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JULY 1976

30p

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CANADA $1

sweet sixteen

8+8 watt stereo amplifier

DIGITAL WATCH SURVEY

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15—240 Watts!

HY5
Preamplifier

The HY5 is a mono hybrid amplifier ideally suited for all applications. All common input functions (mag Cartridge, tuner etc) are catered for internally, the desired function is achieved either by a multi way switch or direct connection to the appropriate pins. The internal volume and tone circuits merely require connecting to external potentiometers (not included). The HY5 is compatible with all I.L.P. power amplifiers and power supplies. To ease construction and mounting a P.C. connector is supplied with each pre-amplifier.

FEATURES: Complete pre-amplifier in single pack – Multi function equalization – Low noise – Low distortion – High overload – Two simply combined for stereo

APPLICATIONS: Hi-Fi – Mixers – Disco – Guitar and Organ – Public address

SPECIFICATIONS:

INPUTS: Magnetic Pick-up 3mV. Ceramic Pick-up 30mV. Tuner 100mV. Microphone 10mV. Auxiliary 3-100mV. Input impedance 47kΩ at 1kHz

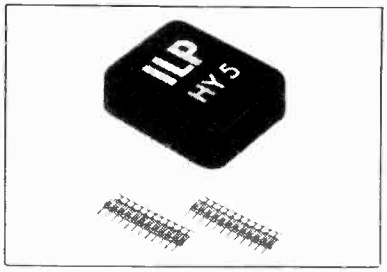
OUTPUTS: Tape 100mV. Main output 500mV R.M.S.

ACTIVE TONE CONTROLS: Treble ± 12dB at 10kHz. Bass ± at 100Hz

DISTORTION: 0.1% at 1kHz. Signal/Noise Ratio 68dB

OVERLOAD: 38dB on Magnetic Pick-up. SUPPLY VOLTAGE: 16-50V

Price £4.75 + 59p VAT P&P free.



HY30
15 Watts into 8Ω

The HY30 is an exciting New kit from I.L.P. It features a virtually indestructible I.C. with short circuit and thermal protection. The kit consists of I.C., heatsink, P.C. board, 4 resistors, 6 capacitors, mounting kit, together with easy to follow construction and operating instructions. This amplifier is ideally suited to the beginner in audio who wishes to use the most up-to-date technology available.

FEATURES: Complete Kit – Low Distortion – Short, Open and Thermal Protection – Easy to Build

APPLICATIONS: Updating audio equipment – Guitar practice amplifier – Test amplifier – audio oscillator

SPECIFICATIONS

OUTPUT POWER 15W R.M.S. into 8Ω. DISTORTION 0.1% at 15W

INPUT SENSITIVITY 500mV. FREQUENCY RESPONSE 10Hz-16kHz -3dB

SUPPLY VOLTAGE ± 18V

Price £4.75 + 59p VAT P&P free.

Available June '76

HY50
25 Watts into 8Ω

The HY50 leads I.L.P.'s total integration approach to power amplifier design. The amplifier features an integral heatsink together with the simplicity of no external components. During the past three years the amplifier has been refined to the extent that it must be one of the most reliable and robust High Fidelity modules in the World.

FEATURES: Low Distortion – Integral Heatsink – Only five connections – 7 Amp output transistors – No external components

APPLICATIONS: Medium Power Hi-Fi systems – Low power disco – Guitar amplifier

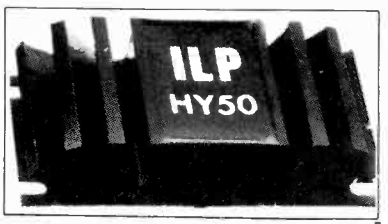
SPECIFICATIONS: INPUT SENSITIVITY 500mV

OUTPUT POWER 25W RMS into 8Ω LOAD IMPEDANCE 4-16Ω DISTORTION 0.04% at 25W at 1kHz

SIGNAL/NOISE RATIO 75dB FREQUENCY RESPONSE 10Hz-45kHz -3dB

SUPPLY VOLTAGE ± 25V. SIZE 105-50-25mm

Price £6.20 + 77p VAT P&P free.



HY120
60 Watts into 8Ω

The HY120 is the baby of I.L.P.'s new high power range, designed to meet the most exacting requirements including load line and thermal protection this amplifier sets a new standard in modular design.

FEATURES: Very low distortion – Integral heatsink – Load line protection – Thermal protection – Five connections – No external components

APPLICATIONS: Hi-Fi – High quality disco – Public address – Monitor amplifier – Guitar and organ

SPECIFICATIONS

INPUT SENSITIVITY 500mV

OUTPUT POWER 60W RMS into 8Ω LOAD IMPEDANCE 4-16Ω DISTORTION 0.04% at 60W at 1kHz

SIGNAL/NOISE RATIO 90dB FREQUENCY RESPONSE 10Hz-45kHz -3dB SUPPLY VOLTAGE ± 35V

SIZE 114-50-85mm

Price £14.40 + £1.16 VAT P&P free.

HY200
120 Watts into 8Ω

The HY200 now improved to give an output of 120 Watts has been designed to stand the most rugged conditions such as disco or group while still retaining true Hi-Fi performance.

FEATURES: Thermal shutdown – Very low distortion – Load line protection – Integral heatsink – No external components

APPLICATIONS: Hi-Fi – Disco – Monitor – Power slave – Industrial – Public Address

SPECIFICATIONS

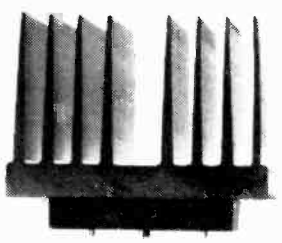
INPUT SENSITIVITY 500mV

OUTPUT POWER 120W RMS into 8Ω LOAD IMPEDANCE 4-16Ω DISTORTION 0.05% at 100W at 1kHz

SIGNAL/NOISE RATIO 96 dB FREQUENCY RESPONSE 10Hz-45kHz -3dB SUPPLY VOLTAGE ± 45V

SIZE 114-100-85mm

Price £21.20 + £1.70 VAT P&P free.



HY400
240 Watts into 4Ω

The HY400 is I.L.P.'s "Big Daddy" of the range producing 240W into 4Ω. It has been designed for high power disco or public address applications. If the amplifier is to be used at continuous high power levels a cooling fan is recommended. The amplifier includes all the qualities of the rest of the family to lead the market as a true high power hi-fidelity power module.

FEATURES: Thermal shutdown – Very low distortion – Load line protection – No external components

APPLICATIONS: Public address – Disco – Power slave – Industrial

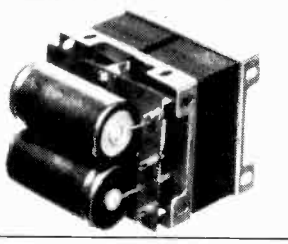
SPECIFICATIONS

OUTPUT POWER 240W RMS into 4Ω LOAD IMPEDANCE 4-16Ω DISTORTION 0.1% at 240W at 1kHz

SIGNAL/NOISE RATIO 94dB FREQUENCY RESPONSE 10Hz-45kHz -3dB SUPPLY VOLTAGE ± 45V

INPUT SENSITIVITY 500mV SIZE 114x100x85mm

Price £29.25 + £2.34 VAT P&P free.



POWER SUPPLIES

PSU36 suitable for two HY30's **£4.75** plus 59p VAT. P.P. free

PSU50 suitable for two HY50's **£6.20** plus 77p VAT. P.P. free

PSU70 suitable for two HY120's **£12.50** plus £1.00 VAT. P.P. free

PSU90 suitable for one HY200 **£11.50** plus £0.92 VAT. P.P. free

PSU180 suitable for two HY200's or one HY400 **£21.00** plus £1.68 VAT. P.P. free

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EDITORIAL AND ADVERTISEMENT OFFICE
36 Ebury Street
London SW1W OLW
Telephone: 01-730 8282

HALVOR W. MOORSHEAD
Editor

ROBERT C. EVANS
Advertisement Manager

LES BELL, G4CFM

RON HARRIS B.Sc
Editorial Assistants

JEAN BELL
Production

INTERNATIONAL EDITIONS

COLLYN RIVERS
Editorial Director

AUSTRALIA
STEVE BRAIDWOOD
Assistant Editor
Modern Magazine Holdings Ltd
Ryrie House, 15 Boundary Street
Rushcutters Bay 2011
Sydney, Australia.

FRANCE
DENIS JACOB
Editor in chief
CHRISTIAN DARTEVILLE
Editor
Electronque Pour Vous International,
17 Rue de Buci
Paris, France.

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These Paks contain a range of Carbon Resistors, assorted into the following groups:—

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These are unbeatable prices.

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500	µF	50V	Elect	0.09 each
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BA4	5¼"	4"	1½"	*0.54
BA5	4"	2½"	2"	*0.45
BA6	3"	2"	1"	*0.39
BA7	7"	5"	2½"	*0.79
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BA9	6"	4"	2"	*0.65

(Each complete with ½" deep lids & screws)
PLEASE ADD 20p POSTAGE AND PACKING FOR EACH BOX

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Pak No.	Qty	Description	Price
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C7	1	Pak Wire 50 metres assorted colours	*.60
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1021 for model G240	1/8"	*46p
1022 for model G240	3/16"	*46p
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51 for model X25	1/8"	*46p
52 for model X25	3/16"	*46p

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Model ECN	*£1.25
Model EG 240	*£1.60
Model ECCN 240	*£1.60
Model EX 25	*£1.40

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ST3 Suitable for all models	*£1.25
Antex heat shunt	*12p

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PS 3	D.I.N. 4 Pin	0.14
PS 4	D.I.N. 5 Pin 180°	0.15
PS 5	D.I.N. 5 Pin 240°	0.15
PS 6	D.I.N. 6 Pin	0.16
PS 7	D.I.N. 7 Pin	0.17
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PS 13	Jack Stereo Screened	0.33
PS 14	Phono	0.09
PS 15	Car Aerial	0.14
PS 16	Co-Axial	0.14

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PS 29	Jack Stereo Plastic	0.28
PS 30	Jack Stereo Screened	0.35
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PS 32	Car Aerial	0.20
PS 33	Co-Axial	0.20

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PS 37	D.I.N. 5 Pin 180°	0.09
PS 38	D.I.N. 5 Pin 240°	0.10
PS 39	Jack 2.5mm Switched	0.11
PS 40	Jack 3.5mm Switched	0.11
PS 41	Jack ¼" Switched	0.19
PS 42	Jack Stereo Switched	0.28
PS 43	Phono Single	0.07
PS 44	Phono Double	0.09
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Containing 6 sheets of 6" x 4" single sided laminate, a generous supply of etchant powder, etching dish, etchant measure, tweezers, etch resistant marking pen, high quality pump drill with spares, cutting knife with spare blades, 6" metal ruler, plus full easy to follow instructions.
*£7.80 per kit
Spare container of etchant for above, complete with instructions *70p

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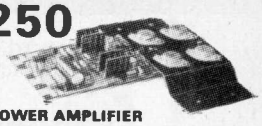

POWER AMPLIFIER
Specially designed for use in—Disco Units, P.A. Systems, high power Hi-Fi, Sound reinforcement systems

The module has a sensitivity of 450mV and frequency response extending from 25Hz to 20KHz whilst distortion levels are typically below 1%. The use of 4, 115w transistors in the output stage makes the unit extremely rugged while damage resulting from incorrect or short-circuit loads is prevented by a four transistor protection circuit.

The unit is intended for use in many applications such as disco units, sound reinforcement systems, background music players, etc.

SPECIFICATION:

Output Power: 125 watt RMS Continuous
Operating voltage: 50-80
Loads: 4-16 ohms
Frequency response: 25Hz-20kHz ***Measured at 100 watts***
Sensitivity for 100 watts output at 1kHz: 450mV
Input impedance: 33K ohms
Total harmonic distortion 50 watts into 4 ohms: 01·1% 50 watts into 8 ohms: 0.06%.
S/N ratio: better than 80dBs
Damping factor, 8 ohms: 65
Semiconductor complement: 13 transistors, 5 diodes
Overall size: Heatsink width 190mm, length 205mm, height 40mm

ONLY £15.95 + 8% VAT

BIB HI-FI ACCESSORIES

REF		PRICE
'D'	2 Hi-Fi Cable & Flex Tidy	*34p
'J'	Tape Head Cleaning Kit	72p
'P'	Hi-Fi Cleaner	*30p
Model 9	Wire Stripper	*£1.00
23	¼" Tape Editing Kit	*£1.80
24	¼" Cassette Editing Kit	*£1.84
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S219	5 pin DIN plug to 5 pin DIN plug length 1.5m	.80p
S474	3.5mm Jack to 3.5mm Jack length 1.5m	.68p
S600	5 pin DIN plug to 3.5mm Jack connected to pins 3 & 5 length 1.5m	.80p
S700	5 pin DIN plug to 3.5 jack connected to pins 1 & 4 length 1.5m	.80p

CERAMIC PAKS

Containing a range of miniature ceramic capacitors in mixed values, unrepeatable value.

MC1 24 ceramic capacitors: 22pF, 27pF, 33pF, 39pF, 47pF, 56pF, 68pF, and 82pF 0.60

MC2 24 ceramic capacitors: 100pF, 120pF, 150pF,180pF, 220pF, 270pF, 330pF, and 390pF 0.60

MC3 24 ceramic capacitors: 470pF, 560pF, 680pF, 830pF, 1000pF, 1500pF, 2200pF, and 3300pF . 0.60

MC4 21 ceramic capacitors: 4700pF, 6800pF, 01µF, .015µF, .022µF, .033µF and .047µF 0.60

MAMMOTH I.C. PAK *

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Assorted fall-out integrated circuits, including: Logic, 74 series, Linear, Audio and D.T.L. Many coded devices but some unmarked — you to identify.
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Price † **£2.95** each

TRANSISTOR EQUIVALENT BOOK BPE 75 256 Pages of cross references and equivalents for European, American and Japanese Transistors. This is the most comprehensive equivalents book on the market today and has an introduction in 13 languages.
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DIODE EQUIVALENT BOOK DE 74 144 Pages of cross references and equivalents for European, American and Japanese Diodes, Zeners, Thyristors, Triacs, Diacs and L.E.D.s.
Price † **£1.98** each

MULLARD DATA BOOK 1974/75 MDB 76 The latest edition of this popular handbook contains information on Semiconductors, Integrated Circuits, Television Picture Tubes, Valves, Capacitors and Resistors. Included in the 161 informative pages are 21 pages on Semiconductor Comparables. Price †**50p** each

TTL DATA BOOK DIC 75 Now complete Data book of 74 series TTL (7400-74132). Covering 13 main manufacturers in U.S.A. and Europe, this book gives full data as well as equivalents. Price †**£3.74**

THE WORLD'S BROADCASTING STATIONS WBS 75 An up-to-the-minute guide for those interested in DX-ing. Contains all the world's broadcasters on SW, MW and LW, as well as European FM/TV stations.
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STEREO FM TUNER

OUR PRICE ONLY

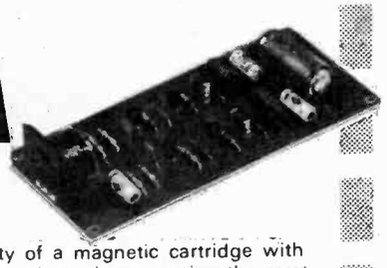
£19.95 **Fitted with Phase Lock-loop Decoder**

The 450 Tuner provides instant program selection at the touch of a button ensuring accurate tuning of 4 pre-selected stations, any of which may be altered as often as you choose, by simply changing the settings of the pre-set controls.
Used with your existing audio equipment or with the BI-KITS **STEREO 30** or the **MK60** Kit etc. Alternatively the **PS12** can be used if no suitable supply is available, together with the Transformer **T461.**
The S450 is supplied fully built, tested and aligned. The unit is easily installed using the simple instructions supplied.

- ★ FET Input Stage
- ★ VARI-CAP diode tuning
- ★ Switched AFC
- ★ Multi turn pre-sets
- ★ LED Stereo Indicator

Typical Specification:
Sensitivity 3μ volts
Stereo separation 30db
Supply required 20-30v at 90 Ma max.

MPA 30



Enjoy the quality of a magnetic cartridge with your existing ceramic equipment using the new M.P.A. 30, a high quality pre-amplifier enabling magnetic cartridges to be used where facilities exist for the use of ceramic cartridges only.
It is provided with a standard DIN input socket for ease of connection.
Full instructions supplied.

£2.65

VAT ADD 12½%

POSTAGE & PACKING

Postage & Packing add 25p unless otherwise shown. Add extra for airmail. Min. £1.00

STEREO PRE-AMPLIFIER

PA100

OUR PRICE
£13.50

A top quality stereo pre-amplifier and tone control unit. The six push-button selector switch provides a choice of inputs together with two really effective filters for high and low frequencies, plus tape output.

MK. 60 AUDIO KIT: Comprising 2 x AL60's. 1 x SPM80. 1 x BTM80. 1 x PA100. 1 front panel and knobs. 1 Kit of parts to include on/off switch, neon indicator, stereo headphone sockets plus instruction booklet. **COMPLETE PRICE £27.55.** plus 62p postage.

TEAK 60 AUDIO KIT: Comprising Teak veneered cabinet size 16¾"x11½"x3¾", other parts include aluminium chassis, heatsink and front panel bracket plus back panel and appropriate sockets etc. **KIT PRICE £9.20** plus 62p postage.

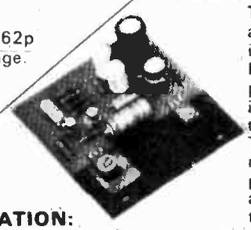
Frequency Response + 1dB 20Hz 20KHz. Sensitivity of inputs
1. Tape Input 100mV into 100K ohms
2. Radio Tuner 100mV into 100K ohms
3. Magnetic P.U. 3mV into 50K ohms

P.U. Input equalises to R1AA curve with 1dB from 20Hz to 20KHz.
Supply — 20-35V at 20mA.

Dimensions 299mm x 89mm x 35mm.

AL10-20-30

AUDIO AMPLIFIER MODULES



The AL10, AL20 and AL30 units are similar in their appearance and in their general specification. However, careful selection of the plastic power devices has resulted in a range of output powers from 3 to 10 watts R.M.S.
The versatility of their design makes them ideal for use in record players, tape recorders, stereo amplifiers and cassette and cartridge tape players in the home.

SPECIFICATION:
- **Harmonic Distortion Po = 3 watts f = 1KHz 02.5%**
- **Load Impedance 8-16ohm**
- **Size: 75mm x 63mm x 25mm**
- **Frequency response ±3dB Po = 2 watts 50Hz-25Hz**
- **Sensitivity for Rated O/P — Vs = 25v. RL = 8ohm f = 1KHz 75mV. RMS**

AL10	AL20	AL30
3w R.M.S. **£2.30**	5w R.M.S. **£2.65**	10w R.M.S. **£2.95**

STEREO 30

COMPLETE AUDIO CHASSIS
7+7 WATTS R.M.S.

P & P 45p.

£15.75

The Stereo 30 comprises a complete stereo pre-amplifier, power amplifiers and power supply. This, with only the addition of a transformer or overwind will produce a high quality audio unit suitable for use with a wide range of inputs i.e. high quality ceramic pick-up, stereo tuner, stereo tape deck etc. Simple to install, capable of producing really first class results, this unit is supplied with full instructions, black front panel knobs, main switch, fuse and fuse holder and universal mounting brackets enabling it to be installed in a record plinth, cabinets of your own construction or the cabinet available. Ideal for the beginner or the advanced constructor who requires Hi-Fi performance with a minimum of installation difficulty (can be installed in 30 mins).

TRANSFORMER £2.45 plus 62p p &p
TEAK CASE £3.65 plus 62p p & p.

AL60

25 Watts (RMS)

★ Max Heat Sink temp 90C. ★ Frequency response 20Hz to 100KHz ★ Distortion better than 0.1 at 1KHz ★ Supply voltage 15-50v ★ Thermal Feedback ★ Latest Design Improvements ★ Load — 3,4,8, or 16 ohms ★ Signal to noise ratio 80db ★ Overall size 63mm. 105mm. 13mm.

Especially designed to a strict specification. Only the finest components have been used and the latest solid-state circuitry incorporated in this powerful little amplifier which should satisfy the most critical A.F. enthusiast.

£3.95

NEW

PA12

NEW PA12 Stereo Pre-Amplifier completely redesigned for use with AL10/20/30 Amplifier Modules. Features include on/off volume. Balance, Bass and Treble controls. Complete with tape output.

Frequency Response 20Hz-20KHz (—3dB). Bass and Treble range 12dB. Input Impedence 1 meg ohm. Input Sensitivity 300mV. Supply requirements 24V .5mA. Size 152mm x 84mm x 33mm.

£6.50

PS12

Power supply for **AL10/20/30, PA12, SA450** etc.

Input voltage 15-20v A.C. Output voltage 22-30v D.C.
Output current 800 mA Max. Size 60mm x 43mm x 26mm.
Transformer T538 £2.30

OUR PRICE £1.20

Stabilised Power Supply Type SPM80

SPM80 is especially designed to power 2 of the AL60 Amplifiers, up to 15 watts (R.M.S.) per channel simultaneously. With the addition of the Mains Transformer **BMT80,** the unit will provide outputs of up to 1.5A at 35V. Size: 63mm. 105mm. 30mm.
Incorporating short circuit protection.
Transformer BMT80
£2.60 + 62p postage

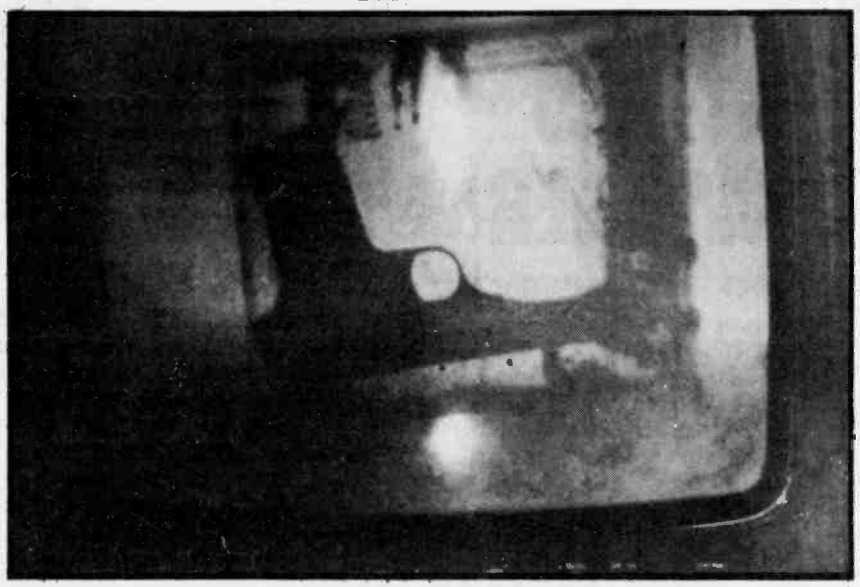
£3.00

BI-PAK

P.O. BOX 6, WARE, HERTS.

news digest

EMI X-RAYS FAIL TO BE FOILED



In a recent incident at John F. Kennedy airport in New York, British X-ray equipment enabled officials to discover a concealed weapon during their routine security checks on passenger luggage. When screening a young lady passenger's portable tape recorder with an advanced X-ray inspection system supplied by EMI Ltd., an automatic pistol was revealed in the recorder's battery compartment. The weapon was clearly outlined on the television monitor even though the gun was wrapped in metal foil in an attempt to evade detection by X-ray equipment. The passenger was arrested by the New York port police and is now awaiting trial.

BRIGHTEST SPARK

Control Technology Ltd have won a £10,000 contract for a specially stable current monitoring system to be used in continuous high energy physics experiments at the Darebury Nuclear Facility of the Science Research Council.

Having a stability better than 25p.p.m. per 24-hours, the special DC current monitors are part of a £40,000, 500kV power supply for the ion injector and accelerator in a 30 million volt tandem Van de Graaf generator, reported to be the largest of its kind in the world.

Control Technology Ltd., Bolney Avenue, Peacehaven, Sussex.

CONTROL OF THE SHUTTLE

The second production protoype of the main engine controller for the US Space Shuttle has been delivered by Honeywell. This controller will operate together with engine sensors and the vehicle control system to monitor and check out operations of the second main engine.

Changes in propellant mixture and engine thrust, general engine functioning and starting/stopping will be governed by the contoller, which also tests its own components every 20 milliseconds. Data received from the controller is relayed to a Honeywell HDC-602 digital computer, which stores information until requested by the vehicle.

Honeywell Ltd., Charles Square, Bracknell, Berkshire.

MOTOROLA 2N DEVICES GET THE CHOP

As a result of information fed back from many customers Motorola now have available many of their 2N transistors with shorter leads. The reason for this is that many customers use automatic handling facilities, and the machines operates more satisfactorily and are more reliable, if shorter component leads are used. Additional benefits from the change are cost savings and less material waste.

Many 2N devices, which where available in TO5 cans, are now available in TO39 cans with the half inch leads.

Motorola Ltd., Semiconductor Products Division, York House, Empire Way, Wembley, Middlesex HA9 OPR.

HP NATIONALISED

National Semiconductors have a new calculator bounding onto the scene, the 4640 scientific. The machine owes much to Hewlett Packards HP-45, as National themselves are the first to admit. The 4640 uses RPN logic with a 4-level rollable stack. A novel feature is the addition of engineering notation display – exponents in multiples of 3 with adjusted mantissa.

It also has trig function and standard deviation keys, together with 3 memories. It comes with recharger and plastic wallet at £59.95.

If you think you've heard that price before you're absolutely right. The CBM 4190R sells for *exactly* that amount. For a detailed look at the CBM machine see our review elsewhere in this issue.

Frankly it is doubtful whether the 4640 will be able to compete with the more comprehensive CBM at the price.

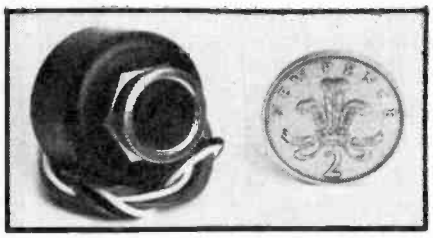
SCANNER RECORDS

EMI's revolutionary EMI-Scanner computerised X-ray systems for medical diagnosis originally launched in mid-1972, has now achieved world-wide orders totalling £105 million in value. Over 90 per cent of this figure is represented by exports. The cumulative order book now stands at 538 systems of which 384 are brain scanners and 154 are body scanners.

It is estimated that at least one million patients have now been scanned by over 265 EMI–Scanners currently in operation in hospitals and clinics throughout the world.

BE WARNED (IN A SMALL WAY!)

The Mini-Bleeptone 525 is a unit which provides a choice of two continous signals of up to 80dBa with current consumption ranging from 3–15mA.



Its applications are wide, being ideally suited as a fault indicator mounted onto portable equipment and instrument panels, or for localised warning of such things as intruders and/or fire. Operation from a power supply of almost any transistorised equipment is possible due to its wide voltage range.

PYSERS DITCH MARANTZ

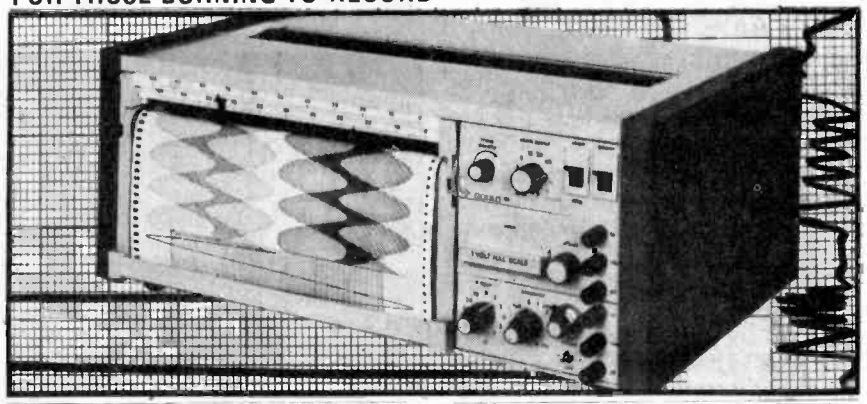
After negotiations Pyser Limited have decided not to accept a further distribution contract for Marantz high fidelity equipment. Pysers took on the agency five years ago, building up Marantz to a "household name" in the audio industry. Marantz is now one of the leading brands in the UK high fidelity market. A quote from Pyser, "We have always operated a limited distribution policy backed by orderly marketing. Our dealers around the country have respected the fact that Marantz has always been a profitable line to sell, backed by a long guarantee and good service. We feel that in order to continue our relationship with Marantz, we would have to change these basic policies and we have therefore decided to cease distributing Marantz on 1st July 1976, and to commence distribution of our own electronics". Pysers will of course honour all their guarantee and servicing obligations to Marantz customers. But will now market NAD equipment exclusively.

Pyser Ltd., Fircroft Way, Edenbridge, Kent.

RICE LOGIC?

Later this summer – about June – National Semiconductor and Kellog's are to hook-up on a promotional deal. All Kellog cereal packets will carry coupons for reductions on National calculators. Barley credible it is not?

FOR THOSE BURNING TO RECORD



The Gould 110 strip-chart recorder, now available from Gould Advance Ltd., features a new fine-line thermal writing pen that is virtually wear-free, offering very high reliability in operation. The recorder is especially suited for long-term unattended monitoring of low-frequency signals in laboratory, analytical or process applications.

Gould Advance Ltd., Raynham Road, Bishop's Stortford, Herts.

AMATEUR EXHIBITIONISTS

The British Amatuer Electronics Club's Exhibition this year will be held from July 17th to 24th., and will have a wide range of projects from members in all parts of the country. It will be held at the Shelter at the centre of the Esplanade, Penarth, South Glamorgan, and will be open every night from 7 p.m., and also the afternoons of July 17th, 18th and 24th.

Details from the Secretary, B.A.E.C. "Dickens", 26 Forrest Road, Penarth, Glamorgan.

SOMETHING FOR NOTHING

The galaxy Centaurus – A may well be powered by a black hole star, with a mass of 10,000,000 of our own Sun. This idea has come from research done by the Cambridge Institute of Astronomy. The galaxy is prolific on optical, radio and X-ray wavelengths. At hard X-rays ranges Centaurus is one of the brightest in the sky. The energy existing in the radio 'lobes' is phenominal – 10^{60} ergs – and all this must be supplied from somewhere, probably nucleus. This is now 'compacted' down to a radius of less than 50 times that of our own Sun, and its likely fate is that of a massive black hole.

This in itself would not produce X-ray energy, but anything straying too close would be torn to shreds by gravity 'tides' set up by the black hole. Colliding particles are then heated to over 100,000,000° due to their proximity hence emitting X-rays. By products of this process could well be the radio and optical emission found from Centaurus.

It will never replace coal.

SNEAK LOOK AT A PIONEER

Hiding behind the disembodied arm is the latest super-fi box from Pioneer, the SX 1250 receiver. With a power output of 160W rms per channel it will assume the top position in Pioneers range when released in late summer. We have no details as yet, but will let you have them as soon as we do.

NEW TRACES FOR OLD

New from Gould the OS250A oscilloscope is an upgraded, version of the established OS250, incorporating a new input y-amplifier that gives a maximum sensitivity of 2mV/cm. The instrument is a 10MHz dual-trace unit with a 10cm x 8cm display, and is designed for general-purpose laboratory work, educational use and TV servicing applications.

Gould Advance Limited, Roebuck Road, Hainault, Essex.

news digest

GREAT MINDS THINK ALIKE

The 1975 award for Achievement, from the American magazine 'Electronics' goes to the inventors of I^2L. All four of them.

The technology was independantly and simultaneously developed by two Philips researchers in Eindhoven and by two IBM researchers in Germany!

I^2L developed from looking at ways to pack transistors more densely into a chip. There was one major problem: heat. This is developed by the rather high supply voltages necessary for the stable working of the current circuits, and the large dimensions of the transistors and resistors on the chip.

However it was found that if the transistors are excited directly from a low voltage supply, by an injection with charge carriers, this makes resistors superfluous and does away with the high supply voltage. PN diodes are used for the injection – these are easily put onto the chip with the transistors.

Transistors are used upside-down and this enables higher densities to be achieved. Using I^2L it is possible to fit 1000 logic circuits onto one chip.

SPOT THE BURGLAR ALARM

A ultrasonic movement detection system called 'Fidela 6' offering a flexible approach to safeguarding large open-plan areas inside buildings systems has been introduced by AFA-Minerva of Twickenham, Middlesex. The 18¼" x 3½" x 2¼" (460mm x 90mm x 60mm) sensor unit looks well hidden in a shopping area or residential environment.

CAREFULLY CALCULATED BATTERY COST

Conventional pocket calculators operate for an average of eight hours with one set of dry cell batteries. Based on new technology and 1200 hours computing time with one set of batteries, the Toshiba LC-810, if used in a normal manner, will need

new batteries only after two to three years of operation. Hourly operating costs of the Toshiba LC-810 therefore amount to fractions of a penny. With normal calculators, their battery set would have to be changed about 150 times in this period. The Toshiba LC-810 has liquid crystal display with black figures on a yellow background. This gives best legibility in bright light.

CROSSROADS ON A PLATE

A new method of storing information – especially TV programmes on a plastic laminated plate (5" x 7") has been developed by DRC of New York. Up to 30mins of TV can be stored on one plate, in the form of micrometer-sized dots and spaces on the photo-sensitive plate. On replay the head scans across laterally, with the disc static. Tracking adjustments to compensate for mechanical tolerances must be included if replay is to be attempted on another machine. A plate could be produced for about 40p, and cost of replay equipment is estimated at about £176. Advantages include immunity to dust and focussing errors, compactness and durability of the plate.

LCD DISPLAYS GROWTH

Light emitting diodes are still the major display type in use in digital watches, but for how much longer? Power consumption ($\approx 1 Wcm^{-2}$) means that the display cannot be on continuously and readibility in bright light leaves a lot to be desired. The signs are now that LCD is galloping up to level things off. An announcement from a major manufacturer (Boveri) shows that this company alone is producing 160,000 LCD displays a month in its factory at Lenzburg in Switzerland. Major customers are (in order!) Switzerland, Japan and Western Europe.

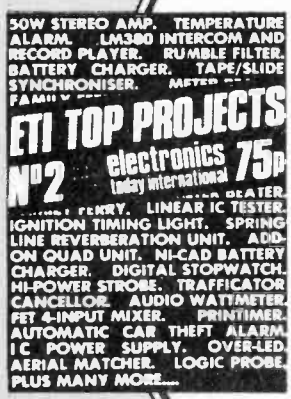
0.42 WATTS PER PIN

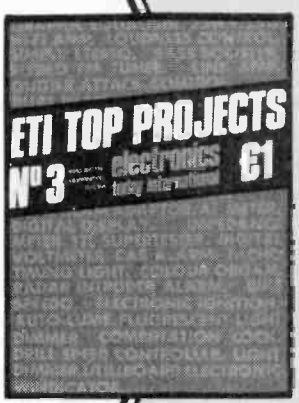
Fairchild has introduced a new 5W, high-voltage audio amplifier circuits in a 12-lead package.

The circuit can be used in a wide variety of audio power applications, and is suited for TV, audio and vertical output stages. The TBA800 is available in two package-lead configurations, both using a copper lead frame for maximum heat transfer that is bent for easy insertion into a printed circuit board. In the TBA800A, the power tab extends stright out from the package and contains holes for mounting an external heatsink.

The TBA800 and TBA800A are identical electrically and have a damping diode on the output to protect the device from electrical transients. The circuits operate over a supply voltage range of 5 to 30V, and are specifically intended for use with a 24V supply. Typical output power is 5W into a 16 ohm load for 24V operation.

SPECIALS





Projects Book Two – contains 26 popular projects from the pages of ETI, first published July 1975. 75p + 15p p&p.

Project Book Three – contains 27 popular projects from the pages of ETI, first published March 1976 £1.00 + 15p p&p.

We regret to say that PROJECT BOOK ONE is now completely sold out, and we cannot accept any more orders.

Electronics – It's Easy – the first thirteen parts of our popular introductory series and a good way to begin finding out more about your hobby. £1.20 + 15p p&p.

4600 Synthesiser – complete reprint of our superb synthesiser design, produced by Maplin, who can also supply the parts. £1.50 + 15p p&p.

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POSTAGE AND PACKING is 15p for the first, 10p for subsequent (overseas 20p and 15p).

Please send me the issues indicated above; I enclose . . . . . , which includes postage . . . . . .

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CB4UK?

Should we have Citizens Band in the United Kingdom?

IT HAPPENED with the streak, it happened with Rock 'n' Roll, the hamburger, Levi jeans, colour TV, Coke — the British importation of American 'phenomena' has been going on for years and will continue for a long time to come. When America does something, we do it too, except the live goldfish craze — somehow that never quite caught on.

The current mania which has swept the New World for pet stones somehow doesen't seem terribly interesting as it's an uphill job trying to teach a stone tricks and so we should like to call your attention to an infinitely more attractive pastime — Citizens Band Radio.

CB was introduced by the US Government in 1958 to fill a need for a low-cost communications system which was an alternative to expensive radio-telephone equipment (if less reliable) and simpler than the complex amateur radio setups which could only be operated by enthusiasts. No technical skill is required to operate a CB set and no tests necessary to obtain a licence.

Three main types of unit are available — base stations, which are operated from home or office; portable hand-held units; and the most numerous, dash mounted transceivers in cars or trucks.

CB caught on immediately, but the real boom came with the truckers' strike of a few years ago. Many truckers had installed CB radios for communication as they travelled over long distances on the Inter-State Highways. Their highly colourful slang caught on and created a CB language, similar in some ways to that used by radio amateurs but revolving around Smokey Bear and traffic conditions.

Smokey Bear doesn't seem to mind his whereabouts being known to CB'ers as they report on him, as drivers then slow down, and this is of course what the police want. In fact many police cars now carry CB monitors or transceivers, as 1 out of 4 cars and 3 out of 4 trucks carry CB and therefore are the first to report on accidents, drunken drivers and similar incidents.

Typical of the more powerful hand-held units is this one from Radio Shack (North America's Tandy). This is supplied with a crystal for Channel II — five other channels can be switched in but crystals are extra. Cost is $89.95 (about £50).

There are 23 channels on a standard AM CB set — channel 9 is reserved for emergency calls, while channel 11 is the calling frequency — once contact is esteblished on this channel, both stations will shift to another channel. In areas around cities, these channels are congested and so many stations have changed over to Single Sideband, which gives higher communications efficiency and an extra 46 channels.

CB has been an extremely high growth-rate market so that supplies are short. Licence applications to the Federal Communications Commission are running at almost half a million per month so that CB rigs are in short supply.

So why not CB for the UK? Well, CB gear operates around 27MHz, which is already allocated for model control and paging systems, so that CB will have to be on a different frequency. A prime contender for this is of course the VHF TV bands I and III which will be vacated in a few years. At the moment there are only about ½ million homes served by VHF only in the UK, and so this frequency area could fairly soon be turned over to CB.

The important point is that if there is a demand for frequencies for what could be an important and useful public service, the frequencies can be found AND SHOULD BE FOUND.

WHAT THE HOME OFFICE SAY

Nothing, The Home Office do not seem to have any official policy, and, in fact, do not seem to be evaluting the possibilities for CB in this country. A spokeman told us simply that Citizens Band equipment was illegal in this country under Statutory Instrument No. 61, 1968 and when we said that CB need not be on 27MHz and mentioned the forthcoming availability of TV Bands I and III he merely said that this was something for the Annan Committee to look into.

It seems, then, that the Home Office are not looking into the technical or other possibilities of CB. Regardless of the technical arguments, if there is sufficient demand for a service, ways will be found to provide it. It seems almost certain that there

A full 23 channel CB rig of the type which is now in 25% of US cars. This is a deluxe type with noise limiter and RF gain control. This will put out the maximum signal of SW. Price is $169.95 (£93).

would be more demand for CB-style radio than there is for VHF radiotelephone services as provided at present, which would seem to argue that the service is economically viable from the potential manufacturer's point of view.

In 1967 the authorities used broadly similar arguments to close down the 'pirate' radio stations, ie that the frequencies simply were not available. Yet shortly afterwards, plans were announced for 20 BBC and 16 commercial radio stations, operating on MW and VHF at powers up to 50kW!

Again, in 1967, the BBC stated in the Radio Times that Radio 1 would not be provided on VHF due to lack of frequency space. Yet now we have countless commercial and local radio stations on Band II and there is still a lot of room at the top of the band which should become clearer as police and other services move up to UHF. Perhaps there might even be a MHz or so on Band II which could be devoted to CB.....

THE RSGB VIEW

The Radio Society of Great Britain made the following statement in the April issue of their journal, Radio Communication: "27MHz *Enquiries have been made to headquarters as to the views of the Society on the so-called citizens band activity in the segment between 27 and 28MHz. At the present time the opinion of the Council is that no support can be given to the establishment of a communications band in this part of the spectrum. In the UK all transmissions in this band comprise the use of tones, ie for paging and location and for model control. Reports of CB activities in the USA show gross violations of the regulations, leading in some cases to heavy fines and prison sentences. The Society has no desire to see the spread of these practices to the UK, particularly as in many cases press reports do not differentiate between the licensed radio amateur and the 27MHz users, most of whom are unlicensed.*"

The RSGB is concerened with the public image of the radio amateur, which has always been a touchy subject. The individual amateur has to contend with the odd case of television interference, which requires kidglove treatment, and, of course, the now infamous Tony Hancock sketch, although funny, hardly promoted a sophisticated image of the 'ham', so that the amateur movement is often extremely sensitive about press reports of prosecutions of unlicensed stations.

The radio amateur is particularly concerned because he has to resist pressure on his frequencies from other users, at ITU conferences, and so is unlikely to find the idea of yet another radio service coming into existence to clamour for airspace, particularly appealing. Further more, to get his license, the amateur had to pass a written examination, and, in many cases, a Morse test – why, then, should somebody else get on the air without any effort?

But the potential CB user is not interested in the technical aspect of radio; he views it as a convenience, and one which would be useful to many – mountain climbers, yachtsmen, travellers etc. as a low cost alternative to an expensive (or often non-existent) service.

Of course 27MHz is at present ruled out for CB – but if there is sufficient demand frequencies can, and will, be found. In the meantime, one can do what a number of amateurs do – join the RSGB, get your license and buy a 2m Japanese 'black box'. It looks and works just like a CB rig.

CB IN UK NOW

The Radiotelephonic Transmitters (Control of Manufacture and Importion) Order 1968:

Statutory Instrument 1968 No. 61

Commencement 1st April 1968

General: For the purpose of preventing or reducing the risk of interference with wireless telegraphy, section 7 of the Wireless Telegraphy Act 1967 enables orders to be made specifying wireless telegraphy apparatus of any class or description to which the section should apply. Under the section, the manufacture or importation of the sepcified apparatus is prohibited, except as may be authorised either generally or specially. This order specifies wireless telegraphy apparatus consisting of radiotelephonic apparatus capable of transmitting on any of the following frequencies ie any frequency between 26.1 and 29.1 megacycles per second, or between 88 and 108 megacycles per second, notwithstanding that the said apparatus is also capable of transmitting on other frequencies outside those limits.

Regardless of the terms of this order, we found it exceptionally easy to buy CB equipment. The second shop we tried in Edgware Road, W2 had a range of portables from £34 to £250 per pair. They were freely on sale, but we really have to warn readers away from these units, as they are ILLEGAL and could cause interference to important hospital paging systems, so that someone's life could be at stake. Don't touch 'em!

Even motorcyclists are being courted by the CB manufacturers!

A common dual CB antenna for mobile use.

SITUATION IN NORTH

By
TOM GRAHAM
EDITOR
CANADIAN
TRANSCEIVER

IN THE PAST 20 years new ideas have come up many times looking like they were going to immediately set the world on fire, and in almost every instance the manufacturers of electronic equipment, who by their every nature are very forward thinking, have jumped aboard the 'bandwagon' only to get their fingers burned in the process. manufacturers got their come-uppance and some went bankrupt in

The first instance of this was in the tape recorder field when many manufacturers got their comeuppance and some went bankrupt in the process. Another one was in the home video cassette market where one major manufacturer went bankrupt to the tune of $52,000,000. Then came the home security alarm business with just about the same disastrous results.

In discussing the CB or personal 2-way communications market, I should add that many of the manufacturers who got into this business too early also got badly burned. Three Canadian companies got into the manufacture of CB radios back in 1963 and none of them are in the business today. In fact, one major US manufacturer pulled out of the CB market when they discovered that their Canadian rep was selling more in total than they were in the US with ten times the potential market. With the incredible boom today, I hardly need mention that they are now getting back into the field.

CB radio was legalized in Canada in 1963, some years after it was initiated in the US, and the Canadian sales hit an instant peak. This started a great rush to get in to the business, but, to their dismay, the market dropped just as suddenly. The reason upon analysis was that the enthusiasts in Canada who had been just waiting for it to become legal all rushed out to buy their rigs. What the Canadian reps didn't realize however, was that the average citizen didn't know a thing about it, so after the initial surge of buying from electronics buffs, the market virtually dried up. Consequently the suppliers were left with egg on their face and a large inventory of 2-way radios they couldn't get rid of at any price.

At that time, I was the publisher of an electronics magazine and suggested editorially that all the suppliers get together to advertise the benefits of 2-way radio for the average citizen in order to make them aware of its existence and availability. Of course no one listened. And anyway how often can you get competitors to cooperate in such a campaign even if it would increase sales? Also, at that time I mentioned that a vast net of 2-way radio operators would be invaluable in a time of a national disaster. With CB operators outnumbering hams at a rate of about 10 to 1, I said that even in the worst disaster there would be enough CBers left to form a communications net and as they are mostly mobile operators, they could supply local communications while the hams could supply national and international communications.

CB RADIO TODAY

The facts that I expounded then, 10 years ago, are much more valid today. The CB radio market has taken off to such an extent that the FCC are seriously considering dropping the licensing requirements simply due to the fact that they don't have enough people on staff to process the more than half million applications coming in every month. It is also estimated that at least that many unlicensed operators are installing CB rigs every month as well. In the States they are called 'Bandits', though not in the literal sense, the accent is on 'band'. Truckers are the most notorious people for not getting a license to operate. This happened for two reasons. One was the lowering of the speed limits in the States, where they found that by using CB they could warn each other that 'Smokey Bear' (truckers slang for the highway patrol police) was at mile 327 or whatever and to 'Lift that hammer' (slang for easing up on the gas peddle) in order not to get a speeding ticket.

The second reason for their not getting a proper license (and in my opinion, the major one) was that you have to apply for a license in your own State or Province. These truckers span the continent and are more often than not over a thousand miles away from home when they decide, after hearing fellow truckers extol the virtues of CB, to have a radio installed in their rig, and are told by the seller that they must apply for a license when they get home. However, by the time they get on the air and find that practically no other truckers have a license, they just forget the whole idea.

CB RADIO SAVES LIVES

The Ohio State Police did a survey last year that proved consclusively that mobile CB operators are a positive benefit to the general public. Without going into the results of the survey in detail, it definitely proved that there were many advanages to having private citizens and truckers using CB on the highways and byways. I could cite from my own personal experiences that its use is of positive benefit to the general public. In times of snow storms, accidents, etc, CB has saved many valuable minutes that could mean the difference between life and death on the highway.

ON THE DEFENSIVE

While I don't like to use this metaphor as I am personally in favour of gun control, when I wrote about my opinions on this in my security magazine, an American wrote back that the right of Americans to carry guns was a positive reason why they would never submit to invasion. With every American allowed to carry guns, any potential conqueror of the USA would have to contend with 'vigilante' groups well armed to harass the invaders. However, the amount of CB operators in North America today gives credence to my original editorial about the fact that in a time of national disaster such as a nuclear war, if the phone system was completely wiped out (and they too have contingency plans in this regard), the CB net would provide a short range communication system that would be second to none.

In deference to my ham friends I must also mention that most of them are now using 2 meter FM in their cars and they are using it in basically the same way as are the CBers. But in talking about numbers, there is just no comparison.

AMERICA

MORE THAN 10,000,000

In an article dated April 1, 1976, the FCC estimated that over 10,000,000 CB sets are now in use in the USA alone! Canadian estimates are in the area of 400,000. In both cases it is estimated that 50% of set owners are unlicensed. In this article they describe the growth of CB, mostly mobile, as the fastest growing communications medium since the telephone! This incredible phenomenon has been variously described as: the dawn of a new era in communications; a disease; a dangerous nuisance; a service that has saved hundreds of lives; an electronic toy for affluent Americans to play with and a legal means of avoiding the police. Whatever simile you pick, it's certainly controversial.

The biggest problem now is that there just aren't enough available channels for the multitude of operators. With all the talk over the past year about expanding from the present 23 channels, AM (SSB sets give you 69 channels when you count the upper and lower sidebands), to 50 channels and also some talk about opening up the 220MHz bands, many manufacturers were so confident that the official announcement of band expansion would be made at the PC '76 (Personal Communications) conference in Las Vegas at the end of March that at least one manufacturer even had a 50 channel set on display. Others have converters designed to accommodate the extra channels. Knowing how governments operate, they should have known better. Even I thought that a joint announcement would be made at the convention. What happened instead was that the FCC commissioner Robert E. Lee announced that it *might* be expanded by the first of next year. Charles Higgenbottom told the attendees that it is still under study and that there are several problems that have to be solved. He added, "Bear with us, the prospect for additional channels is optimistic — we're on your side." It was also stated that converters would definitely *not* be allowed.

This PC '76 convention is the first one ever held that was strictly on CB and it was under the sponsorship of the EIA (Electronic Industries Association). Over 6,000 registered attendees made it the largest convention ever held in Las Vegas. The EIA predicted last fall that the CB market will double each year over the previous year for the next 4 years before it even begins to level off, and then they predict an upsurge in amateur radio. This writer has seen this happening already as CBers who have gotten the communications bug have become disenchanted with the over-crowding and the idle chit-chat on the bands and are now taking courses to get their ham ticket.

Whatever your opinion of all this is, I believe that the positive benefits of CB far outweigh the negative side, and I feel that more countries around the world should open up this personal communications service to the average citizen.

RULE BRITANNIA!

BRITANNIA RULES THE CB AIRWAVES! One point which amused us greatly while we were researching this article is that Britain is very actively involved in the manufacture of CB radios. Plessey Semiconductors of Swindon are well known for their special radio communications integrated circuits which are designed for a wide range of applications, both in and outside the signal path. In the first category are their SL600 series of communications circuits (RF, IF and AF amps and balanced mixers) and in the second category they are very active in the development of frequency synthesisers, including a special 3 chip synthesiser for CB (see ND June).

Now here's the crunch! Plessey have just announced two deals to export almost 1½ millions complete sets of chips for CB radios to Japan where they will be assembled into transceivers and re-exported to America — yet neither Japan not the UK have citizens band radio. So we have a situation where companies in Britain and Japan are applying their skills to a market which does not exist in their home countries. Full marks to Plessey for an aggressive approach to foreign markets, in which British technology now sets a lead.

As regards any potential British market, the companies we spoke to were guarded in their comments in view of Statutory Instrument No. 61, but if a Citizens Band were permitted in the UK, there is no doubt that equipment would be rapidly made available. In fact, at least one American CB manufacturer we contacted expressed interest in Britain as a potential market.

CB4UK?

*"That you Dear? I'm caught in a * * * * * * jam — reckon I'll be fifteen minutes late ". . ." O.K., Honey — I'll put the martinis back in the cooler".*

CB SLANG

Back Door	*Last truck in convoy*	Plain wrapper	*Unmarked police car*
Bear	*Police Officer*	Picture taker	*see Camera*
Bear Cave	*Police Station*	Pregnant Roller Skate	*Volkswagen*
Breaker 21	*CB Break-in signal*	Put the hammer down	*Floor the accelerator*
Camera	*Radar speed trap*	Rocking chair	*Middle trucks in convoy*
Chicken Coop	*Weighing station for trucks*	Roger Roller-skate	*Driver doing more than 20mph over limit*
Clean	*No Police seen*	Seat Covers	*Passengers, esp. female*
County Mounty	*Local Police*	Shakeytown	*Los Angeles, because of its earthquakes*
Double Nickels	*55mph speed limit*	Smokey Bear	*State Police*
Feed the bears	*Get a ticket*	Smokey with Ears	*Police with CB radio*
Five five	*55mph speed limit*	Smokey taking pictures	*Police with radar*
Flip side	*Return trip*	10-4	*OK*
Front door	*Leading truck in convoy*	10-33	*Accident or emergency message*
Green stamps	*Money — dollars*	Tijuana Taxi	*Police car with lights and insignia*
Green stamp road	*Toll road*	Wall to wall bears	*Heavy Police patrols in an area*
		We gone	*End of transmission*

The CBM 4190R Scientific

eti PRODUCT TEST

A calculator for those with 49 fingers.

FIRST OF ALL LET US apologise to those of our readers who have been awaiting this review since we announced the calculator in March "News Digest." CBM also released a financial machine around the time of the 4190's birth, and this has held up the release slightly. Anyway here it is now, and it has certainly been worth the wait.

The functions list gives you an idea of what the machine is capable of, which is really quite amazing for a non-programmable machine. The next step from the 4190 has to be to a programmable scientific, although this 'dreadnought' would seem to have most functions you could wish to programme readily available.

HUMANE LOGIC

It is easy to use, the keyboard being well laid out, and the keys quite 'soft' to the touch — although not as positive in action as some. Surprisingly the calculator runs in algebraic logic, nice for us humans but anathema to those with binary brains. (RPN men to the last!) No trouble was encountered in operation, although when the battery begins to flatten out, some crazy answers manifest themselves. The test for this is simple and ingenious — clear the display and try to put up a row of '8's. If the charge is gone (or going) you won't get very far before strange numbers leap at you from the segments.

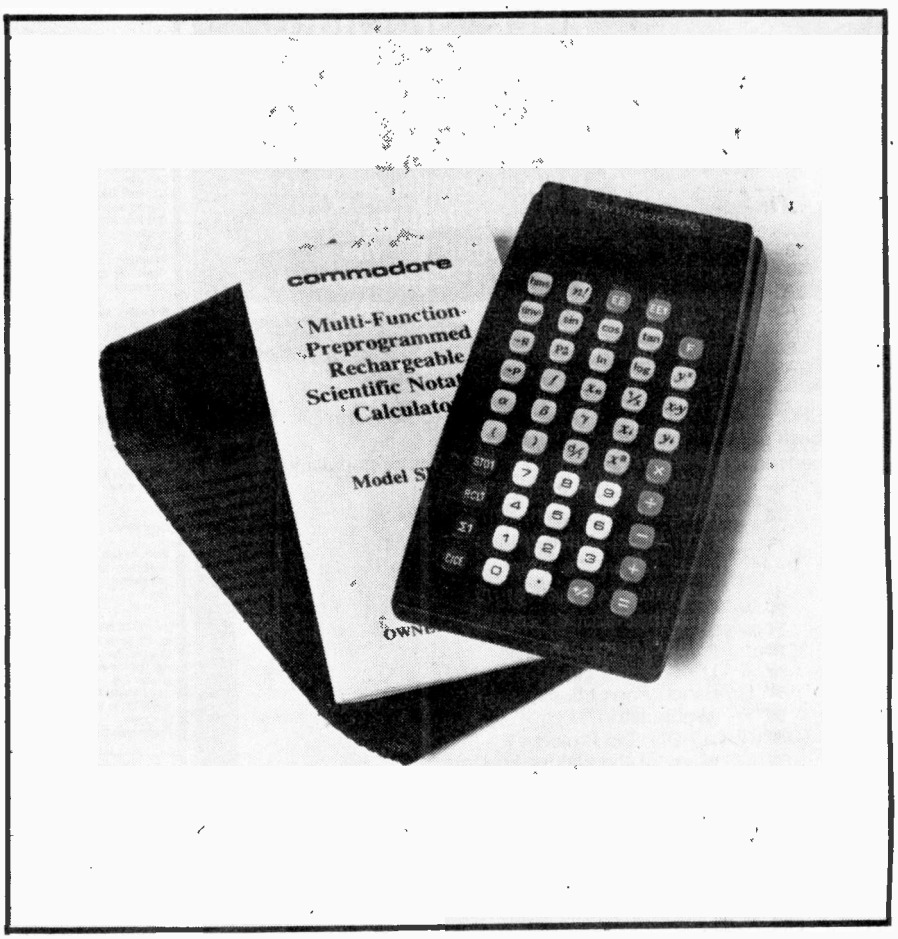
The one great shame about the 4190 is the manual supplied with the machine. This is just not up to the same standard as the calculator itself. Identical symbols are used for 'x' and 'multiply,' leading to immediate confusion. The examples are not as clear as they could be. However anyone who is able to put the 4190 to good use will surely be able to unravel the tangled web CBM have spun here.

ADAPTED AND INTEGRATED

A mains adaptor/recharger is supplied and the calculator will function while on recharge. However, we found its accuracy questionable during the first half-hour if the battery was absolutely dead. Not a real disadvantage, as you shouldn't let it get that bad in the first place.

Perhaps the most unusual key to be found amid the hordes to choose from is the integration key. This function will evaluate a definite integral as the area under a curve, by applying a numerical approximation technique (trapezium rule?) A series of points along the curve are entered one by one at a given interval, and the machine produces the answer between the limits when requested by successive depression of the integration button.

We found the most fascinating function to be P_m^n and C_m^n permutation and combinations! Handy for figuring out your pools odds! Here the manual *is* fairly clear, and the examples provided



make the point concisely. Another rarity which interested us was the 'HMS' function. This will convert decimal to H-M-S display, or for instance convert 4870 seconds to 1-37-50 at a button push. Undoubtedly of use to time and motion engineers.

CONCLUSIONS

One comment about the integration key. By the nature of the method used, the accuracy is very dependent upon the number of points entered into the calculator. This should be as high as possible. We found over an interval of 10 units, 0.2 increments gave acceptable results.

Conversion constants need no comment, except to say they are more comprehensive than any we have seen, as are the statistical and graph plotting facilities. The latter uses linear regression to 'fit' a straight line to a series of up to 99 given (x,y) points.

All in all a distinct step upwards from any other non-programmable calculator, and of more use than some that are programmable. About the only question it won't answer is how CBM produced it at the price they have. Definitely recommended. ●

CBM 4190 — KEY FUNCTIONS

C_m^n	Combinations of n elements taken m at a time
ln	Natural and common
log	logarithm
e^x	Natural and common
10^x	antilogarithm
y^x	Raises y to the xth
$x\sqrt{y}$	or $\frac{1}{x}$th power
d/r	Establishes an angular unit mode degree d or radian r. A dot will appear at the extreme right of the display when in radian mode. Will not convert the displayed number
d↔r	Converts the displayed number into degrees or radians depending on if the radian indicator is lit or not. Will set the mode after conversion
STO1 RCL1 Σ1 STO2 RCL2 Σ2	Memory store, memory recall and add to memory keys
x^2	Square and square
√x	root
C/CE	Clear key
CA	Clear all key
HMS	Hour-minute-second mode
n!	Factorial n
Γ(x)	Gamma function
(and)	Left and right parenthesis
%	Percent add-on/discount
Δ%	Percent variation
(INV)	Generates inverse trigonometric or hyperbolic functions. Converts into the unit between ( ) on the keyboard
sin cos tan	Since, cosine, tangent
sinh cosh tanh	Hyperbolic sine, cosine, tangent
F	Accesses functions symbolized above the key top
→R →P	Coordinate conversion
P_m^n	Permutation of n elements taken m at a time
jx, j+, j−, j÷	Complex numbers arithmetic operations
(unit 1) unit 2	(Legends above numeral keys) Converts a number displayed in unit 1 to the number expressing it in unit 2
π	Enter π = 3.141592654
EE	Sets exponent value entry mode
MANT	Reverts to mantissa value entry mode
EE↑	Increments exponent algebraically and moves decimal point accordingly
EE↓	decrements exponent algebraically and moves decimal point accordingly
+/−	Change sign key

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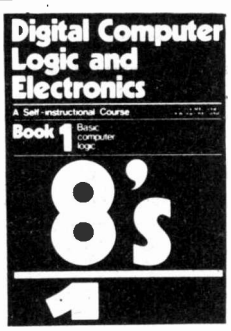

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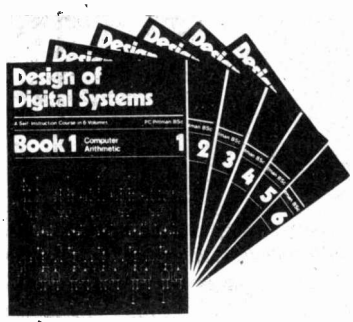

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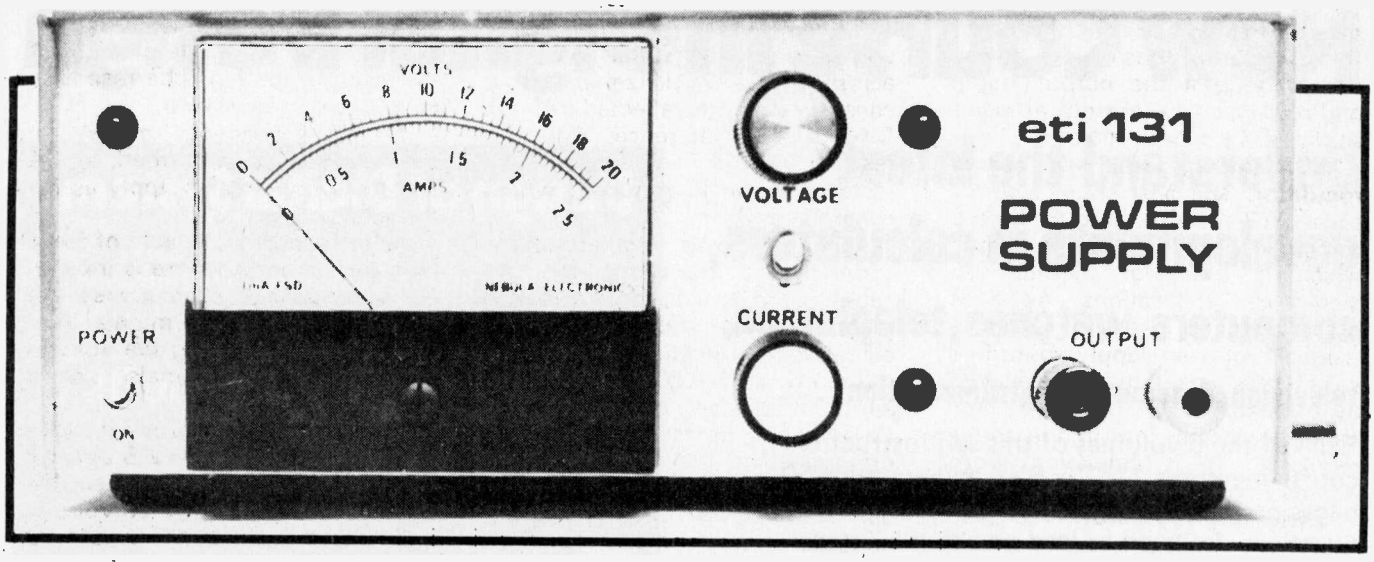


GENERAL PURPOSE POWER SUPPLY

This versatile general purpose supply produces up to 2.5 amps from zero to 20 volts — or up to 1.25 amps from zero to 40 volts. Current limiting is adjustable over the entire range for either output option.

eti 131

AN IDEAL POWER SOURCE should supply a voltage which is adjustable over a wide range, and which remains at the set voltage regardless of line voltage or load variations. The supply should also be undamaged by a short circuit across its output and be capable of limiting the load current so that devices are not destroyed by fault conditions.

Two such supplies have previously been described in ETI. The first was a simple supply providing 0 to 15 volts at up to 750 mA. The second was a dual tracking supply providing ± 20 volts at up to one ampere. Both these supplies have been extremely popular, especially the simple one, and are still being built by many people. However there have been many requests for a supply having a greater output current capability than either of these previous designs could provide.

This project describes a supply that will provide 2.5 amperes at up to 18 volts (up to 20 volts at lower currents). Alternately a few simple changes can make the supply provide up to 40 volts at 1.25 amperes. The supply voltage is settable between zero and the maximum available, and current limiting is also adjustable over the full range. The mode of operation of the supply is indicated by two LEDs. The one beside the voltage control knob indicates when the unit is in normal voltage-regulation mode and the one beside the current limit control indicates when the unit is in current limit mode. In addition a large meter indicates the current or voltage output as selected by a switch.

DESIGN FEATURES

During our initial design stages we looked at various types of regulator and the advantages and disadvantages of each in order to choose the one which would give the best cost-effective performance. The respective methods and their characteristics may be summarized as follows.

The shunt regulator. This design is suitable mainly for low-power supplies — up to 10 to 15 watts. It has good regulation and is inherently short-circuit proof but dissipates the full amount of power it is capable of handling under no-load conditions.

The series regulator. This regulator is suitable for medium-power supplies up to about 50 watts. It can and is used for higher power supplies, but heat dissipation can be a problem especially at very high current with low output voltages. Regulation is good, there is little output noise and the cost is relatively low.

SRC regulator. Suitable for

SPECIFICATION — ETI 131

20 VOLT VERSION	
VOLTAGE	
Output	0—20 volts
Regulation	<20 mV (0—2.5A)
Ripple and noise	<1 mV at 2.5A
CURRENT	
Output	0—2.5A (up to 18 V) 0—2.0A (up to 20 V)
Limit	0—2.5A
Regulation	<10 mA (0—20 V)
40 VOLT VERSION	
VOLTAGE	
Output	0—40 V
Regulation	<20 mV (0—1.25A)
Ripple and noise	<1.5 mV at 1.25A
CURRENT	
Output	0—1.25A
Limit	0—1.25A
Regulation	<10 mA (0—40 V)

In both versions LEDs indicate voltage or current modes and the meter is switchable to read voltage or current.

medium to high power applications, this regulator has low power dissipation, but the output ripple and response time are not as good as those of a series regulator.

SCR preregulator and series regulator. The best characteristics of the SCR and series regulators are combined with this type of supply which is used for medium to high-power applications. An SCR pre-regulator is used to obtain a roughly regulated supply about five volts higher than required, followed by a suitable series regulator. This minimizes power loss in the series regulator. It is however more expensive to build.

Switching regulator. Also used for medium to high-power applications, this method gives reasonable regulation and low power dissipation in the regulator but is expensive to build and has a high frequency ripple on the output.

Switched-mode power supply. The most efficient method of all, this regulator rectifies the mains to run an inverter at 20 kHz or more. To reduce or increase the voltage an inexpensive ferrite transformer is used, the output of which is rectified and filtered to obtain the desired supply. Line regulation is good but it has the disadvantage that it cannot easily be used as a variable supply as it is only adjustable over a very small range.

OUR OWN DESIGN

Our original design concept was for a supply of up to 20 volts at 5 to 10 amps output. However, in the light of the types of regulator available, and the costs, it was decided to limit the current to about 2.5 amps. This allowed us to use a series regulator — the most cost-effective design. Good regulation was required, together with variable-current limit, and it was also specified that the supply would be useable down to virtually zero volts. To obtain the last requirement a negative supply rail or a comparator that will operate with its inputs at zero volts is required.

Rather than use a negative supply rail we chose to use a CA3130 IC operational amplifier as the comparator. The CA3130 requires a single supply (maximum of 15 volts) and, initially, we used a resistor and 12 volt zener to derive a 12 volt supply. The reference voltage was then derived from this zener supply by another resistor and a 5 volt zener. It was telt that this would have given sufficent regulation for the reference voltage but in practice the output from the rectifier was found to vary from 21 to 29 volts and some of the ripple and voltage change that occurred across the 12 volt zener, as a consequence, was reflected into the 5 volt zener reference. For this reason the 12 volt zener was replaced by an IC regulator which cured the problem.

With all series regulators the series-output transistor by the nature of the design, must dissipate a lot of power especially at low output voltage and high current. For this reason an adequate heatsink is an essential part of the design. Commercial heatsinks are very expensive and sometimes difficult to mount. We therefore designed our own heatsink which was not only cheaper but worked better than the commercial version we had been considering — being easier to mount. However at full load the heatsink still runs hot as does the transformer, and under high-current low-voltage conditions the transistor may even be too hot to touch. This is quite normal as the transistor under these conditions is still operating within its specified temperature range.

With any highly regulated supply, stability can be a problem. For this reason in the voltage-regulation mode of operation, capacitors C5 and C7 are incorporated to reduce the loop gain at high frequencies and thus prevent the supply from oscillating. The value of C5 has been chosen for best compromise between stability and response time. If the value of C5 is too low the speed of response is greater — but there is a higher chance of instability. If too high the response time is unduly increased.

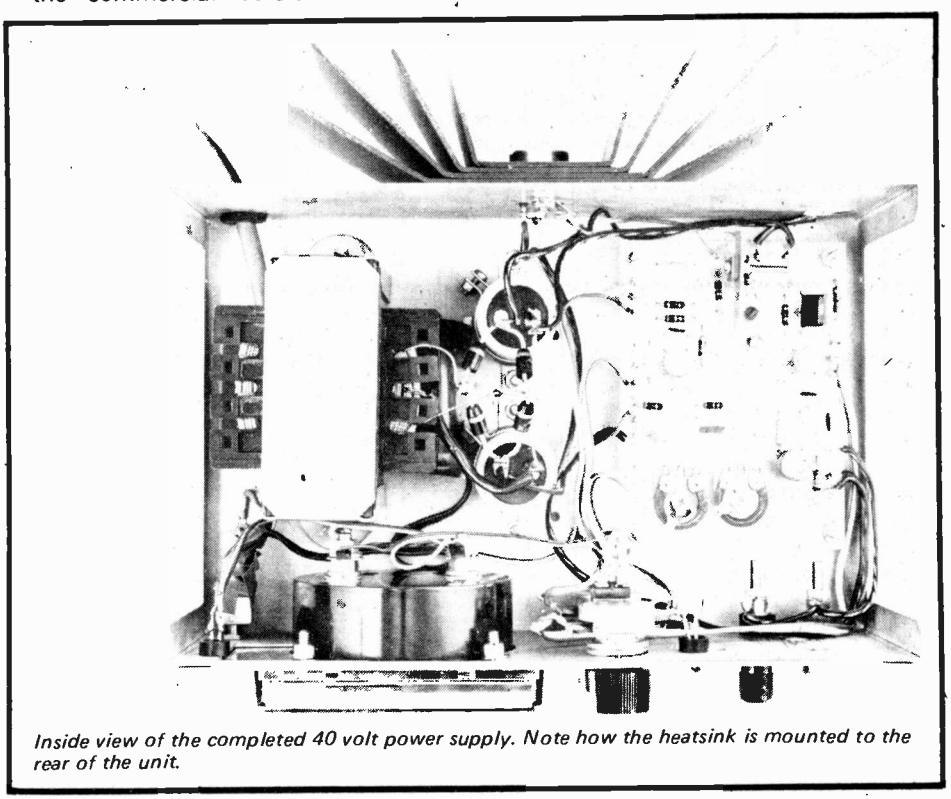
In the current-limit mode the same function is performed by C4 and the same remarks apply as for the voltage case.

As the supply is capable of fairly high current output there is inevitably some voltage drop across the wiring to the output terminals. This is overcome by sensing the voltage at the output terminals via a separate pair of leads.

Whilst the supply was primarily designed for 20 volts at 2.5 amps it was suggested that the same supply could be used to supply 40 volts at 1.25 amps and that this would be of more value to some users. This may be done by changing the configuration of the rectifier and by changing a few components. Some thought was given to making the supply switchable but the extra complication and expense were such that it was not considered to be worthwhile. Thus you should simply decide which configuration suits your need and build the supply accordingly.

The maximum regulated voltage available is limited either by the input voltage to the regulator being too low (at over 18 volts and 2.5 amps) or by the ratio of R14/R15 and by the value of the reference voltage.

$$(\text{Output} = \frac{R14+R15}{R15} \text{ V ref})$$



Inside view of the completed 40 volt power supply. Note how the heatsink is mounted to the rear of the unit.

General purpose power supply

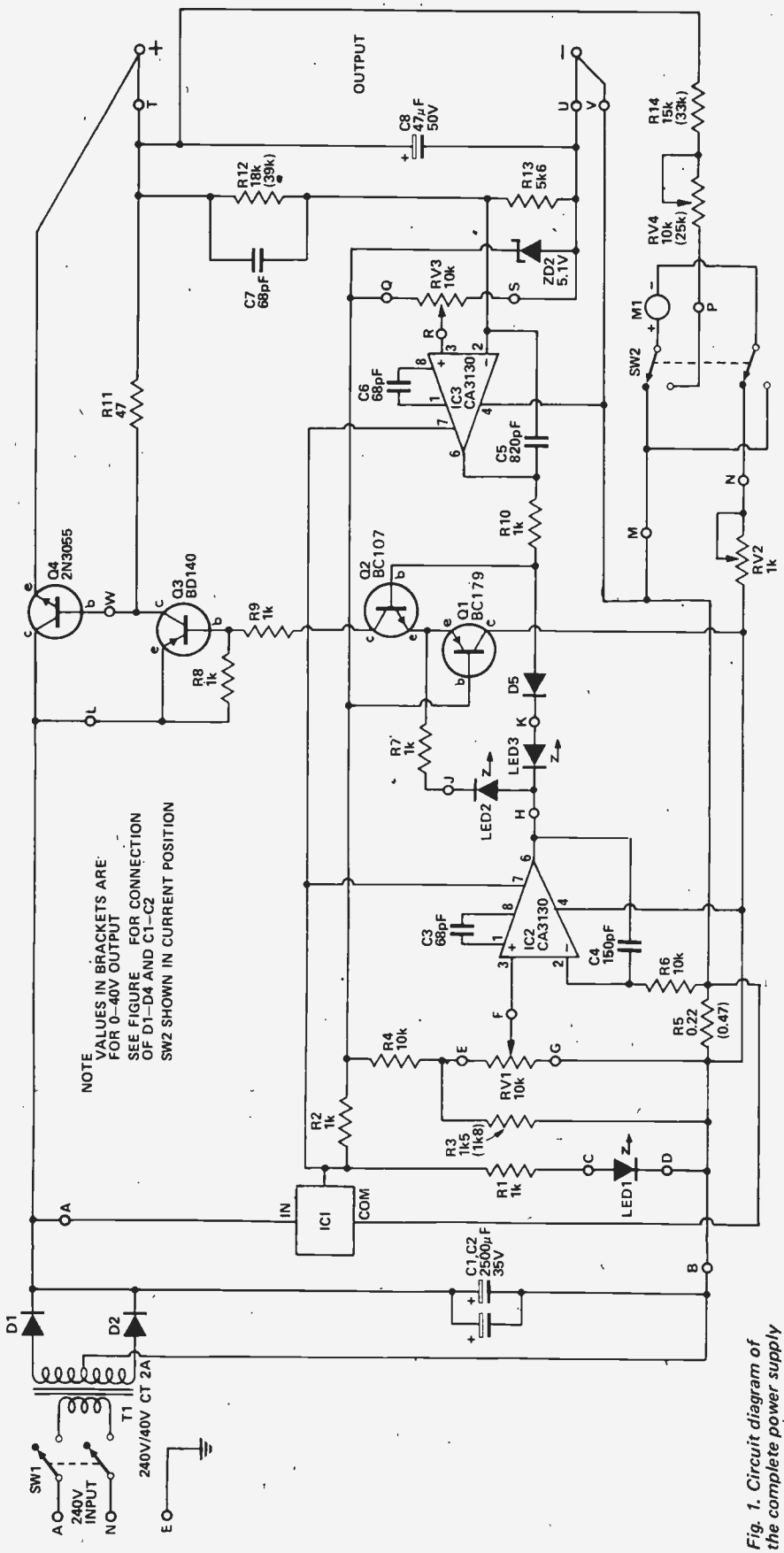


Fig. 1. Circuit diagram of the complete power supply 20 volt 2.5 ampere version.

Due to the tolerance of ZD1 the full 20 volts (or 40 volts) may not be obtainable. If this is found to be the case R14 should be increased to the next preferred value.

Single turn potentiometers have been specified for the voltage and current controls because they are inexpensive. However if precise setability of voltage or current limit is required ten-turn potentiometers should be used instead.

CONSTRUCTION

The recommended printed-circuit board layout should be used as construction is thereby greatly simplified. Printed-circuit board pins should also be used for the 20 wire connections to the board. These should be installed first. The rest of the components may now be assembled onto the board making sure that the polarities of diodes, transistors, ICs and electrolytics are correct. The BD140 (Q3) should be mounted such that the side with the metal surface faces towards IC1. A small heatsink should be bolted onto the transistor as shown in the photograph.

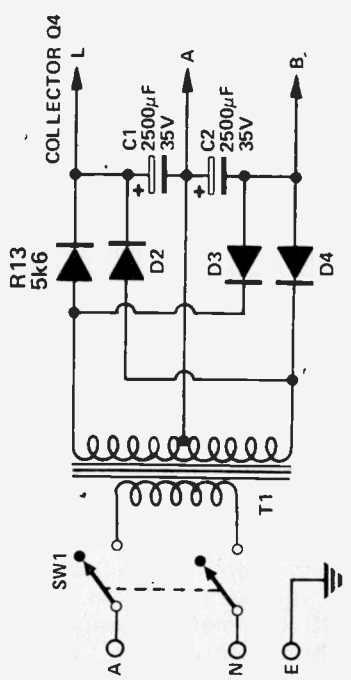


Fig. 2. Alternative rectifier and filter capacitor connections required for 40 volt, 1.25 ampere version.

RECONNECTED POWER SUPPLY FOR 40V 1.25A SUPPLY

HOW IT WORKS – ETI 131.

The 240 volt mains is reduced to 40 Vac by the transformer and, depending on which supply is being built, rectified to either 25 or 50 Vdc. This voltage is only nominal as the actual voltage will vary between 29 volts (58 volts) on no-load to 21 volts (42 volts) at full load. The same filter capacitors are used in either case. They are connected in parallel for the 25 volt version (5000 μF) and in series for the 50 volt version (1250μF). In the 50 volt version the centre tap of the transformer is connected to the centre tap of the capacitors thus ensuring correct voltage sharing between the capacitors. This arrangement also provides a 25 volt supply for the regulator IC.

The voltage regulator is basically a series type where the impedance of the series transistor is controlled in such a way that the voltage across the load is maintained constant at the preset value. The transistor Q4 dissipates a lot of power especially at low output voltages and high current and is therefore mounted on the heatsink on the rear of the unit. Transistor Q3 adds current gain to Q4, the combination acting as a high-power, high-gain, PNP transistor.

The 25 volts is reduced to 12 volts by the integrated-circuit regulator IC1. This voltage is used as the supply voltage for the CA3130 ICs and is further reduced to 5.1 volts by zener diode ZD1–for use as the reference voltage. The voltage regulation is performed by IC3 which compares the voltage as selected by RV3 (0 to 5.1 volts) with the output voltage as divided by R14 and R15. The divider gives a division of 4.2 (0 to 21 volts) or eight (0 to 40 volts). However at the high end the available voltage is limited by the fact that the regulator loses control at high current as the voltage across the filter capacitor approaches the output voltage and some 100 Hz ripple will also be present. The output of IC3 controls transistor Q2 which in turn controls the output transistor such that the output voltage remains constant regardless of line and load variations. The 5.1 volt reference is supplied to the emitter of Q2 via Q1. This transistor is in effect a buffer stage to prevent the 5.1 volt line from being loaded.

Current control is performed by IC2 which compares the voltage selected by RV1 (0 to 0.55 volts) with the voltage generated across R7 by the load current. If say 0.25 volts is set on RV1 and the current drawn from the supply is low, the output of IC2 will be near 12 volts.

This causes LED 2 to be illuminated as the emitter of Q1 is at 5.7 volts. This LED therefore indicates that the supply is operating in the voltage-regulator mode. If however the current drawn is increased such that the voltage across R7 is just above 0.25 volts (in our example) the output of IC2 will fall. When the output of IC2 falls below about 4 volts Q2 starts to turn off via LED 3 and D5.

The effect of this is to reduce the output voltage so that the voltage across R7 cannot rise further. When this happens the voltage comparator IC3 tries to correct for the condition and its output rises to 12 volts. IC2 then takes more current to compensate and this current causes LED 3 to light, indicating that the supply is operating in the current-limit mode.

To ensure accurate regulation the voltage sensing leads are taken to the output terminals separately from those carrying the load current.

The meter has a one milliamp movement and measures the output voltage (directly across the output terminals) or current (by measuring the voltage across R7) as selected by the front panel switch SW2.

PARTS LIST – ETI 131A

Resistors

R1	–	1 k	½ W	5%
R2	–	1 k	"	"
R3	–	1 k5	"	"
R4	–	10 k	"	"
R5	–	0.22 ohm 5 W		
R6	–	10 k	½ W	5%
R7	–	1 k	"	"
R8	–	1 k	"	"
R9	–	1 k	"	"
R10	–	1 k	"	"
R11	–	47	"	"
R12	–	18 k	"	"
R13	–	5 k6	"	"
R14	–	15 k	"	"

Potentiometers

RV1	–	10 k lin rotary
RV2	–	1 k trim
RV3	–	10 k lin rotary
RV4	–	10 k trim

Capacitors

C1	–	2500 μF 35V electro
C2	–	2500 μF 35V electro
C3	–	68 pF ceramic
C4	–	150 pF "
C5	–	820 pF "
C6	–	68 pF "
C7	–	68 pF "
C8	–	47 μF 50V electro

Transistors

Q1	–	BC179
Q2	–	BC107
Q3	–	BD140
Q4	–	2N3055 (with insulation kit)

Diodes

D1,2	–	IN5404
D5	–	IN914

Other Semiconductors

ZD1	Zener Diode 5.1V 400 mW
LED 1,2	LED TIL209 or similar
IC1	Integrated Circuit LM341P-12
IC2,3	" " CA3130

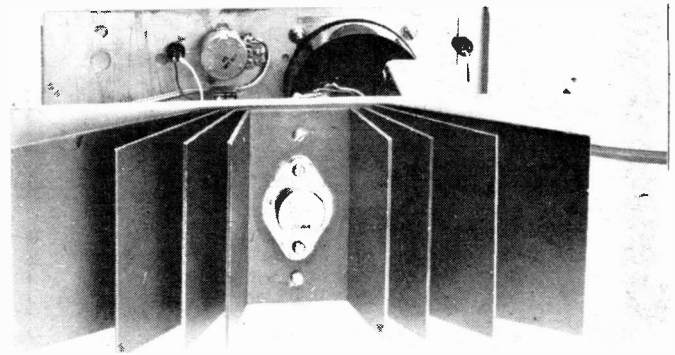
Miscellaneous

PC board ETI 131
Transformer 40V CT 2A
SW1,2 switch DPDT toggle
Meter 1 mA FSD scaled 0-20V, 0-2.5A
Chassis to Fig. 11
Cover to Fig. 13
Heatsink to Fig. 10
Front panel to Fig. 9
Two terminals
Power cord & clamp
Two knobs
Four 10 mm long spacers
20 PC board pins
Four rubber feet
nuts, bolts, washers etc.

PARTS LIST – ETI 131B

All parts for ETI 131A except

Change	R3	to	1 k8
	R5	to	0.47 ohm
	R12	to	39 k
	R14	to	33 k
	RV4	to	25 k



Rear view of the heatsink showing how it and the transistor are mounted.

General purpose power supply

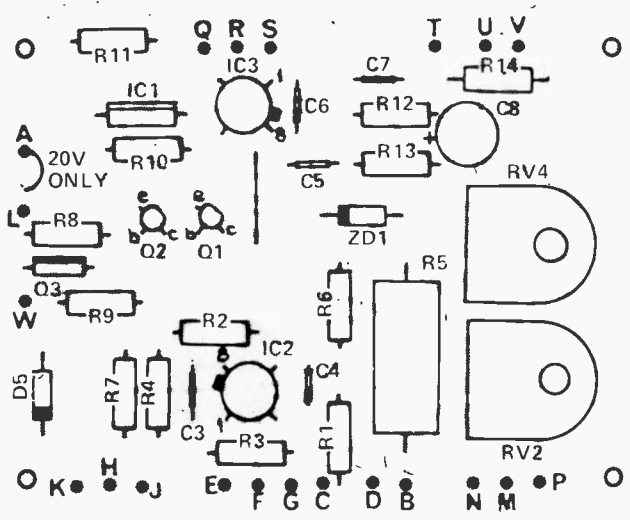


Fig. 3. Component overlay for the printed-circuit board assembly.

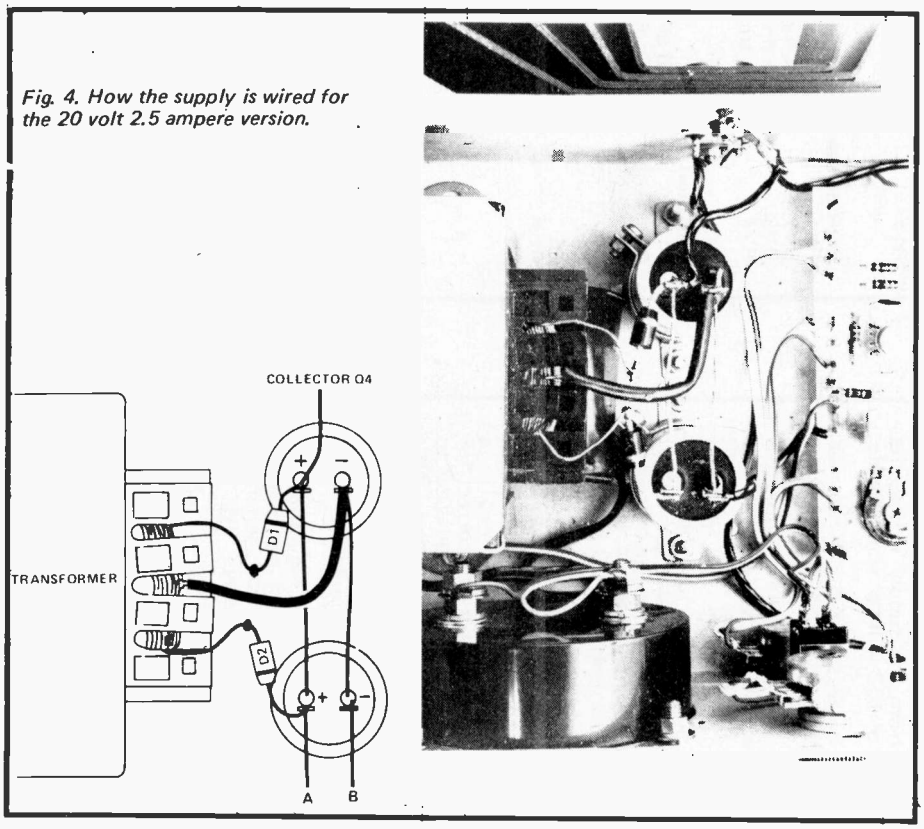


Fig. 4. How the supply is wired for the 20 volt 2.5 ampere version.

If the metalwork as described is used the following assembly order should be used.

a) Mate the front panel to the front of the chassis and secure them together by installing the meter.

b) Fit the output terminals, potentiometers and meter switch on to the front panel.

c) The cathodes of the LEDs (that we used) were marked by a notch in the body which could not be seen when the LEDs were mounted onto the front panel. If this is the case with yours, cut the cathode leads a little shorter to identify them and then mount the LEDs into position.

d) Solder lengths of wire (about 180 mm long) to the 240 volt terminals of the transformer, unsulate the terminals with tape and then mount the transformer into position in the chassis.

f) Install the power cord and the cord retaining clip, wire the power switch, insulate the terminals and then mount the switch onto the front panel.

g) Assemble the heatsink and screw it onto the rear of the chassis via two bolts — then mount the power transistor using insulation washers and silicon grease.

h) Mount the assembled printed-circuit board to the chassis using 10 mm spacers.

i) Wire the transformer secondary, rectifier diodes and filter capacitors. The diode leads are stiff enough not to need any additional support.

j) The wiring between the board and the switches may now be made by connecting points with corresponding letters on the front panel diagram and component overlay diagrams.

The only setting up required is to calibrate the meter. Connect an accurate voltmeter to the output control of the power supply until the external meter reads 15 volts (or 30 volts on the alternate arrangement).

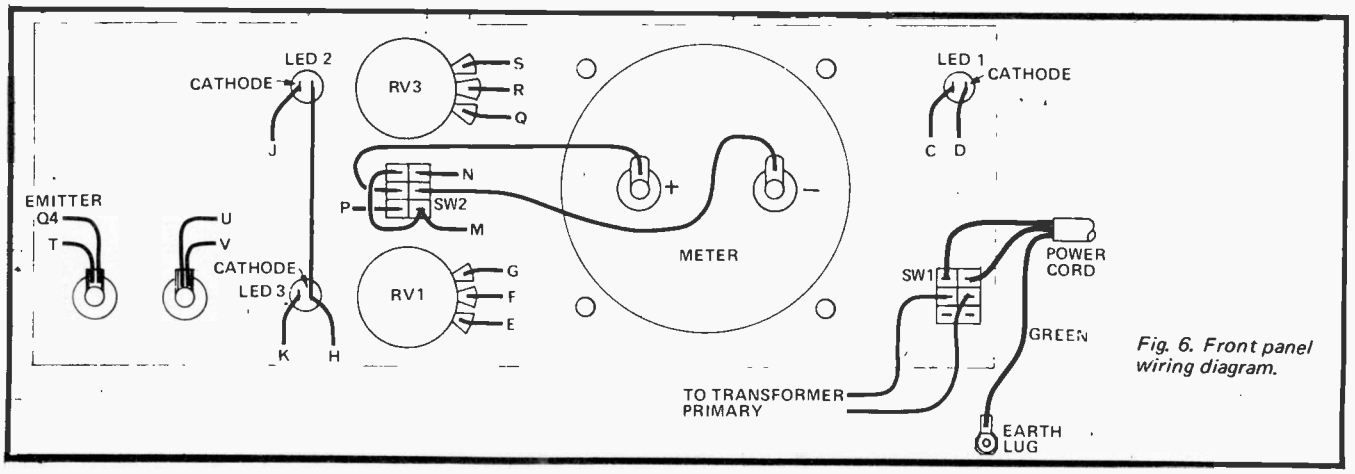


Fig. 6. Front panel wiring diagram.

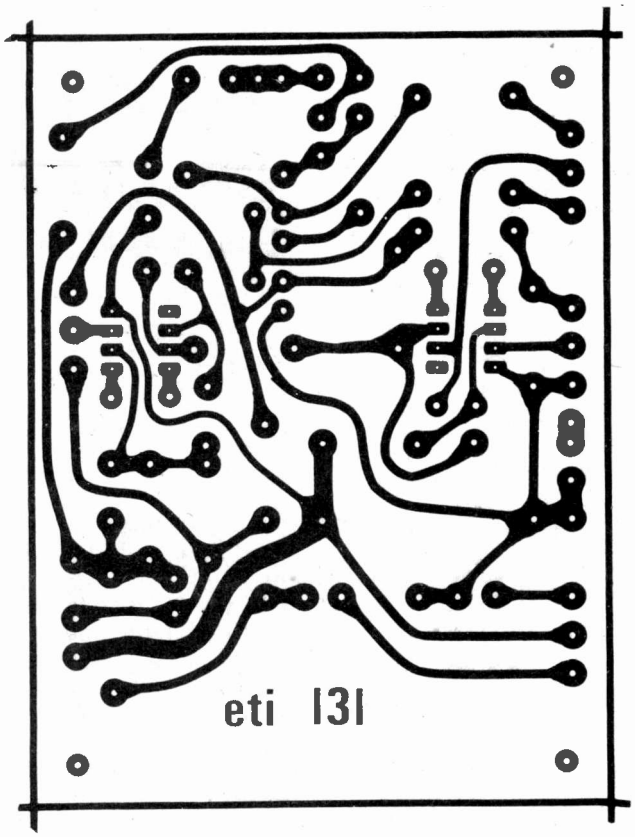


Fig. 7. Printed-circuit board layout for the power supply. Full size 100 x 75 mm.

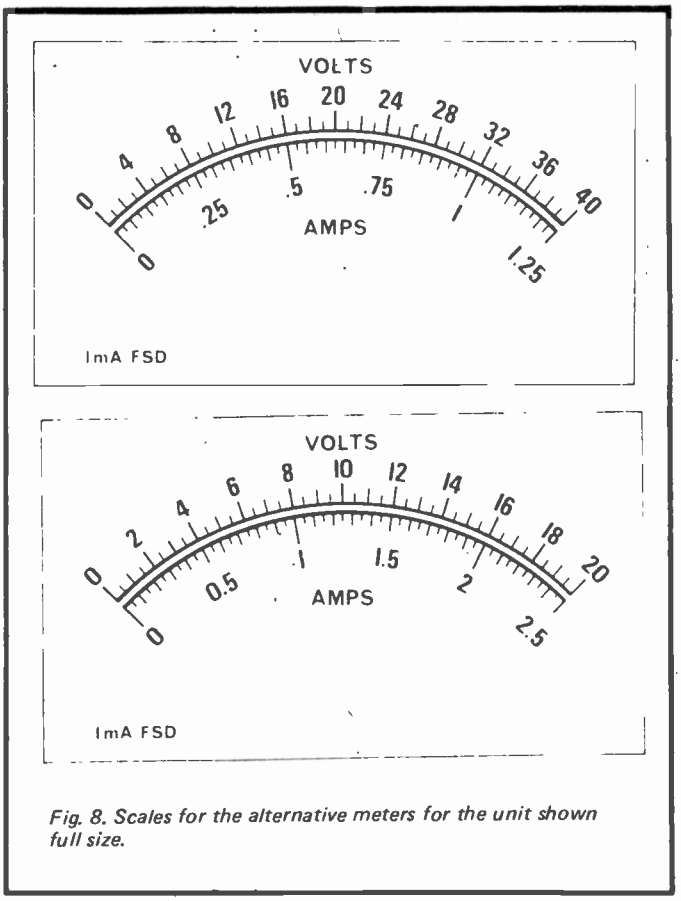


Fig. 8. Scales for the alternative meters for the unit shown full size.

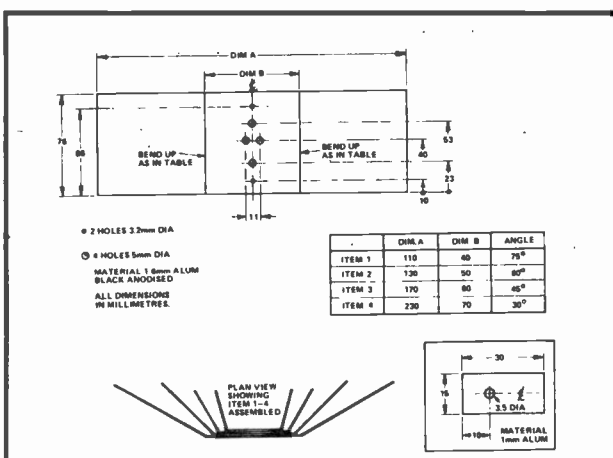
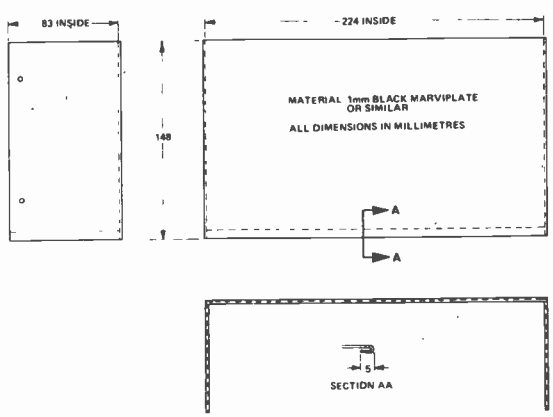


Fig. 10. Heatsink detail.



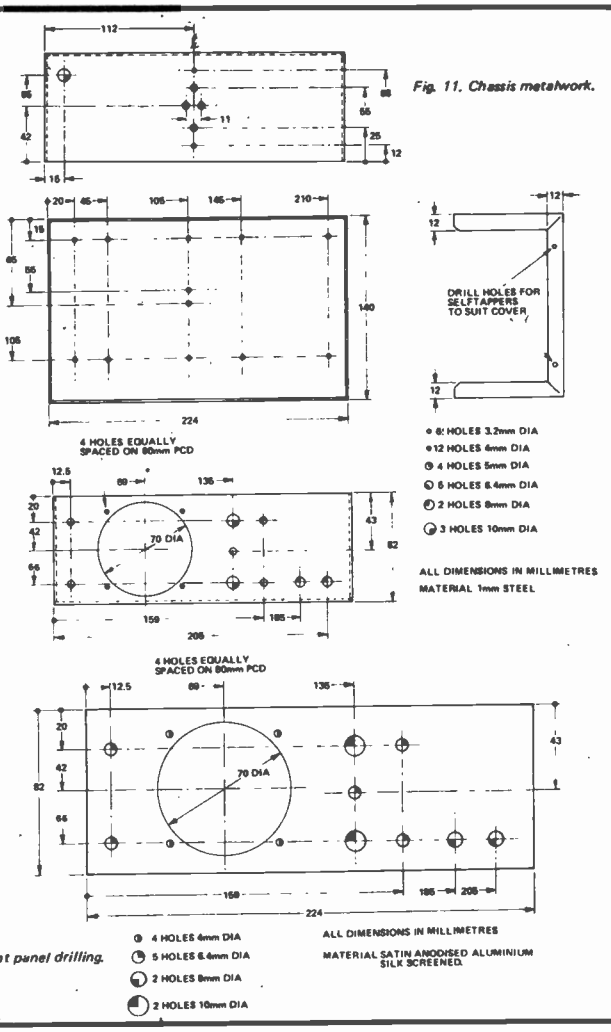


Fig. 11. Chassis metalwork.

Fig. 12. Front panel drilling.

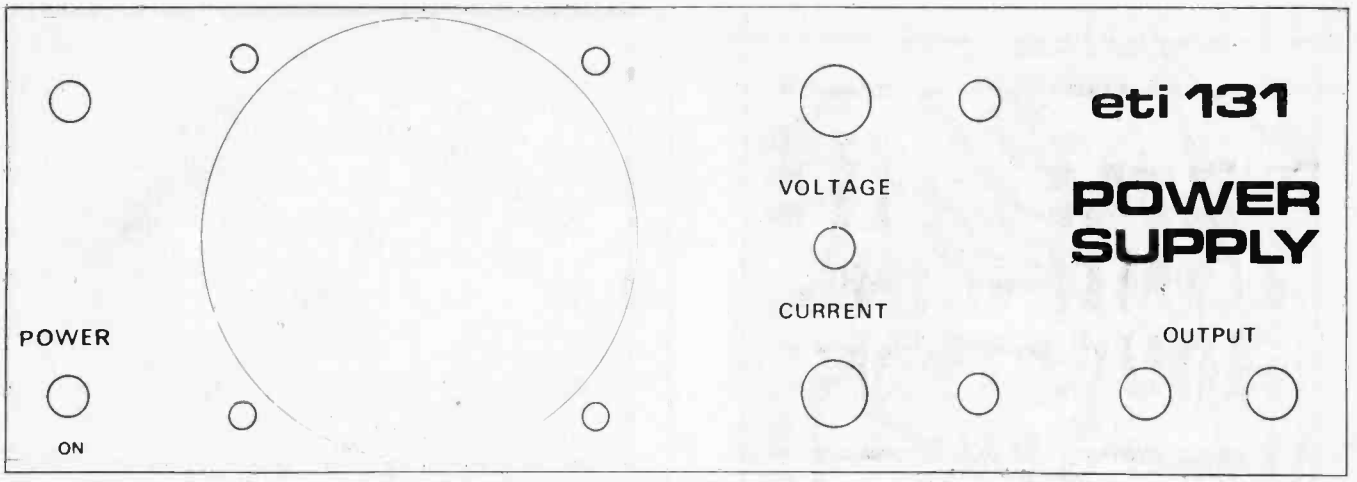


Fig. 9. Artwork for the front panel. Full size 224 x 82 mm.

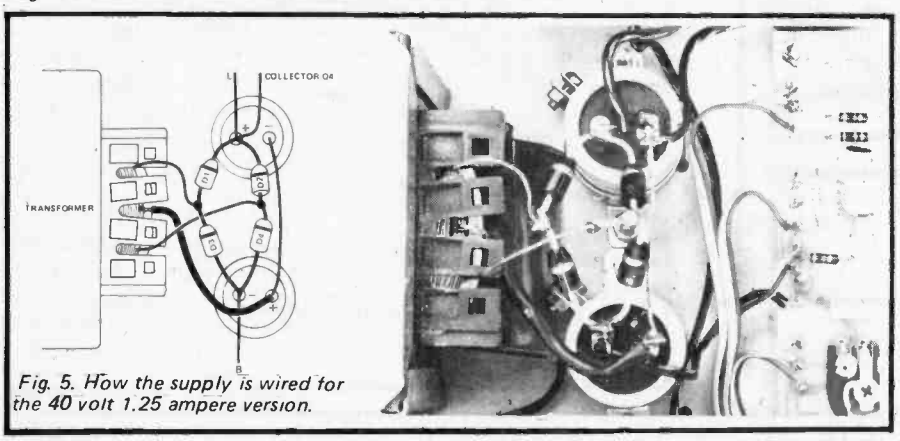


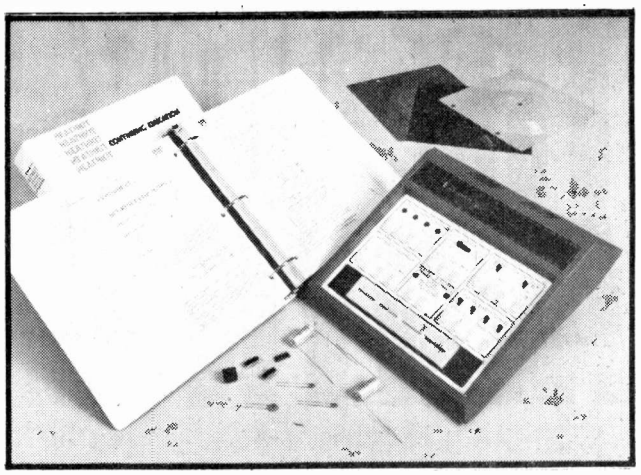
Fig. 5. How the supply is wired for the 40 volt 1.25 ampere version.

Switch the internal meter to read volts and adjust RV4 to obtain the same reading.

To set up the current reading first wind the supply voltage down to zero and connect an accurate ammeter across the output. Wind up the voltage control and observe that the current limit LED is on. Now adjust the current limit control so that the external meter indicates two amps (or one amp on the alternative unit). Now adjust RV2 so that the same reading is obtained on the internal meter when it is switched to the current position. ●

ETI LOOKS AT

HEATHKIT CONTINUING EDUCATION



WE HAVE OFTEN wondered how our readers acquire the standard of knowledge that they do. Certainly many have had formal training in electroncis but most have picked up a bit here and there — much of it we hope from ETI. Even those who *have* had formal training often received this several years ago and electronics development is so fast that it's easy to be stuck with out of date knowledge.

To introduce the amateur to electronics — or update the knowledge of the expert — a number of companies have introduced educational courses. We've seen a number of these and have always been impressed — we know of none that are not good value.

Heathkit are a recent entry in to the educational field. Now Heathkit, as a company, need no introduction and it is natural that they enter this field. When we heard about their new courses we asked to have a look at one. Heathkit have probably forgotten more about electronics kit building than anyone else has ever learnt — they are masters at explanation and clarity. However, as Heathkit aim their products at such an enormous spectrum of the population,' their instructions are always aimed at the lowest common denominator and we awaited the course with the notion that their course would be too slow: We are glad to say that it is not.

THE PACKAGE

Heathkit have now got four courses: DC Electronics, AC Electronics, Semiconductor Theory and Digital Techniques. We have been working our way through Digital Techniques.

The course is basically two large loose-leaf books with an Experimenter/Trainer (Super breadboard) with a set of floppy records.

The course is very clearly laid out. The idea is to work your way through the books, interrupting frequently to play a record and to complete 24 experiments.

The course starts with a record extolling the virtues of further education: Necessary, possibly, but a bit overdone. Much more useful is sound advice on *how* to learn. "Never study for more than an hour at a time but try to do at least one study course each day."

The course is divided into 10 sections and introduces you in an unusual way — but one that we liked. It is obviously important that a full understanding of semiconductor switching techniques is necessary yet this does not appear until Unit 2, Unit 1 being an Introduction to Digital Techniques.

Although *very* little knowledge is assumed, one is treated as being intelligent — and taken rapidly through an explanation of what 'digital" means up to the Binary Code etc. By the end of Unit 1 (53 pages) you should be able to answer not only such basic questions as "Are bathroom scales analogue or digital "as well understanding which of "Gray, 8421, ASCII and Excess 3 are unweighted codes."

The course is full of tests and examinations — at first glance there appear to be far too many but there is a good reason for them all. Every few pages there is a "Self Test Review" which covers the section you have just completed. These are much more than random tests as there is a question on practically every point made. It is an excellent way to learn what you don't know — it's also very good at bringing you down to earth if you think a quick glance will suffice. This rapidly gets you into the habit of reading everything carefully — and in retrospect learning what is significant.

Each Unit is completed by an Examination which does not ask simply for 'parrot' answers, repeating sentences from the text but by tests requiring a genuine understanding. The answers are given quite openly immediately afterwards with quite detailed explanations where you have to use your derived knowledge.

The Experimenter/Trainer is used very early on in the course and starts by demonstrating saturation in transistors but develops to demonstrate all logic functions. All the components used in the experiments are supplied.

The course is truly up to date — Unit 10 (the last) even includes Microprocessors!

We have worked our way through 60% of the course to date and even though it wouldn't be necessary to complete it now that we've reviewed it, we have every intention of doing so. A course of this type is excellent for pointing out your weak spots — and correcting that weakness. The only thing which we found a bit gimmicky was the records. These largely repeat what is written in the introduction to each Unit but perhaps have a 'Big Brother' effect for some people, encouraging them to keep going and acting as the tutor in a correspondence course.

When you have completed the course there's an optional, formal examination. Send this off, completed, to Heathkit at Gloucester with £1.00 and, if your marks are good enough (which they should be) you will be sent a Pass certificate. Now you may not think this worth anything — but we've seen the course — and the questions. It would impress us!

The course is said to take about 40 hours and we reckon this to be about right.

Price of the Digital Techniques course (EE-3201) including a kit of the Experimenter/Trainer (EE-3200) is £65.30 — not cheap but excellent value. ●

THE TDK SUPER AVILYN CASSETTE

eti PRODUCT TEST

Exceptional performance from new formulation tape.

OVER THE PAST FIVE YEARS, WE have seen the cassette recorder advance from its former lowly position in the high fidelity field to become truly comparable with reel-to-reel equipment whose position it now threatens and which it could ultimately usurp.

One cassette recorder has basically outshone the rest and may currently be regarded as the uncrowned champion. This is the Nakamichi 1000 Tri-Tracer 3-Head Cassette Recorder. Choosing the best cassette recording tape is more difficult – the contenders are many and their relative merits far more difficult to assess. The Nakamichi Research Company, during the first two years of sales of their Model 1000 machine, recommended a chromium formulation which offered unquestionably good frequency response together with the possible option of a specially formulated gamma-ferric oxide tape, which, whilst not quite as good as the chromium dioxide tape, nonetheless offered a particularly good response.

MEASURED PERFORMANCE OF SUPER AVILYN C-60 CASSETTE.

FOR COMPARISON THE FIGURES ON THE RIGHT ARE OF THE BEST CASSETTE PREVIOUSLY MEASURED BY OUR LABORATORY.

	TDK SUPER AVILYN	BEST OTHER
Frequency Response:		
0 dB	24 Hz to 11 kHz	24 Hz to 9 kHz
−10 dB	24 Hz to 19 kHz	24 Hz to 15 kHz
−20 dB	24 Hz to > 20 kHz	24 Hz to 20 kHz
Total Harmonic Distortion	100 Hz 1 kHz	6.3 kHz Not Tested
0 dB	.95% 1.69%	2.84% –
−6 dB	.34% .35%	1.52% –
Bulk Erased Noise:	Dolby "In"	Dolby "In"
100 Hz	−70 dB	−70 dB
1 kHz	−80 dB	−77 dB
6.3 kHz	−78 dB	-76 dB
Saturation Level (for 0.1 dB compression):		
100 Hz	+5 dB	Not tested
1 kHz	+4 dB	+2 dB
6.3 kHz	−5 dB	Not tested.
Dynamic Range:		
100 Hz	75 dB	–
1 kHz	84 dB	79 dB
6.3 kHz	73 dB	–

FORMULATION

Now however, for what are apparently good technical reasons, Nakamichi have standardised their latest machine on a new formulation tape from TDK. This formulation, called Super Avilyn, is a combination of cobalt and ferric oxide together with binders, but is not a cobalt-doped or cobalt-energised tape of the type currently being manufactured and marketed in the U.S.A. The end result is a basic particle with an extremely high coercivity, typically four times as high as that provided by regular gamma-ferric oxide particles, and 50% higher than that provided by cobalt-doped ferric oxide formulations.

TDK claim that this is a far more stable formulation offering a number of further advantages including higher stability, higher sensitivity and better uniformity, together with a better tolerance to varying bias settings than previous products that they have produced. It would appear that this tape formulation also causes less head wear than ferrichrome tapes or standard chromium dioxide tapes and, as such, is a preferable tape for use on the Nakamichi 1000.

FREQUENCY RESPONSE

We had previously conducted an exhaustive evaluation on twelve other tapes, using the same procedures and instrumentation (Hi-Fi Review June 1975) and decided to use these tests as a yardstick for evaluating the Super Avilyn tape. Our procedure was simple and straightforward: firstly, to measure the frequency linearity as a record-to-replay response at levels of O dB, −10 dB and −20 dB, the O dB level being that indicated by the inbuilt recording level/meter whilst the −10 dB and −20 dB levels were accurately determined by an external

attenuator. The level recordings were automatically produced for each level without any special adjustment of the machine, apart from the normal azimuth alignment using the tri-tracer system.

The frequency response at O dB, measured performance extending to beyond 11 kHz, was better than any other we have seen, indicating the tape's capacity to accept high levels without saturation. This capacity was further exemplified by the response at −10 dB extending to about 19 kHz, a response which would normally be expected only at a level of −20 dB. The response at −20 dB to beyond 20 kHz is most certainly equal to or slightly better than any other tape we have evaluated.

TO HISS OR NOT TO HISS

Our next series of tests involved the determination of the noise spectrum existing on the tape after bulk erasure. A one-third octave band frequency analyser was used to measure the noise threshold of the erased tape across the audible frequency spectrum when replayed in the normal mode, then with Dolby noise reduction, and finally with Dolby noise reduction and dynamic noise limiting together. The results achieved here were not in themselves astounding, but the measured level of noise compared with our previous measurements showed that the Super Avilyn tape has a threshold at least two decibels lower in the 1 kHz region than any tape previously measured. The figure here was −80 dB (compared with the normal 0 dB recording level), a particularly good performance.

DYNAMIC PERFORMANCE

To determine the upper limit of the tape's dynamic range, we recorded three signals at frequencies of 100 Hz, 1000 Hz and 6.3 kHz, at levels which were raised in one decibel steps from −5 dB to +5 dB. The playback response was then recorded graphically on our level recorder and was used to determine the upper level of the dynamic range. Obviously, as the recording level approaches the tape saturation point, the 1 dB steps become compressed and depart from what is true record-to-replay linearity. We set as our criteria limit the point at which an increase in input level of 1 dB resulted in an output step of 0.9 dB — that is, 0.1 dB compression. This was a far more rigorous test than we had previously applied in tests on other tapes. Even so, it showed that the Super Avilyn tape has a dynamic range of 75 dB at 100 Hz, of 84 dB at 1 kHz, and 76 dB at 6.3 kHz — really excellent figures.

STABILITY

Our next investigation was aimed at determining longterm variation in stability and dropout performance respectively, at 100 Hz, 1 kHz and 10 kHz. At 100 Hz, both in terms of longterm and short-term variation, the results were as linear as one could hope for, and certainly better than anything we had previously seen. At 1 kHz, the dropout performance was very slightly higher than the best we had previously seen, but still exemplary. At 10 kHz the performance was still extremely good with the maximum excursions (typically) being 1 dB and the statistical mean being 0.3 dB — i.e. inaudible. The longterm variation for a full tape was also recorded (at 400 Hz) and this was remarkably flat, showing no significant variation in the mean recording level; most certainly the stablest longterm linearity response that we had seen from any cassette tape to date.

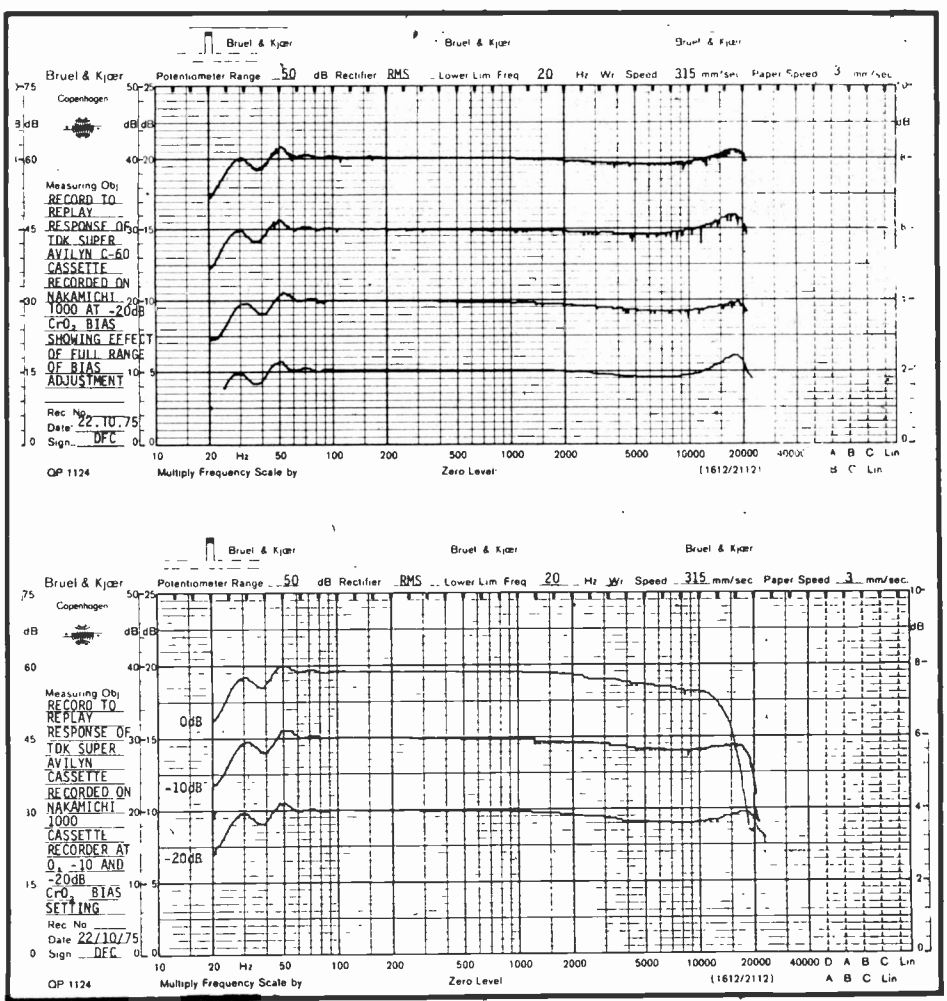
BIASED RESULT

Our next test was an unusual one. We decided to take the Nakamichi 1000 and alter the bias to four different settings to see to what extent we could improve the frequency response at the −20 dB level by small variations in the bias adjustment. By altering the standard bias to alternative settings, we found that we would vary the frequency linearity at the top end of the frequency scale to produce responses ranging from level through to a peak of approximately 2 dB at 18 kHz. The level response was that set by the factory. We found however that the Nakamichi factory setting was already optimal for the Super Avilyn tape.

CONCLUSIONS

Listening tests proved that Super Avilyn tape sounds as good as its measured performance indicates. Background noise is substantially lower than other tapes and the dynamic range is unquestionably better. Frequency response is excellent, and the relatively non-critical bias requirements are a step in the right direction.

Providing you have a cassette recorder capable of exploiting the very high performance of which this tape is capable then it is really worth using — Super Avilyn tape looks in fact as being one of the most important advances in tape formulations in the mid-seventies. ●



Digital Watch Survey

Including: details of over 150 watches
: report from the Basle watch fair
: development news

DIGITAL WATCHES ARE RAPIDLY taking over the market. Both Fairchild and National predict no growth *at all* in the analogue display watch between now and 1980, with all the increase in sales going to digital watches. National, who make more modules than anyone else, see the 'plastic' watch taking possibly half of the total watch market by that time. They have just introduced their own, calling it the 'serious' plastic watch. (Yes it *is* Black!).

There are apparently good reasons for these abominations being thrust at us the public, at the moment it is supply of cases which is limiting production of the digital watches generally. In the UK alone this year, around 1,000,000 digital watches will be sold. How many of these are plastic remains to be seen.

About the easiest wrong assumption to make concerning these items is that they are all the same inside as well as out. Whilst the design premises may well be fairly standard, after a look around at the available produce, it would seem to us that quality control is the main distinguishing factor.

QUALITY AND CONTROLLING IT

Most, if not all, watches presently obtainable run a 32768Hz quartz crystal oscillator, as a frequency reference, and then divide this down and down to provide the 1Hz 'clocking' pulses for the time. Figure 1 shows the inside of a Rotary watch, an Intersil module before encapsulation. This encapsulation is an important factor in determining reliability. Many modules use multiple substrates for the display, divider chip etc, and then wire bond all the sections to a common board. Some (like Intersil [Rotary watches]) encapsulate the module to protect these delicate connections. The ones that don't are asking for trouble.

Merely comparing the price tags of several watches is no way to choose. By itself that can only set the range from which you are able to select. Once there it is far more important to have a close look at guarantee period for one, and constructional quality for another.

Too many of these 'fantastic discount' watches will work fine until the 2,172hr guarantee runs out and then die a silent and blank faced death. It must surely be the established companies, be they experienced watch firms who've taken the time to become expert in this field, or the huge semiconductor manufacturers who will eventually succeed. It is to be hoped that these giants can apply the skill and quality necessary to produce IC's etc to this closely allied field. It is obviously not cost effective for a firm selling a watch right down at bottom price to go through an extensive testing and pre-aging cycle with their modules. Yet this is the only way to be certain of the machines capabilities over a period of time useful to the consumer.

DISPLAYING SOME DEVELOPMENT

Of the two display types vying for dominance – LED and LCD – LED undoubtedly still holds the field of battle by a good margin. But there are signs that as Europe, and the Swiss in particular, take more of a hand in the future of digital timekeeping that we are at last drifting away from the American mania with buttons for everything. This means that LCD with its more convenient continuous display is gaining ground rapidly. In a few years the relative positions of the two may well be reversed.

This is not to say that multi-function watches will not go on – obviously they will and improve as they do so, witness the Pulsar calculator mentioned in this survey. At least with an LCD you are spared the task of having to ask the watch the time. Try driving a car and operating an LED watch at the same time.

THINGS TO COME

Later in the year both Texas and CBM are to come crashing into the watch market. The prices are expected to be low compared to what is asked now, and this will inevitably deal a blow to these present levels. They will go down, and rapidly.

Even National, who have priced their new plastic Exelar in line with present trends, accept that once this deadly duo enter the arena they will hammer the price down somewhat. It will be interesting to watch how this little duel develops.

Work is continuing in the East and the West on a new style of display, an electrochromic type. This would look similar to LCD but posses much sharper definition and a greatly increased viewing angle. In all probability it will be over a year before we see a marketable watch, but it might happen sooner. Later this year National are to launch an LCD watch, despite recent incantations of the gospel according to St. LED. Worth watching for also is the CBM range, which includes a solar powered watch.

QUICK BEFORE IT CHANGES AGAIN

A great deal is about to happen in the digital watch field, so before it does we've taken stock of the devices around now, and a look at the Basle fair to see whats coming. We don't claim to have included every last watch you can buy. That would have been impossible, instead we have provided a survey which covers *nearly* all of them!

We have deliberately refrained from giving too many definite prices. In this field by the time we've written them down, they're wrong. Forgive us our evasion.

In the jewellers range of watches, prices are decided mainly by how good the case is. In the main, the same modules are used in both the most expensive and the cheapest. So don't let the huge prices in the table frighten you. Just think of all them microns of gold....

No mention is made anywhere of quartz analogue watches. These are devices using crystal timing, but instead of a LED or LCD display with drivers a micromotor drives hands around a 'normal' watch dial. These units are high accuracy and impeccable quality, and we are not implying critiscism by excluding them – but we had to stop somewhere.

Or change our name to 'Watch Monthly'.

WHAT TO LOOK FOR IN A WATCH

THE DECISION TO PURCHASE a digital watch is based upon a desire to own a highly accurate timepiece and be one of the first to join the digital revolution.

This high technology, consumer electronic product has entered the same world as the pocket calculators which means that for some time to come it will be a difficult decision deciding on the particular model to buy.

The present trend of manufacturers and distributors is to offer two ranges of watches. One exclusively for the Jewellers and allied traders and the other range is aimed at the mail order, discount warehouse market. The reason it is felt necessary to have the two distinct ranges is because the high street jeweller dislikes seeing the product he has in his shop window on offer in magazines like ETI at half the price. His argument is that he has overheads in prime shopping sites and has to carry more stock.

With the mechanical watch the jeweller could also argue he provided the extra servicing facility, however this has now changed since an electronic watch does not require the same type of servicing as it's predecessor, in fact the simplest remedy for repairing a faulty electronic watch is to change the complete module that houses the whole of the electronics. Battery changes are also quite straight forward as it is only a matter of removing the rear of the watch case and inserting new replacements.

There is not reason why any reputable mail order company cannot offer this service, in fact many such companies are better qualified to handle the repair since they are electronics orientated.

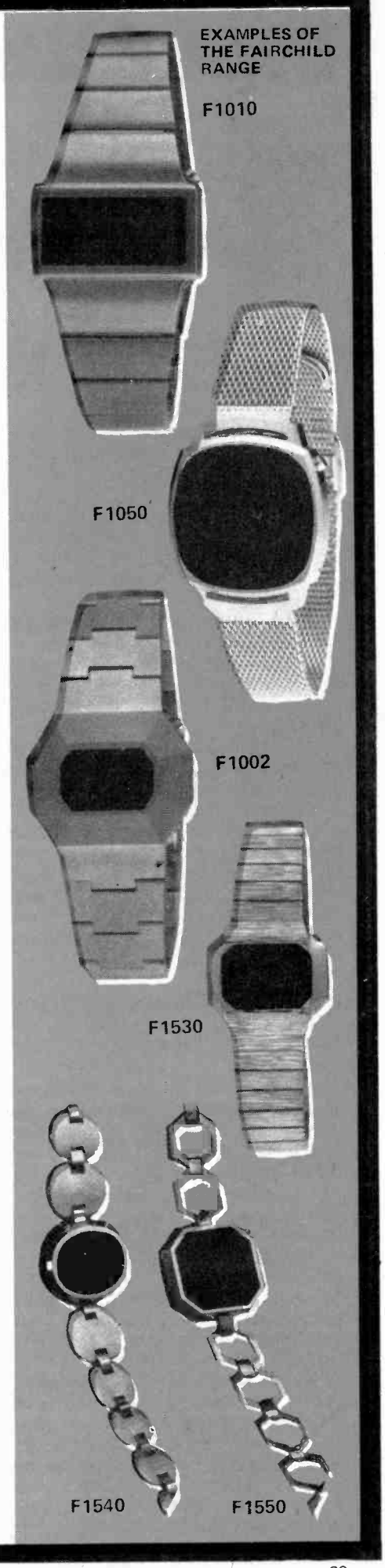
The two types of electronic watches available are the LCD and LED variety. Which model you actually prefer is a matter for personal taste. Liquid Crystal are continuous display and if chosen carefully can give excellent service. The difficulties experienced with LCD displays in the early days are as a result of impurities in the liquid crystal material, also there were problems in the sealing of the displays. These technological problems have now been overcome and the LCD display is being considered for numerous military and aerospace applications. Also considerable work is in progress for advanced clocks and displays for motor vehicles.

With a continuous display you do not have to keep operating a button to read the time except at night when the back light is activated. The popular criticism of the LED display is that it is difficult to read when driving a car. I personally feel that the disadvantage of an LED display is most apparent when the wearer is attending a formal occasion and requires a discreet glance at his watch. This cannot be achieved whilst pressing away at a button. I feel certain that in the near future all electronic watches will be continuous display.

One of the most important aspects of purchasing any new technology product is to make sure that it has a good long guarantee. There are something like 45 companies manufacturing LCD displays world wide and the products are of varying quality.

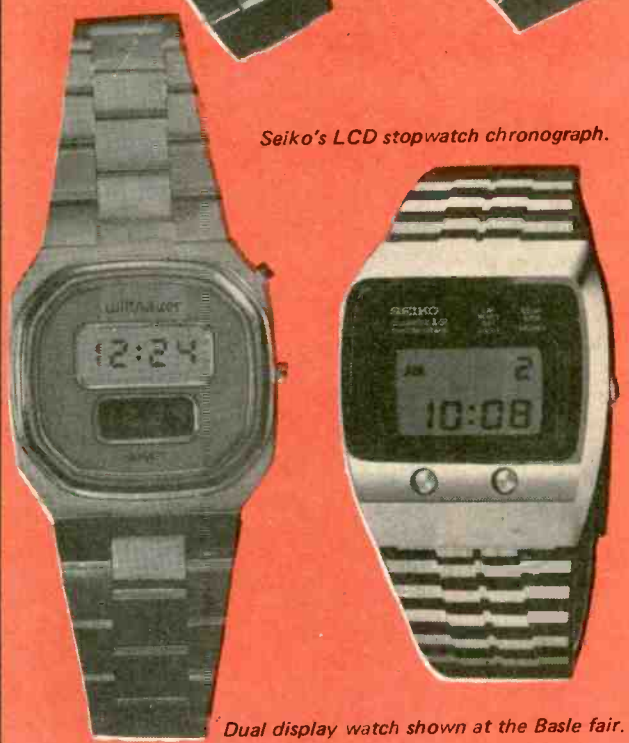
The present trend in the manufacture of electronic watches is to increase the number of functions and at the same time reduce the thickness of the watch case. This is being achieved by the introduction of new integrated circuits and assembling the integrated circuit chip and display directly on to the metalised tracks of the printed circuit. The whole of the circuit is then covered with a clear resin to protect the wire bonds and the components. This means that the manufacturers will be able to turn the assembly procedure into a highly automated process so that the watch modules are virtually assembled and encapsulated untouched by human hand.

One major disadvantage with this technique is the number of individual wire bonds that are required per watch module, also the difficulty in selecting working IC's while still in chip form. This will I feel lead to a higher failure rate of modules and the manufacturer is faced with the problem of scrapping modules as against individual IC's or a display. Even with the calculators which have reached advanced production techniques, I have not yet heard of any company incorporating such advanced production methods in a commercial model. There is possibly a sound technical reason why it has not been done, however, I am tempted to think it may be too early to be trying it with watches.



Digital Watch Survey

Lee Instruments 1130 models.



Seiko's LCD stopwatch chronograph.

Dual display watch shown at the Basle fair.

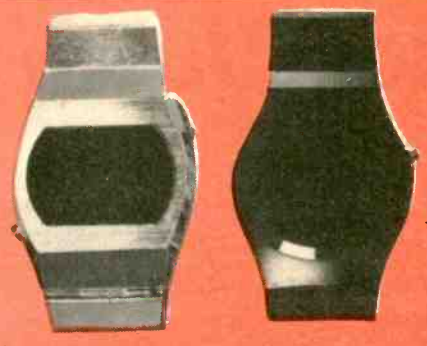
The Trafalgar range of watches.

WATCH

Manufacturer or distributor	Model	Approx Price	Number of Functions	Display	Guarantee in Years	Origins
AVIA	1001 1002	over £140 over £120	5 5	LCD LED	2 2	USA USA
CITIZEN	9011 9030	over £130 over £120	7 2	LCD LCD	1 1	Japan Japan
CHRONOSPLIT (HEVER)		over £200	7	Dual	1	Switz
FAIRCHILD	Large range of Ladies and Gents	£47-£108	5	LED	1	USA
FORDENDALE	ALEC 3 SWE69 SWE16 SWE45 E3281	£11.50 No Prices fixed	3 3	LED LED	1 1	Japan Japan
G. PERREGAUX	G. P. LED	£190-£290	4	LED	1	Switz
GRUEN	4602 4800	over £130 over £150	5 5	LED LED	1 1	USA USA
INVICTA	5183-5025 5183-502530 5185-5035	£90 £90 £150	3 3 3	LCD LCD LED	1 1 1	Switz
LEETRONICS	1113-10 1113-20	£34.50	7	LCD	1	USA
LITRONIX	Full range	£40-50	3	LED	1	USA
LONGINES	L 776	over £250	3	LCD	1	USA / Switz
MERCURY	5000, 5700 6000, 8000 3400 1100 1500	£50-£80 £35 £70	5 3 2	LED LED LCD	3 3 3	USA USA USA

DETAILS

Manufacturer or distributor	Model	Approx Price	Number of Functions	Display	Guarantee in Years	Origin
METAC	TLC 4					
	Steel	£39.89	5	LCD	2	Japan
	Gold	£42.53	5	LCD	2	Japan
	TLE5 TV	£24.28	5	LED	2	Japan
	TLE5 EA					
	TLE 3	£17.64	3	LED	2	Japan
MICROMA	DL 53GB / DL 54SB	£60	5	LCD	1	USA
	DL 61GB / DL 62SB	£80	5	LCD	1	USA
MONDAINE	Digi-Stop 340		5	LCD	1	USA
NATIONAL EXELAR	Plastic Watch	£17.95	3	LED	1	USA
	NWI Range	—	3	LED	1	USA
	ES Range	—	5	LED	1	USA
	KLA Range	—	5	LED	1	USA
OMEGA	Time Computer	£390	5	LED	1	USA
PRESIDENT	Range	£70-£100	4/5	LED	1	UK/USA
PULSAR	Range	£200 up	5	LED	3	USA
	Calculator	£2000 (!)	12	LED	3	USA
	Watch					
ROTARY		£100	5	LED	3	Canada
SEIKO	CQ	£150	3	LCD	1	Japan
	CY	£140	6	LCD	1	
	CX	£160	7	LCD	1	
SINCLAIR	Black Watch	Kit £14.95 Built £24.95	3	LED	1	UK
SYNCHRONAR	2100 Solar	£1200	5	LED	2	USA
TIMEBAND (DIXONS)	Extensive range of Ladies' & Gents'	£20-£40	5	LED	1	USA
RAFAGAR	Range	£20-£30	4	LED	1	USA



The Metac range

An illustration of Dixons Timeband range.

The Alec 3 at under £12 from Fordendale.

Digital Watch Survey

REPORT FROM THE BASLE watch fair 1976

EVERY SPRING THE CLOCK and watchmakers of the world converge on the city of Basle to unveil their latest horological creations, and it is here better than anywhere else that one can see what lies ahead in clocks and watches.

This most European of cities, sitting astride the borders of France, Germany and Switzerland, and with the already wide River Rhine flowing through it, is the perfect setting for a great international trade fair.

This year electronics stole the show.

Electronic watches were on every watch manufacturers stand, and it is just these models which between April 24th and May 3rd were being bought wholesale by professional buyers from all over the world, that will appear in our shops by September. Star of the show was the Pulsar electronic watch-calculator.

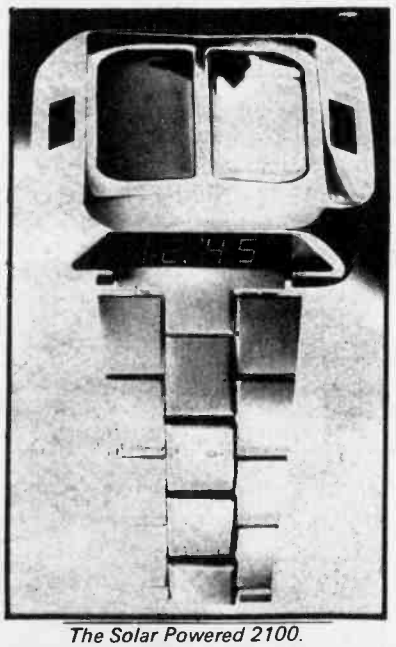
A masterpiece of engineering, this beautiful and perfectly functional computer on the wrist is cased in 22 ct gold and adds, subtracts, multiplies, divides, figues percentages, has a memory, tells the time, month and date. All with a 12 digit capability displaying 6 digits at a time. It retails for about £2,000 and a stainless steel model, will, claim Pulsar, be ready by September and this should retail for only £350.

For us poorer souls who would dearly love to own one, I suggest we wait until next year's Basle Fair when it is a good bet that the first £100 watch-calculator will make its debut.

12 function watches were plentiful. This users nightmare has if you can sort out the correct button pushing sequence hours, minutes, seconds, alpha day, date number, month and for the stop watch sequences 10ths of secs, 100ths of secs, split memory and lap memory and two other functions that I could not even decypher.

The cheaper 12 function watches have LED push to read displays and should retail in the UK for about £80-£90. The more practical LCD continuous display models such as the Mondaine and Seiko watches have clearly identifiable display windows for the separate functions which of course are visible all the time. They retail for about £150 and should be widely available by the autumn.

The Pulsar Calculator Watch.


The Solar Powered 2100.

Among the stranger creations on show was an LED-LCD two dispay hybrid. If you don't like LCD continuous displays then push the button and up comes the bright red digits of an LED watch.

For people who want an LED watch but don't like pressing buttons there is an ideal watch. Just flick the wrist and the display comes on.

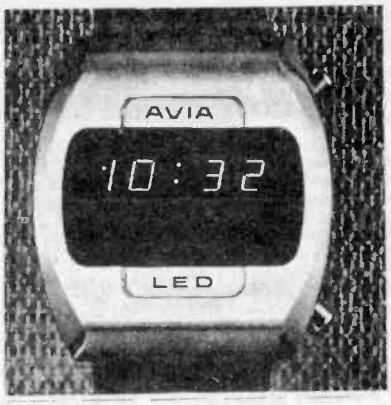
Batteries need never be changed, so the manufacturers claim, with the Nepro and Crystalonic solar watches. Tiny rechargeable cells are used to store electricity from a solar cell on the face of the watch. Even very low ambient light levels are claimed to be sufficient to recharge the batteries.

However a hefty premium is required from those who do not want the once a year task of changing the watch battery and these watches retail for about £100 in the UK.

Now that the European designers have at last turned their attentions to electronic watches the most beautiful shapes and styles are beginning to appear. There is no doubt that the Swiss watch industry is fighting back the threat from America and the Far East. Quality is superb, and the designs compare favourably with the most beautiful creations of the traditional watches. I hope they succeed, for the reliability of watch modules made in the Far East is suspect and our American cousins have never mastered the art of designing for beauty although their very high quality watch modules are without question the best available.

Prices can be expected to fall, and bargains will always be had from reputable electronics mail order companies; but in general you get what you pay for. Very cheap bright pink, red and orange plastic bangles are already on offer with LED watch modules embedded in them. They are for the very young and are worth about £9.95 retail.

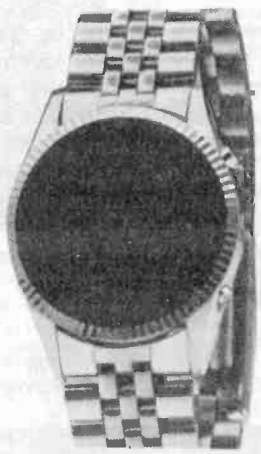
Eventually the electronic watch will settle down to good watches, fully guaranteed and reliable, and cheap watches; just as with the mechanical watches of yesterday.

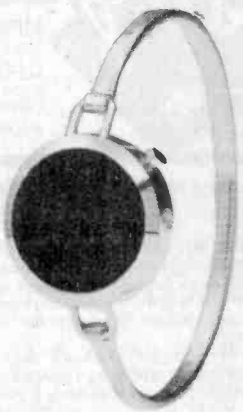


Avia's LED model, with 4 functions, is priced at £120. When 95% of the battery life is used the display begins to wink as an indication that a new battery is needed

The Chronosplit is two digital timepieces in one, a timepiece with hours, minutes, seconds and date on the LCD screen. The LED display has a $\frac{1}{10}$ second display for split action timing

This new model shows hours, minutes, seconds, date and the day of the week in English and Japanese





Two more from the Fairchild jewellery range

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Rotary Watches,
6-10 Kirby Street,
London EC1 8LH

Seiko Time U.K.,
24 Bruton Street,
London W1X 7DA.

President-Prescott,
Clock and Watch Co. Ltd.,
Prescott House,
Humber Road,
London NW2 6ER.

Pulsar Time,
High Bank,
Waterside,
Chesham, Bucks

Synchronar 2100
Ragen Int. Ltd.,
McGran Hill House,
Shoppenhangers Road,
Maidenhead
Berks.

Omega Ltd.,
67-74 Saffron Hill,
London EC1N 8RS

Fairchild,
Consumer Products,
61 Welbeck Street,
London W1M 7HD.

Timeband
(Dixons)

Trafalgar Watch,
CMS Marketing Ltd.,
21 Gt Portland Street,
London W1N 5DB.

Sinclair Radionics,
St Ives,
Huntingdon,
Cambs.

Metac International,
Braunston,
Daventry,
Northants.

Lee Instrumentation Ltd.,
Bedwas,
Newport,
Gwent.

National Semiconductors,
Consumer Products,
19 Goldington Road,
Bedford MK40 3LF.

Fordendale Ltd.,
367 Edgeware Road,
London W2 1BS.

Avia International Ltd.,
101 Bell Street,
Reigate,
Surrey.

Citizen-Anglo Continental
Watch Co. Ltd.,
45-51 Woodhouse Road,
London N12.

Girard-Perregaux,
30 Frederick Street,
Birmingham B1 3HH.

Gruen (Optimisation Ltd),
25a Upper George Street,
Luton,
Beds.

Hever (Cronosplit),
29-31 Euston Road,
London NW1.

Longines,
Baume Ltd.,
81-89 Farringdon Road,
London EC1M 3LM 3LH.

Microma,
60 Victoria Road,
Ruislip,
Middx.

Invicta (England) Ltd.,
33 Oaks Road,
Great Glenn,
Leics.

Litronix (Optimisation Ltd.)
25a Upper George Street,
Luton,
Beds.

Mondaine U K Ltd.,
44 Hatton Garden,
London EC1

RTVC

Now the VISCOUNT IV 30 x 30 Stereo Amp IN KIT FORM

For the experienced constructor the Viscount IV amplifier comes complete with teak finished cabinet, front trim panel, knobs and all necessary metalwork. The specification for the NEW 30 x 30 is similar to the complete system offered below, but of course with the bigger output.

£24.75 +£1.50 p&p

STEREO 21 INCORPORATING A GARRARD DECK

Garrard 3 speed Deck automatic, manual facilities together with stereo cartridge and cueing device.

Stereo 21, easy to assemble audio system kit. No soldering required. The unit is finished in Simi Teak, and the acrylic top presents an unusually interesting variation on the modern deck plinth.
Includes – **3 speed deck**, automatic manual facilities together with stereo cartridge and cueing device.
Two speakers with cabinets.
Amplifier module. Ready built with control panel, speaker leads and full, easy to follow assembly instructions.
Specifications – For the technically minded.
Input sensitivity 600mV. Aux. input sensitivity 120mV. Power output 2.7 watts per channel. Output impedance 8-15 ohms. Stereo headphone socket with automatic speaker cutout. Provision for auxiliary inputs – radio, tape, etc., and outputs for taping discs.
Overall Dimensions. Speakers approx 12" x 9" x 5". Complete deck and cover in closed position approx. 15½ x12 x6.
Extras if required. Optional Diamond Styli **£1.50**
Specially selected pair of stereo headphones with individual level controls and padded earpieces to give optimum performance **£5.25**

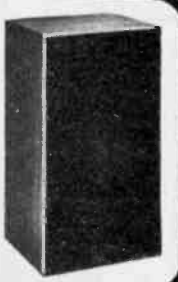
COMPLETE ONLY
£23.00 + p&p £4.00

BSR DECKS WITH PLINTHS AT FANTASTIC REDUCTIONS

MP 60 Type *(illustrated)* Less Cartridge	**£14.40** p&p £2·00
C141 *(not illustrated)* Auto. with Cue Fitted Stereo Cartridge	**£10.80** p&p £1·50

All plinths finished in matching Teak veneer.

EASY TO BUILD SPEAKER KITS



These superb simulated teak-finished speaker kits have been specially designed by RT-VC for the cost-conscious hi-fi enthusiast who wants top quality speakers but doesn't want to spend the earth. Built to EMI's exacting specification, these new RT-VC speaker kits (350 type kit) incorporate 13" x 8" woofer, 3¼" tweeter and matching crossover. Easily put together with just a few basic tools.
Specification (each speaker): Impedance 8 ohms. Power handling 15 watts RMS (30 watts peak). Response 20-20,000 Hz. Size 20" x 11" x 9½" approx. Comparable built units (EMI LE3) sold elsewhere for over £45 pair.

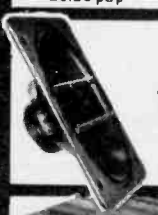
£19.80 pair complete + £5.20 p&p

Complete with crossover Components and circuit diagram.

EASYBUILD SPEAKER KIT THE NEW 'COMPACT'

A compact bookshelf speaker system giving a high electro accoustic efficiency for the low powered amplifier.
The professional finish can be obtained with the minimum of tools, the infinite baffle type enclosures come ready mitred and professionally finished, and fix together with masking tape till glue dries.
The cabinet measures 12" x 9" x 5" deep approx. finished in simulated teak, incorporating a quality 8" speaker, maximum power handling 7 watts, impedance 8 ohms nominal, magnet size 2⅝" approx., with 1½" parasitic tweeter.

£7.50 PAIR INCLUSIVE + p&p £1.70



EMI 350 KIT

£6.55 + £1.20 p & p.

Complete with crossover Components and circuit diagram

System consists of a 13" x 8" approx. woofer with a 3" tweeter, crossover components and circuit diagram. Frequency response: 20 Hz to 20 KHz. Power handling 15 watts RMS into 8 ohms. (Peak 30 watts.)

VISCOUNT IV STEREO AMP

COMPLETE 20 x 20 SYSTEMS

SYSTEM 1b £65.00

The new 20 + 20 watt Stereo Amplifier incorporating the latest silicon transistor solid state circuitry, the RT-VC VISCOUNT IV gives you a powerful 20 watts RMS per channel into 8 ohms. Superb teak-finished cabinet, with anodised fascia to harmonise with any decor. Polished trim and knobs.
The VISCOUNT IV has a comprehensive range of controls –volume, bass, treble, balance mono/stereo, mode selector, and scratch filter.
Front panel socket for stereo headphones. And a host of sockets at the rear – for left and right speakers, tape recorder, auxiliary, tuner, disc and microphone.
SPECIFICATION: 20 watts RMS per channel 40 watts peak. Suitable 8-15 ohms speakers. Total distortion at 10 watts better than 0.2%. Six switched inputs: 1. Magnetic P.U. – 3 millivolts at 47 K ohms (R.I.A.A.); 2. Crystal/ceramic P.U. – 50 millivolts at 50 K ohms (R.I.A.A.); 3, 4, 6. Tape Tuner/Aux. – 140 millivolts at 50 K ohms (flat frequency response); 5. Microphone – 3 millivolts at 50 K ohms (flat frequency response).
CONTROLS: Push button ON/OFF, stereo/mono, scratch filter. 6 position rotary selector. Individual rotary controls for treble, bass, balance and volume. Headphone socket, tape out socket. Aux. mains output. **Frequency response: 25 Hz to 25 kHz at full rated output. Signal to noise ratio:** better than –50 dB on all inputs. **Tone control range:** Bass ±15 dB at 50 Hz; Treble ±12 dB at 10 KHz. **Power requirements:** 250V A.C. mains at 60 watts. **Approx size:** 15¼" x 3" x 10". **MP60 type deck** with magnetic cartridge, de luxe plinth and cover. **Two Duo Type IIB matched speakers**—Enclosure size 18½"×13½"×7¼" approx. in veneer teak. Drive unit 10" with 2½" tweeter. 12 watts handling 24 watts peak.

Complete System with these speakers
£65.00 + £6.50 p&p.

SYSTEM 2 £80.00

Viscount IV amplifier (As System 1a)
MP60 type deck (As System 1a)
Two Duo Type III matched speakers – Enclosure size approx. 27" x 13" x 11½". Finished in teak simulate. Drive units 13" x 8" bass driver, and two 3" (approx.) tweeters. 20 watts RMS, 8 ohms frequency range – 20 Hz to 18,000 Hz.
Complete System with these speakers **£80.00** + £7.60 p & p.

PRICES: SYSTEM 1a

Viscount IV amplifier	£24.75 + £1.90 p & p.
2 Duo Type IIb speakers	£27.00 + £6.50 p & p.
MP60 type deck with Mag. cartridge de luxe plinth and cover	£19.80 + £3.30 p & p.
Total if purchased separately:	**£71.55**
Available complete for only:	**£65.00** + £6.50 p & p.

PRICES: SYSTEM 2

Viscount IV amplifier	£24.75 + £1.90 p & p.
2 Duo Type III speakers	£41.40 + £7.50 p & p.
MP60 type deck with Mag. cartridge de luxe plinth and cover	£19.80 + £3.30 p & p.
Total if purchased separately:	**£85.95**
Available complete for only	**£80.00** + £7.60 p & p.

Scotland P & P Surcharge System 1a £1.75 System 2 £3.50

Note: 30 x 30 kit available only as a separate item.

PUSH BUTTON CAR RADIO KIT– THE TOURIST TT

IF YOU CAN SOLDER CORRECTLY ON A PRINTED CIRCUIT BOARD YOU CAN BUILD THIS KIT CORRECTLY

NOW YOU CAN BUILD YOUR OWN PUSH BUTTON CAR RADIO!

This construction kit comprises a fully built and aligned R.F.I.F. module; Printed circuit board, with ready mounted integrated circuit output stage and all other components. The push button tuning mechanism is fully built and tested ready to mate with the printed circuit board. (once it is assembled).
NOTE: No test equipment is required for alignment, but remember you must have the ability to solder on a printed circuit board.

TECHNICAL SPECIFICATION
(1) Output 4 watts RMS output. For 12 volt operation on negative or positive earth. (2) Integrated circuit output stage, pre-built three stage IF Module. Controls volume manual tuning and five push buttons for station selection, illuminated tuning scale covering full, medium and long wave bands. Size chassis 7" wide, 2" high and $4\frac{3}{4}$" deep approx. Speaker including baffle and fixing strip
£1.80+45p. p&p. Car Aerial Recommended – fully retractable **£1.45+40p. p&p.**

£7.40 +£1.05 p&p.

STEREO CASSETTE TAPE DECK KIT

Kit comprises of ready built cassette tape transport mechanism. Featuring pause control, solenoid assisted auto-stop. 3 digit tape counter, belt-driven balanced fly wheel. DC motor with electronic speed control, ready built and mounted record/replay PC board, and two VU meters, power supply. PC board, mains transformer. Input and output sockets and two level controls. Specification power source 240 AC 50Hz. Output more than 0.5v imput mike – 65dB. 10KΩ. DIN – 47dB. 100KΩ. Track system 2 channel stereo record play-back. Tape speed. 4.8CM/SEC. Frequency response 50-1200 Hz signal to noise ratio – 42dB. Recording system AC Bias. Erasing system AC erase. Bias frequency 57KHz. Size of mechanism 8" x 5" x 3½" approx. unit easy to mount into your cabinet 3" required to clear base of mechanism approx.

* This is an advanced kit not suitable for those without electrical knowledge and those unable to solder.

£29.25 + p&p £1.50 or send SAE for complete details.

NEW PRODUCT

DISCO 35 MONO AMPLIFIER

An ideal general purpose 35 watt mono amplifier with full mixing facilities. Suitable for DISCO, PUBLIC ADDRESS & GUITAR/MUSICAL INSTRUMENTS. Unit housed in an attractively styled teak veneered cabinet. 4 Inputs: DISC 1 & DISC 2 (BOTH FOR CERAMIC CARTRIDGES), tape and microphone. CONTROLS: All level mixing controls are fitted with integral switches, push-button type. DISC 1 & DISC 2: Volume combined treble filter. TAPE: Volume combined bass booster switch. MASTER: Volume control combined on/off. MIC: Volume combined bass booster switch. INDEPENDENT BASS AND TREBLE CONTROLS.

TECHNICAL SPECIFICATION
Power output: 35RMS into 4 ohms. **Speaker:** (Suitable for 4 to 15 ohms speakers). **Sensitivities: DISC 1 & DISC 2:** 30 mv (into 120k RIAA). **Treble Filter Switch:** 12 db@ 10 KHz. **Tape:** 100 mv (into 120k Flat). **Bass Booster Switch**+18 db@ 60 Hz. **Mic:** 2 mv (equilised for dynamic).
Bass Booster Switch+20 db@ 60 Hz. **Bass Control:** ±15 db@ 60 Hz. **Treble Control:** ±12 db@ 10 KHz.

£25.00 +£1.40 p&p

8 TRACK HOME CARTRIDGE PLAYER

Elegant self selector push button player for use with your stereo system. Compatible with Viscount IV system, Unisound module and the Stereo 21. Technical specification Mains input, 240V. Output sensitivity 125mV.

Yours for only
£12.60 +£1.70 p & p.

SPECIAL OFFER

As above but complete with build yourself Unisound Amplifier Kit (see opposite panel) + 2 'Compact' easy to build speaker kits (see opposite page)

£24.50 + p & p £2·00

BUILD YOUR OWN STEREO AMPLIFIER

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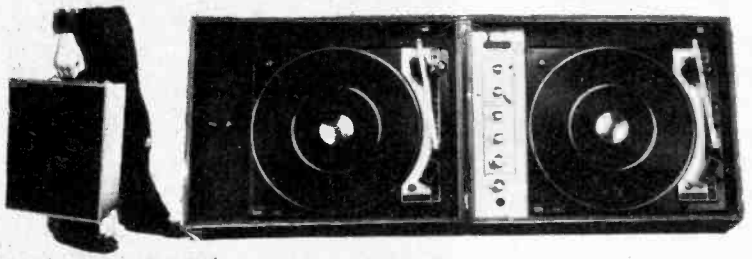

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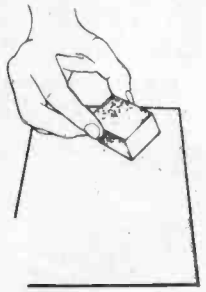

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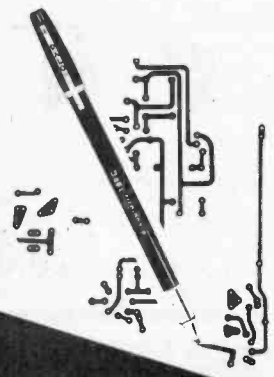

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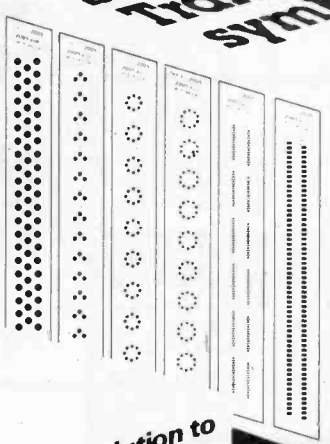

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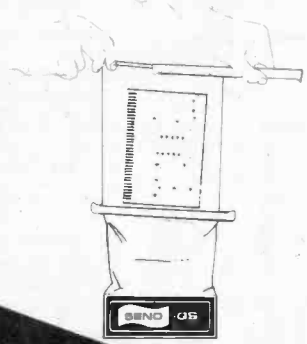

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AUGUST ISSUE ON SALE JULY 2nd 30p

AUGUST IS BARGAIN MONTH IN ETI!

We've brought you good offers in the past — sometimes we've arranged two offers in one month — but wait till you see the August issue. We're still finalising the details with a number of companies but we've arranged for a whole mass — at least 10, hopefully more. The offers cover a whole range of goods which can be bought at bargain prices from publication date through to the end of August using the vouchers in next month's issue.

ETI DIGITAL WATCH OFFER

We've been supplying Pulsar digital alarm clocks to readers for a year — and there's no sign of a fall off in demand — now 5% of our readers have them. Next month we add a second product to this line: a 5-function (hours, minutes, seconds, day and date) digital watch with metal bracelet for the really low price of £18.95 — full details next month.

MEASUREMENTS

Misunderstandings, misuse, mistakes, mirth and misrepresentation — that's how we sub-title this article on measurements. It's so easy to fool others, or more likely yourself, by confusing such parameters as resolution and accuracy.

Our article is written by Dr Peter Sydenham — an expert on measurements and author of our Electronics—It's Easy series.

NEW SERIES: COMPONENTS

PART ONE: CAPACITORS

We bring you a new series which will discuss each family of electronic components and provide all that essential data that is otherwise so difficult to obtain. Next month we kick off with Fixed Capacitors.

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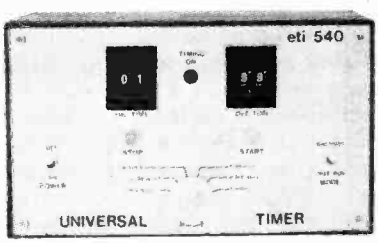
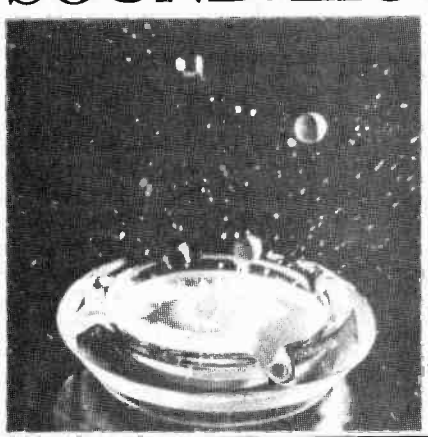
UNIVERSAL TIMER



A comprehensive unit with programmable on and off switching, and an interval range of 0.1s to 99 hours. The mains frequency is used as frequency standard to ensure high, consistent accuracy. Most timers are restricted in timing range, accuracy or facilities by being designed for a particular application. As usual ETI has transcended the traps into which lesser magazines fall and produced a superior unit!

SOUND/LIGHT FLASH TRIGGER



This project comes to you by public demand. We've had requests from our readers to produce a sound/light flash trigger to our usual standard of constructional project. The device will trigger a standard flash unit at a pre-determined time after a certain event has occurred. The event can be any sound or light change, the level of which is adjustable. The time delay is settable anywhere between five and two hundred milliseconds. Considering its flexibility the unit is surprisingly easy to build, and as usual we provide full constructional details.

HIGH POWER BEACON

Designed for the outdoor types amongst our readers (come on, there must be one, somewhere), this device produces high intensity light flashes from a Xenon tube at about 50Hz, but from a hand-held unit, assembled in an old torch tube!

NOTE: We're still only 30p!

Sweet Sixteen

project 457

A simple stereo amplifier which gives about 6W r.m.s. per channel (well over 8W peak) with facilities for three inputs. Simplicity in construction and low cost have been major considerations in establishing the design.

THERE IS A TEMPTATION for projects in electronics magazines to concentrate on the high-power, highly sophisticated designs. Sweet Sixteen has been designed with other criteria in mind: it should have a reasonable output, should be reliable and easy to build. At this stage we have a confession — output is not quite 8W r.m.s. per channel but is nearer 6W r.m.s. At quite a late stage in development the output stage was altered completely for reasons we shall go into. Output is still well over 8W *music power* and that's our excuse for retaining the name.

Readers will find their own uses for this project but it is ideal for a teenager's record player —thus the double meaning of our name.

Design considerations

With the very large range of audio IC amplifiers around we saw no point is using discrete components. Originally we opted for a dual output stage IC and two prototypes were built using this. The particular device was supposed to be short-circuit proof and to include internal thermal limiting. Despite this we ruined two devices — since they were dual types this ruined the whole device. We are certain that the IC is basically O.K. but the troubles were such that we opted for LM380's operating in a bridge configuration — this has cost advantages in that the LM380 is very reasonably priced and output capacitors are not necessary in a bridge configuration.

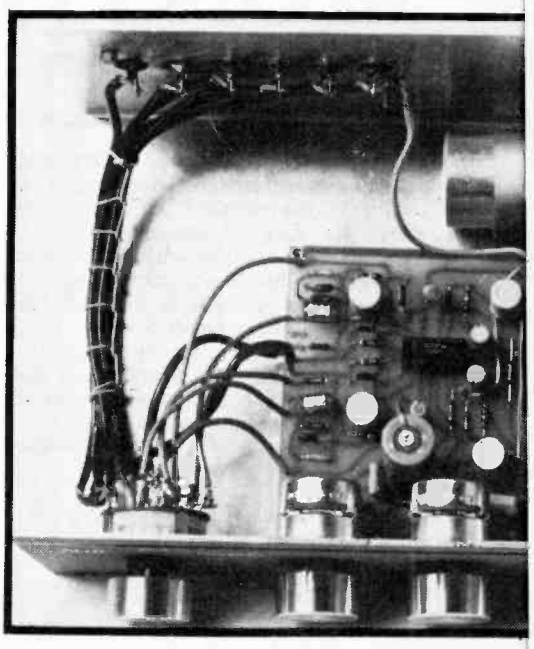
For the preamp we chose the RCA CA3052 with four identical op-amps on one chip: this is specifically designed for use in stereo preamps.

Three inputs are allowed for: magnetic pickup plus another two for use with higher level signals. The p.c.b. has space for a resistor which can be selected for the input level required (this is shown, but not labled, on the circuit).

The tone control, even though it is passive, is extremely effective giving boost of 11.5 dB at 100Hz and 10kHz relative to 1kHz and a cut of 10dB.

The chassis is super simple — a piece of thick aluminium with two bends in it. This will fit easily into a wooden case later or can be covered by a second piece of aluminium to form a cover.

Once you have opted for construction on a PCB, you can take the approach that we took on our International 25 (October 1975) and put *everything* onto the board. This was the original plan as inter-wiring takes far longer than mounting components onto a board. However a selector switch is essential and push-button types



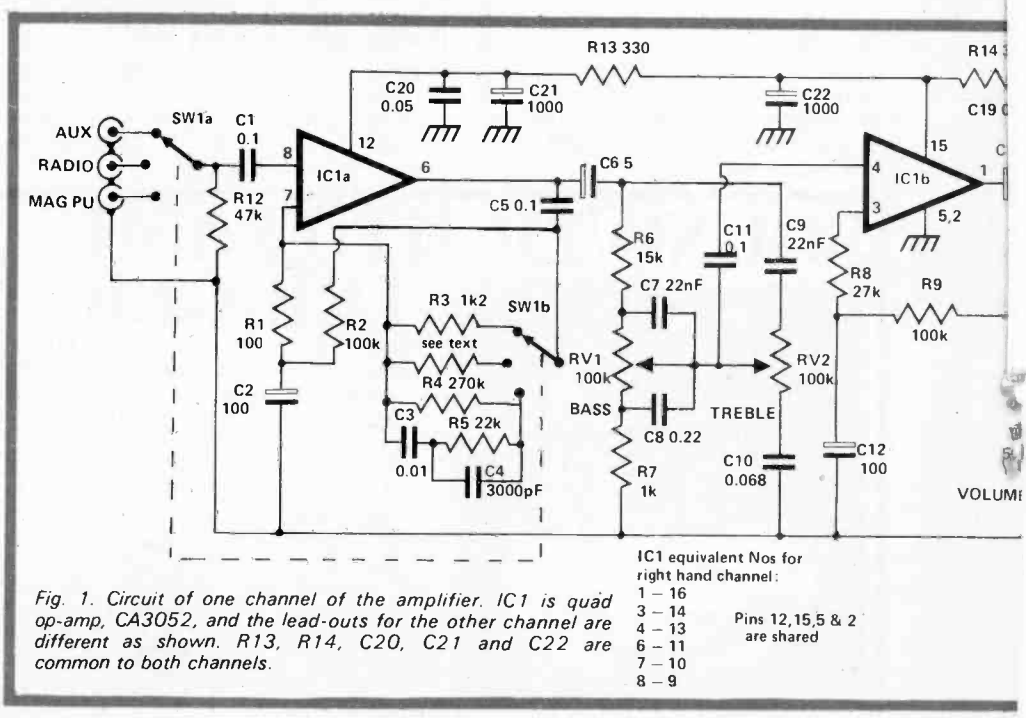


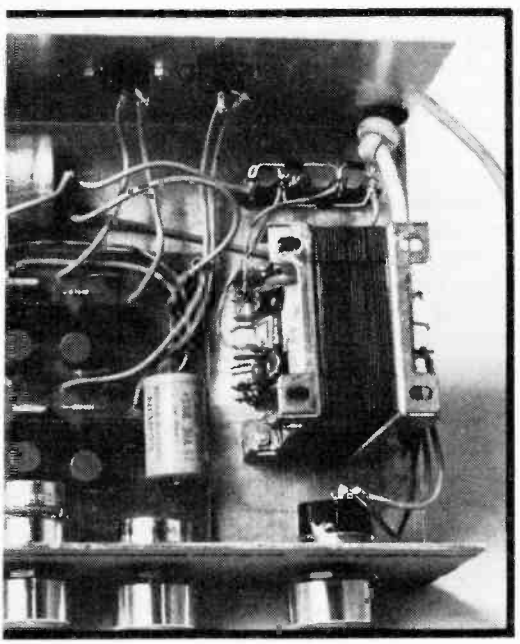
Fig. 1. Circuit of one channel of the amplifier. IC1 is quad op-amp, CA3052, and the lead-outs for the other channel are different as shown. R13, R14, C20, C21 and C22 are common to both channels.

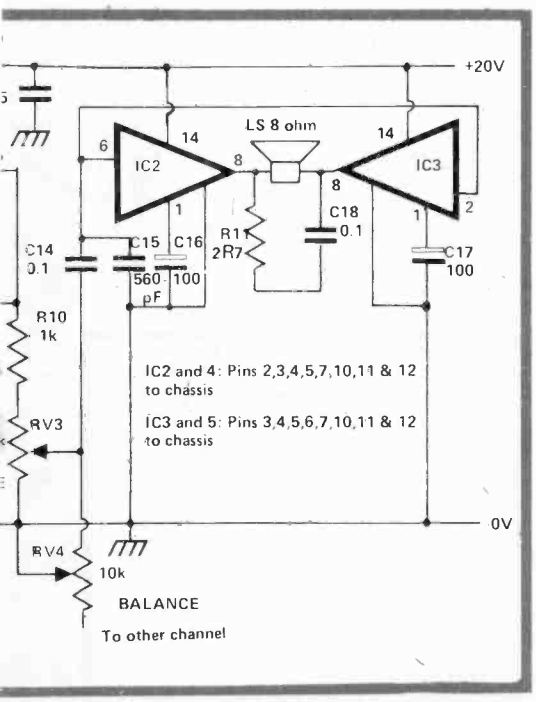
IC1 equivalent Nos for right hand channel:
1 – 16
3 – 14
4 – 13
6 – 11
7 – 10
8 – 9

Pins 12,15,5 & 2 are shared

are expensive and not widely available in any standard design. Secondly PCB mounting pots are not available from many component suppliers. Rather than making a fetish of putting everything on the board, we opted for a more conventional approach.

The positive supply to the three main sections (preamplifier and both output stages) is deliberately supplied via 'above-board' pins — this greatly simplifies testing and isolating problems. The four sections of the preamp IC are independent except for the power supply so a fault in one channel will not normally affect the other.





Construction

First you'll need to obtain your PCB. Advertisers in this issue including Ramar and Croften do all ETI circuit boards but you can do your own. The technique we now use at ETI for quick prototypes may be of interest: for I.C. pads and component terminations we use the press-down transfers (Alfac, Meconorma etc) but use a resist pen for the tracks.

Once the PCB is etched and drilled the components can be mounted — there's nothing out of the ordinary here except perhaps for the connection of the pots. The beauty about all components on a single PCB is that testing and checking are very easy — so it is with Sweet Sixteen. The components associated with the tone control are soldered first to the pots and then these 'flying leads' to the board. This is shown (for one channel only) in Fig. 5 and can be seen in the photograph.

Once the board is completed the power supply can be built — this is done directly on to the chassis. The wiring is shown in Fig. 6. The bridge rectifier diodes are mounted on a small tagstrip behind the transformer.

Heatsinks have to be fitted to the output IC's. These should be cut from thin tin-plate (tin-cans are ideal) to the size shown in Fig. 8. The centre three pins on both sides of LM380's are at chassis potential

HOW IT WORKS

The input is selected by SW1a and is amplified by IC1a. Part of the signal is fed back to pin 7 via the equalisation network selected by SW1b — a very normal arrangement, R4, R5, C3 and C4 give correct equalisation for a magnetic pickup. R3 reduces the gain of the stage to allow signals of 100mV to be handled.

The outputs of IC1a connects to the tone control network — this is passive but gives adequate gain and boost to be regarded as very effective. The loss of signal is substantial and it is necessary to recover this in IC1b. The output connects to the volume control via R10. The value of R10 should be selected so, that clipping—and possible instability — does not occur in the output stage. C14 is not theoretically required due to the input stage of IC2 but blocks any stray d.c. C15 holds back any very high frequencies which may break into the circuit if screening is inadequate. IC2 and IC3 are connected in a bridge configuration doubling the output. LM380's will give a minimum of 5W and up to 7W r.m.s. in this configuration. C16 and C17 are rarely shown for an LM380 but their inclusion reduced the hum level. R11 and C18 are a Zobel network across the speaker.

Substantial decoupling is necessary to IC1 and as large electrolytics are poor at getting rid of high frequencies C20 is included; C19 is fitted close to the positive connection of the output stage for the same reason.

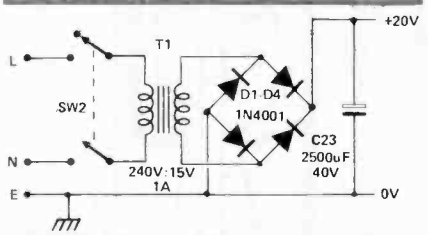


Fig. 2. Circuit of the power supply for Sweet Sixteen.

Resistors

R1	—	100	¼W	5%
R2	—	100 k	"	"
R3	—	1 k2	"	"
R4	—	270 k	"	"
R5	—	22 k	"	"
R6	—	15 k	"	"
R7	—	1 k	"	"
R8	—	27 k	"	"
R9	—	100 k	"	"
R10	—	1 k	See text	
R11	—	2 R7	¼W	
R12	—	47 k	"	"
(Two off each R1-R12 required)				
R13	—	330	¼W	5%
R14	—	330	"	"

Potentiometers

RV1	—	100 k linear dual
RV2	—	100 k linear dual
RV3	—	50 k log dual
RV4	—	10 k linear dual

Capacitors

C1	—	0.1 µF ceramic disc
C2	—	100 µF 25V
C3	—	0.01 ceramic disc
C4	—	3nF polystyrene etc
C5	—	0.1 µF ceramic disc
C6	—	5 µF 25V
C7	—	22 nF ceramic disc
C8	—	0.22 ceramic disc
C9	—	22 nF ceramic disc
C10	—	68 nF ceramic disc
C11	—	0.1 µF ceramic disc
C12	—	100 µF 25V
C13	—	5 µF 25V
C14	—	0.1 µF ceramic disc
C15	—	560 pF polystyrene
C16	—	100 µF 25V
C17	—	100 µF 25V
C18	—	0.1 µF ceramic disc
C19	—	50 nF ceramic disc
(Two off each C1-C19 required)		
C20	—	50 nF ceramic disc
C21	—	1000 µF 16V
C22	—	1000 µF 25V
C23	—	2500 µF 40V

Semiconductors

IC1	—	CA3052
IC2-5	—	LM380 (14-pin package)
D1-D4	—	1N4001

(Marshall's have arranged a special price for ETI readers for the 5 IC's for this project. These are available as a package for £6.00 inclusive of VAT and postage. Orders should be sent direct to A. Marshalls — see advert for address etc.)

Miscellaneous

SW1	—	4 pole, 3 way rotary switch
PCB	—	ETI 457
T1	—	240V:15V 1A Douglas (has several taps up to 30V)

Six way bank of phono sockets (or two 3-way)
Two DIN speaker sockets
Tagstrip for Diodes
Screened cable (for inputs to selector switch)
Rotary on-off switch
Chassis as Fig. 7.
Eight heatsinks as Fig. 8.
Six knobs

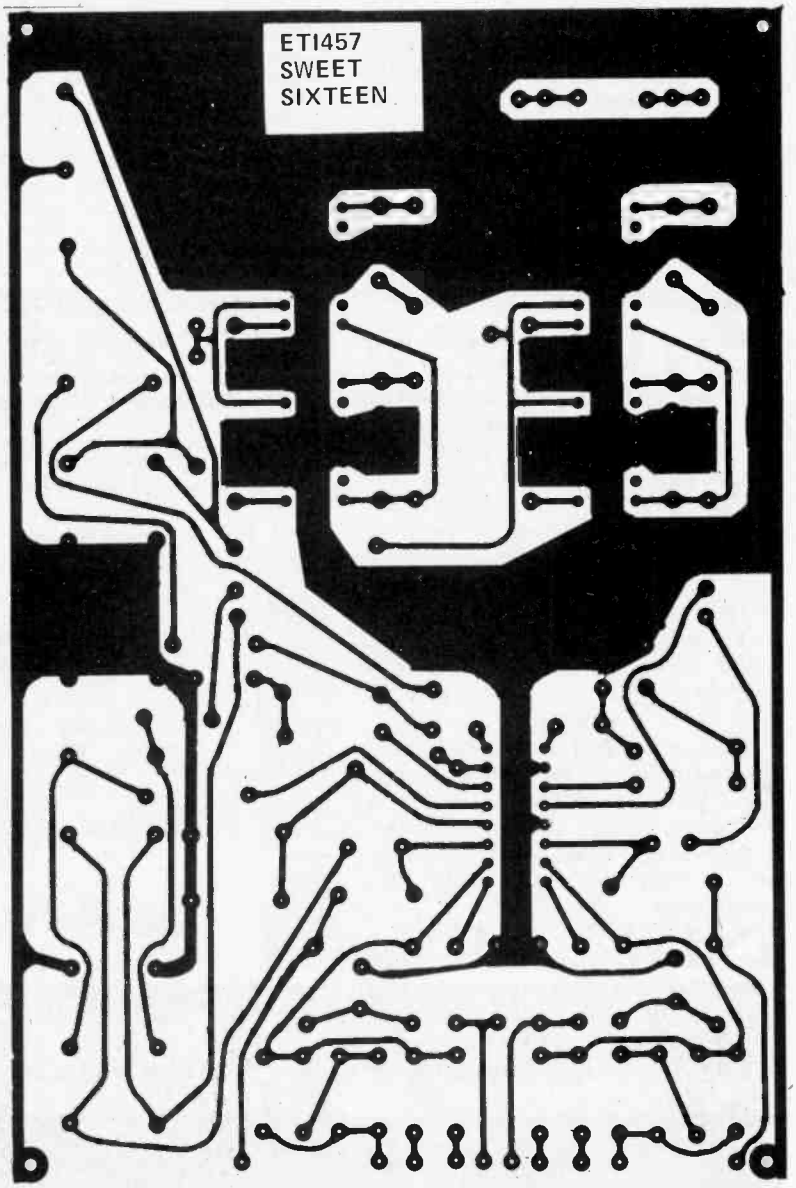


Fig. 3. The P.C.B. design shown full size (6in x 4in).

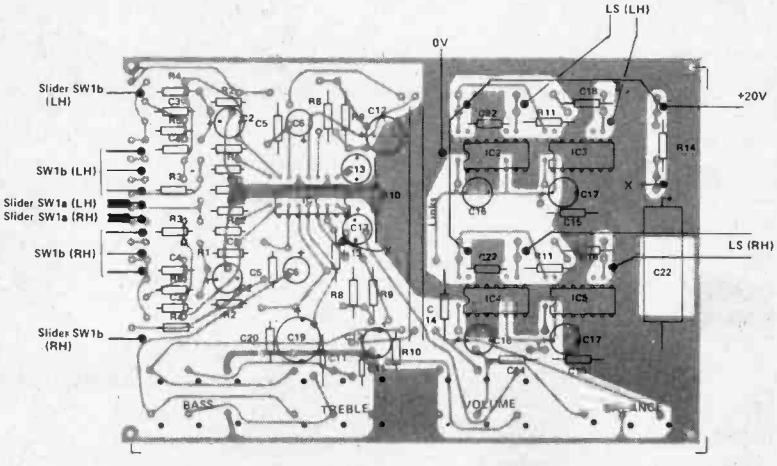
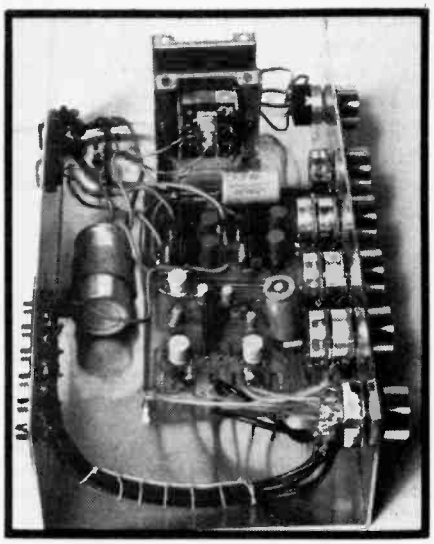


Fig. 4. The component overlay and connections to and from the circuit board.



and are designed to carry away the heat. There is no need to fit the heatsinks until after all the testing is completed as the LM380's are thermally protected and the underside of the PCB is a pretty fair heatsink itself — the maximum area of copper has been left for just this purpose.

We have not shown a drawing of the switch wiring as this will depend on the construction of the rotary switch but is very straightforward. If the high-level inputs are to have the same sensitivity one wire can be omitted to the equalisation network by connecting the wires from R3 to the adjacent tag on the switch.

Testing

Obviously the power supply must be tested first — few problems should occur here. If this is O.K., the 0V can be wired to the pin shown and +20V applied to one of the pins feeding the output stages. The usual 'damp finger' tests to the

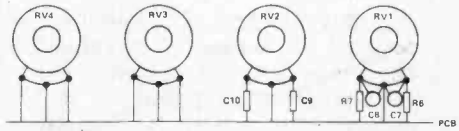


Fig. 5. The tone control components are mounted from the pot tags to the board. The length of lead should be about 14mm when mounted onto the P.C.B. (only the components for one channel are shown).

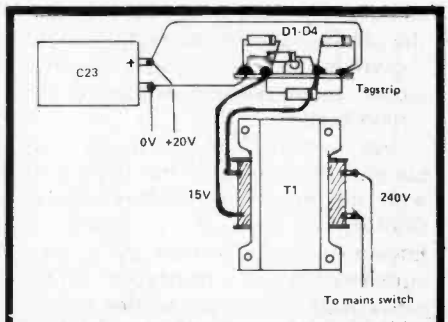


Fig. 6. Wiring of the power supply. The siting of this can be seen from the photographs.

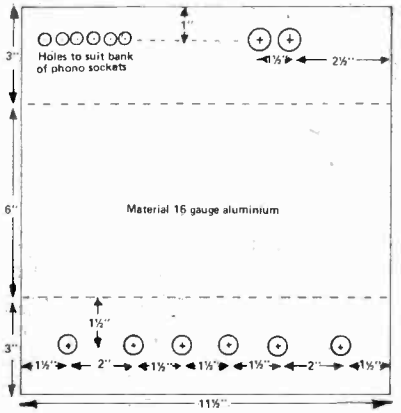


Fig. 7. Metalwork details. The front panel holes are standard ⅜in as are the holes for the bank of phono sockets. ⅝in holes are needed for the DIN speaker sockets.

Fig. 8. Heatsinks can be cut from tin-plate to the size shown. Eight are required. The small lug at the bottom should be soldered to the centre three pins on the LM380's on both sides.

input capacitor should establish if there is any output. If it is found that the cone of the speaker is pushed out, or pulled in, *substantially* this will be due to constant d.c. as a result of imbalance of the two I.C's. In theory a 1Mohm preset should be connected with the track ends to the two pins 1 and with the slider to chassis — this will overcome the problem. We tried 16 LM380's and found that it was unnecessary to add this; in any case the d.c. varies back and forth depending on the output level (presumably due to slight non-linearity in the IC's) but was so small as to be of no importance.

It is possible that instability will occur if the output is driven hard into clipping (this is not uncommon in commercial amps either). If this occurs R13 should be increased until clipping cannot occur with normal level inputs — it may go quite high.

Once everything works the heatsinks can be soldered to the pins of the LM380's. (The heatsinks are not shown in the photograph as they would have hidden much of the circuit board.)

We would like to thank two companies especially for their help with this project — A. Marshall's of Cricklewood and H. L. Smith of Edgware Road, London W.2, who supplied several prototypes of the metal work before we settled on the design shown — and very generously many of the components. ●

COMPUTER MIXING

Digital techniques for channelling sound

IN THE BEGINNING there was the single microphone, and it was not good. Recording was dependent on arrangement of artists within the studio, to balance the sound level at the microphone. Then the engineer took unto the studio many microphones, one for each artist. And still it was not good — until out of the confusion arose the sound mixing console.

At first these were very simple devices, with a single output for glorious mono, and perhaps a small line of rotary knobs. As stereo gained the ascendancy, a second output was spawned to cope. Shortly afterwards multi-track recording arrived to revolutionise sound techniques, and create the post of mixing engineer.

Fig. 1. A typical modern mixing desk.

CONTROLLED INTERFERENCE

The basic idea of using multi-tracking is that different parts of the group or orchestra can be recorded at different times or places, and later assembled — mixed down — to form a (hopefully) coherent whole. This is done by assigning each tape track to its own channel on the mixing desk, and performing the required operations on it there.

These 'operations' consist normally of amplification to bring all outputs to a common working level, and frequency equalisation with any reverberation / echo needed thrown in for good measure.

While all this is going on the sound must be balanced to create a uniform sound field, or to include any 'panning' of effects wanted by the producer.

GOOD OR BAD

Any track can be assigned to any channel, and switching is normally provided to change this at will. Overall then, the engineer can completely alter the sense and sound of the original music if he so wishes. If he's good at his job he preserves the sense and enhances the sound. If you've ever had a badly mixed recording, and haven't we all, you know what horrors a bad mix-down conjures from the grooves.

Perhaps the main controls on a console are the fader potentiometers. (Level controls) The more modern variety of these employ conductive plastics tracks to reduce noise and improve linearity, and are long travel devices with carefully controlled attenuation curves. Monitoring is done with meters for each channel, usually P.P.M.

The total console output is fed through power amps to 'monitor' loudspeakers — true monitors — allowing the engineer to hear the results of his manipulations. To feed every channel of a 24 channel system through its amp and speaker is not feasible either on economic or space grounds.

MIXERS WITHIN MIXERS

Which in turn means that another mixer must be included in the console to combine the channels down to two or four to be output. This device becomes almost a mini-console in its own right, with reverb and echo facilities, and even pan pots. Also from this section comes the headphone 'fold back' signal to be fed to the artists in the studio.

On replay and during experiments all the tracks can be kept locked together by putting the

record heads of the tape machines into a replay mode, which 'syncs' the tracks.

As the scale of operations increases, so does the number of channels required, and the controls multiply like rabbits on the console face. For each channel perhaps 10 controls are added. This brings us to the weakest chain in the mix-down process — the master control and monitor system.

IN NEED OF AID

This is highly inefficient, cannot operate for longer than 10 hours at a time without complete failure, is very prone to error, is unable to operate more than five or six subsiduary controls at any one time, has a limited memory the contents of which are subject to incredible distortion, and is composed mainly of water which it sheds readily if things go wrong or the temperature rises slightly.

Here is where the greatest need for assistance is felt. No-one is ever going to win Design Council award for the human body, effective as it might be at a few basic tasks.

A console such as that in fig 2 shows up the limitations of the beast when faced with a complex machine. This is a 44 channel high efficiency broadcast console. Surely beyond most peoples operational limits! Mix-downs generally are (or were) forced to rely too heavily on the human element for them to be very efficient in time and result. Automation was required to handle the repetitive operations, and allow the engineer freedom to handle the creative side of the task.

RESCUE METHODS

The task of providing this aid can be tackled in two ways. The first is to use the desk faders to 'correct' the attempt already on tape, the final result being computed by the machine as the total of the two added together. The drawback to this is that the 'indicator' function of the faders is lost, as their positions no longer give an idea of relative levels.

The other main method adopted is to provide switching facilities on the controls, so that the operator can quickly throw the faders into a 'record' mode from any set position, thus altering what has been already tape stored. Snags here are the added complexity necessary, and the limited memory which is dependent on the number of tape tracks available. This factor also holds down the number of 'takes' possible.

Fig. 2. A 44 channel broadcast console. Note the studio monitors in the background. The faders are in three groups along the front of each bank.

INTRODUCING DISTORTION

Generally these methods operate by applying a D.C. voltage to the fader, and using them as voltage dividers. The output is then fed through a V.C.A. to a D to A convertor (fig 3). At any instant a digital signal may be recorded which represents the analogue input. In this way every setting and movement of the controls are noted, and on replay the console can repeat the settings. The engineer can now make corrections and replay again, processing until he is satisfied with the result.

Even with this system, there are problems — VCA's introduce distortion, and in order to update, the fader must be returned to the precise position it occupied prior to operation, so that it feeds exactly the same output voltage to the V.C.A., avoiding a step function. To this end monitors must be provided, usually meters and/or L.E.D's. Complications set in again.

THE CAVALRY ARRIVES

Recently a true 'computer mixing' system was introduced which overcomes all the problems so far discussed. The only one remaining

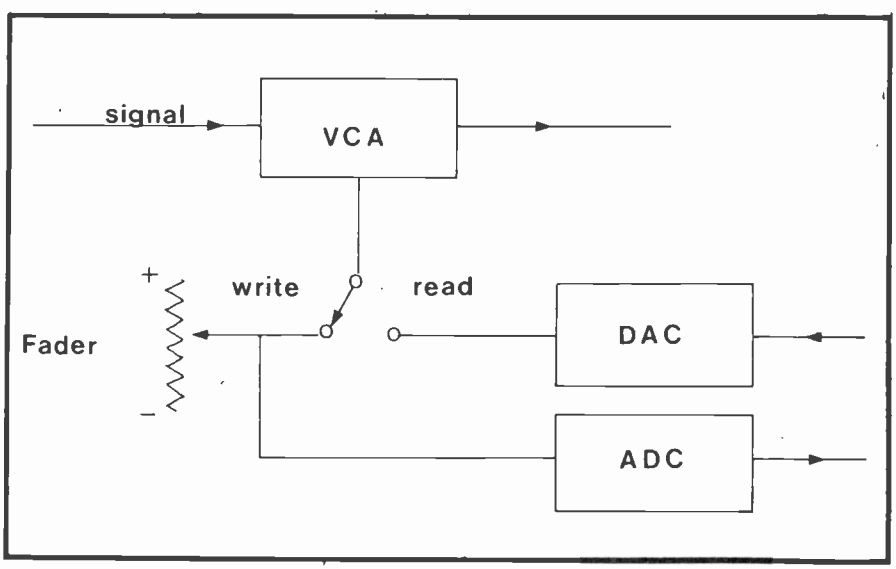


Fig. 3. Block diagram of a modern machine – aided mixing system. Each 'block' will introduce its own distortion.

COMPUTER MIXING

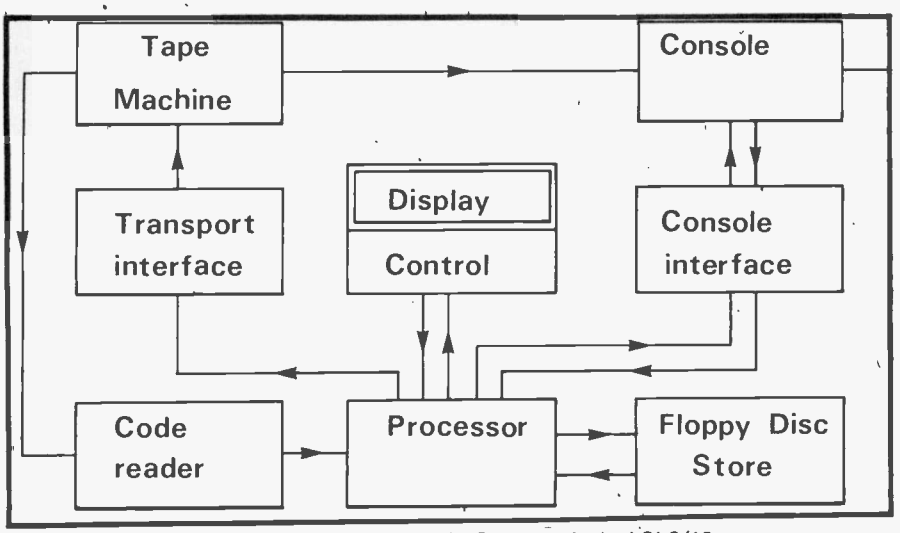


Fig. 4. The Necam computer mixing system. The Processor is the LSI 2/10 computer which controls the entire operation.

is cost. The system is called 'NECAM' and a block diagram of the system is given in fig 4. In this controls are servo driven, having a separate track to provide positional D.C. information for the LSI 2/10 mini-computer. No VCA or DAC is employed.

UPDATE AND DISPLAY

To update, the engineer simply takes hold of the control and moves it to where he wants it! A proximity switch informs the computer that correction is being applied, and automatic switching stores the new information. Using motorised controls means that when in 'replay' the faders move as the engineer moved them in 'record', providing the vital indication function once more. Correction is instantaneous and simple.

A time code is stored on one track of the tape machine, this can be an edge track as quality is not vital and dropouts are tolerated, in the form of an audio tone. This will 'sync' the tracks and operations together meaning that the tapes can be run at any speed interrupted or replayed, with the code correcting back to real time on replay.

An alpha-numeric display provides information to the operator, and the console can be literally programmed to respond to certain tape positions, control settings etc at a given moment, or to switch the channels if required. Any operation carried out is announced on the display so that the engineer can keep an eye on the system while it actions his commands. Labels can be assigned to tape positions and can be stored, along with instruction codes, onto a 'floppy disc'.

We can only hope that this will lead to the upgrading of recording quality that such a system is capable of providing. ●

Our thanks to Rupert Neve and Co who produce the Necam system, and provided information and photographs for this article.

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PART 5–How to MEK a computer

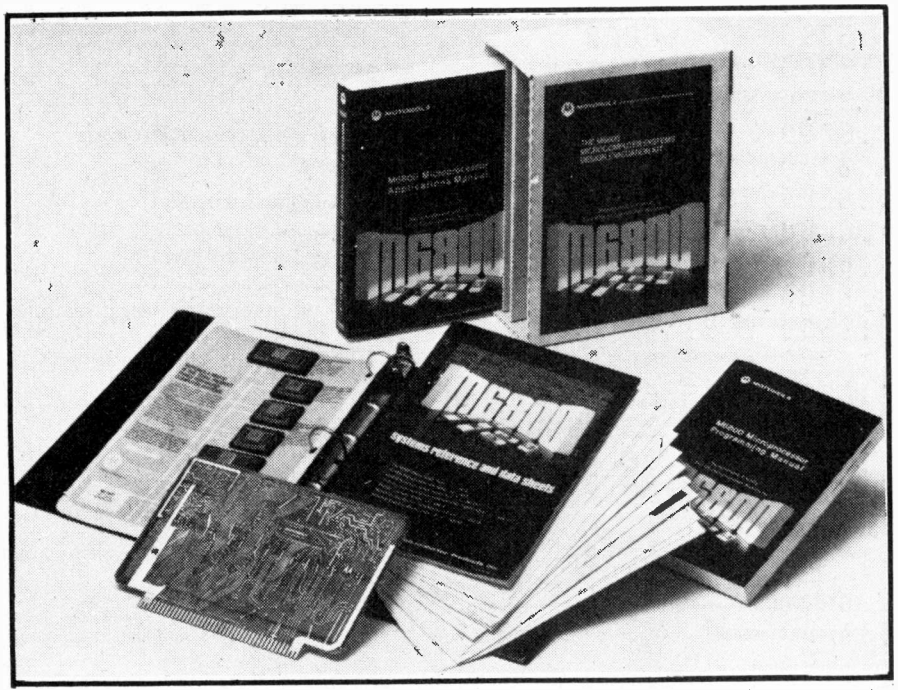
THIS MONTH we are going to round off our introduction to the microprocessor by looking at a small commercially available microcomputer prototyping system. The Motorola Evaluation Kit MEK6800D1 is designed to provide an introduction to the various devices in the M6800 system. The user can firstly experiment with the system to teach himself about the microprocessor and associated LSI parts. He can also run programs on the kit and use it to test his designs for associated hardware.

The kit contains an MC6800 MPU, two Peripheral Interface Adapters, an Asynchronous Communications Interface Adapter, 256 bytes of RAM and 1k of ROM containing a loader and diagnostic control program called MIKBUG. In addition, the kit contains a double-sided through-hole plated PCB to take the devices together with ancillary components and connectors, as well as copies of the M6800 Programming and Applications Manuals and a folder containing instruction booklets and device data sheets.

The extra components which are necessary are a handful of TTL and CMOS, three opto-isolators, some R's and C's, sockets and connectors. Once this is all soldered on, the board is complete and you have a real operable microcomputer for around £130.

The big drawback for the amateur experimenter in using this kit is the peripheral equipment required: +5V and ±12V supplies, which most enthusiasts will have, and a teletype, which they won't. A new teletype costs in the region of £800, is a mechanical miracle which is impossible to maintain without training and can't be bought second hand for love nor money — certainly not for less than several times the cost of the micro it is attached to. There are ways around this problem though: but that's next month's subject.

To get back to the MEK board — one PIA is dedicated to the teletype interface (either 20mA current loop or RS232C), while the other -IA and the ACIA are free for the user to connect externally through a connector at the top of the board. This enables you to connect the MEK kit to peripherals of your choice, such as displays, calculator keyboards, cassette units, etc. 256 bytes of RAM is supplied as standard, of which 128 bytes, at address A000 to A07F, is reserved for use by the MIKBUG program. The remaining RAM, from 0000 up, can be expanded from 128 bytes to 640 bytes, as space has been left for this on the board. If more memory is required, it can be built on a separate card, and connected to the address and data busses through the 2 x 43 way edge connector at the bottom of the board which also carries control signals and power supply rails.



The MEK kit contains the PCB and 6800 parts to build a basic micro-computer.

FIRMWARE

The firmware in the MEK kit is the MIKBUG program, which provides an asynchronous communications routine, a loader routine, and diagnostic routines. On applying power to the board, the RESET button should be pressed, and MIKBUG will respond with a carriage return, line feed and then print an asterisk. By then inputting a single character, the appropriate MIKBUG routines can be entered as follows:

L—Memory Loader, will load a program or data into memory from a paper tape on the teletype tape reader.

P—Print/Punch Memory Dump, will output the contents of memory to the teletype in order to punch a paper tape.

M—Memory Change enables the user to examine the contents of a memory location, and, if necessary, change the contents.

R—Display Contents of MPU Registers, will print out the MPU register contents in the order CC B A X P S by saving them on the stack and then printing it.

G—Go To User's Program will commence execution of the user's program at the address currently in the program counter — which can be set using the R and M functions.

These facilities together provide a basic means of writing, debugging and running a program on the Evaluation Kit, using machine code, which, as we have said, can be a bit mind-boggling — but it works. It is

```
10200                    * PRINT DATA POINTED AT BY X-REG
10300 E07B 8D F8         PDATA2 BSR    OUTCH
10400 E07D 08                   INX
10500 E07E A6 00         PDATA1 LDA A  X
10600 E080 81 04                CMP A  #4
10700 E082 26 F7                BNE    PDATA2
10800 E084 39                   RTS                STOP ON EOT

15600                    * ENTER POWER ON SEQUENCE
15700       E0D0         START  EQU    *
15800 E0D0 8E A042              LDS    #STACK
15900 E0D3 BF A008              STS    SP          INZ TARGET'S STACK PNTR
16000                    * INZ PIA
16100 E0D6 CE 8004              LDX    #PIAD       (X) POINTER TO DEVICE PIA
16200 E0D9 6C 00                INC    0,X         SET DATA DIR PIAD
16300 E0DB 86 07                LDA A  #$7
16400 E0DD A7 01                STA A  1,X         INIT CON PIAS
16500 E0DF 6C 00                INC    0,X         MARK COM LINE
16600 E0E1 A7 02                STA A  2,X         SET DATA DIR PIADB
16700 E0E3 86 34         CONTRL LDA A  #$34
16800 E0E5 B7 8007              STA A  PIASB       SET CONTROL PIASB TURN READ
16900 E0E8 B7 8006              STA A  PIADB       SET TIMER INTERVAL
17000 E0EB 8E A042              LDS    #STACK      SET CONTRL STACK POINTER
17100 E0EE CE E19C              LDX    #MCLOFF

17300 E0F1 8D 8B                BSR    PDATA1      PRINT DATA STRING

27020 E19C 13            MCLOFF FCB    $13         READER OFF
27100 E19D 00            MCL    FCB    $0,$A,$14,0,0,0,'*,4    C/R,L/F,PUNCH
      E19E 0A
      E19F 14
      E1A0 00
      E1A1 00
      E1A2 00
      E1A3 2A
      E1A4 04
```

Fig. 1. The sections of the MIKBUG program discussed in the text. (a) PDATA1 (b) START (c) MCLOFF.

possible to use an assembler with the evaluation kit plus an extra 8k bytes of RAM.

A PROGRAM EXAMPLE

Let's look at an example of M6800 programming by putting a section of MIKBUG under the micros-cope'. In fact, it is the section which operates when the RESTART button is pressed — it sets up the PIA as teletype interface and then prints CR, LF, *. The assembly listing shown in fig 1 is read like this: the first column is the program line number, the second is the memory location of the instruction, the third is the instruction in hex and the fourth is any data which follows the instruction in memory. The fifth column may contain a label, as in line 16700, then the next few columns give the assembly code, followed by any comment.

The assembly language is very simple — a line consists of an instruction followed by an address or data, as in line 16300, LDA A # $ 7, which means 'Load ACCA with the value 7'. The hash mark (#) indicates the immediate mode of addressing, while the dollars sign indicates that the number is hex. Had the $ been missing, the assembler would have assumed the 7 to be an ASCII character 7, while if it had been %, the following number would have been binary. The indexed mode of addressing is indicated by the form 1, X or 2, X which gives an address 1 or 2 offset from the Index Register value.

The MPU commences execution of MIKBUG at line 15800, by setting the stack pointer at address A042, and then stores this value at A008 for future reference. Line 16100 Loads the Index Register with the PIA's base address of 8004 and then increments this memory location from 0 to 1. As this is the PIA A side Data Direction Register, it has set bit 0 as an output. It then loads ACCA with the value 7, and stores this in the PIA Control Register A. As this is equivalent to binary 00000111, it sets both CA1 control bits and the DDRA Access bit, so that when the MPU executes line 16500 it accesses the Peripheral Interface Register to set PAO to 1 (6800 Data Sheets p28). The contents of ACCA (7) are then loaded into the DDR of the PIA B side, setting bits 0 to 2 as outputs. The MPU then loads ACCA with the hex value 34 (binary 00110100) and stores this at the address PIASB, which the assembler converts to its actual value 8007, the Control Register of the PIA B half. This sets CB2 as an output and sets the DDRB Access bit, so that, in line 16900, the MPU is accessing the Peripheral Interface Register B. This completes the setting up of the PIA as a teletype interface so that the MPU can now communicate.

microfile

The program now continues to load the SP and then loads the Index Register with the starting address of a data string called MCLOFF, which is output, character by character, through a subroutine called OUTCH. The keen reader should now be able to follow the program jump to PDATA 1 and see what it does.

The MEK kit, as can be seen from fig 2, uses a PIA as a serial output, although it is designed as a parallel interface device. It does this by a rotation system similar to that described last month except that it performs the rotation in ACCA rather than in the PIA Peripheral Register and it uses a rather more sophisticated programmable timer (MC14536) than the humble 555. Note also the use of opto-isolators to match the PIA to the 20mA current loop and RS232C interfaces.

The MEK6800D1 Kit provides a good introduction to the 6800 devices, but has several disadvantages for the amateur in that it requires a teletype, and provides a PIA and ACIA many experimenters may not need. It is also difficult to expand, as it does not have on-board buffers to drive external memory or peripheral interface. So just what is suited to the amateur?

Next month we'll be discussing this question, and, incidentally, giving some of the philosophy behind the design of the forthcoming ETI microcomputer.

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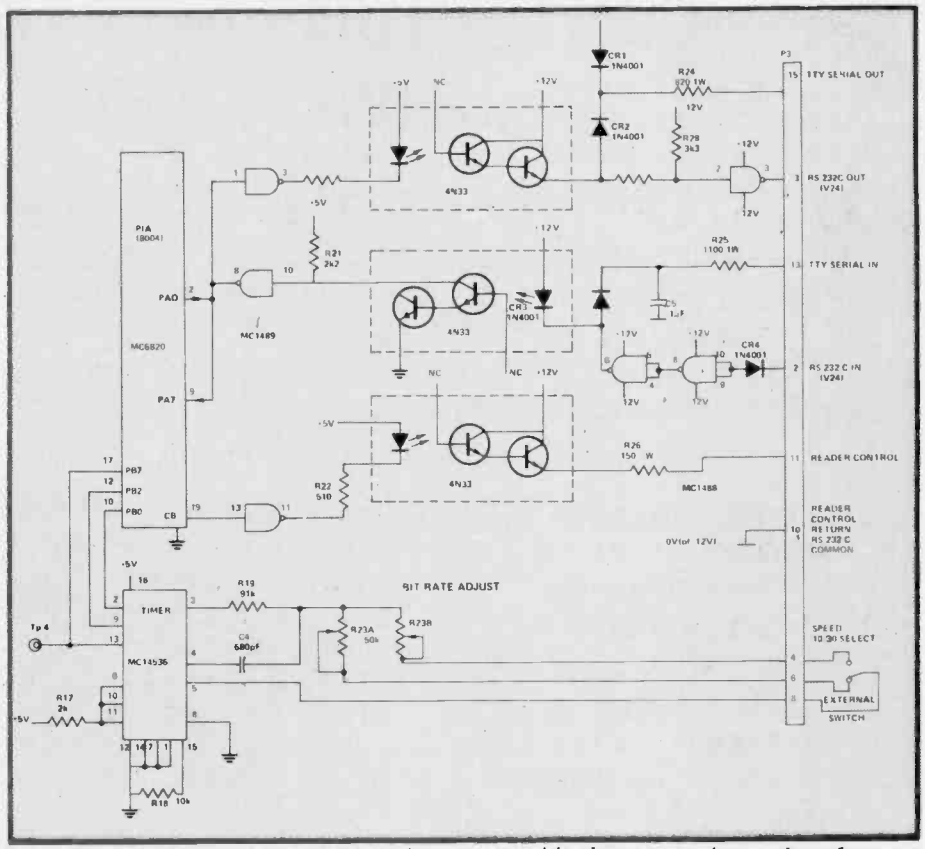

Fig. 2. The MEK kit uses a PIA and programmable timer as a teletype interface.

VDU KIT

A complete visual display terminal kit for under £250 is announced as the first product of a newly formed London company, Computer Workshop.

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The CT 1024 comes complete with ASC11 keyboard, character generator, serial interface and power supply. All standard characters and cursor functions are available under manual and computer control. Up to 16 lines of 32 characters may be displayed from either of two pages giving 1024 characters capacity.

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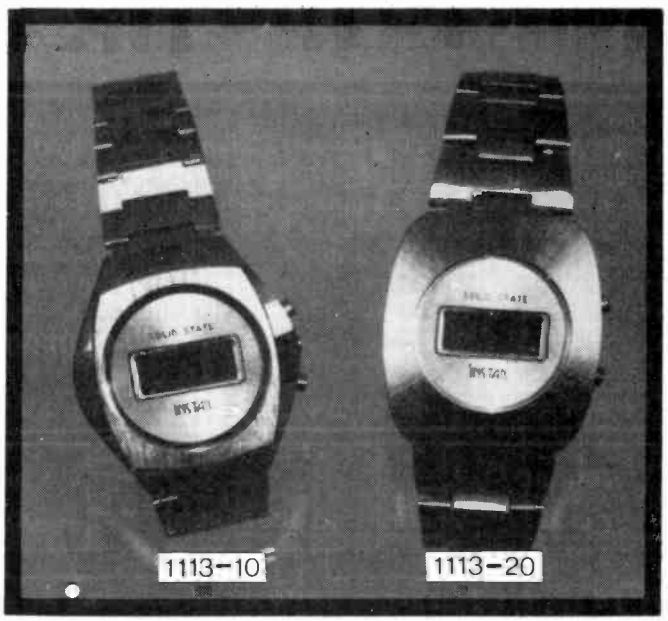

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2N456	0.80	2N3390	0.45	2N5295	0.48	AF186	0.46	BC259	0.17	BF194	0.12	8DIL	0.44	SN76003N	2.92
2N456A	0.85	2N3391	0.28	2N5296	0.48	AF200	0.65	BC261	0.25	BF195	0.12	LM7805	1.88	SN76013N	1.95
2N457A	1.20	2N3391A	0.29	2N5298	0.50	AF239	0.65	BC262	0.22	BF196	0.13	LM7812	1.99	SN76023N	1.60
2N490	4.00	2N3392	0.15	2N5457	0.29	AF240	0.90	BC263	0.25	BF197	0.15	LM7815	1.99	SN76033N	2.92
2N491	4.38	2N3393	0.15	2N5458	0.26	AF279	0.70	BC300	0.38	BF198	0.18	LM7824	1.99	ST2	0.20
2N492	5.00	2N3394	0.15	2N5459	0.29	AF280	0.79	BC301	0.34	BF200	0.40	MC1303	1.50	TAA300	1.84
2N493	5.20	2N3402	0.18	2N5492	0.58	AL102	1.00	BC303	0.54	BF225J	0.23	MC1310	2.50	TAA263	1.20
2N696	0.22	2N3403	0.19	2N5494	0.58	AL103	1.00	BC307	0.17	BF244	0.21	MC1330P	0.90	TAA350	1.96
2N697	0.16	2N3414	0.20	2N5496	0.61	BC107	0.14	BC308A	0.15	BF245	0.45	MC1351P	0.80	TAA550	0.32
2N698	0.82	2N3415	0.24	2N6027	0.45	BC108	0.14	BC309C	0.20	BF246	0.58	MC1352P	0.80	TAA611C	2.18
2N699	0.59	2N3416	0.21	2N5777	0.45	BC109	0.15	BC317	0.12	BF247	0.65	MC1466	3.50	TAA621	2.03
2N706	0.14	2N3417	0.29	3N128	0.73	BC113	0.15	BC318	0.12	BF254	0.19	MC1469	2.75	TAA661B	1.32
2N706A	0.16	2N3440	0.59	3N139	1.42	BC115	0.17	BC337	0.20	BF255	0.19	ME0402	0.20	TBA641B	2.25
2N708	0.17	2N3441	0.97	3N140	1.00	BC116	0.17	BC338	0.20	BF257	0.47	ME0404	0.13	TBA651	1.69
2N709	0.42	2N3442	1.40	3N141	0.81	BC116A	0.18	BCY30	1.03	BF258	0.53	ME0412	0.18	TBA810	0.98
2N711	0.50	2N3638	0.15	3N200	2.49	BC117	0.21	BCY31	1.06	BF259	0.55	ME4102	0.11	TBA820	0.80
2N718	0.23	2N3638A	0.15	40361	0.40	BC118	0.14	BCY32	1.18	BF439	0.24	ME4104	0.11	TBA920	1.79
2N718A	0.28	2N3639	0.27	40362	0.45	BC119	0.29	BCY33	0.96	BFR79	0.24	MJ480	0.95	TIL209	0.35
2N720	0.57	2N3641	0.17	40363	0.88	BC121	0.35	BCY34	1.00	BFS21A	2.30	MJ481	1.20	TIP29A	0.49
2N914	0.22	2N3702	0.12	40389	0.46	BC125	0.16	BCY38	1.00	BFS28	1.36	MJ490	1.05	TIP30A	0.58
2N916	0.28	2N3703	0.12	40394	0.56	BC126	0.23	BCY39	1.50	BFS61	0.27	MJ491	1.45	TIP31A	0.62
2N918	0.32	2N3704	0.15	40395	0.65	BC132	0.30	BCY40	0.97	BFS98	0.25	MJ2955	1.00	TIP32A	0.74
2N929	0.25	2N3705	0.15	40406	0.44	BC134	0.13	BCY42	0.28	BFX29	0.35	MJE340	0.48	TIP33A	1.01
2N930	0.26	2N3706	0.15	40407	0.35	BC135	0.13	BCY58	0.30	BFX30	0.34	MJE370	0.65	TIP34A	1.51
2N1302	0.19	2N3707	0.18	40408	0.35	BC136	0.17	BCY59	0.32	BFX84	0.30	MJE371	0.75	TIP35A	2.90
2N1303	0.19	2N3708	0.14	40409	0.52	BC137	0.17	BCY70	0.17	BFX85	0.35	MJE520	0.60	TIP36A	3.70
2N1304	0.26	2N3709	0.15	40410	0.52	BC140	0.68	BCY71	0.22	BFX87	0.28	MJE521	0.70	TIP41A	0.79
2N1305	0.24	2N3710	0.15	40411	2.00	BC141	0.68	BCY72	0.18	BFX88	0.30	MJE2955	1.20	TIP42A	0.90
2N1306	0.31	2N3711	0.15	40594	0.74	BC142	0.23	BD115	0.75	BFX89	0.90	MJE3055	0.75	TIP29c	0.80
2N1307	0.30	2N3712	1.20	40595	0.84	BC143	0.25	BD116	0.75	BFY50	0.30	MP8111	0.32	TIP30c	0.85
2N1308	0.47	2N3713	1.20	40601	0.67	BC147	0.10	BD121	1.00	BFY51	0.28	MP8112	0.40	TIP31c	1.00
2N1309	0.47	2N3714	1.38	40602	0.61	BC148	0.09	BD123	0.82	BFY52	0.30	MP8113	0.47	TIP32c	1.25
2N1671	1.54	2N3715	1.50	40603	0.58	BC149	0.11	BD124	1.20	BFY53	0.26	MPF102	0.39	TIP33c	1.45
2N1671A	1.67	2N3716	1.80	40604	0.56	BC153	0.18	BD131	0.40	BFY90	1.37	MPSA05	0.25	TIP34c	2.60
2N1671B	1.85	2N3771	2.20	40636	1.10	BC154	0.18	BD132	0.50	BRY39	0.48	MPSA06	0.31	TIP41c	1.40
2N1711	0.27	2N3772	1.80	40669	1.00	BC157	0.16	BD135	0.21	BSX20	0.28	MPSA12	0.35	TIP42c	1.60
2N19D7	0.60	2N3773	2.65	40673	0.73	BC158	0.16	BD136	0.22	BSX21	0.30	MPSA55	0.21	TIP2955	0.98
2N2102	0.60	2N3779	3.15	AC126	0.20	BC160	0.78	BD137	0.24	BU105	2.50	MPSA56	0.31	TIP3055	0.50
2N2147	0.78	2N3790	2.40	AC127	0.40	BC167B	0.15	BD138	0.26	BU205	2.50	MPSU05	0.65	TIS43	0.28
2N2148	0.94	2N3791	2.35	AC128	0.35	BC168B	0.15	BD139	0.71	CA3080A	1.08	MPSU06	0.58	ZTX300	0.13
2N2160	0.90	2N3792	2.60	AC151V	0.27	BC168C	0.15	BD140	0.87	CA3030A	1.80	MPSU55	0.63	ZTX301	0.13
2N2218A	0.47	2N3794	0.10	AC152V	0.49	BC169B	0.15	BD529	0.80	CA3028A	0.79	MPSU56	0.80	ZTX302	0.20
2N2219	0.42	2N3810	0.37	AC153	0.35	BC169C	0.15	BD530	0.80	CA3035	1.37	NE555V	0.70	ZTX500	0.15
2N2219A	0.52	2N3820	0.29	AC153K	0.40	BC170	0.15	BDY20	1.05	CA3052	1.62	NE556	1.30	ZTX501	0.13
2N2220	0.25	2N3823	0.58	AC154	0.25	BC171	0.16	BF115	0.29	CA3046	0.70	NE560	4.48	ZTX502	0.18
2N2221	0.18	2N3904	0.19	AC176	0.41	BC172	0.12	BF117	0.55	CA3048	2.11	NE561	4.48	ZTX530	0.23
2N2221A	0.21	2N3906	0.19	AC176K	0.40	BC177	0.19	BF121	0.35	CA3089E	1.96	NE565A	4.48	ZTX531	0.22
2N2222	0.20	2N4036	0.67	AC187K	0.35	BC178	0.18	BF123	0.35	CA3090Q	4.23	OC23	1.35		
2N2222A	0.25	2N4037	0.42	AC188K	0.40	BC179	0.21	BF125	0.35	LM301A	0.48	OC28	1.48		
2N2368	0.17	2N4058	0.18	AD142	0.57	BC182	0.12	BF152	0.20	LM308	1.17	OC35	1.16		
2N2369A	0.22	2N4059	0.15	AD143	0.68	BC182L	0.12	BF153	0.25	LM309K	1.88	OC42	0.50		
2N2369	0.22	2N4060	0.15	AD149V	0.74	BC183	0.12	BF154	0.16	LM380	0.98	OC45	0.32		
2N2646	0.55	2N4061	0.15	AD150	0.63	BC183L	0.12	BF159	0.27	LM381	2.07	OC71	0.17		
2N2647	0.98	2N4062	0.15	AD161	0.69	BC184	0.13	BF160	0.23	LM702C	0.75	OC72	0.25		
2N2904	0.40	2N4126	0.21	AD162	0.69	BC184L	0.13	BF163	0.32	LM709T099	0.38	OC81	0.25		
2N2904A	0.45	2N4289	0.34	AF106	0.40	BC207	0.27	BF166	0.40	LM741CAN	0.38	OC83	0.24		
2N2905	0.47	2N4919	0.95	AF109R	0.40	BC208	0.11	BF167	0.25	8DIL	0.40	ORP12	0.60		
2N2905A	0.50	2N4920	1.10	AF114	0.35	BC212	0.16	BF173	0.27	14DIL	0.38	R53	1.80		
2N2906	0.33	2N4921	0.83	AF115	0.35	BC212L	0.16	BF177	0.29	LM710	0.47	SL414A	2.35		
2N2906A	0.42	2N4922	0.83	AF116	0.35	BC214L	0.18	BF178	0.35	LM3900	0.61	SL610C	2.35		
2N2907	0.22	2N4923	1.00	AF117	0.35	BC237	0.16	BF179	0.43	LM723C	0.66	SL611C	2.35		
2N2907A	0.24	2N5190	0.92	AF118	0.35	BC238	0.15	BF180	0.35	LM741T099	0.40	SL612C	2.35		
2N2924	0.20	2N5191	0.96	AF124	0.30	BC239	0.15	BF181	0.36	LM709CAN	0.48	SL620C	3.50		
2N2926	0.20	2N5192	1.24	AF125	0.30	BC251	0.25	BF182	0.35	8DIL	0.40	SL621C	3.50		
2N3053	0.25	2N5195	1.46	AF126	0.28	BC253	0.25	BF183	0.55	14DIL	0.38	SL623	5.75		
2N3054	0.60	2N5245	0.29	AF127	0.28	BC257	0.15	BF184	0.30	LM747	1.05	SL640C	4.00		
2N3055	0.65	2N5294	0.48	AF139	0.65	BC258	0.16	BF185	0.30	LM748	0.44	SL641C	4.00		

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CD4008	.82	CD4023	.18	CD4047	.95
CD4009	.52	CD4024	.72	CD4049	.45
CD4010	.52	CD4025	.19	CD4050	.45
CD4011	.18	CD4027	.43	CD45101	.25
CD4012	.18	CD4028	.83	CD45111	.94
CD4013	.45	CD40291	.06	CD45161	.25
CD4014	.89	CD4030	.52	CD45181	.87
CD4015	.89	CD4031	.98	CD45201	.87
CD4016	.45	CD4037	.88		
CD4017	.88	CD4041	.70		

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	Copper		Plain	
	0.1	0.15	0.1	0.15
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2 5x5in	40	39	—	19
3¾x3¾in	40	39	—	—
3¾x5in	45	47	32	32
3¾ x 17in	1.61	1.26	1.00	1.92
PINSx36	30	30		
x200	1.16	1.16		

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SN7401	0.16	SN7412	0.22	SN7438	0.28	SN7454	0.16	SN7483	0.82	SN74100	1.10	SN74153	0.68	SN74175	0.70
SN7402	0.16	SN7413	0.28	SN7440	0.16	SN7460	0.16	SN7484	0.95	SN74107	0.30	SN74154	1.20	SN74176	1.14
SN7403	0.16	SN7416	0.28	SN7441	0.68	SN7470	0.29	SN7485	1.00	SN74118	0.85	SN74155	0.78	SN74180	1.10
SN7404	0.19	SN7417	0.28	SN7442	0.65	SN7472	0.21	SN7486	0.29	SN74119	1.75	SN74157	0.76	SN74181	1.95
SN7405	0.19	SN7420	0.16	SN7445	0.78	SN7473	0.31	SN7490	0.42	SN74121	0.32	SN74160	0.88	SN74190	1.86
SN7406	0.36	SN7423	0.23	SN7446	0.84	SN7474	0.31	SN7491	0.75	SN74122	0.42	SN74161	0.88	SN74191	1.86
SN7407	0.36	SN7425	0.23	SN7447	0.80	SN7475	0.45	SN7492	0.45	SN74123	0.65	SN74162	0.88	SN74192	1.15
SN7408	0.19	SN7427	0.23	SN7448	0.90	SN7476	0.30	SN7493	0.45	SN74141	0.75	SN74163	0.88	SN74193	1.15
SN7409	0.18	SN7430	0.15	SN7450	0.16	SN7480	0.42	SN7494	0.75	SN74145	0.72	SN74164	1.60	SN74196	1.60
SN7410	0.16	SN7432	0.22	SN7451	0.16	SN7481	1.00	SN7495	0.68	SN74150	1.20	SN74165	1.60	SN74197	1.58
												SN74167	3.30	SN74198	1.80
														SN74199	1.80

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¼" stereo plastic line socket	40p
¼" stereo chrome line socket	30p
¼" stereo plastic switched socket (makes 3 circuits)	26p
3.5mm plug	16p
3.5mm socket	8p
3.5mm line socket	16p
2.5mm plug	16p
2.5mm socket	8p

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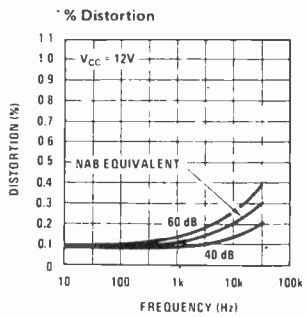
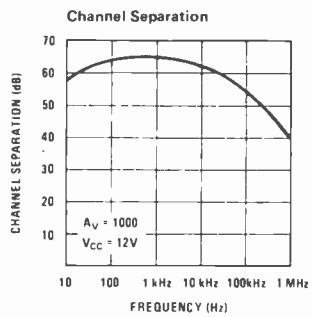
ETI DATA SHEET

LM387 DUAL LOW NOISE PRE-AMP — NATIONAL

The LM387 is a dual preamplifier for the amplification of low level signals in applications requiring optimum noise performance. Each of the two amplifiers is completely independent, with an internal power supply decoupler-regulator, providing 110 dB supply rejection and 60 dB channel separation. Other outstanding features include high gain (104 dB), large output voltage swing (V_{CC}−2V)p-p, and wide power bandwidth (75 kHz, 20 Vp-p). The LM387 operates from a single supply across the wide range of 9 to 40V.

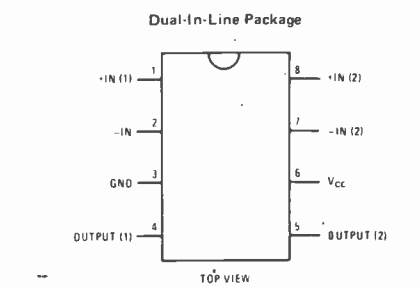
The amplifiers are internally compensated for all gains greater than 10. The LM387 is available in an 8 lead dual-in-line package.

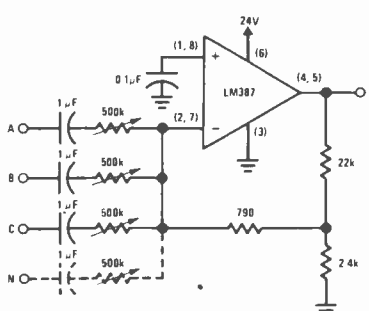




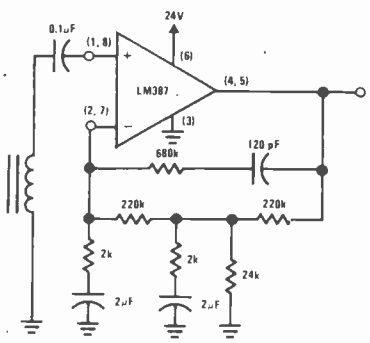
electrical characteristics T_A = 25°C, V_{CC} = 14V

PARAMETER	CONDITIONS	TYP
Voltage Gain	Open Loop	160,000 V/V
Supply Current	V_{CC} 9 to 40V, R_L = ∞	10 mA
Input Resistance		
Positive Input		100 kΩ
Negative Input		200 kΩ
Input Current		
Negative Input		0.5 μA
Output Resistance	Open Loop	150 Ω
Output Current	Source	8 mA
	Sink	2 mA
Output Voltage Swing	Peak-to-Peak	V_{CC}−2 V
Small Signal Bandwidth		15 MHz
Power Bandwidth	20 Vp-p (V_{CC} = 24V)	75 kHz
Maximum Input Voltage	Linear Operation	300, mVrms
Supply Rejection Ratio	f = 1 kHz	110 dB
Channel Separation	f = 1 kHz	60 dB
Total Harmonic Distortion	75 dB Gain, f = 1 kHz	0.1 %
Total Equivalent Input Noise	R_S = 600Ω, 100 – 10,000 Hz	1.4 μVrms
Noise Figure	50 kΩ, 10 – 10,000 Hz	1.0 dB
	10 kΩ, 10 – 10,000 Hz	1.6 dB
	5 kΩ, 10 – 10,000 Hz	2.8 dB

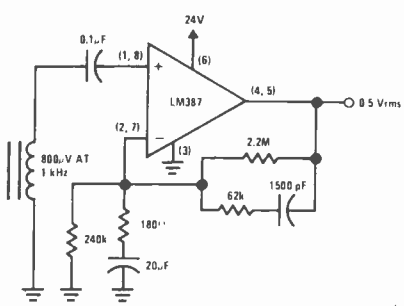




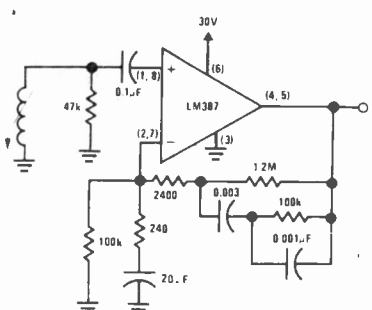
Audio Mixer



Two-Pole Fast Turn-On NAB Tape Preamplifier



Typical Tape Playback Amplifier



Typical Magnetic Phono Preamplifier

GENERAL INSTRUMENTS LTD
57-61 MORTIMER STREET LONDON
W1N 7TD

The AY-5-8100 is a four and a half digit frequency counter for use in Radio Receivers. Three main frequency ranges are provided, 2999kHz and 29.995MHz and 460kHz IF offset and 299.95MHz with 10.7MHz IF offset. For use in VHF FM receivers a channel mode is available, this displays channel number from 0 to 99 together with a +,– sign for tuning indication. In this mode IF is 10.7MHz and channel 0 is 87MHz.

The outputs are multiplexed in five time slots onto a seven segment highway. Digit and segment outputs have high voltage capability and will drive fluourescent displays directly. A pin option allows the driving of liquid crystal displays using the two frequency multiplexing system.

The frequency counter section is intended to work with an external prescaler. The three frequency ranges require division ratios of 8, 80 and 800. The appropriate IF offset is loaded into the counter before measuring. The local oscillator must always be at a high frequency than the receiver frequency.

Measurement period	8mSec
Reading rate	50 per second
Master clock frequency.	1.28MHz

DISPLAY OUTPUT

The output is in 7 segment form multiplexed into five slots at a rate of 50Hz. All the display outputs have high voltage capability and will drive fluorescent displays directly. LED displays can either be driven directly or with simple interfacing depending on the digit size.

A pin selected option allows the direct driving of liquid crystal displays using two frequency multiplexing (125Hz and 8000Hz).

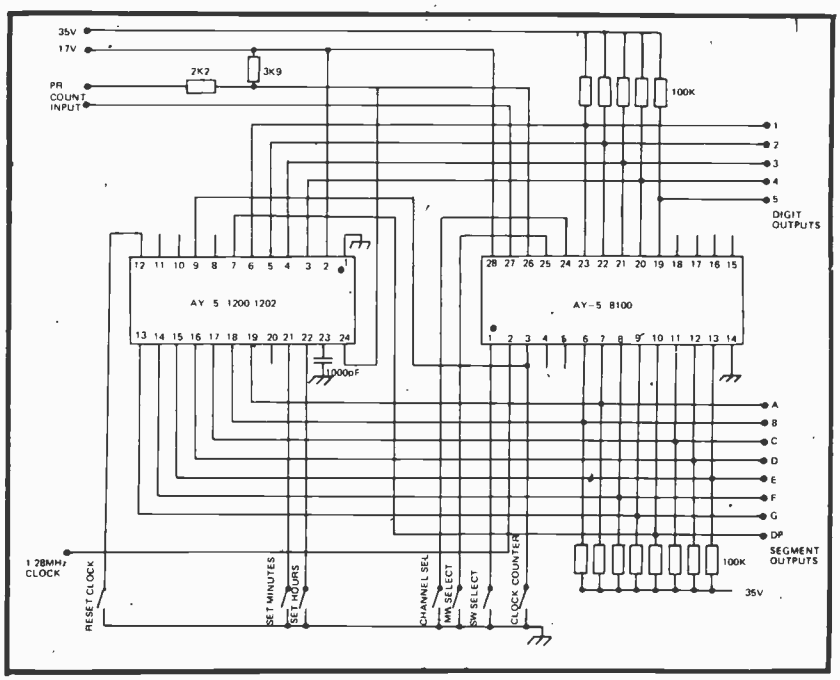
Electrical Characteristics

V_{SS} = +5V ± 0.5V
V_{DD} = –12V ± 1V
V_{II} = –28V ± 2V
Ta = 0°C to +70°C
Fc = 1.28MHz ± 0.01%

Parameter	Max.
Input logic '0' level	+0.8 Volts
Input logic '1' level	
Input load current	0.2 mA
(SW, 1.28MHz, OE, MW, CI, CH)	
Input sink current	0.2 mA
(DMI, SSI, LQ, R)	
Input capacitance	10 pF
Digit Select Outputs	
Logic '1' On Current	
Logic '0' Off Current	10 μA
Segment Outputs	
Logic '1' On Current	
Logic '0' Off Current	10 μA
PR Output	
Logic '0'	0.4 Volts
Logic '1'	
Clock input frequency	1.4 MHz
Clock pulse width	
Count input frequency	600 KHz
Count input pulse width	
Multiplex rate	50 Hz
Power consumption	450 mW

FREQUENCY COUNTER OPERATION

Mode	Display Range 5 4 3 2 1	Discrimination	Prescaler	IF
MW	2 9 9 9 KHz	1KHz	÷ 8	460
SW	2 9 9 9 5 MHz	5KHz	÷ 80	460
FM	2 9 9. 9 5 MHz	50KHz	÷800	10.7
CH	± 9 9	300KHz	÷800	10.7



NOTES:

1. *Leading zeros are blanked.*
2. *In Channel Mode the + or – signs are lit, if the receiver is more than 50kHz off tune.*
3. *The IF offset is mask programmed and can in principle be made to any value.*
4. *In Channel Mode Channel 0 = 87MHz.*

MODE SELECTION

MW	SW	CH	Mode
0	1	X	MW
1	0	X	SW
1	1	1	VHF
1	1	0	VHF/Channel
0	0	X	Counter mode
X	X	X	Clock

The SN72560 is a precision level detector intended for applications that require a Schmitt-trigger function. The detector has excellent voltage and temperature stability and an internal voltage reference for the input threshold level. For the SN72560 only; the reference-voltage pin is available for external adjustment of the positive-going threshold voltage level.

APPLICATION DATA

After switching occurs, the base current of Q1 increases to a somewhat higher value than just below threshold because of higher Q1 operating currents. Once the positive-going threshold level (≈ 3 V) has been reached, the input voltage must be reduced to the negative-going threshold level (≈ 0.6 V) before switching back to the original state will occur; Figure 4 illustrates the threshold levels of the SN72560 and SN72D560. Because the input current increases after the positive-going threshold voltage level has been exceeded, the input voltage will be reduced by an amount dependent on the source resistance. If the reduced input voltage is not below the negative-going threshold voltage level, a stable state will exist. If the source resistance is too high, oscillation or periodic switching may occur.

The positive-going threshold voltage level (V_{T+}) is guaranteed to be 3.00 ± 0.20 volts at a V_{CC} of 5 V. It is also approximately 60% of the supply voltage over the supply voltage range of 2.5 V to 7 V. With a resistor-capacitor network as illustrated in Figure 7; a V_{T+}/V_{CC} ratio of 60% results in a timed interval of approximately RC seconds, independent of the V_{CC} level. Since the input current is nominally 2 nA just below the V_{T+} level, very large values of R and/or large values of C may be used to achieve long-timed intervals. The duration of the timed interval may be greatly increased (at the expense of accuracy) by using a P-N-P transistor as shown in Figure 11 in a capacitance-multiplication technique. The timed interval is, however, sensitive to variations in the h_{FE} of the P-N-P transistor. Also for any of the timing applications, very-low-leakage capacitors are necessary for accurate operation.

The low input current (30 nA maximum for I_{T+}) and high output sink current (160 mA maximum) make the SN72560 or SN72D560 excellent in applications of interfacing between low-level systems and TTL systems where precision level detection is required. The output is capable of sinking up to a maximum of 160 mA with a TTL-compatible on-state voltage of 0.4 V maximum guaranteed at a sink current of 48 mA. With an appropriate output pull-up resistor ($R_L \approx 2\ k\Omega$ to 5 V), a fan-out of approximately 30 Series 74 TTL loads can be accomodated.

In addition to applications interfacing with TTL systems, the SN72560 and SN72D560 find application in driving relays, lamps, solenoids, thyristors (SCRs and triacs), and other peripheral devices.

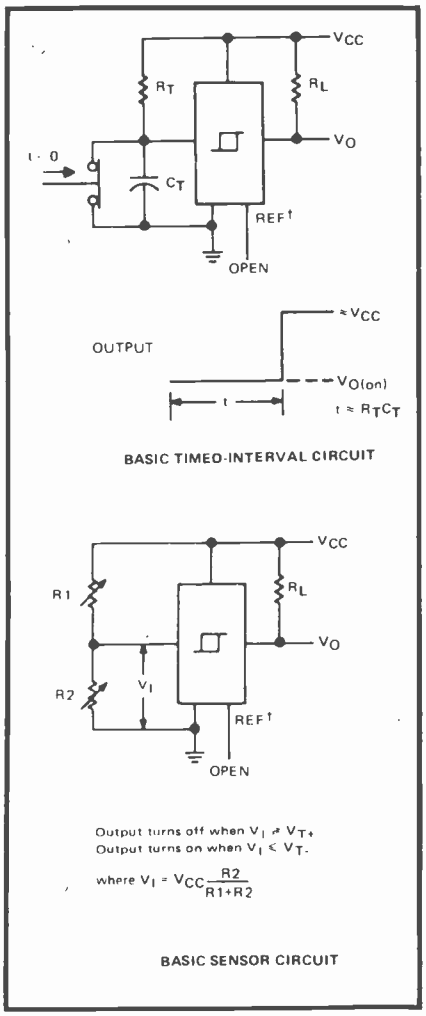
recommended operating conditions

	MIN	NOM	MAX	UNIT
Supply voltage, V_{CC}	2.5	5	7	V
Low-level output current, I_{OL}			48	mA
Operating free air temperature, T_A	0		70	°C

electrical characteristics over recommended operating free-air temperature range, V_{CC} = 5V (unless otherwise noted)

	PARAMETER	TYP	MAX	UNIT
V_{T+}	Positive-going threshold voltage†	3	3.2	V
V_{T+}/V_{CC}	Ratio of positive-going threshold voltage to supply voltage	0.6		
V_{T-}	Negative-going threshold voltage†	0.6	0.8	V
I_{T+}	Input current below positive-going threshold voltage	2	30	nA
I_{T-}	Input current above negative-going threshold voltage	1.2		μA
$I_{O(off)}$	Off-state output current		10	μA
$V_{O(on)}$	On-state output voltage	0.2	0.4	V
$I_{CC(off)}$	Supply current, output off (each detector)	4.8	6.5	mA
$I_{CC(on)}$	Supply current, output on (each detector)	10	15	mA

TEXAS INSTRUMENTS
MOUNTAIN LANE
BEDFORD
MK 41 7PA



BASIC TIMED-INTERVAL CIRCUIT

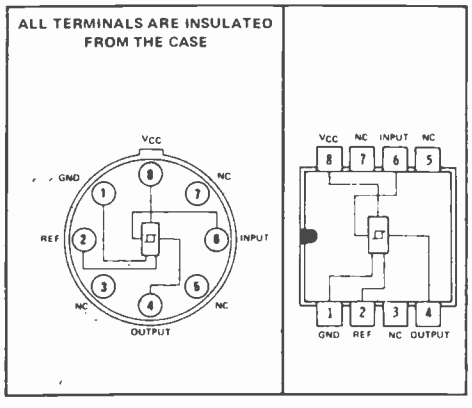
Output turns off when $V_I \geq V_{T+}$
Output turns on when $V_I \leq V_{T-}$

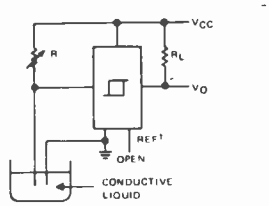
where $V_I = V_{CC}\frac{R2}{R1+R2}$

BASIC SENSOR CIRCUIT

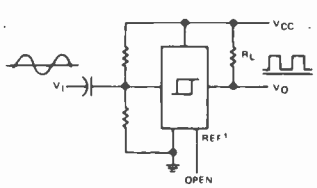
SN72560
L PLUG-IN PACKAGE
(TOP VIEW)

SN72560
P DUAL-IN-LINE
PACKAGE (TOP VIEW)

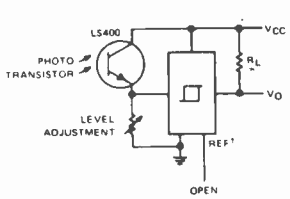




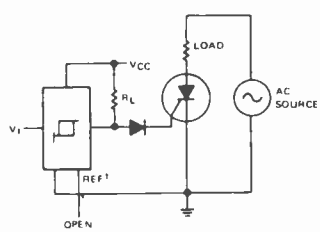
LIQUID-LEVEL SENSOR



SINE-WAVE-TO-SQUARE-WAVE CONVERTER



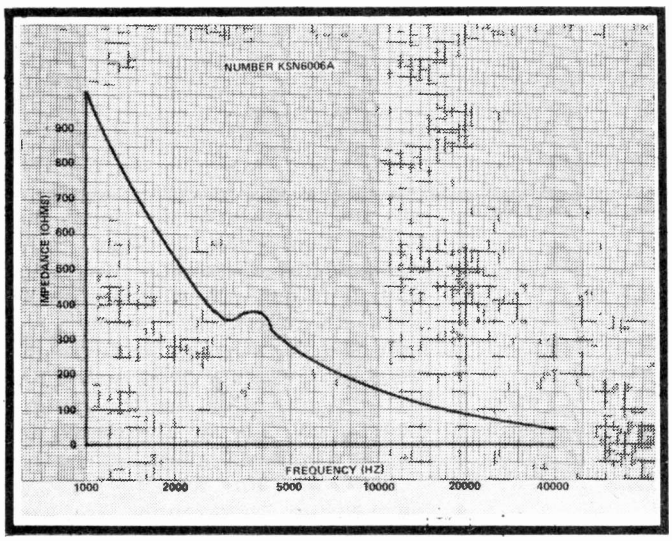
LIGHT-LEVEL SENSOR

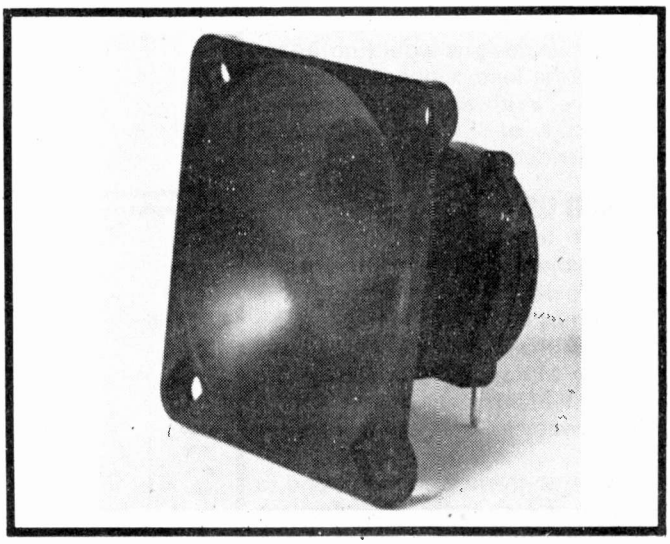


THYRISTOR ORIVER CIRCUIT

MOTOROLA PIEZO-ELECTRIC TWEETERS

eti PRODUCT TEST





PIEZO-ELECTRICS and hi-fi have until now had only the shadowiest connections between them. Ceramic cartridges and devices of a similar ilk just do not possess the delicacy and overall quality required for the higher realms of sound reproduction. However it looks very much as though Motorola (of all people) are about to sweep away such ideas, although at the other end of the reproduction chain, with a 'solid-state' ceramic speaker!

The units are the KSN 6006A and 6001A piezo-electric tweeters, or high frequency speakers. These are being brought into Britain for the first time by Sound Out Labs, at 53 Park Road, Kingston, Surrey and should make enormous impact on speaker markets here. Sound Out tell us that all the major speaker manufacturers are looking closely at the design, which is not surprising when you consider its abilities, and we may well see it incorporated into a commercial enclosure in the future.

At the moment the tweeter is going out to disco and group use, where its enormous power handling and independence of crossover networks give it further advantage. Our review is concerned with the 'hi-fi' model which is slightly cheaper due to the lack of 'beaming' assemblies fitted to the other unit.

HORNING IN

The speaker is basically a horn loaded high frequency unit i.e. using a flared throat to couple the driver to the air loading it. It is the driver that makes the unit so radically different from anything going before.

In 'normal' speakers a coil of wire, the voice coil, is wrapped around a former at the rear of a paper cone or dome and the audio passed through. Since the coil is stiuated in a powerful magnetic field, a force is produced on the coil, causing it to move in sympathy with the incoming electrical signal, and move the cone with it. The mass of the cone is unavoidably greater than that of the actual driven element, the coil.

Compare this with the principle behind Motorola's new unit, in which the voice coil and magnet are dispensed with completely. They are replaced with two thin slices of a ceramic material, called lead-zirconate-lead titante in case it makes your life any the fuller for knowing. The ceramic discs are epoxied onto either side of a brass separator, and nickel electrodes deposited on to make connection. In order that the discs respond to the input, they are polarised in opposing senses. On application of a common signal, one disc expands and the other contracts, acting in the same direction on the air load.

PROS . . .

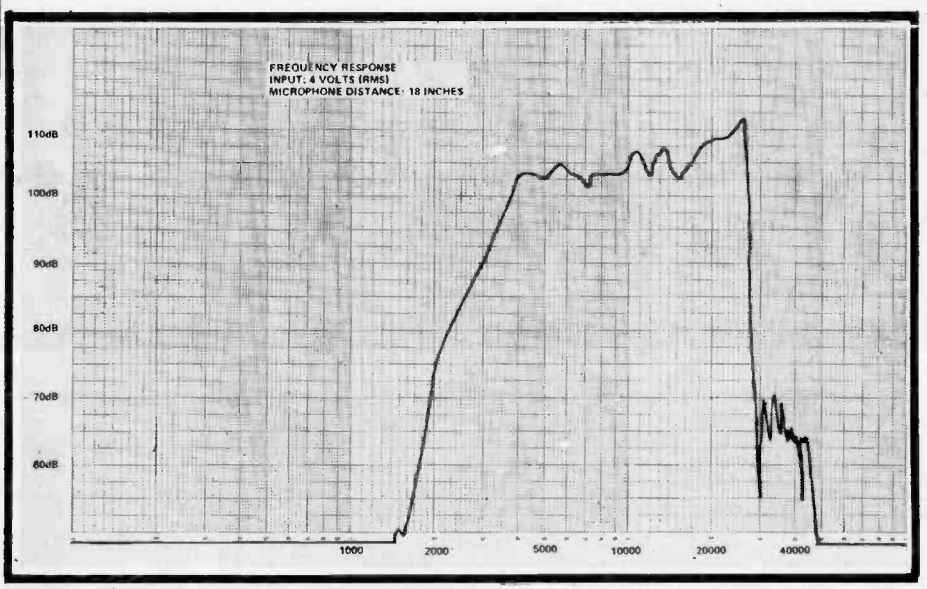
Figure 1 shows the impedance curve for the KSN 6006A tweeter unit. The rising impedance with falling frequency allows the unit to 'reject' low frequencies outside its operating range without the use of a crossover network. Operation is considered useful within its —3dB points, 3.8kHz and 28kHz (Fig. 2), over which range the operation is fairly linear. Since there is no voice coil, the driver mass will be lower than an equivalent conventional speaker, which in theory ought to provide a better transient response. Being composed of a ceramic material, heat dissipation from the active element is not as great a problem as before, and the tweeter will stand 35v r.m.s. for protracted periods without damage.

Due to the nature of the load presented to an amplifier, which is almost entirely capacitive, it is difficult to discuss power output and efficiency in the same manner as with normal units. There is no doubt the unit is very efficient, for 4v r.m.s. input the output is 105dBA at 18in from the horn mouth (pink noise). The material is impervious to humidity variation, and stable to 240° F (115° C).

MOTOROLA PIEZO-ELECTRIC TWEETERS

. . . AND CONS

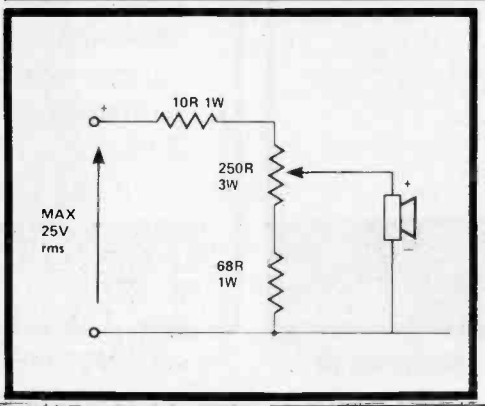
Some amplifiers of a lesser breed than the purest may be unhappy driving the essentially reactive load the Motorola presents to them. Subjective impressions of the unit were gained using a Pioneer SA9100, which of course gave no trouble. In general if your amplifier will drive electrostatic speakers, it will probably be perfectly happy with the Motorola. In fact most commercial designs would not react badly to the load, since it is mainly capacitive. With **all** amps however, the circuit of Fig. 3 is to be recommended.



HOOKED UP

In order to obtain an impression of the subjective performance of the driver, it was wired up using Fig. 3 to a domestic hi-fi system, and the control VR1 set such that the level from the Motorola was roughly the same as that emanating from the HF 2000 tweeter used on the other channel.

This system showed the sound to be very clean with an excellent transient response, justifying nicely the design criteria. If anything the sound was somewhat 'hard' to the ear, and the tweeter did beam the sound more than a dome unit. However the dispersion was certainly on a par with most other h.f. units. Efficiency was indeed very high, and the attenuation definitely required. Overall a good sounding speaker, and well worth experimenting with as an alternative to the more usual h.f. units.



Motorola are working on a piezo-electric mid-range unit to complement the tweeter, and this should be very interesting when teamed up with the KSN 6006. ●

SCRUMPI

SCRUMPI is a microprocessor kit system, it builds up into a complete micro-computer with 64K memory, VDU, cassette I/O, teletype I/O, etc.

PART 1 should be available early in July and is presented as a facia and PCB kit to fit a standard 19" Vero case (or can be used as a stand-alone). PART 1 contains CPU chip, 1K, RAM, buffer/drivers, address and data switches and indicator lamps, complete with assembly instructions and basic programs.

ADD-ON kits will allow for VDU output, TTY I/O, cassette I/O, keyboard input, additional RAM, PROM and EAROM.

SCRUMPI. Part 1 Kit £88 + VAT. Requires only a simple power supply and you have an operational microprocessor. N.B.: This kit does *not* need a £1,000 TTY before you can operate it!!

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MM5379 Car clock, crystal controlled. Gas discharge	6.73
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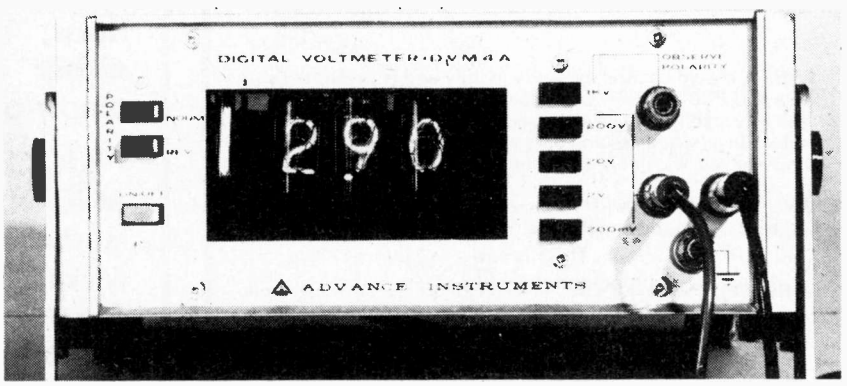
PART 29

Digital displays — historical development and forms

DIGITAL DISPLAYS present information in a readily understandable form — that is, in the decimal numbers, alphabetic characters and symbols of common visual experience. In this section we will study the various types of device used to generate the displays of calculators, DVMs and similar instruments.

Decoding techniques used to convert those numbers held within the system (in the binary or binary-coded-decimal form) into decimal numbers and alphabetical characters are discussed in the next section. Displays are dealt with first because their requirements partly dictate the decoding techniques that are employed.



HISTORICAL DEVELOPMENT

Originally the individual bit positions in the counter or register of interest were displayed using single lamps — on for 1 and off for 0. In the late 50's and early 60's this rather inconvenient method was supplanted by decimal column displays, in which the digits were arranged in front of a column of bulbs which were lit in sequence. Unfortunately, this called for a large panel, and the digits were all out of alignment. To get round this, several manufacturers developed ingenious opto-mechanical modules, including the moving-coil meter type shown in Fig. 2. Watching such a display is somewhat disconcerting, for the individual numbers wobble into position with changing values.

NEON INDICATOR TUBES

Also developed at this time was the neon display device known as the 'Nixie' tube. These are still designed into new equipment today, so we will study how they operate in some detail.

Applying a voltage over 70V to a basic neon lamp causes the gas inside to conduct, producing a red glow on the electrodes. Single neon indicators are used extensively for "mains-on" indication in instruments, power points, and appliances, in which case a series resistor is added to obtain operation at 240V.

The neon-indicator tube, developed from the basic neon lamp, incorporates 10 cathodes (when numbers are to be generated; letters and other symbols are available) one for each 0-9 number, which are stacked on top of each other behind a fine mesh. Each is insulated from the others and has a connection lead brought out through the glass envelope as shown in Fig.3b. The mesh acts as a common anode electrode for whichever cathode is selected. The tube displays just one of its number set. Non-energized grids remain dark and are unseen because they do not glow.

Numerical neon-indicator tubes are made such that the numbers appear either at the side of the glass cylinder or at the end. Character sizes ranging from 10 to 50 mm are available. This form of display has remained popular for reasons of the very acceptable readability, nicely shaped character format and low-costs. They require a relatively high voltage supply (180 Vdc is typical) and are not as robust as the solid-state devices described later.

The format and connections of a typical neon-indicator tube are illustrated in Fig.4. Note that only one input drive signal is required to energize any particular display

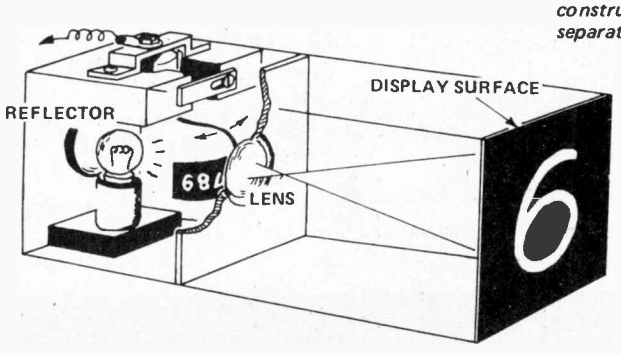
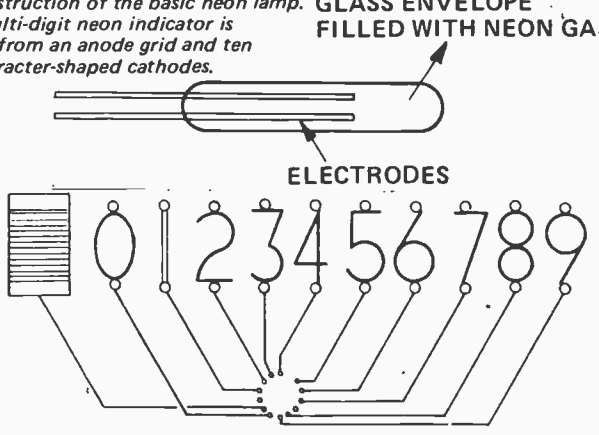


Fig. 2. The moving-coil numerical character display is based on an optical projection system. The numbers are on a graticule which is rotated behind a lens by a meter-like movement.

Fig. 3a. Construction of the basic neon lamp. b. How a multi-digit neon indicator is constructed from an anode grid and ten separate character-shaped cathodes.



character. The majority of all other displays in use require several inputs to be energized in order to produce the desired character. We will see later, however, that the amount of decoding circuitry needed for neon-indicator systems and the solid-state alternatives is similar.

It is possible to construct neon-indicators needing lower input – command voltages. In the Mullard Digitube, for example, the discharge remains on continuously. The trigger voltage, a 5 V level change, causes the discharge to transfer from an out-of-sight cathode to a visible one. This single-bit principle has been applied to a 10 step unit in which individual separate numbers are illuminated as needed. This form of neon display has not become popular, probably because the numbers are arranged in a circle, giving small numerals which do not line up when several displays are used to form a multi-digit decimal number. (One early variety produced a dot glowing at the side of the numbers printed around a circle).

Neon-indicators radiate red light, which (more by chance than design) happens to be at a wavelength of reasonable sensitivity to the eye. Red is particularly suited to strong ambient daylight viewing.

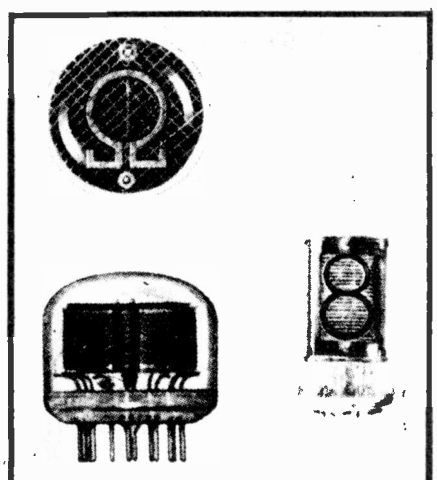


Fig.4. Different types of neon display.

MULTI-SEGMENT FORMATS

Each of the above displays uses characters generated by the application of a single signal that provides the character complete. This is said to be of simple format. An alternative method is to produce the character from individual segments or dots arranged to build-up the shape needed.

After the very active development period of the 60's designers and suppliers are now settling on the use of seven-segments, hexa-decimal 7 by 4 dot and 7 by 5 dot matrix formats.

Seven-segment format – This is the simplest and most used composite matrix method. It consists of seven equal-size bars placed to form the 0 through to 9 series of numbers. Several distinct alphabetical characters and a

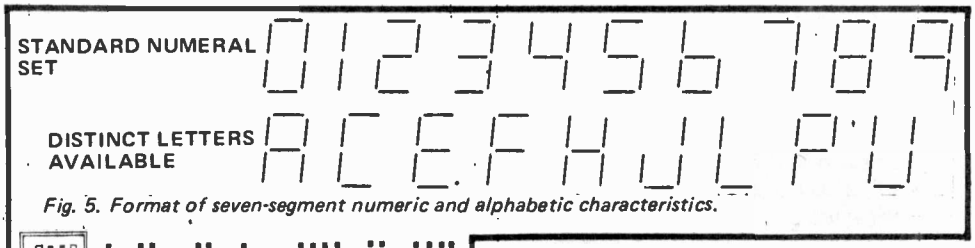


Fig. 5. Format of seven-segment numeric and alphabetic characteristics.

Fig. 6. Typical format of characters of the hexadecimal system using a 4 by 7 dot matrix.

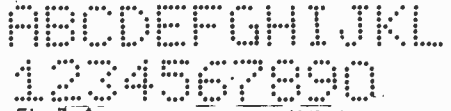


Fig. 7. Alpha-numeric characters as generated by 5 x 7 dot matrix.

minus sign are also possible. The appearance of seven-segment numbers and letters is as shown in Fig.5. This system is based upon a stylised figure of eight. Of particular note is the requirement that the individual characters are generated with different combinations of bars being illuminated.

Methods for illuminating a bar include separate filaments for each, separate incandescent bulbs, luminescent phosphors lit by filaments, light-emitting diodes (LEDs) and liquid crystal indicators – more of these later.

Hexadecimal format – these rely on the formation of a character by illumination of the necessary dots (or small squares) of a 4 by 7 dot matrix. Figure 6 gives the appearance of number characters generated this way. Note again the need to energize selected positions to provide the required character.

Alpha-numeric matrix format – the above 7 by 4 matrix is limited in that whilst it can generate all numbers, it cannot provide all 26 alphabetic characters. If the matrix size is increased to 7 by 5 the full 36 alpha-numeric characters can be generated. Figure 7 gives the characters of the American Standard Code for Information Interface ASC11.

SOLID-STATE DISPLAYS

Incandescent lamps are very inefficient at converting electrical energy into radiant visible energy – conversion is generally only around 20-30 lumens per watt. Neon-indicators consume less power in general and deliver a brighter output but do require a high voltage that is not directly compatible with the new standard 0-5 dc TTL signal levels. The life and robustness of both filament lamps and neon devices is also far from ideal. The breakthrough came several years ago when light-emitting diodes (LEDs) were developed.

Light Emitting Diodes – LEDs are semiconductor junctions (formed by the same processes used to make solid-state signal diodes) which emit radiation from the junction when current is passed through it. The basic materials used are gallium arsenide phosphide GaAsP and gallium phosphide GAP.

This form of light source generates relatively narrow wavelength energy centred on red yellow or green colours. (Typically 635 mm, 583 mm and 565 mm wavelength respectively) with high luminous efficacies of 140, 460 and 610 lumens per watt. Compare these efficacies against that for a typical tungsten filament lamp of 20 lumens per watt. The term efficacy should not be confused with efficiency. Efficiency is the percentage of radiant power compared to input power whereas efficacy refers to the effectiveness of the *radiant* power produced in stimulating the eye. For example an LED producing infra-red radiation will have an efficiency of say 3% but an efficacy of zero.

The high efficacy of LEDs means reduced power supply requirements, and high visibility is obtained even when LEDs are driven via a resistor directly from TTL.

Another feature of LED sources is the high speed of response – 100 ns is typical. The operating voltage is nominally 2 V and current requirement varies around 20 mA.

Single and multiple format LED displays are now available in a wide variety of forms and they are the most used display medium. Figure 8 gives the various data of a typical unit. Figure 9 shows how a single lamp can be mounted in practice.

Developments arising out of the basic single LED lamps are units incorporating an integrated resistor

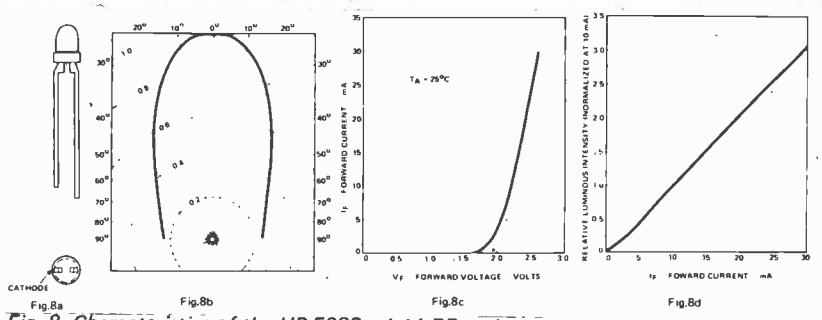
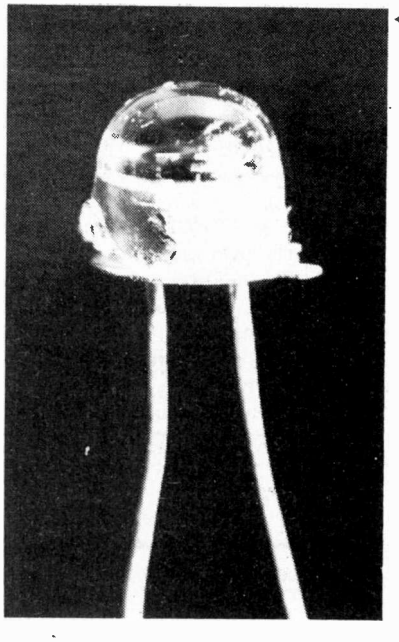
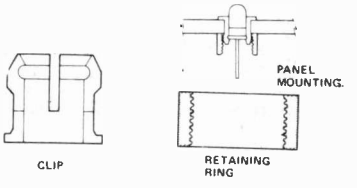


Fig. 8. Characteristics of the HP 5082 mini-LED series lamps. (a) the shape of the lamp; (b) relative luminous intensity versus beam angle; (c) Forward current versus forward voltage.



A typical LED indicator lamp.



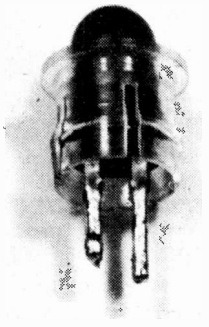


Fig. 9. LED lamps such as this may be mounted directly onto a PC board or onto a front panel by means of the clear plastic clip.

(for direct TTL connection) those having an integrated voltage sensing amplifier (Fig.10) which provides a lamp that triggers on or off as the input level passes up or down through a 2.5 V level and the opto-electronic relay or isolator discussed in a previous section. Hermetically sealed units and military approved units that will operate from -65°C to +100°C with very high reliability over a life measured in years of operation are also available.

Given a matrix of LED lamps it is quite practicable to generate numbers and characters by what is called an addressable system in which decoding logic decides the diodes to be illuminated. LED character displays are marketed as single unit 7 segment modules and as 4 by 7 and 5 by 7 dot matrices. Integration has gone as far as incorporating a complete decade counter stage (Fig. 11), with the necessary decoders, buffer amplifiers and LED display all integrated on a single LSI unit. As LED manufacturing techniques are the same as conventional integration methods it is possible where large quantity production is economic, to integrate the display with the circuitry – examples are to be found in some styles of IC wristwatch.

Seven segment LED displays have the eight diodes placed on a common transparent GaP substrate. (The eighth diode provides a decimal point). A typical single unit is shown in Fig.12 – they are available in red, yellow and green colours. The 7.6 mm letter size is visible at 3 m; a larger 11.0 mm size can be readily seen at 6 m. Another series, shown in Fig.13 includes an integral optical magnification technique that provides improved readability for low drive power (1 mW per segment). These are available as 3, 4 and 5 character units which are mechanically compatible with standard printed-circuit board hole spacings.

To meet the demand for portable calculators manufacturers also supply special units with 8 or 9 digits mounted on a small plug-in printed-circuit board.

The range of dot generated character displays is also extensive. A 39 mm high character is available that can be read from 20 m. This, as can be seen in Fig.14, is based upon a large size

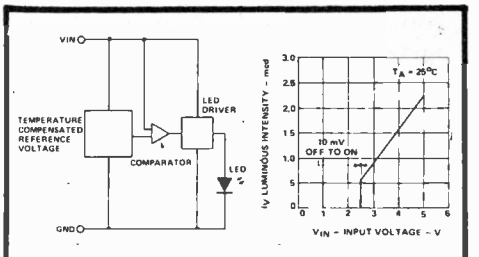


Fig. 10. LEDs with integrated voltage sensing amplifiers turn on when the applied voltage exceeds a built-in value. LEFT: schematic. RIGHT: luminous intensity versus input voltage. BELOW: ways of increasing the threshold voltage.

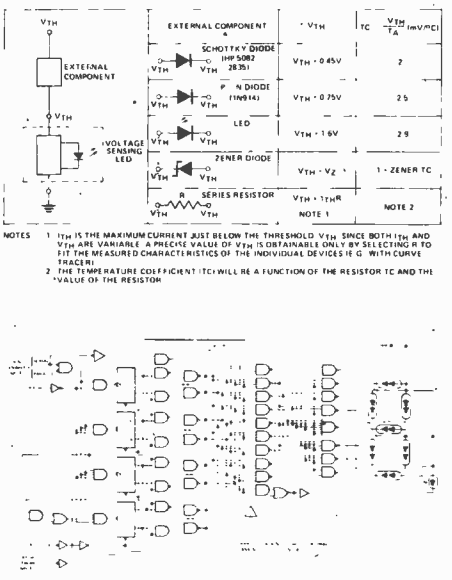


Fig. 11. The Texas Instruments TIL306 display integrates all the logic of a complete decade counter onto the same chip as a 7-segment display. The circuit shown is the schematic of the device.

5 by 7 dot matrix and includes the decoder/driver unit for the most commonly used BCD code – the 8421-logic input (decoders are discussed in the next part). Dot matrix displays with characters as large as 45 cm height are produced. These, however, are not usually solid-state but use electromagnetic drives to rotate reflective dots into or out of the viewing aperture. Such units, given adequate ambient light, are visible at 300 m. Multi-digit dot matrix solid-state displays are also made.

Liquid Crystal Displays. Although LED displays consume little power compared with earlier filament displays very little of the power used is actually transmitted as radiant energy. Efficiencies of visible diodes are typically only 0.1%! Thus an LED display often consumes considerably

more supply power than the rest of the associated digital system. Indicators of all types, except liquid crystal, require about 300 to 500 mW per character (all segments illuminated).

The power requirements of the display could be reduced considerably if the circuit could switch available ambient light rather than actually generate light. Naturally such a method will only work when ambient light is available.

In the dark, displays which generate radiation would still be required. Displays are available which do switch ambient light. They are known as liquid crystal displays and by virtue of their mode of operation consume very little power.

Basically liquid crystal displays consists of a minutely thin layer of liquid-crystal material placed within two thin glass covers. The glass covers have transparent electrodes deposited on them in the shape of the characters or segment needed. This is shown in Fig.15a. With no excitation the whole unit appears transparent, for the liquid crystals remain stationary allowing light to pass through virtually unattenuated, that is, no light is reflected. When an alternating voltage (40-1000 Hz) is applied to the electrodes forming the character shapes, the resultant electric field causes the liquid layer to become turbulent, scattering light between the confines of the deposited areas. The display then shows an optically dense character because the ambient light is reflected. In simple terms application of an input signal causes the liquid crystal in the vicinity of the transparent electrodes to act like a mirror.

The power requirement for the circuit driving liquid crystal displays is around 20μW per segment (compare this with the lowest 100 μW per segment but more usually 20 000 μW for LED characters). Response is not as fast as for LEDs – 20 ms rise-time and 100 ms fall-time, but that is not a serious shortcoming in visual observation applications. In some instances faster response is needed – consider, for example, the use of photographic recording of a character display. With LED displays the display, when being photographically recorded, can be cycled considerably faster than the eye can follow.

Liquid-crystals are the most recent solid-state display to be developed and it is still too early to state with certainty if they will eventually compete seriously with LED techniques. At present the life of the display is inferior to LED units.

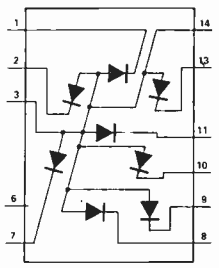


Fig. 12. Internal diode positions for a right-hand decimal point 7-segment display module.

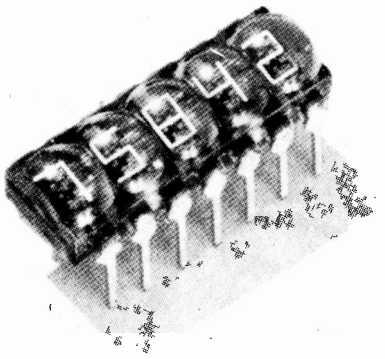


Fig. 13. Some seven-segment displays suitable for calculators etc are assembled in groups and have plastic lenses to increase character size.

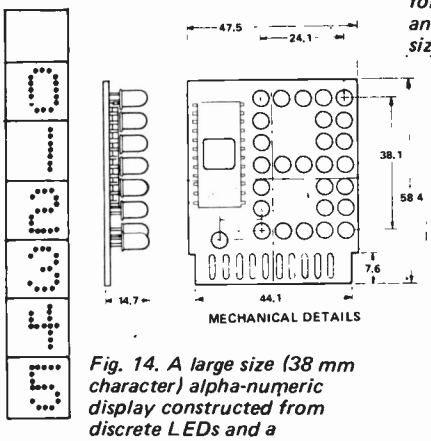


Fig. 14. A large size (38 mm character) alpha-numeric display constructed from discrete LEDs and a decoder/driver IC. (HP5082-7500).

PIN	FUNCTION
1	V_{CC}
2	DP
3	X1
4	X2
5	X4
6	X8
7	GROUND
8	NC
9	NC
10	V_{LED}

FORMAT

Although manufacturers quote 10 000 hours minimum life (just over a year) experience has shown that units often fail after only a 1000 hours.

Seven segment displays are also made using neon lamps, self contained filaments and separate incandescent bulbs. It is to be expected that these will not be in use in new designs of the future for the price alone of solid-state devices will usually undercut the available alternatives.

Regardless of the display used it is necessary to decode the binary logic of digital circuits into a code suited to illuminate the required number and combination of characters in the system used. The next section will look at the schemes used and at more efficient methods of driving multiple character displays.

YOUR LIBRARY

The use of solid-state displays is straight-forward in simple applications. In each case, however, design information is vital to ensure that the displays are used within ratings. Advanced display design has become a high-level art and generally Application Notes are the essential guide to their successful use.

Hewlett-Packard produced an "Opto Electronics Designer's Catalog" in 1973 and 1975. The former included several applications notes, the latter a list of the range of relevant application notes now available from HP: both contain a wealth of practical data.

"Digital display systems", written by E.G. Breeze and available as Fairchild Application note 212/1, 1972 is also worthwhile having.

Many other manufacturers – Texas Instruments, RCA, National, Hawker Siddeley Electronics, Monsanto, Mullard, Atron, Litronix, Siemens – also provide service data that gives practical advice on how to use their display products to best effects. ●

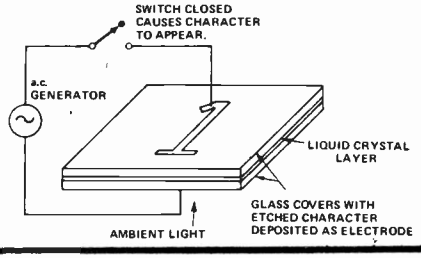


Fig. 15. The construction of a liquid-crystal display.

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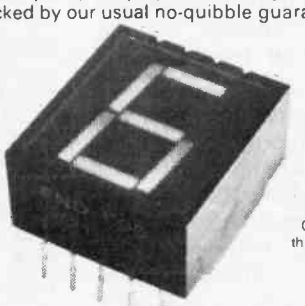

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ELECTRONICS TOMORROW

by John Miller-Kirkpatrick

I HAVE received some interesting correspondence recently on the subject of TV games linked to our run by microprocessors. Many people have become fascinated by these games machines that are found in those drinking hostelries frequented it seems as much by ETI readers as by ETI staff. The basic logic behind these games is not difficult to describe, but the logic of the game iself is very complicated, so we will describe the logic to display the memory of the controlling microprocessor for the game.

100000 DOTS

A normal television picture is made up of 300 odd lines interlaced to give the 625 lines which we are used to seeing, thus there are about 300 possible horizontal lines in each display frame. If we assume that the picture output is to be as close to a normal TV picture as possible then we will require the same definition across the screen as down the screen, to do this we need to split each line into just over 300 possible dots of information. Assuming for the time being that we are using black and white only we would need the capability of controlling any dot on the screen to be in an ON or OFF condition and to remember the status of any given dot at all times. To do this we need a RAM memory with each bit of the memory controlling one dot on the picture screen, thus we need to control 300 lines of dots with over 300 dots in each line, ie about 100,000 dots. An inexpensive RAM such as the 2102 type costs about £3 and contains 1024 bits, thus just the screen memory costs between £200 and £300 before you add the microprocessor. TV monitor, software, etc. This is beyond most amateurs' pockets so let us look at an interesting games unit for people who have or are intending to buy a Teletext decoder and MPU system.

960 CHARACTERS

In addition to the 64 ASCII characters à Teletext decoder can also display graphics characters in colour or black and white by splitting each character space into six bit spaces, each bit can be on or off and the whole character space can be any one of six colours or white. Ignoring the individual bits for the present let us consider the character space and assume that the whole character space can be a coloured or white square or can be off. There are 24 lines of 40 characters, this gives us a total of 960 possible characters each one of which can be in any one of eight states (6 colours, white or off). If you disconnect the CEEFAX data and stop it writing to the screen memory you can use the memory and decoder to display information from an MPU on a TV screen — this can be done but it is more complex than it might seem. Our MPU has to give the decoder an address of a character and data concerning the required status of that character, the address requires 10 bits and the data requires at least 3 bits to indicate one of the eight possible states, most of the MPU chips will control much more than this so there should be no problems.

ADDRESS PLEASE

The decoder memory is being continuously addressed to display the information on the screen, this access rate is about 10 times too fast for a MPU to control and so we have to find a different way for the MPU to access the decoder memory. If the MPY 10 bit address is compared with the decoder address by using a batch of 7486s then a control bit will be activated when both addresses are the same. This control bit is used with MPU Write and memory enable logic to transfer data on the MPY data bus into the decoder RAM at the time that the decoder is accessing the correct address in the RAM. The appropriate code for the required CEEFAX character is written from the MPU system into the decoder system and will be displayed on the screen during the next and all subsequent scans. Although any of the 196 CEEFAX characters can be displayed on what is now effectively a VDU screen we will concentrate only on the patterns and games using only the 960 character squares.

In the MPU program we define 960 bits in a wrap-around configuration, ie the bit in the top left is assumed to be touching all three other corner bits as if the screen had been folded around a football so that the top touched the bottom and one side touched the other. Each of the 960 bits thus has eight neighbours, imagine a game of noughts and crosses, our bit is in the middle square and has eight neighbouring squares.

NEIGHBOURING BITS

The program now examines each bit and counts the number of its neighbours which are in an ON (bit 1) status and uses this data to control the status of the central bit. Any bit with 0 to 1 neighbour ON will be turned OFF, with two or three neighbours there will be no change, with four or more neighbours the bit will be turned OFF, any bit with exactly three neighbours ON will be turned ON. This is called the Game of Life where each bit is a cell in a colony, with three neighbours a cell is born or revived, otherwise the cell can die through isolation or overcrowding. At the

ELECTRONICS TOMORROW

by John Miller-Kirkpatrick

start the bits can all be on or can be randomly on or in a predetermined pattern, the program then changes the pattern according to the above rules and gives changing patterns of life of the various colonies. Colonies can grow from just a few cells to cover the whole screen and then die off, as a competitive game the idea is to design start colonies which will remain stable for as long as possible.

If you can imagine the program and hardware for this simple game then multiply it by 100 then you have the sort of complexity of one of the commercial TV games units. By using a Teletext type decoder or VDU many other games can be played such as draughts, chess and other matrix board games or you can invent new games such as a combination of the Game of Life and the Japanese game Go.

TAILPIECE

Many thanks to the people who wrote to me concerning the seven-segment to BCD converter modification for tailed sevens. I now have about 6 different ways of doing it, probably one of the easiest to add to my original circuit came from A. J. Paterson using 3 7400 gates. Gate 1 inverts the f segment and outputs to one input of gate 2, gate 3 inputs from segments e and g and outputs to gate 2. The output from gate 2 goes to the f segment input of the original circuit. ●

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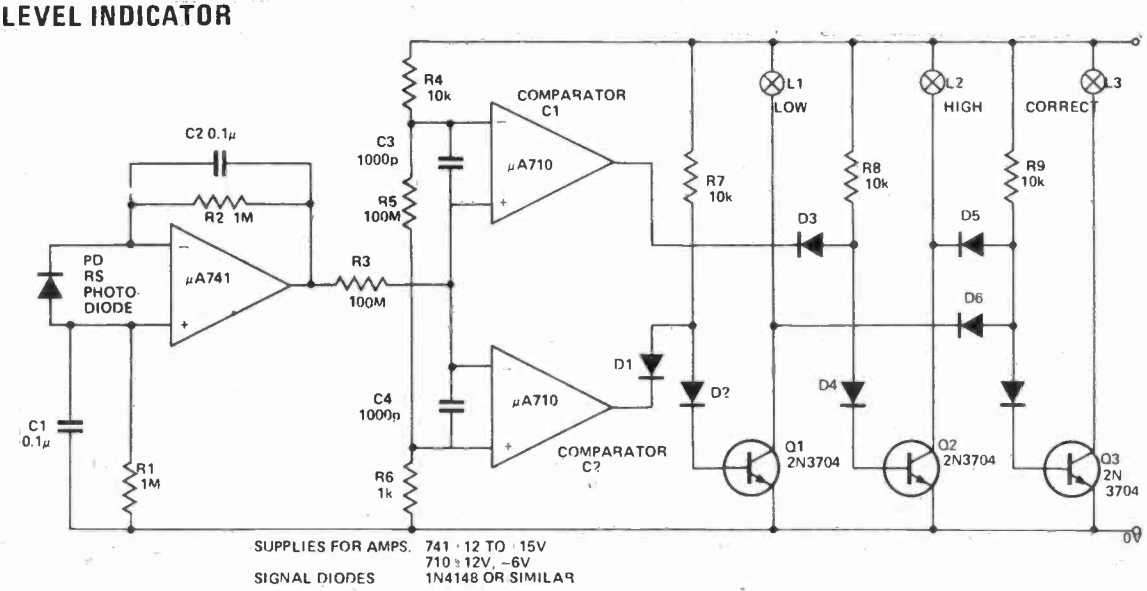


When conducting optical experiments, or calibrating photocells, it may be necessary to set a known light level each time before the experiment is performed. The circuit provides a simple means of setting a light level to a particular value.

A silicon planar photodiode, strategically placed in the optical system, generates a photocurrent proportional to the incident illumination which is fed to the input of an op amp connected as a current amplifier. The output is thus the equivalent photocurrent developed across a 2Mohm resistor.

Two comparators are used to compare the output voltage with a fixed reference set by a potential divider chain. Comparator 2 is set at nominally 1V and Comparator 1 at 1.1V.

The amplifier output is fed via R3 to the inverting input of comparator 2. When the output is below 1V, the output of comparator 2 is positive which enables the current in R7 to turn on Q1, lighting lamp 1 indicating "Too Low". When the output of the amplifier is above 1.1V the output of comparator C1 will be positive, enabling current in R8 to turn on Q2 and lighting lamp L2 indicating "Too High". If the amplifier output is between the two thresholds, both comparator outputs will be low, both lamps will be off, and the current in R9 will be enabled to Q3 and L3 will light giving the green indication "Correct".

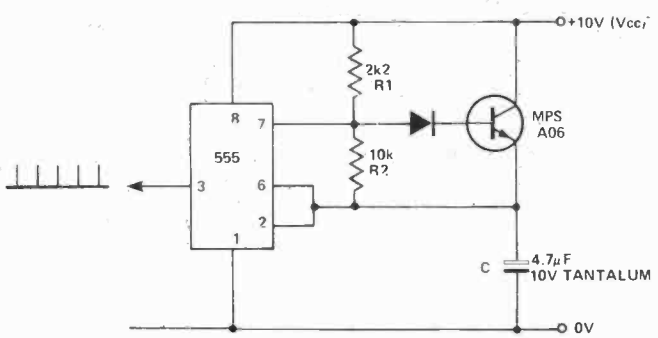
Changing the values of R1 and R2 alters the basic sensitivity of the system, C1 and C2 provide decoupling of noise pick up for remote direction or small content of AC lighting and R3,C3, and C4 minimise instability in the comparators as they pass through their linear region.

Values in the diagram shown give an acceptance band of 10%. Reducing the value of R4 to 50ohms reduces the pass band to 5%. For closer bands, higher gain comparators may be used (eg. μA734 or LM311), but light levels closer than this are rarely necessary.

NEEDLE PULSE GENERATOR

This circuit generates very short positive pulses at long time intervals – useful for strobing sample-and-hold circuits etc.

In the discharge part of the cycle, capacitor C discharges slowly through R2, as reset pin falls below 1/3 Vcc, the bistable (internal) switches, and the short between pin 7 and earth is removed. The transistor is then turned hard on by current flowing through R1, and C charges very rapidly – when the voltage across it exceeds 2/3 Vcc the 555 switches again, and the discharge cycle begins again.



The "charge" portion of the cycle is very short, about 120μS, while the discharge time depends entirely on the value of R2. For example, with R2=2M2, a 120μS pulse is produced about every 10 seconds; a mark/space ratio of 100,000 to one!

Tech-Tips is an ideas forum and is not aimed at the beginner. We regret we cannot answer queries on these items.

ETI is prepared to consider circuits or ideas submitted by readers for this page. All items used will be paid for. Drawings should be as clear as possible and the text should preferably be typed. Circuits must not be subject to copyright. Items for consideration should be sent to ETI TECH-TIPS, Electronics Today International, 36 Ebury Street, London SW1W 0LW.

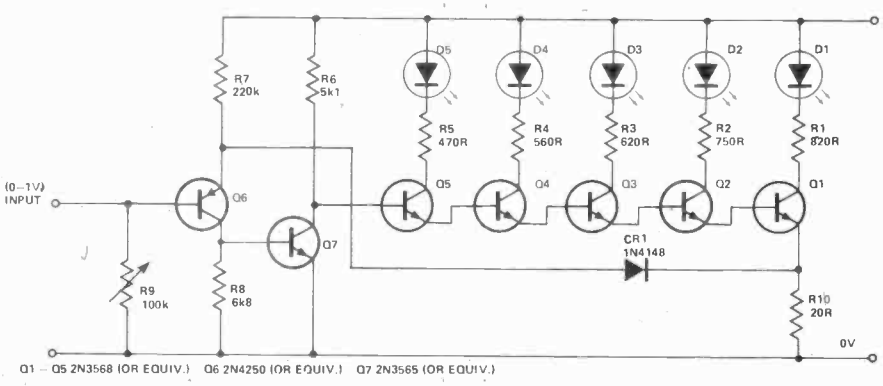
BARGRAPH DISPLAY

A bargraph display is a useful medium for seeing a monitored variable. Where low resolution (5 to 10 segments) is sufficient the display can be built with LED's and a few transistors.

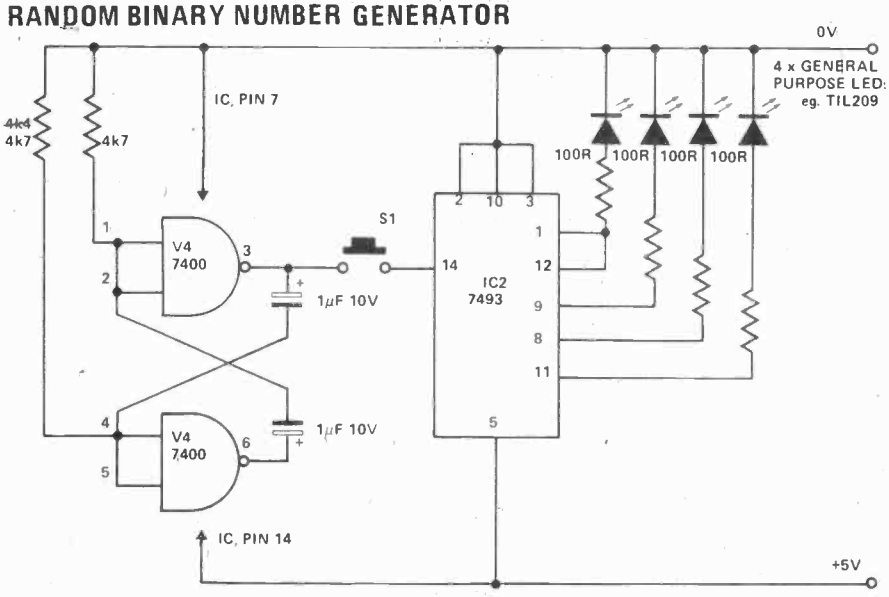
With the 5 segment system shown, transistors Q1 to Q5 saturate successively as the input signal increases from zero. The resulting currents drive LEDs D1 to D5. As each transistor turns on, its emitter current flows through R10. Transistors Q6 and Q7 as well as CR1 and associated resistors, comprise a feedback amplifier that forces the voltage across R10 to equal the inputs voltage. This causes the display to 'deflect' linearly.

For R10 = 20R and a current of 10mA per LED, the resolution is 200mV and the full scale input equals 1V (for five LED's). Diode CR1 cancels the V_{BE} offset of Q6. Resistors R1 through R5 control the LED currents. The voltage across R3 for example is 10V minus 1.5V (two transistors $V_{BE's}$) minus 0.6V (30mA – R10). Since V_{CE} (SAT) of Q3 is negligable at 10mA, 6.4V must be dropped.

i.e. $R3 = \frac{6.4V}{.010A} = 640R$. 620R being the nearest standard value.



RANDOM BINARY NUMBER GENERATOR



The circuit shown is a random indicator or providing an output from one of 16 states.

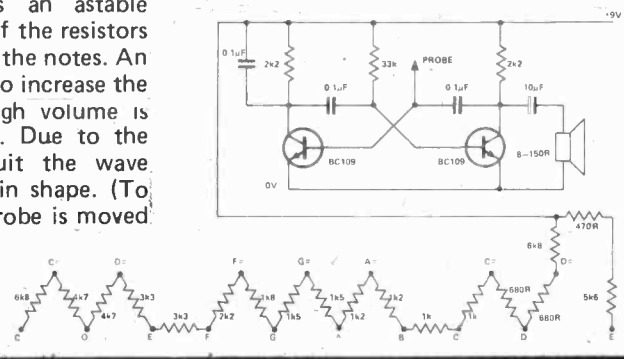
It consists of a BCD counter driven by a multivibrator. As the multivibrator's frequency is relatively high, one can say that the output from the counter, IC2, is random.

IC2 has a fan-out capability of 10 normal TTL loads and so can operate the LED displays directly. The four 100 ohm resistors are used to limit the current through the LEDs and so prevent them and IC2 from being damaged.

The unit is operated by depressing S1, which will cause the LEDs to flash, and when S1 is subsequently released the last number held in the counter will be displayed in BCD (Binary Coded Decimal) form.

SIMPLE ORGAN

The tone generator is an astable multivibrator with one of the resistors being variable to change the notes. An amplifier could be used to increase the volume, but quite a high volume is attained by the astable. Due to the simplicity of the circuit the wave form is rather irregular in shape. (To produce the note, the probe is moved across metal strips wired to points A, B, C etc.)



STENCIL FOR PCB's

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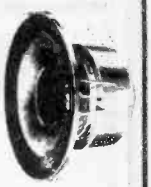

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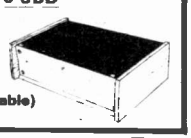

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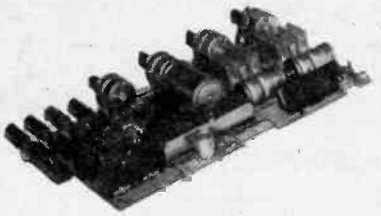

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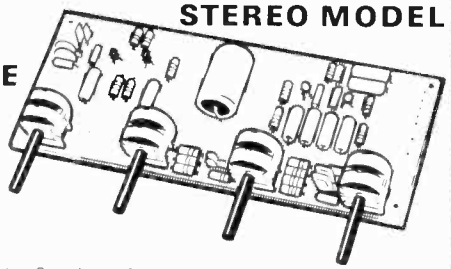

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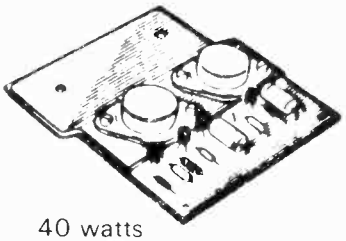

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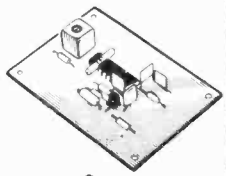

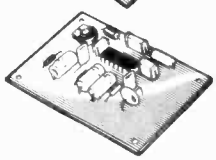

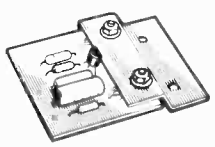

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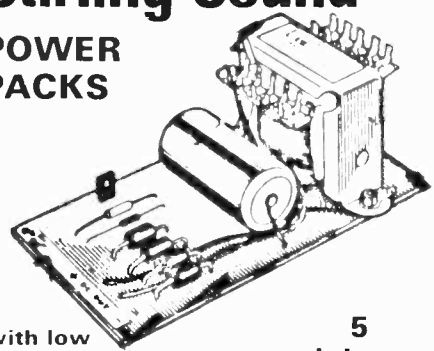

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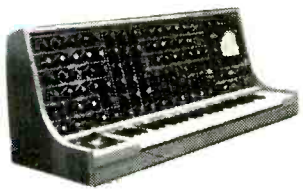

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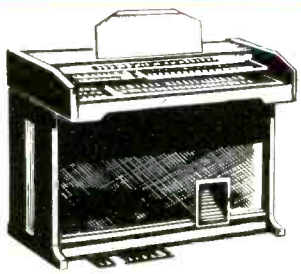

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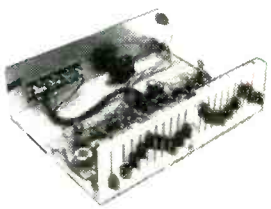

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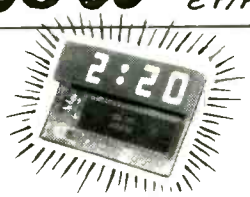

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