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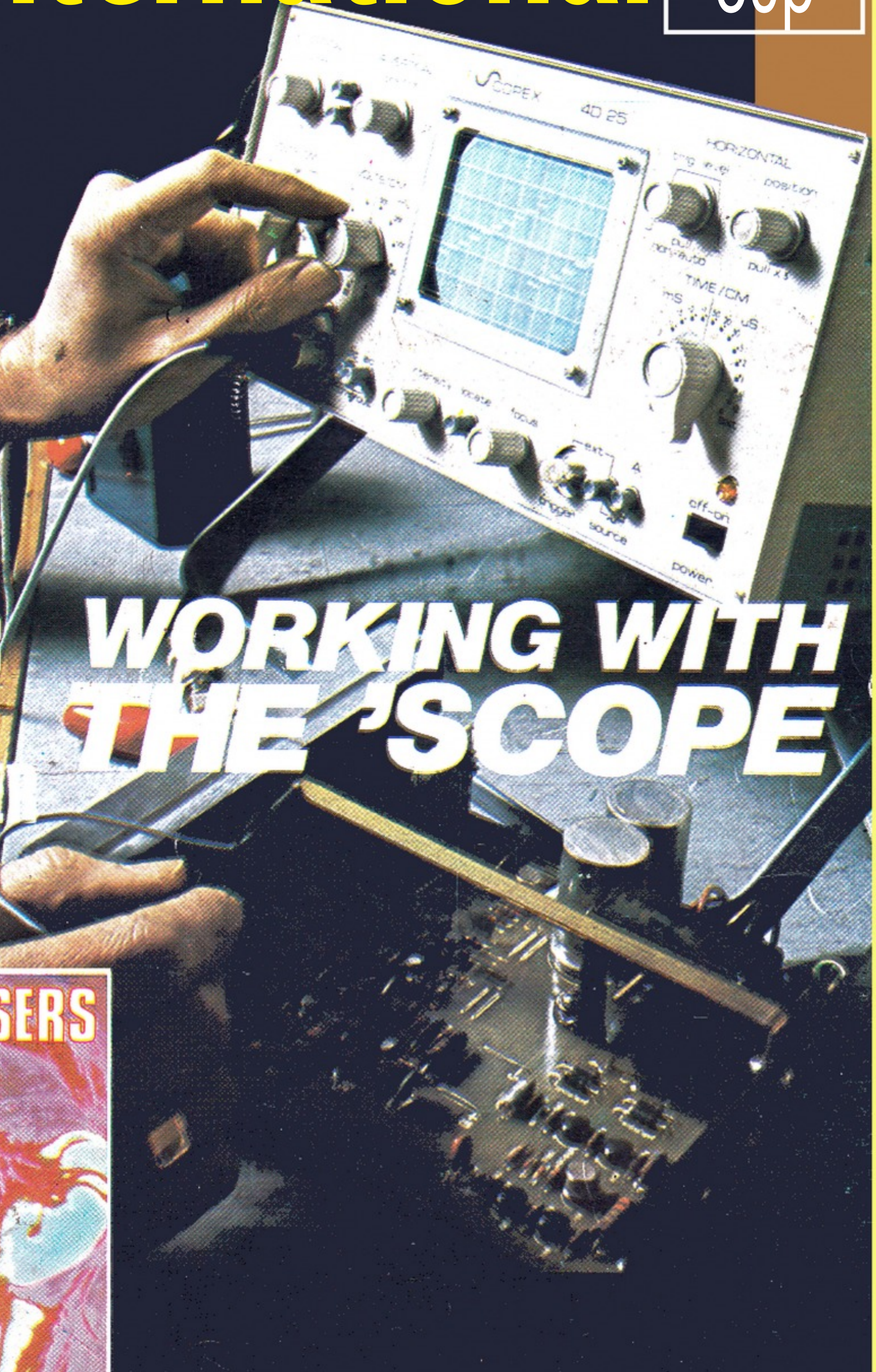

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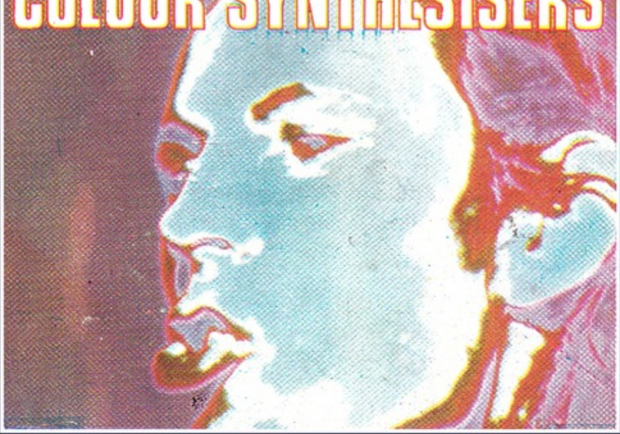

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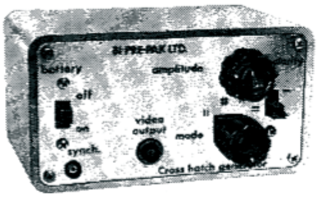

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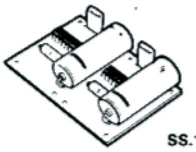
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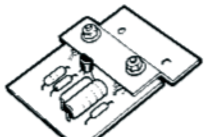
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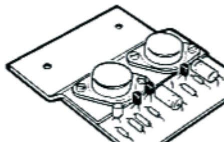
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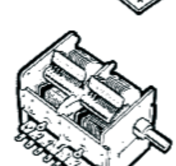
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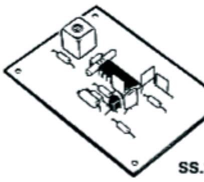
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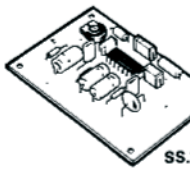
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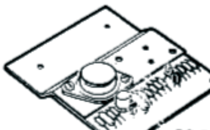
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2N2906	0·17	2N3706	0·13	2S305	0·88
2N2906A	0·20	2N3707	0·14	2S306	0·88
2N2907	0·22	2N3708	0·09	2S307	0·88
2N2907A	0·24	2N3709	0·10	2S321	0·63
2N2923	0·16	2N3710	0·10	2S322	0·48
2N2924	0·16	2N3711	0·10	2S322A	0·48
2N2925	0·16	2N3819	0·31	2S323	0·63
2N2926(G)	14	2N3820	0·55	2S324	0·77
2N2926(Y)	12	2N3821	0·39	2S325	0·77
2N2926(O)	11	2N3823	0·31	2S326	0·77
2N2926(R)	11	2N3903	0·31	2S327	0·77
2N2926(B)	11	2N3904	0·33	2S701	0·48
2N3010	0·77	2N3905	0·31	40361	0·44
2N3011	0·16	2N3906	0·30	40362	0·50

DIODES AND RECTIFIERS

AA119	0·09	BY128	0·17	OA10	0·15
AA120	0·09	BY130	0·18	OA47	0·08
AA129	0·09	BY133	0·23	OA70	0·08
AAY30	0·10	BY164	0·55	OA79	0·08
AAZ13	0·11	BYX38/300	0·46	OA81	0·08
BA100	0·11	BYZ10	0·39	OA85	0·10
BA116	0·22	BYZ11	0·33	OA90	0·07
BA126	0·24	BYZ12	0·33	OA91	0·07
BA148	0·16	BYZ13	0·28	OA95	0·08
BA154	0·13	BYZ16	0·44	OA200	0·07
BA155	0·16	BYZ17	0·39	OA202	0·08
BA156	0·15	BYZ18	0·39	SD10	0·06
BA173	0·16	BYZ19	0·31	SD19	0·06
BY100	0·17	CG62		1N34	0·08
BY101	0·13	(OA91 Eq)	0·06	1N34A	0·08
BY105	0·19	CG651—		1N914	0·06
BY114	0·13	(OA70-79)	0·07	1N916	0·06
BY124	0·13	OA5	0·39	1N4148	0·06
BY126	0·16	OA5 short		IS021	0·11
BY127	0·17	leads	0·23	IS951	0·07

BB104 VARICAP BACK TO BACK 0·16

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T3	8	D1216	OC81I
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T5	8	2G382T	OC82
T6	8	2G344B	OC44
T7	8	2G345B	OC45
T8	8	2G378	OC78
T9	8	2G399A	2N1302
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Q19	3	MADT'S 2 × MAT 101 & 1 × MAT 121	0.54
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Q23	10	OA 202 Silicon diodes sub-min.	0.54
Q24	8	OA 81 diodes	0.54
Q25	15	1N914 Silicon diodes 75 PIV 75mA	0.54
Q26	8	OA95 Germanium diodes sub-min. 1N69	0.54
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Q31	6	Silicon switch transistors 2N708 NPN	0.54
Q32	3	PNP Silicon transistors 2 × 2N1131, 1 × 2N 1132	0.54
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Q34	7	Silicon NPN transistors 2N2369, 500MHz (code P397)	0.54
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200	0·27	0·32	0·54	0·54	0·62	0·67	0·67	1·76
400	0·32	0·42	0·59	0·62	0·67	0·77	0·83	1·93
600	0·42	0·52	0·75	0·75	0·84	1·07	0·97	—
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100	0·05	0·07	1N4002	0·06	0·10	0·17	0·23	0·75
200	0·06	0·10	1N4003	0·07	0·12	0·22	0·25	£1·00
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800	0·12	0·19	1N4006	0·11	0·20	0·38	0·55	£2·10
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UIC03	12 - 7403	0.54	UIC51	12 - 7451	0.54	UIC93	5 - 7493	0.54
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UIC05	12 - 7405	0.54	UIC54	12 - 7454	0.54	UIC95	5 - 7495	0.54
UIC06	8 - 7406	0.54	UIC60	12 - 7460	0.54	UIC96	5 - 7496	0.54
UIC07	8 - 7407	0.54	UIC70	8 - 7470	0.54	UIC100	5 - 74100	0.54
UIC10	12 - 7410	0.54	UIC72	8 - 7472	0.54	UIC121	5 - 74121	0.54
UIC20	12 - 7420	0.54	UIC73	8 - 7473	0.54	UIC141	5 - 74141	0.54
UIC30	12 - 7430	0.54	UIC74	8 - 7474	0.54	UIC151	5 - 74151	0.54
UIC40	12 - 7440	0.54	UIC76	8 - 7476	0.54	UIC154	5 - 74154	0.54
UIC41	5 - 7441	0.54	UIC80	5 - 7480	0.54	UIC193	5 - 74193	0.54
UIC42	5 - 7442	0.54	UIC81	5 - 7481	0.54	UIC199	5 - 74199	0.54
UIC43	5 - 7443	0.54	UIC82	5 - 7482	0.54			
UIC44	5 - 7444	0.54	UIC83	5 - 7483	0.54	UICX1	25 Assorted 74's	£1.65
UIC45	5 - 7445	0.54	UIC86	5 - 7486	0.54			

Paks cannot be split, but 25 assorted pieces (our mix) is available as **PAK UIC X1.**

STEREO PRE-AMPLIFIER TYPE PA100

Built to a specification and NOT a price, and yet still the greatest value on the market, the PA100 stereo pre-amplifier has been conceived from the latest circuit techniques. Designed for use with the AL60 power amplifier system, this quality made unit incorporates no less than eight silicon planar transistors, two of these are specially selected low noise NPN devices for use in the input stages.

Three switched stereo inputs, and rumble and scratch filters are features of the PA100, which also has a STEREO/MONO switch, volume, balance and continuously variable bass and treble controls.

SPECIFICATION:

Frequency response	20Hz—20kHz ±1dB	Bass control	±15dB at 20Hz
Harmonic distortion	better than 0·1%	Treble control	±15dB at 20kHz
Inputs: 1. Tape head	1·25mV into 50KΩ	Filters: Rumble (high pass)	100 Hz
2. Radio, Tuner	35mV into 50KΩ	Scratch (low pass)	8kHz
3. Magnetic P.U.	1·5mV into 50KΩ	Signal/noise ratio	better than +65dB
		Input overload	+26dB
		Supply	+35 volts at 20mA
		Dimensions	292 x 82 x 35 mm

All input voltages are for an output of 250mV. Tape and P.U. inputs equalised to RIAA curve within ±1dB from 20Hz to 20kHz.

only £14.25

LINEAR I.C's—FULL SPEC.

Type No.	1	25	100+
72702	0.50	0.48	0.45
72709	0.25	0.23	0.20
72709P	0.20	0.19	0.18
72710	0.35	0.33	0.30
72741	0.30	0.29	0.28
72741C	0.28	0.27	0.26
72741P	0.30	0.29	0.28
72747	0.85	0.80	0.75
72748P	0.38	0.36	0.34
SL201C	0.50	0.45	0.40
SL701C	0.50	0.45	0.40
SL702C	0.50	0.45	0.40
TAA263	0.80	0.70	0.60
TAA293	£1.00	0.95	0.90
TAA350A	£1.85	£1.80	£1.70
μA703C	0.28	0.26	0.24
μA709C	0.20	0.19	0.18
μA711	0.35	0.33	0.30
μA712	0.35	0.33	0.30
TBA800	0.95	0.93	0.90
76003	£1.50	£1.45	£1.40
76023	£1.50	£1.45	£1.40
76660	0.95	0.93	0.90
LM380	£1.00	0.97	0.95
NE555	0.65	0.63	0.60
NE556	0.95	0.93	0.90
ZN414	£1.20		

DTL 930 SERIES LOGIC I.C's

Type	1	25	100+
BP930	0.15	0.14	0.13
BP932	0.16	0.15	0.14
BP933	0.16	0.15	0.14
BP935	0.16	0.15	0.14
BP936	0.16	0.15	0.14
BP944	0.16	0.15	0.14
BP945	0.30	0.28	0.25
BP946	0.15	0.14	0.13
BP948	0.30	0.28	0.25
BP951	0.70	0.65	0.60
BP962	0.15	0.14	0.13
BP9093	0.45	0.43	0.40
BP9094	0.45	0.43	0.40
BP9097	0.45	0.43	0.40
BP9099	0.45	0.43	0.40

VOLTAGE REGULATORS

TO.3 Plastic 1.5 Amps

μA.7805 L129 5V (Equiv. to MVR5V) £1·35
μA.7812 L130 12V (Equiv. to MVR12V) £1·35

DUAL-IN-LINE SOCKETS.

14 & 16 Lead Sockets for use with DUAL-IN LINE I.C's TWO Ranges PROFESSIONAL & NEW LOW COST.

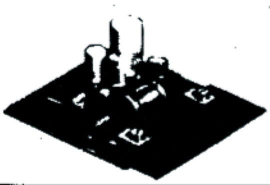
PROF. TYPE No.	1–24	25–99	100up.
TSO 14 pin type	33p	30p	27p
TSO 16	38p	35p	32p
TO 24	75p	70p	68p
LOW COST No.			
BPS 8 pin type	13p	13p	11p
BPS 14	16p	14p	12p
BPS 16	17p	15p	13p

NUMERICAL INDICATOR TUBES

Type	Description	
3015F.	Muntron 7 Segment Indicator	£1.20
MAN 3M	L.E.D. 7 Segment Display 0.127" High Characters	£1.90

BI-PAK 1975
CATALOGUE AND LISTS
Send S.A.E. and 18p.

AL10/AL20/AL30 AUDIO AMPLIFIER MODULES



The AL10, AL20 and AL30 units are similar in their appearance and in their general specification. However, careful selection of the plastic power devices has resulted in a range of output powers from 3 to 10 watts R.M.S.

The versatility of their design makes them ideal for use in record players, tape recorders, stereo amplifiers and cassette and cartridge tape players in the car and at home.

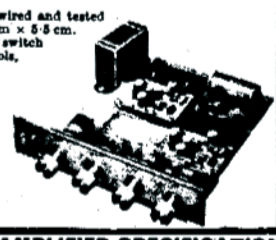
Parameter	Conditions	Performance
HARMONIC DISTORTION	Po = 3 WATTS f=1KHz	0·25%
LOAD IMPEDANCE	—	8 - 16 Ω
INPUT IMPEDANCE	f=1KHz	100 kΩ
FREQUENCY RESPONSE ± 3dB	Po=2 WATTS	50 Hz - 25KHz
SENSITIVITY for RATED O/P	Vs=25V. Rl=8Ω f=1KHz	75mV. RMS
DIMENSIONS	—	3" x 2½" x 1"

The above table relates to the AL10, AL20 and AL30 modules. The following table outlines the differences in their working conditions.

Parameter	AL10	AL20	AL30
Maximum Supply Voltage	25	30	30
Power output for 2% T.H.D. (RL = 8Ω f = 1 KHz)	3 watts RMS Min.	5 watts RMS Min.	10 watts RMS Min.
PRICE	£2·50	£2·85	£3·20

The STEREO 20 £14·45 p & p 45p

The 'Stereo 20' amplifier is mounted, ready wired and tested on a one-piece chassis measuring 20 cm × 14 cm × 5·5 cm. This compact unit comes complete with on/off switch volume control, balance, bass and treble controls, Transformer, Power supply and Power amps. Attractively printed front panel and matching control knobs. The 'Stereo 20' has been designed to fit into most turntable plinths without interfering with the mechanism or, alternatively, into a separate cabinet. Output power 20w peak. Input 1 (Cer.) 300mV into 1M. Freq. res. 25Hz-25kHz. Input 2 (Aux.) 4mV into 30K. Harmonic distortion. Bass control ±12dB at 60Hz typically 0·25% at 1 watt. Treble con. ±14dB at 14kHz.



TEAK VENEERED CABINETS for:

STEREO 20

TC 20. £3·95 p&p 45p

TC 100. £6·50 p&p 40p.

E.M.I. LEK 350 Loudspeaker System Enclosure kit in Teak Veneer, including speakers. Rec Retail Price £45·50 per pr. OUR SPECIAL PRICE £35·50 per pair p&p £1. *ONLY WHILE STOCKS LAST!*

FRONT PANEL, 4 knobs, Headphone Socket, on/off switch and neon for PA 100/MK 50. FPK 100 £2·95.

TRANSFORMERS

T461 (Use with AL10)	£1 60	P & P	22p
T538 (Use with AL20 & AL30)	£2 30	P & P	22p
BMT80 (Use with AL60)	£2 75	P & P	37p

POWER SUPPLIES

PS 12. (Use with AL10, AL20 & AL30)	95p
SPM 80. (Use with AL60)	£3·25

PA 12. PRE-AMPLIFIER SPECIFICATION

The PA 12 pre-amplifier has been designed to match into most budget stereo systems. It is compatible with the AL 10, AL 20 and AL 30 audio power amplifiers and it can be supplied from their associated power supplies. There are two stereo inputs, one has been designed for use with *Ceramic cartridges while the auxiliary input will suit most †Magnetic cartridges. Full details are given in the specification table. The four controls are, from left to right: Volume and on/off switch, balance, bass and treble. Size 152mm × 34mm × 35mm. PRICE £4·35

Frequency response—
20Hz - 50KHz (–3dB)
Bass control—
± 12dB at 60Hz
Treble control—
± 14dB at 14KHz
*Input 1. Impedance
1 Meg. ohm
Sensitivity 300mV
†Input 2. Impedance
30 K ohms
Sensitivity 4mV

FRONT PANEL FP12 with knobs £1·00

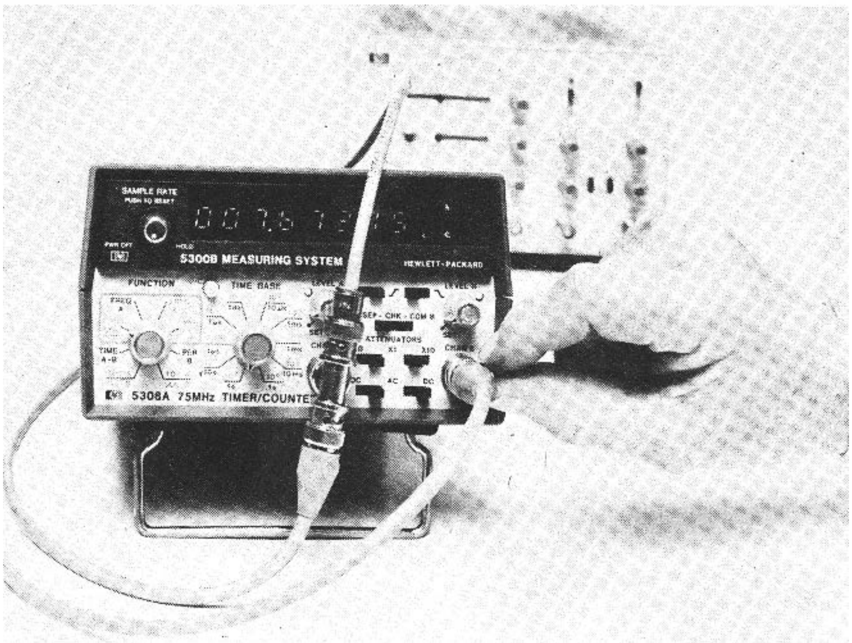
BI-PAK

P.O. BOX 6, WARE · HERTS

Postage and packing add 20p Overseas add extra for airmail · Minimum order 25p Cash with order please

Guaranteed Satisfaction or Money Back

NEWS DIGEST

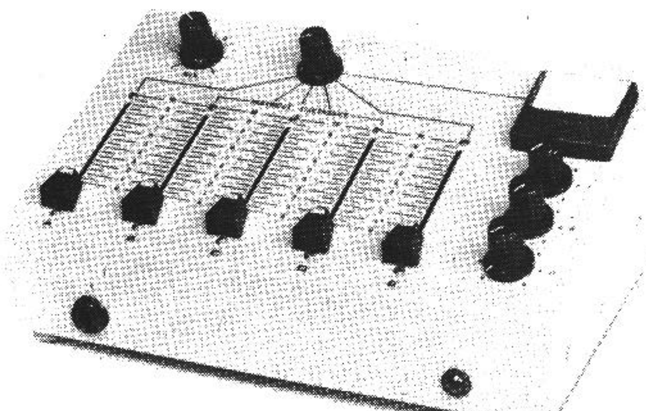


UNIVERSAL COUNTER

The new 75MHz Electronic Counter/ Timer from Hewlett-Packard (Model 5308A) does more than many rack sized models. Like other universal counters, it counts frequency, frequency ratio, period, period average, and time interval; it scales and totalises. Beyond those usual abilities, it offers sub-nanosecond time interval averaging, and it auto-ranges to select the range that gives best resolution within a convenient measuring time.

HP claim this is the first electronic counter to auto-range when averaging time interval or when measuring frequency ratio, in addition to auto-ranging frequency and period average measurements.

Mated with the 8-digit (Model 53008) display, the 5308A forms a package 3 1/2 by 6 1/4 by 9 3/4 inches weighing 5.31bs. The timer/counter module costs £238 (plus £243 for the 53006).



AUDIO MIXERS

Although not designed for professional use a new range of audio mixers is available from Partridge Electronics. These models have some of the facilities of professional mixing equipment.

Full monitoring (via a built-in headphone amplifier) of individual pre-fade channels or post-fade mixer output, and V.U. metering can be provided. Up to five input channels are available and all mixers include a built-in power supply.

The prices range from £ 18.58 for the electronics of the basic 5-channel mono mixer, and £23.22 for a mixer kit with tone controls (cabinet £7.00 extra), to £38.23 for a (mono) mixer kit with tone controls, monitoring facility, and VU meter (all prices plus VAT). There are many other options from Partridge Electronics, 21 Hart Road, Benfleet, Essex, SS7 38P.

ELECTRIC BUS

The first battery-powered electric bus is now in regular service in Manchester. It carries sixty giant batteries and 34 passengers at speeds up to 45 mph. The bus is like the old trolley buses in its performance.

UNDERWATER PLUG AND SOCKET

STC's stand at the Oceanology International 75 exhibition was a new multi-way plug and socket capable of being plugged and unplugged underwater whilst live. STC, 190 Strand, London, WC2R lDU.

SUPERCONDUCTIVITY IN A POLYMER

Three physicists in California recently observed superconductivity below 0.260K in quasi-one-dimensional crystals of polysulphur nitride $(SN)_x$ - a material formed from elements in a region of the periodic table not usually associated with superconductivity.

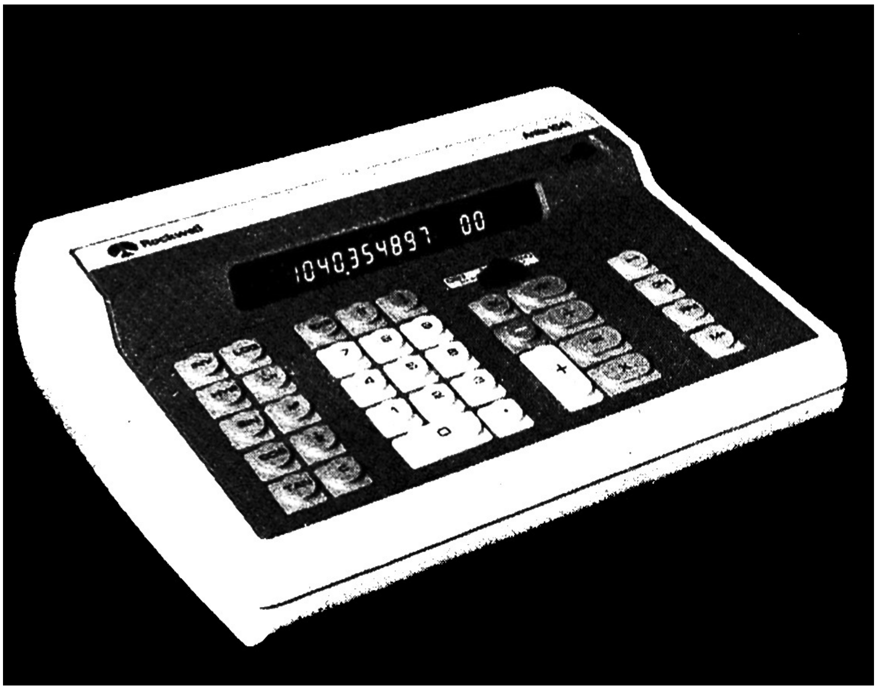
NEW PRICES AND PRODUCTS FROM DORAM

Doram have published a new price list for their products. This will apply until 31st July 1975. They also have a leaflet containing new additions to their range, including a kit for the ETI 'Printimer' (which we published in Nov. 1974) for £7.99, order code 991-451. Doram, P.O. Box TR8, Wellington Road Industrial Estate, Wellington Bridge, Leeds, LS12 2UF.

BATTERY VEHICLE SOCIETY

We have news of a society for people interested in battery-powered transportation. The Battery Vehicle Society was formed in November 1973 and as interest in alternative forms of power has grown so has the membership. An annual membership fee of £2 keeps members in touch with news of the latest developments by local group meetings and the bi-monthly journal.

The society caters for those interested in the history and preservation of electric vehicles
(which goes back to 1837) and those working on their own experimental developments. The secretary of the society is Mr. P. D. Williams, 3, Steyning Court, Steyning Avenue, Peacehaven, Sussex, BN9 8LU.



SCIENTIFIC DESK-TOP CALCULATOR

The Anita 1041-RA is a new desk-top scientific calculator with exponent memory, and a wide range of scientific functions. It costs £119. Details from Sumlock Anita, Rockingham Road, Uxbridge, Middlesex, UBS 2XL.

ALARM CLOCK IC

AMI Microsystems have a-new MOS alarm clock IC with a number of interesting features. It offers a choice of 50 or 60Hz input, alarm with snooze, presettable 59 minute countdown timer, direct LCD/LED/ tube drive, 12 or 24 hour output, power failure indicator and a blanking/ brightness control.

The S1998 also has a sleep output for timed radio turn off. The device operates over a power supply range of 8 to 29 volts (unregulated}. Information is available from: Adrian Electronics ltd., 28 High Street, Winslow, Buckingham, MK18 3HF

THE SECOND NOEL?

A new type of star has been discovered by British scientists using Ariel 5, the UK satellite. It was discovered over the Christmas holiday last year and flared up to its brightest level on Christmas day. It is an X-ray Star with a fluctuation period of 6.75 minutes. This is much slower than,a pulsar (which flickers every second or so) and much faster than a binary system.

A possible explanation which has been suggested is that this is a pair of stars much closer than those previously discovered. One would be a burnt-out star (a white dwarf) which would be losing material to the other (a neutron star or maybe a black hole).

CHILDREN'S TV STUDIO

At a children's club in Kursk, USSR, there is a TV studio staffed by 45 children. The club also has its own film show. The programs they produce describe their town and the activities of the clvb.

10,000 AMP CONTROL

Fosters Transformers Ltd have ordered eight DC current transformers from Control Technology Ltd., of Peacehaven, Sussex, for use in a rectifier control system for British Nuclear Fuels Ltd. The system will handle 10,000 amps. With each unit there will also be a pair of standard AC current transformers used as interposing devices.

LCD HANDBOOK

There are now more than {20 distinct liquid crystal displays on general sale, but few makers of electronic equipment are using LCDs (except for watchmakers).

Details of all LCD manufacturers and their products are brought together for the first time in "The International Handbook of Liquid Crystal Displays", available from Ovum Ltd., 14 Penn Road, London, N7, for £32.

VAT AND COMPONENTS

At the time of this issue going to press, the VAT position on components and kits is far from clear. ETI have discussed the position with H.M. Customs and excise but it could be a while before a ruling is made. As the Customs and Excise interpret the position, electronic components which can be used in Radio, TV and Hi-Fi are chargeable at 25%, others are not. The impracticality of this will be well understood by most electronics enthusiast and a ruling must be made.

We strongly suggest that readers ordering goods should add 25% VAT but should send a self-addressed, stamped envelope with their order for return of the difference.

COMPUTER IN THE CANTEEN

In the canteen of the Institute for Computer Research, at PERM, USSR, you don't have to pay for your food: The cost of the food on your tray is printed out by an electronic cashier, and this is recorded on punched tape alongside your personal reference number when you insert a card into the machine. When the tape is later sent through the computer the expenditure is stopped from your next wage packet!

TELECOMMUNICATIONS 75

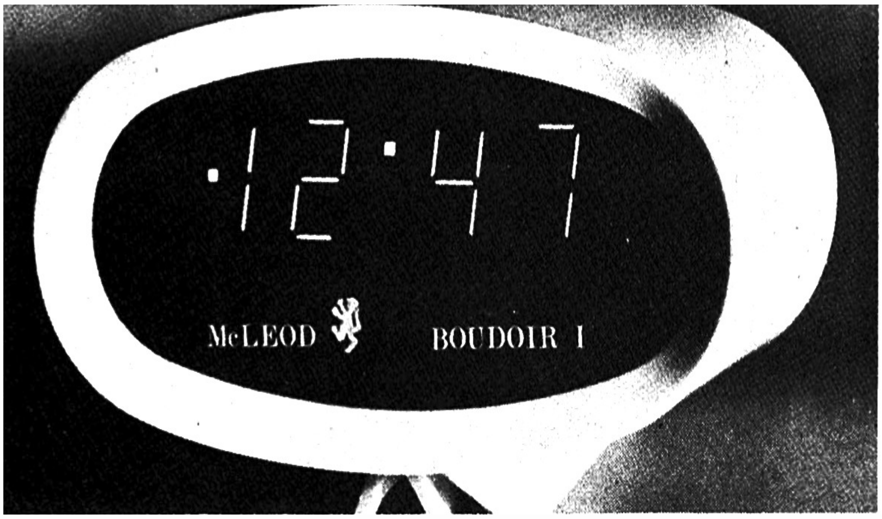
The organiser of the Telecommunications 75 conference and exhibition has announced details of the conference side of this new event, which is to be held in the Metropole Conference Centre, Brighton, on June 3rd, 4th and 5th.

A list of some of the companies who have booked stands and conference details are available from Mr. P. Gordon Saville, Telecommunications 75, 21 Victoria Road, Surbiton, Surrey.

QUICK-DRI PCB PEN

An improved version of the Decon-Dalo 33 PC etch-resist marking pen, under the name of the 33 PC Quick-Dri, is now available. To use you just draw the desired printed circuit on to a copper-clad board allowing the track to dry for two minutes before etching in ferric chloride.

The Decon-Dalo 33 PC Quick-Dri costs £1.08 for one (£4.43 for 6, £8.80 for 12) including post and VAT. From Decon Laboratories Ltd., Ellen Street, Portslade, Brighton, Sussex, BN4 1 EO.



QUARTZ CHRONOMETER KIT

Electro Systems and Timing (48 Robinson Road, Loudwater, High Wycombe, Bucks, HP13 7BJ) have a new chronometer, their Model 401. The 401-4 is a 4 digit model; the 401-6 has six digits; the 401-4-R and401-6-R contain rechargeable batteries.
The kits are based on the MM5314 LSI chip and contain 14 transistors and LEO displays. A 3,276,800Hz crystal controls the instrument to within 1 second a month (indoors). With the display on continuously the batteries last 5 to 6 hours, but this is normally off. There is a 12 month guarantee covering ready-built models and properly constructed kits. The prices are £33.48, £37.80, £45.36 and £51.84 (inc. VAT) respectively.

BEDROOM CLOCK

The Boudoir 1 is a digital alarm clock with a 4 digit, 0.7 inch Planar Gas Discharge display.
Tipping the clock forward stops the alarm and initiates the 'snooze' mode.
Then the alarm will sound every ten minutes until it is turned off. The clock is available in white or beige and costs £17.93 from Mcleod International ltd., Sovereign House, Lion Green Road, Coulsdon, Surrey.

COMPUTERS AT SCHOOL

Systems, Maintenance & Services Ltd., who install electronic equipment in schools, are "installing a mini computer configuration and peripheral equipment in a High Wycombe school. This will be used by 14 to 17 year old students and will be repeated in Oxfordshire, Suffolk, Germany, Turkey, Italy, Spain, Bahrain, Holland and Belgium.
American statistics indicate a 10 per cent educational gain by computer users over non-users. S.M.S. Ltd.,Great South West Road, Feltham, Middlesex.

ETI SUBSCRIPTIONS

If you have no trouble obtaining ETI from your newsagent that's the obvious place to get it. However an early analysis of the reader questionnaire has shown that one in three readers has trouble in buying ETI.

If you are one of those having trouble, why not take out a subscription? Normally you receive your copy for a few days before our official publication.

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36 EBURY STREET
LONDON SW1 1W 0LW

Please find enclosed £4.25 which includes postage (4.75 overseas) for my annual subscription I to ETI starting with the next available issue.

Name..

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June 1975

IMAGE ISOCON

A television camera tube which is claimed to have a potential pickup superior to that obtainable from any previous camera tube has been introduced by RCA. The Image lsocon camera tube retains the desirable characteristics of the image orthicon tube, but it has much less noise (14 to 16dB quieter in the black spots), a greater dynamic range (at least one order of magnitude, a much higher resolution (typically 1000 lines) and virtually no dark current. Setting-up procedure for isocons is simpler than for the image orthicon.

Two versions of the RCA Image lsocon are available. Type 4828A has a plain glass face-place and the image section uses a photoemissive light sensor and a charge-integrating storage target. It has a linear transfer characteristic (unity gamma) which extends to the knee region, sensitivity which is equal to the best image orthicon, very low lag and a high signal output current (provided by a five-stage electron-multiplier).

Type 4807A has a fibre optics faceplate for coupling to additional stages and employs a wide target-to mesh spacing to provide a good sensitivity at very low light levels: RCA, Lincoln Way, Sunbury-on-Thames, Middlesex.

WAVE POWER

Dr. Stephen Salter, of Edinburgh University; has calculated that Britain could get all of its power from 1000 floats, each 1/2 km long and 30 feet deep, situated off our shores. The tidal barrage idea has already been investigated (using estuary tides which have a frequency of one cycle per day) but Dr. Salter's idea involves a different energy source: the six-cycles-per-minute ocean waves. The floats would have to be in at least 300 feet of water and would be linked up to suitable generators. Tests have shown that 9 foot waves lifting a float 3 foot in length six times a minute can produce 50kW.

COMPUTER CONTROLLED BATTERY CHARGER

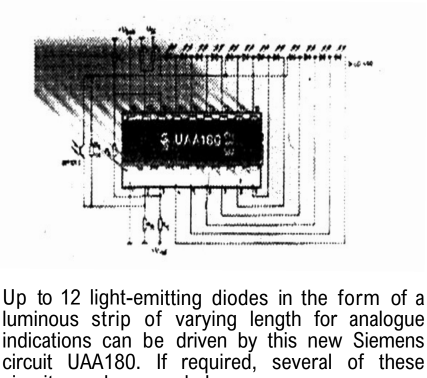
A computer-controlled car battery charger no larger in size than a lady's handbag, yet powerful enough in effect to "jump start" a car has been invented at General Electric Company of the USA's R & D Centre.

Claimed to be as powerful as a 70 pound, four-foot-high commercial chargers, GE(USA)'s seven-pound "Hotshot Battery Booster/Charger" will bring a car battery to full charge within an hour or two.

Designed with average drivers in mind, the new device is equipped with logic and control control circuits which prevent power from flowing unless the charger is properly connected to a battery.

Automatic power conditioning circuits regulate the current to provide optimum charging. As the battery approaches maximum charge, the booster/charger reduces the current and, in effect, becomes a "trickle charger" for overnight use. The device will not damage a car's sensitive electronic components, such as a transistor radio, should they be left on during charging. A built-in fan removes any gases that might evolve from a battery during high-current charging.

The small size of the charger makes it suitable for-on-board applications in electric vehicles. The Hotshot Battery Booster/Charger uses a transformer made from new magnetic materials, and 25KHz AC to DC conversion circuitry. The device is still at the development stage so don't phone in to ask where you can buy one!



Up to 12 light-emitting diodes in the form of a luminous strip of varying length for analogue indications can be driven by this new Siemens circuit UAA180. If required, several of these circuits can be cascaded.

LARGE SCREEN SCOPE

A new large screen oscilloscope system, known as the 9383, has just been introduced by Racal Instruments for use in industry, education, medicine and exhibition displays.

The system consists of three basic units: a display unit with a 19 inch rectangular screen, a power supply and a remote control unit which incorporates the controls.

A maximum of four traces can be displayed simultaneously on the screen, the whole area of which is usable. Under normal lighting conditions the display is clearly visible from a distance of up to 50 feet. A graticule is printed directly on the tube face to avoid parallax errors.

Four independent Y input channels are provided, each with a frequency response to 30kHz and an input impedance of 1 megohm.

Input sensitivity is 10mV/cm. Each trace has its own gain and shift controls and can be moved over the full height of the screen so that any two or more traces can be brought into close proximity or superimposed on one another. The time base speed can be varied between 30 seconds and 300µs per sweep. Information from Racal Instruments Ltd., Duke Street, Windsor, Berks.

LOW LIGHT AND THERMAL IMAGING SYSTEMS

Many new applications of low light and thermal imaging systems were presented at an international conference held recently by the Institution of Electrical Engineers.

One demonstration shows how one could suppress all but moving targets for use in intruder detection. The use of pulsed illumination to enhance the contrast of objects seen by low light viewing systems through mist and fog was described and illustrated. Another paper showed the way in which the medical profession is realising the ability of thermography for detection and monitoring of many medical conditions, such as cancer, and arthritis.

ELECTRONIC COMPONENTS

catalogue no. 4

B.H. COMPONENT FACTORS LTD.

B. H. COMPONENT FACTORS LTD

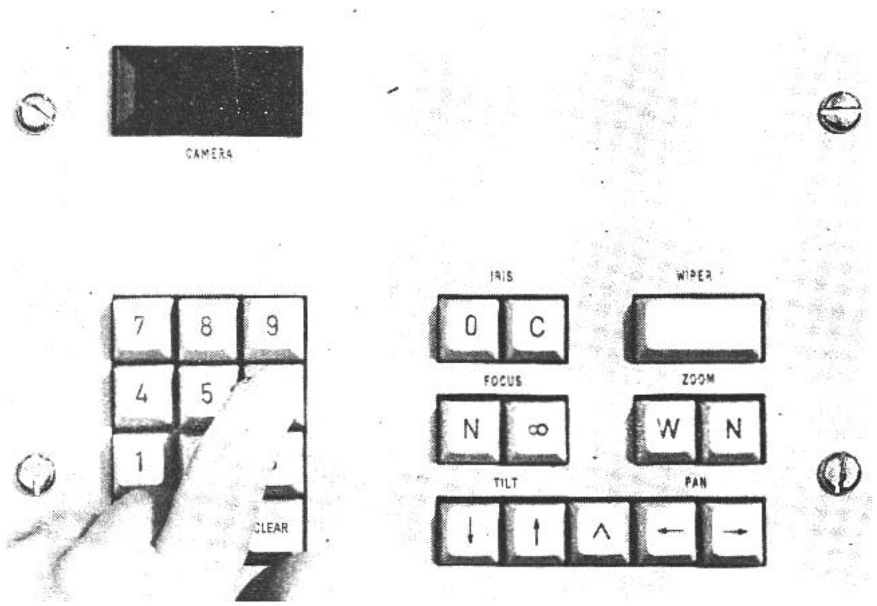
59 North Street, Leighton Buzzard Beds, LU7 7EG

Price: 20p
Size 298 x 210mm 64 pages

B.H. Components sent us their catalogue when they noticed our survey of mail order catalogues in the April ETI. All the major categories of components are covered but the emphasis is on passive components and hardware. Consequently the catalogue doesn't carry much spec., unlike some of the specialist semiconductor catalogues. Fixed capacitors seem to be the speciality, with a very wide range. B.H. sell 'capacitor kits' and 'resistor' kits, containing a selection of values from a particular range. Boxes, cabinets, panels and chassis of all shapes and sizes, lots of plugs, sockets and connectors, knobs and tools are the basis of the thorough hardware range.

The other categories are covered adequately, for instance there are 182 common types of transistor listed and 51 transistor packs (55p each). A few common ICs are carried plus the 74 series TTL.

There are lots of illustrations and the contents/index is clear.

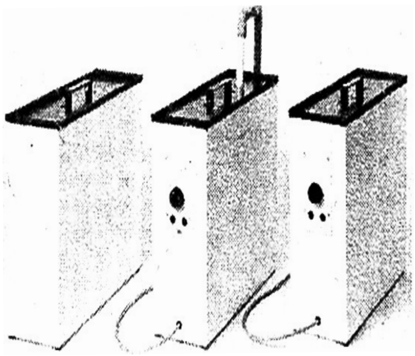


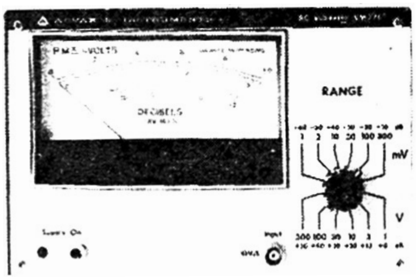
The new EPO telemetry surveillance system introduced by Evershed Power-Optics Limited uses this push-button control panel. The new remote CCTV system is designed to keep a watch against intruders inside industrial plant, and in warehouse areas, docks and airports where the large areas involved create security problems. (Evershed PO Ltd., Bridge Wharf, Chertsey, Surr.ey, KT16 BLJ).

AC MILLIVOLTMETER

The VM77E is an analogue AC millivoltmeter which measures 1mV to 300V full scale over a frequency range of 10Hz-6MHz. The accuracy of measurement is between 2 and 6% and the useful frequency range extends to greater than 10MHz.

There are 12 voltage ranges and 12 decibel ranges, covering -60dBm to +50dBm. Advance Electronics Ltd., Instrument Division, Roebuck Road, Hainault, Essex.





MAKE PCBs

At the Paris Components show we saw two new products from P.B. Electronics of 62 Largo Road, St. Andrews, Fife, Scotland. The DevEtchTin is a complete system for the production of printed circuit boards; ideal for prototypes and short runs. Chemicals some with the three tanks to give you all you need for PCB production.

For labs and workshops wanting UV exposing of PCBs and silk screens, PB have introduced their exposure units. They come ready for use, with vacuum as an optional extra.

HYBRID STEREO AMP

The latest addition to the Guest range of Sanyo modules is the STK014: a 15 + 15 watt amp with a TH D of 0.2% and running off a 38V supply.

Both power amplifier channels are contained in one thick-film hybrid IC package which is very competitive compared with discrete component circuits.

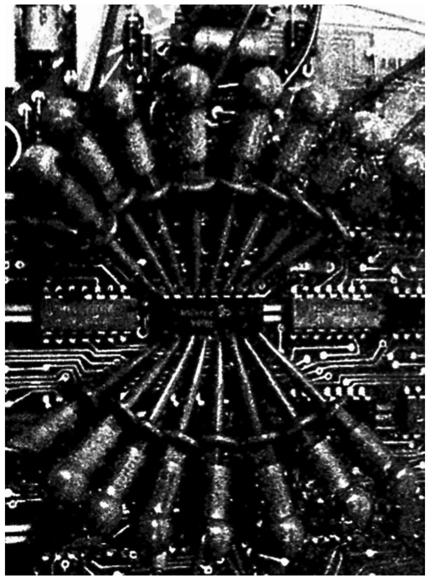
The package dimensions are 78 x 44mm and the devices are available to the trade (£284.60, 100-off) from Guest international Limited, Redlands, Coulsdon, Surrey, CR3 2HT.

E-Z MICRO HOOK

A new E-Z Hook, the E-Z Micro Hook, is available from the British Electrical Co. The new range of six hooks has been designed for difficult IC connections and operates on the same 'hypodermic needle' principle of the standard connectors.

They're 1 3/4 inches long and weigh less than 1 gram, so the Micro Hook can be connected to delicate wires without risk of damage.

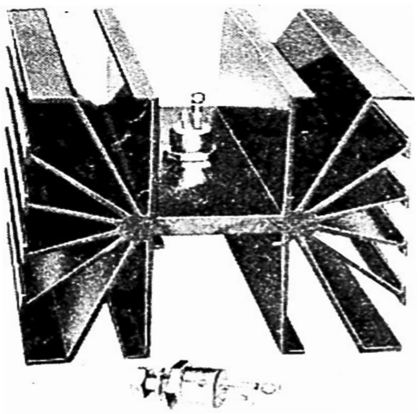
The Micro Hook is available in ten colours and costs 45p (including VAT) from British Central Electrical Co. Ltd., Special Products Division, Briticent House, New Street, Ringwood, Hants.



HIGH CURRENT SCR

A new range of high current SCRs manufactured by the American General Electric Company has been announced by Jermyn Industries.

They are named C147 and are rated at 63A RMS, available in twelve different voltage grades from 100 volts to 1200 volts. The cost of the 400 volt device, the C147D, for mains operation, is £7.25 for small quantities from Jermyn, Sevenoaks, Kent.



BUGHOUND

The most common type of listening bug consists of a small FM radio transmitter, with a range of about 400 yards, incorporating a miniature microphone and batteries. Sound can be picked up 20 - 30 feet from the microphone. EMI have a new transistor radio sized, device to locate such bugs.

The EMI Bughound is a wideband receiver with varying sensitivity covering up to 300MHz. It can quickly detect miniature radio transmitters, wired microphones, bugged telephone and intercom units, and mains carrier transmitters. It is simple to use, portable and battery operated.

MAGNASWITCHES

Four Magnaswitches are available from Photain Controls. They have been primarily designed for use as burglar alarm sensors. Each set is supplied in two parts; the Magnaswitch and the magnet. The magnet is fitted in the door window or cupboard being protected and the switch is fitted in the surround. When these two items are close together (i.e. the door window or cupboard is closed), the Magnaswitch closes, completing the circuit back to the control unit. As soon as the magnet moves away from the surround the Magnaswitch opens, the circuit is broken and the alarm sounds. Any number of Magnaswitches can be wired in series in a loop circuit with any other 'normally closed' sensor which can also be fitted in the same loop circuit.

There are models for wooden or metal window frames; some have two reed switches. Prices start at £1.50 each. From Photain Controls Ltd., Unit 18, Hangar No. 3, The Aerodrome, Ford, Sussex.

BIPOLAR MEMORY COSTS CUT

Signetics Corporation have made price reductions on their complete range of TTL RAMs and PROMs. Announcing reductions of as much as 62%, Dick Baldey, European Bipolar Memory Marketing Manager, said that increased unit throughput in production and extensive cost reduction programmes had enabled Signetics to price Bipolar Memory Products in the "commodity item" price range. Signetics International Corporation, Yeoman House, 63 Croydon Road, London, S.E.20.

TRI-STATE LED

A red and a green light emitting diode connected in parallel with reverse polarity and mounted in a standard package is available from Semicomps Limited. The MV5491 has three states: Green, Red and Off. These states depend on the direction of the current through the lamp or the relative potential across it. Thus the lamp serves as a polarity indicator.

Among other numerous applications is its use as a digital status indicator; a monitor of remote terminals sharing a common line; a beat frequency. indicator; or a zero indicator in a "centre-zero'.' linear LED array, where polarity is indicated by colour. Semicomps Ltd., 5C Northfield Estate, Beresford Avenue, Wembleym Middlesex.

LINEAR IC DATA BOOK

The 13th edition of the Linear Integrated D.A.T.A. Book is now available from London Information at £21.00 for a year's subscription (2 issues). The latest issue gives the parameters of over 7000 devices from 85 international suppliers.

Full details of Operational, Differential, Audio, RF/IF and wide-band amplifiers are presented to facilitate comparison and selection.

The Book is updated and published twice a year. From London Information (Rowse Muir) Ltd., Index House·, Ascot, Berks, SL5 7EU.

BASF COMPETITION

Anyone buying a BASF LH uper cassette can enter a competition for a 2-week holiday for four on the Norfolk Broads, with a food hamper and a radio cassette recorder. The competition closes at the end of June.

ELECTRONIC CHECKOUT

John Sainsbury, the supermarket company, are carrying out trials at Woolwich on an electronic checkout. Three customers through at once and a lot more comfort for the cashier are claimed for the prototype which was developed by branch planning services at Clapham.

The check stand is based on a modified JS twin-bay unit. In place of the cash register is an electronic keyboard, a visual display system and a processor that does a lot more than add up the bill.

The prototype is higher (better for unloading trolleys); longer (more room for customers); and the cashier sits on the left and not the right side of the conveyor belt (a much more comfortable position to work from). As the price of each item is keyed-in, the individual amounts come up on a small display panel over the belt; positioned so both the cashier and the customer can see it. This information is repeated on a second display panel facing the packing bay; designed to encourage the customers to move along, leaving room for the next in line to unload.

When one customer's bill is complete the cashier 'holds' the total in a memory and gets on with serving the next customer. The amount owing is displayed on a panel over the appropriate packing bay. If the cashier completes the second customer's bill before the first has paid the second total is stored and the cashier is free to start on a third customer.

The cashier has signals to remind her which customers still have to pay. It doesn't matter if the cashier is in the middle of serving a customer when someone wants to pay; the electronics allow either of the two previous customer's bills to be 'recalled' without affecting the adding up of the third customer's shopping.

It is better for the cashier, too. She can sit with her knees under the check stand and face the customer.

ERRATA

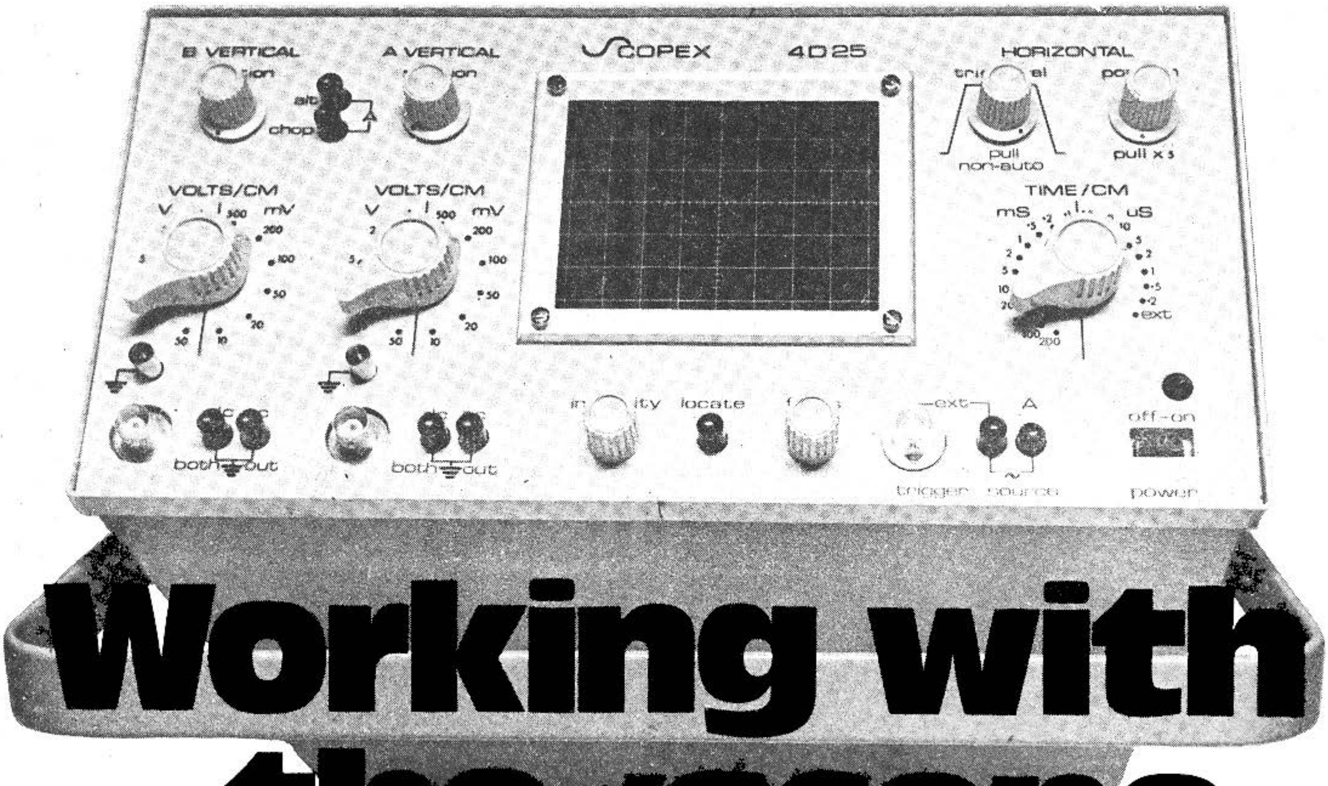
Tech-Tips, April ETI, page 65.

Speed Control for Model Trains, Circuit Diagram.

A wire is shown shorting across one of the diodes in the bridge. This should be deleted.

Electronic Ignition System, May ETI, page 26.

PARTS LIST. The transistor Q1 is the 2N2219 or BC338. Other transistors are correctly specified.



Working with the 'scope

THE EXTENT to which an oscilloscope can be used depends largely on the instrument itself and the most versatile 'scopes are usually the most expensive. One can pay as little as about £50 for a small, general purpose, or service type 'scope and £800 or more for a wide-band multi-purpose instrument with a storage c.r.t. facility. However, good secondhand instruments are available, mostly of the older valve type but these are nearly equal in performance and accuracy to their modern transistorised counterparts, providing they are in good condition and one has the means of checking calibration etc.

As a general rule, the choice of a 'scope should be made according to the kind of work one wishes to do. As a guide, instruments costing between £50 and about £150 are usually perfectly adequate for audio, radio, TV and electronics applications of a general nature. A double beam (two separate traces) instrument is a great asset and allows input and output waveforms to be displayed simultaneously for comparison but, whatever type is used, it is important to know its limitations and the calibration accuracy. For example, a 'scope with a Y amplifier bandwidth of up to say, 2MHz, will not show the amplitude of a 5MHz signal in true relationship to one at 1MHz. One would not be able accurately to measure the duration of a voltage pulse in terms of microseconds with a fastest timebase of a few milliseconds; to display a 1µS pulse opened out to cover one centimeter on a ten centimeter c.r.t. screen would require a timebase speed of 10µS. Signal amplitudes can only be measured accurately if the attenuators for input signals and the Y (or X) amplifiers are in good order. Last but not least comes interpretation of the display itself and here really useful information can only be obtained from intelligent observation made in conjunction with accurate calibration and full knowledge of the performance parameters of the 'scope itself.

CALIBRATION

For the benefit of those unfamiliar with the oscilloscope, a few examples concerned with calibration may not be amiss. The oscillogram in Fig. 1 shows a typical timebase waveform (B) beneath the negative-going trace fly-back suppression pulse: Now the timebase waveform looks linear, which it is, and the fly-back suppression pulse coincides exactly with the return of the timebase waveform from zero to maximum amplitude. A very linear timebase is important otherwise repetitive waveforms will appear as crowding together toward one side or the other of the display. A example of good linearity is shown in Fig. 2 in which (A) is the timebase waveform and (B) an actual display of square waves of 1kHz. The three complete cycles of square-waves are uniform in width and since 1kHz is a time duration of 1mS, the timebase is 3mS. Note that the timebase is synchronised to the square-waves and good

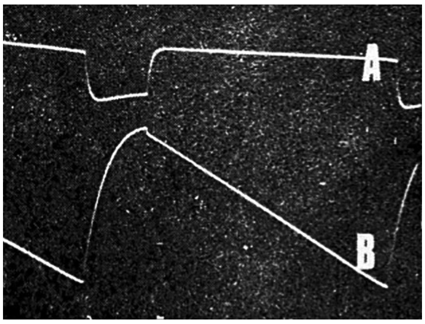


Fig.1. Typical time base waveform (B) with fly back suppression pulse (A) Note excellent linearity of time base waveform.

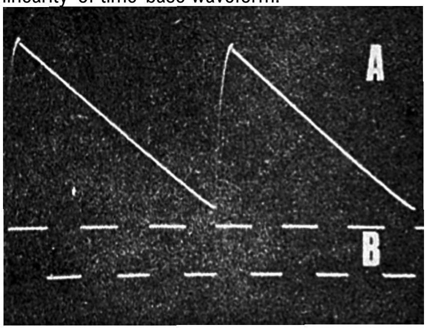


Fig.2. Time base waveform (A) against displayed square waves (B) to show synchronisation. Text explains time relationship.

synchronisation is also important, particularly when examining coincident waveforms.

Most oscilloscopes have a calibration graticule over the c.r.t., usually divided into centimetre squares as in Fig. 3, against which is. displayed a square-wave. If the vertical calibration is say 0.5V per centimeter, then the amplitude of the square-wave is almost 2V. The frequency of the square-wave is unknown and only a complete half-cycles displayed but the horizontal calibration is say 0.1mS/cm. The duration of the half-cycle is almost 5 x 0.1mS = 0.5mS which gives 1mS for the full cycle, or a frequency of 1000Hz.

Finally Fig. 4 shows five complete cycles of a square-wave at a frequency of 1000Hz (A). What is the duration of the time base? Each complete cycle is 1mS so the timebase speed is 5mS, (just over in fact as another quarter-cycle appears at the extreme right). The waveform (B) below, shows marker pips, derived by differentiation of the square-wave. These are more convenient for calibration of unknown duration.

The square-wave is simply passed through a CR circuit (Fig. 5) and the positive or negative-going pulses can be rectified out.

Having devoted a little space to calibration and to some extent interpretation of displays, let us now look at some typical applications of the oscilloscope. These are relatively few and fairly basic for any attempt to cover all the possibilities would require, endless editions of ETI. It should also be mentioned that every oscillogram is genuine and not retouched and photographed from an Advance OS250 oscilloscope with a Model 350 Polaroid camera, although some double or triple exposures of film have been used to show relative wave-forms and to reduce an otherwise formidable number of illustrations.

MISLEADING DISPLAYS

False information can be given by an oscilloscope display because of unwanted signals from circuits under test, defects in the oscilloscope itself and so on. It is also important to make full use of the various timebase speeds when analysing displayed wave-forms. A simple case is shown in Fig. 6 where (A) is a 1000Hz sine-wave but appears to be duplicated.

Reducing the timebase speed reveals that this is due to modulation by another signal of lower frequency, in this case 50Hz mains hum which could come from the circuit being tested, unscreened leads, or even the 'scope itself.

In Fig: 7 a ramp voltage waveform is shown but the first cycle is distorted, in this case by crosstalk in the 'scope, so it pays to investigate not only the equipment being tested but also the 'scope itself when things do not appear as they should. On this point, also examine the waveform (A) in Fig. 8: it appears to be a uniformly modulated R.F. carrier but expansion of the time-base (or speed-up) as in (B) reveals that the positive going half of the envelope is out of phase with the negative going half. This could be due to phase shift in the circuitry being tested or in the 'scope amplifier.

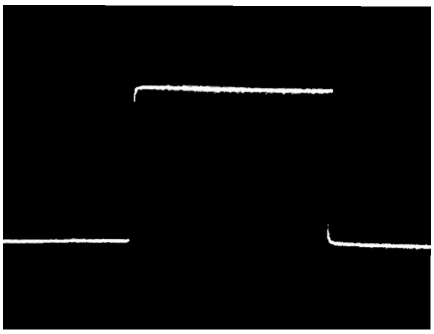
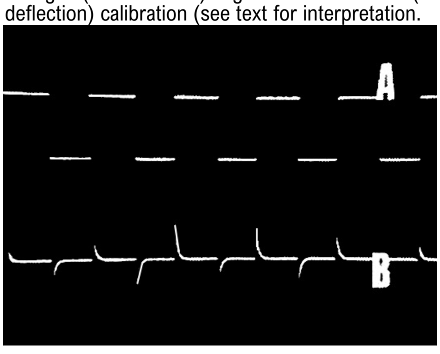


Fig.3. Graticule in centimeter squares provides voltage (Y deflection) against time scale (X deflection) calibration (see text for interpretation.



Flg.4. Display of square-waves (A) and marker pips obtained by differentiation. See also Fig.5 and text for further explanation.

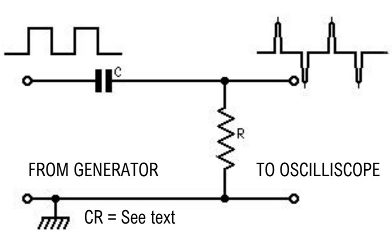


Fig.5. Simple RC network to obtain marker pips from a square-wave signal and which lend themselves for time scale calibration. A diode may be connected across R to eliminate positive and/or negative going pulses as desired.

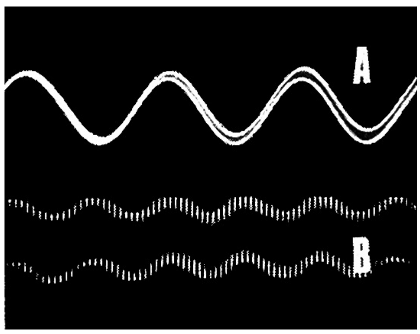


Fig.6. (A) Sine-wave deflected by (B) 50 Hz hum modulation.

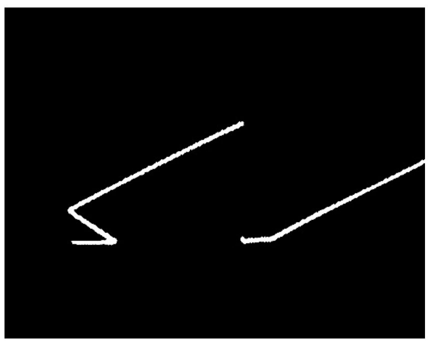


Fig.7. Distortion of displayed waveform due to crosstalk within 'scope circuitry itself.

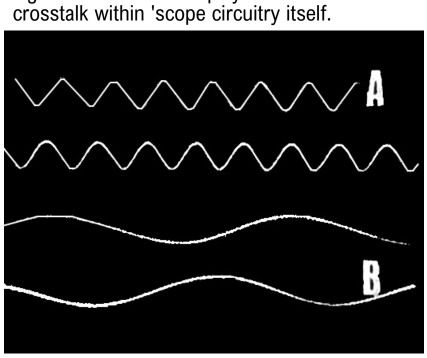


Fig.8. (A) This appears to be a uniformly modulated RF carrier. (B) Reveals phase shift between positive and negative going halves of envelope.

PHASE SHIFT

The oscilloscope can be used to determine. phase shift, of signals through an amplifier for instance, by feeding the input signal to the Y plates and the output signal to the X plates . . Some 'scopes have what is called an XY facility for this and matched amplifiers but accuracy will be limited by phase shift in the X and Y amplifiers themselves. When there is no phase shift (0 degrees) or reversal to 180 degrees, a diagonal line will appear in one direction or the other, as in Fig. 9A. An ellipse indicates phase shift at angles between 0 degrees and 180 degrees, or 180 degrees and 360 degrees, for Example at 450 degrees, 135 degrees, 225 degrees and so on, until the angle is either 90 degrees or 270 degrees at which a full circle is displayed, as in Fig. 9A. The phase angle can be ascertained as per Fig. 9B.

Figure 10 was obtained by frequency sweep from 1Hz to 100,000Hz and shows phase shift through an amplifier which rotates -completely through 360 degrees as the frequency comes down to 1Hz (the spiral part of the display). Multiple exposure photography and phase shift have been used to produce the oscillogram Fig. 11 which should be easy to work out.

LISSAJOUS PATTERNS

Determination of an unknown frequency with the aid of a known frequency and an oscilloscope can be made by the Lissajous method (after the French physicist M. Lissajous).

The known frequency is connected to say, the Y plates and the unknown to the X plates. When the unknown exactly equals the known then a circle is formed as in Fig. 12A if the signals are of equal amplitude. If the frequency difference is 2 to 1 then two loops will be formed and for 3 to 1 three loops will be formed as Fig. 12 (B and C), and so on. When the loops are above each other (turn the page sideways) the frequency ratios are reversed e.g. 1/2 or 1/3 etc.

A similar technique is Z modulation (brilliance modulation of the c.r.t.) and many 'scopes have this facility. In Fig. 13, an ellipse has been formed by phase shift (it may be a circle) of a signal of known frequency. Signals of an unknown, and in this case higher, frequency have been applied to the c.r.t. grid to produce the brilliance modulation.

The ratio is determined by the number of bright or blacked out spaces which in Fig. 13 is six or a 6 to 1 ratio.

SOME AUDIO APPLICATIONS

Square-wave testing is popular with audio engineers as a ready means of estimating, among other things, the frequency response performance of amplifiers including tone controls, filters etc. A uniform square-wave with a rise time over 10% to 90% of the leading edge of about 1uS is essential. This can be checked by using the 'scope calibration as already outlined. Don't accept what appears to be nice looking square-wave as in Fig.14 (A) because the leading edge looks fast.

Opened out, it appears as in Fig. 14 (B) and the rise-time is several micro-seconds, whereas (C) has a rise-time of better than 1µS. We cannot delve too far into the interpretation of square-wave displays as this could warrant a whole article in itself but instead give some general examples, with the aid of oscillograms, of how amplifier performance can be estimated just by looking at the display. These are shown in Figs. 15, 16 and 17 and the captions explain. Further information on. the subject will be found in the references given at the end of this article.

Still on audio however, other examples of oscillogram interpretation may be of interest. Take a look at Fig.18 which shows two 1kHz sine-wave signals (A and B) but each from a different generator. Which is the better signal (the one with least distortion). Neither trace will tell you by looking but in fact (A) has less than 0.02% harmonic distortion whereas (B) has more than 0.3% (fifteen times as much) and the residual of this (output from a distortion meter greatly amplified) is shown as (C).

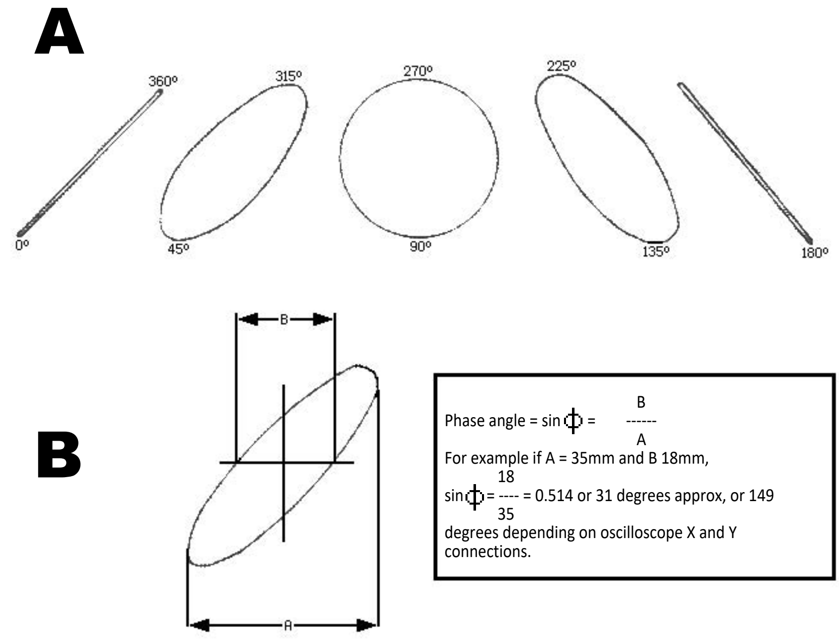


Fig.9 (A). Phase angles. See text for explanation. (B) Determination of phase angle from an oscilloscope.

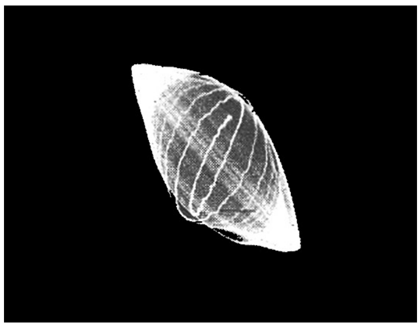


Fig.10. Phase shift from an amplifier during a frequency sweep from 1Hz to 1000,000 Hz.

Fig.13. Frequency comparison by Z modulation is explained in tbe text.

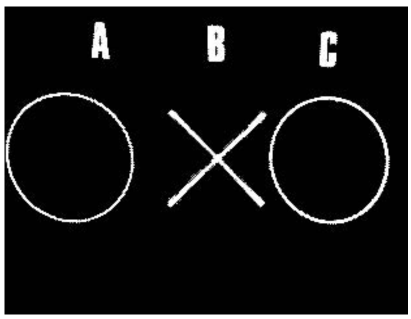


Fig.11. As the text implies you may work these phase shift displays out for yourself with the aid of Fig.9.

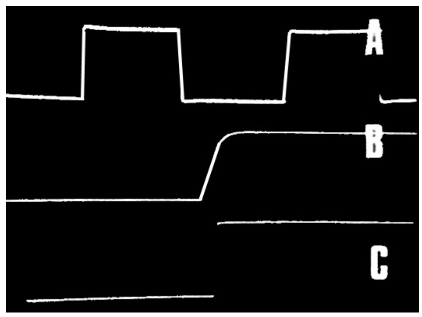


Fig. 14 (A). Appears to be a good square-wave with a fast leading edge. (B) reveals it is not so fast (several µ sec) whereas (B) has a rise time of 1µ sec.

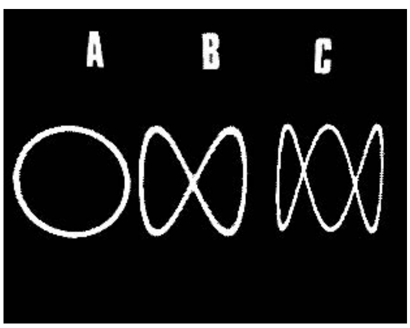


Fig.12. Typical Lissajous patterns of 1:1. 2:1 and 3:1. See text for interpretation.

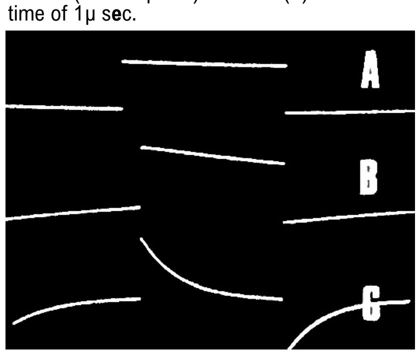


Fig.1 6. Amplifier tests with square-wave (A) 100 0 Hz square-wave Input signal. (B) only slight slope at top Indicates good response at low frequencies. (C) Curved and steep slope indicates severe loss of low frequency response.

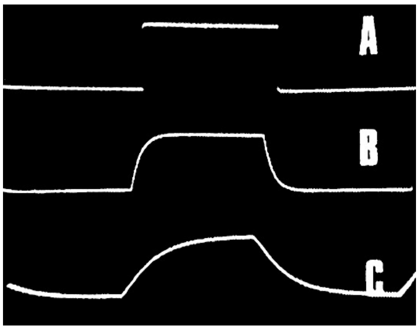


Fig. 16. Amplifier tests-with square-waves. (A) 1000 Hz square-wave input signal. (B) Indicates fairly good high frequency response falling away about about 20kHz. (C) indicates poor high frequency response falling away badly at probably less than 10kHz.

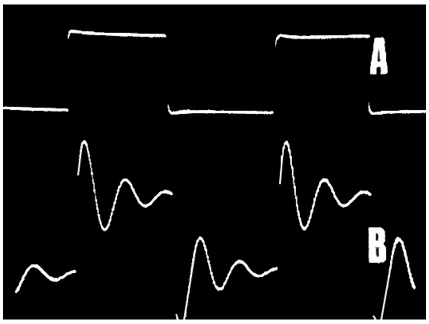


Fig. 11. Square-wave test for ringing, (A) Input signal (B) Output from amplifier showing severe ringing due to inductive circuitry. Frequency of ring is about 5kHz.

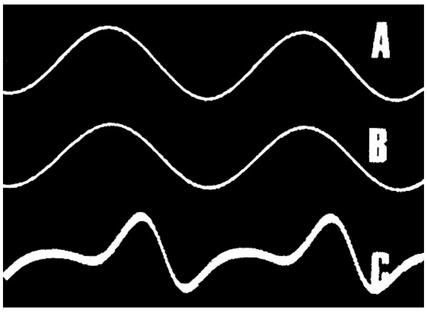


Fig.18. Deceptive sine-waves (A) and (B) both 'look' good but (A) has less than 0.2% distortion whereas (B) has more than 0.3% and its harmonic content is shown at (C) greatly amplified.

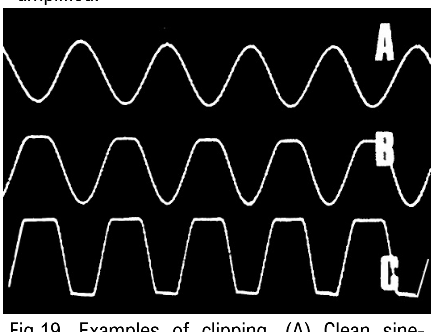


Fig.19. Examples of clipping. (A) Clean sine-wave form generator. (B) and (C) Asymmetrical and symmetrical clipping due to overload, or malfunction of the amplifier under test.

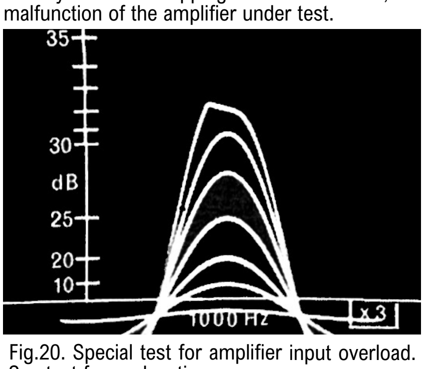


Fig.20. Special test for amplifier input overload. See text for explanation.

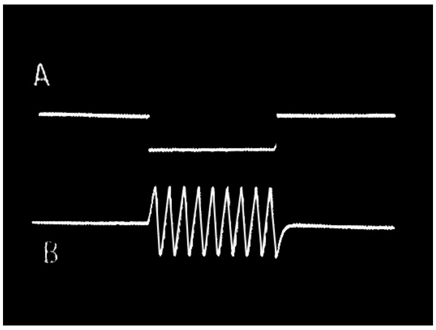


Fig.21. Coincident pulse waveforms. See text for explanation.

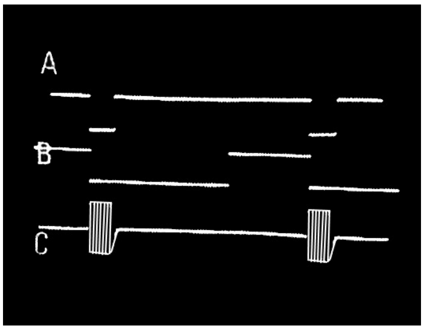


Fig.22. Coincident pulse waveforms. See text for explanation.

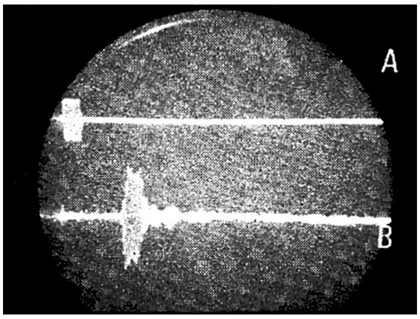


Fig.23 (A). Pulse used for acoustical experiment (B) Result of experiment. See text for explanation.

Fig.24. Spoken voice waveform of the word 'SEE'

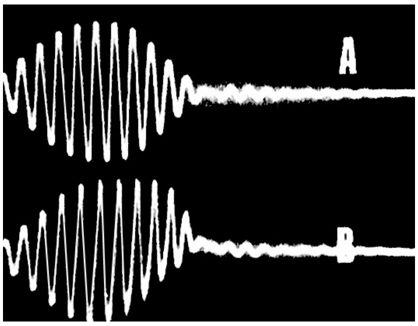


Fig.25. Pickup cartridge track-ability testing. (A) Good track-ability. (B) Poor track-ability. See text for explanation.

Oscillogram Fig. 19 shows at (A) a good clean sine-wave but supposing this is passed through an amplifier you have constructed and appears as either (B) or (C). Both indicate what is called clipping and (B) is asymmetrical i.e., positive peak only clipped, whilst (B) shows symmetrical clipping with both positive and negative peaks clipped. This suggests either too much input signal and therefore overloading at the input stage, or malfunction of the amplifier due to wrong component values causing wrong operating voltages etc. Overloading an amplifier input stage is however, done deliberately to verify what is called 'overload margin' and Fig. 20 shows a special application where the input signal is increased until clipping becomes visible, in this case at about 32dB above the rated input level. The dB scale is photographed separately but is calibrated to match the amplitude of the input signal to the amplifier under test.

SOME GENERAL APPLICATIONS

The double beam (two trace oscilloscope is invaluable for simultaneous display of two events, each time related to the other, and Fig. 21 (A) shows a square pulse (negative going) which has been used to gate a tone burst generator (B). The trace is fast enough to display one pulse so that close examination of time relationship can be made i.e., the tone burst starts its first cycle (positive going) precisely with the leading edge of the gate pulse. However, these two events are also related to another as in Fig. 22 where (A) is the gate pulse again, (B) is a variable width pulse from which the gate pulse was derived in the first place and (C) the tone burst. All three can be examined together but unless you have an expensive multi-beam 'scope this is where photographic records are useful.

The tone burst in the previous example was used for some acoustics work and Fig. 23 shows it again at (A) as a single event. The pulse was fed to a loudspeaker and the signal picked up by a microphone a few feet away. The time difference between the 'transmitted' and 'received' pulse (B) can clearly be seen together with echoes from around the room. As both time traces are the same we are actually measuring the speed of sound through air verified in this case by the time interval between transmitted and received pulses.

The 'scope has many uses in analysing waveforms of unknown component and Fig. 24 shows a display of the spoken word SEE. The timebase was triggered by the beginning of the sound so the whole waveform of the word is displayed. The S sound is clearly definable followed by the EE waveform. A faster time base would show even more detail of frequency components or formats as they are called.

The track-ability of pickup cartridges has become an important performance factor in the world of hi-fi and special laboratory test records are used, with the aid of an oscilloscope, to obtain instant indication of performance. An example is shown in Fig. 25 in which (A) shows a typical test signal consisting of a 10.8kHz sine-wave pulse and how it should appear on the 'scope if the track-ability is good. The lower trace (B) shows poor track-ability by the distortion in the pulse envelope and individual sine-waves.

It would be possible to go on almost ad infinitum giving examples of oscilloscope displays and their interpretation and of course literally hundreds of ways in which a 'scope can be used. It is worth however mentioning one technique developed by Gordon J. King and F. C. Judd (both well-known hi-fi technical authors). This is ailed 'frequency sweep testing' but is really an adaption of an old method used in conjunction with modern test instruments including the oscilloscope.

FREQUENCY SWEEP TECHNIQUES

Checking the bandwidth of intermediate frequency (IF) stages of superhet receivers with aid of a 'wobbulator', or frequency sweeping oscillator, goes back to pre-war days of massed produced radio sets and, apart from being a great time saving method, was a fairly accurate way of obtaining a true band-pas response. The frequency responses of amplifiers and other audio equipment can also be obtained by frequency sweeping and the use of a pen-recorder readout: Bruel and Kjaer equipment is notable for these applications. However, frequency sweep generators, known also as function generators, have become available now .and most have a synchronizing pulse output for triggering an oscilloscope time-base to coincide with the sweep. The sweeps may take only a few seconds and can be dis-played directly on the 'scope screen which provides a virtually instant readout. To put it, another way, one can see what is happening whilst it is happening. Moreover the results can be simultaneously recorded by photography.

The first example, Fig. 26, is a radio application showing the overall selectivity of a VHF/FM receiver with the input signal running into 6dB limiting. The caption explains further

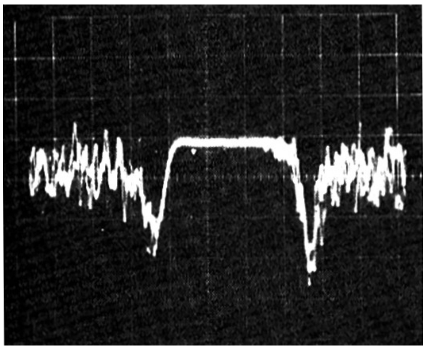


Fig.26. Overall FM selectivity with input signal 6 dB into amplitude limiting, Horizontal calibration 8 0kHz/div showing effective bandwidth of 240kHz. The requirement for good stereo based on a phase linear characteristic.

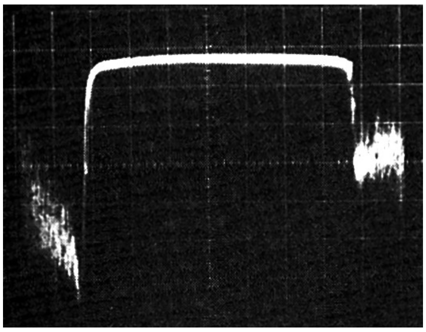


Fig.27. As Fig.26 but with input signal at 60 dB into amplitude limiting, showing even further widening of the characteristic at this level, corresponding to about 530kHz.

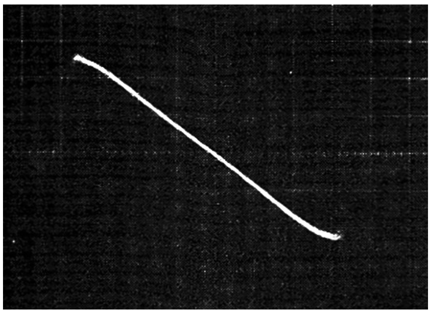


Fig.28. Sweep response. FM detector characteristic with good linearity over about 400kHz.

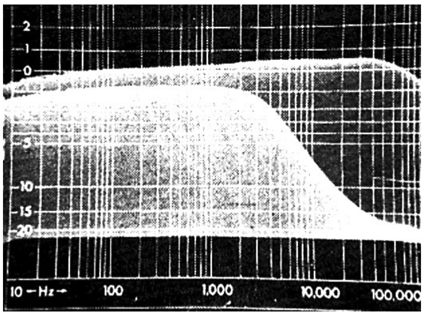


Fig.29. Audio amplifier responses by frequency sweep testing (see text).

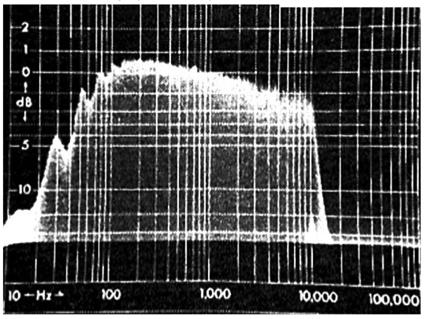


Fig.30. Record-to-replay frequency response of a cassette tape recorder by frequency sweep test.

but this oscillogram relates to Fig.27 in which the input signal is high enough for 60dB limiting and shows a further widening of the characteristic at this level; further details in the caption. Figure 28 is a similar application of this nature and is the sweep response of an FM receiver detector characteristic against a graticule scale of 18kHz per division (horizontally). This signifies good linearity over about 400kHz which ensures minimal FM distortion and inter-modulation products.

Finally, some examples of audio frequency sweep technique for direct display, on the oscilloscope screen, of the frequency responses of amplifiers including their tone controls or filters etc., and of tape recorder record-to-replay response. The frequency sweep generator used for this work covered 10 to 100,000Hz ±0.1dB over the full range for sweep times of about 2 to 15 seconds. The faster sweep times are used for more or less instant visual display. The signal from the generator is sine-wave and of low distortion but the oscilloscope displays only the positive-going portion of the waveform. Amplitude is therefore vertical and frequency horizontal so an appropriate graticule or graph background can be registered and photographed against the sweep display. Oscillogram Fig. 29 is a typical example, in this case of the overall frequency response of a good hi-fi amplifier which is almost flat from 10 to 100,000Hz. Against this is superimposed, by another film exposure, the response of the high frequency filter of the same amplifier, the rate of roll-off being about 3d8 per octave starting at 3.000Hz. The responses of tone controls can also be shown in the same way.

The record-to-replay frequency response of a typical cassette tape recorder is shown in Fig. 30; here the frequency sweep is actually recorded together with a sync pulse for the 'scope. The replay is, therefore, made directly to the 'scope so we have an overall, or record-to-replay response.

In this oscillogram a 10,000Hz marker signal is also displayed and this is derived electronically from the actual sweep signal as it passes exactly 10,000Hz. This is used to ensure accuracy of readout against the logarithmic frequency scale. The oscillogram needs little interpretation and the response scan speaks for itself. The 'fluffy' top i.e., the line of the response, is due to fluctuation in the recorded signal caused by variation in tape to head contact.

Finally a display that might almost be considered unique. Oscillogram Fig. 31 shows the responses of the 12

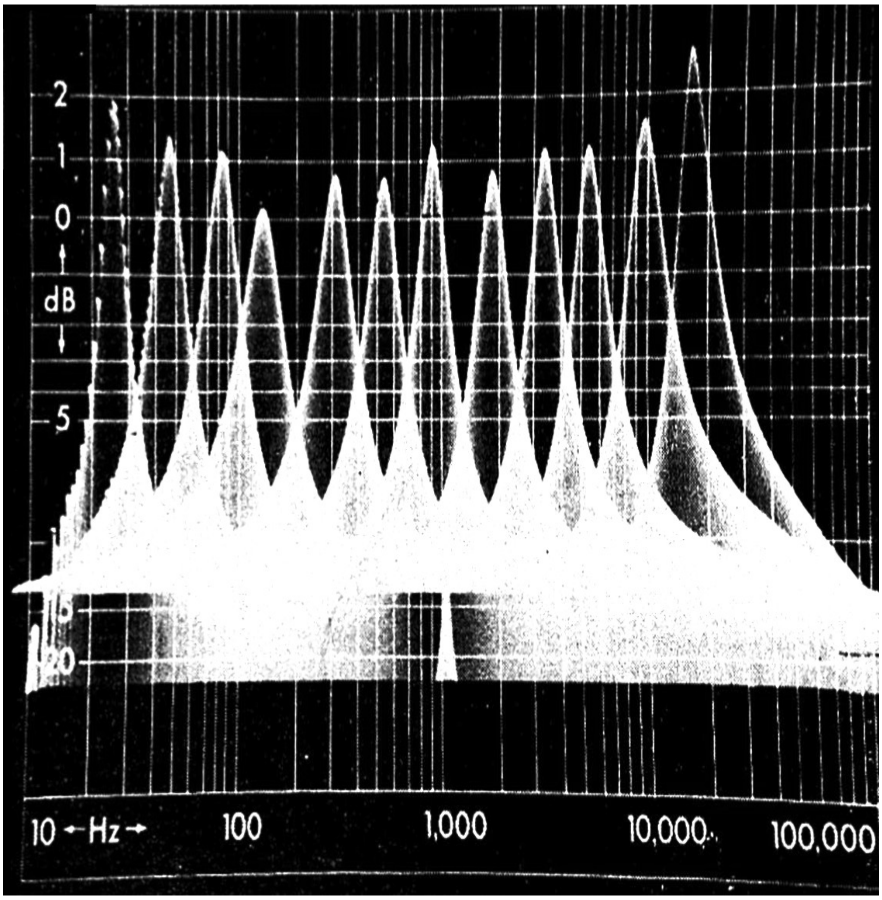


Fig.31. The individual responses of twelve filter controls on a graphic equaliser taken by frequency sweep testing and superimposed .photographs.

filters of a graphic equaliser at maximum lift. The reference is -10dB (1000Hz) so each filter is providing about 11dB lift at peak. The centre, or peak frequencies, can be clearly defined and the slope rate verified quite easily. Hand plotting a complete set of responses of this nature could take a long time as each has to be plotted individually. The sweep technique does this automatically and with equal accuracy and although this example necessitated 12 separate film exposures, a lot of time was saved, in fact it took less than 10 minutes to obtain the photograph. Note also the. 100dHz frequency check marker in this example.

Although not many books have been published that deals exclusively with the oscilloscope, or rather its uses, the following text books do contain further useful information:

The Oscilloscope at Work by A. Haas and R.W. Hallows. Iliffe and Sons. Last published 1959 but should be available from technical libraries. A very comprehensive work.

Servicing with the Oscilloscope by Gordon J. King. Newnes-Butterworth. New edition to be published. Excellent examples covering radio, audio and TV.

Radio and Electronics Laboratory Handbook by M.G. Scroggie. Iliffe Books. Latest edition published 1971. Informative on the use of the oscilloscope and other laboratory instruments.

The book mentioned above by Gordon J. King deals with television very thoroughly and thanks are due to him for the excellent frequency sweep oscillograms of FM tuner responses (26,27 and 28).

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2N438A	NG	TO5	LO4	25V		25V	300MA	85C	150MWF	1500K	25	20MN	50MA	RM	OBS	ASY29	2N1304	
2N439	NG	TO5	LO4	25V		25V	300MA	85C	100MWF	3M	18P	30MN	50MA	RMS	OBS	ASY29	2N1304	0
2N439A	NG	TO5	LO4	25V		25V	300M	85C	150MWF	3M	18P	30MN	50MA	RMS	OBS	ASY29	2N1304	0
2N440	NG	TO5	LO4	30V	15	25V		85C	150MWF	5M	15P	40MN	50MA	RM	OBS	ASY29	2N1304	0
2N440A	NG	TO5	LO4	25V		25V	300M	85C	150MW	4P	18	40MN	50MA	RMS	OBS	ASY29	2N1304	0
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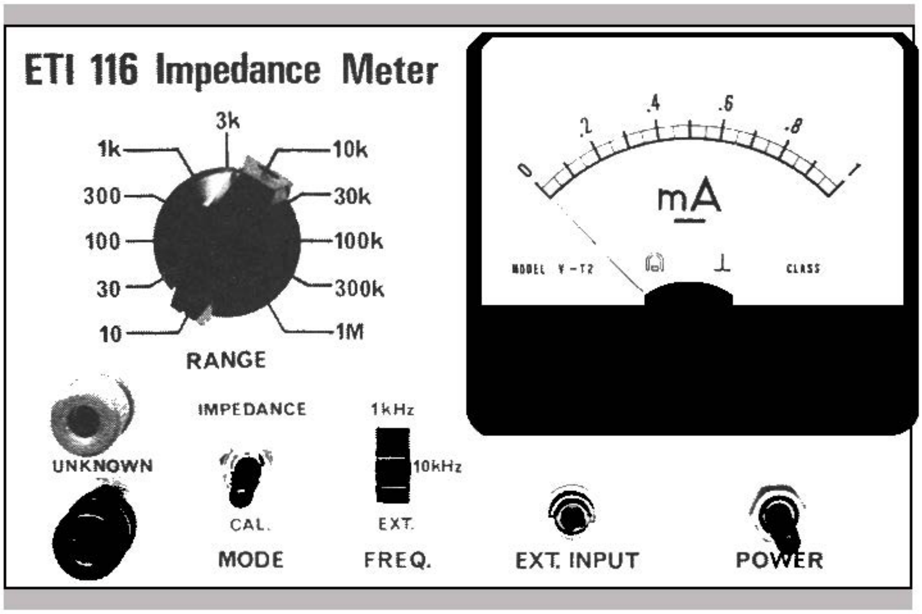
2N442	PG	TO3E	L13	50V	30	30V		95C	50W			20/40	5A	AMG	MOB	AD212	2N1100	0
2N443	PG	TO3E	L13	60V	45	40V		95C	50W			20/40	5A	AMG	MOB	AD212	2N1100	0
2N444	N	TO5	LO4	15V		10V		85C	150MWF	400K	30P	15TP	1MA	ALG	OBS	AC176	2N2430	0
2N444A	N	TO5	LO4	40V		10V		100C	150MWF	400K	28P	20/40	20MA	ALG	OBS	AC176	2N2430	1
2N445	NG	TO5	LO4	15V		10V		85C	150MWF	1M	32P	35TP	1MA	RMS	OBS	ASY29	2N1304	0
2N445A		TO5	LO4	30V		10V		100C	150MWF	2M	28P	40/160	20MA	RMS	OBS	ASY29	2N1304	0
2N446	N	TO5	LO4	15V		10V			150MW	4M	30	60TP	1MA	RMS	OBS	ASY29	2N130[illegible]	
2N446A										8P	28P	[illegible]	[illegible]		OBS	ASY29	[illegible]	

IMPEDANCE METER

Measure impedance directly with ETI's new impedance meter - checks capacitance and inductance too!



THIS IS an unusual project - in that we started out designing one thing and finished up developing another!

We had intended to design an RLC bridge which is a very useful instrument and' perhaps the next most commonly used after the multimeter, signal generator and scope. But whilst it is useful to be able to measure the value of an individual component, on many occasions we are more concerned with the magnitude of the impedance than we are with the actual value of C or L.

For example assume that we require to know how the impedance of a speaker varies with frequency. Due to the effects of the crossover network it will not be known whether the speaker is inductive or capacitive in the crossover region. Additionally a speaker goes capacitive below its natural resonant frequency. Hence the use of an R LC bridge to plot impedance would be very tedious indeed. We would have to determine whether the speaker was capacitive or inductive, measure the actual value and then calculate the impedance for each point to be plotted.

With the ETI impedance meter impedance can be read directly as a function of frequency as shown in Fig. 7.

This is just one example of the many possible applications. In addition the meter may be used to measure component values by simply referring to a reactance chart or doing a simple calculation as detailed below.

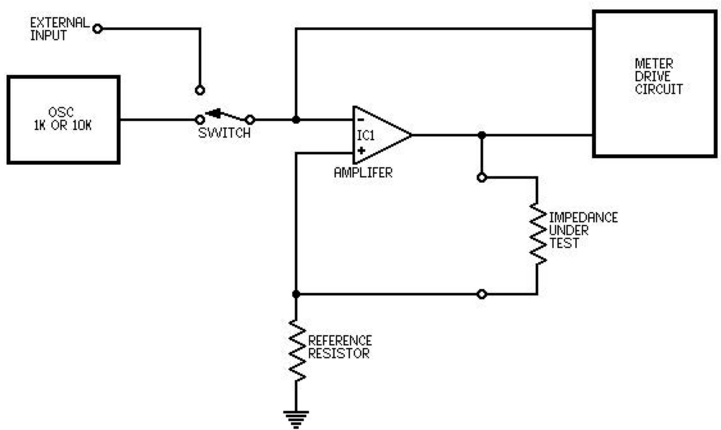
Other applications include measuring the impedances of microphones, filters, transformers and amplifier inputs etc. All can be measured as easily as one would measure a resistor using an ohmmeter. Simply by connecting the device to the input terminals of the meter and making the measurement as detailed in the "How To Use'! section.

In most practical applications we require to know the magnitude of the impedance - we do not care whether the device is predominantly inductive or capacitive.

On the rare occasions that we do require to know reactance we can

Fig. 1. Block diagram of the impedance meter shows that it consists of an oscillator an amplifier and a meter circuit. ▼

eti project



SPECIFICATION

Impedance measuring range	1 ohm - 1 Megohm
Frequency of test	20Hz - 20kHz external 1kHz or 10kHz internal
Range of Inductance	10uH - 1000H external 20uH - 100H internal
Range of capacitance	100pF - 1000uF external 100pF - 100uF internal
Accuracy ± 5%	

Voltage applied to unknown, max 1V rms

When measuring items which are connected to the mains earth either the item, or the meter, must have the earth removed.

IMPEDANCE METER

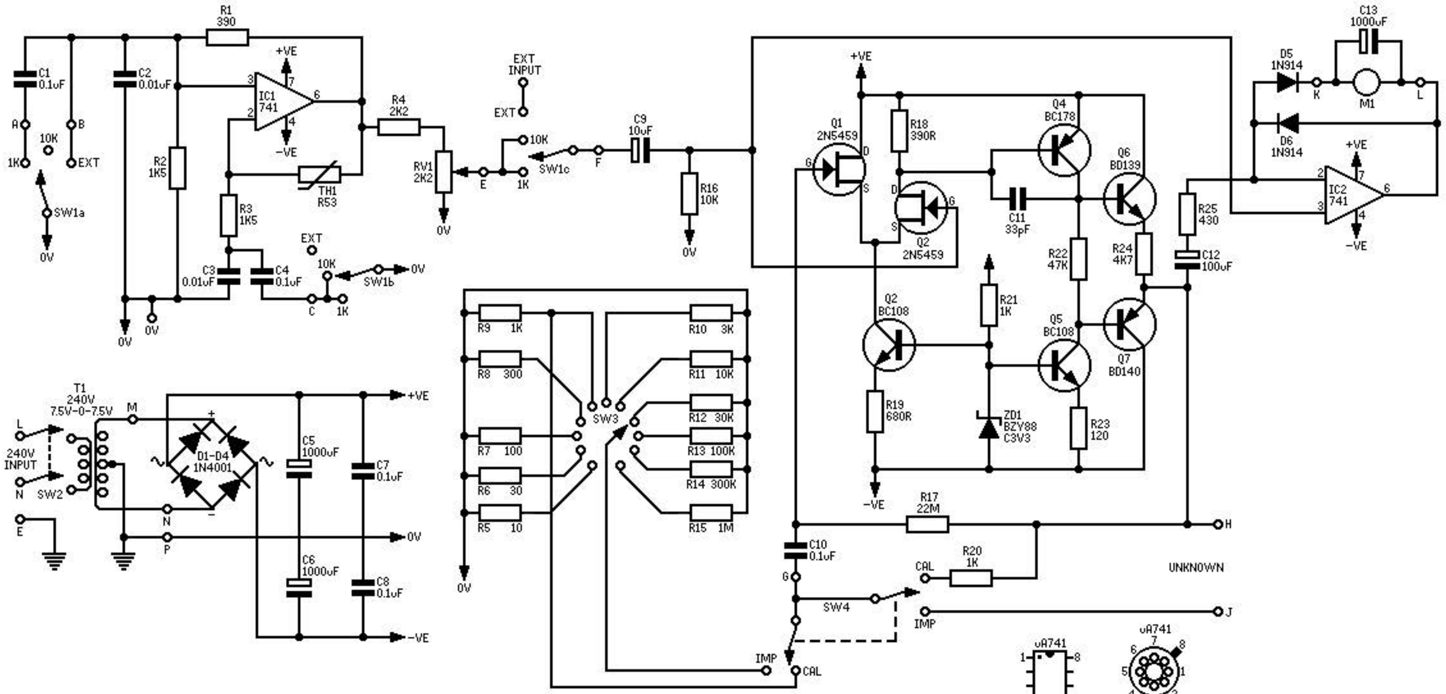


Fig. 2. Circuit diagram of the complete impedance meter.

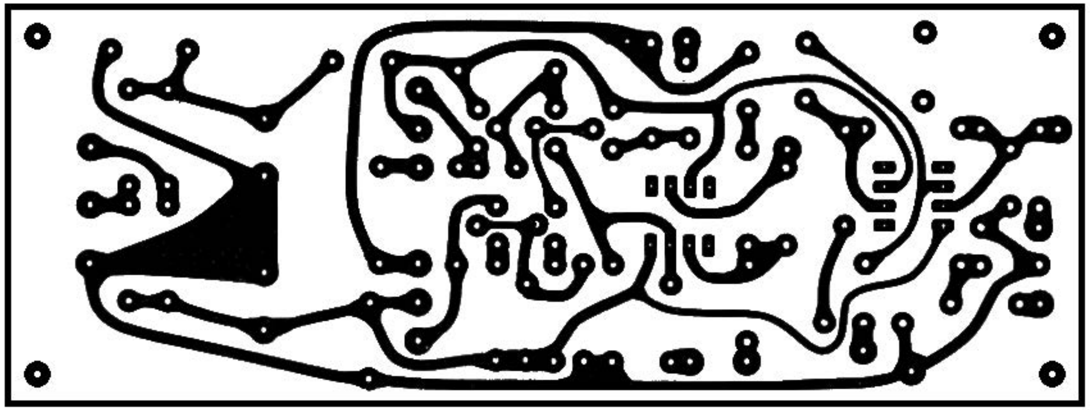


Fig. 3. Printed circuit board layout. Full size. 140 x 62 mm.

measure the DC resistance as well as the impedance and calculate from the formula

$$X = \sqrt{Z^2 - R^2}$$

where X = reactance inductive or capacitive at the frequency used.
Z = magnitude of impedance (as measured on impedance meter).
R = DC resistance (as measured by an ohmmeter).

MEASURING CAPACITANCE

The value of an unknown capacitor can easily be determined by measuring the impedance. and then using the reactance chart. Or, it may be calculated from the formula

$$C = \frac{1}{2\pi F X_c} \quad \text{(with capacitors } X_c = Z_c\text{)}$$

If the 10 kHz frequency is used this may be simplified to

$$\text{C in microfarads} = \frac{16}{Z_c} \quad (Z_c \text{ in ohms})$$

and if 1 kHz

$$CuF = \frac{160}{Z_c} \quad Z_c \text{ in ohms}$$

Since the meter can resolve the range 1 ohm to 1 megohm this implies a capacitance range of 16pF to 60µF. But as explained elsewhere stray capacitance limits the lowest capacitance that can be resolved to about 100pF.

MEASURING INDUCTANCE

To determine the value of an unknown inductance the impedance is again measured and the value read off the reactance chart. Alternately the value may be calculated from

$$L = \frac{X_L}{2\pi F} \quad \text{high Q coils} \quad X_L = Z_L$$

or

$$L = \frac{\sqrt{Z_L^2 - R^2}}{2\pi F} \quad \text{(low Q coils)}$$

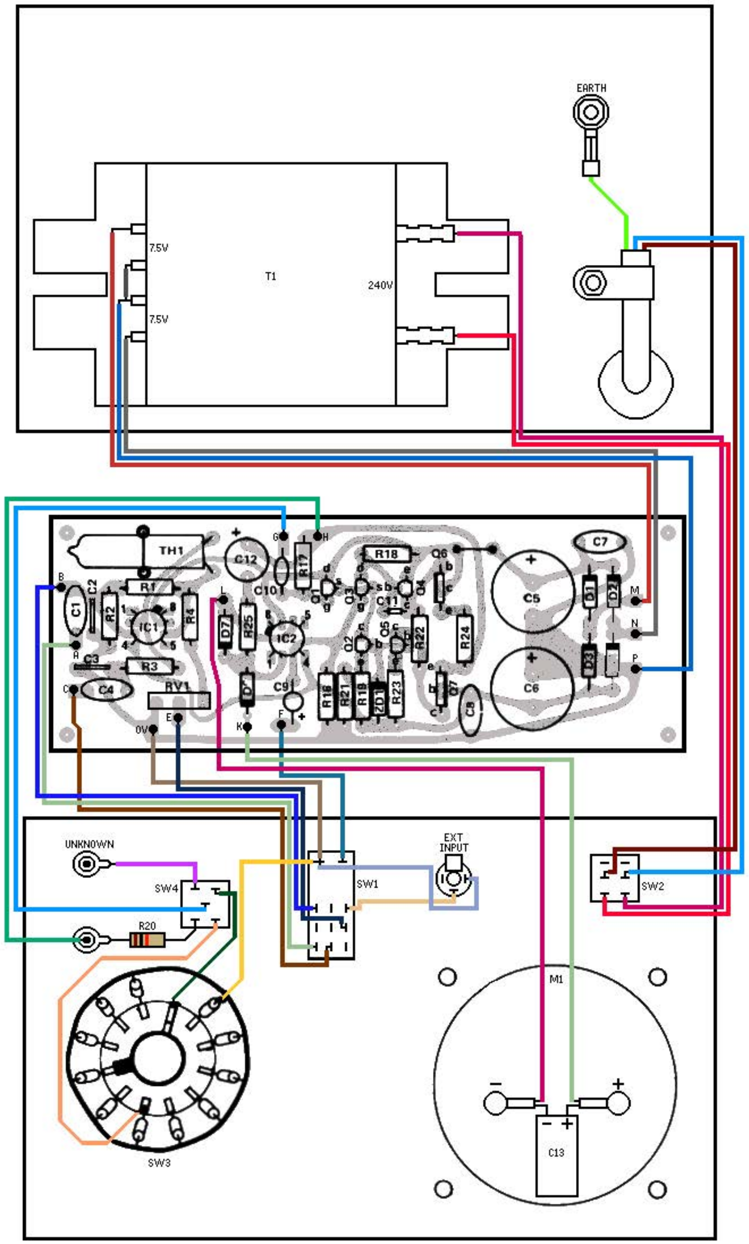


Fig. 4. Component overlay and wiring diagram for the impedance meter.

HOW IT WORKS ETI-116

The basic format of the impedance meter may be seen from the block diagram Fig.1. Firstly, we have an oscillator which may be .switched to provide either 1kHz or 10 kHz. Then. we have a differential amplifier with a high input impedance, and lastly a meter drive circuit.

Either output of the oscillator, or an external frequency, as required, is passed to the non-inverting input of the amplifier.

The amplifier gain is set by the ratio of, the unknown impedance, Z, to the reference resistance, R. Due to feedback, the voltage across R is always equal to the input voltage and', as the amplifier requires no input current, the current through R must also flow through the unknown impedance, Z. The voltage across Z is therefore proportional to its impedance.

The meter circuit measures the output voltage by using the input voltage as a reference. Since the input voltage is equal to the voltage across R we are effectively measuring the voltage across Z.

Refer now to the main circuit diagram Fig.2:The oscillator is of the Wein bridge type and uses a 741 IC as the amplifier and an R53 thermistor as the stabilizing element. The circuit oscillates at the frequency where the impedance of C2 and C3 is equal to the resistance of R2 and R3 respectively. Therefore, to change frequency, we simply change the values of C2 and C3. The output of the oscillator is attenuated by R4 and RV1 to approximately one volt.

The amplifier has a very high input impedance, can supply about 200mA into a 'load, has an open-loop gain of 50dB and can work into any load including a short circuit (unity gain).

An integrated circuit operational amplifier having the above characteristics (at reasonable cost) is not available, hence, a discrete seven transistor design was used.

To obtain the high impedance input a pair of FETs, Q1 and Q3, used as a differential pair, operate with a constant current (4mA) supplied by Q2.

Transistor Q4 is supplied with a constant current of 22 mA by Q5, and Q4, in conjunction with the input pair, supplies the necessary overall gain. Transistors Q6 and Q7 buffer the output of Q4 and Q5 to provide the necessary current drive. The DC bias for the amplifier is provided by R17 such that an output voltage within ±1.5 volts of zero is always obtained.

The meter drive circuitry consists of a 741 IC with a meter, and half wave rectifier in series, connected in the feedback path. A second diode is used to prevent the IC being saturated on the opposite-polarity swing.

The current in the meter is half the current through R25 and, since this is proportional to the difference between input and output voltages of the amplifier, is proportional to the voltage across the unknown impedance. The meter scale is linear and the IC effectively compensates for the diode drop. Capacitor C3 provides the smoothing necessary when working at frequencies less than 40Hz.

As previously stated the gain of the amplifier is set by the ratio of the unknown impedance Z and the reference resistor R, and is equal to

$$\frac{Z + R}{R}$$ where Z may be complex

The value of R is switch selectable from 10 ohms to 1 megohm in eleven ranges. In the calibrate mode a 1k resistor, R20, is substituted for the unknown impedance and the 1k range selected. This provides a gain of two and thus with one volt in we have two volts out and hence 1 volt into the meter circuitry.

Thus, on calibrate, the output of the oscillator (or the external oscillator level) should be adjusted by RV1 to obtain full scale deflection on the meter. The calibrate position should also be selected before changing the unknown impedance, as an open circuit may damage the meter by driving it well beyond full scale.

IMPEDANCE METER

It should be borne in mind that we are determining. impedances by using audio frequencies in this instrument hence components such as RF coils may well have a different impedance at RF frequencies (due to skin effect etc) than they do at audio.

Additionally iron-cored coils have an inductance dependant upon the measuring frequency and upon DC current flowing

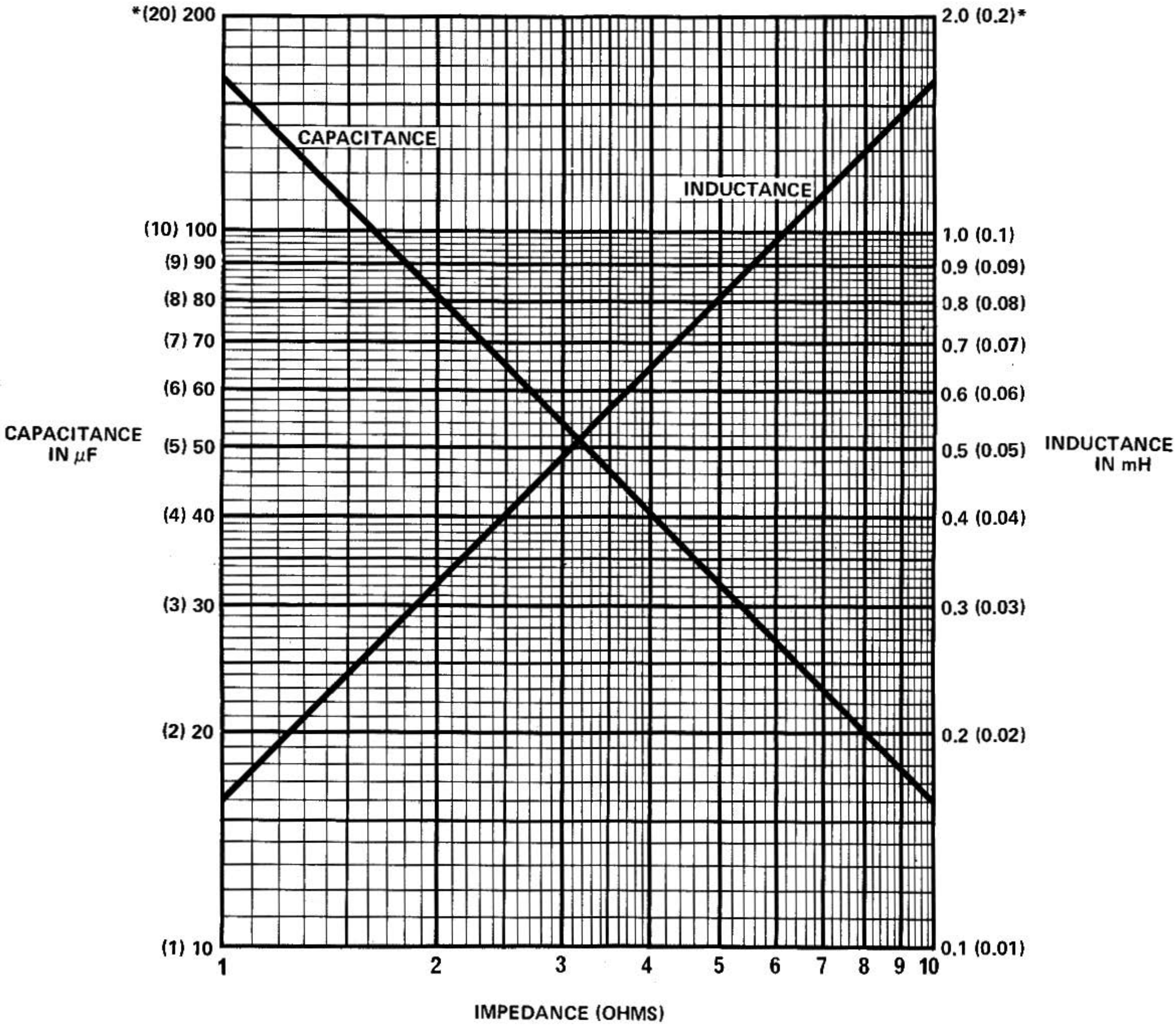
Hence such coils should be measured under conditions as close as possible to those when in circuit. Further the inductance value, as measured, will only be accurate on coils having a Q greater than 10.

If the DC resistance is greater than one tenth of the measured impedance the second formula should be used.

TURNS RATIO

To measure the turns ratio of an unknown transformer simply load the secondary with a value of resistance, R, which causes the impedance Zp (looking into the primary) to drop by 50% from the unloaded value. The turns ratio may then be calculated from

$$\frac{N_1}{N_2} = \sqrt{\frac{Z_p}{R}}$$ (N = number of turns)

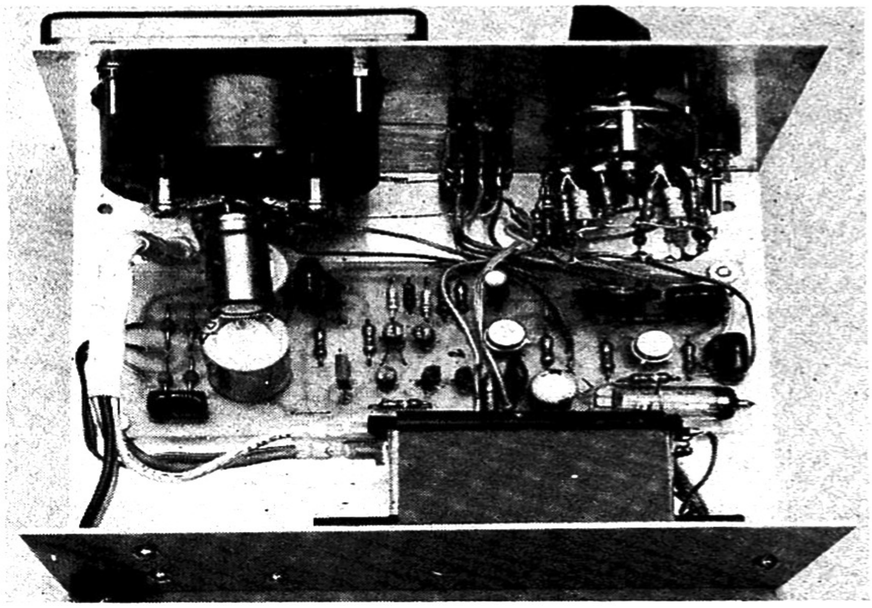


FOR IMPEDANCES GREATER THAN 10OHMS DIVIDE CAPACITANCE SCALE BY THE SCALING FACTOR AND MULTIPLY THE INDUCTANCE SCALES BY THIS FACTOR.
e.g. A CAPACITOR WHOSE IMPEDANCE IS 6000 OHMS (SCALING FACTOR X 1000) AT 1KhZ VALUE IS 27/1000 = 0.027uF.

*FIGURES IN BRACKETS ARE FOR 10 kHz

Fig. 5. Reactance chart for determining values of L or C from measured impedance at 1kHz (10kHz in brackets}.

Fig.4. Internal view of the meter shows how the board end other components are positioned.



This calculation is based on the fact that an impedance in the secondary is transformed to an impedance in the primary that is proportional to the square of the turns ratio.
Many other applications can be devised for an impedance meter and the few mentioned here are indicative of the usefulness of such an instrument.

CONSTRUCTION

Any accepted construction method may be used but the use of a printed circuit board will greatly simplify the procedure.
Components should be assembled onto the printed circuit board, with the aid of the component overlay Fig 4, making sure that all polarized components are orientated correctly. Capacitor C12 should not be fitted initially is the required polarity must be determined as follows.
Temporarily connect the transformer to the otherwise completed board and switch on the power. Measure the voltage from the amplifier at point H. This should be within ± 1.5 volts of zero, If this voltage is negative reverse the polarity of C12 to that shown on the overlay. If the voltage is positive use the polarity shown. This variation of voltage at point H is due to differences in the FET transistors Q1 and Q3.
Attach wires to all output connections of the printed circuit board allowing sufficient length to terminate them in their respective positions. Install the board in position using 12 mm long spacers and countersunk screws. Countersunk screws are necessary as they will be covered by the lid of the box. Install the power transformer and power lead, on the rear panel, together with the power-cord clamp and earth tag. Mount the slide switch to the front panel using countersunk screws.
Resistors R5 to R14 should be mounted on the rotary switch SW3 before mounting it on the front panel. If the 30, 300, 3k etc resistors are not available they may be replaced by a parallel combination; eg 30 ohms is obtained from 33 ohm and 330 ohms in parallel and 3k from 3k3 and 33k in parallel.
The rest of the front panel components, except the meter, (for ease of wiring) should now be mounted together with the escutcheon. The wiring can now be completed and the meter installed and connected.

USING THE METER

The meter should be used in the following manner:-
1. Switch the cal/impedance switch to cal.
2. Switch on power.
3. Select the required test frequency. The meter should read full scale, if not, adjust RV1.
4. If an external oscillator is used set the frequency and adjust oscillator output level to obtain full scale reading.
5. Connect the impedance to be measured.
6. Select the one megohm range.
7. Switch the cal/impedance switch to impedance.
8. Reduce the range, if necessary, to obtain a readable deflection. This reading is the required impedance; eg 0.6 on the 10k range is an impedance of 6k.
9. If desired the external frequency may be varied to obtain a plot of impedance versus frequency.
10. Switch back to 'Cal' before removing the impedance being measured.

TABLE 1

Error	Resistance (R2/R3)	Capacitor (C1/C4)	Capacitor (C2/C3)
1%	150k	0.001uF	100pF
2%	68k	0.0022uF	220pF
3%	47k	0.0033uF	330pF
4%	39k	0.0039uF	390pF
5%	27k	0.0056uF	560pF
6%	22k	0.0068uF	680pF
7%	18k	0.0082uF	820pF
8%	18k	0.0082uF	820pF
9%	15k	0.01uF	1000pF
10%	13k	0.01uF	1000pF

PARTS LIST ETI 116

RESISTORS (All 1/4 watt 5% carbon)

R24	4k7
R5	10R
R6	30R
R22	47R
R7	100R
R23	120R
R8	300R
R1,R18	390R
R25	430R
R19	680R
R9,R20,R21	1k
R2,R3	1k5
R4	2k2
R10	3k
R11,R16	10k
R12	30k
R13	100k
R14	300k
R15	1M
R17	22M
RV1	2k2 trim type potentiometer
TH1	Thermistor type R53

CAPACITORS

C11	33pF ceramic
C2,C3	0.01uF polyester
C1,C4,C7	0.1uF
C8,C10	0.1uF
C9	10uF 16V electrolytic
C12	100uF 6.3V electrolytic
C13	1000uF 6.3V electrolytic
C5,C6	1000uF 25V electrolytic

SEMICONDUCTORS

Q1,Q3	2N5459
Q2,Q5	BC108
Q4	BC178
Q6	BD137, BD139
Q7	BD138, BD140
IC1,IC2	uA741C DIL or TO5
D1 - D4	1N4001 diodes
D5,D6	1N914
ZD1	BZY88C3V3 zener diode

MISCELLANEOUS

T1	240V/7.5V-0-7.5V 1A transformer
M1	0.1mA FSD meter 75 x 65mm
SW1	3-pole 3 position slide switch
SW2	DPDT 240V toggle switch
SW3	1-pole 11 position rotary switch
SW4	DPDT toggle switch

PC board, Metal box, Front panel, small phone socket, pointer knob, 3 core flex and plug, rubber grommet and cable clamp four 12mm long spacers, two terminals, nuts and bolts etc.

IMPEDANCE METER

FREQUENCY CALIBRATION

The frequency should be within 10% of nominal if specified components are used. However, if a frequency meter is available the network can be trimmed to give the correct readings.

Measure both the 1kHz and the 10kHz and calculate the percentage errors. If either or both are low in frequency the resistors R2 and R3 can be paralleled with additional resistors to increase the frequency. Since this will affect both ranges choose the one with the greatest error. Table 1 gives the correct resistance to use.

Remeasure the frequencies. One frequency should now be right and the other high. The capacitors C1 and C4 or C2 and C3 can be paralleled by the appropriate capacitors as selected from Table 1.

LIMITATIONS

Due to stray capacitance, (about 15pF) associated with the front panel terminals and the switches, the 1 Megohm range is useful only up to about 4kHz. The 300k range is useful to about 10kHz.

When measuring series LCR networks (where the impedance rises greatly off resonance) it is usually necessary to parallel a resistor across the network to stabilise it. Once at resonance, the resistor may be removed for actual impedance measurement. The frequency can now be altered provided that the meter is not allowed to go off scale. The resistor used should be not more than 10 times the value of the network impedance at resonance.

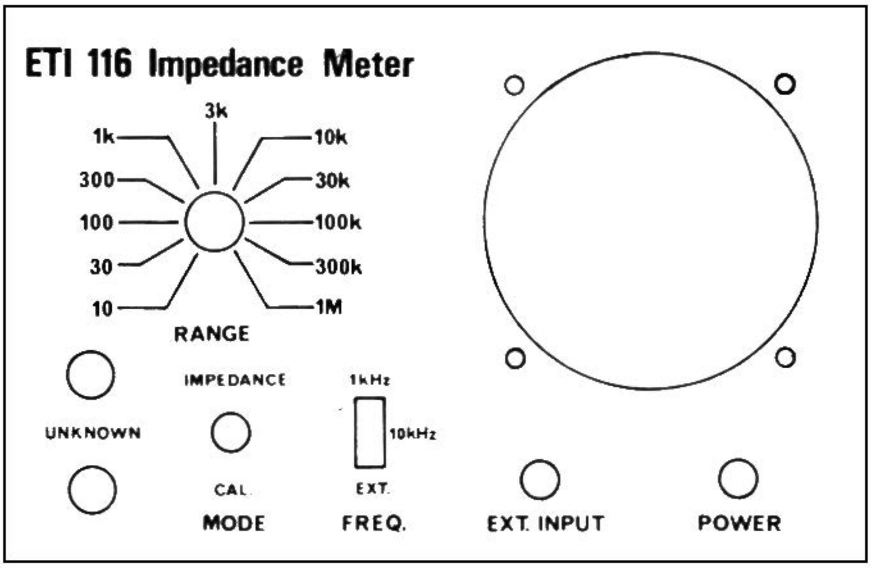


Fig.6. Layout of the front panel. Full size is 152mm x 98mm.

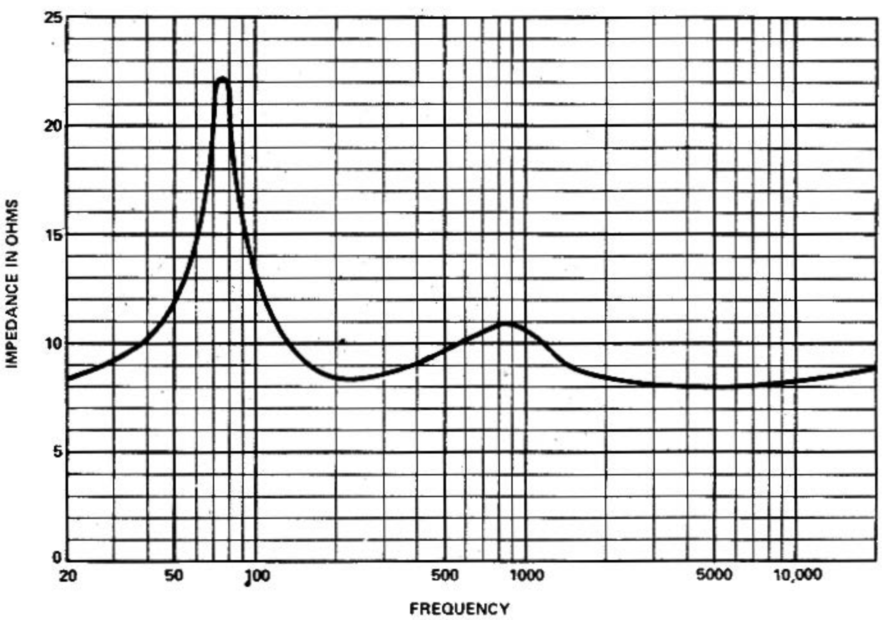


Fig.7. Impedance-versus-frequency plot for a two-way speaker box. Note the combined speaker/box resonance is 75Hz. The crossover frequency was 2kHz. A plot such as this would be extremely difficult to generate using a conventional LCR bridge, but is very simply done using the ET/116 impedance meter.

BICYCLE SPEEDOMETER

Be the first to have an electronic speedo on your bicycle.

BE THE FIRST to have an electronic speedometer on your, or your son's bicycle - calibrated in km/h too! The advantage of an electronic speedometer is that it doesn't take extra muscle power to drive it as do those mechanical ones. The small amount of energy needed comes from a battery which is switched on only when a speed reading is required - this is obtained by pressing a bicycle horn button mounted an the handlebars.

This project was developed around a stripped down bicycle, hence the photographs show bare elements only. The indicator part of the speedometer is a 1mA meter mounted in the lid of a suitably sized tin can, see Fig. 1. This is attached to the handlebar pinch bolt by means of a bracket fashioned from aluminium as can be seen in the photo.

The electronics are in four connected sections: the indicating section (Fig. 1); the switch, which is a push button mounted on the handlebar - a bicycle horn button is ideal; the photo transistor and resistor R2; and the lamp.

INDICATING SECTION

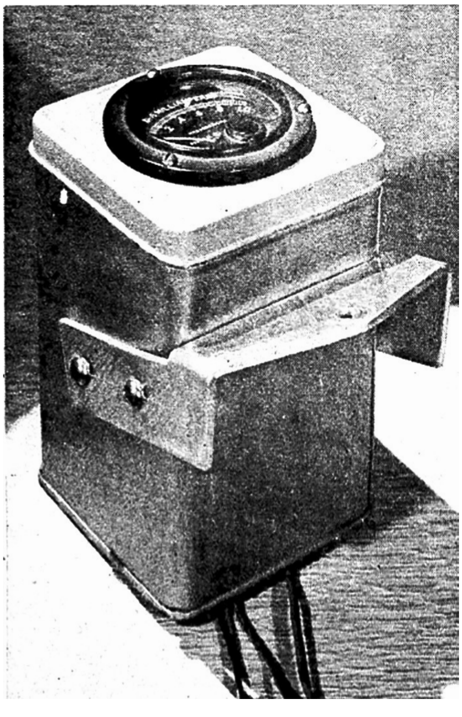
The components of the indicating section are mounted on a very simple printed circuit board, shown full size in Fig.4. This is attached by bent brass strips to the meter terminals. Veroboard or tag-board enthusiasts can use their favoured technique and save themselves the trouble of making a board if they wish.

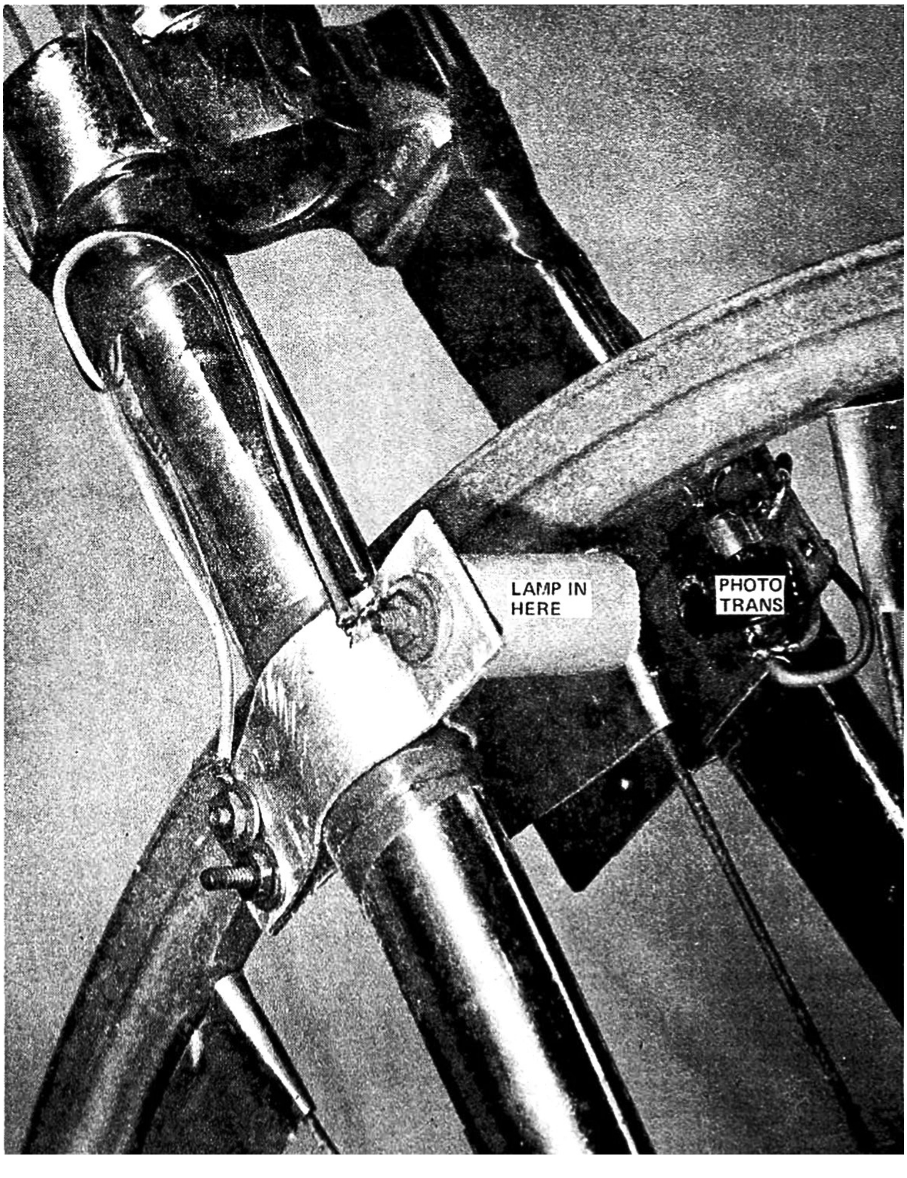
The battery, comprising six 1.5V cells cells, is contained in a battery case also inside the tin box. Note that an extra wire has to be soldered to a connection of the battery case to provide the tap at the 6 volt point as shown.

LAMP AND PHOTOTRANSISTOR

These items are mounted on the insides of the front forks of the bicycle. If this location is not available,

Fig.1. The meter section may be attached to the handlebars by a bracket held by the handlebar pinch bolt. (meter dial is seen here before re-calibration).





BICYCLE SPEEDOMETER

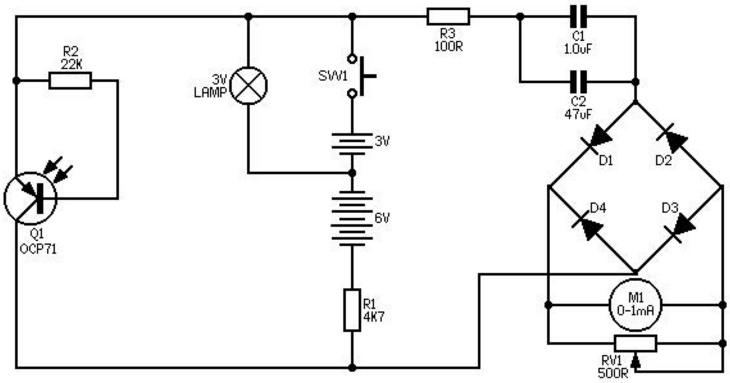


Fig.2. Circuit diagram of the complete unit.

due to the existence of brakes for example, then the rear forks or seat stay may be used as an alternative position. Whatever position is used it is important that the mounting brackets are attached securely so that they will not allow the parts to tangle with the spokes.
The photo transistor is attached to a small strip of phenolic board by means of a shaped brass clip. The resistor R2 is mounted on the opposite side of the board with its leads passed through small holes and bent to form an anchor. When the speedo is working properly this resistor may be covered with epoxy resin. The active portion of the photo transistor is shrouded from unwanted light by a short length of black plastic tubing, cut from an empty ball pen, epoxied on to the board.
Directly opposite the transistor is a lens-end bulb (pen torch variety) in a lamp holder mounted on a suitable bracket. The bulb is shrouded with a piece of plastic conduit -mainly to keep dirt away. It is very important that the bulb selected should have its filament on the bulb axis -so that the bright spot formed by the bulb is in line with the bulb and can be directed on to the transistor. These two elements must be adjusted so that they are rigidly aligned.

CONNECTION

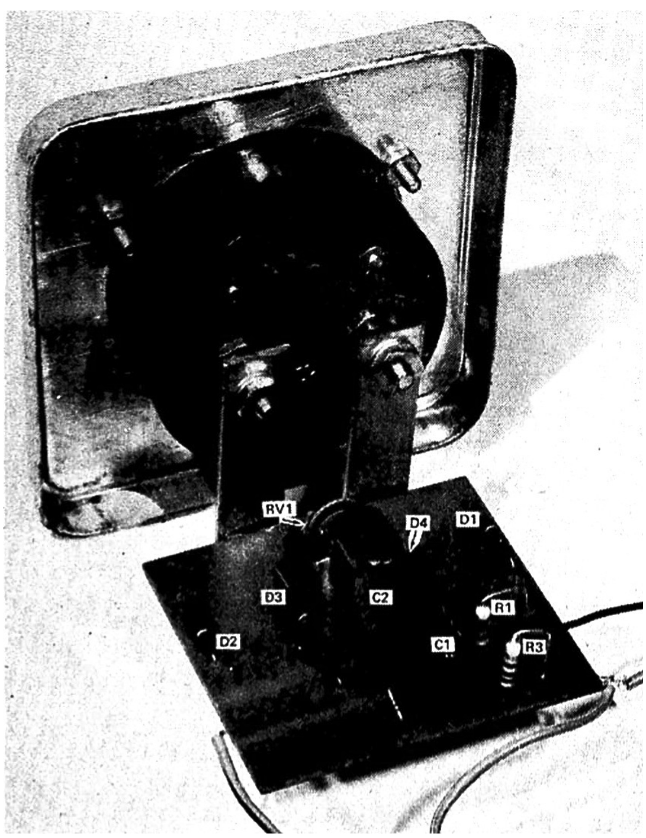
Light twin flex such as speaker lead is suitable for connecting the various elements together.

BARRIERS

The barriers on the prototype were pieces of aluminium about 90mm x 25 mm, actually cut from the aluminium plates used on office offset printers.
Simply bending the ends of the strips around the spokes and pinching them is sufficient to keep them in place.
Constructors who can't obtain similar aluminium could use old

HOW IT WORKS

The speedo is essentially a very simple tachometer which measures the frequency of pulses caused by interrupting a light beam shining on a photo transistor. Fig. 2 shows the circuit. The transistor and lamp are mounted on opposite sides of one of the bicycle wheels and the light from the lamp is interrupted by barriers between alternate pairs of spokes. Pulses of current flowing in the transistor circuit cause a pulsating voltage across the battery and load resistor R1. These pulses are fed to the 1mA meter through a bridge rectifie1 circuit D1 -D4 in series with a capacitor (actually C1 and C2 in parallel). The rectified meter current is directly proportional to the size of the capacitor and pulse frequency. The variable resistor RV1 provides calibration adjustment.



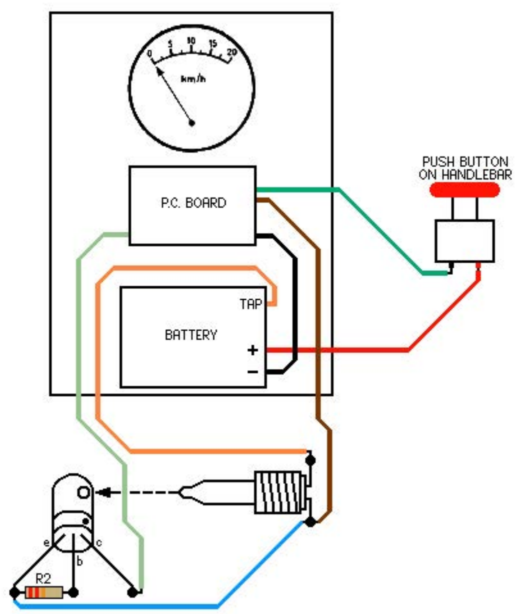


Fig.3. This schematic drawing shows how the various parts are interconnected. The direction of light should be perpendicular to plane of transistor body.

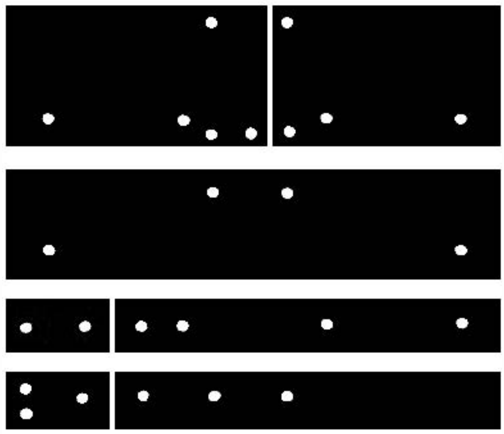


FIg.4. Printed circuit board (shown full size).

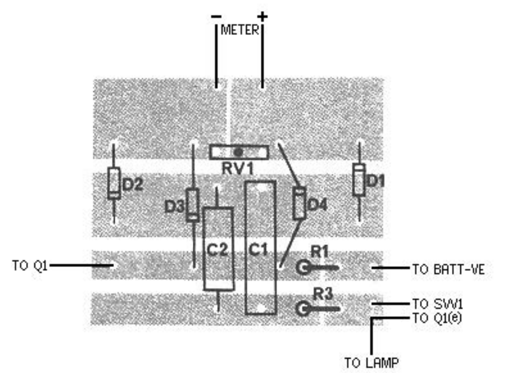


Fig. 5. How the components are mounted on the printed circuit board. The completed board may be fixed rigidly to the meter terminals by two copper straps.

aluminium or tin cans flattened out and perhaps painted.

CALIBRATION

A fairly accurate calibration may be made by attaching a piece of cardboard to the spokes so that it acts as a clicker as it passes the forks. Aim for a light click on one fork only so that the wheel is not slowed down too rapidly. Then. spinning the wheel. counting clicks over say 30 seconds and reading the meter at the same time, provides enough data to work out speeds and calibrate. (Something to do with your new calculator!).

The meter should be adjusted by the calibrating pot RV1 so that it reads full scale at some convenient speed such as 45 km/h. It may be hard to spin the wheel at this speed by hand, but the problem is overcome by driving it by a rope drive from a pulley fitted in the chuck of a drill. This works very well.

As the meter reads linearly, settings below full scale should be accurate enough using the divisions on the original meter scale.

Another possibility for calibration is for the bicycle to be paced by a car with a speedo of known accuracy (remember that only a maximum full scale reading is required).

The meter scale should be fitted with fresh numbers - Letraset figures stuck on white Contact background are ideal.

If there is any problem with getting a full scale reading the most likely causes are:- incorrect alignment of lamp and photo transistor, and a lamp which spreads out the light too much instead of concentrating it.

PARTS LIST ETI 235

R1	Resistor 4k7
R2	Resistor 2k2
R3	Resistor 100R
RV1	500R Potentiometer
C1	Capacitor 1.0uF plastic
C2	Capacitor 0.47uF plastic
D1-D4	OA200 or similar diodes
Q1	OCP71 or similar
S1	Push button switch - normally open - bike horn type
M	0-1mA meter

Lamp 3 volt lens end as used in pen torches
Battery - 6 x 1.5V cells in holder
Aluminium for barriers
Aluminium or light steel for brackets
Tin box

FINISHING TOUCHES

When all is in working order the battery case should be taped up and then 'nested' in plastic foam inside the tin box. The tin box should be sealed against the weather with plastic tape, and the lamp should be lightly soldered to the lamp holder to prevent its being loosened by vibration.

Now-two fascinating ways to enjoy saving money!

NEW! Sinclair Scientific kit

£19.95
(INC. VAT)

Britain's most original calculator now in kit form
The Sinclair Scientific is an altogether remarkable calculator.

It offers logs, trig, and true scientific notation over a 200-decade range – features normally found only on calculators costing around £100 or more.

Yet even ready-built, the Sinclair Scientific costs a mere £32.35 (including VAT).

And as a kit it costs under £20!

Forget slide rules and four-figure tables!
With the functions available on the Scientific keyboard, you can handle *directly*

- **sin and arcsin,**
- **cos and arccos,**
- **tan and arctan,**
- **automatic squaring and doubling,**
- **$\log_{10}$, antilog_{10}, giving quick access to x^y (including square and other roots),**
- **plus, of course, addition, subtraction, multiplication, division, and any calculations based on them.**

In fact, virtually all complex scientific or mathematical calculations can be handled with ease.

So is the Scientific difficult to assemble?
No. Powerful though it is, the Sinclair Scientific is a model of tidy engineering.

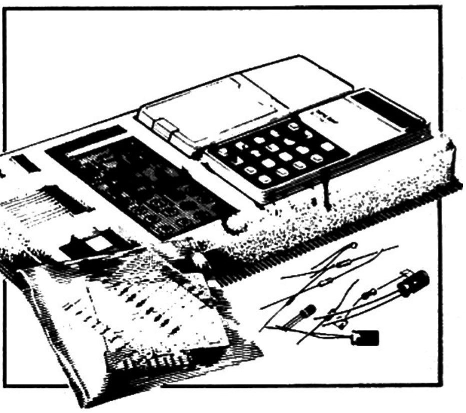
All parts are supplied – all you need provide is a soldering iron and a pair of cutters. Complete step-by-step instructions are provided, and our Service Department will back you throughout if you've any queries or problems.

Of course, we'll happily supply the Scientific or the Cambridge already built, if you prefer – they're still exceptional value.

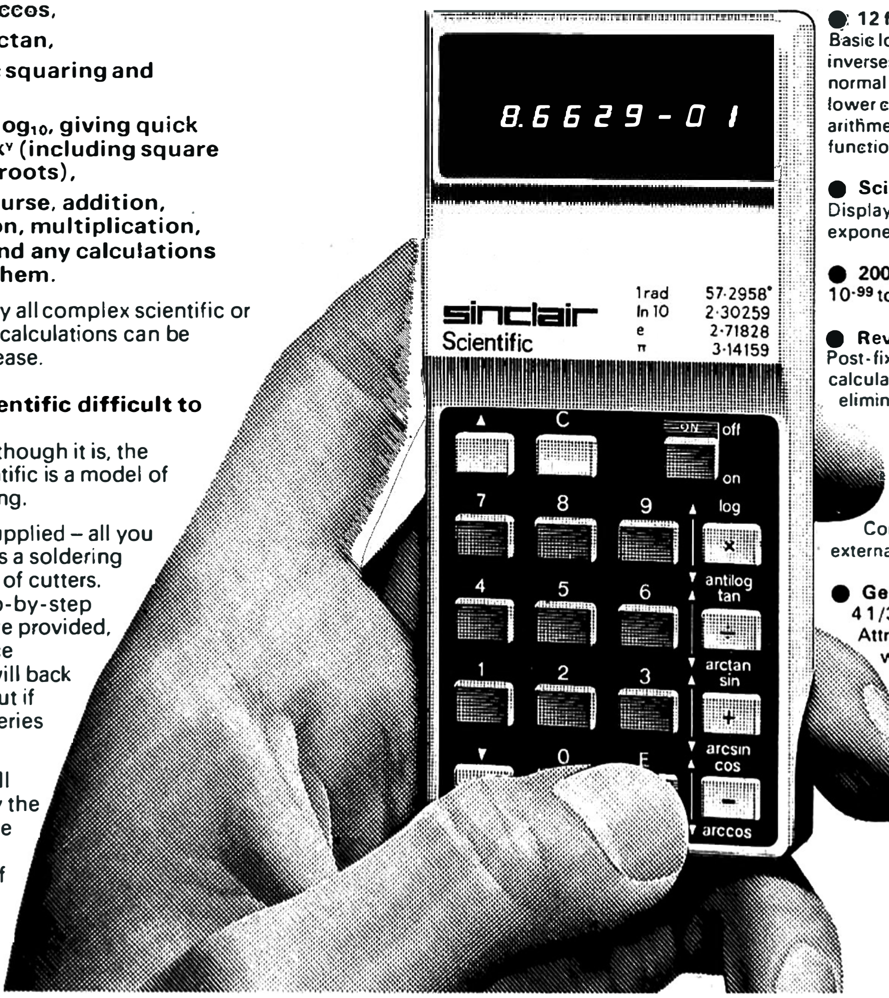
Components for Scientific kit
(illustrated)

1. Coil
2. LSI chip
3. Interface chips
4. Case mouldings, with buttons, windows and light-up display in position
5. Printed circuit board
6. Keyboard panel
7. Electronic components pack (diodes, resistors, capacitors, etc.)
8. Battery assembly and on/off switch
9. Soft carrying wallet
10. Comprehensive instructions for use

Assembly time is about 3 hours.



Features of the Sinclair Scientific



- **12 functions on simple keyboard**
Basic logs and trig functions (and their inverses), all from a keyboard as simple as a normal arithmetic calculator's. 'Upper and lower case' operation means basic arithmetic keys each have two extra functions.
- **Scientific notation**
Display shows 5-digit mantissa, 2-digit exponent, both signable.
- **200-decade range**
10^{-99} to 10^{+99}
- **Reverse Polish logic**
Post-fixed operators allow chain calculations of unlimited length – eliminate need for an = button.
- **25-hour battery life**
4 AAA manganese alkaline batteries (e.g. MN 2400) give 25 hours continuous use. Complete independence from external power.
- **Genuinely pocketable**
4 1/3" x 2" x 11/16". Weight 4 oz. Attractively styled in grey, blue and white.

light dimmer

AL THOUGH commercially made light dimmers have fallen considerably in price recently, they still usually command about £4.00 (though we have seen them advertised a bit cheaper).

In addition to giving control over the brightness of a bulb, modern circuits using a Triac actually save electricity and will eventually pay for themselves though we do not advocate them for this reason.

The circuit' for a light dimmer is not complex, as will be seen from Fig. 1, nor are the components all that expensive.

Including everything, we reckon the cost of this project at about £2.50. The circuit overcomes a drawback in many of the commercial models: the Triac is protected against mains transients. Many versions do not come on until the control is rotated over half way, yet current is still being drawn; in our circuit the light comes on almost at minimum setting.

An unusual facility is also incorporated in the design which some readers might wish to take advantage of. A light dimmer is perfect for use with a TV set as neither viewing in full light or complete darkness is very pleasant. The circuit is so arranged that the switch can also handle a load which is not controlled by the dimmer circuitry. Thus, the TV can be switched on using the unit, but only the light will be controlled. The same arrangement also makes it possible to control only one light, leaving others unaffected.

The unit will handle 500W as shown, but with some modifications can easily be adapted to control 1kW.

CONSTRUCTION

Use of a printed circuit board (the pattern as shown in Fig.2 is recommended. Veroboard can be used but mains voltages are present and many people will consider that the track spacing is a bit close.

First mount the terminals A-D. These are taken from a small terminal connecting block. Each terminal is fitted to the component side of the board being held in place with a screw which can then be soldered to the copper track.

The choke L 1 is made up from a piece of ferrite rod, 1/4 inch diameter and 1 1/2 inches long, wound with 55 turns of 28 swg enamelled copper wire, wound tightly and secured at each end by a strip of adhesive tape. Tin the ends of the wire and attach the choke to the PCB.

Now mix up some quick setting epoxy resin and smear this over the windings, making sure. that some will anchor the choke to the board. If there is any epoxy left over, smear this over the soldered terminals as this will help with rigidity.

The other components can now be mounted, the Triac should be fitted as close to the board as possible. The switch contacts of the pot must fit through the PCB. and should be fitted so that the back of the switch

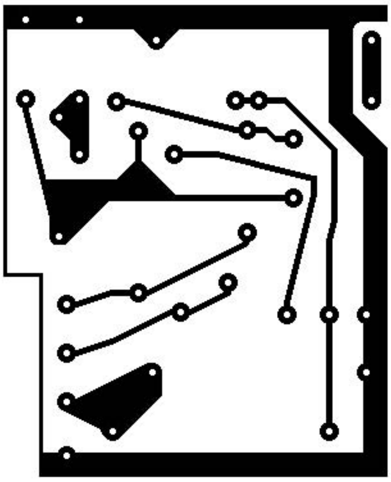


Fig.2. The PCB pattern.

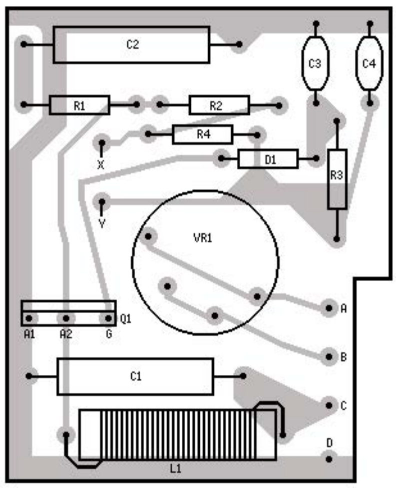
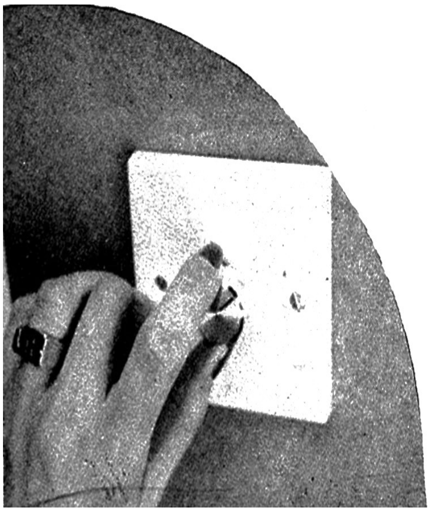


Fig. 3. Components layout, seen from the front of the PCB. The PCB has been flipped from left to right.



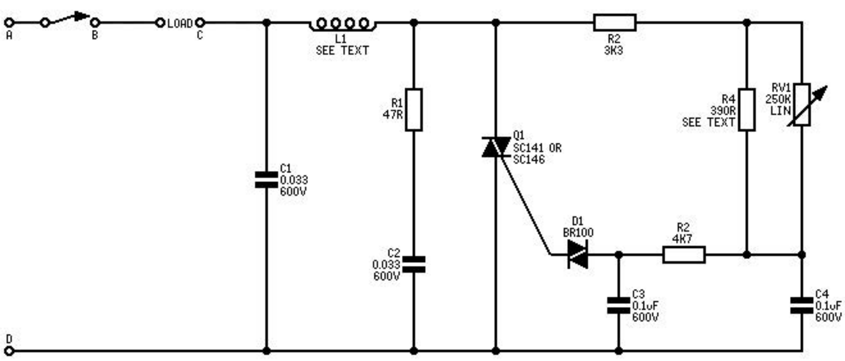


Fig.1. The circuit of the dimmer.

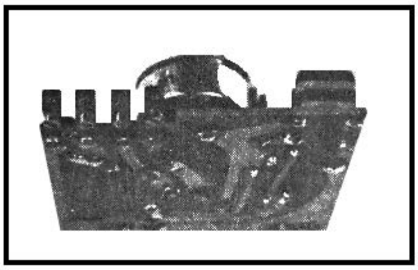


Fig.4. This shows the mounting of the terminals A-D. The mounting screws are soldered to the copper track.

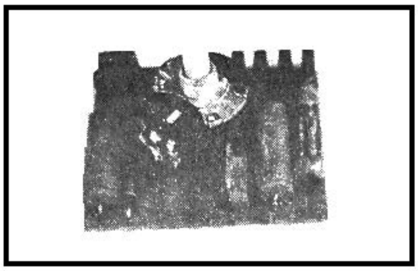


Fig.5. The completed unit, without faceplate and knob.

is firmly up to the board. Note that a double pole switch is used and both poles are wired up in parallel. This is done as the rating of switch contacts in pots is usually about 2A, bringing it a bit close to our 500W rating: doubling up gives a better margin.
Blank switch plates are available, made by M. K. Products, and a 3/8" hole is necessary. As the plastic is rather brittle, it is best to drill a smaller hole and ream out the remainder. With the MK 3827 (used in the prototype) there is a moulded flange on the inside which requires a small slot to be filed to give clearance for the Triac.
For those wishing to use the unit at 1 kW it is necessary, for safety reasons, to use a separate switch from that in the pot. A suitable heatsink will also be necessary on the Triac and the wire gauge on L1 should be slightly heavier: 24 or 26 s.w.g. The greatest drawback when using the higher power is that RFI can be annoying. When used with a lower load, the radio interference is very low and could not be detected 12" from the prototype, even with the radio's ferrite rod in line with the choke.

PARTS LIST

RESISTORS (1/4 watt or 1/2 watt)

R1	47R
R2	3k3
R3	4k7
R4	390k (see text)
RV1	250k potentiometer linear with double pole switch

CAPACITORS

C1, C2	0.033uF 600V
C3, C4	0.1uF 600V
Q1	SC141 or SC146 or similar 400V 6A triac
D1	BR100 diac
L1	Choke (see text)

PCB, Terminal connectors (4 off), Switch faceplate, Control knob

HOW IT WORKS

As with practically all modern dimmer circuits, this one makes use of a Triac for the power control.
A Triac can be regarded as an electronic switch that is turned on by a pulse at a predetermined time in each half cycle and turns off at the end of the half cycle.
Control of the Triac is of the simple resistor/capacitor and Diac system. By varying the resistance of potentiometer RV1, the time constant of RV1/C4 so as to, change the phase at the junction RV1/C4 is passed to the Diac through limiting resistor R3. The Diac is connected to the gate of the Triac and as the Diac is in fact a bi-directional diode, both the positive and negative pulses are applied to the gate.
Capacitor C1 and choke L1 are for suppressing RF1 while R1 and C2 are used for transient suppression.
Resistor R4 is fitted so as to allow full control of light while using RV1. The ideal value for RV1 is 150k but as this value is virtually impossible to obtain, it is paralleled by R4 to give effectively this value.

TEST AND OPERATION

Warning: The circuit board has 240V mains applied to and extreme caution should be used when installing the unit.
Before fitting the unit, it is worth testing on the bench, using a table lamp as a load. Connect this as follows. Terminal A: mains live, Terminals B and C: load, Terminal D: Mains neutral.
If all is well, the unit can be fitted in place of a modern switch fitted in a box. In very shallow boxes, there may not be room for the unit but extension mouldings are available from the same people who supply the switch plate itself.
If the facility for switching an uncontrolled load is not required (i.e. using it conventionally), a jumper wire should be fitted between Terminals B and C and the two wires which normally connect to the switch that the dimmer replaces can be connected to A and D. The unit will work whichever way around the wires are connected but to keep as little of the PCB. live as possible, the live should be connected to A.

INTERNATIONAL 3600

CONSTRUCTIONAL DETAILS

UNLIKE our larger 4600 unit, the modules in the 3600 are not designed to be removable as a single unit. Additional components (such as input and output switching for the oscillators) are mounted directly on the front panel (rather than on a sub-panel) and some printed circuit boards, such as the keyboard controller, are mounted in the box and connected to the potentiometers and switches on the front panel by means of leads.

OSCILLATORS

These are the same as the larger unit except that only three (instead of four) are used. The oscillators, as described, are configured for use with F to F keyboards. If C to B keyboards· are used resistors R11 and R12 should be changed to 47k. In using the larger

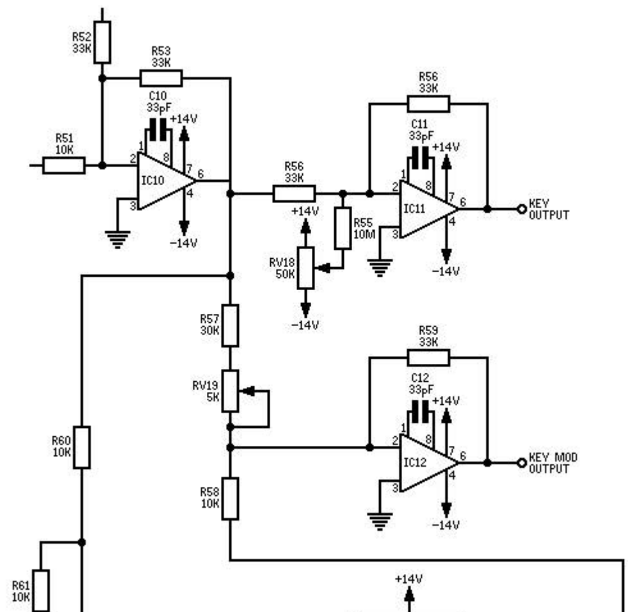
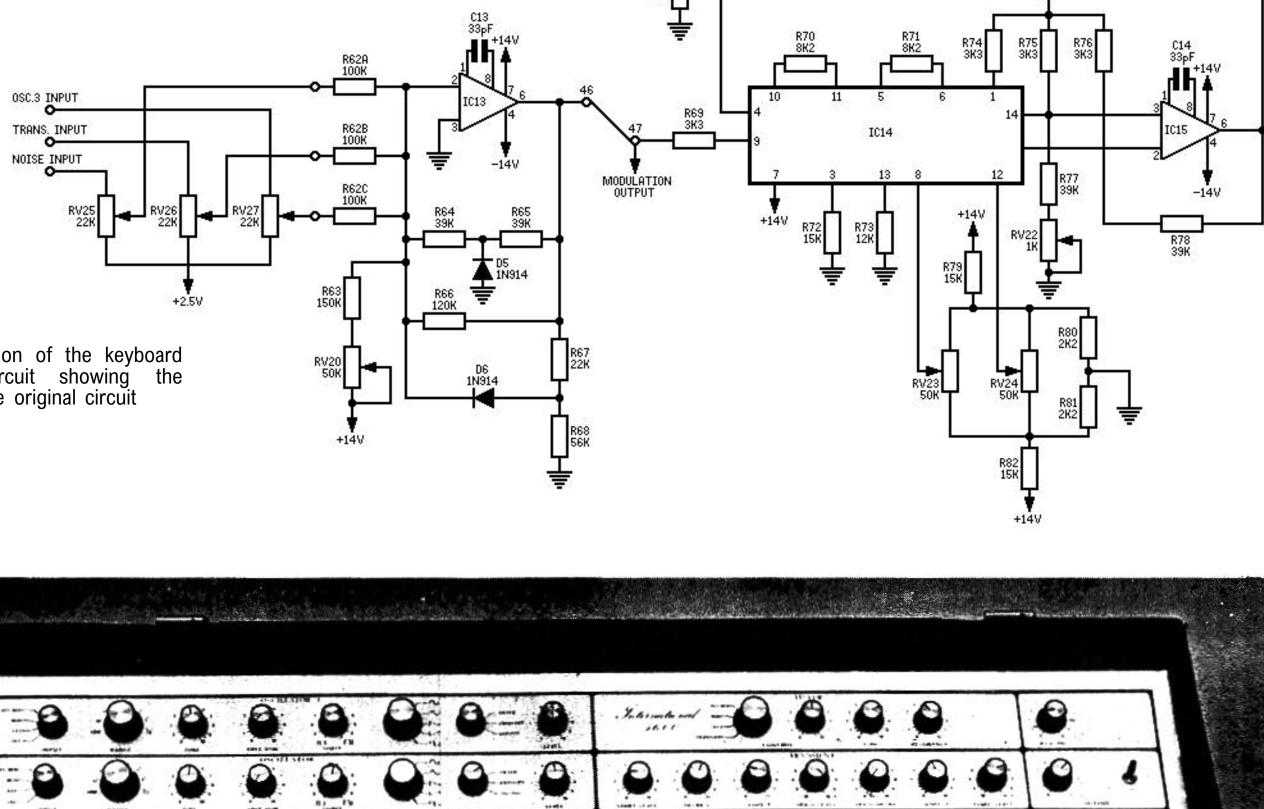
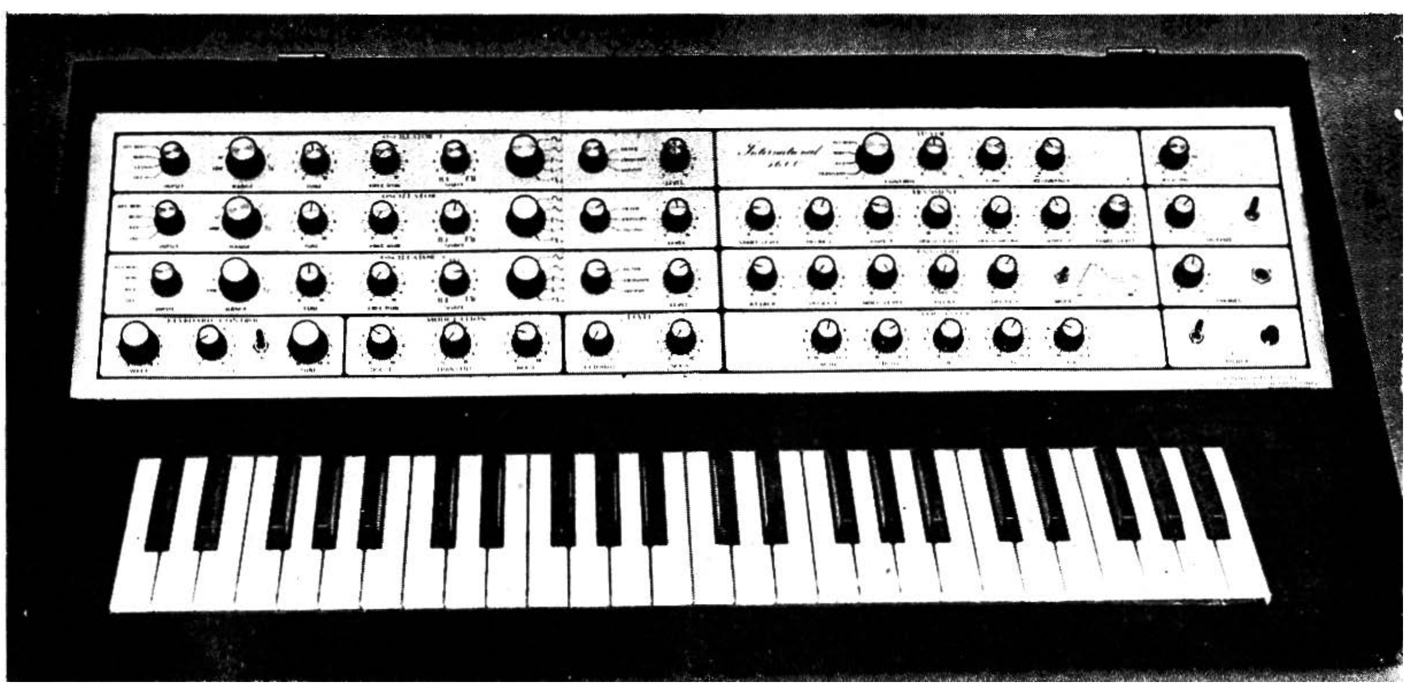
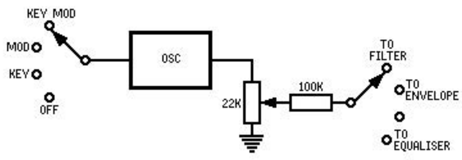



Fig. 1. Portion of the keyboard controller circuit showing the changes to the original circuit



SYNTHESIZER



4600 unit it was determined that the low range of the oscillator is lower than really necessary. It is therefore suggested that the value of C4 be reduced to 1uF

Additional front panel controls required for the oscillator are a four position rotary switch switch to select input, a level control potentiometer and resistor, and a three position rotary switch on the output (see diagram left).

KEYBOARD CONTROLLER

The keyboard controller is substantially as published in February 1974 and the subsequent modification published in August 1974. Some parts are deleted and others added (see parts list) to make minor improvements and to adapt the unit to the 3600 format.

A minor modification, which improves accuracy in setting up the keyboard modulation output, is performed by changing R57 to 30k, RV19 to 5k, R77 to 39k and RV22 to 1k (see Fig. 1).

To set up the controls the following procedure should be used. Connect two oscillators to the 'key output', select '4 foot' range and check that the oscillators track over the entire keyboard range. After setting up RV23 and RV24 as described for the 4600 Unit, connect one oscillator to 'KEY OUTPUT' and the other to 'KEY MOD OUTPUT'.

Disconnect the link between 46 and 47 (if connected) connect 47 to zero volts and adjust RV22 to 'beat' the oscillators on the lowest note. Then adjust RV19 at the top end. These two controls interact and it will be necessary to repeat the procedure several times to get both ends right. The range of RV22 has been made small so that adjustment is less sensitive. However this means that component tolerances may cause the correct setting to be outside the range of RV22. If the correct setting is below the minimum setting of RV22 parallel R77 with 1.5 megohm. If still not correct use 820k. If the correct setting is above the maximum setting of RV22 parallel R78 with 1.5 megohm or 820k as required.

On the 3600 the modulation potentiometer, RV21 as fitted to the 4600, is not used and 46 and 47 are therefore linked. An output is taken from this point, being the modulation output. To prevent confusion the output of IC12 is relabelled 'KEY MOD OUTPUT'.

The input to the exponential converter, IC13, is modified to accept the three inputs required. The. bias network R63-RV20, has also been changed.

The original R62 (47k) is replaced by three resistors, labelled R62A, B and C, each of 100k. To save making a different printed circuit board the two additional resistors are glued onto the top surface of the board with epoxy cement.

Potentiometer RV20 is adjusted to give zero volts at point 46 when all modulation controls are at zero. Zero volts can be checked by switching one of the oscillators to 1/2 foot range and

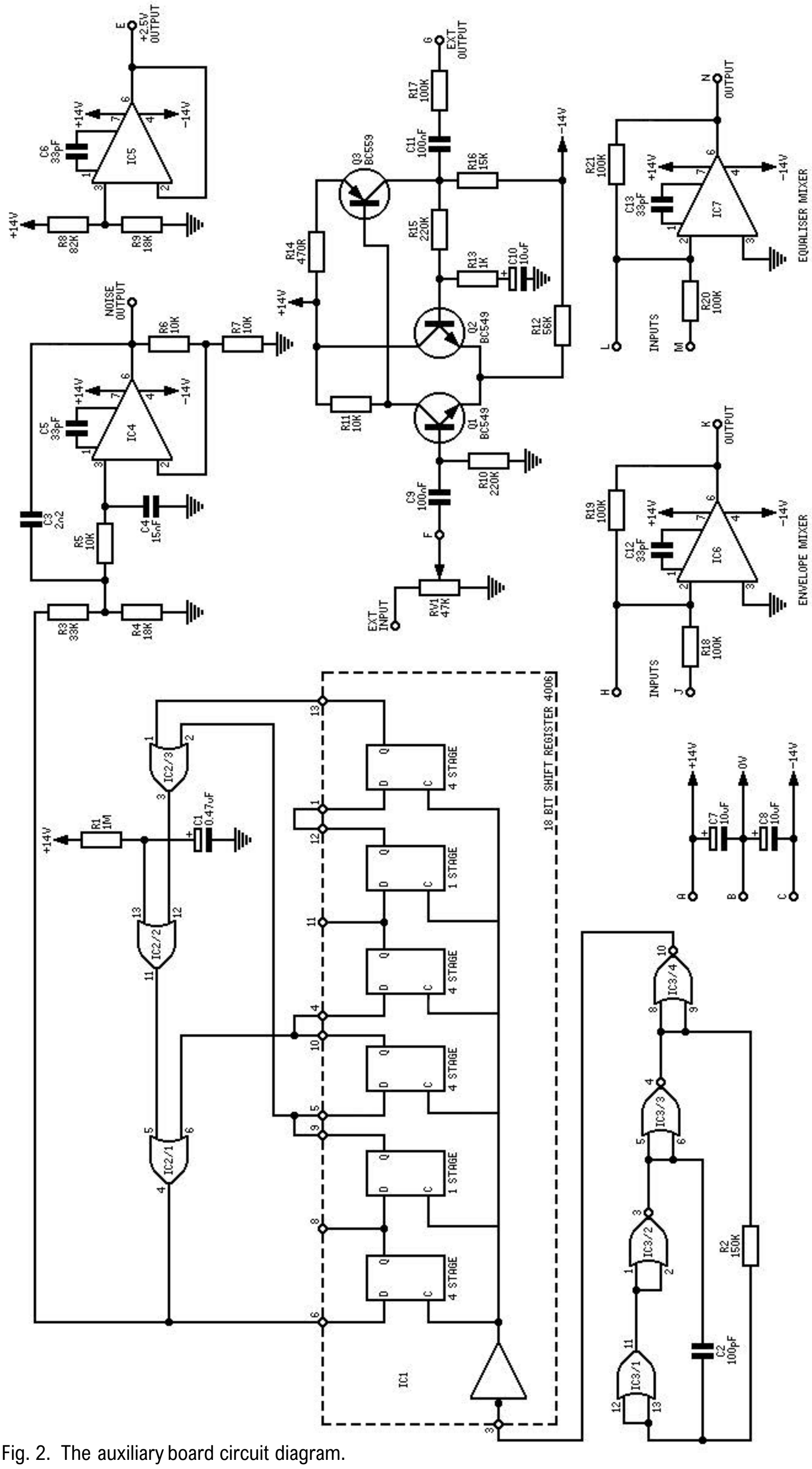


Fig. 2. The auxiliary board circuit diagram.

INTERNATIONAL 3600 SYNTHESIZER

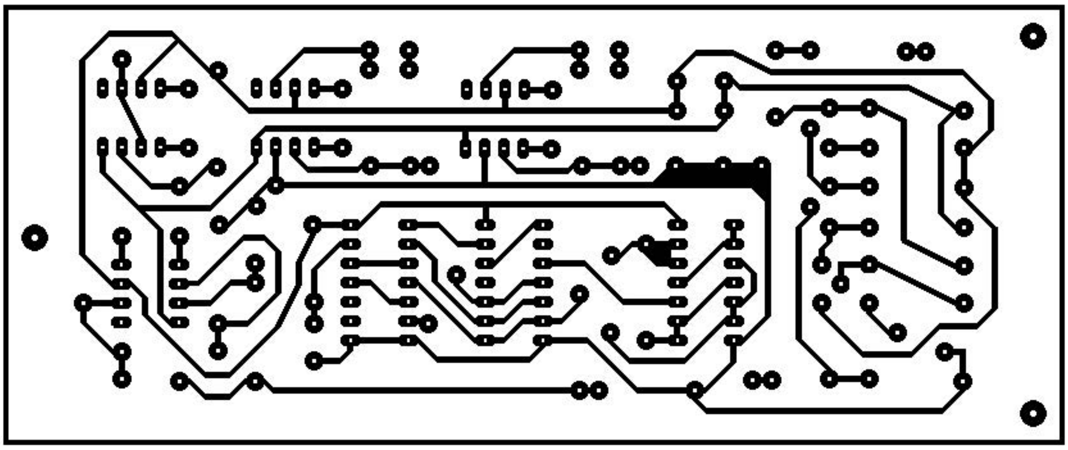


Fig. 3. Printed circuit board layout for the auxiliary board. Full size 142 x 57 mm.

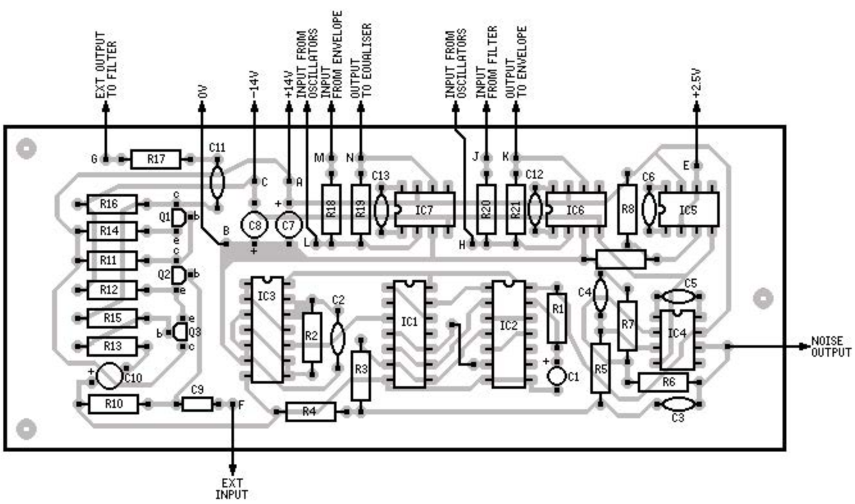


Fig. 4. Component overlay for the auxiliary board. The PCB is flipped from left to right.

PARTS LISTS

PARTS LIST - OSCILLATORS
(Three required)

1 Oscillator as published in ETI February 1974
1 Switch 1 pole 4 position rotary (or 2 pole 4 position)
1 Switch 1 pole 3 position rotary (or 3 pole 2 position)
1 Potentiometer 22k Lin rotary
1 Resistor 100k 1/4 watt 5%

KEYBOARD CONTROLLER

1 Keyboard Controller as published in ETI February 1974
1 Keyboard Controller mod as published in ETI February 1974
1 1k trimpot
1 5k trimpot
1 50k trimpot
3 22k potentiometers Lin rotary
3 100k resistors 1/4 watt 5%
1 150k resistor 1/4 watt 5%
1 30k resistor 1/4 watt 5%
1 39k resistor 1/4 watt 5%

The following parts are not used - delete from list
2 10k trimpot
1 10k rotary potentiometer
1 100k trimpot
1 27k resistor 1/4 watt 5%
1 33k resistor 1/4 watt 5%
1 47k resistor 1/4 watt 5%
1 220k resistor 1/4 watt 5%

PARTS LIST - AUXILIARY BOARD

R14	470R resistor 1/4 watt 5%
R13	1k resistor 1/4 watt 5%
R5,6,7,11	10k resistor 1/4 watt 5%
R16	15k resistor 1/4 watt 5%
R4,9	18k resistor 1/4 watt 5%
R3	33k resistor 1/4 watt 5%
R12	56k resistor 1/4 watt 5%
R8	82k resistor 1/4 watt 5%
R17,18,19	100k resistor 1/4 watt 5%
R20,21	100k resistor 1/4 watt 5%
R2	150k resistor 1/4 watt 5%
R10,15	220k resistor 1/4 watt 5%
R1	1M resistor 1/4 watt 5%
RV1	47k Log potentiometer rotary
C6,11,12	33pF ceramic capacitor
C2	100pF ceramic capacitor
C3	0.0022uF polyester capacitor
C4	0.015uF polyester capacitor
C9,11	0.1uF polyester capacitor
C1	0.47uF tantalum capacitor
C7,8,10	10uF 16V electrolytic capacitor
Q1,2	BC109 transistor or similar
Q3	BC179 transistor or similar
IC1	4006
IC2	4030
IC3	4001
IC4,5,6,7	LM301A

Back issues are available for some of the original 4600 articles (Not March or September which ran from January to September 1974
Maplin Electronic Supplies, P.O. Box 3, Rayleigh, Essex, SS6 8LR will be stocking all parts for the ETI 3600 as they did for the ETI 4600.

zero volts can he checked by switching one of the oscillators to the 1/2 foot range and the input selector to off. Adjust the oscillator to the lowest frequency possible. Now select the modulation input and adjust RV20 to give the same frequency.

AUXILIARY BOARD

The auxiliary hoard contains the odd circuitry necessary to interface the various sections of the 3600 synthesizer. It contains two mixers one for the envelope inputs and one for the equalizer inputs. A circuit is incorporated to derive a 2.5 volt supply for the modulation potentiometers.

Additionally the board contains a noise generator, similar to that described in the March. 1974 edition, with the exception that it is permanently connected to produce 'pink' noise.

Reference should be made to that issue for the principle of operation of this circuit. The two mixers are simply LM301 operational amplifiers which have two inputs. One input is via a 100k resistor and the other is direct to pin 2 of the IC. The later input is used for the oscillator which has a 100k output impedance.

A 2.5 volt supply is derived from the +14 volt supply by divider R8 and R9. This voltage is buffered by IC5 which is connected as a unity gain non-inverting amplifier.

The external input amplifier uses a differential pair Q1 and Q2, followed by an additional gain stage, Q3. The feedback components R15, R13 and C10 provide a gain of approximately 40dB. The output of this amplifier, goes to the filter input.

to be continued next month

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CD 4029AE	£1.40	£3.50
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2N457A	1.20	2N3391A	0.29	2N5298	0.50	AF118	0.35	BC212K	0.16	BF163	0.32	LM380	1.10	OC71	0.17
2N490	3.15	2N3392	0.15	2N5457	0.49	AF124	0.30	BC212L	0.16	BF166	0.40	LM381	2.20	OC72	0.25
2N491	4.38	2N3393	0.15	2N5458	0.45	AF125	0.30	BC214L	0.18	BF167	0.25	LM702C	0.75	OC81	0.25
2N492	3.00	2N3394	0.15	2N5459	0.49	AF126	0.28	BC237	0.16	BF173	0.27	LM709T099	0.48	OC83	0.24
2N493	5.20	2N3402	0.18	2N5492	0.58	AF127	0.28	BC238	0.15	BF177	0.29	8DIL	0.38	ORP12	0.55
2N696	0.22	2N3403	0.19	2N5494	0.61	AF139	0.65	BC239	0.15	BF178	0.33	14DIL	0.40	R53	1.80
2N697	0.16	2N3440	0.59	2N5496	0.68	AF186	0.46	BC251	0.25	BF179	0.43	LM710	0.47	SL414A	1.80
2N698	0.82	2N3441	0.97	2N6027	0.45	AF200	0.65	BC253	0.25	BF180	0.35	LM3900	0.70	SL610C	1.70
2N699	0.59	2N3442	1.40	2N5777	0.45	AF239	0.65	BC257	0.15	BF181	0.36	LM723C	0.90	SL611C	1.70
2N706	0.14	2N3414	0.10	3N128	0.73	AF240	0.90	BC258	0.16	BF182	0.35	LM741T099	0.40	SL612C	1.70
2N706A	0.16	2N3415	0.10	3N139	1.42	AF279	0.70	BC259	0.17	BF183	0.55	8DIL	0.40	SL620C	2.60
2N708	0.17	2N3416	0.15	3N140	1.00	AF280	0.79	BC261	0.25	BF184	0.30	14DIL	0.38	SL621C	2.60
2N709	0.42	2N3417	0.21	3N141	0.81	AL102	1.00	BC262	0.25	BF185	0.30	LM747	1.00	SL623	4.59
2N711	0.50	2N3638	0.15	3N200	2.49	AL103	1.00	BC263	0.25	BF194	0.12	LM7488DIL	0.60	SL640C	3.10
2N718	0.23	2N3638A	0.15	40361	0.40	BC107	0.14	BC300	0.38	BF195	0.12	LM7805	2.00	SL641C	3.10
2N718A	0.28	2N3639	0.27	40362	0.45	BC108	0.14	BC301	0.34	BF196	0.13	14DIL	0.73	SN76003N	2.92
2N720	0.57	2N3641	0.17	40363	0.88	BC109	0.14	BC302	0.29	BF197	0.15	LM7805	2.50	SN76013N	1.95
2N914	0.39	2N3702	0.11	40389	0.46	BC113	0.15	BC303	0.54	BF198	0.18	LM7812	2.50	SN76023N	1.60
2N916	0.28	2N3703	0.12	40394	0.56	BC115	0.17	BC307	0.17	BF200	0.40	LM7815	2.50	SN76033N	2.92
2N918	0.32	2N3704	0.15	40395	0.65	BC116	0.17	BC308A	0.15	BF225J	0.23	LM7824	2.50	ST2	0.20
2N929	0.37	2N3705	0.15	40406	0.44	BC116A	0.18	BC309C	0.20	BF244	0.21	MC1303	1.50	TAA300	1.80
2N930	0.22	2N3706	0.15	40407	0.35	BC117	0.21	BC327	0.27	BF245	0.45	MC1310	2.92	TAA263	1.10
2N1302	0.19	2N3707	0.18	40408	0.50	BC118	0.14	BC328	0.28	BF246	0.58	MC13300P	0.90	TAA350	2.10
2N1303	0.19	2N3708	0.14	40409	0.52	BC119	0.29	BC337	0.20	BF247	0.65	MC135IP	0.80	TAA550	0.60
2N1304	0.26	2N3709	0.15	40410	0.52	BC121	0.35	BC338	0.20	BF254	0.19	MC1352P	0.80	TAA611C	2.18
2N1305	0.24	2N3710	0.15	40411	2.25	BC125	0.16	BCY30	0.80	BF255	0.19	MC1466	3.50	TAA621	2.03
2N1306	0.31	2N3711	0.15	40594	0.74	BC126	0.23	BCY31	0.85	BF257	0.47	MC1469	2.75	TAA661B	1.32
2N1307	0.30	2N3712	1.20	40595	0.84	BC132	0.30	BCY32	1.15	BF258	0.53	ME0402	0.20	TBA641B	2.25
2N1308	0.47	2N3713	1.20	40601	0.67	BC134	0.13	BCY33	0.85	BF259	0.55	ME0404	0.13	TBA651	1.69
2N1309	0.47	2N3714	1.38	40602	0.46	BC135	0.13	BCY34	0.79	BFR39	0.24	ME0412	0.18	TBA810	1.50
2N1671	1.54	2N3715	1.50	40603	0.58	BC136	0.17	BCY38	1.00	BFR79	0.24	ME4102	0.11	TBA820	1.15
2N1671A	1.67	2N3716	1.80	40604	0.56	BC137	0.17	BCY39	1.50	BFS21A	2.30	ME4104	0.11	TBA920	4.00
2N1671B	1.85	2N3771	2.20	40636	1.10	BC138	0.24	BCY40	0.97	BFS28	0.92	MJ480	0.95	TIL209	0.30
2N1711	0.45	2N3772	1.80	40669	1.00	BC140	0.68	BCY42	0.28	BFS61	0.27	MJ481	1.20	TIP29A	0.49
2N1907	5.50	2N3773	2.65	40673	0.73	BC141	0.68	BCY58	0.30	BFS98	0.25	MJ490	1.05	TIP30A	0.58
2N2102	0.66	2N3779	3.15	AC126	0.20	BC142	0.23	BCY59	0.32	BFX29	0.30	MJ491	1.45	TIP31A	0.62
2N2147	0.78	2N3790	2.40	AC127	0.20	BC143	0.25	BCY70	0.17	BFX30	0.27	MJ2955	1.00	TIP32A	0.74
2N2148	0.94	2N3791	2.35	AC128	0.20	BC145	0.21	BCY71	0.22	BFX84	0.24	MJE340	0.48	TIP33A	1.01
2N2160	0.90	2N3792	2.60	AC151V	0.27	BC147	0.14	BCY72	0.15	BFX85	0.30	MJE370	0.65	TIP34A	1.51
2N2218A	0.22	2N3794	0.10	AC152V	0.49	BC148	0.14	BD115	0.75	BFX87	0.28	MJE371	0.75	TIP35A	2.90
2N2219	0.24	2N3819	0.37	AC153	0.35	BC149	0.15	BD116	0.75	BFX88	0.25	MJE520	0.60	TIP36A	3.70
2N2219A	0.26	2N3820	0.38	AC153K	0.40	BC153	0.18	BD121	1.00	BFX89	0.90	MJE521	0.70	TIP41A	0.79
2N2220	0.25	2N3823	1.42	AC154	0.25	BC154	0.18	BD123	0.82	BFY50	0.23	MJE2955	1.20	TIP42A	0.90
2N2221	0.18	2N3904	0.27	AC176	0.30	BC157	0.16	BD124	0.67	BFY51	0.23	MJE3055	0.75	TIP29c	0.80
2N2221A	0.21	2N3906	0.27	AC176K	0.40	BC158	0.16	BD131	0.40	BFY52	0.21	MP8111	0.32	TIP30c	0.85
2N2222	0.20	2N4036	0.67	AC187K	0.35	BC160	0.60	BD132	0.50	BFY53	0.18	MP8112	0.40	TIP31c	1.00
2N2222A	0.25	2N4037	0.42	AC188K	0.40	BC167B	0.15	BD135	0.43	BFY90	0.75	MP8113	0.47	TIP32c	1.25
2N2368	0.25	2N4058	0.18	ACY18	0.24	BC168B	0.15	BD136	0.49	BRY39	0.48	MPF102	0.30	TIP33c	1.45
2N2369	0.20	2N4059	0.15	ACY19	0.27	BC168C	0.15	BD137	0.55	BSX20	0.21	MPSA05	0.25	TIP34c	2.60
2N2369	0.22	2N4060	0.15	ACY20	0.26	BC169B	0.15	BD138	0.63	BSX20	0.21	MPSA06	0.31	TIP41c	1.40
2N2646	0.55	2N4061	0.15	ACY21	0.26	BC169C	0.15	BD139	0.71	BSX21	0.29	MPSA12	0.35	TIP42c	1.60
2N2647	0.98	2N4062	0.15	ACY28	0.20	BC170	0.15	BD140	0.87	BU104	2.00	MPSA55	0.26	TIP49	0.70
2N2904	0.22	2N4126	0.21	ACY30	0.58	BC171	0.16	BD529	0.80	BU105	2.25	MPSA56	0.31	TIP53	0.53
2N2904A	0.24	2N4289	0.34	AD142	0.57	BC172	0.17	BD530	0.80	C106D	0.65	MPSU05	0.65	TIP2955	0.98
2N2905	0.25	2N4919	0.95	AD143	0.66	BC177	0.28	BFR39	0.24	CA3180A	0.85	MPSU06	0.58	TIP3055	0.50
2N2905A	0.26	2N4920	1.10	AD149V	1.20	BC178	0.27	BFR79	0.24	CA3020A	1.80	MPSU55	0.63	TIS43	0.28
2N2906	0.19	2N4921	0.80	AD150	0.63	BC179	0.30	BDY20	1.05	CA3028A	0.79	MPSU56	0.80	ZTX300	0.13
2N2906A	0.21	2N4922	0.83	AD161	1.15	BC182	0.12	BF115	0.36	CA3035	1.37	NE555V	0.70	ZTX301	0.13
2N2907	0.22	2N4923	1.00	AD162	1.15	BC182L	0.12	BF117	0.55	CA3052	1.62	NE556	1.30	ZTX302	0.20
2N2907A	0.24	2N5190	0.82	AD161	pr	BC183	0.12	BF121	0.35	CA3046	0.70	NE560	4.48	ZTX500	0.15
2N2924	0.20	2N5191	0.98	AD162	1.05	BC183L	0.12	BF123	0.35	CA3048	2.11	NE561	4.48	ZTX501	0.13
2N2926	0.20	2N5192	1.24	AF106	0.40	BC184	0.13	BF125	0.35	CA3089E	1.96	NE565A	4.48	ZTX502	0.18
2N3053	0.25	2N5195	1.46	AF109R	0.40	BC184L	0.13	BF152	0.20	CA3090Q	4.23	OC23	1.35	ZTX530	0.23
2N3054	0.60	2N5245	0.47	AF114	0.35	BC186	0.25	BF153	0.25	LM301A	0.48	OC28	0.76		
2N3055	0.75	2N5294	0.48	AF115	0.35	BC187	0.27	BF154	0.16	LM308	2.60	OC35	0.60		

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SN7407	0.45	SN7425	0.29	SN7447	0.95	SN7475	0.50	SN7492	0.45	SN74141	0.86	SN74164	2.01	SN74197	1.58
SN7408	0.19	SN7427	0.29	SN7448	0.90	SN7476	0.35	SN7493	0.45	SN74145	0.90	SN74165	2.01	SN74198	2.25
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What to look for in July's ETI

SPECIAL

HOW TO BUILD ELECTRONIC PROJECTS

A major feature which starts from scratch describing how to tackle project building. A suggested 'stock' is given together with details on how to solder, constructional methods etc.

SPECIAL

BUMPER TECH-TIPS

We get so many excellent submissions to this feature and it is so popular that our July issue is carrying 8 pages of these useful ideas and circuits.

HOW AMBISONICS WORKS

ETI Technical Staff have bisected Patent 1369813 which manages to give true surround-sound on only two channels - and the effect is far better than current quadrophonic systems!

HIGH VOLTAGE FOR LOW COST!

Something for nothing? Not quite but voltage multipliers using diodes and capacitors can be cascaded to give almost any desired voltage. Theory and examples are given.

STAGE MIXER PROJECT

Our 8-channel Master Mixer (April-July 1973 and Project Book 1) was a very successful feature. This article takes the design a step further to give professional quality stage mixer.

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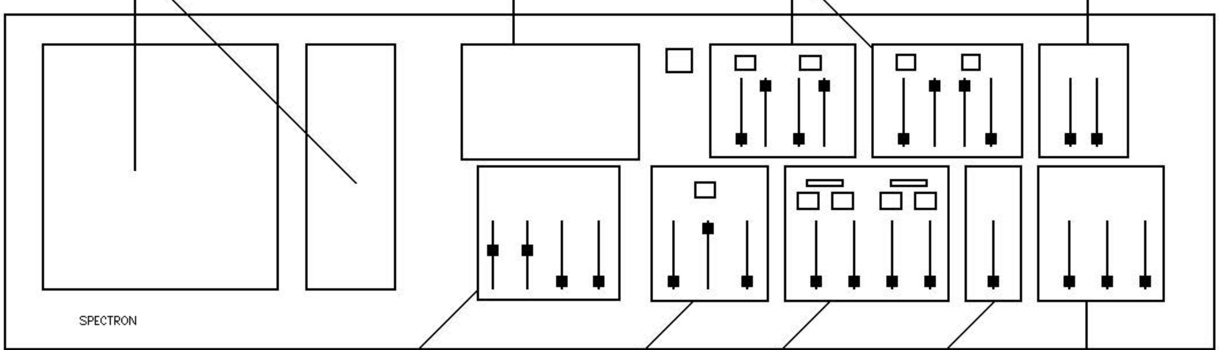
electronics today international

colour synthesiser



SPECIFICATION

IMAGE SOURCES

X and Y Counters
Slow Counter
4 Shape Generator Outputs
Video Comparator

IMAGE MODIFIERS

4 Overlay Gates
4 Inverters
Edge Connector
Delay
2 Flip Flops
Invert X, Invert Y

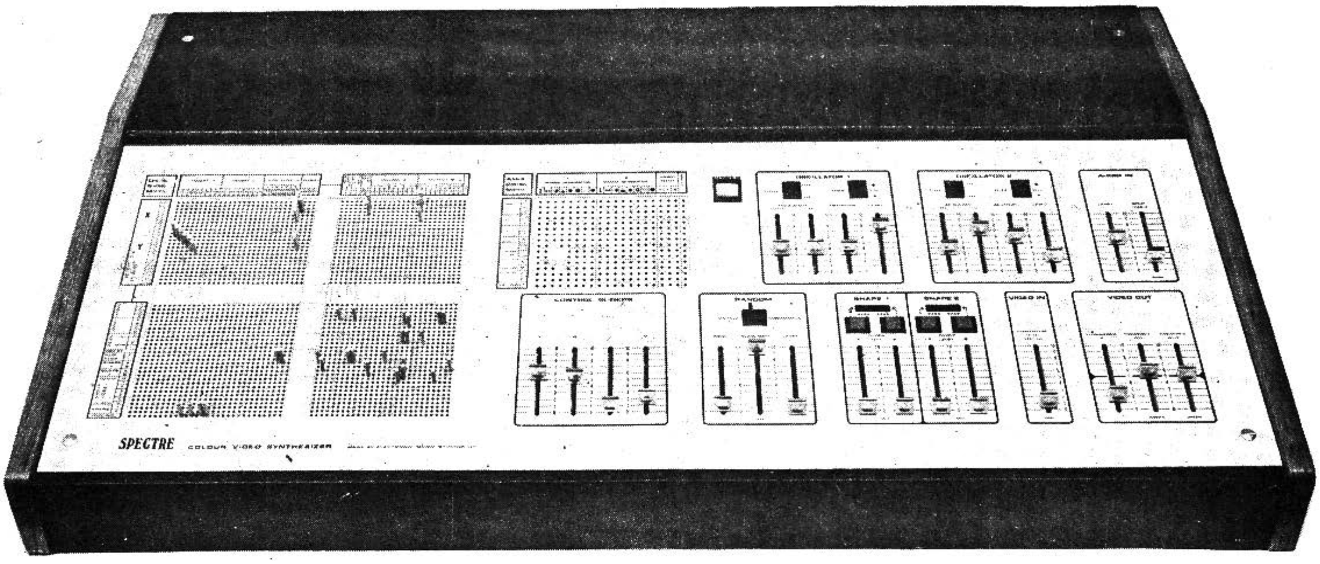
VOLTAGE CONTROL SOURCES

2 Oscillators with both Square and sine output
2 Random voltages
3 Audio inputs (Bass envelope, Treble envelope and Signal)
2 From D.S.M. inputs (Low or high frequency filtering)
4 Voltage Control slider inputs
1 External Input

VOLTAGE CONTROL INPUTS
2 Shape Generators to control various functions
1 Video input with controls of Luminance, red or blue bias which affects the whole of the final picture
Comparator Level Spacing input

VIDEO EXHIBITION

A tape of experimental work by Adam Sedgewick using the EMS synthesiser, is one of the exhibits at the Serpentine Gallery's Video Exhibition from 1st to 26th May this year. This is a free exhibition of tapes (which will be played on request), performances and fixed pieces.



The EMS graphic colour synthesizer (note unit is now called 'Spectron' not 'Spectre' as seen here).

A vast repertoire of static or moving colour effects displayed on a 625-line. PAL TV screen, Terry Mendoza reports.

ELECTRONIC music synthesizers are such incredibly versatile devices that, around the world, a number of people are investigating their use in another art-form: that of visual display.

Now EMS, in London, have produced a commercial visual synthesizer called Spectron.

In common with its audio counter-part, Spectrum utilizes a small number of modules to create a vast repertoire of static or moving colour effects for display on a conventional 625 PAL video screen. Apart from obvious applications in the special effects sector of video work and TV broadcasting, its designer Richard Monkhouse envisages it being applied to X-ray recognition it is particularly suited to this application for it can accept an external video input and split its grey scale into seven discrete bands, each of which may then be coloured differently.

Matrix patching (common to all EMS synthesizers) has been retained - inputs to modifiers and outputs that produce the final image are sited at the top of the board, and outputs from the modifiers and all video sources are at the side of the board. However, due to noise and crosstalk difficulties encountered with analogue video-frequency signals, the direct picture signals are in digital form. This adds greatly to flexibility; a 'form-specifying' digital signal only governs shape and area texture, hue, brightness and apparent position are controlled by further digital signals combined with the first. There now follows a survey of the various modules incorporated in Spectron.

X AND Y COUNTERS

The X counter produces vertical bars and the Y counter horizontal bars, the width of the bars and the spacing between them are variable and dependent on which outputs of the binary counters have been patched to the AND gates which sum them.

The bars or, when simultaneously used, the chequerboard, can be modified by the superimposition of the outputs from an analogue generator -of which more later. Each of the counters has nine different outputs, the bar-width going down by a factor of two between each pair of adjacent outputs. Any, or all, of the outputs may be phase-inverted by grounding its 'invert' input.

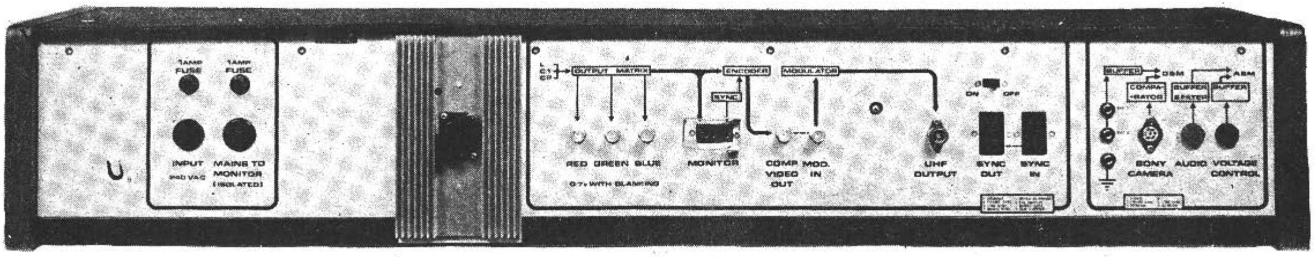
OVERLAY GATES

There are four overlay gates which can overlay one moving (or static) pattern with another. The signal representing the background of the video 'scene' is patched into the 'sig' input apd the signal intended for the foreground is fed to the 'dis' (disable) input; only wh n this input is not pulled low will the background signal be gated through.

SHAPE GENERATORS

There are two shape generators, each of which produces two outputs, which may themselves be preselected from sixteen possible design shapes. The two generators both have four LED displays to indicate, in binary form, which shape has been selected i.e. all indicators off indicates 0000 = circle shape; 0010 = 'gear' shape (see illustration 2).

The shape can be selected by manual switching or can be allowed to cycle through its a 'catalogue' at predetermined rate. Ovoids and triangles are generated by dual-ramp generators, with the intersection of two voltages producing a visible low. Any shape or pattern may be fed to an inverter in order to be able to utilise the background of the shape for modification rather than the shape



COLOUR SYNTHESIZER

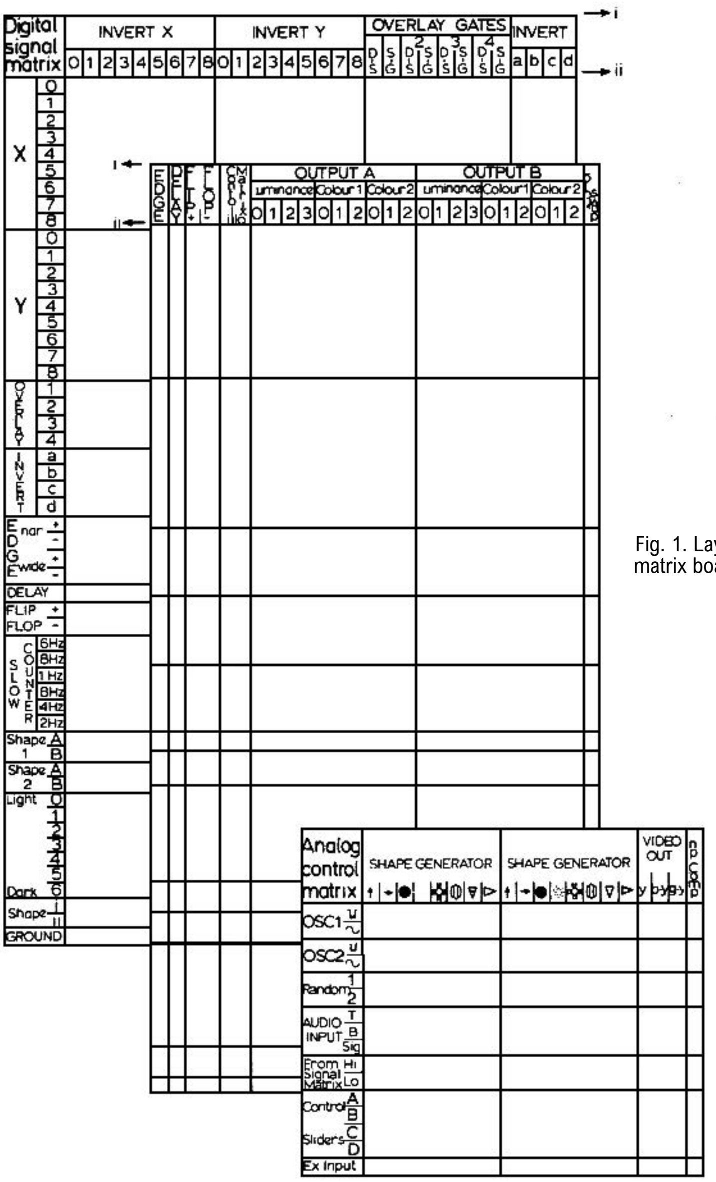


Fig. 1. Layout of front panel matrix boards.

itself, (see Fig. 3). Thus a circle and moving pattern fed to the overlay gate will give rise to a blank circle in the foreground with the pattern moving around and 'behind' it. Inverting the circle before patching it to the gate will completely alter the effect -the pattern will only appear within the confines of the circle which will lay on a blank background:

A mini analogue synthesizer panel (Fig.1) feeds each shape generator to allow controlled distortion to be imparted to the chosen shape.

The shape-generator parameters fed by the analogue controls are as follows:

1. horizontal position
2. vertical position
3. horizontal zoom
4. vertical zoom
5. circle size
6. 'gear' size
7. 'frizz' size
8. 'lantern' size

It can be seen that inputs 5-8 are, to use the physiological term, species specific and will only affect the shape indicated. Hence a circle shape will only be influenced· by parameters 1, 2 and 5.

The following analogue controls are available:

a. Two sine/square wave generators with a wide highly stable range between 0.1Hz and 30kHz which can be very finely controlled. When the controlling signal forms a harmonic of the line frequency very beautiful patterns result and these control generators have been designed to lock onto these integer frequencies to make full use of this effect.

b. A random voltage generator with Gaussian distribution, two independent outputs and a slew rate control. It also has a switch to recycle the sixteen most recent events .

c. Four slider-fader control voltage inputs.

d. A buffered audio signal input together with another input which is split to give treble and bass envelope following.

e. Two output lines are provided, with different time constants, direct from the digital signal matrix.

f. A buffered external control voltage input.

As well as influencing the shape generators, these analogue modules may also be used to bias the two colour parameters, the picture brightness and the step spacing of the video comparator. This latter is the device that likes a black and white camera input signal and splits it-into a seven level grey scale feeding to seven output rows on the digital control patch board. A certain brightness level at the input will activate one output row, causing it to go 'low' and this may then be patched to a combination of luminance and colour outputs to give a particular hue and brightness each time the same brightness is encountered at the input. It is this that could provide the medical application mentioned earlier. The output row need not only be patched to relate grey-scale brightness to colour but in conjunction with the overlay gates, could be used to produce a chequered pattern each time a chosen brightness level is reached quite a startling effect when used, for instance, on the human face.

SLOW COUNTER

This is another source on the digital signal matrix giving six outputs consisting of binary multiples of frequency from 6 Hz to 0.15 Hz. It is synchronized so that it only changes state during the frame fly-back and is used to give sudden rapid changes and movements.

EDGE GENERATOR

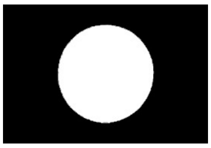
This is an interesting device which synthesises an apparent three-dimensional edge to a pattern or shape. It is described by the designer as a "cut out of plywood" effect (see Fig. 2). There are four outputs from this module giving either a narrow or wide edge which is situated to the left or the right of the pattern.

A delay module, which causes 0.6µS signal retardation, can be used to generate a different variety of edge effect and a type of feedback which produces an 'echo oscillation' (Fig. 4).

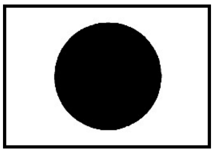
The digital matrix is completed by a flip-flop device which halves the

Function of inverters

Start with a black screen



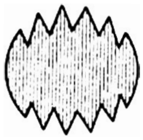
Circle (shape No 0) patched to output LO



Circle patched to Inverter. Inverter patched to LO

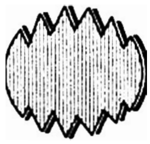
Fig. 2

Action of edge generators



'Gear' shape alone

Output of edge generator with Gear patched into it



Gear with edge (the edge may be any independently chosen hue and shape).

Fig. 3

Echo oscillation

Echo oscillation on the Inside of a circle shape

Fig. 4

Wired OR action of output column. Patching more signals into the same output column combines them in a way rather like cutting out cardboard. The same combinational logic applies to all the columns on the matrix board

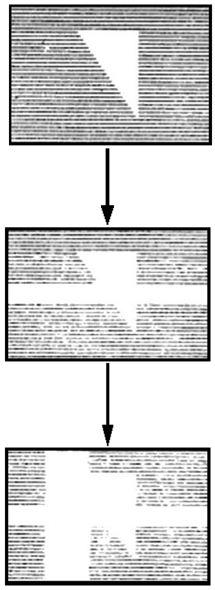


Fig. 5

Modulated circle. Appearance of circle when size modulated by 50 Hz sine wave.

Fig. 6

horizontal spatial frequency of patterns patched to it, and may also be used to fill out shapes that start as outlines or to divide the width of the 'echo oscillation' mentioned above.

There are two output channels which are identical in every respect. Each has four luminance channels, three 'colour 1' (controlling red intensity) and three 'colour 2' (controlling blue intensity).

Binary combinations of outputs produce a graduated scale of brightness and colour i.e. for brightness the following sixteen-step scale is used:

	L0	L1	L2	L3
1 Black				X
2			X	
3			X	
4			X	X
5		X		
6		X		X
7		X	X	
8		X	X	X
9	X			
10	X			X
11	X		X	
12	X		X	X
13	X	X		
14	X	X		X
15	X	X	X	
16 White	X	X	X	X

In the same binary fashion, each three-column colour channel can be made to produce an eight-step scale of saturation. The value of the digital system can now be seen. At its simplest, patching different outputs of the slow counter to a combination of colour and brightness outputs will produce a rhythmically flashing screen in different colours and brightness.

Special circuitry ensures that increasing the luminance will not result in a reduction in perceived colour saturation.

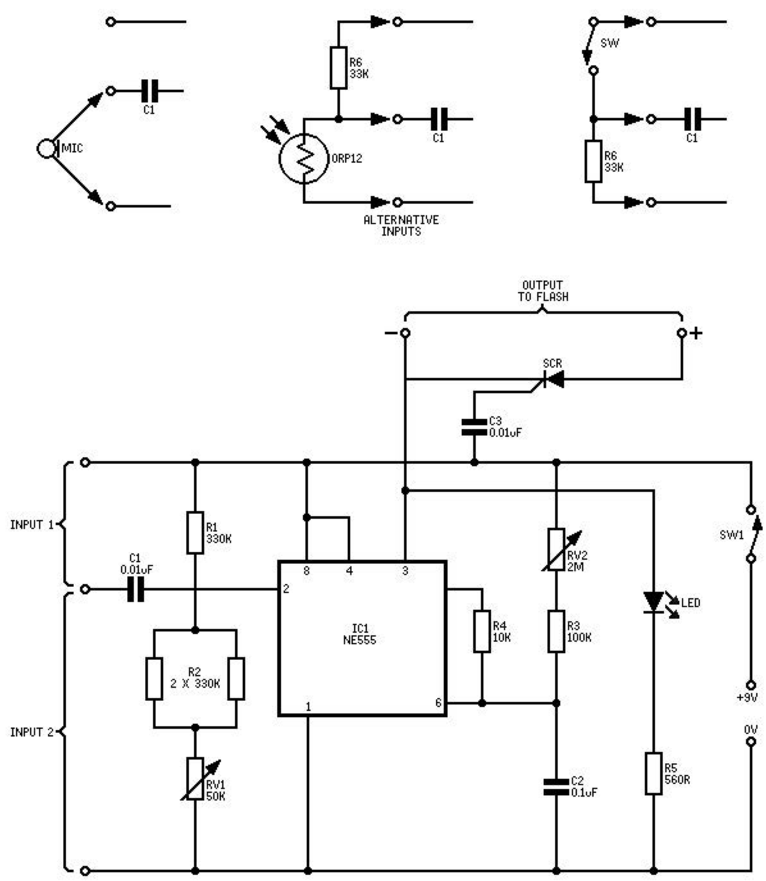
Incidentally all the output columns have a wired OR action which means they will go low if a signal patched into. them goes low, and only one signal patched in needs to go low to produce this effect. In terms of the visible end effect, feeding more signals into the same output column is, to quote the designer, "like carving away a piece of black card to expose a white surface behind one can never add a new area of black" (see Fig.6).

Though Spectron is thorough and capable of high complexity, EMS are adamant that maximum potential can only be realized if the system is used in conjunction with camera feedback focussing the camera on the screen of the monitor. This results in a moving pattern with the modification of the image each time the signal travels around the loop.

EMS are producing a complete package incorporating a Sony black and white camera and modified Sony monitor, priced at £4000. The Spectron alone is available for £3000 and for this price, despite its versatility it may still suffer the same fate as the audio synthesizer the majority of operators will find themselves generating the same hackneyed patterns that could probably be realized by much simpler circuitry.

It will be left to a talented few to use the device to the limits of its capabilities and to develop video graphics into a new art form.

ELECTRONIC FLASH TRIGGER



Circuit Diagram

MANY sound-operated flash trigger circuits have been published, some of which can be adapted to accept other means of triggering.

The one described here will trigger from virtually any energy source. All that is required is a sound, light flash or other effect that can provide a sudden voltage change.

The unit also incorporates a variable time delay between the trigger input and the flash triggering.

It has been based on the NE 555 timer IC - this has a very sensitive input, the ability to provide the required variable time delay and an output of sufficient energy to trigger an SCR.

CONSTRUCTION

The prototype unit was constructed on Veroboard, taking care not to apply too much heat to either the components or the board.

The most critical part of the circuit is around pin 2 of the IC. The triggering current needed is only 0.5 micro-amps and with pin 1 being the negative supply line and pin 3 the output, leakage currents across a dirty board can easily cause continuous triggering. To prevent this the strip to which pin 2 is attached should be as short as possible. It is also a good idea to clean off any excess flux with methylated spirits on completion of soldering.

Input is via two miniature earphone sockets mounted on an insulating strip. The outside connection goes to the positive and negative lines respectively with the centre connection of both plugs going to the input.

USING THE UNIT

Sound trigger. The unit may be triggered by a crystal microphone insert or by a loudspeaker used as a microphone. The input can be to input 1 or 2. When the sensitivity is turned up to maximum; (RV1 at minimum) the unit may trigger continuously. To avoid this, simply turn the control back until the LED goes out, but flashes when the required sound is made. The photo of the tennis ball hitting a stool was made in this way with the time delay at minimum about 4 milliseconds.

Light trigger. The resistance change of a cadmium sulphide cell may be used to trigger the unit when the light level falling on the cell varies. If the intensity of light increases, the resistance drops rapidly, while if the intensity falls, the resistance increases but much more slowly. Triggering is thus best done by increasing the light level. Connect the CdS cell to input 2 via a 33k resistor across input 1. A sudden increase in the light level will then fire the flash. If the time is set at a minimum this can be used as a slave flash unit as it only responds to sudden changes.

The photos of the fluid drop falling into the beaker of water were taken by having the drops interrupt a light beam falling onto a cadmium sulphide cell. The cell is in the tube in the top left of the large photo. The drops were Indian ink to be certain they would block out the light beam. The time delay was about 250 milliseconds.

Switch triggering. With a switch connected to input 1 and a resistor to input 2 (33k), the unit will fire when the switch is opened. If the position of the switch and resistor are interchanged the unit will fire as the switch is closed.

For simplicity in use the inputs have been devised using miniature earphone sockets with a resistor connected to a plug so by simply changing the plugs the input can be changed.

HOW IT WORKS

A negative pulse at the input is fed via capacitor Cl to the input pin (2) of the IC. Pin 2 is held slightly above its triggering voltage of 1/3 V_{CC} by the voltage divider comprising R1, R2, and RV1. The negative pulse triggers the IC and the output (pin 3) goes high for a time period controlled by RV2, R3 and C2. When the output goes low again at the end of the time interval capacitor C3 charges through the gate cathode circuit of the SCR switching it on and firing the flash.

Capacitor C1 isolates the input from the voltage divider so that the unit isn't sensitive to the DC level at the input. RV1 acts as a sensitivity control by allowing the voltage to be adjusted to a suitable level so that the input signal will trigger the IC. Resistor R4 limits the discharge current from C2 at the end of the timing cycle so protecting the IC. The LED and its protective resistor RS act as an indicator to show that the unit has triggered, so simplifying the setting up process and minimising the number of times the flash has to be fired. This means that the flashgun needn't be fired until a photo is to be taken.

PARTS LIST

SEMICONDUCTORS
IC NE555
SCR C106D or similar with a 400V rating
LED Miniature red

RESISTORS (10%)

R1	330k
R2	165k (2 x 330k in parallel)
R3	100k
R4	10k
R5	560R
R6	33k (optional depending on input)

CAPACITORS

C1	0.01uF
C2	0.1uF
C3	0.01uF

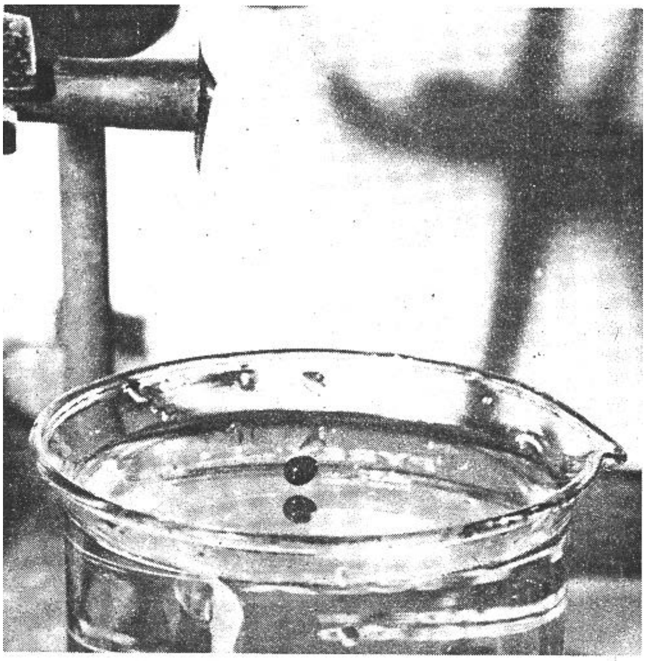
SWITCH
Any SPST switch suitable

POTENTIOMETER
RV2 2 Meg linear
RVI 50k linear

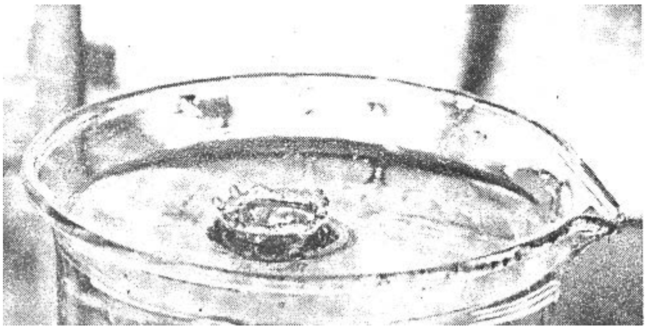
INPUT DEVICE
CdS cell (ORP12)
Crystal mike insert etc.

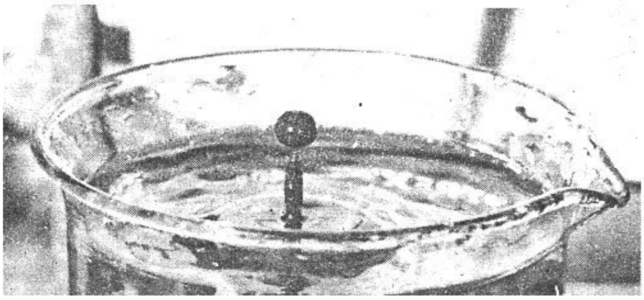
OUTPUT DEVICE
Electronic. flashgun, preferably computer type as these give a much shorter flash duration at close range.

OTHER PARTS
Metal case (58 x 58 x 100 mm)
Veroboard"(40 x 80 mm)
Input sockets (earphone type)
Output to suit flash unit being used
Knobs 2 for pots
Battery Connector



Drops of Indian ink are 'caught' here splashing into a beaker.





THE µA706 AUDIO POWER AMP

THE CONSTRUCTOR who employs integrated circuits instead of discrete devices will save himself much time and trouble in circuit wiring. In addition, he will be rewarded by the more compact unit which can be made with one or more integrated circuits. One of the most obvious applications for integrated circuits, especially for the beginner, is in the field of audio amplifiers for power output levels up to a few watts.

This article will cover the Fairchild Semiconductor µA706 device in detail. It can provide a power output of up to 5.5W into a 4 ohm loudspeaker when used with a single 14V supply. This fairly new integrated circuit is very suitable for use as an audio amplifier in car radio receivers, but it can also be employed in television receivers, portable radios, domestic stereo equipment and in various industrial applications.

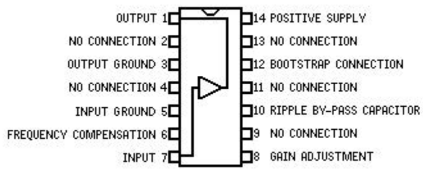


Fig.1. Connections of the 14-pin dual-in-line uA706

CONNECTIONS AND ENCAPSULATIONS

The µA706 is a 14 pin dual-in-line device in a plastic encapsulation with the connections shown in Fig, 1. The device is available as a type 'A' package without any heat sink other than the copper slug fitted at the back of the device. The active components of the integrated circuit itself are soldered to the lower side of this copper slug. This type of device is shown in the centre of Photo 1; when in use, the copper slug should be in contact with a suitable heat sink.

Amateur constructors will generally find the type 'B' package more convenient, since it contains a bracket heat sink permanently soldered to the copper slug (Photo 1). A larger heat sink may be bolted to the bracket for better cooling.

At the time of writing, the µA706 is listed at £1.94 and the µA706B at £2.17.

Details of the internal circuit design of the device may be found in reference 1.

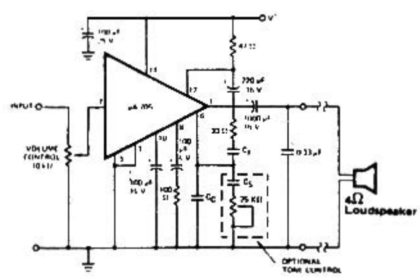


Fig.2. A uA706 circuit using a minimum number of components.

SIMPLE CIRCUIT

One of the simplest possible circuits for the use of the µA706 is shown in Fig.2. The two earth connections (pins 3 and 5) are joined just outside the integrated circuit so as to minimise feedback current loops.

The 100µF capacitor in the pin 10 circuit can be used to smooth out any hum or ripple which may be present on the power supply line and prevent it appearing across the output. This. capacitor may be omitted if a battery power supply or a well smoothed mains power pack is employed.

The gain of the circuit is determined by the value of the resistor R_B in the feedback circuit of pin 8. If R_B is 100 ohms, the voltage gain will be about 50 or 34dB. If, however, R_B is reduced to zero, the voltage gain will rise by a factor of four to 200 or 46dB. The gain is equal to the value of an internal feedback resistor (7000 ohms) divided by (R_B + 35), since R_B is in series with an internal 35 ohm resistor.

The capacitors Cc and C1 provide high frequency compensation in the circuit. Suitable values are shown in Table 1 for gains of 34dB and 46dB. The values of these capacitors can be changed somewhat (as shown in the Table) so that one can obtain a frequency response to 20kHz or 10kHz at 3dB down. The low frequency response extends to about 40Hz at 3 dB down in the circuits included in this article.

	Gain = 34dB		Gain = 46dB	
Bandwidth	10kHz	20kHz	10kHz	20kHz
R_B	100Ω	100Ω	0Ω	0Ω
C_C	10nF	6.8nF	2.7nF	1.5nF
C_F	1nF	470pF	330pF	150pF

The 1000µF capacitor in the output (pin 1) circuit prevents any steady current from flowing through the loudspeaker. It also provides a correctly biased signal for the bootstrap feedback circuit of pin 12.

OUTPUT POWER

The increase in output power obtainable from a typical µA706 device with the supply voltage is shown in Fig.3. between the recommended limits of 6V and 16V. A 4 ohms loudspeaker was employed and the power output was measured at a total harmonic distortion level of 10%.

OUTPUT POWER AS A FUNCTION OF SUPPLY VOLTAGE

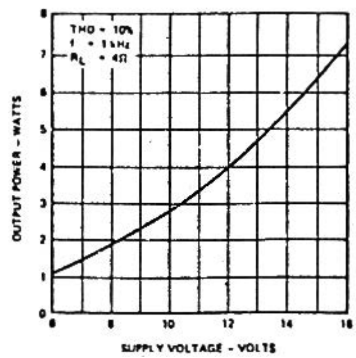


Fig.8. Maximum power output plotted against the supply voltage.

TOTAL HARMONIC DISTORTION AS A FUNCTION OF OUTPUT POWER

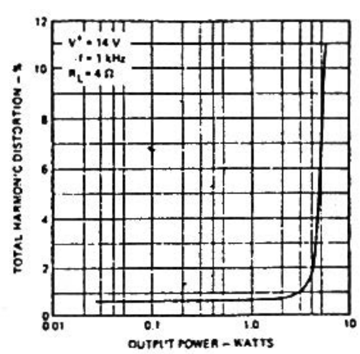


Fig.4. This graph shows that the distortion is almost independent of output power at low levels, but increases extremely rapidly at the onset of clipping.

The variation of the total harmonic distortion with the output power is shown in Fig.4. It can be seen that the distortion rises very rapidly at power levels exceeding about 4W owing to clipping of the waveform. The distortion is almost constant at about 0.5% at output power levels up to about 2W.

The power supply current required with no input signal is typically 18mA. The current rises with output power when a signal is applied.

The maximum permissible output current is 2.5A. but the device will not be damaged by repeated accidental short circuiting of the speaker load provided that the short circuits do not last long enough for the silicon chip in the device to become overheated.

MAXIMUM POWER DISSIPATION BY THE INTEGRATED CIRCUIT AS A FUNCTION OF SUPPLY VOLTAGE

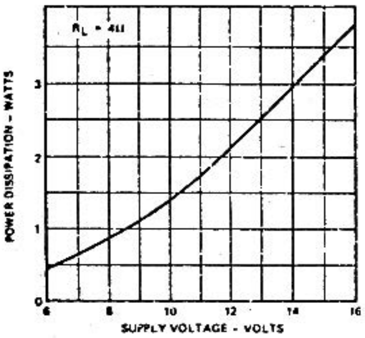


Fig.5. The maximum power dissipated in the device plotted against the supply voltage.

POWER DISSIPATION AND EFFECIENCY AS A FUNCTION OF OUTPUT POWER

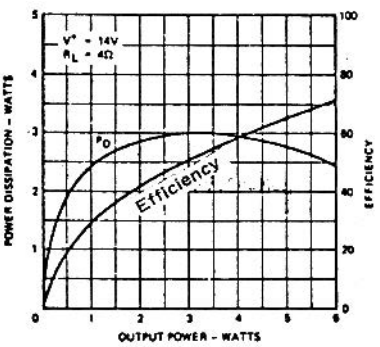


Fig.6. The power dissipated in the device at various output power levels.

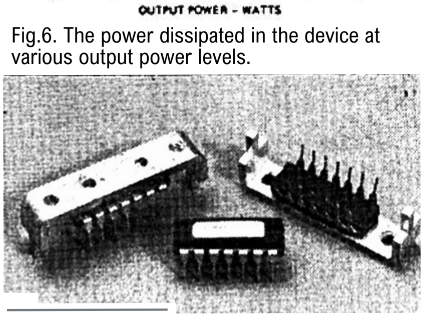
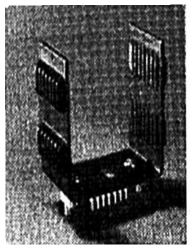


Photo 1. The uA706 (centre) has a copper cooling slug at the centre of the plastic package, whilst the uA706B has a small cooling bracket soldered to the back of the device.

HEAT SINKS

The maximum power dissipated in the device at various values of the power supply voltage is shown in Fig. 5.This maximum power dissipation occurs only when the input signal is large. If no additional heat sink is fitted,



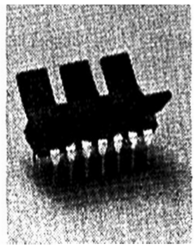


Photo 2. A large heat sink for the efficient cooling of the uA706.
Photo 3. A small heat sink attached to a uA706A.

the type 'A' package can dissipate up to about 1.7 W and the type 'B' package up to 2.4W provided that the ambient temperature does not exceed 25°C.

These power dissipation levels can occur at supply voltages of 11V and 12.8V for the type 'A' type 'B' packages respectively. In practice one, can employ rather higher supply voltages before one requires a heat sink provided that the ambient temperature does not exceed 25 degrees and provided one does not feed sine waves into the input for more than a moment.

This is because ordinary speech and music signals will not cause the maximum power dissipation to occur for more than a very short time.

As shown in Fig.6, the power dissipated in the device reaches a maximum of about 3W when the output power is about 3W. The efficiency (power output/power delivered from the supply) is also shown for various output power levels.

If the type 'B' package is fitted with a large heat sink, it can dissipate up to about 5 W.

STABILITY

The use of the compensating capacitor Cc enables stability to be obtained at high frequencies. However, as with all high gain amplifiers, reasonable precautions must be

observed in the component layout, etc. In particular the following points should be noted.

(a) The two ground connections (pins 3 and, 5) must be connected, together as close as possible to the integrated circuit to a common earth. This avoids the possibility of ground loop problems causing instability.

(b) The output coupling capacitor (1000µF) must be close to the output terminal (pin 1) to reduce the lead inductance.

(c) The 0.33µF capacitor across the loudspeaker terminals should be placed close to the output coupling capacitor to ensure that the speaker and lead inductances are completely swamped.

(d) The Input and output leads must be kept well separated.

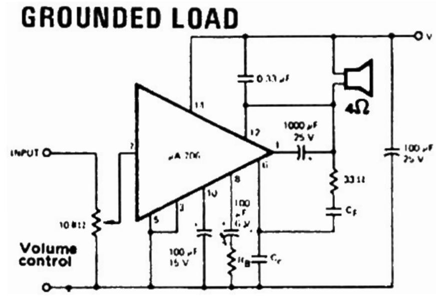


Fig.7. A circuit in which one side of the of the loudspeaker is earthed.

Another circuit using the µA706 is shown in Fig.7. The performance is similar to that of the circuit of Fig.2, but one side of the loudspeaker can be earthed. The circuit of Fig. 7 requires an additional 220µF capacitor and a 47 ohm resistor in order to provide feedback to the bootstrap connection at pin 12.

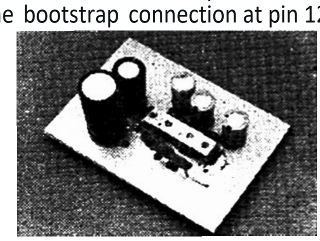


Photo 4. An amplifier using the circuit of Fig.7. The upper side of the board is covered in copper and the uA706B brackets are soldered to this copper foil for cooling purposes. The printed circuit connections are on the underside of the board.

The gain of the circuit shown in Fig.7 is 34dB. The capacitor Cs in the optional tone control can have a value of 27nF to produce a 3 dB 'roll-off' at 3kHz. If the resistor Re is replaced by a shorting wire, the gain is increased to 36dB; Cs may then have a value of 5.6nF to produce a similar 3dB fall at 4kHz.

OTHER CIRCUITS

The µA706 devices can be used in the stereo amplifier circuit shown in Photo 4. Each circuit may be like that of Fig.2 or Fig. 7.

If a higher power output is required, two of the µA706 devices may be used in a bridge circuit. The inputs to the two devices are of the opposite phase, so a push-pull output is obtained. This output can be used to drive an 8 ohm loudspeaker. The circuit details are given in reference 1.

The use of various integrated circuits, including the µA706, in stereo FM receivers is discussed in reference 2. Discrete semiconductor components are required only in the FM front end, the remainder of the receiver employing integrated circuits and requiring only two adjustments before use.

REFERENCES

1.John-W. Chu: A High Output Power, (6 Watt), Low Distortion, IC Audio Amplifier, Fairchild Application Report APP-317.

2.David K. Long, Integrated Circuits for FM Receivers, Fairchild Application Report APP-318. Fairchild, Mountain View, California, June 1972.

By BrianDance

UNDERSTANDING COLOUR TV
The Signal Circuits

by Caleb Bradley B.Sc.

THE EARLIEST colour receivers (for NTSC system in USA) used a staggering number of valves but before long transistors were in use in the low-power signal circuits. Further progress with high power transistors eventually made possible the first all-transistor colour set, with no thermionic device except the display tube itself. This was introduced by the British Radio Corporation in the sixties. Current progress involves compacting as much circuitry as possible into special purpose integrated circuits. All but the higher power stages can now be contained in a handful of ICs. Good manufacturing economy but often introducing servicing headaches!

A television receiver is a harsh environment for semiconductors because of the surge currents caused by sparking inside the display tube or by reservoir capacitor charging at switch-on. Unless controlled by careful design, these surges can destroy transistors instantly. As a result many European manufacturers prefer to build 'hybrid' receivers which use both semiconductors and valves, using the valves for their tolerance of transients in high power sections.

In spite of their constructional variations virtually all PAL colour receivers conform to the block diagram in Fig. 30.

TUNER

This is a compact pre-assembled box containing two or three transistors with the functions of tuned RF amplifier and mixer/oscillator. The modern type uses varicap diodes in the tuned stages to allow remote de channel selection by a push button/potentiometer assembly on the front of the receiver. This gives far easier and more accurately repeatable tuning than mechanical capacitor drives. Automatic frequency control can also be applied to the de tuning input to further improve tuning stability.

The tuner mixer converts the incoming sound and vision signals at UHF (or VHF where used) to a standard- intermediate frequency which is 39.5MHz for the vision carrier. Since it is impractical to achieve much selectivity in the tuner the frequency response of the following IF strip must be carefully tailored for optimum amplification of each component of the television signal - see Fig. 31a.

IF STRIP

Figure 31a shows in idealized form the components of the television signal after frequency changing to IF. The vision carder is amplitude modulated by the luminance signal whose frequency range extends to about 5 MHz. Side-band energy is therefore generated up to 5 MHz either side of this carrier. but the lower side-band is almost completely suppressed at the transmitter in order to use frequency space more efficiently. Since some low frequencies in the lower side-band (which appears above the vision carrier after inversion in the mixer) are allowed to remain this is known as vestigial side-band transmission.

A colour transmission also contains chroma side-bands which centre on a frequency 4.43 MHz below (at IF) the vision carrier. Frequency interleaving is used to enable luminance and chroma to share the same frequency space as was described last month.

The sound is frequency modulated on a separate carrier above the vision carrier. Due to frequency inversion in the mixer it appears below the carrier at IF.

Figure 31b shows the actual IF response shape of a high quality

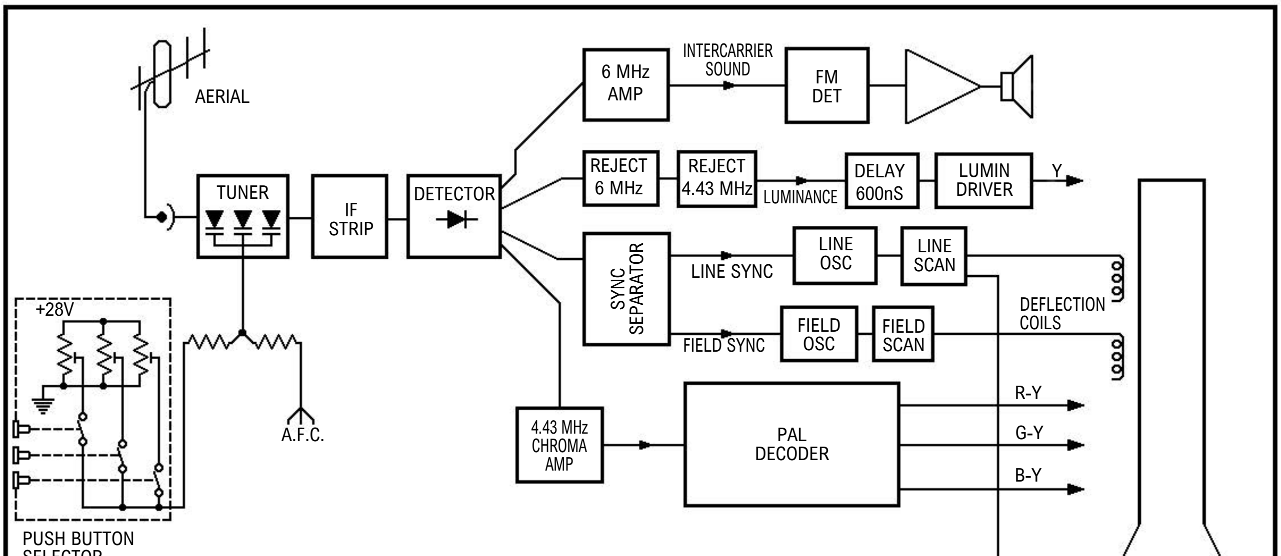


Fig.30. Block diagram of a colour receiver. The display tube is driven by colour difference signals from the decoder. Alternatively it can be driven by pure R, G and B.

UNDERSTANDING COLOUR TV

receiver. Relative gain is plotted on a logarithmic (decibel) scale since on a linear scale the lower details would be too compressed into the base line to see properly. Such a response shape is only obtained after careful alignment of as many as a dozen tuned circuits and reflects a number of engineering compromises.

The first requirement is a high quality luminance signal. For this the response shape would ideally have a flat top and steeply falling edges to match the transmitted luminance spectrum. However there are limits to what can be achieved with conventional tuned circuits. A flat top requires a number of low-Q tuned circuits stagger-tuned and there are economical limits to this. Steep sides require the use of high-Q tuned circuits and these introduce large phase changes in the region of their resonance. Such distortion of the luminance signal appears as ringing or vertical striations after (i.e. to the right of) major picture details. Since the edges of the luminance response cannot be steep it is usual to place the vision carrier about 6dB down on the high-frequency fall-off. A correctly shaped fall-off in this region prevents attenuation of low frequency luminance components by allowing some vestigial side-band energy to supplement the main side-band.

At the high frequency end of the luminance spectrum a compromise is made between the desire for maximum picture resolution and the inevitable slight interference by chroma on luminance i.e. fine patterning in areas of saturated colour. Therefore the response will be 'rolling off' somewhat before the 5 MHz luminance limit.

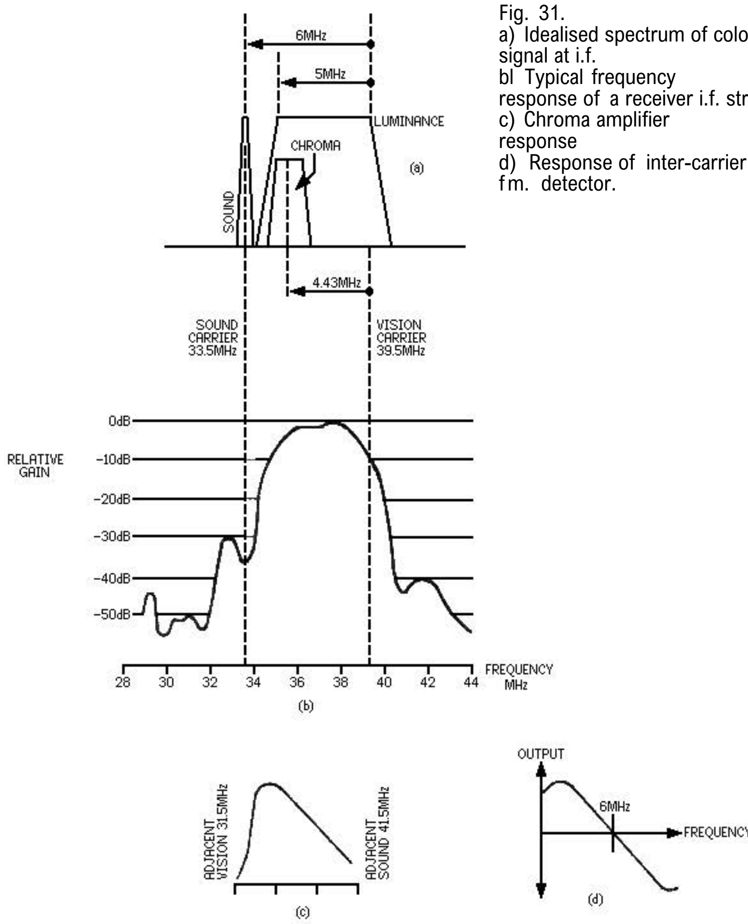
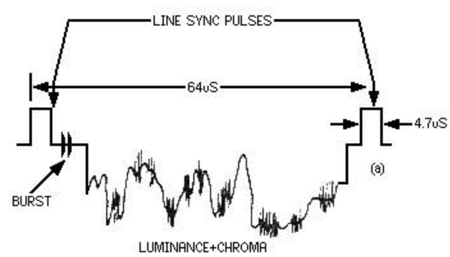
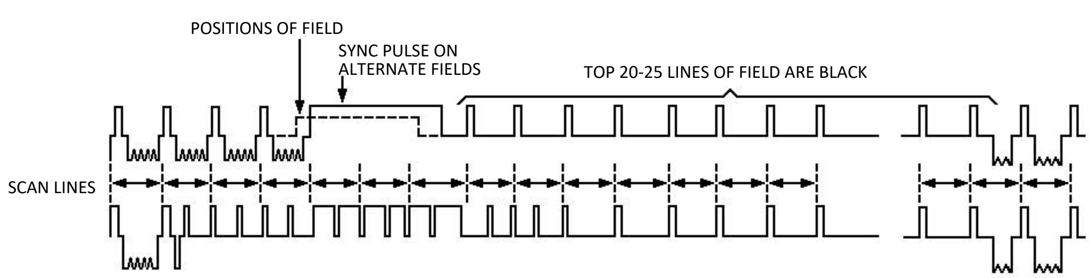


Fig. 31.
a) Idealised spectrum of colour TV signal at i.f.
bl Typical frequency response of a receiver i.f. strip
c) Chroma amplifier response
d) Response of inter-carrier sound f.m. detector.

Fig.32. a) Line sync pulse
(b) Basic form of field sync. pulse
(c) Actual form of field sync. pulse





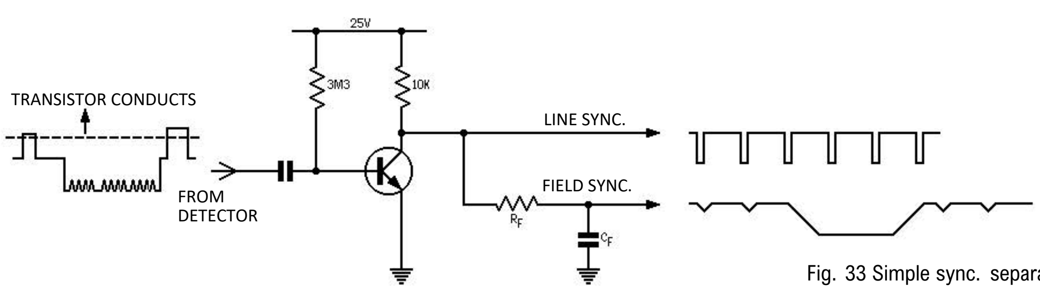


Fig. 33 Simple sync. separator

The sound carrier passes ,through the i.f. strip at considerably lower level than luminance or chroma for reasons which will become clear. Two other features of the IF response are the strong rejections at 41.5MHz and 31.5MHz which prevent interference from the sound or vision carriers of transmissions on adjacent channels.
The IF response shape of a colour receiver is far too critical to set up without the proper equipment - a sweep frequency generator and synchronised oscilloscope. Fortunately it usually only has to be done at the factory.

DETECTOR

Sometimes a single diode envelope detector, as in an am radio, is used after the IF strip. However the diode non-linearity encourages the generation of beat products between sound and chroma (6 - 4.43 = 1.57) MHz) which can cause an unpleasant coarse, 'herringbone' patterning in coloured areas. Therefore many sets use two or more detectors. In the future synchronous detection may be used in this stage. After the detector the various components of the television signal are separated as follows.

SOUND

The FM sound signal is extracted by an amplifier tuned to the difference (6MHz) between the sound and vision carriers, known as the inter-carrier frequency. This frequency is produced when the two carriers beat together in the detector and has the sound frequency modulation. The reason for presenting the amplitude modulated vision carrier to the detector at much higher level than the sound carrier is now clear: it is to ensure that the inter-carrier product does not disappear on picture whites where the vision carrier is at minimum amplitude. A single 6MHz tuned stage gives sufficient gain to drive the FM detector (which has the response in Fig. 31d). This stage must be accurately tuned to reject any vision amplitude modulation present on the inter-carrier signal. This causes a buzz on the sound channel, primarily at field frequency (50Hz). Inter-carrier buzz is easily recognised because it changes pitch as the picture content changes and is worst on pictures containing peak whites e.g. captions.

LUMINANCE

The strongest signal from the detector is the luminance signal. lnter-carrier sound (6MHz) and chroma (4.43MHz region) are filtered out to prevent fine patterning, the latter rejection being a compromise with resolution.
Luminance ls fed through a small delay line (1 1/2 micro-second approx.) to the driver stage which controls the red, green and blue beams of the display tube equally to give shades of grey and white. The luminance delay, not to be confused with the much longer PAL-D delay in the decoder, compensates for the time taken by signals to pass through the decoder and ensures that the colour signals are registered in time with luminance when they reach the display tube.

CHROMA

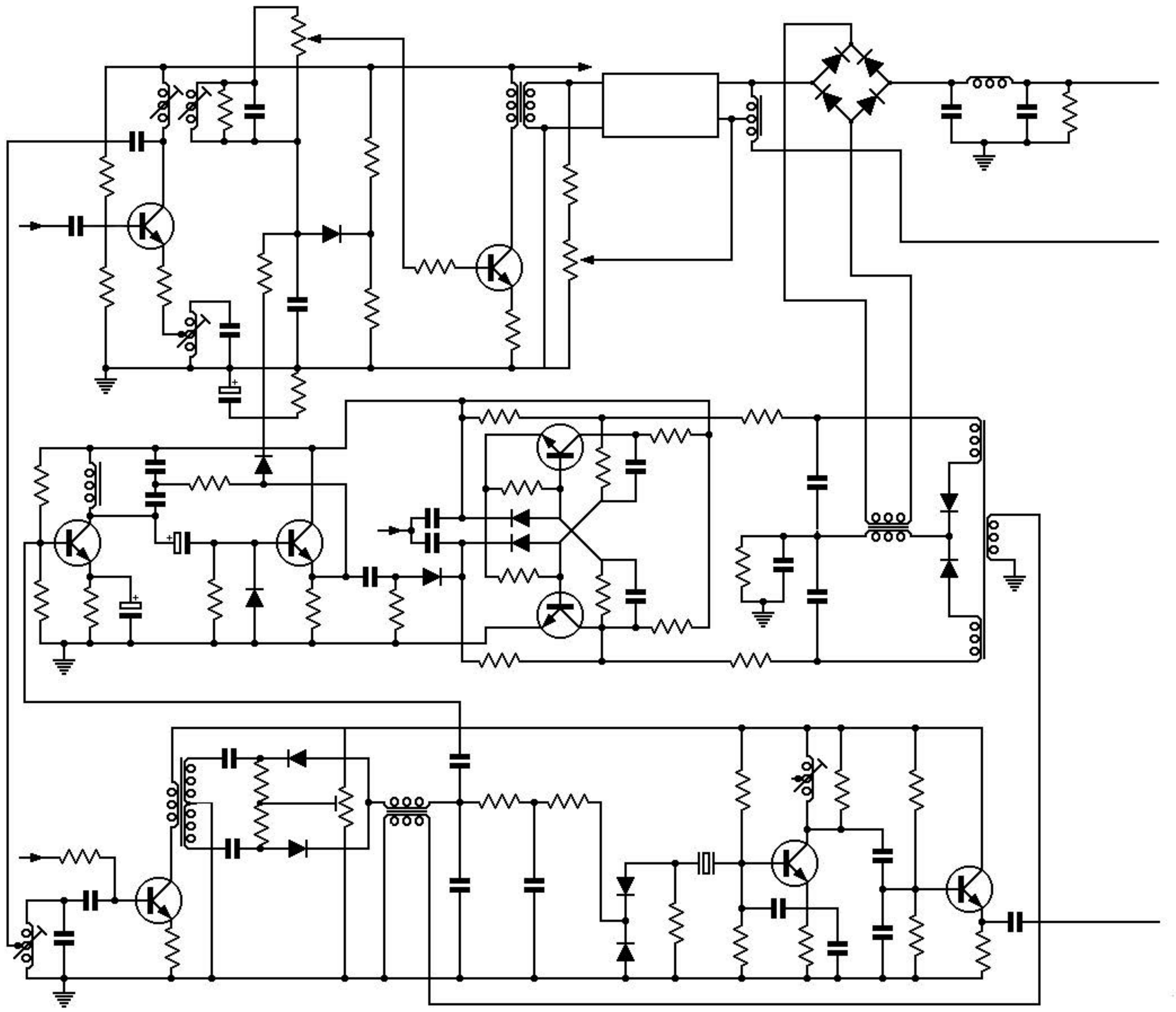
The chroma signal is extracted from the detector by a tuned (± 1MHz about 4.43MHz) amplifier. This often has a non-symmetrical response as in Fig. 31c) to compensate for the falling IF response to the upper chroma side-band. The reference burst also passes through this amplifier to the PAL decoder.

SYNCHRONIZATION

The vision signal carries two sets of pulses for the purpose of synchronizing the line (horizontal) and field (vertical) picture scan rates in the receiver to the studio camera. They are pulses of peak carrier strength i.e. 'blacker' than black video level, and therefore appear as peak positive excursions from the detector. Their shapes are shown in Fig. 32. The sync. separator is a simple peak detecting stage such as a transistor with small forward base bias and no emitter resistor as in Fig. 33. This serves to strip all but sync. pulses from the signal.
The field sync. pulse is distinguished from the line sync. pulse by being much wider - as crudely shown in Fig. 32b). It can therefore be separated from. the line pulses by a simple integrator RF/CF in the sync. separator, and then used to trigger the start of each field scan. Note that in each field half of the 625 lines (= 312%) are scanned. This means that the field pulse must trigger the field scan at the start of a line or half way through a line on successive fields. This starting difference must be established accurately or the fields will not interlace properly, with unpleasant effects. Therefore the waveform (in Fig. 32b) is improved in a number of ways before transmission.
Firstly by providing uninterrupted line sync. during the field pulse. the line scan is given no opportunity to drift off frequency. In Fig. 32c there is a positive-going synchronizing edge at the start of every line.
Secondly the video information is blacked out on 2% lines before the field pulse. The line sync. pulse for each of these lines is 'split' into two half-width pulses known as equalizing pulses. Their purpose is not to make the line scan suddenly run at double speed; instead it is a way of ensuring that the level on the field sync. integrating capacitor CF in Fig.33 is exactly the same before every field pulse, whether it happens to start on a whole line or half a line. Therefore the time taken to charge CF to the field scan trigger level is constant so interlace is correct.
The original reason for blanking so many lines after the field pulse was to allow enough time for receiver line and field scans to stabilise. Modern sets do not need anything like as much time as this and most of these lines could now be included in the picture proper with a slight gain in vertical resolution. However there is no sign of this being done because these non-picture lines (as many an 50 out of 625) have other uses. The viewer is unaware of anything transmitted on these lines because they are 'off the top' of his picture. They often carry test signals for studio and network monitoring and a recent exciting proposal is to put alpha-numeric information on them in digital code the British CEEFAX/ ORACLE system now under trial.

PAL DECODER

The-function of a colour decoder is to recover the two colour difference signals from the chroma (modulated sub-carrier) signal and thereby control the proportions of red, green and blue light produced by the display tube to create correct colour impressions by additive mixing. A commercial decoder circuit and its block-diagram are shown in Fig. 34. A hybrid circuit is chosen because the stages are most readily identifiable.
The chroma amplifier is a simple tuned stage Q0. The 6MHz sound inter-carrier is blocked by a tuned trap in Q0 emitter. Amplified chroma passes via a viewer control to the PAL delay line driver Q0. The control VRO varies the overall gain of the chroma stages. Although this could be fixed by the designer virtually all PAL receivers have this control which enables the picture colours to be set under-saturated, correctly saturated or over-saturated to taste. It does not affect the colour hues which are never adjustable on PAL receivers.
Note that Q1 obtains its base bias through the 'colour killer' D3. Excessive forward bias is prevented by D0. For the moment note only that the colour killer has the power to shu off this chroma stage, as its name suggests.
Transistor Q1 drives the PAL delay line via a transformer FXTO. The delayed chroma passes to an autotransformer FXT1. Suppose VR1 is anticlockwise so the centre tap is earthed. Then delayed chroma appears at the bottom of FXT1 and inverted delayed chroma appears at the top. Now by advancing VR1 some undelayed chroma can be added both these. If the undelayed chroma strength



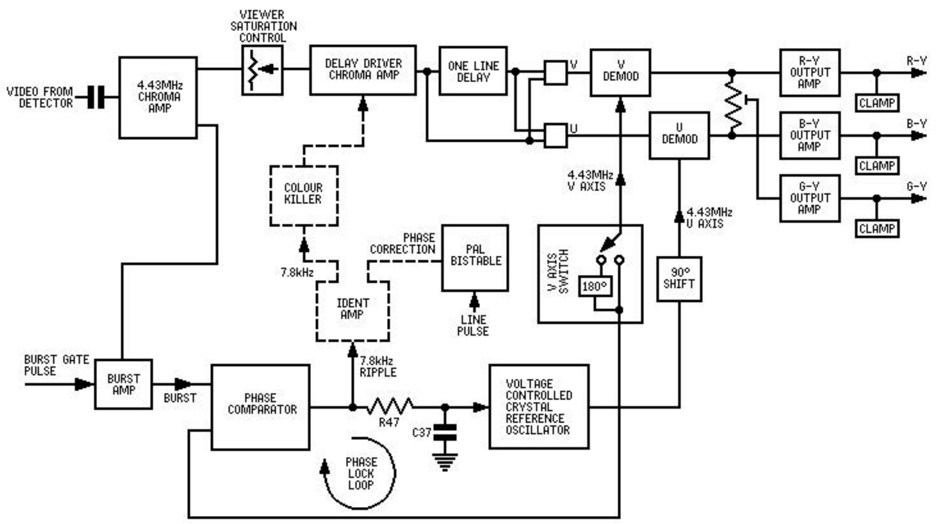


Fig. 34b This is a block schematic of Fig. 34a. The dotted stages are not essential for decoding.

is set exactly equal to the delayed signals (after delay loss) the upper and lower autotransformer outputs become: (undelayed - delayed) and (undelayed + delayed).

As explained last month, this separates the V and U components of chroma respectively and achieves electronic cancellation of phase errors. These components are fed to two synchronous demodulators which also receive suitably phased sub-carrier frequency from the crystal oscillator Q7.This is controlled by the burst in a phase-lock loop similar to the one described last month.

PHASE LOCK LOOP

The chroma at Q0 collector is also picked off by C4 and fed via a 4.43MHz tuned circuit to the burst amplifier Q6. This transistor receives forward bias only during the 4.43MHz reference burst (Fig. 32a) i.e. during the back porch period just before the picture information on each line. This is achieved by a burst gate pulse which is derived elsewhere in the receiver by delaying line sync. pulses to turn on Q6 at exactly the right times. It is essential that no picture chroma information should get past Q6 to the phase comparator.

The frequency of the reference oscillator Q7 is accurately held at 4.43 MHz by the quartz crystal. Its output is buffered by emitter follower Q8 and fed back to the phase comparator.

The action of the phase comparator is to produce an output voltage on C36 which is proportional to the phase difference between the burst and reference oscillation. On the half cycles of burst when the lower end of FXT4 secondary is positive and the upper end is negative, D13 and D14 conduct. This effectively connects VR2 slider to C36, via the 180k resistors and FXT5 secondary. Since the latter is a source of reference oscillation the voltage left on C36 after the burst has passed is equal to VR2 slider voltage plus or minus the average level of the reference oscillation during D13 and D14 conduction. This depends on the phase relation between burst and reference -see Fig. 35.

If burst lags reference by 90 degrees the mean level is zero and nothing is added to or subtracted from VR2 slider voltage. In practice this phase relation never occurs because a feature of the PAL signal is that the burst phase jumps forwards and backwards through 90 degrees on successive lines. This causes alternate positive and negative swings on C36 - see Fig. 35 (b) and (c). This waveform is smoothed by R47/C37 to obtain its mean DC level which is applied as a control voltage to the two varicap diodes in the reference oscillator. Increased positive voltage causes these diodes to lose capacity causing the oscillator to gain in phase (slightly increased frequency);

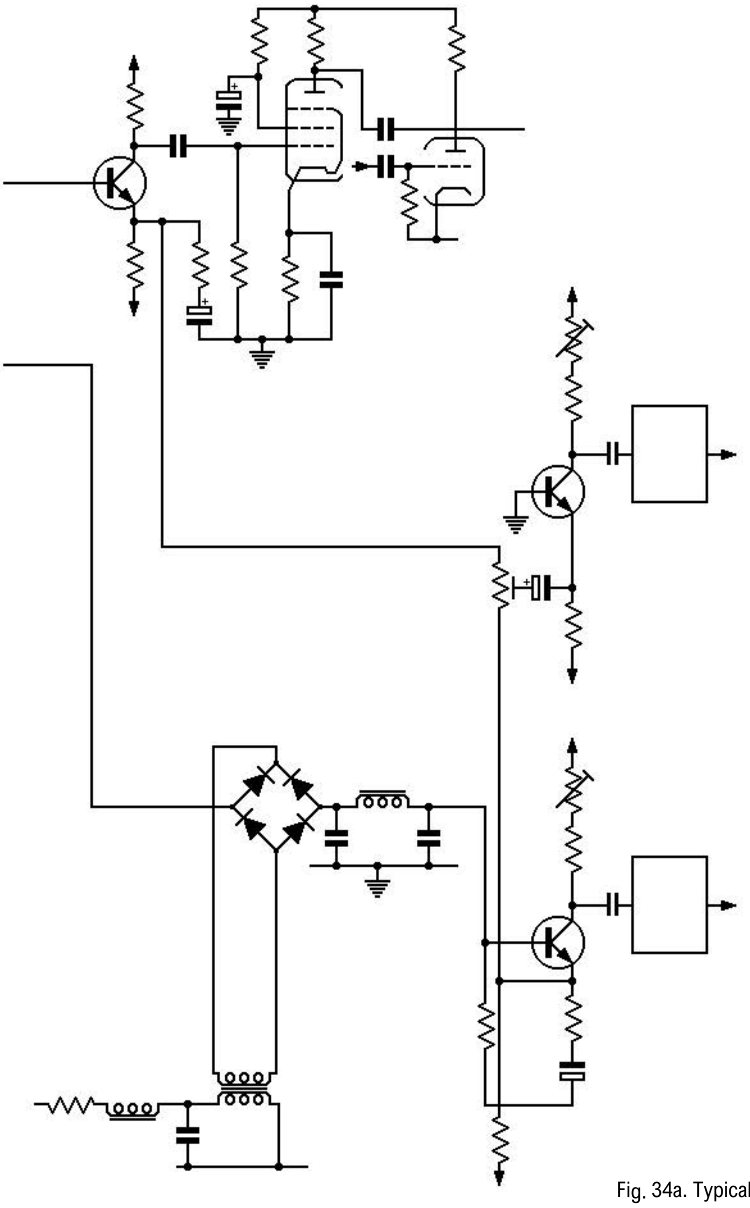


Fig. 34a. Typical PAL decoder.

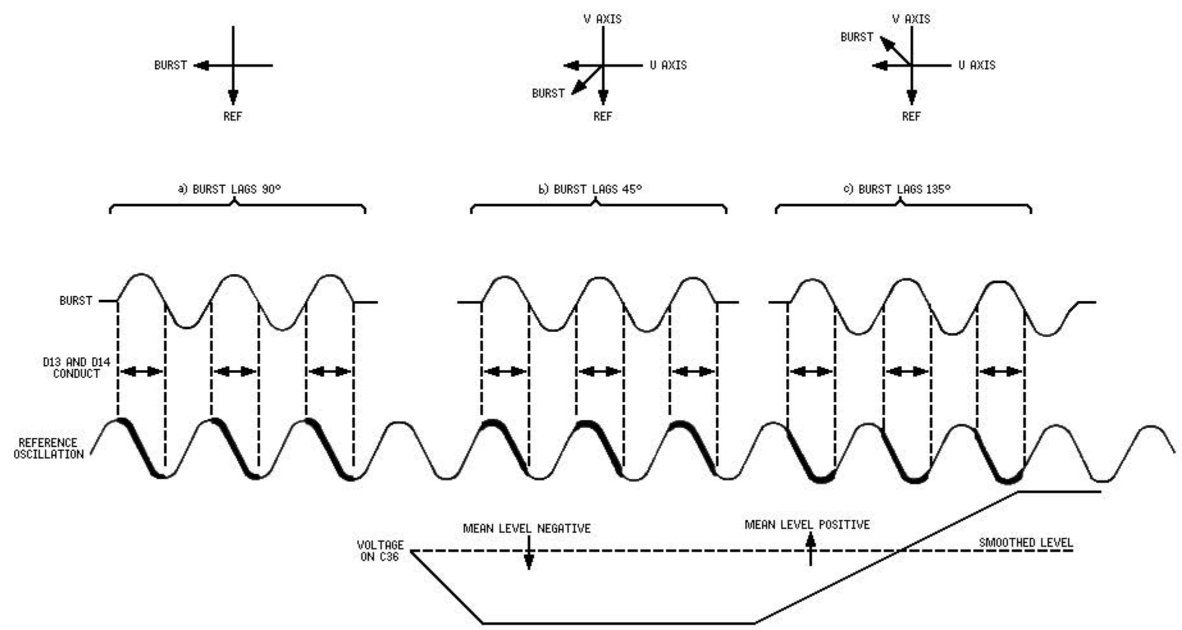


Fig. 35. Phase comparator action. The bursts actually consist of ten cycles of sub-carrier frequency only three of which are shown here. The burst swings between case (b) and case (c) on successive lines causing an AC waveform on C36.

decreased voltage causes the oscillator to lag. If VR2 is set for exactly correct reference the smoothed phase comparator output stabilises the oscillator phase on the - V axis (see Fig. 35) since here alternate bursts cause equal swings of the C36 waveform about its mean level.

SYNCHRONOUS DEMODULATION

The U and V demodulators each consist of a four-diode switch. Half cycles of reference oscillation cause all four to conduct, alternate half cycles cause them to block. The output of each demodulator is the algebraic product of the two inputs; high frequency harmonics are also produced because the cycle of conduction of the diodes is rather more abrupt than a true sine law. All harmonics are removed by the low pass filters following the demodulators. From these are obtained demodulated U and V.

The U axis reference oscillation feed for the U demodulator is simply obtained by delaying the reference oscillator output by 1/4 cycle (90 degrees) in an LC delay L5/C46. However the V demodulator needs a reference feed which differs 180 degrees on successive lines to follow the PAL reversals of the V signal. The reference oscillator is already at the - V phase. The phase. switching is performed by D11 and D12. One or the other of these diodes is always conducting depending on the state of the 'PAL bistable' ,04/05. Therefore either the upper or the lower secondary winding of FXT3 is connected to the V demodulator via FXT2. (C23/C24/ C25 have low impedance at 4.43MHz.) Since FXT3 secondary are oppositely phased with respect to earth, the V demodulation phase is reversible simply by changing or 'toggling' the PAL bistable. This is done at the start of every line by a line sync. pulse which is 'steered' by D5/ D6 to whichever of 04 or 05 happens to be on. It turns off this transistor causing the bistable to adopt a new state until the next pulse.

IDENT

The problem of ensuring PAL switching operates in correct phase has been mentioned. It is solved by the ident amplifier 02/03. This is tuned to magnify the 7.8kHz ripple produced on C36 by the swinging bursts. The ripple is amplified to a beefy sinewave, the 'ident' at Q3 emitter. Note that 7.8kHz (half line-frequency) is also the operating frequency of the PAL bistable. The ident however carries the correct PAL phase information. Diode D4 allows the ident to overrule the toggle pulse steering to correct the bistable phase if necessary.

In theory the ident could be amplified sufficiently to drive the V phase switch directly but only one manufacturer is known to have ·chosen this approach. The scheme described is used by the majority of PAL receivers for its simplicity.

THE COLOUR KILLER

During a colour programme D3 receives the 7.8kHz ident signal and half wave rectifies it to produce several volts positive on reservoir capacitor C7. This voltage is the source of forward bias for the chroma amplifier Q1.

Like any amplifier, the chroma stages generate some electrical noise. It happens that a small amount of chroma noise which would be unnoticed in a colour picture can cause a very unpleasant effect on a monochrome picture, appearing as a kind of 'coloured confetti'. The purpose of the colour killer to switch off the chroma stage(s) to prevent this.

Monochrome transmissions do not (or should not) carry any sub-carrier burst in the line back porch period. No swinging bursts means no 7.8kHz ripple from the phase comparator thus there is no ident and hence no bias supply from D3 for TR1. Therefore Q1 draws no collector current and no chroma noise is fed into the PAL delay line.

WEAK SIGNALS

Because of the colour killer, a PAL colour receiver gives only a monochrome picture if tuned to a distant colour transmitter. The sub-carrier bursts in this case are too weak to bring the decoder's phase-lock loop into control so no (or weak) ident is produced. This is satisfactory because a weak television signal may give an annoying confetti-ridden colour picture but only a slightly degraded monochrome picture.

In receiver repair the colour killer is rather a nuisance because a wide variety of component failures can cause it to shut off the chroma leaving no colour information on the screen to interpret. Therefore servicemen often deliberately over-ride (disable) the colour killer circuit by some simple means. For example in Fig.34 an appropriate method is to solder a resistor of 10k or so from HT to Q1 base to provide uninterrupted forward bias. For other circuits the manufacturers service information, if available, usually gives a method. But don't forget you've done it. One is liable to forget to 'unkill' the killer when 'shutting up' the set after servicing!

Many receivers employ a sophistication of the colour killer which improves picture resolution on monochrome. We recall that the luminance signal chain includes a 4.43MHz trap circuit to remove chroma. The principle is to fit a diode in series with this trap and use the 'colour killer voltage' on C7 to keep the diode forward biassed so the trap action is unaffected. However the absence of voltage on monochrome causes the diode to block. This disables the trap to restore full bandwidth luminance drive to the tube.

DECODER OUTPUTS

It will be shown later that the outputs of a decoder can be either ER,EG,EB or ER-EY, EG,EY,EB,EY

depending on how the display tube is connected. The latter set of signals is produced by the decoder in Fig. 34.

Since V = 0.877 (ER -EY) and U = 0.493 (EB-EY) the signals in brackets are simply obtained by passing the outputs of the U arid V demodulators through stages of suitable gains. In Fig.34, VR0 sets the overall colour gain and VR5 sets the gain for EB-EY relative to ER,EY.

The third signal EG-EY is obtained by adding together suitable proportions of the other two - see Part 2. The proportions are set by VR3 and VR4 in Fig.34.

The display tube requires large voltage swings from the decoder which are provided in this hybrid design by the three identical pentode amplifiers V0a, V1a and V2a. Since each colour difference signal may swing positively or negatively from its 'no colour' (black, grey or white) level, it is important to fix this level. This is achieved by coupling each colour difference signal to the tube via a capacitor (C47, etc.) and a driven clamp consisting of the triode section of each output valve. Normally this valve is off. Between scanning lines where there is no chroma signal, the clamp triodes are briefly turned on by a line sync. pulse fed to their grids. This adjusts the charge on C47 so that the no-colour output level is the voltage at the triode cathodes, which is fixed by a resistor divider. A long time-constant is formed by R64 and C47 which prevents the no-colour level drifting during the scanning line. The decoder, which is the most formidable part of any colour receiver circuit has now been fully described.

to be continued . . . .

ELECTRONICS PART 16 - it's easy!

How regulated power supplies work.

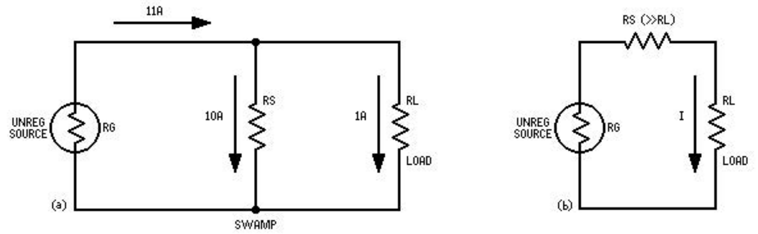


Fig. 1. Regulation can be slightly improved by: (a}. Voltage regulation - an additional shunt load. (b). Current regulation - an additional series load.

WE HAVE SEEN how the regulation of a power supply is related to its effective internal resistance. A voltage source requires low internal resistance, whilst a current supply requires maximum internal resistance for best operation.

PASSIVE METHODS

A simple and very elementary method of improving the regulation is, to impose a dummy load on the supply that is much greater than the normal load. Figure 1a shows a swamping load of 10 amps in parallel with 1 amp. If the real load (the smaller) varies by a value comparable with 1 amp, far less change occurs in the total load drawn from the supply - the output voltage, therefore, changes less.

This method improves regulation for load changes, out does nothing to guard against input supply changes. Furthermore, it is clearly inefficient. Note that RL is now connected to a lower source resistance - that of Rg in parallel with Rs. The reduction in resistance is however, not great.

If a constant current through the load resistance is required a similarly crude method is to place the load in series with a resistor that is much greater than the load value - as shown in Fig, 1b. It can be seen (from Ohms law) that I will now remain constant over a wider range of RL variation.

Again there is a disadvantage, the input voltage must be raised to drive the same current through the increased resistance circuit. Furthermore, if this is done, RS wastes considerably more power than is used in the load. As required, for better current regulation.

RL now sees a higher source resistance.

Both circuits are used occasionally but their real relevance is that the same basic principle (modifying the impedance of the supply) is used in more sophisticated supplies. These supplies use special non-linear components and active devices to provide much better regulation with considerably less loss of power.

NON-LINEAR DEVICES

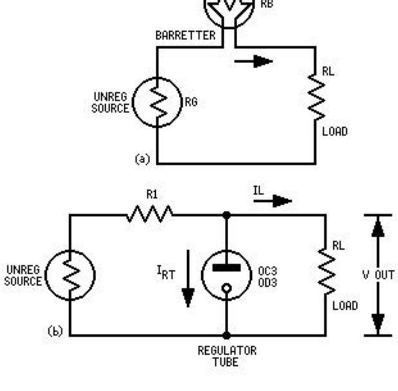
Before low cost semiconductors became widely available in the form of regulating diodes (Zeners) and regulator integrated circuits, designers used the barretter current regulator and the gaseous-tube voltage regulator. These are still found in older equipment but would not normally be used in new designs.

The barretter contains an iron filament in a hydrogen filled envelope and is used in series with the load. Over a reasonably wide range of voltage (100-200V) the load current remains constant to within 20% (typical value would be 300mA). By today's design standards they waste power and run extremely hot.

Regulation occurs because an increase in current through the filament (see Figure 2a) causes its resistance to increase thus tending to reduce the current to its previous level - RS in Fig. 1b, increases with increasing current. Note that the current itself provides a feedback effect (via heating of the filament) that controls the current. The use of feedback (but in a more effective way based upon active elements) is the secret of obtaining really, good regulation, as we shall see later.

The gaseous-tube voltage regulator is a gas-filled two-electrode valve which, once the gas is ionised into conduction, provides a reasonably constant voltage drop between its electrodes with varying current values flowing through the ionised gas. Again these are seldom used today, being more suited to voltages much larger than those needed in semiconductor work (they strike and operate at around 100V).

In use, the regulator is wired in parallel with the load, the two being fed from the supply via a series resistor, as shown in Fig. 2b. If the input voltage increases (assuming a constant load) the total current must rise. But as the VR tube maintains constant voltage across itself, the load current remains steady and all the excess current flows through the VR tube. Thus the voltage drop across the series resistor increases so that the voltage applied to the load remains the same.



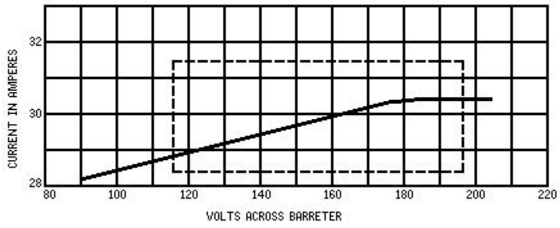


Fig. 2 (a}. The barretter tube regulates by the increase in resistance with temperature (and hence current) of an iron wire filament. (b). The gaseous-tube voltage regulator operates by virtue of the constant voltage which appears across a gas discharger over a wide range of current.

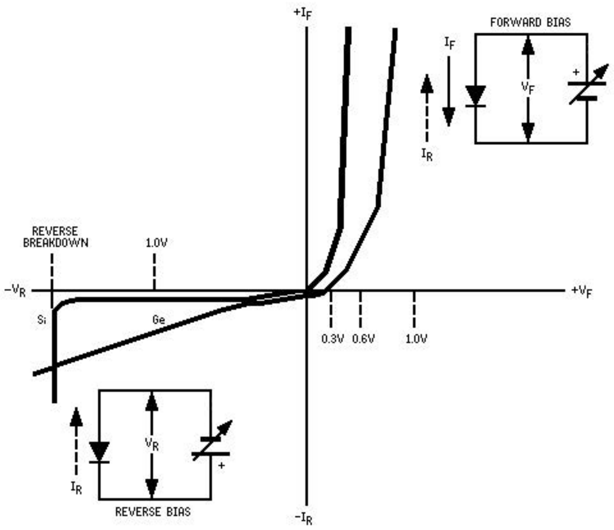


Fig. 3. Forward and reverse bias characteristics of germanium and silicon diodes.

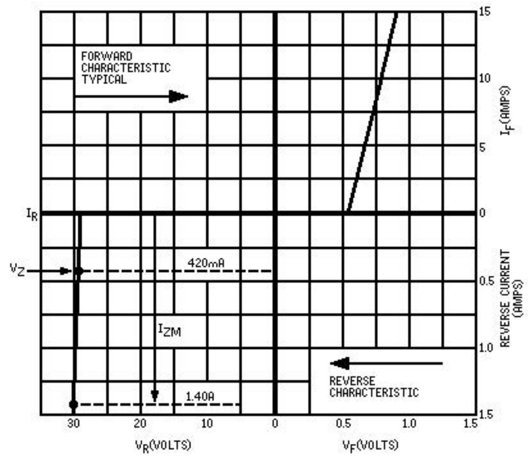


Fig. 4. In a zener diode the reverse breakdown region is used to provide a constant voltage as current demand varies.

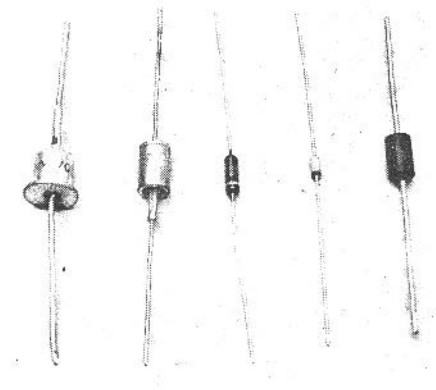


Fig. 5. Zener diodes are manufactured in a wide variety of packages. The larger capacity (not shown here) units,are usually mounted on heat sinks if run at their maximum rating.

The effectiveness of the compensation depends upon the rate of change of the voltage-current characteristic of the device. The barretter represented in Fig. 2a changes some 200µA/V. A flatter curve would imply a current that changes less per volt and this is to be preferred. Neither of these two devices has a particularly low V/1 ratio and neither, therefore, is able to provide close control over wide ranges of input change. Negative temperature coefficient NTC resistors - more commonly called thermistors or varistor's - have a similar voltage-current characteristic but the slope is in the reverse direction, that is, increase in current increases their temperature .which, in turn; decreases their resistance. They are not suited to regulator design where constancy is desired but are useful in providing the reverse effect, for example, when wired in series with a load, that could be damaged by switch on current surges. An NTC resistor suitable for such. use might have a resistance of 3000 ohms cold reducing to 200 ohms when heated by 100mA passing through it.

ZENER DIODES

The current versus-voltage characteristics of both germanium and silicon diodes are illustrated in Fig. 3. In the forward direction (positive voltage at anode with respect to cathode) the devices operate, as shown, in the right-hand region of the graph:

It can be seen that once the forward voltage across the diodes reaches 650mV for silicon (or 350mV for germanium) it remains substantially constant over quite wide excursions of the forward current. Thus forward-biased diodes could be used as constant-voltage regulator elements but only at the low voltages mentioned above or at multiples of these voltages (using diodes in series). If a conventional diode is reverse biased its operating characteristic will be as shown on the left hand side of Fig. 3. Very little current (micro-amps) will flow until the reverse voltage reaches a comparatively large value when the current starts to increase much more rapidly: In a germanium device the voltage across the diode will still increase relatively slowly with increasing current, but in a silicon device the voltage across the diode now remains substantially constant regardless of further increase in current. This point is known as the Reverse Breakdown Point.

In a normal diode the rapid increase in reverse current causes the semiconductor junction to overheat and the device may fail. This breakdown effect occurs at voltages between two and a half volts and several thousand volts depending upon the material and construction of the semiconductor junction.

However, this seeming disadvantage may be put to work in special constructed devices known as Zener diodes. Zener diodes are invariably silicon devices which have been specially designed to operate within the reverse-breakdown region, without damage, provided that the maximum-specified power dissipation (Vxl) is not exceeded.

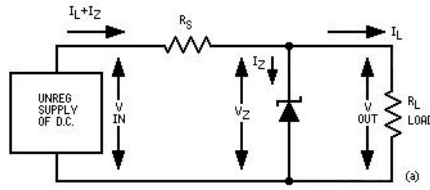
DYNAMIC RESISTANCE OF ZENER DIODES

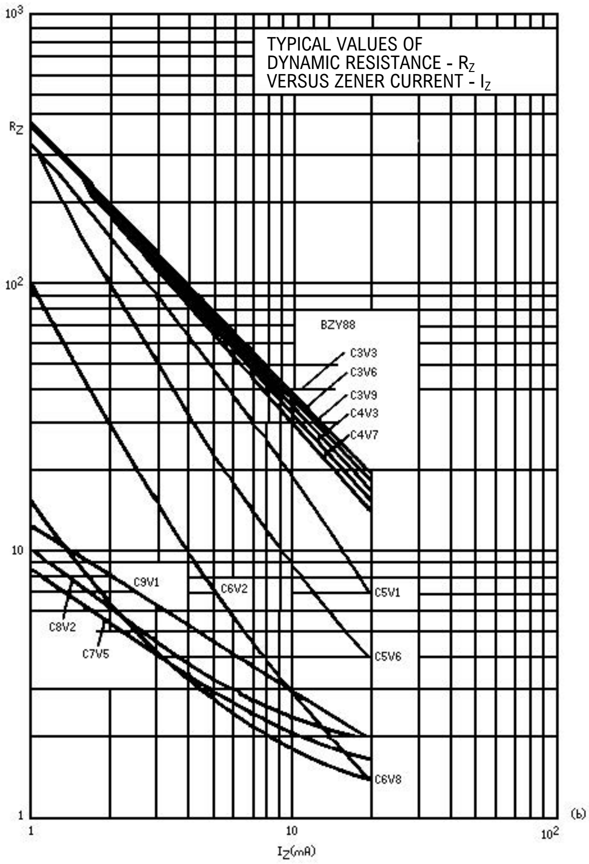
Ideally, a Zener diode should maintain a constant voltage across itself with varying current through it. However, practical devices don't behave quite like that. In Fig. 4 we see, from the typical characteristics of a 30 volt, 90 watt device, that if the current through the device changes by 1.0 amp, the voltage across it will change by 2 volts. This may be expressed as a resistance as follows:-

By Ohm's Law t:N = R i.e.I= 2 ohms L:.I 1

As this resistance is the ratio of changes of voltage with respect to current it is a dynamic quantity, and is therefore known as the Dynamic

ELECTRONICS - it's easy!





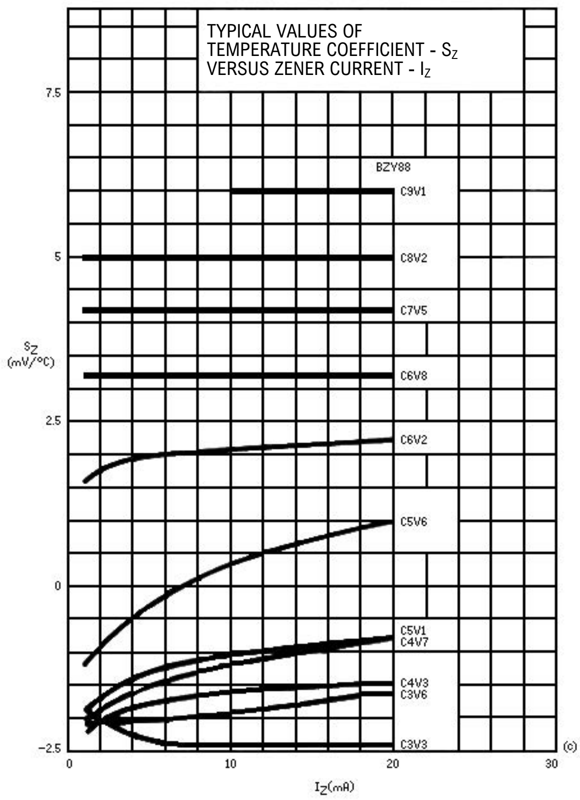


Fig.6a. Typical Zener diode regulator. (b) Dynamic resistance of BZY88 series Zeners. (c) Temperature coefficients of BZY88 series diodes.

Resistance of the Zener. It tells us how well the Zener will regulate the voltage with changes in load current. Thus a Zener having the desired reverse-breakdown voltage may be used to replace the gas-regulator valve shown in Fig. 2b. Any load connected across the Zener will see a source impedance which is the parallel combination of the dynamic resistance of the Zener, and the internal impedance of the power supply.

TEMPERATURE COEFFICIENT

The reverse-voltage characteristic of the Zener is temperature dependent, the extent of this dependency being determined by the designed Zener voltage and power dissipation. For example in typical 400mW devices the temperature coefficient ranges from 2.5mV for a 2.7 volt Zener to + 26mV for a 30 volt Zener. Zero temperature coefficient is obtained with a device having a nominal voltage of 5.6.

Where Zener regulators are required to have minimum temperature coefficient and higher than 5.6 volt rating, several diodes with temperature coefficients which cancel may be used in series.

For example, if 9.8 volts is required with zero temperature coefficient, a 3.6 volt 2.0mV diode may be used together with a 6.2 volt + 2.0mV diode.

REGULATOR DESIGN

The circuit of Fig. 6 is that of a typical Zener diode regulator stage. The series resistors must be large enough such that when the load current is at its minimum (Zener current at maximum) the power dissipation rating of the diode is not exceeded, and small enough to ensure that when the load current is maximum (Zener current at minimum) the voltage across the load does not fall below E_z (Zener voltage). Additionally the Zener current should always be at least one tenth of the maximum load current. The optimum value of R_s may be calculated from

$$R_S = \left[\frac{E_{S1}-E_Z}{1.1\ I_{L1}}\right]$$

Power in R_S = $(1.1\ I_{L1})^2\ R_S$ and maximum Zener dissipation may be calculated from

$$P_Z = \left[\frac{E_{S2}-E_Z}{R_S}\right] I_{L2}\ E_Z$$

where

E_{S1} = minimum supply voltage

E_{S2} = maximum supply voltage

E_Z = zener voltage

I_{L1} = minimum load current

I_{L2} = maximum load current

For example assume that we have a car battery supply that varies from 11 to 14 volts and from this we wish to obtain a stabilized 6 volt supply at currents from 40mA to 60mA.

The nearest available Zener voltage is 6.2. Thus

E_{S1} = 11 I_{L1} = 0.06A

E_{S2} = 14 I_{L2} = 0.04A

E_Z = 6.2

$$\frac{11 - 6.2}{1.1 \times 0.06} = 72.7$$

use nearest preferred value 68 ohms.

The power rating of this resistor must be

$$(1.1 \times 0.06)^2 \times 68$$

= 296mW - a 1/2 watt resistor will do.

$$P_Z = \left[\frac{14-6.2}{68}\right] -0.04\ 6.2$$

$$= 463\text{mW}$$

Hence a suitable device would be one with a power rating of 1.25 watts and a nominal Zener voltage of 6.2.

Where Zeners with power ratings greater than one watt are used a heat sink will usually be necessary. Note also that the supply voltage must always be greater than the Zener voltage if regulation is to be maintained - at least 10% higher is a safe minimum value.

The Zener voltage regulator is widely used throughout electronics. It may be. used as a basic regulator as in Fig. 6, or, it may be used to provide the reference voltage for more accurate and powerful regulators which make use of active devices as well.

The aim of good voltage supply design is to achieve lowest practical effective internal resistance. The Zener does this reasonably well, for the load sees only the dynamic resistance of the Zener which is much lower than the source impedance. As a rough guide the dynamic impedance RZ of the Zener, varies (according to device) from 30 ohms per volt of the Zener, downward to fractional ohms per volt.

If one Zener stage cannot provide enough stability it is quite practicable to join stages in cascade. Each stage thereby lowers the effective source resistance (because stages are connected in parallel) but, more significant is the fact that input voltage variations are more adequately attenuated, each stage running from a progressively better stabilised source.

Fig. 7a shows a typical dual stage supply. Figure 7b is the preferred method, of providing the same illustrated 5.6 V, for in this alternative all of the diodes have optimum temperature stability.

Zeners also have other uses - to clip and hold voltages at fixed levels and to convert sine-wave signals to square-wave signals.

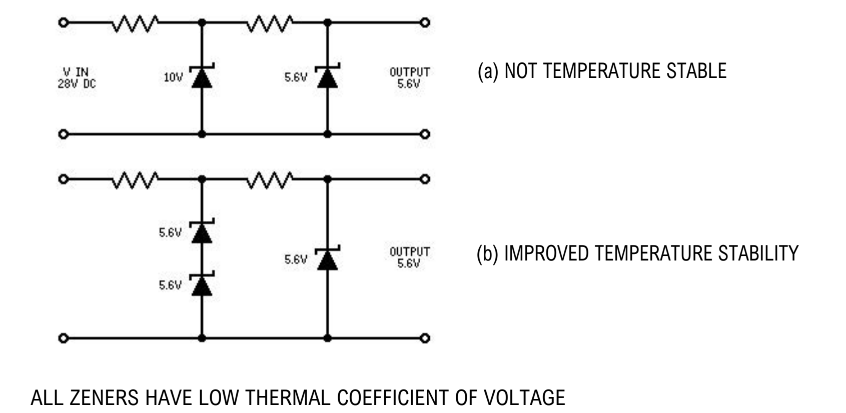


Fig. 7(a). Cascading Zener regulator stages improves voltage stability. (b) Selected Zeners are often joined in series to achieve the lowest temperature error.

ACTIVE COMPENSATION

Although the Zener can provide a relatively low dynamic resistance value, it is possible to provide still lower resistance by incorporating active amplifiers into the regulator circuitry.

If the actual load voltage is compared with a constant reference-voltage source, it is possible to determine if the output is greater or smaller than required and by how much. Having made I such a comparison, the difference, called the error signal, can be used to modify the incoming signal accordingly. This is the principle of feedback. Figure 8 shows how feedback is used in the electro-mechanical type of supply regulator. These regulators are used where loads are high and the unwanted changes occur only relatively slowly. In operation the output of a basic rectifier is smoothed by a capacitor. (C) to provide the required output voltage. The output voltage is compared with a reference voltage and the difference between them (that is the error) is amplified. The amplifier output drives a motor such that a tapping on the AC transformer is changed - thus reducing the error.

Thus, by using feedback, changes in output voltage are rapidly sensed and the input quickly compensated. The feedback amplifier and control actuator (the motor in Fig. 8) need not be precision devices - they can be quite crude in fact - but the reference voltage must have better stability and accuracy than is required from the output.

The reference voltage is quite often, and effectively, supplied by a Zener. As the Zener now only has to supply a reference voltage, and not operate over a wide range of current, its operation will be much more stable. That is, its dynamic impedance will not be a source of error. Additionally, the Zener current may be set at a level which gives optimum temperature stability.

Although electro-mechanical

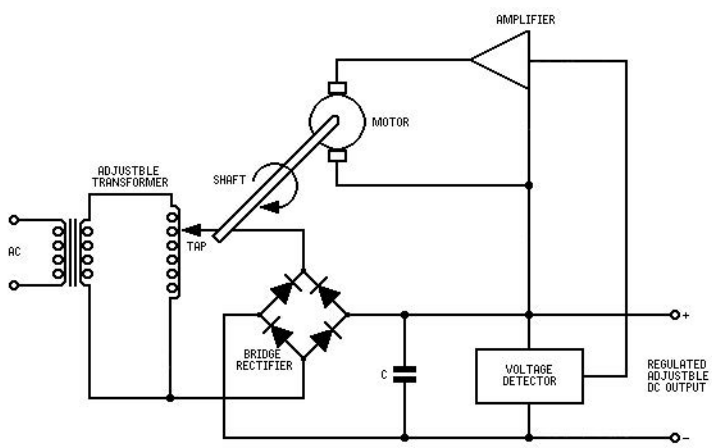


Fig.8. Superior regulation is obtained by using feedback - as demonstrated by this electromechanical form of regulator.

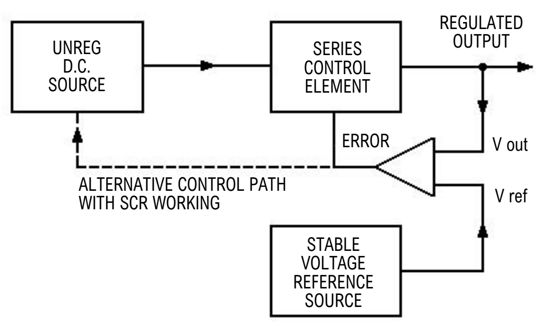


Fig. 9. Generalised diagram of active feedback type regulator.

regulators have their uses, the majority of regulators for low-power electronic systems now use totally solid-state components to build systems such as that shown in Fig. 9.
A wide range of control methods are used using such devices as transistors and integrated circuits, silicon controlled rectifiers (SCRs) and saturate reactors to achieve fast and accurate regulation.
The voltage reference is again generally derived from a Zener network. However, precision units may use a Weston standard cell or a special high-stability Zener. arrangement. Yet another kind of regulator may use an external varying voltage as the reference in the feedback system. With such supplies the output is made to track the varying input voltage - these are called programmable supplies.

SHUNT REGULATORS

We have seen how the basic Zener arrangement may be used to provide a shunt path around the load thus stabilizing load voltage. By reducing the current range required of the Zener diode it is possible to improve the regulation and to reduce the power handling required of the Zener. Figure 10 illustrates how a transistor is added to the basic Zener circuit to produce a more precise shunt regulator.
Now the Zener regulator only has to supply the base current 0f the transistor which in tur controls the much-larger collector current.
To see how the regulator works let us assume that the current demanded by the load falls. The voltage across the load would tend to rise (due to less voltage drop across the series resistor (R) and this would cause the base-emitter voltage on the transistor to rise (as VR is held constant by the Zener). Hence the transistor draws more current to compensate for the current shed by the load. That is the current drawn through the series resistor R is held constant, current not needed by the load being shunted by the transistor.
As the transistor provides current gain ranging from tens to hundreds, the current variations demanded from the Zener are reduced by the same factor, with consequent improvement in regulation. Although not immediately obvious, feedback is used in this circuit. Voltage changes across the load appear at the base of the transistor which acts to reduce the original change to zero.
One vitally needed characteristic of a general-purpose power supply is that the output should be capable of being short-circuited without damaging any components. The shunt regulator does just this - a shorted output merely connects the emitter of the transistor to collector, thereby reducing the voltage applied tot the device. The transistor therefore cannot be damaged by a shorted output. Such a supply is, however, inefficient, especially at light loads, for shunt regulators act always to dissipate the same maximum amount of power - either in the load, in the shunt element or in both. Hence, at zero load the unit wastes as much power as the maximum safe load would consume, and if ever the load is disconnected the transistor must be capable of passing the full load current.

SERIES REGULATORS

The Zener reference may be used to control a transistor in series with the load such that a constant voltage appears across the load. Figure 11 is the circuit of such a basic series regulator.
The operation of a series regulator may most easily be understood by considering the transistor and load to be an emitter follower circuit. We know from our previous theory that an emitter follower maintains its emitter at Vbe (0.6 volts for silicon) less than the voltage at its base, regardless of the value of the collector supply. Thus the transistor, because of the Zener reference voltage at its base, varies its impedance and hence the voltage dropped across itself, in order to maintain a constant voltage across the load, regardless of load current and supply-voltage variations.
As the transistor has a large current-gain the Zener diode again only has to supply a small current range and regulation is therefore improved. However, the transistor must be capable of withstanding the full load current and of dissipating fairly high power. The series regulator is more efficient on light loads than the shunt regulator but if the output is short-circuited the transistor in a series supply will be destroyed (unless pro ected in some way), as the full supply voltage and base drive is applied to it.

IMPROVING SERIES REGULATORS

The simple series regulator, just described, is a great improvement on the simple Zener regulator but may still be improved further by additional circuit refinements.
Figure 12 show the schematic diagram of a typical series regulator supply. The AC transformer has two secondaries the first of which provides DC to the regulator and hence the load via a bridge rectifier and smoothing capacitor. The second winding provides a separate supply to a Zener regulator, As this winding does not have to supply the varying load current - only the steady Zener supply, regulation of the reference

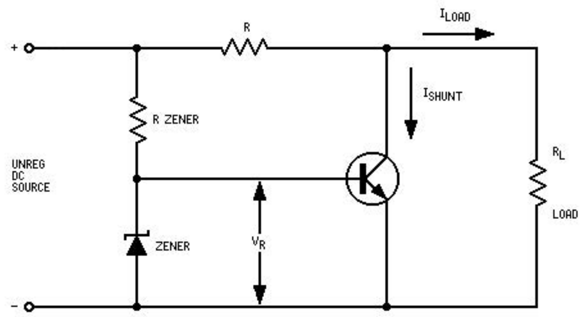


Fig.10. Basic shunt regulator uses transistor to maintain constant load current on the unregulated DC source.

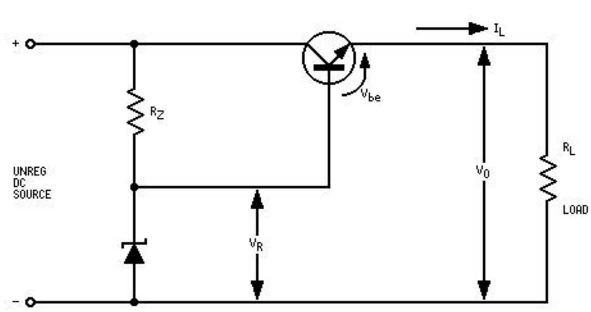


Fig. 11. The series regulator also relies on feed-back to control voltage drop across a series-pass transistor.

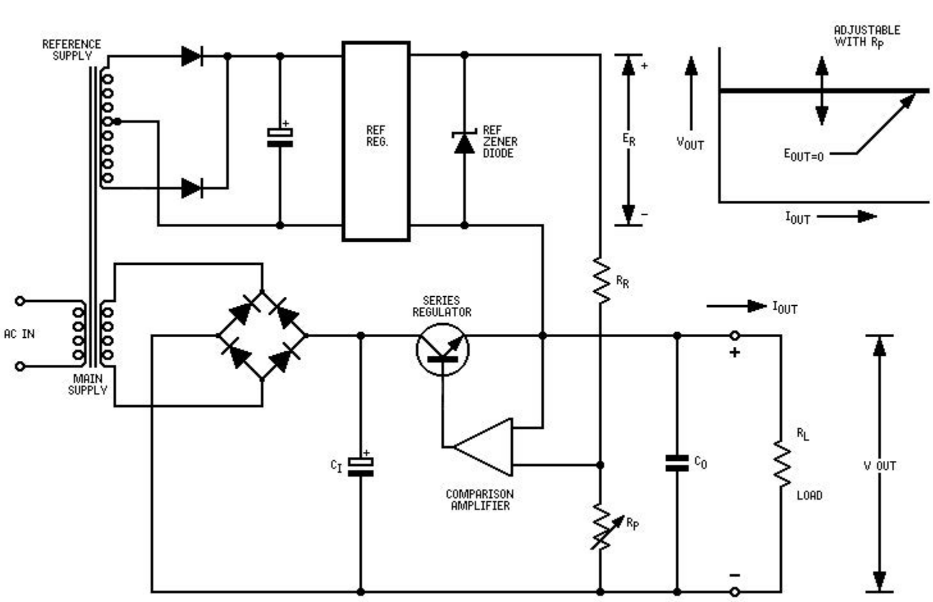


Fig.12. This schematic diagram of a Hewlett Packard series - regulated constant voltage power supply illustrates the design philosophy of precision supplies.

Zener is considerably improved. In addition a temperature compensated Zener may be used which could have a temperature coefficient as good as 0.01%/C.

This very stable Zener reference is compared to the output voltage of the supply by a differential-operational amplifier. Thus the Zener does not have to supply any appreciable current. This results in still further improvement in regulation. The operational amplifier provides a change in base current to the series regulator in such a direction as to correct any error between the output voltage and the Zener reference.

CONSTANT CURRENT

In some applications - magnetic circuits, focussing coils, semiconductor testing, the requirement is for constant output current regardless of load changes. Loads connected to such supplies are connected in series, rather than in parallel as is the case for voltage regulated supplies. Ohms Law tells us that a certain value of current is related to voltage via a fixed value of resistance. Hence constant current supplies can make use of a small series resistor to monitor the output current by virtue of the voltage developed across the resistor. This voltage is then compared with a reference (the actual value is a matter of design choice, the lower the series resistance the lower the voltages and losses involved) in much the same way as for a stabilised voltage supply. The differences in circuitry needed can be seen by comparing Fig. 13 - that of a well-designed constant current unit - with Fig. 12.

By combining these two concepts into one supply a combined constant voltage and constant current unit is formed (denoted CV/CC). This holds a constant voltage up to a preset maximum load current where after it provides constant current.

Power supplies designed to provide variable output for experimental purposes, or equipment (or component) testing are often subject to severe or extended overloads. Units such as these are generally equipped with various protective devices that safeguard not only the power supplies themselves but also the loads that they are driving. These various protective circuits will be described in this series next month.

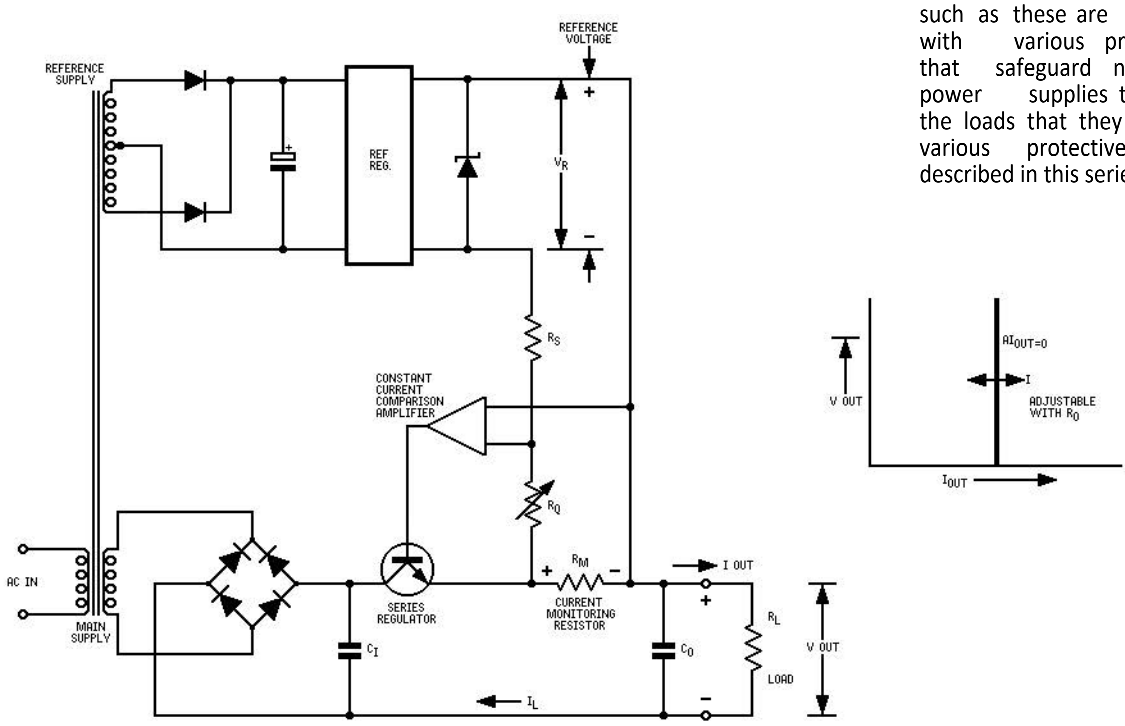


Fig. 13. Constant-current control is easily obtained as an extension of the constant-voltage supply. A series sensing resistor produces a voltage which, in conjunction with an error amplifier, controls the series pass transistor to maintain constant current.

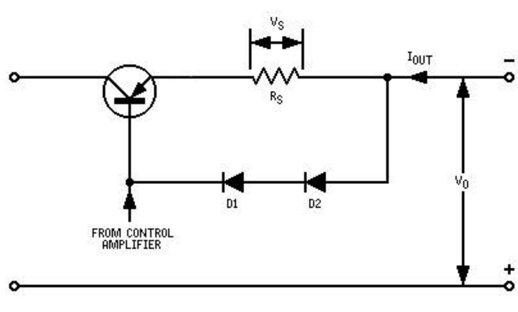


Fig.14. Automatic current limiting is obtained with a series sensing resistor. This method of control is often used in series-pass voltage regulators.

Electronics Tomorrow

by John Miller-Kirkpatrick

LAST MONTH we described a BCD counter with preset and comparator options, this might be too complicated for some simpler applications such as a simple counter, frequency counter or timer. This month we have a new device from Ferranti which could make life a lot easier when designing or building such a project. The, ZN1040E is a four digit decade counter with BCD and seven segment outputs in a multiplexed mode. Counting can be up or down with a carry/borrow output in a synchronous type of operation and with reset to zero facility. As with the MK50395 last month, the count and the display can be used separately with an external latching input, this means that the counter can collect a count, transfer it to the output register for display, reset the counter and start collecting a new count. This makes it ideal for a frequency counter operation or for the back end of an A-D converter such as a digital multimeter. As the maximum count rate is up to 8MHz, the ZN1040E is one of the fastest frequency counter chips available. One other main a vantage of this chip is that it has segment output current limits of 100mA and thus can typically drive LED segments directly. Other chips also make this claim but they are intended to drive small calculator displays, this chip will drive large Jumbo DL747 displays using only four cheap PNP digit drivers.

To use the ZN1040E as a frequency counter, the frequency is connected to the count input. An external clocking source gives outputs at 1Hz, 10Hz, 100Hz and 1KHz, the output is used to gate the input frequency into some form of shift register ring counter. The ring counter has two outputs one controlling the latch input and the other gating the clear input of the main chip, the event sequence is given in Table 1.

The ZN1040E also has a lamp test input and a blanking input which may be used to switch off the display completely or to dim the display by inputting a variable mark space signal. The IC is presented in a standard 28-pin DIL package, and requires 5V at 90mA. With this chip and a few parts of low-power TTL, you can build several portable instruments for counting or timing applications.

RECORDING DIGITAL DATA

Both the amateur and professional engineer often have a requirement to record digital data from a TTL source for analysis or for input to another TTL unit. There are tape systems which will do this but they are very expensive and have a specification far beyond requirements.

I was working on a system recently where we needed to record BCD data on magnetic cassette tape; there was not much data to record at each sample and there were not many sampling times each week. The system was switched on by an external signal and the time (hours and minutes) and two other four figure data were to be recorded. This data was to be played back onto a digital display and manually recorded on a graph. As yet the system has not been implemented but it did point out a requirement for a piece of equipment that was cheap and reasonably easy to build. As some of you might have a similar requirement or would like to build a similar unit, I will outline the basic ideas.

The system uses a standard cassette tape recorder (mono) with a normal cassette. Two frequencies are produced continuously at the recorder end, these two frequencies must be within the recording capability of the cassette and also a reasonable distance apart from each other, let us say a nominal frequency of 2kHz to indicate logical 'O' and 6kHz to indicate logical '1 '. Thus we can record any one of four signals on the tape: 2kHz, 6kHz, 6kHz modulated at 2kHz, no signal. If we ignore the modulated (combined) signal we are left with . indications of no data; logic 'O' or logic '1'. We load our data to be recorded into a set of Parallel-In, Serial-Out shift registers and give the signal to start the tape recorder. To start with we record a few inches of no signal in order to separate the data from different samples; this is not necessary in all applications. A clock oscillator then addresses each bit of the shift register and presents the data therein to the decoder. The clock also informs the encoder that there is some data to be recorded, the encoder thus allows one of our two recording frequencies to be input to the recorder. The clock oscillator then switches to low, which inhibits both frequencies thus leaving a no-signal gap on the tape, thus the data on our tape looks like Fig.2, the digits 17 are represented. Figure 3 shows the block diagram of the encoder, additional logic is required to start the encoder for each sampling system and to count the pulses of the clock oscillator in

TABLE ONE	Latch Input	Clear Input	Ext Clock
a. Counter incrementing with previous total being held and displayed.	0		0
b. Ext clock indicates end of sample period.	0		
c. Next count pulse is now gated into shift register counter. Data is transferred into display register.	1	1	
d. Next count pulse latches count data.	0	1	
e. Next count pulse resets counter.	0	0	
f. Next count pulse is counted, stops reset and clears the external clock pulse.	0		0
g. External clock now starts a new timing period and a new count data is collected in the main chip.			

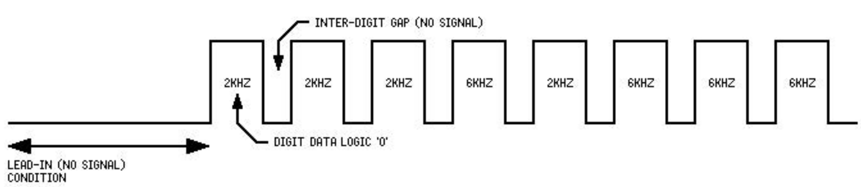


Fig.2. How a BCD number "17" goes onto cassette.

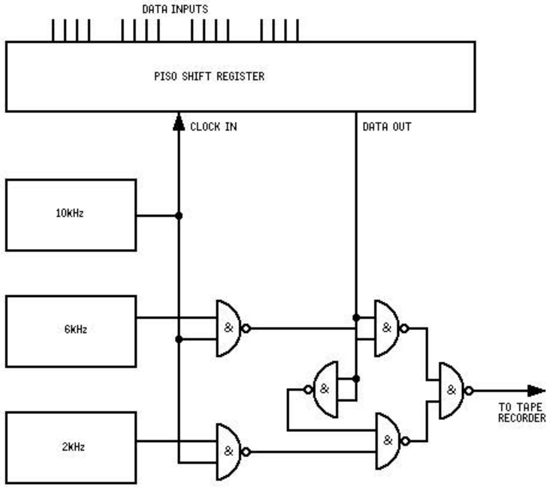


Fig.3. Encoder Block Diagram.

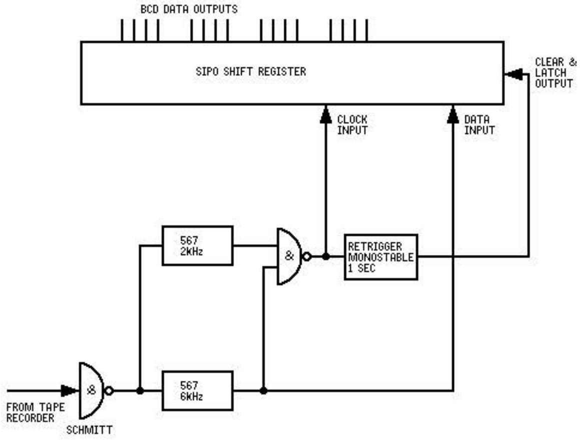


Fig.4. Decoder Block Diagram.

order to stop the encoder when all data bits have been recorded. In the above example two 7490s would count the 48 bits to be recorded and as the count of 49 was sensed the clock oscillator would be inhibited by a 'D' flip-flop output. The START signal would reset this flip-flop and thus allow the clock to run.

The output from the last gate is fed to the tape recorder input after suitable interfacing to the recorder input.

The data is read off on another similar device which works from the earpiece passed through a Schmitt trigger to shape the signals. The signals are then passed to two LM567 phase locked loop tone decoders, one set to switch with 2kHz input signals and the other set to operate on 6KHz input signals. The bandwidth of these decoders needs to be set rather wide to allow for differences in tape transport speeds between the recorder and player. The outputs from these tone decoders will be a logic '1' if the specific tone is present at the input and logic '0' if no tone or a tone outside the bandwidth is present. If the two outputs are fed to a 7486 Exclusive Or gate then this gate will give an output logic '1' either when both tones are received together or when no tone is received. Additionally the output from the 6KHz tone decoder will give a logic '1' if a logic one is encoded on the tape and a logic '0' if either a logic '0' is encoded or no signal is encoded. Thus by a simple form of gating we can use the 7486 output as the sync clock and the 6kHz LM567 output as the data for a Serial In, Parallel-Out shift register. When all of the data has been loaded into the register the clock pulses will stop and thus the monostable will turn off after one second, this turn-off signal can be used to latch the output data from the register into the displays and also to clear the register ready for the next set of data.

Including the shift registers, the whole unit would cost about £25 for both encoder and decoder and can be used with virtually ant type of tape recorder on the market. The data transmission speed is a nominal 10Hz but this depends on the reaction speeds of the LM567s and this depends on the allowable bandwidths; without actually trying out the system it is difficult to know how much faster than this it might work. In our example we would allow 214 seconds of tape at each end of the data for starting and stopping and to act as an inter-sample gap, our data would take 4.8 seconds of tape making each sample take 10 seconds of tape. We would thus be able to record up to 360 samples on a standard C60 cassette. If much more data is to be recorded at each sample then it might be an idea to put a sync pulse or a set of pulses within the data by recording another tone or shorter inter-sample gaps.

Data on the ZN1040E from Ferranti Ltd., Electronic Components Division, Gem Mill, Chadderton, Oldham, OL9 BNP. Data on the LM567 tone decoder from Ambit International, 37a High Street, Brentwood, Essex.

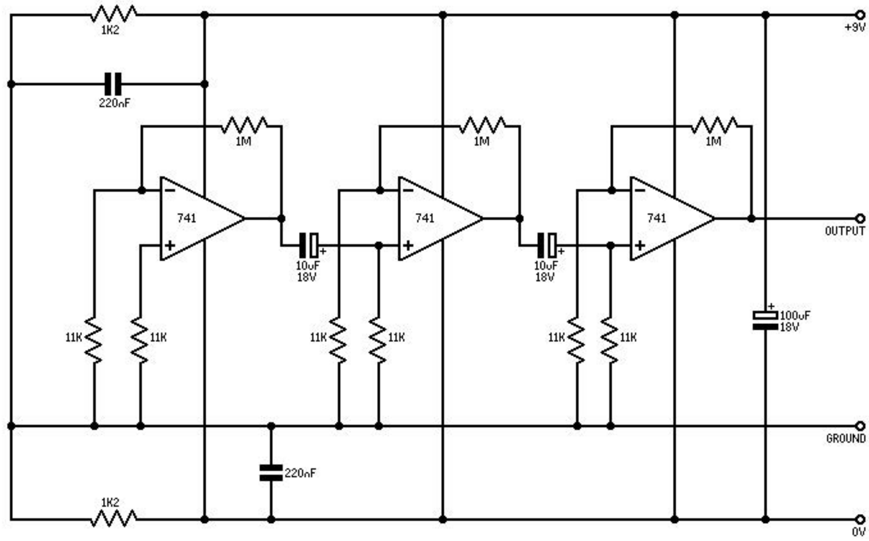
tech-tips

PINK NOISE GENERATOR

A useful method of frequency response testing of audio equipment is to excite the system with a random noise electrical signal and then analyse the output into its various frequency components using narrow band filters. The ideal noise signal is one having unit power per unit bandwidth (this is termed "white" noise). The system will be effectively driven by all frequencies at once. The frequency· spectrum of the output will then be the required frequency response of the system.

However, the most common form of frequency analyser uses filters with a constant percentage bandwidth (often one-third-octave). Thus an analysis of true white noise would give a frequency spectrum rising at 3dB per octave, because the power in a noise signal is directly proportional to the measuring bandwidth.

Pink noise was developed to give a flat frequency spectrum into such filters. The output of a pink noise generator falls at 3dB per octave. Normally they are made by installing a -3dB per octave filter after a white noise source. By a fortunate coincid-ence, the electrical noise from a 741 operational amplifier, when connected as shown, does have if pink noise frequency spectrum.



The circuit is simply three high gain operational amplifier stages cascaded. The first stage generates internal electrical noise which is amplified to approximately one volt r.m.s. by the two following stages. The circuit must be laid out as closely as possible to the schematic diagram, and carefully screened, because the input stage is very sensitive to extraneous signals and could pick up hum or oscillate due to capacitive coupling with the output. The prototype is run from a PP9 battery, mounted inside the case, to further reduce any possibility of hum pick-up.

The output does have a slight roll-off from a pink noise characteristic, starting at about 100Hz. This is caused by the AC coupling between stages in the circuit which is necessary to prevent DC fluctuations from saturating the output.

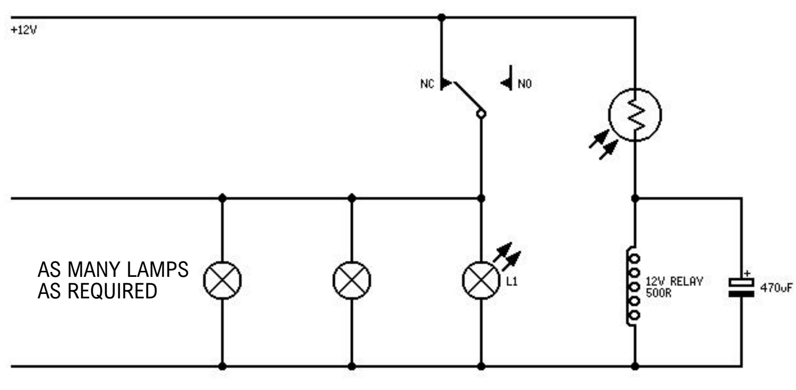
Also there is a roll-off at the high frequency end caused by the internal compensation in the operational amplifiers. There is, nevertheless, usable output up to 25kHz.

My apologises are due to the manufacturers concerned for using their devices in this unorthodox fashion.

It may be useful to point out that the cheaper brands of 741 op-amp are likely to have higher noise levels and thus be more useful for this particular purpose.

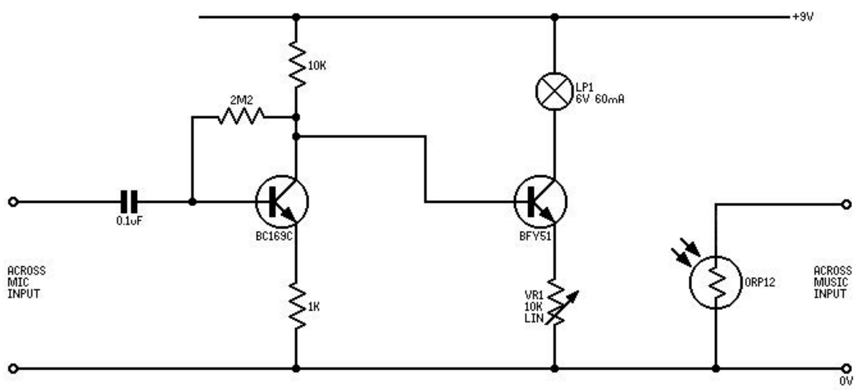
SIMPLE HAZARD LIGHT

When switched on, the lamp will light, at the same time, this light will lower the resistance of the LDR thus operating the relay, which in turn disconnects the supply to the lamp. This causes the LDR resistance to increase thus de-energising the relay. Time delay is introduced by the add-ition of the capacitor across the coil. Lamp L1 must be positioned close to the LOR. The only limit to the number of other lamps is the current rating of the relay contacts.



Tech-Tips is an ideas forum and is not 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 the Editor, Electronics Today international, 36 Ebury Stret, London SW1W OLW.

SIMPLE DISCO AUTO FADE

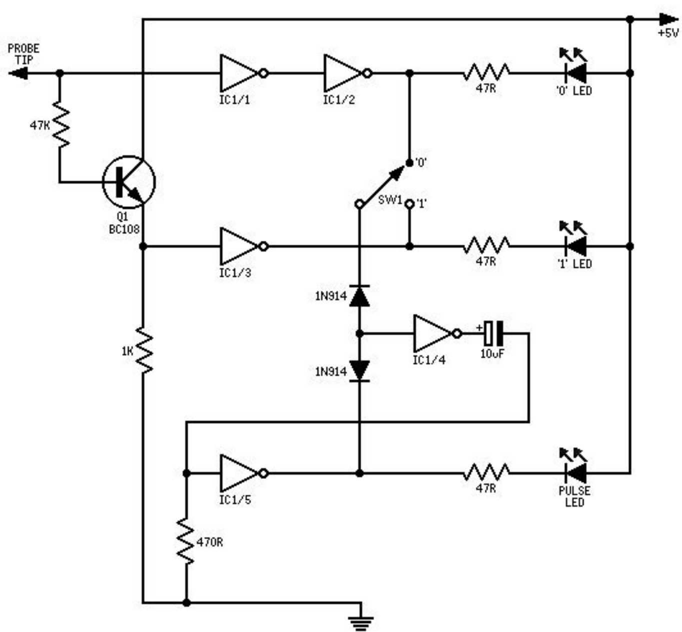


When a DJ has to make an announcement over a record, the normal procedure is to fade out the deck, fade in the microphone, and vice versa at the end. If this unit is used, however, the operator need only speak into the microphone, the deck being faded out automatically.

The lamp and LDR need to be taped together, preferably with black tape, to exclude light. VR1 is used to set the brightness of the lamp. With no signal on the input, VR1 is set for no attenuation of the music signal. When speaking at normal volume through the microphone the music should fade down until it can be heard quietly in the background.

Some microphones may not produce enough signal to do this. If this happens, a simple pre-amp can be added to the input stage, as was done in the prototype.

LOW COST LOGIC PROBE CUM PULSE CATCHER



When working on digital equipment it is very often desirable to know the state of various points of the circuit. Usually an oscilloscope is used, however a very short duration pulse is usually hard to see unless the scope is a sophisticated wide-bandwidth type.

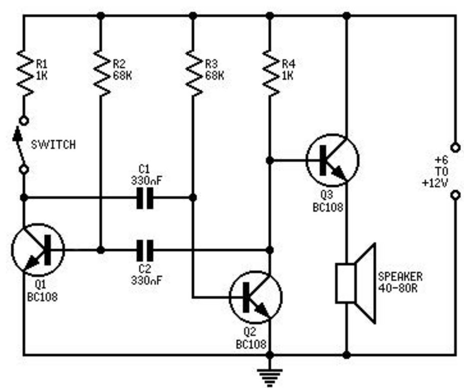
This logic probe has its own readout which illuminates a LED indicating whether the point tested is a logical "0" or "1 ".

It also indicates the presence of a high speed pulse, whether positive or negative going, (SW1 selects the polarity). This LED will also indicate a pulse train.

An inexpensive TTL Hex inverter is used. Power is derived from the 5V supply to the circuit being tested.

Having connected the earth and +5V leads a simple check is to connect the probe tip to the 5V supply and then to earth. The "1" and "0" LEDs should light in turn.

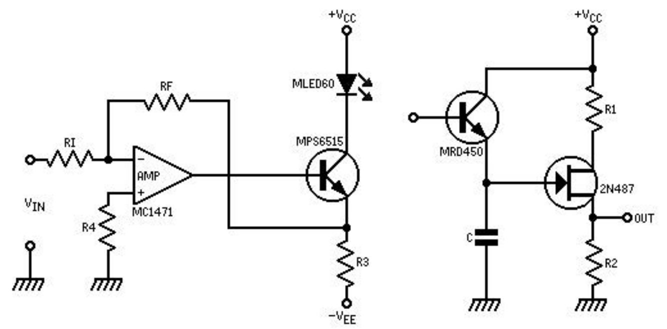
ELECTRONIC SHIP SIREN



This circuit will give a sound like a ship's siren. It can be used with the low power output source for model ships if fed into a more powerful amplifier/ speaker, as an alarm tone. The circuit consists of a multivibrator (Q1 & Q2), and a low power output stage Q3. The speaker should have an impedance in the region of 40 to 80 ohms. C1 and C2 determine the pitch of the siren and the values specified will provide a tone of about 300Hz. Quiescent current is negligible. Should a more powerful output be desired then the output at the collector of 02 can be fed into an amplifier input via a 1µF electrolytic, in series with a 12k resistor.

tech-tips

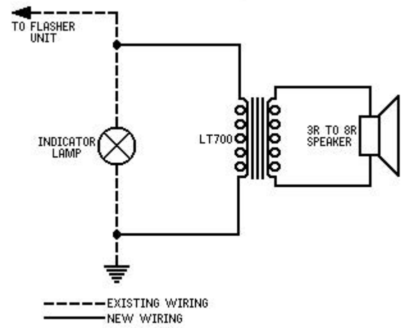
LIGHT-COUPLED VOLTAGE - TO - FREQUENCY CONVERTER



It is often necessary to convey information from two electrically isolated points. The circuit shown here was developed in the applications department of Motorola Semiconductors and allows information represented by voltage to be transferred to a remote point via a light beam.

The functioning of the circuit is more or less self-evident. An operational amplifier drives a l.e.d. to provide a light output proportional to the applied input. The operational amplifier's scaling resistors are chosen to suit the application. At the receiving end the impedance of the impedance of the photo-transistor alters the time constant in a conventional UJT relaxation oscillator circuit in sympathy with the level of incoming light beam to alter the output frequency.

AUDIO TRAFFICATOR INDICATOR



On some cars, the click of the flasher unit cannot be heard above the engine noise etc. This can lead to the trafficator being left on, possibly lead-ing to an accident. The device shown above is simply connected across the existing indicator light, and, when in operation, gives out a loud pulse every time the lamp is turned on and another when the lamps turns off. Most transistor output transformers could be used, although an LT700 was used in the prototype. The loudspeaker should be a small 3 or 8 ohm unit.

ELECTRONIC SWITCH

The switch in this circuit uses an N channel FET to present either a high or low impedance path to ground for any incoming signal.

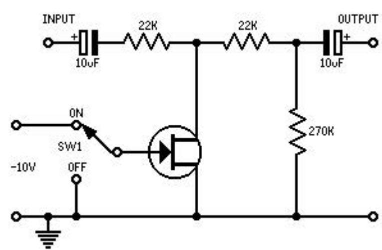
The main advantage of such a switch is that the actual switching of an audio or RF signal can be done in-situ on the board rather than bringing the signal along a cable to and from a mechanical switch.

This eliminates hum pick up and other stray problems.

The mechanical switch simply switches DC to the FET gate.

Another feature of the circuit is that one mechanical switch is sufficient to key a a number of FET switches with no crosstalk between channels.

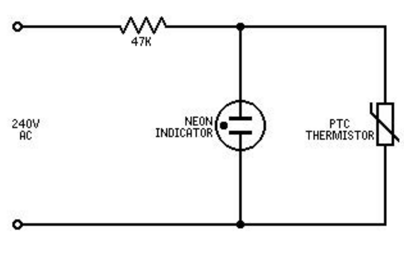
The operation is that when the switch is in the "off" state the F ET is biased hard on. Any incoming signal is effectively shorted to ground. In the "on" position the FET is biased to the non-conducting region thus presenting a high impedance to ground. This allows the incoming signal to appear at the output terminals unattenuated. The output impedance of the circuit is high and the following stage impedance should be in the excess of 50k if excessive loading is to be avoided.



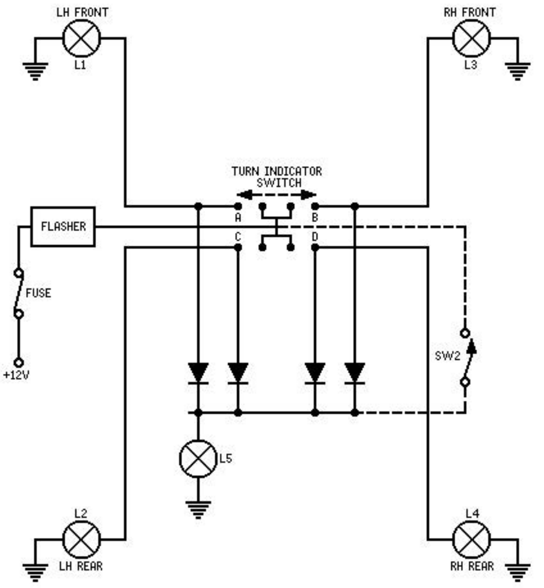
SIMPLE FIRE ALARM CIRCUIT

A voltage divider made up of a resistor and positive temperature co-efficient thermistor has its incremental voltage fed to a neon indicator lamp. The thermistor is used as the temperature sensor. Its value is such that under normal ambient conditions the neon voltage across it is below striking voltage for the neon.

If a fire causes the thermistor to heat up, its resistance rises, and the neon ignites giving a visual alarm. The value of the PTC thermistor is selected to give the necessary resistance change to ignite the particular neon lamp used. An audible alarm can be activated by adding suitable electronic circuitry.



FOUR-WAY FLASHER ADAPTOR UNIT



Many current model cars now incorporate a turn indicator switch position which causes all four indicator lamps to flash simultaneously. This is a valuable safety device if stalled on the road especially at night.

Older model cars fitted with normal winking indicators can be converted to include this facility with the aid of a few diodes, a switch and a heavy duty flasher unit. Since in the "four" position the flasher must switch twice its normal load it Is advisable to substitute the normal flasher unit with a heavy duty one as supplied for use with caravans and trailers.

Diodes D1-D4 are any rectifier types capable of handling about 3A. Switch 2 is fitted in on the dashboard and L5 is a optional indicator also located to the dashboard.

The circuit as shown will work with both 6 and 12 volt negative earth systems. If the wiring is positive earth, reverse the direction of the diodes.

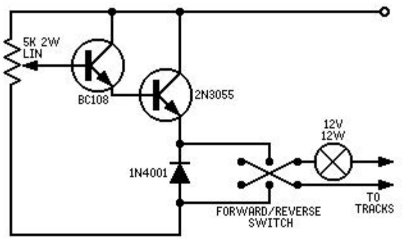
SIMPLE MODEL TRAIN SPEED CONTROL

Two transistors, a diode and a potentiometer can be used in place of the large and expensive rheostat usually provided in model train controllers.

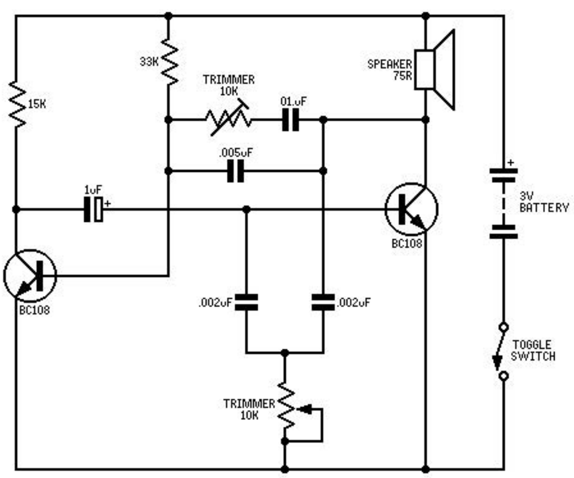
Virtually any n.p.n small signal transistor may be used in place of the BC108 shown, likewise any suitable n.p.n power transistor can be used in place of the 2N3055.

The output transistor must be mounted on a suitable heatsink.

Short circuit protection may be provided by wiring a 12 volt 12 watt globe in series with the output. This will glow in event of a short circuit and thus effectively current-limit the output. It also acts a a visual short-circuit alarm.



ELECTRONIC FISH CALLER



A lot of controversy exists among amateur fishermen as to the effectiveness of "fish callers". Some swear by them, others just shake their heads.

Here's an inexpensive way of finding out. The two-transistor circuit drives the speaker: Varying the two potentiometers produces a wide variety of sounds. You may be lucky and hit on one that will bring in the big ones.

An inexpensive waterproof housing is a thick-walled polythene bag with a few lead sinkers inside. An on-off toggle switch can be manipulated without opening the bag when switching power on and off. The bag opening is sealed with good quality electrical tape to make system waterproof. Tape seal should be renewed after each use.

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BFR50/51	23p	2N2926royg	9p
BFR50/51	23p	2N3053	17p
BFR88 250V	29p	2N3055 115W	37p
BFY50/1/2	15p	2N3563 & 64	16p
		2N3614	49p
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10µF	16V	6½p	220µF	10V	6½p
10µF	25V	6½p	220µF	16V	8p
10µF	63V	6½p	220µF	63V	21p
15µF	16V	6½p	330µF	16V	12p
15µF	63V	6½p	330µF	63V	25p
16µF	40V	6½p	470µF	6.4V	9p
22µF	25V	6½p	470µF	40V	20p
22µF	63V	6½p	680µF	16V	15p
32µF	10V	6½p	680µF	40V	25p
33µF	16V	6½p	1000µF	16V	20p
33µF	40V	6½p	1000µF	25V	25p
32µF	63V	6½p	1500µF	6.4	15p
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LEDs

with Data clip **1p**

dia	0.125	0.2	DIL SOCKET
RED	**15p**	**19p**	8 pin **12p**
GREEN	**27p**	**33p**	14 pin **13p**
YELLOW	**27p**	**33p**	

INFRA-RED LEDs with Data: 550μW axial lead, **49p**; 1.5 mW TO46 **£1.10**

OPTO-ISOLATORS with Data

IL74 1.5kV 150kHz	**£1**
4350 2.5kV, 5MHz	**£2.25**

OP. AMPS

709 all	**25p**
714 8-pin	**29p**
748 DIL	**36p**

AC127/8	**15p**
AF117	**20p**
BC107	**10p**
BC108	**9p**
BC109C	**12p**
BC147/8/9	**10p**
BC157/8/9	**11p**
BC169B	**11p**
BC169C	**12p**
BC177/8/9	**17p**
BC182/3/4L	**11p**
BC212/3/4L	**12p**
BCY70	**15p**
BCY71	**22p**
BCY72	**12p**
BFY50 51	**16p**
BFX29	**30p**
OC71	**10p**
2N706	**10p**
2N2904	**16p**
2N2904A	**18p**
2N2906	**16p**
2N2906A	**18p**

2N2926(R)	**7p**
2N2926(G)	**12p**
2N3053	**15p**
2N3055	**41p**
2N3702/3/4	**12p**
TIS43	**25p**
MPF102	**40p**
2N3819	**25p**
2N3823	**30p**

ZENERS BZY88 2 7V-33V **9p**

Bridge Rectifiers

50V, 2A	**30p**
100V, 2A	**36p**
200V, 2A	**41p**
400V, 2A	**46p**

NE555V	**60p**
ZN414	**£1.10**
7400	**16p**
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Plastic 1 5 Amp
Dalo Pen **70p**

IN914	**3p**
IN4001	**5p**
IN4002	**6p**
IN4004	**7p**
IN4148	**4p**
OA47	**6p**
OA81	**7p**
OA91	**5p**
OA95	**5p**
OA200	**6p**
OA202	**7p**

Thyristors	50V	100V	400V
TO5, 1A	**25p**	**27p**	**46p**
TO66, 3A	**27p**	**35p**	**50p**

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0.1μF	(1 1/8"x½")	50p	0.47μF	56p	46p	36p
0.22μF	(1 3/8"x5/8")	59p	1.0μF	66p	56p	46p
0.25μF	(1 3/8"5/8")	62p	2.2μF	80p	65p	55p
0.47μF	(1 3/8"x¾")	71p	4.7μF	£1.30	£1.05	85p
0.5μF	(1 3/8"x¾")	75p	6.8μF	£1.64	£1.29	£1.09
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1.0μF	(2"x¾")	91p	15.0μF	£2.75	£2.15	£1.90
2.0μF	(2"x1")	£1.22p	22.0μF	£3.50	£2.90	£2.55

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BC147/8/9	10p	BC547	12p	BFY51	20p
BC157/8	12p	BC558A	12p	BFY52	20p
BC182/182L	11p	BF194	12p	OC71	12p
BC183/183L	11p	BF197	13p	2N3055	50p
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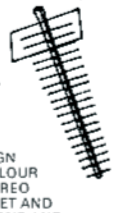

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