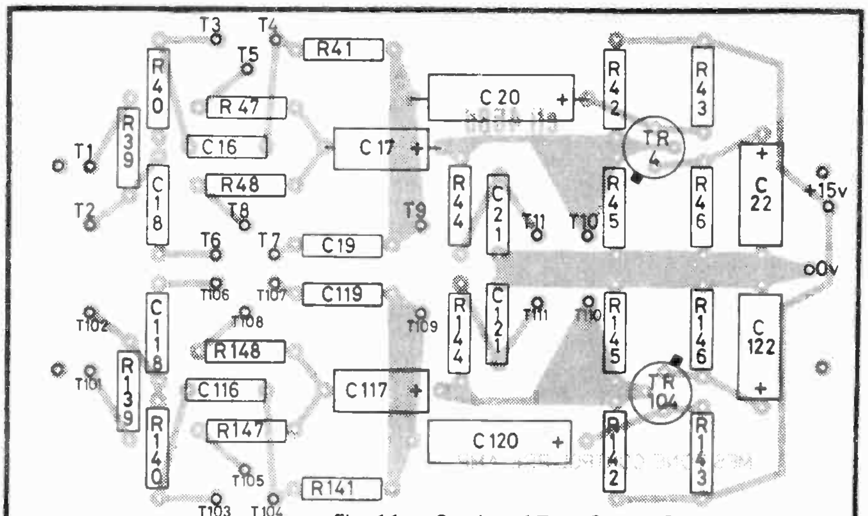


Fig. 11 — Overlay of Tone Control Board.

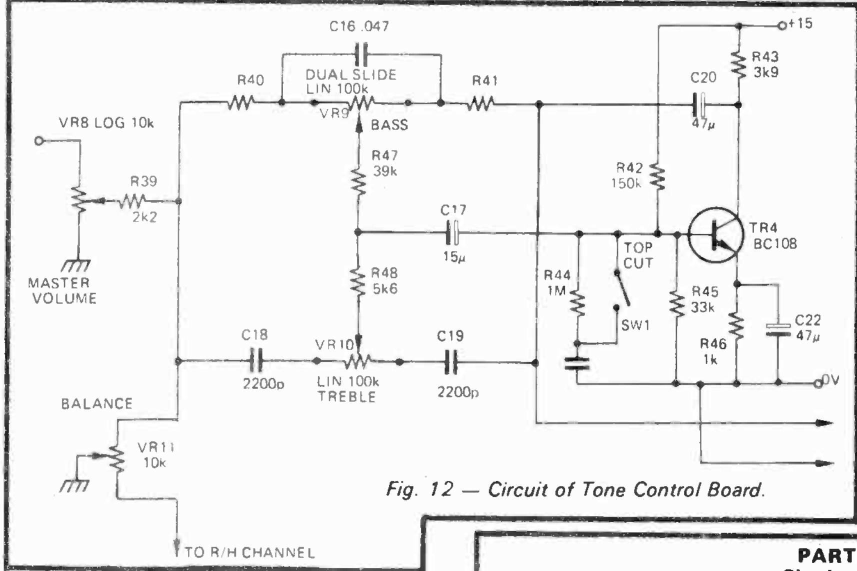


Fig. 12 — Circuit of Tone Control Board.

THIS PROJECT WAS DESIGNED BY MAPLIN ELECTRONICS SUPPLIES, AND THEY ARE STOCKING ALL THE PARTS AND P.C.B.'s FOR THE PROJECT. WOOD-WORK AND METALWORK WILL BE AVAILABLE

PARTS LIST FOR TONE CONTROL

R39	2K2
R40, 41	4K7
R42	150K
R43	3K9
R44	1M
R45	33K
R46	1K
R47 39K	All ⅓N 5% carbon film
R48 5K6	
C16	Polyester .047 μF
C17	15 μF 16V
C18, 19	Polystyrene 2200pF
C20	47 μF 25V
C21	Polyester .1 μF
C22	47 μF 10V
VR8*	Dual Slide Log 10K
VR9*, 10*	Dual Slide Lin 100K
VR11*	Single Slide Lin 10K
TR4	BC108
SW1*	Sub Miniature DPDT Toggle SW
Misc.	*1 × Tune Control Pre-Amp Pcb *4 × Slide Knobs

How it Works: Fader

Signals directly from the microphone not affected by the mic level control are fed into the high impedance stage TR5, through the fade sensitivity control, and then through IC2.

D1 and D2 then rectify the signal, producing a DC level. TR6, which is normally on, is turned off when this level reaches a certain point. The potential at the collector goes from OV to a positive voltage and a current now flows through R55, VR13 D3 and C28 (which charges up).

A voltage appears at R57, R59 and consequently the gate voltages of TR7 and TR8 go positive. The FET's are normally just biased off by the negative supply from VR1 (on the power supply board). When the gate moves positive the resistance between the drain and source drops and the signal at point D in the mixer is shunted by VR7, R58 and R60.

PARTS LIST FOR FADER
Single quantity only required

R47, 48, 57, 59, 61, 62		C28	1 μF 63V
R49	47K	VR12	Single Slide Log 100K
R50, 51, 54, 56	100K	VR13, 14	Sub min Horizontal Preset 470K
R52	1K		
R53	470K	TR5, 6	BC108
R55	10K	TR7, 8	MEF 4220 matched for
R58, 60	100R		
	All ⅓w 5% carbon film	IC2	A741C
		D1, 2, 3	1N4148
C23, 24, 25	Polyester .01 μF	Misc.	1 × "fader" pcb
C26	p-sty 100pF		1 × slide knob
C27	Polyester .47 μF		

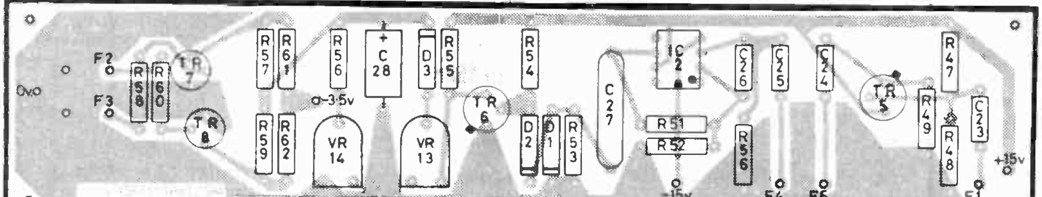
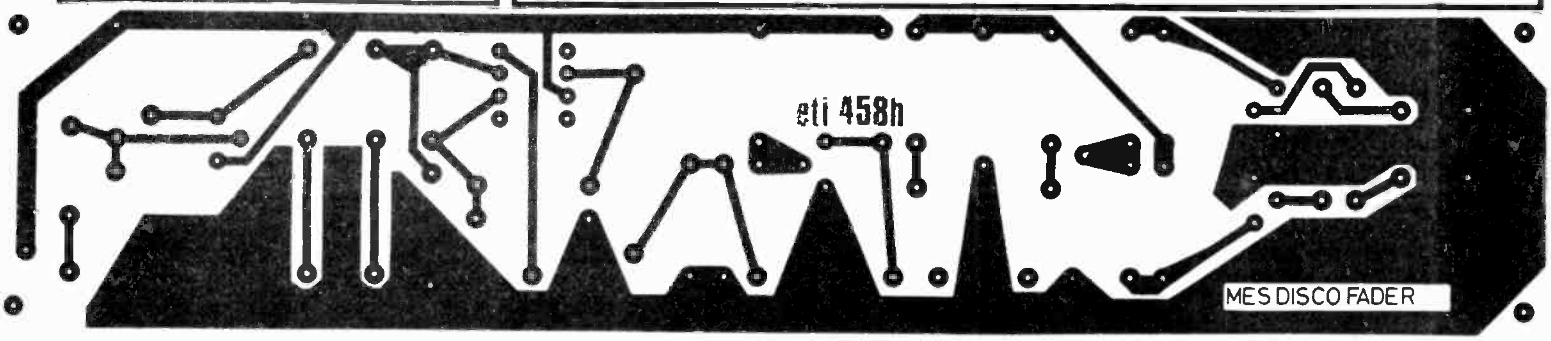


Fig. 13 — Overlay of Fader Board.



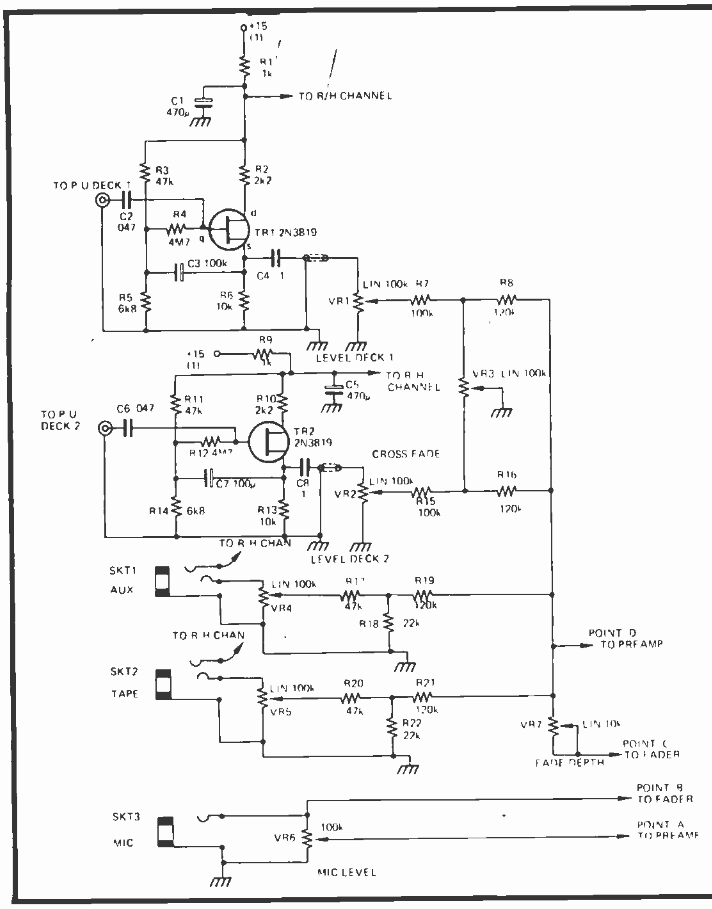


Fig. 14 — Circuit of P/U board and mixer.

PARTS LIST MIXER

Double all quantities for stereo except those marked *

R1*, 9*	1K
R2, 10	2K2
R3, 11, 17, 20	47K
R4, 12	4M7
R5, 14	6K8
R6, 13	10K
R7, 15	100K
R8, 16	120K
R18, 22	22K
VR1*, 2*, 3*, 4*, 5*	Dual Slide Lin 100K
VR6*	Single Slide Log 10K
VR7*	Dual Slide Lin 10K
C1*, 5*	470μF 25V
C2, 6	Polyester .047μF
C3, 7	100μF 10V
C4, 8	Polyester .1μF
TR1, TR2	2N3819
Skt 1*, 2*	Jack skt stereo (plastic moulded)
Skt 3*	Jack skt mono (plastic moulded)
Misc.*	4× Screened phono plug
	4 metres low capacitance 50ohm screened cable
	1 metre twin screened cable
	7× slider knobs
	2×f.e.t./ceramic p.u. bd

PARTS FOR HEADPHONE/VU MONITOR

Double all quantities for stereo except where marked *

R63, 70, 73	4K7	C36	2.2μF 63V
R64	2R7	VR15	Sub miniature horizontal preset 1M
R65	1M		
R66	150K	VR16*	Dual Slide Log 500K
R67	1K	VR17	Sub miniature horizontal preset 220K
R68, 72	100K		
R69	470K	D3, 4	1N4148
R71	470R	TR9	BC108
R74 680K	All ⅓w 5% carbon film	IC3	LM380
		IC4	μA741C
R75 220K		SW3*, 4*	Sub miniature DPDT Toggle SW
C29*	Polyester .47μF		
C30, 33	Polyester .1μF	Misc.	VU meter
C31	470μF 25V	VU meter and headphone	
C32*	4.7μF at 63V		*Jack skt stereo (plastic moulded)
C34, 35	1μF 63V	*Disco monitor pcb	*Slide knob

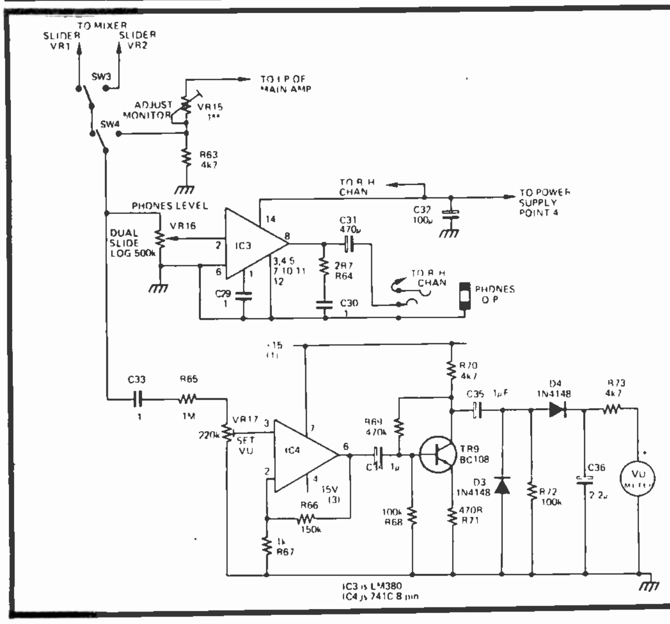


Fig. 15 — Headphone/VU Monitor Board Circuit.

SETTING-UP: VU METERS

Swith SW4 up and SW3 to one deck. On that deck play a record with some very loud passages. Turn up the master volume (VR8) slightly, then listening carefully, turn up the deck level. When distortion is heard adjust VR17 (VR117) so that the meter reads +3dB. Decrease the deck level until distortion is just not audible then switch SW4 and turn the master volume control (VR8) until the music is just distorted on loud passages. Adjust VR15 (VR115) until VU meter reads +3dB.

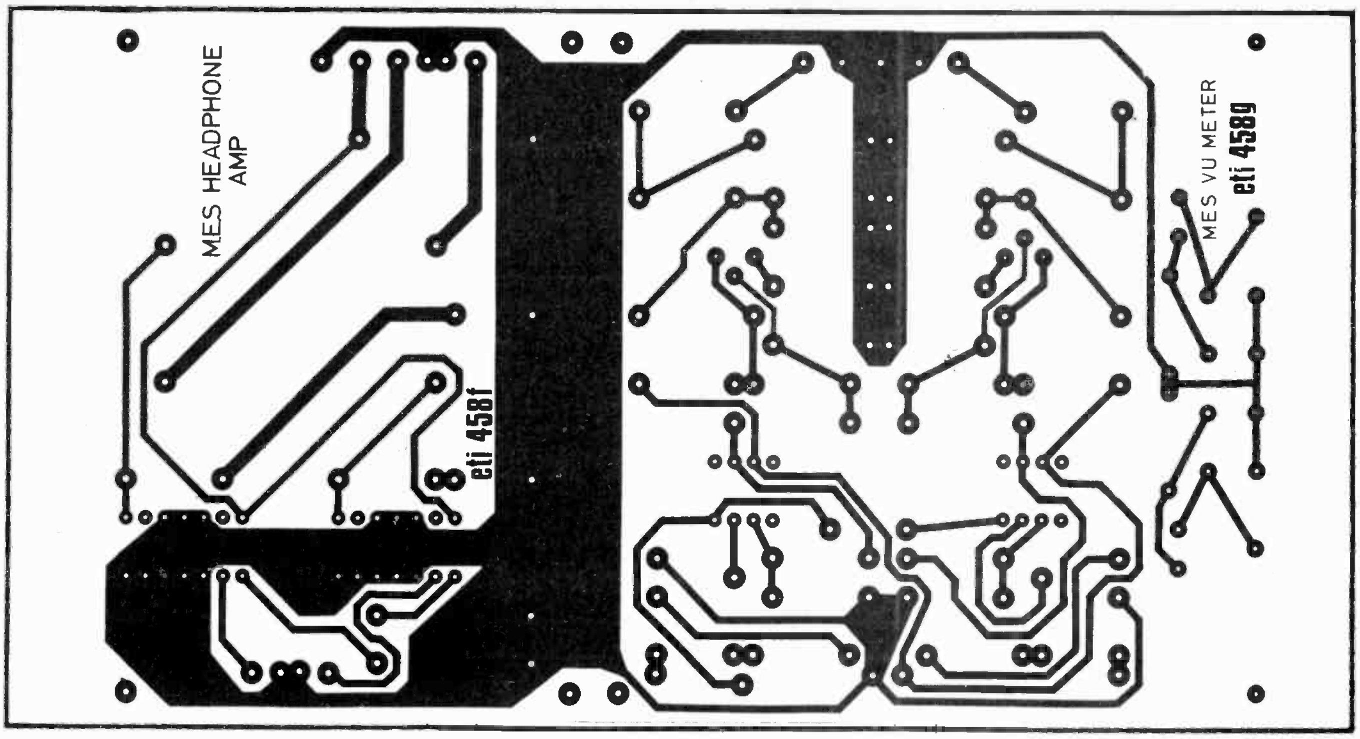
How It Works: Monitor

With SW4 down the board input is derived from the input to the power amps, regardless of the position of SW3. If SW4 is up, the input comes from the mixer (Deck 1 or 2 dependent on SW3).

Signals are then fed simultaneously into two high impedance points — a headphone amp and a VU meter amp. The headphone amp is a very simple 2W stereo amplifier giving a high level to the headphones, so that a second sound source can be hears clearly when the main amps are driving the loudspeakers hard.

Op-amp IC4 amplifies the signal across VR17 (43dB gain). Further amplification is provided by TR9 in order to give sufficient level to drive the VU meters. Under no signal conditions the voltage at the junction of D3, D4 falls to OV under the influence of R72. When a negative going waveform appears at the collector of TR9, C35 will discharge on the peak negative voltage reached by the signal.

As this goes to its positive peak the total voltage difference between the negative and positive peaks will be transfered through D4 to C36.



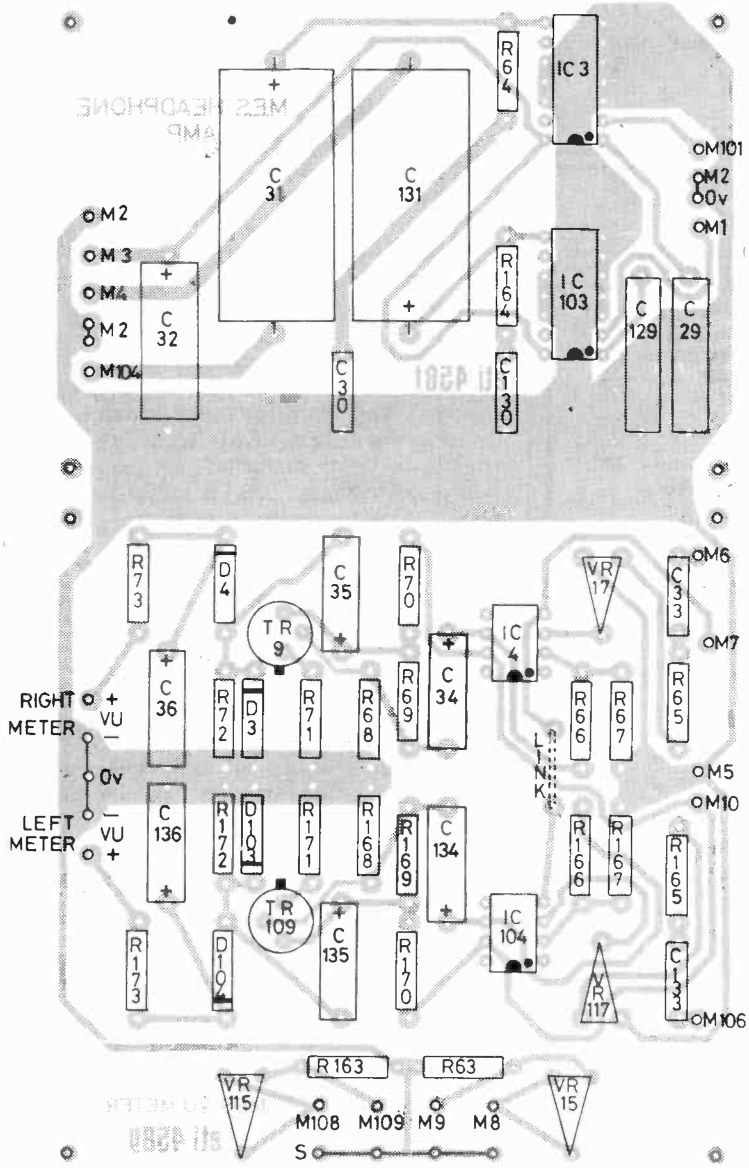
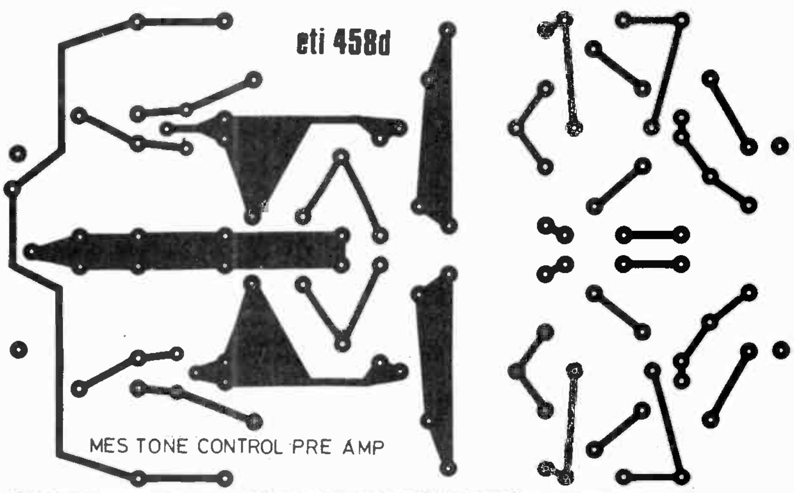


Fig. 16 — Overlay of Headphone / VU Monitor Board.



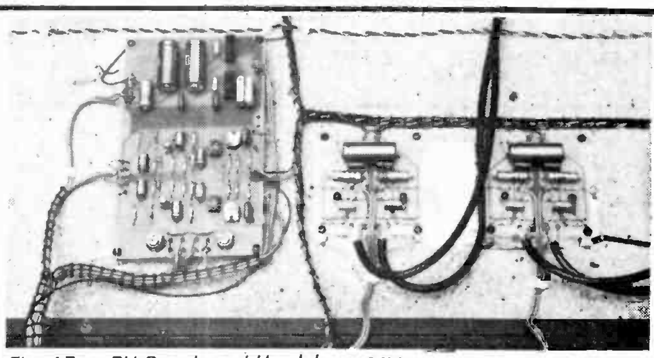


Fig. 17 — PU Boards and Headphone amp.

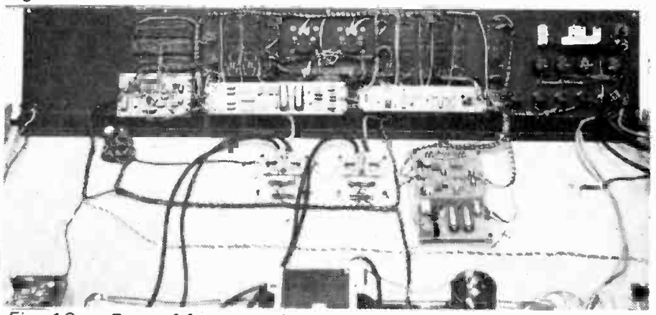
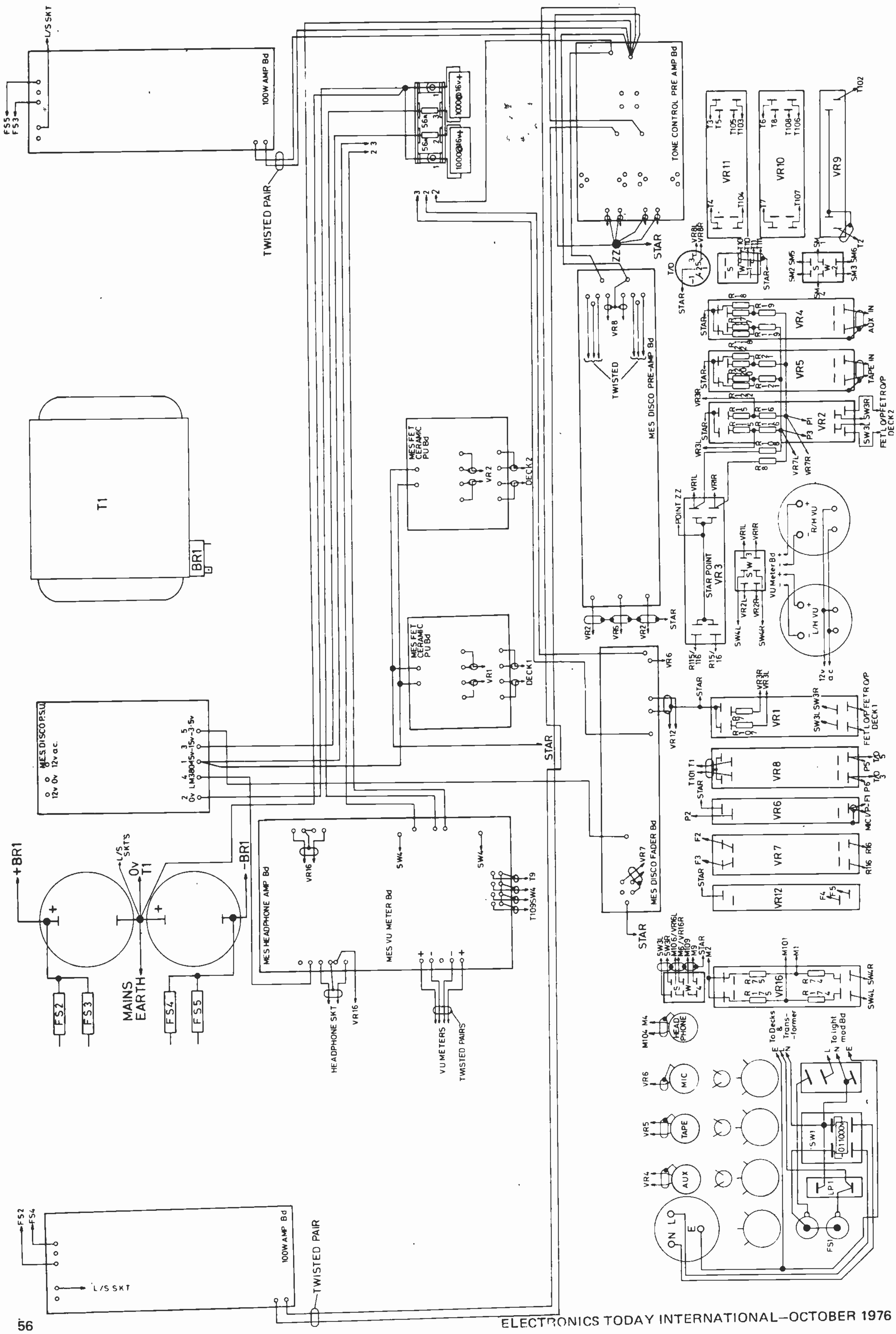


Fig. 18 — Rear of front panel.


100W AMP Bd
TWISTED PAIR
L/S SKT
T1
BR1
+BR1
-BR1
MAINS EARTH
FS2
FS3
FS4
FS5
MES DISCO PSU
TONE CONTROL PRE AMP Bd
MES DISCO PRE-AMP Bd
TWISTED
MES FET CERAMIC PU Bd
DECK 1
DECK 2
MES DISCO FADER Bd
MES HEADPHONE AMP Bd
MES VU METER Bd
HEADPHONE SKT
VU METERS
TWISTED PAIRS
STAR
STAR POINT VR3
POINT ZZ
VU Meter Bd
L/H VU
R/H VU
AUX IN
TAPE IN
HEAD PHONE
MIC
TAPE
AUX
ON
FS1
LP1
SW1

Part 8 - Introduction to System 68

DESIGN PHILOSOPHY

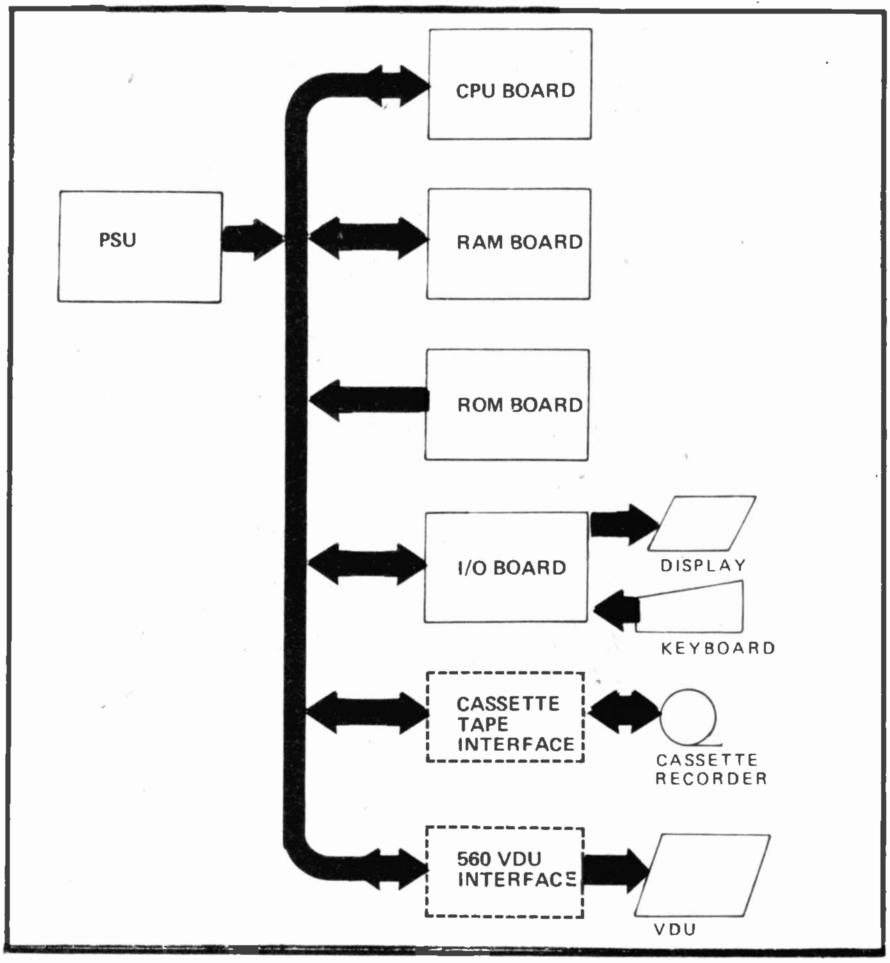
SYSTEM 68 HAS BEEN DESIGNED to satisfy the requirements of a variety of users; firstly the home constructor, whose need for low cost I/O has not so far been catered for, and also the many people who need a small system for commercial use but find that many of the kits available are not suitable. In order to gain maximum flexibility, the system has been designed on Eurocards (100 X 160 mm) which plug into a standard Vero case.

The home constructor has (we hope!) many potential applications for equipment of this type. Consequently, the memory size required and also the peripheral handling capabilities will vary from application to application. A computer system for the amateur, then, must be expandable, and configurable by the user. Hence the choice of Eurocards as the board size.

One thing we really should point out is that, although this project is fairly expensive, by normal standards, this is by no means an ordinary project. A high initial investment results in a device which can be turned to many applications, limited only by the user's imagination and patience! What's more the application can be changed by reprogramming your system through the keyboard, which is only a few moments work. But by now we are probably preaching to the converted!

We envisualise the amateur as using a microprocessor in two different types of application: firstly, where the MPU is dedicated to performing one function only, e.g. controlling the central heating, or playing a TV game, and secondly, where the control program is changed frequently, e.g. a general purpose microcomputer, or programmable calculator.

The first application does not require teletype-like I/O in operation; this is only a problem when writing a program. Conversely, the computer type applications almost always require some kind of alphanumeric I/O. Obviously, it doesn't make sense to buy a teletype simply to write one program which will never again be changed. Consequently, we have set about designing a method of program writing which does not require a teletype or an expensive VDU (we're not saying anything about cheap VDUs!). System 68, then uses a calculator type display and keyboard for program entry, and these can also be used by the operator for entry of data while the system is executing his program.



HARDWARE

The system is based on 5 main boards, each of which is a functional block in the system. Each board is Eurocard sized so that it will slot into a Verocase, and has all connections to the system bus on a plug-in conector at the rear. The bus lines, i.e. Data Bus, Address Bus, Control Bus, and power distribution, are carried by a Mother Board which runs across the rear of the case. The other boards in the basic system are: a CPU Board, RAM Board, ROM Board, and an I/O Board. We shall now discuss these in detail.

The CPU Board carries an M6800 microprocessor, along with its associated clock circuitry, and there is space on the board for bus buffers for systems above the M6800's maximum drive capability. This is the heart of the system, and controls the operation of all the other boards.

The RAM board carries 1k (i.e. 1024 bytes) of static RAM. in the basic system this board is set up at location 0000 in memory, as the control programs require the bottom section of RAM as scratchpad memory. This card can be set up virtually anywhere in memory, to suit the program you have written.

The ROM card could also be said to be the heart of the system. It carries the control program, which was written specially for the system. This program, called, predictably enough, ETIBUG, runs the display, decodes inputs from the uncoded Hex keyboard and generally runs the system.

The I/O card is special to the system, and carries a PIA and a very small amount of additional logic which, under firmware control, drives the display and accepts inputs from from the keyboard. There are two distinct areas on the keyboard: one consists of 16 keys bearing the Hex digits 0-9 and A-F, which is used to input program steps or data, and the other is 4 keys which immediately execute what we term 'System Commands'. These commands are as follows: 'Deposit' places the data or instruction currently in the 'Data Field' of the display into the location in memory currently shown by the 'Address Field' of the display. The 'Load Address' command sets the Address Field to the correct value. The 'Examine' instruction reads out the contents of a memory location, and the 'Execute' instruction jumps to a location in memory and starts executing a program there. These 4 commands are sufficient to enable one eventually to load and run virtually any program.

The display is an 8-digit 7-segment display which is capable of displaying all the Hex characters and quite a few other useful things as well. In normal use, when programming, the first 4 digits constitute the Address Field and the last 4 digits the Data Field. If things go wrong at any time, however the display will show an error message consisting of the word 'Error' followed by a 3-digit code. Various other words and prompts can be displayed, and the programmer has access to the display routines so that he can display his own messages. In addition, there is a 'Restart' button, which is used on switch-on to enter the ETIBUG control program.

FIRMWARE

The firmware in System 68 is the ETIBUG control program. This is really made up of a bunch of subroutines which perform various functions. The ones that make System 68 different are the Display Driver and Keyboard Decoder routines. These work in a similar manner to a pocket calculator. One half of a PIA outputs 7-segment codes while the other half outputs a BCD code indicating the digit being addressed, and also inputs a code from the keyboard whenever a key is pressed. The display is perpetually strobed in this manner until a key is pressed, which generates an interrupt and forces the program out of this loop. The firmware then works out which key was depressed and decodes this to Hex. It then also codes it in 7-segment and stores this in the display buffer so that when the display scanning routine resumes operation,the digit will appear on the display. System Commands operate in a similar way.

The display firmware is modular and can operate independently of the ETIBUG control program, so that it can be used by any other programs in the system. This permits the display of prompts and messages by the user's program.

In addition, it is possible for the ETIBUG firmware to call up subroutines from other ROMs, enabling expansion of the system. For example, if it is desired to add the ETI 560 VDU to the system, then an extra ROM can be added which will carry the subroutines necessary to drive it, as well as providing some extra facilities. Another possibility is to add a ROM which contains calculator routines, or alternatively, calculator chip interface routines, and thereby configure a programmable calculator. The ETIBUG ROMs will be commercially available — full details in the parts list next month.

SOFTWARE

This is where you come in. System 68 is designed to be used as a stepping stone to bigger and better things. It is, in its present form, a Development System; in other words it will be used by most people to write and test their own programs, and this will be done mainly through the Hex keyboard and display. But, once that program is written, it can in many cases, be put onto a PROM and then the keyboard, etc. can be removed from the completed system, so that you are left only with the minimum number of parts required to make it operate. This is something very few other development systems will let you do.

On the other hand, if you want to progress to a large-scale computer type set-up, then you will need that expensive I/O device we mentioned earlier. Where other development systems will only interface typically to ASCII coded teletypes, System 68 enables you to interface to any kind of device that comes your way -- you simply write the required interface program on the keyboard-display system and then run it. Hey Presto, Instant Interface!

So far, so good. But we're still only on the first rung of the ladder. If you stop to think how many programs could be written to do all the things this kind of system is capable of, or even if you only consider the programs you'd like to write, it becomes obvious that no one person could possibly do it! What is needed is some kind of software interchange, i.e. if Joe Bloggs has written a program to interface to an Acme Computer Company terminal, and you have one, you'd obviously like to get your hands on that program. Or suppose someone has written a program to play Draughts, that would be in great demand.

And this is where ETI comes in, and where System 68 proves itself to be a system in the broadest sense of the word. Software support is very important to any computer system, and we aim to support System 68 fully in two ways: firstly, by developing applications programs in-house, and also by publishing our readers programs along similar lines to 'Tech-Tips'.

CRYSTAL BALL GAZING

So far we have outlined the basic system and some of its potential, but what is actually going to follow? Probably the first extension to the basic system, or Simple 68, as we've nicknamed it, will be a cassette tape interface to the CUTS standard. Non-volatile program storage is a problem faced by all micro users, and so we have given it a high priority in our development program. Because of the common circuitry, it is possible that this card will also carry a TTY or RS232 interface for standard terminals and VDUs.

Following that will be a general purpose parallel interface board which can be used to build special circuitry, and perhaps a serial interface. A possibility also being looked at is that of larger memory boards or modules.

Using this kind of hardware, many users will by then have set-ups capable of running large programs, and in some cases even assemblers or, perhaps, compilers. For this reason, the System 68 hardware is compatible with many systems currently available, and the systems are often software compatible also.

Next month we shall cover the constructional details of the system.

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		601C	£1.48
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		601E	£3.36
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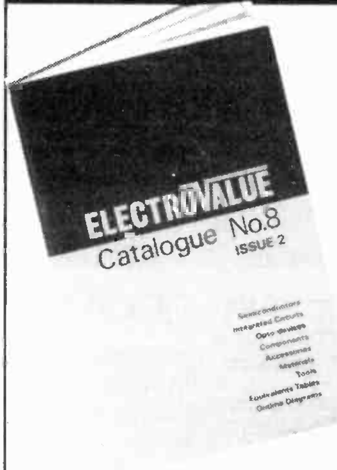

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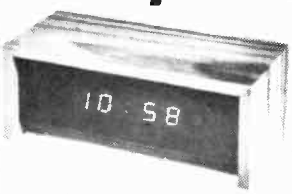

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COMPONENT CODES

COMPONENT SERIES PART 3

RESISTOR AND CAPACITOR CODES AND VALUES — AND HOW TO INTERPRET THEM

MODERN FIXED RESISTORS, capacitors and RF chokes are encapsulated in a variety of packages.

For resistors, the most common package is a cylindrical casing having axial leads (Fig 1). Cylindrical body types having radial leads and single-ended types are also manufactured. Some power resistors are rectangular with a square cross-section — Fig. 1. (d).

Moulded inductors, principally used as RF chokes are generally cylindrical with axial leads, very similar to resistors.

COMPONENT MARKING

The value, tolerance and other characteristics are marked on the body of fixed components using one of three basic systems:—

(d) directly on the body

(b) a series of coloured bands or dots according to a standard code.

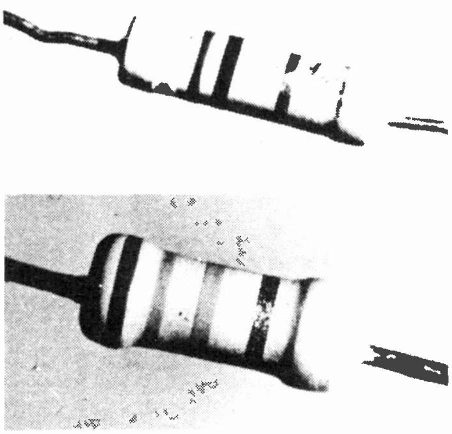
(c) a series of numbers and letters according to a standard code — known as a typographic code.

The basic colour code is given in Table 1. Its use on typical cylindrical-shaped components is illustrated in Fig 3. The first and second digits represent the significant figures of the component value. The decimal multiplier determines the position of the decimal point and the order of the value of the component — i.e., ohms, megohms etc, or μF, pF etc. The tolerance indicates the tolerance range either side of the nominal value of the component. This means that the actual component value may lie anywhere between the tolerance extremes. Tolerance is usually quoted as a percentage.

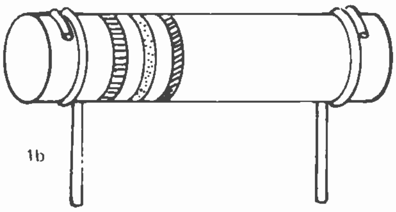
The way in which the standard colour code is applied on a component and how other characteristics, such as voltage rating or temperature coefficient, are indicated is explained in detail in the sections of this series dealing with component marking codes.

Typographic marking codes take a variety of forms. They generally involve a group of numbers indicating the value of the component, and prefix or suffix letters (or both) indicating other characteristics such as voltage rating, tolerance etc. The letters are deciphered by reference to tables showing the characteristic accorded to a particular letter. These tables are drawn up according to a standard international convention. The different typographic codes used and how to interpret them are also explained in the sections on component marking codes.

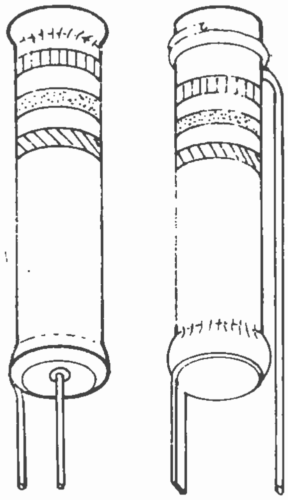
Figure 1. Common body shapes of small, modern fixed resistors. RF chokes and some capacitors are similarly encapsulated.



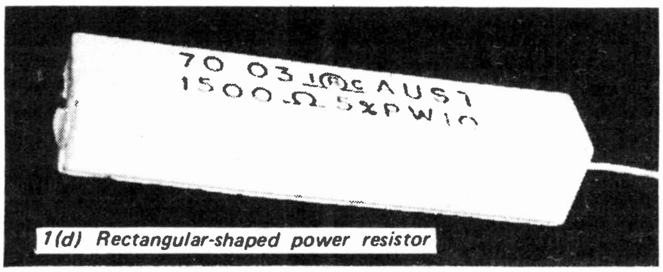
1(a) Cylindrical body type with axial leads



1(b) Cylindrical body type with radial leads



1(c) Single-ended cylindrical body types



1(d) Rectangular-shaped power resistor

PREFERRED VALUE

If you examine the values of fixed components, you will notice that the values appear 'odd', and further more, that the same significant figures repeat in each decade — i.e., 47, 470, 4700; .0068, .068,0.68 etc. This is because a system of what is called *'preferred numbers'* or *'preferred values'* is used. The basic system of preferred numbers spans the decade from 10 to 100. Higher and lower decades simply have the decimal place shifted right or left accordingly.

There are several preferred number series, the three most common ones have six, twelve and twenty four numbers per decade and are known as the E6, E12 and E24 series respectively.

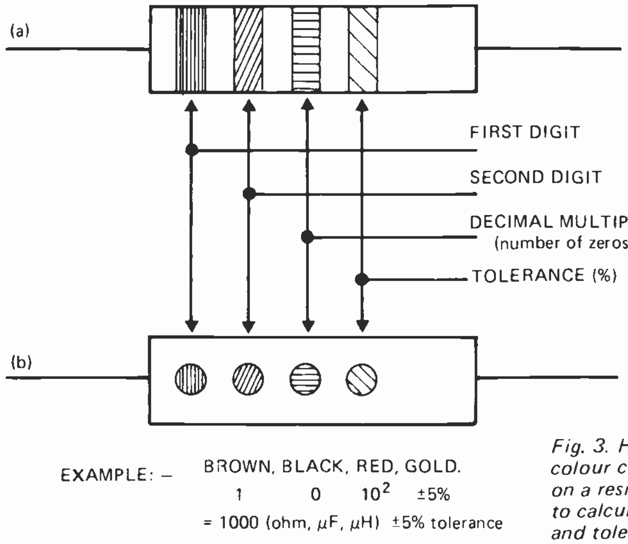


Fig. 3. How the colour code values on a resistor are used to calculate the value and tolerance.

THE STANDARD COLOUR CODE — TABLE 1

colour	significant figure	decimal multiplier	tolerance ±%
BLACK	0	1	20 *
BROWN	1	10	1
RED	2	10^2 or 100	2
ORANGE	3	10^3 or 1000	
YELLOW	4	10^4 or 10,000	
GREEN	5	10^5 or 100,000	
BLUE	6	10^6 or 1,000,000	
VIOLET	7	10^7 or 10,000,000	
GREY	8	10^8 or 100,000,000	
WHITE	9	10^9 or 1,000,000,000	
GOLD	–	0.1 or 10^{-1}	5
SILVER	–	0.01 or 10^{-2}	10
none	–		20

* used with capacitors

The numbers in a decade of each of these series are given in Table 2. Each number is derived from a constant difference between numbers (or steps) of $10^{1/6}$ for the E6 series, $10^{1/12}$ for the E12 series and $10^{1/24}$ for the E24 series. The numbers are rounded off to two significant figures for convenience. These numbers provide a convenient tolerance range for component values in the different series. The E6 series is used for ± 20% tolerance components, the E12 series for ± 10%, and the E24 series for ± 5% components.

For close tolerance, high stability components, the E96 series is used. This provides a series of 96 numbers per decade, each being approximately 2% higher than the preceding value. Thus, this series is used for components having specified tolerances of 1% and 2%. The tolerance extremes of 1% components overlap. As the values need to be quoted to three figures, the component markings will, accordingly, be different from those components having values in the E6, E12 or E24 series. The values in the E96 series are also shown in Table 2.

The tolerance specification indicates that a component may have a value, differing from the nominal value, anywhere between the limits specified. For example, a 1000 ohm resistor with a tolerance specification of ± 10% may have a value anywhere between 900 ohms and 1100 ohms.

The tolerance extremities for the E6, E12 and E24 series are indicated in Table 3 and the way in which the tolerance extremes overlap are illustrated, for the E6 and E12 series, in Fig. 4.

A batch of components of the same nominal value may not have actual values spread throughout the tolerance range, centred on the nominal value.

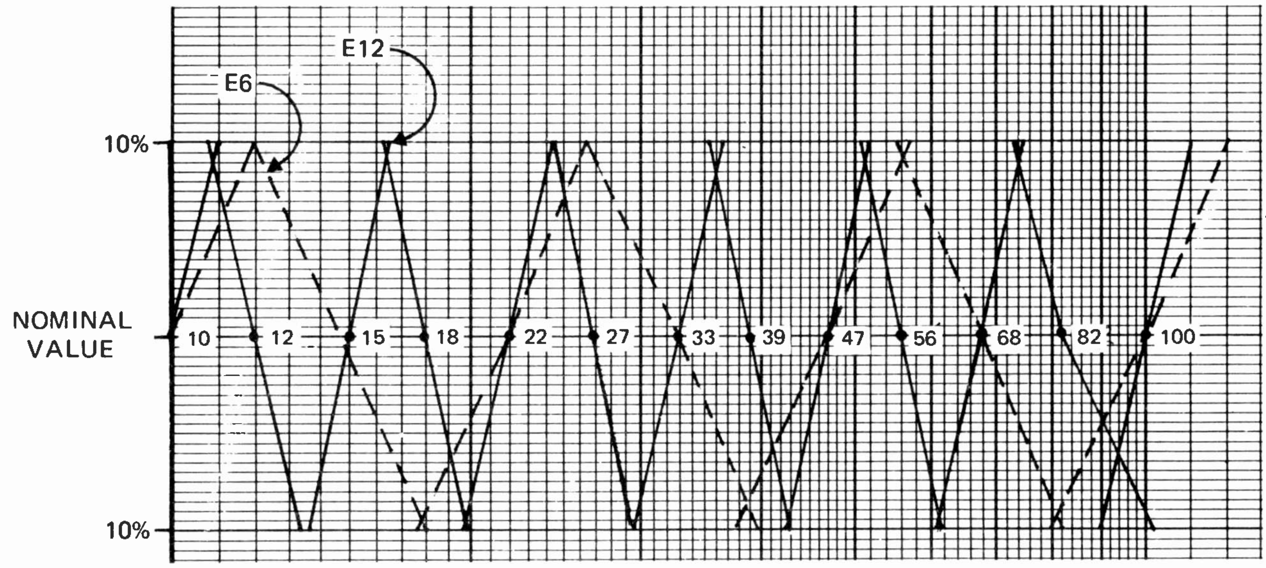


Figure 4: Tolerance extremes of the E6 and E12 preferred series of values.

TABLE 2

Preferred numbers in a decade for the E6, E12, E24 & E96 series

E6 20%	E12 10%	E24 5%	E96 1% and 2%
10	10	10	10.0 10.2 10.5 10.7
		11	11.0 11.3 11.5 11.8
	12	12	12.1 12.4 12.7
		13	13.0 13.3 13.7 14.0 14.3 14.7
15	15	15	15.0 15.4 15.8
		16	16.2 16.5 16.9 17.4 17.8
	18	18	18.2 18.7 19.1 19.6
		20	20.0 20.5 21.0 21.5
22	22	22	22.1 22.6 23.2 23.7
		24	24.3 24.9 25.5 26.1 26.7
	27	27	27.4 28.0 28.7 29.4
		30	30.1 30.9 31.6 32.4
33	33	33	33.2 34.0 34.8 35.7
		36	36.5 37.4 38.3
	39	39	39.2 40.2 41.2 42.2
		43	43.2 44.2 45.3 46.4
47	47	47	47.5 48.7 49.9
		51	51.1 52.3 53.6 54.9
	56	56	56.2 57.6 59.0 60.4
		62	61.9 63.4 64.9 66.5
68	68	68	68.1 69.8 71.5 73.2
		75	75.0 76.8 78.7 80.6
	82	82	82.5 84.5 86.6 88.7
		91	90.9 93.1 95.3 97.6

TABLE 3

Tolerance extremities for the E6, E12 and E24 preferred value series

−20%	−10%	−5%	nominal value	+5%	+10%	+20%
8	9	9.5	10	10.5	11	12
		10.5	11	11.6		
	10.8	11.4	12	12.6	13.2	
		12.4	13	13.7		
12	13.5	14.3	15	15.8	16.5	18
		15.2	16	16.8		
	16.2	17.1	18	18.9	19.8	
		19.0	20	21.0		
17.	19.8	20.9	22	23.1	24.2	26.4
		22.8	24	25.2		
	24.3	25.7	27	28.4	29.7	
		28.5	30	31.5		
26.4	29.7	31.4	33	34.7	36.3	39.6
		34.2	36	37.8		
	35.1	37.1	39	41.0	42.9	
		40.9	43	45.2		
37.6	42.3	44.7	47	49.4	51.7	56.4
		48.5	51	53.6		
	50.4	53.2	56	58.8	61.6	
		58.9	62	65.1		
54.4	61.2	64.6	68	71.4	74.8	81.6
		71.3	75	78.8		
	73.8	77.9	82	86.1	90.2	
		86.5	91	95.6		
E6	E12	E24		E24	E12	E6
← lower extremities				upper extremities →		

COMPONENT CODES

For example, a batch of ± 20% tolerance components may have actual values between +10% and +17% of the nominal value. More usually, actual values may be spread between say, −18% and +11% with a few outside this range. Those components falling within the tolerance extremities of the closer tolerance series are usually selected from the batch prior to marking. Thus, a batch of ± 20% tolerance (E6 series) components of a particular nominal value, may not contain any values within ± 5% of the nominal value. However, there may be many in the batch within ± 5% (or closer) of a value 10% higher than the nominal value. As an example, a batch of 1000 ohm resistors may have most of the actual values spread between 1045 ohms and 1155 ohms, with the rest scattered across the tolerance range.

Apart from resistors, capacitors and RF chokes, zener diodes are manufactured according to the preferred values system also, having nominal zener voltages according to the E24 series and voltage tolerances of ± 2% and ±5%.

The temperature coefficient characteristic of capacitors may also be specified with values in the preferred series, usually from the E24 series, although for convenience, and by convention, only selected numbers through several decades are used. This is discussed in the section on capacitors.

SELECTING AND SUBSTITUTING

In many applications in electronic circuits, the component values, unless otherwise specified, may be varied substantially without markedly affecting the performance of a circuit. This applies particularly to decoupling and bypass components where components having tolerances of −20%, +80% are commonly used. Apart from this, tolerance limits of component values in a particular circuit or portion of a circuit, of ± 20% are common, otherwise the E6 series of values would not be used. This wide latitude in tolerance limits rarely has much effect on the performance of a circuit. If close tolerance components are necessary then they will be specified on the circuit or in any description of the circuit.

(It should be noted however that 5% tolerance resistors are now almost universally available and cost little more – if anything at all – than 10% or 20% resistors. For this reason, 5% resistors are generally specified for Electronics Today's projects). ●

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ELECTRONICS —it's easy! PART 32

Concluding Digital-to-Analogue and introducing Analogue-to-Digital conversion.

INTEGRATED CIRCUIT CURRENT SOURCES — As the DAC principle finds a variety of uses, manufacturers offer an integrated current, the magnitude of which is controlled by a four bit, binary-code input. The IC, as shown in Fig. 1, has enough precision to be used in 12-bit D/A and A/D conversion. Figure 2 illustrates how two of these ICs are combined to produce an 8-bit DAC.

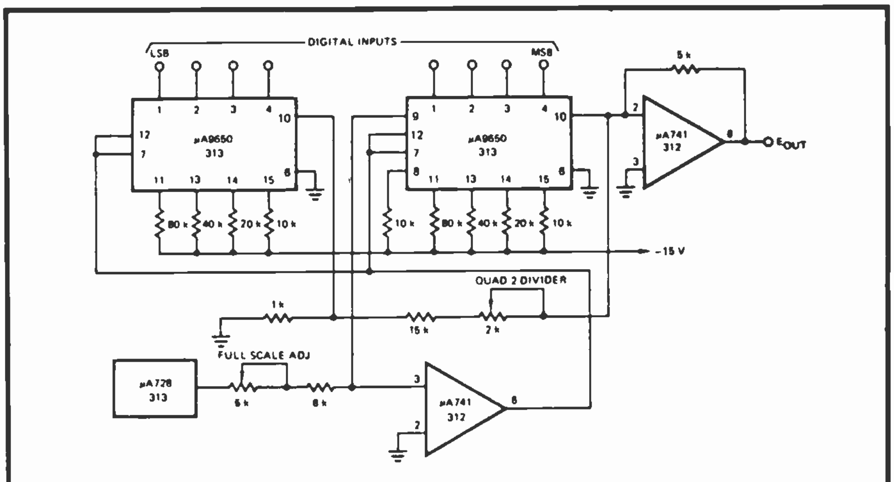

Fig. 2. Applying 4-bit current source IC's to form an 8-bit DAC.

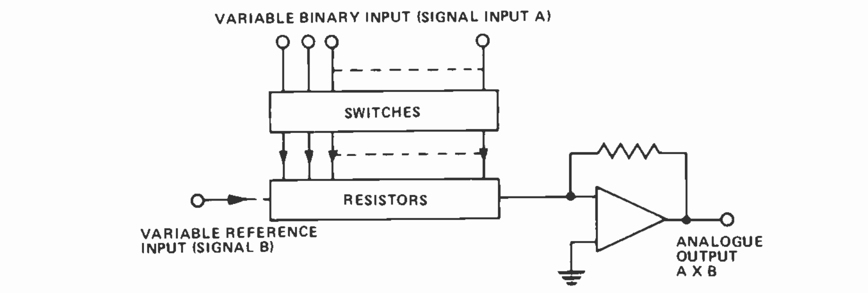

Fig. 3. Using a DAC to multiply an analogue signal by a digital signal.

Digitally controlled sources — The DAC's described above are usually concerned with signal processing as opposed to analogue power control. If larger output powers are needed digitally-controlled power supplies can be used — also referred to as digitally programmed supplies. They are available with digital control of current or voltage outputs. Instruments in the Hewlett-Packard range, for example, can provide up to 125 watt maximum demand whilst the output is controlled by binary or BCD inputs with a programming time of around 350μs.

ARITHMETIC OPERATIONS WITH DAC's

Multiplication — The resistor network of a DAC has two inputs — the reference supply (which is fixed in normal D/A conversion) and the switch inputs representing digital numbers. If the reference is allowed to vary as an input variable, see Fig. 3, the output of the DAC is the multiplicand of the two signal inputs. The reference may also be an ac signal and division and attenuation are also possible. The advantages of this method are the high precision and speed available.

Addition — If the difference or sum of two digital signals is needed as an analogue output, two DAC's may be combined, as sum or difference, into the output op-amp, as shown in Fig. 4.

ANALOGUE TO DIGITAL CONVERSION

Conversion from analogue to digital code can be obtained by many alternative techniques, each alternative having many variations. Basically, methods group into open-loop and feedback-loop systems. In each group some four to eight ways are in common usage. Here we look at a few of the most popular techniques, beginning with open-loop methods.

Analogue-to-frequency — The analogue voltage is converted, on a continuous basis, into a signal of proportional frequency by the use of an appropriately accurate V-to-F converter. (Voltage controlled oscillators are used — they must be adequately linear). This signal, see Fig. 5, is gated into a digital counter using fixed times of gate aperture. The counter accumulates a digital number equal to the average analogue level over the gate period. The counter output is released upon demand when gate periods expire. This method suffices for low accuracy analogue

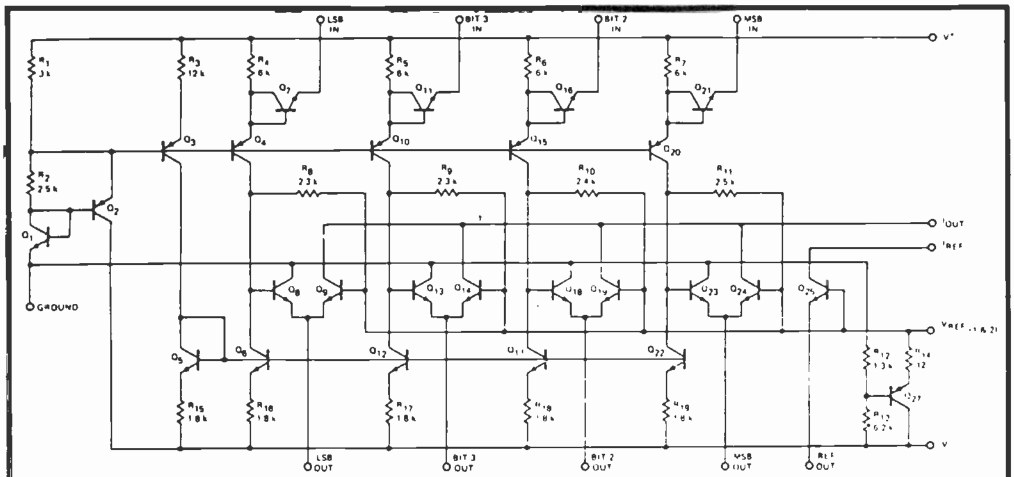

Fig. 1. Schematic of dual- in-line 4-bit current source (Fairchild μA9650).

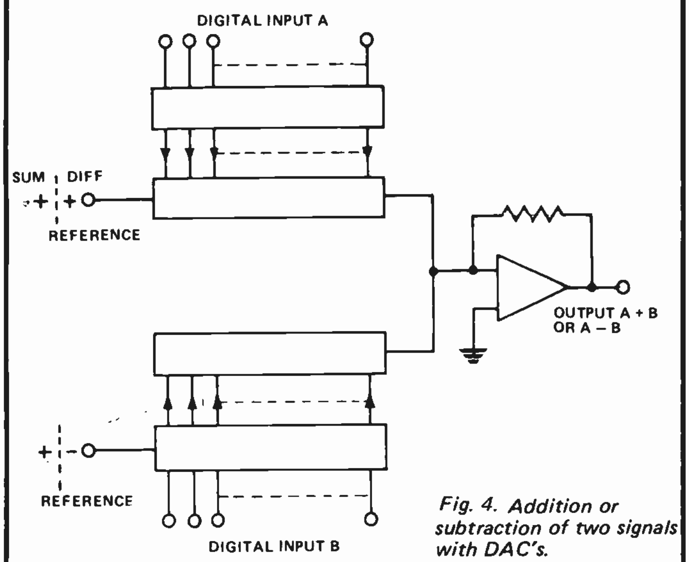

Fig. 4. Addition or subtraction of two signals with DAC's.

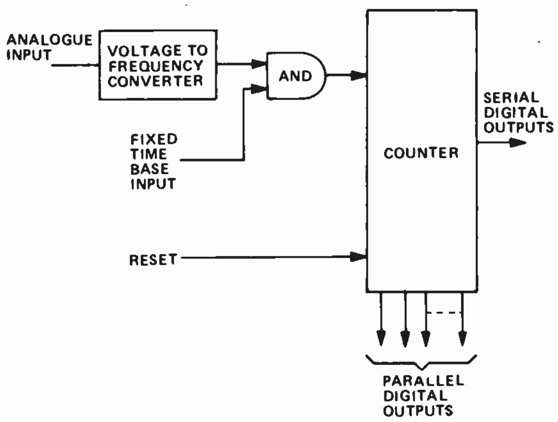

Fig. 5. Voltage-to-frequency method of A/D conversion.

inputs but becomes expensive when precision, wide dynamic range is required.

A variation of this is to reverse the philosophy and vary the pulse width of accurately generated pulses of constant frequency. The variable pulse width is then converted to a digital count proportional to the pulse width.

Simultaneous, parallel or flash conversion – The input analogue signal is presented to a stack of comparators (Schmidtt trigger action) each set to trigger at increasing binary-weighted signal levels. The set of comparator outputs are then decoded to provide the required binary output form. Decoding is needed because at any instant all comparators set to below the signal level are in the one state, all above in the other. The method is given in Fig. 6. Although extremely fast – quantization time is the speed of a single comparator – the method has the serious disadvantage that large bit ranges require many comparators and numerous decoding gates.

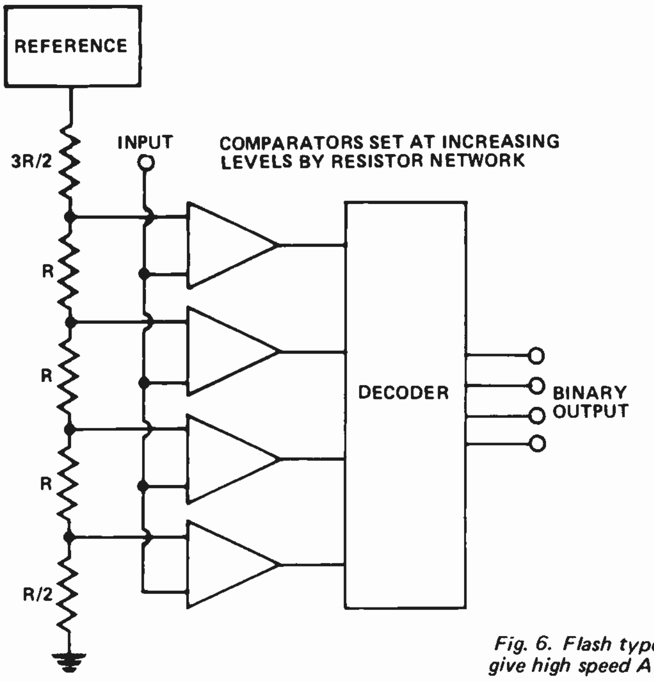

Fig. 6. Flash type converters give high speed A/D conversion.

Closed-loop methods – are more popular and there are about six main alternatives The methods known as integrating, successive approximation and servo-DAC are most generally applied.

Dual-ramp integration – The analogue voltage is first converted to a time period which in turn is converted into a binary number by a timer/counting system. Referring to Fig. 7a, conversion begins when the switch connects the analogue-signal input to the integrator which commences to ramp up. At the same time the counter begins, from zero, to count the clock pulses. When a predetermined number of pulses (1000 is convenient) appear in the counter the integrator is electronically switched over to the reference. At this point the capacitor has then charged linearly from the input, rising as a ramp to a voltage level decided by the average input-signal value as shown in Fig. 7b.

As the switch changes to the reference position the counter is reset to zero and begins counting again. The reference, chosen to be of opposite polarity to the input signal, now causes the charged capacitor of the integrator to ramp back downward at a constant slope. When the integrator output reaches the zero threshold the counter is stopped and its contents displayed. The count displayed is the ratio of downward ramp counts to upward ramp counts which, when a 1000 upward limit is used, gives a direct reading of input voltage if the reference voltage is appropriately chosen.

A simpler form, using only one ramp, is also used but it lacks the features of the dual-ramp method in which the absolute value of the capacitor and the clock frequency are of no significance provided they are stable for the duration of the conversion period. The dual ramp method does, however, require a relatively long conversion period but this is an advantage in one respect – the value measured is more accurate. This is due to the fact that when noise is integrated over an extended time period it tends to zero.

A more sophisticated triple-ramp method provides increased speed and accuracy for a moderate increase in cost and complexity. In essence two reference signals are provided, one

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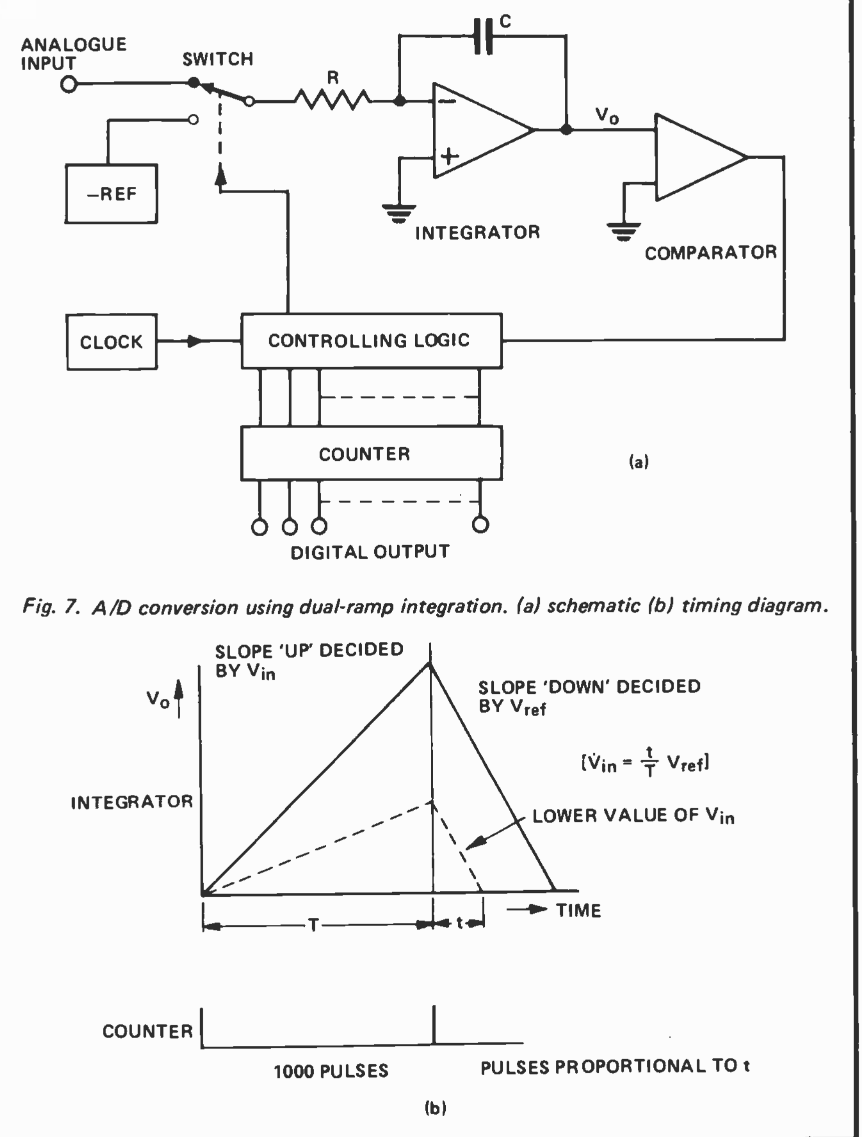

Fig. 7. A/D conversion using dual-ramp integration. (a) schematic (b) timing diagram.

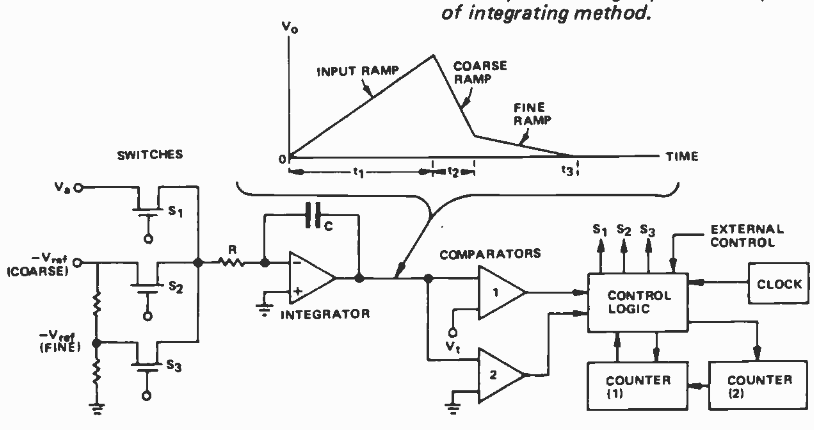

Fig. 8. Triple-ramp A/D converters offer faster speed for slightly more complexity of integrating method.

acting as a 'coarse', the other as a 'fine' ramping control. The 'coarse' ramp rapidly converts the bulk of the input signal level leaving the 'fine' ramp to add the extra resolution. Figure 8 shows the schematic and timing diagram of a triple-ramp A/D converter.

Successive approximation – Due to its high resolution and fast conversion speed successive approximation is the most widely used method. A schematic diagram is given in Fig. 9. Conversion progresses step-wise with the precisely generated DAC output being compared against the unknown analogue input. The first comparison is made with the most significant digit of the DAC, which gives 1/2 full scale, being compared against the unknown. If it is smaller, the bit is retained as a '0', if larger it is set to '1', thus the MSD value of the programmer is found. The next digit, working towards the least significant end one digit at a time, is then tested for the same criteria being set accordingly. The process is repeated until all programmer digits are set to '0' or '1'. The value in the programmer is then transferred to the register for outputing in parallel or serial form. Conversion time is not decided by the value of input as in ramp methods, duration of conversion being the number of bits times a fixed digit test interval, which can be as fast as 100ns. By comparison, from one maker's options, successive approximation instruments offer conversion times which range from 1-60μs compared with 2.5-6.0ms for integrating converters. Accuracy clearly depends upon that of the DAC which forms part of the comparison system.

Serve DAC method – Fig. 10 shows this system. When conversion begins, a counter is gated and commences to count upward. Its digital output is converted back to analogue form by a DAC. The output of the DAC is compared against the unknown input voltage. When the two analogue voltages are equal, the comparator inhibits the counter. At that time the value in the counter is a digital representation of the input – with 1:1 correspondence; or other ratios depending upon the summing resistances used. It is a simple low-cost method providing reasonable accuracy but operates at a slower speed than offered by successive approximation designs.

Non-linear conversion – Each bit of the above methods represents an equal quantum error. Thus one quantum error in full-scale is considerably less inaccuracy than in say a tenth or hundredth of full-scale. The smaller the reading, the greater the relative error of quantisation. When range-changing is not practicable a non-linear digital method can be used to compress the large scale in order to reduce the percentage of reading error The method is explained in Motorola Application Note AN-471.

SAMPLE-AND-HOLD UNITS

A digital signal provided by an A/D converter represents some measure of the analogue level seen in a certain gating period – the so-called aperture time. Aperture time, bit resolution and maximum signal frequency are strictly interrelated. Figure 11 is a chart enabling this characteristic to be found. For example, we may need to digitize a 10 kHz sinusoid (as the highest frequency to be preserved in a complex waveform) to a resolution of 12 bits. The chart shows we must have an aperture time of no greater than 42 ns. Thus we see extremely fast converters are needed for direct conversion of moderately high-frequency signals at high resolution.

A sample-and-hold circuit circumvents this difficulty by taking a rapid narrow-aperture sample of a signal and holding it in a simple analogue store long enough for the converter to act with a much wider aperture time. Figure 14 shows such a system. To preserve the highest signal frequency of a complex signal we only need to sample at twice (or higher) the signal frequency (Shannon's sampling theorem). This is a considerably slower rate than needed for direct A/D conversion. If sampled too slowly, not only will higher frequency information be lost but an effect, called aliasing, will occur by which a lower frequency is generated that may not exist in the original signal.

As mentioned above sample-and-hold circuits are also used in DAC's to remove glitches.

Basically a sample-and-hold comprises a capacitor with which to store an analogue voltage level, and a switch to charge the capacitor to that value in a way that can be rapidly and effectively isolated from the source. In practice low leakage FET switches are used in conjunction with IC op-amp integrators. It is also important to buffer the output of the sample-and-hold to reduce the loading which would otherwise decay the stored level.

Many circuit variations exist, the one shown in Fig. 12 — a closed loop configuration — gives good linearity and accuracy. When extremely long storage times, or negligible decay with time is needed, the voltage on the capacitor can be transferred via an A/D converter into a digital storage register and back again into analogue form via a DAC as shown schematically in Fig. 13. This naturally increases the cost considerably. More detailed information is available in "Analog-digital conversion handbook" TH6, by Analog Devices.

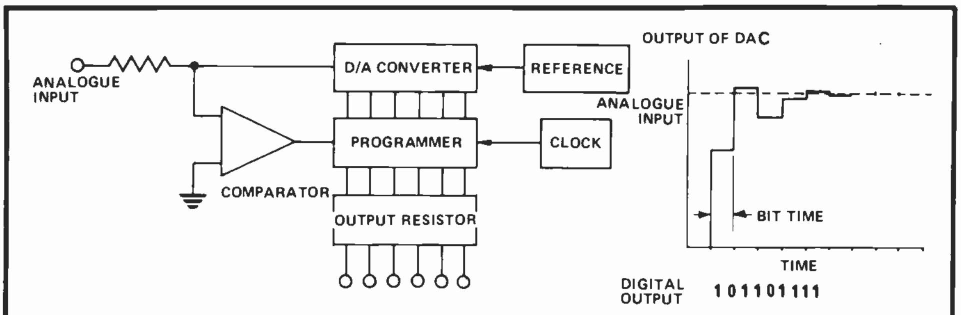

Fig. 9. In the successive approximation A/D converters a DAC is used to convert the incremented digital stage output back to analogue form for comparision with the input.

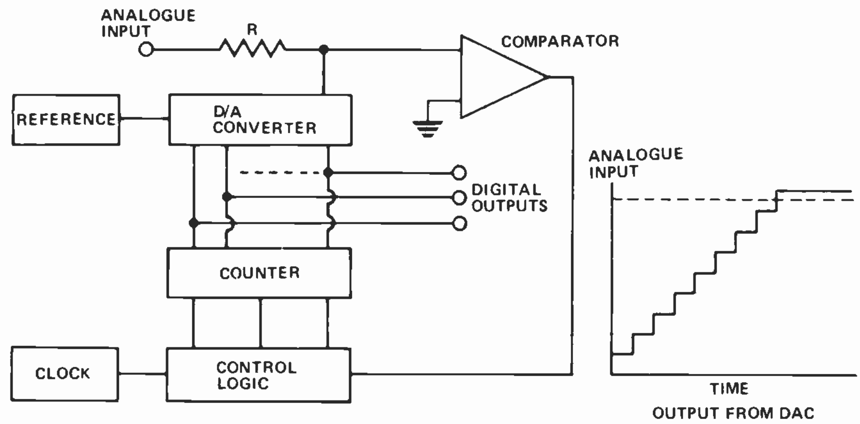

Fig. 10. Schematic of servo A/D converter system.

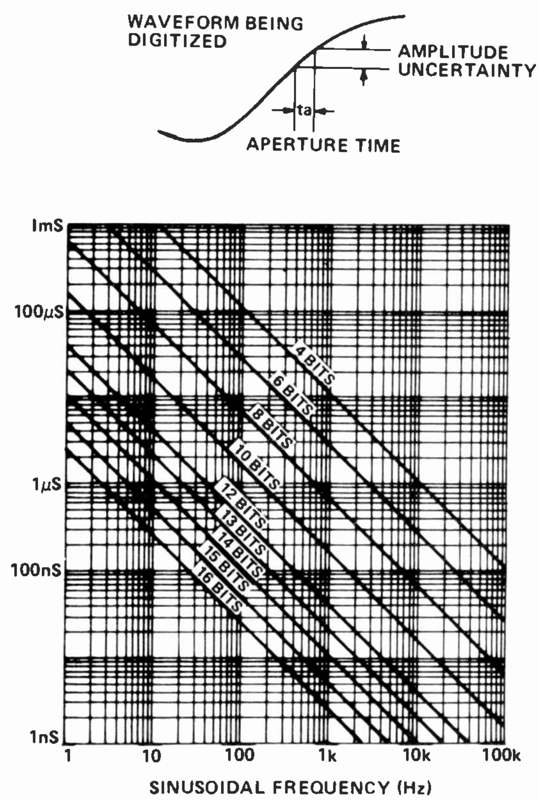

Fig. 11. Graph showing relationship between aperture time required, resolution of signal conversion and frequency of sinusoidal signal undergoing conversion.

MULTIPLEXERS

The task of the multiplexer, shown in Fig. 14, is to sequentially connect a multiplicity of compatible inputs to a single output line. In the case given in Fig. 14 it feeds a sample-and-hold, which stores the signal for A/D conversion.

A multiplexer consists, therefore, of as many switches as there are input channels to be combined. In practice these must possess adequate speed and very low on-to-off switch resistance ratio. Solid-state multiplexers mostly use MOSFET switching devices feeding a buffer stage (a voltage follower configuration which has extremely high, 10^9 ohms, input impedance).

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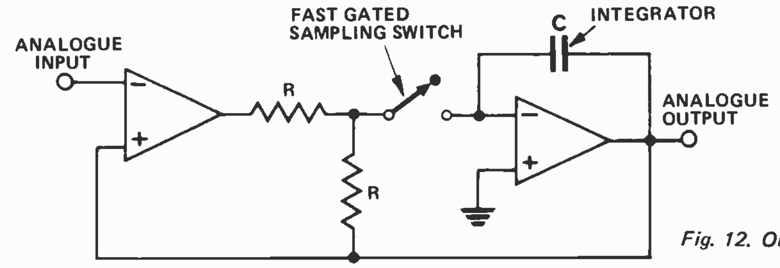

Fig. 12. One form of stable and accurate sample-and-hold circuit.

FURTHER READING

A comprehensive discussion of the topics, and a long bibliography, of this part is to be found in "Analog-digital conversion handbook", D.H. Sheingold, Analog Devices, U.S.A. 1972. Less extensive but nevertheless very useful articles are – "Engineering product handbook", Datel Systems, CAT-T99405, 1974, U.S.A. "Analog-to-digital conversion techniques", E. Renschler, Motorola Semiconductor Products Inc., AN-471, 1969, U.S.A. "Product Guide", Analog Devices, 1975, U.S.A. ●

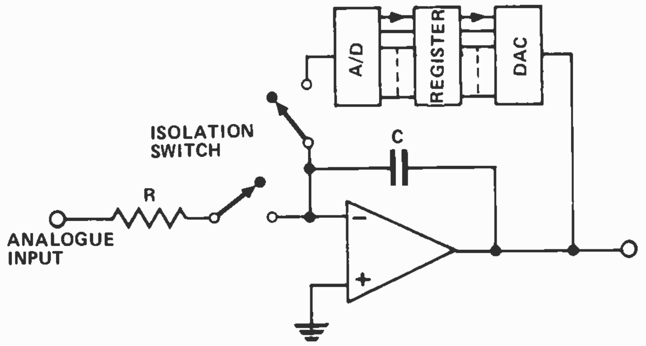

Fig. 13. Infinite hold is obtained by transferring the integrated value into a digital store using A/D and D/A conversion.

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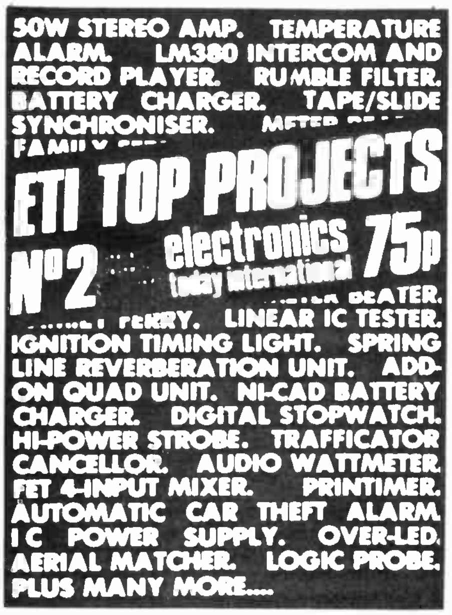

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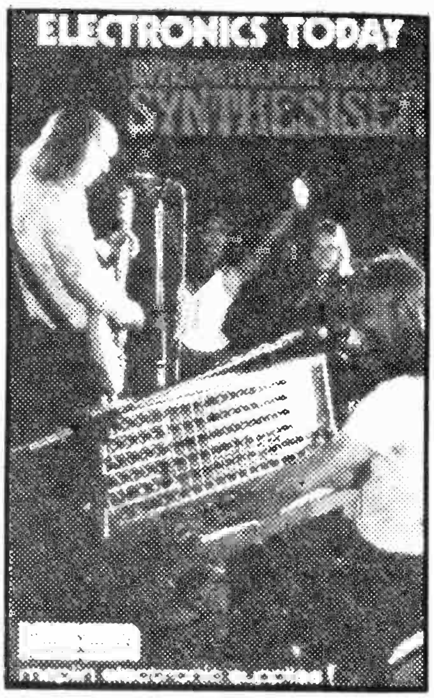

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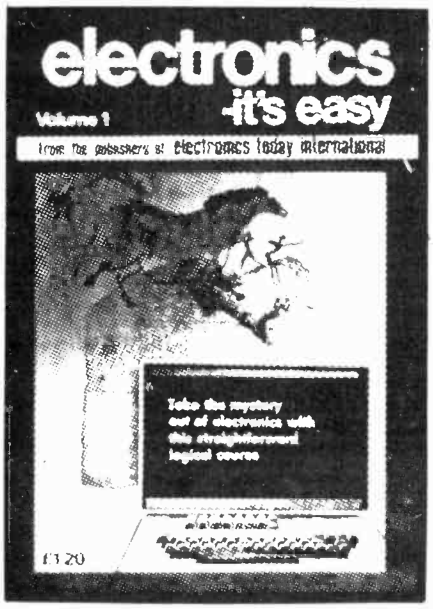

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ELECTRONICS TOMORROW

by John Miller-Kirkpatrick

IN ANY COMPUTER SYSTEM whatever the size there is always a need to store information which can be retrieved at a later date by the same or another computer. The data can be stored inside or outside of the man CPU area, inside it would be stored in RAM but outside we have the alternatives of a large RAM store, magnetic tape, paper tape or cards, or a magnetic disk. The main problem with tape is that the data is in serial form and can only be retrieved in the same sequence as it was written; on the other hand a magnetic disk can be written or read in a none-sequential form thus allowing direct access to any part of data on the disk file.

The disk always used to be a collection of disks (about 10) each about 15-20 inches in diameter and all based on a central pillar looking very much like a pile of LPs except that each was separated from the next by about half an inch. Each disk in the pile was divided into 200 'grooves' except that the 'grooves' were in fact magnetic tracks, one R/W head per disk side travelled across the disk and stopped at the selected track. The R/W head for the selected disk would then read the track until is recognised a marker called the 'Home Address' which was the start of the data on that track. The R/W head could then select a logical record or even one bit and read or write that particular location.

The logic involved in locating a particular record would involve a table which would be in main RAM storage, this table was usually kept on the disk at a fixed location. The table would contain for instance a record number and its address on the disk in the form of disk and side number of the 20 available, track number from the 200 available and possibly its position on that track. Thus to record AC12345 we would first look up that code in the table this would tell us that this record was the third record on track 175 on side 5, the computer would then cause the disk drive to move all of the R/W heads to be opposite track 175 on each disk, all 20 R/W heads would then start to read the 20 track 175s but only the data from head 5 would be sent back to the OPU. After the 'Home Address' marker had been recognised the logic then ignored two records and read the third record into main storage thus completing the read cycle. This record could then be modified and replaced by a similar sequence of events.

When the 'Its Better Manually' people introduced their 370 range of computers the CPUs had a unit called a Diskette reader. The disk is a floppy plastic disk about the size of a 45 covered in magnetic film. When the disk is revolving at high speed two R/W heads (one each side) move across the disk to selected tracks and read or write into records on the tracks, because of its pliability this type of disk is now referred to as a Floppy. Floppy drives are now available from many manufacturers and are used widely in minicomputer systems as well as some microprocessor systems. Prices seem to start at about £750 in the States for a basic unit, a completely cased unit with all the knobs and whistles added can cost over £2,000.

SAVE YOUR OLD LPs.

What is needed is a low cost system which can be used by those who cannot afford £2,000 for their MPUs or other logic. How feasible would it be to have a conversion to an ordinary record player to allow you to play an LP covered in magnetic film with a cheap record/play head travelling back and forth across the LP selecting one of say 50 tracks? If one side of the LP was covered and 50 tracks about ¼in. apart were layed out from the rim towards the centre then the smallest track would have a circumference of about 10 inches. At 331/3 rpm this centre track would be travelling at about 5in per second which is a good recording speed for music or data. The cassette recording system CUTS could be used for the disk thus allowing 300 bits per second or 600 bits per track to be recorded. This would allow for 15000 bits per disk with a maximum access time of about 5 secs. A RAM of the same capacity would cost about £60 and would have an access time of 1uS, there is therefore a requirement to hold a lot more than 15000 bits per LP to make the disk unit worth building. Recording at the same speed as a cassette machine would multiply the capacity and access time by three, recording more tracks per side would require very accurate mechanism for the travelling R/W heads. So what is the answer, any of you geniuses (or is it genii?), any brilliant ideas on the subject?

CMOS COUNTER

Natonal Semiconductors have announced a range of CMOS counter chips with the codes MM 74C 925, 6, 7, 8. These CMOS counters consist of a four digit counter, internal output latch, NPN output source, int. drivers for a seven segment display, and an internal multiplexing circuit with four multiplexed outputs. The MM 74C925 is a four decade counter with Latch Enable, Clock and Reset inputs, the 926 is similar but includes a display enable and a carry output which goes high when the count reaches 6000. The 927 is similar to the 926 except that digit 2 divides by six to give a maximum count of 9599, thus if the input frequency is 10Hz the display would read tenths of seconds, seconds and up to 10 minutes. The last one in the range, the 928, is programmed to behave as a 3½ digit counter where the maximum count is 1999. The counters advance on the negative edge of the clock pulses and the reset input has to be low to count and high to reset all of the counters and the carry output to zero. The latch input will cause the data in the counter to be stored in the display register on a high to low transition of this input, the display enable input will cause either the counter or the latch contents to be displayed.

"No, No dammit! That suit was for the Plasma Torch Barbecue . . . this string one's *for the microwave oven."*

tech-tips

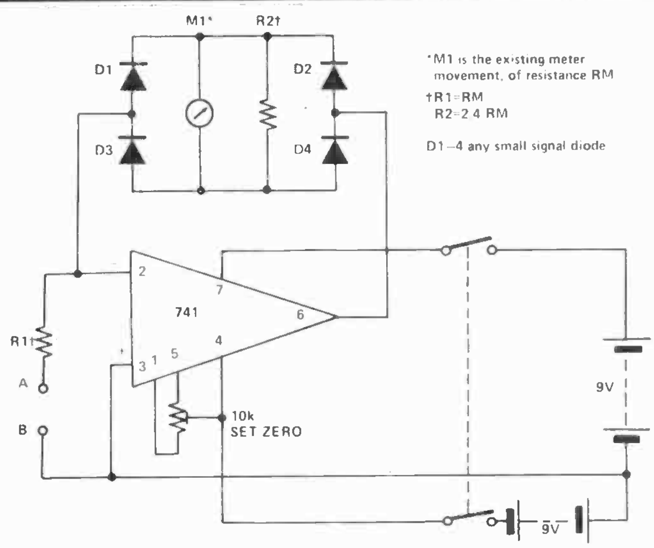
UNIVERSAL METER RECTIFIER

This circuit can be built for about £1 but could save pounds in multimeter repair costs.

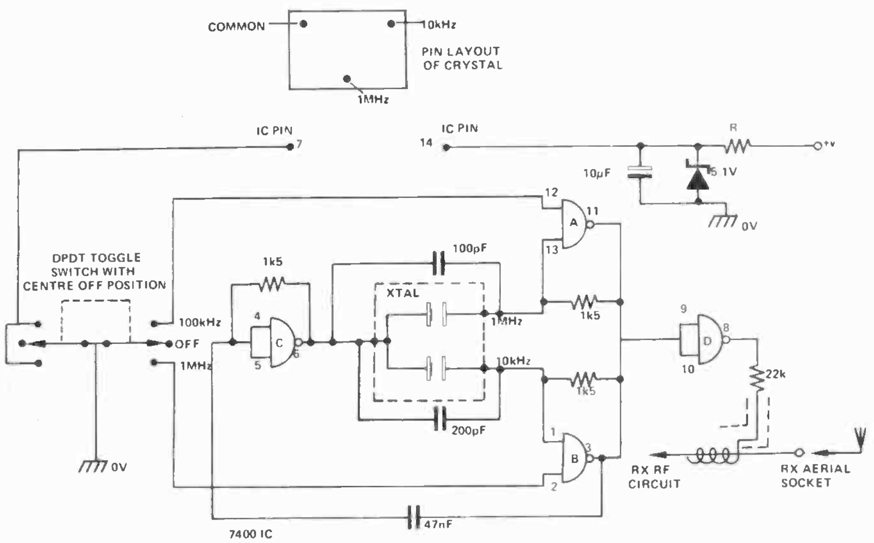
The meter movement is removed from the meter circuit, it's place being filled by the input (terminals A and B) of the circuit shown. Pin 2 of the 741 remains at the same potential as pin 3, so the input signal "sees" R1 as it's load. However, the current which flows through R1 does not flow into pin 2, but through D1–D4, the original meter movement M1 and RMS correction resistors R2, to pin 6. Hence the circuit is current controlled, and so unaffected by the non-linearity of the rectifier, D1–D4.

R2 should only be in the circuit if it is desired to measure RMS AC values, all measurements are made on the DC ranges of the instrument.

R1 and R2 should be close tolerance types for accuracy; the circuit is accurate up to 100kHz.



TTL CRYSTAL MARKER



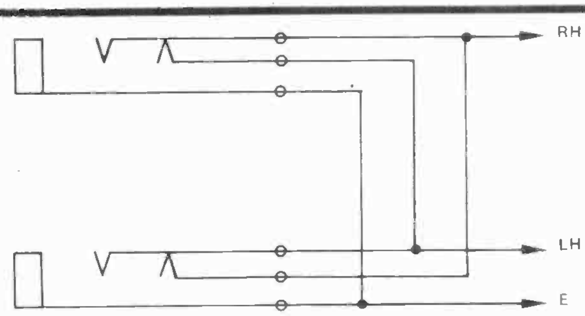
This circuit was designed to make use of an old 100kHz–1000kHz 10X, 3 pin twin crystal, which are available from Henry's Radio.

With the switch in the 100kHz position the 0V line is applied to pin 7 of the 7400 (connecting ie. to supply) and also to pin 12 which disables gate A. This allows gates B and C to operate as an oscillator at the crystal frequency of 100kHz.

With the switch in the 1Mz position the 'inhibit' line is fed to pin 2. This disables gate B and allows gates A and C to operate as a 1MHz oscillator.

As DC switching is employed the switch can be remote from the oscillator unit. Gate D is used as a buffer/shaper stage.

The output of the unit is loosely coupled to the aerial input lead providing adequate marker amplitude well above 30MHz.



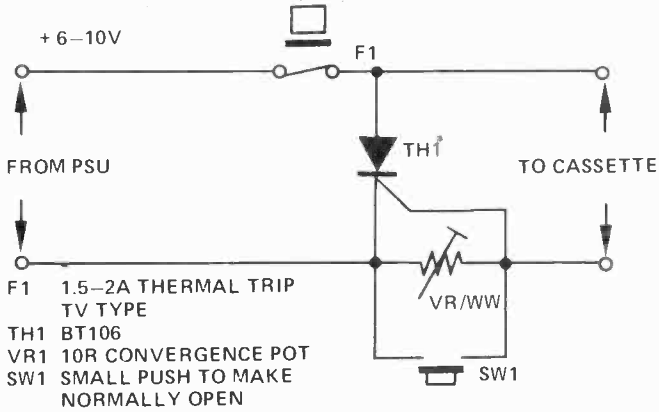
SIMPLY MONO

By simply cross connecting the NC contacts on the two standard jack sockets in a stereo system, automatic stereo/mono switching is achieved.

On the input to stereo tape recorders, this gives a mono recording on both tracks wheneber only one mic. is used. This gives an increased S/N figure and a more acceptable central mono sound image, as opposed to an image at extreme right or left.

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, 36 Ebury Street, London SW1W 0LW.

AUTOMATIC CASSETTE TURN OFF



This circuit was designed to turn off a cassette when it reached the end of the tape.

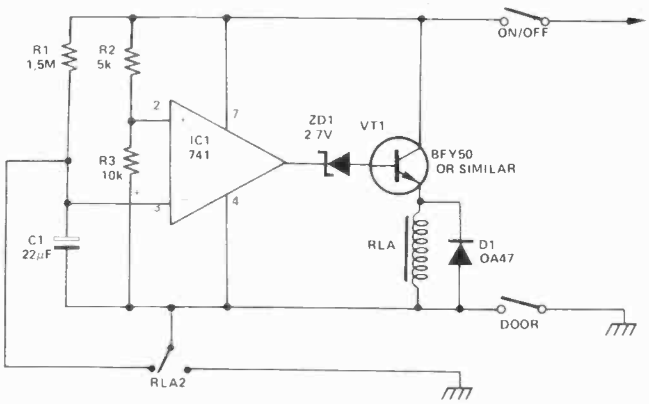
It works because a cassette takes a great deal more current in the 'stall', condition than while actually running.

The components used are by no means critical those listed were closest to hand when the device was first constructed.

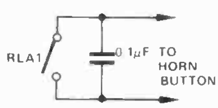
When using the device SW1 closes at the instant of switch on. This is due to the motor being stationary, and passing excessive current.

The power from the PSU passes through the trip and flows through the motor. This gives a PD across the resistor, and when this rises to the trigger point of the thyristor it will 'short' the HT line triggering the trip.

SIMPLE CAR ALARM



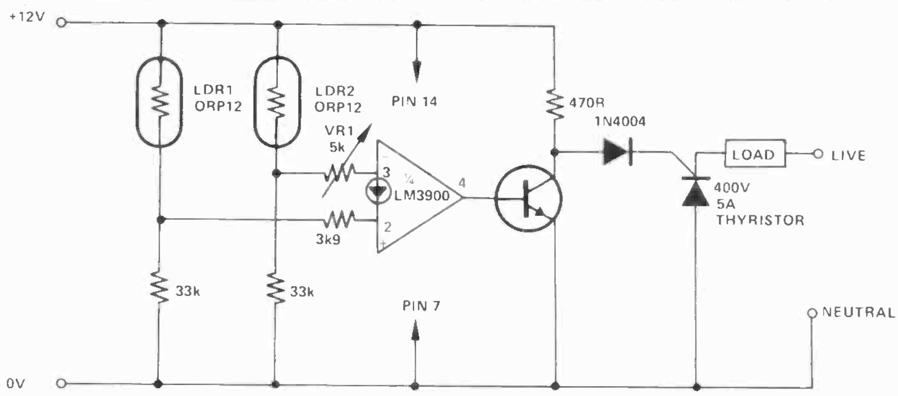
NOTE
RLA–12V ABOUT 200R
741 –VE SATURATION INSUFFICIENT TO TURN OFF VT1. IF ZD1 IS OMITTED SOME TYPES OF RELAY MAY NOT RELEASE.
ALL RELAY CONTACTS SHOWN RELEASED.



At the instant the door switch is operated the +Ve 741 input is at 2/3 the rail voltage. The –Ve 741 input is fully negative. The –Ve input is thus –Ve with respect to the positive input and an output near the rail voltage results turning on VT1 and operating RLA.

RLA1 sounds the horn and so must have heavy duty contacts. RLA2 shunts the door switch and also removes the short from C1. C1 now charges Via R1 until the voltage at IC1 –Ve is approaching that of the +Ve input. The output of IC1 now falls until –Ve saturation occurs and VT1 is turned off releasing RLA. This takes approximately C1 x R1 seconds. The components shown gave a 30 second delay in the prototype.

LDR MAINS CONTROL



This circuit is used to turn off and on a light of up to 100W. When LDR1 is shaded from any incident light it will cause the output of the amplifier to fall, thus switching of TR1 and causing the thyristor to be turned on. The light will remain on because of the introduction of LDR2, which feeds the inverting input of the amplifier.

To turn the light off, LDR2 must be shielded from the light of the bulb.

To set the circuit up it is necessary to adjust VR1 by trial and error until LDR1 turns the light on and LDR2 switches it back off, and the normal level of background illumination has no effect.

LDR1 and LDR2 should be placed in full view of the light they are switching.

tech-tips

20W SLAVE AMP

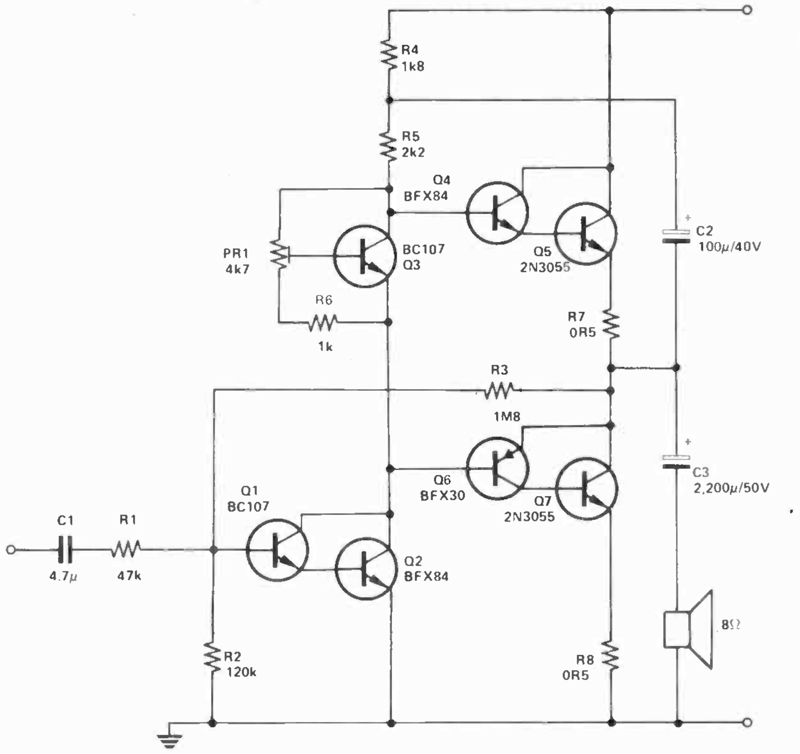
This amplifier is very simple to build and most of the parts will probably be available from the constructor's 'junk' box. The circuit consists of a Darlington pre-driver, Q1 and Q2, a V_{BE} multiplier Q3 and a quasi-complementary output stage Q4–7.

Overall shunt feedback is applied from the collector of Q7 to Q1's base via R3 which, in conjunction with R2, also provides DC feedback and input bias. The voltage gain, and hence the sensitivity of the amplifier, is set at 33 and 370mV by the ratio of R3 to R1.

Quiescent current through Q5 and Q7 should be set at 30mA by PR1.

The collector load of the Darlington, R4 and R5, is bootstrapped by C2 to provide a current drive for the output stage.

Although simple the amplifier is capable of good quality reproduction and will operate quite happily into a 4, 8 or 16R load.

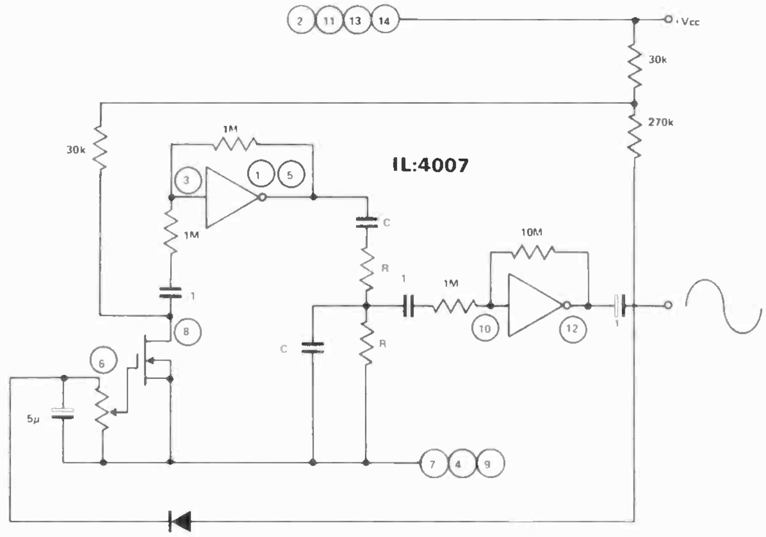


CHEAPO OSCILLATOR

The two inverters give a gain of 100; the MOSFET reducing this to a necessary level to just sustain oscillation.

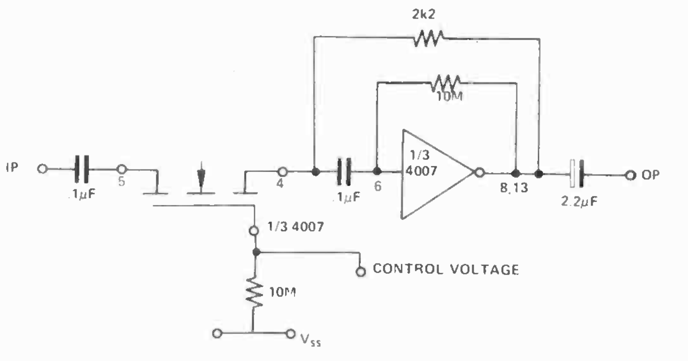
Supply voltage can be between 5V and 15V. (10V is recommended). Do not try to obtain more than 1mA from the circuit. At 5V supply a buffer is required.

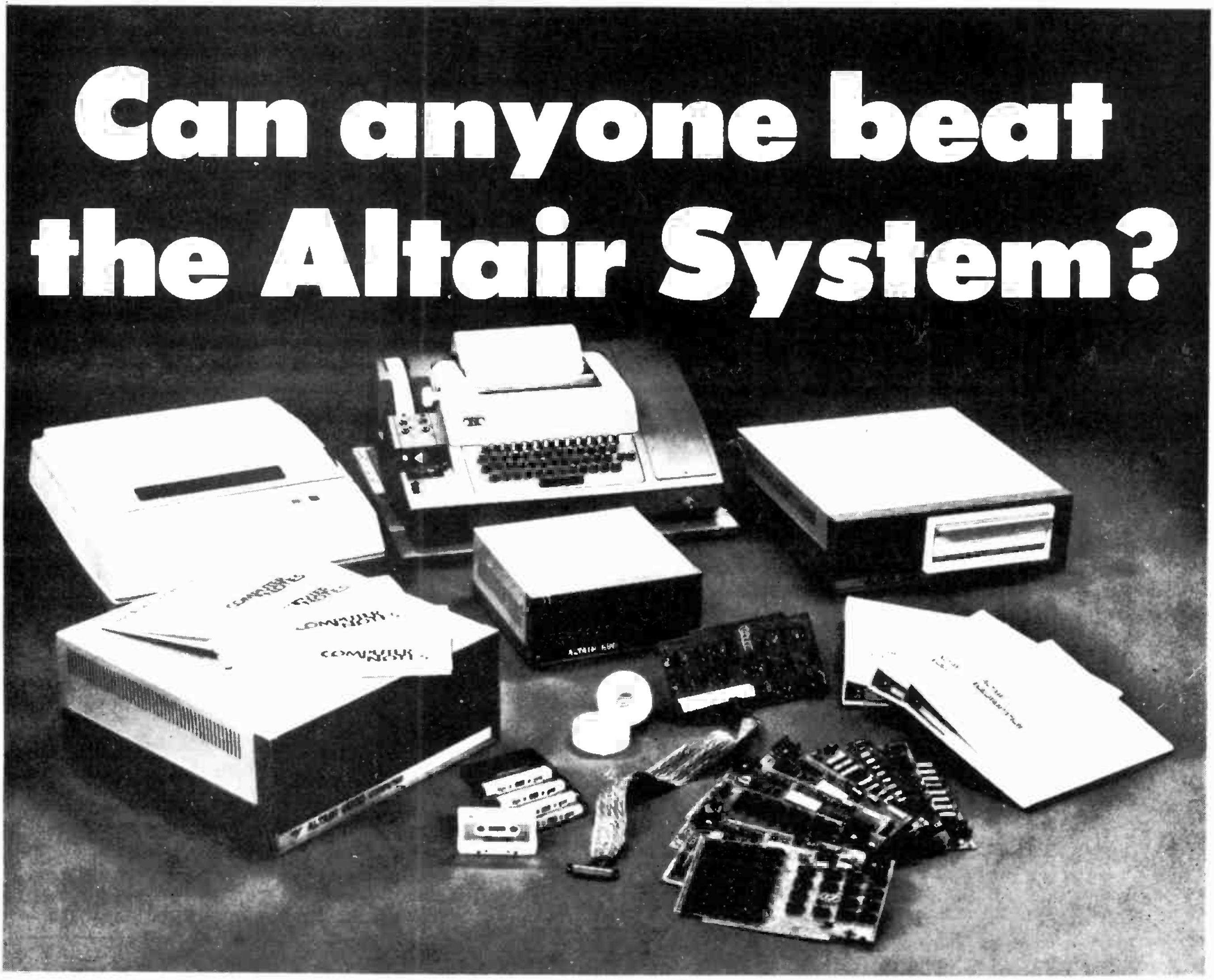
The supply should be ripple free, as any ripple will be passed to the output.



VOLTAGE CONTROLLED AMPLIFIER

When the voltage at the gate of a n-channel MOSFET is varied from 0V – supply volts its resistance varies from about 1kΩ to several tens of megohms. This fact is utilised in the following VCA. The inverter is biased into linear operation by the 10mΩ resistor. When feedback is applied the gain is set by $\frac{RF}{RIN}$. By allowing a MOSFET to be RIN and RF fixed, with the values shown as the control voltage varies from $V_{DD} - V_{SS}$ the gain of the amplifier varies from cut-off to just over unity.





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2N3054	45p
2N3055	41p
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ALLOW 10 TO 14 DAYS FOR DELIVERY