CB RADIO – NEWS AND VIEWS INSIDE

Hobby Electronics

December '80

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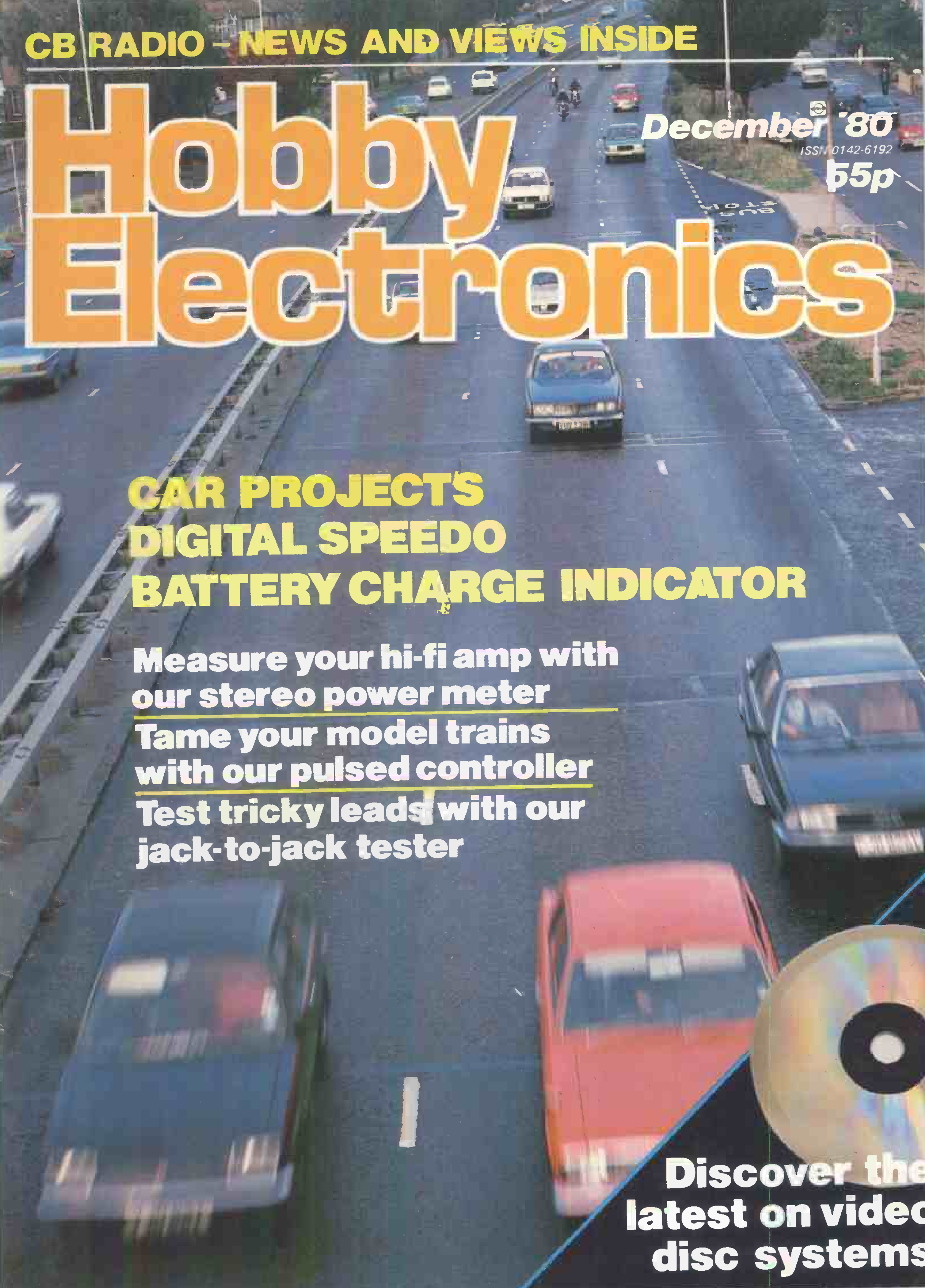
55p



CAR PROJECTS
DIGITAL SPEEDO
BATTERY CHARGE INDICATOR

Measure your hi-fi amp with our stereo power meter

Tame your model trains with our pulsed controller

Test tricky leads with our jack-to-jack tester

Discover the latest on video disc systems

Ever wondered who buys electronics today? You'd be surprised!
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TON AHLERS ELEKTRONIKA B.V.
Aalsmeerderdijk 349, 1436 BH Rijsenhout - Holland, tel. 010 31 2977-2 86 11 (4 lines), telex 15181 tonel nl. (near Schiphol Airport).
Even the old boys circuit is getting electronicized. With our help.

Hobby Electronics

DECEMBER 1980
Vol. 3 No. 2

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FEATURES

NEWS & INFO

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I.L.P

SIMPLY AHEAD and staying there

The range grows bigger...better...

New Profile Amplifiers - Two New Series

MOSFET

CHOOSE AN I.L.P MOSFET POWER AMP when it is advantageous to have a faster slew rate, lower distortion at higher frequencies, enhanced thermal stability, the ability to work with complex loads without difficulty and complete absence of cross-over distortion. I.L.P's exclusive encapsulation technique within fully adequate heatsinks has been taken a stage further with specially developed computer-verified 'New Profile' extrusions. These ensure optimum operating efficiency from our new MOSFETS, and are easier to mount. Connection is via five pins on the underside. **I.L.P MOSFETS ARE IDENTICAL IN PERFORMANCE TO THE COSTLIEST AMPLIFIERS IN THIS EXCITING NEW CATEGORY BUT ARE ONLY A FRACTION OF PRICES CHARGED ELSEWHERE.**

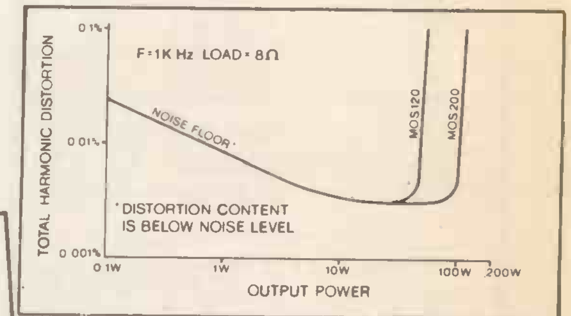
Model	Output Power RMS	Distortion Typical at 1KHz	Slew Rate	Rise Time	Signal/Noise Ratio DIN AUDIO	Price & VAT
MOS120	60W into 4-8Ω	0.005%	20V/μs	3μs	100dB	£25.88 + £3.88
MOS200	120W into 4-8Ω	0.005%	20V/μs	3μs	100dB	£33.46 + £5.02

BIPOLAR

CHOOSE AN I.L.P BIPOLAR POWER AMP where power and price are first consideration while maintaining optimum performance with hi-fi quality and wide choice of models. From domestic hi-fi to disco and P.A., for instrument amplification, there is an I.L.P Bipolar to fill the bill, and as with our new Mosfets, we have encapsulated Bipolars within our New Profile extrusions with their computer-verified thermal efficiency and improved mounting shoulders. Connections are simple, via five pins on the underside and with our newest pre-amps and power supply units, it becomes easier than ever to have a system layout housed the way you want it.

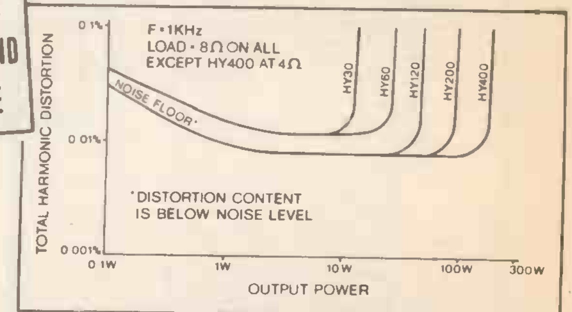
Model	Output Power RMS	Distortion Typical at 1KHz	Slew Rate	Rise Time	Signal/Noise Ratio DIN AUDIO	Price & VAT
HY30	15W into 4-8Ω	0.015%	15V/μs	5μs	100dB	£6.34 + 95p
HY60	30W into 4-8Ω	0.015%	15V/μs	5μs	100dB	£7.24 + £1.09
HY120	60W into 4-8Ω	0.01%	15V/μs	5μs	100dB	£15.20 + £2.28
HY200	120W into 4-8Ω	0.01%	15V/μs	5μs	100dB	£18.44 + £2.77
HY400	240W into 4Ω	0.01%	15V/μs	5μs	100dB	£27.68 + £4.15

ILP POWER AMPS ARE ENCAPSULATED FOR THERMAL STABILITY AND LONGER LIFE



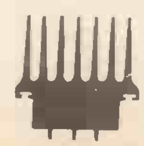
Load impedance both models 4Ω - ∞ Input sensitivity both models 500mV

Input impedance both models 100KΩ Frequency response both models 15Hz-100KHz – 3dB



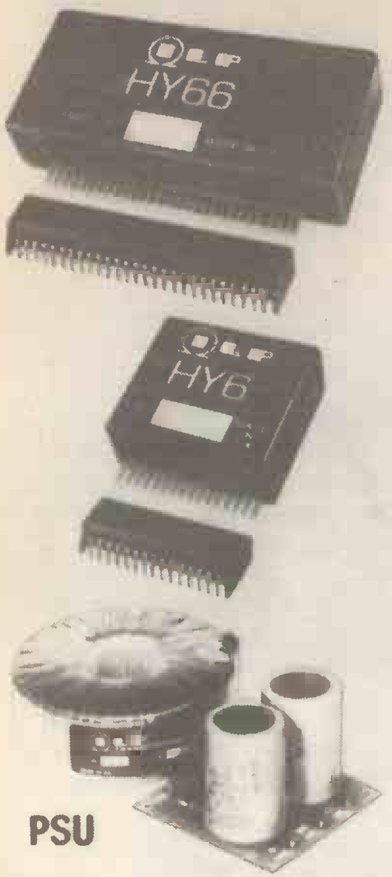
Load impedance all models 4Ω - ∞ Input sensitivity all models 500mV

Input impedance all models 100KΩ Frequency response all models 15Hz-50KHz – 3dB



THE NEW PROFILE EXTRUSIONS

The introduction of standard heatsink extrusion for all I.L.P power amplifiers achieves many advantages: – Research shows they provide optimum thermal dissipation and stability. Slotted shoulders allow easy mounting; standardisation enables us to keep our prices competitive. Surfaces are matt black, anodised for lower thermal conductivity. Extrusions vary in size according to module number.



PSU

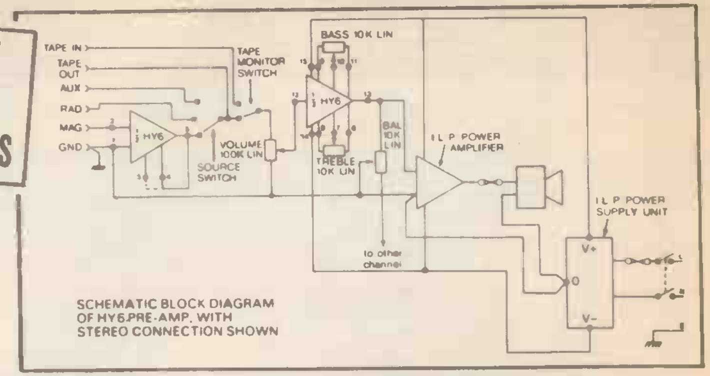
NEW PRE-AMPS

HY6 (mono) and **HY66** (stereo) are new to I.L.P's range of advanced audio modules. Their improved characteristics and styling ensure their being compatible with all I.L.P power-amps both MOSFET and BIPOLAR, giving you chance to get the best possible reproduction from your equipment. HY6 and HY66 pre-amps are protected against short circuit and wrong polarity. Full assembly instructions are provided. Mounting boards are available as below.

Sizes – **HY6** – 45 x 20 x 40 mm. **HY66** – 90 x 20 x 40 mm. Active Tone Control circuits provide ±12dB cut and boost. **Inputs Sensitivity** – Mag. PU. –3mV: Mic – selectable 1-12mV: All others 100mV. **Tape O/P** – 100mV: **Main O/P** – 500mV: **Frequency response** – D.C. to 100KHz – 3dB.

HY6 mono £5.60 + 84p VAT Connectors included
HY66 stereo £10.60 + £1.59 VAT Connectors included
B6 Mounting Board for one HY6 78p + 12p VAT
B66 Mounting Board for one HY66 99p + 15p VAT

COMPATIBLE WITH ALL ILP MODULES



SCHEMATIC BLOCK DIAGRAM OF HY6 PRE-AMP, WITH STEREO CONNECTION SHOWN

- **DISTORTION TYPICALLY 0.005%**
- **S/N RATIO – 90dB (Mag. P.U. – 68 dB)**
- **38 dB overload margin on Mag. P.U.**
- **LATEST DESIGN HIGH QUALITY CONNECTORS**
- **ONLY POTS, SWITCHES AND PLUGS/SOCKETS NEED ADDING**
- **NEEDS ONLY UNREGULATED POWER SUPPLY ±15 to ±60v**

NEW POWER SUPPLY UNITS

IN A RANGE OF 11 MODELS USING LATEST TOROIDAL TRANSFORMERS

Of the eleven power supply units which comprise our current range, nine have toroidal transformers made in our own factory. Thus these I.L.P power supply units are space-saving, more efficient and their better overall design helps enormously when assembly building. All models in the range are compatible with all I.L.P amps and pre-amps with types to match whatever I.L.P power amps you choose.

PSU30 ±15V at 100mA to drive up to 12 x HY6 or 6 x HY66	£4.50 + 0.68p VAT
● *THE FOLLOWING WILL ALSO DRIVE I.L.P PRE-AMPS*	
PSU36 for use with 1 or 2 HY30's	£8.10 + £1.22 VAT
● *ALL THE FOLLOWING USE TOROIDAL TRANSFORMERS*	
PSU50 for use with 1 or 2 HY60's	£9.75 + £1.46 VAT
PSU60 for use with 1 HY120	£9.75 + £1.46 VAT
PSU65 for use with 1 MOS120	£9.75 + £1.46 VAT
PSU70 for use with 1 or 2 HY120's	£13.61 + £2.04 VAT
PSU75 for use with 1 or 2 **MOS120**	£13.61 + £2.04 VAT
PSU90 for use with 1 HY200	£13.61 + £2.04 VAT
PSU95 for use with 1 **MOS200**	£14.75 + £2.21 VAT
PSU180 for use with 1 HY400 or 2 HY200	£23.02 + £3.45 VAT
PSU185 for use with 1 or 2 **MOS200**	£24.20 + £3.63 VAT

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Available also from MARSHALLS, WATFORD ELECTRONICS and certain other selected retailers

Monitor

Tiny Tape

"I have seen the future, and it works". So said some Communist type gentleman on a visit to Russia after the revolution. We had a similar experience in the HE offices a couple of weeks ago when a gentleman with a little box showed us the future — and it was small. The diminutive box contained a rather nondescript looking cassette recorder, the type you would buy for around £50 almost anywhere. The only unusual thing about it was the name 'Technicolor' emblazoned across the cabinet. The gentleman then proceeded to take a coaxial lead from his box, plug one end into the recorder and (here's the good bit) plug the other end into a small colour TV set he just happened to have about his person. You can guess the rest: Technicolor is the very first subminiature video cassette recorder to use the (slightly modified) compact cassette format for recording video.

Even before we get down to the technical stuff a few words about the rather 'shady' history of this machine. It has been developed by the Technicolor company, (the same people who make the films) in absolute secrecy. There was a very good reason for this, if JVC or Sony had got wind of it, it is likely that they would have bought up all the rights to the machine and thrown it in the nearest dustbin. This new tape format could well make VHS and Betamax totally redundant in the next year or so.

The machine itself is similar in concept to the VHS format, the mechanical operation is just like a scaled-down version of any VHS machine. We asked the gentleman how they had achieved such an incredible reduction in size over existing formats. His reply rather took us aback. We had been expecting some long discourse on new technology, inspired use of microprocessors, etc. In fact the reduction is simply due to very high precision mechanics: the electronics are well proven and have been around for some years. Unlike the much-rumoured (but rarely seen) LVR (longitudinal video recording) format where the tape whizzes past the head at high speed and undergoes a rapid change of direction when the tape reaches the end, Technicolor uses conventional helical scanning techniques to record the pictures. When you consider that it uses only ¼" tape, and that each scan of the tape contains one frame of picture information you can see what is meant by high precision mechanics.

The Technicolor should be on sale over here by the end of this month. Target price for the record/playback unit with rechargeable batteries should be around £600. You will need to add to that the price of a tuner unit to get the overall price. That's not cheap when compared with the £400 or so for a VHS or Beta machine but we are assured that this should drop dramatically inside a year.

Here for the technical buffs are some facts and figures on the machine: bandwidth around 3MHz, video S/N ratio 43 dB, tape speed 1.26" per second, weight seven pounds!

If you want to talk to someone about this machine then you'll have to contact Gordon Gilbert, Video Work, The Studio, Fernlea Estate, Cryers Hill, Nr High Wickham, Bucks.

It's British Folks

After months of intensive planning we have what we believe to be the master plan for Britain to regain control of the world and colour the maps red again. It all revolves around a new TV game from Rowtron. This game is so good that it's bound to be bought by just about everybody: the Russians, Chinese and Japanese just won't be able to resist it. Once everybody has got one of these games we'll wait until six thirty when everyone will be playing with their game (because Crossroads is on) and then we'll move in. It can't fail, the Rowtron can claim to be the only all British (well, nearly all) microprocessor-based TV game. OK, so we're about five years behind the rest of the world but like the Mini Metro we seem to have got it right. This machine will be retailing for under £70.00 with additional car-

News from the Electronics World

Albert Hall On Wheels?

Well, not *quite* the Albert Hall, but nevertheless a high-power pair of loudspeakers that don't cost as much as the radio/cassette player. These speakers from Harvard are bracket mounted and are supplied under the model number H949S. They are claimed to dish out up to 30 W music power, and a pair costs £16 (plus £1.20 p&p).

You can get them from: Minikits Ltd., 88 Hainault Road, Leytonstone E11.

Important Notice

Readers have recently confused Electronics Today Limited as being associated with the ownership of our Magazine, Electronics Today International. Our Magazine is owned by Modmags Limited, part of the Argus Press Holdings Limited Group of Companies.

Electronics Today Limited advertises in our Magazine, as "Metac", but so as to prevent any further confusion we wish to make it clear that Electronics Today Limited is not owned or managed by any member of the Argus Press Holdings Limited Group of Companies.

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tridges for just £11.95. The graphics are not as good as the Matell Intellivision but then it doesn't cost as much which means more people will be able to afford it. After extensive tests we have concluded that the game 'Four In A Row' would be the most popular choice for world domination purposes. On the high skill level against the computer it is all but impossible to win: that should keep everyone occupied. Other games like Boxing and Sportsworld are OK but they lack the sheer brain-busting challenge of this devastating little game. Just in case anyone ever manages to beat Four In A Row then they could try Maze — that will be enough to reduce most strong-willed men to tears. How can the plan fail?

There are some 18 cartridges in all, with some new ones planned for next year. For more information contact Rowtron at: Thorp Arch Trading Estate, Wetherby, West Yorkshire.

Book Reviews

The ever-prolific Bernard Babani (Publishing) Ltd. has two more offerings for your approval this month. First away is; Radio Control for Beginners (Rayer, F.G., ISBN 0 900162 99 6, £1.75). Mr Rayer does a splendid job of explaining simple R/C systems including a few simple practical circuits for the home constructor. Our only criticism lies with the rather scanty mention of digital proportional systems which, although too complicated for a book of this level deserve greater coverage. Nonetheless this book is an excellent addition to any R/C modellers' library and is particularly useful to the absolute beginner with a limited budget.

Book number two is (just to confuse matters) book 4 in a series called 'Elements Of Electronics', (Wilson, F.A., ISBN 0 900162 97 X, £2.95). Coverage in books one to three ranges from simple electrical theory to the theory of alternating currents right up to semiconductor technology. Book four is subtitled Microprocessing systems and circuits. As you will have gathered from the title this book deals in depth with digital techniques and theory up to the level of microproprocessors. Providing you have read (and digested) the other three in this series then Book 4 should present no problems.

All of these books are available from Babani (Publishing) Ltd., The Grampians, Shepherds, Bush Road, London W6 7NF.

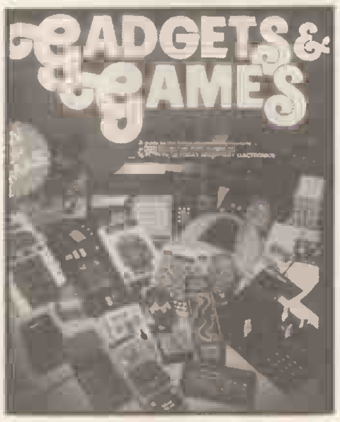
New Catalogues

Okay mail-order fans, postal orders at the ready because we have two new catalogues for your approval. First is from Magenta Electronics (they're the people who produce kits for all of our projects). This well-produced item contains thousands of components, hardware, tools and kits — all at very competitive prices. A very worthwhile addition to your collection.

Just send six ten pee stamps to: Magenta Electronics Ltd, 98 Calais Road, Burton-on-Trent, Staffs DE13 0UL.

Number two comes from HRS Electronic Components Ltd. Rarely have we seen such a comprehensive range of bits and pieces, again at competitive prices. Some 3,000 items are included, ranging from resistors to oscilloscopes.

Write to HRS direct for more information. They can be found at: Brasshouse Passage, Birmingham B1 2HR.



Gadgets & Games

With Christmas just around the corner we thought it would be a good idea to put our obsession for electronic games and gadgets to good use.

In a few weeks from now a new special publication from Modmags will be appearing on the bookstalls. It's called simply Gadgets & Games. It contains a comprehensive listing of just about every electronic game on the market.

- PLUS the most up-to-date directory of software games for minicomputers
- PLUS all the latest video and hand-held games
- PLUS a selection of the most interesting and unusual electronic gadgets around

We have everything from talking language translators to a 16,000-channel FM scanner receiver. Cover price will be just 85 pence: to avoid disappointment place an order with your newsagent now or forever wonder what you've missed.

LCD Microvision

Before you jump to conclusions this Microvision has absolutely nothing to do with diminutive TV sets of the same name, in fact nothing to do with tellys at all. This one is a cartridge programmable hand-held game. It comes from MB — the people who brought you Simon — so the pedigree's sound. The basic games unit comes complete with one cartridge called Blockbuster. This is a devastating version of the ever popular Breakout game. Four other games are available, they are; Connect Four, Pinball, Bowling and Shooting Star. All of the games are displayed on a 2" LCD screen. Some ingenious design work has gone into this device, it combines excellent graphics resolution with admirable simplicity, and it even has a contrast control for different viewing angles and lighting conditions. All of the games have been well thought out, and adequate provision has been made for 'beatability'! Most games from other manufacturers can be easily conquered in a very short time, but it might take half a life time to get familiar with the 'lo' skill levels of each Microvision game. The only real criticism of the system must be the price: at £40.00 for the basic unit with the Blockbuster game plus £12.50 for each cartridge it seems a mite expensive.

If you would like to have a look at a Microvision then pop round to NIC at 61 Broad Lane, Tottenham.

Hobby Electronics

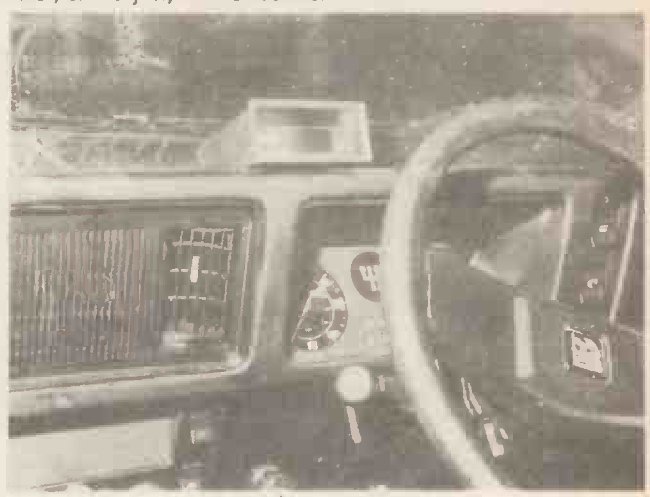
ON SALE 12th DECEMBER

General-purpose Amplifier

Many a hobbyist has ground to a halt, when all the shops are closed and said: 'If only I had a simple *amplifier* to listen to the weak signal coming from my electronic flugit'. (You can substitute radio, guitar, pickup, etc. for flugit.)
Well, here's one you can build and have ready for such emergencies.

Car Tachometer

This tachometer (rev counter if you like) will fit neatly into the same box as that for this month's Digital Speedo project, but you can use it on its own. A bright bar-graph display is provided, which flashes when you get near to a pre-set engine-about-to-explode value. We give enough information for it to be used with a variety of engines but draw the line at steam power, turbo jets, rubber bands...



Electronic Games

Hundreds of different electronic games are swamping the market (we're knee-deep in them at HE). They range from hand-held mind-twisting dexterity games to multi-level speaking-chess and TV games armed with a host of plug-in options. We thought it was about time to sort out some of the best, and give you a run down on our top 10.

HE Chuffer

What's a 'chuffer' you may ask. If you can remember steam-powered locomotives or have a model train set then you'll know it's synonymous with *steam engines*. Trouble with model steam engines is that they sound nothing like the real thing. Our project will produce 'chuffing' sounds for you and, if you build this month's Train Controller project, will vary the chug rate according to speed.

NiCad Charger

Rechargeable NiCad (nickel-cadmium) cells have a nasty habit of dying — suddenly — because of their inherent characteristics. Ready-made chargers can be pricey and are often dedicated to only one type of cell or battery. Our one is more versatile. See next month's issue for details.

AS ADVERTISED ON LOCAL RADIO

Items mentioned here are those planned, but unforeseen circumstances may affect the actual contents.

WATFORD ELECTRONICS

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POLYESTER CAPACITORS: Axial lead type.
400V: 1nF, 1n5, 2n2, 3n3, 4n7, 6n8, 10n, 15n **9p**; 18n **10p**; 22n, 33n **11p**; 47n, 68n **14p**; 100n **17p**; 150n, 220n **24p**; 330n, 470n **41p**; 680n **52p**; 1µF **64p**; 2µ2 **82p**; 4µ7 **85p**.
160V: 39µF, 100n, 150n, 220n **11p**; 330n, 470n **19p**; 680n, 1µF **22p**; 1µ5, 2µ2 **32p**; 4µ7F **36p**.
1000V: 10nF, 15n **20p**; 22n **22p**; 47n **26p**; 100n **38p**; 470n **80p**; 1µF **175p**.

POLYESTER RADIAL LEAD CAPACITORS: 250V:
10nF, 15n, 22n, 27n **6p**; 33n, 47n, 68n, 100n **7p**; 150n **10p**; 220n, 330n **13p**; 470n **17p**; 680n **19p**; 1µF **22p**; 1µ5 **30p**; 2µ2 **34p**; 4µ7 **60p**.

ULTRASONIC TRANSDUCERS 40kHz **350p/pr**

ELECTROLYTIC CAPACITORS: Axial lead type (Values are in µF). 500V: 10 **50p**; 47 **78p**; **250V**: 100 **65p**; **63V**: 0.47, 1.0, 1.5, 2.2, 2.5, 3.3, 4.7, 6.8, 8, 10, **8p**; 15, 22, 47, 32, 50 **12p**; 63, 100, **27p**; **50V**: 50, 100, 220, **25p**; 470, **32p** 1000 **80p**; **40V**: 22, 33, **10p**; 100, **12p**; 2200, 3300 **85p**; 4700, **98p**; **35V**: 33, **10p**; 330, 470, **32p**; **25V**: 10, 22, 47, 100, **8p**; 160, 220, 250, **15p**; 470, **25p**; 640, 1000, **35p**; 1500, 40p; 2200, **54p**; 3300, **77p**; 4700 **85p**; **16V**: 10, 47, 68, **7p**; 100, 125, **8p**; 220, 330, **16p**; 470, **20p**; 1000, 1500, **30p**; 2200, **36p**.
TAG-END TYPE: 450V: 100µF **180p**; **70V**: 4700, **165p**; **64V**: 3300 **150p**; 2500 **110p**; **50V**: 3300 **135p**; 2200 **99p**; **40V**: 4700 **130p**; 4000 **92p**; 3300 **93p**; 2500, 2200 **90p**; 2000 + 2000 **120p**; **30V**: 4700 **110p**; **25V**: 15,000 **195p**; 6400 **120p**; 4700 **100p**; 3300 **85p**; 2200 **60p**.

TANTALUM BEAD CAPACITORS
35V: 0.1µ; 0.22; 0.33; 0.47; 0.68, 1.0µ; 2.2µ; 3.3µ; 4.7; **25V**: 10. **20V**: 6µ8; **16V**: 2µ2; 4µ7; 10, **20p.** **16V**: 22µ; **30p**; 47; 100 **58p**; 220 **80p**. **10V**: 15µ, 22µ, 33, 28p; 100 **40p**; **6V**: 47µ; 68, 100 **32p**; **3V**: 100 **23p**..

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TIL209 Red	13
TIL211 Grn.	18
TIL212 Yel.	18
.2" Red	15
.2" Yel. Grn.	18
Square LEDs	30
ORP12	63
2N5777	45
LD271	40
SFH205	98
TIL32	58
TIL78	70
7 Segment Displays	
TIL321 C.A .5"	115
TIL322 C.C .5"	115
DL704 C Cth .3"	99
DL707 C.A. .3"	99
.3" Green CA	150
DL747 C.A .6"	180
FND357	120
MAN3640	175
10 Seg Bargraph	225
LC0 3 ½Digit	775

MYLAR FILM CAPACITORS
100V: 0.001, 0.002, 0.005, 0.01µF **6p**
0.015, 0.02, 0.04, 0.05, 0.056µF **7p**
0.1µF **8p**, 50V: 0.47µF **12p**

SLIDER POTENTIOMETERS
0.25W log and linear values 60mm
5KΩ-500KΩ single gang **70p**
10KΩ-500KΩ dual gang **80p**
Self Stick Graduated Bews **36p**

MINIATURE TYPE TRIMMERS
2.5-6pF; 3-10pF; 10-40pF **28p**
5-25pF; 5-45pF; 60pF; 88pF **35p**

COMPRESSION TRIMMERS
3-40pF; 10-80pF; 25-190pF **33p**
100-500pF **45p** 1250pF **58p**

PRESET POTENTIOMETERS
Vertical & Horizontal
0.1W 50Ω—5MΩ Miniature **7p**
0.25W 100Ω—3.3MΩ horiz. **10p**
0.25W 200Ω—4.7MΩ vert. **10p**

POLYSTYRENE CAPACITORS:
10pF to 1nF **8p**; 1.5nF to 10nF **10p**

RESISTORS — Carbon Film, High Stability, Low Noise, Minimum Tolerance 5%.

	RANGE	VAL	1-99	100+
¼W	2Ω2—4M7	E24	2p	1p
½W	2Ω2—4M7	E12	2p	1p
1W	2Ω2—10M	E12	5p	4p
2%Metal Film 10Ω-1M			6p	4p
1%Metal Film 51Ω-1M			8p	6p

100+ price applies to Resistors of each value not mixed.

SILVER MICA (Values in pF) 3-3, 4-7, 6-8, 10, 12, 18, 22, 33, 47, 50, 68, 75, 82, 85, 100, 120, 150, 180 **11p** each; 220, 250, 270, 300, 330, 360, 390, 470, 600, 800, 820 **16p** each; 1000, 1200, 1800, 2200 **26p** each.

CERAMIC CAPACITORS 50V: 0-5pF to 10nF **4p**; 22n to 47n **6p.** 100n. **7p.**

EURO BREADBOARD £6.20.

S-Dec **350p** T-Dec **400p**
U-Dec 'A' **465p** U-Dec 'B' **699p**

SWITCHES
MEC, Black body, Red, Grn, Blue.

SRL Latching	125
SRM Momentary	125
TOGGLE: 2A 250V	
SPST	32
DPDT	44
4 Pole on/off	54
SUB-MIN TOGGLE	
SP changeover	59
SPST on/off	54
DPDT 6 tags	70
DPDT c/of	79
DPDT Biased	115
SLIDE 250V:	
1A DPDT	14
1A DP c/off	15
½A DPDT	13
4 pole c/over	24

VOLTAGE REGULATORS

		+ ve		— ve	
1A	TO3				
5V	7805	145p		7906	220p
12V	7812	145p		7912	220p
15V	7815	145p		—	
18V	7818	145p		—	
1A	TO220	Plastic Casing			
5V	7805	60p		7905	65p
12V	7812	60p		7912	65p
15V	7815	60p		7915	65p
18V	7818	60p		7918	65p
24V	7824	60p		7924	65p
100mA	TO92 Plastic Casing				
5V	78L05	30p		79L05	65p
6V	78L62	30p		—	
8V	78L82	30p		—	
12V	78L12	30p		79L12	65p
15V	78L15	30p		79L15	65p

CA3085	95p	LM323K	625p	TAA550	50p
LM300H	170p	LM325N	240p	TBA625B	95p
LM305H	140p	LM326N	240p	TDA1412	150p
LM309K	135p	LM327	270p	7BHO5	595p
LM317K	350p	LM723	39p	7BHG5	650p

We stock parts for most of the projects in this magazine.

ACCESS
Just phone your order through. We deal with the rest (but min. £10 please).

SWITCHES Miniature Non-Locking
Push to Make **15** Push Break **25**
ROCKER: SPST on/off 10A/250V **30**
ROCKER: Illuminated (white) chrome bezel, lights when on DPST 3A 240V **85**
ROTARY: (ADJUSTABLE STOP) 1 pole/2-12 way, 2p/2-6 way, 3p/2-4 way, 4p/2-3 way **45**
ROTARY: Mains 250V AC 4 Amp **52**

DIL SOCKETS (Low Profile — Texas) 8 pin **10p**; 14 pin **12p**; 16 pin **13p**; 18 pin **16p**; 20 pin **22p**; 24 pin **30p**; 28 pin **35p**; 40 pin **40p**.

JACKSONS VARIABLE CAPACITORS

Dielectric	
100/300pF	205p
500pF	250p
6:1 Ball Drive	
4511/DAF	145p
Dial Drive 4103	
6:1/36:1	775p
Drum 54mm	69p
0-1.365pF	325p
00-2.365pF	395p
0 2 365pF with slow motion Drive	450p
00 208/176	395p
00 208/176 with slow motion drive	410p
C804-5pF: 10: 15: 25: 50pF	250p
100, 150pF	335p
'L' 3x310pF	725p
00.3x25pF	550p

DENCO COILS

'OP' VALVE TYPE	
Range 1 to 5 Bl., Rd., Tl., Wht.	106p
6-7 B Y R	95p
1.5 Green	130p
'T' type 1 to 5, Bl. Rd. Wht. Yl	130p
B9A Valve Holder	35p
RDT2	120p
RFC 5 chokes	120p
RFC 7 (19mH)	133p
13; 14; 15; 16; 17	110p
18/1.6	116p
18/465	132p
TOC 1	110p
MW5FR	112p
MW/LW SFR	134p

VEROBOARD

	0.1	0.15 (copper clad)	0.15 (plain)
2½ x 3¼"	66p	59p	34p
2½ x 5"	75p	69p	39p
3¾ x 3¾"	75p	75p	—
3¾ x 5"	86p	92p	65p
2½ x 17"	—	202p	125p
3¾ x 17"	296p	260p	178p
4¾ x 17"	387p	—	280p
Pkt of 36pins	20p		
Spot face cutter	107p		
Pin Insertion tool	147p		

'DIP' Board **326p**
'VQ' Board **144p**
Veroblock **350p**

DIODES

BA100	16
BY126	12
BY127	12
CR033	158
OA9	45
OA47	18
OA70	12
OA79	15
OA81	15
OA85	15
OA90	8
OA91	8
OA95	8
OA200	9
OA202	9
IN914	4
IN916	6
IN4001/2	5
IN4003	6
IN4004/5	6
IN4006/7	7
IN4148	4
IN5401/2	15
IN5403/4	20
IS44	20
3A/100V	18
3A/400V	20
3A/600V	27
3A/1000V	30

We stock a wide selection of Electronic Books and Magazines

ZENERS
Range: 2V7 to 39V 400mW **8p each**
Range: 3V3 to 33V, 1.3W **15p each**

NOISE
Z5J **180p**

BRIDGE RECTIFIERS

(plastic case)	p
1A/50V	20
1A/100V	22
1A/200V	25
1A/400V	29
1A/600V	34
2A/50V	35
2A/100V	44
2A/200V	46
2A/400V	53
2A/600V	65
6A/100V	73
6A/200V	78
6A/400V	85
BY164	56
VM18 DIL	50

DIAC
ST2 **25**

SCRs Thyristors

0.6A/200V	30
0.8A100V	30
0.8A200A	35
1A100V	42
1A200V	47
1A600V	70
5A300V	35
5A600V	43
8A300V	48
8A500V	58
8A600V	85
12A300V	59
12A500V	92
15A700V	195
2N4444	140
BT106	150
C106D	38
TIC44	25
TIC45	45

TRIACS

3A100V	48
3A200V	49
3A400V	50
8A100V	54
8A400V	64
8A800V	108
12A100V	60
12A400V	70
12A800V	130
16A100V	95
16A500V	150
25A800V	295
25A1000V	480
T280000	120

TTL 74

7400	11	7441	68	74125	50	74174	100
7401	11	7442	58	74126	45	74175	82
7402	11	7443	120	74128	65	74176	80
7403	14	7444	116	74132	55	74177	85
7404	14	7445	105	74136	65	74178	110
7405	18	7446	132	74141	75	74180	90
7406	36	7447	72	74142	185	74181	280
7407	36	7448	75	74143	250	74182	85
7408	17	7450	20	74145	90	74184	130
7409	20	7451	20	74147	150	74185	130
7410	17	7453	20	74148	125	74188	310
7411	25	7454	20	74150	130	74190	130
7412	20	7460	20	74151	70	74191	120
7413	32	7470	40	74153	70	74192	120
7414	38	7472	30	74154	120	74193	120
7416	30	7473	35	74156	75	74194	102
7417	30	7474	34	74157	70	74195	75
7420	19	7475	56	74159	185	74196	99
7421	38	7476	40	74160	99	74197	88
7422	25	7480	52	74161	99	74198	160
7423	28	7481	120	74162	99	74199	160
7425	28	7482	75	74163	99	74221	150
7426	43	7483	90	74164	120	74246	150
7427	32	7484	99	74165	120	74247	151
7428	35	7485	105	74166	130	74248	189
7430	19	7486	33	74167	205		
7432	27	7489	205	74170	205		
7433	36	7490	42	74172	375		
7437	35	7491	84	74173	110		
7438	32	7492	50				
7440	20	7493	57				

7494	88	74109	60
7495	70	74110	54
7496	80	74111	68
7497	176	74112	170
74100	130	74116	180
74104	62	74118	85
74105	62	74119	120
74107	34	74120	75
		74121	35
		74122	50
		74123	65

74LS

74LS00	13	74LS74	35	74LS151	90
74LS01	13	74LS75	45	74LS153	85
74LS02	15	74LS76	45	74LS155	75
74LS03	15	74LS83	105	74LS157	30
74LS04	16	74LS85	85	74LS158	70
74LS05	23	74LS86	38	74LS160	90
74LS08	22	74LS90	50	74LS161	98
74LS09	23	74LS92	75	74LS162	110
74LS10	20	74LS93	60	74LS163	95
74LS11	32	74LS95	115	74LS164	115
74LS12	32	74LS96	120	74LS165	145
74LS13	40	74LS107	45	74LS166	175
74LS14	60	74LS109	75	74LS173	105
74LS15	40	74LS112	40	74LS174	110
74LS20	21	74LS113	75	74LS175	110
74LS21	32	74LS114	40	74LS181	295
74LS22	35	74LS122	70	74LS190	95
74LS26	44	74LS123	75	74LS191	95
74LS27	45	74LS124	180	74LS192	95
74LS28	35	74LS125	45	74LS193	95
74LS30	20	74LS126	45	74LS195	130
74LS32	25	74LS132	60	74LS196	120
74LS42	62	74LS136	55	74LS197	85
74LS47	85	74LS138	70	74LS221	120
74LS48	105	74LS139	70	74LS240	165
74LS55	30	74LS145	120	74LS241	165
74LS63	150	74LS147	210	74LS242	165
74LS73	45	74LS148	170	74LS243	165
				74LS244	195
				74LS245	350
				74LS247	135
				74LS248	135
				74LS249	135
				74LS251	130
				74LS365	65
				74LS367	65

CMOS★

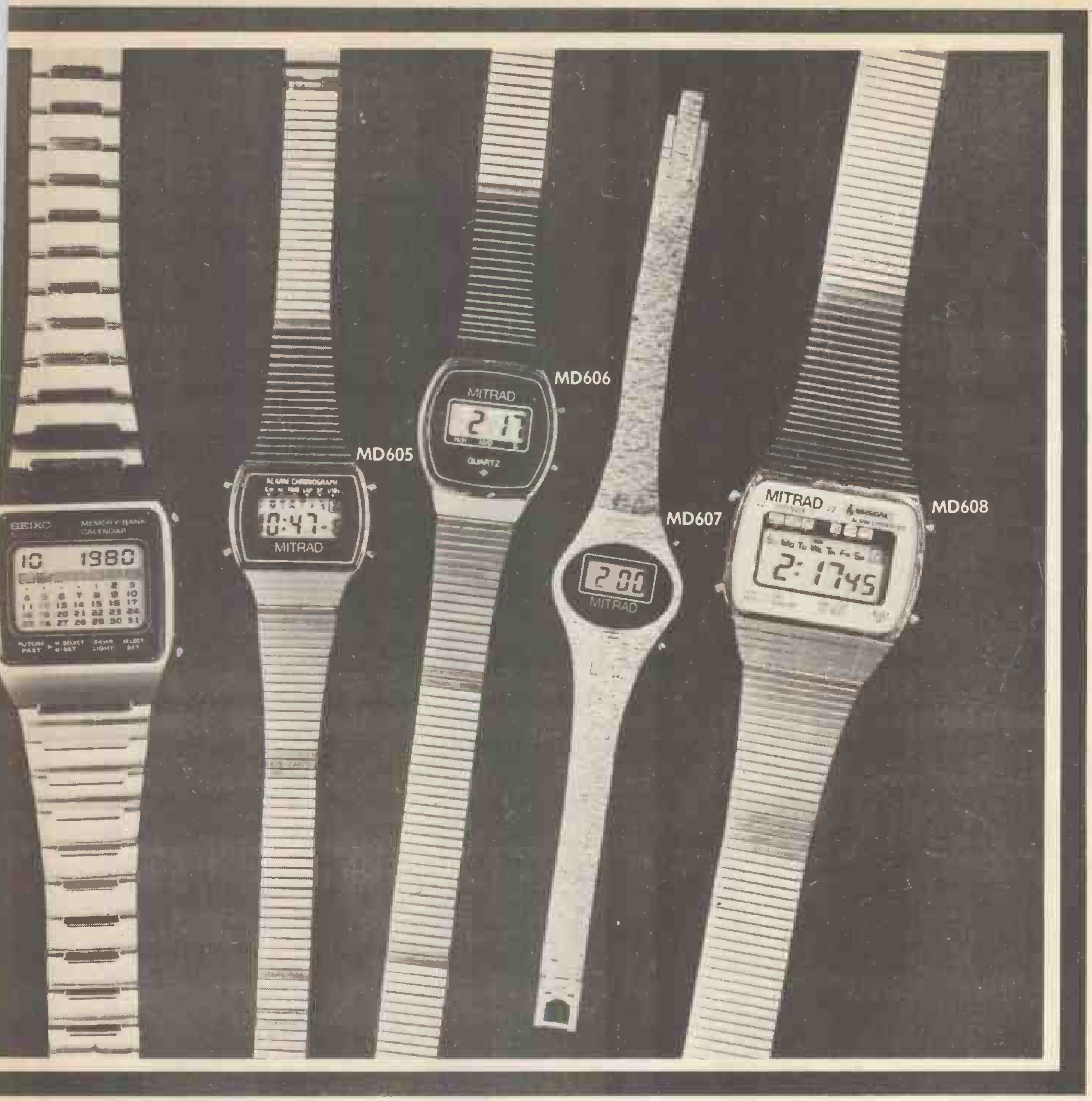
4000	14	4019	48	4053	84	4094	210
4001	14	4020	85	4054	130	4095	105
4002	15	4021	40	4055	130	4096	105
4006	92	4022	85	4056	135	4097	350
4007	19	4023	24	4057	1000	4098	115
4008	76	4024	66	4059	675	4099	150
4009	40	4025	24	4060	130	4160	125
4010	48	4026	180	4061	1225	4161	125
4011	18	4027	45	4062	995	4162	125
4012	24	4028	92	4063	120	4163	125
4013	43	4029	98	4066	46	4174	130
4014	90	4030	60	4067	430	4175	120
4015	82	4031	225	4068	26	4194	125
4016	35	4032	125	4069	22	4408	790
4017	70	4033	175	4070	25	4409	790
4018	76	4034	243	4071	25	4410	790
		4035	95	4072	25	4411	1020
		4036	365	4073	25	4412F	1520
		4037	115	4075	23	4412V	1520
		4038	110	4076	85	4415F	850
		4039	360	4077	30	4415V	850
		4040	85	4078	28	4419	320
		4041	80	4081	26	4422	570
		4042	70	4082	26	4432	1050
		4043	80	4085	90	4435	1050
		4044	80	4086	90	4440	999
		4045	175	4089	150	4450	350
		4046	96	4093	55	4451	350
		4047	98			4452	—
		4048	65			4490F	750
		4049	35			4490V	750
		4050	38			4501	28
		4051	86			4502	105
		4052	86			4503	65
						4506	75
						4507	48
						4508	325
						4510	85
						4511	98

LINEAR ICs

2102-2	225	LM348	90	NE571	420
2114	225	LM349	115	RC4136	110
2708	495	LM379	415	S556B	275
4116	395	LM380	80	SAB3209	425
6502	995	LM381	145	SAB3210	275
6800	800	LM382	125	SN76003	240
709C 8 pin	35	LM386	99	SN76013	170
710	67	LM387	120	SN76023	170
733	75	LM1458	45	SN76033	195
741C 8 pin	17	LM3900	60	SN76477	175
747C	78	LM3909N	70	TAA621	250
748C	36	LM3911	125	TBA120	70
753	150	LM3914	240	TBA641	250
810	159	LM3916	255	TBA800	90
81LS95	130	M252	625	TBA810	70
81LS96	130	M253AA	1150	TCA965	120
81LS97	140	MC1304P	260	TDA1004	290
AY-1-0212	595	MC1310	150	TDA1008	310
AY-1-1313A	660	MC1458	45	TDA1022	575
AY-1-1320	225	MC1488	90	TDA1024	105
AY-1-5050	99	MC1489	90	TDA2020	320
AY-1-5051	160	MC1495	350	TL061	46
AY-1-6721/6	210	MC1496	92	TL071CP	45
AY-3-8500	390	MC1710	79	TL074	140
AY-3-8910	850	MC3340P	120	TL081	42
AY-5-1224A	235	MC3360P	120	TL082	70
AY-5-1230	450	MC3401	52	TL083	95
CA3011	110	MC3403	135	TL084	120
CA3018	68	MFC6040	97	UAA170	170
CA3020	186	MK50398	635	UAA180	170
CA3023	191	MM5303	635	Z80	780
CA3028A	80	MM5307	1275	Z80A	899
CA3035	2'5	NE543	210	Z80CTC	595
CA3043	275	NE544	185	Z80P10	575
CA3045	365	NE555	22	ZN1034E	200
CA3046	71	NE556	55	ZN1040E	685
CA3048	214	NE560	325	ZN414	80
CA3059	195	NE561	398	ZN424E	130
CA3080E	65	NE562	410	ZN425E	415
CA3081	190	NE564	435		
CA3085	85	NE565	120		
CA3089E	215	NE566	180		
CA3090AQ	375	NE567	170		
CA3123E	150	NE570	450		
CA3130	90				
CA3140	48				
ICL7106E	795				
ICL7107	975				
ICL8038CC	340				
ICM7205	1150				
ICM7216A	1950				
ICM7217A	790				
ICM7555	89				
LD130	452				
LF356	90				
LM10	395				
LM300HX	170				
LM301A	26				
LM308	95				
LM318	200				
LM324	50				
LM339	68				

TRANSISTORS

AC125	35	BC183L	10	BF257	32	OC70	40	ZTX504	25	2N3773	270
AC126	25	BC184	10	BF258	32	OC71	40	ZTX531	25	2N3819	22
AC127	25	BC184L	10	BF259	35	OC72	40	ZTX550	25	2N3820	45
AC128	25	BC187	26	BF594	40	OC76	50	2N526	58	2N3822	65
AC141	30	BC212	10	BF595	40	OC77	50	2N696	30	2N3823	65
AC142	30	BC212L	10	BFR39	23	OC81	50	2N697	[illegible]	2N3866	90
AC176	28	BC213	10	BFR40	23	OC82	50	2N698	40	2N3903	18
AC187	28	BC213L	10	BFR41	23	OC83	40	2N699	48	2N3904	18
AC188	30	BC214	10	BFR79	23	OC84	40	2N706	19	2N3905	15
ACY17	70	BC214L	10	BFR80	25	OC140	110	2N708	19	2N3906	17
ACY18	70	BC307B	14	BFR81	25	OC170	85	2N918	35	2N4037	46
ACY20	75	BC328	12	BFX29	28	OC171	85	2N930	20	2N4058	10
ACY21	75	BC338	15	BFX81	45	TIP29	48	2N961	65	2N4061	10
ACY22	60	BC441	34	BFX84	26	TIP29C	60	2N1131	24	2N4062	10
AD140	120	BC461	34	BFX85	28	TIP30	48	2N1132	24	2N4069	45
AD149	79	BC477	40	BFX86	28	TIP30C	58	2N1302	45	2N4859	78
AD161	42	BC516	38	BFX87	28	TIP31A	42	2N1304	65	2N4871	55
AD162	42	BC517	38	BFX88	28	TIP31C	58	2N1305	60	2N5135	20
AF115	60	BC547	14	BFY50	23	TIP32A	46	2N1671B	120	2N5136	20
AF139	40	BC548	14	BFY51	23	TIP32C	56	2N2160	350	2N5138	18
AF178	75	BC549	14	BFY52	23	TIP33A	65	2N2219A	23	2N5172	18
AF180	70	BC557	15	BRY39	40	TIP33C	78	2N2220A	23	2N5179	45
AF186	70	BC558	15	BSX20	20	TIP34A	74	2N2222	25	2N5180	45
AF239	78	BC559	15	BSY65	35	TIP34C	88	N2369	18	2N5191	75
BC107	10	BCY70	16	BSY95A	35	TIP35A	156	2N2476	50	2N5305	24
BC108	10	BCY71	18	BU105	170	TIP35C	185	2N2484	27	2N5457	36
BC108B	12	BCY72	20	BU205	190	TIP36A	170	2N5172	13	2N5458	36
BC108C	12	BD131	48	BU208	200	TIP36C	199	2N2497	63	2N5459	36
BC109	10	BD132	48	E113	45	TIP41A	60	2N2646	45	2N5485	36
BC109B	12	BD133	60	E176	50	TIP41B	68	2N2894	30	2N5777	45
BC109C	12	BD135	40	E421	250	TIP42A	60	2N2904	28	2N6027	32
BC117	24	BD136	40	MJ2955	90	TIP42B	75	2N2905A	26	3N128	112
BC119	38	BD137	40	MJE340	54	TIP120	90	2N2906	23	3N140	112
BC137	40	BD138	40	MJE370	100	TIP121	99	2N2907	26	40311	60
BC140	30	BD139	40	MJE371	100	TIP122	99	2N2926G	10	40313	130
BC143	30	BD140	40	MJE520	95	TIP142	120	2N3053	26	40316	85
BC147	9	BD695A	85	MJE521	95	TIP147	120	2N3054	58	40317	60
BC148	9	BD696A	85	MJE2955	99	TIP2955	60	2N3055	48	40324	100
BC149	9	BDY17	195	MJE3055	70	TIP3055	60	2N3121	30	40326	60
BC153	27	BDY60	160	MPF102	66	TIS43	32	2N3133	45	40327	70
BC154	27	BDY61	160	MPF103	38	TIS44	45	2N3135	30	40348	120
BC157	10	BF115	35	MPF104	36	TIS90	30	2N3252	46	40360	40
BC158	10	BF167	29	MPF105	40	TIS91	32	2N3442	140	40361	50
BC159	11	BF173	27	MPF106	40	ZTX107	11	2N3568	25	40362	50
BC160	45	BF177	25	MPSA05	25	ZTX108	11	2N3663	15	40407	60
BC167A	10	BF178	30	MPSA06	32	ZTX109	12	2N3702	10	40408	70
BC168C	10	BF179	35	MPSA12	30	ZTX300	13	2N3703	10	40411	285
BC169C	10	BF180	38	MPSA55	30	ZTX301	16	2N3704	10	40412	65
BC170	15	BF194	11	MPSA56	30	ZTX302	16	2N3705	10	40467	130
BC171	11	BF195	11	MPSU06	55	ZTX303	25	2N3706	10	40468	85
BC172	11	BF196	12	MPSU56	60	ZTX304	17	2N3707	10	40594	105
BC177	20	BF197	12	OC28	120	ZTX314	25	2N3708	11	40595	110
BC178	20	BF198	18	OC35	125	ZTX326	30	2N3709	11	40603	110
BC179	20	BF200	30	OC36	120	ZTX341	30	2N3710	10	40636	170
BC182	10	BF224A	28	OC41	120	ZTX500	14	2N3711	10	40673	95
BC182L	10	BF244	24	OC42	120	ZTX501	15	2N3713	215		
BC183	10	BF256	45	OC44	120	ZTX502	15	2N3771	179		
				OC45	40	ZTX503	18	2N3772	195		



D609 Gentleman's **super slim** flag date larm. Only 4mm case thickness. Continuous isplay of hours, minutes, seconds and day; ptional display of date, month, year. 24 hour larm, alarm mode indication. Back light. finitely adjustable stainless steel strap. Very test technology.
10.95 + 85p p&p

D610 Gentleman's dual time melody alarm hrono. Only 5mm case thickness. Continuous isplay of hours, minutes, seconds plus date nd mode indications. 'Running horse' chrono o 1/10 sec, 12 hour alarm plays 30 seconds of 'ellow Rose of Texas'. Infinitely adjustable ainless steel strap.
16.95 + 85p p&p

MD605 Ladies musical alarm chrono. Continuous display of hours, minutes, seconds; optional display of day, date, month. Auto calendar. Chronograph with lap timing facilities, to 1/10 sec. 24 hour alarm plays 30 seconds of Beethoven's 'Fur Elise'. Back light. Infinitely adjustable stainless steel strap.
£11.95 + 85p p&p

MD606 Ladies five function fashion LCD watch with 3 year battery. Continuous display of hours and minutes, with month/date and date/ seconds available. Auto calendar. Only 6mm case thickness. Back light. Infinitely adjustable stainless steel strap.
£9.95 + 85p p&p

MD607 Ladies slim 'sugar coated' dress watch. Continuous display of hours and minutes; optional display of month and date. Auto calendar. Back light. Integral watch and strap. In gold or silver finish.
£9.95 + 85p p&p

MD608 Gentleman's musical alarm chrono. Continuous display of hours, minutes, seconds, plus day indication. Also month and date. Chronograph with lap timing facilities, to 1/10 sec. 24 hour alarm plays 30 seconds of Beethoven's 'Fur Elise' or can be set to awaken to a single note. Back light. Infinitely adjustable stainless steel strap.
£15.50 + 85p p&p

AND THERE'S MORE WHERE THIS CAME FROM

It's a long time since one of our adverts was presented in 'list' form - but simply because we do not try to squeeze this lot in every time doesn't mean that it's not available. Our new style price list (now some 40 pages long) includes all this and more, including quantity prices and a brief description. The kits, modules and specialized RF components - such as TOKO coils, filters etc. are covered in the general price list - so send now for a free copy (with an SAE please). Part 4 of the catalogue is due out now (incorporating a revised version of pt.1).

LINEAR ICs - NUMERIC LISTINGS

TBA120S 1.00
L200 1.95
U237B 1.28
U247B 1.28
U257B 1.28
U267B 1.28
LM301H 0.67
LM301N 0.30
LM308H 0.96
LM308N 0.65
LM339N 0.66
LM348N 1.86
LF351N 0.38
LF353N 0.76
LM374N 3.75
LM380N-14 1.00
LM380N-8 1.00
LM381N 1.81
ZN419CE 1.95
NE544N 1.80
NE555N 0.30
NE556N 0.50
NE560N 3.50
NE562N 4.05
NE564N 4.29
NE565N 1.00
NE566N 1.60
NE570N 3.85
SL624 3.28
TBA651 1.81
uA709HC 0.64
uA709PC 0.36
uA710HC 0.65
uA710PC 0.59
uA741CH 0.66
uA741CN 0.27
uA747CN 0.70
uA748CN 0.36
uA753 2.44
uA758 2.35
TBA810AS 1.09
TBA820M 0.75
TCA940E 1.80
TDA1028 2.11
TDA1029 2.11
TDA1054 1.45
TDA1062 1.95
TDA1072 2.69
TDA1074A 5.04
TDA1083 1.95
TDA1090 3.05
HA1137 1.20
HA1196 2.00
HA1197 1.00
TDA1220 1.40
LM1303 0.99
LM1307 1.55
MC1310P 1.90
MC1330 1.20
MC1350 1.20
HA1370 1.90
HA1388 2.75
TDA1490 1.86
MC1496P 1.25
SL1610P 1.60
SL1611P 1.60
SL1612P 1.60
SL1613P 1.89
SL1620P 2.17
SL1621P 2.17
SL1623P 2.24
SL1624C 3.28
SL1625P 2.17
SL1626P 2.44
SL1630P 1.62
SL1640P 1.89
SL1641P 1.89
TDA2002 1.25
TDA2020 3.00
ULN2242A 3.05
ULN2283B 1.00
CA3080E 0.70
CA3089E 1.84
CA3090AQ 3.35
CA3123E 1.40
CA3130E 0.80
CA3130T 0.90
CA3140E 0.46
CA3189E 2.20
MC3357P 2.35
LM3900N 0.60
LM3909N 0.68
LM3914N 2.80
LM3915N 2.80
KB4400 0.80
KB4406 0.60
KB4412 1.95
KB4413 1.95
KB4417 1.80
TDA4420 2.25
KB4420B 1.09
KB4423 2.30
KB4424 1.65
KB4431 1.95
KB4432 1.95
KB4433 1.52
KB4436 2.53
KB4437 1.75
KB4438 2.22
KB4441 1.35
KB4445 1.29
KB4446 2.75
KB4448 1.65
NE5044N 2.26
NE5532N 1.85
SD6000 3.75
SL6270 2.03
SL6310 2.03
SL6600 3.75
SL6640 2.75
SL6690 3.20
SL6700 2.35
ICL8038CC 4.50
MSL9362 1.75
MSL9363 1.75
HA11211 1.95
HA11223 2.15
HA11225 1.45
HA12002 1.45
HA12017 0.80
HA12402 1.95
HA12411 1.20
HA12412 1.55
LF13741 0.33
SN76660N 0.80

FREQUENCY DISPLAY & SYNTHESISER ICs

SAA1056 3.75
SAA1058 3.35
SAA1059 3.35
11C90DC 14.00
LN1232 19.00
LN1242 19.00
MSL2318 3.84
MSM5523 11.30
MSM5524 11.30
MSM5525 7.85
MSM5526 7.85
MSM5527 9.75
MSM55271 9.75
ICM7106CP 9.55
ICM7107CP 9.55
ICM7216B 19.25
ICM7217A 9.50
SP8629 3.85
SP8647 6.00
95H90PC 6.00
HD10551 2.45
HD44015 4.45
HD12009 6.00
HD44752 8.00

CMOS 4000 SERIES

4001 0.17
4000 0.17
4002 0.23
4008 0.80
4009 0.58
4010B 0.58
4011AE 0.20
4011B 0.20
4012 0.55
4013 0.55
4015 0.95
4016 0.52
4017 0.80
4019 0.60
4020B 0.93
4021 0.82
4022 0.90
4023 0.17
4024 0.76
4025 0.17
4026 1.80
4028 0.72
4029 1.00
4030 0.58
4035 1.20
4040 0.83
4042 0.85
4043 0.85
4044 0.80
4046 1.30
4047 0.99
4049 0.52
4050 0.55
4051 0.65
4052 0.65
4053 0.65
4063 1.09
4066 0.56
4068 0.25
4069 0.20
4070 0.20
4071 0.20
4072 0.20
4073 0.20
4075 0.20
4076 0.90
4077 0.20
4078 0.20
4082 0.20
4093 0.78
4175 0.95
4503 0.69
4506 0.51
4510 0.99
4511 1.49
4512 0.98
4514 2.55
4518 1.03
4520 1.09
4521 2.36
4522 1.49
4529 1.41
4539 1.10
4549 3.50
4554 1.53
4560 2.18
4566 1.59
4568 2.18
4569 3.03
4572 0.30
4585 1.10

TTL N and LSN

7400N 0.13
74LS00 0.20
7401N 0.13
74LS01 0.20
7402N 0.14
74LS02 0.20
7403N 0.14
74LS03 0.20
7404N 0.14
74LS04 0.24
7405N 0.18
74LS05 0.26
7406N 0.28
7407N 0.38
7408N 0.17
74LS08 0.24
7409N 0.17
74LS09 0.24
7410N 0.15
74LS10 0.24
7411N 0.20
74LS11 0.24
7412N 0.17
7413N 0.30
7414N 0.51
74LS15 0.24
7416N 0.30
7417N 0.30
7420N 0.16
74LS20 0.24
7421N 0.29
74LS21 0.24
7423N 0.27
7425N 0.27
7427N 0.27
74LS27 0.44
7428N 0.35
74LS28 0.32
7430N 0.17
74LS30 0.24
7432N 0.25
74LS32 0.24
7437N 0.40
7438N 0.33
74LS38 0.24
7440N 0.17
74LS40 0.24
7441N 0.74
7442N 0.70
74LS42 0.99
7443N 1.15
7444N 1.12
7445N 0.94
7446N 0.94
74LS47 0.89
7448N 0.56
74LS48 0.99
74LS49 0.99
7451N 0.17
74LS51 0.24
7453N 0.17
7454N 0.17
74LS54 0.24
74LS55 0.24
7460N 0.17
74LS63 1.24
7470N 0.28
7472N 0.28
7473N 0.32
74LS73 0.38
7474N 0.27
74LS74 0.28
7475N 0.38
7476N 0.37
74LS76 0.38
74LS78 0.38
7480N 0.48
7481N 0.86
7482N 0.69
7485N 1.04
74LS85 0.99
74LS86 0.40
7489N 2.05
7490N 0.33
74LS90 0.90
7491N 0.76
74LS91 1.10
7492N 0.38
74LS92 0.78
7493N 0.32
74LS93 0.99
7494N 0.78
7495N 0.65
74LS95 1.14
7496N 0.58
74LS96 1.20
7497N 1.85
74LS107 0.38
74109N 0.63
74LS109 0.70
74110N 0.54
74111N 0.68
74LS112 0.38
74LS113 0.38
74LS114 0.38
74118N 0.83
74120N 1.15
74121N 0.42
74122N 0.46
74123N 0.73
74LS124 1.75
74125N 0.38
74LS125 0.44
74126N 0.57
74LS126 0.44
74128N 0.74
74132N 0.73
74LS132 0.78
74LS136 0.40
74LS138 0.60
74141N 0.56
74142N 2.65
74143N 3.12
74144N 3.12
74LS145 0.97
74147N 1.75
74148N 1.09
74LS148 1.19
74150N 0.99
74151N 0.55
74LS151 0.84
74153N 0.64
74LS153 0.54
74154N 0.96
74155N 0.54
74LS155 1.10
74156N 0.80
74157N 0.67
74LS157 0.55
74LS158 0.60
74159N 2.10
74160N 0.82
74LS160 1.30
74161N 0.92
74LS161 0.78
74LS162 1.30
74163N 0.92
74LS163 0.78
74164N 1.04
74LS164 1.30
74165N 1.05
74LS165 1.04
74167N 2.50
74LS169 2.00
74170N 2.30
74LS170 2.00
74LS174 1.20
74175N 0.87
74LS175 1.10
74176N 0.75
74177N 0.78
74181N 1.65
74LS181 3.50
74LS183 2.10
74184N 1.35
74185N 1.34
74LS190 0.92
74192N 1.05
74LS192 1.80
74193N 1.05
74LS193 1.80
74194N 1.05
74196N 0.99
74LS196 1.10
74LS197 1.10
74198N 1.50
74199N 1.60
74LS247 0.93
74LS257 1.08
74LS260 1.53
74LS279 0.52
74LS283 1.20
74LS293 0.95
74LS365 0.49
74LS366 0.49
74LS367 0.43
74LS368 0.49
74LS374 1.80
74LS377 1.95
74LS379 1.30
74LS393 1.40

VOLTAGE REGULATORS

78series 0.95
79series 1.00
78Mseries 0.65
78Lseries 0.35
79L05 0.85
78MGT2C 1.75
79MGT2C 1.75
723CN 0.65
L200 1.95
TDA1412 0.75
NE5553N 1.25
LM317MP 1.48
LM337MP 1.48

MICROMARKET

8080A/2 7.50
8212 2.30
8214 3.50
8216 1.95
8224 3.50
8251 6.25
8255 5.40
6800P 7.50
6810 5.95
6820 7.45
6850 4.90
6852 4.85
MC2708 7.50
2114 6.50
4027 5.78
2102 1.70
2112 3.40
2513 7.54
HM4716 4.50
81LS97 1.25

VARICAP TUNING DIODES

BA102 0.30
BA121 0.30
ITT210 0.30
BB204B 0.36
BB105B 0.36
BB109 0.27
MVM125 1.05
BB212 1.95
KV1210 2.45
KV1211 1.75
KV1226 1.95
KV1225 2.75
KV1215 2.55
KV1225 2.75

SWITCHING AND PIN DIODES

SHOTTKY DIODES

1N6263 0.62
BA182 0.19
BA244 0.17
BA379 0.35
TDA1061 0.95

SIGNAL DIODES & RECTIFIERS

1N4148 0.06
1N4001 0.06
1N4002 0.07
1N5402 0.15
OA91 0.07
AA112 0.25
BRIDGES:
1A/50V 0.35
6A/200V 0.75

TOKO COILS AND FILTERS SEE THE EXTENSIVE SECTION IN OUR NEW PRICE LISTS AND CATALOGUE

LF/HF FIXED INDUCTORS
—FULL E12 RANGE
7BA series 1uH-1mH 0.16
8RB series 100uH-33mH 0.19
10RB series 33mH-120mH 0.33
10RBH series 120mH-1.5H 0.55
PIEZO SOUNDER PB2720 0.44

CRYSTAL FILTER PRODUCTS

10.7MHZ 2 POLE TYPES:
10M15A 15KHZ BW 2.49
10.7MHZ 8 POLE TYPES:
10M4B1 15kHz BW 14.50
H4402 7.5KHZ BW 15.50
10M22D 2.4KHZ SSB 17.20
HF FIRST FILTER:
B34F8A 34.5MHz HF 32.00

RADIO CONTROL CRYSTALS

(No splits available)
AM TX:-
3rd OT 30pF HC25U 1.65
AM/FM RX:-
3rd OT 30pF HC25U 1.65
FM TX :-
Fund 20pF HC25U 1.85
Pairs FM 3.25
Pairs AM 3.10

CRYSTALS

32.768 kHz 2.70
100kHZ 3.85
455kHZ 5.00
1.0MHz 3.00
3.2768MHz 2.70
4.000MHz 2.00
4.19439MHz 2.30
6.5536MHz 2.10
10.0MHz 2.50
10.6985MHz 2.50
10.7015MHz 2.50
10.245MHz 2.50
10.7MHz 3.00
11.52MHz 2.50
100MHz 3.00

LEDs

5MM RED 0.12
3MM RED CLEAR 0.15
3MM RED 0.15
2.5 X 5MM RED 0.17
5MM GREEN 0.15
3MM GN CLEAR 0.16
3MM GREEN 0.16
2.5 X 5MM GN 0.20
5MM YELLOW 0.15
3MM YELLOW CL 0.16
3MM YELLOW 0.18
2.5 X 5MM YE 0.20
5MM ORANGERED 0.20
5MM ORA CL 0.29
3MM ORANGERED 0.19
2.5 X 5MM ORA 0.24
5MM INFRA RED 0.56
BPW41 IR DET 1.51
IR OPT CPLR 1.44
5MM CLIP 0.04

LCDs

3.5 digit 9.45
4 digit 8.95
5 digit 8.95

SCHOTTKY DIODE BAL MIXERS (SBL1=MD108)

SBL1 1-500MHz 4.25
SBL1-8 .1-200MHz 4.55
SBL1-X 10-1000MHZ 5.75
SRA1 .5-500MHz 8.45
SRA1-1 .1-500MHz 9.25
SRA1H .5-500MHz 13.35
SRA3 .025-200MHz 10.25

LCD Module

CM161.
Miniature clock, 12/24 hr., alarm, day, date, backlight.
All for.....9.95

TRANSISTORS

AUDIO DEVICES

BC237 0.08
BC238 0.08
BC239 0.08
BC307 0.08
BC308 0.08
BC309 0.08
BC413 0.10
BC414 0.11
BC415 0.07
BC416 0.08
BC546 0.12
BC556 0.12
BC550 0.12
BC560 0.12
BC639 0.22
BC640 0.23
2SC1775 0.18
2SA872A 0.14
2SD666A 0.30
2SB646A 0.30
2SD668A 0.40
2SB648A 0.40
2SD760 0.45
2SB720 0.45
2SC2546 0.19
2SA1084 0.20
2SC2547 0.19
2SA1085 0.20

AUDIO POWER DEVICES

2SB753 2.34
2SB723 2.34
2SK133 3.00
2SJ 48 3.00
2SK134 3.10
2SK135 3.75
2SJ 50 3.75
BD535 0.52
BD536 0.52
BD377 0.33
BD378 0.33
BD165 0.30
BD166 0.31

SMALL SIGNAL RF DEVICES

BF194 0.18
BF195 0.18
BF224 0.22
BF241 0.18
BF274 0.18
BF440 0.21
BF441 0.21
BF362 0.49
BF395 0.18
BF479 0.66
BF679S 0.55
BFR91 1.33
BFW92 0.60
BFT95 0.99
BFY90 0.90
40238 0.85

RF POWER DEVICES

VN66AF 0.95
2N3866 0.85

SMALL SIGNAL RF FET/MOSFET

BF256 0.38
2SK55 0.28
2SK168 0.35
J310 0.69
J176 0.65
40823 0.65
40673 3SK51
3SK45 0.49
3SK51 0.54
3SK60 0.58
MEM680 0.75
BF961 0.70
BF960 1.24
3SK48 1.64

CAPACITORS

All 5mm or less spacing

CERAMIC 50v
2P2,3P3,4P7,6P8
8P2,10P,15P,18P..0.04
22P,27P,33P,47P
56P,68P,82P,100P.0.05
150P,220P,270P
330P,390P,470P...0.055
1N0,2N2,3N3,4N7..0.06
10N (0.01uF)....0.05
22N,47N.........0.06
100N,220N........0.09
MONOLITHIC CERAMIC
10N,100N.........0.16
FEEDTHRU
1N0 SOLDER IN....0.09
POLYESTER (SIEMENS)
10mm LEAD SPACING
10N,22N,33N......0.17
47N,68N,100N.....0.19
220N,470N.........0.22
1uF..............0.29
POLYESTER (GENERAL)
10mm LEAD SPACING
10N,15N,22N,33N..0.06
47N,68N,100N.....0.08
220N............0.11
20mm LEAD SPACING
220N,330N,470N...0.18
MYLAR
5mm LEAD SPACING
1N0,10N,22N,33N..0.08
100N............0.09
20mm LEAD SPACING
220N,470N....... 0.17
POLYSTYRENE
10P,15P,18P,22P,
27P,47P,56P,68P..0.08
100P,180P,220P,
270P,330P,390P...0.09
470P,680P,820P...0.10
1N0,1N2,1N5,1N8..0.11
2N2,2N7,3N3,3N9..0.12
4N7,5N6,6N8,10N..0.13
TANTALUM BEAD CAPS
16v: 0.22,0.33,
0.68,1.0.........0.18
16v: 2.2,4.7,10..0.19
6v3: 22,47.......0.30
10v: 22,100.......0.35

ALUMIN ELECTROLYTICS RADIAL (VERT. MOUNT)

(uF/voltage)
1/63,2.2/50,4.7/35
10/16,15/16,22/10
33/6.3..........0.08
22/16,33/10,
47/10..........0.09
10/63,22/50,33/50,
47/16,100/16.....0.10
47/63,100/25,220/16
470/6.3..........0.12
100/63,470/16,
1000/10..........0.18
1000/16,470/63...0.23
1000/63,2200/16..0.30
3300/25..........0.69
1000/100.........0.88
10000/70.........3.00
AXIAL (HORIZ. MOUNT)
1/25,4.7/16,6.4/25
10/16...........0.08
4.7/63,22/10,22/16
33/16...........0.09
47/25,100/16.....0.10
100/25..........0.11
1000/16..........0.25
2200/16,1000/25..0.36
1000/35,4700/16..0.45
1000/50..........0.58

RESISTORS

0.25W, 5% E12 CARBON
1ohm-10M.........0.02
0.25W 1% E12 METAL FILM
1.1ohm-1M.........0.05
HORIZ CARBON PRESETS
10mm TYPE,
100ohms-2M5......0.12
HORIZ CERMET PRESETS
1k, 10k..........0.27

Please send an SAE with all enquiries. Access/Barclaycard (min £5 please) Callers welcome

PRICES EXCLUDE VAT - PLEASE ADD 15%*
Postage 35p per order. CWO please. (*UK only)

ambit INTERNATIONAL

CWO PLEASE : Commercial MA terms on application. Goods are offered subject to availability, prices subject to change - so please phone and check if in doubt.

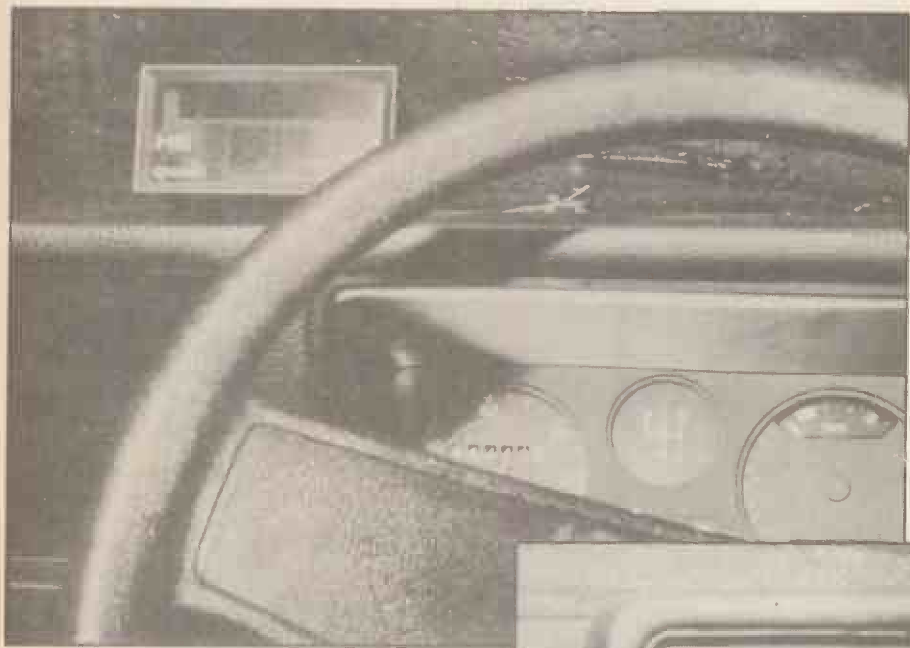
CATALOGUES
2 & 3....60p ea
4...........75p
(4 inc. rev. of part 1)
ALL PARTS : ....£1.75.....

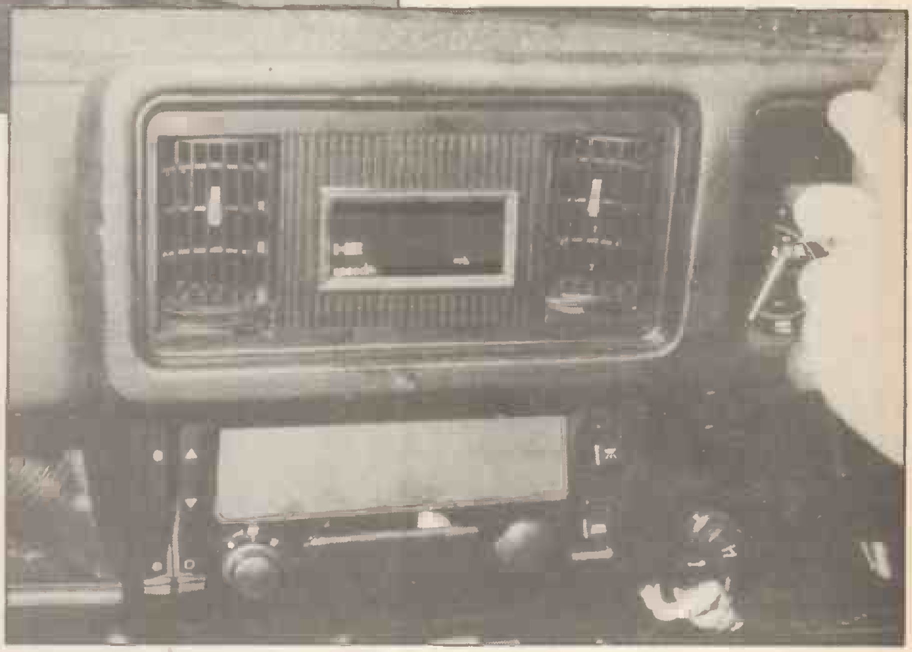
200 North Service Road, Brentwood, Essex

TELEPHONE (STD 0277) 230909 TELEX 995194 AMBIT G POSTCODE CM14 4SG

Digital Speedo

Check your car velocity with this super project — designed to be free standing or panel mounted in your car





AT LAST, here it is, the project all the many motorist readers have been waiting for to update their car dashboard and make it look sleek and sporty. Yes, we've done it again (?) with a superlative project of unparallelled innovativeness (not that we're boasting!).

You can simply leave the HE Digital Speedo on top of your dash to provide an impressive-looking readout of car velocity or mount the whole project into the facia panel to look even better — the case is suitable for either.

A six-IC circuit gives all control, timing and counting functions to drive the large, two-digit, 7-segment display. Most of the components fit compactly onto a main PCB, which slides neatly into the case, and a small sub-board is used to hold the two ½" LED displays. The acrylic front panel hides the internal circuitry from view but gives good sight of the red LED segments of the display.

Just think, as you start the car engine, our digital speedo will burst into life with a readout (from a single digit) of 0 MPH. And there the speedo waits, almost purring, until you rev up, slide into gear and put in the clutch. Then, as you pull away from standstill the speedo follows, registering first from 0 to 9 till the second digit shows you are in double figures. A display rate of around four times a second means that the readout more or less instantly follows the velocity, maintaining good accuracy. Never again do you need to rely on those old-fashioned, out-dated mechanical counterparts that are virtually guaranteed to give you an incorrect reading. The digital speedo can eliminate all that — who needs 'em when you've got a *digital* one at your fingertips!

The design of our speedo allows its use with a wide variety of rear-wheel drive cars. The speedo may be usable with front wheel drive vehicles too, but we did not perform any calculations on these. (The final drive shafts are not as accessible on front wheel drive vehicles.)

Rear wheel drive vehicles have an open driveshaft from gear box to rear axle and we have taken this as our starting point. All that the speedo does is to count the number of revolutions of

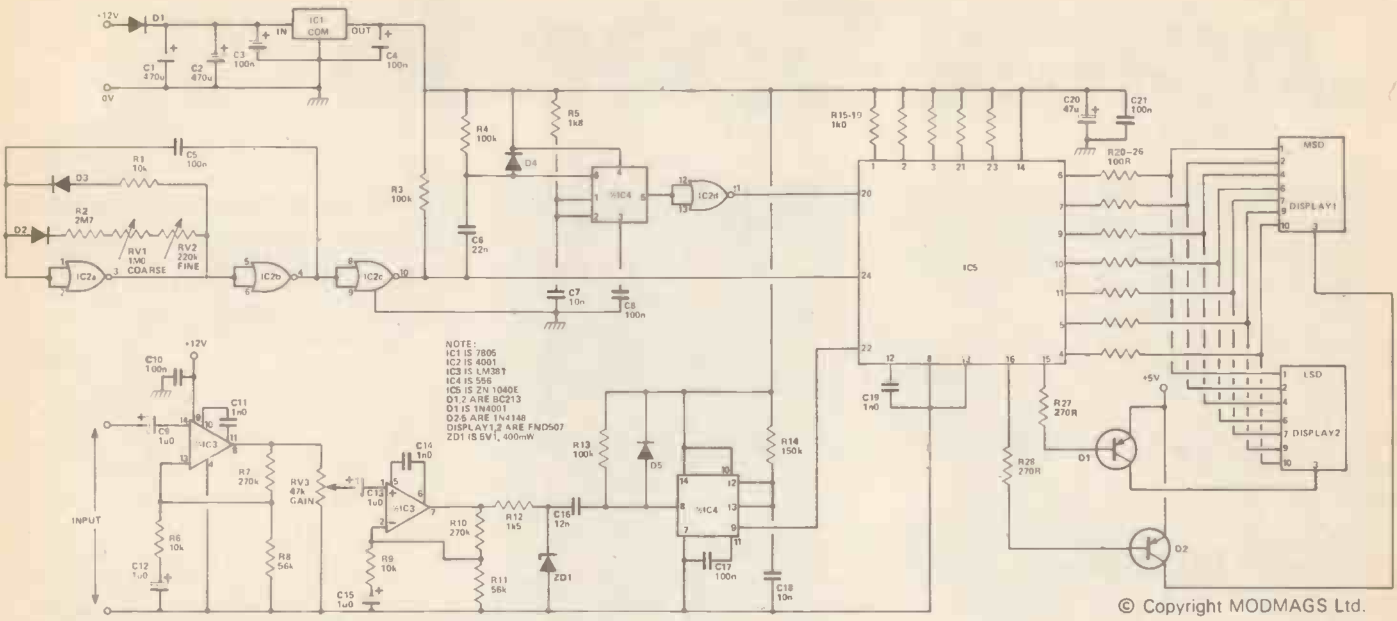


Figure 1. Complete circuit diagram of the HE Digital Speedo. Two PCBs are used in its construction.

the drive shaft over a set period. This is then related to distance so that a reading of MPH is obtained.

Now, the speedo as it stands will function correctly with any drive shaft which turns approximately once per MPH. For example, the shaft must turn at about 50 Hz when the car is travelling at 50 MPH. To find out if your car will suit, do the following calculations:

- divide the circumference (in feet) of the car wheel by 1.47
- Divide this result by the vehicle's drive shaft/wheel ratio (found in the car manual)

The final result should be about 1 ±30%. If this is not so, all is not yet lost! If your particular calculations yield a result a lot less than one, (eg 0.5) then the situation is remedied by doubling resistor R2, (in **Fig.1**) in value. Likewise, if the calculations provide a figure of, say, 2, then halving resistor R2's value should do the trick. A special sensor has been used to detect the rotation of the drive shaft and it consists of a coil fastened to the car chassis in close vicinity to the drive shaft. Small magnets must be positioned on the drive shaft so that they pass by the coil. As they do, a voltage is induced in the coil and passed on to the main circuit to be counted. Full details of the sensor are given next month along with general guidelines of its mounting. Individual cars will need different fixing methods and we leave these up to the reader.

How it Works

The HE Digital Speedo uses one of the most complex circuits seen in HE for a while. With this in mind a good block diagram of the system is called for and Fig.2 shows just that. The waveforms at various points around the circuit are shown in Fig.3 and the following should clarify its operating principle.

A low, near sinewave, voltage is generated by the magnets passing close by the pickup coil (Fig. 3a). This voltage is directly proportional to the rate of change of flux through the coil — in other words, the faster the magnets are travelling the larger the induced voltage. Thus this voltage is proportional to the speed of the car. The following stage, a very high gain pre-amplifier, corrects this voltage.

The preamplifier, formed by two op amps within IC3, amplifies the signal so much that it limits (or clips) as in waveform b. The gain of the pre-amp is adjustable to a certain degree by RV1. In most applications this should be mid-position and left untouched. The clipped waveform triggers a monostable multivibrator formed by the first half of 1C4 (a dual 555 timer) with an 'on' period of about 1.5 ms — hence the waveform illustrated at point c in Fig.3. This is the waveform applied to the count input of the counter integrated circuit IC5.

This IC, the ZN1040E, digitally counts the number of pulses at its input and displays the result on two 7-segment displays. Although the ZN1040E is usable for up to a four digit display, we thought it unlikely that the average family saloon would attain speeds of up to 9999 MPH and so we restricted the speedo to two digits. This allows a reading up to 99 MPH. If the vehicle just did happen to exceed 'the ton' (not in this country of course) the display would simply 'clock on' — a speed of 112 MPH reading as 12 MPH. We feel that most drivers will be able to tell the difference between 12 and 112 MPH!

Now, to be able to display speed (ie dist./time) as a number we have to relate the pulses (which represent distance) of waveform c, to a set period. The following formulae show how we did it.

The circumference of a typical car wheel is approximately equal to:

$2\pi r$,

where r is the tyre radius, and is roughly 6 feet for most cars.

Now,

1 MPH = 1.47 ft. s^{-1},

so it takes 6/1.47 (about 4 seconds) for the wheel to turn once (at 1 MPH).

The typical drive shaft/wheel ratio is about 4:1. Therefore, the drive shaft turns four times in 4 seconds.

Or, put another way, the drive shaft turns once a second for every MPH the car is travelling.

If a magnet was fixed to the drive shaft and a coil was used to pick up the rotation of the magnet, then all we need to do is count the number of rotations of the magnet in one second and we can therefore have a direct reading of the MPH the vehicle is maintaining. Better still, if we put four magnets on the shaft and counted the pulses over ¼ second the same result occurs with better low-speed performance.

The rest of the circuit allows the counter to do this. IC2 a,b,c form an astable, clocking about 4 Hz (waveform d) to time the count intervals, and the second half of IC4 and IC2d form a monostable multivibrator to reset the counter to zero at the end of every timed period, shown in waveform e.

Presets RV2 (coarse) and RV3 (fine) allow for adjustment of the timing period so that different wheel sizes and drive shaft/wheel ratios can be accommodated to give an accurate speed readout.

Finally, IC1 is a voltage regulator (not shown on the block diagram) giving a stable voltage of 5 VDC for the ZN1040E and all other ICs apart from IC3, which runs direct from the car battery voltage of 12 VDC.

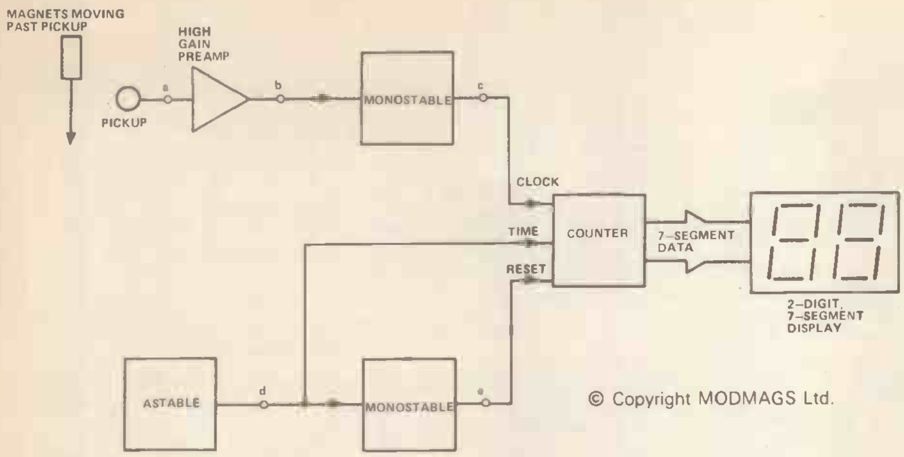


Figure 2. An overall block diagram of the circuit. The waveforms at various points are shown in Fig. 3

Buylines

All parts used in the HE Digital Speedo are fairly common devices, but if your local stockist can't supply, then the usual mail order companies will be able to help. Integrated circuit IC5 and the 7-segment displays are available from Technomatic.

Approximate cost (excluding case and PCBs) should be around £30.

The case is a DIN standard and thus various makes are available. Overall front panel dimensions are 96 x 48 mm and depth is 110 mm. If your local supplier deals with RS Components (most do), you can get their style, which is the variety we used — stock no. 508-683.

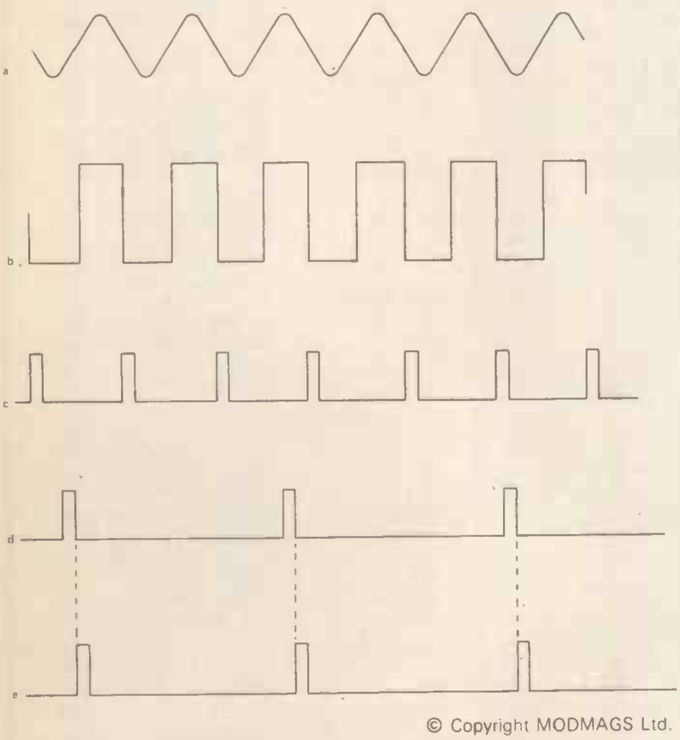


Figure 3. Waveforms within the circuit of the Digital Speedo. Read the HOW IT WORKS section to find where they belong

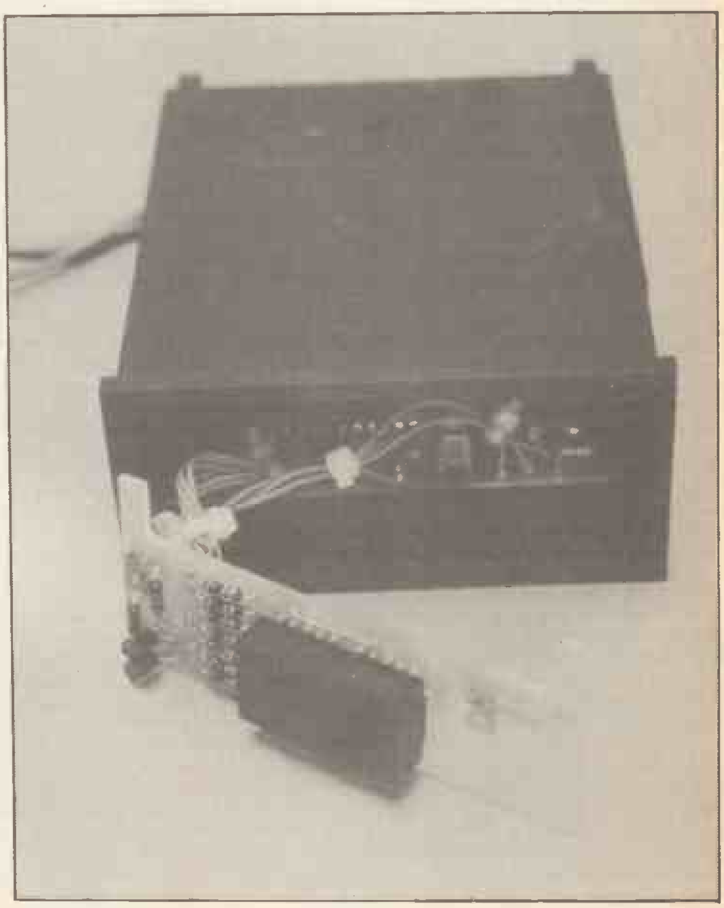
Construction

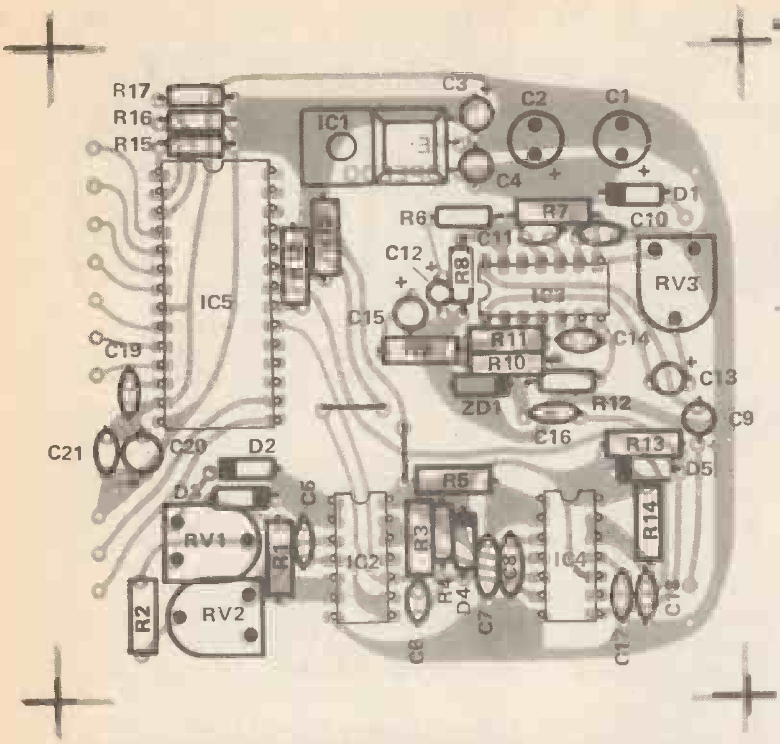
Take all the usual precautions when making up the PCBs such as noting the correct polarisation of the capacitors and using IC sockets for the DIL integrated circuits. Build the main board first, inserting components in order of resistors, capacitors and semiconductors. There are two wire links to be made, so don't forget them!

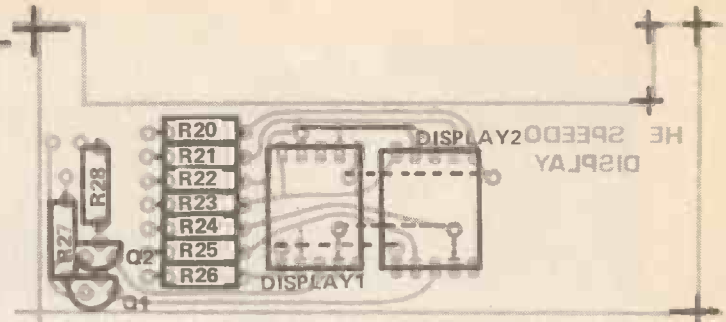
Integrated circuit IC1, the voltage regulator, should be laid flush to the board, with its pins bent vertically about ⅛" from its body, through the PCB. Finally insert all other ICs, checking they are the right way round, and set all presets to mid-position. This board can now be laid to one side.

The display board is somewhat trickier. It has an optional cut-out to enable the insertion of a further project — a tachometer (rev counter) — next month. If you intend to build the tacho you need to cut or file out the rectangular shape in the edge of the display board. There are four links on this board — three of which are underneath the displays. Insert these links as close to the board as possible.

The 7-segment displays must be inserted with the decimal points to the bottom. Align them carefully before soldering so that they are level. Finally, the resistors and Q1 and 2 can be put in. Make sure the transistors are in the right way round and that they are mounted close to the board.







IMPORTANT—NOTE LINKS UNDERNEATH THE DISPLAY

Figure 4. Overlays for the two PCBs. Left is the main circuit board and above is the display board. The photograph below shows the two boards together. Connection details are given next month

Parts List

RESISTORS (all ¼ W, 5%)

R1	10k
R2	2M7
R3,4,13	100k
R5	1k8
R6,9	10k
R7,10	270k
R8,11	56k
R12	1k5
R14	150k
R15,16,17,18,19	1k0
R20,21,22,23,24,25,26	100R
R27,28	270R

POTENTIOMETERS

RV1	1M0 miniature horizontal preset
RV2	220k miniature horizontal preset
RV3	47k miniature horizontal preset

CAPACITORS

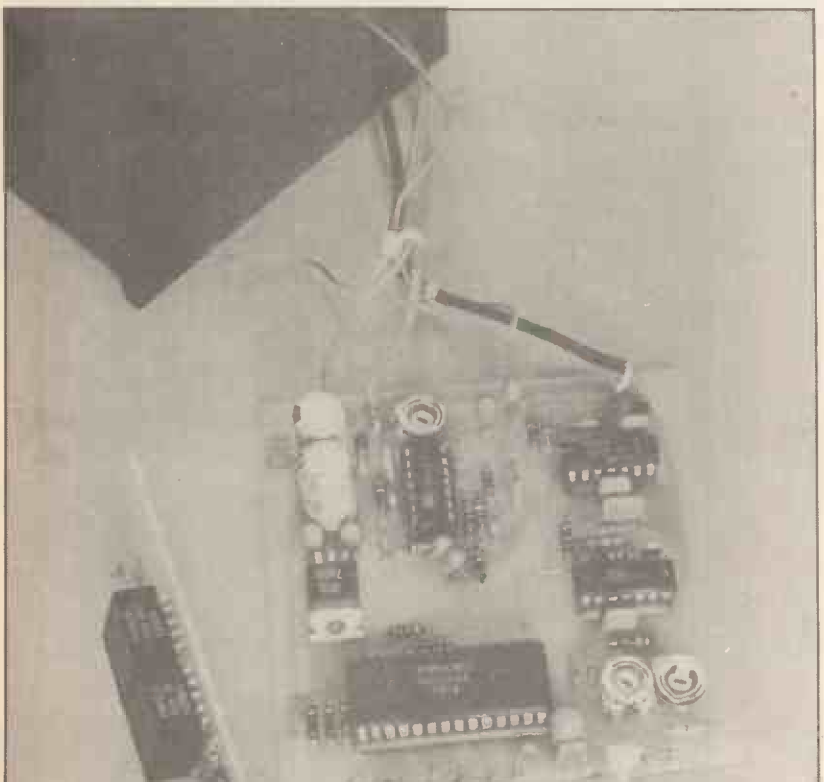
C1,2	470u 16 V printed circuit mounting electrolytic
C3,4	100n 35 V tantalum
C5,8,10,17,21	100n resin dipped ceramic
C6	22n resin dipped ceramic
C7,18	10n resin dipped ceramic
C9,12,13,15	1u 35 V tantalum
C11,14,19	1n resin dipped ceramic
C16	12n resin dipped ceramic
C20	47u 6V3 tantalum

SEMICONDUCTORS

IC1	7805 1 A, 5 V regulator
IC2	4001 quad NOR gates
IC3	LM381 dual preamp
IC4	556 dual timer
IC5	ZN1040E counter/display
Q1,2	BC213 PNP transistor
D1	1N4001 1A diode
D2 to 5	1N4148 diode
ZD1	5V1, 400 mW zener diode
Display 1,2	FND507 common anode, 7-segment displays

MISCELLANEOUS

case to suit (see BUYLINES)



Readers should note that the conventional speedometer/odometer found in most vehicles is a legal necessity. We therefore suggest the HE Digital Speedo should be included as an extra rather than as an alternative instrument.

HE

3 GREAT BARGAINS

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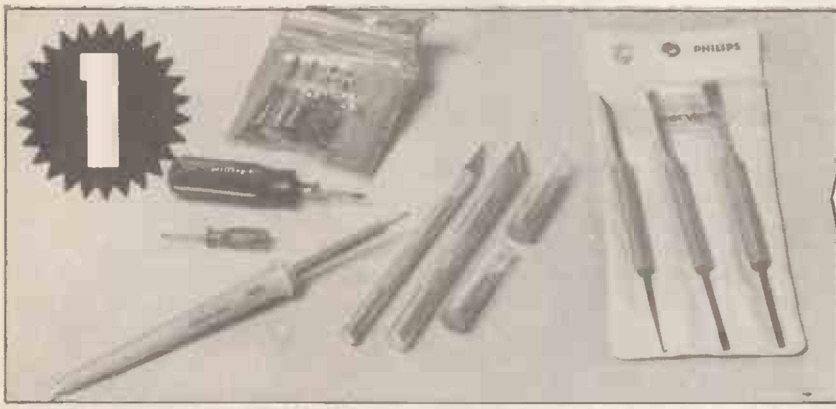

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Philips Service

View Into Video Discs

Video disc systems have been hinted at in recent years: in 1981 we should start to see them in the UK. Hugh Davies looks at what they do, how they work and their likely cost

MOST OF YOU will be familiar with the variety of video cassette recorder/ playback systems on the market. Now a new form of video *playback* is due for release — the video disc.

The concept of this disc is a simple one, namely an hour or two of colour TV film material (loosely termed 'software'), recorded on a disc about the size of a conventional audio LP. Nice concept, but like its predecessor the cassette, no standardisation exists between manufacturers (see inset box on page). In the UK the 'big three' are Philips, RCA and JVC. Although each has its own system, there are very rough similarities between those of the last two.
consists of video and audio information (mono or stereo) with some means of cueing for the selection of individual frames or groups of frames. (Just as a reminder, 50 complete TV frames are transmitted each second on individual TV broadcasts.)

How is the software recorded and how is it extracted from each type of disc? Because of the inherent differences between the three systems it is preferable to look at each one individually, starting with that of Philips.

Philips — light and grooveless

Production of the VLP (video long play) disc starts with a master tape of the software material. **Figure 1** gives an outline of the main stages of production. The master disc is made of glass, and has a photosensitive layer deposited on one side. Information is 'written' into this layer with a 100 mW laser. After exposure to the laser, the disc undergoes a development process which leaves a pattern of microscopic pits (about 0.4 um wide). This pattern is transferred, using a galvanic process, to what are called 'stampers'. It is from these that the final discs are produced, using a 'cold' pressing process. (A 'hot' process is used for pressing conventional audio discs.) According to Philips, there's less chance of warping and stressing the discs with a cold process.

What about the VLP discs themselves? These start life as clear plastic discs, coated on one side with a photosensitive lacquer. It is this lacquer which is impressed with the stamper. After pressing, the lacquer is hardened with ultraviolet light and coated with a thin layer of highly-reflective aluminium. This coating follows the pits in the lacquer faithfully and is sealed with a protective layer.

After all this, what do we have? Only half a disc! The two halves, each containing different software, are made in an identical manner and glued together on their metallised sides. Thus the software is sandwiched — and fully protected — between two clear-plastic discs. The finished disc resembles an audio LP record but it has a grooveless mirror-like appearance.

Right, we've got the disc: the problem is how to play it. On the VLP system this is done with a very low power (1 mW) helium-neon gas laser which produces a coherent beam of light having a wavelength of 0.63 um. This beam finds its way through a network of lenses, mirrors and a special prism to the surface of the disc. In fact what comes out of the final lens is *three* beams, as will now be explained.

The beams penetrate the clear plastic of the disc (which is spun on the machine with the laser scanning the underside) and strikes the metal coating. This coating in turn reflects the light, the degree of reflection depending on the formation of pits (**Fig. 2**) strung out in a long spiral. The reflected beams are detected by three light-sensitive devices called photodiodes.

Now why three beams? Well, think of a beam of light aimed at the surface of a perfectly flat disc having no grooves. The information to be extracted is contained on a continuous spiral track only 0.4 um wide. (The spacing between in-

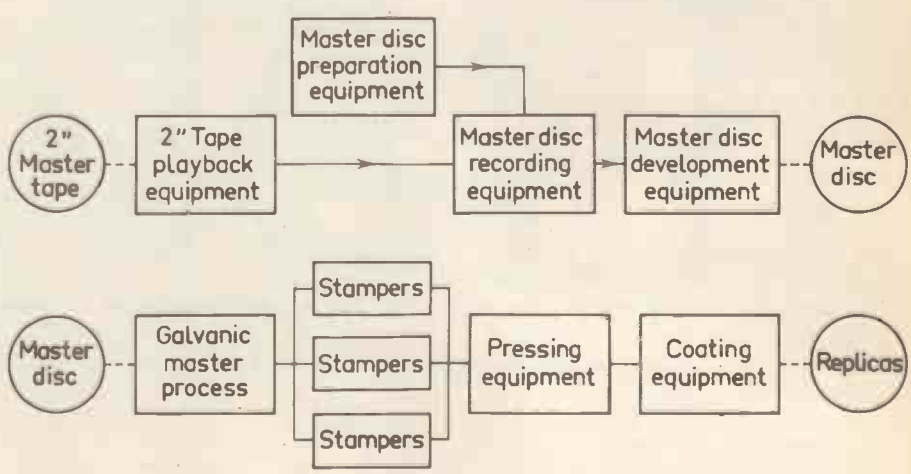
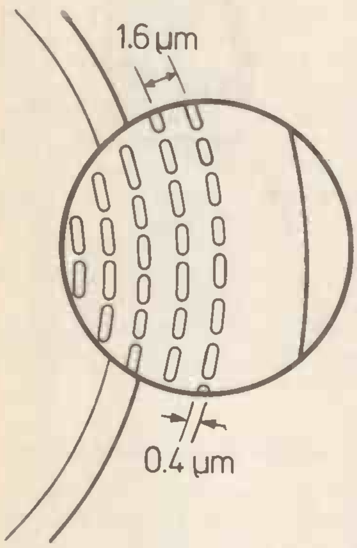


Figure 1. Main stages in mastering and replicating a VLP disc

Figure 2. Formation of pits on a VLP disc:
a) electron microscope view of disc surface



b) how pits are arranged and spaced

dividual tracks is about 60 times less than that of an audio record.) Unlike a record, where the stylus is guided in a groove — also in a spiral — the VLP disc has no groove. And anyway, how do you hold a beam of light? To solve this problem two of the beams are used to guide the laser assembly, keeping it 'on track'. By an arrangement of mirrors, one beam is held dead centre on the track while the other two fall slightly to the left and right of it (see **Fig.3**). While a small motor is adequate to guide the assembly, mounted on a 'sledge' which travels radially across the disc, it is too sluggish to cope with the minute movements required to hold the centre beam continuously on track. Thus one mirror is mounted on an assembly resembling the construction of a moving-coil galvonometer, where the coil forms part of the radial servo-control circuit. Yet another pivoting mirror scans the track tangentially to check for errors in rotational speed: all-in-all a very complicated optical system. (I haven't even touched on the automatic focusing network used to cope with undulations in the disc!)

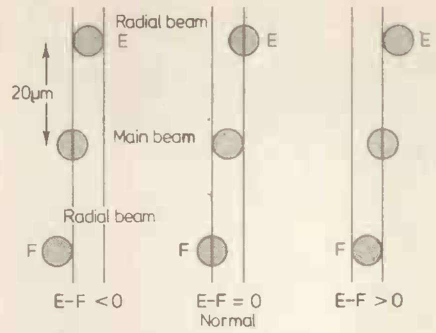


Figure 3. Keeping on track with the three beams from the laser

The VLP machine as a whole (**Fig. 4**) can be split into three main parts. First is the audio section, which contains the sound demodulator for left- and right-hand stereo channels. (Two outputs are provided for separate amplification as TVs generally don't have facilities for stereo sound.) A mono signal is fed to a UHF modulator which provides the signal for the aerial socket of a colour TV. Second is the video section, which amplifies and processes the signals from the photodiodes. These signals also go into the UHF modulator. Third is the servo section, which looks after the overall control of the spinning disc and the optical sledge.

Discs for the system will come in two diameters: 300 mm (11.8") and 200 mm (7.9"), each with a thickness of 2.5 mm (about 0.1"). (Thinner discs may be produced later.) Two different types of disc will be produced: the CAV (constant *angular* velocity) and the CLV (constant *linear* velocity). The first one has a constant speed of rotation, namely 1500 RPM for the British PAL television system. Playing time for the CAV is 36 minutes on each side, and the recording technique enables special effects such as stills (displaying one picture frame at a time) and slow motion to be produced. The other type of disc, the CLV, requires a speed of rotation that decreases inversely proportional with the read-out diameter. Advantage? About one hour/side playing time but continuous operation only — no stills or slow motion. On both types of disc, each rotation coincides with one TV frame. This makes it easier to extract stills of one frame only from the CAV disc. (Currently, the other video disc systems pack in more than one frame for each rotation, making it difficult to extract individual frames, as will be explained later.)

Total scanning time of a complete disc is around 20 seconds, which seems a reasonable rate when searching for, say, part of a recorded film. You should bear in mind that a 12", 36 minute disc contains 54,000 individual frames!

Figure 4. Philips' VLP video disc system

Figure 5. RCA's SelectaVision player with CED disc alongside

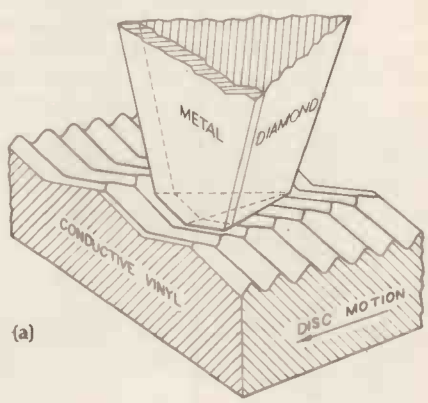
RCA — firmly in the groove

In some respects the CED (capacitance electronic disc) from RCA is similar to an audio record. It is about the same size as an LP (302 mm, or 11.9"), made of plastic and is pressed in a similar manner to records. It also has grooves like a record but here the comparison falls apart. The grooves merely *guide* the stylus over a track containing the software information, and the diamond stylus is a lot smaller than that used for record reproduction.

Master discs for the CEDs are similar to those used in record production, except that they receive a coating of copper, deposited over the groove area. An electromagnetic 'cold' process is used to encode the metal tracks, defined by the grooves, with the software information in the form of a microscopic pattern. From these masters, nickel matrix stampers are produced, ready for use in the production of the CEDs.

When a CED is spun (at 450 RPM) on the SelectaVision player (**Fig. 5**), and the stylus is riding in the groove, information is picked up from the track *capacitively*. Part of the stylus is coated with metal, and it is this area which glides on an electrically-insulated (dielectric) layer in the groove (see **Fig. 6**). As the stylus makes its way along the groove, its tip detects the rapidly changing pattern in the sub-coating of metal. In other words, this pattern, in relation to the metal coating on the stylus, produces a fluctuation in capacitance. This fluctuation in turn produces a change in frequency in an LC (inductive-capacitive) oscillator. (If this seems a bit technical to some of you, then have a look at this month's O Level Q & A, where the effects of connecting inductors and capacitors together are discussed.) The rapidly changing frequency, or frequency modulation (FM) as it is known, is translated by the player into the original software information.

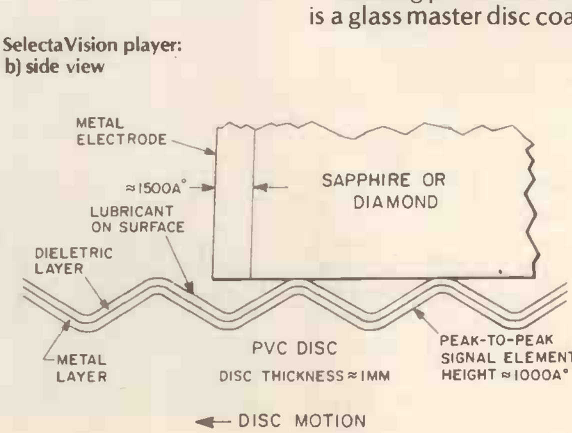
The CEDs provide up to two hours' playing time (one hour on each side), the software consisting at present of colour video and *mono* sound. Stereo sound hasn't been included on the first discs due for release. It is RCA's view that because all the TV's in the USA (where the first launch is due to take place in March 1981) are mono, the provision of stereo would have added unnecessarily to the cost.



(a)

Figure 6. Stylus for SelectaVision player: a) perspective view, b) side view

(b)



Unlike Philips' VLP, the CED is more susceptible to the ingress of dust and harmful particles into its grooves. For this reason, the disc is fully protected inside a plastic caddy. Thus you never actually *touch* the disc, but load the caddy into the player, which retains the disc when the caddy is removed. After playing, you insert the caddy again and — presto — the disc is snug inside its caddy again. According to RCA, the CED is not as vulnerable to dust particles as it first may seem, because the specially-shaped stylus has a cleaning action. Anyway, it was said, the caddy provides more scope for artwork than the cramped area of a record label!

I mentioned earlier the facility of 'freezing' individual frames. SelectaVision offers this, but not for single frames. On the CED, each revolution corresponds to *four* frames, and special techniques such as an electronic memory called a frame store would be required to extract a single frame. At present, frame stores are very costly and bulky. RCA has come to a compromise by freezing a block of four frames at a time, which must result in jitter on moving scenes.

Additional facilities on the SelectaVision include forward and reverse search.

JVC — with an eye to the future

While one disc system is on target for release in the UK towards the end of 1981, it appears that JVC has kept a number of future options in reserve.

Let's have a look at the more tangible one first, comprising the VHD (video high density) and AHD (audio high density) disc system. It should be made clear at the outset that JVC's strategy, unlike that of the other two companies, is to combine video disc and stereo audio disc playback in one player, as will be discussed later.

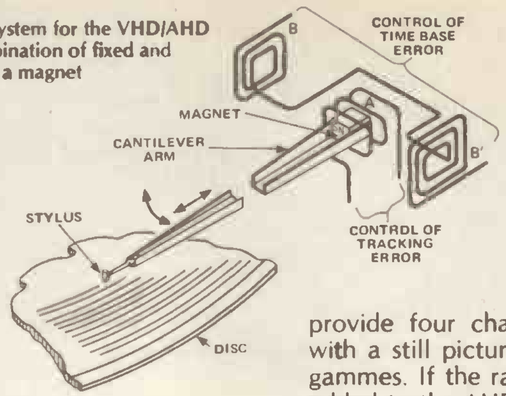
Starting point for a VHD or AHD disc is a glass master disc coated on one side with a photosensitive material. The disc is rotated at 900 RPM while the software information is recorded on its coating in two parallel tracks by the use of two laser beams. One track carries the audio and video (or audio alone) while the other carries the tracking signals. The software is encoded as pits in the photosensitive coating. A metallic master disc is produced from the glass one, for use in a production process similar to that used for LP records.

Now let's look at the VHD or AHD disc, which is flat, grooveless and recorded with a spiral of double tracks. As can be seen in **Fig. 7**, the stylus 'shoe' has a flat tip and glides in contact with the surface of the disc. In common with the RCA system, detection is capacitive. The stylus, which has a metal strip deposited on it, is guided by the tracking pits as shown.

Because the disc is grooveless, some method of holding the stylus precisely on track is necessary. (You will remember that the same problem had to be solved for Philips' VLP system.) **Figure 8** shows how JVC does it. The stylus is mounted at one end of a cantilever pickup arm: the other end of this arm is attached to a magnet. Fixed coils are mounted near the magnet, a single coil is wound around the magnet but not in contact with it and a pair of vertical coils are mounted on either side of the single coil, in phase opposition to each other. Thus the stylus can be moved transversely and longitudinally in response to signal currents in these coils. Currents are produced in response to the tracking error signal, timebase error signal or by a command to move the stylus to a desired track.

Coming back to strategy again, it's

Figure 8. Tracking system for the VHD/AHD stylus, using a combination of fixed and stationary coils and a magnet



worth looking at what the system offers in video and audio modes.

For VHD operation, the player (**Fig. 9**) provides normal play from a 260 mm (10") disc giving two hours' playing time (one hour on each side). Features include fast search, audio channel selection, quick and slow motion and still play, picture-by-picture (back and forth).

To enhance the player's functions, a random access unit based on a microprocessor can be used with it. Facilities provided by this add-on unit include still play of a selected frame, normal, quick and slow motion between selected frames or periods and sequential play of different functions selected by a software program (five steps maximum). It should be borne in mind that because each rotation of the disc corresponds to two frames, jitter may be apparent on still-frame mode unless some method of frame storage is used.

For AHD operation on the other hand, the player is used with a PCM (pulse code modulated) demodulator. This box of tricks enables the system to provide four channels: stereo sound with a still picture or two stereo progammes. If the random access unit is added to the AHD set-up then several search and playback facilities can be selected or programmed. Disc size is the same as the VHD type.

Because a stylus is used to scan VHD and AHD discs, there is a need to keep them 'clean'. For this reason, JVC has, like RCA, opted for protective caddies.

As to the futuristic options, some of these are dependent on technological developments. Take, for example, the frame store. With current integrated circuit technology, an unreasonable number of memory ICs are required to hold a complete TV frame. If the rapid development of IC technology is taken into account then LSI (large-scale integration) could make the frame store a more practical proposition.

Another idea in the JVC crystal ball is a disc made specially for freeze playing. It would enable vast amounts of information to be stored in disc form — typically 45,000 frames on one side of a two-hour disc. An example given by JVC was highly-detailed map information (such as details of houses, street-by-street) for use by the police.

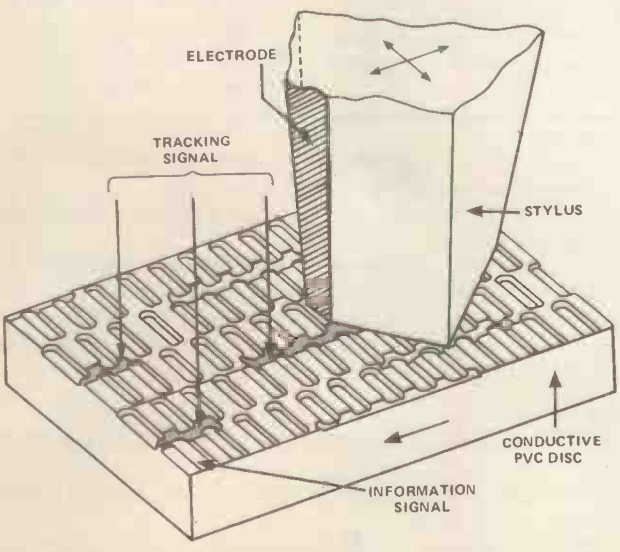


Figure 7. How the JVC stylus scans the double tracks on VHD or AHD discs

Freezing Reality

Apart from problems of jitter associated with still or 'frozen' frames on some of the machines, there is one more related point worth considering, namely that of wear.

Freezing a frame indefinitely on the Philips system results in no wear of the selected track because the only thing touching it is a beam of light. In the other systems, a stylus is in mechanical contact with the disc and so freezing individual frames for long periods could result in premature wear of the associated tracks. But assessment of this wear is difficult, because the styli tend to clear the tracks of debris on the first revolution, running in a relatively clear path after this.

From JVC's tests, without a protective caddy, life of a frozen frame was found to be around one hour. But where the software material put strong demands on freezing (such as for maps)

Figure 9. JVC's player for VHD and AHD discs

then, it was claimed, the disc could be coated with a special lubricant to increase life.

Long live lsd (laser, stylus and disc)!

Theoretically, the Philips disc has an infinite life, but the same is not true of the gas laser. Estimated life was given as 5,000 hours (about six years at 2½ hours playing time every day). No estimate could be obtained of its likely replacement cost. It will, however, need to be fitted by a service engineer.

RCA tests showed that the CED could be played 200 times without deterioration. Stylus life was said to be at least 200 hours. The stylus will be 'quite moderate' in price and will be simple to change by the user.

Estimated life of a VHD or AHD disc was given by JVC as about 10,000 runs. Stylus life was said to be about 2,000 hours, and it was claimed to be easy to change.

Your choice . . . eventually

When will you see these systems on sale in the UK, and how much will they cost?

At the time of writing (mid October) only Philips could be specific about a release date, namely May/June 1981. Cost was estimated at £450 to £500 (including VAT) for the player. Philips' spokesman found it difficult to estimate the cost of the discs because they will not be sold under Philips' name and the final cost will depend largely on the recorded material. An 'average' price could be £15.

As mentioned earlier, the first launch of the RCA system is planned for March 1981 in the USA. It was estimated that the system could reach the UK market by 'early 1982'. No indication was given of the likely cost, and it will, of course, be a system with *mono* sound. A stereo version is planned for 1982 in the USA, but it's anybody's guess when we'll see it here.

A UK licence for SelectaVision is held by GEC, but no improvement could be made on the above information by the UK company. According to Ron Bosanko, managing director of GEC's radio and TV division, when talking about the various systems said: 'The RCA one looked the most interesting'. But he saw the availability of software as being the biggest hurdle.

An agreement has been established between JVC in Japan and Thorn/EMI in the UK. But no date could be obtained from the UK company, only an 'end of 1981' estimate. It is understood that this may be firmed up by the end of October 1980. As for the cost, this was estimated as being about £300, presumably for the basic VHD/AHD player alone. Cost of discs is likely to be between £10 and £20, depending on the subject matter.

Hardening-up the software

Now the subject matter — the software — may indeed be a hurdle. The Philips' spokesman said: '120 titles will be available from day one', this being increased to 250 by Autumn 1981.

RCA, on the other hand, plans to have 'hundreds of titles at launch', according to its spokesman.

The JVC estimate — from Thorn/EMI — was given as 200 titles.

And what will be the composition of the software? Mostly, it seems, popular cinema-type films. It seems feasible that latest, or very recent, releases will cost more. It is also likely that a range of educational discs will be available, particularly for 'freeze' operation and other special effects.

Competition

It is difficult to estimate, at this early stage, how each company will fare on the UK market. No doubt by 1982 there will be other contenders, particularly from Japan. We have got used to cassette systems, and some at least are getting cheaper: cassette software has certainly come down in price.

Cassettes offer what video discs can't: playback and *record*. So this is obviously going to be one of the main areas of competition — and barriers of public acceptance to break through. Some of the cassette systems are getting very clever; for instance the ¼" mini cassette system from Technicolor.

Likely to be confusing are the different philosophies of the disc manufacturers. Take RCA for instance: a straightforward video version of the long-accepted LP record at, we hope, a reasonable cost. Meanwhile, Philips plans to launch the VLP but, probably some time in 1982, it aims to launch a *separate* audio disc system. This will be known as the ALP (audio long play) disc. It works on similar principles to the VLP but will take smaller audio-only discs about the size of 45 RPM records. And, as described earlier, JVC is going for the all-in-one video/audio package but with the need for additional boxes of electronics for stereo operation and special effects.

But don't be confused! Assess these systems as they appear, especially in terms of whether they meet *your* needs. **HE**

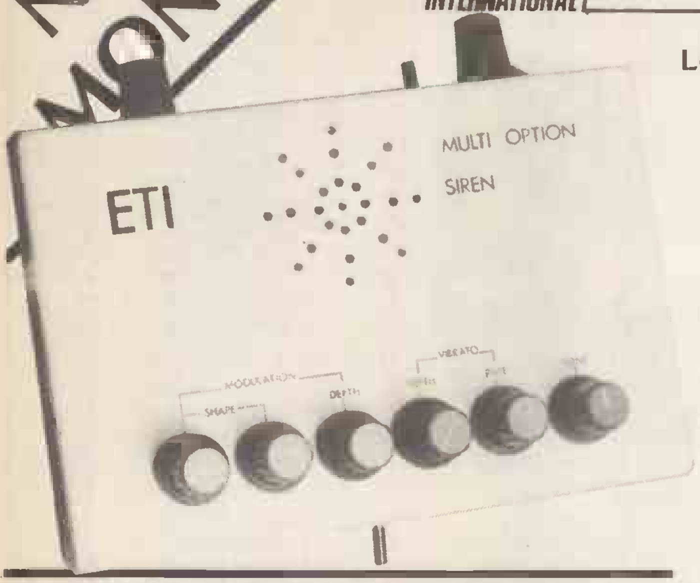
Video Cassettes
VHS (developed by JVC) — most widely available in the UK
Betamax (Sony) — second in the popularity league
VCR, VCRP, VC2000 (Philips) — although of a high standard, relatively less software is available in UK
U-matic — similar to VHS and Betamax but larger-sized and generally used in semi-professional application (such as for tape mastering)
VCR (Technicolor — not to be confused with Philips' VCR) — recently announced and uses ¼" colour video tape, compared with normal ½" tape. (See special report in this months' Monitor)

Video Discs
VLP (Philips) — grooveless disc with spiral pitless tracks scanned by helium-neon gas laser
SelectaVision (RCA) — disc cut with grooves and scanned capacitively by diamond stylus
VHD and AHD (JVC) — grooveless disc with spiral tracks of micropits scanned capacitively by flat-ended shoe-type stylus

NEXT MONTH

electronics today INTERNATIONAL

Look out for the January issue on sale December 5th



MULTI-OPTION SIREN

You can build a circuit that sounds like Kojak on his way to the lollipop store; you can knock up a little black box to make a few sci-fi sound effects; you can probably even find a device to imitate a trimphone. But our Multi-Option Siren does it all. This versatile box of tricks gives you full control of tone, vibrato and shape modulation and vibrato depth and rate. That little lot offers almost limitless combinations of sounds. As if that wasn't enough, you can also select ramp or pulse output.

DIGITAL TACHO/OVER-REV INDICATOR

Keep track of your revs with the ETI Digital Tacho and Over-Rev Indicator. Watch the revs climb the LEDs in two ranges up to a maximum of 10,000 RPM. Set the rev limit of your choice. When you exceed it, the display flashes *and* continues to give a true read-out — suitable for most makes of cars with four, six or eight cylinders.

FM TUNER

This attractive FM Tuner, built around the 7254 tuner module from Ambit, has been designed to match the popular Audiophile 4000 Amplifier. It offers switch selectable muting, AFC and mono/stereo. The 200 mV output can be fed directly to the input of any stereo audio preamplifier. Tuning is selected by switch or by a conventional rotary control. The design also incorporates a search and lock facility to find strong FM broadcasts in the 87.5 to 104.5 MHz band.

And that's not all — the unit is fitted with a 20-LED tuning indicator, a 10-LED signal strength meter and there's provision for an optional 10-LED stereo audio level indicator.

PULSE GENERATOR

Our battery operated delay/tone burst generator is an accurate and reliable piece of test gear, offering tone burst, pulse positive and pulse negative outputs. It features three clock generator ranges, six pulse delay ranges (from nanoseconds to milliseconds), six pulse width ranges (also from nanoseconds to milliseconds) and three tone ranges covering 1 Hz to 1 MHz in decade steps.

ELECTRONICS IN PHOTOGRAPHY

Microminiature electronic circuits and microprocessors — they've found their way into most aspects of work and play. Photography is no exception. Next month we look at what has happened to the humble 35 mm camera. You'll be amazed at what the manufacturers can pack into its compact frame.

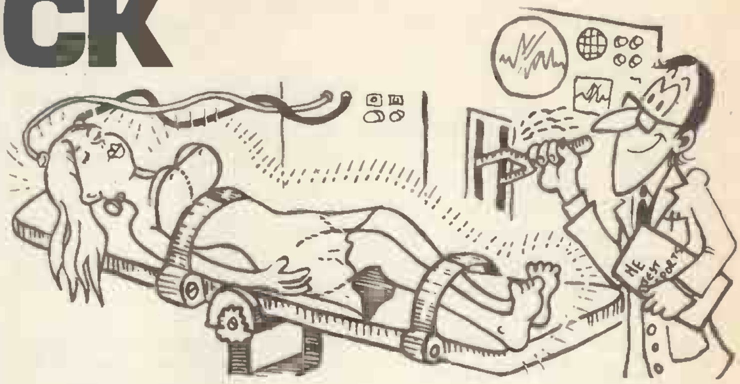
GENERAL PURPOSE TIMER

Whether you want to time an egg or find out how long it takes to read ETI from cover to cover, our General Purpose Timer can solve your problem. There are two ranges — 1 to 10 minutes and 10 to 100 minutes. The relay output will handle up to 10 A. With the flick of a switch you can select timed make or timed break, with a neon indication of the output state — an economical project with a whole host of applications around the home and workshop.

Articles described here are in an advanced state of preparation. However, circumstances may dictate changes to the final contents.

Clever Dick

This month we have a couple of letters from our overseas readers, perhaps we should call our magazine Hobby Electronics International!



OUR NEW SERIES 'O level Q & A has turned out to be something of a winner with school students studying the course. Here's a typical letter from a definite candidate for this month's free binder.

Dear Dick,
Congratulations to HE on the marvellous new series 'O level Q & A'. Although I am only doing Physics 'O' level I am very keen on electronics, as are quite a few other pupils at my school, (Warren Comprehensive). Congratulations on two very fine electronics magazines and of course Computing today.
Neil Churchill
Romford
PS. On a measley pocket money budget of only 50 pence a week I cannot afford a binder, and after all those compliments I must deserve one ..... mustn't I? .... Yes? ..... Thanks!

How can I refuse such sincere grovelling, a binder is on its way Neil. Now to more pressing matters. As I've mentioned once or twice in the past, HE ends up in some pretty far away places: here's a plaintive plea from Spain. I've left in the original spelling, not to make fun but to show you the sort of letters we get from our overseas readers. Indeed this gentleman can write English better than we can wright Spanish (our English is questionable too!)

Dear CD,
My father bourth a TV set (PYE model 4219/1) in Ingland and it broak here in Span, here they can't repair it so I aske you:
— could you sen me the circuit diagram of the TV set
— please tell me how much a heve tu pay for the diagram (I could send you Spanish mony or international reply coupons) tell me the amount and which way you prefer me to.
Manuel Barrera Cobacho
Madrid 19 Spain.

We must be a soft touch, as we have sent Manuel the diagram. How about one of you lot writing to Manuel? Drop us a line and we'll send his address to you.

Still in foreign parts our next letter comes from South Africa. Young Ant Brink has a useful modification for one of our projects.

Dear Dick
I've thought up an alternative use for your Movement Alarm (HE August '80), which could be a boon to anyone, who like myself, regularly sleeps through the ringing of an alarm clock. What it entails is this — place the Movement Alarm near the alarm clock (having connected the relay between your radio and its battery). Turn the radio on with the volume set above normal. When the alarm rings it will switch the radio on and if it is loud enough it should prevent you from dozing off again. You could install a simple jack socket on the side of the radio so that the Movement Alarm can be plugged in only when needed, the radio can then be used at other times.
Ant Brink
Pietermaritzburg
South Africa

Sounds OK to me, any other bright ideas for modifying or using our projects in unusual ways? Tee-shirts to the senders of the best suggestions.

Here's a cautionary tale from David Wilkins: beware of dusting digital devices!

Dear Dickey,
Help please! Due to over enthusiastic dusting by my girlfriend, my home built digital clock is now very dead. It used an older clock IC, the CT7001 (7445), which is no longer available.
I would like to use the six FND500 displays, so can you recommend an up-to-date clock IC which is compatible with the '500s and gives a 24 hr, hr's, minutes and seconds output. I realise that you get lots of letters so any quick reply would be fine, even just a note on the IC number would do.
David Wilkins
Harrow Weald.

I'm afraid it doesn't look too promising for you David, most IC manufacturers have moved over to 4-digit multiplexed displays. This means that your 'venerable' FND 500s are somewhat redundant, as far as clocks are concerned anyway. As a suggestion why not try Marshalls Ltd, they have a reputation of finding old or obscure semiconductors — they might even be able to come up with a C7001. If all else fails you'll just have to build yourself a four-digit clock or buy one (you can find cheap ones for around £8.00 these days). You would be hard pressed to build one that cheaply!

Now for something a little closer to home. Mr Briggs wants details of the cases we've used on a couple of recent projects.

Dear Clever Dick
Initially I must congratulate HE for bringing out such a brilliant mag. I have every copy to date, keep up the good work. Now for the crunch:-could you please tell me what cases were used for the Bench

PSU (Sept '80) and the Intruder Alarm (Oct '80). They both look the same, could you please tell me who supplies them?
Mr P Briggs
West Yorkshire.

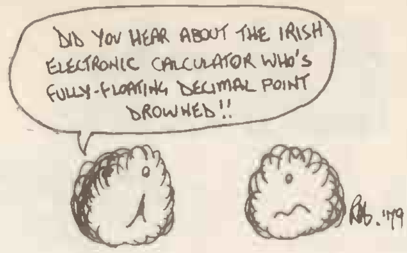
Actually they're not the same. The PSU case comes from Watford Electronics, and is called the PW3 and costs £2.95. The Alarm case comes from Marshals: ask for the RB2, this costs just £2.00.
Time now for a couple of quickies.

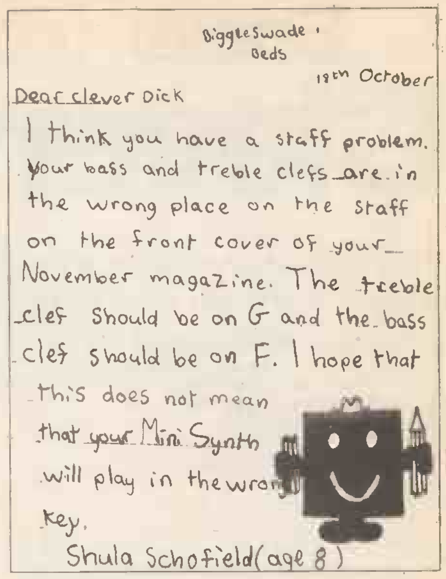
Where can I get the 7555 IC used in the Radio Timer project in the August '80 issue.
Ian Woods
Wigan.

Watford Electronics of course.

Where can I get a service sheet for the Cossor 339A Oscillograph.
N Vaswaney
London

Try Austrec Ltd, 76 Church Road, Larkhall, Lanarkshire ML9 1EH.




Biggleswade,
Beds
19th October
Dear clever Dick
I think you have a staff problem. your bass and treble clefs are in the wrong place on the staff on the front cover of your November magazine. The treble clef should be on G and the bass clef should be on F. I hope that this does not mean that your Mini Synth will play in the wrong key.
Shula Schofield (age 8)

The letter from Shula Schofield. Is the gentleman in the bottom right-hand corner, our Art Editor in disguise?

Just before I depart I thought you might like to see this letter from young Shula Schofield. Not only does she know more about music than our Art Editor the illustration in the bottom right hand corner of her letter bears a remarkable resemblance to the gentleman concerned. Thanks to Shula for her note and we're sending the Art Editor back to school for music lessons.

The end of the page has caught up with me once again. Before I drop off the bottom of the page just let me remind you that I cannot reply personally to your letters unless it really is a matter of life and death. In that case you should include a note from your doctor and an SAE and I'll do my best. See you next month. **HE**

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Battery Charge Monitor

Is your battery flat? Find out what shape it should be with this clever car project from HE

ONE WAY to discover that your car battery is not holding its charge, or is not being charged properly is to try to start the car and find that you can't! A better method is to use the HE Battery Charge Monitor which has five LEDs to indicate the battery voltage. These switch on at voltages of 10, 11, 12, 13, and 14 V, and give warning of a faulty battery or charge circuit before the electrical system simply gives out.

How it Works

As reference to the circuit in Fig. 1 will show, the use of a bargraph driver device (IC1) permits an extremely simple circuit to be used. The internal circuitry of the U237B bargraph driver device consists of five comparators each driving an output transistor, and a stable multi-voltage reference source which feeds the comparators with individual input voltages of 0.2, 0.4, 0.6, 0.8 and 1 V. The other input of each comparator is connected to pin 7 of the device. Integrated circuit IC1 also contains a 20 mA constant current source which has its output at pin 6 and feeds the series of five LEDs. However, the latter do not normally switch on as they are short-circuited by the output transistors of IC1; one transistor for each LED.

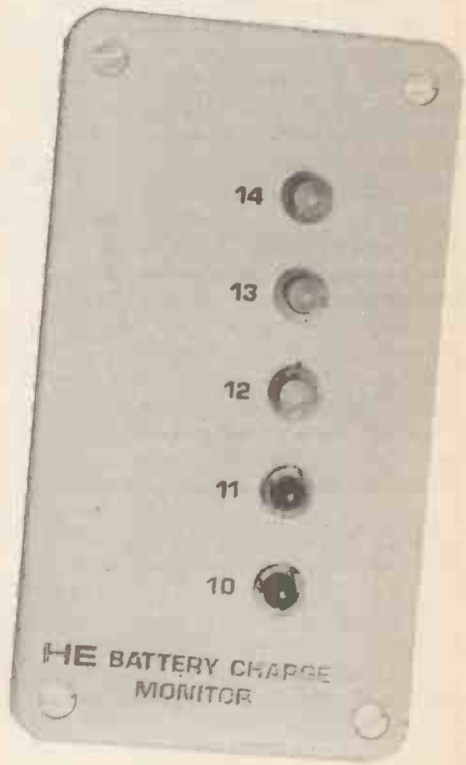
If the voltage at pin 7 of IC1 is taken above 0.2 V, one of the comparators changes output state, switching off its output transistor and removing the short circuit across LED1 so that this device can switch on. Raising the input voltage above 0.4 V has a similar effect with the short being removed from LED2 so that this device switches on. In the same way, raising the input voltage above 0.6, 0.8, and 1 V results in LED3 to LED5 switching on.

About 9 V is dropped across ZD1, and the voltage developed across R1 is therefore the supply voltage minus 9 V. Resistors R2 and RV1 form an attenuator that reduces this voltage further by a factor of five. Thus a 10 V input gives 0.2 V at the input to IC1 ($10-9=1$, $1\div5=0.2$), and a 14 V supply gives a 1 V input to IC1 ($14-9=5$, $5\div5=1$). The LED threshold voltages are therefore converted to the appropriate supply voltages.

A single-IC bargraph voltmeter forms the heart of the monitor, sensing the car battery voltage level and driving the LEDs directly. The use of this IC, the U237B, makes this project easy to build and cheap — ideal for beginners and non-beginners alike.

Construction

Figure 2 shows the layout for the battery monitor, and it uses one of our standard 10 x 24 hole Veroboards. Make the breaks in the copper strips at the places indicated in the underside view of the board before soldering the components and link wires into place. The breaks can be made using the standard Veroboard cutting tool, or a ⅛" drill bit (hand held). Twist the tool clockwise, until the copper is broken in a clean circle and make sure that no loose bits of swarf bridge adjacent strips. Be careful to connect IC1 and ZD1 with the correct polarity, especially IC1 which cannot easily be removed from the board once soldered in place. Better still — use an IC socket!



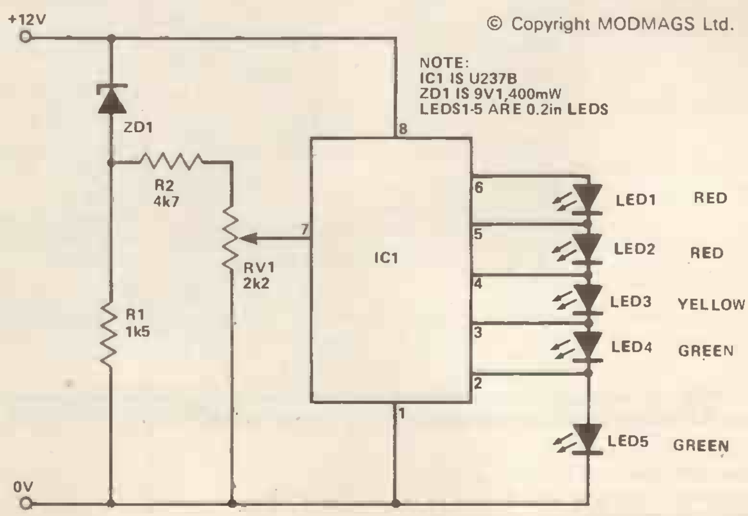


Figure 1. Circuit diagram of HE Battery Charge Monitor with suggested range of coloured LEDs

The five LEDs are mounted off-board, and are fitted on the front panel of the unit. Short insulated multistrand leads are used to connect the display to the component board. Practically any small metal or plastic case should comfortably accommodate the unit. Alternatively, you may wish to mount the whole circuit behind the dash panel of your car, making a neat built-in display.

As the current consumption of the unit is only about 25 mA the unit could be connected direct across the battery terminals since this current is negligible when compared to the capacity of a car battery, but you may prefer to connect the unit via the ignition switch. Whichever method is chosen, it is advisable to include an in-line fuse holder in the supply lead. A 100 mA fuse is recommended for this purpose.

The best way to adjust RV1 for correct setting is to first connect the Battery Monitor to an accurate 12 V source, and then turn RV1 just far enough clockwise to cause LED3 to switch on. Alternatively, the unit can be connected to a battery that is known to be reasonably well charged, and RV1 is then adjusted just far enough clockwise to cause LED4 to switch on. In use there should never be less than one LED switched on if the battery and charging circuit are satisfactory, and never less than two LEDs when the battery is unloaded.

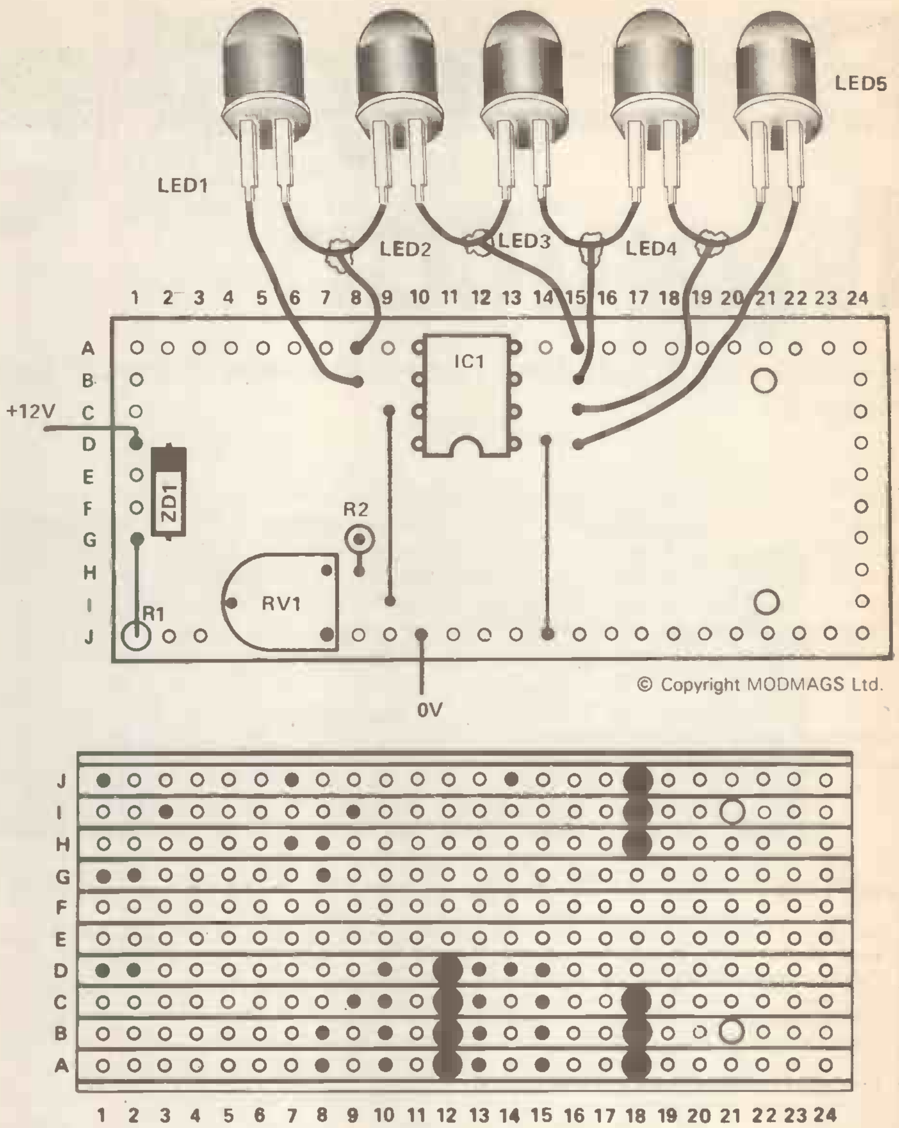
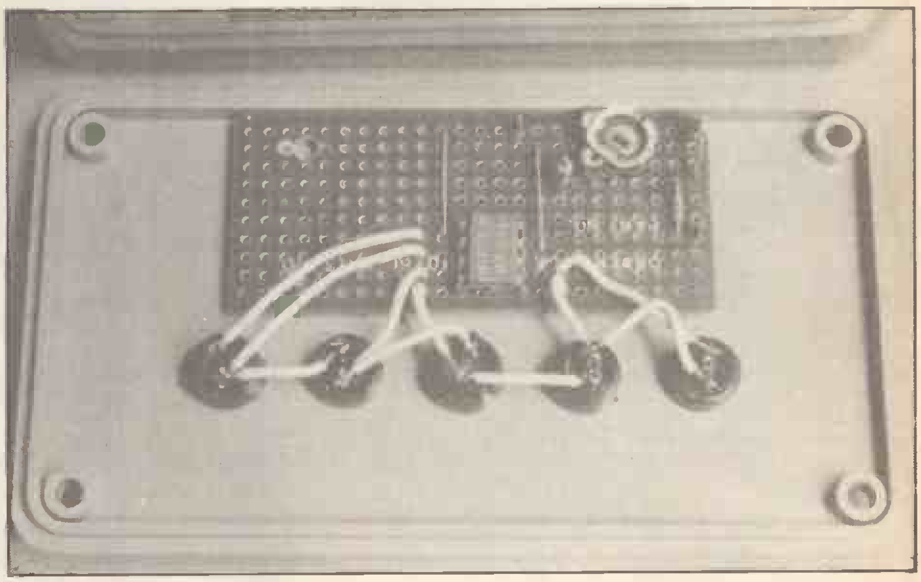


Figure 2. Verboard overlay (above) and the underside track layout showing the necessary track-breaks



Parts List

RESISTORS (All ¼ W, 5%)	
R1	1k5
R2	4k7
POTENTIOMETER	
RV1	2k2 miniature horizontal preset
SEMICONDUCTORS	
IC1	U237B
ZD1	9V1 400 mW zener diode
LED1 to 6	0.2in LEDs (various colours)
MISCELLANEOUS	
10 strip by 24 hole Veroboard	
case to suit.	

Buylines

IC1 is available from Ambit International, a regular advertiser in HE. No other component will cause any difficulty.

Approximate cost of all parts (excluding case) should be no more than £4.50.

HE

BI-PAK

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BOOK NO	DESCRIPTION	£ p
BP6	Engineers & Machinists Ref. Tables	0.75
BP14	2nd Book Transistor Equivs & Subs	1.10
BP24	52 Projects Using IC741 (or equiv)	0.95
BP26	Radio Antenna Book Long Distance Reception & Transmission	1.00
BP27	Giant Chart of Radio Electronic Semi-conductor & Logic Symbols	0.60
BP32	Build Metal & Treasure Locators	1.00
BP34	Practical Repair & Renovation of Colour TVs	1.25
BP35	Handbook of IC Audio Preamplifier	1.25
BP36	50 Ccts use Germ/Sil/Zener Diodes	0.75
BP37	50 Projects using Relays/SCRs/Triacs	1.25
BP39	50 Field Effect Trans Projects	1.25
BP40	Digital IC Equivs & Pin Connection	2.50
BP41	Linear IC Equivs & Pin Connection	2.75
BP43	How to make Walkie Talkies	1.50
BP44	ICC555 Projects (Revised & Enlarged Edition)	1.75
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BP48	Electronics Projects for Beginners	1.35
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BP52	Long Distance Television Reception (TV-DX) For the Enthusiast	1.95
BP53	Practical Electronic Calculations & Formulae	2.25
BP55	Radio Stations Guide	1.45
BP56	Electronic Security Devices	1.45
BP57	How to Build Your Own Solid State Oscilloscope	1.50
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BP62	Elements of Electronics — Book I	2.25
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BP65	Single IC Projects	1.50
BP66	Beginners Guide to Microprocessors & Computing	1.75
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BP68	Choosing & Using your Hi-Fi	1.65
BP69	Electronic Games	1.75
BP70	Transistor Radio Fault-Finding Chart	0.50
BP160	Coil Design & Construction Manual	0.75
BP202	Handbook of Integrated Circuits Equivs & Substitutes	1.00
BP211	First Book of Diode Characteristics & Equivalents & Substitutes	1.25
BP213	Electronic Circuits for Model Railways	1.00
BP215	Shortwave Circuits & Gear for Experimenters & Radio Hams	0.85
BP221	28 Tested Transistor Projects	1.25
BP224	50 CMOS IC Projects	0.95
BP226	Build Advanced Short wave receivers	1.20
BP227	Beginners Guide to Building Electronic Projects	1.25
RCC	Resistor Colour Code Disc	0.20

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Right-angle mounting brackets Ideal for mounting, PCB, panels et cetera into boxes and cases.
18SWG — Mild steel — short face has slotted hole 6.5cm x 3.7cm long face has 3.7cm diam. hole

O/NO:1726	Height 15cm, length 15cm, width 10cm	£0.06
O/NO.1727	Height 25cm, length 15cm, width 10cm	£0.07

SWITCHES

Description	No.	Price
DPDT miniature slide	1973	£0.16
DPDT standard slide	1974	£0.17
Toggle switch SPST 1½ amp 250V ac	1975	£0.38
Toggle switch DPDT 1 amp 250V ac	1976	£0.48
Rotary on-off mains switch	1977	£0.58
Push switch — Push to make	1978	£0.16
Push switch — Push to break	1979	£0.21

ROCKER SWITCH

A range of rocker switches SPST — moulded in high insulation material available in a choice of colours ideal for small apparatus

Colour	No.	Price
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BLACK	1981	£0.35
WHITE	1982	£0.35
BLUE	1983	£0.35
YELLOW	1984	£0.35
LUMINOUS	1985	£0.35

Description	No.	Price
Miniature SPST toggle 2 amp 250V ac	1958	£0.81
Miniature SPST toggle 2 amp 250V ac	1959	£0.86
Miniature DPDT toggle 2 amp 250V ac	1960	£0.92
Miniature DPDT toggle centre off 2 amp 250V ac	1961	£1.09
Push-button SPST 2 amp 250V ac	1962	£1.04
Push-button SPST 2 amp 250V ac	1963	£1.09
Push-button DPDT 2 amp 250V ac	1964	£1.38

MIDGET WAFER SWITCHES

Single bank wafer type — suitable for switching at 250V ac 100mA or 150V dc in non-reactive loads make-before-break contacts These switches have a spindle 0 25 in dia and 30 indexing

Description		No.	Price
1 pole	12 way	1965	£0.55
2 pole	6 way	1966	£0.55
3 pole	4 way	1967	£0.55
4 pole	3 way	1968	£0.55

MICRO SWITCHES

	No.	Price
Plastic button gives simple 1 pole change over action Rating 10 amp 250V ac	1970	£0.29

ANTEX IRONS

1943	15 watt iron element ceramic fitted with 3/32" bit	£6.12
1947	Replacement element for 1943 iron	£2.33
1944	Iron coated bit 3/32" for 1943 iron	£0.58
1945	Iron coated bit ⅛" for 1943 iron	£0.58
1946	Iron coated bit 3/16" for 1943 iron	£0.58
1948	General purpose 18 watt iron fitted with iron coated bit	£5.12
1952	Replacement element for 1948 iron	£2.22
1949	Iron coated bit 3/32" for 1948 iron	£0.58
1958	Iron coated bit ⅛" for 1948 iron	£0.58
1951	Iron coated bit 3/16" for 1948 iron	£0.58
1931	Highly popular X 25 25 watt quality iron ceramic shafts to provide near perfect insulation breakdown voltage of 1500 volts AC and a leakage current of only 3.5uA and another shaft of stainless steel to ensure strength	£5.12
1935	Replacement element for 1931 iron	£2.00
1932	Iron coated bit ⅛" for 1931 iron	£0.58
1933	Iron coated bit ⅛" for 1931 iron	£0.58
1934	Iron coated bit 3/32" for 1931 iron	£0.58
1953	SK1 kit contains 15 watt iron with a 3/16" bit plus two spare solder, heat-sink and a booklet 'How to solder', in presentation display box	£7.28

VEROBOARD

2201	2.5"×5" .1 Copper	£0.71	2211	2.5"×2.5" .15 Copper	£0.63
2201	2.5"×3.75" .1 Copper	£0.61	2212	3.75"×17" .15 Copper	£2.39
2203	2.5"×17" .1 Copper	£2.14	2213	3.75"×5" .15 Copper	£0.90
2205	3.75"×3.75" .1 Copper	£0.71	2217	3.75"×17.9" .1 Plain	£1.79
2206	3.75"×17" .1 Copper	£2.76	2218	3.75"×2.5" .1 Plain	£0.44
2207	4.75"×17.9" .1 Copper	£3.61	2219	5"×3.75" .1 Plain	£0.68
2208	2.5"×1", 5 in pack	£0.85	2223	2.5"×5" .15 Plain	£0.37
2204	3.75"×5" .1 Copper	£0.79	2225	5"×3.75" .15 Plain	£0.56
2210	2.5"×5" .15 Copper	£0.64			

BIB HI-FI ACCESSORIES

806	J	Compact tape head cleaning kit	£1.22
810	23	Tape Editing kit	£2.65
811	24	Cassette Tape editing and joining kit	£2.76
813	29A	Salvage cassette	£0.51
814	31	Cassette Head cleaning tape	£0.71
817	36A	Record & Stylus cleaning kit	£0.46
818	41	8-track Cartridge tape head cleaner	£1.24
819	42	Groove Kleen auto metal record cleaner	£2.65
826	52A	Cassette storage tray (holds 10)	£0.92
827	53	Hi-Fi stereo test cassette	£3.17
829	60	Chrome finish 'Groove Kleen' (plastic)	£2.12
834	69	Anti-static Hi-Fi cleaning liquid	£0.35
838	78	Cassette hand tape winder	£1.50

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Entirely new range of connectors for Discrete wire Uniquely designed Wirepost is soldered to the P.C. Board. A pre-stripped wire is inserted into the connector and easily locked by pressing the housing down. The wire is alternatively removed by lifting the housing Tin alloy plated contacts ensure good as gold performance

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1728	Single connector in red/black or white	£0.12 inc VAT
1729	Threeway connector black ONLY	£0.23 inc VAT
1730	Fourway connector black ONLY	£0.28 inc VAT

FUSE HOLDERS AND FUSES

Description	No.	Price
20mm × 5mm chassis mounting	506	£0.18
1¼in × ¼in chassis mounting	507	£0.14
1¼in car inline type	508	£0.18
Panel mounting 20mm	509	£0.23
Panel mounting 1¼in	510	£0.37

QUICK BLOW 20mm

Type	No.		Type	No.		Type	No.	
150mA	611	7p	1A	615	6p	3A	619	6p
250mA	612	6p	1.5A	616	7p	4A	620	10p
550mA	613	6p	2A	617	6p	5A	621	6p
800mA	614	8p	2.5A	618	7p			

ANTI-SURGE 20mm

Type	No.	Type	No.	Type	No.
100mA	622	1A	625	2.5A	628
250mA	623	2A	626	3.15A	629
500mA	624	1.6A	627	5A	630

All 8p each

QUICK-BLOW 1¼in

Type	No.	Type	No.	Type	No.
250mA	631	500mA	632	800mA	634

All 8p each

Type	No.	Type	No.	Type	No.
1A	635	2.5A	638	4A	641
2A	637	3A	639	5A	642

All 7p each

NUTS AND BOLTS

BA BOLTS — packs of BA threaded cadmium plated screws slotted cheese head Supplied in multiples of 50

Type	No.	Price	Type	No.	Price
1in 0BA	839	£1.38	½in 4BA	846	£0.37
½in 0BA	840	£0.86	¼in 4BA	847	£0.29
1in 2BA	842	£0.75	1in 6BA	848	£0.46
½in 2BA	843	£0.52	½in 6BA	849	£0.24
¼in 2BA	844	£0.60	¼in 6BA	850	£0.29
1in 4BA	845	£0.51			

BA NUTS — packs of cadmium plated full nuts in multiples of 50

Type	No.	Price	Type	No.	Price
0BA	855	£0.83	4BA	857	£0.35
2BA	856	£0.55	6BA	858	£0.28

BA WASHERS — flat cadmium plated plain stamped washers supplied in multiples of 50

Type	No.	Price	Type	No.	Price
0BA	859	£0.16	4BA	861	£0.14
2BA	860	£0.14	6BA	862	£0.14

SOLDER TAGS — Hot tinned supplied in multiples of 50

Type	No.	Price	Type	No.	Price
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2BA	852	£0.32	6BA	854	£0.25

AUDIO LEADS

No.	Type	Price
107	FM indoor Ribbon Aerial	£0.69
113	3 5mm Jack plug to 3 5mm Jack plug Length 1 5m	£0.86
114	5 pin DIN plug to 3.5mm Jack connected to pins 3 & 5 Length 1 5m	£0.98
115	5 pin DIN plug to 3 5mm Jack connected to pins 1 & 4 Length 1 5m	£0.98
116	Car aerial extension Screened insulated lead Fitted plug and socket	£1.44
117	AC mains connecting lead for cassette recorders and radios 2 metres	£0.78
118	5 pin DIN phono plug to stereo headphone Jack socket	£1.21
119	2+2 pin DIN plugs to stereo Jack socket with attenuation network for stereo headphones Length 0 2m	£1.04
120	Car stereo connector Variable geometry plug to fit most car cassettes 8-track cartridge and combination units Supplied with inlined fuse power lead and instructions	£0.69
123	6 6m Coded Guitar Lead Mono Jack plug to Mono Jack plug Black	£1.73
124	3 pin DIN plug to 3 pin DIN plug Length 1 5m	£0.86
125	5 pin DIN plug to 5 pin DIN plug Length 1 5m	£0.86
126	5 pin DIN plug to Tinned open end Length 1 5m	£0.86
127	5 pin DIN plug to 4 Phono Plugs All colour coded Length 1 5m	£1.50
128	5 pin DIN plug to 5 pin DIN socket Length 1 5m	£0.92
129	5 pin DIN plug to 5 pin DIN plug mirror image Length 1 5m	£1.21
130	2 pin DIN plug to 2 pin DIN inline socket Length 5m	£0.78
131	5 pin DIN plug to 3 pin DIN plug 1 & 4 and 3 & 5 Length 1 5m	£0.95
132	2 pin DIN plug to 2 pin DIN socket Length 10m	£1.13
133	5 pin DIN plug to 2 Phono plugs Connected pins 3 & 5 Length 1 5m	£0.86
134	5 pin DIN plug to 2 Phono sockets Connected pins 3 & 5 Length 23cm	£0.78
135	5 pin DIN socket to 2 Phono plugs Connected pins 3 & 5 Length 23cm	£0.78
136	Coded stereo headphone extension lead Black Length 6m	£2.01
178	AC mains lead for calculators, etc	£0.52

TRANSFORMERS

MINIATURE MAINS Primary 240V

No.	Secondary	Price
2021	6V-0-6V 100mA	£1.04
2022	9v-0-9v 75mA	£1.04
2023	12V-0-12V 100mA	£1.29

MINIATURE MAINS Primary 240V
with two independent secondary windings

No.	Type	Price
2024	MT280-0-6V 0-6V RMS	£1.84
2025	MT150-0-12V 0 12V RMS	£1.84

1 AMP MAINS Primary 240V

No.	Secondary	Price	
2026	6V-0-6V 1 amp	£2.88	P & P 45p
2027	9V-0-9V 1 amp	£2.30	P & P 45p
2028	12V-0-12V 1 amp	£2.89	P & P 55p
2029	15V-0-15V 1 amp	£3.16	P & P 66p
2030	30V-0-30V 1 amp	£3.97	P & P 86p

STANDARD MAINS Primary 240V

Multi tapped secondary mains transformers available in ½ amp 1 amp and 2 amp current rating Secondary taps are 0 19 25 33-40 50V Voltages available by use of taps, 7, 8, 10 14 15 17 19, 25 31, 33 40 25-0 25V

No.	Rating	Price	
2031	½ amp	£3.91	P & P 86p
2032	1 amp	£5.06	P & P 86p
2033	2 amp	£6.27	P & P 11
2035	240V Primary 0-55V @ 2A Secondary	£7.30	P & P 11

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INSTRUMENT CASES. In two sections vinyl covered top and sides aluminium bottom front and back

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156	11in	6in	3in	£3.10
157	6in	4¾in	1¾in	£1.93
158	9in	5¼in	2¼in	£2.59

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160	4in	4in	1½in	£0.98
161	4in	2¼in	1½in	£0.98
162	5¼in	4in	1½in	£1.10
163	4in	2½in	2in	£0.98
164	3in	2in	1in	£0.67
165	7in	5in	2½in	£1.54
166	8in	6in	3in	£1.98
167	6in	4in	2in	£1.32

SLOPE front aluminium boxes with black vinyl base and sides & aluminium back top & front — strong construction easily accessible

169	2¼in	5¾in	2¼in	12in	3½in	8in	£8.21
168	2¾in	2¼in	4in	16in	4½	11in	£5.45

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GIRO A/C No 3887006

What's In A Name

Our subject this month is Opto-Electronics. Rick Maybury makes light work of this particular branch of electronics

IF YOU THINK ABOUT IT all of our so-called five senses can be duplicated in one way or another by electronic systems and components. Admittedly some are more successful than others: taste and smell for instance can be duplicated with a process known as chromatography and gas ionisation. A chromatograph as sensitive as the human nose or palate would be several times larger than its human counterpart. In contrast touch, sight and hearing using electronics can be many times more efficient and in the case of sound and light, sensitive to a greater variation of amplitudes and frequencies than our own ears and eyes.

In the next few months we shall be looking at some of the electronic systems and components that respond to the same stimuli as we do, namely sight, sound, touch, taste and smell. To get the ball rolling we're going to look at the field of opto electronics, devices that respond to or produce light.

Light Work

The very first man-made detector of light was developed as long ago as 1839. Unfortunately all we know about this device is the name of the inventor — Becquerel — and that it used selenium for the cell. The first documented experiments into opto-electronics are dated 1873 when a gentleman called Willoughby-Smith read a paper based on Becquerel's work to the Institute of Electrical Engineers. This paper gave details of the photoconductive properties of selenium. The first practical application of the photoconductive cell came in 1878 when Dr Alexander Graham Bell demonstrated a device called the Photophone. It used a selenium photoconductive cell to detect the variations in amplitude of a modulated light beam. This technique of sending messages over beams of light has only recently become a practical proposition with the advent of lasers and fibre optics but as we have seen so many times before, there really is nothing new under the sun!

Today opto-electronics covers a vast section of the science of electronics, encompassing everything from solar cells on satellites to LED displays on clocks and watches. Broadly speaking there are three basic applications of opto-electronic devices: to detect the presence or absence of light, to convert light energy into electrical energy and to produce light.

Photoconductive effect

As its name implies, photoconductivity involves a change of resistance in a material when it is exposed to light. Many materials exhibit this property — we use photoconductive cells or light dependent resistors (LDRs) in all sorts of places. The most familiar application is in photography where the LDR measures light intensity to help the photographer choose the correct speed and aperture. Less well known is the use of photoconductive cells in television cameras where a large flat photoconductive cell is placed behind the lens of the camera. An electron beam 'scans' the cell or target and a voltage proportional to the amount of light falling on the target is delivered to all the electronic gubbins that transmits the TV signal. In the case of a simple LDR, in a camera for instance, a material known as cadmium sulphide or CdS is used as this responds to light over a wide range of frequencies and light levels. The operation of LDRs is rather too complicated for us to deal with in such a limited space (we don't really understand them either). Suffice it to say that the effect relies upon a photon (particle of light) creating what is known as an electron-hole pair within the structure. This electron-pair combination is known as a charge carrier and will lower the electrical resistance of the material. So much for photoconductivity, now on to the photovoltaic effect.

Photovoltaic effect

We are perhaps more familiar with the term solar cell when talking about photovoltaic devices. We have all seen them on spacecraft or digital watches but they all do the same job no matter where they are. The function of a solar cell is to produce electricity from light or, to put it another way, convert light energy into electrical energy. The most efficient solar cells at the moment use a semiconductor junction formed from incredibly pure silicon. Even the best cells can only convert about 15% of the light energy into electrical energy, and this accounts both for the high price and the relative obscurity of solar power as a serious alternative to fossile and nuclear fuels. However, research into solar energy looks set for a big breakthrough in the next few years so one day it may become a practical alternative to our dwindling and expensive energy sources today.

Before we leave solar cells a quick word on their operation. Again you would need a degree in molecular physics to fully understand them but anyway here goes. A photon entering the PN junction region of a silicon solar cell (see September What's In A Name for an explanation of semiconductor junctions) will break down an electron-hole pair, sending the electron and hole scuttling the P and N regions. This movement of electrons will form a small current when connected to an external circuit.

Photoemissive effect

Our last group of opto-electronic devices are known as photoemissive components; ie, they produce light. This is almost the opposite of the photovoltaic effect; where electrical energy is converted into light energy. The most common form of photoemissive component is the gallium arsenide light-emitting diode or LED. This works by using the minute energy change that occurs when electron-hole pairs are formed to produce light instead of the more usual heat that is produced in a conventional semiconductor diode. As virtually no heat is produced this is often called 'cold light'! this constrasts with the way we usually produce light by heating a thin tungsten filament by passing a large current through it until it glows white-hot. LEDs can produce light well into the invisble infra-red region but, surprisingly, have difficulty in producing light at lower wavelengths. Only within the last few months has it become possible to produce blue light from LEDs, though it will be some time before you see them in an HE project. **HE**

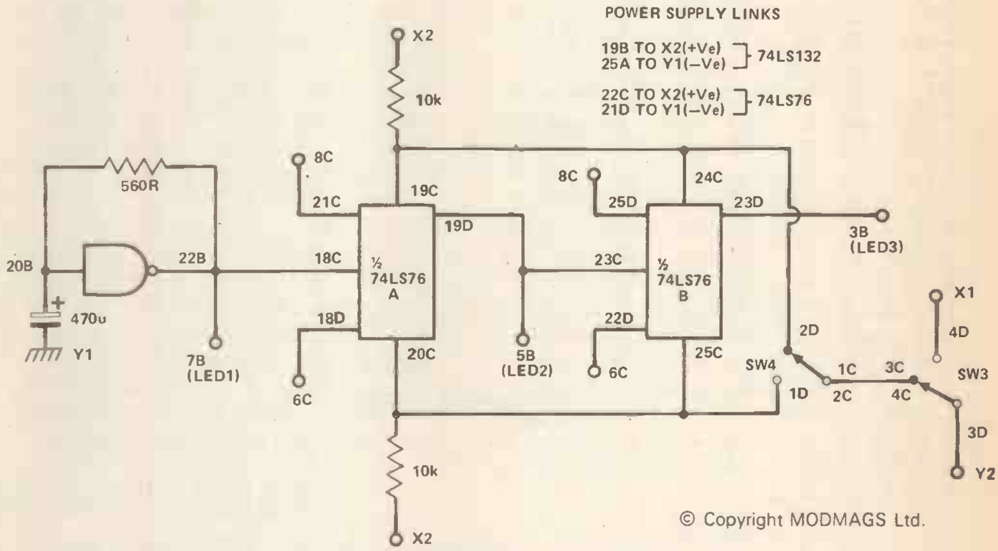
Into Digital Electronics

We're down to the real nitty-gritty this month as Ian Sinclair describes how simple counting circuits work. As usual there are plenty of practical circuits for you to experiment with

LAST MONTH, we spent some time making a J — K flip-flop toggle. In case you've forgotten, the J — K toggles when J = 1 and K = 1. This can be done by connecting each of these terminals to the +5 V line or, if we're using slow clock speeds, just by ignoring them — unconnected inputs will 'float' to logic 1. As we don't want to encourage sloppy habits, we'll use a wire link to make quite sure that these terminals are at +5 V.

The toggling J — K, like any other toggling flip-flop, gives one complete pulse out for two clock pulses in. What about using two such flip-flops, with the Q output of the first flip-flop connected to the clock input of the next? Nothing like trying it, and we can use the board more or less as it was connected before. **Figure 4.1** shows the circuit, including the clock pulse generator and switch arrangements, just in case you've stripped or changed the board since last month. We're now making use of both of the flip-flops in the 74LS76 package.

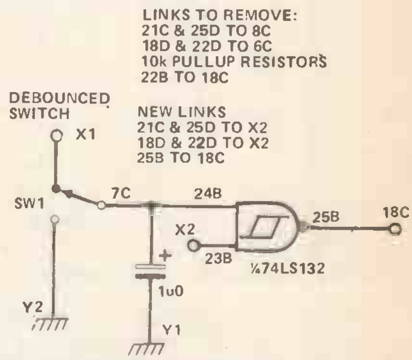
Now in this circuit, LED1 indicates the clock pulses, LED2 shows the output of the first J — K and LED3 shows the output of the second J — K. The switches are still wired to control J, K, R and S, and so they have to be set with SW1 and 2 high, SW3 low and SW4 low. This resets both flip-flops (because we've connected both the R pins and both of the S pins to their respective control lines). When you're ready, push SW3 high so that the set/reset lines are no longer used, and watch the LEDs. The flashing is not just at random because these LEDs are indicating a two-stage binary count.



4.1 Two-stage counter using a single 74LS76, with the 74LS132 providing clock pulses

Binary Counting

If you haven't made friends with binary counting yet, then help is at hand. Instead of letting the clock pulse do the counting, we'll use a switch, SW1, so that there is a count each time we switch up and down. Now since this is a mechanical switch, its contacts will bounce, so the switch has to be rewired using an R — S flip-flop to get rid of the bouncing. This calls for the 74LS132 to be used, and **Fig. 4.2** shows the complete circuit. You won't need to change the connections to the 74LS76 much, only the J and K pins need to be connected to +5 V instead of to the switches. The new connections around SW1 are shown, SW2 is not used, and SW3 and 4 are unchanged.



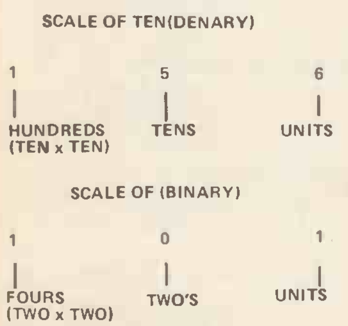
4.2 Debounced switch clock generator for the counter

Now try again, using a bit of table filling this time. One of life's little confusions is that we show circuit diagrams with inputs coming from the left-hand side and outputs at the right-hand side. The input to a counter, however, goes to the counter unit which changes at each pulse, the units counter. When we write a number, though, we show the lowest value units on the right, and the highest on the left. Since J — K A is the units counter, its LED, LED2, is counting units, and its state (0 or 1) goes in a column at the *right* of **Table 1.** The next J — K, B, is counting 2s and its state (0 or 1) goes in a column which is to the left of the first one.

BINARY		
TWO'S	UNITS	DENARY
0	0	0
0	1	1
1	0	2
1	1	3

Table 1. Binary outputs from units and twos counters and their denary equivalents

Did I say units and 2s? Yes, because these counters don't use the familiar scale of ten, in which units up to 9 go into the units column, and each goes in the next column to the left **(Fig. 4.3)**.. Because J — K's count in 2s, the columns don't contain units, tens, hundreds, thousands, etc., but units, twos, fours, eights, etc. We're using two J — K sections, so we are counting units with F/F A and two's with F/F B. **Table 1** shows a counting sequence for two flip-flops, with the decimal numbers shown alongside. With two flip-flops we can count only up to three (Q_B = 1, a two, and Q_A = 1, a one, making a total of 3) before the flip-flops go back to Q_B = 0, Q_A = 0.



4.3 Comparing binary and denary numbers

Before we move on, try the small modification which is shown in **Fig. 4.4.** This consists of moving the clock input connection of F/F A from the R — S to the switch, so that the debouncing circuit is no longer

REMOVE LINKS:
25B TO 18C
7C TO CAPACITOR (REMOVE CAPACITOR ALSO)

CONNECT LINK:
7C TO 18C

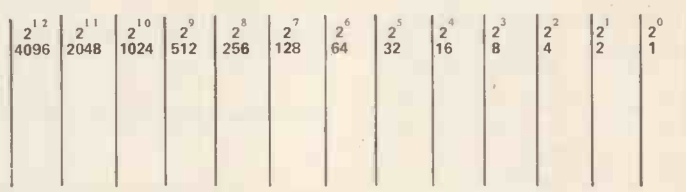
4.4 Connection changes for using the switch without the debounce circuit

in use. Reset (SW3 down, then up again, with SW4 down), so that LEDs 2 and 3 are unlit. Use SW1 once, and see what happens. Keep using SW1, and you'll find in all probability that at some stage the count goes haywire, jumping from 01 to 11 or 11 to 01 and so on. What happens is that each time the switch bounces, the pulse created by the bounce is counted as another clock pulse by the flip-flops. It's for this reason that any switch which controls a pulse circuit needs to be debounced. Switches which simply set or reset don't need this treatment.

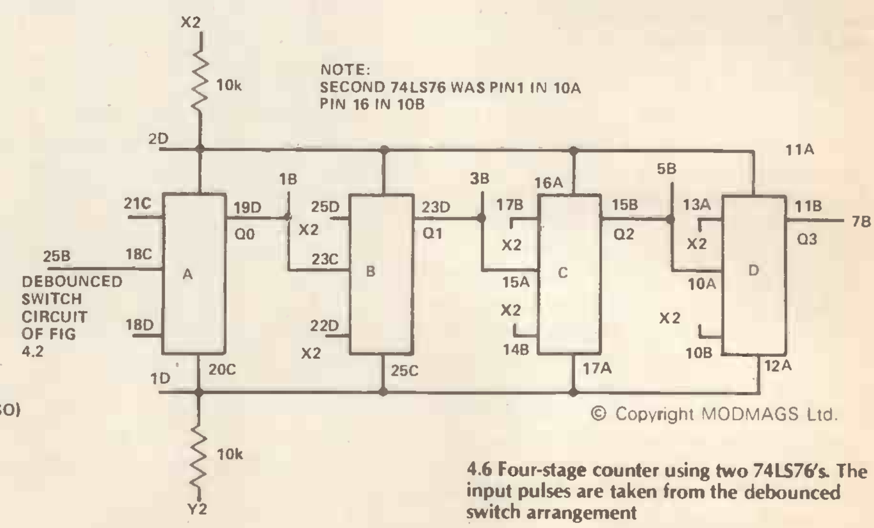
Now to greater things. Suppose we add another two J — K flip-flops to our circuit, in the form of another 74LS76. We can now have LEDs which indicate a 4s column and an 8s column, and we can count up to the binary number 1111, which is decimal 15. At this point, it's convenient to introduce a method of numbering flip-flops and outputs which is used a lot in digital circuitry. Instead of numbering 1, 2, 3 . . . as we would normally do, we use 0, 1, 2 . . . . As usual, there's a perfectly good reason. Numbers such as 2, 4, 8, 16, 32, 64 and so on, which are the values of the quantities in binary number columns **(Fig. 4.5)** are all powers of 2. A power of 2 is the number of twos which have to be multiplied together to get the column number. For example, 4 is 2 x 2, two multiplied by itself, written 2^2. Eight is 2^3, or 2 x 2 x 2; sixteen is 2^4, 2 x 2 x 2 x 2. The power or index is written as a small number, raised higher than the 2 and on its right-hand side. A few hundred years ago, mathematicians agreed that the meaning of 2^1 would be simply 2, and 2^0 would mean 1. The columns for a four-digit binary number will be written as 2^3, 2^2, 2^1, 2^0, so we number the flip-flops F/F3, F/F2, F/F1, F/F0. This makes it a lot easier to remember what each flip-flop is counting, the number of the flip-flop is the power of two.

Having swallowed all that, have a go at the circuit of **Fig. 4.6.** It's a four-stage binary counter, using two 74LS76 ICs, and with the 74LS132 used for debouncing SW1. As usual, we start by resetting, with switches 3 and 4 both low, then SW3 set high. After that, each complete up-and-down movement of SW1 will cause a single pulse to be counted. Fill in the count table **(Fig. 4.7)** for yourself — it's quite a long one with 16 entries.

Once you've satisfied yourself that the count is a regular binary sequence (translation — each binary number is one greater than the one before), switch off and reconnect the 74LS132 as a clock oscillator, and use SW1 in a gating circuit **(Fig. 4.8)** with one of the spare



4.5 Denary number columns for binary numbers, showing the powers of two

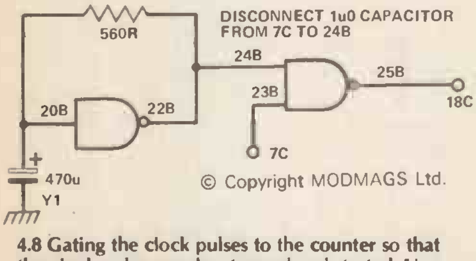


4.6 Four-stage counter using two 74LS76's. The input pulses are taken from the debounced switch arrangement

COUNT	D (LED1)	C (LED2)	B (LED3)	A (LED4)
0				
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				

4.7 Blank truth table for the four-stage counter

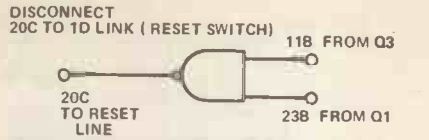
NAND gates of the 74LS132. The reset action is as normal, but now counting will take place only if SW1 is at logic 1. You can interrupt the count at any time, and the number of pulses which have entered the counter (at the clock input of F/FO) will have caused LEDs to light. They stay lit when the counting stops. If you don't reset, switch off or start counting again. The number of pulses remains stored in the form of flip-flop outputs for as long as you like. You can use SW1 to count a few more pulses, then stop again just as you wish; this is one more step in the construction of a binary counter.



4.8 Gating the clock pulses to the counter so that the clock pulses can be stopped and started. Use this in place of the debounced switch

Excuse-me circuits

The four stage binary counter goes through its count from binary 0000 to binary 1111 (decimal 15) before going back to 0000 again. Suppose we wanted to count to nine and then reset back to zero? Nine in binary is 1001 (eight plus one), so we need four binary digits (or bits) to count to nine. Four bits means four flip-flops, so we can't economise in flip-flops just by counting to a smaller number. In addition, because a four-stage counter, left to itself, will count up to 1111, we need some method of stopping the action when the count gets too high.



4.9 Automatic resetting on a count of ten. This lets us use binary counters for counting denary scale (BCD, which is binary coded decimal)

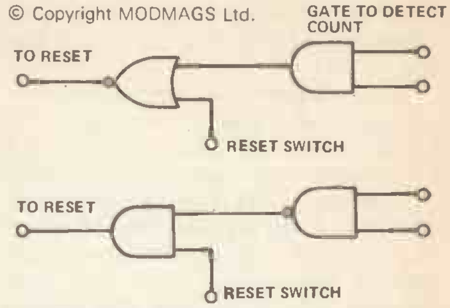
Figure 4.9 shows how this can be done. The Q outputs of flip-flops are used to operate a gate, in this case a NAND gate whose output is connected to the reset line. The two Q outputs which are used are Q_1 and Q_3, so that the NAND gate is activated when the outputs are $Q_3 = 1$, $Q_2 = 0$, $Q_1 = 0$, $Q_0 = 0$. This is 1010 in binary, which is decimal ten.

What happens? Well, the counter works quite normally, starting from 0000 and counting up to 1001 (decimal nine). At no point in the count do we ever have Q_3 and Q_1 both at 1, so the NAND gate always has 1 at its output. That in turn keeps the RESET inputs high, so there is no reset. At the instant when the Q_3 and Q_1 outputs go high together, though, the output of the NAND gate goes low, and operates the reset. This makes all the outputs zero, and the gate output goes high again, letting the count continue again from 0000. This is a method which is used in some simple counters, but it has two disadvantages:

1) if you have a latching circuit at the counter outputs, the value 1010 (decimal 10) will be latched in, even though it existed for only a fraction of a microsecond

2) using the reset input for this purpose makes it more difficult to use it for manual (switch) resetting — you have to use a NOR gate or a NAND gate, as shown in **Fig. 4.10**

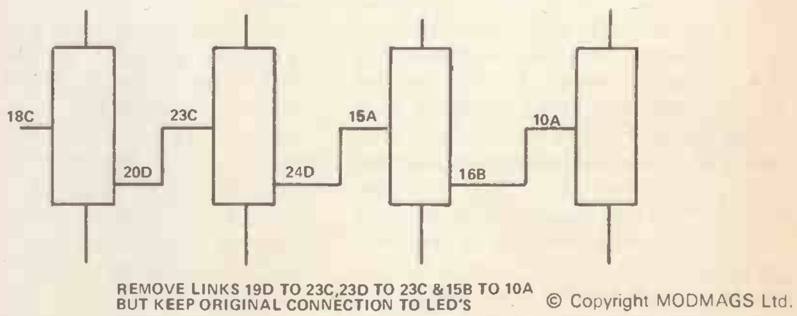
A four-bit binary set of outputs which goes only to 1001 (nine) before resetting is called a BCD count — the letters mean binary-coded decimal. BCD counters are used whenever a decimal number has to be displayed — which means practically every counter which uses a display. Later on we'll look at how these BCD counts are converted and displayed as decimal numbers.



4.10 Alternative resetting systems which permit both automatic (at the count of ten) and manual resetting.

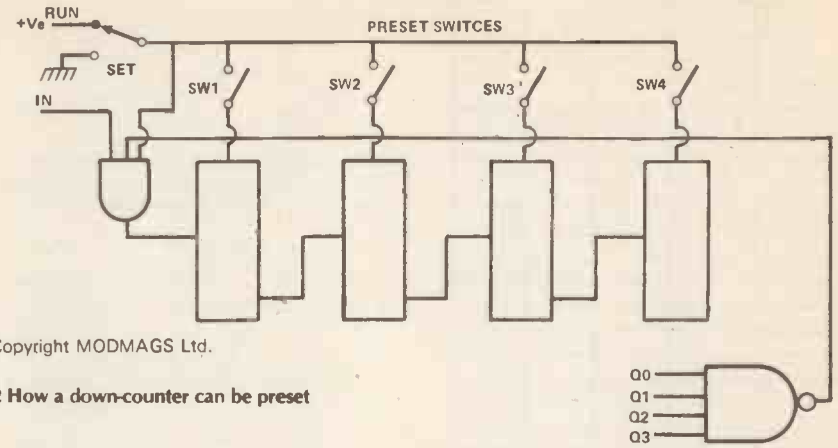
Meantime, we have a four-stage counter on the board, and there are still a lot of things we can do with four J — K flip-flops. **Figure 4.11** shows just one of them. We've removed the BCD gate wiring, so that the counter is back to a normal four-stage counter again, but there's another alternative to each flip-flop except the first (F/F0). This time, instead of connecting Q0 to Ckl, Q1 to Ck2, Q2 to Ck3, we've used the Q outputs to connect to the clock inputs. The LEDs are still connected to the Q outputs, but the clock inputs for F/F1, F/F2 and F/F3 are connected to the Q outputs of the previous flip-flops. What does this do? Try it!

Set switch 3 low and 4 high. This sets each flip-flop, so that the LEDs should read 1111. Make sure SW1 is down, so that the flip-flops are not being clocked, and slide SW3 high, isolating the R — S inputs. Now watch the LEDs very carefully, and flick SW1 up to start counting. What happens? Right — it's counting backwards, starting at 1111 and going to 1110, 1101 and so on up to 0000. After 0000, the next step is

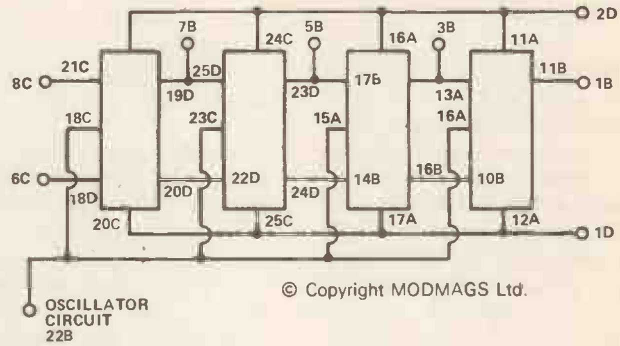


4.11 Modifications to the flip-flop connections so that it can act as a down-counter back to 1111 again, just the reverse of the counter circuit we had in **Fig. 4.6.**

Very interesting, but what's the advantage? There's one peculiar advantage of down-counting compared with up-counting — the end of the count is always 0000. We could arrange to gate the input to the counter so that the counter always stopped at 0000. It's easy enough, a four-input OR gate will do the trick and we don't need to try it out. We can now use this as a counter for any number up to 15! How? Just by using switches to set each flip-flop. Take a look at the circuit in **Fig. 4.12,** which is not intended for construction, because we're not using any 4-input gates. The switches 1 to 4 control each input separately, and can be set so that any binary number from 0001 to 1111 can be 'loaded-in' to the flip-flops. Switch SW5 (another reason for not trying it out!) then acts as a load/run switch — in the load position, it allows switches 1 to 4 to set the flip-flops. In the run position it releases the R and S lines so that the counter can operate. The counter will now count down starting at whatever value it was set to and ending at 0000, when the gate switches the input pulses off. It's very useful if you want to count a different number every now and again. If you used an up-counter, you would have to redesign the gating system each time you wanted to change the count number, which is a lot less convenient.



4.12 How a down-counter can be preset



4.13 Action of a shift-register

Counting ripples

Up and down counters, incidentally, are called ripple counters. The reason for the name is that a change 'ripples' through all the counter stages. For example, when a ripple counter has reached a count of 0111, the next pulse in will change the last digit to 0. This in turn will sent a pulse to the next clock input to change the next 1 to zero. The same happens at the third flip-flop, and a pulse from that one makes the final change from 0 to 1 at the fourth flip-flop. The change has 'rippled' from one to another, and there will be a small but significant delay between one step and the next. This causes trouble in high-speed counters when gates are used to detect numbers, because by the time the last digit has changed, the first might have counted-on several digits more! This is overcome by using synchronous counters, which apply the same input pulse to all the clock inputs, and use the J and K inputs to control the action. We're only going to look at the simpler types of synchronous counters here, because the more complicated types are available in IC form anyway.

Shift 'em

To start with, take a look at the circuit in **Fig. 4.13.** It uses four stages of J — K flip-flops with switches 1 and 2 feeding the J — K inputs of F/FA and switches 3 and 4 used for setting/resetting just as before. The new step is that each Q output is connected to the next J input, and each $\bar{Q}$ output is conected to the next K input. This is a circuit called a shift register, and the LEDs on each of the $\bar{Q}$ outputs will show us what happens in the circuit. Start by resetting (SW3 and 4 both down), Set SW1 high (J = 1) and SW2 low (K = 0). Now watch your LEDs, and set SW3 up so as to release the flip-flops. Whenever LED 1 lights, put SW1 low (J = 0) and keep watching as the clock ticks on. Interesting? OK, try again, but this time keep SW1 set high after you release the flip-flops by setting SW3 high. Just for an encore, you can try the effect of starting from scratch with J = 1 and K = 1.

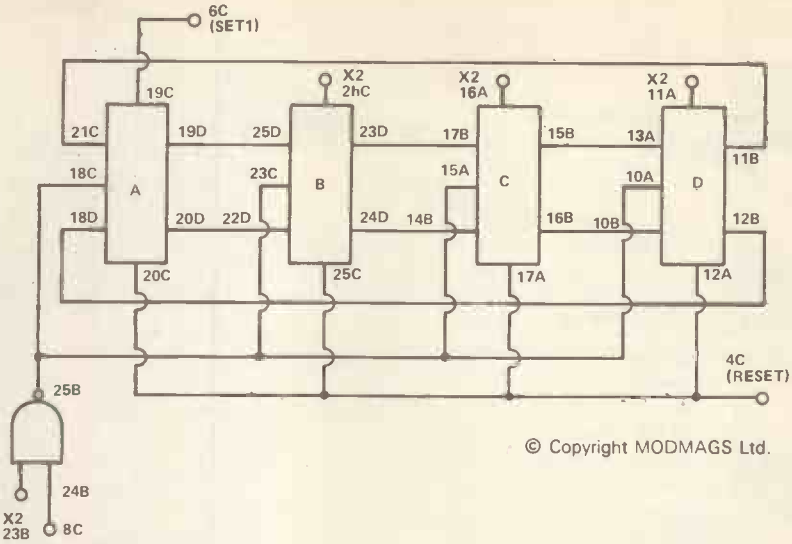
What's happening is the action called right shift. At each clock pulse, a bit at the Q output of a flip-flop is 'shifted' to the Q output of the next flip-flop to the right. It's not really shifted, what is happening is that the bit at the Q output sets up the J input of the next flip-flop so as to cause that flip-flop to go to the same output on the next clock pulse. For example, imagine F/F A with Q = 1, $\bar{Q}$ = 0. That sets up the J and K inputs of F/F B, with JB = 1, KB = 0. When the next clock pulse comes along, JA = 1, KB = 0 will cause QB to go to logic 1, the same bit as was on QA. Now think of the other possible action. If QA = 0, then $\bar{Q}$A = 1 and JB = 0, KB = 1. With these voltages on the J, K inputs, QB will go to logic 0 at the next clock pulse.

What happens at the input depends on how the J and K inputs of F/F1 were set, and the exercises we tried used different types of inputs. For example, with JA = 1, KA = 1, the first flip-flop will toggle, and this will cause a pattern of 1s and 0s to shift through all the other stages. This is a nice way of creating a chain of changing lights, incidentally.

Reversing the direction of the shift isn't quite so easy, because we have to connect the Q output of each flip-flop to the J input of the *previous* flip-flop and the $\overline{Q}$ output of each flip-flop to the K input of the previous flip-flop. A few IC shift registers (noticably the 74194) will shift in either direction, making use of the voltage on a 'SHIFT' pin to control the shift direction. These ICs use gating, with each Q output taken to a gate system which will connect it either to the next flip-flop or to the previous one.

Now the straightforward shift register in **Fig. 4.13** is quite useful, but we can generate even more interesting effects by connecting the outputs of such a register back to the inputs. Connect up the circuit which is shown in **Fig. 4.14.** This one uses SW1 to gate the clock pulses into the register, and SW2 to set the output of F/F A. Switch SW3 is used to reset all the flip-flops in the register. The clock generator and gate are the same circuit as we've used before. Start with SW1 down, so that clock pulses are gated out. Put SW2 up, and SW3 down. This resets flip-flops B, C, and D, and putting SW2 down will now set F/F A. Now put switches SW2 and 3 up to isolate the set and reset lines. Note, incidentally, that we have not connected the set terminal of flip-flops B, C, or D.

The register should now show a 1 at QA and 0 at all the other outputs.



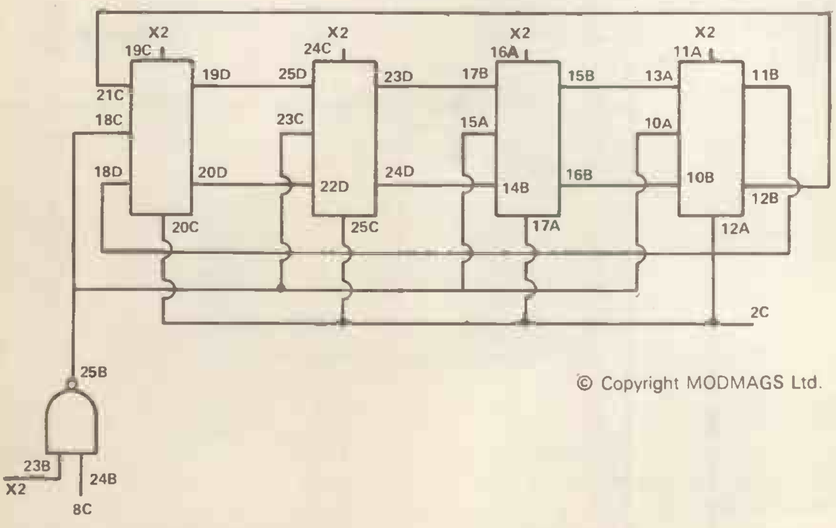
4.14 Simple ring-counter circuit

Start the clock pulses by switching SW1 up, and watch what happens to the LEDs. A circuit like this is called a ring counter because the connections between flip-flops form a complete ring. A 1 at any output will be shifted to the next flip-flop at each clock pulse. There's even a special name for this operation: it's called a right rotation, and it's one of the actions which every microprocessor must carry out.

A ring counter is very useful if you want to display counted numbers simply. For example, if the LEDs are labelled 1, 2, 3, 4 ..... and so on, then the number of pulses which have been inputed will be shown by the number on the LED which is lit. This is a very simple way of making a decimal number counter without having to use a seven-segment display. If you need a large display, then each Q output can drive an emitter-follower which in turn drives a power transistor connected in a lamp driver circuit. If you're a really determined lamp flasher, you could even use thyristors or triacs — but make sure that the high-voltage circuits are completely isolated from the low-voltages of the digital circuits.

There's a rather natty variation on the ring counter in **Fig. 4.14** which is shown in **Fig. 4.15.** This is a 'twisted-ring' counter, and the main change is that the connections between QD, $\overline{Q}$D, KA and JA have been crossed over. Try this one out, starting with *all* the flip-flops reset, and fill in the state table for each pulse. You can use SW1 to stop and start the clock pulses, and SW4 to reset the circuit — SW2 and SW3 are not used this time.

A simple ring counter will count to a number equal to the number of flip-flops — in our example, four. A twisted-ring counter will count to a greater number, equal to twice the number of flip-flops (eight in our example), but the outputs have to be decoded — you can't just use one LED to represent one digit. The twisted-ring counter is sometimes known as the Johnson counter.



4.15 'Twisted ring' or Johnson counter circuit

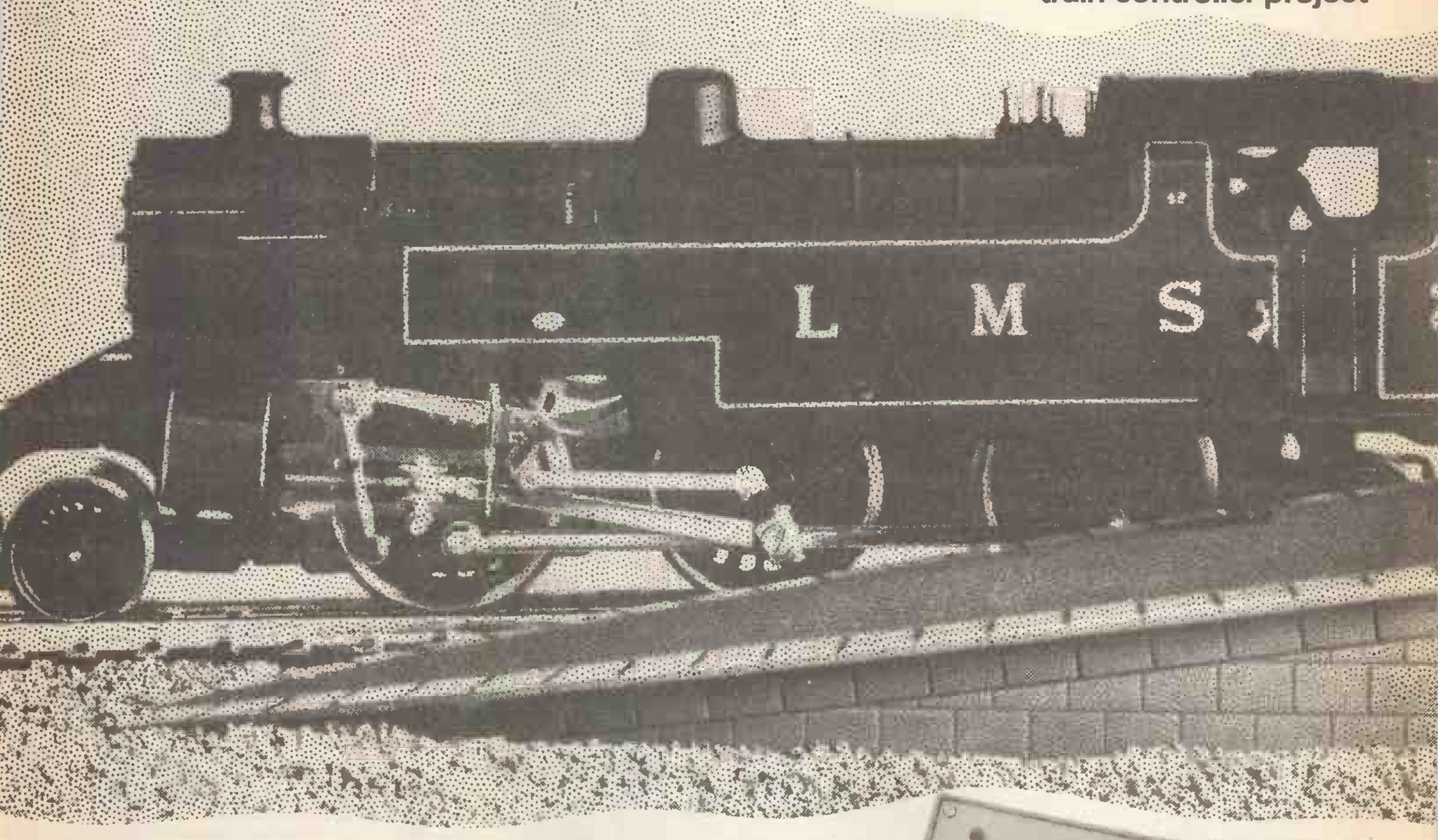
Corrections to Parts List

(HE September '80 Vol. 2, No. 11, page 33)
The D-type flip-flop shown in the list in this first part of the series should be 74LS74, *not* 74LS75 as shown.
Aslo, a lu0, 10 V capacitor should be added to the list.

HE

Model Train Controller

Keep in total command of your rolling stock — control them from snail's-pace through to full speed, accurately and precisely with the help of HE's simple-to-build train controller project



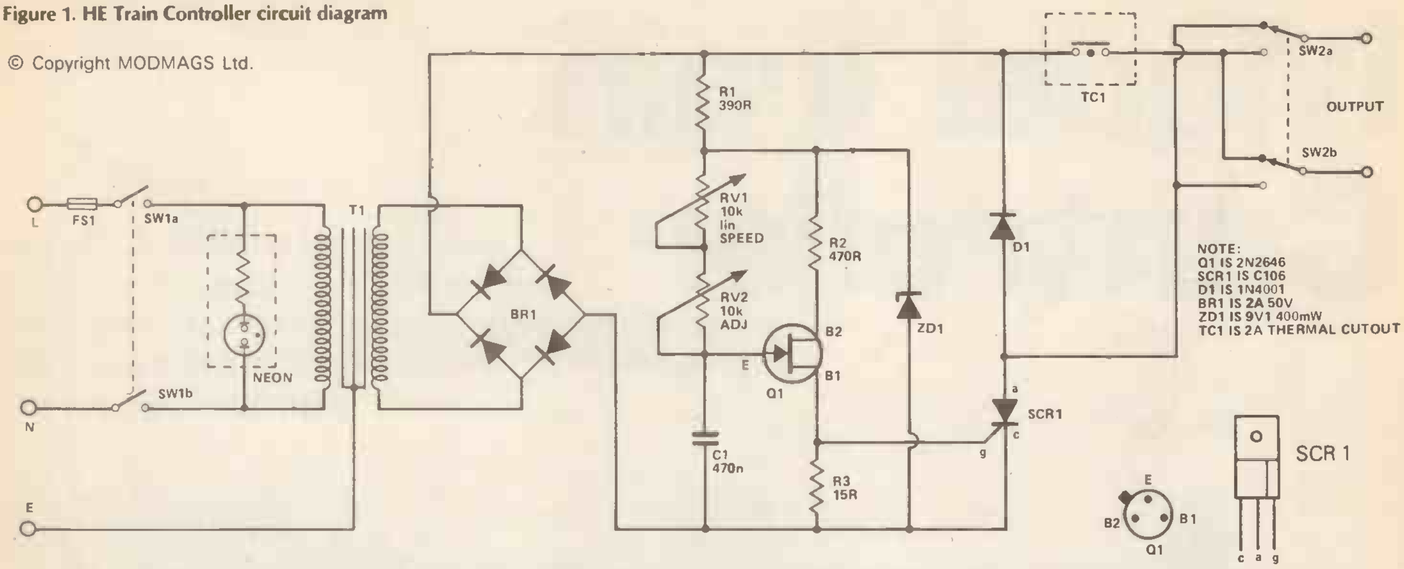
MODEL TRAIN SET controllers usually consist of a simple rheostat to control power to the train. The main drawback of this form of controller is that it doesn't permit fine control and tends to have a large amount of hysteresis (lag in response). Hysteresis is most obvious when starting a train from standstill — the rheostat has to be moved a fair way round, until the train suddenly jerks into life. It then rushes off down the track until you turn back the control to a more reasonable setting.

Enthusiasts will agree that a controller which controls the train precisely is preferable. Thus, to start the train moving, just a slight turn of the rotary control should suffice — more accurately simulating train movement. The HE Train Controller does just that with a very simple circuit utilising thyristor control. The whole circuit of our prototype is totally self-contained and simply requires connection to 240 VAC mains to be usable with any train set-up. Alternatively, for those readers who possess a transformer unit with a 15 VAC output, the mains part of the controller can be omitted.

Construction

Begin construction of this project with the Veroboard. The copper strips need to be broken with either a cutting tool or a hand-held ⅛" in drill bit. Twisting the tool gently against the copper at the hole in question (indicated on the underside view of the board in **Fig. 2)**

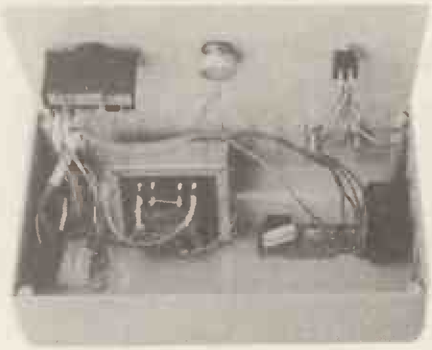
Figure 1. HE Train Controller circuit diagram



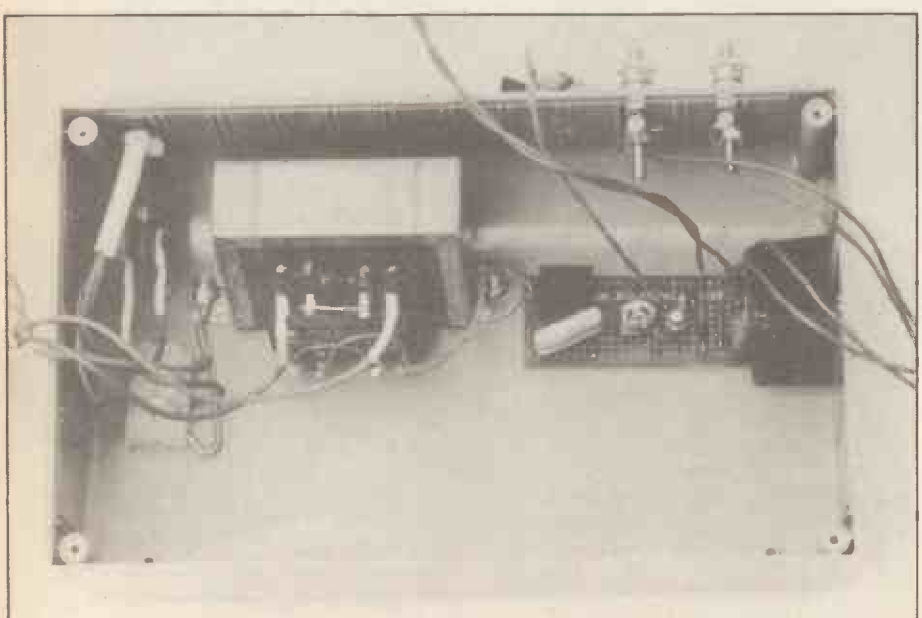
will break the strip. Clear away any loose swarf which may form a bridge between adjacent strips and create a short-circuit.

Insert all links into the board followed by resistors, the capacitor and finally, the semiconductors. Check that all semiconductors are inserted the right way, and before you test the circuit make sure the heatsink is firmly attached to the thyristor.

Wire up the project according to the connection diagram, being particularly careful with the mains circuitry — you may only have *one* chance to get it right. Heat-shrink sleeving around mains connections is a good idea to safeguard against electric shock.



Take care when wiring up the circuit — particularly with mains connections



How it Works

The secondary of T1 provides approximately 15 VAC which is full-wave rectified by BR1. There is no smoothing capacitor in the circuit: after each half-cycle the rectified voltage *always* returns to 0 V. This is quite an important point and we shall return to it later.

Transistor Q1 is a unijunction (UJT) device and is connected in a conventional oscillator format. Potentiometers RV1 and RV2 control the charging rate of timing capacitor C1, and thus the frequency of the oscillator. The output waveform is taken from terminal B1 of the UJT and comprises a short-duration pulse of variable frequency, which is applied to the gate of thyristor SCR1.

A thyristor can be thought of as an electronic switch applying power to the train. One of the pulses from the UJT oscillator switches on the thyristor and, as long as the applied voltage at the anode, a, is above the voltage at the cathode, c, (ie 0 V) the thyristor will remain on. However, the applied voltage is full-wave rectified DC and unsmoothed. As explained above, after every half-cycle (ie at 100 Hz) it goes to 0 V and consequently turns the thyristor off. Thyristor SCR1 then remains off until it receives a further pulse at its gate. By altering the frequency (and therefore the repetition rate of the pulses), the average power applied to the train can be varied, allowing full control of train speed.

A thermal cutout, TC1, is in circuit to prevent any damage caused by accidental short-circuits, and it 'trips-out' at about 2 A.

Buylines

Thermal cutout, TC1, is the only component which could be difficult to obtain. It is a fairly standard TV component accessory and you may be able to locate one at a TV repair shop. Alternatively, HRS Electronic Components Ltd. (Tel. 021 643 0705) stock one — type CO1P. The approximate cost of all parts excluding the case will be around £15.

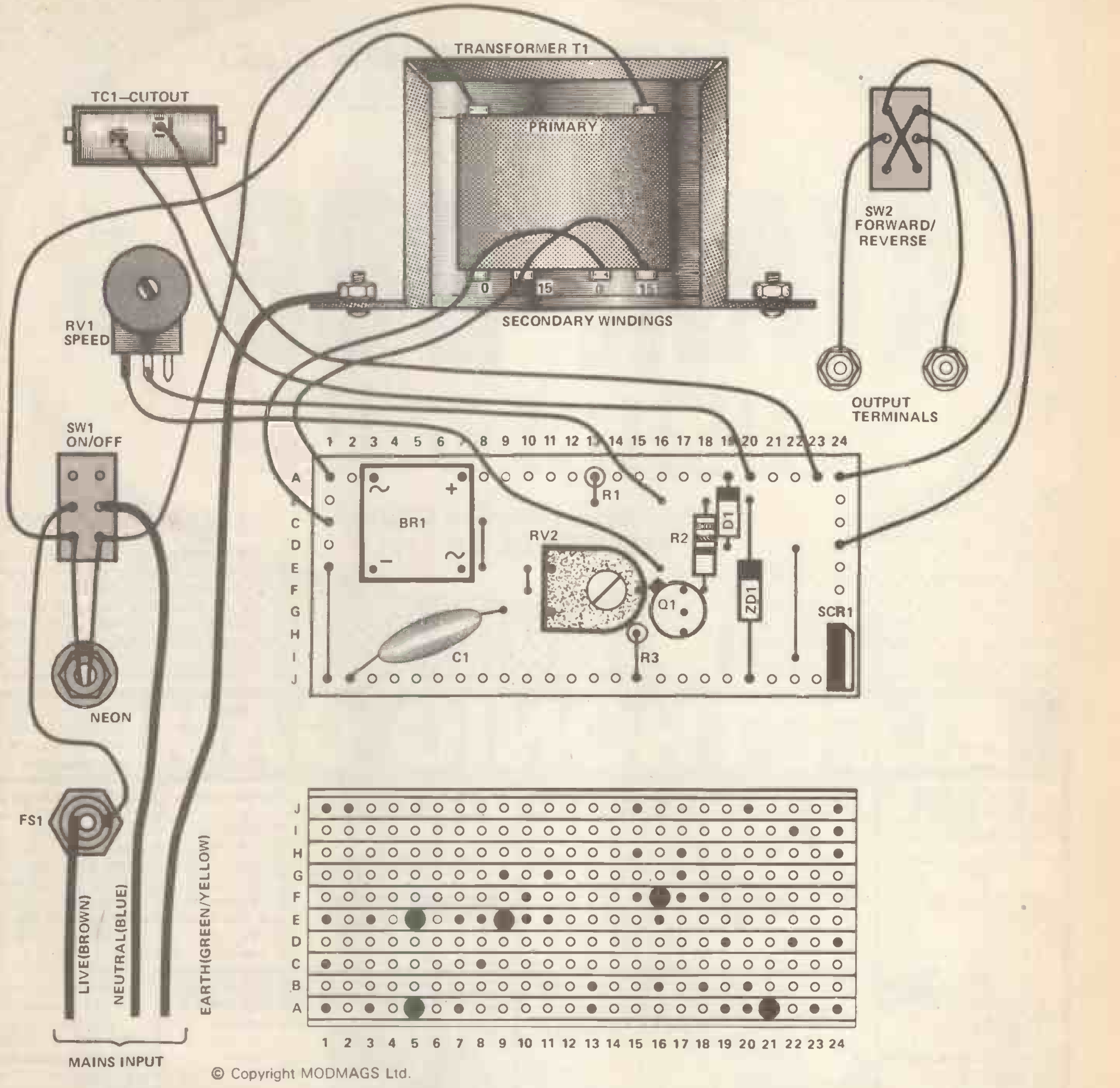


Figure 2. Connection diagram of the project with Veroboard overlay and breaks in track

Parts List

RESISTORS (All ¼ W, 5%)

R1	390R
R2	470R
R3	15R

POTENTIOMETERS

RV1	10k linear
RV2	10k miniature horizontal preset

CAPACITORS

C1	470n polyester

SEMICONDUCTORS

Q1	2N2646 unijunction
SCR1	C106 thyristor
D1	1N4001 diode
BR1	2A, 50 V bridge rectifier
ZD1	9V1,400 mW zener diode

MISCELLANEOUS

T1	240/15 V, 20 VA transformer
FS1	2A fuse + holder
SW1,2	double-pole, double-throw toggle
TC1	2A thermal cutout (see BUYLINES)

neon with inegral resistor
heatsink for SCR1
grommet, connecting block, screw-on terminals, knob
case to suit

HE

O Level Q & A

Time for some induction. Nick Walton introduces you to inductors, describes how they work as electromagnets, relays and transformers, and how they team up with capacitors to resonate

IN ELECTRICAL WORK, you might say that there are three basic circuit components: the resistor, the capacitor and the inductor. If you understood last month's article you will know all about the first two (well, all you need to know at the moment) and now we look at the third of these, the inductor. That's its posh name, but really it is just a coil of wire which can be wound on either a hollow cardboard former or an iron or ferrite rod.

Mr Oersted in Copenhagen discovered in 1819 that a magnetic field surrounds a wire — something which is easy to demonstrate with one or two amps of current and a little magnetic compass (or some iron filings) on a card. If you just happen to have a couple of dozen or so little compasses so much the better but one is just as effective put in 24 different positions. As you can see from **Fig. 1** we get magnetic field lines (also called lines of force or flux) running in circles round the wire at the centre. The same applies to a series of such wires forming a coil as shown in **Fig. 2** which is really no more than **Fig. 1** drawn a few more times. The field that results is just the same as the field you get round an ordinary permanent magnet, but with the advantage that being electrically produced it can be switched on and off at will. This is called an electromagnet.

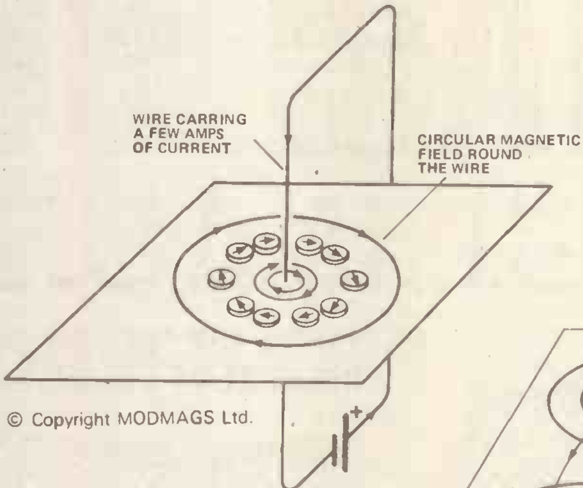


Figure 1. The magnetic field around a conductor carrying current is circular

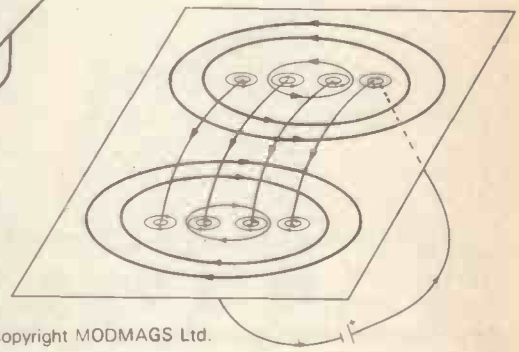


Figure 2. This is what happens if you extend the idea in Fig. 1 a few times to create a coil. You will get the same pattern of magnetic field as you would get with a permanent magnet

The relay **(Fig. 3)** is an excellent example of an electromagnet being used to close a pair of contacts in a switch. It is extensively used in remote control, telephone switching and for switching a high-voltage circuit using a low voltage **(Fig. 3)**. Alternatively it can switch on a high current as it does every time you use your car's starter motor, a hungry beast sometimes consuming in excess of three hundred amps (300 A).

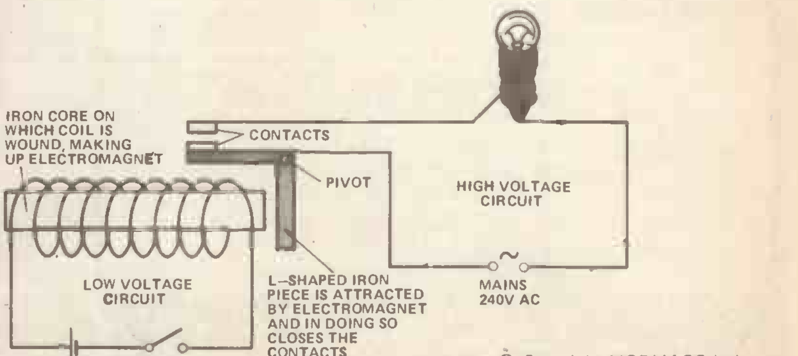


Figure 3. Electromagnetic relay. Note that the two electrical circuits are quite separate

Current Affairs

Thus electricity gives us magnetism. Faraday discovered the reverse, that a magnetic field could produce a current in a wire moving through it, or indeed whenever a wire was subjected to a changing field, however caused. For instance, a wire could be in the field of an electromagnet which is then switched off. A current produced in this way is called an induced current and it always opposes whatever motion is causing it. Scientists know this as Lenz's law, but the rest of us know it as the fundamental awkwardness of nature. Whatever you try to do, someone or something will try to stop you. It can be well illustrated by bringing a magnet up to a coil of wire **(Fig. 4)**. As it approaches, the magnet will produce an induced current in the coil, in turn producing a magnetic field which *opposes* that of the magnet. Thus the coil becomes, instantaneously, an electromagnet with a south pole at the end nearest the approaching magnet, thus repelling it. If you pull the magnet away, the current in the coil flows to make a north pole to attract the magnet's receding south

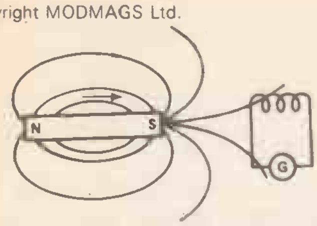


Figure 4. Bar magnet approaching a coil. The lines of force 'cut' the wire thus inducing a current in the coil in a direction opposite to the direction of approach

pole. There could be something of the boy-meets-girl situation here. The initial approach is met with opposition, but once that is overcome we draw a discrete veil over what happens at close quarters only to find that when it is time to part, this too is resisted!

Now the same sort of hindrance occurs if you have just a single coil (or inductor). If you want to change the value of the current you are passing through it, it will resist this change with an opposing voltage. If a coil produces an opposing voltage of one volt (1 V) for a current changing at a rate of one amp per second then it is said to possess an inductance of one Henry. Joseph Henry was an American scientist who discovered induction a little before Faraday (and quite independently of him) but published his work after him. He invented the relay originally for telegraph communication and also developed the electromagnet (though in doing so he found it necessary to tear up one of his wife's silk petticoats for the insulation to wrap round the wire!). Just as the capacitance (in Farads) of a capacitor is denoted by the letter F, the inductance (in Henrys) of an inductor is denoted by H (obvious, isn't it!) The value of H will depend upon how you wind the coil, number of turns, type of core, and so forth. Thus if you want to change the value of current you are passing through your coil, it will resist this change to an extent depending on its H value, but also the more rapidly you make the change (ie the faster you alternate the current) the more the coil will resist this.

The ohms rating (reactance) of an inductor is given by $2\pi fL$, where L is the inductance, f is the AC frequency and $\pi = 3.14$ as in circles. We saw last month that when the frequency goes up, the ohms rating (or reactance) for a capacitor goes down, but here we see it going up for an inductor under the same conditions. For DC, inductors behave in the opposite way to capacitors. While theoretically a capacitor blocks DC totally, an inductor will in theory provide no opposition to it.

Wind Ups

An inductor is an easy thing to make. You just wind a wire round some sort of former — you can wind it round a pencil if you like — and you have one. Often they are iron-cored, which improves their efficiency but the trouble with iron is that while it strengthens the magnetic field on which the whole effect is based, iron also conducts electricity. Therefore, currents can be induced in it with a consequent loss of energy. Ferrite overcomes this problem by being non-conducting but just as good magnetically.

Transformation

Perhaps the best known application of induction is found in the transformer, just humming away quietly to itself on occasions (did it forget the words?), modestly making an enormous contribution to our civilisation. If you are reading this by artificial light, that energy is coming to you by courtesy of several transformers. In essence they are just a pair of coils as close as possible to each other so that the changing magnetic field from one coil can induce a voltage in the other. The coils are called the primary and the secondary and it should be clear that they feed on a diet solely of AC since if you put DC through a coil you do not get the change of magnetic field vital for induction to occur.

There are two simple relationships involving transformers that we have to be aware of. The first is that the AC voltage you get out across the ends of the secondary is related to the AC voltage you put in on the primary by the ratio of the number of turns in the primary to the secondary. For instance, if you wanted your transformer to step the voltage down from 240 V to half that value, then the secondary coil would just have half the number of turns that the primary had. Mathematically it is stated as:

$$\frac{\text{Voltage of primary coil}}{\text{Voltage of secondary coil}} = \frac{\text{Number of turns in primary}}{\text{Number of turns in secondary}}$$

or

$$\frac{V_P}{V_S} = \frac{N_P}{N_S}$$

The other relation says in effect that you cannot get more energy each second out of a transformer than you put in. Energy-per-second is power (wattage), which is voltage times current, so we have:

(Primary voltage) x (Primary current) =

(Secondary voltage) x (Secondary current),

or $V_P \times I_P = V_S \times I_S$

As an example, for a given power put into the primary side, the greater the secondary voltage, the smaller the secondary current you get out. (Don't make the mistake of thinking that Ohm's law, which applies to the DC scene, is applicable here — it can get you into brain-bursting difficulties.)

In addition one often finds transformers hiding away in radios doing a job called impedance matching. You might find the output stage of an amplifier connected through a transformer to a speaker. The output stage of the amplifier will provide a voltage but there will also be some ohms (properly called impedance here) lurking between the terminals. Ideally the impedance of the speaker should be the same as the output impedance of the amplifier. If this is not the case, then you call in the transformer to help out. It needs to have a turns ratio such that squaring it gives the ratio of the impedances matched. If Z_1 and Z_2 are the impedances in question and N_1 and N_2 are the turns, then all you need is:

$$\frac{Z_1}{Z_2} = \left(\frac{N_2}{N_2}\right)^2$$

Easy! . . . hmm!

Good Vibrations

In this article we have made the occasional comparison of inductors and capacitors and it seems reasonable to end things off by looking at what they do when put together. This involves the idea of resonance, so first let's be clear what resonance really is. Just about anything will vibrate when you strike it and it will do so at its own natural frequency. A child on a swing will vibrate to and fro at a fairly low natural frequency and if you tap a wine glass gently with your finger nail it will ring at a much higher natural frequency. If you now apply externally a vibration which is the same as the natural frequency of your system it will respond with large vibrations. If you are pushing a child on a swing you can build up big vibrations by pushing at just the right frequency, called the resonant frequency. Stories of powerful soprano singers (or even a well-known brand of cassette tape) being able to shatter wine glasses are based on this idea of resonance: the frequency of the sound is the same as the resonant frequency of the glass, so its vibrations can build up till it breaks.

In a similar way, a circuit containing an inductor and a capacitor will have a resonant frequency. The inductor has a reactance (ie an ohms value) which depends on AC frequency, as does the capacitor. The frequency at which these reactances are the same is called the resonant frequency and is given by:

$$f = \frac{1}{2\pi LC}$$

which comes from equating the inductive reactance $2\pi fL$ with capacitive reactance xc, given by:

$$Xc = \frac{1}{2\pi fC}$$

Radio Tunes

This is how a radio is tuned. The tuning circuit is called a series-resonant circuit which strictly speaking consists of an inductor, a capacitor and a resistor all in series, as shown in **Fig. 5**. In practice you

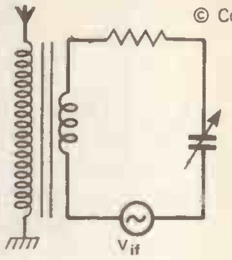


Figure 5. Aerial and series-resonant circuit as used in radio tuning. Note that for clarity the voltage is shown separately and is in series with the other three components, though in practice it appears as an induced voltage across the coil. (The coils would be ferrite cored)

do not need to put in a resistor as you are lumbered with resistance (resistive losses in the circuit) whether you like it or not. The aerial induces all sorts of different alternating voltages in the series-resonant circuit which then responds most strongly to that alternating voltage which corresponds to its resonant frequency. This can be altered with

Figure 6. Parallel resonant circuit

the variable capacitor so you can tune in to different stations transmitting at different frequencies.

If now you put your alternating voltage supply in parallel with L and C at resonant frequency, as arranged in **Fig. 6,** you will have quite large currents sloshing around the LC loop but since they flow in opposition to each other, not much actually flows in the rest of the circuit. This is called a parallel resonant circuit and can be seen as offering a large resistance at a particular frequency.

That rounds things off for this month. If you are taking the exam start thinking about a project and a topic, and keep brain and soldering iron good and active!

HE

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Jack Lead Tester

Test your Jack-to-Jack leads in record time with the help of this simple to build circuit

HE reader, Donncha Butler explains his own design

JACK-TO-JACK leads are used by almost every band and disco in the country (the exceptions are those who can afford expensive cannon connectors and those who can't even afford standard jacks!) Now, provided all goes well, these leads perform admirably. But — there is a well known law — Murphy's — which states that: 'any seemingly perfect contribution to the whole entity's function will, at the most inconvenient time, pack in — good and proper.' Put simply, what this means is that half-way through a jig (no, sorry I mean gig!) at least one of the jack leads will develop a one-in-a million fault which leaves the owner, running around like a rabbit lost in a maze, looking for the lead which has gone down and for a good replacement. Having been in this sort of situation myself from time to time, I decided to do some research into the subject and found that any fault in a lead must fall into one of three categories:

- an open-circuit
- a short-circuit
- crossed wires (out-of-phase connections)

With the aid of the HE Jack-to-Jack Tester, leads can be tested for these three areas of fault in less time than it takes to say xxxx!

At last, no more frantic struggles, holding the jack plug steady between your knees, whilst you grapple with the multimeter prods in one hand (and to stop the meter falling off the table onto the floor with the other), trying to make good contact with the plug connections. All you need to do is plug both ends of the lead into the unit and visual indication of the lead's state of health is given instantly by three LEDs:

- **RED** — indicates a short-circuit
- **YELLOW** — indicates that the plugs are wired out-of-phase
- **NONE** — indicates an open-circuit
- **GREEN** — indicates the lead is OK

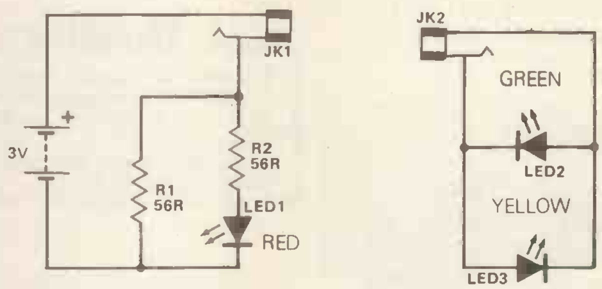

Figure 1. Circuit diagram of the ingenious HE Jack Lead Tester

How it Works

If a good lead is plugged in, the green LED will be forward-biased and current will flow through via R1 (there will not be sufficient voltage across the red LED to light it).

If the lead is wired out of phase, the yellow LED will be forward-biased and so will light. If there is a short-circuit, 3 V will be dropped across R1 and so the red LED will light.

Note that 50 mA is shunted through R1, so the circuit should not be left in the short-circuit condition or the batteries will soon go flat. No switch is included in the circuit, because the battery is automatically disconnected once the plugs are removed.

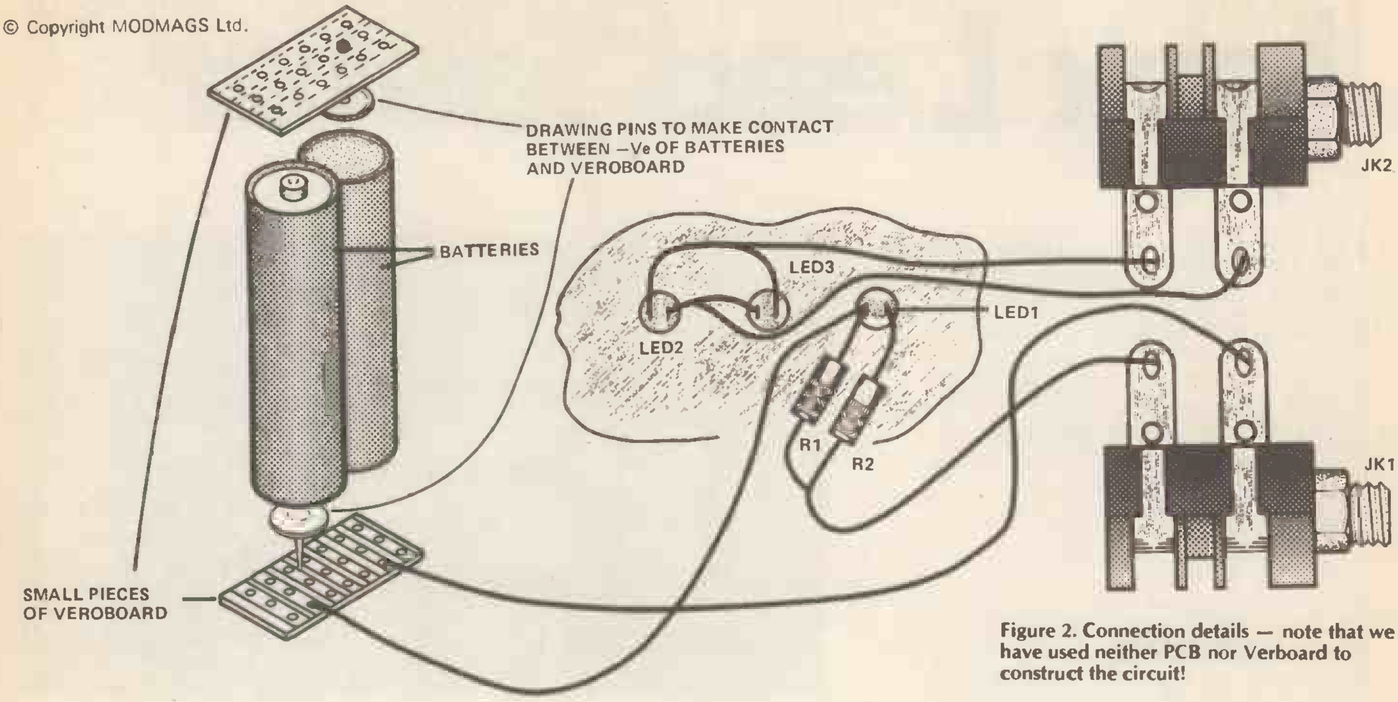

Figure 2. Connection details — note that we have used neither PCB nor Verboard to construct the circuit!

Construction

The prototype was constructed in a black Vero potting box and makes use of two matching plastic jack-sockets. A PCB is not necessary as there are so few components and they may be connected quite neatly with insulated wire. Follow the connection diagram for details. Two holes are drilled in one end of the box for the jack sockets and three holes are drilled in the front of the box for the LEDs. The jack sockets are fixed in place and the LEDs may be glued in place or held in LED clips. The batteries may be soldered in or contacts may be made of Vero-board.

When all the parts are in place, screw on the lid and the tester is ready for use.

Buylines

You will find that all parts are available at your local component stockist and the total cost shouldn't be much more than about £1.50.

The case is available from Vero, the order code is 202-21024B.

Parts List

Resistors (All ¼W, 5%)	
R1, 2	56R
Semiconductors	
LED1	0.2" Red LED
LED2	0.2" Green LED
LED3	0.2" Yellow LED
Miscellaneous	
JK1, 2	¼" jack sockets
batteries	(2 x HP16 size)
Vero potting box	(see Buylines)

HE

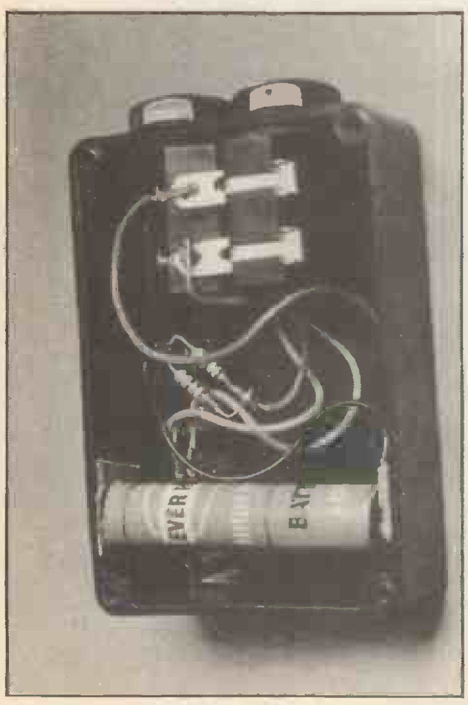

Figure 3. The innards

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3300*	63	115 × 35	80p	
3300*	150	100 × 65	120p	
4700	75	115 × 35	190p	
11000	25	68 × 50	180p	
15000	16	80 × 35	180p	
15000	40	115 × 35	190p	
22000	16	80 × 50	220p	
22000	25	115 × 35	250p	
28000	25	105 × 70	270p	80p
34000	50	145 × 75	350p	80p
64000	40	115 × 75	590p	80p
68000	16	115 × 60	575p	80p
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7403	14p	–	16p
7404	14p	15p	–
7405	18p	–	–
7406	32p	–	–
7407	32p	–	–
7408	17p	22p	–
7409	22p	–	–
7410	15p	19p	–
7411	–	38p	–
7413	30p	–	–
7414	50p	–	–
7416	27p	–	–
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7428	35p	–	–
7430	17p	20p	–
7432	28p	30p	–
7437	35p	–	–
7438	30p	35p	–
7439	30p	–	–
7440	17p	19p	–
7441	65p	–	–
7442	55p	–	–
7445	120p	–	–
7447	45p	–	–
7450	17p	–	–
7451	–	22p	–
7454	17p	23p	–
7470	33p	–	–
7472	28p	–	–
7473	34p	–	–
7474	28p	32p	36p
7475	28p	–	–
7476	35p	–	–
7485	–	–	–
7486	34p	35p	–
7489	200p	–	–
7490	28p	–	–
7492	50p	–	–
7493	28p	–	–
7495	65p	–	–
7496	60p	–	–
7497	175p	–	–
74100	130p	–	–
74104	45p	–	–
74107	32p	–	–
74109	50p	–	–
74111	50p	–	–
74112	–	–	90p
74114	–	–	45p
74116	195p	–	–
74118	75p	–	–
74121	28p	–	–
74122	41p	–	–
74123	45p	60p	–
74125	53p	–	–
74128	72p	–	–
74132	68p	–	–
74133	–	25p	–
74147	180p	–	–
74148	103p	–	–
74150	98p	–	–
74151	60p	100p	–
74153	65p	–	–
74154	98p	–	–
74155	60p	–	–
74157	60p	65p	–
74161	90p	–	–
74163	80p	–	–
74164	120p	110p	–
74166	120p	–	–
74170	235p	–	–
74172	445p	–	–
74173	110p	–	–
74174	85p	–	–
74175	80p	100p	–
74180	92p	–	–
74181	150p	–	–
74182	–	90p	–
74190	85p	–	–
74191	85p	–	–
74193	85p	95p	–
74194	85p	–	–
74197	75p	–	–
74198	140p	–	–
74241	150p	–	–
74266	–	95p	–
74273	265p	–	–
74279	80p	–	–
74283	155p	–	–
74284	400p	–	–
74285	400p	–	–
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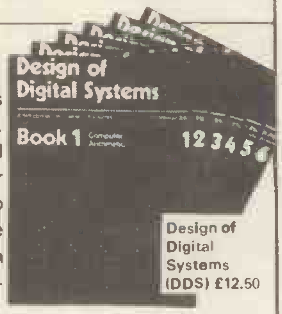

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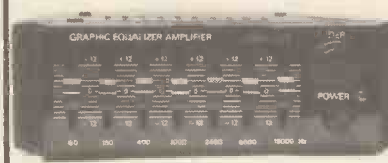

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Talking Design

This month's episode of Talking Design looks at our old friend the op amp. As usual we have a buildable circuit for you to put theory into practice

AT THE CENTRE of this month's design is an op amp. The op amp principle is to be found in many analogue circuits: an understanding of this principle is a key to the understanding of these circuits. **Figure 1** shows the circuit symbol of an op amp. Disregarding the supply connections the device, usually in the form of an IC, has three terminals. One is the output and the other two, labelled '+' and '−', are the inputs. Any signals fed to the non-inverting (+) input will appear at the output in phase with this input. A signal fed to the inverting (−) input will appear at the output phase-inverted. Now the voltage gain of an op amp is high: the 741 for instance has an open loop gain at DC of 100 dB, equivalent to 1×10^5. For the amplifier to remain stable, however, it is necessary to provide 'roll off' or frequency compensation to the gain at high frequencies. This compensation is either applied within the op amp (as is done in the 741) or, if no internal compensation is used, through peripheral components. The easiest way to visualise how an op amp works is to remember that the change in output voltage is equal to the open-loop gain (Av) multiplied by the *difference* in voltage between the two inputs. (By open loop we mean that the op amp is working without any feedback components.) Op amps are rarely used without feedback — but more on the techniques of feedback later.

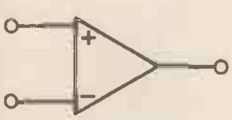

Figure 1. Circuit symbol of an op amp

It is customary to run op amps from dual power supply lines, where 0 V is the centre rail. Input and output voltages swing, therefore, above and below this centre point.

In **Fig. 2a**, the inverting input is connected to the junction of R1 and R2. The input signal, Vin, is applied between R1 and 0 V. For the sake of argument assume that the input signal is a positive voltage. In consequence the op amp's output voltage will be such that the inverting input is at the same voltage as the non-inverting input (0 V). A current I_1 thus flows through R1 to the inverting input. From Ohm's law this current must be equal to Vin/R1. To maintain the inverting input at 0 V the output must go negative to produce an identical current I_2 through R2. Knowing this we can determine the gain of the circuit thus:

The currents I_1 and I_2 are given by:

$$I_1 = \frac{V_{in}}{R1}$$

and

$$I_2 = \frac{V_O}{R2}$$

Since $I_1 = -I_2$,

$$\frac{V_{in}}{R1} = -\frac{V_O}{R2}$$

Multiplying by R2:

$$\frac{R2V_{in}}{R1} = -V_O.$$

Hence the gain Av is given by:

$$Av = \frac{V_O}{V_{in}}$$

$$= -\frac{R2}{R3}$$

The minus sign indicates that the output voltage is out of phase with the input.

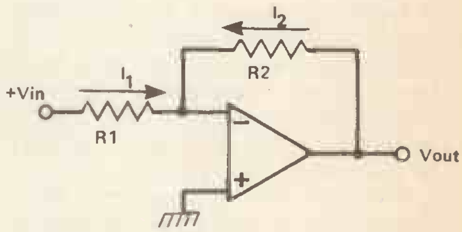

Figure 2a. Resistor used to feed back current between output and inverting input

The non-inverting amplifier

Figure 2b shows one of the most popular op amp configurations, the non-inverting amplifier.

Again we will assume that the input voltage is positive.

If the inverting input is held at Vin the op amp's output will go positive until the voltage on the inverting input is also Vin. To do this a current, I_1 equal to Vin /R1 must flow from the output of the op amp, through R2 and R1. Once again this gives us all the information that we need to determine the gain in terms of R1 and R2:

From Ohm's law,

$$V_O = I_1 (R1 + R2),$$

but

$$\frac{V_{in}}{R1} = I_1.$$

Therefore,

$$V_O = \frac{V_{in} (R1 + R2)}{R1}$$

Thus:

$$\frac{V_O}{V_{in}} = \frac{R1 + R2}{R1}$$

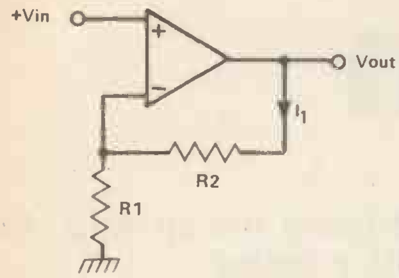

Figure 2b. Non-inverting amplifier configuration

Figure 2c shows a practical non-inverting amplifier stage. As you will notice three other components have been added. Capacitor C1 couples AC signals but it's main function is to block any DC voltages that may be present in the input.

Resistor R3 defines the input impedance of the stage. The input impedance, at the non-inverting input, is at least 1M0 before feedback is applied. The feedback increases this value so that the effective input impedance is set by the value of R3.

Notice also that with the non-inverting amplifier, if the output is shorted to the inverting input, the gain will be unity. In fact it is impossible to produce an amplifier which has a gain of less than unity in the non-inverting mode.

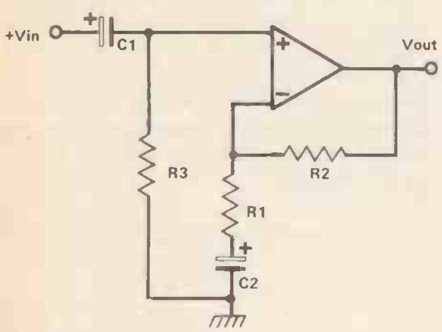

Figure 2c. Practical non-inverting amplifier with AC input coupling

Capacitor C2 is included in the feedback loop, in series with R2. At AC it's value is chosen so that it's impedance at the lowest frequency to be amplified is much smaller, typically ten times less, than the value of R2.

Equalisation

So much for linear feedback amplifiers. On occasions though it is necessary to produce non-linear feedback to equalise for various types of transducer. Take, for instance, the magnetic cartridge. **Figure 3** shows the response required to equalise a magnetic cartridge so that the output signal is 'flat' relative to frequency, and is specified by the RIAA (Record Industry Association of America).

The response curve can be considered in four parts. At low frequencies (up to 50Hz) the response is flat. At 50Hz it is 3dB down and falls at 6 dB/octave to 500 Hz where it is 3 dB up relative to 1 kHz. Another flat portion extends from 500 Hz to 2.1 kHz where the response is again 3 dB down. From this point the response falls at 6 dB/octave, theoretically to an infinite frequency.

This replay response is required because records are produced with bass cut and treble boost. The bass cut is required because at low frequencies the cutting stylus makes much larger excursions than at mid and high frequenies. If the amplitude was not reduced in this way the grooves would have to be far wider and spaced further apart. So much so in fact that the microgroove LP would not be technically possible. The high-frequency signals are boosted so that on replay the inherent noise produced by the vinyl is also attenuated.

Looking again at the response curve you will notice that the variation in gain is 40 dB or 100:1 between 20 Hz and 20 kHz.

To see how this is achieved in practice look at the circuit in **Fig. 4**. This shows a non-inverting amplifier with R2 shunted by a capacitor, C2. At low frequencies the impedance of the capacitor will be much higher than the value of R2, and the gain will be defined by the ratio of R1 to

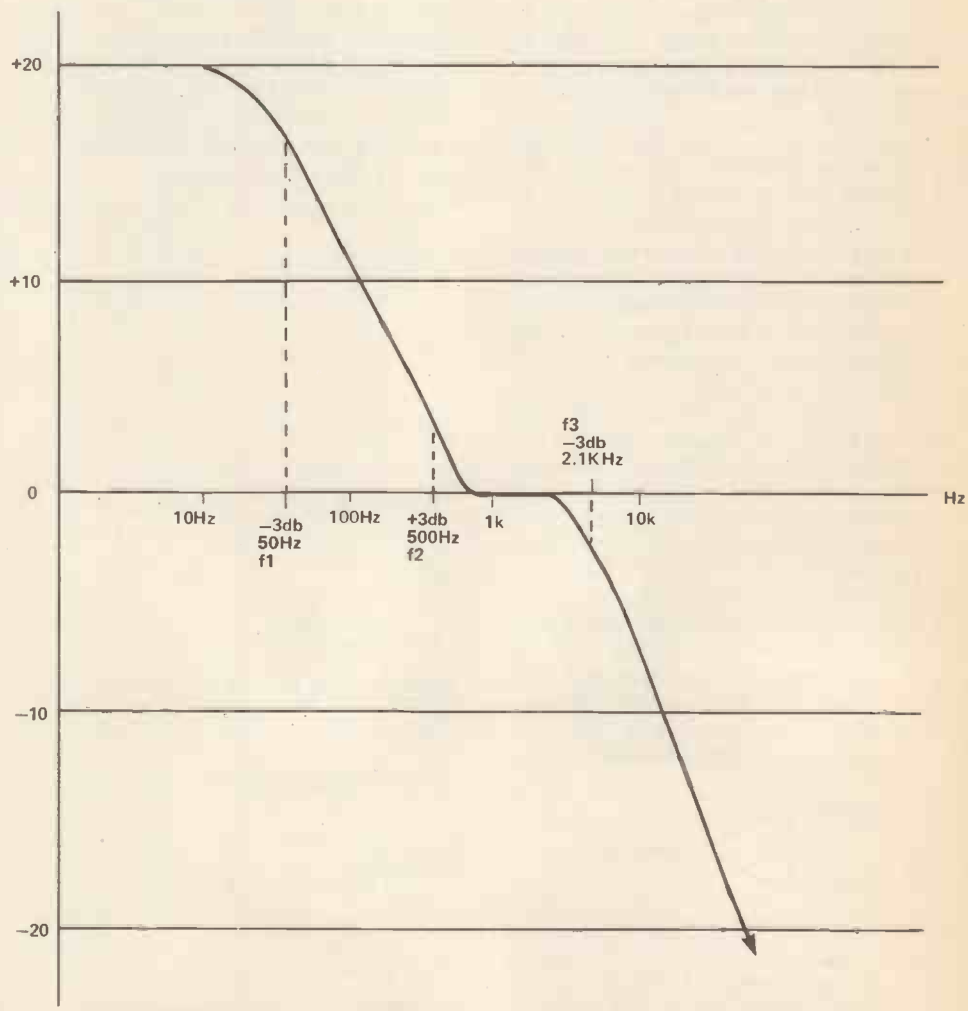

Figure 3. RIAA frequency response curve for a magnetic pickup

R2. At a particular frequency, however, this fall will not continue indefinitely but will level off to unity again. The 3 dB-up point f_2 occurs when the impedance of the capacitor is equal to that of R1.

To take an actual example let's assume that the resistors in **Fig. 4** have the values shown in brackets.

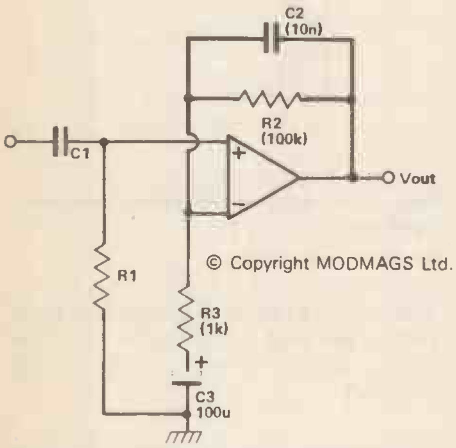

Figure 4. Non-inverting amplifier circuit using some practical component values

Now the frequency f_1 at which the response has fallen by 3 dB can be calculated from the equation:

Beyond this frequency the response will fall at 6 db/octave until the impedance of C1 is equal to that of R3. From the equation above, and substituting the value of R3:

$$f = \frac{1}{2\pi CR}.$$

Substituting for C and R,

$$f_1 = \frac{1}{2 \times 3.14 \times 10^{-8} \times 10^{-5}}$$

$$= 159\text{Hz}$$

The magnetic equalisation curve consists of two of these simple 6 dB/octave curves and we now know enough to calculate the required values. **Figure 5** shows an equalisation circuit which will feed one auxilliary input (100 mV rating) of a power amplifier. The typical output of a magnetic cartridge is 5 mV and we want, at the output, 100 mV. This sets the midband gain for us at 100 mV/5 mV: that is, 20.

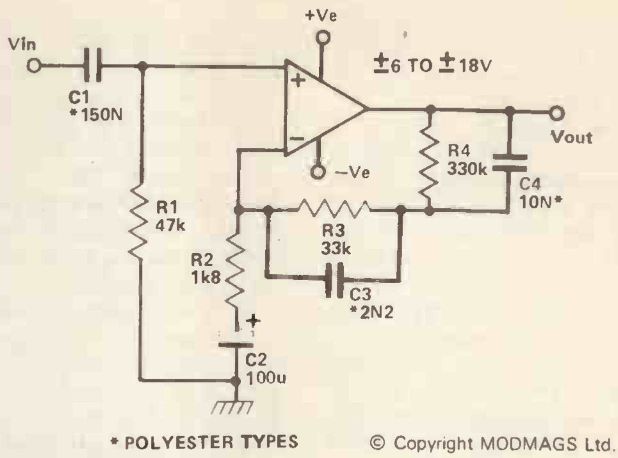

Figure 5. Practical RIAA equalisation circuit

Resistor R3 sets the midband gain, in conjunction with R3, and R2 is set to an arbitrary value, for our circuit 1k8. Since the gain is given by R3 + R2/R2, this equation can be rearranged thus:

$$20 = \frac{R3 + R2}{R2},$$

$$20R2 = R3 + R2,$$

giving:

$$R3 = 19R2 = 34k2,$$

(nearest value 33k).

This sets our gain between 500 Hz and 2.1 kHz. First roll-off to be calculated is that above 2.1 kHz. Capacitor C3 provides this function as it shunts R3 at high frequencies thus reducing the gain as required by the response curve. To set the -3 dB point at 2.1 kHz we make use of the equation for impedance Z, given by:

$$Z = \frac{1}{2\pi fC}$$

Substituting R3 for Z, and C3 for C gives:

$$C_3 = \frac{1}{2\pi fR3},$$

$$= \frac{1}{2 \times 3.14 \times 3.3 \times 10^4 \times 2.1 \times 10^3}$$

$$= 2.29 \times 10^{-9}\text{F}.$$

The nearest value is 2n2. Now we turn our attention to the bass boost part of the circuit below 500 Hz. This boost is obtained by connecting C4 in series with R3 and C3. To obtain the boost between the output of the op amp and the inverting input the impedance must increase as the frequency decreases. This, of course, is exactly what happens with a capacitor. To calculate its value, R3 is substituted for Z and 500 Hz for f, giving:

$$C4 = \frac{1}{2\pi fR3},$$

$$= \frac{1}{2 \times 3.14 \times 5 \times 10^2 \times 3.3 \times 10^4},$$

$$= 9.64 \times 10^{-9}$$

The nearest value is 10n. With the circuit as it stands the gain of the amplifier would try to increase indefinitely as the frequency decreases. The response curve calls for a flat portion below 50 Hz so further modification is required. Resistor R4 is thus placed in parallel with C4 to limit the gain and produce the -3 dB point at 50 Hz. The value of R4 is equal to the impedance of C4 at 50 Hz where:

$$R4 = \frac{1}{2\pi fC4},$$

$$= \frac{1}{2 \times 3.14 \times 5 \times 10^1 \times 10^{-8}},$$

$$= 3.18 \times 10^{-5}$$

(nearest value 330k)

The feedback loop we have just designed will produce the required gain and response: however, we are not quite finished yet.

Magnetic cartridges require a load impedance of 47k to produce the correct response. We can ensure this by making R1 equal to 47k.

Lastly we have to calculate the value of C1. A recent European standard recommends that magnetic cartridge amplifiers should have their response rolled off below 20 Hz to help attenuate subsonic signals produced by record warps. By ensuring that the impedance of C1 is equal to that of R1 at 20Hz this extra roll off can be obtained. The value of C1 is given by:

$$C1 = \frac{1}{2\pi f R1}$$

$$= \frac{1}{2 \times 3.14 \times 2 \times 10^1 \times 4.7 \times 10^4}$$

$$= 150n.$$

The circuit was designed to operate with a 741 as the op amp but if an LF356 is substituted a far better response can be obtained. The LF356 will also give a better signal-to-noise ratio.

Although this hasn't been measured the improvement is quite audible. With a 741 the S/N ratio is -65 dB unweighted relative to an output of 100 mV.

When this circuit is duplicated for stereo operation it consumes about 6 mA from the dual supply. Although a pair of 9 V batteries can be used, it is best to use a mains-operated supply. Now obtaining a dual supply for this project can be a pain and so the circuit shown in **Fig. 5** can be modified for single supply rail operation. To do this, connect the earthy end of R1 to the junction of R5 and R6 in the circuit shown in **Fig. 6**. Resistor R6 in this circuit is decoupled to earth by C5 as shown. (Capacitor C2 is connected to the negative rail instead of to 0V if this modification is used).

To prevent the introduction of mains hum it is imperative that screened cable is used between the cartridge and the input of the equalisation circuit for each channel.

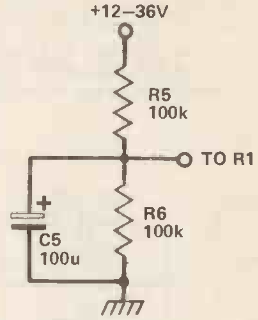

Figure 6. Circuit to allow operation from a single supply rail

Figure 7 shows a suitable layout for stereo operation.

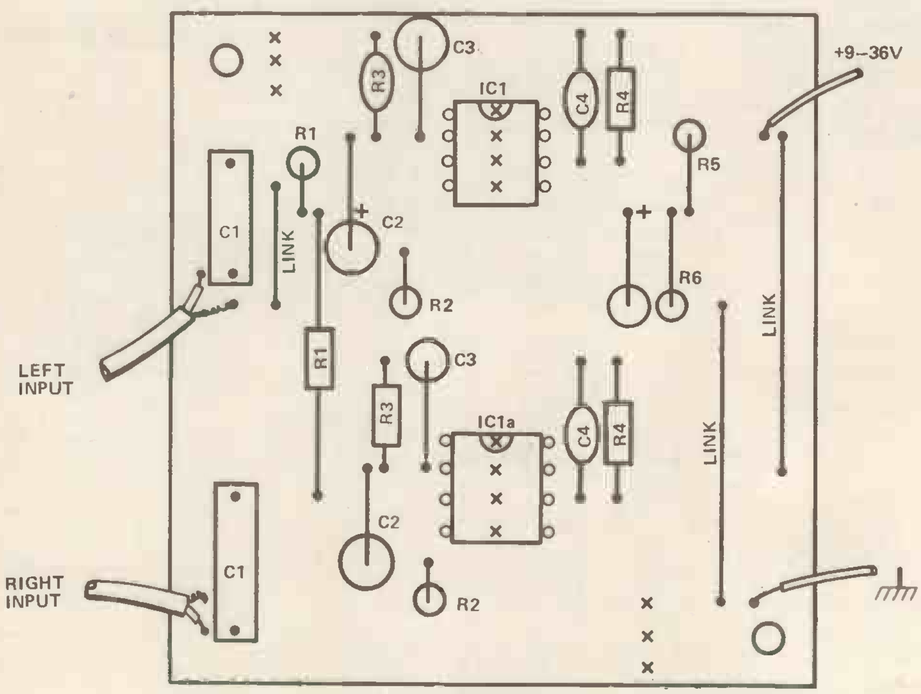

Figure 7. Recommended component layout for stereo operation

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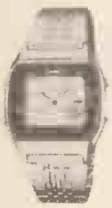

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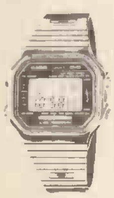

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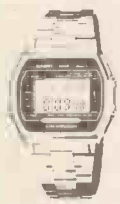

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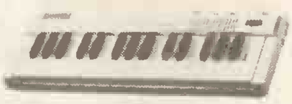

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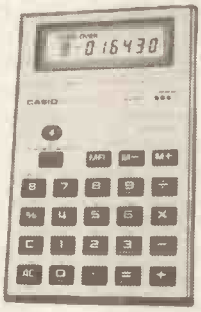

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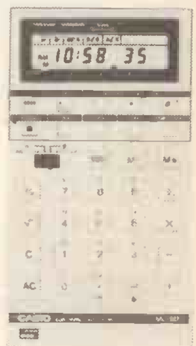

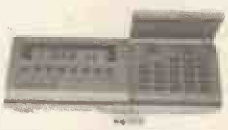

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THERE ARE TWO main problems associated with audio power measurements:

- the signal peaks (that is the changes in volume level) are so fast-moving that an ordinary meter — digital or analogue, cannot respond fast enough to give an accurate reading
- the changes of levels of volume occur over a very wide range — for example, the difference in signal amplitude between the quietest sound we can *hear* and the loudest sound we can *bear* is over 100,000 times

The HE Audio Power Meter overcomes both problems by using a 'line of LEDs' display instead of a conventional moving coil meter. The LEDs are scaled in logarithmic steps of 3 dB (each step representing a doubling of power). This display responds exceptionally quickly to the signal peaks and is easily read and also very rugged, whilst the logarithmic scale reduces the apparent scale length to a manageable form.

The circuit is for a stereo version and it fits into a small hand-held case. Two ICs (one per channel) do literally all of the work, measuring the audio power and driving the LED display in the correct logarithmic manner, measuring from 0.2 to 100 W in 3 dB steps. The meter is simply connected to the two speakers. If a continuous display is desired (such as for use as a decorative ornament), then a mains-operated power supply should be used in preference to the built-in PP3 battery. (A fair amount of current is required to drive the LEDs.) An ideal supply unit is the HE Battery Eliminator featured in last month's issue.

Construction

Start construction with the printed circuit board. Insert the link first, followed by passive components, the resistors, capacitor and the two IC sockets (if used).

Mark and drill the bottom of the case to fit the phono plugs, JK1 and SW1, and insert all four into their places. Next, attach 22 leads, about five inches long, to the board, where connections to the LEDs go, but don't attach the leads to the LEDs yet. Before fastening the PCB into the case connect the phono sockets, jack and switch to the relevant places on the board, following the diagram in **Fig. 2.**

The top half of the case should now be marked and drilled for the 20 LEDs. If you make the holes just the right diameter for the LEDs to push-fit then no special fixing procedures are necessary. Alternatively, a spot of glue will be OK.

The anodes of each line of LEDs can be wired together using a short length of uninsulated wire and from there to the relevant point on the PCB shown in **Fig. 2.** Next, wire the remaining 20 connections from the PCB to the correct cathode of each LED and finally cable-form the two groups of leads using a couple of cable ties.

Resistors Rx and Ry can both be calculated from the table in **Fig. 3** and need to be the correct value for whatever speaker impedance the audio system uses. Simply check on the table what the speaker impedance is and insert Rx and Ry as the corresponding resistor values.

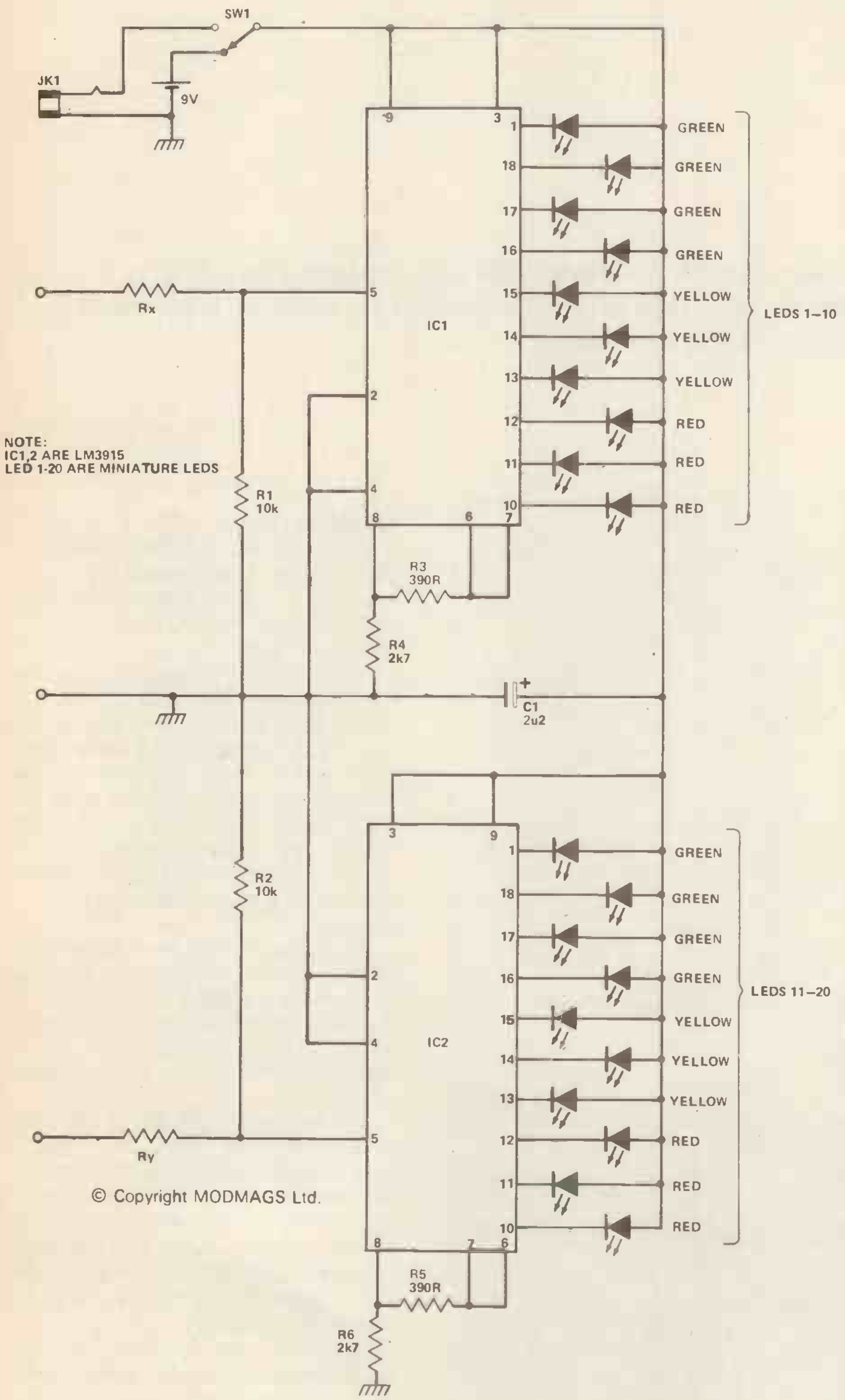


Figure 1. With only one IC per channel the HE Stereo Power Meter combines accuracy with simplicity

How it Works

Figure 1 shows the full circuit diagram of the audio power meter and from this the reader can appreciate that each stereo channel is identical. The following description therefore explains how only one channel (IC1 and associated components) functions — the other (IC2 and its components) operates similarly.

Integrated circuit IC1 is an LM3915, which is classified as a dot/bar display driver — suitable for driving a line of 10 LEDs either in dot mode (one LED at a time) or bar mode (a continuous line of LEDs). This application sees the LM3915 in bar mode.

The IC has an internal ten-step voltage divider and as the voltage at pin 5 (owing to the varying audio signal) increases above these steps a corresponding LED is turned on. Thus if the voltage at pin 5 was half way up the voltage divider scale then five LEDs would be on. The voltage divider is

Parts List

RESISTORS (All ¼ W 5%)	
R1,2	10k
R3,5	390R
R4,6	2k7
Rx,y	see text
CAPACITORS	
C1	2u2 16 V tantalum
SEMICONDUCTORS	
IC1,2	LM3915 dot/bar display driver
LED 1 to 20	miniature LEDs (various colours — see Fig. 1)
MISCELLANEOUS	
SW1	single-pole, double-throw toggle
JK1	3.5 mm jack socket
2 x phono sockets	
9 V battery and clip	
case to suit (see BUYLINES)	

Buylines

Although the LM3915 has been around for a few months now, you may still have difficulty finding a local supplier but the larger mail order companies will be able to help. The approximate cost of components (excluding case and PCB) for this project should be around £15. The case is type no. 202-21048D from Vero.

measured in steps of 3 dB. Now, we weren't too sure what this meant so we asked the postman and he told us that when a voltage V_1 increases by 3 dB over a second voltage V_2 it simply means that it is $\sqrt{2}$ times as big. Thus:

$$V_2 = V_1\sqrt{2}, \quad = 1.414\,V_1.$$

Now, power P is given by:

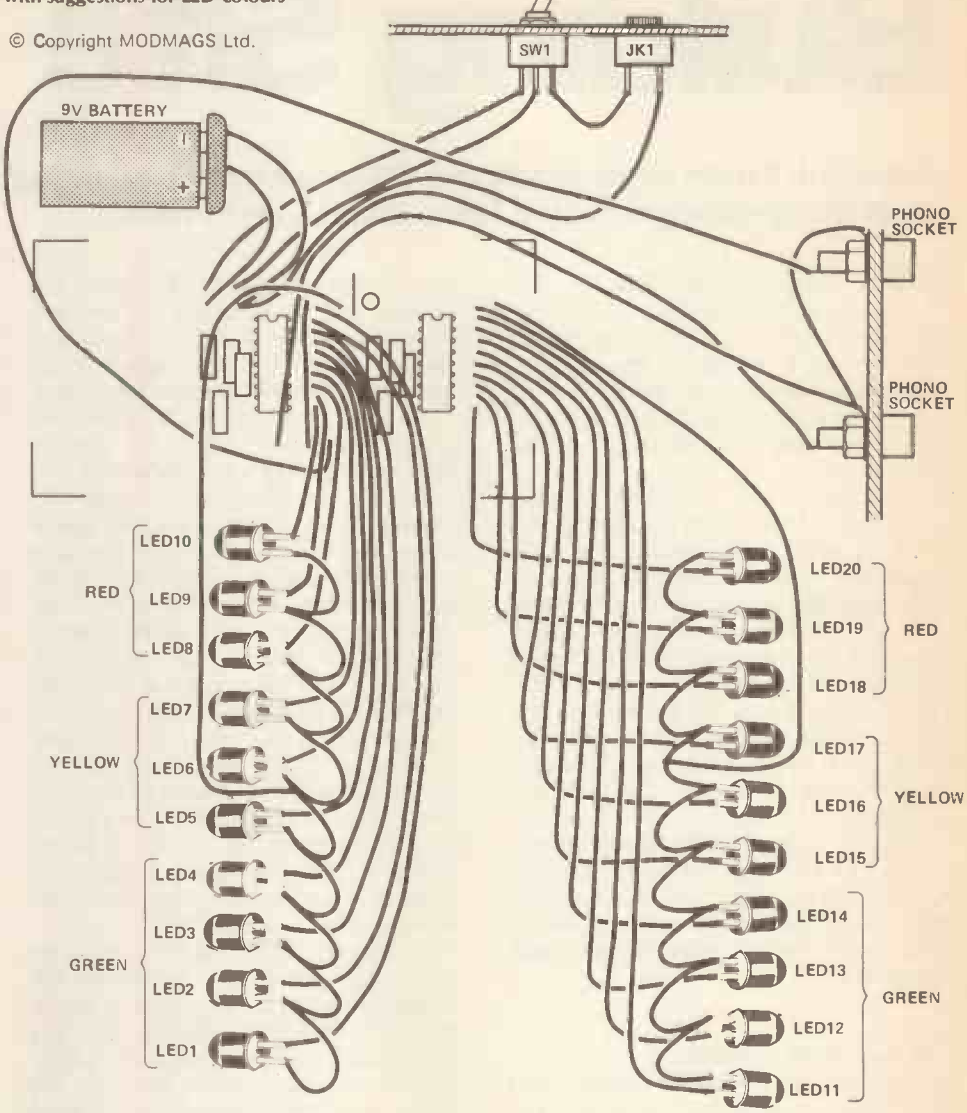
$$P = \frac{V^2}{R}, \quad \text{so}$$

$$P_1 = \frac{V_1^2}{R} \quad \text{and} \quad P_2 = \frac{(V_1\sqrt{2})^2}{R}, \quad = \frac{2V_1^2}{R} \quad = 2P_1.$$

Hence for a voltage gain of 3 dB, power is doubled.

Correspondingly, the scale of the power meter can be marked off either in steps of 3 dB or as power (doubling for each LED in the line).

Figure 2. Connection details of the project with suggestions for LED colours



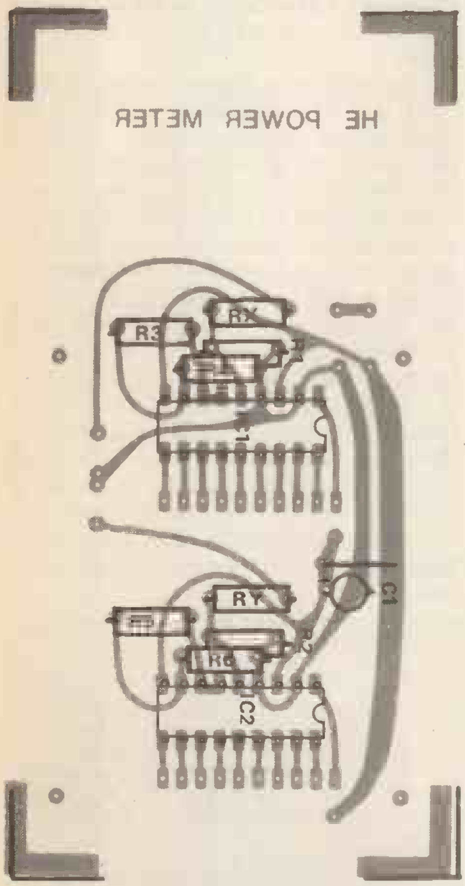
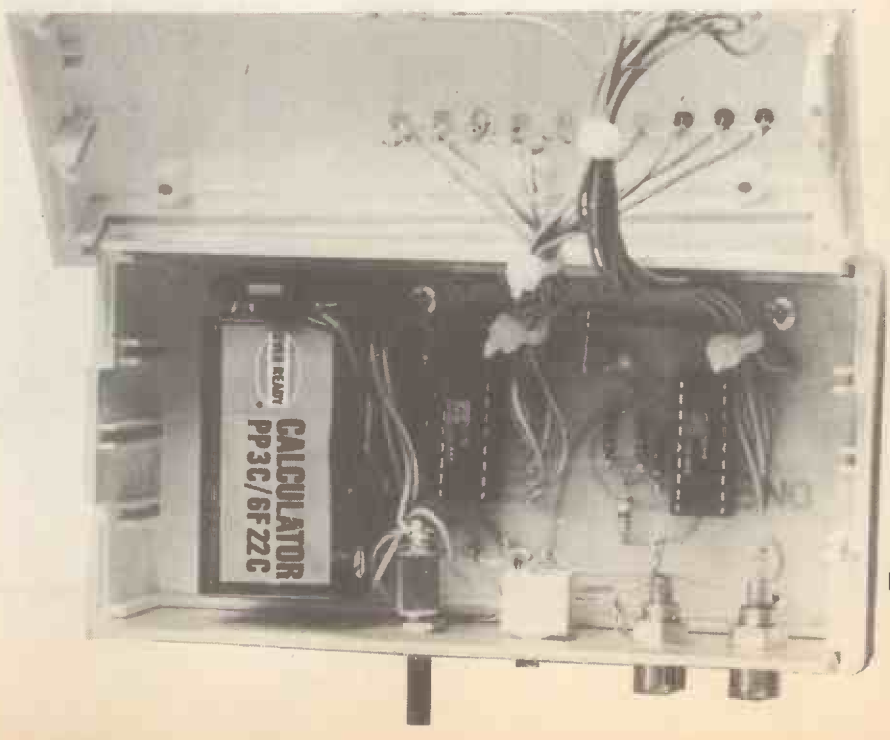


Figure 3. Above is the PCB overlay — below shows how to calculate Rx and Ry

SPEAKER IMPEDANCE	Rx,Ry
4R	10k
8R	18k
16R	33k



HE

Building Site

After the Prof's cartoon last month on incorrect soldering techniques, Keith Brindley puts things straight with a few down-to-earth hints

DON'T LET ANYBODY kid you into believing that soldering is difficult — it's not! There's no art to soldering, it's simply just a matter of applying the right rules at the right time. Nothing else! Once you know the rules, soldering is as easy as falling off a log, backwards.

First things first, you must have the equipment for the job: a soldering iron with a good tip; cored solder (not plumbers' stuff); and a good quality pair of long-nosed pliers and side-cutters. **Figure 1** shows the sort of equipment we have at HE — although we should point out that this particular set-up is quite pricey (it *is* worth the expense in our case, because it's in almost constant use) and is not, usually, the sort of gear which the hobbyist can afford. However, very good quality irons and tools can be purchased at prices more suited to the amateur's pocket from around £5 per item. Irons are rated by their electrical power and any within the range 15-40 W is normally adequate for PCB work.

What's it all about?

Now, just before we jump into soldering technique it might be a good idea to take a brief look at why we use solder at all. Well, the answer is simple — correct use of solder along with a PCB gives us a method of connecting the components of a circuit together in a permanent fashion which is the toughest, most resilient and neatest method available. The idea is that the joint is heated and solder is applied to 'alloy' the component to the copper track of the PCB.

Solder for electronic components consists of a mixture of tin and lead in about a 60/40 ratio and as such has quite a low melting-point (about 190°C) compared with the other metals in the joint. This low temperature melting-point of solder is the key to understanding the process — it means that the joint does not have to be heated up so much that component damage occurs, but nevertheless, a strong join between the metals can still be obtained. Included in the solder are a number of thin veins of flux, which promote the fusion of the metals by preventing any rapid oxide build-up which would otherwise occur when the metals are heated.

Everything to be soldered must be clean and greasefree, otherwise the solder cannot make a good joint. This is the area where most problems lie — any grease on the copper track or component leads may remain between the solder and metal, preventing a good electrical contact. Even if a total open circuit (ie no connection) doesn't occur, the joint may still possess an electrical resistance which could prevent your circuit from working. Methylated spirits, wire-wool, fine emery paper or simple detergent powder can be used to clean the two metals of the joint. The surface of copper in particular should be shiny clean — remember that copper oxidises in contact with air and the oxide layer needs to be removed before soldering. If your board has been left for more than just a few hours without being completed, you may have to clean it again.

One way of avoiding having to re-clean the PCB is to make use of the fact that solder doesn't oxidise easily, because of its high percentage of tin. By heating the copper at each joint to be made and melting a thin layer of solder around the hole, the copper is protected against dirt and grease. This process, shown in **Fig. 2**, is called 'tinning' and can be used successfully to keep the soldering iron tip clean too! Wipe the hot tip of the iron on a damp sponge to get rid of any gunge and simply melt some solder on it — letting the solder flow over the end ¼" or so. The tip should now have a silvery, shiny appearance and you should keep it so. In use, every time the tip loses the shiny appearance clean it on the sponge and tin it.

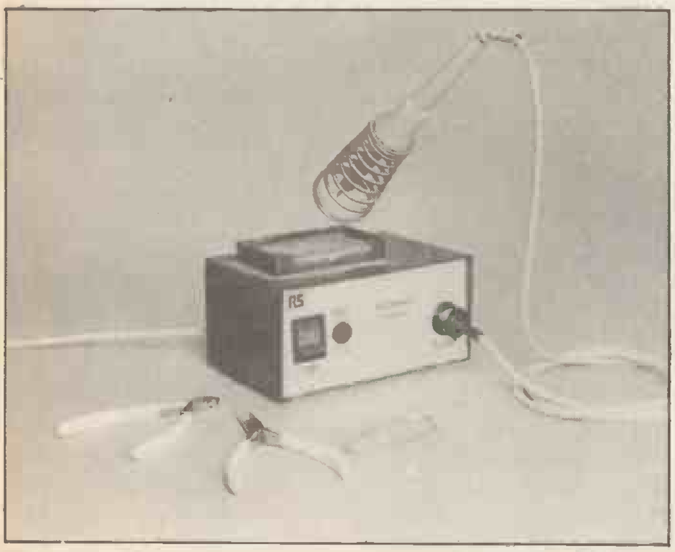


Figure 1. A collection of tools which we use regularly in the HE workshop

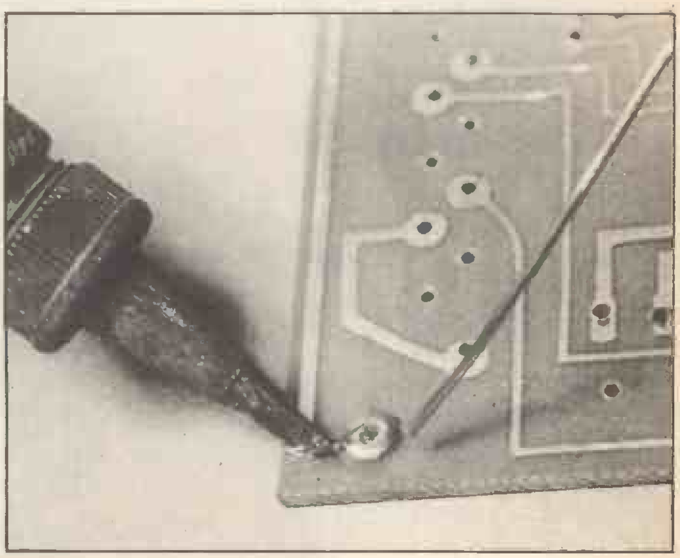


Figure 2. 'Tinning' a hole on a PCB to ease future soldering

Technique

Well, that's got the equipment and its upkeep out of the way — we can move on now to the actual soldering process. The simple knack here is to remember that the joint needs to be heated up to a temperature which exceeds that of the melting-point of solder. BUT, you must not heat the joint up so hot that you damage the component through excess heat!

So, how do you know when the temperature is correct? Short of a thermocouple and a meter, you don't — it's a matter of guesswork! However, there is a simple way to keep the amount of uncertainty to a minimum and this relies on the fact that heat should only be applied to the component itself at the very last minute. The copper, because of its large surface area compared with the component lead, needs far more heat and thus the tinned iron tip can be held steady on the surface of the copper so that maximum heat transfer takes place. At no time yet should the component lead be heated. Holding the iron tip at one side of the component hole, as in **Fig. 3**, you can now apply the solder — to the other side of the hole. When the copper is hot enough (which shouldn't take more than five or six seconds, depending on the power of the iron and the surface area of the copper), the solder will begin to flow onto the metal. You then know that the copper is just at the correct temperature! At this point, the iron can be moved up to the component lead (still touching the copper, as in **Fig. 4**) so that it also can be heated. In a couple of seconds the lead will be hot enough, and solder can be applied there.

As soon as the joint has been made, remove the soldering iron completely, to prevent heat damage to components. The large area of copper (a good heat conductor) will dissipate the excess heat rapidly. Let the joint cool naturally in air — don't blow on it, because this may make the solder brittle and it may break. If all goes well and you make a 'good' joint, the solder will flow into a smooth, arc-shaped form as pictured in **Fig. 5**, and have a shiny, bright appearance. Alternatively, if you make a 'cock-up' of the joint, you will have a dreaded 'blob' — a more or less round ball of solder which doesn't make good soldered contact with either copper track or component lead.

Finally, all that remains is to cut off the excess component leads close to the board with your side-cutters, to avoid short-circuits between individual leads or between leads and printed tracks. After all that, it's just practice — you will soon reach a stage when soldering is second nature to you and it becomes difficult to solder a bad joint.

HE

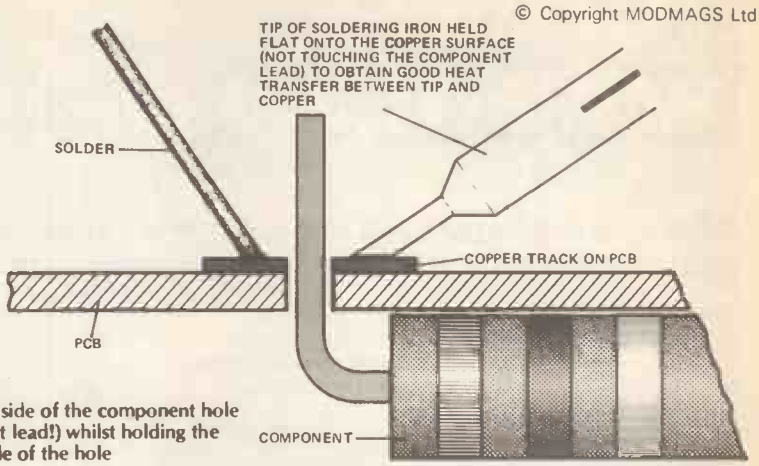


Figure 3. Heat one side of the component hole (not the component lead!) whilst holding the solder at the far side of the hole

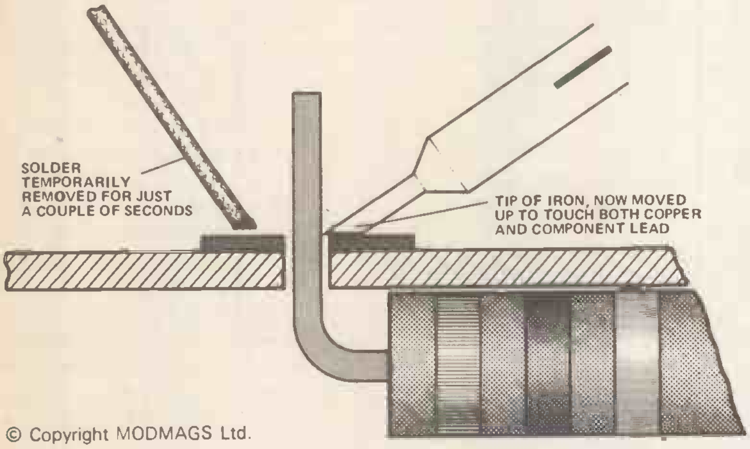


Figure 4. Just as the copper is hot enough, indicated by the solder beginning to melt, move the Iron tip up to the component lead

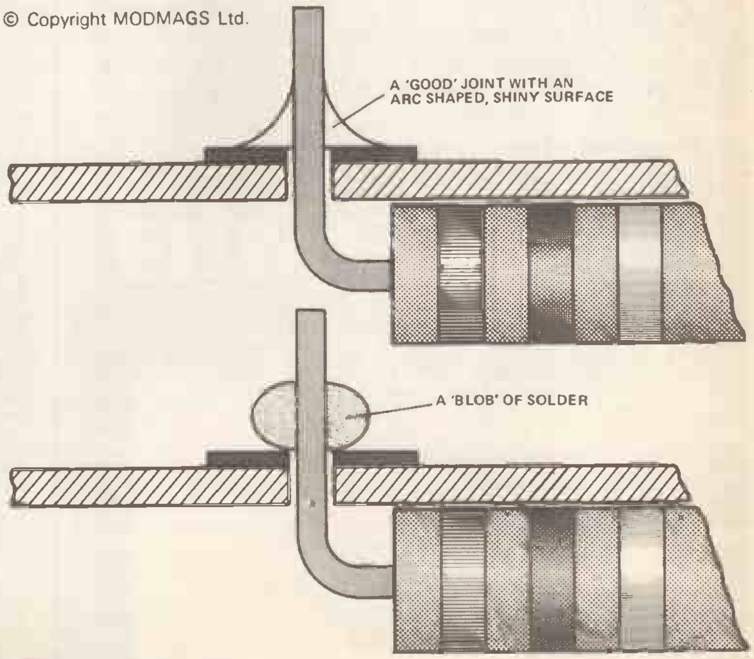


Figure 5. How to do it and how not to do it. Try not to get the 'blob'!

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HEF4002	22	HEF4047	109	HEF4517	478
HEF4006	119	HEF4049	57	HEF4518	118
HEF4007	22	HEF4050	57	HEF4519	69
HEF4008	100	HEF4051	87	HEF4520	118
HEF4011	22	HEF4052	90	HEF4521	235
HEF4012	22	HEF4053	90	HEF4528	124
HEF4013	57	HEF4066	62	HEF4532	150
HEF4014	105	HEF4067	475	HEF4534	638
HEF4015	100	HEF4068	22	HEF4539	138
HEF4016	57	HEF4069	22	HEF4585	122
HEF4017	100	HEF4070	22	HEF4724	214
HEF4018	100	HEF4071	23	HEF40097	113
HEF4019	58	HEF4072	23	HEF40098	92
HEF4020	112	HEF4073	23	HEF40106	78
HEF4021	107	HEF4075	23	HEF40160	149
HEF4022	103	HEF4076	130	HEF40192	149
HEF4023	22	HEF4077	22		
HEF4024	78	HEF4078	23		
HEF4025	22	HEF4081	23		
HEF4026	244	HEF4082	23		
HEF4027	57	HEF4085	80		
HEF4028	89	HEF4086	80		
HEF4029	113	HEF4093	63		
HEF4030	58	HEF4094	219		
HEF4031	250	HEF4104	208		
HEF4035	138	HEF4502	114		
HEF4040	107	HEF4505	714		
HEF4041	94	HEF4508	230		
HEF4042	83	HEF4510	135		
HEF4043	100	HEF4511	157		

Voltage Regulators

LM309DA(K)	119
UA723CN	42
UA7805CU	78
UA7812CU	78
UA7815CU	78
UA7912CU	97
UA7915CU	97
UA78L05CS	38
UA78L12CS	38
UA78L15CS	38

LINEAR

CA3046	84
CA3080E	77
CA3130E	99
CA3140E	48
CA3189E	293
LM301AN	34
LM339N	78
LM380N	104
LM381AN	198
LM3900N	75
MC3403P	156
NE531	131
NE536T	259
NE555N	28
NE556N	66
NE566N	171
NE570N	485
NE571N	505
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IN4007	9	BC212L	12
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IN5402	15	BC214L	12
2N2369	21	BC547	13
2N2646	46	BC548	11
2N2926G	13	BC549	12
2N3053	19	BC557	15
2N3054	55	BC558	15
2N3055	55	BCY70	15
2N3702	9	BCY71	15
2N3704	9	BD131	39
2N3705	10	BD132	39
2N3773	297	BD139	39
2N3819	22	BD140	39
2N3820	39	BFR90	333
2N3904	9	BFX85	29
2N5457	39	BFY50	17
2N5459	35	BFY51	17
40673	88	BRY39	50
BC107	14	BSX20	21
BC108	14	CL8960	2850
BC108C	18	TIP31	48
BC109	14	TIP32	54
BC109B	19	TIP41C	76
BC109C	20	TIP42C	76
BC148	10	TIP2955	75
BC158	10	TIP3055	60
BC177	17	TIS43	36

CAPACITORS

Electrolytic Axial — Order Code
−10% to +50% Tol. — Cap 015 + μF

μF \ V	16	25	40	63
1.0				9
1.5				9
2.2				9
3.3				9
4.7				9
6.8			9	10
10		8		10
15	8		9	11
22		8		13
33	8		9	
47		8	11	13
68	9			
100		9	13	
150	9	10		31
220	13		26	36
330			30	40
470		23	32	47
680	21	30	39	54
1000	25	30	59	
1500	35	39		
2200	42			

Polyester Radial Leads — Order Code
Dipped Type, C280/352 Style — Cap 352
Moulded Type, 10.2mm Pitch — Cap 360
+ Value

μF	352	360	μF	352	360
.001		7	.1	7	9
.0015		7	.15	8	10
.0022	6	7	.22	9	11
.0033	6	7	.33	11	
.0047	6	7	.47	14	
.0068	6	7	.68	17	
.01	6	8	1.0	21	
.015	6	8	1.5	30	
.022	6	8	2.2	35	
.033	6	8			
.047	6	8			
.068	7	8			

Electrolytic Radial Leads — Order Code
−10% to +50% Tol. — Cap 034 + μF

μF \ V	10	16	25	36	40	50	63
.47							7
68							7
1.0							7
1.5							7
2.2							7
3.3							7
4.7					7		8
6.8			7			8	9
10		7			8		9
15		7	8			9	11
22	7	8			9	11	
33		8	9		11		
47	8	9		11			
68		9	11				
100	9						
150	11						

D.I.L. Sockets

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16 Pin Low Profile Socket Tin	16	DIL SKT 16

P.C.B. Components

Dalo Pen, Blue Ink, Slow Drying — 69

RESISTORS — Order Code

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0.25W, E24 Values 1R0-10M, 5% Tol. 100/100 (Mult 10/Value)	2 each	Res RO¼
0.5W, E12 Values 1R0-4M7, 10% Tol.	3 each	Res RO½ + Value

Metal Film, Fixed

0.5W, E24 Values, SR1-1M, 2% Tol.	8 each	Res MR30
2.5W, E12 Values, 10R-27K, 5% Tol	16 each	Res PR52 + Value

Metal Glaze, Fixed

0.5W, E24 Values, 1M-33M, 5% Tol.	18 each	Res VR37 + Value

Skeleton Presets, Miniature — Order Code

0.1W, E3 Values, 100R-1M, Lin. Vertical Mounting	8	Min. Preset V
0.1W, E3 Values, 100R-1M, Lin. Horizontal Mount	8	Min. Preset H + Value

Skeleton Presets, Standard

0.3W, E3 Values, 100R-4M7, Lin. Vertical Mounting	11	Std. Preset V
0.3W, E3 Values, 100R-4M7, Lin. Horizontal Mount	11	Std. Preset H + Value

Potentiometer, Rotary

0.5W, E3 Values, 1K-2M2 Lin.	39	Ro Pot Lin
0.25W, E3 Values, 4K7-2M2 Log.	39	Ro Pot Log + Value

Potentiometer, Slider

0.5W, E3 Values, 2K2-470 . Lin.	45	Sl Pot Lin
0.25W, E3 Values, 1K0 - 1M0 Log.	45	Sl Pot Log + Value

MAINS TRANSFORMERS — Order Code

Secondaries may be connected in series or parallel to give wide voltage range
Primaries 0-220, 240V

6VA Clamp Type Construction — 235 each
Approx 18% Regulation F C 54, H36, W35

0-4.5V, 0-4.5V Secondaries — Trans 6VA
0-5V, 0-6V
0-12V, 0-12V
0-15V, 0-15V
0-20V, 0-20V

20VA – Clamp Type Construction — 360 each
Approx 16% Regulation F C 70, H48, W46

0-4.5V, 0-4.5V Secondaries — Trans 20VA
0-6V, 0-6V
0-12V, 0-12V
0-15V, 0-15V
0-17.5V, 0-17.5V
0-20V, 0-20V

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ABS Box, C/W Brass Bushes, and Lid In Orange

		Order Code
L112 W82 D31	99	Case BIM2003 OR
L150 W80 D50	131	Case BIM2005 OR
L190 W110 D60	223	Case BIM2006 OR

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L111 W71 D42	150	Case BIM4004 OR
L161 W96 D53	208	Case BIM4005 OR

Diecast Boxes

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Aluminium Box and Lid in Natural Finish

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L192 W113 D61	334	Case BIM5006 NA

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Pin Insertion Tool for .040 type pin	147	203-21015F
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SS Pins 040 (100)	44/Pack	200-21017B
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Verowire Combs (25)	109/Pack	200-21339F
Verowire Wire (2)	109/Pack	200-21340G

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SPDT	C/Off	81	SW 8A1021
SPDT	Double Bias To Centre	90	SW 8A1041
DPDT		99	SW 8A2011
DPDT	C/Off	111	SW 8A2021

Miniature Push – C & K

SP	Push To Make, Momentary	62	SW 8531
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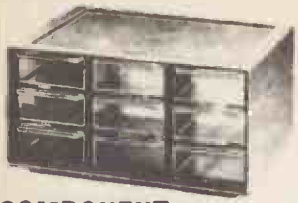

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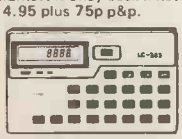

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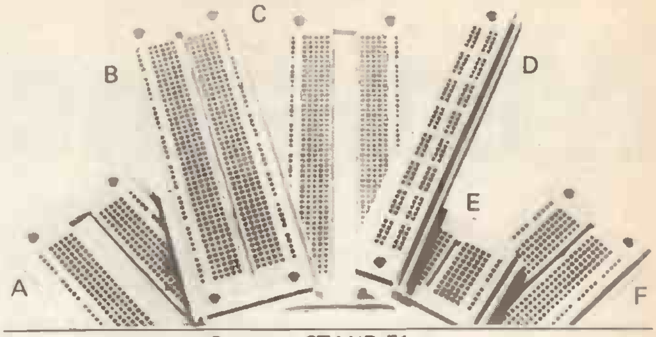

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Minisynth-2

Continuing the saga of HE's very own Minisynth — the musical gadget that's guaranteed to fascinate kids and adults alike

FIRST THINGS FIRST, let's have a brief recap of where you should be in your construction of HE Memory Bank if you followed last month's advice. Both PCBs, the main circuit board along with that of the keyboard, should now be finished and thoroughly checked for correct insertion of all semiconductors and polarised capacitors. If you've got this far then the boards can be laid carefully aside for the time being.

This month's construction work starts with the case and its associated marking and drilling — two jobs in one really: the front panel and the shell. The panel needs to be marked out according to whatever layout you require: ours is seen in the photographs and we shall assume that you follow it. Holes for pots and switches are no real problem as they can all be drilled, but the oblong hole for the keys of the keyboard will need to be very carefully filed out. Note that a slightly enlarged section is required on the right-hand side of the panel to allow the control push buttons to fit.

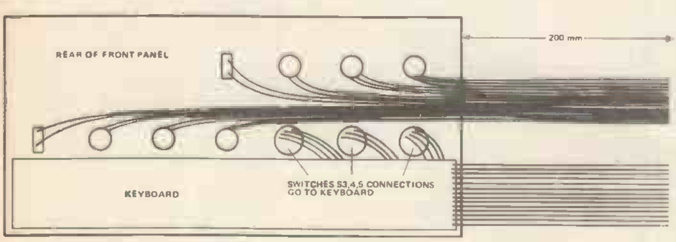
Mount the keyboard on the back of the panel using double-sided adhesive pads along the edge, and make sure that the pads aren't visible from the front. This may seem a very unorthodox method of fixing but it *is* reliable and provides a convenient means of insulating the board from the metal of the front panel. This part of the construction is completed with the insertion of all pots and switches.

The case itself needs to be drilled for the main PCB mounting screws, loudspeaker grille and jack socket. Their siting is not critical but make sure that wherever they are placed, they don't obstruct the front panel in its final position.

Buylines

A kit of parts for Memory Bank is obtainable from Magenta Electronics, who advertise in HE. They are the only known suppliers of IC1.

All parts (excluding the case) cost £28.50 inclusive of p&p and VAT. Magenta can also supply the type of case we used, for an extra £5.80 inc p&p and VAT, when ordered with the kit.



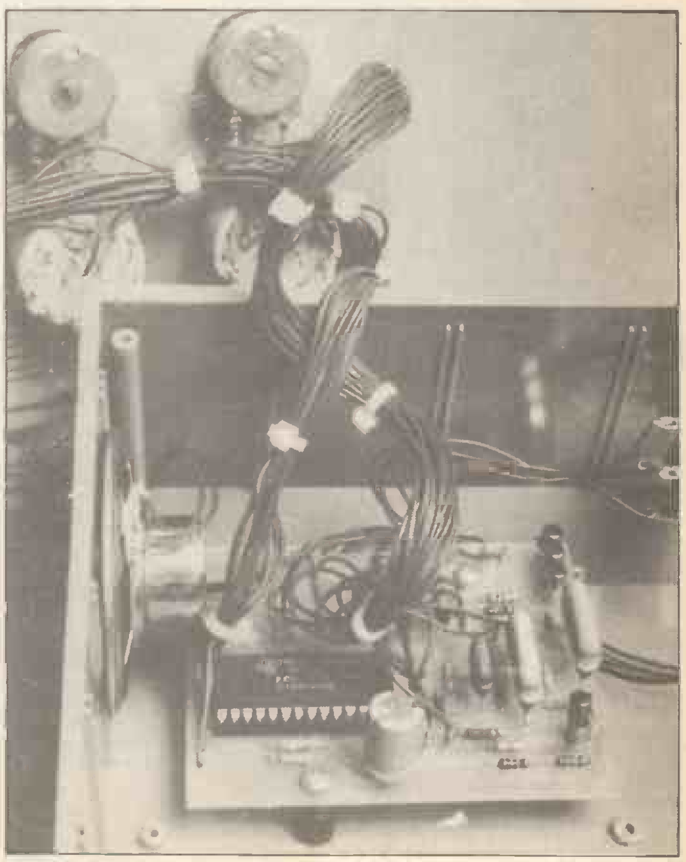


Figure 2. How to determine lead lengths (above), and how cables were connected to PCB of prototype (right)

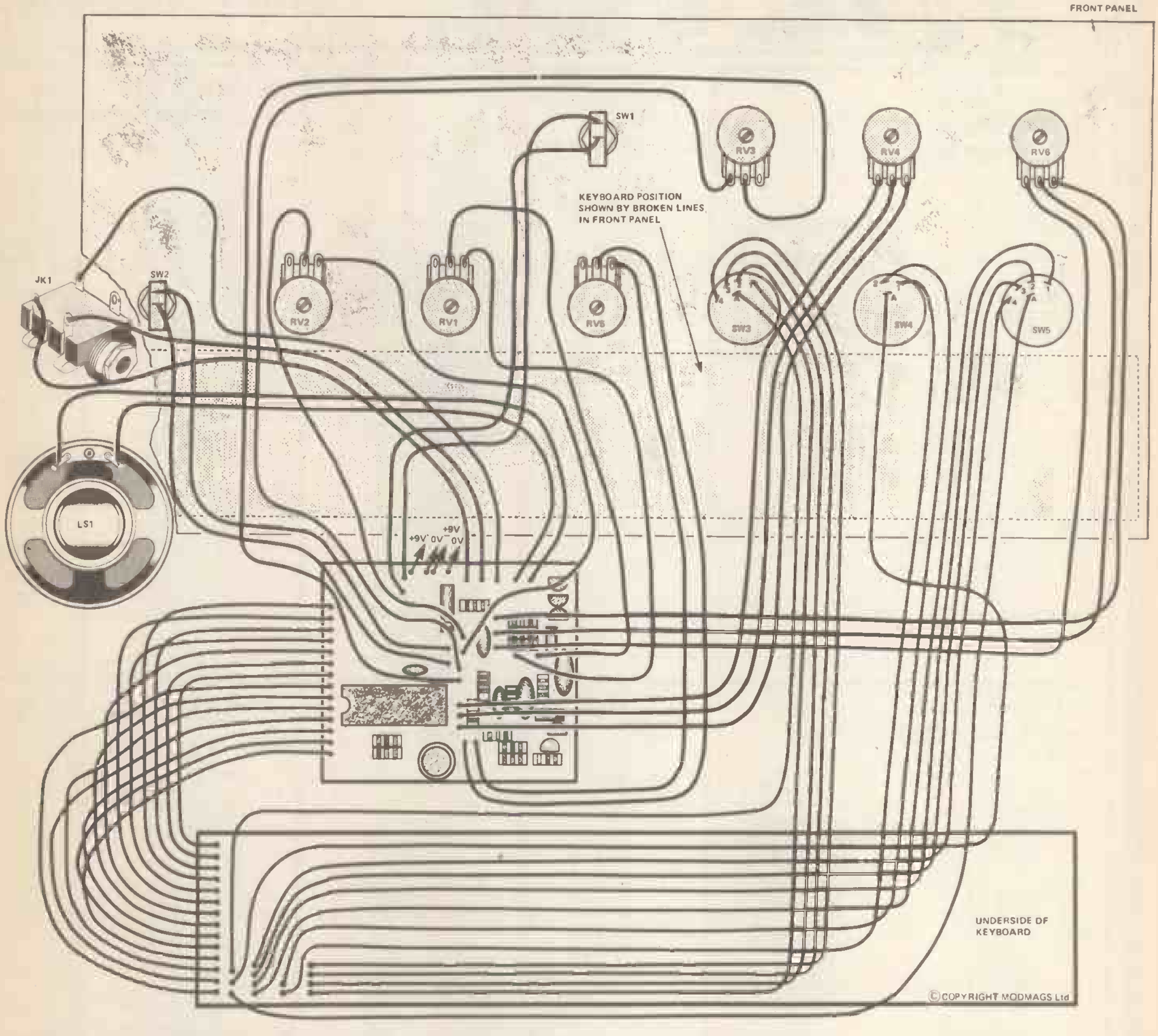


Figure 1. Connection diagram for Minisynth. Note: all connections are shown diagrammatically only — leads are not necessarily the same length

The difficult bit!

Now if you think construction so far is easy, just wait for the next stage! As with any circuitry which has a variety of pots and switches, Memory Bank has a large number of interconnecting leads. We have provided a connection diagram of the project (**Fig. 1**) ↑ in an attempt to make things easy for you, but you must bear in mind that this is only a representation of *where* connections are to be made. Note that lead *lengths* do not necessarily correspond exactly to the diagram.

Actual lengths of individual leads are best determined by making connections to the front panel controls as shown in **Fig. 2**, and then by simply cutting off all leads about 200.mm from the edge of the panel. In this way all connections are about the right length (as they all now go to the main PCB) enabling two neat cables to be formed. This method eliminates the 'birds nest' type of project. Keyboard connections are made from the back (ie the copper side).

Now, following **Fig. 1** carefully (a good idea is to mark off and colour each lead on the diagram as you go), solder the connections (32 in all) to their correct places on the main PCB. There are also 13 leads which connect SW3, 4 and 5 directly to the keyboard.

Finally, connect the jack socket, loudspeaker and the two batteries, and then tighten all screws. The wires from the front panel will form themselves into two main groups which can be held together with cable ties for neatness. You are now ready for testing and use! **HE**

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7490	35p
7492	50p
7493	50p
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4056	121p
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4066	56p
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4512	75p
4514	250p
4515	290p
4516	109p
4518	99p
4520	99p
4521	230p
4526	105p
4527	130p
4528	99p
4529	140p
4531	150p
4532	125p
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CB Breaker One Four

The publishers of HOBBY ELECTRONICS would like to point out that it is at present a contravention of the Wireless Telegraphy Act of 1949 and 1968 to use, manufacture, install or import CB transmitting equipment. It is not the intention of Modmags Ltd to incite, encourage or condone the use of such equipment.

Important news for all CB enthusiasts this month. A new magazine entitled CITIZENS BAND will be appearing on the bookstalls in a few weeks from now. Rick Maybury tells all

A COUPLE of weeks after you read this, on November the 21st there will be a new monthly magazine appearing on the bookstalls. It is called simply 'CITIZENS BAND' and there are no prizes for guessing where it comes from.

For some months now it has become apparent that the space limitations in Hobby Electronics were becoming a problem. It was therefore decided some time ago that as soon as circumstances permitted Breaker One Four would develop into a magazine in its own right. We had hoped to be the first UK magazine devoted to a legal CB system but it is obvious that the slow process of Government is likely to delay matters for some time to come. CITIZENS BAND will continue where BOF leaves off: it will deal with the latest news in depth and there will be features on the technical side of CB. It will include the latest club news from around the country and for the first time ever, we will be publishing a simple project for you to build each month. Issue number one has complete instructions for an SWR meter that is both cheap and simple to build yet will be as accurate as commercially-available devices costing several times as much.

Our old friend Mack The Hack will be bringing us his own off-beat view of the month's events in his new regular monthly column and a new feature called CB soapbox will allow anyone with a point to make to have their say. Our technical background and experience allows us to bring you regular equipment reviews, and the first issue contains an in-depth comparison of two of the most popular base station antennas.

If you think number one sounds promising then wait until the next one. CITIZENS BAND will be appearing at your newsagents on the third Friday of each month. Price will be just 50 pence so don't miss it!

Whilst we're on the subject of new publications, a few quick words about the CB Handbook and National Directory of Handles. Since we started selling them last month the orders have been coming in thick and fast. As this is only a limited edition and it can only be obtained from us then you should get your order in as quickly as possible as they're disappearing fast. Each Handbook will cost just 85 pence to personal callers or £1.00 including post and package from our usual address. Remember to mark your envelopes 'Modmags Sales Office, CB Handbook'.

Now back to the CB scene in general, and don't worry, BOF will still be the first place to look for the latest CB news each month.

Demo Dilemma

October was a busy month as far as demonstrations were concerned. In all there were three; two in London and one in Brighton. Unfortunately we were only able to attend the first of these functions but our spies have given us reports on the other two.

Speakers Corner, just before the 500 move off.

? GUESS WHO IS MISSING THIS MONTH — SEE INSIDE BACK COVER ?

First away was the UBA-organised march on Saturday the 11th. Venue was as usual Speakers' Corner. The theme of this particular gathering was the now familiar cry by the UBA to legalise on 27 MHz. The turnout exceeded everyone's expectations and was somewhere between 500 to 800. The march was pleasantly good-humoured and proceeded with the customary police escort to the Home Office on Waterloo Bridge. Not really much to say about this event really, we just hope the HO took notice and remember how strong the feelings are on this subject when they come to choose their frequency.

The procession leaving the park

The second of last month's demos was down in Brighton, on Saturday the 18th. Some 300 to 400 marchers turned up, and by all accounts things went quite smoothly. It is quite refreshing to hear of events outside London, I just wish the organisers would give us a little more warning so the BOF could get along.

Number three was on Sunday the 19th and was again a largely UBA event. This time the protest was centered around the BBC's reluctance to give air-time to the CB Independence record. Unfortunately things were a little muddled and not as many people as hoped for turned up.

Club Call

Most CB clubs start off in a fairly modest way. Usually, half a dozen or so breakers meet in a pub and gradually tell their friends until there are so many people that they either get thrown out of the pub or they form a committee, hire a hall and do it properly. You can imagine how impressed we were when we heard of a club that managed to attract nearly 300 people to the first meeting, so we decided to have a look for ourselves.

The Big Eyeball Breakers Club meets every Thursday at 8.30 pm at the White Hart Pub, off White Hart Lane, Tottenham. The club is quite unique in that there is no committee as such and little or no formalities. Membership is a flat 50 pence per week which goes toward arranging special functions throughout the year. The hall used for the meet is ideally situated for parking and is just big enough to prevent the inevitable crowding but without being so large that it seems empty. A reasonable bar serving dreadful beer is laid on and there is an unobtrusive disco for those not 100% into CB. All in all it was a refreshing change from some of the stuffier clubs that seem to think that CB should be talked about for as long as possible yet still not really do anything about it. The Big Eyeball is destined to get even bigger, so if you want more details you can either turn up on a Thursday or contact Alan Suleyman at: 53 Church Crescent, Finchley N20 for more details. See you there next week.

Here for your notebooks are the latest additions to our club file.

Hinckley Breakers Club
Secretary: Mile Richardson
8 Gladstone Close, Swallows Green,
Hinckley, Leics.

West Glamorgan Breakers Association
Secretary: G Bunce
25 Plas Newydd, Baglan Moors,
Port Talbot, West Glam SA12 7DF

North Manchester CB Club
PRO: Blaster Bates
Belmont Hotel, Middleton Road,
Crumpsall, Manchester 8.
(Meet alternate Mondays 8pm)

Kent and Essex Breakers Association
Chairman: Charlie
c/o 24 Mill Lane,
West Thurrock,
Grays, Essex.

Wheeler Dealer

Here we have a rather miserable-looking Steve Urry ouside his shop SRU Autos. We promise he doesn't look that unhappy usually, he must have been thinking about the large order of CB goodies he's waiting for from the States. By the time you read this Steve's shop should be bristling with Firestiks and Shakespear antennas as well as his very comprehensive range of CB accessories. Steve has covered all eventualities by stocking a very complete range of car customising equipment and he's open on Sundays. So if you're into Holley carburettors and mag wheels why not pay Steve a visit. Whilst you're there you might like to say hello to Steve's dad who helps out in the shop. Steve and his dad can be found at 229 Chertsey Road, Addlestone, Surrey.

928 — The Final Proof

If proof were ever needed that 928 MHz was unsuitable for two-way communications, then here it is. A study group set up by Motorola in the USA has concluded that transmitting equipment using this frequency should not be held close to the head. The reason for this startling revelation is that radio waves can produce a heating effect in human or animal tissue.

This heating effect has been well known for many years: indeed it has many beneficial uses ranging from medicine (diathermy treatment) to domestic cooking (microwave ovens). In general, devices designed to generate this heat by radio waves use a combination of very high power and, usually, very high frequency radio waves. These waves are concentrated on the area to be heated by the use of specially-designed radiating elements. A microwave oven for instances uses up to 2 kW of power at a frequency of 2000 MHz (2 gigahertz).

Lower down the frequency scale the heating effect decreases as the frequency decreases because of the lessening field density of the RF radiation. Field density is the term used by scientists to quantify the heating effect.

The Motorola group carries out extensive studies of these effects using a wide range of frequencies and powers. Most interesting from our point of view was the use of 860 MHz (0.86 GHz) with a power output of just 6 W. They discovered that a radiating element (a deliberately mis-matched antenna around 6" long was used) could produce a 'hot spot' at a depth of approximately 1" inside a test skull when the antenna was placed 0.35" from the subject. This area experienced a rise of up to 0.4°C. Although such a small rise may sound insignificant it was enough for the study group to publish the recommendation that walkie-talkie units should be used with care and not brought too close to the head when in use.

No one could suggest that these studies are conclusive and certainly it would be unwise to start 'scare mongering' but the fact remains that this and other study groups have found cause for concern. **We would therefore suggest to Her Majesty's Government that they abandon the proposal for Open Channel on 928 MHz and re-assess the more viable (and safer) possibilities.**

A recent meeting of the NATCOLCIBAR industrial and technical sub-committee headed by the GLC discussed this important new evidence. They will be issuing a statement to the Press in the very near future. It will be interesting to see how the Home Office react.

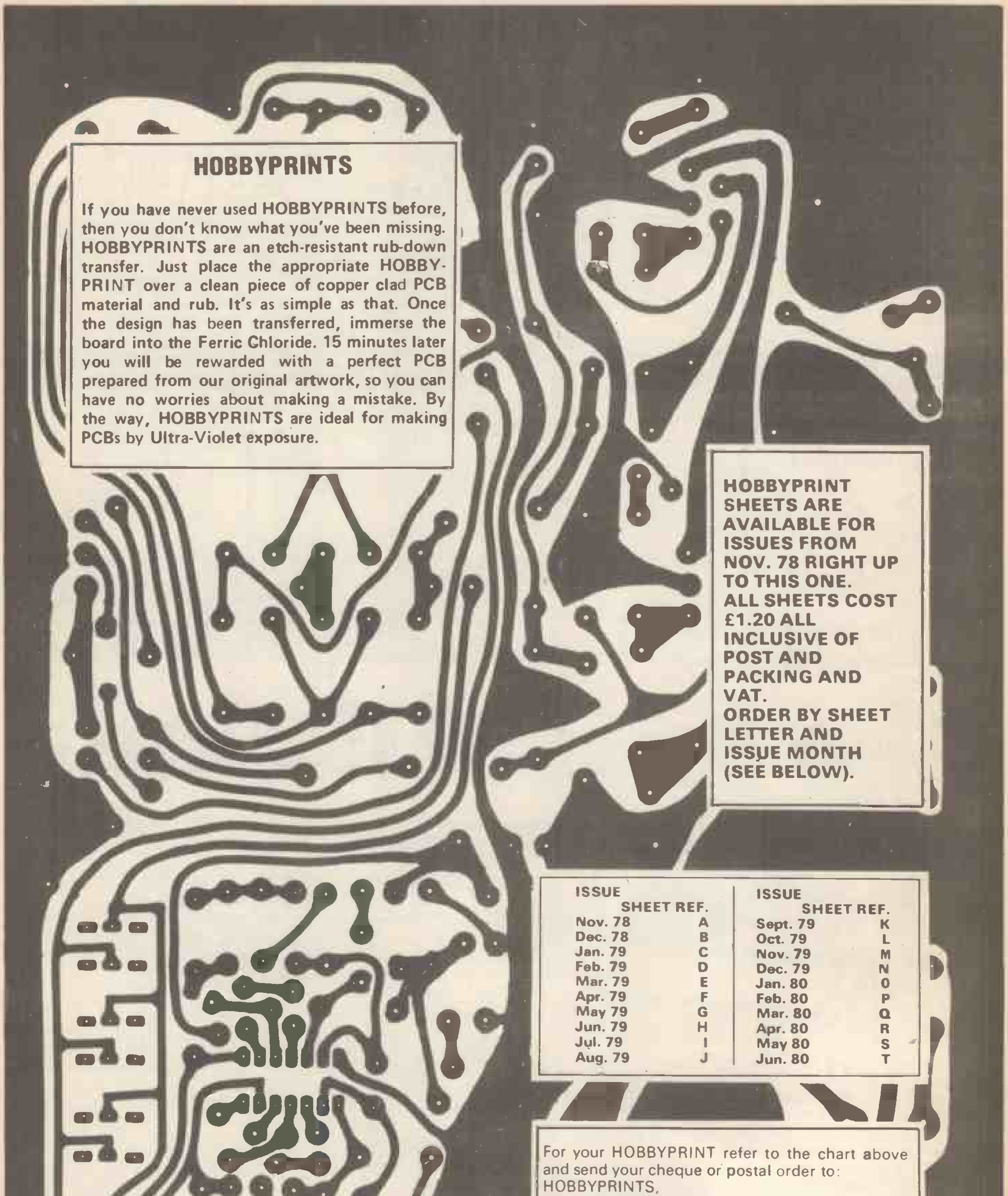
And Finally . . . . . .

Times up again for another month. Before I go just let me remind you again about CITIZENS BAND, you really can't afford to miss it if you are into CB. Oh, and before I forget, regular readers of Hobby Electronics need not worry about BOF disappearing altogether, we'll be back, same place, same time next month. Until then stay lucky.

See you next month.

Send any news, comments or information you have to: Breaker One Four, Hobby Electronics, 145 Charing Cross Road, London WC2H 0EE

HE



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Jan. 79	C	Nov. 79	M
Feb. 79	D	Dec. 79	N
Mar. 79	E	Jan. 80	O
Apr. 79	F	Feb. 80	P
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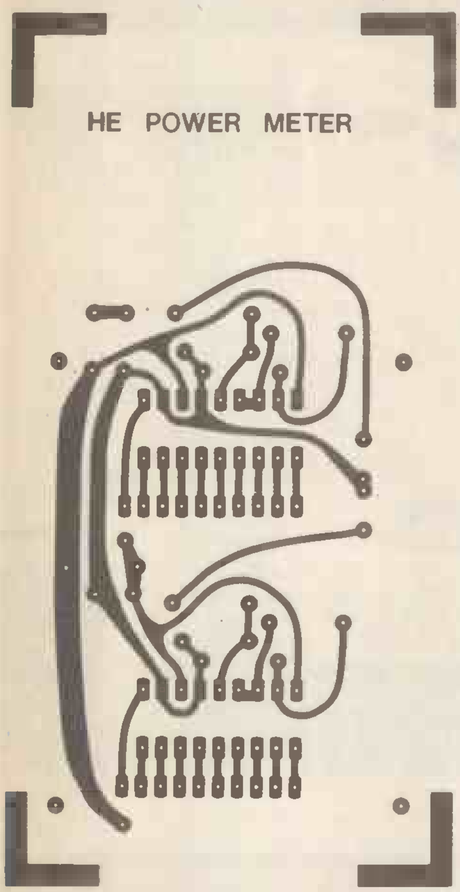

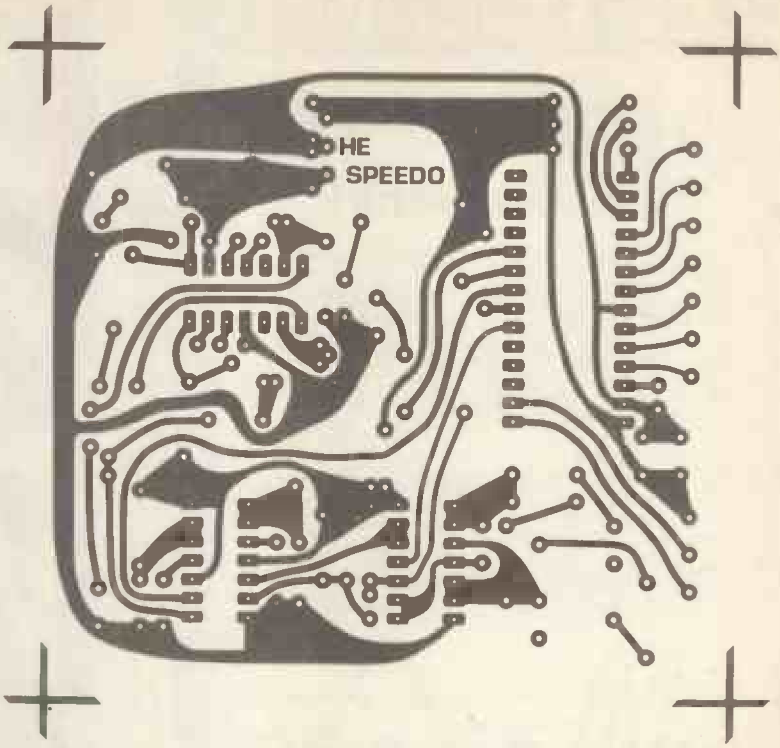

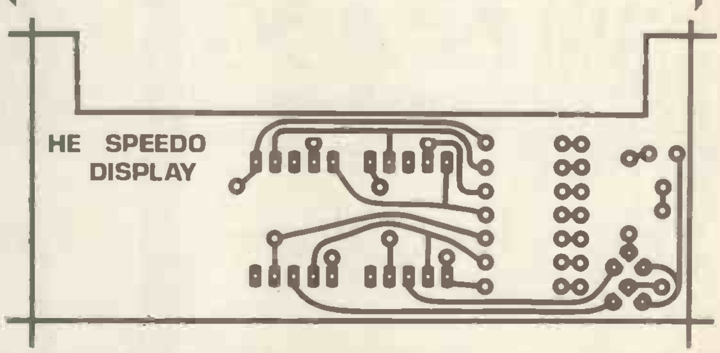

This month's foil patterns are: (above) the board for the Audio Power Meter, and (right) the two boards for the Digital Speedo

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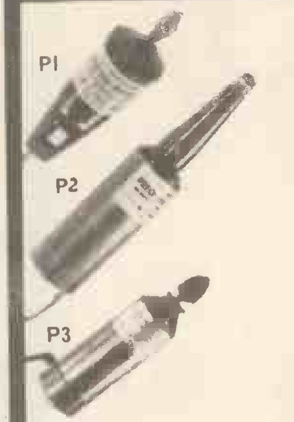

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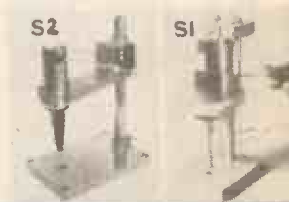

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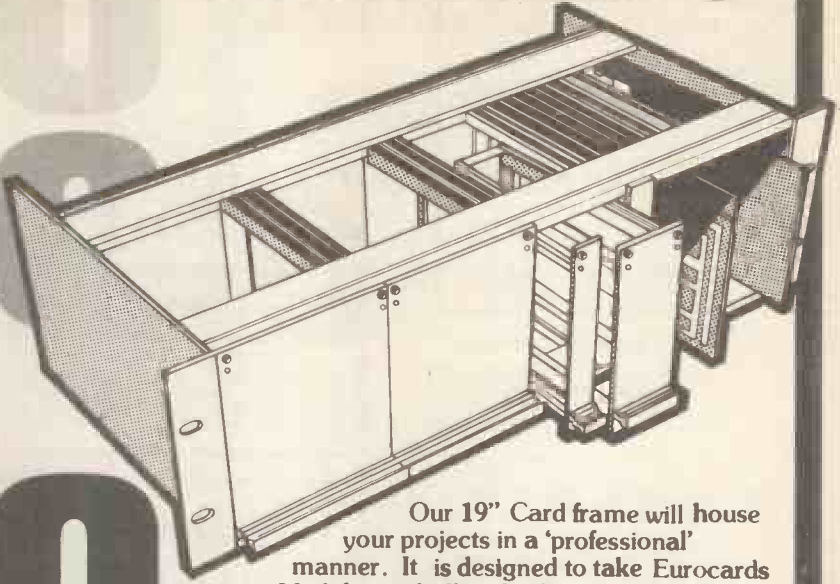

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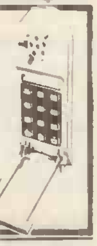

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