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NZ $1.15

electronics TODAY INTERNATIONAL

CONCRETE LOUDSPEAKERS

HOW TO BUILD ANTENNAS

SOUND/LIGHT FLASH

Registered for posting as a periodical — Category C

SPECIAL OFFERS! Diodes - 50 for $1·00
741s - 4 for $2·00
(plus postage)

A turntable with features you'd expect only on a more expensive unit

One feature you'll notice is the price; in fact we believe it to be 'the best buy' turntable available today.

With features only expected on more expensive units, such as wow and flutter of 0.5 WRMS thanks to the DC motor with FG (frequency generator) servo-controlled circuits.

How's this for a list of features. Practical, purposeful features like

- ☐ illuminated stroboscope
- ☐ elliptical stylus
- ☐ completely automatic tone arm return
- ☐ viscous-damped cueing lever
- ☐ anti-skating dial scale control
- ☐ CD4 ready
- ☐ audio insulated legs

and the list just goes on.

Any way you want to look at it, you'll agree the Technics SL23 is a sound buy, with appearance and performance to match.

WARRANTY AND SERVICE BY HACO

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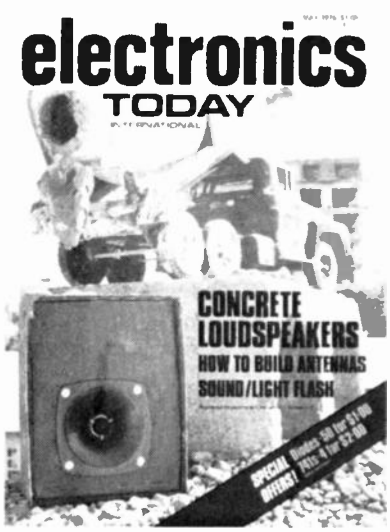
electronics TODAY INTERNATIONAL

MAY 1976, VOL. 6 No. 5

A MODERN MAGAZINES PUBLICATION

Editorial Director Collyn Rivers
Assistant Editor Steve Braidwood



COVER: Loudspeaker colouration is often caused by panel resonances — new speakers from GHE use a concrete/polystyrene ball mix to stiffen enclosure panels — full review page 31 onwards.

*Recommended retail price only

PROJECTS

FEATURES

DATA SHEETS

NEWS & INFORMATION

For optimum performance we recommend BASF tapes.

Its rewards might be in another place and time, but yours are here and now.

The GX600D tape deck illustrated above is one of our top models. It retails around $770. That's a lot. But the GX600D is a lot of tape deck. It's totally professional in every function. Recording, dubbing, mixing, playback.

Yet the controls are beautifully simple. After all, we want to give you good times. Not hard times.

It comes, like all AKAI hi-fi equipment distributed by AKAI Australia, with our Complete Protection Plan*. Which simply means 12 months full parts and labour warranty on all Tape Equipment, 2 years full parts and labour warranty on all Amplifiers, Turntables and Speakers and a lifetime warranty on all GX Tape Heads.

If you're still thinking about the price, think about this: sure, we could have compromised and saved a hundred. But we can't see any future in that.

The AKAI Hi-Fi Professionals are **NEW SOUTH WALES — SYDNEY CITY AND METROPOLITAN. Sydney**: Douglas Hi-Fi, 338 George Street; Duty Free Travellers Supplies, 400 Kent Street; European Electronics, 187 Clarence Street; Instrol Hi Fi, Cnr. Pitt & King Streets; Magnetic Sound Industries, 32 York Street, Jack Stein Audio, 275 Clarence Street. **Bankstown**: Selsound Hi Fi, Cnr. North Terrace & Apian Way. **Burwood**: Electronic Enterprises, 11 Burwood Road; Edge Electrix, 31 Burwood Road. **Concord**: Sonarta Music Services, 24 Cabarita Road. **Cremorne**: Photo Art & Sound, 287 Military Road. **Crows Nest**: Allied Hi Fi, 330 Pacific Highway. **Hurstville**: Hi Fi House, 127 Forest Road. **Liverpool**: Miranda Stereo & Hi Fi Centre, 166 Macquarie Street. **Miranda Fair**: Miranda Hi Fi & Stereo Centre, Shop 67, Top Level. **Mona Vale**: Warringah Hi Fi, Shop 5, Mona Vale Court. **Parramatta**: Gramophone Shop, Shop 151, Westfield Shoppingtown, Selsound Hi Fi, 27 Darcey Street. **Roselands**: Roselands Hi Fi, Gallery Level. **South Hurstville**: Selsound Hi Fi, 803 King George's Road. **Summer Hill**: Fidela Sound Centre, 93B Liverpool Street. **Sutherland**: Sutherland Hi Fi, 5 Boyle Street. **Waitara**: Hornsby Hi Fi, 71 Pacific Highway. **Westleigh**: Sound Incorporated, 16 Westleigh Shopping Centre. **NEW SOUTH WALES COUNTRY. Albury**: Haberecht's Radio & TV, 610 Dean Street. **Bega**: Easdowns, 187-191 Carp Street. **Bowral**: Fred Hayes, 293 Bong Bong Street. **Broken Hill**: Pee Jay Sound Centre, 364 Argent Street. **Gosford**: Gosford Hi Fi, 163 Mann Street; Miranda Stereo & Hi Fi Centre, Cnr. Donnison & Baker Streets. **Moss Vale**: Bourne's Merchandising, 1 White Street. **Newcastle**: Ron Chapman Hi Fi, 880 Hunter Street, Eastern Hi Fi, 519 Hunter Street. **Nowra**: Nowra Hi Fi, Shoalhaven Arcade. **Taree**: Taree Photographics, Graphic House, 105 Victoria Street. **Wagga Wagga**: Haberecht's Radio & TV, 128 Baylis Street. **Wollongong**: Hi Fi House, 268 Keira Street; Selsound Hi Fi, 2-6 Crown Lane. **A.C.T. Civic**: Allied Hi Fi, 122 Bunda Street. **Fyshwick**: Allied Hi Fi, 3 Paragon Mall, Gladstone Street. **QUEENSLAND. Brisbane**: Chandler's, 120 Edward Street; Chandler's, 399 Montague Road, West End; Stereo Supplies, 95 Turbot Street, Tel Air Electronics, 187 George Street. **Nambour**: Custom Sound, Currie Street. **Mt. Isa**: The Sound Centre, West Street. **Rockhampton**: Chandler's, 144 Alma Street. **Southport**: Stokes Electronics, Scarborough Street. **SOUTH AUSTRALIA. Adelaide**: Ernsmiths, 48-50 King William Street; Flinders Trading Co., 55 Flinders Street; J B Electronics, 115 Gouger Street. **Blackwood**: Blackwood Sound Centre, 4 Coromandel Parade. **Glenside**: Steiner Electronics, Conygham Street. **Moana**: Bob Carmen, 185 Commercial Road. **VICTORIA. Melbourne**: Douglas Hi Fi, 191 Bourke Street; **Warrnambool**: A. G. Smith, 159 Liebig Street. **WESTERN AUSTRALIA. Perth**: The Audio Centre, 883 Wellington Street. **Calista**: Hub Hi Fi, Kwinana Hub, Gilmore Avenue. **East Victoria Park**: Japan Hi Fi, 889 Albany Highway. **Nedlands**: Audio Distributors, Broadway Shopping Centre, Broadway. **Midland**: Midland Audio, 16B Great Northern Highway. **Mosman Park**: Audio Distributors, 14 Glyde Street. **W.A. COUNTRY. Bunbury**: Aabel Music, 130 Victoria Street. **Kalgoorlie**: Hambley's Hi Fi, Shop 13, Central Arcade, Hannan Street. **TASMANIA. Burnie**: James Loughran & Sons, 29-31 Wilmot Street. **Hobart**: Quantum Electronics, 181 Collins Street. **Launceston**: Wills & Co., 7 Quadrant. **NORTHERN TERRITORY. Darwin**: Pfitzners Music House, Smith Street.

AKAI

The name you don't have to justify to your friends.

*The Complete Protection Plan does not cover equipment purchased outside Australia

70621

news digest

KODAK – INSTANT CAMERAS

NEW easy-to-use instant cameras and a film for self-developing colour prints based on reversal colour imaging techniques were announced on April 20th by Eastman Kodak Company at press conferences in New York and Toronto.

The new Kodak cameras produce instant prints with a high degree of colour fidelity, according to Walter A. Fallon, company president. Development of the instant prints, which are litter-free, takes place outside the camera in daylight or room light. An image begins to appear in a minute or two and development is essentially complete in about eight minutes.

The colour quality of the instant prints is a result of fundamental breakthrough in imaging chemistry, Fallon said. Kodak instant print film is exposed through the back of the film, and during development imaging dyes are released for direct migration to the front or viewing surface, producing images with a high degree of colour fidelity.

The new instant cameras start at a list price of US$53.50. They will be available in early May to the Canadian market and shipped to U.S. dealers in late June.

Kodak instant print film offers excellent colour reproduction within a rectangular format producing an image size of 66 mm x 90 mm inches. Each picture unit is encased in a tough plastic sandwich consisting of 19 layers, with most measuring only a few micrometres in thickness. A Kodak instant print film pack containing 10 picture units has a list price of $7.45 (in U.S.A.).

The two new cameras share three-element, 137 mm, f/11, plastic lenses which have antireflection coatings to reduce lens flare and improve colour saturation. Both cameras have an electronic shutter with speeds from 1/300 to 1/20 second and two apertures, f/16 and f/11, which are controlled by an IC containing a silicon photosensor. Both daylight and flash exposure are under its command.

A red low-light signal appears in the viewfinder of both cameras when the light level is too low for exposure at f/11 and 1/20 second. A print (Lighten/Darken) control permits manual exposure override up to plus or minus one f/stop.

A spokesman for Kodak in Australia said that a date had not yet been fixed for the introduction of Kodak instant cameras to the Australian market.

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.

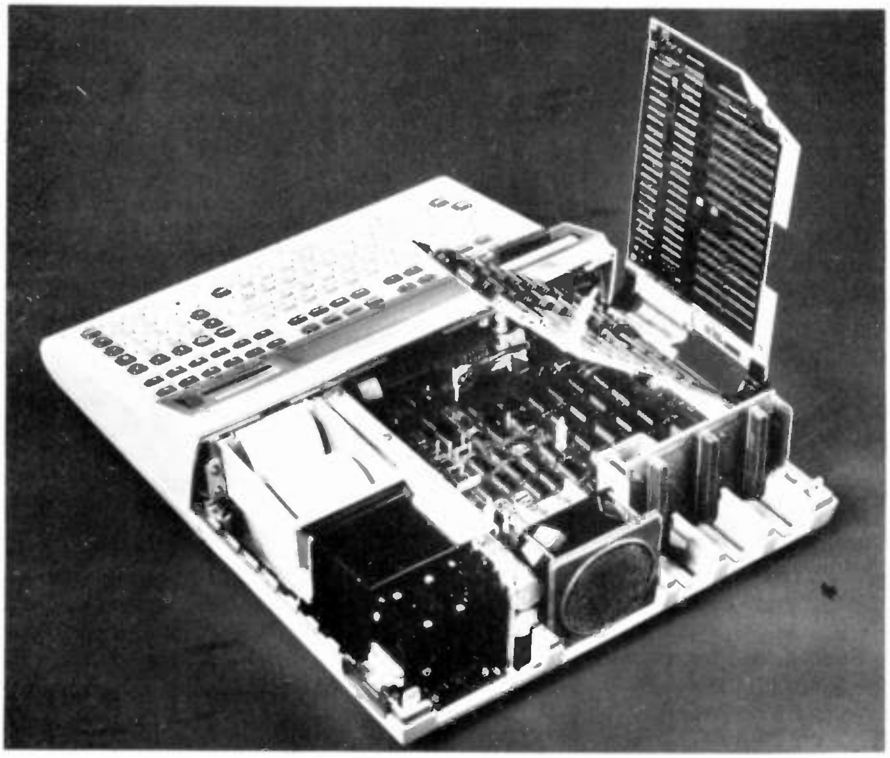
The technology was independantly and simultaneously developed by two Philips researchers in Eindhoven and by two IBM researchers in Germany!

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 dimentions 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.

news digest



NEW HP PROGRAMMABLE

A powerful desktop programmable calculator with many features previously found only on minicomputers has been introduced by Hewlett-Packard. The new HP 9825A calculator, priced at under $5800 (duty and Sales tax additional if applicable) is designed primarily for use in the fields of engineering, research and statistics.

The major benefits of 9825 are: two-level priority interrupt, live keyboard, direct memory access with input speeds up to 400 000 16-bit words per second, high-performance bidirectional tape drive, multidimensional arrays, automatic memory record and load, extended internal calculation range ($\pm 10^{511}$ to $\pm 10^{-511}$), and optional plug-in ROMs.

The 9825 uses a high-level programming language called HPL. This formula-oriented language handles subroutine nesting and flags, and allows 26 simple variables and 26 multidimensional array variables.

With the live keyboard, never before found on a desktop calculator, the user can examine and change program variables, perform complex calculations, call subroutines, and record and list programs while the calculator is performing other operations.

The 9825's new 32-character LED display and built-in 16-character thermal printer provide upper and lower case alphanumeric read-out. The display and printer provide the full ASCII character set.

While a long program is running, an operator can stop it, record the entire memory onto the cartridge, run another program and then reload and continue the first program from the point of interruption.

With 90 ips search and rewind speed and a 22 ips read/write speed, the 9825's built-in tape cartridge drive gives an average access time of six seconds. It provides automatic verification during recording. In addition, the calculator always knows the location of the tape, so it saves time by being able to search at high speed in either direction for the next file.

The 9825 comes with 8K bytes of internal read/write memory, which is expandable in optional 8K increments to a total of 32K bytes. Four plug-in slots in the front of the calculator provide space for optional ROMs.

Hewlett Packard Australia Pty Ltd, 31 41 Joseph St., Blackburn, Victoria 3130.

MEMORY TUBE

A memory tube developed by Sony is expected to provide a better price-performance index than disc or semiconductor memories. The tube is based on the vidicon but the photoconductive target is replaced by a glass target with a metal pattern. The pattern consists of alternating glass and chromium dots or stripes (5 μm wide). The signal electrode is 1 μm above the memory surface.

The information is stored as electrical charges on the dielectric of the memory surface. Erasure speed is slow, 2 or 3 TV frames.

Dick has been let down. He ordered two hundred boxes for a miniature power supply and to his surprise the boxes arrived in two truck loads instead

of a small carton. Anyone who can modify his design — a 100 A supply, or perhaps a bath tub — had better not be too hopeful about getting a happy response from Dick. It appears his favorite employee, his new computer, is responsible for letting him down. Instead of ordering in millimeters the electronic genius quoted inches!

MAKING USE OF THE INTERVAL

Following the use of digitally-encoded information transmitted on spare lines of the TV signal in the UK (Ceefax and Oracle) the Public Broadcasting Service in the US has filed a petition to the FCC, and they have responded with a proposal, that a part of the vertical blanking interval be used for transmitting captions to aid the deaf. The PBS experiments have used line 21. The FCC are now awaiting comments.

The FCC has just eliminated a rule permitting the use of a system for identifying TV programmes by placing patterns in the corners of the picture. The International Digisonics Corp developed the system to give advertisers positive proof that the programmes were transmitted. The FCC found that the system was unable to consistently keep the patterns out of view on a normally adjusted receiver.

AWA MAKE FIRST FLIGHT TRAINERS

Production of the first flight trainers to be commercially manufactured in Australia will begin in Sydney later this year. The trainers, GAT-1 models for training light aircraft pilots, will be built by Amalgamated Wireless (Australasia) Limited at their North Ryde plant. The GAT-1 was developed from the well known Link trainer.

AWA claim the GAT-1 simulates almost everything possible to experience in a light single engine aircraft. Trainees working the controls feel the actual motion of climbing, diving, turning and banking, pitch roll, and yaw. Sound simulation and external environmental effects, such as wind and rough air add to the effect of realism.

The advanced analogue-digital computer, which is the heart of the GAT-1, enables it to perform realistically in response, not only to all pilot controls, but also to atmospheric, aerodynamic, and ground effects introduced by the instructor.

147.91585 THz

That's the highest directly measureable frequency and the American National Bureau of Standards claim an error of one part in ten million. At these frequencies that is plus-or-minus 14.7 MHz! Soon the laboratory expects to extend measurability to visible frequencies. The infra-red measurement was made by measuring the beat frequency between the unknown radiation and a standard synthesised frequency.

ELECTRONIC CHESS SET

Mostek have demonstrated a breadboard form of an electronic chess player they plan to launch in the US this June. The game looks like a calculator but instead of a keyboard there is a small chessboard. Beneath the board there are keys labelled 1 to 8, and in the shift mode a to h, so that moves can be entered. The machine replies to the player's move by displaying its move on LED 7-segment displays using 1 to 8 and a to h to locate the squares the piece is required to move from and to.

Mostek are second-sourcing the brains of the machine: a Fairchild F8 microprocessor. The company planning to sell the machine is Cardinal Industries Inc. of New York.

AN EYE FOR ENERGY

Football-sized plastic eyeballs that move to keep looking at the sun and convert the light directly into electricity are being developed by a British research establishment. Standard Telecommunications Laboratories are working on what researchers refer to as "solar eyeballs", which automatically follow the movement of the sun by new self-contained magnetic drive.

Each one of the eyes can give up to one volt, but greater output is possible by using several units. To allow them to move freely, the eyeballs are floated in a water tank.

As the sun moves, light tends to wander off the solar cell, which is surrounded by four gas reservoirs rather like four large petals. When the sunlight touches any one of these the gas inside expands and moves a small magnet inside the eyeball. This reacts with an outside field and the unit is 'nudged', aligning it with the sun again.

STL researchers emphasise that the device is still under development and cannot forecast when it could be offered for sale. However, it is tentatively predicted that for a peak output of one kilowatt cost would be about $800.

LF TUNING FORK

A miniature LF tuning fork for use with integrated circuit systems covers the 150-1000 Hz range and can be employed as a precision AF oscillator, frequency or time standard and tuning unit.

The P1110 is a robust assembly utilising an alloy steel fork mounted together with transducers and silicon semi-conductor circuits. Its range extends to 4 kHz. The devices can be calibrated to any frequency within the range.

Typical overall accuracy is said to be better than 0.1 per cent and adjustment accuracy ± 0.01 per cent. It is suitable for IC systems on account of its size, 75 x 40 x 20 mm and 5 V operation.

Manufactured by Andretta Ltd, Wellington, Somerset. Australian Agent: Straintech P/L, 161 Galston Road, Hornsby Heights, NSW 2077.

Continued on page 10

DESOLDERING

FAST SAFE EASY with **Soder-Wick**

1. Hold Soder-Wick on termination with hot soldering tip. Wicking action soaks up solder.

2. Remove tip and braid. Termination is left clean and free of solder.

Soder-Wick is a specially treated copper braid which soaks up molten solder like a sponge. Desolders a P.C. pad in a second or so: acts as a heat sink to protect circuits and components.

In a range of sizes from your wholesaler or

02-709 5293
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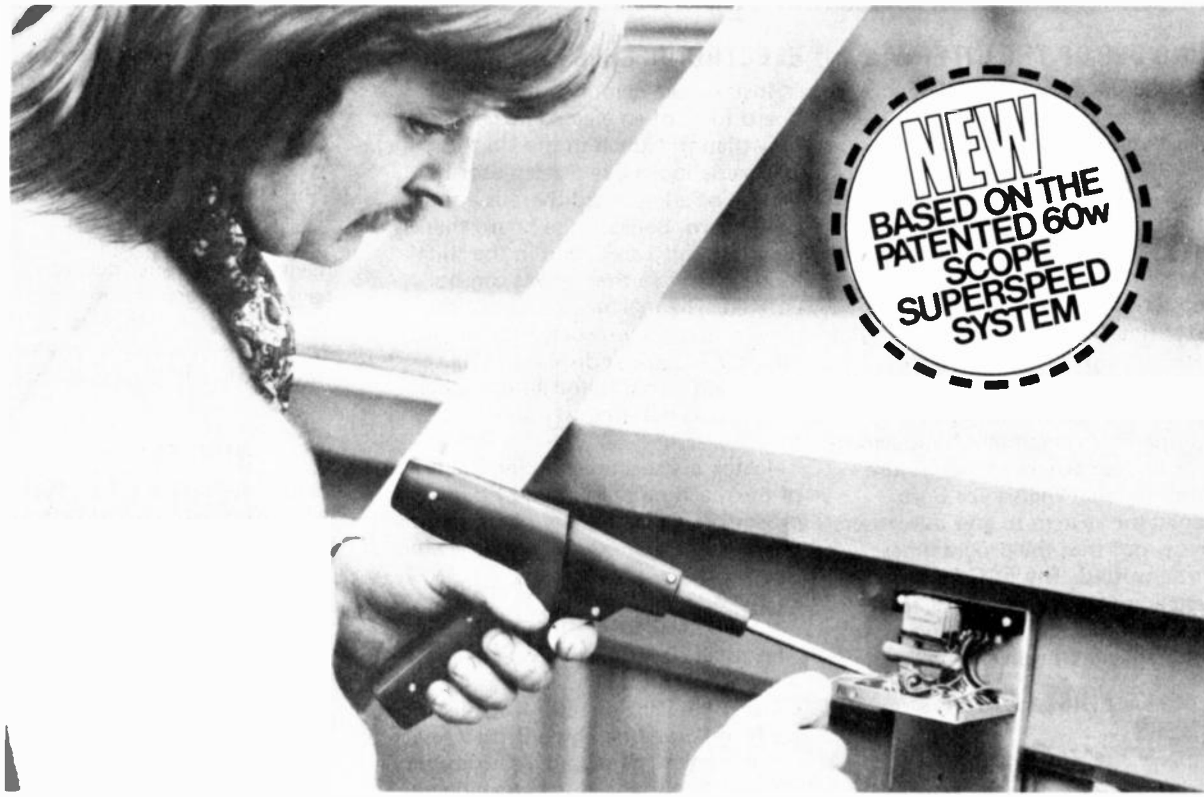
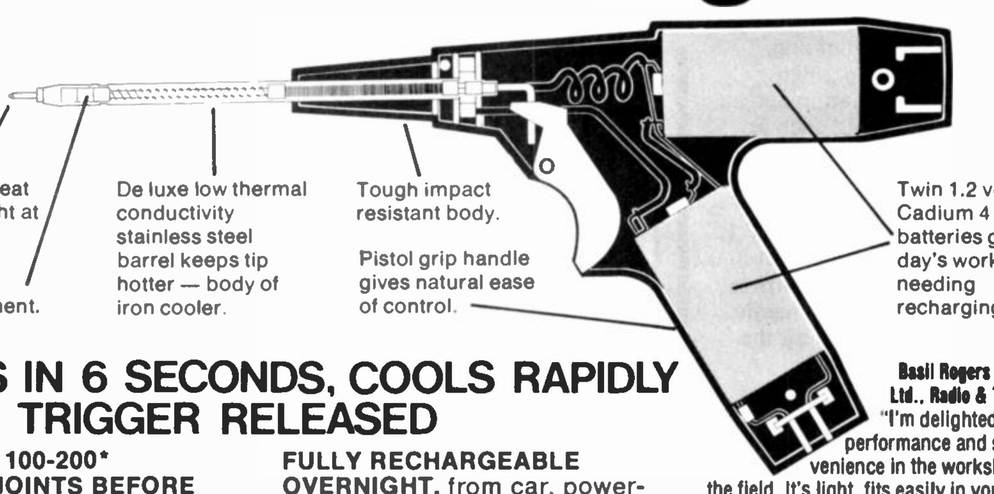
ROYSTON ELECTRONICS

RE475



Scope Cordless 60w Soldering Tool



HEATS IN 6 SECONDS, COOLS RAPIDLY WHEN TRIGGER RELEASED

SOLDERS 100-200* TYPICAL JOINTS BEFORE RECHARGING
*Light electrical connections. Capacity will vary for lighter or heavier joints.

PISTOL GRIP DESIGN balances weight of cells for comfort and tip control.

FULLY RECHARGEABLE OVERNIGHT, from car, power-point or Scope Transformer.

ABSOLUTE SAFETY
No earth leakage currents. Solder anywhere with total personal and component protection.

Basil Rogers & Co. Pty. Ltd., Radio & T.V. Repairs.
"I'm delighted with its performance and sheer convenience in the workshop or in the field. It's light, fits easily in your hand and you can solder even with the set on."

Kevin Ball, T.V. Technician.
"In my job I work mainly on circuit boards and I'm rapt with Scope Cordless. I've never reached a point where the gun can't handle a day's soldering. I like the feel of it; tremendous balance."

SCOPE

Distributors to the Electrical Trade:
NATRONICS PTY. LTD. The Crescent, Kingsgrove, N.S.W. 2208

Manufactured by: SCOPE LABORATORIES, MELBOURNE.

Ever wondered how a recording studio copes with the pressure level extremes between an orchestral fortissimo and the gentle whisper of an alto flute? They don't! A piece of equipment called a Peak Limiter generally does it for them, simply and efficiently, by flattening out the entire dynamic range being fed into it. Which results in a flattened out sort of sound. Listeners can usually sense the dynamic range deficiency, even though they may not be consciously aware of just what has happened. There are other forms of dynamic range control which include manual "Gain Riding" and compression. The magnetic tape itself also tends to round off the signal peaks, thereby acting as its own limiter by restricting high level peak signal excursions. The end result of these forms of dynamic range "tampering" is that, whilst the basic sounds produced by the orchestra are recorded on tape above the noise level and without severe distortion, the sounds are displaced from their original dynamic relationship. Crescendos and loudness variations containing vital musical information have been reduced in scale, compromising the presence and excitement of the performance. Same thing applies to pop-music and rock, for whilst generally requiring a narrower dynamic range, the actual sound levels at rock performances frequently exceed 115 db due to the use of amplified instruments. This, plus the wide-spread use of 16 or more tracks of tape in recording, contribute dynamic range problems just as great as those experienced in recording classical music. Now whilst no recorded performance can fully duplicate all the sensory impressions received at a concert hall or rock festival, dbx does restore a substantial portion of the dynamic range which has been sacrificed during the recording process. And, at the same time, reduces the noise level quite significantly.

The difference in playback of most recorded material is quite dramatic. Presence is increased, and the excitement and intense realism of a live performance is startlingly restored.

Sound Un-Limited

Ask your dealer to give you a listening test of either the 117 or 119, and judge for yourself. You can't help but be impressed.

dbx 117 = For use in home music playback systems.

dbx 119 = Features extended compression range for tape enthusiasts and for semi-professional studio use.

For brochures and the name of your nearest dbxpert write to

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PO Box 604
BROOKVALE 2100
Phone 939 1900

dbx

117 & 119

dynamic range enhancers

AUM11.25.19cm

news digest

CROSSOVER NETWORKS

Zephyr Products have introduced a loudspeaker crossover network design and manufacture service. In the past it has been difficult to obtain specific crossover requirements — the only alternatives have been to either compromise to some commercially available unit or "do it yourself".

The company are now offering a standard high quality unit with pushbutton selection of separate left land right channel crossover frequencies of 150, 400, 750 or 1000 Hz bass to mid at 18 dB/octave and 3500, 5000, 7500 or 10 000 Hz mid to high frequencies at 12 dB/octave. Separate regulation is provided for left and right channel mid range and high frequency.

The standard unit is housed in a high quality brushed aluminium box with leatherette top and rubber feet. Alternatively a wooden housing can be supplied to order.

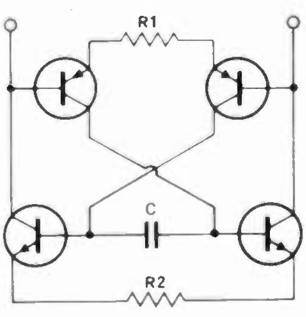
Enquiries to Zephyr Products, 70 Batesford Rd, Chadstone, Vic 3148.

NASA

MARTIAN ART

This Viking emblem is painted on the two spacecraft due to reach Mars this summer. It was the winning entry in a competition sponsored by NASA in co-operation with the National Science Teachers Association. The artist is 17 year old Peter Purol of Baltimore.

IC REPLACES FILTER INDUCTANCES



$L = R_1 \times R_2 \times C$ henries.

Simplified circuit of gyrator.

Philips TCA580 monolithic integrated gyrator circuit is a 16-pin DIL IC which uses two external resistors and one capacitor to simulate inductance up to 10^6 henries. The gyrator can be used in audio frequency applications up to 10 kHz.

The tolerance on the inductance value obtained is ± 0.2%, the behaviour of the inductance being determined almost entirely by the external components. Low losses, smaller size and weight, easy handling, and insensitivity to magnetic interference are the advantages of using the TCA580 instead of coils. When used in resonant circuits where high selectivity is required, a quality factor from 500 to 5000 can be obtained (even with large coils, a quality factor of 2000 is almost impossible to achieve).

MICRO MAGAZINE

Microtrek is a magazine newly launched in the US to serve microcomputer enthusiasts. It reviews kits, gives practical advice on hardware and software, and puts the readers in touch with computer clubs. A year's subscription costs US$8.95 plus US$2 postage. The publishers warn it could be 8 weeks before you get your first issue. Schneider Publications, Inc., Dows Building, Cedar Rapids, Iowa 52401, USA.

Continued on page 13

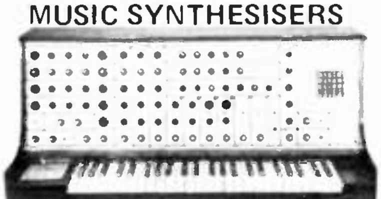
ETI by jaycar PTY LTD.

PROFESSIONAL SOUND EQUIPMENT FOR THEATRE AND ROCK BANDS

AUDIO EXPANDER COMPRESSOR

Complete Kits Now Available at $80.00.

ETI 3600 and 4600 MUSIC SYNTHESISERS



STAGE MIXER

414 MASTER MIXER

For audio engineers we have a wide range of electronic components at wholesale prices, cannon plugs and sockets, microphone cable etc., also available:— electronic crossovers 100 watt power slaves

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MAY MADNESS AT hi-fi-house

Monarch System

Turntable T700A — Monarch semi-automatic, belt-driven, 2 speed auto-return. Wow and flutter 0.1% (WRMS). Motor — one 4 pole synchronous.
Amplifier 88 — 24 watts AMS. Frequency response — 20-40,000 Hz ±1 dB. Harmonic distortion — less than 0.4%.
Loudspeakers — 3 way 12" woofer, Philips tweeter and clear midrange.
Why not add a tuner now that FM is here — Monarch 88X AM/FM tuner, same dimensions as amplifier. **Special price $139.00.**

Retail value — $623.00

SUPER PRICE $498.00

Atron System

Turntable — BSR 128 automatic.
Amplifier — KA-2015 — Power output 15 watts per channel. Frequency response — 25-35,000 Hz. Total harmonic distortion — 0.1% at rated output. Can handle four sets of speakers.
Loudspeakers — Novik 2-way speakers.

Why not add a tuner now that FM is here — the AM/FM Atron KT1000 — **Special price $135.00**

Retail value — $379.00

SUPER PRICE $295.00

Kenwood System

Four channel matrix SQ discreet with a full 36 watt RMS power output. Includes four speakers. Fully automatic turntable with separate motor to operate arm.

Retail value $795.00

SUPER PRICE $545.00

SPECIAL INTRODUCTORY GIVE-AWAY OFFER FOR MAY ONLY!

This handsome tool kit is yours if any one of the above systems is purchased (valued at $28.00).

hi-fi-house

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Hurstville, NSW
Phone 579-4673

268 Keira Street,
Wollongong, NSW
Phone 28-6661

Roll over, chromium!

Extracts from an address by Mr. E. Nakamichi, President Nakamichi Research Inc. at a recent Seminar in Sydney for Nakamichi dealers.

"TDK Super Avilyn Cassettes are recommended for use with all Nakamichi tape decks. Before leaving our factory, all Nakamichi equipment has bias voltages set for TDK SA to achieve optimum performance".

"Chromium Dioxide tape is not recommended for use with any Nakamichi tape decks."

"The wear on recording heads is significantly reduced by using TDK Super Avilyn as compared with any Chromium Dioxide tape."

From the report by Louis A. Challis & Associates Pty Ltd. Consulting Acoustical & Vibration Engineers, NATA laboratory.

"TDK Super Avilyn Tape looks like being one of the most important advances in tape formulations in the mid-seventies."

TDK SA breakthrough in tape technology

Super Avilyn's performance exceeds that of Chromium Dioxide formulation which previously was the best choice for linear high frequency response and high-end S/N, but Cr02 suffered from reduced output in the middle and low frequencies (SA provides 1.5-2db more output than the best Cr02 in those ranges, equal output at high frequency).

SA also outperforms the ferric oxide tapes (regular or cobalt energized) which are unable to take full advantage of the noise reduction benefits of the Cr02 equalization because their high end saturation characteristics are not compatible with this standard (they require 1EC 120ms, normal or high EQ).

The net result of SA's characteristics and this EQ difference is a tape with an impressive 4-5db S/N gain over the latest top-ranked high output ferric oxide tapes and more than 10-12 db S/N gain over many so-called low noise ferric oxide tapes.

Ask for TDK SA Cassettes

TDK

Australian Distributor
Convoy International Pty. Ltd.
4 Dowling Street,
Woolloomooloo 2011 358 2088

news digest

MORSE COMPUTER

The Morsetyper BDC generates and stores morse code for radio operators. The memory can store 256 'V' characters or six "Quick Brown Fox . . ." sentences. The output speed is held constant and can be set in the range 5 to 200 wpm. Input typing speed is unimportant. The unit operates from 120/240 V, 50/60 Hz ac. The equipment is on sale in the US for $495 from Computronics.

TV TUBE TESTER

The Arlunya TC46 is a rugged compact CRT tester/reactivator. It has been designed to minimise the application of excess heater voltage and misreading of meter scales.

The TC46 tests CRTs in situ without removing EHT cap. The base box fits the common CRTs in use in Australia and New Zealand, and separate connector leads are available for unusual types. Provision is made to set up the heater voltage from 4 V to 12.6 V with overcurrent protection, with a calibrated 6.3 V position.

The TC46 tests inter-electrode leakage with the tube at operating temperature, using a 300 V dc test voltage between a selected electrode and all others. Emission is measured with the beam current collected at the first anode, avoiding difficult connections to the final anode.

Push-button operation enables fast comparison of the red, green and blue guns. A cathode surface reactivate facility is included to extend the life of tubes that are not exhausted. A short circuit removal facility enables the application of a current pulse which burns out tiny metal shorts that are sometimes present in CRTs after transporting.

The instrument incorporates an insulation test facility via a built-in 100 V dc, 50 Meg ohmmeter which enables many voltage dependent insulation weaknesses to be detected. This is useful for transformer primary to secondary insulation checks, chassis isolation checks, etc. Arlunya Pty Ltd, P.O. Box 113, Balwyn, Victoria, 3103.

BIORHYTHM CALCULATOR

Seen in Hong Kong recently, the Casio Biolator is an electronic calculator with a novel facility: it tells you the level of your biorhythms. A graph above the display shows the three sinewaves of 23, 28 and 33 day periods: the physique, sensitivity and intellect rhythms. Using the BIO and DATE buttons enables you to decide how you feel when you get out of bed each day!

STATIC SWITCH IC

Philips' new IC static switch for ON/OFF switching of triacs and thyristors has adjustable hysteresis to prevent false triggering due to noise. The TDA1024 requires few external components and has low power dissipation.

The IC comprises a stabilized power supply, a zero-crossing detector, a comparator with adjustable hysteresis, and an output stage. The hysteresis effect is independent of operating temperature.

In temperature control applications an external bridge circuit is used containing an NTC resistor. Voltage errors are compared with a reference by a comparator circuit, and the zero-crossing detector times the triac trigger pulses at the mains voltage zeros so that RF suppression is not required.

SCOPE CAMERAS

News of two scope cameras has come in this month, from Hewlett-Packard and Tektronix.

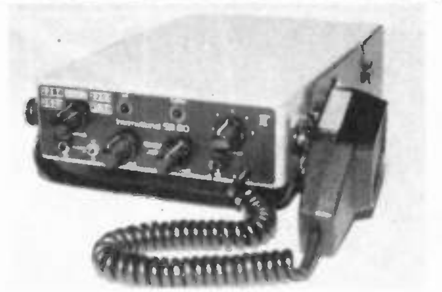
The C5A camera is Tektronix's model; it features fixed focus and fixed aperture (f16). Exposure is controlled by shutter speed (1/5 to 1/25s). Xenon flash enables graticules to be recorded.

A direct interface is provided for 97.6 x 122 mm or 80 x 100 mm screens. Magnification may be selected at 0.67 or 0.85. The camera is powered by two penlight batteries.

The other scope camera is the HP 124A. There is only one control, the trigger. Aperture and shutter speed are fixed. To prevent overexposure one must use the intensity control on the oscilloscope. To get additional exposure the trigger may be pressed several times. There is flash facility for when it is needed to record the graticule.

The price of the HP 124A (without duty) is $233.

Hewlett-Packard are at 31 Joseph St, Blackburn, Victoria 3130. Tektronix are at PO Box 500, Beaverton, Oregon 97077, USA.



NEW SSB TRANSCEIVER

International Transceivers Pty. Ltd., manufacturers of the first marine SSB transceiver in Australia, SB100, have recently developed a new type of SSB transceiver, the SB80. The new transceiver is fully approved by the P.M.G.

Mr. G. Cohen, technical director and designer of the unit believes it to be the first commercial marine application of a SSB speech processing technique, which eliminates expensive crystal filters and IF amplifiers.

The transceiver is a 60-80 watt PEP unit, depending on installation, and has provision for five channels including 1 or 2 duplex.

Features include low battery current, effective noise limiter and squelch control, rugged die cast case with matching cradle and built in aerial tuning unit.

International Transceivers Pty. Ltd., 535 Pittwater Road, Brookvale, NSW 2100.

Continued on page 15

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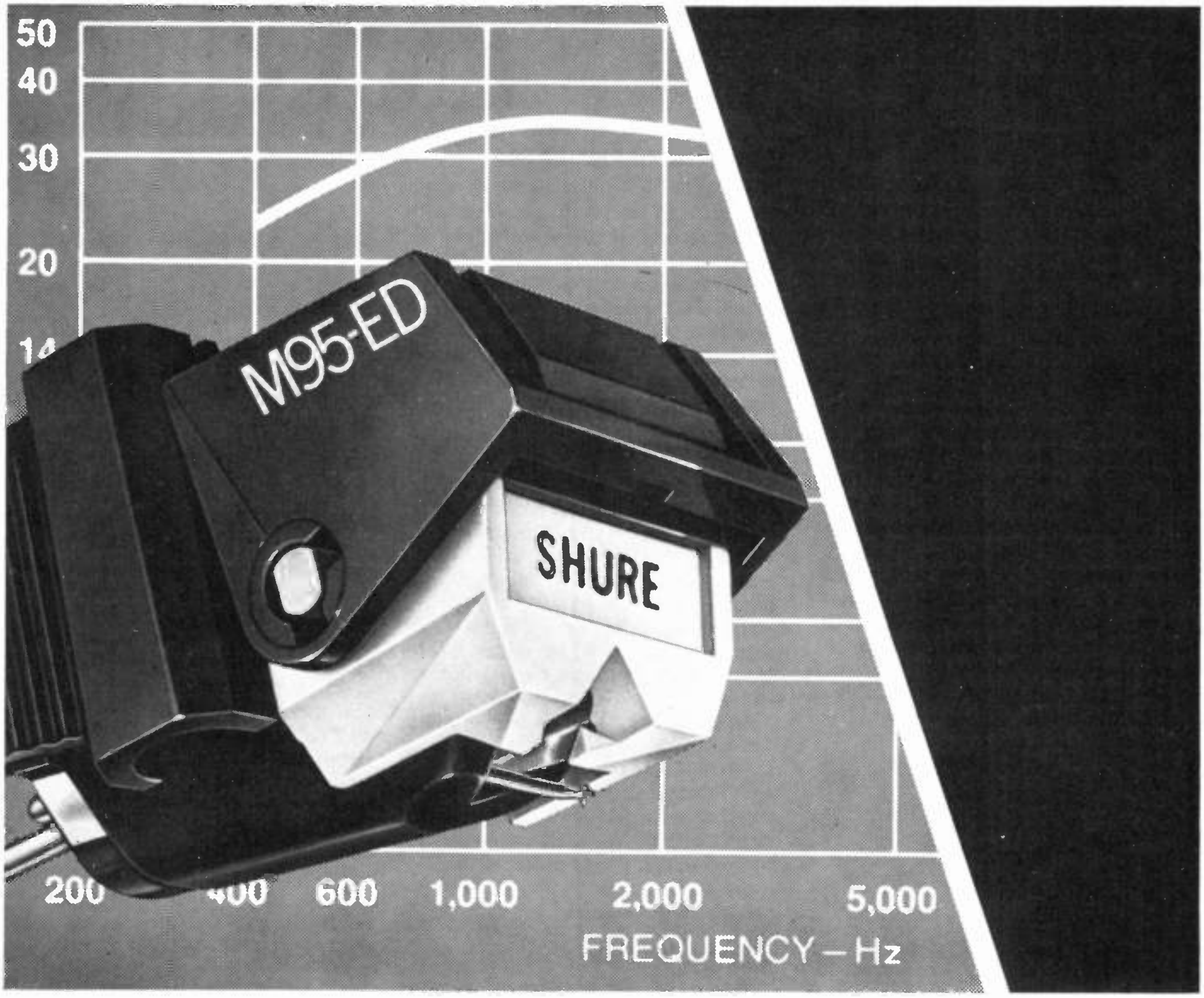
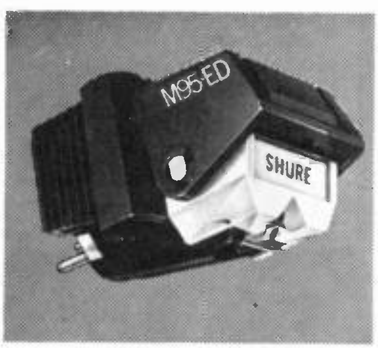


M95ED: A Significant Technological Innovation



Shure now introduces a superb, moderately priced pick-up cartridge with a performance second only to the renowned V-15 Type III. The technologically advanced electromagnetic structure with a newly designed pole-piece virtually eliminates hysteresis loss. The frequency response from 20 to 20,000 Hz remains essentially flat. Operating at extremely light tracking forces of between ¾ and 1½ grams, the exceptional trackability of the M95ED enables it to trace the very high recorded velocities encountered on many modern recordings with the result that in addition to providing faithful reproduction of the recorded sound, stylus and record wear are reduced to minimum proportions. The M95ED: A notable addition to the Shure range with a performance never before available at such a competitive price.

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AUDIO ENGINEERS PTY. LTD.
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CALCULATOR TO WIN!

UNITREX' 901MR ELECTRONIC Sliderule is featured in this month's contest. This unit has been designed to handle nearly all commercial and most arithmetic operations quickly and simply.

Apart from the usual four functions of addition, subtraction, multiplication and division, the unit will also perform square, square root, reciprocal and percentage calculations. Features include full-accumulating memory, floating decimal point, constant and sequential operation etc etc.

Here's how to win one of these units –

An infinite number of one ohm resistors is wired so as to form an infinite mesh – as shown on the right. What is the resistance between points A and B?

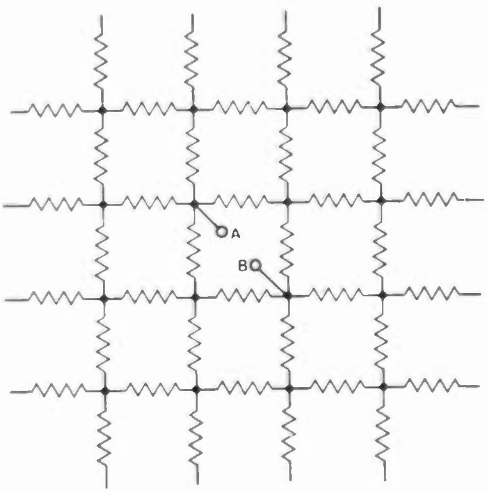
To send in your entry just complete the entry form printed on this page – or if you'd sooner not cut up your ETI just copy the details onto a sheet of paper and send that instead. Make sure to include your name and address.

All answers received before May 25th will be placed in a large barrel. These will be thoroughly mixed and entries drawn one at a time until a correct answer is found. That first correct entry will be the winning one.

The winner's name will be announced in ETI as soon as possible.

The March contest was won by Mr. P. Thompson of Penrith NSW. Entrants were asked to calculate the interest payable on a transaction involving ancient Greek currency.

The correct answer – which was obtained by about 10% of the entrants was 3 talents, 4955 drachmae, 2.875 obols.



Send to:
Calculator Contest (May)
Electronics Today International
15 Boundary St
Rushcutters Bay NSW 2011

Permit No. TC 7578

The resistance is . . . .
Name . . . .
Address . . . .
. . . .
. . . . P/Code . . . . .

news digest

EVENT COUNTER

Non-Linear Systems have a new event counter: the PC-4. It displays a 4½ digit count using 75 mm LEDs. The package is the same as the company's PM series panel meters, 24 x 63.5 x 82.5 mm deep. The counter handles pulses or contacts, and gives out a multiplexed BCD code on four output lines. The maximum count rate can be 200 000 per second. These units can be cascaded to give 8, 12½ or 16½ digits. The meter draws less than 750 mW from a 4½ to 7½ V supply. The retail price is $49. Nonlinear Systems, PO Box 122, Glen Waverley, Vic 3150.

COLOUR TV GUIDE CONTEST WINNER

An HMV colour TV was offered as a prize in a contest run in the first issue of our associated publication –Colour TV Guide.

Winner of this receiver is Mr. John Stanmore of Grafton, NSW. Congratulations Mr. Stanmore! We're sure you'll enjoy this magnificent receiver.

A HI-FI RECORD

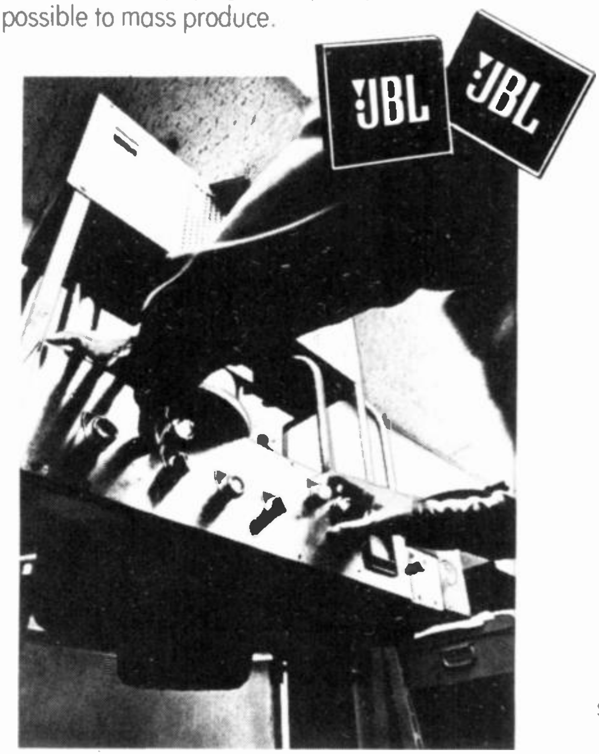
At RAF High Wycombe, Bucks, England a hi-fi record was made recently. SAC Buckley, 31, operated a hi-fi disco continuously for 284.4 hours. Singles or tracks from LPs were played for nearly 12 days! The equipment he used was a pair of Pioneer PL12D turntables, Audio Technica cartridges and headshells, a C-3 amplifier, CS3000A speakers and SE700 headphones.

ERRATA

General purpose power supply, ETI 131, April 1976. Throughout the text mention is made of R14 and R15 as being resistors which determine the maximum regulated voltage. R14 and R15 should read R12 and R13.

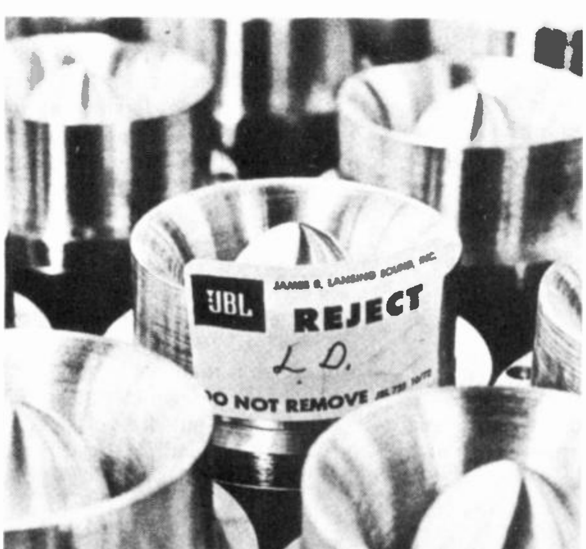
Hand made sound.

With JBL you know you're not just paying for the name. You're paying for a quality of sound that is impossible to mass produce.



JBL's require equipment so specialised we had to design and build our own.

If we cut out all the things we do by hand, and the checking double checking and rejecting, we could probably produce a speaker for about 25% less. But then it wouldn't really be a JBL. Our reputation is based on an unchanging commitment to quality. We make no compromises. Never have, never will. The same applies to all the JBL range. Like the JBL Decades.

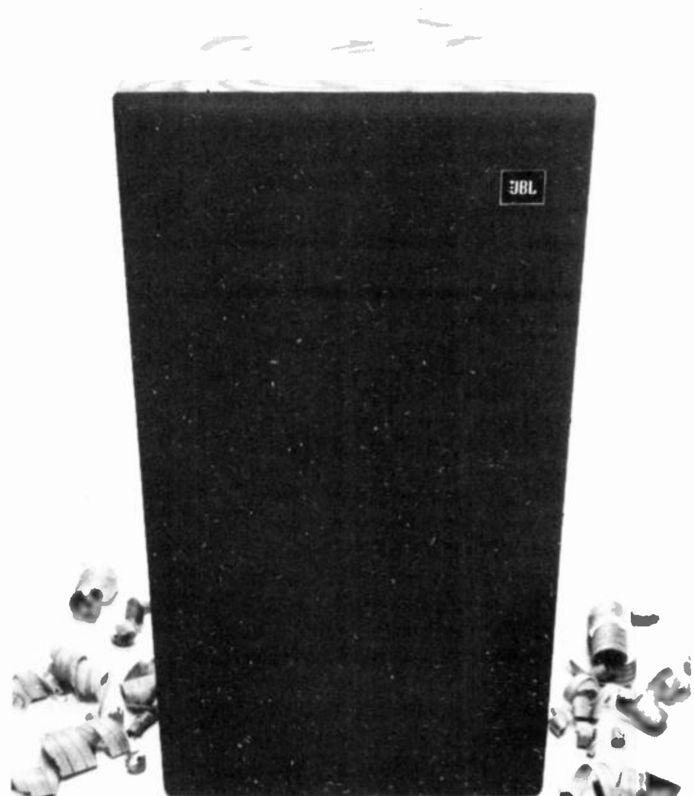


Near enough is just not good enough.

Cabinet tolerances are typically held to 1/64th of an inch.

Until we developed them just recently, most JBL's were out of the normal person's reach. Now you can own a pair of JBL's for around $500.

They're still more expensive than ordinary speakers, but then they're JBL's aren't they.



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AUDIO FACTS

NEW TECHNIQUE FOR PLAYING WAX CYLINDERS

Valuable insights into New Zealand's pre-European history are expected to be brought to light thanks to an improvised magnetic tape transcription method devised by the NZ Department of Scientific and Industrial Research's physics and engineering laboratory. Hundreds of old wax cylinder recordings, dating back as far as 1919, may now rest in peace now that the project is complete.

The laboratory received a batch of 165 dictaphone wax records — the cylindrical Edison type, dating from 1919-1922 — two years ago.

The National Museum, unable to play the frail cylinders for fear they would deteriorate further, asked the DSIR for help. The Physics and Engineering Laboratory decided the only feasible way to preserve the recordings would be to copy, as near as possible, the cylinder tracks on to a more durable medium such as magnetic tape.

But preliminary investigations revealed a number of problems that rendered existing equipment useless for the task:

The recordings comprised sound tracks that had been recorded at highly and arbitrarily varying rotation speeds, ranging from around 90 to 160 rpm.

The sound tracks were weak and shallow, which meant the tracking properties were poor and the relative surface interference noise levels were high. As well, ordinary replay machines would induce intolerably high ambient noise levels.

The soft deteriorated material necessitated stylus pressures well below those available from existing machines. And the collection included records of two different pitches, so that transcription rig had to accommodate for these by having two sets of gearwheels mounted.

These problems were all solved by applying modern engineering principles and materials to the transcription rig design. Major components were: Edison dictaphone body, induction motor drive, rotation stabilising flywheel, tracking arm with pickup head, preamplifier, and high performance tape recorder.

The mandrel supporting the wax cylinders was altered to cope with the weak wax records. Also, special low-noise Teflon bearings were made to support the mandrel for smooth rotation. The drive between motor and mandrel was made of a fine neoprene cord drive to reduce transmission noise. Vibration isolating rubber springs and vibration damping weights were used extensively to reduce any remaining ambient noise.

A high fidelity magnetic pickup with a stylus about 40 times bigger than normal was used to fit the wide grooves of the records and, because of the high demands on the stability of the tracking arm and the unevenness of the cylinder surface, most of the recordings were transcribed at half speed, resulting in improved clarity.

The equipment worked well, and the cylinders have since been deposited with the National Museum. In the meantime, a second batch of 210 cylinder records was received from Auckland University; these turned out to be a goldmine of Maori chants, songs, and genealogies, with "voice reports" by Sir Apirana Ngata, Native Affairs Minister of the 1930s.

The contents of these cylinders had remained a mystery over the years, because it was feared playing them for research would cause irreparable damage. Now, the cylinders are with the National Museum and the tapes are being studied at the university.

The equipment itself has been handed over to the National Library, and will be available for use as further wax cylinders turn up.

* Recommended retail price.

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- MM cartridge integrally combined with the head shell for high compliance support and good channel separation. **$169.00**

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5AU6	1.13	1.02
6AX4	1.61	1.45
6BA6	1.50	1.36
6BE6	1.75	1.59
6BL8	.99	.89
6BM8	1.17	1.06
6BQ5	1.52	1.38
6BQ7	2.04	1.85
6BX6	1.42	1.29
6CA7	3.47	3.17
6CM5	1.67	1.52
6DQ6A	2.69	1.44
6DX8	1.52	1.38
6EA8	1.53	1.39
6EB8	1.87	1.71
6EJ7	1.30	1.16
6EH7	1.30	1.18
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P & P 1-5 $1 00 5-20 $2 00 20+ $3 50

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Semi-automatic. Integrated hydraulic cue device.

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C60	Low Noise	1.50	1.35	1.25
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C60	Ultra Dynamic	2.05	1.95	1.85
C90	Ultra Dynamic	2.40	2.30	2.20
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AUDIO FACTS

PROGRAMMABLE TURNTABLE

A programmable memory built-in to BSR's new Accutrac 4000 automatic direct-drive turntable enables the user to cue directly to any required tracks.

An infra-red scanner incorporated in the ADC LMA-1 cartridge focusses a beam of light onto the record. Closely spaced grooves scatter this light — but the smooth surfaces between recorded sections reflect the light back to a detector within the cartridge housing triggering the arm mechanism via logic circuitry.

The turntable may be controlled directly or remotely via an ultra-sonic transmitter.

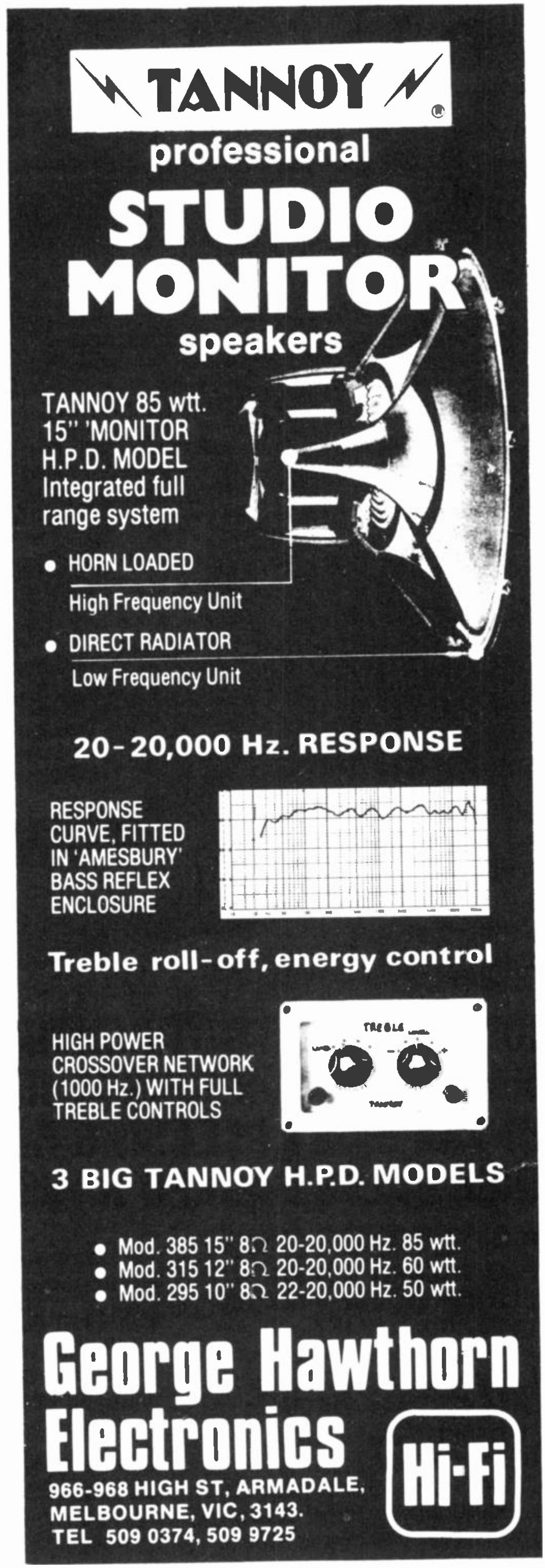
PHILIPS SQUAWKER

For some years now the Philips Dome Tweeter type ADO160/T has been acclaimed for its excellence in the reproduction of the upper frequencies in multi-way high fidelity loudspeaker systems.

The superior dispersion and transient response characteristics of the dome type diaphragm have now been extended to the very critical mid-range region with the release of the Philips Dome Squawker type ADO210 SQ. This squawker has a response curve which is almost flat (± 3 db) within the range from 50 Hz to 5 kHz. The resonance frequency is a very low 270 Hz.

By using both the ADO160/T and the ADO210/SQ it is possible to obtain a much improved level of realism from high-fidelity recordings in the region from 500 Hz to beyond 20 kHz. Since the human ear is not very directional below 500 Hertz, the conventional cone speaker is adequate for the bass region. Both the ADO160/T and the ADO210/SQ will be stocked in 4 ohms and 8 ohms versions.

The ADO210 SQ Dome Squawker is marketed by Elcoma. Electronic Components and Materials — 67 Mars Road, Lane Cove NSW 2066.



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Auto stop on all functions. High density permaloy heads. CrO2 Tape selector for bias and equalizing.

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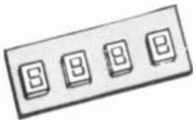
MR239

NEW! SCIENTIFIC KITS

Now you can build some of the most advanced digital electronic instruments with our new series of low cost modular scientific kits. These kits will expand the range of your electronic applications enormously — and all at a surprisingly low cost.

The heart of the system is our 4 digit Decade Counter (Kit 012) which features a full 4 digit LED readout (you choose the size best suited to your application). Combine this with a 5 volt regulated power supply (Kit 030) and you have the basis of a wide range of sophisticated electronic instruments including:

- A Digital Voltmeter (DVM) — Kit 012 • Kit 030 • Kit 017
- Frequency Counter — Kit 012 • Kit 030 • Kit 016 • Kit 014 or 031
- RPM Counter — Kit 012 • Kit 030 • Kit 020 • Kit 032



KIT 012 4-DIGIT DECADE COUNTER

Features include:

- On chip internal oscillator for scanning speed
- Overflow and count extend outputs
- Transfer, reset, count, blanking and true compliment control inputs
- Circuit board can be cascaded to 8, 12, 16 etc. digits
- Kit includes all components, PCB's, and LED displays and full assembly instructions

Kit 012a (with 0.25" displays) $23.95

Kit 012b (with 0.50" displays) $27.95

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- Input voltage 25V max
- Output current 1 amp max
- Load regulation 50mV
- Output voltage 5V
- Line regulation .01
- (Needs 8-20 volt transformer)

Kit 030 (contains all parts except transformer) . . . . . $ 7.95

KIT 017 DIGITAL VOLTMETER

1.999V as basic with polarity indication, 1 M ohm input impedance and accuracy to 1% if properly adjusted.

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KIT 016 FREQUENCY COUNTER

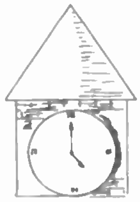
Features FET input front end with trigger circuit for measuring complex waveforms. Measures from 0.1 Hz to 10 MHz when used with Kit 031. Measures from 0.1 Hz to 20 Mhz when used with Kit 014.

Kit 016 . . . . . $16.50

KIT 020 RPM COUNTER

RPM Counter. Counts from 1 to 100,000 RPM.

Kit 020 . . . . . $ 8.95



KIT 014 1MHZ CRYSTAL TIME BASE

1 MHz crystal chain time base divider. Output 1 MHz, 100 KHz, 1 KHz, 100 Hz, 10 Hz, 1 Hz, 0.1 Hz. Accuracy better than .005%.

Kit 014 . . . . . $14.95

KIT 031 TIME BASE

Uses power line (mains) frequency as reference. Output 10 Hz, 1 Hz and 0.1 Hz. Accuracy 0.1%.

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50 Hz chain time base. Output 0.6 sec., 6 sec., 60 sec.

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MORE TO COME...

Watch this space in future issues for additional kits including Multimeter, Timer, Capacitance Meter, Thermometer and many more. With our kits and your imagination you'll find dozens of new and exciting applications.

AT LAST!

4 & 6 DIGIT PC BOARDS

PC Board for 4 digit display MAN series or DL707	$1.75
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PC Board for 4 digit display DL747	$2.50
PC Board for 6 digit display DL747	$3.00
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PC Board for 6 digit display DL727	$3.00
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All PC display Boards are multiplexed for adding additional digits.

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FOUR DIGIT TEMPERATURE KIT

FATIMA, the first in a series of time sharing kits to interface with THE KING.

FATIMA FEATURES **$19.95**

1) 4 digit temperature display
2) Farenheit or Centigrade
3) Temperature 10 sec. display, time 20 sec. display
4) Complete C-Mos application
5) Kit uses 7002 4 digit counter

Kit includes all components, PC Board and instructions for interfacing with THE KING 6 digit alarm clock.

Watch next issue for yet another addition!

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1) 6 digit, 12 hr, 60 cycle or 24 hr, 50 cycle alarm clock
2) Time sharing capability for display of additional information
3) Built in alarm generator and automatic output for intensity control of LEDs
4) Single 12v supply and a minimum of interface components
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6) 10 minute snooze
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THE KING **$23.50**

Kit No. 70250 1R (Red readouts)	
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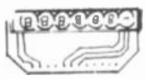
Kit No. 70250 1Y (Yellow readouts)	
Kit No. 70250 2R (DL727 readouts)	$27.50
Kit No. 70250 3R (DL747 readouts)	$29.50

Kits contain all components, PCB's, switches, alarm speaker and instructions. (Does not include 12-15 volt transformer and case)

DISPLAY SPECIAL



$1.30 Full, multiplexed, common cathode. Goldplated. Ideal for mini 6 digit clock.

DL747 Jumbo .6 in. high and only 20mA per segment. $2.75

DL727 One of our best readouts .5 in. high. 20 mA per segment. Common anode. $3.75

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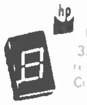

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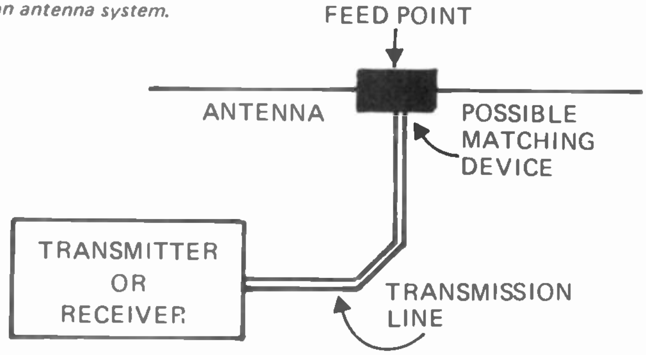
Antennas

A practical down-to-earth guide to antennas and transmission lines with particular relevance to Australia's recently introduced Novice Licence. This two-part article is by Roger Harrison VK2ZTB.

Fig. 1. General form of an antenna system.



THE ANTENNA IS THE CRUX OF any communications station. It is the most important single link in the whole system. It is particularly important in low power installations.

An **antenna installation** is a system consisting of the antenna itself -- the actual radiating and receiving device – and a **transmission line** which connects the antenna to the transmitter or the receiver. There may also be interposed in the transmission line somewhere a device for matching the impedance of the antenna to the transmission line or the unit (transmitter or receiver) connected to the transmission line. The general form of an antenna system is shown in Fig 1. Antennas may differ in shape, size and method of operation but their general characteristics are defined by the following terms:–

Directivity – The directivity of an antenna is its ability to absorb or radiate more power along a particular axis, or in a particular direction, than any other direction. An antenna that absorbs or radiates power equally in all directions is termed an *isotropic* antenna. It exists only as a mathematical concept and is used as a convenient reference. The simple dipole is also used as a convenient reference antenna.

Radiation Pattern – The radiation pattern is a measure of the directivity of an antenna. In practical circumstances it is usually measured in the horizontal or vertical plane if the antenna is to be mounted in relation to the earth, or in a convenient plane in relation to the elements of the antenna. Radiation patterns of two typical antennas are shown in Fig 2. The radiation pattern is also sometimes referred to as the directivity pattern.

Beamwidth – This is the angle between the 'half power' points of the radiation pattern, as shown in Fig 2. The half power points are those points on the radiation pattern where the power radiated or absorbed by the antenna has decreased to half that radiated or absorbed along the main axis of the radiation pattern.

Gain – Gain in an antenna system is a term used to express the increased sensitivity of a particular antenna compared to a reference antenna. That is, it will absorb or radiate more power along the direction of the main beam than the reference antenna along its favoured direction (if not an isotropic reference). The gain is a measure of how *much* more. For example, if a certain antenna produces ten times the voltage at its feedpoint terminals, from a distant source, than that produced by a dipole under equivalent conditions, then the voltage gain of the antenna is said to be 10, or in other words, 10 dB.

Bandwith – This refers to the frequency characteristics of an antenna. The bandwidth can be specified or defined

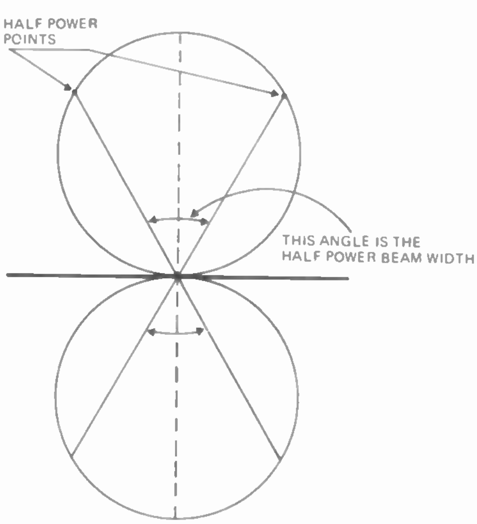


Fig. 2(a). Radiation pattern of a dipole, in a plane through the elements, illustrating half-power beamwidth.

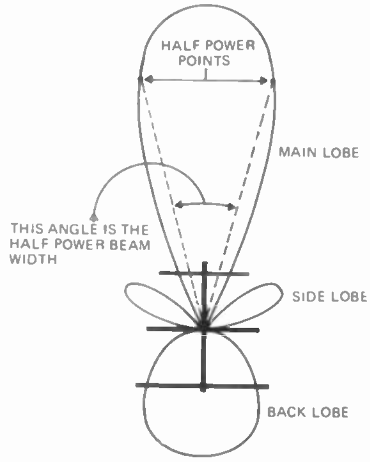


Fig. 2(b). Radiation pattern of a three-element Yagi antenna, in a plane through the elements, illustrating the half-power beamwidth.

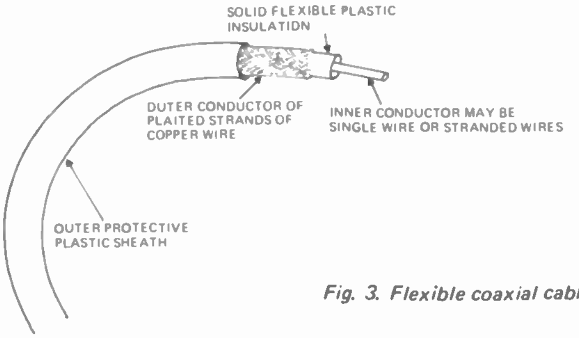


Fig. 3. Flexible coaxial cable.

in a number of different ways. Sometimes it is specified as plus/minus so many kHz or MHz either side of the operating frequency for a certain variation of the feedpoint impedance (usually expressed as a 'standing wave ratio' or SWR). It is sometimes also expressed as a percentage of the operating frequency. Some times it is expressed as a half-power bandwidth. That is, the frequency limits where the gain of the antenna decreases to half that (i.e.: decreases by 3 dB) at the operating frequency or the centre of the passband. Some antennas have a very broad bandwidth, the rhombic and the log-periodic being two examples. Some have quite a narrow bandwidth, such as the simple dipole and yagi antenna.

Feedpoint – The feedpoint of an antenna is that point where the receiver or transmitter is connected in order to couple signals to or from the antenna. Every antenna will exhibit a characteristic impedance at its feedpoint and it may be necessary, in order to maximise the power coupled to or from the antenna, to install a device which transforms the feedpoint impedance of the antenna to the impedance of the transmission line. This device is often referred to as a 'balun' an abbreviation of 'balanced-to-unbalanced transformer'. Its purpose is to match a balanced antenna feedpoint to an unbalanced transmission line. An impedance transformation is not necessarily involved although this is often the case. A device that transforms a high impedance balanced feedpoint to a lower impedance balanced transmission line is not a balun but simply a matching device or transformer.

The feedpoint of an antenna is usually chosen to be at a convenient position on the antenna in order that the impedance is resistive and thus easy to match to a transmission line.

TRANSMISSION LINES

Antennas are rarely driven directly by a transmitter or connected directly to the receiver input. They are usually connected to the transmitter or receiver via a transmission line.

Transmission lines take a variety of forms, but the most commonly encountered are coaxial line and two-wire lines such as open-wire line and flat-ribbon (used on TV antennas).

Coaxial line comes in three different forms: flexible, semi-flexible and solid. Flexible coaxial cable is probably the most widely used and is made in a variety of ways but generally of the form shown in Fig 3. The semi-flexible and solid varieties are similar to each other but for the arrangement of the inner and outer conductors. Soft copper is used for the inner and outer conductors of semi-flexible coax to allow it to be 'formed' freely. Sometimes the outer conductor is specially shaped to allow it to be formed or allow limited flexing. Solid tubing is used for the inflexible or solid variety of coaxial transmission line. The ordinary 'garden variety' flexible coaxial cable is the cheapest and certainly the best for any installations you are likely to construct. Semi-flexible and solid coaxial cables are illustrated in Figs 4 (a) and (b).

Two-wire transmission lines are referred to as 'balanced lines' as the RF currents flowing in them are normally balanced with respect to earth. Coaxial transmission lines are referred to as unbalanced lines because the cable is not symmetrical and is not balanced with respect to ground.

The two-wire flat ribbon type of transmission line is used extensively for connecting TV antennas. It is probably the cheapest of manufactured transmission lines. The open-wire line is another form of two-wire transmission line, but has no solid insulator to maintain a constant distance between the conductors. Instead, small insulators are placed at intervals along the line to perform this function. These two types of transmission line are illustrated in Figs 5(a) and (b).

All transmission lines have a *characteristic impedance* seen by an RF current sent down the line. The characteristic impedance is a function of the diameters and the distance between the two conductors and the dielectric constant of the insulation used in the transmission line.

Common impedances for coaxial lines are 50 ohms or 52 ohms, and 70 or 75

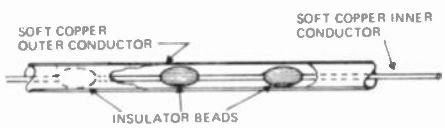


Fig. 4(a). Semi-flexible coaxial cable; note insulating beads spaced at intervals along inner conductor to maintain inner conductor in place.

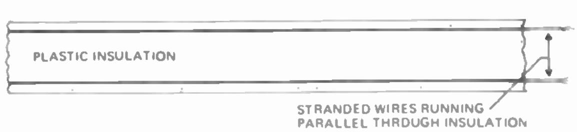


Fig. 5(a). Two-wire flat ribbon transmission line.

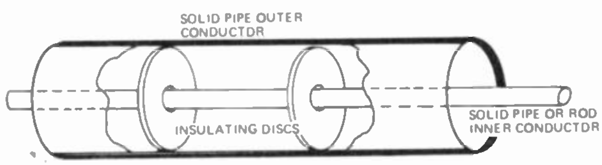


Fig. 4(b). Solid coaxial cable. The insulating discs maintain the centre conductor in position.

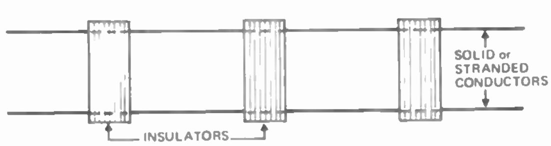


Fig. 5(b). Two-wire open line.

ohms. Open wire or flat ribbon types generally available have a characteristic impedance of 300 ohms.

You can't measure the characteristic impedance of a transmission line with an ohm meter. But it can be measured. If you were to take a very long piece of line (many wavelengths long at the frequency used for measurement) and applied a signal generator to one end and then measured the RF voltage and current at the input of the transmission line, the ratio of the voltage to the current would yield an impedance which is equal to the impedance of the line — regardless of whether the other end were open-circuited or short-circuited.

All transmission lines have a certain amount of loss due to the conductor resistance and dielectric losses. This is usually expressed as a loss of so many dB/100m. Below 30 MHz most common transmission lines have such small losses that they can be neglected for all practical purposes.

Standing Waves and Standing Wave Ratio — Standing waves occur on a transmission line when RF is applied to one end and the other end is connected (terminated is the jargon) to an impedance different from the characteristic impedance of the transmission line. The outgoing power, when it meets the load, will be partially dissipated in the load, that part not dissipated will be returned or reflected. The RF wave travelling down the line towards the load will meet the reflected wave, and at intervals of half a wavelength the in-phase currents or voltages will *add*, when they are out of phase, they will *cancel*. As the voltage produced by the incident wave is greater than that produced by the reflected wave, complete cancellation does not occur. If the voltage across the line is measured at a cancellation point (called a node) is compared to the voltage measured across the line at an addition point (called an anti-node) then their ratio is **called the standing wave ratio**. A standing wave ratio of one to one (1:1) means that the transmission line impedance matches that of the load. An infinite SWR (or, more correctly, VSWR) means that there is a short or open circuit at the other end of the line. All the power sent down the line is reflected. If that happens, then you have reason to worry. None of the transmitter power gets to the antenna.

If the antenna feedpoint impedance does not exactly match the transmission line (or feedline) impedance (as is usually the case) then it is a question how the mismatch affects things. An SWR of 5:1 will mean an extra loss in the transmission line of less than 1 dB. That really isn't worth worrying about.

A mismatched transmission line will present at its input end a different impedance from that at the load end (the antenna usually being the load). If the output impedance of the transmitter cannot be adjusted to this impedance then it will not deliver full power output. So, if each part of the system is designed or arranged to have similar impedances then the whole system is simplified. By common agreement, and a little help from nature, transmission lines and antenna systems are usually contrived to have impedances around 50 ohms, 70 ohms or 300 ohms. Higher impedances are also encountered, usually 400, 600 or 800 ohms.

Velocity Factor — An RF wave travels more slowly in a transmission line than it does in space. This is because the wave slows down in the dielectric medium of the transmission line. The degree of slowing down is called the velocity factor. For example, in polyethylene insulated coax, the velocity factor is typically 0.66. This means that the RF wave travels along the transmission line at 2/3 the velocity it does in space. As a consequence, a half-wavelength, at a particular frequency, in a transmission line will be less than it is in space. For the coax line just mentioned it is 2/3 of the length in free space.

The velocity factor of foam dielectric coax is typically 0.8. That for 300 ohm flat TV ribbon is usually about 0.82 and open wire line about 0.95.

TABLE 1 **Characteristics of various coaxial and twin-wire feeders.**

Type	Impedance (ohms)	Nominal O.D.	Dielectric & Velocity Factor		Capacitance/100mm	Attenuation dB/10m 3.5 MHz	21 MHz	27 MHz
RG58	50	5 mm	solid poly.	0.66	10 pF	0.28	0.82	0.98
RG59	73	6 mm	solid poly.	066	6.9 pF	0.21	0.53	0.62
RG8	52	10.3 mm	solid poly.	0.66	10 pF	0.10	0.26	0.33
RG11	75	10.3 mm	solid poly.	0.66	6.7 pF	0.12	0.31	0.36
UR57	75	10.3 mm	solid poly.	0.66	6.7 pF	0.12	0.31	0.36
UR70	72	6 mm	solid poly.	0.66	6.9 pF	0.22	0.59	0.69
ET13M	75	9.4 mm	foam poly.	0.8	5.4 pF	0.03	0.13	0.15
Flat TV ribbon	300	—	polythene	0.82	1.9 pF	0.06	0.17	0.2
Open Wire TV feeder	400	—	mostly air	0.97	—	0.01	0.04	0.06

Obviously, attenuation is not a factor to be concerned about on the HF bands — unless you are considering having a feedline 100 m long!

The characteristics of a number of commonly available transmission lines are shown in table 1.

DIPOLE CONSTRUCTION

The dipole is probably the simplest of antennas to construct and use. The basic form and dimensions are shown in Fig. 6.

The easiest way to construct a dipole is to have wire elements suspended between two supports as shown. The wire used must be able to withstand the tension placed on it by its own weight, the stretching force applied to reduce sag, and the weight of the feedline. Hookup wire at 4c to 6c per metre is probably the cheapest. Use something like 7/0026 or 10/010 gauge It is immaterial whether it is solid, stranded, insulated, or un-insulated. Enamelled coil wire, tinned copper wire etc, will all work well, just make sure that it will not break or stretch too much when tensioned; that lengthens the antenna, detuning it!

The ends of the dipole need to be insulated and this is best done with 'egg' insulators or strain insulators. Some types are illustrated in Fig. 7. These insulators are available in porcelain, nylon and glass. The nylon type of egg insulator is usually the least expensive but they do have one drawback. After sometime in use, the tension of the wire causes the nylon to creep or remold itself and the wire literally pulls itself through the insulator. This may cause the insulator to fail completely. This is not so much a disaster however as the antenna wire and the support rope or wire are looped through one another — an advantage of the egg insulator. The antenna won't fall down, but its

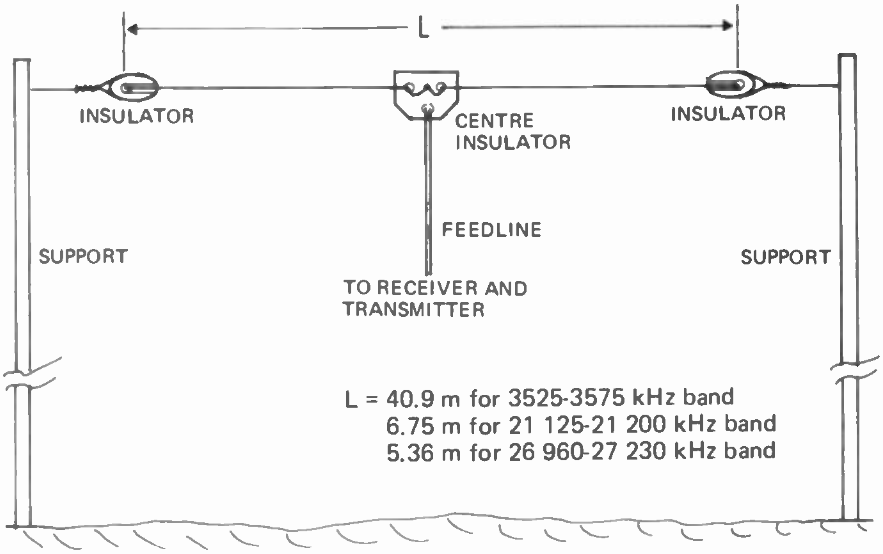


Fig. 6. The simple wire dipole, general construction and dimensions.

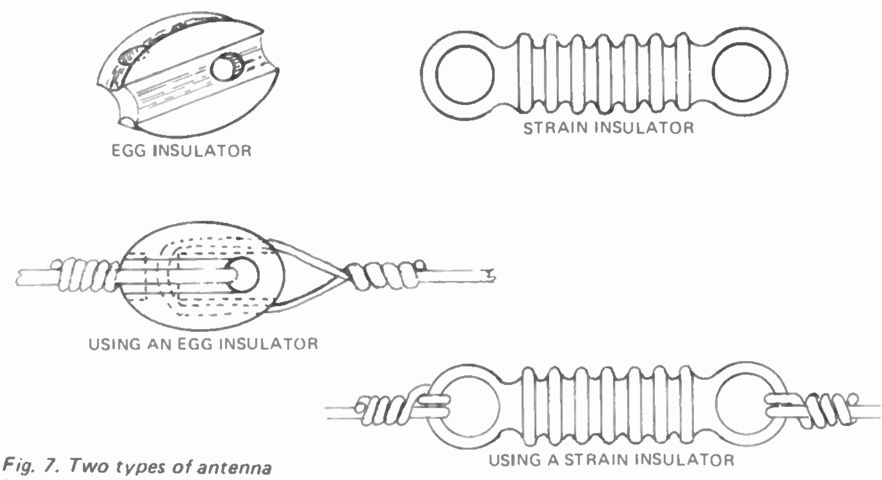


Fig. 7. Two types of antenna insulator — and how to attach them.

Fig. 8(a). Attaching feedline to the centre of the dipole using two egg insulators.

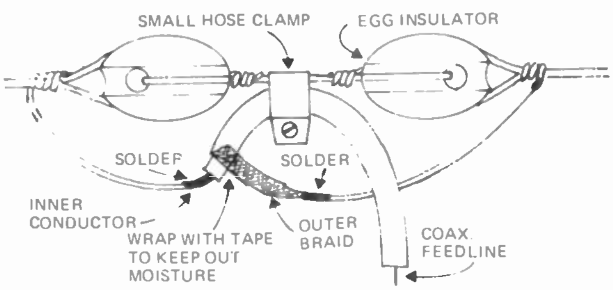
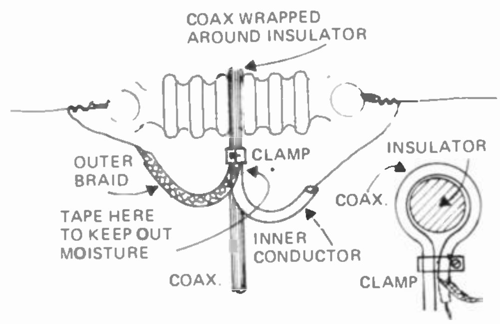


Fig. 8(b). An alternative method of attaching the feedline to the centre of the dipole using a strain insulator.



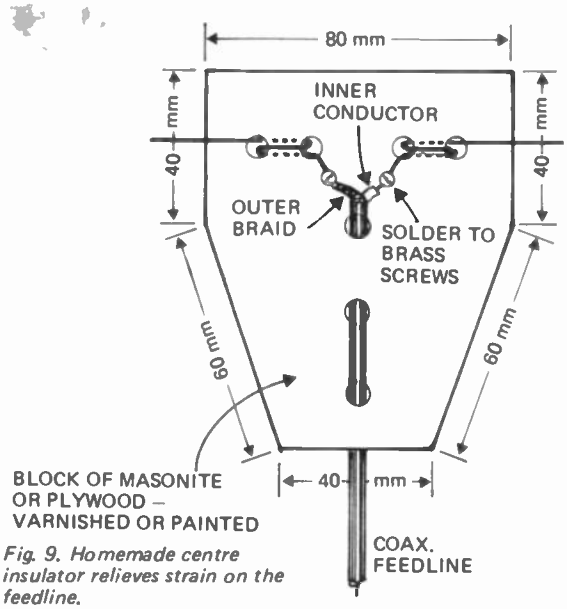


Fig. 9. Homemade centre insulator relieves strain on the feedline.

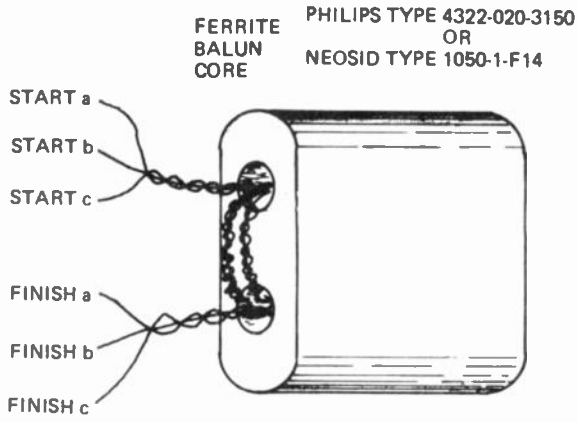


Fig. 10. Construction of 1:1 wideband balun transformer.

efficiency may be impaired. It depends a great deal on the weight of the antenna and the tension applied.

The feedline is connected to the centre of the antenna – an insulator being installed between each half of the wire. A pair of egg insulators may be installed here as illustrated in Fig. 8(a). A strain insulator may also be used again as shown in Fig. 8(b). Special centre insulators are available but may be difficult to obtain. Another alternative is illustrated in Fig.9. You can make this yourself out of masonite or 10 mm thick plywood, suitably cut to shape and drilled as shown. If preferred, rather than drilling the block, the feedline may be held with a small clamp. The main idea, no matter which method you use, is to relieve the strain on the feedline.

A dipole antenna has a balanced feedpoint with respect to earth and thus normally requires to be connected to a balanced feedline. The impedance is usually between 30 ohms and 70 ohms, depending on its height above ground. It is convenient to feed it with coaxial cable as this is readily available. The coax may be connected directly to the antenna despite the fact that it is an unbalanced feedline, and does not usually cause any problems, particularly at the power levels permitted for novices. However, it is better to install a balanced-to-unbalanced transformer between the antenna feedpoint and the coaxial feedline. These may be purchased, or you can make your own. The impedance transformation is nominally one-to-one (1:1).

One way to make a 'balun', as they are called, is to construct a wideband transformer. That is, an RF transformer that has no resonance effects and covers a wide range of frequencies. For the power level involved (i.e.: about 30 W peak power for novices), a small ferrite core, such as the Philips 4322-020-3150 type or the Neosid 1050-1-F14 type may be used.

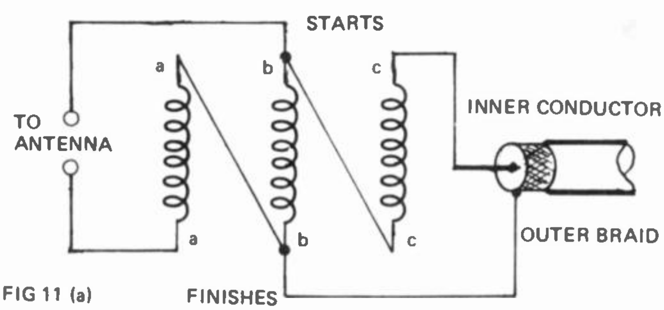


FIG 11 (a)

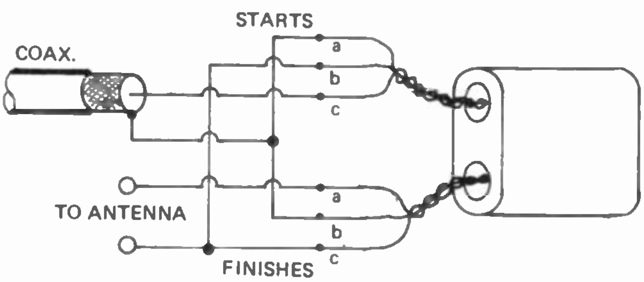


FIG 11 (b)

Fig. 11(b). Connections for 1:1 wideband balun transformer.

WIDEBAND (1:1) BALUN CONSTRUCTION

Take three 180 mm lengths of light gauge hookup wire or 22 gauge enamelled copper wire and twist them together at about two twists per 10 mm. The ferrite core specified has two holes passing through it. Wind three turns of the twisted strands through the holes of the core as illustrated in Fig.10. Identify and mark the three separate wires. Having done this, connect them as shown in Fig.11. Use a small tagstrip or terminal block to support the joints. The balun may be potted in Araldite or 5-minute epoxy to keep out moisture and make it weather-proof. A coax socket and nut-&-bolt connections may be potted in with the balun for convenience.

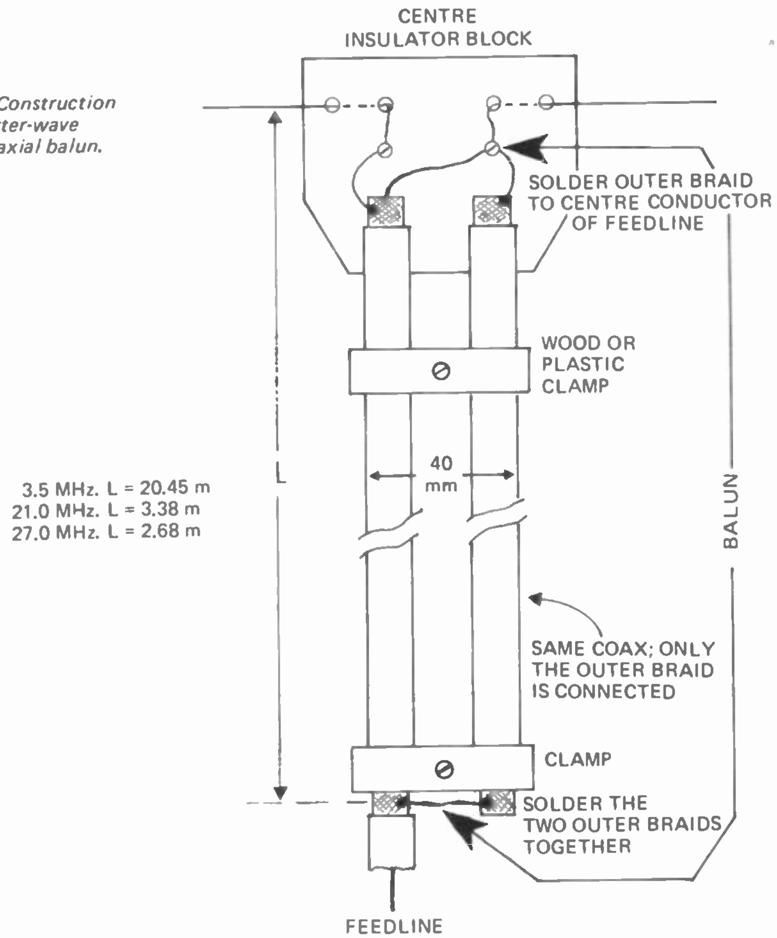
The balun and feedline will need to be supported at the centre insulator, adapting any of the methods illustrated in Fig.8 and 9.

SINGLE-BAND (1:1) COAXIAL BALUN CONSTRUCTION

A balun may also be made from a length of the same coax used to feed the antenna. This is referred to as a 'linear coaxial balun' and its construction is illustrated in Fig.12. A quarter wavelength of coax is run parallel to the main feedline down from the antenna feedpoint. Only the outer braid is connected. The lengths required for the different bands are also given in Fig.12. This construction makes a balanced two-wire line, a quarter wavelength long and shorted at the end opposite the feedpoint. The coax is connected through one line, effecting the required transformation from balanced to unbalanced line without changing the impedance. This sort of balun may be somewhat impractical on the 3.5 MHz band as it is over 20 m in length. It is however more suitable on 21 MHz or 27 MHz. ●

Continued next month

Fig. 12. Construction of a quarter-wave linear coaxial balun.



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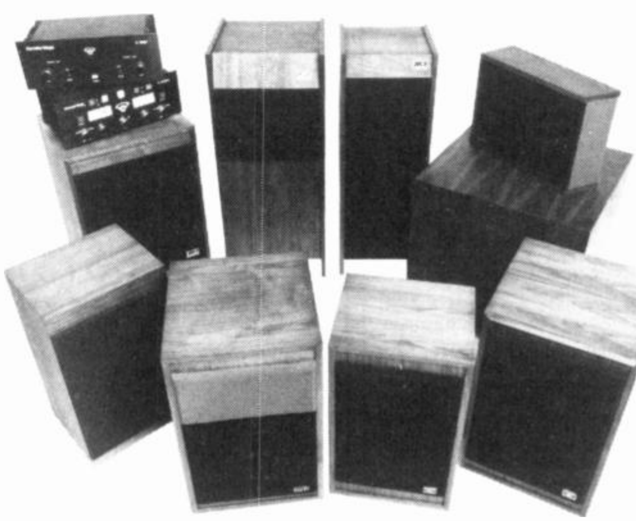

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freight extra per rail or air freight.
Cabinet available

MAGNAVOX 8–30 SPEAKER SYSTEM (4 Way)

DRIVE UNITS: Magnavox 8-30 high performance 8" bass unit. Magnavox 6J 6" mid range speaker. Magnavox new high fidelity dome tweeters (two supplied). SPEAKER KIT: (less cabinet) comprises above speaker, 1mh inductance, 1 8mfd and 1 4mfd. polyester capacitor, 1-3" and 1-6" tube, innabond, speaker silk and plans of cabinet.

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per kit
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Cabinets available

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Phones 798-7145, 798-6507

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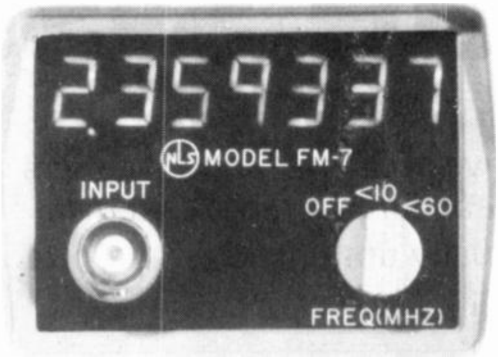
A frequency monitor that can go anywhere — from the originator of the Digital Voltmeter

Portable
Battery Operated



Actual size!

Only $180*

With rechargeable NiCad Batteries & Charger unit.
***All prices plus 15% sales tax if applicable**

● Large 7-digit LED display ● 10 Hz to 60 MHz frequency* range ● C-MOS construction ● 30 mV sensitivity-Amateur and CB frequencies ● Typical maximum frequency — guaranteed to 54 MHz ● Small and RUGGED-ideal for field use ● 1 Hz resolution on low range ● Overload protection ● Input cable — 4 ft. coaxial, terminated with "mini-gator" clips

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Note: A copy of this advertisement must accompany your order.

Volksmeters and FM-7's are available throughout Australia at the following local distributors, radio shops, hobbies & electrical stores:

MELBOURNE: Radio Parts (all stores), Lawrence & Hanson, I.E.I. Pty. Ltd., Magrath's.
SYDNEY: Dick Smith (all stores), Lawrence & Hanson, Radio Despatch Service, I.E.I. Pty. Ltd.
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PERTH: Lawrence & Hanson.
NEWCASTLE: Digitronics, Division of Edmonds Moir & Co.
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NEW ZEALAND: Pye Ltd., Systems Division.

Other products include panel meters, digital voltmeters, data acquisition Mil Spec DVMs, comparators, serializers, digital clocks, word generators, signal conditioners, scanners, digital printers, special-purpose digital instruments and MOS/LSI array testers. For more information on these NLS instruments/systems contact:

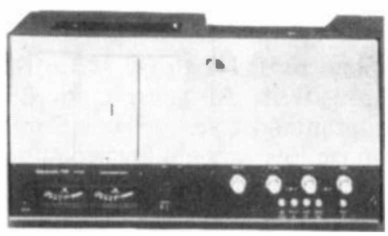
Non-Linear Systems, (Australia) Pty Ltd

61 Lothian Street, North Melbourne, 3051
Telephone (03) 329-9951/329-9377. Telex 34082

Nakamichi revolutionary new cassette systems

Nakamichi tapedecks' many special features take them well beyond the capabilities of other cassette decks . . . and into a range that makes possible professional applications otherwise virtually unthinkable.

NAKAMICHI 1000
TRI-TRACER The Nakamichi 1000 probably represents the most advanced cassette deck ever made. Nothing has been spared to ensure a level of performance that rivals that of professional reel-to-reel recorders. Noise has been reduced to the vanishing point. Speed stability is unconditional. Frequency response has been extended to beyond audibility. Particular emphasis has been placed on reliability and ease of operation. To achieve these goals, conventional cassette technology had to be discarded and new, innovative solutions found. Foremost among them is the use of three completely separate heads for erase, record and playback.



NAKAMICHI 700
TRI-TRACER The Nakamichi 700 was created in response to the demand for a machine that could offer the essential performance of our highly acclaimed Model 1000 Tri-Tracer, but at a more modest cost. Since a compromise in performance was unthinkable, the alternative was to simplify the design and develop new construction techniques that would permit cost reductions while maintaining quality. The 700 employs the same advanced transport system and shares most of the features of the more expensive model. Central to both Tri-Tracers are three separate heads, erase, record and playback.

NAKAMICHI 550
DUAL-TRACER extends cassette technology to in-the-field recording. The 550 employs Nakamichi's exclusive Focused-Gap head for extended high frequency response and extremely low distortion. With its own self-contained battery power supply, the Nakamichi 550 may also be operated from a car battery, or from a standard AC line (adaptors supplied). Professional 45 dB range, peak level meters attest to the unit's extended dynamic range and are especially useful during live recording sessions. Under rigorous field conditions or in your home the Nakamichi 550 is the perfect companion.

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Please send me your fully detailed brochure on
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Concrete loudspeaker system

Polystyrene beads impregnated with concrete help reduce colouration-causing panel vibrations in Melbourne Audio Clinic's interesting new Philips'-based speakers.

Recommended retail price $370 pair. Test units from — George Hawthorne Electronics, 966 High St, Armadale, Vic 3143.

Enclosure is cast using a concrete and polystyrene beads mixture.

IT HAS BEEN REALISED FOR OVER 25 years that one of the biggest limitations in conventional loudspeaker enclosures is their internal resonances.

The vibration induced in the panels is significant and is a factor in both differential absorption internally and frequency selective radiation from the various surfaces of the speaker enclosure which are free to radiate sound.

If a light-weight accelerometer is placed on the centres of the sides, top or back of any conventional loud speaker the frequency plot of the radiation characteristics can be readily produced. We have measured many troublesome loudspeakers from manufacturers who sought to reduce these undesirable vibrations in order to improve the overall sound of the loudspeaker concerned. In so doing we found that the radiation characteristics from the front, sides and rear of many loudspeaker enclosures (independent of the *intended* radiation from the speaker cones) was either significant or in some cases totally unacceptable.

We have found that colouration is frequently more a function of the resonance characteristics of the enclosure rather than those of the loudspeakers, equalisers and cross-overs used in their construction. The best loudspeakers use what the manufacturers describe as heavy dense particle board panel construction with suitable bracing and internal dampening. Nevertheless such techniques often leave much to be desired — as the Melbourne Audio Clinic deduced in applying for a patent on a light-weight concrete speaker enclosure in 1975. Their patent was based on the concept that polystyrene beads impregnated with concrete to minimise the total weight and density, would provide a speaker enclosure with high rigidity and substantially reduced resonance performance compared to a conventional wood or particle board fabricated enclosure.

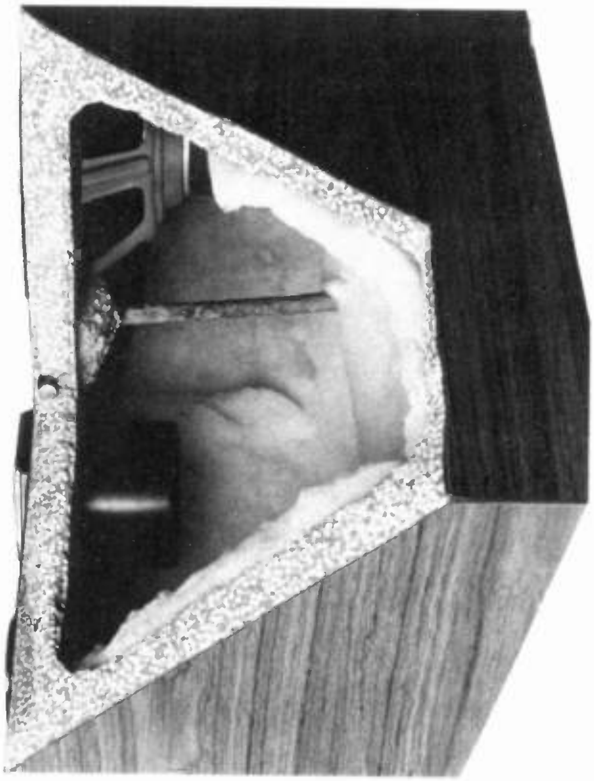
The company's 7B1 concrete speaker system is based on the above concept. The 35 kg enclosure is cast in one piece (which is no mean feat in itself) and at the time of fabrication has the openings for the speakers and a steel brace incorporated between the front and rear panels. The pre-expanded polystyrene beads reduce total density and for a given weight provide a substantially more rigid and practical form of construction.

The drive units consist of a Philips AD1265/W8 300 mm diameter woofer with an AD5060/W8 mid-range with a diameter of 120 mm and the very popular AD160/T8 tweeter, which is still one of the most popular dome tweeters in the world. Even the cross-over is a Philips manufactured unit — being an ADF500/4500/8. All of these speakers are well proven and whilst not in themselves new, offer a particularly clean individual performance. Whilst we did not have available a conventional speaker enclosure with the same lineup, we did nonetheless have previous measurements of comparable speakers to use as a reference.

MEASURED PERFORMANCE

The overall on-axis frequency response recorded by us in our anechoic chamber was found to be within 6 dB from 45 Hz to beyond 20 kHz. This is an unusually good frequency response and indicative of the performance which the Philips 3-way system can achieve.

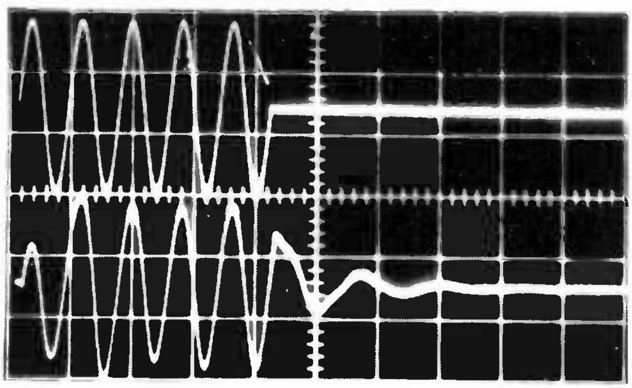
The AD160/T8 tweeter is an improvement on the original unit's tweeter and now incorporates a passive reflector immediately in front of the centre of the dome tweeter's cone. This enhances the off-axis frequency response in the range 2 kHz to 16 kHz. We measured the impedance



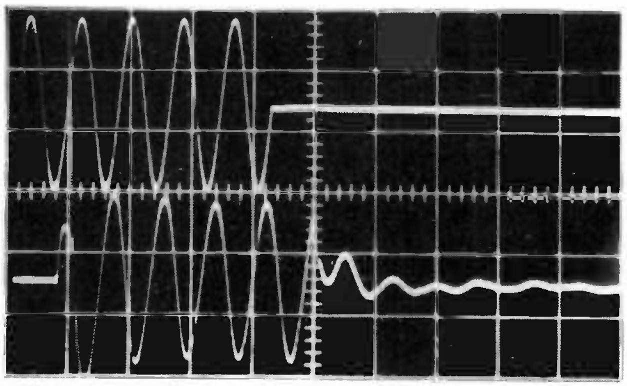
MEASURED PERFORMANCE OF PHILIPS GHE LOUDSPEAKER

Frequency response:	± 5 dB 45 Hz to > 20 kHz	
Electro-acoustic efficiency: (for 90 dB @ 2 metres)	3.0 watts at 500 Hz	
Total Harmonic Distortion: (for 90 dB @ 2 metres)	100 Hz	3.6%
	1 kHz	0.32%
	6.3 kHz	0.29%
Measured Impedance:	100 Hz	9.0Ω
	1 kHz	8.0Ω
	6.3 kHz	7.6Ω
Dimensions:	685 x 443 x 315 mm	
Weight:	35 kg	

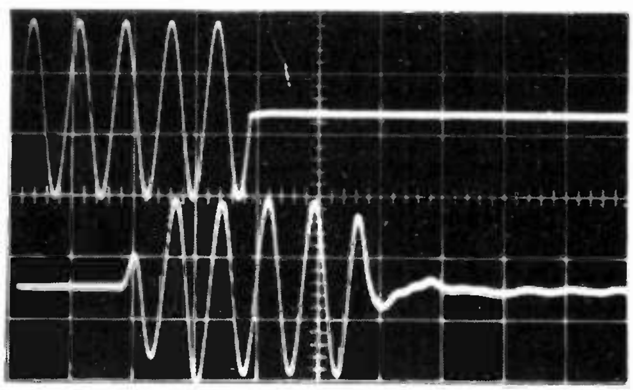
Tone burst performance, output equivalent to 90 dB at two metres.



A: 100 Hz;



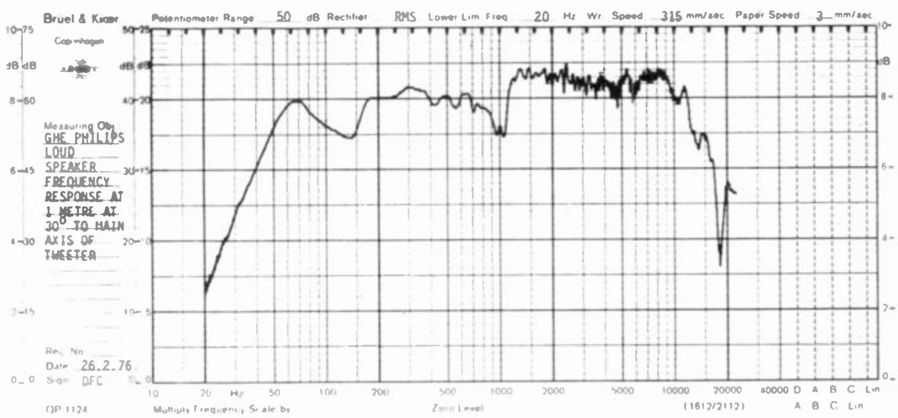
B: 1 kHz;

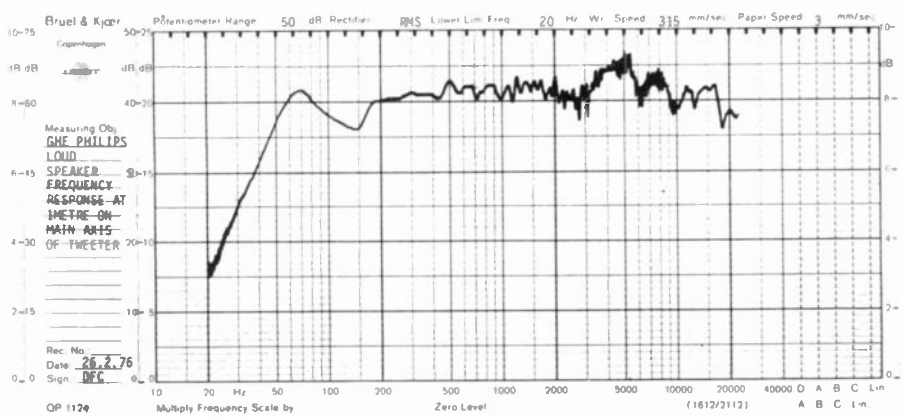


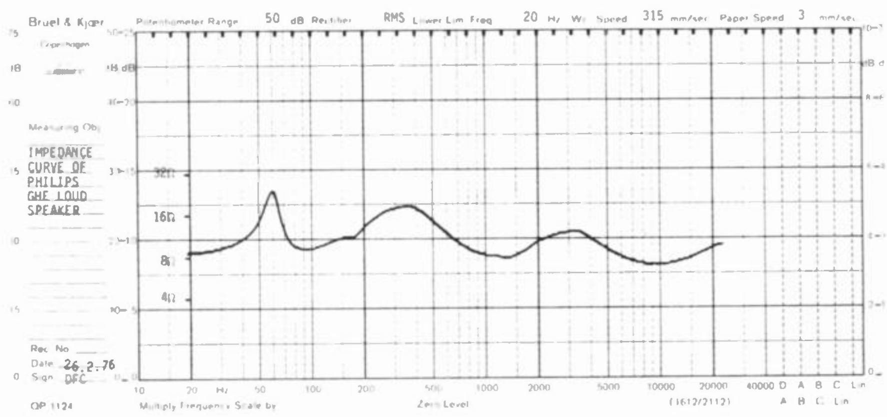
C: 6.3 kHz.

characteristics of the speaker and found these to be quite smooth. The main speaker resonance occurs at 60 Hz as was to be expected from the free field frequency response. Whilst the speaker exhibited a 6 dB drop between 60 Hz and 160 Hz this was not audible on programme content and is in itself no significant problem.

The tone burst performance of the speakers was particularly good and illustrated to us the benefits which result from the dynamic damping characteristics of the concrete enclosure. This is particularly true in the frequency region below 300 Hz and is subjectively capable of being assessed by striking the side panels or rear panels of these enclosures and comparing the results with that sound which results from striking the sides of a wood or particle board type construction.







To try and quantify these results we placed accelerometers on the sides of the GHE 7B1 enclosure at the geometric centre of the side panel and separately on the side panel of our laboratory monitors which are of conventional veneered particle board construction. We measured the vibration level (acceleration) for both speakers when radiating the same mean acoustical output as measured on axis. The difference, as measured by this technique, is less than we would have expected and is most significant in the frequency regions 100 Hz to 300 Hz. This is the frequency range which is audible as the resonance thump when you strike a conventional loudspeaker enclosure with your knuckles.

To say that the concrete construction eliminates resonance effects would be incorrect. Compared to our monitor speakers the reduction of vibration level is not substantially different in the frequency region above 300 Hz and in point of fact there are many regions above this frequency were there is no differential.

The manufacturers merely claim substantial reductions below 200 Hz but there are still *some* resonances below 100 Hz. Two quite significant resonances were observed (at 75 Hz and 95 Hz) corresponding to two standing waves within the enclosure.

HOW THEY SOUND

Despite the still measurable panel vibrations, the dynamic performance of the 7B1 concrete enclosure is basically good. Listening tests showed that colouration is audibly reduced and that transient performance is remarkably good.

Very low frequency performance – 20 Hz–80 Hz – was no better or worse than most other high quality sealed enclosures. This reinforces our belief that a sealed enclosure cannot generally compete with bass reflex designs at the extreme low frequency end of the spectrum.

Apart from this one limitation, these speakers perform well. They are a definite improvement over most conventional sealed enclosures and many other reflex systems in the critical region 80 Hz to 300 Hz.

There are very few speaker systems which we can say offer outstanding performance, but at a recommended retail price of $370 we are satisfied that the 7B1 Concrete Speaker System is well up the list. ●

C.E.C. has a turntable to turn YOU on...

the ideal system starter BD1000 complete with EMPIRE 2000E cartridge

BD1000

- Wow and flutter less than 0.12%.
- Rumble better than 40DB.
- Complete in fully imported base and cover.

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BD7000

for the audiophile BD 7000

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The CEC turntable range includes the semi-automatic BA300 and fully automatic BA600. One of the four models is right for you. All have the famous C.E.C. 5-YEAR WARRANTY.

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If one really appreciates music, there's one way, and only one way, to hear it in its completely natural form; with perspective, with dimension, with depth, without 'artificial colouring'. That's to be there, at the time, at the concert.

The piccolo players are not wedged in between the violinists, and the man with the tympany drums is not standing up front with the conductor. At IMF, we design and build speakers with one goal uppermost in our minds; to reproduce music naturally, as it was played with each instrument in its proper place, and at its proper weight. Call it perspective; call it depth; call it dimension; call it lack of extraneous gimmickry; call it what you will. It's the goal we've set ourselves, and we believe (as many leading world authorities on music and its reproduction are beginning to agree) that our success in achieving that goal is, so far, unrivalled.

There are those, especially hard rock enthusiasts, who will find our sound (at least at first) a little unexciting. But 'natural sound', like anything to which one is unaccustomed, is a taste one needs to acquire.

If you appreciate not only fine music, but also fine equipment, we invite you to take a look at; and a good listen to; our speakers.

Available from:

N.S.W.: M & G Hoskins Pty. Ltd, (Showroom) 400 Kent Street, Sydney 2000. Telephone: 559-4545 and 559-3693.

QLD.: Stereo Supplies, 95 Turbot St, Brisbane 4000, Telephone: 21-3623.

S.A.: Challenge Hi Fi Stereo, 96 Pirie St, Adelaide 5000, Telephone: 223-3599.

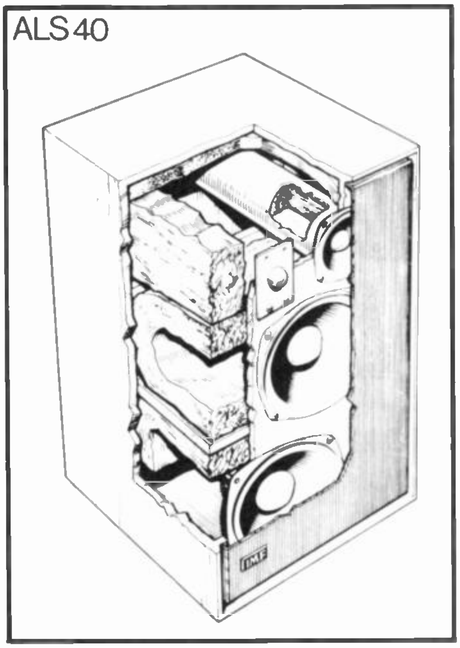
TAS.: Audio Wholesalers 9 Wilson St, Burnie 7320, Telephone: 31 4111.

VIC.: Encel Electronics Pty. Ltd, 431 Bridge Rd, Richmond 3121. Telephone: 42-3761

W.A.: Arena Distributors, 282 Hay St, Perth 6000, Telephone: 25-2699.

A.C.T.: Duratone Hi Fi, Cnr. Botany St. & Altree Crt, Phillip 2606, Telephone: 82-1388.

Sole Australian Distributors
INTERNATIONAL DYNAMICS (AGENCIES) PTY. LTD.,
23 Elma Rd., North Cheltenham, 3192, Melbourne 95-1280.



IMF

IMF/1

WHAT GOES IN, COMES OUT. NATURALLY

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Full complete instruction manual supplied. (Not just a reprint of the E.A. article). Makes assembly very easy — even for the beginner.
If you can use a soldering iron then you can build this amplifier easily.

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Special Silk Screened component overlay on PC board for easy identification and assembly.

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" it is about half the price of an imported amplifier with the same power output "
" The overall performance of the new Playmaster is equal to that of many amplifiers costing up to three & four times the price "
Says Leo Simpson in the Electronics Australia for April 1976.

The Twin Twenty-five is the latest and the best in a long line of very popular Hi Fi amplifier kits. You really have to hear this amp. to believe that such quality is possible for such a low price. Even beginners can tackle this project ! We have arranged a special service offer for you. If the amp. wont go - check the power transistors with a multimeter. If they are OK, return the completed circuit board with $8. and we will service, replace any parts and return to you.

Preliminary Specifications
Power Output: 25W/channel into 4/8 ohm with one channel driven.
Frequency Response: ±1dB from 20 Hz to 20 kHz with tone controls level.
Compensation: RIAA to within ±1dB.
Sensitivity: Phono 2mV into 50K for 25W output. Other inputs 150mV into 500K nom.
Overload: On phono 120mV.
Sig/Noise: 74dB (on phono) @ 10mV and 25W. 68dB (other inputs).
Crosstalk: Better than -45dB over 100 -10kHz.
Distortion: 0.15% at full power over whole band.
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Stability: Unconditional.

Cat. K-3410 .. .. $89.50
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- Put in any signal (AM/FM/SSB) on the 27Mhz novice band and it is instantly "Transformed" down to 80 metres.
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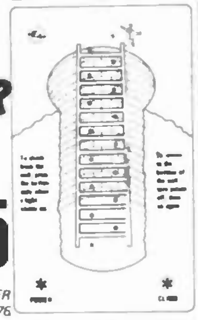
Cat. K3134 . . . . Very Special Offer $ 99.50

L.E.D LADDER KIT

$16.75



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Push the button - make the light climb up the ladder - but it gets harder near the top.

A GAME OF SKILL

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All parts supplied.
Cat. K3390 Complete Kit for only $16.75

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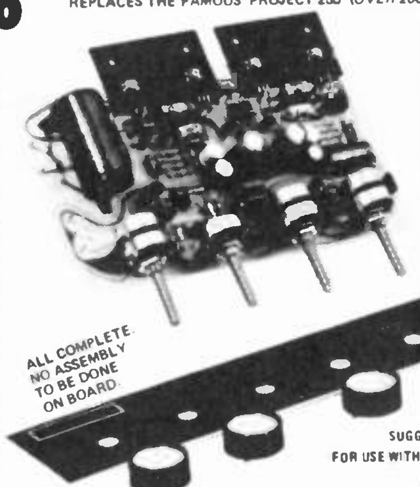
REPLACES THE FAMOUS 'PROJECT 250' (OVER 2000 SOLD)



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Famous Garrard Record Changer Model CC10, complete with ceramic stereo cartridge and cueing device. We sold previously at $32.50
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Acrylic Cover to suit above base.
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NOTE: The above 28 watt system costing just over $100 complete would be hard to purchase built up for under $200, so why not build one and save yourself a mint.

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Special kit includes silk screened printed circuit and all components to build this handy timer. Includes the Novus 650 Calculator!
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SEE E.A. MAY 1976

Fantastic for Electronic Organs, Amplifiers, P.A. Systems, Car Stereo Systems etc. Complete kit includes all components and Reverb Spring Unit.

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WAS $89.50
NOW **$39.50**

SEE E.A. MAY '76

SAVE $50

T.V. games open up a whole new vista of fun and this project must be the best of any yet! On the screen you get a net and top & bottom to the court. You can sellect bat or hole-in-the-wall. There are seperate controls for each player plus an adjustable ball speed control. The ball bounces off the top and bottom edges. A special 'interaction' control introduces a wobble on both sides for extra fun. We reckon there are 15 different games you can make up by adjusting the controls, some for 2 players and some you play against yourself. Circuit uses 13 IC's, 5 transistors and is battery powered with a seperate moduler board and two control boxes. Highly recommended for the more advanced constructor.
Cat. K-3415 Build Yourself and SAVE $39.50

NEW INCREASE RECEIVER SENSITIVITY RP-10 SIGNALIZER

$39.50

SPECIFICATIONS
27-28 MHz RF amplifier and attenuator
Gain adjustable from +15dB to -20dB.
No modification to existing equipment.
Just insert between transceiver/receiver & aerial.
Requires 12-14 V DC @ 35mA.
Automatic aerial change over built in for transmit.
Insertion loss negligeable.
Use with transceiver up to 80 watts PEP.
Uses dual gate MOS FET for maximum performance.
The best investment ever for any CB'er or Marine user.
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DICK'S PRICE **$69.95**

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40,20,15 & 10 metres, vertical 19 foot high, Ideal for restricted areas and minimal cost.
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- Helical resonator and crystal filter
- Speaker can be changed to top or bottom of cabinet
- Special "instantaneous" channel button allows instant QSY to nominated channel.

Frequency Range. 146.0 to 148.0 MHz. 23 Channel FM Transceiver
All solid state construction. RF power output 10W or 1W with switch. Receiver Sensitivity: 1.0μV @ 30 dB S/N Power Requirements: 13.5V DC @ 2.3A max. Size: 134Wx58Hx216D mm Weight: 1.8 kg. Comes with microphone, mobile mount, manual and DC leads.
Supplied complete with one set of crystals on channel 40 (146.00 MHz)
Cat. D-3007 .. .. $189.00

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Additional crystals available at $6.00 per channel if purchased with the Multi 7 (Yes - this will give you 6 channels for only $219.00 - a bargain).
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NOTE........*On page 71 of the new 76-77 Dick Smith Catalogue the catalogue number for the Computer Resistor Pack was omitted. It should read*..... Cat. R-7010 .. .. Only $5.90

On page 72 the Linear IC LM741 8DIL should read " Price 1-9 $1.00 & Price 10 99 95c".
On page 74 " Video Games Pack" should read " in E.A. MAY 1976 "

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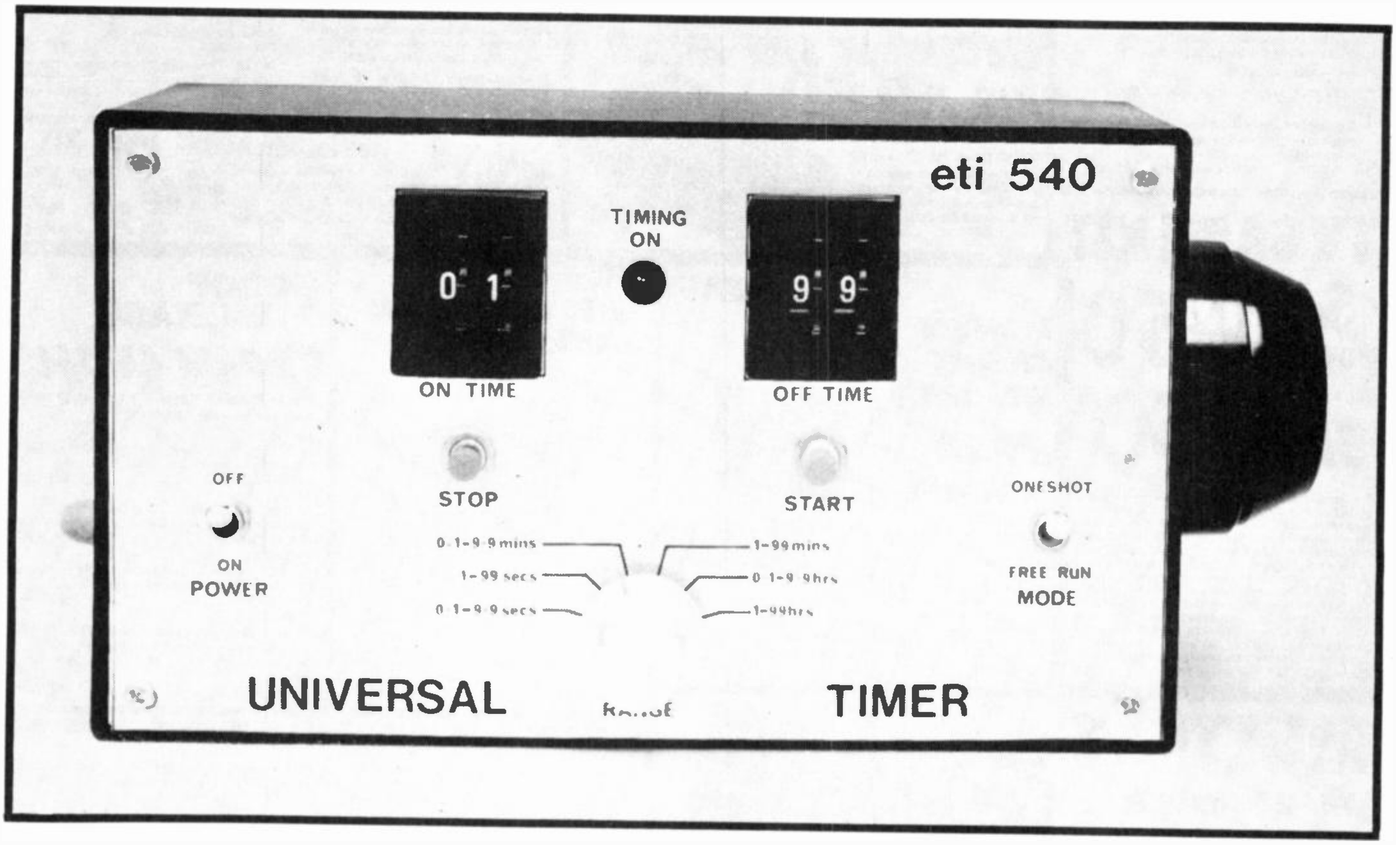
Universal timer

One tenth of a second to 99 hours. Both on and off times programmable. Manual or automatic operation resettable at any time.



THE TIMING OF EVENTS and processes is becoming an ever-increasing necessity particularly in applications involving automation.

Unfortunately most timers are either specifically made for a particular application — and difficult to adapt to others — or have restricted timing range, accuracy and facilities.

The ETI Universal Timer described in this project is free of most such constraints. It is extremely flexible, accurate and versatile. Its timing range is from 0.1 seconds to 99 hours. Both 'on' and 'off' times can be programmed (for example 12 hours on and 47 hours off). It can be manually started, stopped, or reset at any time, can be set for automatic cycling or for single cycle operation. It may be triggered by an external source (light, sound or pressure transducer etc). Finally, as the unit is digital — the 50 Hz mains is used as the reference — timing accuracy is very high indeed, and a manual reset facility enables the timer to be synchronized with local time if so desired.

Clearly not all users will need all the facilities provided — so if the unit is required for a specific permanent use it is a simple matter just to leave out those ICs not required — several variations are described at the end of this project.

CONSTRUCTION

We strongly recommend that this unit be assembled using the printed circuit board shown.

Begin construction by fitting the links to the board as shown on the component overlay. Note that there are two points labelled 'a' and two points labelled 'b'. Link 'a' to 'a' and 'b' to 'b' using insulated hook-up wire routed on the copper side of the board.

Mount the resistors to the board followed by the diodes, transistors, capacitors and finally the ICs. Take particular care to ensure that all the polarized components are orientated correctly — especially the integrated circuits.

Wires should now be attached to the board for later connection to the front panel switches. We used rainbow cable for the connections to the thumb-wheel switches as this makes the wiring easier and also helps to keep the wiring tidy. Mount the printed-circuit board into the case and mount the power outlet socket. Assemble the switches to the front panel and then interconnect the printed-circuit board, front panel and power socket in accordance with the interconnection diagram.

Finally after wiring the 240 Vac power circuitry insulate all 240 V terminals with tape to ensure that there is no risk of personal contact when fault finding is required at any later date.

CUSTOMIZING

The unit need not necessarily be built in its complete form and many different modifications are possible to lessen the cost of the unit when it is to be used for one particular application only. The modifications required for a number of specific applications are described below.

Specific fixed time — delete selector switches SW3 to SW6, and replace by wiring links from the appropriate outputs of IC4 and IC5 to the inputs of IC6/1 and IC6/2 respectively. The range switch may also be omitted by installing a link between the appropriate output of IC1 to IC3 and pin 13 of IC4.

Single shot operation — connect both inputs of IC6/2 to ground and omit switches SW5 and SW6.

Timing 99 hours or less — omit IC3 and connect inputs of IC7/3 and IC7/4 to ground.

Timing 99 seconds or less — omit IC2, IC3 and IC7.

External triggering — simplest way is a relay contact in parallel with start or stop button.

SPECIFICATION ETI 540

MODES

Freerun
On/off (note 1)
One shot
Manual override (note 2)

TIMING RANGE

0.1 seconds to 99 hours (note 3)

ACCURACY

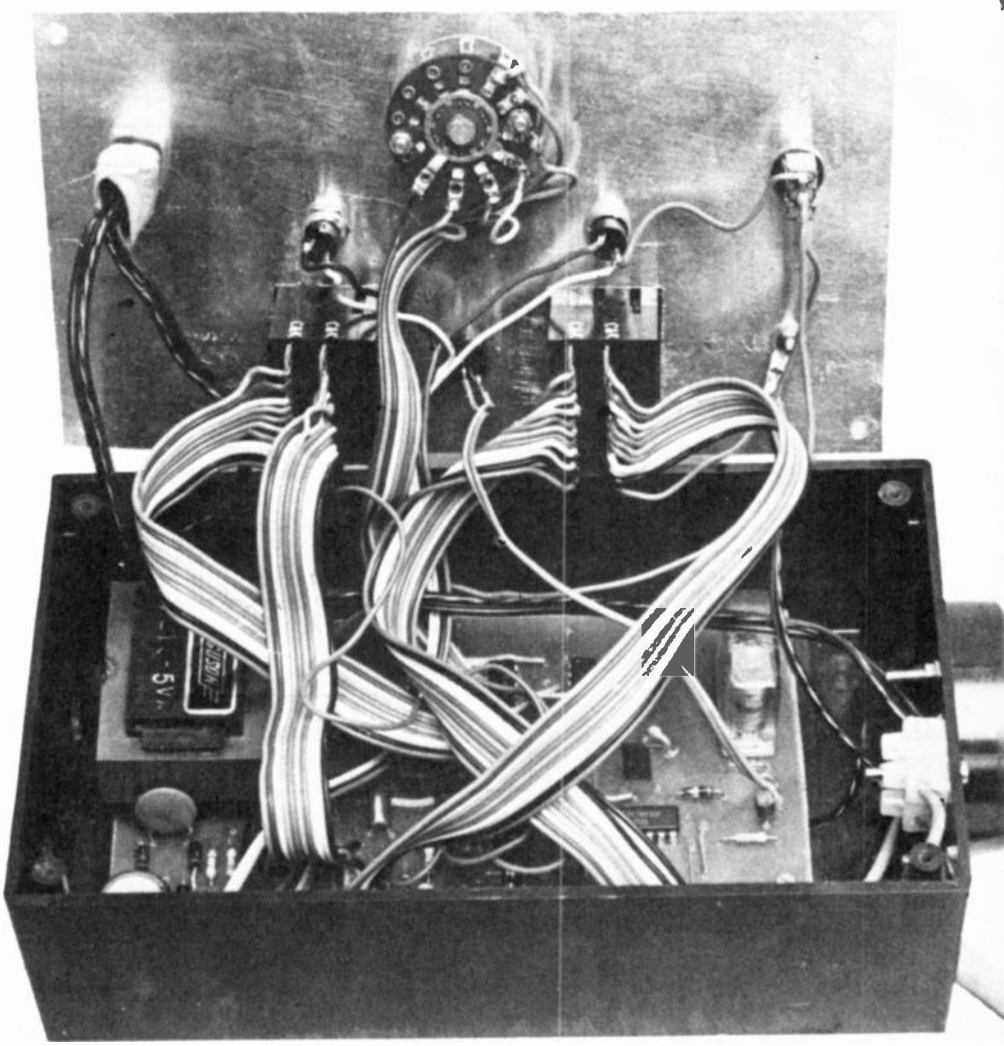
Mains synchronized

OUTPUT

240 volts ac relay switched

Note 1. Both on and off times are variable independently.
Note 2. Unit may be stopped or started at any time. If the appropriate button is pressed whilst in the same mode the timing is recommenced.
Note 3. Timing is adjustable by a common coarse control which gives ranges having a full scale of 9.9 seconds, 9.9 minutes, 99 minutes, 9.9 hours and 99 hours. Each range is adjustable from 1 to 99 that is one second on and 99 seconds off is possible whereas one second on and two minutes off is not (different coarse range is required).

The main consideration when making any changes is that the logic is CMOS and any unused inputs must be connected to ground or to +12 volts to prevent damage to the IC (which may overheat with unconnected inputs).



Universal timer

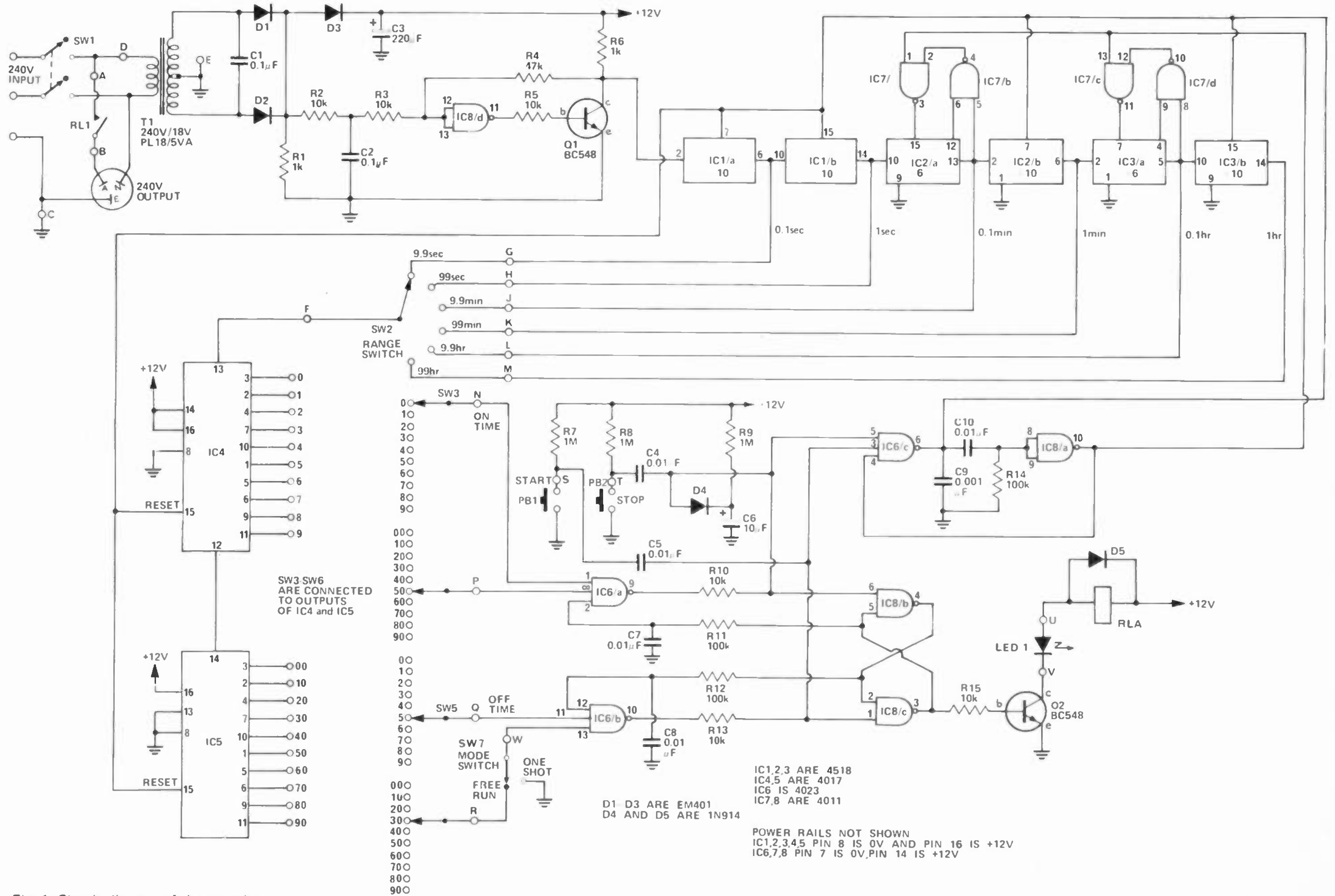


Fig. 1. Circuit diagram of the complete timer.

HOW IT WORKS – ETI 540

THE 240 Vac is reduced to 12 Vdc by transformer T1 and diodes D1 to D3. Diode D3 isolates the smoothing capacitor C3 from the rectifiers and therefore 100 Hz ripple appears across R1. This waveform is used for the basic timing reference for the timer. To operate the counting ICs reliably a very fast rise-time waveform is required at the clock input. This is obtained by feeding the 100 Hz to a Schmitt trigger formed by IC8/1 and Q1. Capacitor C2 is included to prevent the control tones superimposed on the mains for the control of hot-water services from upsetting the timing accuracy.

The 100 Hz from the Schmitt trigger is divided by 10 by IC1/1 to give a 10 Hz or 0.1 second output – the first required. Note that due to the low frequencies involved from now on the outputs will be referred to as time periods not as frequencies. A second divide by ten stage is used to give a nne second output. A division by six is then performed by IC2/1 with IC7/1 and IC7/2 being used to decode the six count and reset the counter. This gives the one minute (or sixty second) period required. Further divisions of 10,6 and 10 are used to provide the six outputs required to select periods from 0.1 seconds to one hour.

One of these six outputs is selected by the range switch SW2 and is fed to a 4017 IC – the first of a pair of decade counters which have ten decoded outputs. The ten outputs of each IC go high in turn for one clock period each. As the two 4017 ICs are in series, a total division of 100 is obtainable. We have labelled the outputs of IC4 and IC5 as 0 to 9 and 00 to 90 respectively. IC4 is triggered by the clock enable as negative edge triggering is required. The second IC is clocked normally by the carry output from IC4.

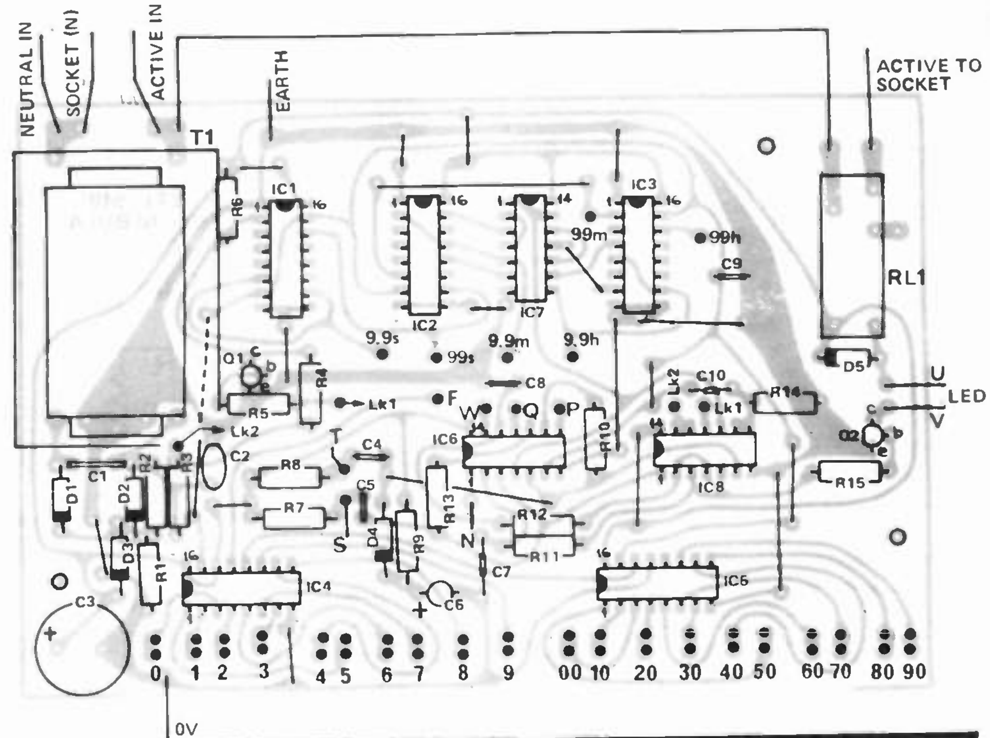
We pause at this point to go straight to the control output which is via a relay RL1, this in turn being controlled by the flip-flop made up of IC8/2 and IC8/3. This flip-flop can be controlled either manually by PB1 (manual on) and PB2 (manual off) or automatically by IC6/1 and IC6/2. To toggle the flip-flop automatically the output of either IC6/1 or IC6/2 must be low and for the output to be low the three inputs must all be high. This occurs only when the number selected by SW3 and SW4 (for IC6/1) and SW5 and SW6 (for IC6/2) is held by the counters IC4 and IC5 and the third input from the flip-flop is used to ensure that the off-time of the relay is controlled only by the off-time selector switches. A small time delay is incorporated in the signal back from the flip-flop to avoid the ambiguity that could arise with equal times.

If the output of either IC6/1 or IC6/2 goes low the monostable formed by IC6/3 and IC6/4 is triggered and its resultant output is used to reset all the counters to zero. This reset also occurs if either of the manual push buttons is pressed. The push buttons are coupled into the logic by capacitors so that only the initial part of the press actuates the logic and there is therefore no dependency on the length of time for which the button is pressed.

The sequence of events is as follows assuming that initially the switches are set for 25 seconds on and 14 seconds off.

On first switch-on C6 ensures that the flip-flop is toggled into the off state and also that the counters are all reset to zero. The control inputs from the flip-flop to IC6/1 and IC6/2 are low and high respectively. Therefore until the flip-flop changes state only IC6/2 can have the three high inputs necessary to provide a low at the output. Meanwhile the counters IC4 and IC5 are counting up at the rate of one count per second. After 14 seconds all three inputs to IC6/2 are high and the output goes low toggling the flip-flop. The monostable is then triggered and all counters are reset to zero. This removes the three high inputs to IC6/2 and the output goes high again. The pulse output of IC6/2 is very narrow and is about a microsecond long. As the flip-flop has now changed state the relay has been closed and IC6/1 has been enabled (control input to pin 2 now high). After 25 seconds all the inputs to IC6/1 are high and the same procedure as before resets the counters and changes the state of the flip-flop.

In the one-shot mode of operation one input of the off timer is grounded and the off time procedure is effectively disabled. The only way that the timer can now start is for the manual start button to be pressed.



PARTS LIST – ETI 540

Resistors

R1	–	1 k	½ W	5%
R2,3	–	10 k	,,	,,
R4	–	47 k	,,	,,
R5	–	10 k	,,	,,
R6	–	1 k	,,	,,
R7-R9	–	1 M	,,	,,
R10	–	10 k	,,	,,
R11,12	–	100 k	,,	,,
R13	–	10 k	,,	,,
R14	–	100 k	,,	,,
R15	–	10 k	,,	,,

Capacitors

C1	–	0.1 µF 50 V disc ceramic
C2	–	0.1 µF polyester
C3	–	220 µF 16 V electro
C4,5	–	0.01 µF polyester
C6	–	10 µF 16 V electro
C7,8	–	0.01 µF polyester
C9	–	0.001 µF ,,
C10	–	0.01 µF ,,

Diodes

D1-D3	–	EM401 or similar
D4, 5	–	IN914 or similar
LED 1	–	RL4850 or similar

Transistors

Q1,Q2	–	BC548 or similar

Integrated Circuits

IC1-IC3	–	4518
IC4,5	–	4017
IC6	–	4023
IC7,8	–	4011

Transformer 240 V/18 V CT PL18/5 VA
pc Board ETI 540
Relay, single pole 280 Ω coil 240 V 5A contact

Switches

SW1	double pole toggle switch
SW2	single pole 6 position rotary
SW3-6	single pole 10 position *
SW7	single pole toggle
PB1,2	single pole "make" push buttons

* C&K 321100000 is a 2 section Thumbwheel switch forming SW3 + 4 and SW5 + 6 (2 required)

Case plastic 196 x 113 x 60 mm
power cord, plug and clamp
3 pin power outlet socket

Universal timer

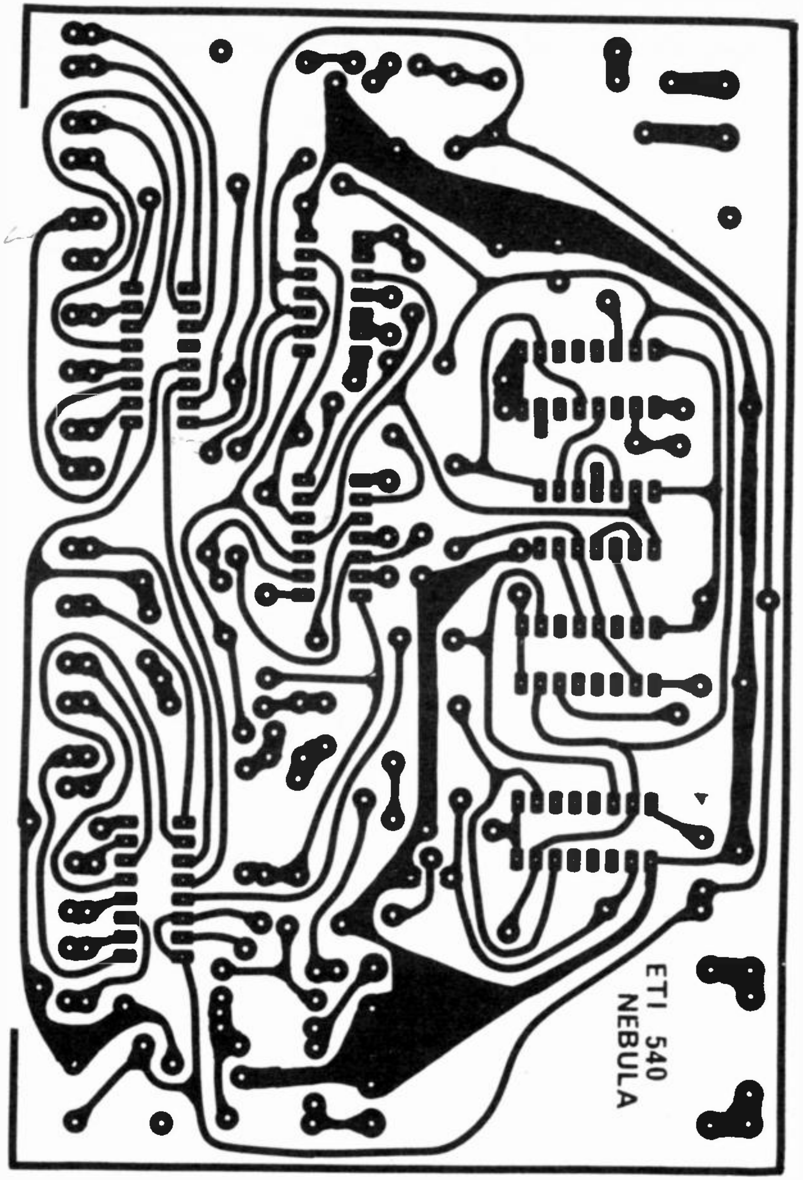


Fig. 4. Printed-Circuit board layout for the timer. Full size 153 x 100 mm.

Give your Universal Timer a professional look! Finished Scotchcal panels are available from ETI for $3.00 — plus self-addressed stamped envelope at least 120 mm x 200 mm. Please make cheques or postal orders payable to 'Scotchcal Offer' not Electronics Today.

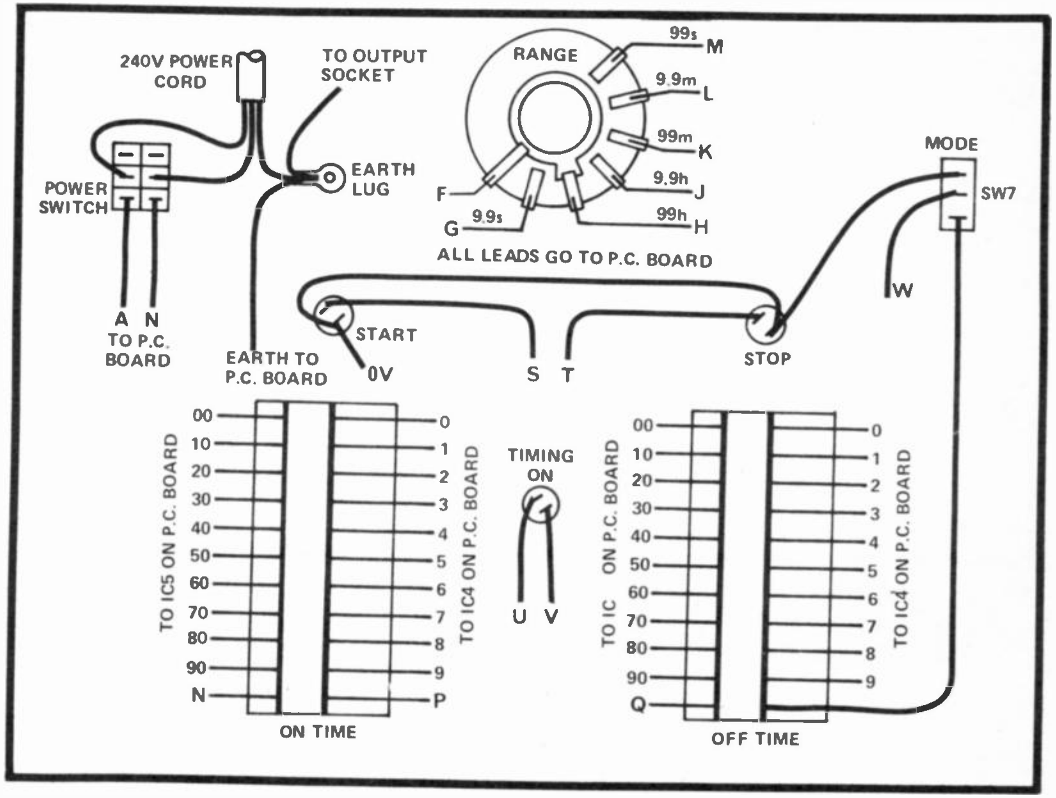
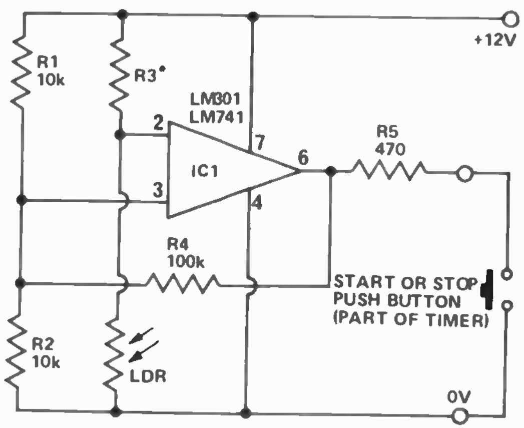


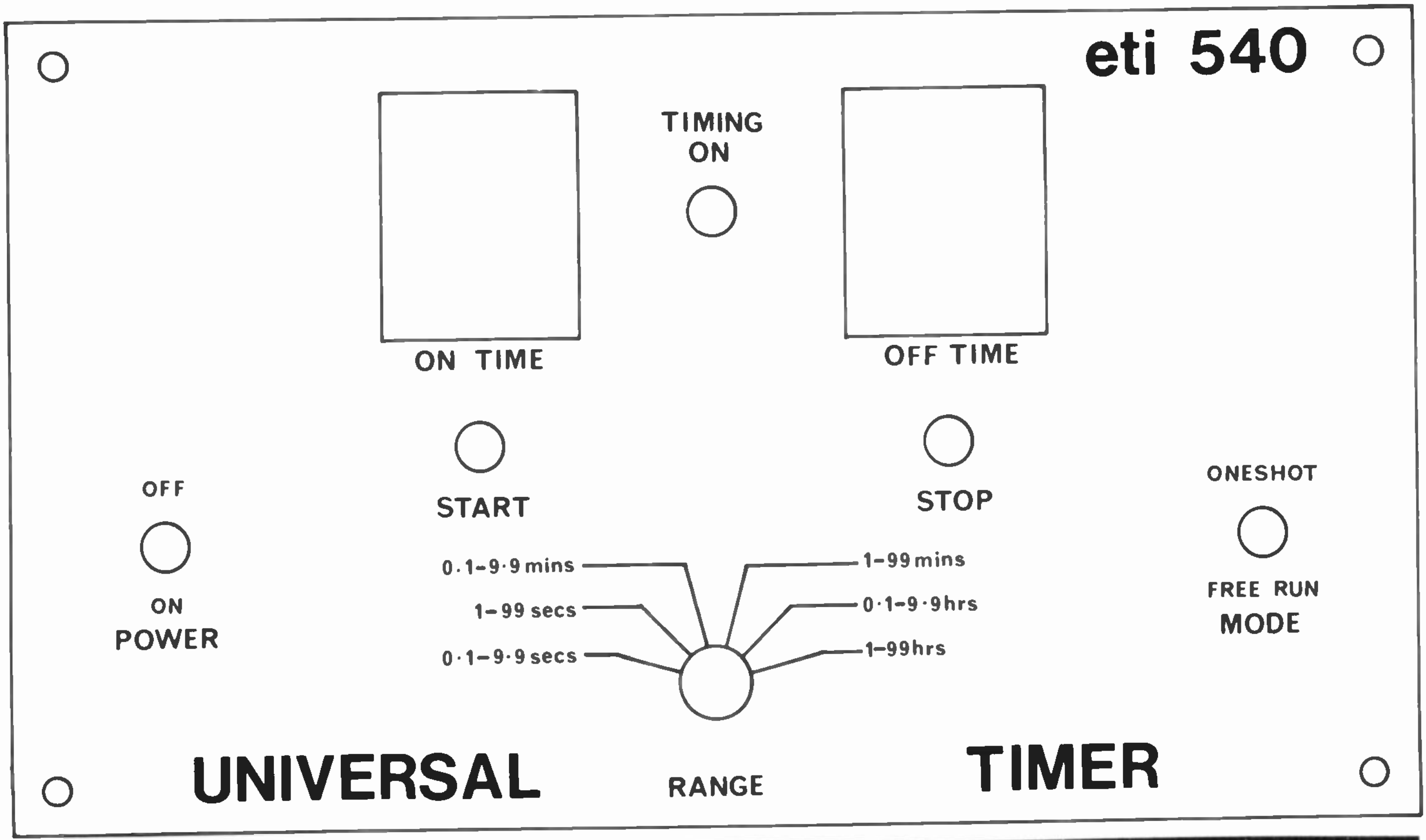
Fig. 3. Interconnection diagram.



*R3 SHOULD EQUAL LDR RESISTANCE AT OPERATING POINT (COULD BE VARIABLE)

Fig. 6. For triggering timer from a change in light level this circuit will be found suitable.

Fig. 5. Front panel artwork. Full size 190 x 109 mm.



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B40-12	40W out	$17.50	$17.20

or $30 per set

Send S.A.E. for details of other kits, components.
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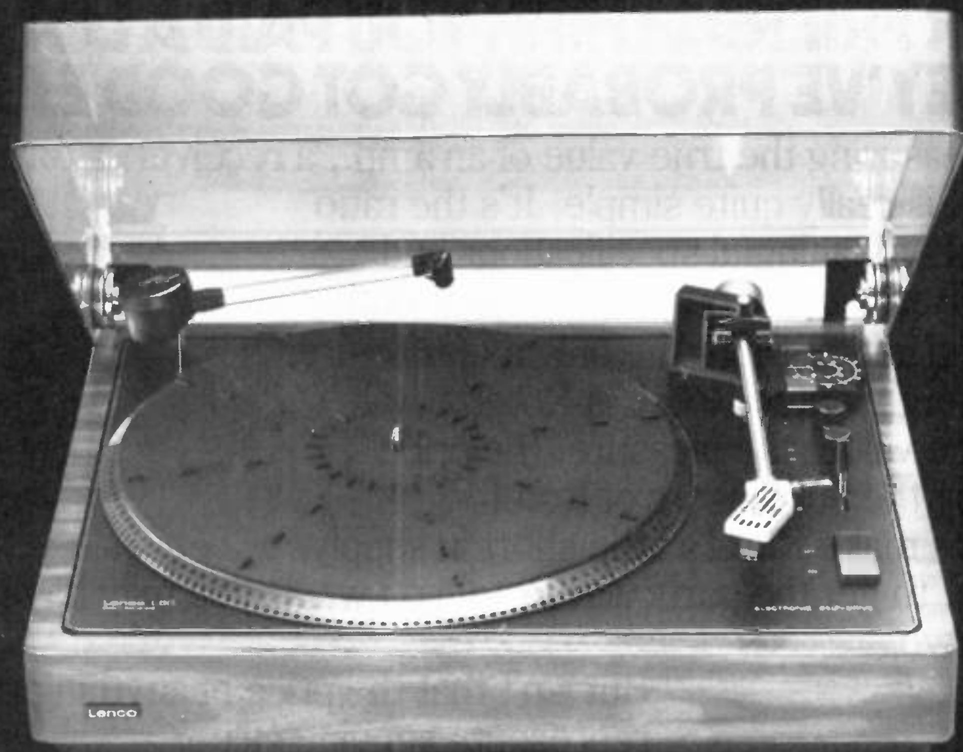

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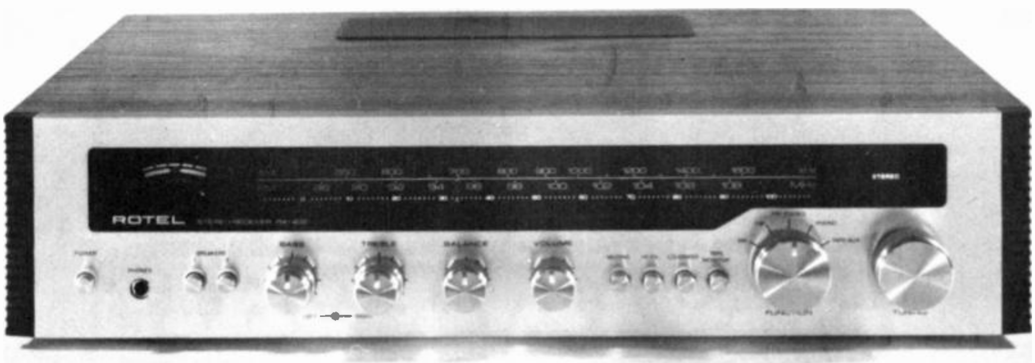


Rotel RX 402 FM/AM Receiver

Emergency flash

Truly portable battery-operated unit generates immensely bright flashes about fifty times a minute for up to 20 hours.

A COMPLETELY PORTABLE emergency flash unit has many applications – particularly as a rescue aid when boating or hiking in isolated areas.

For such purposes it is essential that the unit be self-contained, compact and light in weight. It must above all produce a brilliant powerful flash that will attract attention over long distances, yet be capable of operating for at least eight hours from a couple of torch batteries.

The two requirements of high power and battery economy preclude the use of incandescent globes. However a xenon flash tube is capable of producing about fifty 0.6 joule flashes per minute for 20 hours or so if energised – via suitable circuitry – from a pair of alkaline 'D' cells.

CONSTRUCTION

This may take any number of suitable forms. One approach is shown in the drawings and photos in this feature. No doubt readers will be able to construct individual housings to suit their own requirements.

Our unit was based on a metal-cased torch powered by two 'D' cells. We discarded the torch globe and reflector but retained the switch mechanism.

Regardless of the form of housing, construction should be based on the printed circuit board shown. All components should be mounted on the board as shown in the overlay drawing taking care that the diode, SCR, power transistor and pulse transformer are the correct way round.

The trigger lead of the pulse transformer is connected to a spiral of copper wire wound around the body of the flash tube to ensure reliable triggering. The inverter transformer is mounted to the board with a 4 BA or similar screw. This also secures the special bracket that contacts the positive terminal of the battery. This bracket is made from a piece of 18 gauge aluminium as shown in the side view diagram. The brass strip in the torch housing which normally makes contact with the reflector is soldered to the large pad provided for this purpose. This connection, as well as forming the negative battery connection, also holds the board down into the torch body.

We discarded the torch glass and the threaded flange which retains the glass, trimmed back the torch housing a little with tin snips, and then soldered the lid of a jam jar to the torch housing. The jar lid had previously had a hole cut through it to allow the electronics to protrude through into the jar. The jar should be kept over the unit whenever it is being operated as some parts of the circuit are at 400 volts or so and a nasty shock could be received.

The capacitor used for CI is not rated at 300 V but has been found to be entirely suitable for such intermittent pulse operation. A capacitor rated at the full voltage would not only be much bigger and much more expensive, but would not add anything in the way of reliability.

SPECIFICATION ETI 240

INPUT	
Voltage	3 volts (nominal)
Current	400 to 450 mA at 3 volts
Power	1.25 watts
OUTPUT POWER	0.6 joules/flash
FLASH RATE	1.2 seconds per flash typical
EXPECTED BATTERY LIFE (2 D size cells)	
Alkaline	20 hours
Normal	8 hours
Nickel cadmium	10 hours

Emergency flash

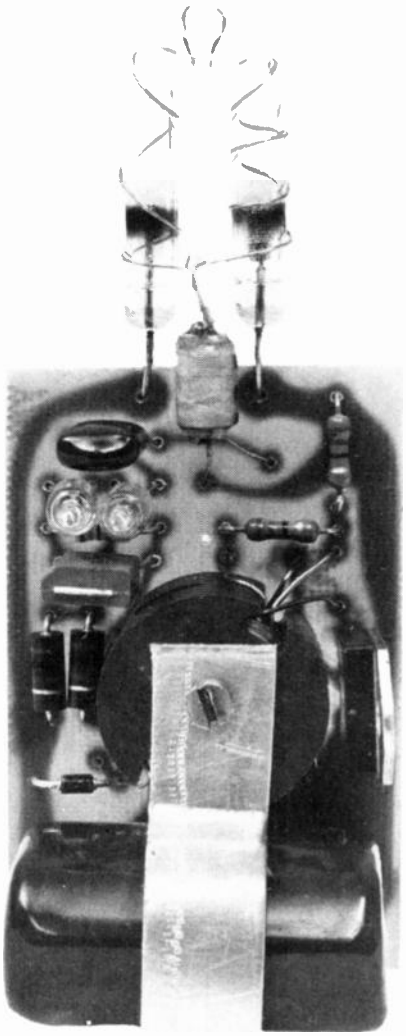


TABLE 1

Winding details transformer T1.

CORE	FX2240 (2 halves) plus single section bobbin to suit
SECONDARY (wound first)	150 turns of 0.315 mm wire
PRIMARY	4 turns 0.5 mm wire (or two 0.315 mm in parallel)
FEEDBACK	4 turns 0.315 mm wire

Mark the start of all windings clearly as polarity is important
Add a layer of Sellotape over the secondary for insulation.

Note that for six volt operation primary should be wound with eight turns of 0.315 mm.

PARTS LIST — ETI 240

Resistors				
R1,2*	—	220	½W	5%
R3,4	—	2M2	"	"
R5	—	10 k	"	"
Capacitors				
C1	—	10 μF	250 V polyester	
C2	—	0.1 μF	200 V	
Transistor				
Q1	—	TIP 3055		
Diode				
D1	EM408			
SCR1	C106D			

Transformer

T1	See Text
T2	TR-4 KN

LP1, LP2, Neon Lamps NE2 (75 v)
LP3 Flash Tube MPF 1210

PC Board ETI 240

Torch, Battery etc.

* For 6v operation change R1 to 470 ohm.

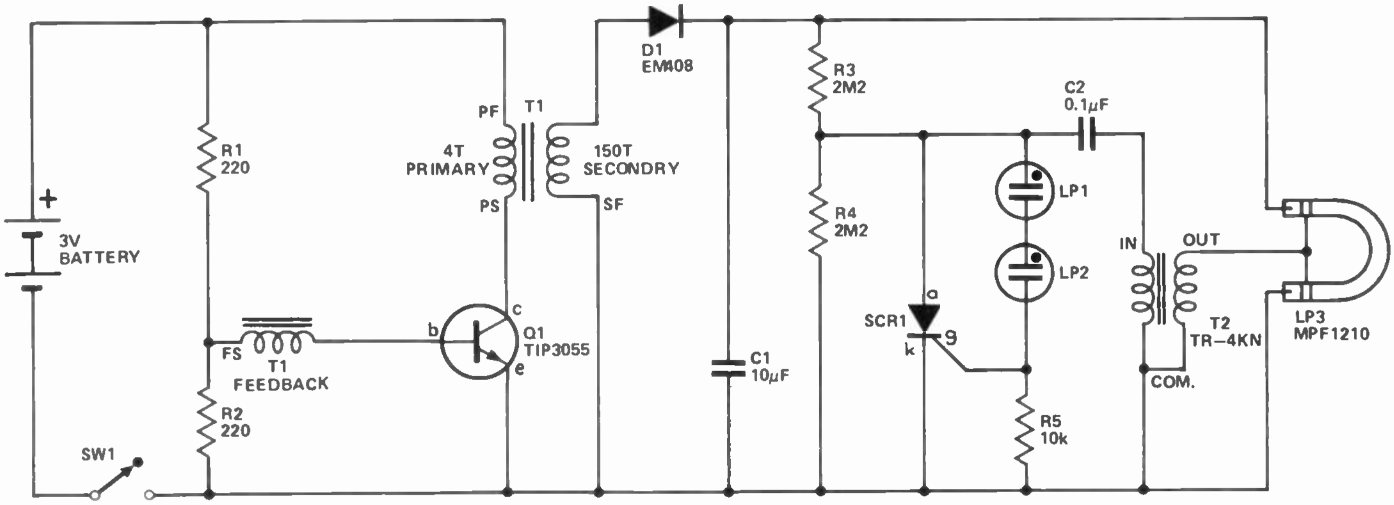


Fig. 1. Circuit diagram of the portable emergency flash.

Fig. 3. Side view of the flash unit showing how board is secured into the torch body. Note particularly the bracket which connects to the battery positive terminal.

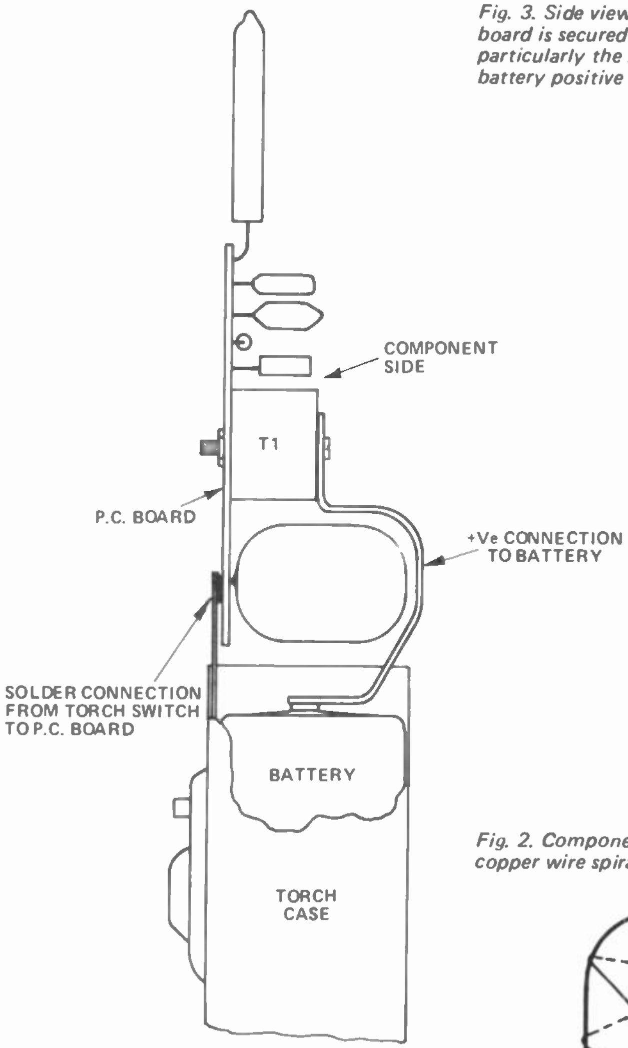
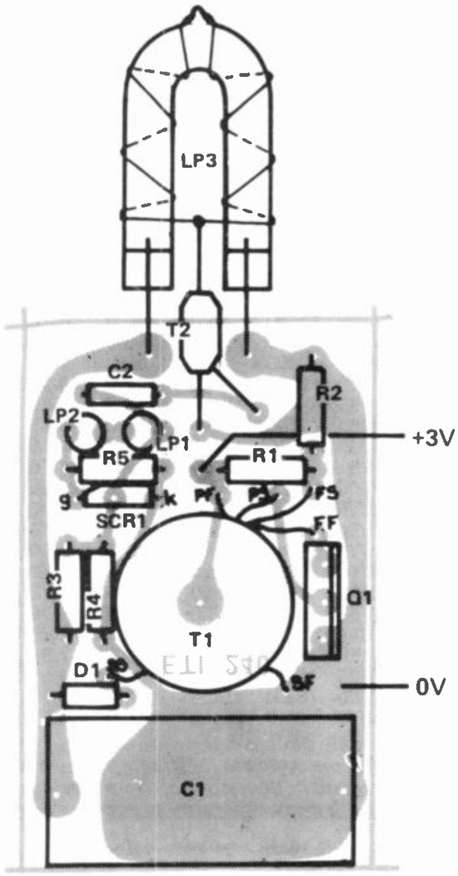


Fig. 2. Component overlay. Note copper wire spiral around flash tube.



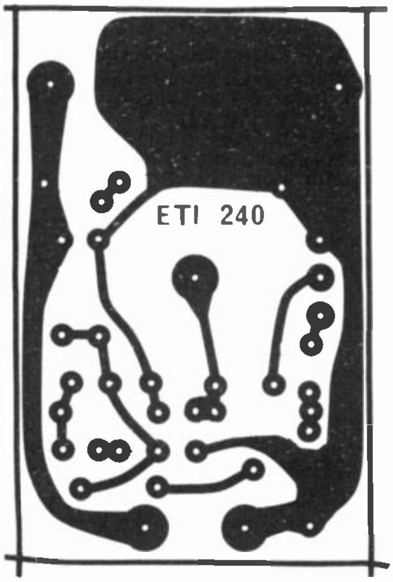


Fig. 4. Printed-circuit layout for the flash. Full size 73 x 47 mm.

HOW IT WORKS – ETI 240

The flash tube requires about 300 to 350 volts to supply the flash energy, and about 4000 volts to trigger it into conduction. The 300 volts is generated from a three-volt battery supply via a blocking oscillator. The oscillator works as follows.

On switch-on the transistor Q1 is biased on by R1 and R2 and a small voltage is generated across the primary of transformer T1. Due to the action of the transformer a voltage is induced in the feedback winding of the transformer which turns on Q1 hard. The current in the primary therefore increases sharply until the transformer core-material saturates. At this time normal transformer action stops, the feedback voltage disappears and the transistor turns off. The polarity of the voltage on the primary reverses and the energy stored in the core must be dissipated. In effect the energy is dumped into capacitor C1 via the diode D1 causing C1 to charge to the 300 volts or so required. If the capacitor was not present the voltage on the collector of the transistor would be high (60 volts or more) and the secondary voltage would be well over 1000 volts. Therefore it is essential that the oscillator never be run without the load connected. It is also essential that the polarity of the windings be correct as marked on the circuit diagram (PS for primary start etc).

When the energy in the core has been dumped into C1 the transistor turns on again and the cycle is repeated. The repetition rate depends on the voltage across C1 but is typically within the range 8 to 15 kHz.

When the voltage across C1 reaches 300 to 350 volts the voltage across the SCR is about 150 volts and at this point the two neon lamps conduct thus triggering the SCR. The SCR now discharges C2 via the primary of the pulse transformer thus generating a pulse of about 4000 volts amplitude on the secondary. The pulse is applied to the trigger electrode of the xenon tube causing it to strike. The flash tube then discharges capacitor C1 in about 10 microseconds giving a very intense and high-speed flash of light. The peak current in the flash tube is about 350 amps.

The SCR turns off automatically due to ringing of the pulse transformer and the low amount of current available through R3.

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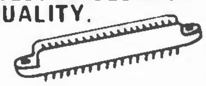

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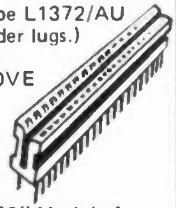

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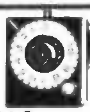

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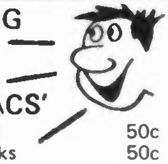

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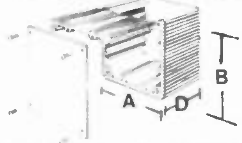

Will give your equipment a professional look without special tooling. The precision joints tighten under stress and are rigidly secured when the cover plate screws are fitted. 2 1.5 mm slots are provided on the inside surface of each extrusion to accommodate either P.C. cards or metal deck plates. The finned sides act as an effective heat radiating surface. The following types are available:–

Part No.	Depth (mm)	End Plate Dim: A (mm)	B	Price	P & P
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EVB/F/50-50/50	50.0	58.0	58.0	2.00	.75
EVB/F/50-50/75	75.0	58.0	58.0	2.25	.75
EVB/F/50-100/25	25.0	58.0	108.0	2.25	.75
EVB/F/50-100/50	50.0	58.0	108.0	2.60	1.00
EVB/F/50-100/75	75.0	58.0	108.0	2.95	1.00
EVB/F/50-100/150	150.0	58.0	108.0	5.25	1.25
EVB/F/50-150/25	25.0	58.0	158.0	3.25	1.25
EVB/F/50-150/75	75.0	58.0	158.0	4.25	1.25
EVB/F/50-150/100	100.0	58.0	158.0	4.85	1.25
EVB/F/50-150/150	150.0	58.0	158.0	5.75	1.50
EVB/F/50-200/25	25.0	58.0	208.0	4.15	.85
EVB/F/50-200/50	50.0	58.0	208.0	4.50	1.00
EVB/F/50-200/75	75.0	58.0	208.0	4.75	1.00
EVB/F/50-200/100	100.0	58.0	208.0	5.50	1.25
EVB/F/100-100/25	25.0	108.0	108.0	2.95	1.00
EVB/F/100-100/50	50.0	108.0	108.0	3.55	1.00
EVB/F/100-100/75	75.0	108.0	108.0	4.50	1.25
EVB/F/100-100/100	100.0	108.0	108.0	5.50	1.25
EVB/F/100-150/25	25.0	108.0	158.0	3.75	.90
EVB/F/100-150/50	50.0	108.0	158.0	4.25	1.00
EVB/F/100-150/75	75.0	108.0	158.0	4.85	1.25
EVB/F/100-150/150	150.0	108.0	158.0	7.25	1.50
EVB/F/100-200/25	25.0	108.0	208.0	4.25	1.00
EVB/F/150-150/50	50.0	158.0	158.0	5.15	1.00
EVB/F/150-150/150	150.0	158.0	158.0	8.50	1.25

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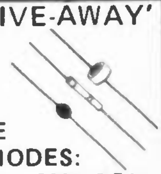

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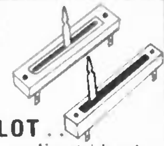

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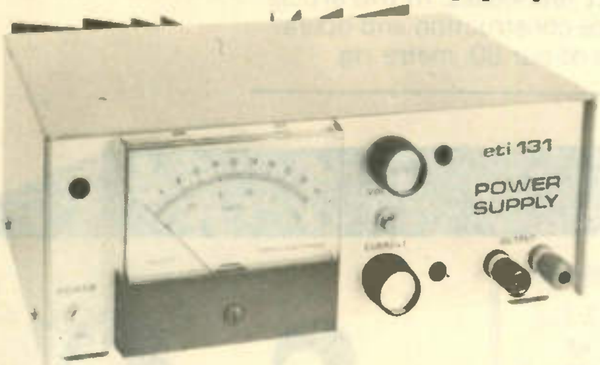

Build this superb 0-20 volt (or 40v) 0-2.5A (0-1.25A) general purpose power supply. See ETI April 1976 for details.

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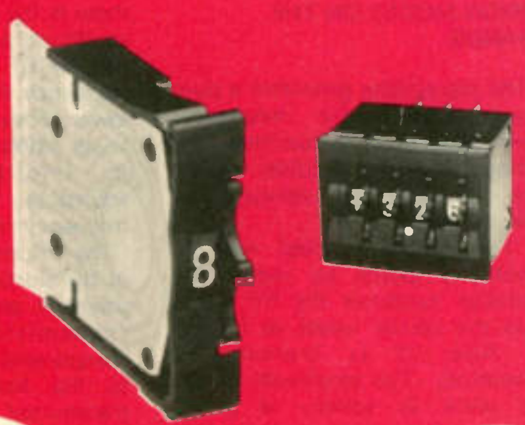

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Novice transmitter

Australia's first novice licences will be issued in the next few weeks. In this article we look at the design of a transmitter suitable for novice construction and operation. Next month we will publish constructional details of our 80 metre rig.

NOVICE BANDS
3.525 to 3.575 MHz
21.125 to 21.200 MHz
26.96 to 27.23 MHz

NOVICE LICENCE EXAMINATIONS
The PMG will not grant a licence unless the applicant has passed the following tests:

(i) **Theory** This is a 1-hour multiple-choice examination on the principles of radio and electronics.
(ii) **Regulations** This tests knowledge of the regulations imposed by the PMG. It is the same exam for novices and amateurs.
(iii) **Morse code** A novice must show proficiency in sending and receiving morse at five words per minute.

COMMON MODES ON THE HF BANDS

CW The transmitter generates a pure sinewave at radio frequency. Information is transmitted by emitting this energy in pulses – using morse code. CW stands for continuous wave.

AM This is the simplest way of transmitting speech by radio. The transmitter produces the RF signal (called the carrier wave) as in CW, but now it is transmitted continuously. The amplitude of the radio wave is varied, at audio frequency, by a process known as modulation. AM stands for amplitude modulation and this is the mode used by medium-wave broadcast stations.

SSB The AM waveform is complex. It can be analysed as the sum of three component waveforms. One of these is the carrier wave (constant in amplitude and frequency); the other two are RF waveforms, one higher in frequency than the carrier, the other lower. These are called the upper and lower sidebands. The sidebands vary in amplitude and frequency according to the amplitude and frequency of the audio modulation.

The information is carried in each of the sidebands. The carrier and one sideband are redundant. In an SSB transmitter these redundant components are not allowed through to the final amplifier so all the transmitted power goes to a single sideband (hence SSB). An SSB station occupies half the bandspace of an AM station.

DSB In a double sideband transmitter only the carrier is suppressed. The bandwidth is the same as that of an AM station.

THE NOVICE LICENCE PERMITS the holder to operate a crystal-controlled transmitter on certain frequencies on the 80, 15, and 10 metre bands. The output power of the transmitter is limited to 10 watts (AM) or 30 watts PEP (SSB). Permitted modes include CW, AM, SSB and DSB.

Mode The most effective way to make a long-distance contact from a novice station is to operate CW (ie morse code). This facility will be included in our design. It requires no extra circuitry to incorporate CW in a transmitter and it is essential that the novice practises his morse. Before he can obtain an amateur licence he will have to improve his speed from 5 to 10 words per minute.

Most amateurs prefer to communicate by speech so we will incorporate this facility in our transmitter. The three common ways a transmitter can do this are AM, SSB, and DSB.

The most effective, and nowadays the most common, of the speech modes is SSB. A novice, however, is advised against starting out experimenting with SSB. The building of the transmitter and its setting up require expertise and equipment.

DSB comes next – it is simpler than SSB and more effective than AM. The problem with DSB is that it is difficult to receive unless you have an expensive receiver. The novice would find it easier to get contacts with AM.

Our consideration of the possible

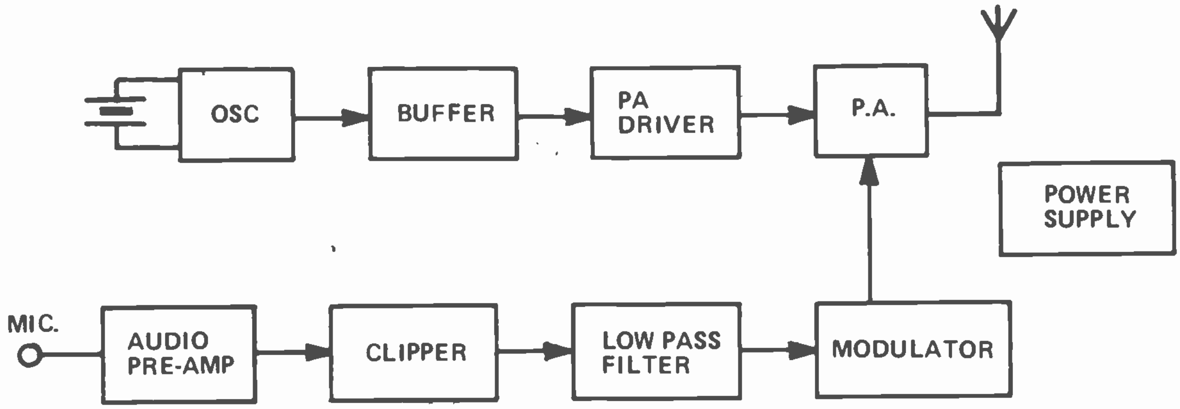


Fig. 1. Block diagram of the Novice transmitter.

modes has lead us to choose CWand AM for our project. AM is simple to receive and requires no complex circuitry in the transmitter. It is ideal for local contacts.

VALVES OR TRANSISTORS

Our next decision was whether to use valves, transistors, or a combination. New valves are expensive and require a high voltage power supply. Novices who build valve transmitters will probably get their components from their junk-box.

Transistors designed for transmitters are also expensive. We considered other types of transistor. Recently we used high-speed switching transistors in a power supply project (ETI119, December 1975) and they proved to be very robust. The BDY92 from Philips has an applications note for use in an SSB linear amplifier so we gave it a try in our design.

With the BDY92 as a power amplifier we need about one watt of drive. We have used the BD139 in audio amplifiers to give this power level and the spec shows it to be quite fast with high voltage ratings. In our design it proved to be adequate. The BDY92 and BD139 take care of the RF section of the transmitter; the audio processing and modulation stages need to be decided.

Processing By this we mean tailoring of the frequency response and limiting of the positive and negative peaks of the audio modulation waveform. Limiting the frequency response means that more energy can be devoted to the useful part of the spectrum and it means that the station takes up less room on the band (which allows more stations to use it). Fortunately speech can be limited to 3 kHz and retain all the useful information.

MODULATION

Overmodulation · If the audio input to the modulator is too high the signal will be distorted and it will cause interference. The distortion manifests itself as a considerable increase in harmonic content. These harmonics modulate the carrier and extend the radiated bandwidth many kilohertz. This interference can ruin communications for other stations in the band. The name given to interference of this type is 'splatter'.

The way a sophisticated amateur station prevents splatter is to use an audio compressor to keep the average audio level constant, followed by a peak clipper to catch the occasional fast peak. Compressors are complicated and expensive so we have taken the simpler alternative of using only a clipper.

In practice it has been found that despite distortion heavy clipping of an audio signal considerably increases its readability. This is because higher levels of modulation can be used. Clipping distortion is nothing like as bad as the distortion (from overmodulation) which would be caused if the audio was not clipped (assuming the same modulation level). The operator can establish his own compromise between distortion and modulation level, within the limits of overmodulation, using the clipper control on the front panel.

Low level modulation There are several methods we could use to amplitude-modulate our RF carrier. It can be done at low signal levels — then the final amplifier has to handle a complex AM signal. The more usual method is to modulate after the final RF amplifier — high level modulation. Normally low level modulation is ruled out because it requires the final stage to be linear, but with our final (BDY92) this method is possible.

We used our audio to control the drive to the final power amplifier (PA for short). Distortion was reduced by feeding back a sample of the audio from after the PA. The results were good when the system was set up properly. Distortion was kept down to 1% at 50% modulation and 2.5% at 95% modulation. The beauty of this method is that a PA stage of 10 watts is controlled by an audio signal of 1 watt. High level modulation systems require audio of about two thirds or the power of the PA stage.

We were reluctantly forced to abandon this method of modulation because of the difficulty in setting up the transmitter. An audio oscillator and a CRO are needed.

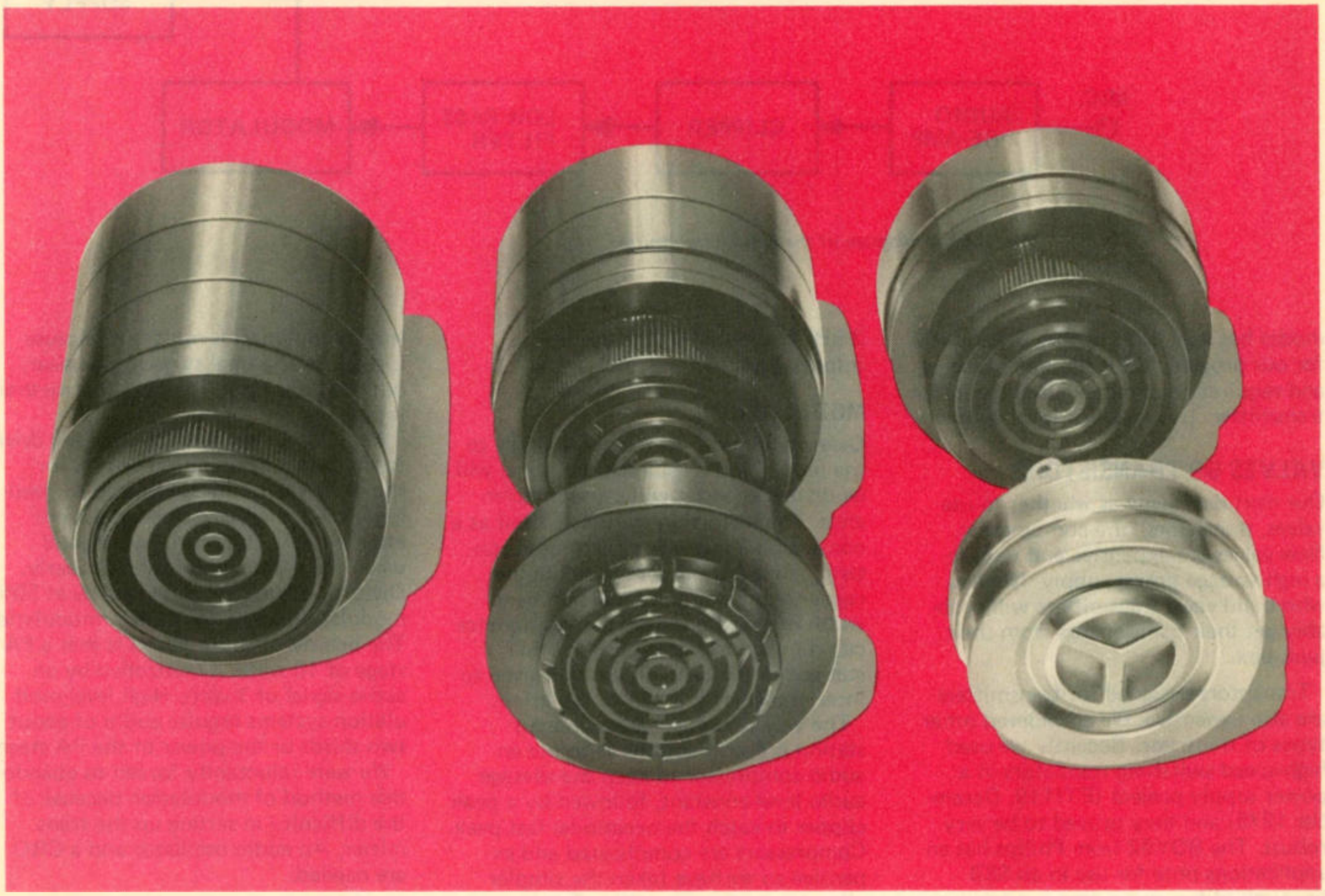
High level modulation The method we finally chose was high level series modulation. The audio signal is superimposed on the positive supply rail of the PA. This varies the amplification of RF by this stage at audio frequencies. To obtain full modulation in the upwards direction we found it necessary to modulate the driver as well as the PA (but only in the upward direction).

Finally, PMG regulations require the operator to have provision for monitoring the input power to the antenna and a meter has been provided for this purpose.

The result is an inexpensive transmitter which is easy to build and set up. It gives the novice a basic understanding of radio and provision to practice morse and discuss his hobby with other enthusiasts.

Full constructional details will be given next month.

If anything alarming were to happen now this page would make one helluva noise.



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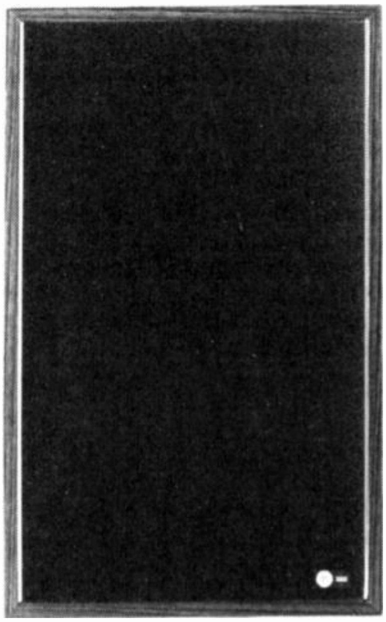
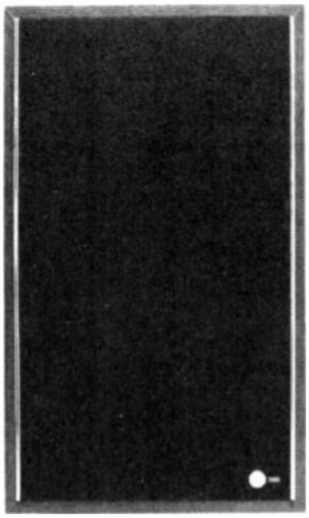
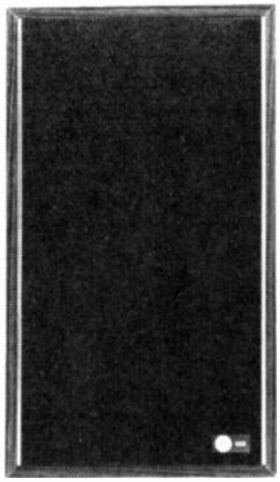
Model: EDS 3000
12" Woofer 4¼" Midrange 3" Tweeter
25-20,000 Hz 60 Watts RMS at 8 ohms



Model: EDS 2000
10" Woofer 3" Tweeter
35-20,000 Hz
30 Watts RMS at 8 ohms



Model: EDS 1000
8" Woofer 3" Tweeter
35-20,000 Hz
30 Watts RMS at 8 ohms



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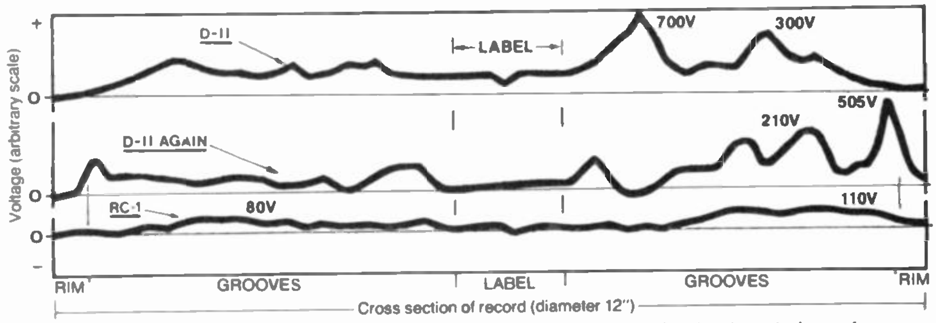
Tests prove that Tracker cleans up the competition, as well as your records and tapes.

Various types of record cleaners have been available for decades. However, most of these products have failed to keep pace with modern advances in record materials and recording techniques. The Tracker RC-1 record cleaning solution was developed to meet these modern demands.

Tracker cleaning products went into stringent testing at the Chemistry Dept. at the University of Victoria, B.C., Canada in 1974 and as this chart shows, Tracker RC-1 dramatically reduced the records static charge.

Further information on the Canadian Tests is available by writing to us at Box No. 882, G.P.O. Sydney, 2001.

Tracker products are suited to all the new and advanced record materials, advanced sound techniques and delicate tape heads.



These 3 traces show static charge on a record after cleaning twice with competitive cleaning solution and then once with RC-1 solution.

There's the RC-1 Record Care Kit, that not only thoroughly removes the static, but helps to resist further build-up of negative static charge. This protects the grooves from being ground away by new particles of dirt. This modern cleaning kit consists of an exclusive formulation together with handy screw-on spray, plus a fine velvet pad. Refills are available.

And for your tape collection, Tracker provides delicate professional care with the HC-1 Tape Recorder Care Kit. Tracker came through the tests, so give your old cleaners the brush off and go with the winner!

Look for the Tracker RC-1 and HC-1 under our label, or branded under your hi-fi shop's name.

tracker
Better than anything you've used before.

PKB88530

ETI data sheet

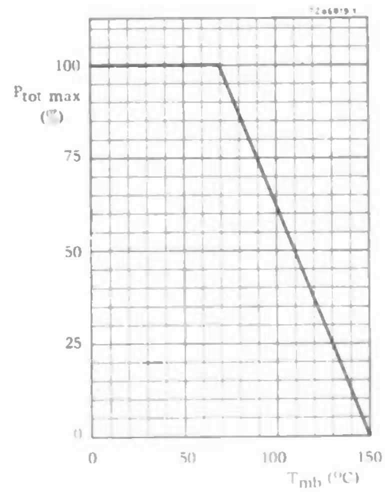
BD 136-140 General purpose npn transistors

The BD 136-140 series are general purpose pnp transistors recommended for driver stages in hi-fi amplifiers and TV receivers. They are housed in SOT-32 plastic cases. Their npn equivalent is the BD 135-139.

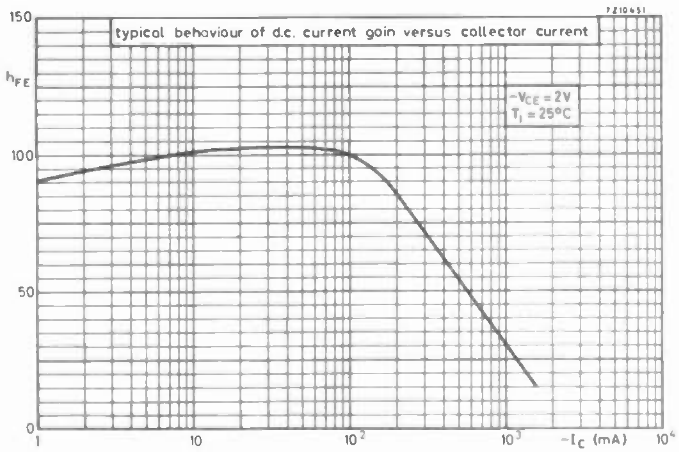
Transistors BD 636, 638 and 640 use the same clip as the BD 136-140 series. The devices are however mounted in a TO 92 plastic case. Power is limited to 1 watt and thermal resistance Rth j-a increases to 156° C/W.

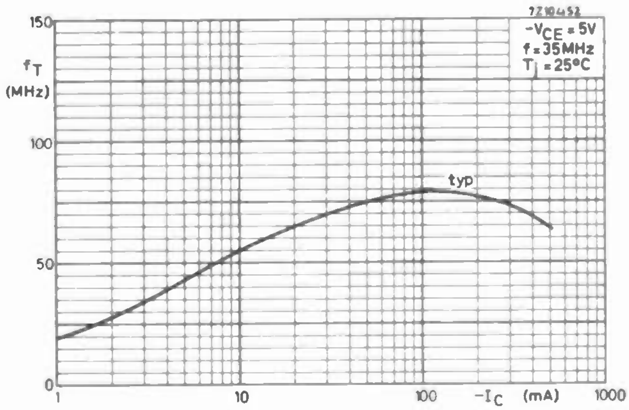
QUICK REFERENCE DATA

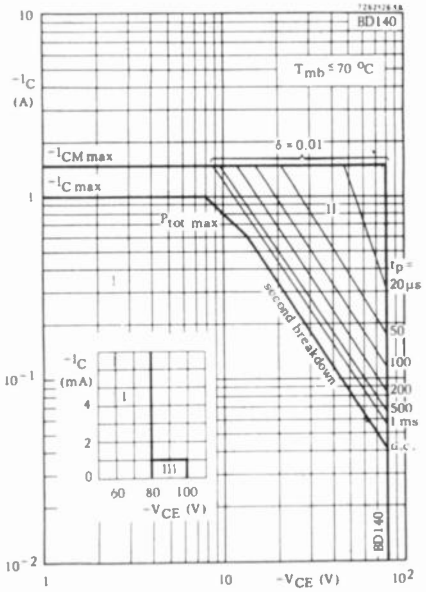
			BD 136	BD 138	BD 140
Collector-base voltage (open emitter)	$-V_{CBO}$	max.	45	60	100 V
Collector-emitter voltage (open base)	$-V_{CEO}$	max.	45	60	80 V
Collector-emitter voltage (R_{BE} = 1 kΩ)	$-V_{CER}$	max.	45	60	100 V
Collector-current (peak value)	$-I_{CM}$	max.	1.5	1.5	1.5 A
Total power dissipation up to T_{mb} = 70°C	P_{tot}	max.	8	8	8 W
Junction temperature	T	max.	150	150	150°C
D.C. current gain					
$-I_C$ = 150 mA; $-V_{CE}$ = 2 V	h_{FE}	>	40	40	40
		<	250	160	160
Transition frequency at f = 35 MHz					
$-I_C$ = 50 mA; $-V_{CE}$ = 5 V	f_T	typ.		75 MHz	
Collector current (dc)	$-I_C$	max.		1.0 A	
Total power dissipation up to T_{mb} = 70°C	P_{tot}	max.		8 W	
Thermal Resistance					
From junction to ambient in free air	$R_{th\ j\text{-}a}$			100°C/W	
From junction to mounting base	$R_{th\ j\text{-}mb}$			10°C/W	
Saturation voltage					
I_C = 500 mA; I_B = 50 mA	$-V_{CEsat}$	<		0.5 V	
D.C. current gain ratio of matched pairs BD135/BD136; BD137/BD138 BD139/BD140					
$\lvert I_S \rvert$ = 150 mA; $\lvert V_{CE} \rvert$ = 2 V	h_{FE1}/h_{FE2}	typ.		1.3	
		<		1.6	
D.C. current gain					
$-I_C$ = 5 mA; $-V_{CE}$ = 2 V	h_{FE}	>	25	25	25
$-I_C$ = 150 mA; $-V_{CE}$ = 2 V	h_{FE}	>	40	40	40
		<	250	160	160
$-I_C$ = 500 mA; $-V_{CE}$ = 2 V	h_{FE}	>	25	25	25



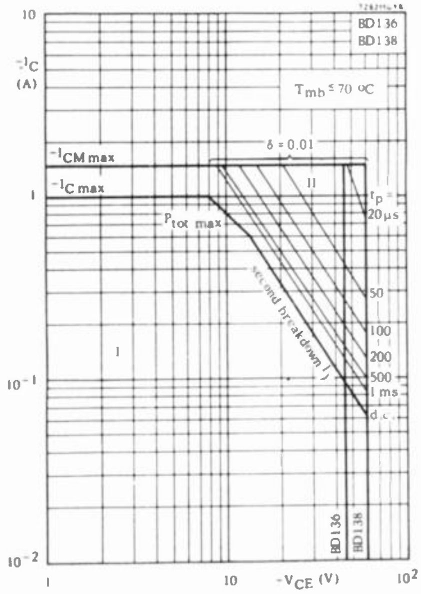
Maximum dissipation related to case temperature.







Safe operating area for BD 136 and 138.

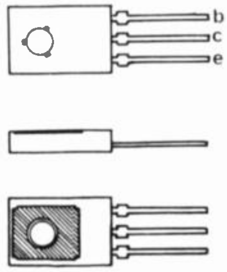


Safe operating for BD 140

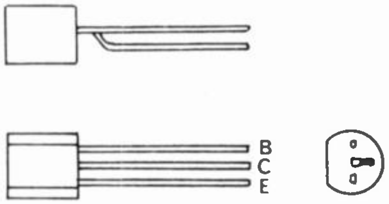
NOTE – operation outside the areas shown for longer than the specified time can lead to transistor failure.

Transistor Types				Connections
	BD136	BD138	BD140	1
Electrically similar (but see main text)	BD636	BD638	BD640	2

1



2



CIRCUIT DIAGRAM MARKINGS

ELECTRONICS Today International is adopting British Standard BS1852: 1967 for marking component values on circuit diagrams.

The values of components are given by figures but the decimal point is replaced by a multiplier symbol in accordance with a table of standard prefixes. This procedure greatly reduces the possibility of errors (due to decimal points being left out, or a random printing spot falling in the wrong place).

The changeover should be completed in the next few months.

Examples

4 k7	equals	4.7 k ohm
47 k	"	47 k ohm
1M5	"	1.5M ohm
4n7	"	4.7 nF
6p8	"	6.8 pF

Where a multiplier is not needed, the symbol 'R' is inserted to signify ohms.

Example

4R7 equals 4.7 ohms

Note also that capacitors that were formerly specified as decimal fractions of microfarads (10^{-6}F) expressed in nanofarads (10^{-9}F).

Example

0.01μF = 10 nF

Abbreviation	Read as:	Multiplies unit by:
T	tera	10^{12}
G	giga	10^{9}
M	mega	10^{6}
k	kilo	10^{3}
h	hecto	10^{2}
da	deka	10
d	deci	10^{-1}
c	centi	10^{-2}
m	milli	10^{-3}
μ	micro	10^{-6}
n	nano	10^{-9}
p	pico	10^{-12}
f	femto	10^{-15}
a	atto	10^{-18}

Standard prefixes. Multiplier symbols above 1000 are written with capital (upper case) letters, multipliers below 1000 do not use capitals (i.e. they are in lower case).

When spelled out in full, all multipliers start with a lower case letter (except when it is the first letter in a sentence).

Thus – 10 MW = 10 megawatts
– 10 mW = 10 milliwatts

The hungry leader.

At Altec, we're not taking our leadership position for granted. We're always trying harder — challenging ourselves to develop studio monitor speakers that stay a step ahead of constant improvements in the contemporary recording process. And we can prove it. Here's the latest data on monitors installed in U.S. studios, as published in Billboard's 1974 International Directory of Recording Studios.

MANUFACTURER	NUMBER OF MONITORS USED IN U.S. STUDIOS
Altec	522
JBL	339
EV	82
KLH	39
AR	34
Tannoy	24

But we're not really satisfied — even with this impressive track record. We're still trying to better ourselves. In fact, Altec has three all-new studio monitors available right now. They're a whole new generation of speakers designed to meet the whole new range of tomorrow's dynamic recording techniques. Your studio may need them. Why not call us for full details.

Altec gives you the best of both worlds proven leadership, plus an unrelenting commitment to doing a better job. That's because we've really grown to enjoy being # 1 in studio monitor sales during the past three decades. And we intend to stay right there for at least the next three decades by always being our own biggest competitor — in research, in quality, in service and in satisfying the demanding needs of an ever-evolving industry. The domestic ALTEC recently introduced into Australia has already gained rapid response from the discerning Hi-Fi enthusiasts.

Domestic from

$320

pair

Number one. And have been for nearly 3 decades.

Limited numbers of 604E professional monitors available at $285 each.

ALTEC

the sound of experience

KENT HI-FI

(WHERE THE BEST EQUIPMENT COSTS LESS)

410 KENT STREET
SYDNEY
ph: 29-2743

DRAKE

R.L. DRAKE COMMUNICATIONS GEAR

DSR2 Digital readout communications **RECEIVER** 10 kHz-30 MHz continuous coverage, fully synthesized, for AM-USB-LSB-CW reception. **$3495.**

SPR4 communications **RECEIVER** for AM-USB-LSB-CW reception. Direct frequency dialling 150-500 kHz plus any 23 x 500 kHz ranges between 0.5 and 30 MHz. **$697**

R4C Amateur **RECEIVER** covers H.F. ham bands plus any 15 x 500 kHz ranges between 1.5 and 30 MHz except 5.0 to 6.0 MHz. **$640.** (transceives with T4XC)

SSRI Synthesized communications **RECEIVER**. Provides continuous coverage 500 kHz to 30.0 MHz for AM-USB-LSB reception. Operates from A.C. Mains or internal batteries. **$375**

TR4C sideband **TRANSCEIVER** full amateur band coverage 10 through 80 meters. **$630**

T4XC sideband **TRANSMITTER** full amateur band coverage 10 through 80 meters plus 160 meters accessory crystal plus 4 fixed frequency positions. **$609** (Transceives with R4C).

MN4 and MN2000 **MATCHING NETWORKS** – enable Feedline SWR's of up to 5:1 to be matched to the Transmitter. Built in Wattmeter. MN4 Handles 200 Watts. MN2000 Handles 1000 Watts continuous and 2000 Watts PEP MN4 **$115** MN2000 **$230.**

TV – 42 – L.P. **FILTER** for Transmitters below 30 MHz – 100 Watts continuous. **$11.50**

TV – 300 – HP **FILTER** – TV Set protection from transmitters 6 – 160 meters. **$9.00**

TV – 3300 – LP **FILTER** 1000 Watts continuous to 30 MHz with sharp cut off above 30 MHz. **$24.00.**

RP500 – Receiver **PROTECTOR** for Receiver front end protection from close proximity high power transmitters. Less than 0.5 dB Insertion Loss to 30 MHz. **$77.00**

W4 WATTMETER/SWR METER 2 – 30 MHz with 200 Watt and 2000 Watt ranges. **$65.00.**

WV4 WATTMETER/SWR METER 20 – 200 MHz with 100 Watt and 1000 Watt ranges. **$78.00.**

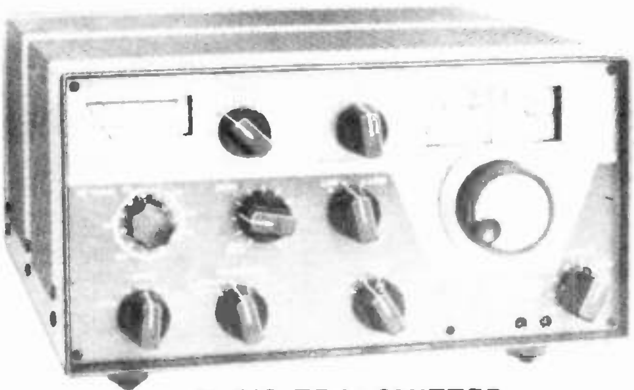
AC4 **POWER SUPPLY** for mains operation of TR4C or T4XC. **$175.00**

DC4 **POWER SUPPLY** for battery operation of TR4C or T4XC. **$187.00**

NIPPAN FC **FREQUENCY COUNTER** 15 Hz-250 MHz. Operates from mains or battery. **$258.00**

MINIPET LARGE DISPLAY 10 DIGIT MAINS OPERATED 4 FUNCTION **CALCULATORS** with floating decimal and constant. **$30.00**

PRICES shown include Sales Tax



T-4XC TRANSMITTER

TR4C TRANSCEIVER

ELMEASCO

Instruments Pty. Ltd.

P.O. Box 334, Brookvale, N.S.W. 2100
939-7944.
Melbourne: 233-4044; Adelaide 42-666
Brisbane: 36-5061;
Perth: 25-3144;
Wellington. N.Z.: 69-7566

ETI data sheet

μA741 Frequency-compensated operational amplifier

QUICK REFERENCE DATA

Maximum ratings

Supply voltage	± 18 V
Internal power dissipation, metal can	500 mW
Internal power dissipation ceramic DIP	670 mW
Internal power dissipation, silicone DIP	340 mW
Internal power dissipation, mini DIP	310 mW
Internal power dissipation, flatpack	570 mW
Differential input voltage	± 30 V
Input voltage	± 15 V
Operating temperature range	0°C to 70°C
Output short-circuit duration	Indefinite

Characteristics (V = ± 15V)

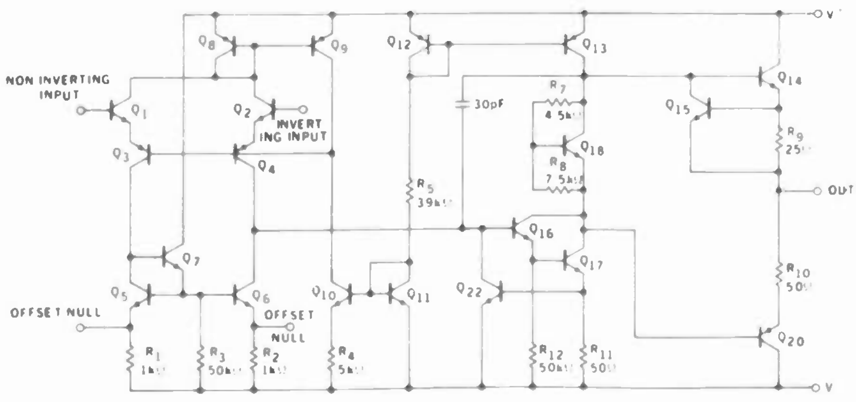
Input offset voltage ($R_S \leqslant 10\ k\Omega$)	typ. 2 mV
Input offset current	typ. 20 nA
Input bias current	typ. 80 nA
Input resistance	typ. 2 MΩ
Input capacitance	typ. 1.4 pF
Offset voltage adjustment range	typ. ± 15 mV
Input voltage range	typ. ± 13 V
Common mode rejection ratio ($R_S \leqslant 10\ k\Omega$)	typ. 90 dB
Supply voltage rejection ratio ($R_S \leqslant 10\ k\Omega$)	typ. 30 μV/V
Large-signal voltage gain ($R_L \geqslant 2\ k\Omega$, $V_{OUT} = \pm 10\ V$)	typ. 200 000
Output voltage swing ($R_L \geqslant 10\ k\Omega$)	typ. ± 14 V
Output voltage swing ($R_L \geqslant 2\ k\Omega$)	typ. ± 13 V
Output resistance	typ. 75 Ω
Output short circuit current	typ. 25 mA
Supply current	typ. 1.7 mA
Power consumption	typ. 50 mW
Transient response, unity gain ($V_{in} = 20\ mV$, $R_L = 2\ k\Omega$, $C_L \leqslant 100\ pF$)	
risetime	typ. 0.3 μs
overshoot	typ. 5%
Slew rate ($R_L \geqslant 2\ k\Omega$)	typ. 0.5 V/μs
Input offset voltage	max. 7.5 mV
Input offset current	max. 300 nA
Input bias current	max. 800 nA
Large-signal voltage gain ($R_L \geqslant 2\ k\Omega$, $V_{out} = \pm 10\ V$)	min. 15 000
Output voltage swing ($R_L \geqslant 2\ k\Omega$)	typ. ± 13 V

The μA741 is a high performance monolithic operational amplifier. It is suitable for a wide range of analogue applications. As a voltage follower it is ideal; the common mode voltage range is wide and there is no latch-up. The high gain and wide range of operating voltages provides superior performance in integrator, summing amplifier, and general feedback applications.

The 741 requires no frequency compensation and is internally protected against short-circuits. It is by far the most common op-amp in amateur use.

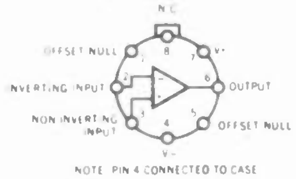
The device comes in two grades — military (312) and commercial (393). Here we deal only with the commercial grade.

EQUIVALENT CIRCUIT

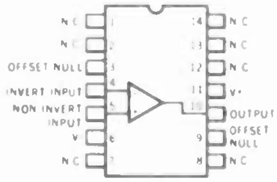


CONNECTION DIAGRAMS (TOP VIEW)

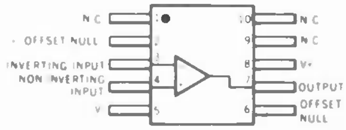
8 LEAD METAL CAN



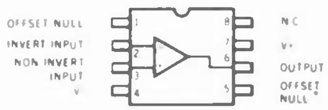
14 LEAD DIP



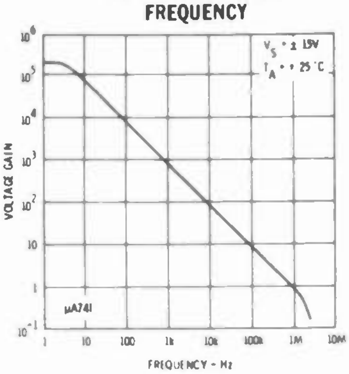
FLATPACK



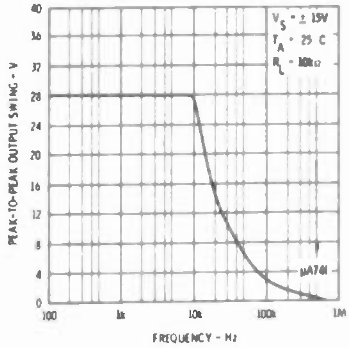
MINIDIP



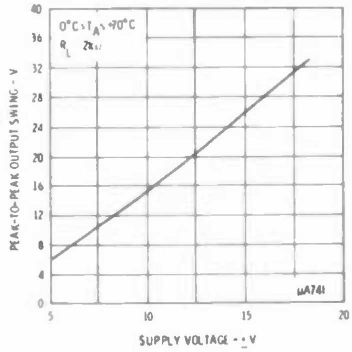
OPEN LOOP VOLTAGE GAIN AS A FUNCTION OF FREQUENCY



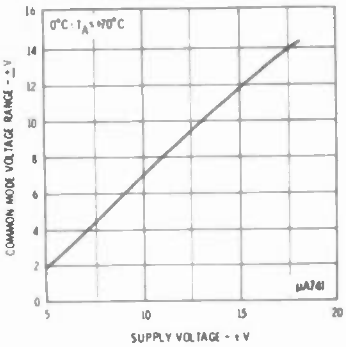
OUTPUT VOLTAGE SWING AS A FUNCTION OF FREQUENCY



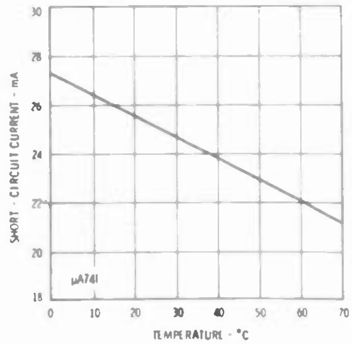
OUTPUT VOLTAGE SWING AS A FUNCTION OF SUPPLY VOLTAGE



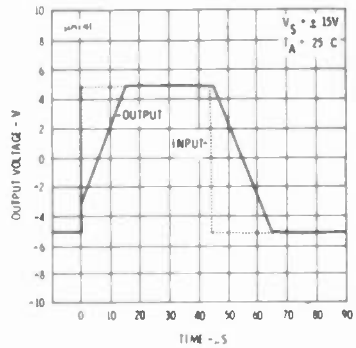
INPUT COMMON MODE VOLTAGE RANGE AS A FUNCTION OF SUPPLY VOLTAGE



OUTPUT SHORT-CIRCUIT CURRENT AS A FUNCTION OF AMBIENT TEMPERATURE

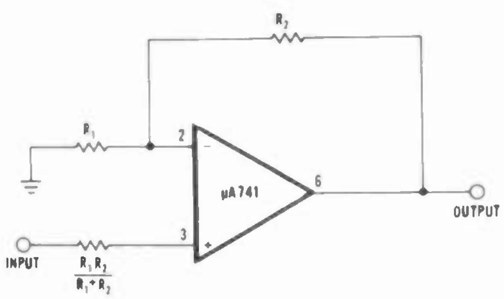


VOLTAGE FOLLOWER LARGE-SIGNAL PULSE RESPONSE



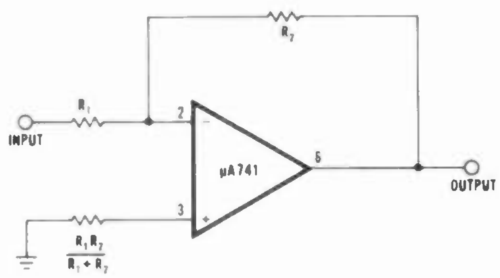
TYPICAL APPLICATIONS

Non-inverting Amplifier



GAIN	R_1	R_2	B.W.	R_{IN}
10	1 kΩ	9 kΩ	100 kHz	400 MΩ
100	100 Ω	9.9 kΩ	10 kHz	280 MΩ
1000	100 Ω	99.9 kΩ	1 kHz	80 MΩ

Inverting Amplifier



GAIN	R_1	R_2	B.W.	R_{IN}
1	10 kΩ	10 kΩ	1 MHz	10 kΩ
10	1 kΩ	10 kΩ	100 kHz	1 kΩ
100	1 kΩ	100 kΩ	10 kHz	1 kΩ
1000	100 Ω	100 kΩ	1 kHz	100 Ω

We've found a tape deck with the beauty of Hasselblad, the clarity of Minolta, and the precision of Bolex.

We searched high and low, reel to reel and deck to deck. For sound recording equipment that has the same high standard of manufacture as our leading camera brands. Top of our list came a brand named Dokorder. Dokorder's reel to reel tape decks are available in two and four channel stereo featuring three-motor and three-head facilities. Dokorder machines range in price from less than $285 to around $915. Advanced design features include electronic operation of tape transport, speed change and multi-sync facilities on the more expensive models. Cassette decks are available with amplifier options, the celebrated Dolby noise reduction system and many other special features.

Telephone or drop us a line. We'd be pleased to send you full specification and price details.

The name is Dokorder.

Second reel (illustrated) extra.

PHOTIMPORT

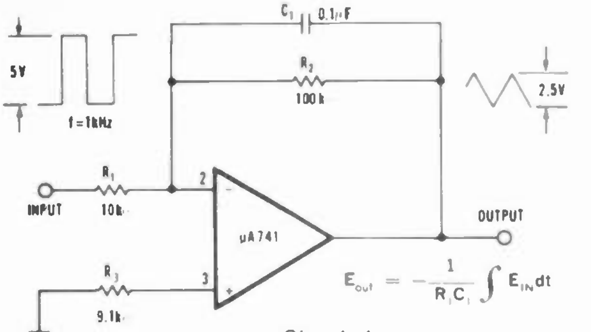
Melbourne Adelaide Brisbane Perth Sydney

For descriptive literature and specifications, send a 30 cent stamp to **Qualitron Industries Division** of Photimport (Australia) Pty. Ltd.

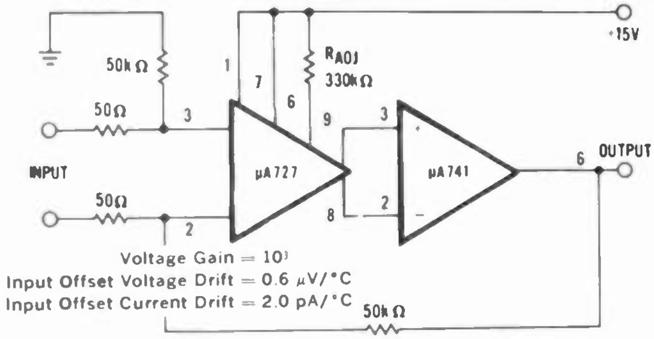
Head Office: 69 Nicholson Street, East Brunswick, Vic. 3057 Australia, Telephone 38 6922

PA3/D

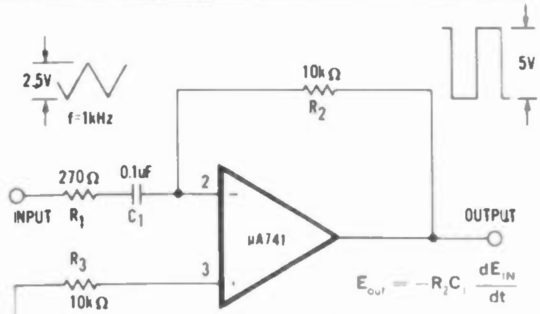
ETI data sheet — 741 applications, cont'



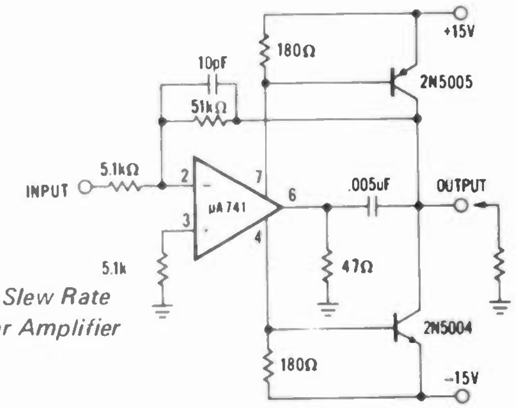
Simple Integrator



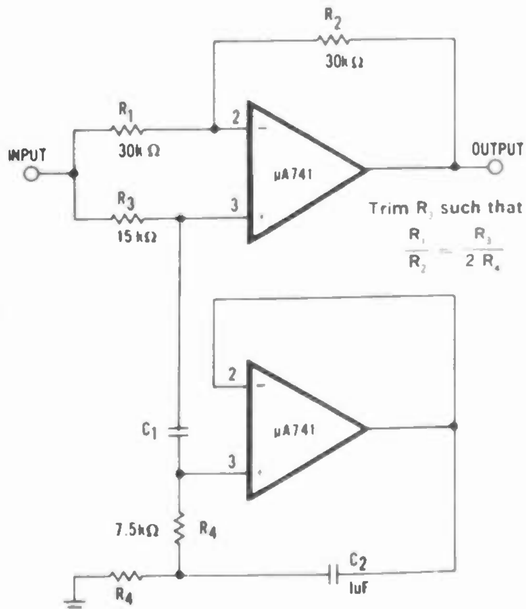
Low Drift Low Noise Amplifier

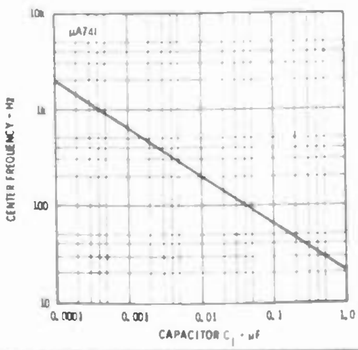


Simple Differentiator



High Slew Rate Power Amplifier





Notch Filter Using the 741 As A Gyrator

Cheap 741s

Special offer to readers of this issue of ETI
T05 8-lead metal can 741s
Special price to readers using the coupon below —
Four ICs for $2
These devices are made by Teledyne and are available by mail order from Dick Smith Electronics Pty Ltd, PO Box 747, Crows Nest, NSW 2065. Please include 50c post and packing charge

OTHER OFFERS — DIODES

This offer is also extended to cover EM402 diodes, which normally sell for 14c each
Our special price:
25 for $1.
These are 1 amp, 100 volt silicon diodes.

UNMARKED DIODES, 50 for $1.

These devices are unmarked: there is no indication of polarity.
They are all made and tested by STC. They are rated at 1 amp, 50 volts.

P&P charge covers any quantity.

Readers not wishing to cut their magazine may use a photocopy or a hand-drawn copy of the coupon.
The offer is limited to the first 15 000 units.
Personal callers wishing to buy these ICs should bring a copy of this advertisement with them to our store in Gore Hill, Bankstown or the City

GORE HILL
162 Pacific Highway

BANKSTOWN
361 Hume Highway

CITY
125 York Street

Offer coupon
Dick Smith Electronics, PO Box 747, Crows Nest, NSW. 2065
Please send me the following devices —

... packs of 4x741 ICs, for $2 each pack ....
... packs of 50xEM402 diodes, for $1 each pack ...
... packs of 50x unmarked diodes, for $1 each pack.
PLUS total postage and packing charge of 50c .... .50

I enclose a cheque/postal order for the total amount ...
These offers are only valid as long as stocks last.

NAME ....
ADDRESS ....

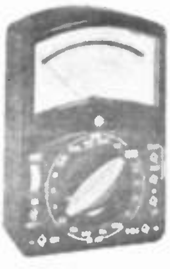
HAM RADIO SUPPLIES

MAIL ORDER SPECIALISTS

323 Elizabeth Street, Melbourne (2 doors from Little Lonsdale Street) 674286 67 7329
new Richmond branch now at 390 Bridge Rd., Richmond Phone 42-5174

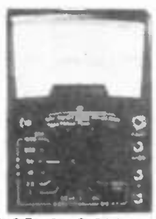
MODEL C1000M MULTIMETER Compact, handy and versatile, the C1000M is the ideal low cost pocket meter, Mirror Scale. **Specifications:** 1,000 Ohm/Volc DC; 1,000 Ohm/Volt AC; DC volts — 10; 50; 250; 1,000; AC volts — 10; 50; 250; 1,000; DC amps — 1 mA; 100 mA; Ohms — 150 KΩ; Centre scale — 3 KΩ; Decibel — 10 dB to 22 dB; Dimensions — 3-1/2" x 2-3/8" x 1-1/8" 90 x 60 x 30 mm.

$7.95
Post Free.



MODEL C-7077/P MULTIMETER. Specifications: 100,000 ohms/volt DC; 10,000 ohms/volt AC; DC volts — 5,5; 25; 50; 250; 500; 1,000. AC volts — 10; 50; 250; 500; 1,000. DC amps — 10μA; 2-5 mA; 25 mA; 500 mA. Ohms — 10 kΩ; 1 MΩ; 10 MΩ; 100 MΩ. Centre scale — 150Ω; 15 KΩ; 150 KΩ; 1-5 MΩ. Decibel — —20 to +22 dB. Dimensions — 151 x 102 x 48 mm Diode protected movement. Carrying case available Model C.

$29.50
P&P $1.50.



MODEL OL64 D/P MULTIMETER. Very ruggedly constructed this model is particularly suitable for workshops. It features special scales for measurement of capacitance and inductance. Diode protected movement: **Specifications:** 20,000 Ohm/Volt DC. 8,000 Ohm/Volt AC. DC volts — 0.25; 1; 2.5V; 10; 50; 250; 1,000; 5.000. AC volts — 10; 50; 250; 1,000. DC amps: 50μA; 1 mA; 50 mA; 500 mA; 10 A. Ohms — 4 KΩ; 400 KΩ; 4 MΩ; 40 MΩ. Centre scale — 40Ω; 4,000Ω; 40,000Ω; 400,000Ω. Decibel: —20 to +62 dB, Dimensions: 6" x 4-1/5" x 2"; 152 x 107 x 51 mm. Capacitance: 250 pF to 0.02 uF. Inductance — 0/5000H Carrying case available Model C.

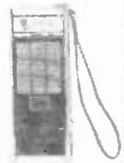
$25.95 **P&P $1.50.**

MODEL AS100 D/P MULTIMETER. This meter features double zener diode meter protection and 3½" full view easy to read 2 colour scale. It is fitted with polarity reversing switch and housed in a strong moulded case with carrying handle. Specifications: 100,000 ohm/volt DC. 10,000 ohm/volt AC. DC volts — 0.3; 12; 60; 120; 300; 600; 1,200. AC volts — 6; 30; 120; 300; 600; 1,200V. DC amps — 2 KΩ; 200 KΩ; 20 MΩ; 200 MΩ; Centre scale — 20Ω; 2,000Ω; 20,000Ω; 200,000Ω; 20 MΩ Decibel — —20 to +57 dB. Dimensions — 7-3/5" x 5-2/5" x 2-3/5" 193 x 137 x 66 mm. Carrying case available model I.

$39.50
P&P $1.50.

27 MHz TWO-WAY RADIOS

FOR INDUSTRY, FARM, BOATS, SPORTS, ETC.



MODEL NC-310 DE LUXE 1 WATT 3 CHANNEL CB. TRANSCEIVER

- **WITH CALL SYSTEM**
- **EXTERNAL AERIAL CONNECTION**

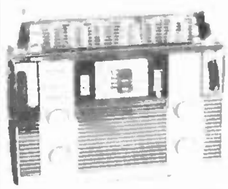
SPECIFICATIONS, NC-310

Transistors: 13. Channel Number: 3. 27.2400 MHz Citz. Band included. Transmitter Frequency Tolerance: ±0.005% RF Input Power: 1 Watt. Tone Call Frequency: 2000 Hz.

Full range of crystals for 27 MHz novice band available $6.50 pair extra.

$49.50 PER UNIT.

TARIFF REDUCED PRICE



BARLOW-WADLEY XCR-30

a truly portable communications receiver, based on the WADLEY LOOP principle, the same principle as applied in the DELTAHET and RACAL receivers. A truly crystal-controlled highly sensitive multiple heterodyne portable receiver of exceptional stability with continuous, uninterrupted coverage from 500 kHz to 31 MHz.

All for $239 F.O.R.

AM/FM/VHF/TV. MONITOR MULTIBAND RADIO. NEW MODEL AC/DC.

Latest military design multi-band radio, 30 transistors and diodes. With exclusive (LED) light emitting diode tuning indicator for positive station selection.
Battery and electric covers all popular AM and FM bands.

$39.50
P & P $2.50

Beware of more expensive imitations

SOLID STATE 19 TRANSISTOR MULTI-BAND RADIO — 9 RANGES

AM, SW, FM, VHF, AIR, PB BATTERY/OPERATED COLOUR CODED 9 BAND DIAL

1 . AM 535 to 1600 kHz, 2. Marine 1·5 to 4 MHz, 3 & 4. Combined SW 4 to 12 MHz, 5. 30 to 50 MHz, 6. 88 to 108 MHz, 7, 8 & 9 combined VHF Aircraft 145 MHz-174 MHz incorporating weather band.
Slider controls, Dial light, Fine tuning control, Flip-up Time Zone map, Telescope antennas complete with batteries.

SPECIAL PRICE **$59** **Post Pack $3.00**

HAM GEAR NOW IN STOCK

Uniden 2020 AC-DC transceivers 10 to 80 M. **$570** Trio Kenwood TS-520 AC-DC transceivers 10 to 80 M. **$560.** Yaesu Musen FT-10-T-E AC-DC transceivers 10 to 160 M. **$670.** Trio-Kenwood model QR-666 170 kHz to 30 mHz AC-DC receivers. **$300.** Drake model SSR-1 Wadley loop 500 kHz to 30 mHz AC-DC receivers. **$325.** Hy-gain antennas — 14AVQ 10-40 M. verticals, 19' tall, no guys. **$69.** 18AVT-WB 10-80 M. verticals, 23' tall, no guys. **$95.** FDK Multi-7 2M. FM 10 Watt transceivers with 12 sets of crystals, available at 7 repeater and anti-repeater frequencies plus channels 40, 50 and 52 **$230.** Ken products KP-202 2 M. FM handheld transceivers with crystals for repeaters 1 to 4 incl. and channels 40 and 50. **$149.** Kyokuto 2M. FM 12 Watt output transceivers with digital read-out and crystal synthesized PLL circuitry, 400 5 kHz transmit and 1000 5 kHz receive channels for normal simplex, repeater and anti-repeater operation. **$300.** Icom IC-202 2 M. SSB handy transceivers 144.0-144.4 MHz. **$195.** Antenna rotators — CDR AR-22 junior for light and vhf beams. **$55.** CDR Ham-II senior for all but 40 M hf beams. **$175.** KEN KR-400 for all medium hf beams with disc brake. **$105.** All three models rotators complete with 230V AC indicator-control box.

SE-360 SIGNAL TRACER & INJECTOR

SPECIFICATION: Single injector approx 1 kHz level 0-5V. Gain: 60 dB. Input impedance: Over 75K ohms. Attenuation Factor: 0-20-40-60 dB. Output impedance: 8 ohms and 600 ohms. Meter: VU200 uA. Speaker: 2¼ Dynamic. Power Supply: 9 Volt Dry Cell. Size: 5¾ x 3 x 2". Supplied complete with two shielded test leads (AF & RF). R.F. probe and instruction manual. **$37** **P.P. $2.00**

C.B. CRYSTALS

HC18 holders. Standard size fit. All modern transceivers with 455 kHz I.F. 27.065 mHz. 27.085 mHz. 27.125 mHz. 27.155 mHz. 27.185 mHz. 27.205 mHz. 27.225 mHz.

$6.50 a pair (receive & transmitter)

SPECIFICATIONS:

TE-20/D R.F. SIGNAL GENERATOR

SPECIFICATIONS: Frequency Range: 120kc/s — 500mc/s (6 Fundamental Bands and 1 Harmonic Band). Frequency Accuracy: ± 2%. Audio output: to 8 volts. Internal Modulation: Approx. 400c/s. Tube complement: 12BH7A, 6AR5, Silicon Diode and Germanium Diode. Printed Circuit for uniform characteristics. Power Source: 105/125, 220/240 volts AC, 50/60 cps 12 watts. Dimensions: 140 x 215 x 170mm. Weight: 2.8kg.

$52.50 **p.p. $2.00**

TE-22/D AUDIO GENERATOR

SPECIFICATIONS: Frequency Range: Sine Wave — 20 to 200,000c/s in 4 bands. Square Wave — 20 to 30,000cps. Frequency Response: ± 1½ dB. Output Impedance: 1 Kohm. Frequency Accuracy: ± 5%. Output Voltage: Sine wave 7 volts (RMS). Square wave 7 volts (P-P). Distortion: Less than 2%. Tube complement: 6BM8, 12AT7, 6x4. Accessory: 1 — Output cable. Power Supply: AC 50/60 cps 220—240 volts. Dimensions: 215 x 170 x 140mm. Net Weight: 3 Kgs. **$62.50** **p.p. $2.00**

TE-15 TRANSISTOR GRID DIP METER.

SPECIFICATIONS: Transistors: 3 and 1 diode. Meter: 500uA F/S. Battery: 9 volts PP3. Dimensions: 180 x 80 x 40mm. Weight: 730 g. Frequency Range: 400 kc/s — 280 mc/s with 6 coils; A coil 0.44—1.3 mc/s; B coil 1.3—4.4 mc/s; C coil 4—14 mc/s; D coil 14—40 mc/s; E coil 40—140 mc/s; F coil 120—280 mc/s.

$39.50 **p.p. $2.00**

FS5 SWR AND R.F. POWER METER.

Power Range: 0, 10W, 100W (2 ranges). SWR: 1:1, 1:3. Freq. Response: 3MHZ—150MHZ. Suitable Connector: M type. Impedance: 50 ohm, 75 ohm. Dimensions: 160 x 85 x 98 mm. Weight: 750 g. **$29.50** **p.p. $2.00**

A beautiful combination of components that were made for each other.

If you want a perfectly matched combination of stereo components without spending hundreds and hundreds of dollars and having your house look like a recording studio, it's hard to go past the Toshiba SX 150 C.

Each piece was designed with the other components in mind.

The receiver has all the features you would expect from separate units. A pre-amplifier, power amplifier and tuner all in the one space-saving unit. The performance is something that has to be experienced to be really appreciated.

The high-precision turntable is semi-automatic in operation with an MM phono cartridge and an S-type tone arm. The two-way speakers give superb reproduction with beautiful highs and lows divided between tweeter and woofer.

And if you buy two more speakers you can enjoy speaker matrix 4-channel effects at the flick of a switch.

All-in-all, the SX 150 C is a sensible combination of beautiful units put together by the company with its feet on the ground and its thoughts on tomorrow.

Specifications

2/4 channel speaker matrix. AM/FM/LW-FM stereo receiver with output of 6 watt x 2 (RMS at 8 ohms). Turntable is belt driven from 4-pole synchronous motor. Aluminium die-cast turntable. S-type tone arm. Two-way speakers comprising 2 x 16 cm woofers and 2 x 5 cm tweeters. Dimensions of receiver 450 mm (W), 331 mm (D), 110 mm (H). player 450 mm (W), 350 mm (D), 180 mm (H), speaker 280 mm (W), 170 mm (D), 460 mm (H). Power Source is 110/120/220/240 V AC, 50/60 Hz.

Price and specifications subject to change without notice.

Toshiba SX 150 C
$319 recommended retail price
AR201 Audio Rack—Optional extra

Toshiba
TOSHIBA
In Touch with Tomorrow

TS7756

ETI data sheet

2N 3638 & 2N 3638A pnp high current switches

QUICK REFERENCE DATA

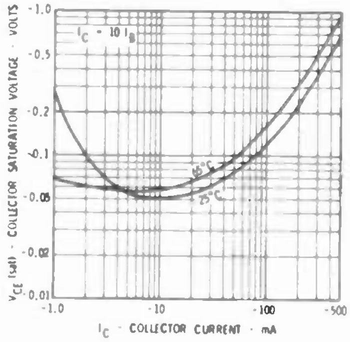
Total power dissipation at 25°C case temperature		max.	0.7 W*
Total power dissipation at 25°C ambient temperature		max.	0.3 W*
Collector-base voltage	V_{CBO}	max.	−25 V
Collector-emitter voltage	V_{CES} & V_{CEO}	max.	−25 V
Emitter-base voltage	V_{EBO}	max.	−4 V
Collector current	I_C	max.	500 mA

			2N3638	2N3638A
DC pulse current gain	h_{FE}	typ.	67	130
Pulsed collector saturation voltage	V_{CE} (sat)	typ.	−0.38 V	−0.38 V
Collector-emitter sustaining voltage	V_{CEO} (sust)	min.	−25 V	−25 V
Collector-emitter breakdown voltage	BV_{CES}	min.	−25 V	−25 V
Collector-base breakdown voltage	BV_{CBO}	min.	−25 V	−25 V
Turn On time	t_{ON}	typ.	28 ns	28 ns
Turn off time	t_{OFF}	typ.	110 ns	110 ns
High frequency current gain (f = 100 MHz)	h_{FE}	typ.	1.9	1.9
Common-base, open-circuit output capacitance	C_{obo}	typ.	6 pF	6 pF
Common-base, open-circuit input capacitance	C_{obo}	typ.	18 pF	18 pF
Base-emitter saturation voltage (pulsed) (I = 50 mA, I = 2.5 mA)	V_{BE} (sat)	typ.	−09 V	−0.9 V
Base-emitter saturation voltage (pulsed) (I = 300 mA, I = 30 mA)	V_{BE} (sat)	typ.	−1.25 V	−1.25 V
Emitter-base breakdown voltage	BV_{EBO}	min.	−4 V	−4 V
Collector reverse current	I_{CES}	typ.	0.1 nA	0.1 nA
Collector reverse current (65°C)	I_{CES} (65°C)	typ.	0.002 μA	0.002 μA

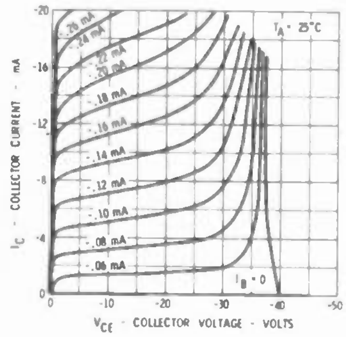
* The max. power dissipation of the PN3638 is 1 W and 0.625 W.

The 2N3638 and its higher gain version, the 2N3638A, are silicon planar epitaxial transistors for high-current switching circuits. The total switching time at 300 mA is 245 ns or faster. The gains are high — 67 (typ.) and 130 for the 3638 and 3638A, respectively. The power dissipation is 0.7 for the 2N types, or 1 W for the PN3638 & PN3638A.

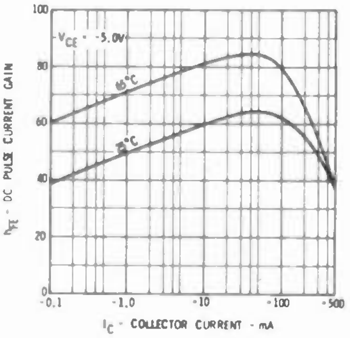
2N3638 & 2N3638A Collector saturation voltage versus collector current.



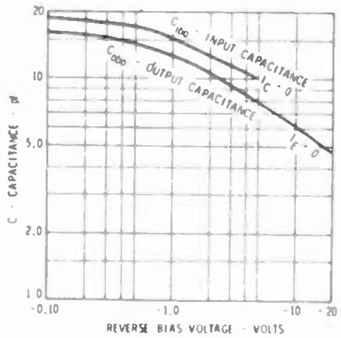
2N3638 Collector characteristics.



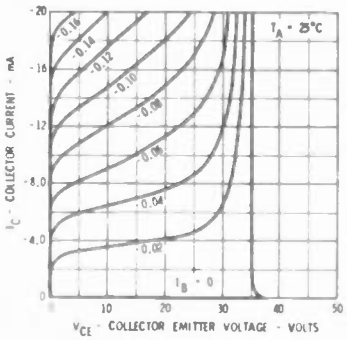
2N3638 dc pulse current gain versus collector current.



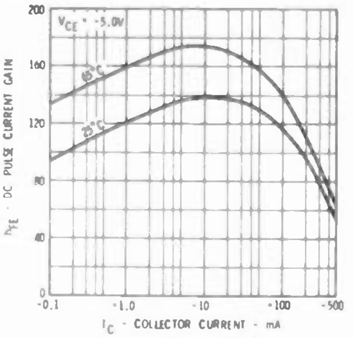
2N3638 & 2N3638A input and output capacitance versus reverse bias voltage.



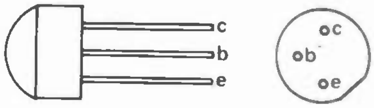
2N3638A Collector characteristics.



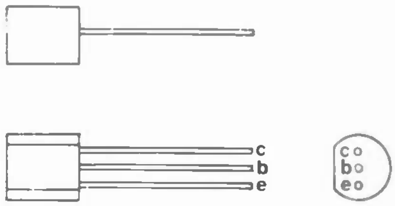
2N3638A dc pulse current gain versus collector current.



Lead connections for the 2N3638 and 2N3638A.



Lead connections for the PN3638 and PN3638A.



2N 3641, 42 & 43 npn class-C RF amplifiers and high current switches

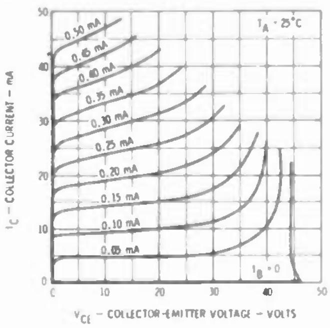
QUICK REFERENCE DATA

			2N3641 2N3643	2N3642
Total power dissipation at 25°C case temperature		max.	0.7 W*	0.7 W*
Total power dissipation at 25°C ambient temperature		max.	0.35 W*	0.35 W*
Collector-base voltage	V_{CBO}	max.	60 V	60 V
Collector-emitter voltage	V_{CEO}	max.	30 V	45 V
Emitter-base voltage	V_{EBO}	max.	5 V	5 V
Amplifier power gain (f = 30 MHz)	G_{PE}	typ.	12 dB	12 dB
Collector efficiency (f = 30 MHz)	η	typ.	75	75
High frequency current gain (f = 100 MHz)	h_{fe}	min.	2.5	2.5
			2N3641 2N3642	**2N3643**
DC pulse current gain (I = 150 mA, V = 10 V)	h_{FE}	typ.	75	220
DC pulse current gain (I = 500 mA, V = 10 V)	h_{FE}	typ.	62	125
Turn on time	t_{ON}	typ.	14 ns	14 ns
Turn off time	t_{OFF}	typ.	80 ns	80 ns
Collector-base breakdown voltage	BV_{CBO}	min.	60 V	60 V
			2N3641 2N3643	**2N3642**
Collector-emitter sustaining voltage	V_{CEO} (sust)	min.	30 V	45 V
Emitter-base breakdown voltage	BV_{EBO}	min.	5 V	5 V
Output capacitance	C_{obo}	max.	8 pF	8 pF
Collector saturation voltage (I = 150 mA, I = 15 mA)	V_{CE} (sat)	typ.	0.13 V	0.13 V
Collector saturation voltage (I = 500 mA, I = 50)	V_{CE} (sat)	typ.	0.35 V	0.35 V
Collector reverse current	I_{CES}	max.	0.05 A	0.05 A
Collector reverse current (65°C)	I_{CES} (65°C)	max.	1 A	1 A

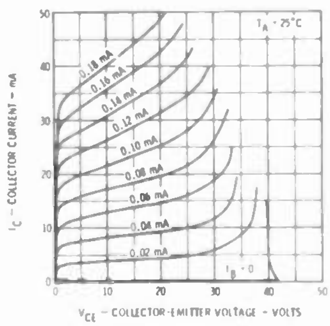
*Note: The max power dissipation of the PN3641-3 series is 1 W and 0.625 W.

The 2N3641-3 series covers silicon planar epitaxial transistors recommended for use in class-C RF amps and high current switches. They deliver 700 mW of RF at 30 MHz (typically). The PN3641-3 series is electrically identical in all respects except the transistors deliver a typical maximum power of 1 W at 30 MHz (and they do run a little hotter). Total switching times, for all types, are typically 94 ns at 300 mA.

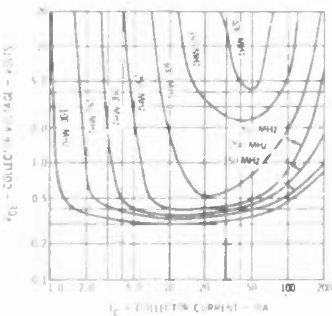
2N3641 & 2N3642 Collector characteristics active region.



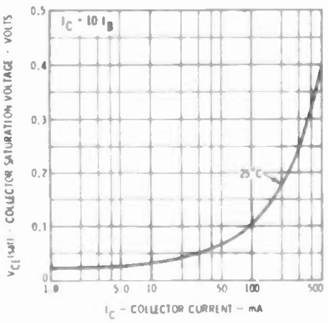
2N3643 Collector characteristics active region.



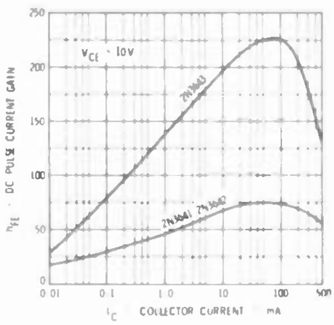
Contours of constant gain bandwidth product.



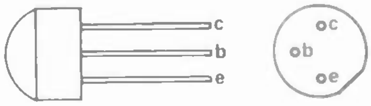
Collector saturation voltage versus collector current.



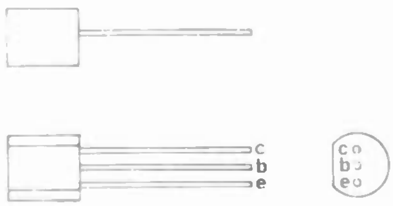
Pulse dc current gain versus collector current.



Lead connections for 2N3641, 42, 43.



Lead connections for the PN3641, 42, 43.



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7402	Quad 2-Input Pos. Nor Gate	.35
7403	Quad 2-Input Pos. Nor Gate with O/C Outputs	.35
7404	Hex Inverter	.35
7405	Hex Inverter with O/C Outputs	.35
7406	Hex Inverter Buffer/Driver 30V Output	.60
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7409	Quad 2-Input and Gate with O/C Outputs	.35
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7413	Dual Nand Schmitt Trigger	.85
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7430	8 Input Pos. Nand Gate	.35
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7448	BCD-To-Seven Segment Decoder	1.50
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7453	Exp. 4-Wide 2-Input and-or-Invert Gate	.35
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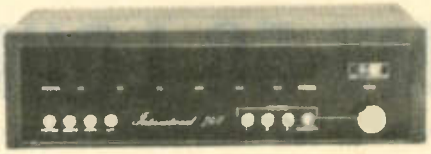

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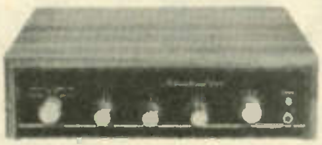

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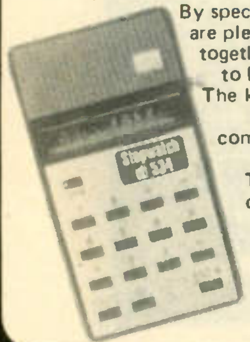

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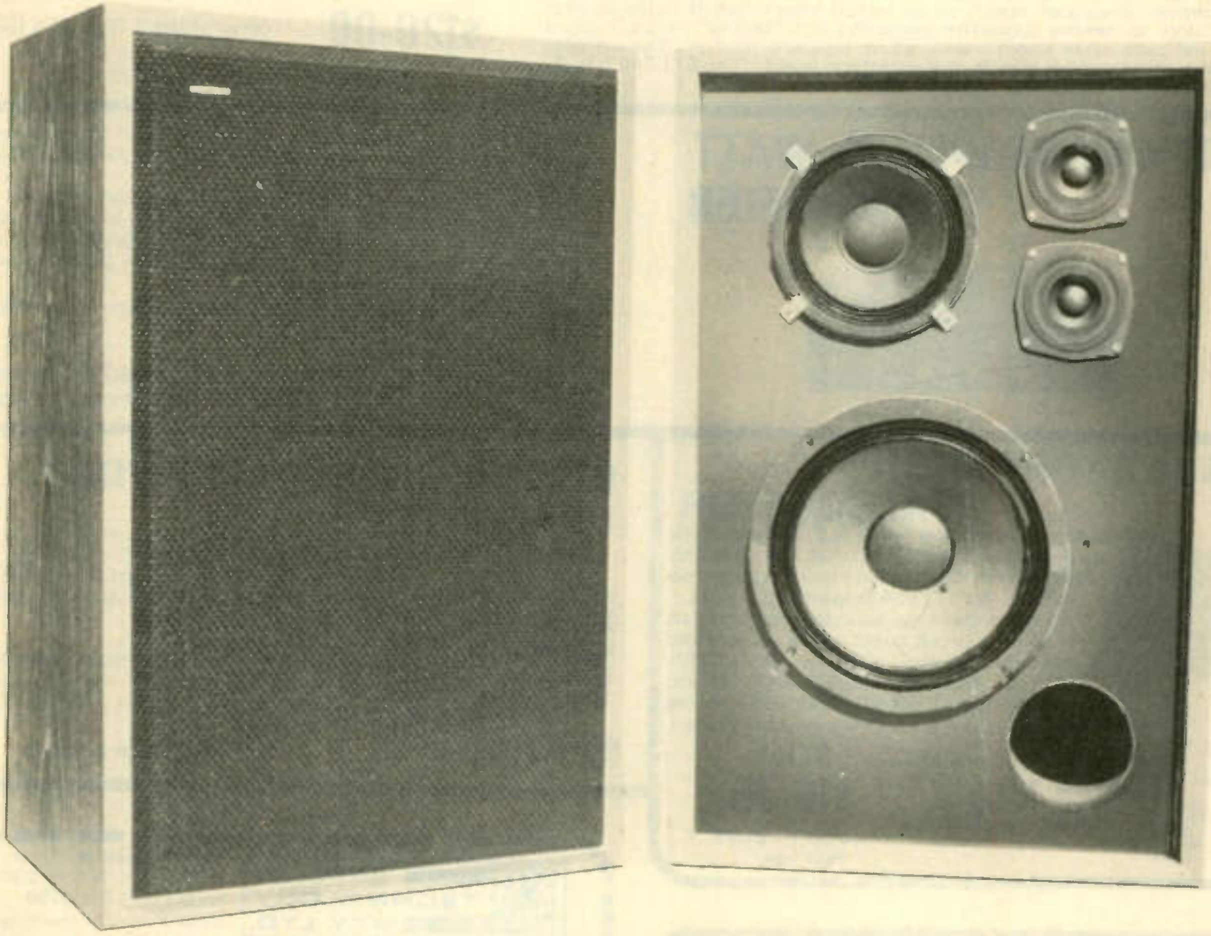

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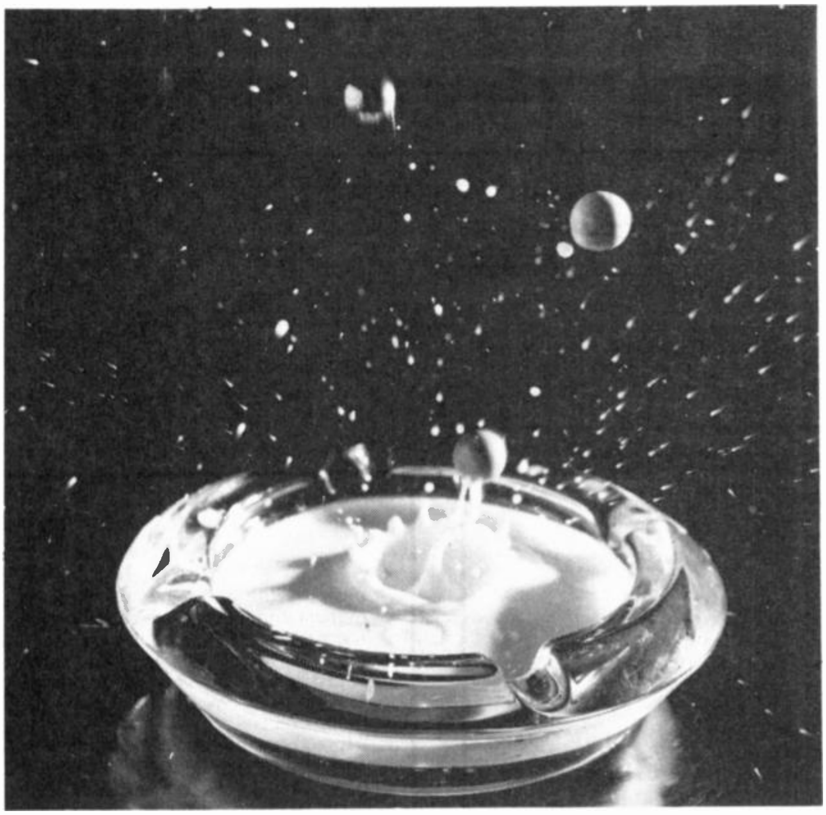
Versatile flash trigger

This flash trigger sets off any standard electronic flash unit a predetermined and adjustable time after a specific change in light or sound has occurred.



DURING THE PAST FEW YEARS WE have received many requests to publish full constructional details of a light and sound operated photographic flash trigger that would be cheap to build, versatile in use and small enough to slip into the pocket or camera bag.

So here it is . . . it can be triggered by any sudden change in light or sound to photograph any related transient phenomena. It has innumerable applications in specialised photography, science and industry.

The device will set off any standard electronic flash unit a pre-determined time (adjustable between five milli-seconds and 200 milli-seconds) after a sudden change in ambient light or sound. The magnitude of the change required to trigger the unit is also adjustable.

The light triggering facility enables the trigger unit to be used as a slave flash.

CONSTRUCTION

Solder all components onto the printed circuit board — with the exception of the LDR and potentiometers RV1 and RV2. Ensure that capacitors C1 and C3 are correctly orientated — see overlay drawing.

Note that there are two possible lead configurations for the BC558 — Philips use a different configuration from other manufacturers — both types are shown at the bottom of the main circuit drawing.

Solder short lengths of tinned copper wire onto the potentiometer terminals — insert ends into the pc board and locate as shown.

Don't solder the leads though until the final position of the potentiometers relative to the rest of the assembly has been established.

When assembling the potentiometers onto the front panel space the potentiometers away from the panel by two washers on each potentiometer.

Locate the LDR so that the light sensitive grid is lined up with the hole in the front panel of the unit.

Finally mount the switch and microphone socket onto the front panel and wire them to the pc board and battery clip as shown in the component overlay.

A synchronization extension flash lead must be purchased to suit the camera in use. Remove the unused connector from the end of the lead and solder the lead to the board as shown in the overlay.

OPERATION

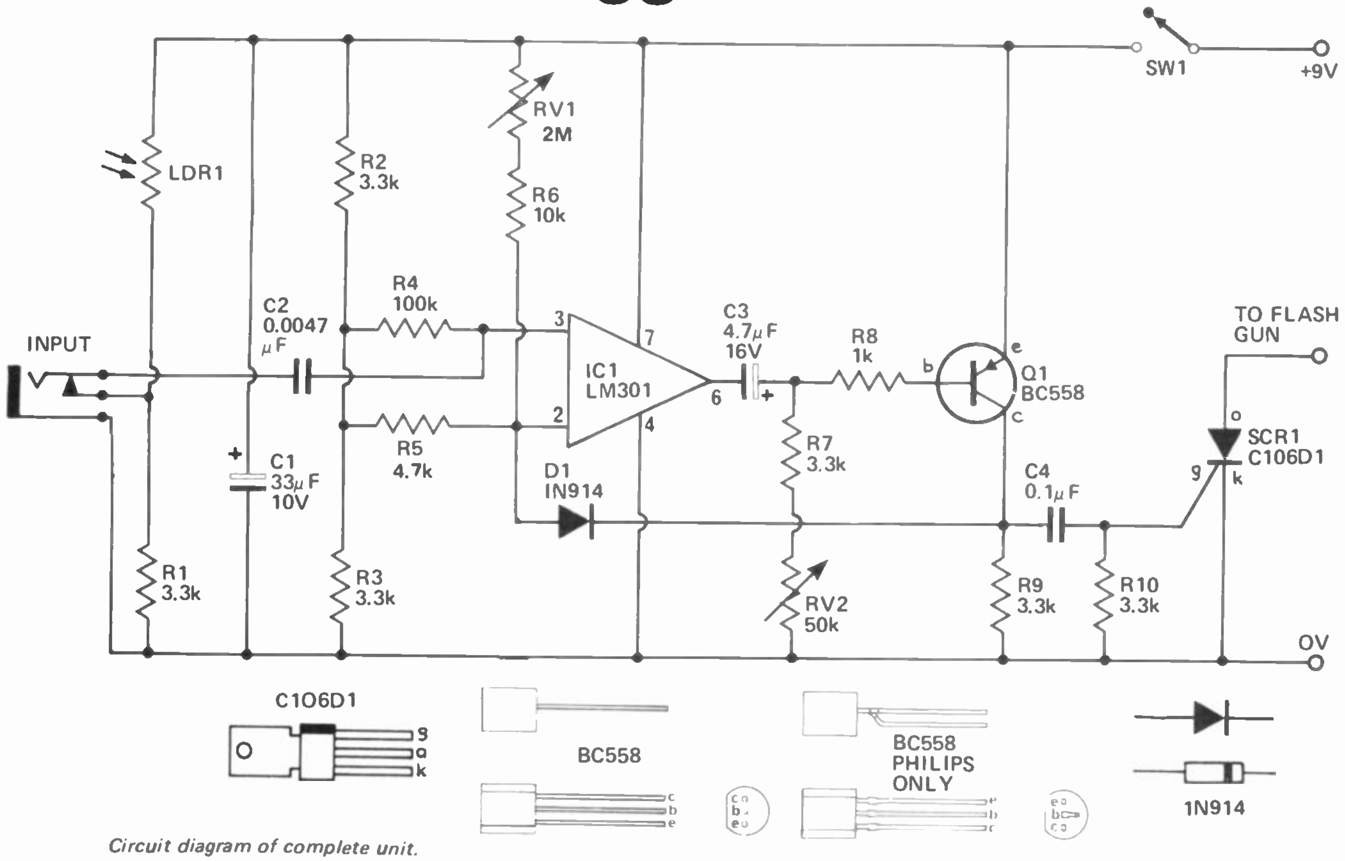
To use the unit in the sound operated mode simply plug the microphone into the socket provided and connect the unit's flash lead to the camera.

Switch on SW1 and adjust RV1 so that the flash is not triggered by ambient noise, but will be triggered by the event to be recorded — i.e. gun firing, hands clapping, glass breaking, etc.

In most circumstances the stop-action photography must be done in a dark room with the camera shutter open, or if only black and white film is used — using a red safelight.

Assume for example that you wanted to photograph a bottle at the instant it

Versatile flash trigger



Circuit diagram of complete unit.

PARTS LIST ETI 514B

Resistors

R1	–	3.3 k	5%	¼ W
R2	–	3.3 k	"	"
R3	–	3.3 k	"	"
R4	–	100 k	"	"
R5	–	4.7 k	"	"
R6	–	10 k	"	"
R7	–	3.3 k	"	"
R8	–	1 k	"	"
R9	–	3.3 k	"	"
R10	–	3.3 k	"	"

Potentiometers

RV1	–	2 M log rotary
RV2	–	50 k lin "

Capacitors

C1	–	33 μF 10 V electro
C2	–	0.0047 μF polyester
C3	–	4.7 μF 16 V electro
C4	–	0.1 μF polyester

Seniconductors

Q1	–	transistor BC558 or similar
D1	–	diode IN914 or similar
IC1	–	integrated circuit LM301
SCR1	–	SCR C106 D1

Miscellaneous

LDR1	–	Philips
PCB	–	ETI 514B
SW1	–	switch spst

3.5 mm phone jack
plastic box, flash cord, microphone, battery and battery clip.

HOW IT WORKS

Basically the microphone triggers the IC monostable circuit which subsequently triggers an SCR, and hence the flash, after a time delay. This delay is adjustable – by varying a monostable on-time – from 5 milliseconds to 200 milliseconds.

Integrated circuit IC1 is an LM301A. This is a dc differential amplifier with a high gain – typically 25 000. The output swing of the IC with a 9 volt dc supply is of the order of 6 volts, and this is obtained with an input swing of only 24 microvolts. This makes the IC ideally suited for use as a comparator and is the mode of operation utilised in our circuit.

Due to the very high gain and the relatively large input signals normally encountered, the IC is almost always either fully cut off or fully saturated. The linear region is very narrow and is not utilized in this circuit.

The two inputs of the IC (pins 2 and 3) would be at the same potential were it not for the bias current supplied through RV1. This raises the voltage at pin 2 of the IC by 10 mV or more above pin 3 depending on the setting of RV1. The IC will therefore normally be fully saturated and the output voltage will be low.

Transistor Q1 is normally held on by the current through RV2, and its collector is high.

When an audio signal from the microphone produces at pin 3 a level exceeding that set on pin 2 by RV1, the IC will rapidly change state and its output will go high.

The front edge of this transition turns off Q1 via C3. The collector of Q1 will fall, D1 becomes forward biased and pulls down pin 2 to about one volt – the IC output is maintained in its high state.

After a time – determined by the time constant of C3 and RV2 – Q1 turns on again allowing the IC to revert to tis normal low output.

The output signal from Q1 is differentiated by C4 and R10. The positive pulse which occurs at the end of the delay period, triggers the SCR and fires the flash.

When the microphone is pulled out LDR1 and R1 are placed in circuit. When the light falling on the LDR suddenly increases, the resistance of the LDR falls and the voltage across R1 increases. This increase is passed via C2 to pin 3 of the IC triggering it if it is above that on pin 2.

is broken by a stone from a catapult. The equipment, catapult and bottle are set up initially in the light and tested to confirm correct function and sequence.

A test film is then shot using an arbitrary setting of the delay in the now darkened room. This is done by opening the shutter, firing the catapult and then closing the shutter before turning on the lights. (Although shooting a bottle in the dark may seem difficult — with a little practice it is surprisingly easy. But do wear eye protection).

A run through the test film will show whether the chosen delay was correct. If too short, the bulb or bottle will be photographed before actually breaking up — if too late the action will have progressed further than needed or wanted.

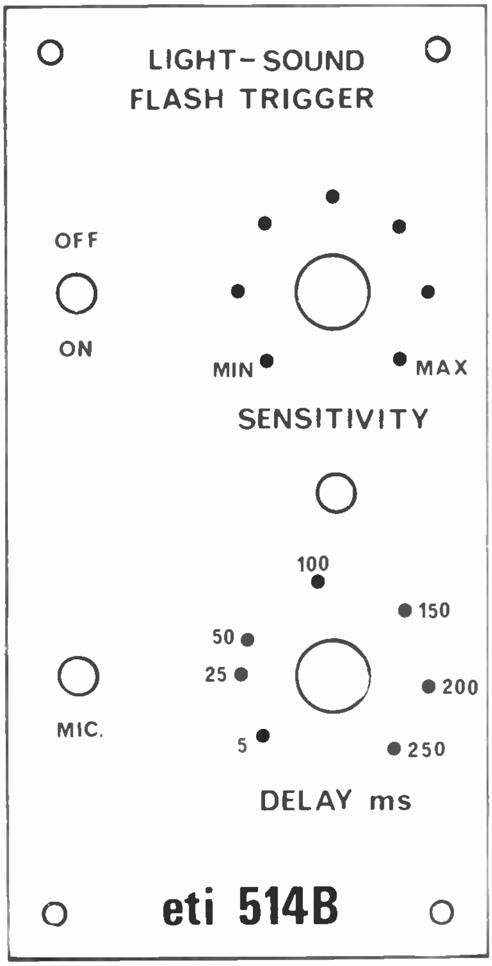
Further pictures should then be taken, varying the time delay to bracket the actual delay that is now estimated as correct. With a little experience you'll be able to estimate the required delay accurately.

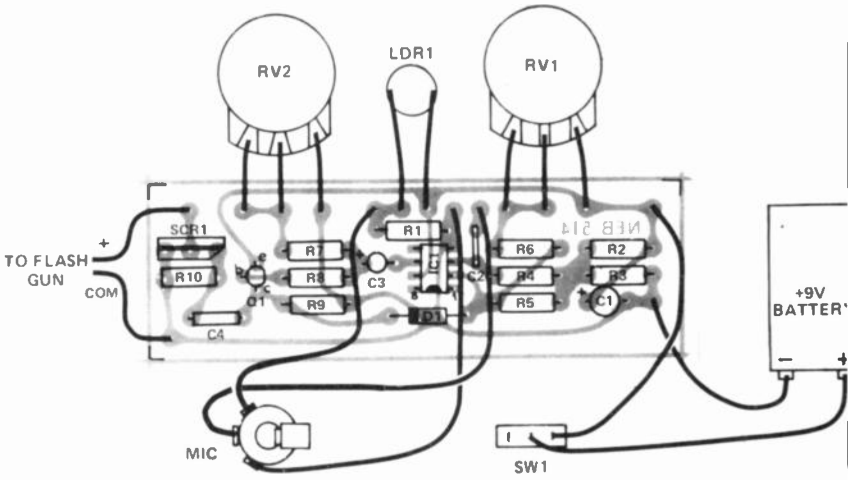
(Don't forget to get in a good supply of bottles).

As the flash duration is typically 1000-2000th sec, high speed action can be frozen as our lead picture shows.

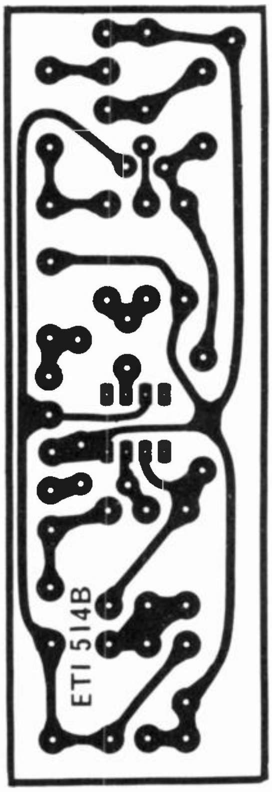
To use the unit as a slave flash simply unplug the microphone. This automatically places the built-in light sensor in circuit — adjust the sensitivity so that the unit is triggered out by the master flash when it is operated. In this particular application the delay should be set to minimum for use as a slave flash.

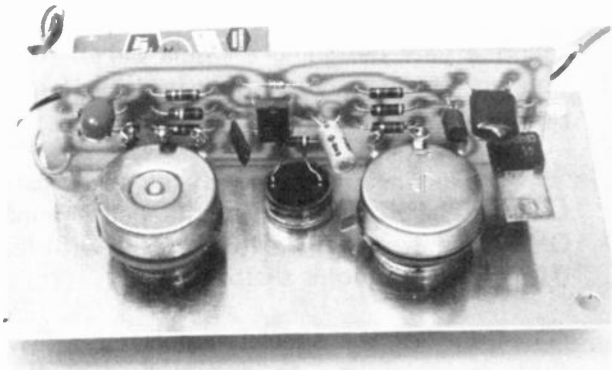
Or some delay may be used to obtain a time sequence exposure. Note that the minimum delay is 5 ms and hence the unit cannot be used as a slave flash for extremely fast action without a double exposure occuring.●

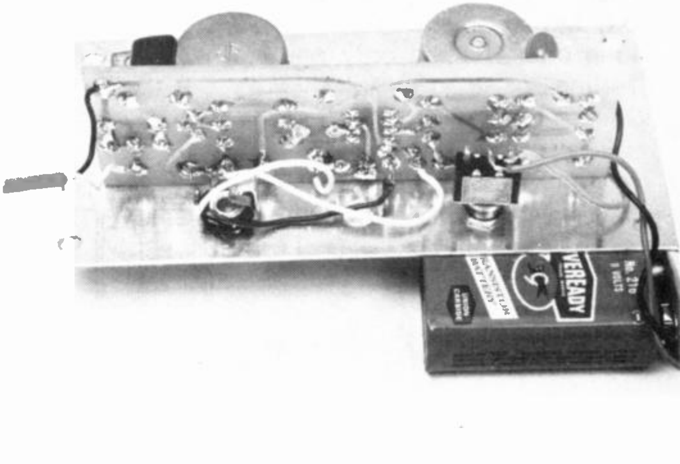




Follow this diagram to mount components and for interconnections.







KITS for this project are available from:
Nebula Electronics Pty Ltd
15 Boundary Street
Rush cutters Bay 2011

KIT 1 . . . . **$14.99**
Contains all parts except battery and flash cable

KIT 2 . . . . **$22.30**
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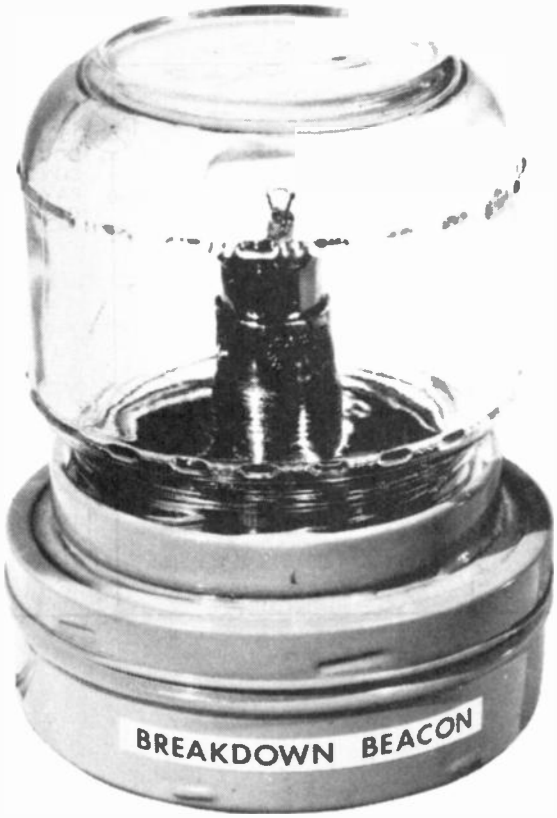
Breakdown beacon

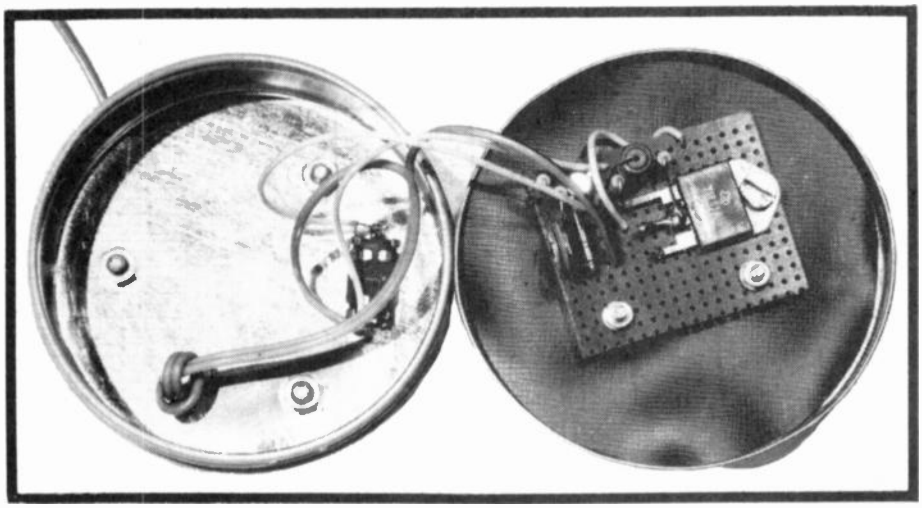
An essential device for any car owner — this project doubles as emergency flasher or trouble lamp.

THE BREAKDOWN BEACON IS A dual purpose device. It stands about 115 mm high and can be used atop a disabled motor vehicle as a flashing warning to other traffic — a highly desirable safety device. Alternatively it can be used as a non-flashing trouble light for finding and fixing faults at night. Its three rubber-sucker feet will hold it to the roof of a car, to the underside of a bonnet, or to any other convenient flat surface.

The circuit operates from the vehicle's battery and, as all electrical parts are isolated from the metal case, the same circuit can be used for cars with either negative or positive earth wiring systems. The beacon is fed from a plug pushed into the cigarette lighter socket — however as this plug is polarised, a beacon with a plug for negative earth cannot be used in a car with opposite polarity unless the plug connections are reversed.



Inside view of the completed unit. Note the plastic disc used to replace the normal airtight seal of the jar.



CONSTRUCTION

The nicest thing about the construction of this project is that first you have to eat half a pound of jam, in order to get the empty glass jar for the lamp housing. Other, less tasty, good jars about 70 mm dia. and 70 mm high with a twist off cap would do. You'll need also a round tobacco tin about 75-80 mm dia. and 30 mm high with a twist off cap. These two parts make up the case.

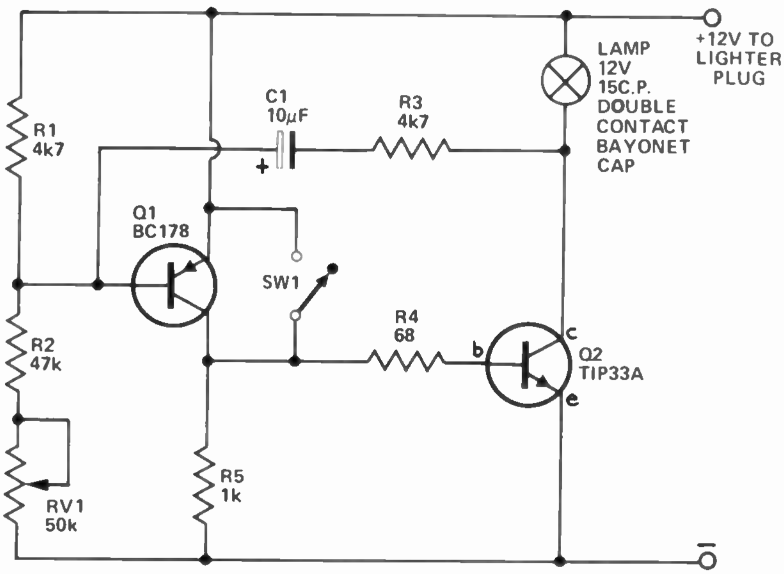
First solder the lids of the jar and the tin together, concentrically — outside to outside. Then before fitting the batten lamp holder fit the lamp to it and check that it will fit inside the jar when the jar is screwed into its lid. If it will, then mount the lamp holder by three bolts through both lids. Two of these bolts should be longer than the third as they will carry a piece of Veroboard. If the jar is slightly too short to accept the lamp holder and lamp — as was the case

Breakdown beacon

PARTS LIST – ETI 239

R1	Resistor	4k7	¼ watt
R2	"	47k	"
R3	"	4k7	"
R4	"	68	"
R5	"	1k	"
RV1	Preset pot	50k	
C	Electrolytic capacitor 10 µF at least 15 volts		
Q1	Transistor PNP BC 178 or similar		
Q2	Transistor NPN TI P33A or similar		
SW1	small on/off slider switch, single pole		

Lamp 12 volt automotive lamp 15 candlepower double contact cap.
Lampholder – to suit lamp, batten mounting, double contact bayonet catch type. (This is an electricians line not an automotive line. They are used for pilot lamps).
Tobacco tin, jam jar, or similar. Nuts and bolts, hook up wire.
Lead to battery – 7 m speaker extension lead.
Cigarette-lighter plug.



Circuit diagram of the Breakdown Beacon.

HOW IT WORKS

The circuit is an oscillator of a not very common type. It is *not* a multivibrator as both transistors conduct at the same time rather than alternately as in a multivibrator. Most 'explanations' of this type of circuit state that the circuit oscillates by a regenerative action from Q2 to Q1. This doesn't really explain how it works, so perhaps the following is a little clearer.

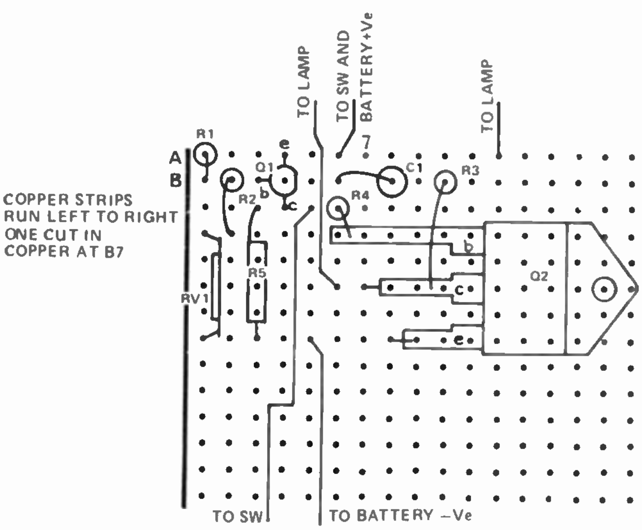
The setting of the pot RV1 is such that when power is first applied Q1 is turned on slightly. By varying RV1 the circuit can be made to 'lock' with the lamp on or off. In between these extremes the circuit oscillates. The setting of RV1 is not critical.

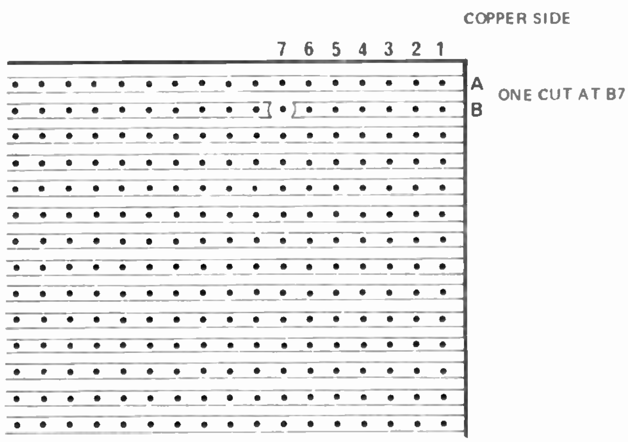
As said above, when power is applied Q1 turns on slightly. Current through Q1 feeds into the base of Q2 and turns it on. Capacitor C charges through R1, R3 and Q2. This increases the current through R1 and so lowers the voltage at the base of Q1 thus turning it on harder – hard enough to turn Q2 full on and light the lamp.

As C charges, the voltage at the base of Q1 rises and so tends to turn Q1 off, thus reducing the base current in Q2 and hence the current through the lamp. This increases the voltage across Q2 quite rapidly. As the voltage across the capacitor cannot be changed rapidly, the increase of voltage across Q2, i.e. the voltage change at the collector of Q2, is transferred through the capacitor to the base of Q1 – so turning it off. This turns Q2 hard off. The voltage at the collector of Q2 then rises rapidly to 12 volts, so the voltage at the base of Q1 is forced up through capacitor C, turning Q1 hard off.

Capacitor C then discharges round R1, the lamp, and R3 until, when fully discharged, Q1 turns on slightly and the cycle is repeated.

The switch SW1 (connected across Q1) is used to disable Q1 and so give a steady light when SW1 is closed.





Only one break in the Veroboard copper pattern is required – as shown in this diagram.

in the prototype — then cut a hole for the lamp holder through both lids, and fit the lamp holder so that its flange finishes up inside the tobacco tin. Spacing washers may be added if necessary. Again the lamp holder is secured to the lids with one short and two long bolts.

The electronic part of the beacon is constructed on 0.1 inch matrix Veroboard 45mm x 36 mm. Only one break needs to be cut in the copper strips — between the two leads of capacitor C. Only the outer legs of RV1, which is a medium size preset, are passed through the Veroboard. The centre leg is connected to either outer leg above the board and the excess cut off. Note that all resistors except R5 are vertically mounted. The upper end of R4 is soldered straight on to the base terminal of Q2, and the upper end of R3 is soldered straight on to the collector. A wire is also run from the collector terminal of Q2 through the board to the strip below it.

Another wire is run from the emitter terminal of Q2 to the negative rail which is the copper strip just below.

The Veroboard is mounted into the case below the lamp holder, using two of the lamp holder mounting bolts.

The switch SW1 is mounted on the bottom of the tobacco tin where it is out of the weather. The switch must be positioned such that it does not clash with the components on the Veroboard when the tobacco tin is screwed together.

The long twin-lead to the battery is run through the bottom of the tin (to prevent moisture entering) and connected to a cigarette-lighter plug taking care to wire with a polarity to suit the car system (positive or negative earth). Speaker extension lead is good for this purpose as it has polarity marking.

It is likely that the operation of soldering the two lids together will have destroyed the air-tight seals in the jar and tin; they should be replaced with a disc in the tin and a ring in the jar cut from fairly heavy plastic sheeting.

TESTING

Before connecting up make sure that switch SW1 is open — otherwise the unit will not flash.

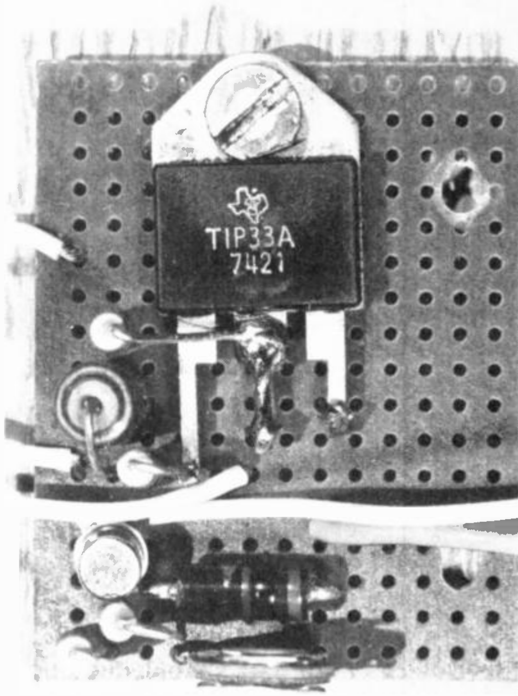
Connect the unit to the battery by inserting the plug into the cigarette lighter socket. It may now be found that RV1 needs some adjustment to make the circuit operate correctly, so don't be disappointed if the lamp does not light at first or alternatively, stays on all the time. The flashing rate may be altered by changing either C or R3 if thought necessary. About 70 to 100 flashes per minute is right.

The value of R4 shown in the circuit was selected to suit the transistor Q2 used in our prototype. If the lamp lights at less than full brilliance then R4 may be reduced until Q2 saturates and the lamp is turned on fully.

USE

The illustration shows the prototype with a clear glass 'lens'. This is ideal when the beacon is used as a trouble light — turned permanently on. However, if it is thought desirable to have an amber or red colour when the beacon is flashing, then it is a simple matter to make a sleeve of suitably coloured material to be dropped inside the jar.

A simple inexpensive project with an intriguing circuit — and it may save you a lot of trouble! Make one.



The completed board.

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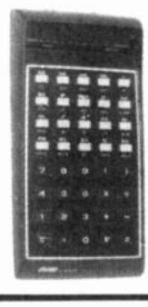
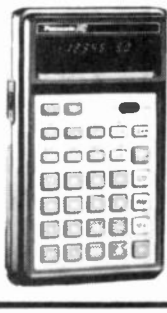


SC-6010



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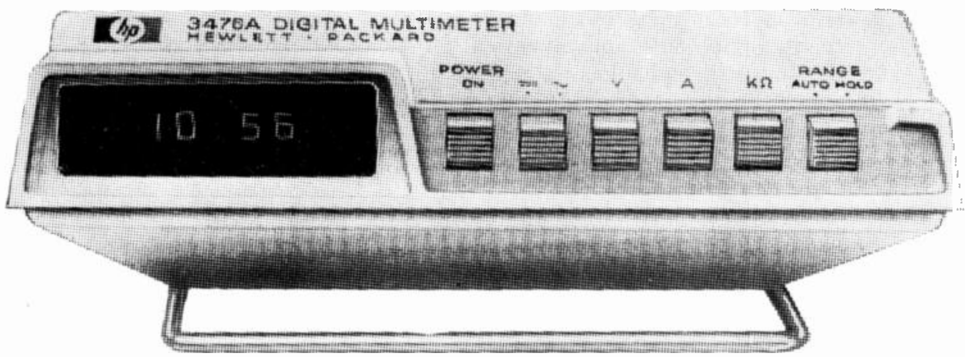

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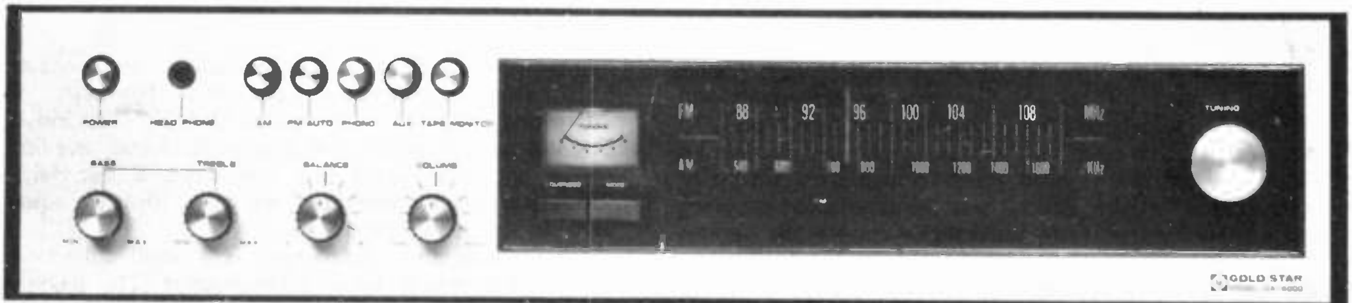
JUST RELEASED!

The Gold-Star GA-6000 FM Receiver



Challenge Hi-Fi have scooped the hi-fi scene with this first Australian release of the GA-6000 AM/FM stereo tuner/amplifier from Gold Star Electronics! The GA-6000, rated at 10 watts r.m.s. per channel and priced around $140, provides hi-fidelity performance from disc, tape and FM broadcasts at a surprisingly low cost. Although in the "budget" price area the workmanship and circuit design is sound and reliable. Twelve months guarantee, parts and labour, are effective from the date of purchase. FM de-emphasis is set to the Australian 50 microsecond standard. Technical Details • 10 watts r.m.s. per channel from 50-20,000Hz at less than 1% total harmonic distortion with both channels driven into 8 ohm load • Total Harmonic Distortion: 0.2% at 1,000Hz, 10 watts r.m.s. per channel (both driven).

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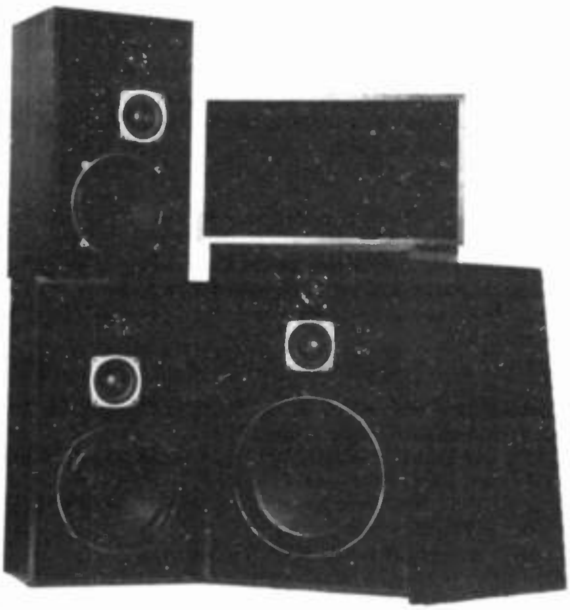

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FLH-2
12″ acoustic suspension woofer (2″ voice coil) 5″ midrange 1″ dome tweeter • frequency response 25-20,000Hz: handles the output from a 35 watt r.m.s. per channel amplifier (1,000Hz 8 ohms) • cabinet size 740mm(H) × 440mm(W) × 300mm(D).

FLH-3
15″ acoustic suspension woofer (2″ voice coil) 5″ midrange 1″ dome tweeter • frequency response 20-20,000Hz: handles the output from a 45 watt r.m.s. per channel amplifier (1,000Hz 8 ohms) • cabinet size 940mm(H) × 490mm(W) × 400mm(D).

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The novice licence

A guide to articles, books and magazines

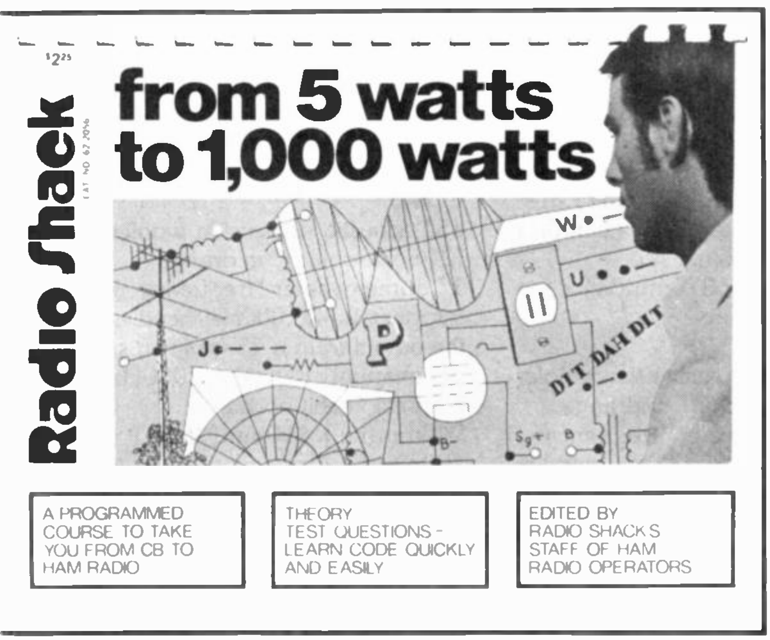
Compiled by Roger Harrison VK2ZTB

THE RECENTLY introduced Australian novice licence creates a need for current literature on equipment and techniques suited to the novice-licence privileges. To partially fill this need, whilst equipment and techniques directly suited to the need are developed, here is a list of construction articles which have been selected as being appropriate, or, of wide interest. Of course the various amateur handbooks have quite suitable material, however, the articles selected mostly contain more details, or describe techniques and equipment not covered in such handbooks.

COMMENTS ON THE ARTICLES

The articles on the transmitters were chosen for their description of equipment that is simple to construct and align. The 'Tucker Tin Mark II' was once obtainable as a kit. However, details in the article are sufficient to allow easy duplication. Performance of this equipment is very good. One would need to have some experience in construction, though, to satisfactorily complete any of these projects. The power input to the transmitters described in (6) would have to be reduced to comply with regulations, and crystal control would be necessary, but these requirements are easily met.

Direct-conversion receivers are an obvious choice owing to their relative simplicity. I have included six articles on D-C receivers (7, 8, 10, 12, 13, 16). A number of articles covering simple superhet receivers are also included. The projects in (13) and (15) are particularly recommended. "Learning to Work with Semiconductors" is one of the best introductions I have seen to solid-state techniques and communications receivers in particular. A complete CW transceiver is covered in (5) and (17).



This book from Tandy is specifically intended for the novice and is good value.

Antennas are well covered in the various handbooks as are applicable construction practices. However, some interesting antennas are described in (18), (19) and (20). The last two are particularly applicable if you have limited means and even erect just one antenna. Pat Hawker's "Amateur Radio Techniques" has many ideas for antennas suitable for use in a small area.

"Instruments and Techniques" is a small collection of articles that should be of wide interest. The techniques discussed in (26) and (27) are easily duplicated in the home workshop, on the kitchen table or what-have-you.

A grid/gate/base-dip oscillator is almost indispensible. But you should know how to use it properly – even if it seems obvious. 'The Art of Dipping' (23) is thus recommended reading.

WHERE TO FIND THE MAGAZINES

The capital city public libraries, and many municipal libraries carry copies, and you can arrange inter-library loans and photostats. The WIA Divisional offices in some states have good libraries that carry all the magazines listed.

TRANSMITTERS

(1) The Tucker-Tin Mark II, Fred Johnson ZL2AMJ, Break-In August 1971.

(2) Aligning the Tucker-Tin Mark II, Fred Johnson ZL2AMJ, Break-In May 1972.

(3) Questions and Answers on the Tucker-Tin Mark II, Break-In May 1972.

(4) A Double Sideband and CW QRP Transmitter, M. Ringer W6CTM, QST Sept. 1973.

(5) The Mountaineer – An Ultraportable CW Station, W. Hayward W7ZOI and T. White K7TAU, QST August 1972.

(6) A Simple Single-Band Transmitter, Harold Hepburn VK3AFQ, Amateur Radio (WIA) Jan. 1974

RECEIVERS

(7) An Experimental Direct Conversion Receiver, Fred Johnson ZL2AMJ, Break-In May 1971.

(8) An Adventure into Solid-State Direct Conversion, J. Whittaker ZL1ACA, Break-In Sept. 1973 and correction Nov. 1973.

(9) A Simple Receiver For The New Amateur, K. Mundell ZL2TPY, Break-In March 1974.

(1) A Direct Conversion Receiver, B. M. Durdle ZL2BAM, Break-In Dec. 1974

(11) 80 Metre SSB Receiver, W. B. de Ruyter PA0PRW, Wireless World March 1970 and correction April 1970.

(12) A New Front End For Direct Conversion Receivers, B. Pasaric YU2HL, QST Oct. 1974.

(13) Learing To Work With Semi-conductors, Doug De Maw W1CER and Lew McCoy W1ICP,
QST – April 1974 – Introduction & DC Voltmeter.
– May 1974 – About Transistors & Designs, AF Amplifier.
– June 1974 – Tuneable LC Oscillators.
– July 1974 – FET Mixer & Simple D-C Receiver.
– Aug. 1974 – IF Amp. & Product Detector.
– BFO and Complete Receiver.

(14) An 80-10 Metre FET Preselector, D.A. Blakeslee W1KLK and A.M. Wilson W1NPG, QST Sept. 1971.

(15) High Performance Solid-State Receiver for the Novice or Beginner, J. Kaufmann W1CQW and Doug. De Maw W1CER, QST Oct. 1972.

(17) The Mountaineer – An Ultraportable CW Station, W. Hayward W7Z0I and T. White K7TAU, QST August 1972.

ANTENNAS

(18) A Broadband 80 Metre Antenna, F. Jennings, ZL1GET, Break-In July 1973.
(19) A Wideband Dipole Antenna, C. Williams ZL1BKB, Break-In Nov. 1974.
(20) A Broadband Travelling-Wave Dipole, Dr. R. F. Guertler and G. E. Collyer, Amateur Radio (WIA) April 1974.

INSTRUMENTS AND TECHNIQUES

(21) A Simple RF Wattmeter, W. Bell ZL3AO, Break-In April 1971.
(22) Hybrid Gate Dip Oscillator, B. Clark WB4OBZ, QST June 1974.
(23) The Art of Dipping, B. Clark WB4OBZ, QST Jan. 1974.
(24) NFO/XTAL-controlled Gate/Grid Dipper, W. L. Steed K4PRL, QST April 1972.
(25) A Simple Ham Shack Wavemeter, Lew McCoy W1ICP, QST June 1972.
(26) A Breadboard Revisited, S. B. Leslie W5EU, QST Feb. 1974.
(27) Low Cost Printed Circuit Boards, Bill Wildenhein W8YFB, Ham Radio Jan. 1975.

MAGAZINES OF INTEREST

'AMATEUR RADIO' – Journal of the Wireless Institute of Australia. You have to join the Institute to obtain it. There is a Divisional office and various clubs in each State through which one may join. Write to:– WIA Federal Manager, P.O. Box 150, Toorak, Vic, 3142 for information on joining.

'BREAK-IN' – Journal of the New Zealand Amateur Radio Transmitters. Obtainable from Dick Smith Electronics or by joining the NZART. Costs about $7.00 per year. You can obtain it direct from the NZART at:– P.O. Box 1459, Christchurch, N.Z.

'THE MILLIWATT' – Devoted entirely to under 5 watt amateur radio. Published in the U.S.A. Last heard it was available through the EEB, P.O. Box 177, Sandy Bay, Tasmania 7005, for about $3.50/year.

'QST' – Journal of the American Radio Relay League (AARL), the US Amateur Radio Society. They have a monthly feature called 'Beginner and Novice' which often has really excellent material. You have to join the ARRL to get a mailed subscription. Join through:– WIA Magpubs, P.O. Box 150, Toorak, Vic. 3142. Costs about $9/year that way. Many technical bookshops carry it as does Dick Smith, usually costs about $1.00 to $1.20 per copy.

'ZERO BEAT' – Journal of the WIA Youth Radio Club Scheme. You can join the YRCS through your local Division of WIA. Edited and published bi-monthly, commencing February each year. Costs a nominal sum.

BOOKS OF INTEREST

'A COURSE IN RADIO FUNDAMENTALS' by the ARRL. Obtainable through most technical bookshops. Probably obtainable through the WIA in some States. Cost varies from $4.25 to $4.95.

'NOVICE RADIO GUIDE' by the ARRL. The theory and construction practices are very good. Learning the code is included. Some things do not apply in Australia of course, but most of the material is good stuff and easy to read. Obtainable through most technical bookshops and probably the WIA. Cost varies from $4.50 to $5.25.

'QUESTIONS AND ANSWERS, A STUDY GUIDE FOR THE RADIO AMATEUR LICENSE' by the NZART. Very good, not as comprehensive as the above two books but an excellent introduction for raw beginners. Some material is only applicable to New Zealand of course. Well worth $1.75. Can be hard to get as few bookshops stock it. Dick Smith lists it in his catalogue.

And then, of course, you have 'ELECTRONICS – IT'S EASY' published by Electronics Today. It won't teach you the Morse Code but there are lots of other goodies in there. A snap at $3.00.

Naturally, if your are going to build equipment, you'll need to buy parts etc. This means you need 'THE WHAT WHERE WHO HASSLES AND HOW MUCH BOOK' published by Amateur Communications Advancements, 47 Ballast Point Road, Birchgrove, NSW 2041. Costs $2.80 post paid or you can buy it from Pre-Pak Electronics and Dick Smith Electronics for $2.50. This is a catalogue of companies, listed under 20 categories, that are of interest to hobbists. Australian and New Zealand companies listed along with selected, useful overseas companies. ●

THE NOVICE LICENCE

Seeking a Novice Licence? Here are ten questions, typical of those that you will be asked.

1. Which of the following microphones requires a source of direct current in order to operate efficiently:–
   (a) crystal (b) dynamic (c) velocity (ribbon)
   (d) carbon?

2. One of the electrodes of the triode valve usually operates at a potential which could result in severe electric shock to a person who accidentally made a contact between it and earth. This electrode is:–
   (a) heater (b) cathode (c) grid (d) anode

3. Indicate which of the following frequencies falls within the VHF (very high frequency) amateur bands:–
   (a) 3.53 MHz (b) 27.12 MHz (c) 146.10 MHz
   (d) 432.00 MHz

4. An amateur station operating on a frequency of 21.125 megahertz could also be referred to as operating on:–
   (a) 21 125 000 Hertz (b) 21 125 000 kilohertz
   (c) 21 125 gigahertz (d) 21 125 cycles per second.

5. A half wave dipole antenna is always:–
   (a) supported on two wooden poles
   (b) fed by a single wire feed line
   (c) fed at the centre by a two wire feed line
   (d) fed at each end by a two wire feed line.

6. Which of the following materials would you consider the best conductor of electricity:–
   (a) carbon (b) bakelite (c) silver (d) silicon?

7. When it is required to reduce the mains voltage from 240 volts to 12 volts with a minimum loss, use is usually made of a:–
   (a) power transformer (b) frequency divider
   (c) current limiting circuit (d) power amplifier.

8. Radiation of harmonics of the operating frequency of an amateur station is undesirable because they may cause:–
   (a) overloading to occur in the antenna coupling circuits;
   (b) harmful interference to other receiving stations;
   (c) severe distortion to the modulation on the operating frequency;
   (d) the operating frequency to vary considerably during modulation.

9. When connected to a direct current reading meter, which of the following components will enable the meter to indicate alternating current:–
   (a) A resistor in series (b) a capacitor in parallel
   (c) a diode in series (d) a thermistor in parallel?

10. Propagation of high frequency radio waves is possible between Australia and Europe due to the presence of the:–
    (a) troposphere (b) atmosphere
    (c) stratosphere (d) ionosphere.

NOTE:

(i) The above Sample Questions were supplied to the Wireless Institute by the Radio Branch of the PMG Department.

(ii) Candidates must gain 70% of the possible marks in order to obtain a a pass in the Novice Theory Examination. ●

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Special Keys

d/r	Degree Radian Mode Key
( )	Parenthesis Keys
→P	Converts Rectangular Coordinates to Polar
→R	Converts Polar Coordinates to Rectangular

Log Keys

e^x	Calculates natural antiloganthm of x
log	Calculates common logarithm of x
Ln	Calculates natural loganthm of x
10^x	Calculates common antiloganthm of x

Statistical Keys

x_n	The distribution key is pressed after each numenc entry in a mean/standard deviation example
$\bar{x} \leftrightarrow \sigma$	To find the average distribution x press the statistical key Finally, to see the standard deviation σ press the exchange register key x↔y

Trigonometric Keys

arc	used when determining inverse trig calculations
sin	Calculates the sine of x
cos	Calculates the cosine of x
tan	Calculates the tangent of x

Power Keys

y^x	Raises the base y to the x power
x^2	Squares x
$\sqrt{x}$	Obtains the square root of x
$\sqrt[x]{y}$	Determines the x root of y
π	Pi is an automatic constant which is recalled when this key is pressed

Standard Keys

x↔y	Exchange register key
+/−	Sign change key
1/x	Inverse or reciprocal key
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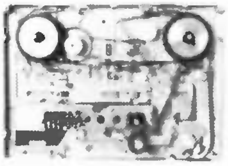

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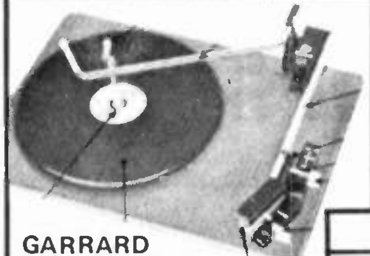

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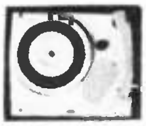

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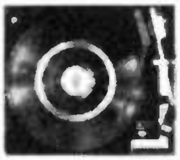

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AWA 11 inch P.I. TV EHT transformers $5.00.
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2 Meg double pole switch $1.50.
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5 x 7 in 8 or 15 ohm	$5.00
6½ inch 8 or 15 ohm	$4.50
8 x 4 8 or 15 ohm	$4.50
6 x 4 8 or 15 ohm	$3.50
4 inch 8 ohm	$2.75
3 inch 3.5 ohm	$2.50
6 inch Dual Cone Tweeters	$6.00
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National 10 inch speaker 16/OHM 3 in one mid-range woofer and tweeter	$32.00
3 inch 8 ohm	$1.50
Magnavox 5 inch 4 ohm 8 Watts	$5.00
Magnavox 5 inch 15 ohm	$4.00
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Magnavox 10 inch 8 ohm	$8.00
Pioneer horn type Tweeter 3 inch	$9.50
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MSP 6 x 2	$3.50
MSP 4 x 2 5 ohm	$2.50
MSP 6 x 4 47 ohm	$3.50
ROLA 5 x 7 47 ohm	$6.00
ROLA 6 x 9 47 ohm	$6.00
Magnavox 5 inch 8 ohm	$4.00
Magnavox 10 Watt	$12.00
4 inch 120 ohm	$4.50

Fixed capacitors

Capacitor markings puzzle professionals and amateurs alike — there are so many different codes. This section in our electronic component series is a definitive guide to the many various systems commonly in use.

THE CHARACTERISTICS AND value of a capacitor may be indicated on the body of the component in one of three ways:—

(a) The value, tolerance, working voltage and any other characteristic may be stamped or printed on the body of the component. This is usually used on physically large components such as paper capacitors, electrolytics etc. However, it is being increasingly used on smaller capacitors, particularly plastic film types. Figure 1 shows representative markings.

(b) A sequence of coloured bands or dots is painted on the component body. This is deciphered according to the standard colour code table for the value and tolerance. Additional bands may indicate other characteristics according to a specified table.

(c) The value and other characteristics may be indicated by a 'typographic' code; a sequence of numbers and letters stamped or printed on the component body. There is a variety of these codes. These will be elaborated upon shortly.

The particular marking code used depends largely on the style and type of capacitor, i.e: paper, mica, button mica, plastic film, ceramic, etc, and the code preferred by the manufacturer.

The temperature coefficient of a capacitor may be expressed directly in parts per million per centigrade degree (ppm/°C) or simply the significant figures preceeded by the letter N for a negative coefficient or P for a positive coefficient. Examples are given below:—

P100	=	+100 ppm/°C
P30 or P030	=	+30 ppm/°C
NPO	=	0 ppm/°C (negative/ positive zero)
N30 or N030	=	−30 ppm/°C
N033	=	−30 ppm/°C
N075 or N080	=	−75 ppm/°C
N470	=	−470 ppm/°C
N2200	=	−2200 ppm/°C

Wound foil and metallized capacitors may have a black line marking one end of the component body, as illustrated in Figure 2. This indicates that the *outermost* foil is connected to the lead at that end of the body. This is useful in bypassing applications or where the 'hot' terminal may be sensitive to the surrounding environment. This lead is connected to the circuit common, or the 'low' portion of the circuit and shields the 'hot' electrode of the capacitor, reducing stray coupling to or from the external circuit.

Remember that the capacitors are non-polar so that the black line does not indicate polarity or the negative terminal.

Mica Capacitors: The most common method of marking moulded mica capacitors is by an arrangement of

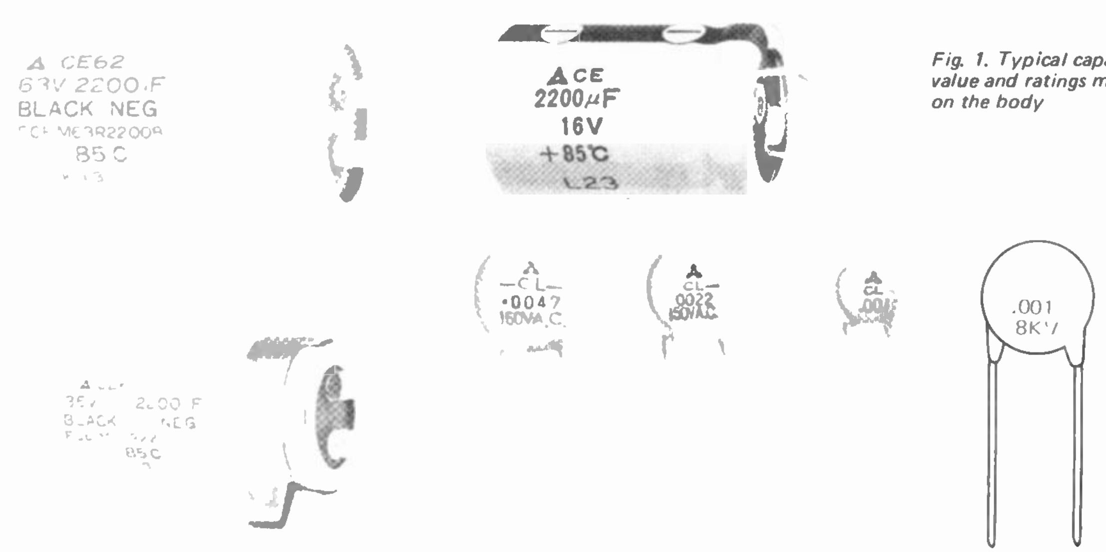


Fig. 1. Typical capacitors with value and ratings marked directly on the body

TABLE 1
MICA CAPACITOR COLOUR CODE

Colour	1st & 2nd Digits	Multiplier	Tolerance	Voltage Rating	Characteristic: Temp. Coeff. (ppm/°C)	Characteristic: Capacitance Drift
Black	0	1	±20%**		±1000	±5% + 1 pF
Brown	1	10	± 1%		± 500	±3% + 1 pF
Red	2	10^2	± 2%	350	± 200	±0.5%
Orange	3	10^3			± 100	±0.3%
Yellow	4	10^4		750	– 20 to + 100	±0.1% + 0.1 pF
Green	5	–	± 5%		0 to + 70	±0.05% + 0.1 pF
Blue	6	–				
Violet	7	–				
Grey	8	–		2000	–50 to + 150	±0.3% + 0.2 pF
White	9	–	±10%		–50 to + 100	±0.2% + 0.2 pF
Gold	–	0.1				
Silver	–	0.01				

Note: Value indicated in pF. ** no-colour also used in lieu of black.

TABLE 2

Colour	Voltage Rating	Operating Temp. Range
Black		–55 to +70°C
Brown	100	
Red		–55 to +85°C
Orange	300	
Yellow		–55 to 125°C
Green	500	
Blue		–55 to +150°C
Violet		
Grey		
White		
Gold	1000	
Silver		

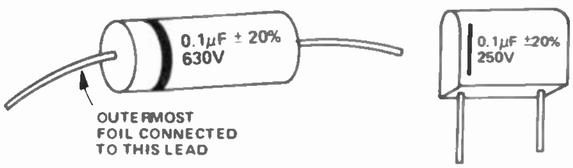


Fig. 2. Wound foil and metallised capacitors have the outermost foil connected to the lead at the end marked by a black band or line.

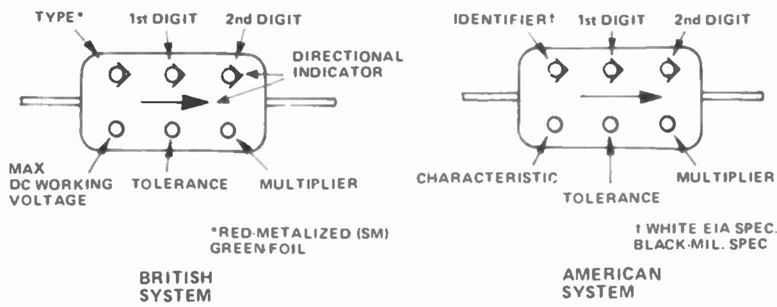


Fig. 3. Six-dot colour coding for mica capacitors.

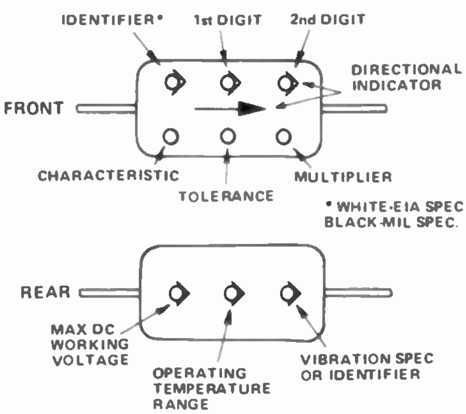
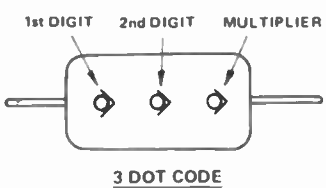


Fig. 4. Nine-dot colour coding for mica capacitors.



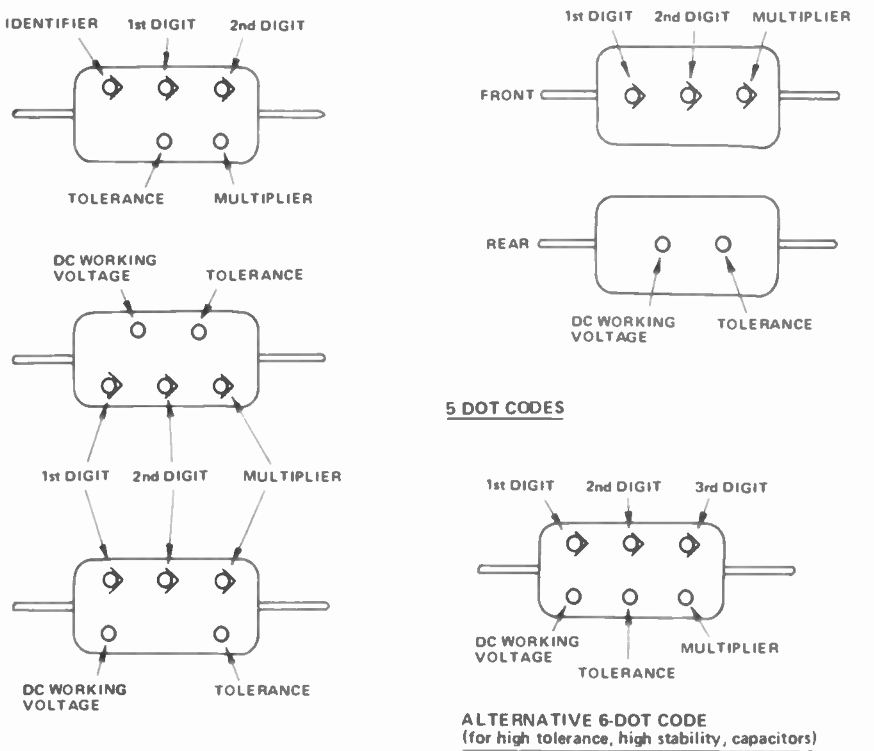
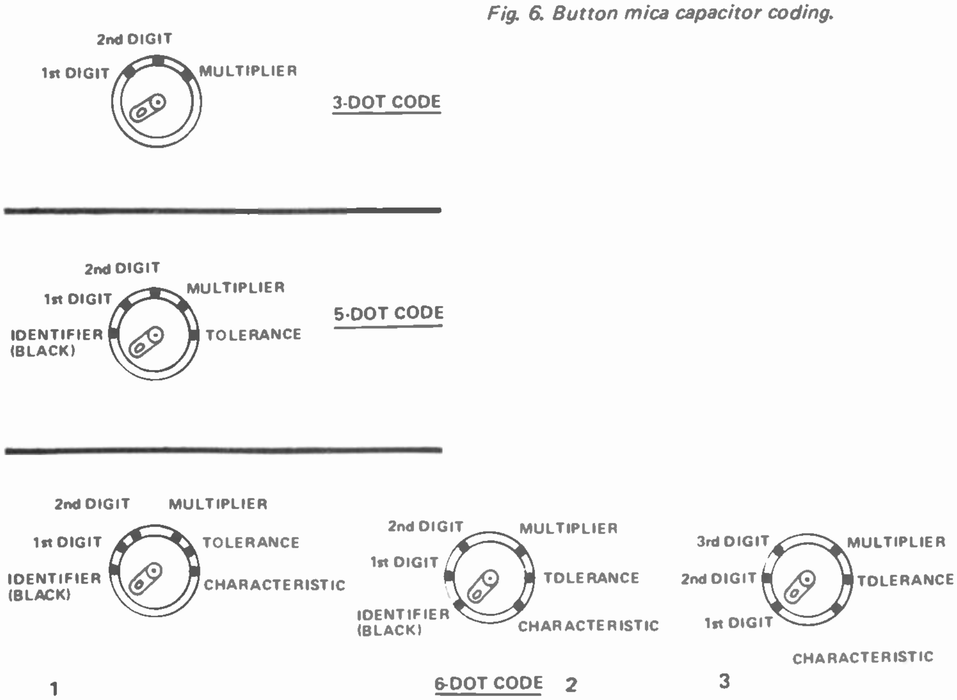
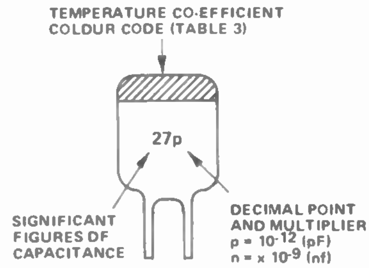


Fig. 5. Other codes for mica capacitors.

Fixed capacitors

Fig. 6. *Button mica capacitor coding.*





(pF)	marking	(pF)	marking
0.68	p68	15	15p
0.82	p82	18	18p
1.0	1p0	22	22p
1.2	1p2	27	27p
1.5	1p5	33	33p
1.8	1p8	39	33p
2.2	2p2	47	47p
2.7	2p7	56	56p
3.3	303	68	68p
3.9	3p9	82	82p
4.7	4p7	100	n10
5.6	5p6	120	n10
6.8	6p8	150	n15
8.2	8p2	180	n18
10	10p	220	n22
12	12p	270	n27

Fig. 9. Typographic code used on miniature plate ceramic capacitors.

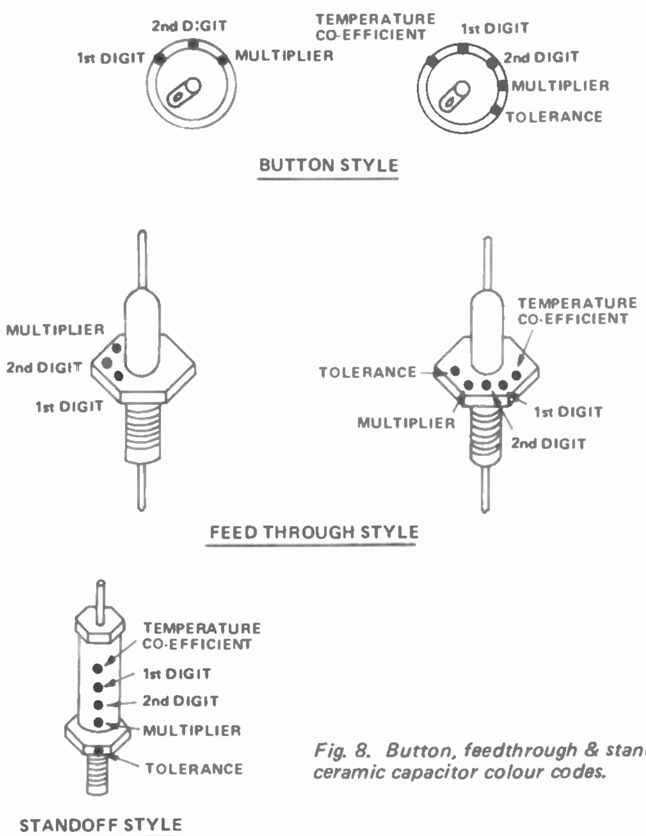


Fig. 8. Button, feedthrough & standoff ceramic capacitor colour codes.

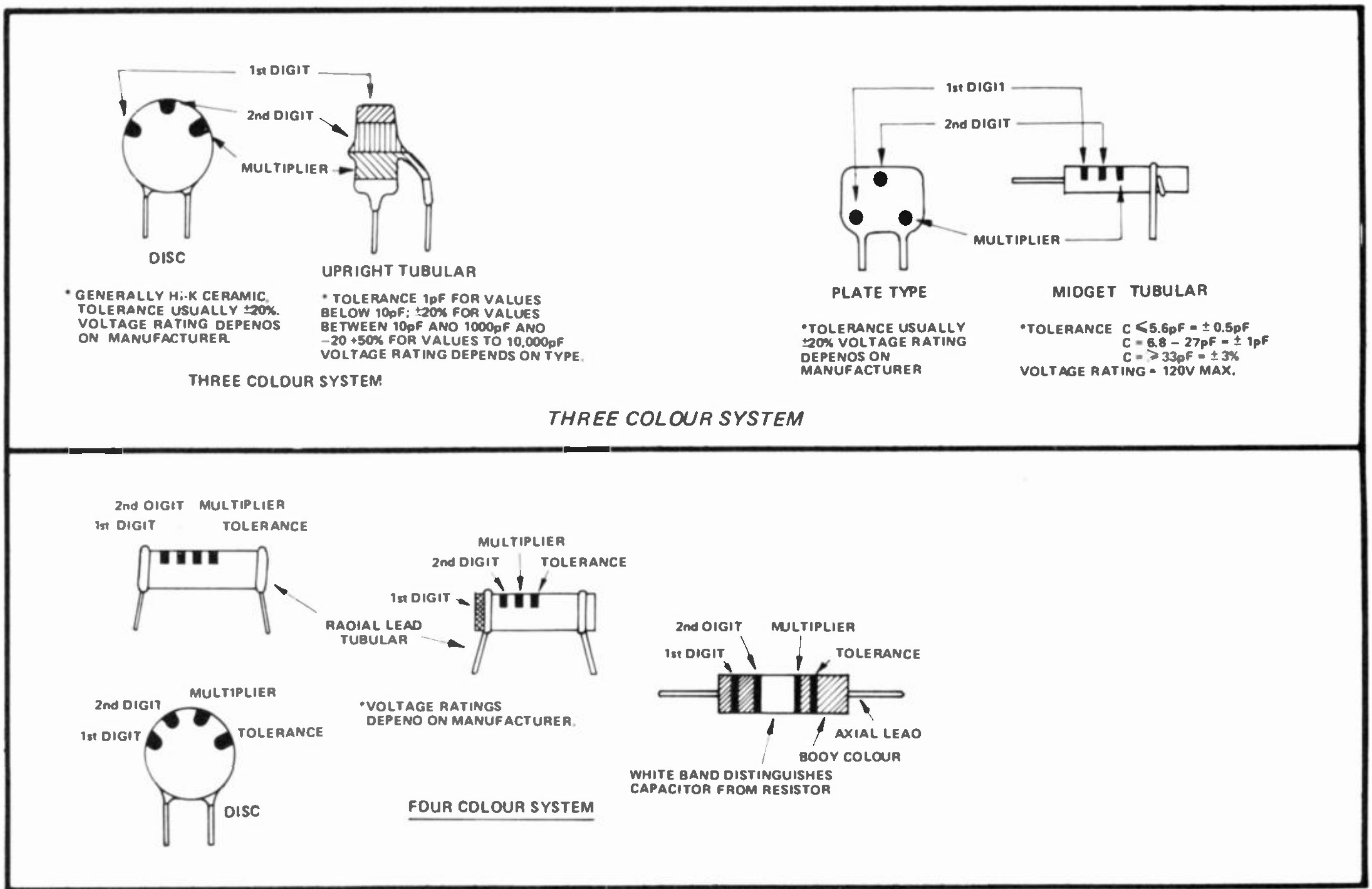
coloured dots. The widely used British and American systems are illustrated in Figs 3 and 4. The value and tolerance may be found by referring to Table I. The other characteristics may be obtained from Table 2.

Three, four, five and alternative six-dot codes have been employed from time to time. These are illustrated in Fig 5. The capacitor's value and other characteristics can be obtained from Table I. The alternative six-dot code is for high-tolerance, high stability capacitors.

Button Mica Capacitors: The characteristics of button mica capacitors are indicated by a system of three, five or six dots on the rim of the component. These are illustrated in Fig 6. The value and characteristics are obtained from Table I.

Note that there are three six-dot codes. Numbers 1 and 2 are for standard tolerance capacitors but number 3 in Fig 6 is for close tolerance, high stability types where the capacitance is specified to three significant figures.

Ceramic Capacitors: A variety of



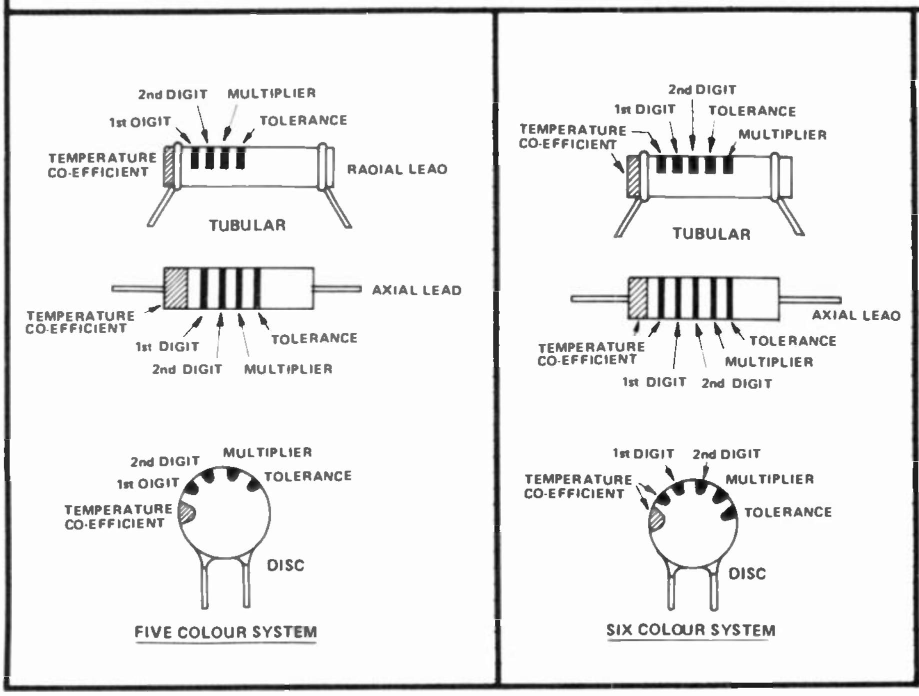


Fig. 7. Common ceramic capacitor colour codes.

typographic and colour codes is used for ceramic capacitors, largely depending on style of construction and the preference of the manufacturer. The codes used for various construction styles are illustrated and explained.

Colour code systems for the common styles of ceramic capacitor are illustrated in Fig 7. Note that in the five and six colour systems, the first band or dot is always larger than the others. For the axial lead style, this distinguishes them from resistors. In the six-colour system, the first two bands indicate the temperature coefficient. The value and other characteristics of these capacitors may be obtained from Table 3. Figure 8 illustrates colour codes for button, feedthrough and standoff style capacitors.

The typographic codes used on ceramic capacitors are illustrated in Figs 9, 10 and 11.

The code used on miniature plate ceramic capacitors, typical of the type manufactured by Philips, is illustrated in Fig 9. The value is indicated in *farads*, the letters p and n being used as a multiplier and to indicate the decimal point. If the multiplier is omitted, the value is indicated directly in pF. The temperature coefficient is indicated by a coloured band on top of the capacitor, the characteristic can be obtained from Table 3. Values below 100 pF (In) are generally Low-K, temperature compensating (TC) types. Hi-K types will not have the coloured band. Typical markings and corresponding values for low value capacitors are shown in the table on the right of Fig 9.

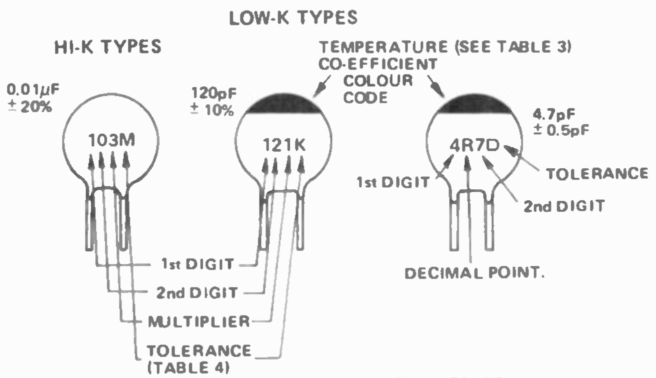
Another widely used code is illustrated in Fig 10. Generally, this involves a group of three numbers with a following letter. The first two numbers are the significant figures of capacitance, the third digit denoting the number of following zeros. The value is indicated in pF. For values below 10 pF which

Fixed capacitors

TABLE 3
CERAMIC CAPACITOR
COLOUR CODE

COLOUR	1st & 2nd digits	Multiplier	Tolerance C⩽10pF (pF)	C⩾10pF (%)	Temperature Coefficient	6-COLOUR SYSTEM TEMPERATURE COEFFICIENT Integrer	Multiplier
Black	0	1	±2pF	±20	NPO	±0	1
Brown	1	10	±0.1	±1	N030/N033	−3	10
Red	2	10^2	±0.25	±2	N075/N080	−8	10^2
Orange	3	10^3	±0.25	±2.5 (or 3)	N 150	−1.5	10^3
Yellow	4	10^4			N 220	−2.2	10^4
Green	5		±0.5	±5	N 330	−3.3	–
Blue	6				N 470	−4.7	–
Violet	7				N 750	−7.5	–
Grey	8	10^{-2} (0.01)	±0.25			+3	–
White	9	10^{-1} (0.1)	±1.0	±10	P 100	+1	–
Red and Violet	–	–	–	–	P 100	–	–

NOTE: Value indicated in pF



MULTIPLIER

FIGURE	MULTIPLY BY
0	NONE
1	10
2	100
3	1000
4	10,000

EXAMPLES

CODE	CAPACITANCE
010	1 pF
1R5	1.5 pF
100	10 pF
101	100 pF
472	4700 pF
223	22 000 pF (22 nF, .022 µF)

Fig. 10. Commonly used typographic code for ceramic capacitors.

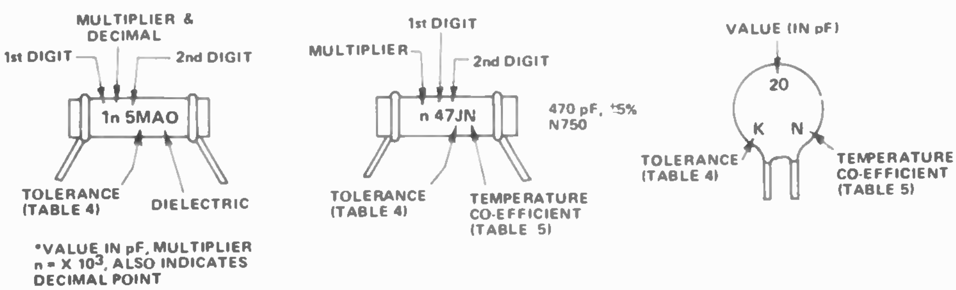


Fig. 11. Typographic code typically used on ceramic capacitors of British and European manufacture.

require a decimal point, the letter R is interposed between the two significant figures of capacitance. The value is followed by a single letter indicating the tolerance. The tolerance can be obtained from Table 4. If the tolerance code is not included, assume a tolerance of ±20%. Low-K types will have a colour-coded band on top similar to the miniature plate ceramics, and Table 3 will indicate the value.

A typographic system used commonly on capacitors of British and European manufacture, particular tubular, radial-lead types, is illustrated in Fig 11. Values below 100 pF are indicated directly in pF. Values between 100 pF and 1000 pF are indicated in pF using the multiplier n (= x10^3). The position of the multiplier may indicate the decimal point. For example, a 470 pF capacitor will be marked n47 for the value, whereas a 1500 pF capacitor will be marked ln5. Values above 10000 pF are generally marked in uF.

A system of two or three letters following the value are used to indicate the tolerance and temperature coefficient or dielectric characteristics

TABLE 4
Typographic Tolerance Code

Letter	Tolerance ⩽10 pF	⩾10 pF
B	±0.1 pF	
C	±0.25 pF	
D	±0.5 pF	
E	–	±25%
F	±1 pF	±1%
G	–	±2%
H	–	±2.5%
J	–	±5%
K	–	±10%
M	–	±20%
P	–	−0 + 100%
S	–	−20 + 50%
W	–	−0 + 200%
X	–	−20 + 40%
Z	–	−20 + 80%

TABLE 5
Typographic T.C. code

Letter	Temp. Coeff.
A	P100
C	NPO
D	N033/N030
E	N047/N050
F	N075/N080
G	N150
H	N220
J	N330
K	N470
N	N750
P	N1500
R	N2200
S	N3300
T	N4200
U	N4700
V	N5600

TABLE 6

Voltage rating code for Japanese ceramic capacitors	
Code	**Rating**
1E	25 Vdc
1H	50 "
2H	500 "
3A	1 kV "
3D	2 kV "
3F	3 kV "
3G	4 kV "
3H	5 kV "
3J	6 kV "
3M	7 kV "
3K	8 kV "
4A	10 kV "
4B	12 kV "
4C	15 kV "
AL CL	1500 Vac
DS	2500 Vac

of the capacitor in this system. The first letter indicates tolerance, the value being obtainable from Table 4. A single letter following the tolerance code indicates that the capacitor is a Low-K TC type, the value of the temperature coefficient can be found from Table 5. If the tolerance code is followed by two letters, this indicates an H-K type and the manufacturer's data should be consulted if the dielectric characteristics are needed.

Some ceramic capacitors of Japanese manufacture may have a voltage rating code, consisting of a number and a letter, or two letters, also stamped on the component. It may precede the value and tolerance code or be placed separately. This code is given in Table 6.

A range of Hi-K disc ceramic capacitors are manufactured that have the value printed on the body and a red band painted at the end opposite the leads. They are commonly known as 'redcaps', the red band indicating a Hi-K capacitor with a 25 Vdc working rating. They should not be confused with a range of epoxy-encapsulated ceramic capacitors manufactured by Erie, which have a red coating all over and are also known as redcaps.

Plastic Film Capacitors: By and large, plastic film capacitors have their value, tolerance and voltage rating marked on them directly. Small, low-value polystyrene capacitors are marked thus:— 47/100. The first figure is the value in pF, the latter figure the dc working voltage. Thus, a capacitor marked that way would be 47 pF, 100 Vdc working. Polystyrene capacitors have the lead connected to the outer foil marked by a black band at the end of the body as illustrated in Fig 2.

Often, the tolerance rating is not marked on plastic film capacitors. Except for polystyrene and mylar capacitors, a tolerance of ±20% can be assumed.

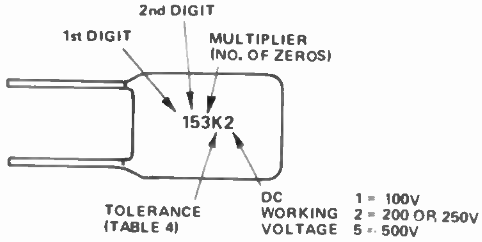


Fig. 12. Commonly used typographic code for Plastic Film capacitors.

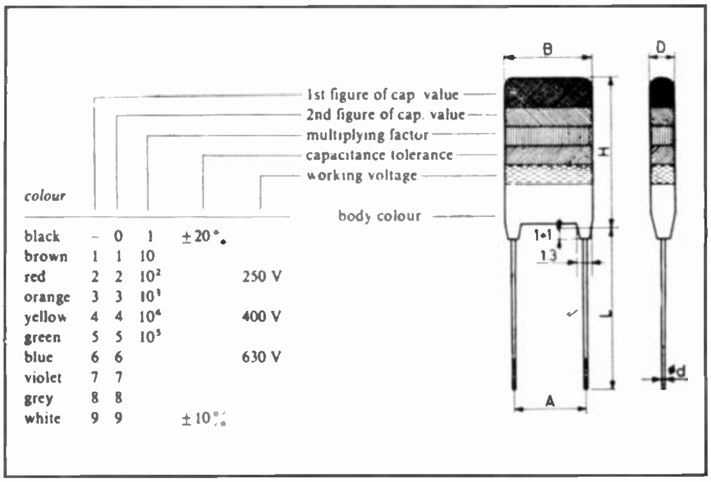


Fig. 13. Colour code for polycarbonate and polyester capacitors.

Typographic codes used on plastic film capacitors are very similar to that used on Hi-K disc ceramics as illustrated in Fig 10. For example, a capacitor may be marked 102K, which indicates a 1000 pF, ±10% capacitor. In addition, a single digit following the tolerance code may be added. This indicates the voltage rating and represents volts x 100. For example, a capacitor marked 272K1 is a 2700 pF, ±10% 100 V capacitor.

The common typographic code used on plastic film capacitors is shown in Fig 12.

Polycarbonate and polyester capacitors are marked with coloured bands around their body indicating their value and characteristics — illustrated in Fig 13. The table gives the values of the bands. The capacitance is indicated in pF. The body colour is usually a light tan.

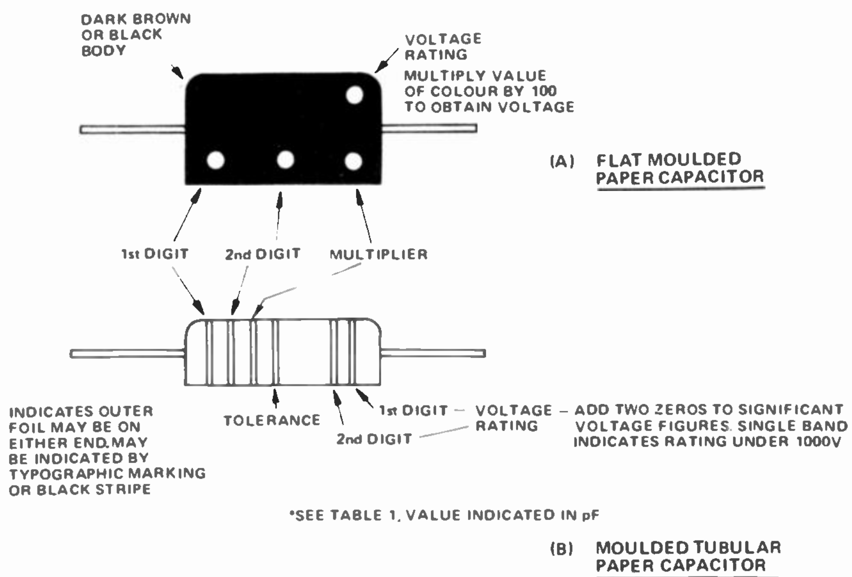


Fig. 14. Paper capacitor colour codes.

Fixed capacitors

Paper Capacitors: Paper capacitors are large enough to have the value, tolerance and rating printed directly on them. The flat moulded style, largely superceded, now uses a code of four coloured dots, similar to that used on flat moulded mica capacitors. Figure 14(A) illustrates the code for flat moulded paper capacitors. Note that the body will be dark brown or black in contrast to the light tan bodies used on flat moulded mica capacitors. The capacitance and voltage rating may be obtained from Table 1.

Moulded tubular paper capacitors are sometimes marked with a colour code as illustrated in Fig 14(B). The capacitance and tolerance may be obtained from Table 1. The voltage rating is indicated by one or two coloured bands at the end opposite the value. Add two zeros to the significant figures. A single band indicates a rating under 1000 volts. A gold band indicates a rating of 1000 volts. The value is indicated in pF. Example:—

	1st band = brown	
	2nd band = red	
Value	3rd band = yellow	120000 pF
	4th band = black	± 20%
	1st band = brown	
Voltage	2nd band = green	1500 volts

Electrolytic Capacitors: Most wet electrolytic capacitors have the capacitance, voltage rating and tolerance rating marked on them. Miniature, low voltage types use a kind of shorthand as follows:— 25/25 means 25 uF, 25 V working. The tolerance is not usually marked on them but it may be assumed to be at least −20%, +80%. The positive terminal will be marked with a + symbol or perhaps a red end cap or red dot. The negative terminal may be marked with a — symbol or a black stripe. One terminal may not be marked. In this case it is usually the negative terminal that is not marked. Most electrolytics have the can connected to the negative terminal. Some high voltage electrolytics have the can insulated and the electrodes brought out to separate terminals.

Tantalum Capacitors: These may have the value marked on them or the value and voltage marked in a shorthand as explained previously. The positive terminal is usually marked with a black stripe and/or a + symbol. The negative terminal is usually not marked. Markings on a solid tantalum and a moulded tantalum are shown in Fig 15. The solid tantalum type has the positive lead longer than the negative lead — the opposite with moulded tantalum.

Solid tantalum ('Tag') capacitors are also marked with a colour code. There are two systems in use, illustrated in Fig. 16. Table 7 gives the values and ratings for the colours.

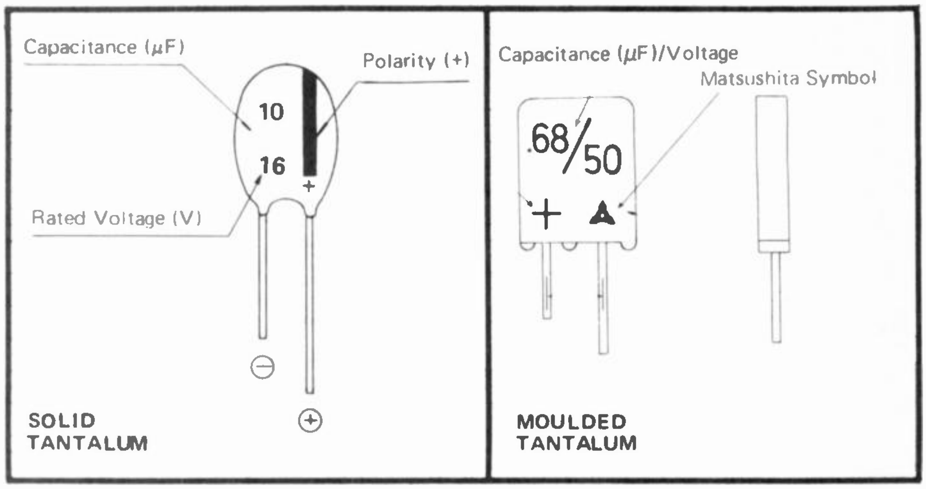
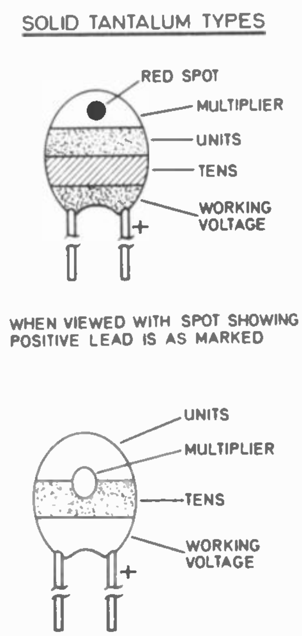


Fig. 15. Typical markings used on tantalum capacitors.



Example

Units = Blue = 6
Tens = Grey = 8
Mult. = White = x0.1µF
Body = Grey = 25V

6.8µF/25V

Fig. 16. Common colour code for tantalum capacitors.

Tantalum capacitors can withstand a surge voltage about 20-30% greater than their rated working voltage. Table 8 below lists the maximum surge voltage of a capacitor having the rated working voltage shown. ●

TABLE 7
COLOUR CODE FOR TANTALUM CAPACITORS

Colour	Voltage	Tens & Units	Multiplier
Brown	—	1	x 10
Red	—	2	x 100
Orange	35 V	3	—
Yellow	6.3 V	4	—
Green	16 V	5	—
Blue	20 V	6	—
Violet	—	7	—
Grey	25 V	8	x 0.01
White	3 V	9	x 0.1
Black	10 V	0	x 1
Pink	35 V	—	—

TABLE 8

Working Voltage	Surge Voltage
3.15 volts	4 volts
6.3	8
10	13
16	20
20	25
25	32
35	44
50	63

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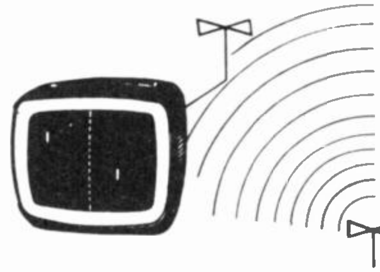

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PART 30

Digital Computers

THROUGHOUT THIS COURSE we have been steadily building up sufficient information to enable discussion of computing machine operations. What follows is necessarily an introduction only — computers are now extremely sophisticated in design and the manufacturing methods very specialised. It is, however, quite important that the operation of computers be understood by electronic craftsmen at a general systems level. This, and the next part, will introduce the philosophies, the hardware and the operation of digital computers from a technical rather than user-only viewpoint. (Analogue computers were briefly mentioned in part 12 — they are still valuable in some applications but in general, machine computing is now mainly done digitally).

Already we have introduced the systems approach of understanding analogue and digital electronic systems (Parts 1, 21); how information can be conveyed in binary code form and how different channels can be handled simultaneously on a common transmission line (Part 5); how square-wave clock signals are generated was covered in parts 17 and 18. The history of the development of logical operation by electrical switches and how logic gates operate to perform simple arithmetic was covered in Part 22 — other basic digital functions being dealt with in Part 23. Storage of digital numbers in solid-state counters was the subject of Part 24 and the conversion of signals from code-to-code and from analogue-to-digital, and vice versa, were discussed in Parts 26 and 27, respectively. How computers become involved in testing was briefly mentioned in Part 29. These are each important concepts, worth revising at this stage.

With this much learned there is little else that need be studied about components (stores of various kinds and IC developments in computers are discussed later) in order to understand how digital computers operate. Our emphasis must now be on the design arrangement of the computing machine as a whole and how the user can make it work.

WHAT IS A COMPUTER?

Regardless of whether a computer is digital or analogue in operation its role is to perform various kinds of mathematical operations. The analogue machine cannot perform logic operations: (unless cojoined with a digital computer, in which case it is known as a hybrid computer — as shown in Fig. 1) its use is generally restricted to what are called linear mathematical problems in which signals vary continuously and information is transferred as levels not as digital codes. Analogue computers can be very good at such operations, often better than a digital computer of similar cost. The digital machine, on the other hand, (a general purpose installation is shown in Fig. 2) can perform almost any kind of mathematical manipulation, however special techniques are often needed to solve analogue problems. Analogue type signals must be sampled and each sample converted into a digital equivalent before they can be processed in digital machines: this is where the digital machine in certain applications may be less efficient than the analogue alternative.

As well as performing arithmetical operations (called scientific computing) the digital machine can be instructed to process or sort discrete data in digitally encoded form (called

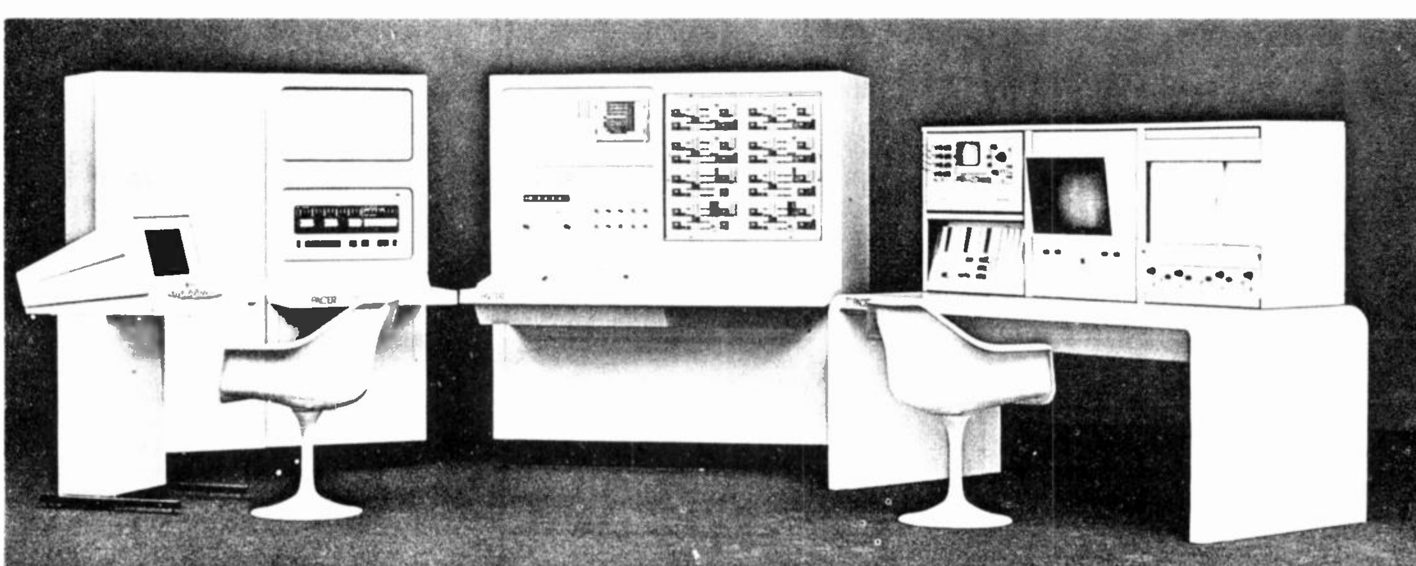


Fig. 1. Here a digital computer and an analogue computer are combined — the result is known as a hybrid computer.

Fig. 2. General purpose digital computer, this centre is used by Lloyds Bank in Britain.

data processing or DP, for short). Typical computer data processing operations are the sorting of numerical data – for example to see how many people have heights of various chosen values, or the booking of airline seats. Mixed working, where scientific calculation and data-processing are both involved, occurs for example, in costing out a building estimate, raising a stock value for a business, or producing pay-slips.

Digital computers may also calculate tables by automatically incrementing the input data between preset limits. For example the computer could be asked to generate and print the sines of all angles between 10° and 90° at 1° intervals.

We pause now to note that we call such machines computers *not* calculators. The term calculator has traditionally been used to describe machines which perform a fixed set of mathematical calculations. The term computer on the other hand, is reserved for those machines which may be reconfigured by a set of programme instructions to perform any particular task. However such distinction between the roles of calculator and computer is becoming increasingly difficult to make. Some computers are now dedicated to performing calculator like tasks and some calculators are now so flexible that they can be programmed to perform a variety of tasks.

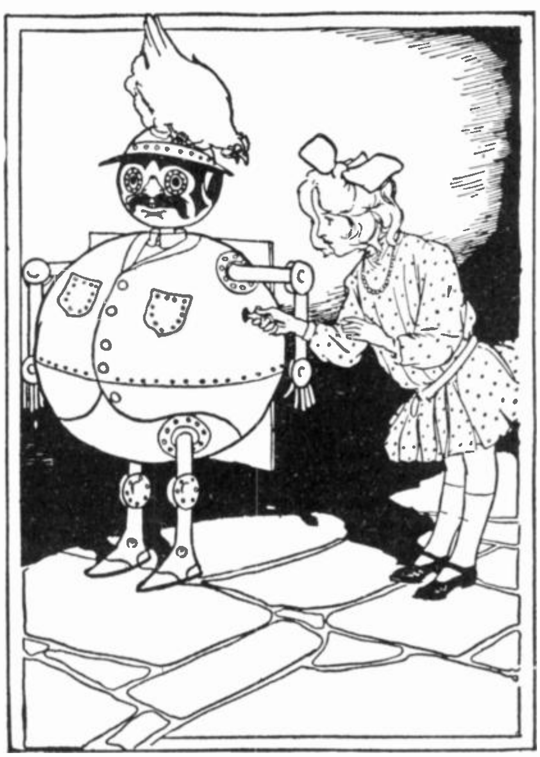


Fig. 3. As yet, computers can only do what they are programmed to do.

In the 1950s, when powerful electronic computers were emerging, the popular concept was of a machine that would soon have thinking powers of its own – and its own will and imagination – as depicted in Fig. 3. Although we must concede such is probably possible one day – no one has yet gained an inkling into how this extra facility could be realised. Computers are merely machine slaves that, if working internally as the designer thinks and intends, will perform as commanded. The operator informs the machine of its job via the programme presented to it. Where the computer has valuable merit is in its ability to perform calculations and process numerical data at rates vastly greater than a human mind, with rarely an error, and for hours on end if need be. It is a tool and no more. To say the computer accidently sent the $1,000,000 bill to Bill Blogs is entirely incorrect. The programmer or the machine did not perform as hoped through one or the other being defective in the instructions given or the way they were obeyed.

As well as computers that operate only when the operator gives instructions there is also the dedicated machine that, once set internally to compute or process in a predetermined way, becomes part of a process. It helps control by working at the same rate as signals are generated in the process – real time working. Process-control computers, as these are called, operate on data and perform calculations as part of many feedback loops in, say, a chemical plant. Figure 4 shows this use in a diagrammatic form. Other names variously used to describe this use are in-line, on-line, direct-digital-control (DDC) or just plain computer control. Wherever automation of extensive complex process is necessary a computer will usually be found – waste-water treatment plants, paper manufacture, natural gas and electricity distribution networks, satellite control and power-station plant operation are but a few of thousands of in-line applications. Computers are far more useful in this task than human operators – see Fig. 5.

On-line operation (although not generally agreed upon) is a term probably best reserved for cases where each of many input terminals connected to a central computer can gain access to the unit when it becomes available. This is also known as time-sharing and is used where the signal processing rate need not match the process. The computers used in

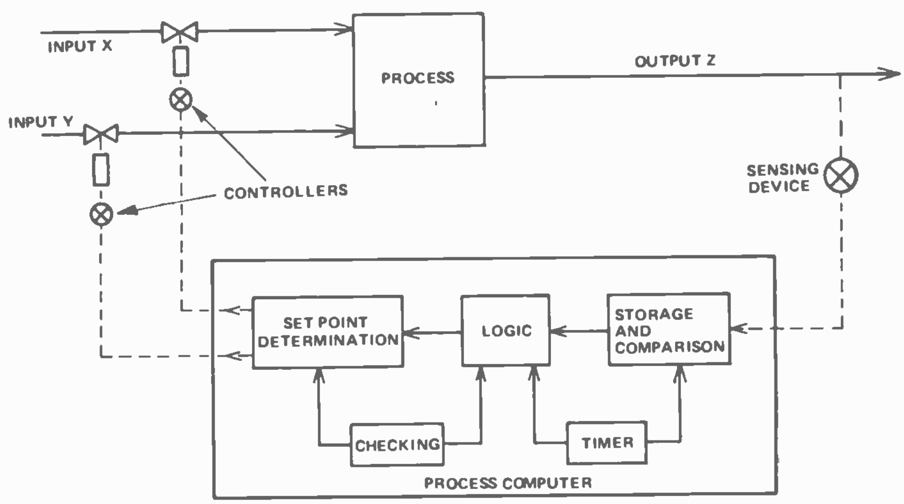


Fig.4. Process control computers are electronic data processing machines, dedicated to a specific task.

banking in Britain operate in a time-sharing mode – bank branches, as shown in Fig. 6, can gain access to the central-account records – a short wait may be necessary. When the computer works on diverse problems at the will of the operator and is not used for any dedicated purpose it is said to be off-line.

Originally electronic computers were huge – several rooms filled with racks of valve electronic circuits. In the mid-sixties manufacturing techniques and designs were such that a new style of less versatile but compact computer was marketed – the so-called minicomputer. Figure 7 shows but one kind of mini-computer system employed to control a process by providing instructions as needed. (It is not used in closed-loop as this process does not feed data back to the computer).

We do not use the word "generation" in connection with the minicomputer because that term is used in computer jargon in two distinct ways. It may describe the hardware used – first generation computers use thermionic valves and ordinary cable wiring, such as shown in Fig. 8, second generation machines use discrete transistor circuits on printed-circuit boards, third generation machines use integrated-circuitry and the most recent, about to emerge, fourth generation computers use large-scale-integration LSI manufacturing methods – see Fig. 9. A fifth generation computer is yet to emerge as an accepted concept. The other use of "generation" is in describing the system interconnections – the philosophy of system hardware interconnection and style, and capacity of the store involved.

	Machine	Man
Speed	Much superior	Lag 1 sec.
Power	Consistent at any level	1500W for about 10 sec, 350 W for a few minutes, 150 W for continuous work over a day.
Consistency	Ideal for routine, repetition, precision	Not reliable – should be monitored by machine.
Complex activities	Multi-channel	Single channel.
Memory	Best for literal reproduction and short-term storage	Large store multiple access. Better for principles and strategies.
Reasoning	Good deductive	Good inductive.
Computation	Fast, accurate – poor at error correction	Slow, subject to error. Good at error correction.
Input sensitivity	Some outside human senses, e.g. radioactivity	Wide range (10^{12}) and variety of stimuli dealt with by one unit, e.g. eye deals with relative location, movement and colour.
	Insensitive to extraneous	Affected by heat, cold, noise and vibration.
	Poor for pattern detection	Good at pattern detection. Can detect signals in high noise levels.
Overload reliability	Sudden breakdown	Graceful degradation.
Intelligence	None	Can deal with unpredicted and unpredictable. Can anticipate.
Manipulative abilities	Specific	Great versatility.

Fig. 5. Fitt's list summarizes the relative advantages of man versus machine control.

A HISTORY OF COMPUTING MACHINES

Intertwined with the development of machine operated logic (studied at the beginning of Part 22) was the gradual increase in sophistication of computing machine systems.

Earliest devices were simple calculators based on mechanical concepts. They performed simple addition, subtraction and sometimes multiplication and division, doing this without the ability to store or hold values other than inputs and computed output.

Space does not permit extensive description of this history – see the reading list for that. Figure 10 shows the style of the first calculating machine of the "modern" kind. This performed arithmetic addition and subtraction only, by mechanically manipulating interconnected counting wheels and was probably made by Pascal in 1642. In 1671 Leibniz modified the same mechanism (see Fig. 10) to obtain multiplier action, producing his own design calculator much later – in 1694. Because mechanism manufacture at that time was crude indeed – all parts were individually hand-crafted – the Leibniz machine was not reliable even though the concepts involved were sound. Improvements in mechanical manufacture had to occur before a routinely useful gear and crank calculator could be built (by de Colmar in 1820). Thus, through these and many other gradual improvements to method and manufacture, the scene was set for grander ideas.

A major advance was made by Babbage. Charles Babbage was born in Devon, England. In 1792, he became a Professor of Mathematics at Cambridge University and had a consuming passion for mechanical machines that could perform far more advanced mathematical operations than any previous apparatus. His first machine, shown in Fig. 11, was devised to solve differential equations by calculating differences. This was his "Difference Engine" of about 1812. In 1833 he conceived a second, quite different general-purpose engine – the so-called "Great Calculating Engine". In principle, it could do any mathematical operation by following instructions programmed into it by the operators. It could also make decisions, on what to do next, that were based on its just calculated results.

Babbage used punched-cards for input information (a reasonably logical choice in view of the many repetitive industrial processes using this control medium at that time), a memory (which he called "the store"), a number processing section (called the mill), a means of transferring results to and from the store, and automatic output (as cast type ready to print). It was a grand machine having ability to store 1000 fifty-digit numbers in its store. It even had overflow indication.

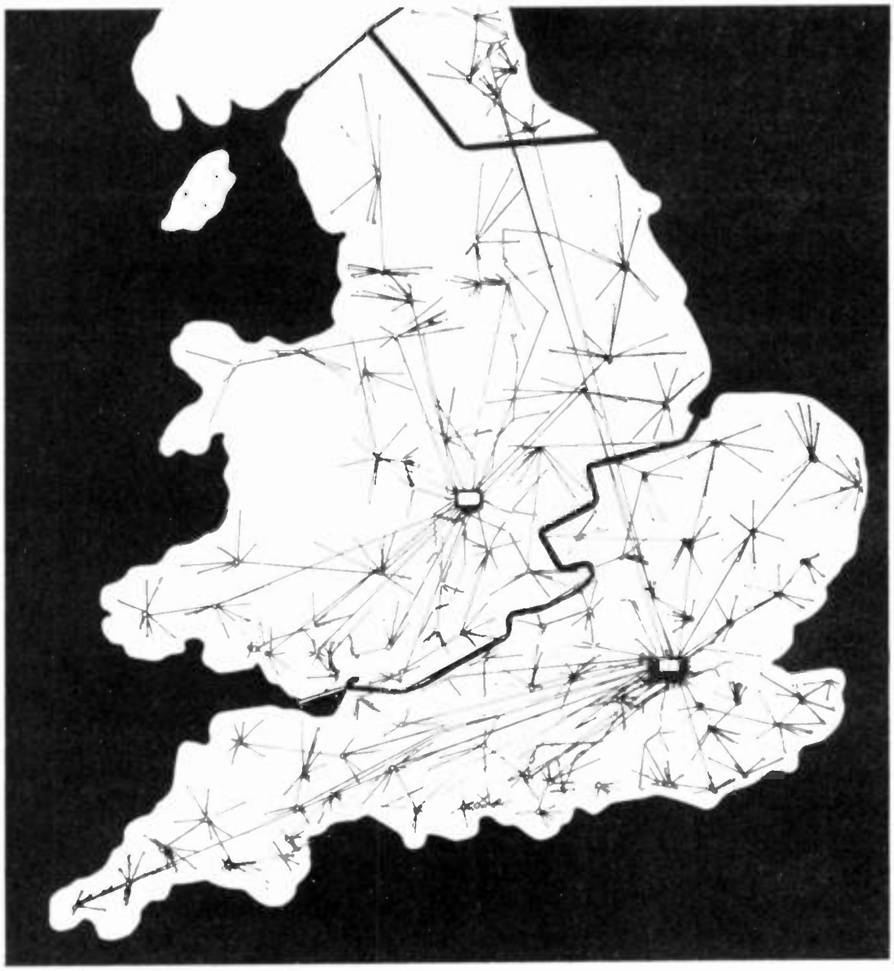
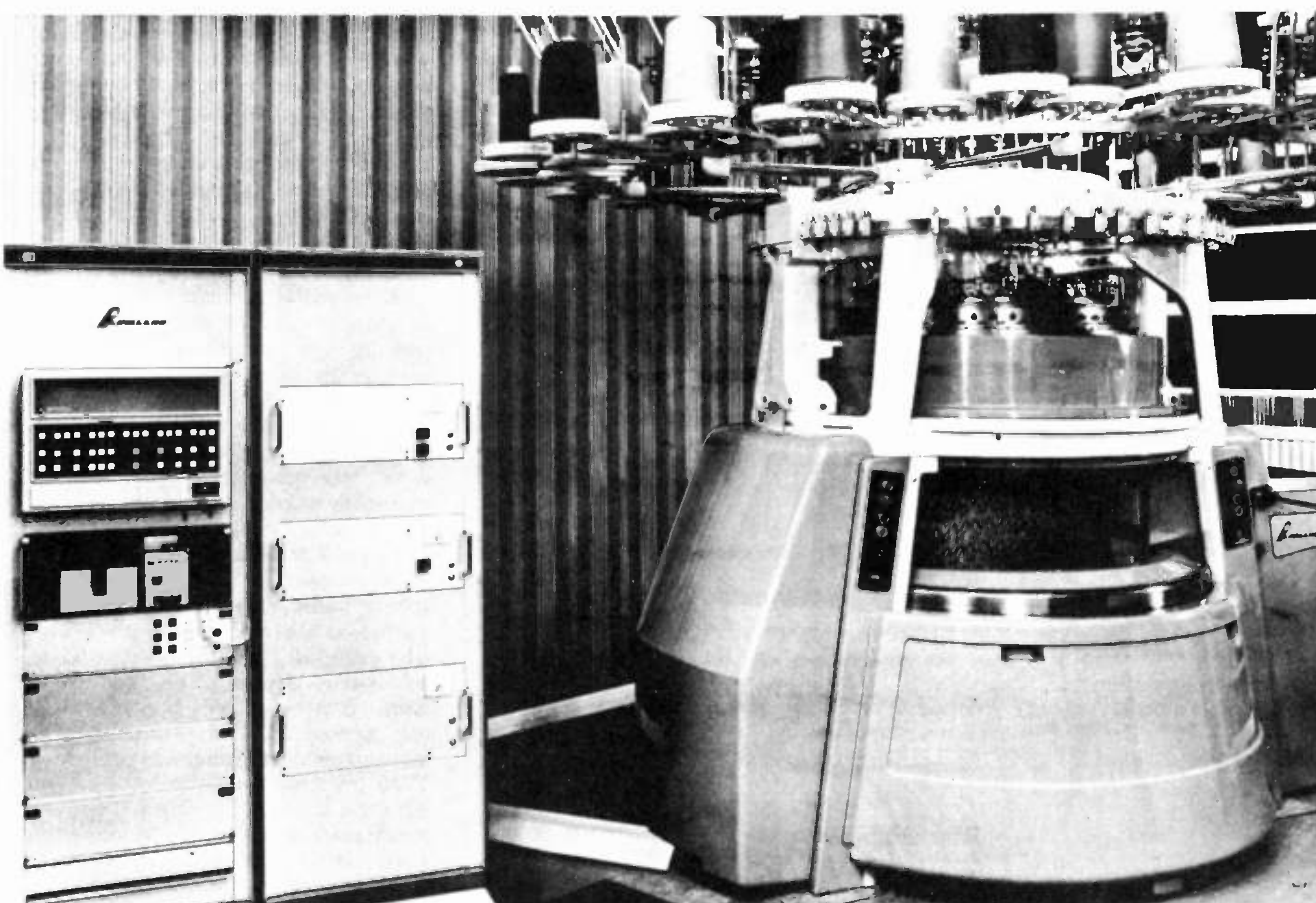


Fig. 6. In time-shared operation a central computer is made available to terminals. This map shows the links of bank branches to two central computer centres via concentrators.

Fig. 7. Mini-computers come in all shapes and sizes. On the left, in the console, is the H.P. 2000 that controls the pattern being knitted on the Kirkland knitting machine.



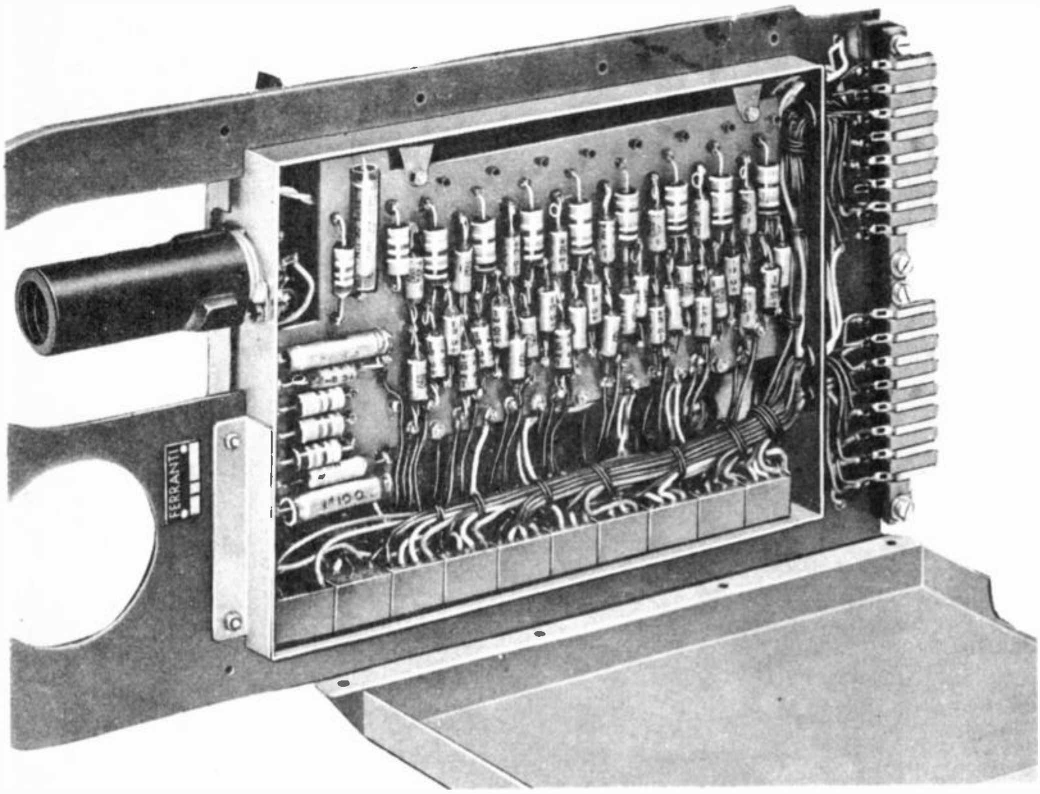


Fig. 8. Compact electronic computer systems become reality when valves were replaced by solid-state components. This single plug-in unit, from a Pegasus computer of the 50s, would today have its entire function made on a pinhead in LSI technology.

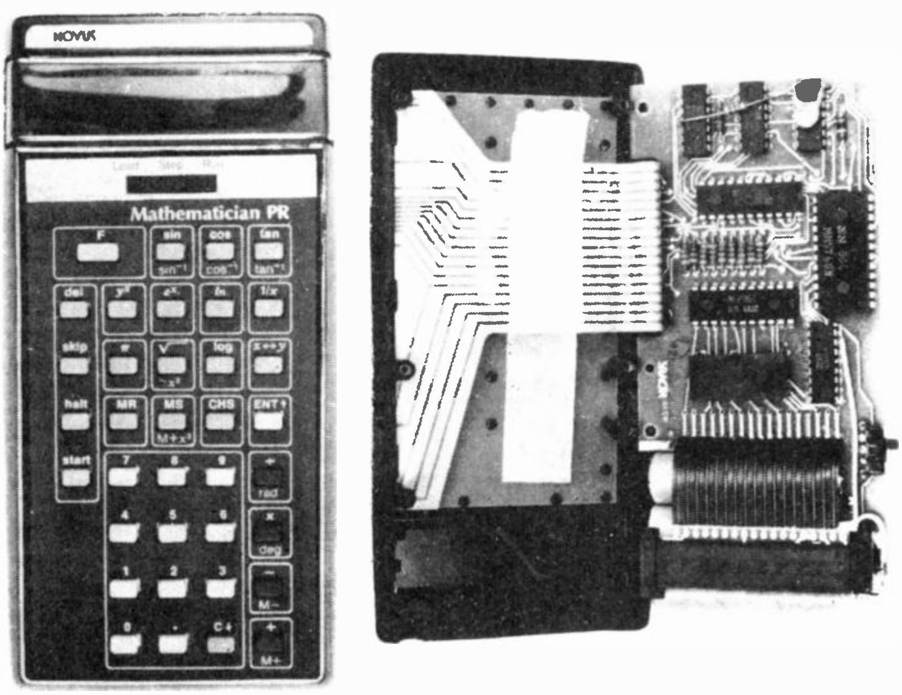
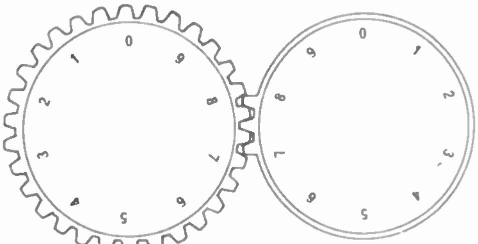


Fig. 9. Today's computers use LSI techniques in which thousands of transistors and diodes are contained within a single chip.

The intended power supply was steam. Sadly, Babbage's engines were not proven in practice in his time; those built were either not completed or proved too unreliable. Manufacturing methods were still incapable of maintaining the tolerances needed — it was a classical example of a concept waiting for the requisite technology.

However from that time on calculators rapidly became more sophisticated. Keyboard entry (Fig.12) of data, instead of the need to turn wheels, was introduced, (but the mechanism was still handcranked) number length was limited and speed was very slow (by today's standards). Around 1910 electric-motor drives were incorporated to perform the numerous mechanical rotations needed to transfer the carry-over value through all decades.

Complicated mathematical equation solving in the 19th and very early 20th century was performed on other kinds of special purpose mechanical calculating devices. The planimeter, which determines area under a curve, was devised in 1814, the mechanical ball-and-disk integrator was deviced in 1876 (by Lord Kelvin's brother). With these and other basic mechanical-function solving ideas, Lord Kelvin and others put systems together that carried out specialised calculations. Kelvin produced a tidal



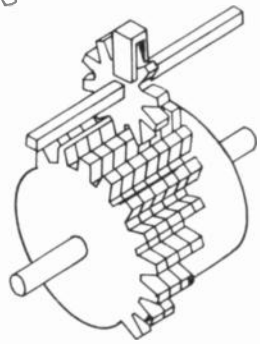


Fig. 10. Pascal's calculator of 1642 used stripped-gear toothed-wheels to produce a carry to the next decade: The Leibniz machine made use of the stepped wheel.

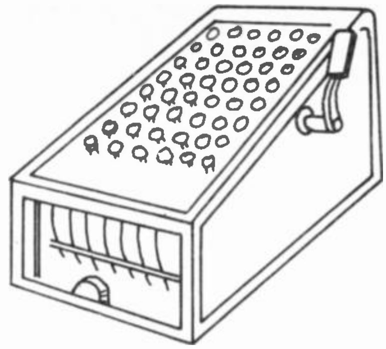


Fig. 12. Keyboard data entry was introduced around turn of the century — but speed of entry was still very slow.

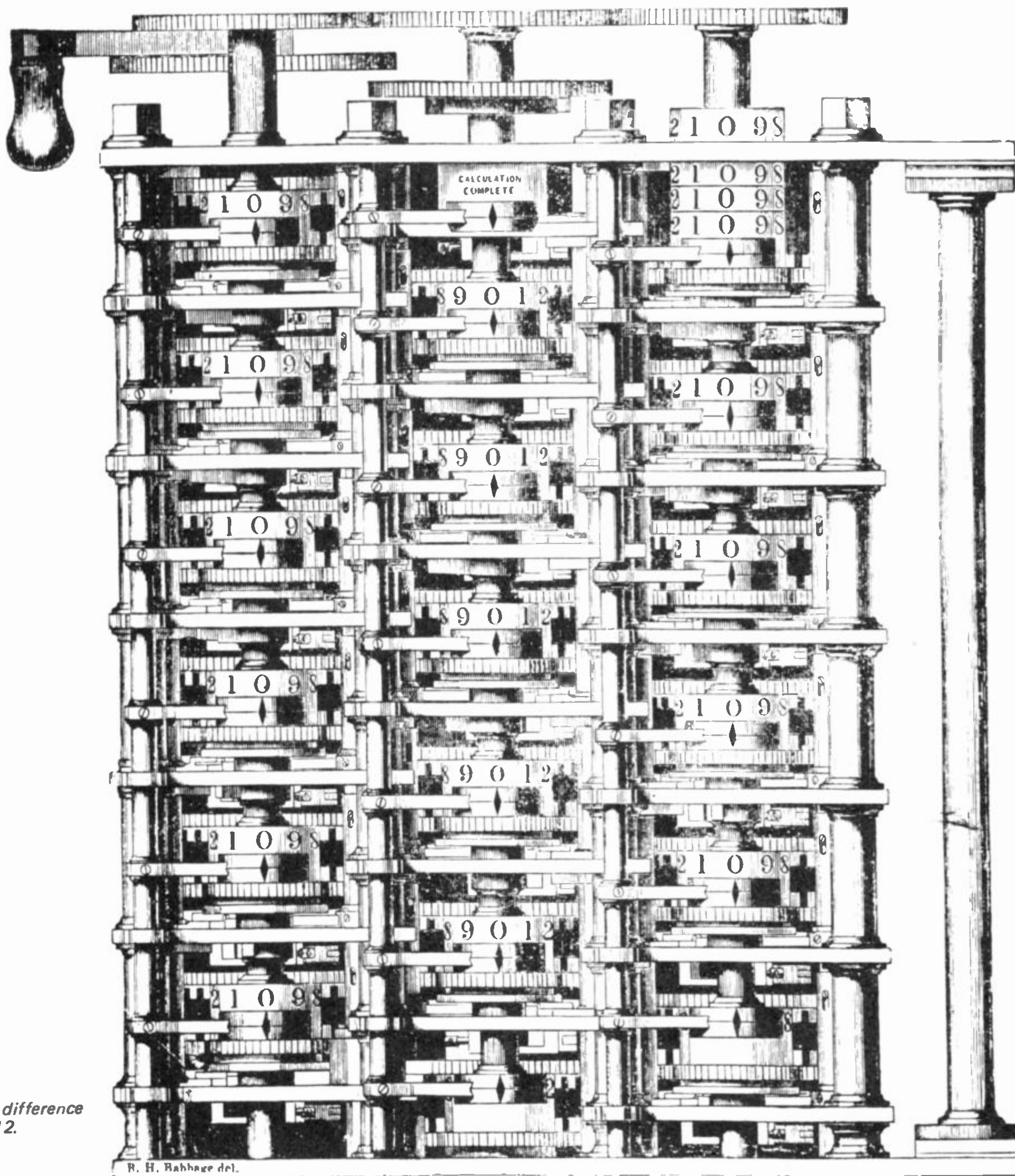


Fig. 11. Babbage's difference engine of circa 1812.

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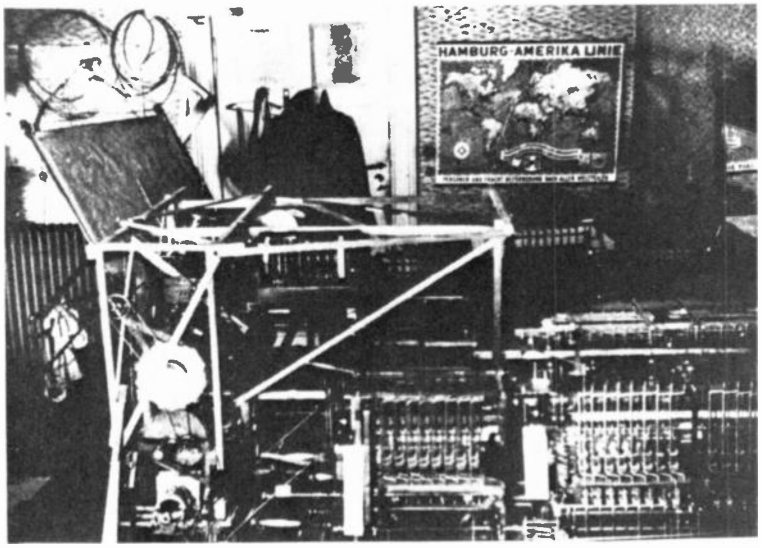

Fig. 13. This relay-switched digital calculator was built by Zuse in Germany in 1936. ((This photograph has been included because of its historical interest – unfortunately the original print is of border-line quality).

amplitude and phase predictor for sea-tide forecasting around 1874. Later in 1898 Michelson (of speed of light fame) worked with Stratton to produce a mechanical harmonic analyser.

Special-purpose mechanical calculators were still in use in the 1940s. During World War II, for instance, gun crews fed data concerning range, direction and wind strength into computers by which the correct aiming information for the gun was computed.

Today a few equipments still perform simple operations by mechanical means for in applications where electrical power is not available and the inputs not in electrical form it may be more economic to use mechanical methods.

With the advent of electronic amplification at the turn of this century electronic circuitry gradually replaced mechanical mathematical functions. This was feasible because of the superior speed of calculation, reduced manufacturing tolerances and greater reliability of electronics. The swing to electronics was intensified by the need to process an ever increasing amount of data that arises in, for example, more complex equation solving, census taking, or warfare. Hollerith devised the punched-card sorting machine to help handle the U.S. census data. This device won an 1890 competition organised by the U.S. Government.

Electric computers using the same basic system that we use today became reality around 1936 when Zuse, in Germany, built the relay-switched digital calculator (shown in Fig. 13). This machine featured automatic computing, binary arithmetic, floating decimal point and punched-tape programming. In 1937 the USA's IBM Corporation began development of a machine called the Automatic Sequence-Controlled Calculator, or, locally, just Mark I.

The trend toward total electronic working continued. ENIAC, generally recognised as the first all-electronic computer, had 18 000 valves and could operate at 500 additions per second. This was followed, after many other developments, by the first production computer – the Remington Rand UNIVAC I. It has been estimated that all computers installed in the U.S. in 1955 could do just 250 000 additions per second. Just one low-cost mini can do that today.

In 1959 a U.S. refinery installed the first process-control computer system and in 1960 a large steel corporation in U.S. was the first to use a computer to carry out inventories, handle orders and control production. Airline booking by computer began in 1964.

Integrated circuits (in the third generation machines) came into use in 1964 via the IBM 360 system and by 1970, in the U.S. alone, roughly 1 000 000 people were employed in making and using digital computers.

Single chip, fourth generation machines came to reality around 1972 with the use of LSI. Today (or at least when this was written early in 1976) pocket scientific calculators containing over 30 000 transistors in LSI form can be purchased for less than a week's wages. In 1974 the world market for small calculators was estimated to be 40 million! The cost of modern computers is now governed by the cost of the peripheral bits and pieces rather than the processing unit itself – the cost of the electronic components is now just a minor part of the whole.

BASIC ORGANISATION

The complete electronic data processing (EDP) system comprises *hardware* and *software*. The former pertains to the physical machinery of the computing system – that which can be seen to exist in containers and cabinets. Software is the jargon term used to cover the multitude of different programmes devised to instruct the hardware about the tasks it has to perform – these may come in punched card, punched tape, magnetic tape and disks or in written format.

The hardware of electronic data processing systems comprises the several basic functional blocks depicted diagrammatically in Fig. 14. Peripherals enable the electronic circuitry of computation to communicate with external information flows via the input and output units. The heart of the system is the central processing unit (CPU) comprising a very fast-access store (also called the high-speed memory) of digital numbers; a unit that performs simple arithmetic operations at high-speed (called the arithmetic unit), and a control unit that coordinates all units by stepping (clocking) the system on bit-by-bit by means of a clock pluse source.

A CPU can serve many different functions and all CPUs are not identical by any means. Typical tasks are to control the peripherals and the input/output information flow, perform the arithmetic in scientific work or compare data in data-processing uses where the logical capability is exploited more directly.

Data is shunted back and forth between units on the bus lines using parallel, and serial forms of binary number transfer. (A number of binary bits, when combined into a number, are described as words). Different manufacturers use different word lengths – 24 in ICL 1900, 32 in IBM 360; 36, 48 and 60 are also used. The term 'byte' will also be met and this is the designation for a short segment of the full word. For example an 8 bit segment of a 24 bit word.

Words are held in the store when not being operated upon. As well as being a binary number that is directly equatable to a decimal number, words can also represent instructions for the control unit to use, a piece of a number, a sequence of letters or any

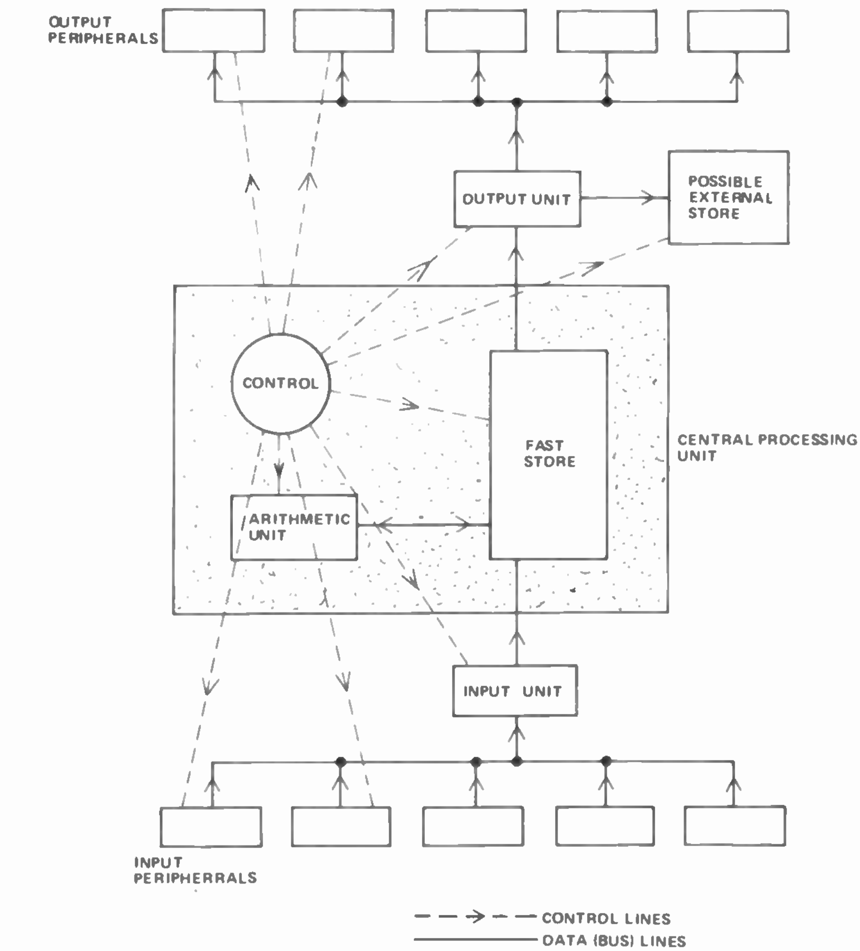

Fig. 14. Basic functional blocks of electronic data processing system.

other symbols (eg graphics) as desired.

Words usually include one extra bit called the parity bit. The parity bit is used as a continuous check that the words transferred between locations have arrived as sent without any binary position of a single word having its state altered on the way.

In order to make use of this versatile arrangement, a CPU must have a set of instructions to tell it when and where the data has been placed for optimum use of time. The programme, that is the software, performs this task at speeds much greater than human operator or the input units could. A programme is loaded into the CPU at the speed allowable by the input mechanism, during which time the computer is often employed on other tasks. Once loaded the system is started on the problem, and then runs at the maximum speed of which it is capable. To give some idea of speeds involved, a CPU internal operation will take around 1μs or less whereas a fast peripheral barely gets down to 100 000 μs per operation. The design of EDP systems is very much one of careful systems organisation to avoid wasted operating time.

We say software programmes operate with various languages. The most basic and original language is *machine language* wherein the programmer must specify exactly which bit must go to exactly what store location and so on. This is seldom used today at operator level. With time, languages have come closer to normal spoken language; this being achieved by building more and more automatic programming functions into the CPU. The closer the language to everyday expression the higher the level of the computer language. Many aids have been established to ease the skill needed by the programmer in compiling a workable programme. We are however a long way from programming by merely talking to the machine. Computers must still have their instructions in a strict written format. In compiling the exacting programme sheets the user must first establish what he wishes to do mathematically, and detail the steps required on a flow chart. Figure 15 shows a typical flow-chart for a data processing problem.

It is not possible to state, in general, how long a computer may take to provide a solution: tasks can take many hours to mere fractions of seconds, depending on the size of problem and computer power. Off-line computations may not necessarily have to be performed at high speed (except when other jobs await their turn) but in process-operations it will often be vital that a calculation is made in sufficient time to gain stable control. Remembering that all calculation required must be reduced to the basic four functions of add, subtract, divide and multiply it does not take much of a calculation to consume many milliseconds, especially when the decimal accuracy needed is high. A particularly fast computer may be essential to obtain millisecond time-constant control in computer-control work.

(Continued on page 106)

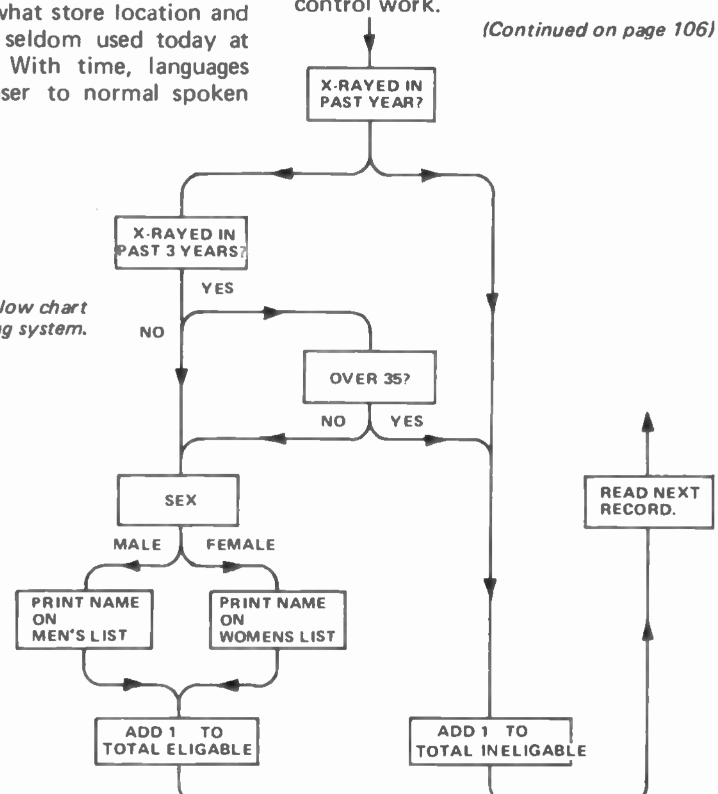

Fig. 15. Typical flow chart for data processing system.

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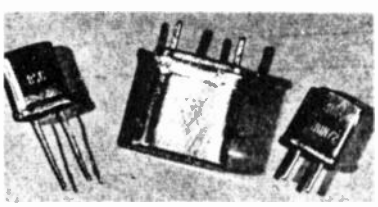

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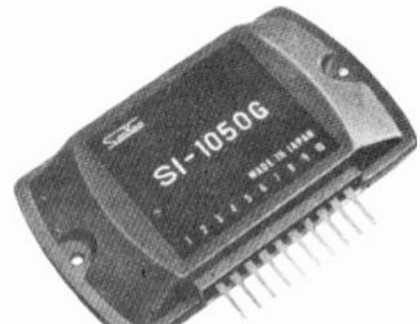

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Supply Current (ave.)	0.86A	1.1A
Protective Fusing	1.5A Quick Blow	2A Quick Blow
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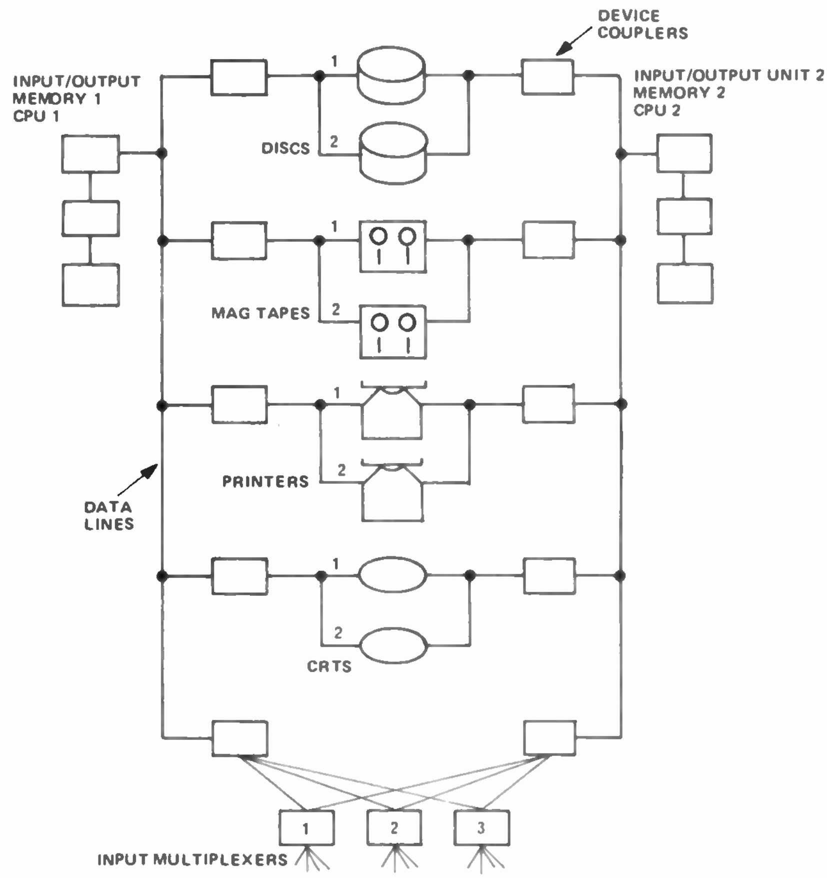

Fig. 16. Redundant circuits are incorporated so that one unit will continue to perform a vital task even if though its complementary unit fails.

ADVANCED ORGANISATION

Even the best designed digital circuits occasionally go wrong or pick up stray noise thus causing errors. A single parity check greatly enhances the chances of detecting errors, but with the development of faster machines that conduct vastly greater numbers of operations in a given time, the reliability of the systems to perform correctly without error comes into question. When reliability is a vital consideration, as for instance it is when designing computers for manned space shots, the equipment may be duplicated or triplicated — this extra equipment is called 'redundant'. An obvious way to incorporate redundancy is shown in Fig. 16 where all units are simply doubled-up and connected so that one can perform the task if the other fails. There are preferred ways to connect extra equipment, the general rule being that as many cross-connections are made as possible as demonstrated by the two systems shown in Fig. 17. In Fig. 17a, the data path can be via A or B which is clearly more reliable than via just A if both A and B have equal reliabilities. If an additional path C is added, as shown in Fig. 17b, we have improved the chance of data being processed by an M and P unit sequence.

The reliability of systems is measured in terms of the mean-time between failures (MTBF) and the mean-time to repair (MTTR). As a guide only, Fig. 18 shows typical values for the various kinds of units involved. (The following part gives more detail of peripherals mentioned in the figure).

Taking the idea of interconnected redundancy to the limit we have a system schematic like that given in Fig. 19. At each nodal point any one of a multiplicity of units can be brought to bear on the nodal task. If a single unit fails, the effect is not a total shutdown of the task but a slight degradation in speed and capability of the whole system. This has been called the *fail-soft* design and such systems exhibit the graceful degradation that occurs in physiological brains. The concept of total interconnection is loosely analogous with the way in which physiological brain cells are connected.

In the next part of this series we look at the peripherals used, various kinds of stores, microprocessors and the latest manufacturing techniques.

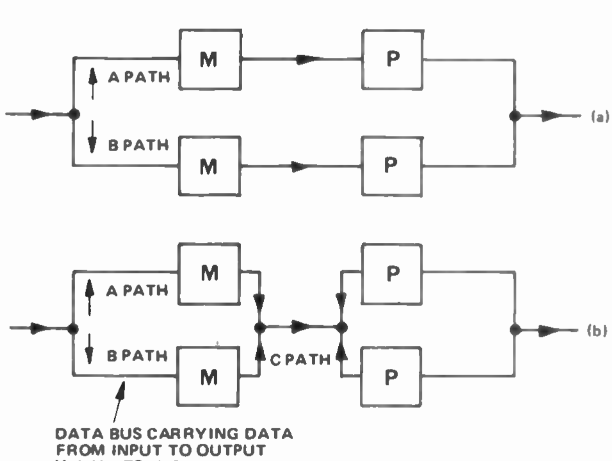

Fig. 17a. The data path may be via A or B. Fig. 17b, if an additional path 'C' is added, reliability is clearly improved.

Further reading

Two books, already referred to in Part 22, are relevant, these are:

"A Computer Perspective", C. and R. Eames, Harvard University Press, Massachusetts, 1973. (This is a definitive work on the development of data processing equipment from 1800 to 1940).

"Electronic Computers -- Made Simple", H. Jacobowitz and L. Basford, W.H. Allen, London, 1967. (Although out of date with respect to certain aspects of hardware this provides a valuable basis for technical understanding of both analogue and digital computers. It also explains the arithmetrical operations).

"Introducing Computers", M. Laver, HMSO, London, 1973. (A version compiled for users with a little technical knowledge. It discusses programming procedures).

"Computers at work" J.O.E. Clark, Bantam Books, London 1973 (A most useful book on where computers are used).

"Electronic Computers", S.H. Hollingdale and G.C. Tootil, Penguin Book A524, Harmondsworth, 1965. (A fine layman's summary of analogue and digital computers including a lengthy chapter on what sort of jobs computers do).

Computer programming is covered in many texts and booklets. One example is:

"Elements of Computer Programming", K.P. Swallow and W.T. Price; Holt, Rinehart and Wilson. New York, 1965.

When the need to learn how to programme a computer arises it is best to seek specialised advice about reading material pertaining to the computer to be used. There are numerous models available each having its own peculiarities and each requires considerable operator training-time. Fortran, by IBM, and its dialects are commonly used programmes; an inexpensive programming primer is:

"A First Course in Fortran", E.J. Burr, Department of Continuing Education, University of New England, N.S.W. 1974 (Third edition).

ALGOL language began to emerge in 1958 as a step toward a universal computer language for scientific working. COBOL is the commercial counterpart. Relevant books are:

"Basic ALGOL", W.R. Broderick and J.P. Barker, IPC Electrical and Electronic Press, 1970.

"A Guide to COBOL Programming", D. McCracken, Wiley, New York, 1970. ●

Fig.19. The fail-safe design — see main text.

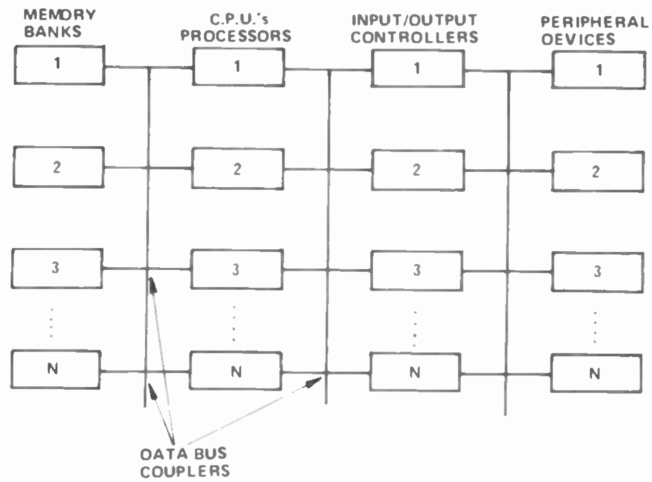

Fig.18. Typical mean time between failures — and typical mean time to repair.

	CPU	Memory	Input/output unit	Device coupler	Disk store	Mag-tape store	Line printer	C.R.T. display	Multiplexer
M.T.B.F. hrs x 10^3	6.0	15.0	6.0	12.0	15.0	3.0	1.5	4.0	10.0
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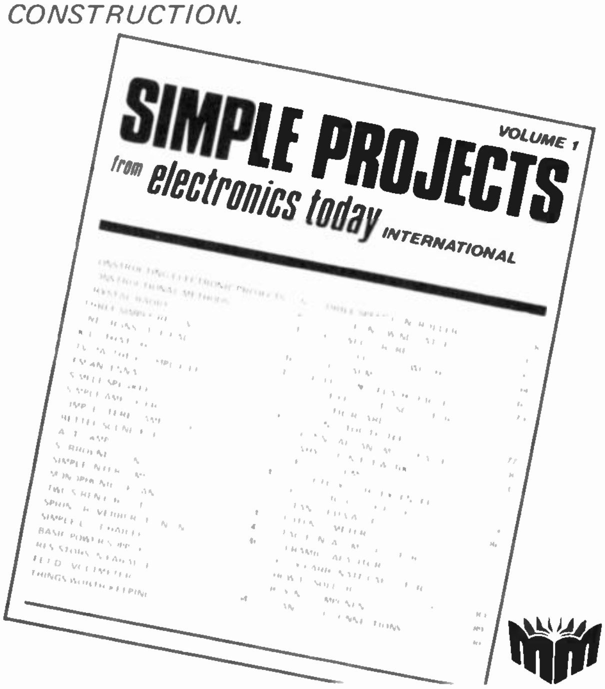

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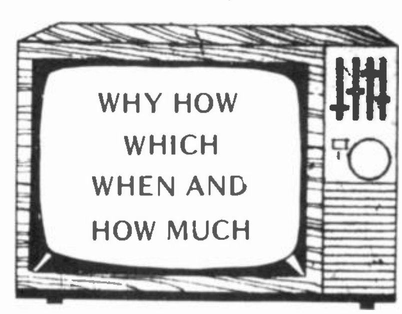

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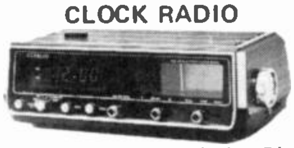

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33µF	8c	9c	10c	13c
47µF	9c	11c	11c	14c
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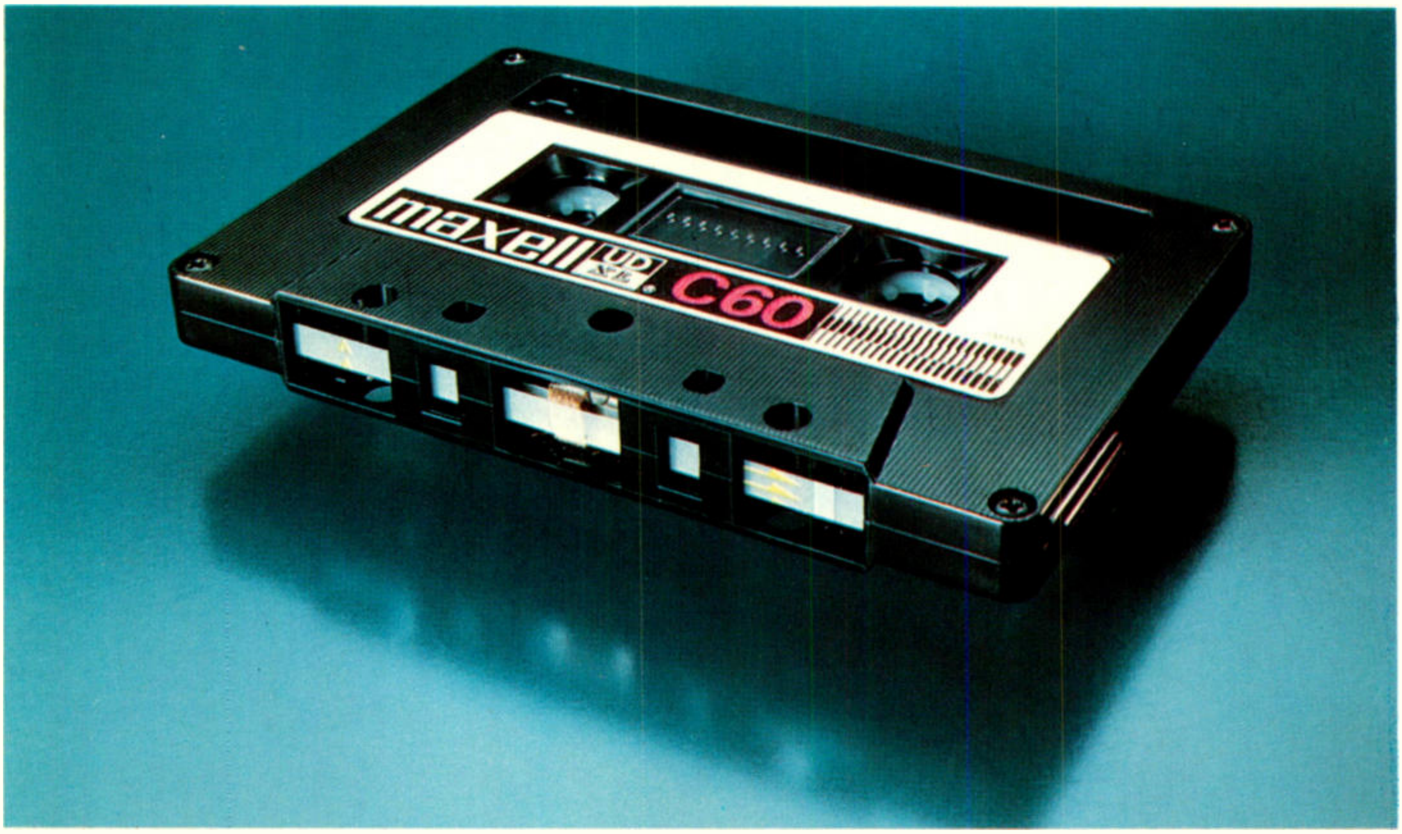

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UD XL

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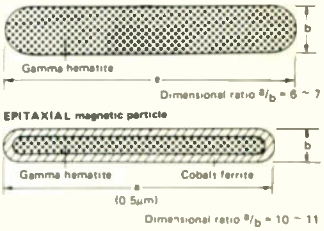
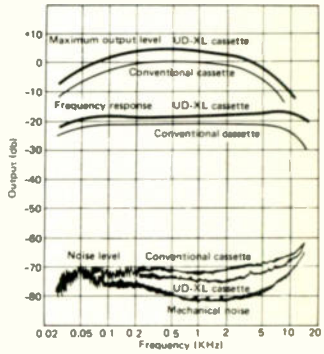
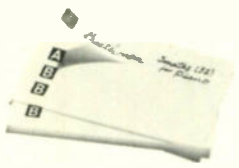


Compared to chrome tape, sensitivity has been improved by more than 3.5dB. Because EPITAXIAL is non-abrasive, it extends to the life of the head. Consequently, the UD-XL delivers smooth, distortion-free performance during live recording with high input. When using UD-XL it is recommended that tape selector be in the NORMAL position.



Fidelity is also ensured by a precision-manufactured cassette shell with a special anti-jamming rib that provides smooth tape travel and helps eliminate wow and flutter.



Another good idea of the UD-XL cassette is a replaceable self-index label. Simply peel off the old label and put on a new one when you change the recording contents. No more mess on the label.

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For further information please write to Maxell Advisory Service, P.O. Box 49, Kensington, N.S.W. 2033.

WT.GD. 76M

Ideas for experimenters

These pages are intended primarily as a source of ideas. As far as reasonably possible all material has been checked for feasibility, component availability etc, but the circuits have not necessarily been built and tested in our laboratory. Because of the nature of the information in this section we cannot enter into any correspondence about any of the circuits, nor can we produce constructional details.
Electronics Today is always seeking material for these pages. All published material is paid for – generally at a rate of $5 to $7 per item.

CAR BATTERY WATCHDOG

In winter, motorists are apt to emerge from work to face the inconvenience and perhaps expense of a totally flat battery due to having left their headlights switched on when parking.

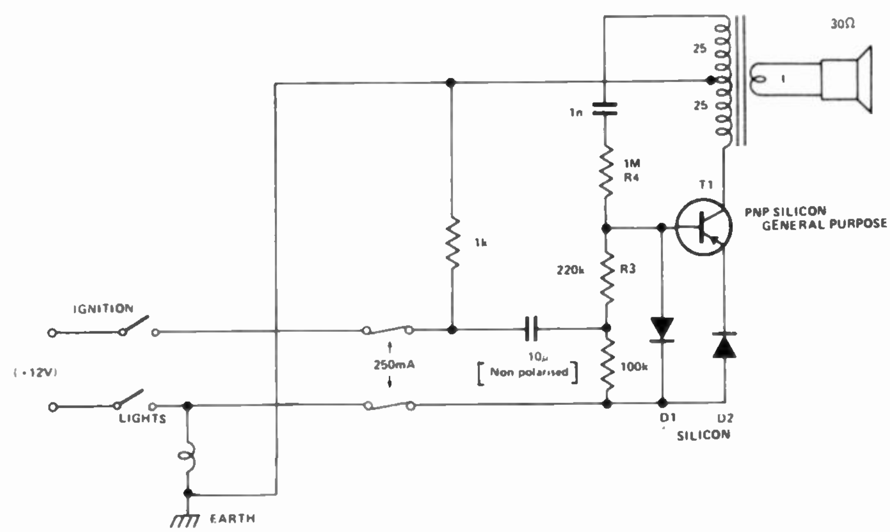
This circuit provides an audible warning if the ignition is switched off with the lights left on, in the form of a few seconds of output of varying pitch. No switches are required and standby current is very small.

The audio oscillator is normally biased off, but when the ignition switch is opened it is temporarily biased on the charging action of R1, R2, C1.

D1 in conjunction with R3, prevents damage to T1 due to spikes on the ignition line, etc. The fuses are an optional precaution against short circuits across ignition or lighting supplies.

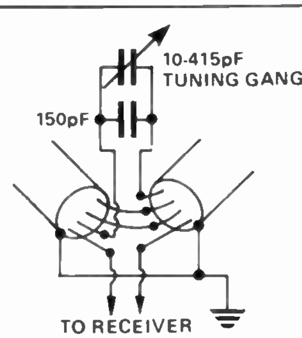
The oscillator circuit will no doubt depend, as will the transducer, on the content of the experimenter's junk box. Basic requirements are that it should not be self-sustaining when the ignition switching transient in the base circuit has died away. The ratio R3/R4 was of course chosen to achieve this in the circuit shown, assisted by D2.

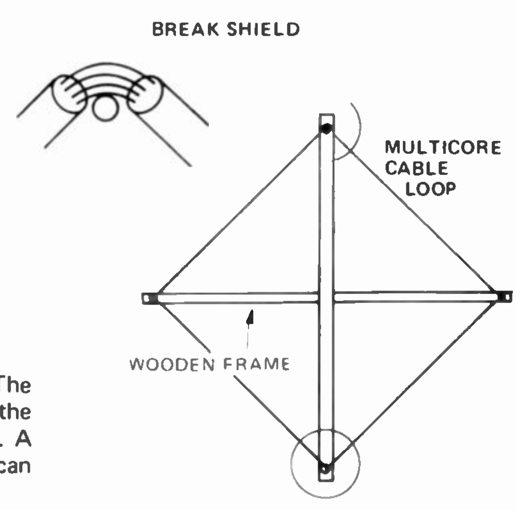
For negative earth operation T1 would of course be NPN and D1 and D2 would be reversed.



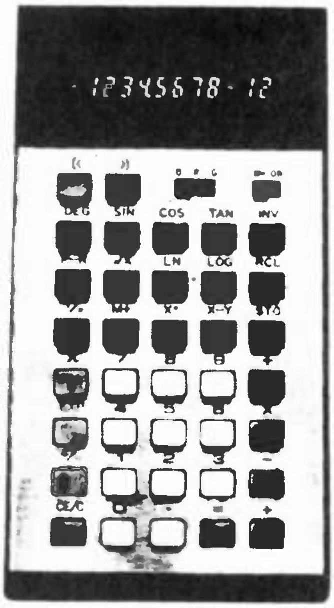
BROADCAST BAND LOOP ANTENNA

A loop receiving antenna is useful when receiving broadcast-band signals from a distance where interference is a problem. A multicore shielded cable is used to make up a shielded loop with a number of the wires connected in series to form a multi-turn loop which is tuned as shown here. One wire is left to serve as a coupling loop. The cable shield is broken at the top, as shown, but connected together at the feedpoint down at the bottom. For balanced input connect the single turn to the receivers. Earth one end of the single turn and the shield for unbalanced input. This shield should be earthed and connected to the receiver chassis at all times. The antenna exhibits a sharp null in the direction of the plane of the loop. A multicore cable having more wires can be used if so desired.





Polar ⟷ Rectangular, Bracket
Decimal Degree ⟷ Degree, Minute, Second



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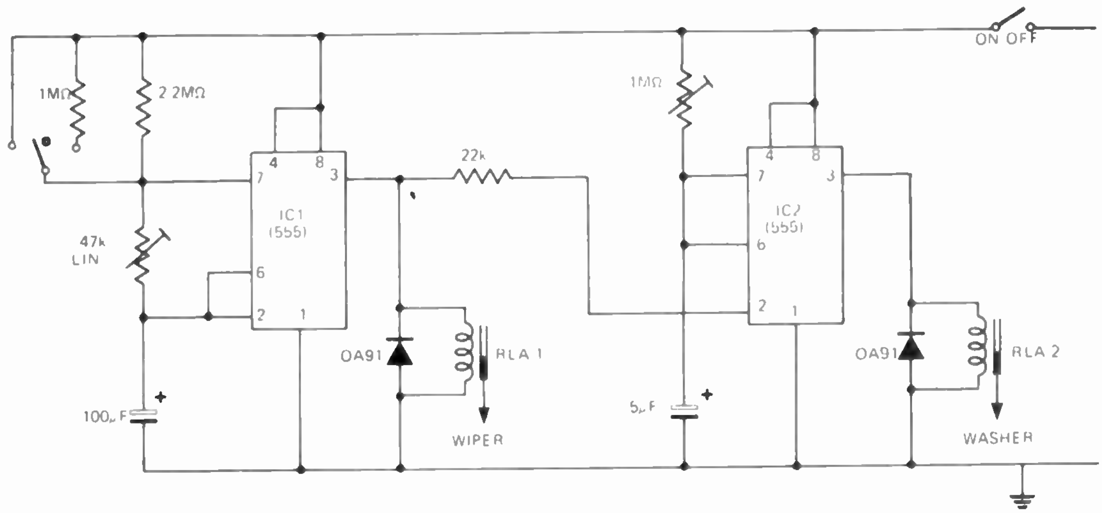
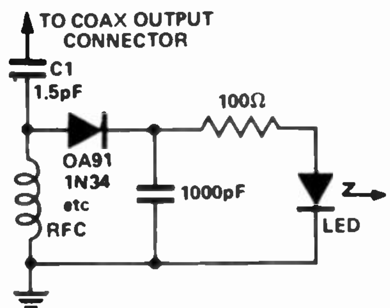
Ideas for experimenters



AUTOMATION FOR REAR WIPERS

Many station wagons are now fitted with rear washer/wiper sets without any sort of automation. This circuit provides an end-of-cycle stop, a delay of 1 minute, 4 minutes, or continuous operation, and, from RLA2, a measured squirt of water at the start of each cycle. The circuit has been slightly modified to use a standard auto 3-way toggle, on which the first pole has no connection. One of the many published spike suppression circuits should be used to protect the ICs. The circuit uses no more switches than manual control and requires less concentration from the driver.

LED RF INDICATOR



An RF output indicator using a LED is very useful for monitoring the output of a transmitter. This circuit will give indication from a 5 W transmitter. The capacitor C1 and the RFC are chosen for the appropriate frequency. The RFC could be replaced by a resistor for wideband use. The sensitivity depends on the value of C1 and the resistor used if the RFC is replaced. For high power transmitters, C1 could be a small "gimmick" capacitor.

IDENTIFYING SURPLUS ICs

In checking unmarked surplus ICs, a clue can be gained as to the identity of the IC if the ground pin can be located first. In epoxy encapsulated ICs, the truncated part of the lead frame can be seen at both ends, perhaps partially covered by moulding flash. This is generally connected to the substrate. In TTL and most linear ICs, this is the most negative pin (ground). In PMOS (clock and calculator chips) this is Vss, the most positive pin. An ohmmeter can find which pin is connected to the substrate by touching one probe to the frame and the other to each pin in turn.

Another clue to whether the IC is linear or digital is the fact that most digital ICs have diode protection against reverse bias at inputs. Knowing the ground pin, this can be checked rapidly.

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74LS93	1.30
74LS95	2.09
74LS107	.59
74LS164	2.20
74LS193	2.50

METAL FILM RESISTORS
±1% ¼ WATT

QTY	PRICE EACH	PRICE MINIMUM 10 PER VALUE	PRICE MINIMUM 100 PER VALUE
0 - 10	$.20		
10 - 100	.20	$.15	
100 - 1000	"	.10	$.09
1000 -	"	.10	.08

RESISTANCE (OHMS)

22.6	71.5	182	887	11.8K	40.2K
23.7	78.7	187	1.15K	13.0K	45.3K
25.5	84.5	191	1.5 K	.0K	48.7K
30.9	105	205	2.49K	2K	54.9K
34.8	110	232	3.57K	19.1K	60.4K
40.2	115	243	4.75K	19.6K	64.9K
45.3	137	499	5.49K	22.6K	69.8K
51.1	147	604	6.04K	24.9K	84.5K
61.9	158	715	7.15K	28.0K	
64.9	178	806	8. K	37.4K	

Data sheets on request. With order add $.30 for items less than $1.00 ea.

LINEAR CIRCUITS

L100	Red LED	.15
L101	Red LED	.15
300	Pos V Reg (super 723) TO-5	$ .71
301	Hi Perf Op Amp mDIP TO-5	.29
302	Volt follower TO-5	.53
304	Neg V Reg TO-5	.97
305	Pos V Reg TO-5	.71
307	Op AMP (super 741) mDIP TO-5	.26
308	Mciro Pwr Op Amp mDIP TO-5	.89
309K	5V 1A regulator TO-3	1.35
310	V Follower Op Amp mDIP	1.07
311	Hi perf V Comp mDIP TO-5	.95
319	Hi Speed Dual Comp DIP	1.13
320T	Neg Reg 5, 12, 15, TO-3	$1.39
320K	Neg Reg 5.2, 12 TO-3	1.39
322	Precision Timer DIP	1.70
324	Quad Op Amp DIP	1.52
339	Quad Comparator DIP	1.58
340K	Pos V reg (5V, 6V, 8V, 12V, 15V, 18V, 24V) TO-3	1.69
340T	Pos V reg (5V, 6V, 8V, 12V, 15V, 18V, 24V) TO-220	1.49
372	AF-IF Strip detector DIP	2.93
376	Pos V Reg mDIP	2.42
380	2w Audio Amp DIP	1.13
380-8	.6w Audio Amp mDIP	1.52
381	Lo Noise Dual preamp DIP	1.52
382	Lo Noise Dual preamp DIP	.71
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556A	Dual 555 Timer DIP	1.49
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562	Phase Locked Loop DIP	3.95
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75452	Dual Peripheral Driver mDIP	.35
75453	(351) Dual Periph Driver mDIP	.35
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.33 mfd	35V	.25 ea.	6.8 mfd	50V	.40 ea.
1 mfd	35V	.25 ea.	10 mfd	25V	.40 ea.
2.2 mfd	20V	.25 ea.	15 mfd	10V	.40 ea.
2.2 mfd	35V	.30 ea.	33 mfd	10V	.40 ea.
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Opto-electronics -move to plastics

Optics have added a new dimension to electronics, but it is only with the advent of precision-moulded optical systems that the way to practical opto-electronic devices has really opened up.

FOR SOME time now there has been an increasing trend towards integration between optics and electronics. For this there are two main reasons: visible light may well become the carrier medium for the next generation of communications systems, and the greater need for accurate information in all fields has led to a great expansion in the demand for visual displays.

Before visible light can be employed for data transmission, a whole range of components will have to be developed as the optical equivalents of electrical plugs and sockets, jacks, switches and relays, amplifiers, attenuators, filters, tuners and similar units.

Miniaturisation resulting from solid-state technology has drastically reduced the size of electronic equipment. Meters, indicators and display screens, however, cannot be similarly reduced in size, because no one could read them. An important sector of opto-electronics therefore concerns itself with providing legible data from systems of the smallest possible size. The most common example is probably the light-emitting diode (LED) display.

The layout and arrangement of printed circuit boards and the interchangeable plug-in modules (which presuppose the absence of permanent wiring to the outer case), often create problems of conveying indication from the point most convenient to the circuit designer to the point most convenient to the user. Again, optical components in the form of mirrors, prisms, light guides and lenses (or any combination of them) can solve such problems.

ADVANTAGES OF PLASTICS LENSES

Several clear polymers, such as acrylics, polystyrene, polycarbonate, ABS, cellulose, vinyl, polyester and others, can be used instead of glass to make optical components. The most important technical advantages of plastics optics are freedom of design, greatly reduced assembly costs, greatly reduced weight, and elimination of shattering.

On average, optical plastics are about 55-65% lighter than glass. In practical terms the weight saving is usually much greater because most of the metal mounting and retaining parts essential for glass lenses can be dispensed with, since plastics lenses can be moulded with integral spacers and retaining lugs.

The most interesting aspect of plastics lenses is the freedom of optical form conferred by the nature of the material. With moulded plastics optics, human skill is concentrated on the manufacture of the moulds, from which any required number of lenses of uniform quality can be produced, aspheric (non-spherical) lenses can readily be made.

Aspheric lenses are important because they permit aberrational correction of a system without affecting its focal length and magnification. Certain shortcomings of spheric lenses can therefore be eliminated or minimised by 'asphering' one or several lens surfaces in an optical system. A given amount of correction can be achieved by fewer components if one or more of them are made aspheric. In both cases significant savings result.

The advantage of aspherics is well shown in Fig.1. Both magnifiers have the same size and magnification, but while the aspheric moulded plastics lens in the top unit has a distortion-free field of view of 20 squares, the spherical glass lens of the lower unit has an effective field of

Fig.1. The aspheric lens (top) gives an undistorted view of at least 20 squares, while the spherical glass lens (below), of the same diameter and power, only shows four reasonably undistorted squares.

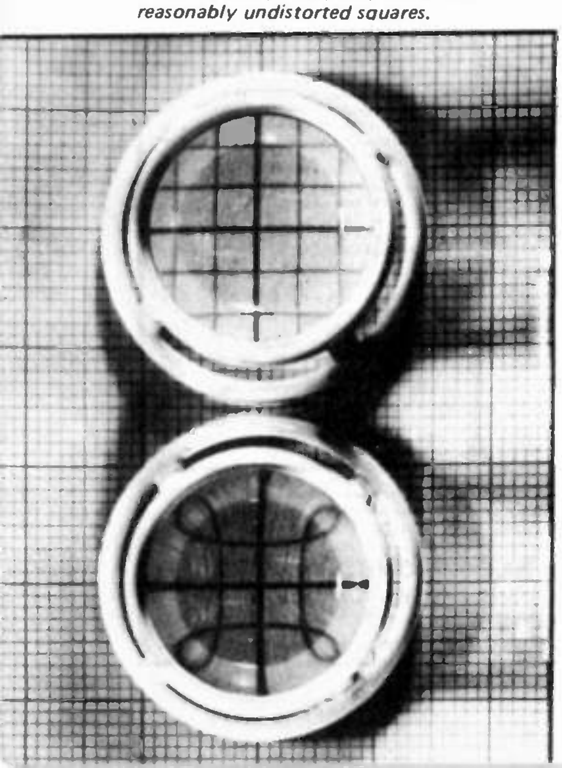
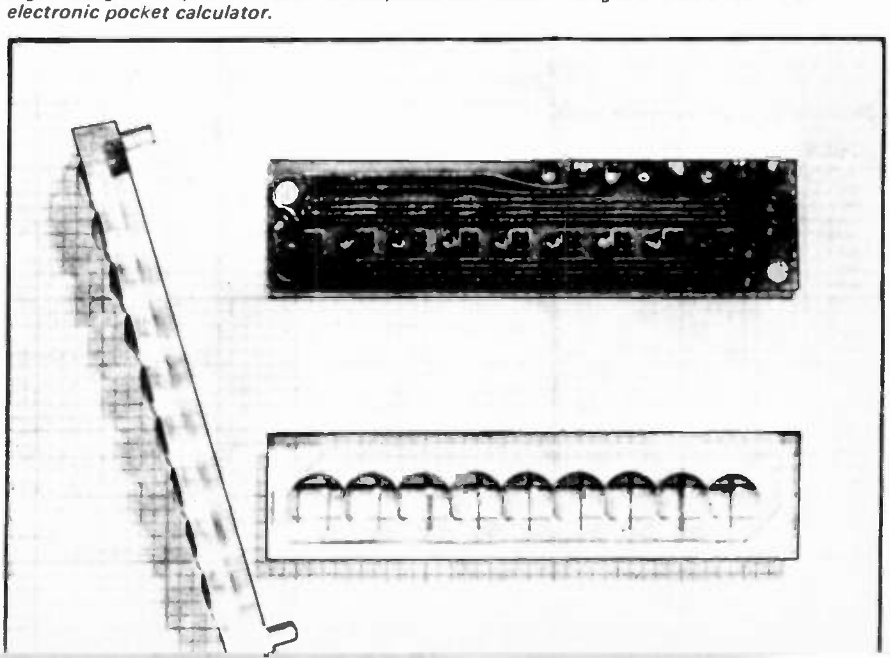


Fig.2. Integral array of nine miniature aspheric lenses with a magnification of 3x for an electronic pocket calculator.



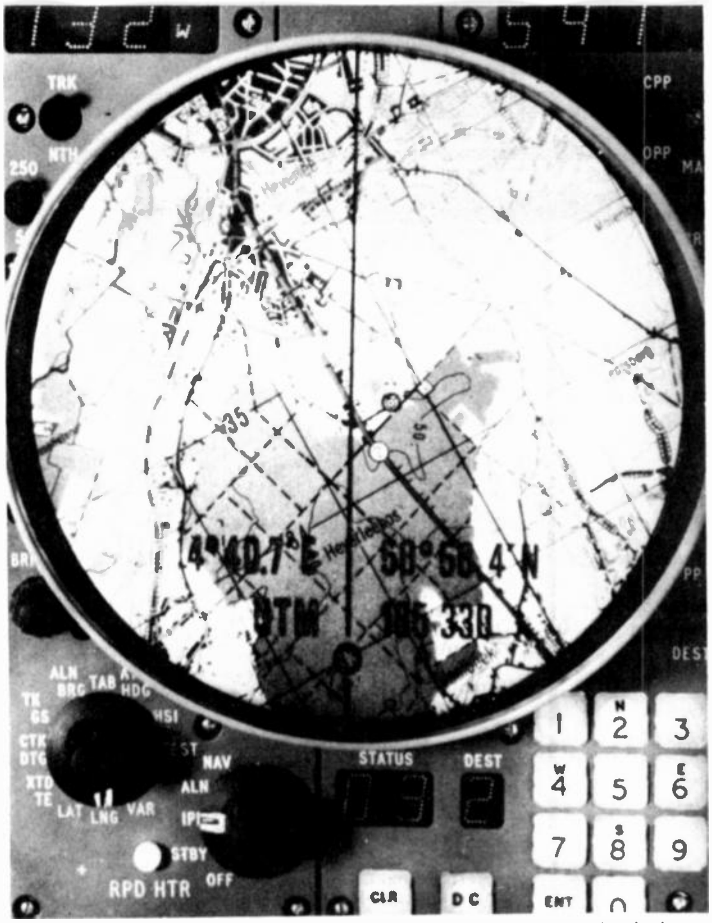


Fig.3. This combined mini-computer, moving map and electronic display unit (Comed) for aircraft navigation uses a moulded plastics lens of complex aspheric design to give an undistorted, brilliant image of the map.

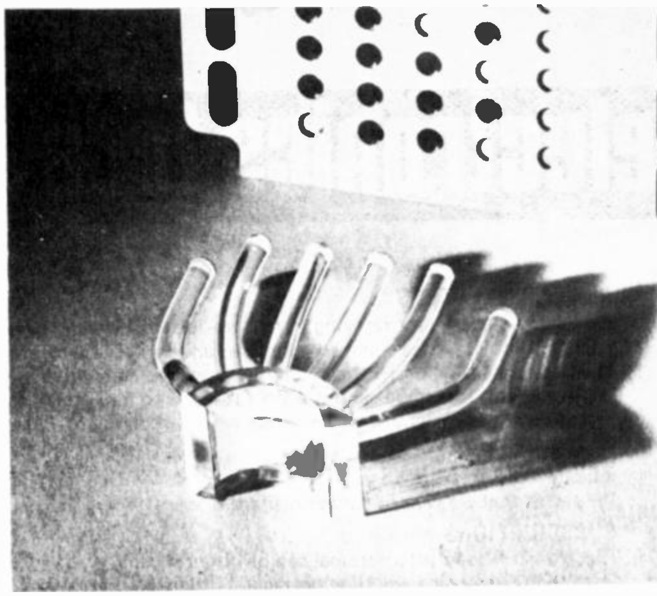


Fig.4. This one-piece light guide splits the light from a single bulb into six beams to scan six rows of holes in a punched card for an automatic telephone dialling unit.

view of only four squares. Yet the glass lens is heavier and more expensive.

Aspherics can be also produced at apertures greater than f/1. They are already widely used in portable devices involving high magnification, such as reading aids for sub-normal vision. Aspheric lenses from 3 mm to 180 mm diameter are readily available, while lenses up to 630 mm diameter have been made. In opthalmics, magnifications of 8x are frequently used.

INTEGRAL PLASTICS OPTICS

The freedom of shape conferred by moulding frees designers from the limitations imposed by glass – he can create systems which are functionally superior. Plastics lenses can be moulded with integral lugs, bosses, rims, pivots and similar mounting, swivelling, adjusting and actuating members, in a wide range of shapes, sizes or configurations, as shown for instance in Fig.4. This means that in a well-designed product, the optical system parts snap or slide into the housing without any further assembly operations and, with precision-moulded housings, no subsequent setting or adjustment should be necessary.

TYPICAL APPLICATIONS

A multiple aspheric lens array moulded integrally with its mounting plate is shown in Fig. 2, with the associated nine-digit seven-bar circuit board for pocket calculators. The moulding has two pins on the underside which locate through the two holes in the board in two further holes in the calculator casing. Two ledges on the underside of the moulding ensure that it is held at the correct focal distance above the board. Assembly is therefore very simple and the need for any adjustment is eliminated. The lenses have a magnification of 3x and provide a distortion-free image.

A much larger moulded lens is used on the Ferranti Comed (combined map and electronic display) for aircraft, shown in Fig.3. In addition to alpha-numeric readouts of latitude, longitude, range, bearing and other navigational data, the unit has a screen on to which a moving map or radar picture can be projected from the rear. The lens is a bivex type, the flatter surface having a special form known as a Schmidt corrector plate. This complex aspheric surface is essential to ensure an undistorted image from any position, despite movements of the pilot's head, and a brilliant image even in strong daylight.

Light guides can be of many different basic types, depending on the function they are required to perform. A good example is the Card Callmaker, a compact unit which can automatically dial a telephone number with up to 16 digits when the appropriate punched card is inserted into it. The light guide (see Fig.4), which is moulded accurate to ± 0.012 mm in all dimensions, has six 'fingers', which split the light from a single lamp into six beams. Each finger incorporates a lens at its tip, which focuses the light on to a photocell. The inserted card blocks the light, except where holes are punched in any of the six rows available. This automatic dialling unit could, of course, also work with six lamps and conventional glass lenses, but then failure of any one lamp out of six would result in a wrong number. If the single lamp in the Card Callmaker fails, the unit will simply not operate. This moulded unit is much cheaper than a light guide made up from bundles of glass fibres.

In addition to lenses, prisms, light guides and similar components, mirrors and reflecting surfaces of almost any shape can also be produced. Aluminium, gold and thorium are most commonly used for coating the reflective surface, which may be the front or rear surface of the component.

Integrally moulded optics will undoubtedly play an increasing part in opto-electronics, including such equipment as self-scanning arrays, low light level vision aids (both active and passive), cathode-ray tubes (for combined optical digitisers), rear-ported cathode-ray tubes (for combined optical and electronic projection), photometers and densitometers, video recording systems, optical character readers, holographic and thermal imaging equipment, laser equipment of all kinds and many others. ●

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Direct-drive cuts the clatter between the motor and the music.

PL-71

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PL-A45D	Fully Automatic	Belt Drive	Less than 0.1%	Better than 47dB	Induced Mag. Type (PC-30)	10Hz-23kHz
PL-15R	Auto-return	Belt Drive	Less than 0.08%	Better than 47dB	M.M. Type (PC-12)	20Hz-23kHz
PL-12R	Manual	Belt Drive	Less than 0.1%	Better than 47dB	M.M. Type (PC-12)	20Hz-23kHz

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