Free Supplement - 112 page WHK Product Guide

electronics TODAY

INTERNATIONAL

JULY 1976 $1.00* NZ $1.15

Remote controller
Twin electronic dice
Stereo preamp

CMOS EXPLAINED NEW SERIES

Registered for posting as a periodical — Category C

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 0.05 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

For a National Technics Catalogue please write to:
National Technics Advisory Service, P.O. Box 49, Kensington, N.S.W. 2033.

National Technics
by National

WT GD 105 T

electronics TODAY INTERNATIONAL

A MODERN MAGAZINES PUBLICATION

JULY 1976, Vol. 6 No. 7

Electronics Today International is Australian owned and produced. It is published both in Australia and Britain and is the fastest growing electronics magazine in each country.

COVER: You may prefer not to know but those who would like to keep an eye on the cost of their phone calls can save dollars by using our STD Timer. Constructional details on page 48.

*Recommended retail price only

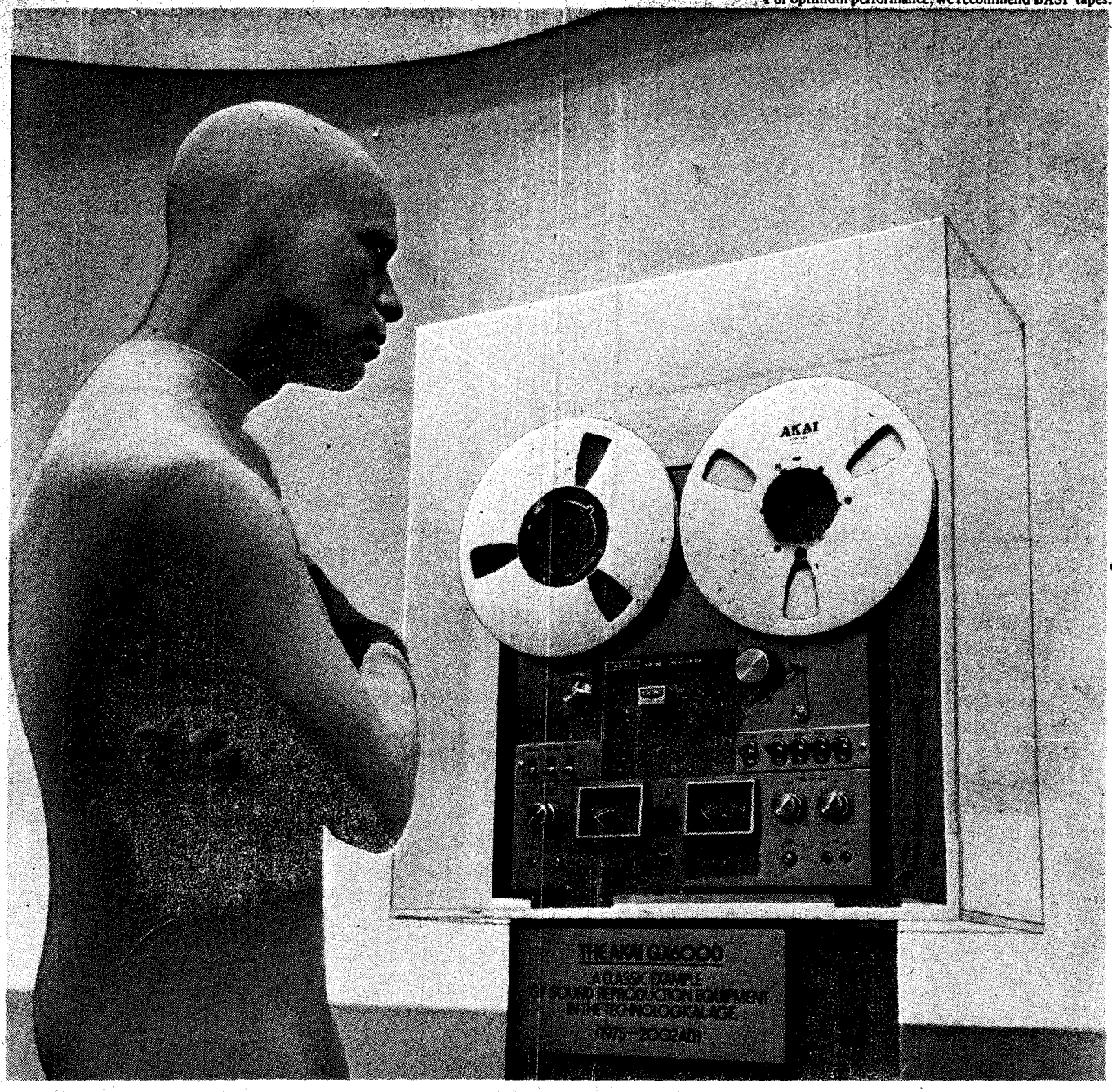
PROJECTS

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 630D tape deck is one of our top models. It retails around $656†. That's a lot. But the 630D 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; JB 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.

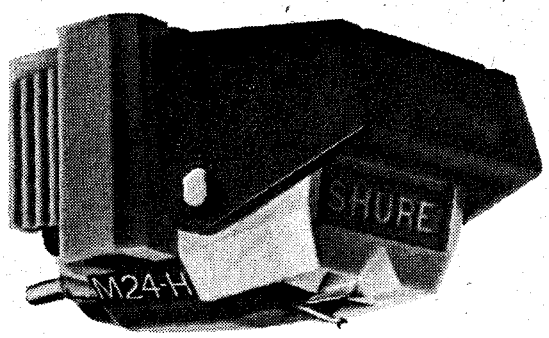
AKAI

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

70621R

*The Complete Protection Plan does not cover equipment purchased outside Australia. †Recommended retail price only.

2+4!!



SHURE® M24H

We call it "2+4": *a totally different concept in a phono cartridge* that combines Shure's traditional pre-eminence in *stereo* and state-of-the-art *quad* technology. It's the first such cartridge that doesn't sacrifice stereo for quad capability!

For quad enthusiasts, both matrix and discrete, this M24H Cartridge represents the distillation of the most advanced quadriphonic technology — PLUS new Shure advancements, such as the lowest effective stylus mass (0.39 mg.) available in quadriphony, and a new hyperbolic stylus tip for improved groove contact.

Each of these dimensions in hi-fi performance would be a best seller in its own right, but with "2+4" synergism, the M24H will be the blockbuster the hi-fi enthusiast has been waiting for.

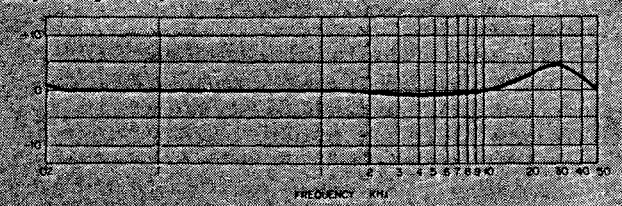
The M24H does not compete with the V-15 Type III or M95 Cartridge. The M24H is for those who want excellent stereo and quad without having to change cartridges every time they change records.

FEW CARTRIDGES AVAILABLE TODAY CAN OFFER THIS COMBINATION OF STEREO SUPERIORITY AND QUAD CAPABILITY.

WIDE-RANGE DYNETIC® PHONOGRAPH CARTRIDGE

BRIEF SPECIFICATIONS

Frequency Response 20 to 50,000 Hz.



Output Voltage 3.0 mV per channel (at 1,000 Hz, 5 cm/sec peak recorded velocity).

Channel Balance Within 2 dB.

Channel Separation (minimum) 22 dB at 1 kHz.

Optimum Load Stereo and Four Channel Matrix: 20,000 to 100,000 ohms resistance in parallel with 100 to 250 picofarads total capacitance* per channel.
Discrete Four-Channel: 100,000 ohms resistance in parallel with 100 picofarads total capacitance* per channel.
* Total capacitance includes the capacitances of the tone arm wiring, phono cables, and the amplifier input circuit.

Tracking Force Optimum: 1¼ grams.

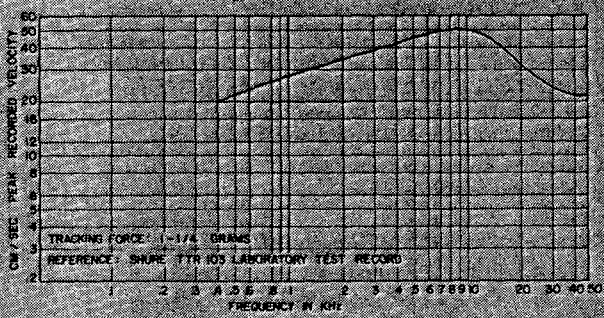
Trackability

400 Hz	20 cm/sec*
1,000 Hz	28 cm/sec*
5,000 Hz	47 cm/sec*
10,000 Hz	50 cm/sec*

* Peak recorded velocity.

(Measurements made using a Shure/SME Tone Arm.)

TRACKABILITY CURVE



Stylus Model N24H: 8 x 18 microns (.0003 x .0007 in.) hyperbolic diamond tip.

Weight Net ..... 5.8 grams (0.2 oz)

STEREO OR FOUR-CHANNEL MATRIX

This Wide-Range Dynetic® cartridge is compatible with all conventional stereo or four-channel matrix systems. Set function switch on amplifier as required.

DISCRETE QUADRIPHONIC OPERATION

For optimum discrete quadriphonic performance, be sure to use low-capacitance cables (less than 100 pF). Adjust decoder or receiver separation, level and other controls as required.

SHURE®

AUDIO ENGINEERS P/L
342 Kent Street
SYDNEY 2000. N.S.W.

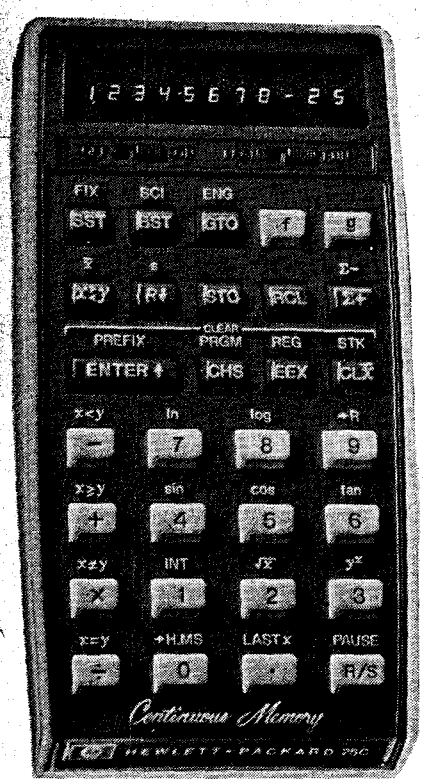
AUDIO ENGINEERS (Vic.)
2A Hill Street
THORNBURY 3071. Vic.

RON JONES PTY. LTD
57 Castlemaine Street
MILTON 4064. Qld.

ATHOL M. HILL P/L
1000 Hay Street
PERTH 6000. W.A.

AE106/FP

NEWS DIGEST



Non-volatile HP

The first Hewlett-Packard programmable scientific pocket calculator with a memory that retains stored information even while the calculator is turned off was introduced to Australia recently.

The HP25C is priced at $195.00; $217.00 including sales tax. The machine is identical to the HP25 with the addition of the continuous memory. On this new calculator often-used conversion constants can be recalled minutes, days or weeks later at the touch of a key.

Programs that are used over and over again can also be stored, so that they don't have to be re-entered every time they are needed. Any stored information can of course can be cleared or changed at will.

The two CMOS data storage chips use very little battery power — typically the chips require only 1/80,000 of the power needed by the calculator in operation (5 μW vs 400 mW). When the batteries are being changed, a small capacitor provides enough power to keep data in memory for five seconds to two minutes.

Hewlett-Packard Australia, 31-41 Joseph St., Blackburn, Victoria, 3130. Telephone 896351 (Sydney 4496566).

NEW BRISBANE COMPONENT SUPPLIER

A new components source for readers in Brisbane opened recently. The manager, Garry Worth, says Techniparts also have a large range of specialist tools, boxes, hardware etc.

Techniparts are in Woolworths Arcade 95 Latrobe Terrace, Paddington. The phone no is 361474 and they are open Monday to Friday and Saturday mornings.

Throwaway calculator

A calculator for less than four bucks? That's what the ads say . . . a Sheen calculator is being offered by Target Supermarkets for just $3.99! Perhaps they made a mistake in working out the cost?

Smokey gets busted

A police CB station in New Jersey got fined by the FCC recently. They had to pay $50 for not replying to official communications, according to a report in the American magazine Radio-Electronics.

To our children's children

Pioneer spacecraft have carried plaques to communicate with potential life outside our solar system, but now NASA has launched a satellite carrying a plaque with a message for the inhabitants of our planet. The satellite LAGEOS, is expected to orbit the earth for at least 8 million years. The message is a fairly simple one: it gives the name of the satellite and an indication of when it was launched. There is no information about the people who launched it or about its purpose.

The message is displayed on a 4 x 7 inch plate which was designed by Dr Carl Sagan of Cornell University (who designed plaques for Pioneer 10 and 11). The top left of the plaque gives the name of the satellite, LASER GEODYNAMIC SATELLITE (LAGEOS). (Remarkably this 'geodynamic satellite' is more stable in its position above the earth than any geostationary satellite!) Then there is a drawing of the satellite and the numbers 1 to 5 and 6 to 10 in binary 0s and 1s. In the top right there is a picture of the earth orbiting the sun and the number 1 beneath the orbit.

Beneath these messages comes the main point made by the designer: a three-part strip of the evolution of the earth's land formations. The top map shows the continents 225 million years ago and this is dated beneath by an arrow pointing to the left and a binary 225 million (1 followed by 28 0s). The middle map shows present continental positions and shows the launch path of Lageos; the date is indicated by a 0 with arrows pointing left and right. The bottom map shows the end of Lageos in 8.4 million years when the braking effect of the atmosphere finally brings the satellite back to earth. The date is indicated by a 1 and 23 0s and an arrow pointing to the right; the continents are shown as they are likely to be in 8 401 976 AD.

There is a clue to the purpose of the satellite contained in the message. Lageos is to help monitor continental drift by reflecting laser beams back to earth. By the 1780s there should be four laser stations operating and enabling calculation of drift to better than one inch in a thousand miles.

I wonder if any intelligent creatures will ever learn anything from this plaque in millenia to come?

Cool and attractive

The Japanese National Research Institute for Metals has recently installed the world's most powerful superconducting electromagnet. A field of 175 000 gauss — 350 000 times stronger than the earth's magnetic field — has been generated using this device.

Mechanical digital stopwatch

The Psyonics LED is a miniature digital stopwatch with the 'feel' of a mechanical instrument. The unit is small, between the sizes of a matchbox and cigarette pack, with large pushbuttons. It runs for 12 hours from ni-cads and is on sale in the US for around $70 (from Psyonics, Box 1004, New Brunswick, NJ 08903).

DS data bar

Dick Smith's Customers with a component data or substitution problem now have at their disposal a range of component data books – nearly $100 worth – on a new in-store data bar. Dick has set up the data bar in his Gore Hill store on a trial basis and says that if it is successful, he will put data bars in all branches.

FIRE AND WATER

Some readers will have already read about the fire at the premises of Modern Magazines at the end of June. Fortunately the fire itself did not reach ETI's offices, but we have suffered a considerable setback as a result of water damage – the heart of the fire was on the floor above us.

We have done all we can to bring out this issue as soon as possible but you will notice that we have had to use some strange typefaces in parts of the magazine.

2000 MW laser

The first argon fluoride gas laser has been developed in the US by Sandia laboratories. The pulses of energy (in the UV region) come from a two metre cylinder filled with pressurised argon, krypton and flourine. The molecules are excited by bombardment with an electron beam.

NEW RECEIVERS FROM TOSHIBA

Toshiba have three new receivers on the market, the SA320L, and the SA420. They deliver 11 W, 15 W and 25 W per channel. All three models receive FM stero and MW mono, and the recommended retail prices are $199, $259 and $349.

Test for g-waves

For some time theoretical physicists have predicted the existence of gravitational waves, but they haven't yet been observed empirically. However a way to verify their existence and to study them has been recently predicted by an American and a Soviet scientist.

Gravitational waves are related to gravitational forces as electromagnetic waves are related to electromagnetic forces.

The scientists suggest sending radio signals to an orbiting satellite fitted with a reflector. Atomic clocks would time the return of the reflected waves and hopefully detect displacement of the earth and the satellite under the influence of gravity waves with a wavelength of at least 6 million miles!

It may be another ten or so years before we have clocks accurate enough to detect this effect. If we do get this this field of study opened up as the scientists predict,the new science would provide information on the interior of quasars, galactic cores and collapsing stars.

PUTTING SOME COLOUR INTO CASSETTES

At a recent Hi-Fi seminar in Japan, Matsushita showed a cassette tape which carried up to 1000 colour pictures, as well as normal stereo sound tracks. Special play-back machinery is needed to display the pictures, and the company is looking to hold down the cost of this to present a challenge to normal audio-visual presentation.

The extra information is carried on two extra 0.2 mm wide tracks. An extra head is added which reads off the digital information, and builds up the information in an IC memory. This takes 3.5 secs at standard tape speed, meaning that a C-60 can carry 1000 complete pictures. The cassettes are compatible with normal recorders, reproducing normal stereo sound on replay. Commercially, the system's future depends on its price.

Microwave safety

Exposure to microwaves can cause tissue damage, especially to the eyes. The danger is highest when the radiation is at close range, and microwave ovens are therefore a potential danger. In response to many requests CSIRO have brought out a set of safety rules for users of these ovens:

- *Keep a little distance away from the oven when it is operating – an arm's length is recommended, and never allow children to put their faces (particularly their eyes) close to the oven door when it is operating.*
- *Do not operate a damaged oven, or one with warped or loose components. An oven which has been tampered with,so heating continues when the door is open is dangerous and must not be used.*
- *Keep the door seal and the area it contacts clean and free of burnt food or food particles which might create gaps in the seal.*
- *Never put any object through the door vents, particularly metal objects such as skewers. They could conduct radiation out of the safety of the oven compartment.*
- *Do not operate the oven when it is empty. The absence of food to heat can cause microwaves to feed back into the expensive microwave generator, shortening its life.*
- *Have your oven checked for microwave leakage regularly, say every 12 months. Generally the dealer will do this.*
- *Trust repairs only to a skilled serviceman. The home handy-man can endanger himself and others.*

The greatest show on earth

More than 27 000 visitors to CSIRO's radiotelescope at Parkes, NSW, have visited the space research show — an audio-visual presentation showing CSIRO's part in the development of radioastronomy. In 27 minutes viewers see some of the CSIRO firsts: identifying the first radio source in the universe (in the Crab Nebula); discovering quasars and pulsars; etc. The show is presented seven days a week from 9 am to 4 pm.

Electronics show

Here are the dates and times for the first Consumer Electronics Show to be held at the Sydney Hilton early next month. The show opens to the trade from 1 to 6 on the afternoon of Wednesday 4th August and from 10 to 6 on the following Thursday and Friday. The public will be admitted between 6 and 10 on the evenings of Thursday and Friday, and from 10am to 10pm on Saturday 7th August and from 1 to 5 on the afternoon of Sunday 8th August. More details on page 100.

You can build this 12" three-way imported Philips speaker system

— all it takes is a couple of hours and a screwdriver

PHILIPS **Electronic Components and Materials**

This new addition to the Philips series of assemble-it-yourself professional quality speaker systems introduces an altogether higher standard of performance.
It is a three way system with imported European tweeters, squawkers and woofers.
By assembling the kit yourself you save on a ready built-up system. All you need is a screwdriver, a couple of hours or so, and you will have a magnificent three-way speaker system of professional finish.
The kits are complete. There's nothing else to buy.

The Philips AD 12K12 Speaker kit contains:

2 8X AD 140/T8 tweeters
2 AD 5060/5Q8 squawkers
2 AD 1265/W8 woofers
2 ADF 500/4500/8 networks
2 ADF 12K12 level control modules
2 sets of leads with fastons
2 tubes of woodglue
Strip caulk sealing compound
Innerbond damping material
44 wood screws

The Philips AD 12K12 TK kit contains:

2 enclosure kits with walnut grain, wrap around walls, stained baffles and grille cloth assemblies.

Plus full assembly instructions

For further information contact
PHILIPS ELECTRONIC COMPONENTS AND MATERIALS,
P.O. Box 50, Lane Cove. N.S.W. 2066
Or phone 421261 or 420361. Branches in all States.

PHILIPS

153-0151

Continued from page 7

The Mettler PL300 is an electronic balance with a range of 320 g at 0.01 g resolution. The display is automatically rounded off and a digital output option is available. The balance is available from Watson Victor Ltd, PO Box 100, North Ryde 2113.

NS MPU kit for $80

National Semiconductor have recently introduced a micro – processor which they call SC/MP (for Simple Cost-effective MicroProcessor). This device is rising to fame under such names as SCAMP and SCRUMPI, and now NS announce it is available in a kit system for $79.95.

The SC/MP kit includes all the firmware and components needed to build a working system. The kit contains the following components: One SC/MP Microprocessor (model ISP-8A/500D) housed in a 40-pin dual-in-line ceramic package, one 4k ROM (model MM5204) pre-programmed to contain "KITBUG" (a monitor and debugging program), two 1k RAMs (model MM2101N), one Voltage Regulator (model LM320MP-12) which provides a stable -7 volt supply for the microprocessor chip, one 8-bit Data Buffer (model DM81LS95N) to interface between the memory and the micro-processor's data lines, one Timing Crystal for the clock circuit on the MPU chip, one Teletype Interface (model DM7414N), one 72-pin Edge-Connector, one 24-pin IC Socket for easy the ROM, one 40-pin IC socket for mounting the MPU, one PCB which provides all component interconnections, eight capacitors and seven resistors.

One-way heat mirror

MIT scientists have developed thin films (less than a ten thousandth of an inch thick) which freely transmit sunlight in one direction but reflect heat radiation from the other. One of the scientists, Dr John C C Fan, claims that 2% of the total consumption of energy in the USA could be saved by fitting the heat mirrors to all buildings.

Non-tracking solar funnels

To concentrate the sun's rays more than about 3 times usually requires the focussing lens/mirror to track the path of the sun across the sky. However an American professor has developed a system which can give 10 times concentration without tracking. The CPCs (compound parabolic concentrators) are used in a solar thermal device which heats up its circulating fluid to 600°F, high enough to generate power efficiently. The design is also used in a solar photoelectric device which utilises total internal reflection in solid acrylic bars and the higher light concentration here means that less silicon needs to be used to provide an overall performance equal to more expensive previous devices.

THE PURITY BARRIER

Solarex in the US have found a way of making cheaper solar cells – using dirty silicon. The new cells from Solarex use poly-crystaline silicon, much less pure than the material used at present by other manufacturers. No longer does the silicon have to be grown as a single crystal.

The compromise means that rather than having an efficiency of 12 percent the cells are something like 10 percent efficient.

Continued on page 11

EDGE ELECTRIX

31 BURWOOD ROAD, BURWOOD, NSW 2134,
PO BOX 1003 BURWOOD NORTH TELEPHONE 747 2931

Country Customers Please Note We are mail order specialists and would like to supply your requirements. For free quotation write or phone.

KEF

Concerto Kit SK3	$279.00 pr.
Concerto Boxes	$ 55.00 ea.
Kef Kit 3 – same as SK3 but with speakers already mounted on front baffle	$319.00 pr.
Kef Kit 2 – Cadenza Baffle Kit	$239.00 pr.
Kef Concerto complete	$469.00 pr.
Kef Cadenza complete	$339.00 pr.
SPEAKERS	
B139 Bass Driver	$ 65.00 ea.
B110 Mid range/Bass	$ 32.00 ea.
B200/SP1022 Bass	$ 42.00 ea.
B200/SP1014 Bass	$ 33.00 ea.
T15 Treble	$ 22.00 ea.
T27 Treble	$ 24.00 ea.
BD139 Passive Bass	$ 22.00 ea.
DN12 Concerto Crossover	$ 19.00 ea.
DN14 Cadenza Crossover	$ 17.50 ea.

Please write for any information required on KEF Speakers and Kits. Remember 5 year warranty.

PHILIPS

Brand new AD12K12 Kit consisting of
2 – AD1265/W8 40w Woofer
(in it's enclosure)
2 – AD5060/Sq8 Squawkers
2 – Brand new ADO140/T8
Dome Tweeter
2 – Crossovers
Also complete with 2 enclosures containing innerbond, speaker cloth etc. $239.00 pr.

GREENCAP CAPACITORS

.001, .0015, .0022, .0033, .0039, .0047, .0056, .0068, .0082, .01, .015, .022.	12c ea.
.033, .039, .047, .056, .068, .082	14c ea.
.1	16c ea.
.15, .22	24c ea.

Post & Packing Free

EDGE ELECTRIX SPECIAL PLAYMASTER 146 AM/FM TUNER KIT

$135.00 p&p $3.00 including front panel but no metal work.

Philips and Kef speaker kits are freight on via Hawthorn

SEMICONDUCTOR PRICES SLASHED

BC107 20c metal can
BC108 20c metal can BCI48
BC109 20c metal can
EM404 15c

AUDIO PLUGS & SKTS

3.5 m mini plug	20c
Line & chassis skt	20c
6.5 m P.M.G. mono plug	35c
Chassis skt	35c
6.5 m stereo plug	48c
Chassis skt	60c
RCA plug	24c
RCA line skt	24c
RCA chassis skt	20c
RCA chassis skt double	35c
5 Pin din plug	43c
5 Pin din chassis skt	30c
Banana plug	20c
Banana skt	20c
2 Pin din plug	28c
2 Pin din skt	20c
2 Pin mcm plug	15c
2 Pin mcm skt	15c
75 (ohm) COAX plug	63c

Post & Packing Free

HITACHI CASSETTES

	Qty.	1 to 11	12 to 23	24 plus
C60	Low Noise	1.50	1.35	1.25
C90	Low Noise	1.85	1.75	1.65
C120	Low Noise	2.45	2.30	2.20
C46	Ultra Dynamic	1.85	1.75	1.65
C60	Ultra Dynamic	2.05	1.95	1.85
C90	Ultra Dynamic	2.40	2.30	2.20
C120	Ultra Dynamic	3.20	3.10	2.90
C60	Ultra Dynamic Royal	2.40	2.30	2.20
C90	Ultra Dynamic Royal	3.00	2.85	2.70
C90SM	BASF	2.40	2.20	2.00

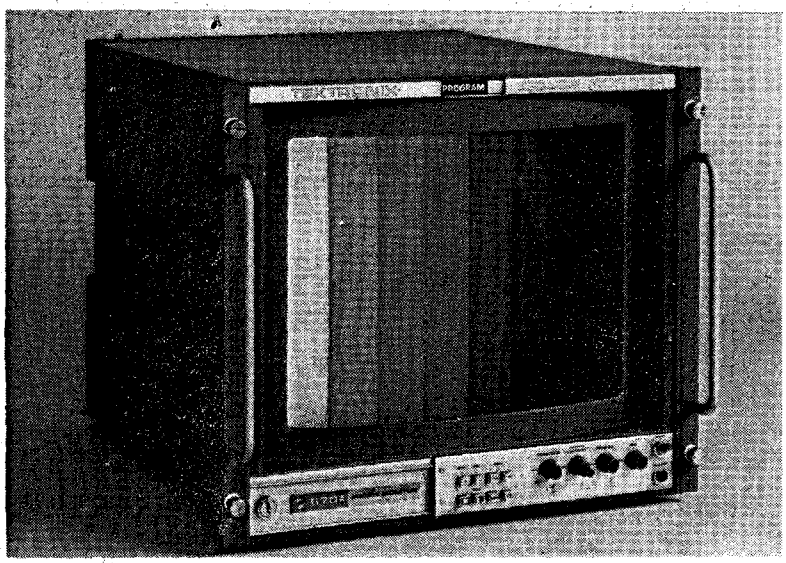
P & P 1-12 $2.00 *12-24 $3.00* *24+ $3.50*

Trading Hours

MON–FRI 8.30 am – 5.30 pm
THURSDAY NIGHTS 'TILL 9pm
SATURDAY 8 am – 12 MIDDAY.

NEWS DIGEST

Continued from page 9



The new Tektronix 670A Series is a group of precision colour picture monitors for NTSC and PAL Television standards. They use a 17-inch Trinitron tube and enhance sharpness by a new feature — variable aperture control.

No-push LED watch

Sooner or later someone had to bring out an LED watch without the pushbutton. The obvious way to enable the time to be read without using the other hand is to build into the watch some kind of sensor so the display can be lit by the action of the wrist holding the watch. After all the wrist has to be turned to enable the wearer to see the display (isn't it about time someone came up with a watch that can be read without turning the wrist?).

Gruen Industries have launched a watch in the US that displays at the flick of the wrist. For compulsive button pushers they have a button for seconds, month and day. The watch sells, complete with gold case and adjustable RGP bracelet, for US$250.

Get rich quick in electronics

Small new companies have the greatest freedom from competition from the big companies in businesses where the risks are high. And in the fast-developing new areas of electronics the rewards can also be high for the lucky ones. The newest explosion in consumer electronics is the CB craze in the US and the companies cashing-in are not the big names like Sony but new names like Xtal, Hy-Gain, and Dynascan. In 1973 Xtal was a one-room operation in Los Angeles. In 1975 the sales were US$11 million and the 1976 figure is estimated at 25 million. But there are still risks: prices fluctuate erratically and the manufacturer has to be careful he doesn't get overstocked with high-priced goods.

The latest CB count shows there are nearly 15 million sets in the US and it is expected that last year's retail sales figure of US$1 000 million will be doubled in 1976.

Fraction calculator

A calculator which the manufacturers claim to be the first to calculate in fractions has been launched in the US by Casio. The AL8 accepts quantities keyed in as fractions and after calculation it can display the result as a fraction. The display looks a bit weird — the two segments at the bottom right corner of the seven segment display are used to make a symbol to separate the integer, the numerator and the denominator. The calculator has other interesting features including the facility for 'sexagesimal' calculations. This means you can do calculations in hours/minutes/seconds or degrees minutes seconds.

We have news about an interesting calculator from Casio which we first mentioned in our May issue: the Casio Biolator will be available in Australia this month, from David Jones and hifi/camera shops. In next month's ETI we will have more information on this interesting biorhythm calculator.

Continued on page 13

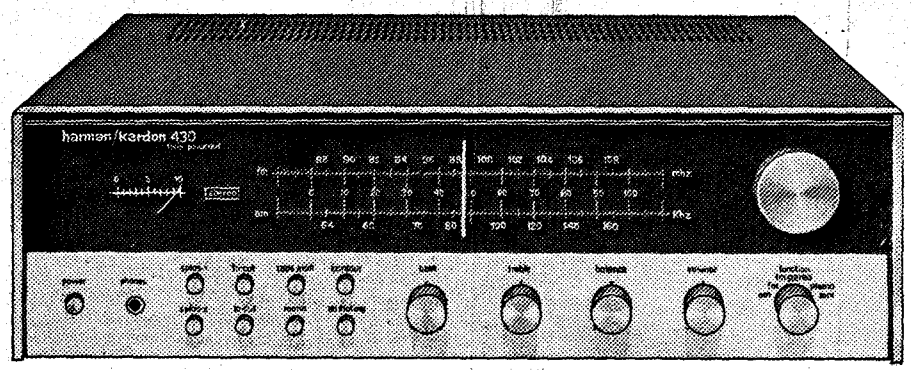
The Harman Kardon $100 Challenge

We've got $100 waiting for you. Bring in any commercially available receiver, regardless of price (except for another Harman Kardon product). If that receiver surpasses the square wave response of the HK 430 or 730 at 20Hz and 20,000Hz, we'll give you the $100.

Why are we making this challenge?

Square wave response is profoundly useful because it is a precise measurement of musical quality. It can be said that an instrument which fails to produce an excellent square wave response is limited in musical authenticity.

So come on in and match your receiver's square wave response against the 430 and 730. If it's better you get $100 — cash. If not, listen to the 430 and 730. You'll find that in all but absolute power levels, they're the sonic equivalents of any individual component system. The implication of a comparison with conventional receivers is obvious.



Your local Harman Kardon dealer will have the H/K factory sponsored Square Wave Clinic soon. Watch local press for details.

harman australia pty ltd

P.O. Box 6,
Brookvale, 2100
Phone 939-2922

Continued from page 11

Quad op-amp

An IC which combines four popular standard op-amps and yet consumes the same power as a single 741 has been developed by National Semiconductor.

It consists of four independent, high gain, internally compensated, low power operational amplifiers. Each is designed to provide functional characteristics identical to the 741.

However, the input offset current is only 4nA and the input bias current is 30nA. The new series also features low supply current drain (0.6mA/amplifier), low input offset voltage (1mV) and overload protection for both inputs and outputs.

A high degree of isolation between amplifiers has been achieved by independently biasing each amplifier and using layout techniques which minimize thermal coupling.

Two versions of the quad op-amp, the LM148 and LM149, are available. The LM148 is pin compatible with the older LM124 quad op-amps and can be used anywhere that the 741 or 1558 amps are being used. It is designed for applications where amplifier matching or high packing density is required.

The LM149 series has same features as the LM148, plus a gain bandwidth product of 4 MHz at a gain of 5 or greater.

NS Electronics: Melbourne 729-6333; Sydney 93-0481.

A to D converter

The ZN425E is an 8 bit dual mode analogue-to-digital/digital-to-analogue converter. It contains an 8 bit D to A converter using an advanced design R-2R ladder network and an array of precision bipolar switches plus an 8 bit binary counter and a 2.5 volt precision voltage reference. All on a single monolithic chip.

Further information from Namco Electronics, 239 Bay Street, North Brighton, Vic. 3186.

NEW FAIRCHILD DISTRIBUTOR

Fairchild Australia recently announced the appointment of Ohmtronics as franchised Fairchild distributors. Their address is 73 Beattie Street, Balmain, telephone 820701. The Melbourne number is 292339, address 1100 Toorak Road, Hartwell, 2134.

ERRATUM

ETI June 1976, page 44

The specification of our five watt stereo amplifier should have given the frequency response as ranging from 4 Hz to 200 kHz within +1 dB and -3 dB.

WIN A CALCULATOR!

This month's contest is based on work with microprocessors at the Royal Melbourne Institute of Technology. Dr Tim Hendtlass sent us the printout shown on the coupon for this month's competition. It shows how the microcomputer can be used to generate a maze. With the program in the machine the operator has to answer two questions to decide the size of the maze. As you can see from the lines at the top of the printout this maze is set to a width of 22 units and a height of 30 units. The microprocessor inside the machine then goes to work and constructs a maze which is unlikely to be the same as any other maze drawn by the computer. Do you know how many possible mazes there are for this 22x30 outline? All the mazes have the start somewhere on the top line and the finish somewhere on the bottom line. If you can calculate (or guess!) the figure all you need to do to enter the contest is to tick the figure on the entry coupon which is nearest and then solve the maze.

We have some good news for those of you who are interested in microprocessors: Dr Hendtlass will be explaining these devices in ETI next month.

This month's prize

The winner of this month's contest will get a Unitrex 901M – an ac adaptable machine with 8-digit green display, four-key memory, switch for accumulating memory, % key for add-on and discount calculations, and constant facility on all four functions.

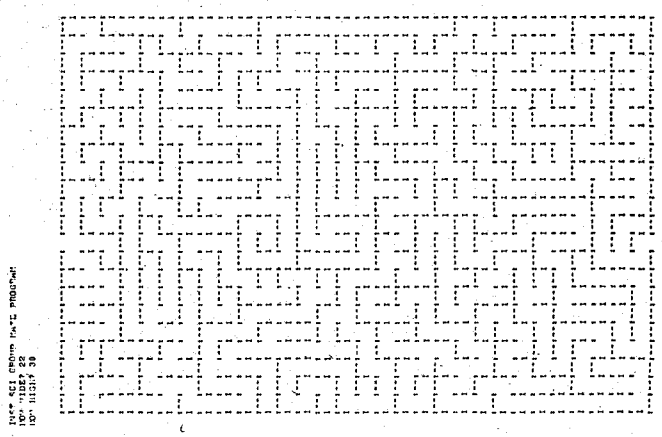
Results of March contest

Our March calculator contest required entrants to calculate the resistance across the diagonal of one square of an infinite square mesh of 1 ohm resistors. No-one sent us the correct answer, $2/\pi$ ohms, but we had several entries with values near to 0.6366 ohms, the nearest was from Mr W White of Randwick, NSW, and he will get the calculator. Surprisingly the majority of entries gave the solution as one ohm: the resistance across just one square in isolation.

The closing date for this contest is 13th August 1976. The winner will be the sender of the first correct entry drawn from a barrel after that date. The result will be announced in ETI as soon as possible afterwards.

TICK ONE BOX

10^5	10^8	10^{15}	10^{27}	10^{50}	10^{80}	10^{150}	10^{270}	10^{500}	10^{800}

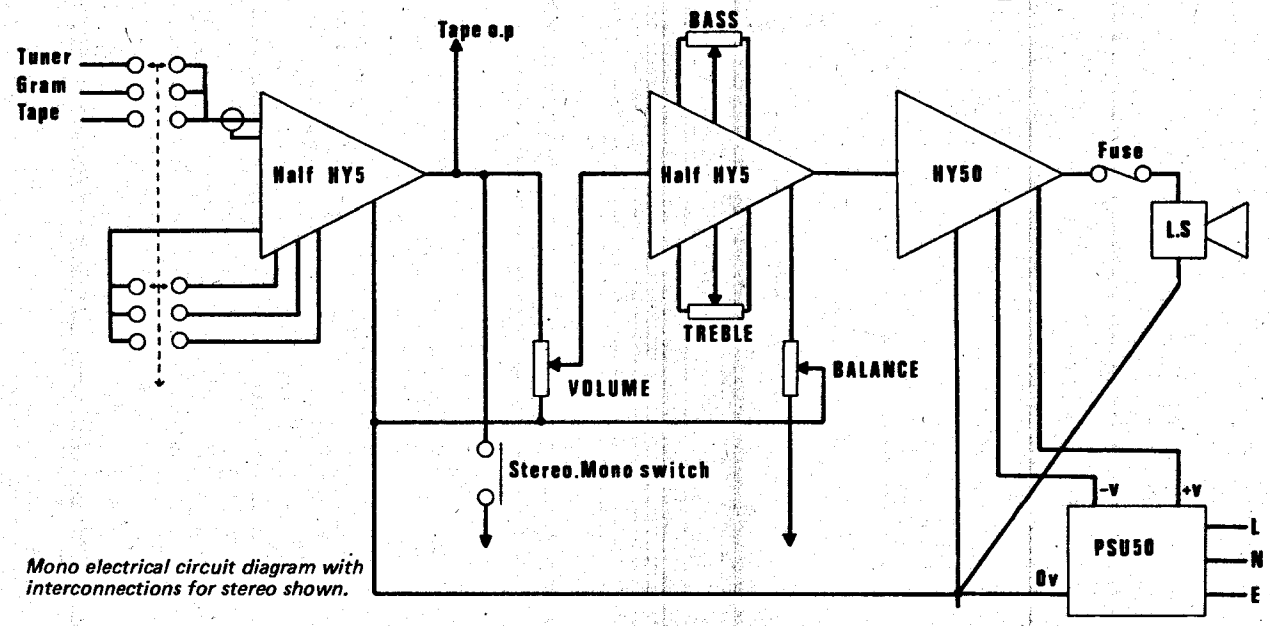


Permit No TC 7578
Send to Calculator Contest (July),
Electronics Today International,
15 Boundary St,
Rushcutters Bay, NSW 2011.

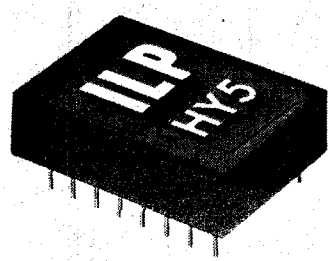
NAME .....
ADDRESS .....

I.L.P.

SHEER SIMPLICITY!



Mono electrical circuit diagram with interconnections for stereo shown.



The HY5 is a complete mono hybrid preamplifier, ideally suited for both mono and stereo applications. Internally the device consists of two high quality amplifiers—the first contains frequency equalisation and gain correction, while the second caters for tone control and balance.

TECHNICAL SPECIFICATION

Inputs

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

Outputs

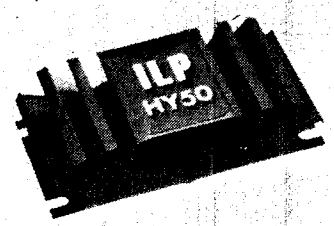
Tape	100mV
Main output Odb (0.775 volts RMS)	

Active Tone Controls

Treble	±12db at 10kHz
Bass	±12db at 100Hz

Distortion	0.05% at 1kHz
Signal/Noise Ratio	68db
Overload Capability	40db on most sensitive input
Supply Voltage	+16—25 volts.

PRICE $16.06 P&P $0.30

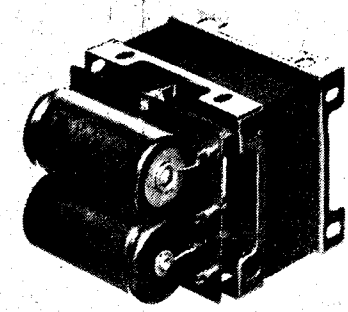


The HY50 is a complete solid state hybrid Hi-Fi amplifier incorporating its own high conductivity heatsink hermetically sealed in black epoxy resin. Only five connections are provided: Input, output, power lines and earth.

TECHNICAL SPECIFICATION

Output Power 25 watts RMS into 8Ω
Load Impedance 4—16Ω
Input Sensitivity Odb (0.775 volts RMS)
Input Impedance 47kΩ
Distortion Less than 0.1% at 25 watts typically 0.05%
Signal/Noise Ratio Better than 75db
Frequency Response 10Hz—50kHz ± 3db
Supply Voltage ± 25 volts
Size 105 x 50 x 25 mm.

PRICE $20.27 P&P $0.40



The PSU50 incorporated a specially designed transformer and can be used for either mono or stereo systems.

TECHNICAL SPECIFICATIONS

Output voltage	50 volts (25–0–25)
Input voltage	210–240 volts
Size	L.70, D.90, H.60 mm.

PRICE $20.41 P&P $2.00

P&P $2.00 FOR 1 COMPLETE SET OF HY5 + HY50 + PSU50

TWO YEARS GUARANTEE ON ALL OUR PRODUCTS

K. D. FISHER & CO.
P. O. Box 34, Nailsworth, S.A. 5083.
Telephone 269-2544.

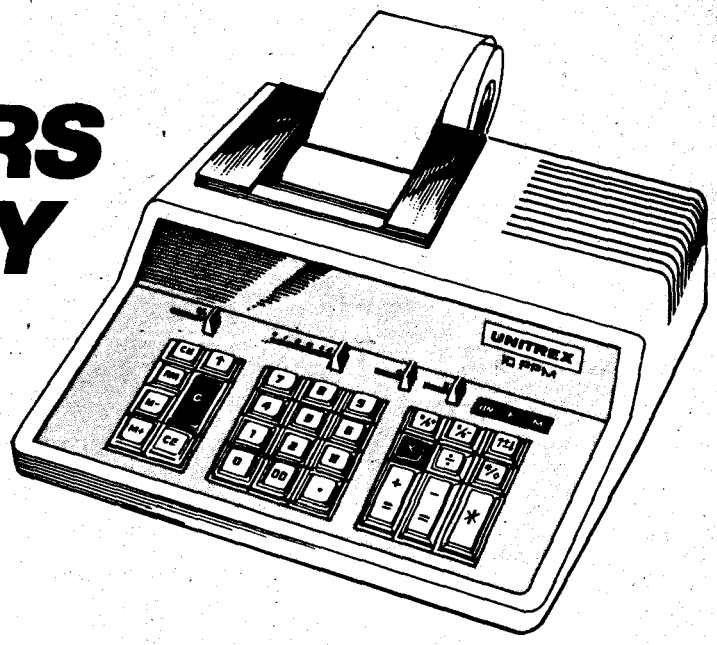
Please Supply_____
Total Purchase Price_____
I Enclose Cheque ☐ Postal Orders ☐ Money Order ☐

Name & Address_____

Signature_____

PRINTING CALCULATORS with MEMORY

for home — office — or schools



MODEL 10PPM **$99.95***

MODEL 14 PPMD **$154.95***

(plus $5 post and packing)*

UNITREX PTY LTD have arranged to supply ETI readers with two types of printing calculator at low introductory prices.

Model 10 PPM has a full 10 digit capacity, add, divide, multiply and subtract functions plus fully addressable memory with direct access.

Model 14 PPMD has even more facilities including 12 digit green digitron display as well as full printing capability. Full specifications of both units are included in the data table.

SIMPLE FOUR-FUNCTION POCKET CALCULATORS COST MORE THAN THE 10 PPM JUST A FEW YEARS AGO!

SPECIFICATIONS — BOTH UNITS

- Adds, subtracts, multiplies, divides
- Chain and mixed calculations
- Fully addressable memory with direct access — selectively stores and accumulates in separate register
- Auto constants in all functions and memory
- Memory accumulation setting enables all calculated results to be accumulated in the memory
- Calculates reciprocals, squares and raising numbers to a power
- Item count key
- Auto percentage key with add-on and discount capability
- 5/4 switch for round-off or truncated results
- Hi-speed buffered keyboard
- Power, memory, overflow and error indicators
- Weight 2.72 kg—240 mm by 290 mm by 90 mm.

10PPM ONLY

- Full floating decimal entries — selectable fixed decimal setting of 0-4 with 'add-mode' for results
- 10 digit capacity — entries and answers up to 99,999,999,99
- Separate zero and double zero keys

14PPMD ONLY

- Results shown in print, or large green digitron display—or both as required.
- Selectable decimal point with 0-7, two or three decimal place with 'add mode' and 'full float' positions
- 12 digit capacity, entries and answers to 9,999,999,999.99
- Separate zero and triple zero keys
- Non-add, sign change, exchange, clear and clear entry keys.

NOTES

The Unitrex 901SR calculators offered are warranted "for a period of 12 months from original purchase date — under normal use and service against defective materials or workmanship. Defective parts will be repaired or replaced at Unitrex's option when the calculator is returned prepaid to Unitrex of Australia Pty Ltd., 414 Collins Street, Melbourne, Vic 3000. The warranty is void if the calculator has been damaged by accident or misuse. Removal or alteration of serial number or repair by unauthorised personnel also voids warranty".

"The warranty contains the entire obligation of Unitrex of Australia Pty Ltd and no other warranties, expressed, implied or statutory are given — this warranty does not exclude limit restrict or modify any condition or warranty implied by the Trade Practices Act 1974, or other State laws or Acts . . ."

All units will be thoroughly inspected by Unitrex before despatch. The package should be carefully inspected before accepting delivery. Acceptance should be refused if the package is damaged.

Orders must be addressed exactly as per the coupon. Please note — due to current postal delays, readers should expect a delay of between three to four weeks.

Finally — in the event of the unit not working — please return it directly to Unitrex, 414 Collins St., Melbourne, Vic 3000. This offer closes on August 31st 1976.

COUPON – UNITREX PRINTING CALCULATOR OFFER

Please forward Unitrex model . . . . . My cheque/postal order for $104.95 – $159.95 (including post and packing) is attached. Please make cheque/postal note payable to 'Unitrex Offer'

SEND TO UNITREX PRINTING CALCULATOR OFFER
C/- ELECTRONICS TODAY INTERNATIONAL
15 BOUNDARY ST, RUSHCUTTERS BAY, NSW 2011.

NAME .....

ADDRESS .....

.....

BC108-10 for 90c METAL CAN NEW, MARKED

BC108—10 for 90c New, Guaranteed, Marked. We are clearing these as we have a limited quantity left. GET yours NOW! (LIMIT of 10 to each customer.) This fantastic offer will never be repeated.

555 TIMER—3 for $2 I.C.TIMER in mDIP package. New, Marked, Guaranteed. Stock up NOW!

741 OP. AMP—5 for $2.50 New, Marked, Guaranteed, in mDIP package. Fantastic!

EM410—10 for $1 Silicon RECTIFIER (1000v, 1A). New, Marked, Guaranteed (LIMIT of 10 to each customer)

C106D—3 for $3.75 SCR (400V, 4A). New, Marked, Guaranteed. Top Quality.

POLYESTER CAP. PACK—2 PACKS for $6 100 Caps per pack. All 10% Polyesters. Post and Pack: Interstate $1.50, N.S.W. $1.30.

HA1322. AUDIO POWER I.C.—4 for $7.50 Each rated at 5.5 watts peak. Supply volt 13V. You get a total of 22 watts peak for $7.50.

GET YOURS NOW! DON'T BE DISAPPOINTED LATER! 10% DISCOUNT FOR ORDERS OVER $20. MONEY BACK IF NOT SATISFIED!

C-MOS

4000 — **40c**
4001 — **40c**
4002 — **40c**
4006 — **$2.75**
4007 — **40c**
4009 — **$1.25**
4011 — **45c**
4012 — **45c**

74C SERIES

74C00 — **45c**
74C02 — **45c**

I.C. SOCKETS

8 Pin mDIP socket — **40c**
14 Pin DIP socket — **45c**
16 Pin DIP socket — **50c**

CARBON FILM RESISTORS

(All 3c each)

Top Quality, High Stability, 5%, ½ watt in E12 values. Your choice from 10 ohm to 1 MEG.

LINEAR I.C.'s

The Best Prices for Top Quality I.C.'s:

741	m DIP—	**60c**
709	DIP—	**70c**
555	m DIP—	**85c**
301	m DIP—	**70c**
307	m DIP—	**70c**
723	DIP—	**$1.00**
3900	DIP—	**$1.25**
CA3012	(Can)—	**$1.50**
CA3013	(Can)—	**$1.50**
CA3018	(Can)—	**$1.50**

COPPER CLAD BOARD

Fantastic Value:
6½" x 5" — 4 for **$2.00**
10" x 6" — 3 for **$2.75**
9" x 12" — 2 for **$3.50**

RESISTOR PACK

Super pack of resistors. Mostly ½ watt, 1 watt, 5% and 10% resistors. No short lead rubbish — 100 for **$1.25.**

POLYESTER GREENCAPS

(from 10c each)

All 10%, 100V. Rating. Fantastic Value —

.001, .0015, .0022	— **10c** ea.
.0033, .0039, .0047	— **10c** ea.
.0056, .0068, .0082	— **10c** ea.
.01	— **10c** ea.
.015, .022	— **12c** ea.
.033, .039, .047	— **14c** ea.
.056, .068, .082	— **17c** ea.
.1	— **20c** ea.
.15	— **23c** ea.
.22	— **26c** ea.

ELECTROLYTICS

(Single Ended — from 7c each)

New, top quality for P.C. board mounting. All 25V.

4.7uf — **7c**	100uf — **19c**
10uf — **7c**	220uf — **25c**
22uf — **9c**	470uf — **30c**
47uf — **14c**	1000uf — **40c**

DIGITAL T.T.L. I.C.'s

New, Guaranteed, Low, Low Prices!

7400	**35c**	7430	**35c**
7401	**35c**	7440	**35c**
7402	**35c**	7441	**$1.20**
7404	**35c**	7442	**$1.00**
7408	**35c**	7447	**$1.50**
7410	**35c**	7473	**90c**
7413	**80c**	7474	**90c**
7420	**35c**	7475	**$1.00**

POLYESTER PACK

Super pack of polyester caps. All 10% incl. 160V, 270V, 400V types — 100 for **$3.50.**

CERAMIC CAP. PACK

Super pack of ceramic caps incl. low and high volt. types. Top quality — 50 for **$1.**

ELECTROLYTIC PACK

Super pack of electrolytics. Top quality pig-tails, low and high volt. — 25 for **$2.50.**

DISCOUNT FOR VOLUME BUYERS IDEAL FOR ALL RADIO CLUBS, SERVICEMEN AND GROUP BUYERS, ETC.

POPULAR SEMICONDUCTORS

Transistors

BC548	— 10 for **$1.80**
BC549	— 10 for **$1.80**
BC558 (178, 158)	— 10 for **$1.80**
BC559 (179, 159)	— 10 for **$1.80**
BC328	— 10 for **$2.00**
BC338	— 10 for **$2.00**
BC547	— 10 for **$1.80**
BC635	— **70c** ea.
BC636	— **70c** ea.
BF198	— **60c** ea.
2SA353 (AF126)	— **60c** ea.
2SB367 (AD162)	— **$1.00** ea.
2N6107	— **$1.00** ea.
40250	— **$1.45** ea.

Silicon Rectifiers

EM402	— 10 for **$1.00**
1N5059	— 10 for **$1.00**

Stick Rectifier

TV18-2MT	— **$2.00** ea.
SCR C106D (400V, 4A)	— **$1.40** ea.
RL4850 L.E.D. Red ¼ with clips	— **40c** ea.

Diodes

1N914	— **10c** ea.
0A90	— **10c** ea.

FANTASTIC SPEAKER SPECIALS

(Limited Quantity Only)

M.S.P. 6WAC16 — 6½ inch round WOOFER, 16 WATTS R.M.S. power output. 15 OHMS IMP., FREQ. RESPONSE 35-6000 Hz. This high performance, high compliance, hi-flux, low Q, low resonance speaker with heavy duty ferrite magnet. Must be heard to be believed. A bargain at **$9.85** ea. or 2 for **$19** or 4 for **$36.** Pack and Postage in N.S.W. is $1.50 for up to 4 speakers. Pack and Postage INTERSTATE is $2 for 1 or $2.50 for up to 4 speakers. MS.P. 64LC — 6" x 4" 15 OHM oval speaker, General purpose speaker, ideal for Car Radio, T.V. replacement, etc., etc. A BARGAIN at **$3.85** ea. or 4 for **$14.50.** (LIMITED QUANTITY ONLY.)

STYROSEAL CAPACITORS

680pf/1000V — 200 for **$12.00**
100pf/125V — 200 for **$5.50**
680pf/630V — 100 for **$3.50**
680pf/125V — 100 for **$2.75**
270pf/125V — 200 for **$5.50**
220pf/125V — 100 for **$2.75**

TANTALUMS (Miniature Type)

4uf/6V — 100 for **$3.50**
5uf/3V — 100 for **$3.00**
7uf/3V — 100 for **$3.00**

TRIMPOTS

(Miniature 10mm vertical Mount. All 20c ea.)

100, 220, 470, 1k, 2.2k, 4.7k, 10k, 22k, 47k, 100k, 220k, 470k, 1M — All **20c** ea.

Discounts on all orders: over $20 — 10%
over $100 — 12%
over $200 — 15%

Basic post and pack 60 cents. Please assist by including extra postage for heavier parcels. Take advantage of these rockbottom prices as supplies are already limited. STOCK UP NOW!!! DON'T DELAY!!! POST YOUR ORDER TODAY!!!

POST AND PACK 60c OR EXTRA FOR HEAVY PACKAGES

MICRONICS

P.O. BOX 175, RANDWICK, N.S.W. 2031

USE THE HOT SOUND TAPES

Ampex 406/407 and GRAND MASTER Studio Mastering Tapes

Hot!
Ampex Low Noise/High Output 406/407 Series

Although GRAND MASTER Studio Mastering Tape stands at the very peak of magnetic recording technology, it could not have reached those heights without the solid foundation laid by the 406/407 Series. All the improvements offered by GRAND MASTER tape derive from the research which has made 406/407 the standard of the industry.

The magnetic oxide system has satisfied stringent studio requirements for low noise, high signal-to-noise ratio, and low distortion in studios throughout the world. The extremely durable oxide binder system was developed to endure the rigors of multiple pass mixdowns. And both 406/407 and GRAND MASTER Studio Mastering Tapes use the same high strength, backcoated polyester base film.

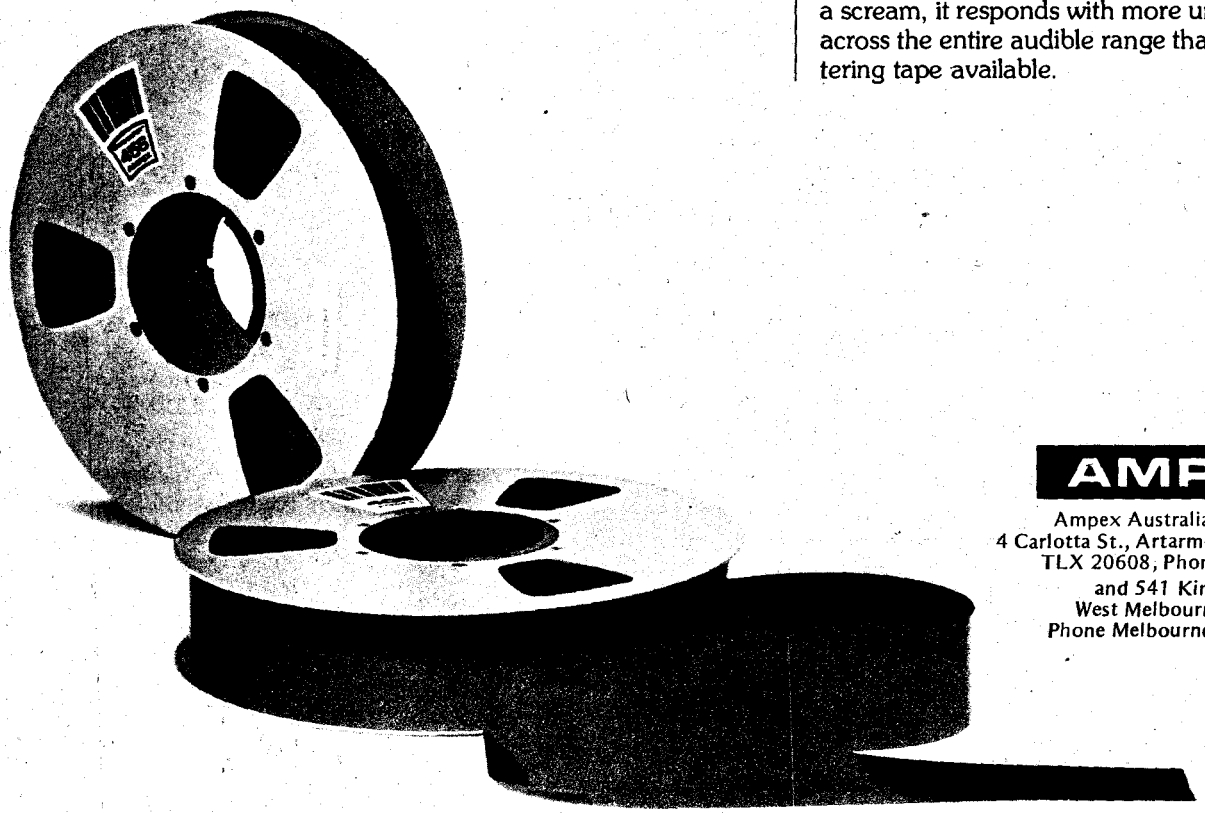
With 406/407 you get proven quality plus the added bonus of biasing compatibility with the new GRAND MASTER.

Hotter!
Ampex GRAND MASTER Studio Mastering Tape

A Product of continuing Ampex research, GRAND MASTER Studio Mastering Tape provides improved electro-magnetic performance properties resulting in higher output, lower distortion, greater saturation capability, and sound quality which must be heard to be believed.

It delivers all these superior qualities while maintaining the identical biasing requirements as the 406/407 series, which means not only added convenience, but greater eraseability than other high output tapes which require an increase in bias setting. Like 406/407, the foundation of GRAND MASTER Tape is a durable polyester film with high conductivity backcoating which improves mechanical handling and eliminates dropouts caused by electrostatic attraction of contaminants.

You can drive GRAND MASTER tape harder than you've ever driven a tape before. From a whisper to a scream, it responds with more undistorted output across the entire audible range than any other mastering tape available.



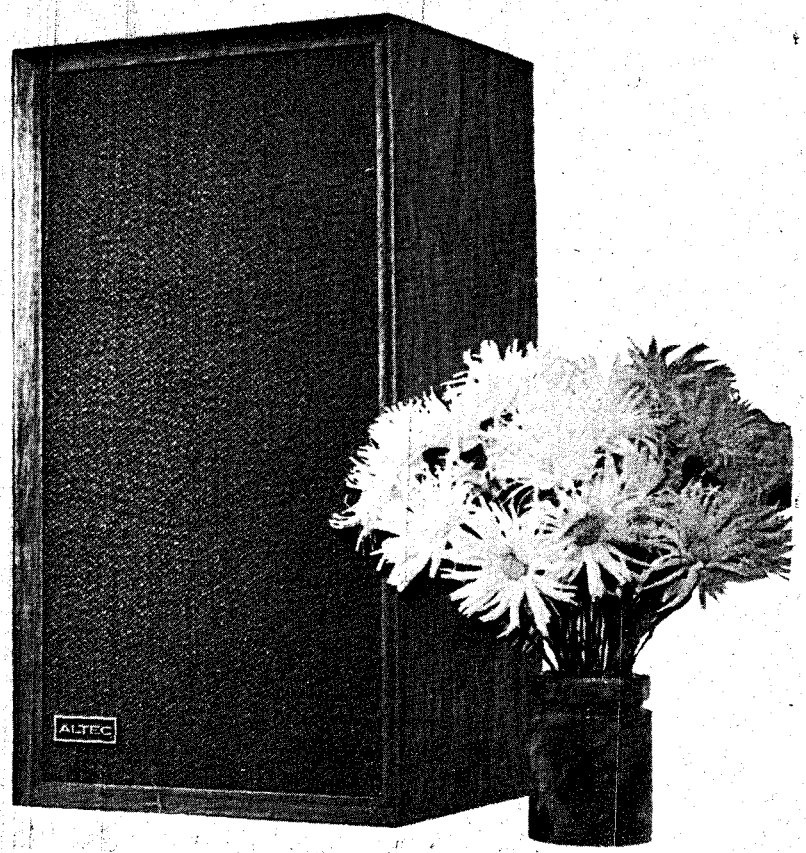
AMPEX

Ampex Australia Pty. Ltd.
4 Carlotta St., Artarmon, N.S.W. 2064
TLX 20608, Phone 439-4077
and 541 King St.,
West Melbourne, 3003
Phone Melbourne 329-0388

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

The colouriser

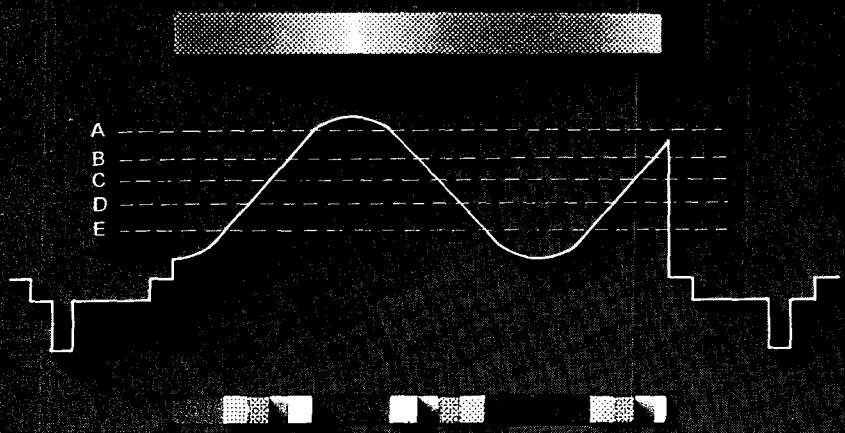
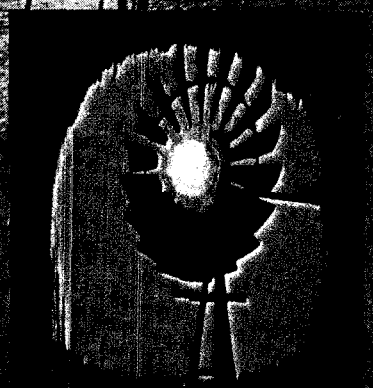
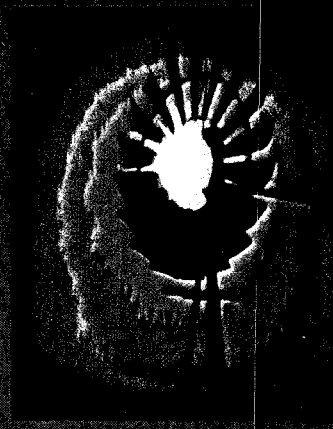
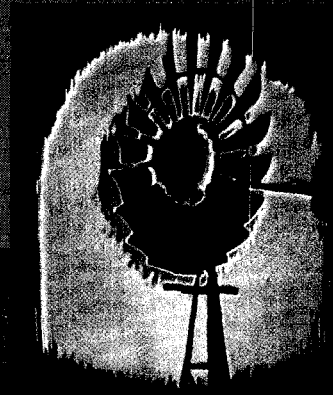
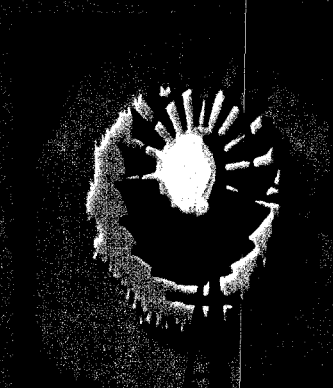


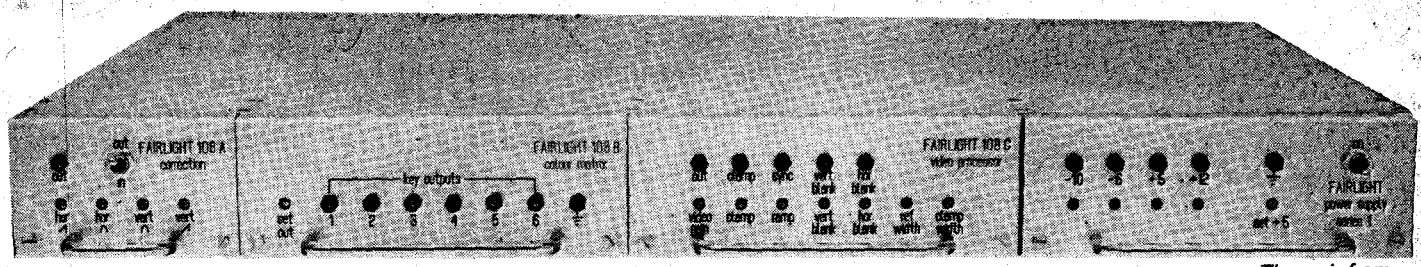
Fig. 1. The strip above the graph shows a monochrome pattern. On a TV this would be made up of lines like the one shown on the graph. The graph also shows five settings of the turnover controls on the colouriser necessary to split up the pattern to produce the colour effect shown below the graph. Each of the six colour areas in the final picture can be any colour selected by the operator.



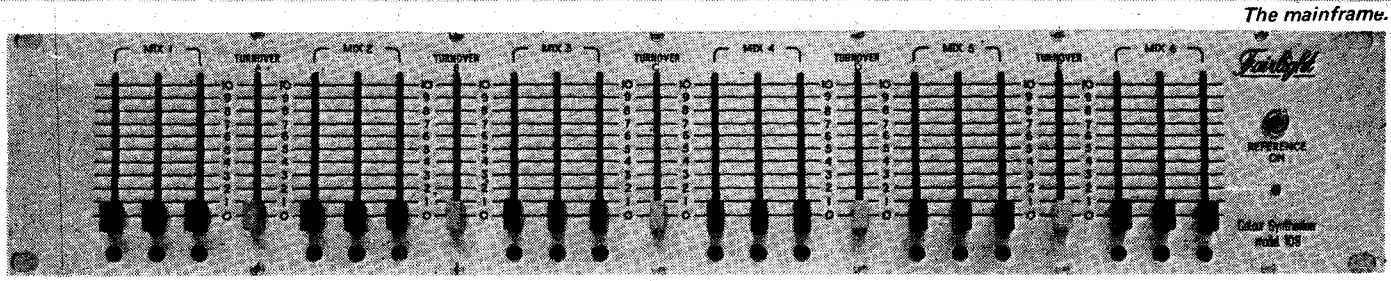








The mainframe.



The control panel.

This new equipment was first mentioned in ETI's News Digest last month. Since then we have had a demonstration of the remarkable effects this device can produce.

THE FAIRLIGHT 108 Colour Synthesiser opens up new possibilities for the designer, the TV producer and the animated film maker. Now a designer working on a new print for textiles (or it could be a carpet or wallpaper design) can make up a design in 6 shades of grey and put this in front of a black and white TV camera. Then he can mix six colours (any of the colours that can be reproduced on a TV screen) and place them in any of the six areas of his original. Whilst watching a TV monitor he can change any of the colours until he finds the best combination.

Similarly a TV producer can use the colouriser to colour six different captions in six different colours on one picture.

But the Fairlight 108 can do more than this. In the examples above the original black and white picture does not have a continuous gradation of grey, it is made up of areas at six discrete levels of brightness. The 108 has circuitry for splitting a normal black and white TV picture (with continuous shades of grey) into a picture made up of only six brightness levels; then colours can be mixed for each of these as before. See Figure 1. The thresholds of the levels are variable: they can be adjusted as the operator watches the picture.

This facility can be particularly useful in situations where small tone changes in a grey picture need to be detected (in analysing x-ray photographs, for instance).

The pictures on page 20 show what we did with a black and white photograph. The original black and white picture was taken by a reader of Camera & Cine magazine, Phil Robinson. The inset colour pictures are shot from the screen of the colour TV we were watching. The various effects are the result of changing the colour mixes for the six levels and changing the thresholds of the levels.

The control panel

The rationalised layout of the controls is obvious from a brief study of the control panel. The position of the 'turnover' sliders gives a graphic representation of the grey-scale separation points. Setting-up is further aided by using a switchable reference-band test-pattern. This displays the colour and grey-scale values across the top of the output picture.

To avoid strange effects the turnover controls should be set in an ascending sequence from left to right. In operation the control A is first set to a minimum and the other turnover controls to a maximum. Now the complete video input lies between thresholds A and B, and the output is a plain screen (coloured by the 'Mix 2' controls).

Now you set up a colour on Mix 1 and raise Turnover A to bring this colour into the darkest areas of the source picture. If a colour is now set up on Mix 3 this will come in on the highlights as Turnover B is lowered. By setting up more colours and lowering turnovers B, C, D and E the final picture is created.

The operator controls are voltage-controlled and can be used from up to 100 metres from the main equipment rack.

The mainframe

The mainframe occupies 44mm of rack space and contains four modules — the correction module, the colour matrix, the video processor, and the power supply.

Correction Module This offers facility for the colourisation of video which is not of uniform brightness across the frame. The picture of the correction module shows the four controls and will give you an idea of what can be done. The polarity and amplitude of the waveforms (shown below the controls) can be set.

Although the 108 will normally take its sync and blanking from the rest of the system, it can provide its own if desired. This means a system can comprise a simple black and white television camera, a colour monitor and the 108.

Key Outputs These are available from the six grey-scale triggers and can be used to drive an external keyer so that, rather than filling a particular grey-scale area with a colour, an external video picture can be switched in. The effect will be similar to chroma-key, but rather than coming in on a particular chrominance level it is operated between luminance levels. If this method is used on all six grey-scale segments, the 108 can switch between six separate video sources.

Applications The Fairlight 108 has many more potential applications than those mentioned here. Film animation can now be done in shades of grey and the colour added later. A black and white video signal can be used to montage up to six other pictures in a dynamic way. The equipment can be used to display small luminance changes in black and white pictures being monitored. Weird effects can be created for entertainment purposes. It will be interesting to see how the device will now be used.

The manufacturers are Fairlight Instruments Pty Ltd., of 15 Boundary Street, Rushcutters Bay, NSW 2011. The phone No is 31 3606.

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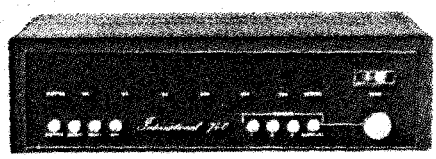

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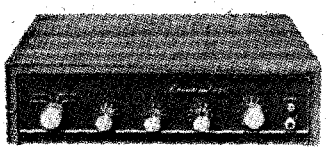

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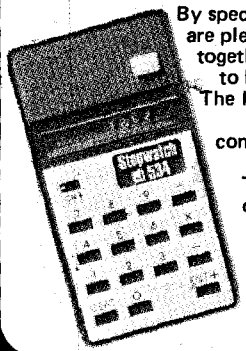

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ETI 5/76

Part 1

CMOS–a practical guide

Inherently rugged CMOS logic has many advantages over other logic families – high noise immunity and uncritical power requirements are but two. This new five-part series explains in practical down-to-earth terms just how CMOS should be used.

THE AVAILABILITY OF THE CD4000 series of chips brings CMOS to the forefront of logic technology to rival TTL in many applications. CMOS is far less critical as regards power supplies and possesses high noise immunity as well as capabilities which are not offered by other logic families.

In this series of articles we shall give various circuits which illustrate the use of CMOS. We suggest that these circuits can be 'breadboarded' on ETI Utilboard (Aug 1975 issue) using DIL sockets – there is nothing like trying it to see. Some of the circuitry,of course, is capable of realisation in a number of different logic families, so that, in these cases, we will merely be introducing equivalents of familiar devices. However, some of the applications we give show the major possibilities of CMOS.

HANDLING AND USE

Firstly we shall deal with the disadvantages of CMOS and get these behind us before we look more closely at some of the virtues. The first point is that these devices are very susceptible to damage from surges of over-voltage from static electricity and unearthed test equipment. When you come to buy any CMOS ICs you should find them with their leads buried in foam. This foam is conductive and protects the device by putting all the pins together so do not remove it until the IC is to be put in circuit. If you run out of foam for storing devices then stick them into a piece of soft balsa wood. Whatever else you do, must not keep them in plastic containers or use ordinary plastic foam as this may develop a great deal of static. It is in fact a good rule to keep the devices away from all plastics as much as possible including any nylon clothing.

It is sensible to use IC sockets for the more expensive devices and also for any chip you may wish to re-use, but if you do solder them in solder the V_{DD} pin first, then V_{SS} and then all the others. The reason for this is that the common ranges of CMOS have internal protection devices which operate fully only when the supply lines are connected. While we are on the subject of soldering, check that your iron and any other instruments you may use (meters, oscilloscopes, etc) are all properly earthed.

The only other real disadvantages of CMOS compared with TTL are that it is slower (typical gate rise time 25 nS) and that a few operating precautions are necessary.

Firstly, all unused inputs must go somewhere. The alternatives are tying unused inputs to used inputs, either to the supply line as appropriate, or to a supply line via a resistor (220 kΩ is usually about right). The latter solution is particularly helpful for inputs to which off-board connections are to be made. This avoids leaving the input "floating" until it is wired in. The other point is to ensure that the chips do not have signals at their inputs when the power supply is not on.

Now we shall consider a few of the advantages of CMOS. Most of these will come out more clearly later and so we shall just mention them briefly here.

The principal virtue is the ease of choice of power supply. This may be anywhere between three and fifteen volts at low current. The actual power required depends on operating frequency (see Fig 1) being comparable with TTL at ten MHz but it is in the region of a few microwatts at sub-kilohertz speeds. Voltage regulation is not requied but operating speed and current consumption rise with increasing supply voltage. For most practical purposes CMOS will run off a nine volt battery or the simplest of mains power supplies. Other advantages include high noise immunity and analogue possibilities. Before we proceed with some circuitry the table of operating conditions (Table 1) should be studied. The limits shown in the table should be adhered to rigidly.

TABLE 1 CMOS OPERATING LIMITS	CD400A SERIES
STORAGE TEMPERATURE	–65 to +150°C
OPERATING TEMPERATURE	–40 to +85°C
SUPPLY VOLTAGE LIMITS (V_{DD}–V_{SS})	–0.5 to +15 V
PACKAGE DISSIPATION	200 mW max.
INPUT VOLTAGE	$V_{SS} \leqslant Vin \leqslant V_{DD}$
RECOMMENDED SUPPLY VOLTAGE (V_{DD}–V_{SS})	+3 V to +15 V

Unused inputs should be tied to a supply line. No input should be present when the supply lines are off.

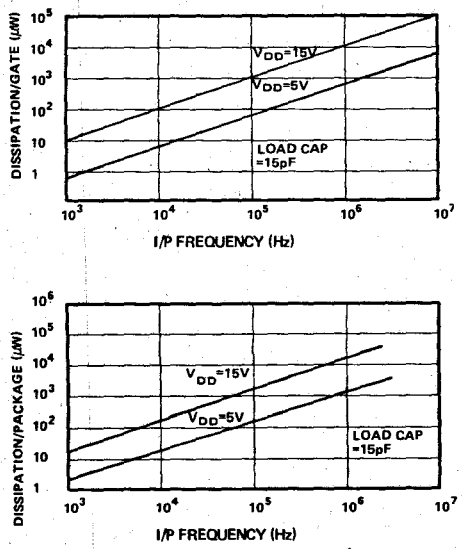

Fig. 1. Power dissipation in CMOS as a function of frequency for a) a simple gate and b) an MSJ package.

SIMPLE GATES

It is an unpleasant fact that it seems one must always start considering any subject at its least interesting parts and it is hardly surprising that the least interesting logic ICs are the simple gates.

We shall assume that the reader is familiar with truth tables and terminology and logic consequently our discussion will mainly be on the subject of monostable and astable multivibrators. For ease of future reference a list of basic CMOS gates and their pin-outs is given in Fig. 2. It is worth remembering that inverters may be realised by tying together all the inputs of a NAND or NOR gate, thus allowing a circuit requiring two NOR gates and two inverters to be constructed for a single type 4001A package.

ASTABLE MULTIVIBRATORS

The basic CMOS astable is shown in Fig. 3. This could of course be built using any of the packages in Fig 2 with the exceptions of the 4030A and 4050A, indeed, the 4049A could produce three of these circuits simultaneously. The period is approximately 1.4RC (R in ohms, C in farads), and the waveform may have a non-unity markspace ratio due to the voltage at which the inverters switch (called the transfer voltage – V_{tr}) not being exactly half way between V_{DD} and V_{SS}. The frequency is also dependent on the supply voltage. In

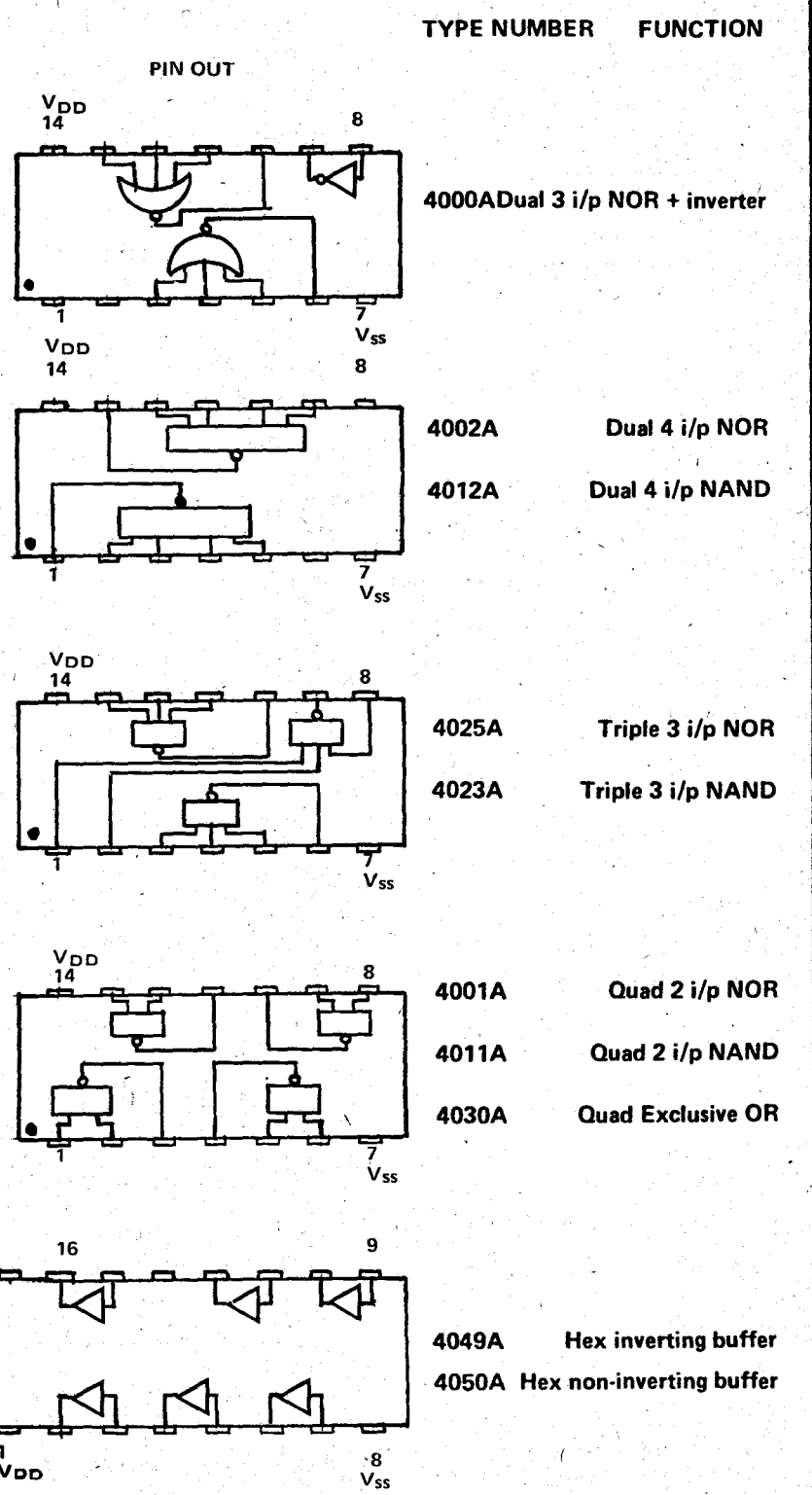

Fig. 2. Some simple CMOS gate packages.

CMOS - a practical guide

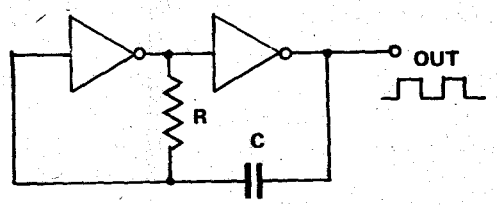

Fig. 3. Basic CMOS as table.

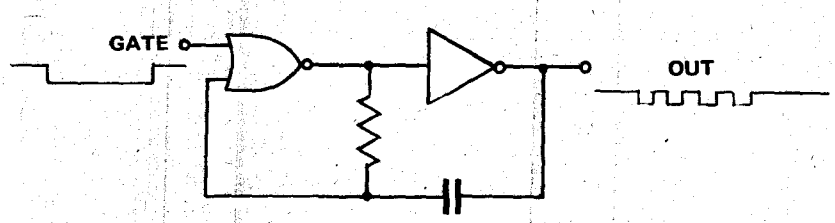

Fig. 6. A gated astable multivibrator.

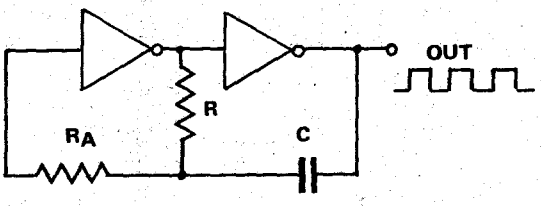

Fig. 4. Improved astable multivibrator.

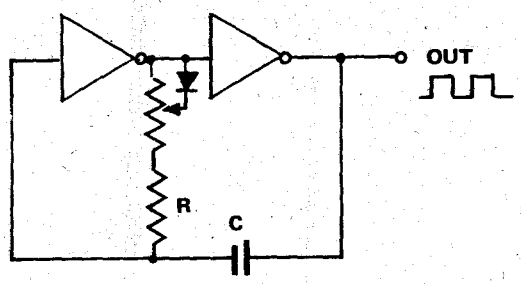

Fig. 5. Duty cycle adjustment.

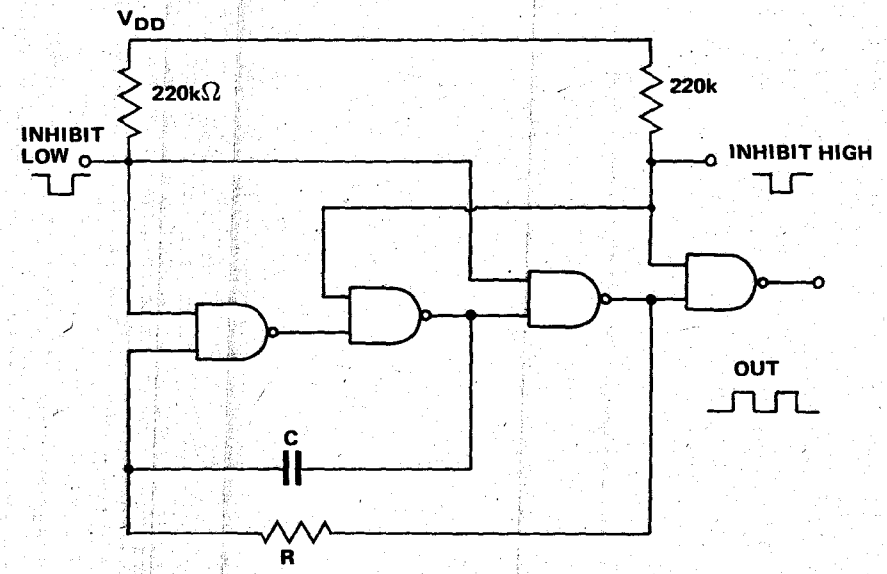

Fig. 7. This jitter-free multivibrator (with inhibits) may be made from a 4011A.

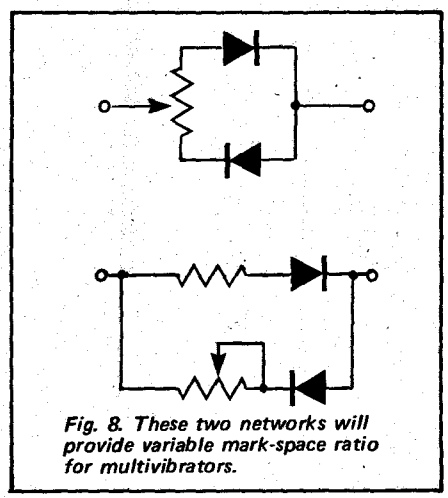

Fig. 8. These two networks will provide variable mark-space ratio for multivibrators.

keeping with normal practice, connections of the device to the supply voltage have not been shown.

The next few circuits will rectify some of the aberrations of the simple version. The addition in Fig. 4 of R_A, which should be at least twice as large as R, makes the frequency almost independent of the supply voltage over a wide range. The frequency of any of the circuits may be made variable by making R a variable resistor.

Duty cycle adjustment may be achieved using the circuit in Fig. 5 Altering the duty cycle will affect the frequency and the diode may have to be reversed to achieve the desired result.

GATING

A gated multivibrator is shown in Fig. 6 where the oscillator only runs when the gate input is low, thus producing "bursts" of output in synchronism with the control signal. Using a NAND gate instead of the NOR would cause the circuit to run when the gate was high instead of low.

One of the huge advantages of CMOS is the very high input impedance. As a consequence timing resistors can be very large — values in the hundred megohm region with capacitors of several microfarads can be a practical proposition.

Before we leave the astable multivibrator for a time we shall give one more circuit which corrects a tendency of all the preceding ones to "jitter" near the switching point. This requires an extra inverter and a fourth has been added as an output buffer. There are also two inhibit inputs which stop the circuit with the output high or low, depending on which is used. The theoretical diagram is shown in Fig 7. Another feature of this circuit, and indeed virtually all the others, is that the timing resistor may be substituted by one of the networks in Fig 8 to give a variable mark-space ratio. They work because the diodes effectively change the value of the timing resistor depending on whether the capacitor is charging or discharging, ratios as large as 5000:1 maybe used.

MONOSTABLE MULTIVIBRATORS

The basic CMOS monostable is shown in Fig. 9. It is triggered by the input pulse's leading edge and produces a positive going output pulse. The period may vary by more than ±50% with different devices due to the dependence of the circuit on the transfer voltage of the inverter.

The circuit in Fig. 10 operates in an interesting way. The quiescent state is with the first and second inverter outputs at "0" and "1" respectively.

The falling edge of the triggering pulse makes the first inverter go high, C2 charges through the diode up to VDD and the second inverter goes low thus initiating the output pulse. C1 recharges through R1 and crosses the transfer voltage of the first inverter which consequently goes low and is isolated from C2 by the now reverse-biased diode. Capacitor C2 then discharges through R2 and causes the second inverter to revert to its initial state, thus completing the output pulse. The advantage of all this is that inverters fabricated on the same chip have similar transfer voltages and if the two time constants (R1C1 and R2C2) are made identical, errors cancel out and the period becomes well defined. It is in fact approximately equal to 1.4R1C1 (= 1.4R2C2) and this circuit is capable of being retriggered during the output pulse.

Our last two monostables (Figs.11/12) are non-retriggerable and the two time constants should be made the same as in the previous circuit. Figure 12 is particularly interesting because the circuit isolates the trigger input during the output pulse as the charge on C2 holds one input to the NOR gate high, thus keeping the output low independently of the state of the trigger input.

FREQUENCY DOUBLER

The frequency doubler shown in Fig. 13 works by differentiating the leading and trailing edges of the waveform and applying the resulting pulses to the two inputs of a NAND gate. This produces a complete output pulse at both the rise and fall of the input signal. The values of the discrete components will depend on the desired frequency of operation.

THE 4007

The next device we are going to consider has no equivalent in other logic systems. It is described as a "dual complementary pair plus inverter" and its type number is 4007. It can perform several different functions and while we are discussing it we shall present a number of useful circuits and have the added advantage of learning a little about the internal operation of CMOS.

In CMOS there are two different types of field-effect transistors, namely n-channel and p-channel enhancement mode devices (see Fig. 14). What all this means is that when based in the conventional manner (drain positive in n-channel devices but negative in p-channel devices), the n-type turns on

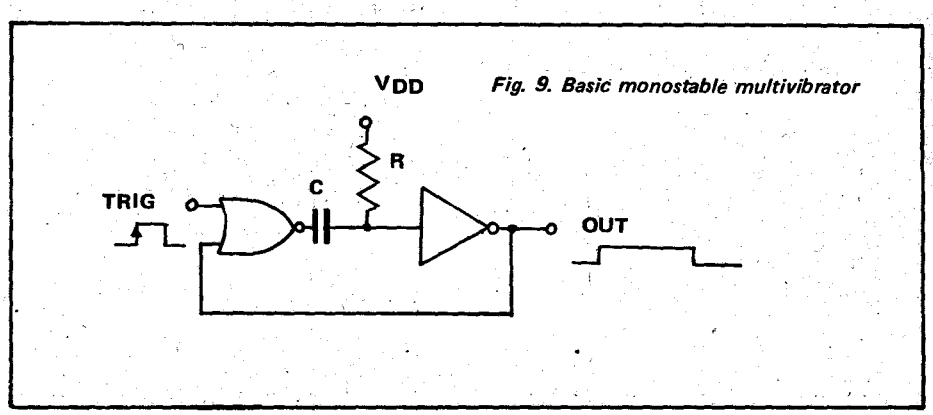

Fig. 9. Basic monostable multivibrator

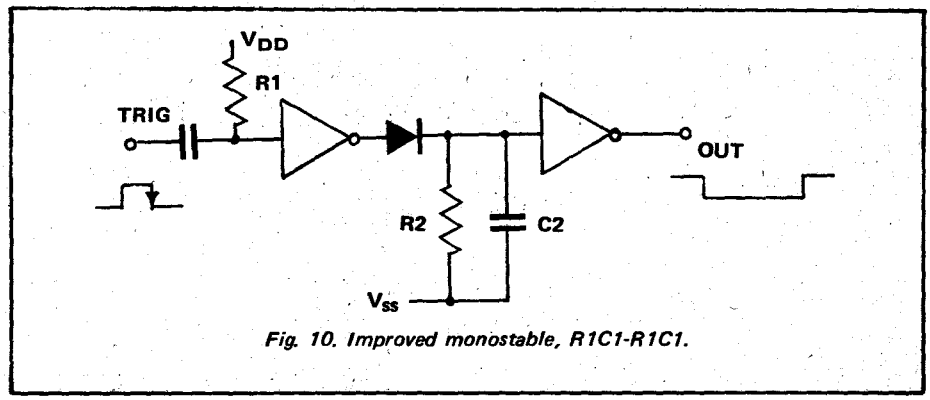

Fig. 10. Improved monostable, R1C1-R1C1.

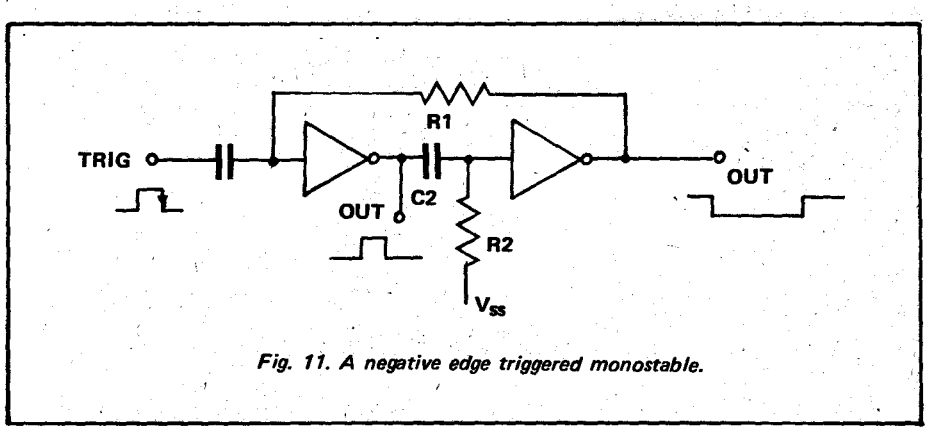

Fig. 11. A negative edge triggered monostable.

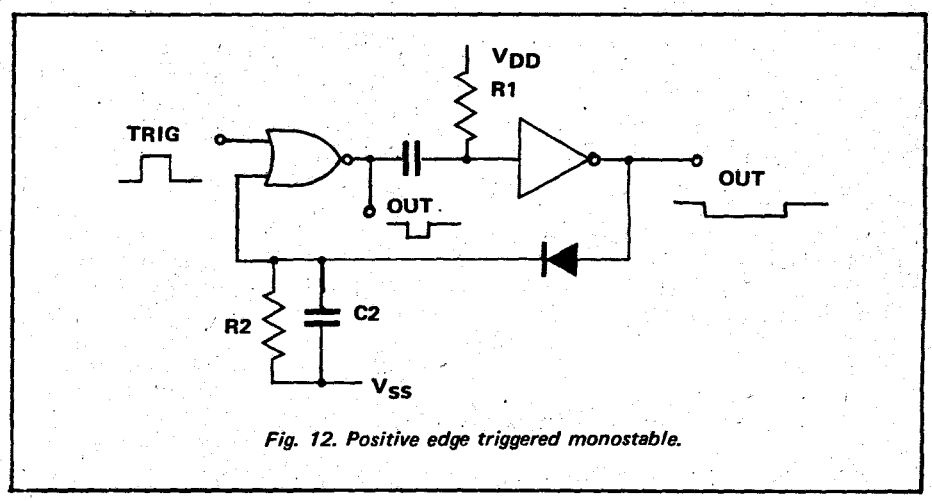

Fig. 12. Positive edge triggered monostable.

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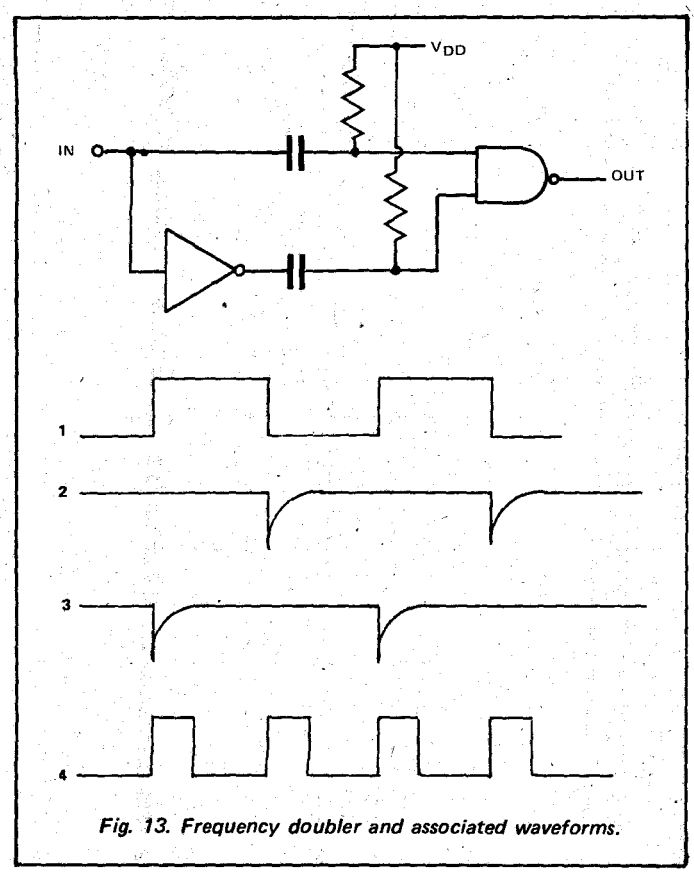


Fig. 13. Frequency doubler and associated waveforms.

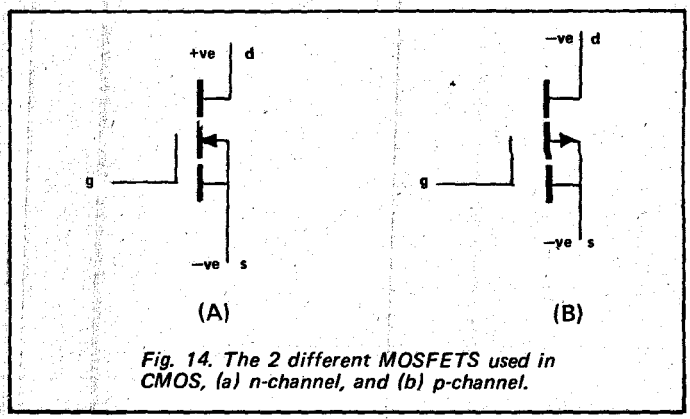


Fig. 14. The 2 different MOSFETS used in CMOS, (a) n-channel, and (b) p-channel.

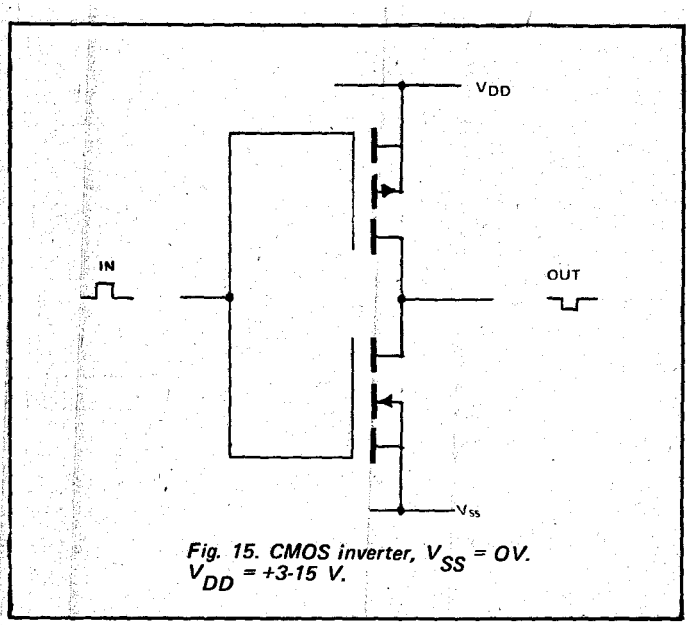


Fig. 15. CMOS inverter, V_{SS} = OV. V_{DD} = +3-15 V.

when the gate becomes sufficiently positive with respect to the source and the p-type when it is sufficiently negative. A "turned on" device may be considered to have a resistance of the order of 500 ohms – 1k between source and drain whereas the equivalent resistance when "off" is about $10^9\Omega$. The resistance at the gate is always very high ($> 10^{12}\Omega$) regardless of the state of the device.

The working of the CMOS inverter (Fig. 15) should now be fairly clear. When the input is "high" the bottom FET is turned on and the top one off. Thus the output voltage is held very low. When the input is low the FETs reverse roles and the output is high. Now look at Fig. 16 which shows the internal circuitry of the 4007. You should be able to see how joining a few pins together will allow three separate inverters to be produced. Reference to Fig. 17 will reveal how several other gates may be produced and their mode of operation should be relatively easy to discern.

TRANSMISSION GATES

There is another way of connecting two FETS which produces a result unique to CMOS. This is the transmission gate (Fig. 18). Here, due to the inverter, both FETS are either on or off simultaneously. When they are on, the path between input and output (they are interchangeable) may be regarded as a resistor of about 500 ohms – 1kΩ whereas when they are off the equivalent value is about 1000 MΩ.

Thus the device behaves as a switch capable of passing analogue signals with very little distortion provided that the load resistance is fairly high ($\approx$ 100 kΩ). We shall have more to say about these "bilateral switches" later but while we are dealing with the 4007 Fig. 19 shows how to connect one as a single pole-double throw switch which will pass analogue signals in both directions.

Any of the three or less inverter circuits we have mentioned to date may be realised with a 4007, as may several more interesting designs. Figure 22 shows a linear frequency-to-voltage converter which works by charging a capacitor once for every input cycle, the charge to do so being passed by a MOSFET into a summing amplifier. The component values given are based on an approximate five volt output for the given frequency. The resistor R1 should be made a 100 kΩ preset if it is required to set a range exactly. The capacitor C2 "smooths" the output and need not be changed from 10μF if fast response on the upper ranges is not needed. The linearity achieved on the top range will depend on the particular "741" used and if reliable operation is required higher speed op-amp should be used.

Figure 21 shows an alternative monostable multivibrator. We have already given a number of multivibrator circuits and so we shall say nothing more about this one except that it has an extremely small power consumption. This is due to the feedback connection (pins 12-6) which turns off the n-channel MOSFET during the discharge of the time constant. This circuit is also

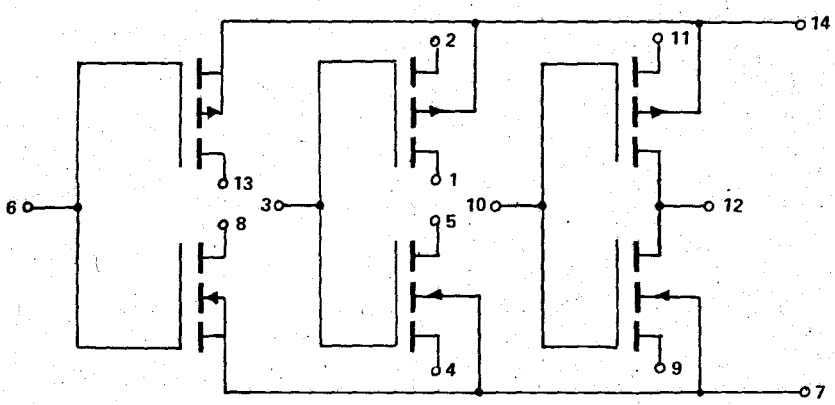


Fig. 16. The internal circuitry of the 4007 dual complementary pair plus inverter.

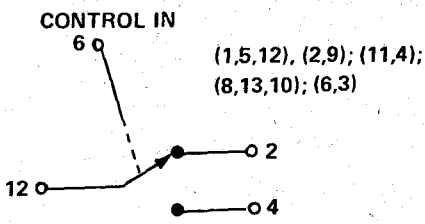
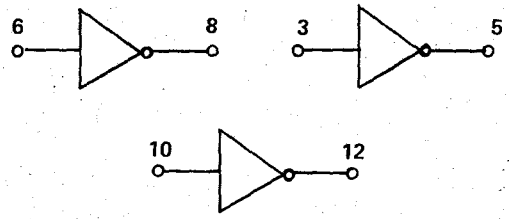


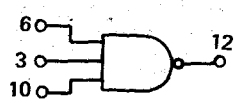
Fig. 18. The transmission gate.

TRIPLE INVERTERS



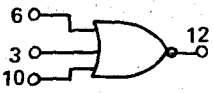
(14,2,11); (8,13); (7,4,9), (1,5)

THREE I/P NAND



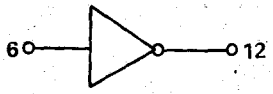
(1,12,13); (4,8); (2,14,11); (5,9)

THREE I/P NOR



(13,2); (12,5,8); (1,11); (7,4,9)

CURRENT DRIVER



(13,8,1,5,12); (6,3,10); (14,2,11); (7,4,9)

Fig. 17. Some uses of the 4007; pins bracketed should be connected together.
V_{DD} (pin 14) V_{SS} (pin 7)

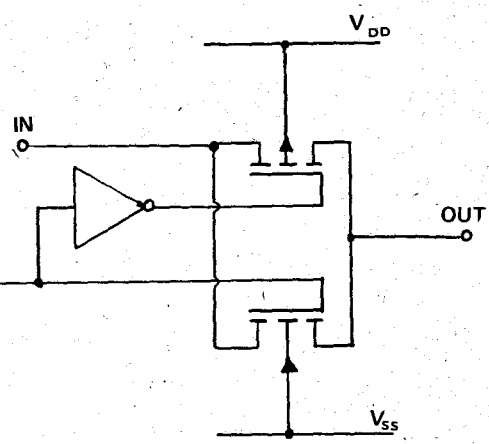
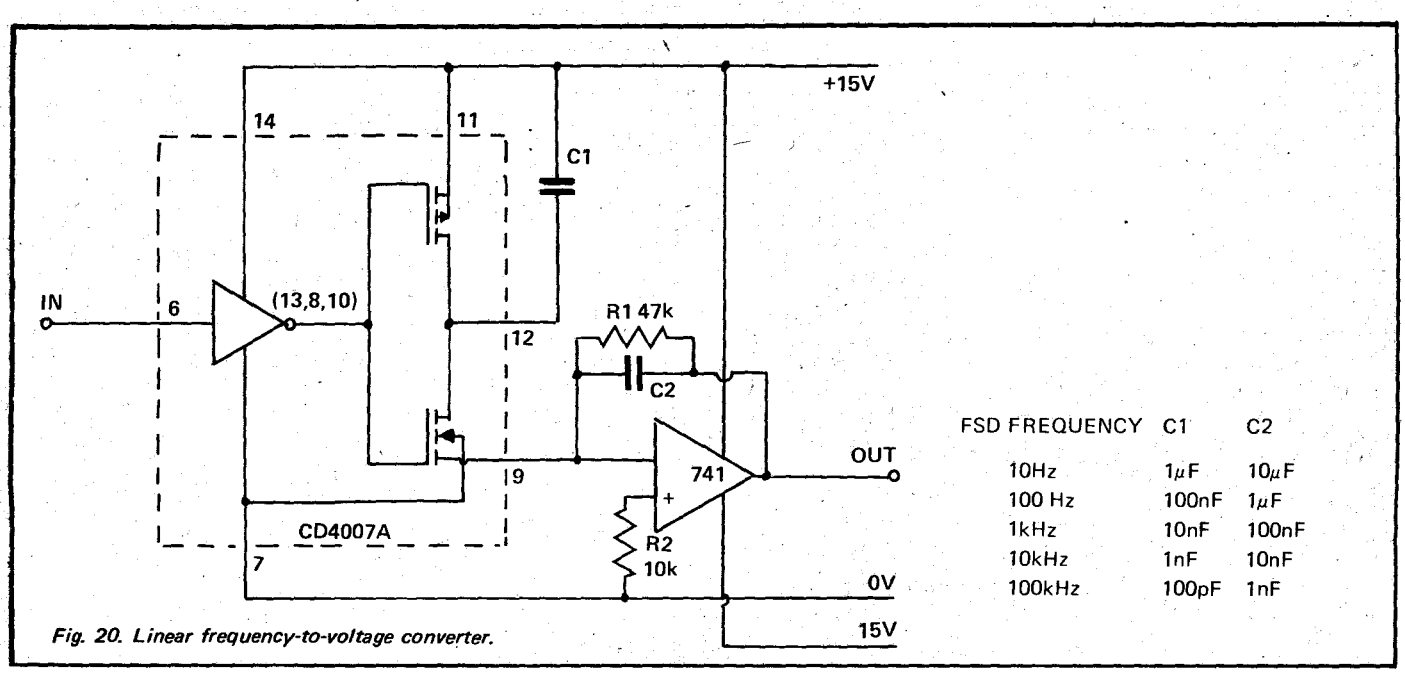


Fig. 19. An SPDT Electronic switch which could be used for multiplexing.



FSD FREQUENCY	C1	C2
10Hz	1μF	10μF
100 Hz	100nF	1μF
1kHz	10nF	100nF
10kHz	1nF	10nF
100kHz	100pF	1nF

Fig. 20. Linear frequency-to-voltage converter.

CMOS - a practical guide

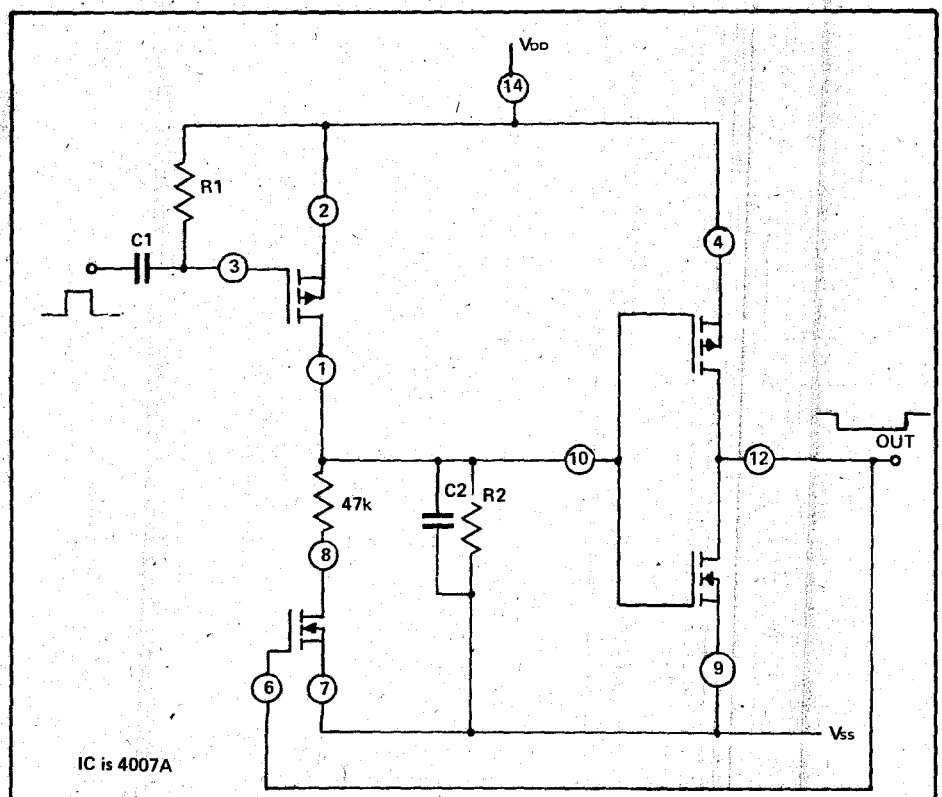


Fig. 21. Low power monostable, for stability R2=3R1C1.

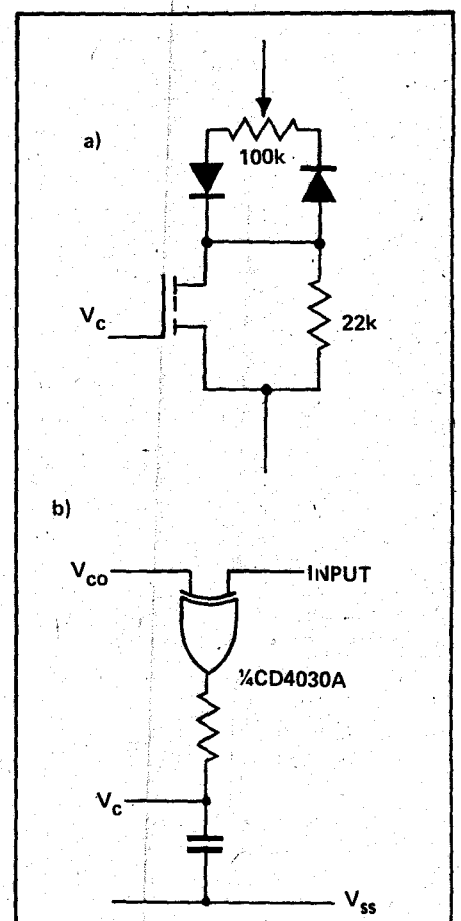


Fig. 24. (a) Adjustable M–S ratio narrow range controller, (b) Exclusive–OR phase comparator.

an interesting demonstration of the use of components in the 4007 as discrete transistors.

A WIDE RANGE VCO

The voltage controlled oscillator shown in Fig. 24 uses two inverters as well as a separate transistor as a voltage controlled resistor. The inverters function as an astable multivibrator in the manner of Fig. 4 but the timing resistance is the parallel combination of R_T and the FET. As V_c varies between V_{dd} and V_{ss} so the resistance of the FET varies between about 1 k and 1000 MΩ. If the upper value is limited to 10 M Ω by making R_t that value, then the circuit will sweep over a 10000:1 range in frequency. There

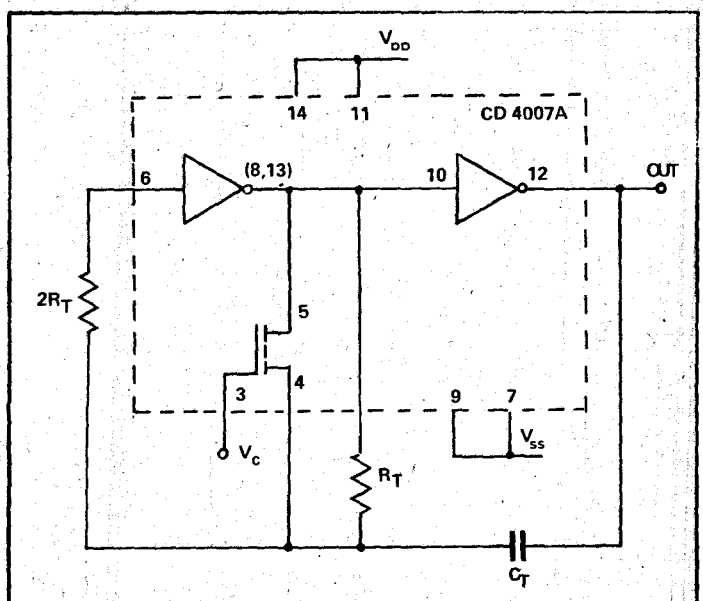


Fig. 22. A voltage controlled oscillator using the 4007 IC.

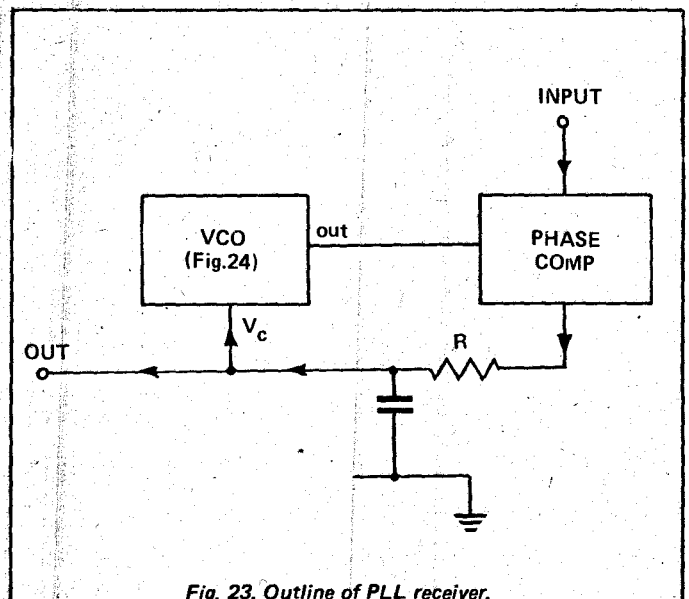
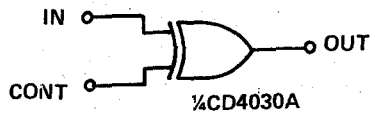


Fig. 23. Outline of PLL receiver.



IN-1	IN-2	OUT
0	0	0
0	1	1
1	0	1
1	1	0

Fig. 25. Exclusive–OR gate used as a conditional inverter together with the device's truth table.

would seem to be scope here for experimenting with a pulse frequency modulation communications system. One might produce an analogue system although distortion would probably be high due to mismatching. The transmitter could be the circuit in Fig. 22 and the receiver a phase locked loop along similar lines (Fig. 23) using some sort of phase comparator and a low-pass R-C filter.

EXCLUSIVE-OR GATES

Exclusive-or gates, for example the 4030 (see Fig. 2), will function as phase comparators but they require a unity mark-space ratio to be effective. Perhaps a voltage controlled oscillator might be designed with a narrower range along the lines of Fig. 24 for both transmitter and receiver, together with a phase comparator and low pass filter as shown in Fig. 24. While we are on the subject of the exclusive-or function we shall consider two more uses of these devices. Figure 25 shows the exclusive-or truth table and its use as a conditional inverter. This configuration causes the input signal to be inverted when the control input is high but not when it is low.

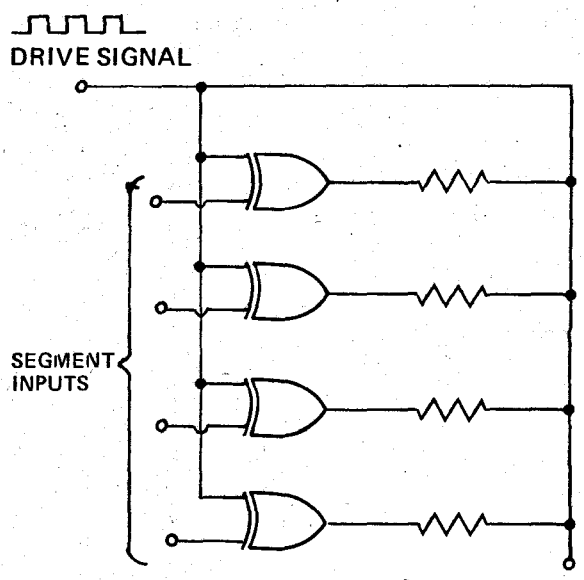


Fig. 26. Exclusive–OR gates driving liquid crystals segments, represented by resistors.

Liquid crystal displays are undoubtedly the readout devices of the future but they last longer in general if ac drive is used. If then a square wave is applied to one end of a liquid crystal segment and also to the other connection via a conditional inverter (see Fig. 26) then the control input will decide whether or not there is a net voltage across the segment.

CMOS and liquid crystal make an ideal combination for ultra-low power logic and display systems and so manufacturers have produced BCD-to-seven-segment decoders and drivers specifically for this application.

Their type numbers are 4054/5/6, the variations being due to the addition of latches and other refinements. These devices have too limited an appeal to justify a full description here.

Continued next month.

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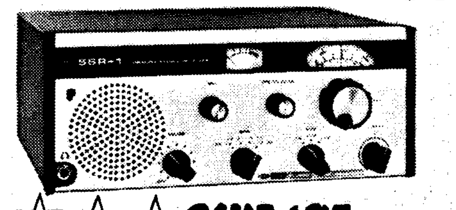

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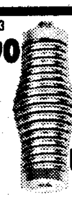

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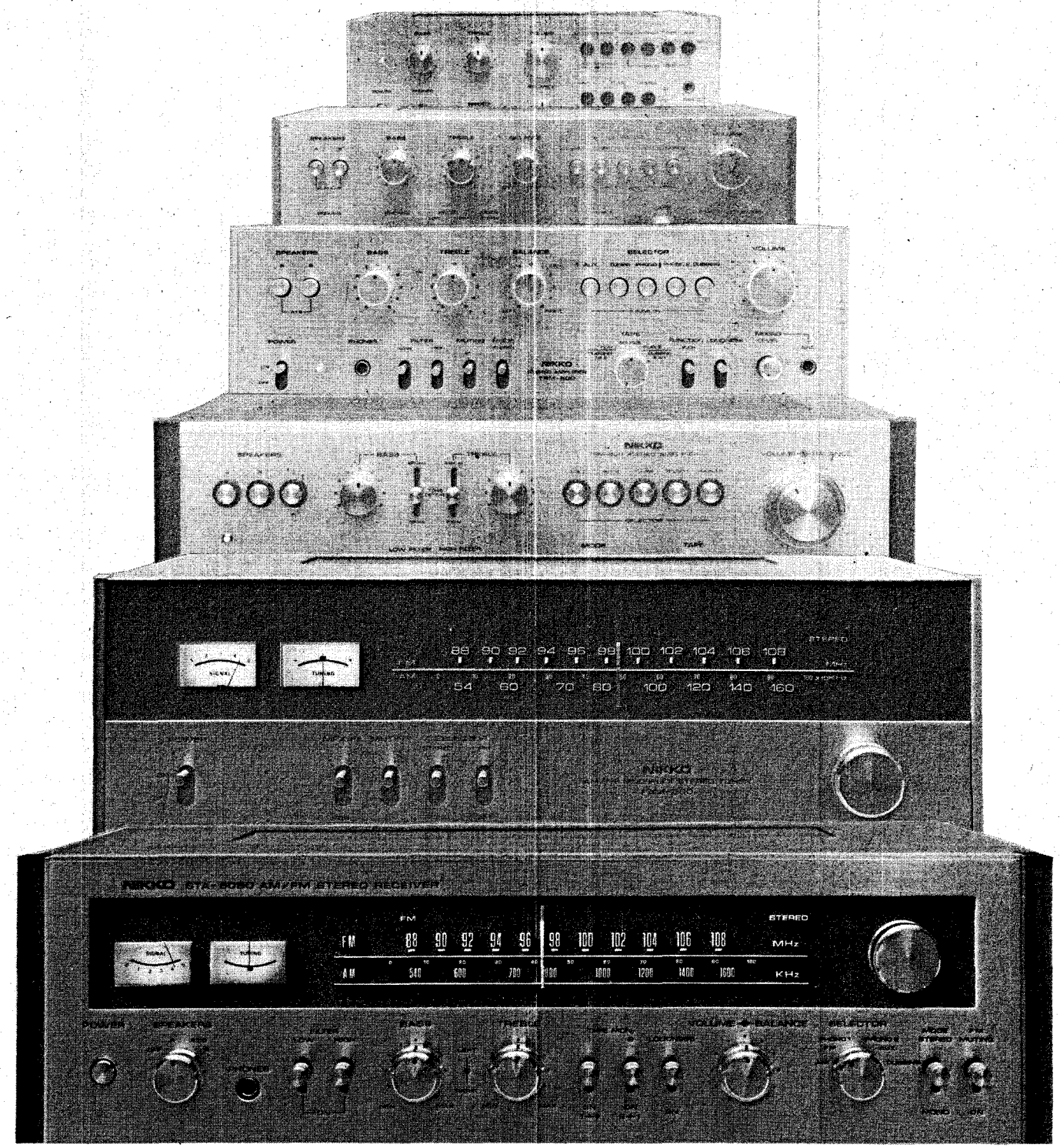

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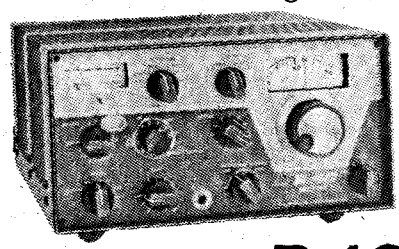

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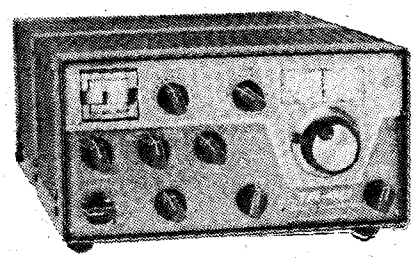

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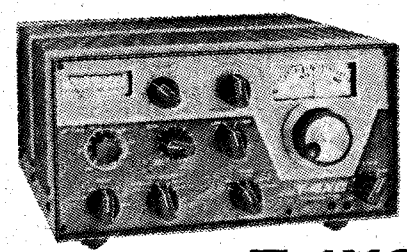

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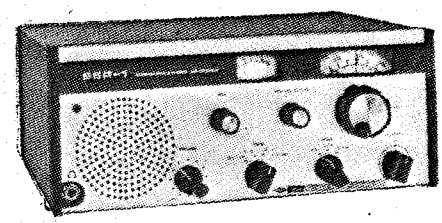
• **Covers ham bands** 80, 40, 20, 15 meters completely and 28.5 to 29.0 MHz of 10 meters with crystals furnished; MARS and other frequencies with accessory crystals, except 2.3-3, 5-6, 10.5-12 MHz. • **Upper and Lower Sideband** on all frequencies • **Automatic Transmit Receive Switching on CW** (semi break-in) • **Controlled Carrier Modulation for AM** is completely compatible with SSB linear amplifiers • **VOX or PTT** on SSB and AM built-in • **Separate VOX Delay Controls** for SSB/AM and CW • **Adjustable Pi-Network Output** • **Two 8-pole Crystal-Lattice Filters** for sideband selection, 2.4 kHz bandwidth • **Transmitting AGC** prevents flat topping • **Shaped Grid Block Keying** with side tone output • **200 Watts PEP Input on SSB**—200 watts input CW • **Meter indicates plate current and relative output** • **Compact size; rugged construction** • **Solid State Permeability Tuned VFO** with 1 kHz dial divisions • **Solid State HF Crystal Oscillator** • **Dimensions:** 5½"H, 10¾"W, 12¼"D (14.0 x 27.3 x 31.1 cm). **Wt.:** 14 lbs. (6.4 kg).



SSR-1 COMMUNICATIONS RECEIVER $290

• Synthesized • General Coverage • Low Cost • All Solid State • Built-in AC Power Supply • Selectable Sidebands • Excellent Performance

PRELIMINARY SPECIFICATIONS: • **Coverage:** 500 kHz to 30 MHz • **Frequency** can be read accurately to better than 5 kHz • **Sensitivity** typically 0.5 microvolts for 10 dB S + N/N SSB and better than 2 microvolts for 10 dB S + N/N AM • **Selectable sidebands** • **Built-in power supply:** 117/234 VAC ± 20% • **If the AC power source fails** the unit switches automatically to an infernal battery pack which uses eight D-cells (not supplied) • **For reduced current drain** on DC operation the dials do not light up unless a red pushbutton on the front panel is depressed.

The performance, versatility, size and low cost of the SSR-1 make it ideal for use as a stand-by amateur or novice-amateur receiver, short wave receiver, CB monitor receiver, or general purpose laboratory receiver.

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Variable capacitors

Our series on passive components has already presented valuable reference data on fixed capacitors. In this part we look at the range of variable capacitors available and where to use them.

VARIABLE CAPACITORS CAN BE divided into two basic groups: continuously variable types, generally called tuning capacitors, and preset types, generally called trimmers.

Tuning capacitors have a set of fixed plates and a set of moving plates that mesh with the fixed plates. The position of the moving plates with respect to the fixed plates determines the capacitance. Capacitance is maximum when the plates are fully meshed. The dielectric may be air, mica or plastic film. Various tuning capacitors are shown in Fig. 1. Most tuning capacitors have air as the dielectric. Miniature tuning capacitors such as those used in portable transistor radios, have a plastic film dielectric. As this has a greater permittivity than air, a considerable reduction in size is achieved. Precision tuning capacitors such as those used in instruments and communications receivers have precision ball-race bearings at each end of the shaft and a heavy, rigid frame to provide stability and reset accuracy.

Tuning capacitors are available in various sizes and values for different applications. Those for receiver applications generally have small, closely-spaced plates, several units being "ganged" together in one frame so that several circuits may be tuned simultaneously. Two and three gang capacitors are quite common. The plates are often semi-circular or specially shaped to produce the desired tuning scale or "law". This is done to obtain linear or logarithmic dial calibrations for example.

There are four basic tuning characteristics.

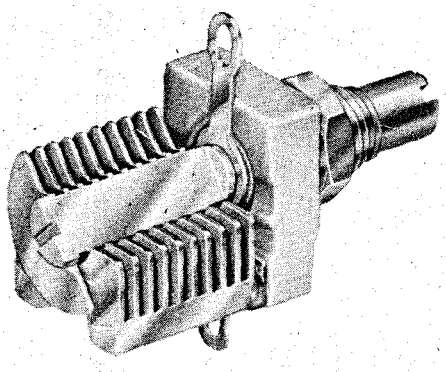
Linear Capacitance For each degree of rotation there is an equal change in capacitance. For example, a capacitor may change by 2 pF for each degree of rotation. This produces a square-law dial scale.

Linear Frequency Each degree of rotation causes an equal change in frequency. This produces a linear dial scale. This characterisation is very useful in tuners and communication receivers.

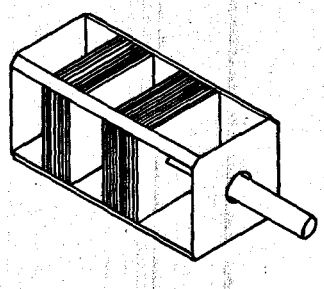
Log Frequency Each degree of rotation produces a constant percentage change in frequency, e.g. a 1% change in frequency for each degree of rotation. This produces a logarithmic dial scale which is sometimes seen on AM tuners and broadcast receivers. It is often used in measuring instruments and signal generators.

Square Law The variation in capacitance is proportional to the square of the angle of rotation. This is also used in measuring instruments. Typical dial calibrations and capacitor tuning law curves are shown in Fig. 2.

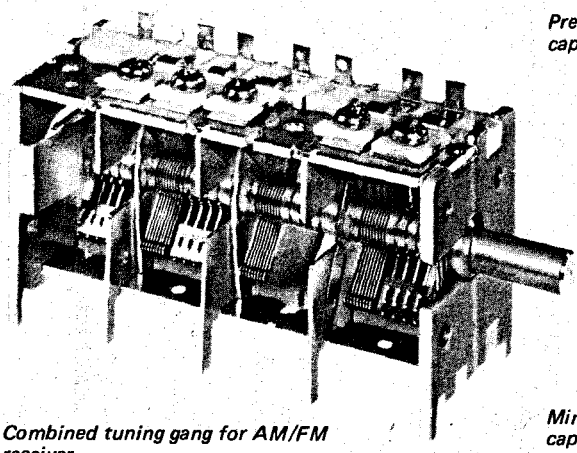
Multiple-gang capacitors are commonly used in superhet receivers, particularly AM and FM broadcast receivers, where the RF, mixer and



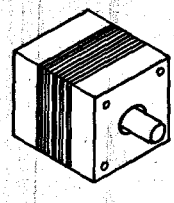
Low capacitance, single section air dielectric variable capacitor.



Precision, high stability, tuning capacitor.



Combined tuning gang for AM/FM receiver.



Miniature, film dielectric tuning capacitor from portable transistor receiver.

Fig 1. Different types of variable capacitor used where the circuit requires continual readjustment.

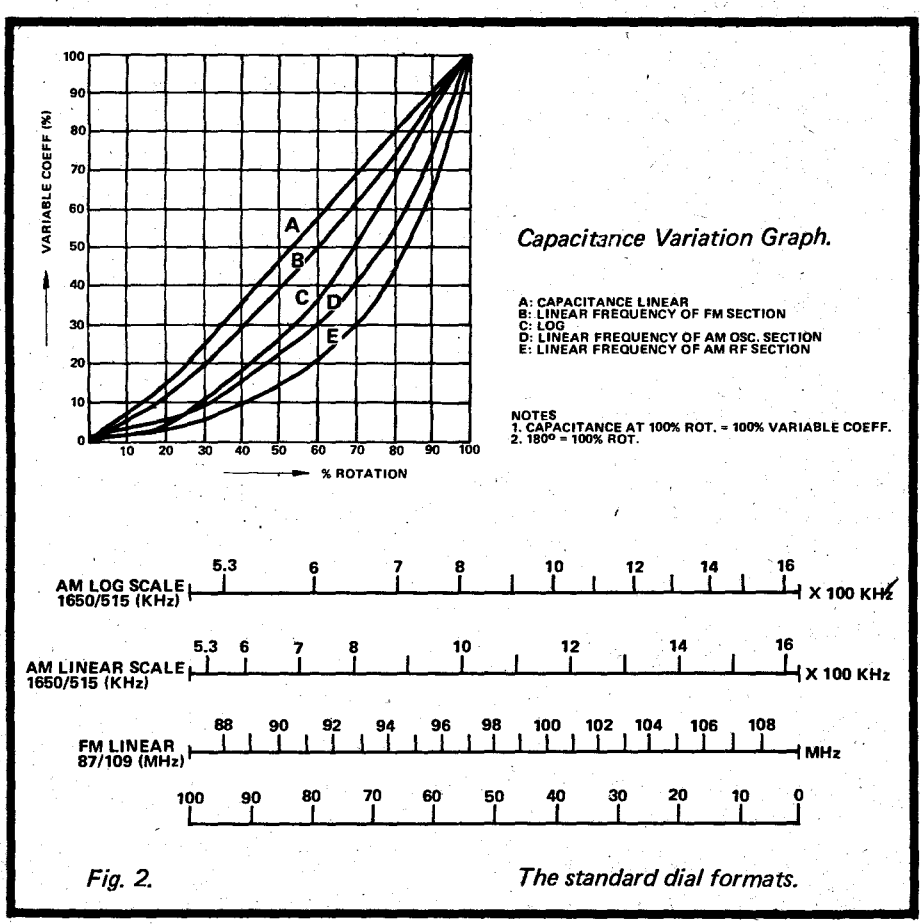


Fig. 2. *The standard dial formats.*

oscillator circuits are ganged to tune a range of frequencies. Usually, each section of a gang covers the same capacitance range and has the same tuning law. As the oscillator circuit covers a different frequency range from the RF and mixer, one section of a gang may have less plates and thus a different capacitance range or a slightly different tuning law. This is done so that the oscillator can correctly "track" the RF and mixer circuit with an almost constant frequency difference (the intermediate frequency).

Maximum and minimum capacitance values used for tuning the AM broadcast band and in general coverage HF receivers are:—

3 – 120 pF
10 – 240 pF
4 – 250 pF
6 – 340 pF
10 – 365 pF
11 – 415 pF

For the 88-108 MHz FM broadcast band, common values are:—

0.9 – 19 pF
1 – 22 pF
2 – 32 pF
7 – 40 pF

Some gangs may have each section fitted with trimmers so that the effect of stray capacitance may be compensated for and to provide alignment for the high frequency end of the tuning range.

Tuning capacitors for use in transmitters usually have large, widely-spaced plates to withstand high voltages, and special connections to reduce inductance and to conduct high RF currents. Semi-circular plates are commonly used. For push-pull tuned circuits, requiring two sets of fixed plates and common moving plates, 'butterfly' capacitors are used. See Fig. 3. The construction permits 90° rotation only. 'Split-Stator' capacitors are also used in this application: these have two sets of semi-circular rotor plates on opposite sides of a common shaft and two sets of stator plates with separate connections. These turn a full 180°.

TRIMMERS

Trimming capacitors are available in a wide variety of constructions and adjustment methods. The most common dielectrics are air, mica and ceramic, although glass and quartz are also used for their superior temperature stability. A representative selection is illustrated in Fig. 3.

Vane Trimmers These trimmers have solid metal plates that may be silver-soldered to a rigid frame or the plates and frame milled from a single piece of specially shaped metal. The latter have better mechanical and electrical stability. The capacitor assembly is usually fixed to a ceramic mounting plate. This type of trimmer is usually more costly than other types but has superior electrical characteristics. Vane trimmers are available in a wide variety of values and sizes, with breakdown voltage ratings from 100 V to 1500 V, depending on the air gap between the fixed and moving plates. Butterfly and split-stator types can also be obtained.

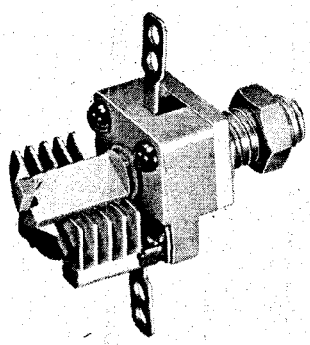
Concentric or 'Beehive' Trimmers The fixed and moving plates of these trimmers are constructed from short sections of different diameter aluminium cylinders, nested inside each other and mounted concentrically around a central shaft. The diameters of the moving plates are such that they mesh between the fixed plates with a small air gap. The central shaft is threaded and a hexagonal boss on top of the moving plates enables capacitance to be adjusted by using a simple plastic tool. These trimmers are cheap and have a wide variety of applications. They are made in several values, the most common being 3-30 pF and 5-60 pF. Their breakdown voltage is usually above 250 V, although it is not *recommended* that they be operated at high voltages. The threaded centre shaft imparts a vernier action which makes adjustment easy and accurate.

Compression Trimmers These consist of several thin plates of springy metal interleaved with a mica or plastic film dielectric. An insulated screw is passed through the centre of the plates and threaded into a phenolic, plastic or ceramic mounting compressing the springy plates. The further the screw is turned in, the more compression is applied to the plates, thus increasing the capacitance. Trimmers of this type are usually quite inexpensive. Their stability is not very good but is nevertheless adequate for many applications, but they drift appreciably with time necessitating frequent realignment.

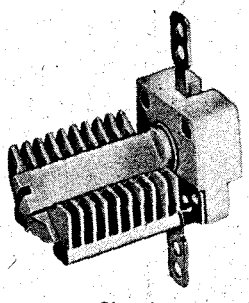
Mica compression trimmers are generally constructed on a ceramic mount. They have the best characteristics of all the compression trimmers and find application in solid state transmitters as they can withstand appreciable RF currents. Some types are manufactured especially for this application. The other styles having a phenolic or plastic mount are used mostly in receiver or non-critical instrument applications.

Compression trimmers are capable of quite a wide adjustment range — an advantage over other trimmers, although the adjustment may be coarse and quite

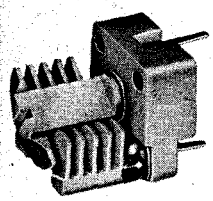
Variable capacitors



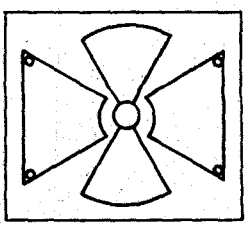
Panel mounted



Chassis mounted



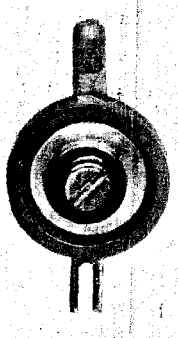
PC mounted



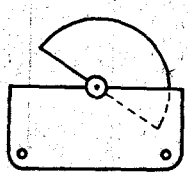
Butterfly style

VANE TRIMMERS

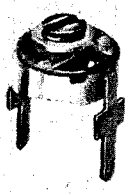
The concentric or 'Beehive' trimmer



A compression trimmer

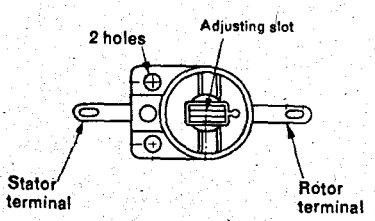


Plastic film trimmer

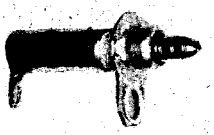


PC mount styles

Chassis mount style

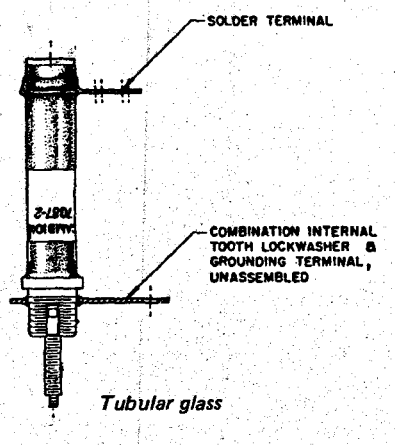


CERAMIC TRIMMERS



Tubular ceramic

Tubular teflon



Tubular glass

TUBULAR TRIMMERS

Fig. 3. Different types of trimmers. These are used when the circuit requires adjustment in setting-up but not in everyday use.

non-linear. Typical minimum and maximum values are:—

2 – 25 pF
3 – 30 pF
2.5 – 40 pF
3 – 55 pF
10 – 80 pF
30 – 150 pF
20 – 220 pF

Compression trimmers have a large, and not really predictable temperature co-efficient that varies appreciably over their range. Their breakdown voltage is in the order of 100 V to 300 V.

Plastic Film Trimmers. These are constructed in a way similar to vane trimmers and generally have semi-circular fixed and moving plates with a plastic film dielectric. Consequently they are smaller in size for similar values. These trimmers are relatively inexpensive and are a good alternative to air dielectric trimmers. They generally have a negative temperature coefficient of about 200 ppm/°C (decrease capacitance with increasing temperature). They are generally manufactured for p.c. board mounting although chassis-mounting styles are available. Typical minimum and maximum values are:—

1 – 5 pF
1.8 – 10 pF
2 – 18 pF
1.5 – 20 pF
4 – 40 pF
5 – 60 pF
7 – 100 pF

Film dielectric trimmers generally have a breakdown voltage of 100 V.

Ceramic Trimmers. These consist of a ceramic body with a semi-circular metal film deposited on it as the fixed plate. The moving plate is a ceramic disc with a semi-circular film (the same size as the fixed plate) deposited on it, and pivoted over the fixed plate by a metal screw which is soldered to the metal film. The screw passes through a nut in the ceramic body, the moving plate connection being made to this nut.

Ceramic trimmers are available having a variety of temperature characteristics ranging from P 100 to N 500, the more common values having negative temperature coefficients. Typical maximum and minimum values and temperature coefficients are:—

2 – 4 pF/P100
3 – 9 pF/N033 or N075*
3 – 12 pF/N 470
4 – 20 pF/N 470 or N 750*
7 – 35 pF/N 1500
10 – 60 pF/N 1500

* Characteristic depends on size, the subminiature ones having the smaller coefficient. Ceramic trimmers are obtainable in pc board or chassis mounting styles and may be operated at voltages of at least 200 V or greater.

Tubular Trimmers. Tubular trimmers are also known as 'piston' trimmers. They consist of a tube of dielectric material which has a metal band or metal film around one end forming the fixed plate and a threaded metal cap on the other, through which passes a screw; this latter assembly forms the moving plate. The dielectric material may be ceramic, glass, PTFE (Teflon), polypropylene or quartz. Tubular trimmers are very stable but are used only in VHF/UHF receiver applications (i.e. TV tuners, VHF converters as their particular construction limits the maximum capacitance obtainable. However, ceramic, glass and quartz types can withstand considerable RF currents and voltages, so find some applications in transmitters. Typical working voltages are 250 Vdc to 600 Vdc. Tubular trimmers with a plastic dielectric are generally cheapest, the more costly styles being ceramic, glass and quartz. Typical maximum and minimum values are:—

0.25 – 1.5 pF
0.7 – 3 pF
0.8 – 8.5 pF
1.8 – 10 pF
0.8 – 12 pF
0.8 – 23 pF
0.8 – 38 pF
2 – 60 pF

Both printed circuit and chassis mounting styles are available.

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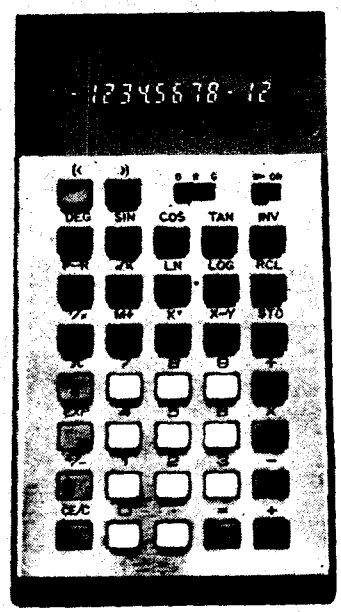

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LC-21F	12.00	21.00	3	*Large green 8-digit display *Chain operation *Memory *Square root *Constant operation *Fully floating decimal point *Percentage calculation
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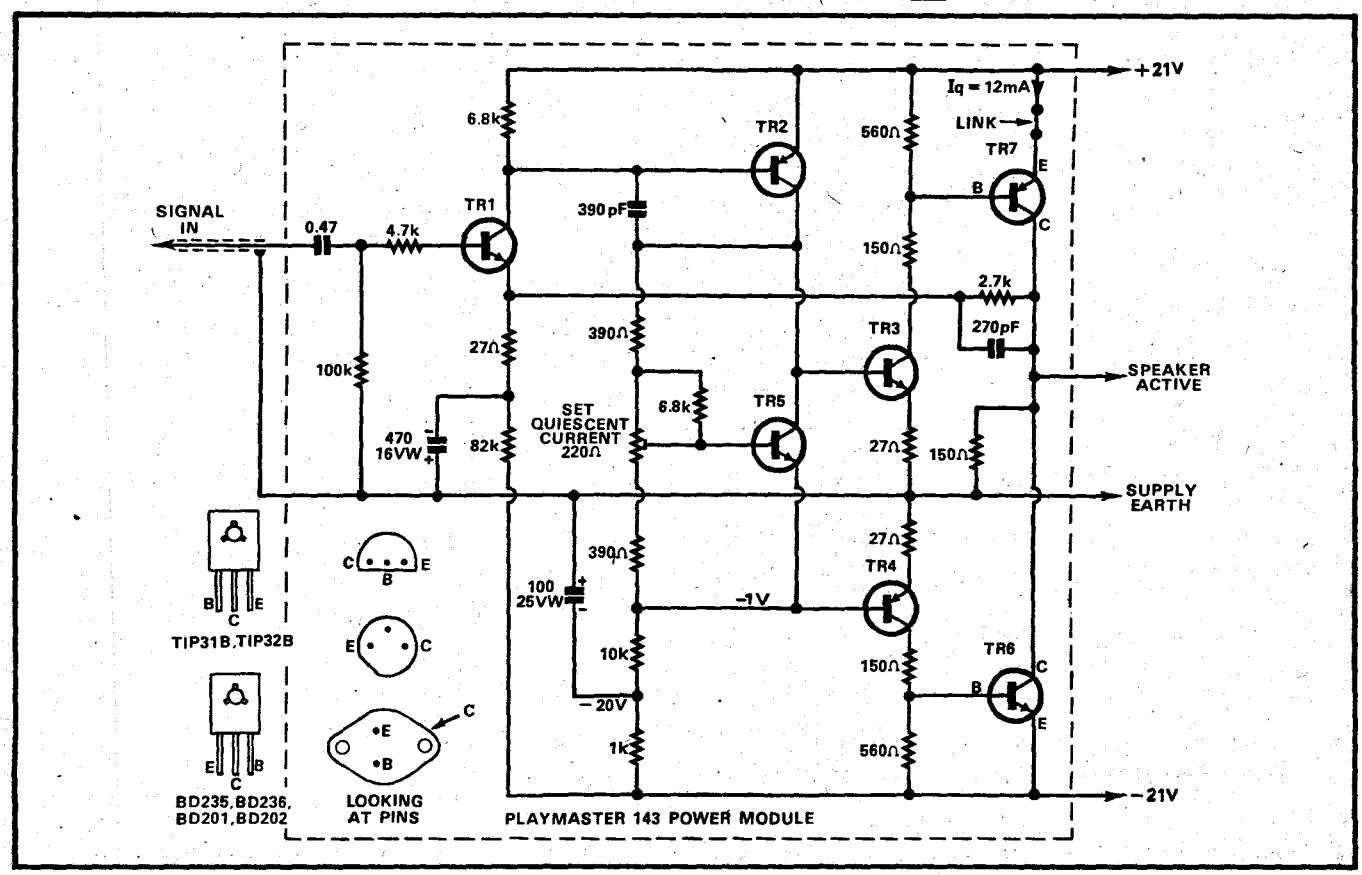

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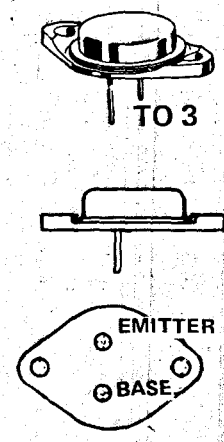
ETI data sheet

2N3055 npn silicon power transistor

The 2N3055 and it usual pnp complement, MJ2955, are popular high-power transistors in metal packages. The 2955 is dealt with in an accompanying data sheet.

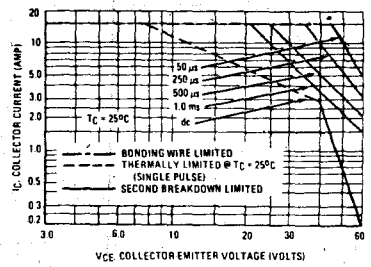
Motorola and Texas Instruments manufacture plastic encapsulated versions of this pair with the following type numbers: MJE3055/MJE2955, and TIP3055/TIP2955, respectively. The plastic types cannot handle the same collector currents as the metal types; see the graphs of the safe operating areas. The total device power dissipation of the pnp types is: 115 W (2N3055), and 90 W (MJE3055 and TIP3055). Recent ETI projects using this transistor include: — ETI 240 Emergency flash, — ETI 541 Train controller, — ETI 780 Novice transmitter, — ETI 131 General purpose power supply.

2N3055 package

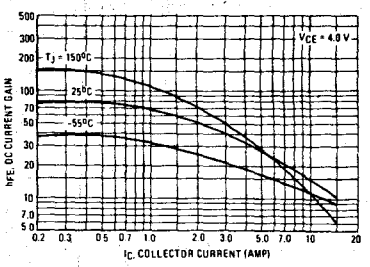


COLLECTOR connected to mounting base

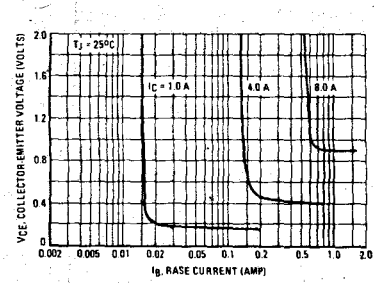
2N3055 safe operating area



2N3055 DC current gain



2N3055 Collector saturation region



QUICK REFERENCE DATA
2N3055

Maximum ratings		
Collector-emitter voltage (V_{CEO})		60 V
Collector-emitter voltage (V_{CER})		70 V
Collector-base voltage (V_{CB})		100 V
Emitter-base voltage (V_{EB})		7 V
Collector current (continuous) (I_C)		15 A
Power dissipation (P_D)		115 W
Off characteristics		
Collector-emitter sustaining voltage (I_C = 0.2 A, I_B = 0)	V_{CEO} (sus)	min. 60 V
Collector-emitter sustaining voltage (I_C = 0.2 A, R_{BE} = 100 ohms)	V_{CER} (sus)	min. 70 V
Collector cut-off current (V_{CE} = 30 V, I_B = 0)	I_{CEO}	max. 0.7 mA
Emitter cut-off current (V_{BE} = 7 V, I_C = 0)	I_{EBO}	max. 5 mA
On Characteristics		
DC current gain	h_{FE}	
(I_C = 4 A, V_{CE} = 4 V)		min. 20; max. 70
(I_C = 10 A, V_{CE} = 4 V)		min. 5
Collector-emitter saturation voltage	V_{CE} (sat)	
(I_C = 4 A, I_B = 0.4 A)		max. 1.1 V
(I_C = 10 A, I_B = 3.3 A)		max. 3 V
Base-emitter on voltage (I_C = 4 A, V_{CE} = 4 V)	V_{BE} (on)	max. 1.5 V
Second breakdown collector current with base forward biased (t ≠ 1 s, V_{CE} = 40 V)	$I_{S/b}$	min. 2.87 A
Dynamic Characteristics		
Current gain – bandwidth product (I_C = 1 A, V_{CE} = 4 V, f_{test} = 1 MHz)	f_T	min. 2.5 MHz
Small-signal current gain (I_C = 1A, V_{CE} = 4 V, f = 1 kHz)	h_{fe}	min. 15 max. 120

Safe operation

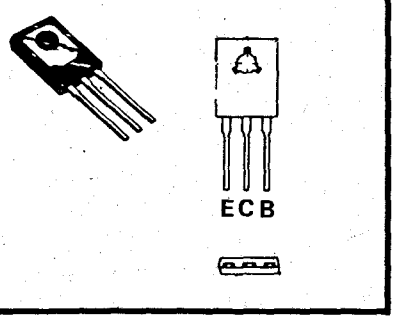
For the three types we have mentioned in this data sheet we have printed the most important graph of a transistor's operating characteristics: the active-region safe operating area graph. These graphs show the different limits on use of the plastic and metal types, and the experimenter ought to be familiar with their interpretation.

There are two limitations on the power handling ability of a transistor: average junction temperature and second breakdown. Safe operating area curves indicate IC — VCE limits of the transistor that must be observed for reliable operation, i.e., the transistor must not be subjected to greater dissipation than the curves indicate.

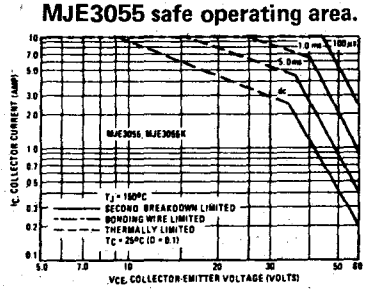
Second breakdown pulse limits are valid for duty cycles to 10%. At high case temperatures, thermal limitations may reduce the power that can be handled to values less than the limitations imposed by second breakdown.

NOTE Beware using transistors with these type numbers followed by suffix 1 or suffix 2. These are low voltage rejects and it is important to establish their limits before using them in power circuits.

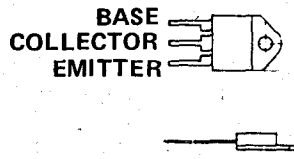
MJE3055



MJE3055 safe operating area.

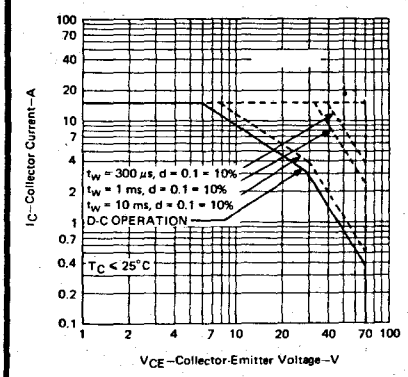


TIP3055



The collector is in electrical contact with the mounting tab

TIP3055 safe operating area



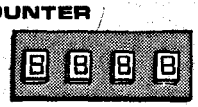
SCIENTIFIC KITS

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

4-DIGIT DECADE COUNTER



- 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 .25" displays) $23.95
Kit 012B (with .50" displays) $27.95

5V REG. POWER SUPPLY

- 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 (excluding transformer) $5.95

DIGITAL VOLTMETER

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

Kit 017 . . . . . $17.95

FREQUENCY COUNTER

Features FET input front end with trigger circuit for measuring complex waveforms. Measures from 0.1 Hz to 35 Mhz when used with kit 014.

Kit 016 . . . . . $16.50

LINE TIME BASE

50 Hz or 60 Hz chain time base using line (mains) frequency as reference. Outputs: 10 Hz – 1 Hz – 0.1 Hz. Accuracy: 0.1% – 0.05%.

Kit 015 . . . . . $ 9.75

R.P.M. COUNTER

Counts from 1 to 100,000 RPM.

Kit 020 . . . . . $ 8.95

1 MHZ CRYSTAL TIME BASE

Crystal time base divider. Output 1 Mhz – 100 Khz – 10 Khz – 1 Khz – 100 Hz – 10 Hz – 1 Hz – 0.1 Hz. Accuracy better than .005% with proper adjustment.

Kit 014 . . . . . $14.95

MORE TO COME . . .

Watch future issues for further announcements.

NEW! GIANT 0.8" READOUT

The latest giant size readout by Fairchild. Surpasses all other jumbo LEDs available today. Available in both, Common Anode and Common Cathode. Fits standard DIP sockets with 0.6" pin row. RH decimal. Typical forward current of only 10mA/segment. Forward voltage: 1.7V (typ.). Supplied with data.

FND 800 Common Cathode $4.75
FND 807 Common Anode $4.75

LED'S

Mini red 13
Mini green 15
Jumbo red 16
Jumbo green 20
Jumbo yellow 25

New .5 in. display by Fairchild. Common Cathode.

FND503
$1.80
5/$7.50

TI

TEXAS INSTRUMENTS 6 DIGIT DISPLAY.

Fully multiplexed, Common Cathode by Texas Instruments. Goldplated. Ideal for a mini 6-digit clock or stopwatch.

$1.30

DL33

If you like an array of displays, we have it. Common cathode.

$1.45

DL727

One of our best readouts .5 in. high, 20mA per segment. Common anode.

$3.75

HP7730

.33 in. high red very bright 25mA per seg. Common anode.

$1.20

SPECIAL OFFER

FND70

.25" high. Bright red. Common Cathode type by Fairchild.

85c ea.
5/$3.95

THE KING

INTRODUCING TANYA

(60 Hz. Crystal Time Base)

ADDITIONAL FEATURES:
1.) Low Power Consumption
2.) Directly Interfaces with King MOS Clock Chip.
3.) 60 Hz output with crystal time base accuracy
4.) Ideal for Cars, Boats, & Campers.

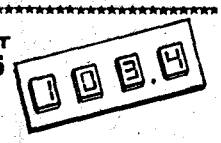
Kit includes All Components, P.C. Board, and Instructions for Interfacing with 'THE KING' 6-Digit Alarm Clock. **$6.95**

DELILA APPLIANCE STARTER $9.95

(Example) Set your alarm for 7: a.m., set timer for 15 min. At exactly 7: a.m., the appliance will start; at 7:15 your clock alarm will wake you.

Kit includes all components, PC Board and instructions for interfacing with THE KING 6-digit alarm clock. **Addition Number 2**

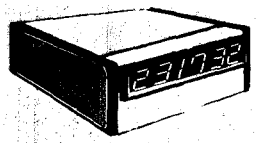
FATIMA 4-DIGIT TEMP. KIT $19.95



Features 4-digit temperature display; farenheit or centigrade; complete C-Mos application; uses 7002 4-digit counter.

Kit includes all components, PC Board and instructions for interfacing with THE KING 6-digit alarm clock. **Addition Number 1**

THE KING $23.50 6-DIGIT ALARM CLOCK



THE KING FEATURES:

1) 6 digit, 12 hr. 60 cycle or 24 hr. 50 cycle alarm clock.
2) Time sharing capability for display of additional information
3) Single 12v. supply and a minimum of interface components.
4) AM-PM and automatic power failure indications.
5) 10 minute snooze
6) Intensity control of LEDs.

Kit No. 70250-1R (Red readouts)
Kit No. 70250-1G (Green readouts) } 23.50
Kit No. 70250-1Y (Yellow readouts)
Kit No. 70250-2R (DL727 readouts) 27.50

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

LSI INTEGRATION IC chips with data

MM5314	-6 digit digital clock 24 pin dip w/spec.	$ 3.75
MM5316	-4-6 digit alarm clock 40 pin dip w/spec.	$ 4.25
7002	-4 digit counter/latch decoder; 7 segment and BCD outputs. 28 pin dip w/spec.	$12.50
7005	-4 digit counter/latch decoder; 7 segment output only .24 pin dip w/spec.	$ 9.50
7007	-4 digit counter/latch decoder with BCD output only. 16 pin dip w/spec.	$ 7.00
MK50250	4-6 digit alarm clock multiplexed 28 pin dip w/spec.	$5.50
MK50381	4 digit non-multipled radio alarm clock featuring direct drive display output. 40 pin dip w/spec.	$7.95
PC Board for MK50250		$4.25
PC Board for MK50381		$3.75
7020	6 function calculator chip with direct segment drive. 8 digit	$2.25
TDA2020	20 watt RMS audio amp. quad in-line package	$8.95
Data sheets only for any of the above (if IC's not purchased)		each $0.80

LINEARS

555 Timer Mini dip	0.59
8038 Functional generator	4.25
RCA 3043 FM If, Aud Preamp.	1.20
565 Phase Lock Loop	1.95
567V Tone Decoder	1.95
LM723 Pos. Volt. Reg.	0.59
LM309 5v. Lamp Reg'	1.20
LM380 2w. Audio Amp. 8 pin dip	1.00
LM741 Operational Amp.	0.25

TRANSISTORS-DIODES

RCA200V 115W T05 NPN		1.25
GE D40C1 NPN Darl.		0.25
2N4443SCR 400v8A T0220		0.65
2N2222 NPN Gen Ampl.		0.20
2N3904 NPN Driver		0.15
2N3906 PNP Compl. 2N3904		0.15
2N4400 NPN Low level noise		0.20
2N5401 PNP Nixie driver		0.25
1N4004	400PIV	15 for 1.00
1N4007	1000PIV	10 for 1.00
1N746	3.3 Zen.	4 for 1.00
1N4148	Switch	20 for 1.00

CPU

8008	8 bit parallel CPU	$22.50
2102	1K Static RAM for 8008	$ 2.25
MM5203	2K UV eraseable PROM	$12.25

GE TRANSISTOR ASSORTMENT
T098 cased Darling., SCRs, NPN,PNP, ect.(untested)
50 for $0.95
100 for $1.75
300 for $5.00

LED DRIVERS

75491 Quad Segment Driver . $0.39
75492 Hex Digit Driver . . . $0.49

RCA3062

Photodetector with power amplifier. Data included. 2.25

CERAMIC DISC CAPS
.01 MFD 50 VDC 20/$1
68 PFD 50 VDC 20/$1

TANTALUM CAPS
4.7 MFD 10VDC. Axial. .10/$1

ELECTROLYTIC CAPS
220 MFD 25 VDC. PC type 5/$1

SUPER VALUES FOR ONLY $1 EA.

SPECIAL #1 – 2N2501 (house numbered 25107) NPN Brand new full lead devices by Motorola. Vcb 40; Vce 20; Hfe 100; Pt. 360mW; Ft. 350 MHz. TO 92 case. Pak of 10 for $1.00

SPECIAL #2 – EN2222 (house numbered RD5449) NPN Leads cut for PCB insertion but still very usable. Brand new by National. Vcb 60; Vce 30; Hfe 175; Ic 800mA. TO 106 case. Pak of 20 for $1.00

SPECIAL #3 – Same as #2 but PNP. 20 for $1.00

Special #4 – 1N4148 diodes. Leads cut and formed for PCB insertion but still very usable. Pak of 40 – $1.00

Special #5 – .01uF/100V ceramic disc caps. PCB leads. Pak of 30 – $1.00

All prices are listed in Australian dollars. Minimum order $A5.00. Remittance by Bank Draft or Bank Cheque, preferably for an equivalent amount in U.S. dollars. If an international postal money order is used, include receipt with order. Unless otherwise specified, goods will be shipped postpaid via airmail within three days from receipt of order.

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A SOUND IMPROVEMENT

The Hi Fi enthusiast is continually searching for and demanding higher sound quality from recorded material. The ZEROSTAT ANTISTATIC PISTOL, a product of industrial research, was created to overcome the problem of static-induced dust, with the associated hazards of annoying static-induced surface pops and crackles.
The ZEROSTAT PISTOL is a simple, effective and inexpensive tool which when aimed at a record and the trigger squeezed, emits ions which positively neutralise the static charge on the record surface.

The ZEROSTAT PISTOL uses no batteries, is guaranteed for one year, and has an effective life of at least 50,000 operations (ie, fourteen times a day for ten years!)

Can you afford not to protect your record collection with a Zerostat?

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ALPHA

MODEL DMM-1ER DIGITAL MULTIMETER KIT

$69.95*

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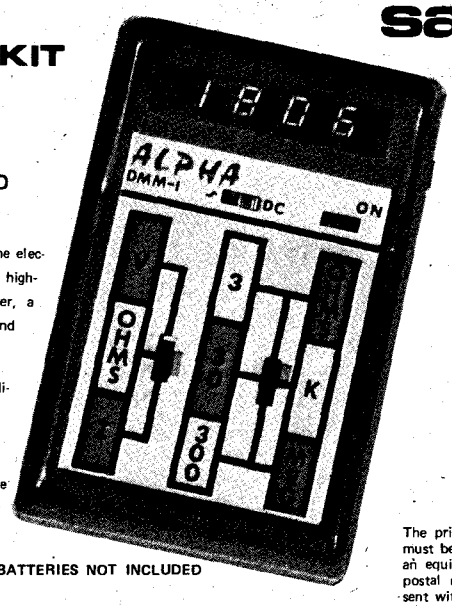
sabtronics INTERNATIONAL



auto polarity, auto zero

For some time, the multimeter has been the most popular instrument in the electronics field. But until recently, there were no alternatives to complex, high-cost professional equipment. Now comes the Alpha Digital Multimeter, a full-service, low-cost instrument which will appeal to both amateur and professional alike.

Features like automatic polarity, automatic zeroing and over-range indication combine to give you a high-quality instrument you'll be proud to own. And as you test and make measurements using this versatile unit, you'll being to "know" your equipment as never before. The Alpha Digital Multimeter – your way to greater independence in the lab or at home.

- Bright 3½-digit display with automatic decimal and polarity indication
- Measures AC/DC voltage, AC/DC current and resistance
- Compact, light weight and battery operated for "anywhere, anytime" operation
- Exceptional accuracy and high resolution
- High-impact Cycolac® case for durability and ruggedness

specifications

*TEST LEADS AND BATTERIES NOT INCLUDED

AC VOLTAGE
1 millivolt to 300 volts in three ranges. **Input impedance:** 10 megohms. **Accuracy:** ±1%. **Frequency Response:** 0 to full-scale voltage between 40 and 100 Hz; 0 to 2.4 volts between 100 and 10,000 Hz; 0 to 1.5 volts between 10 Khz and 50 Khz.

RESISTANCE
1 ohm to 6 megohms. **Accuracy:** ±0.1%.

CURRENT
DC current: 1 microamp to 2 amps. **Accuracy:** ±1%. **AC current:** 1 microamp to 300 milliamps. **Accuracy:** ±1%. **AC Frequency Response:** Same as for AC voltage.

DC VOLTAGE
1 millivolt to 600 volts in four ranges. **Input Impedance:** 10 megohms. **Accuracy:** 0.1%.

RESOLUTION
1 millivolt – 1 microamp – 1 ohm.

GENERAL
Readout: 3½-digit LED. **Power Source:** four AA (penlight) size batteries (Ni-Cad, alkaline or carbon-zinc). **Over-range Indication:** display flashes when input exceeds value of range selected. **Polarity Indication:** automatic (negative voltage and current indicated by display). **Size:** 5.1" x 3.4" x 1.5". **Weight:** 8 oz. **Case:** high-impact Cycolac®. **Color:** Red.

The price as listed is in Australian dollars. Remittance must be by Bank Draft or Bank Cheque (preferably for an equivalent amount in U.S. dollars) or international postal money order in which case receipt should be sent with order.

To: **Sabtronics International, P.O. Box 64683, Dallas, Texas 75206, U.S.A.**

Please send via insured air mail _____(quantity) Alpha DMM-1ER Digital Multimeter kit(s) @ $69.95 plus $2.95 postage and insurance for each kit ordered.

I enclose ☐ Bank Draft ☐ Bank Cheque or
☐ International postal money order receipt
in the amount of _____.

(Please Print)

Name _____

Address _____

_____ (Postcode)

eti/7A.

STD TIMER

This compact unit calculates the total cost of STD phone calls by counting the number of local-call charges appropriate to the called distance and the duration of the call.

SUBSCRIBER TRUNK DIALLING STD, is now the preferred method of making trunk phone calls within Australia. In fact there is now a surcharge applied to any operator-connected call which could have been made by STD. STD calls are easier and faster to make and can be cheaper than the old 'charge per three-minute period' system. However, the method of charging for STD has a hidden trap which can result in phone bills being unexpectedly high.

The STD billing system works by charging a fixed amount (equal to the local-call charge) for each time unit used in making the call. The time allocated to each unit varies according to the distance. Thus if the call is only over a short distance and at night you may be charged one local call every 180 seconds, but if over a long distance and during the day the charge may be as much as one local call every six seconds. The disadvantage of this method as far as the subscriber is concerned is that he loses track of time when talking – there are no pips to warn him

The ETI 543 STD Timer operates by counting the number of local call periods used. Thus at the end of the call you simply multiply the number held in the counter by the local call charge to get at an accurate cost. Local-call charges are frequently reviewed, so the timer is designed to count the number of local-call charges only.

To use the timer simply check the phone book before making the call to determine the number of seconds per charge applicable, then set this time on the selector switch of the timer. Now dial the number and when the called party answers press the start button. The timer will switch on, '1' will be added to the display and the display will be incremented by '1' at the end of each time period (as selected). When the call is finished, you press the stop button and read the total units used. After about five seconds the timer will switch off automatically.

Note that although the power is still connected in the off-state the power consumption (in this state) is so low that battery drain doesn't affect battery life. In fact on the prototype the current drain was 2×10^{-10} amps! Yes we actually measured it – guess how.

Construction

As the unit will be used on the phone table small size and neat appearance is necessary. We therefore built our unit into a zippy box which although looking neat does become a little crammed inside. For this reason it is important to use the printed circuit boards specified if all the electronics is to fit.

Commence construction by assembling components to the display board, ETI 543A, starting by installing the tinned-copper wire links as shown on the overlay diagram. Watch the orientation of the integrated circuits: the two 4511s have opposite orientations.

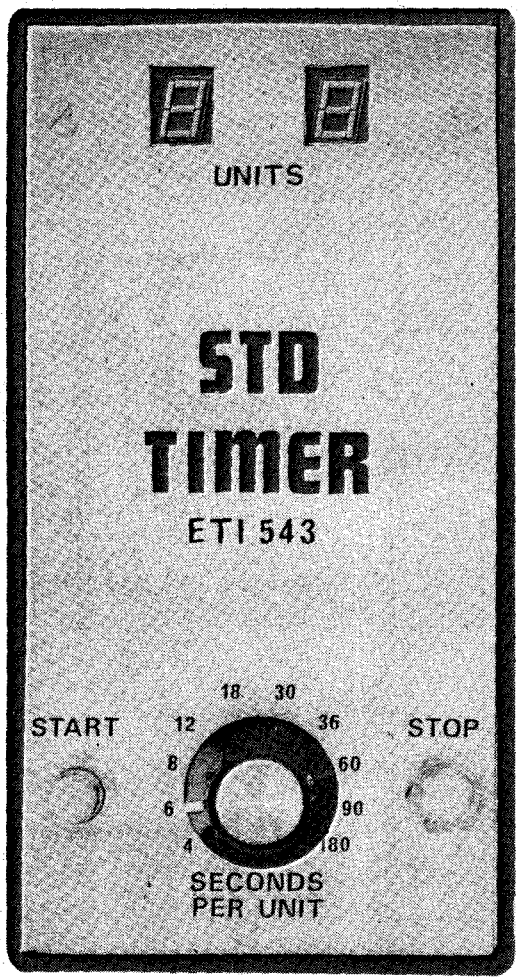
Now assemble the second board, again installing the links first. Do not mount R1 to R16 just yet. The rotary switch used for range selection must now be modified by removing the wafer, cutting the spacers in half and then reassembling (as shown in Fig. 2) on the printed-circuit board. The terminals of the switch should now be connected to the board by threading tinned-copper wire through the appropriate hole in the board (from the copperside) and through the terminal and then soldering to the terminal and the board. The resistors R1 to R16 may now be mounted into position and soldered, noting that they are mounted on-end – not flat.

Mount the two push-buttons to the front panel temporarily and then mount the completed second board and switch assembly to the front panel. Use spacing washers between the switch and the front panel. Connect the push-buttons to the board using tinned-copper wire and then remove the front panel.

Now place the two boards end-to-end about 50 mm apart and wire then together as shown in Fig. 3. The 50 mm spacing ensures that when the boards are folded later the spacing will be OK. The battery holder may now be connected. However, note that there is insufficient room to allow a conventional battery power clip to be used. You have to solder the leads directly to the holder.
directly to the terminals on the holder.

Impedances around the switch are fairly high, and leakage through flux could affect timing accuracy.

So clean the copper side of the boards with turps or methylated spirits to remove excess flux. Insert the batteries in the holder and select the four second range. If the display is on press the stop button and after about



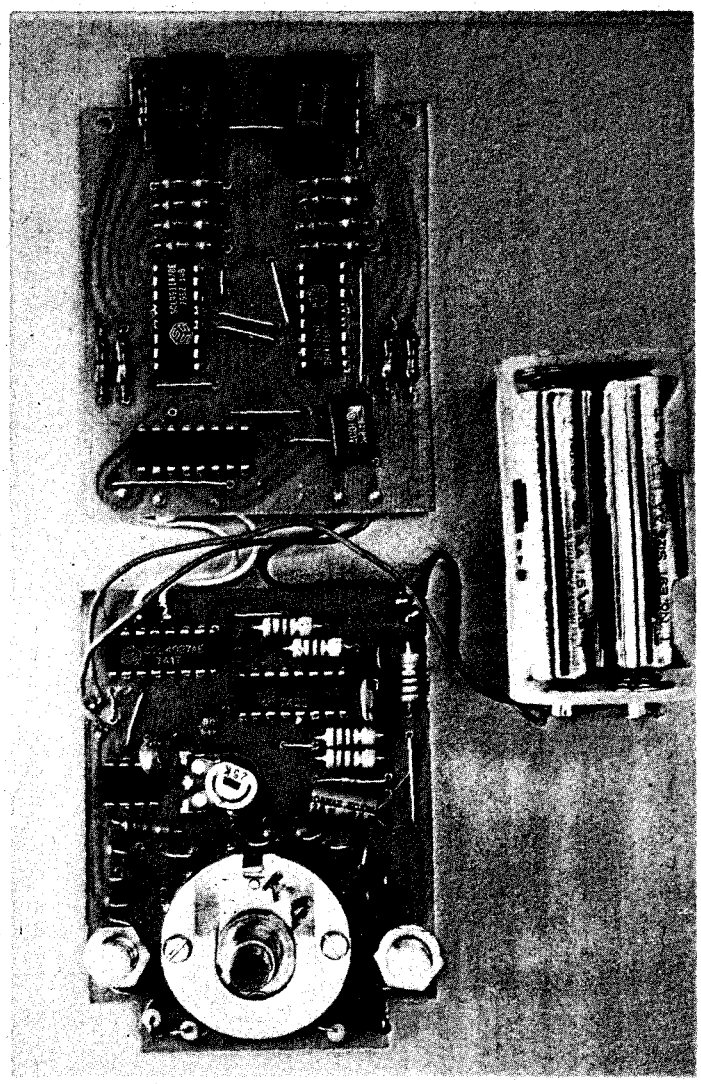
SPECIFICATION ETI 543

TIMING	
Periods provided	6,8,9,12,18,24,36,45,90 and 180 seconds
Accuracy	first count −20% successive counts ± 5%
DISPLAY	2 digit, seven-segment LED
POWER	
Batteries	4 x pen cell (6V)
Battery drain	approx 50 mA in 'ON' state " 1 μA in 'OFF' state
START AND STOP	by separate push buttons

five seconds the display should extinguish. Now press the start button and note that the display should show '01' and should increment by one every four seconds. Check the timing accuracy over a number of increments with a watch and adjust RV1 to obtain increments of exactly four seconds. (eg 10 counts should be exactly 40 seconds). Check the other ranges for accuracy and if greatly in error check and adjust the values of the appropriate resistors in the R1 to R16 chain.

Remove the batteries and mount the display board onto the front panel using 6 BA screws and spacers. If the box as specified is used the front panel will have to be cut to allow the displays to protrude through, thus allowing more room for the batteries. A quick assembly check will show how much extra room is required. Now mount the second board by means of the range switch and the push buttons and mount the completed unit into the box.

That completes the unit the only thing left to do is to instruct the family how to use it and to persuade them to do so on every STD call. Best of luck.



The two boards and battery assembly before being mounted in the case

STD TIMER

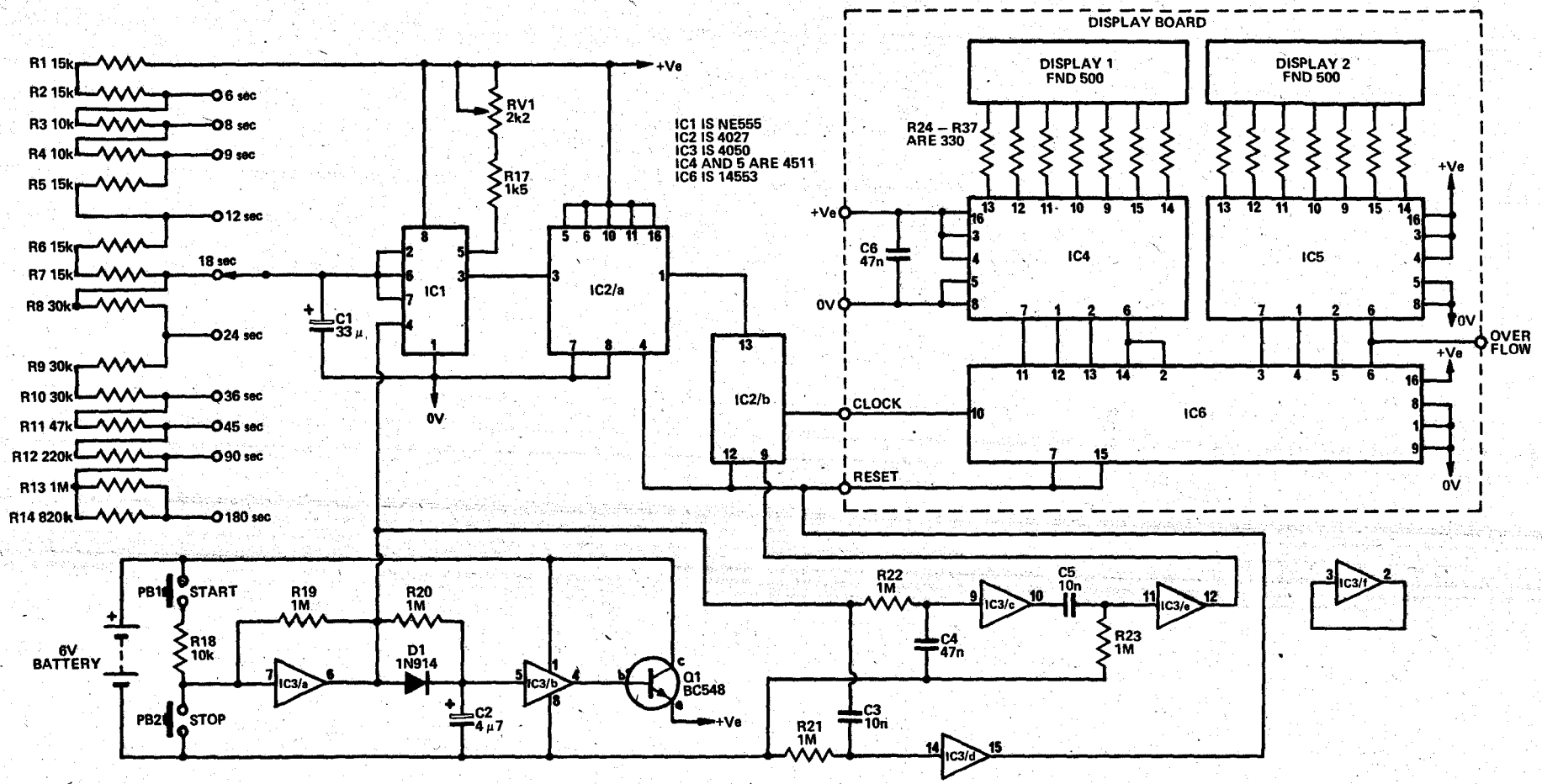


Fig. 1 Circuit diagram of the STD timer unit

Fig. 2 The switch must be disassembled, the spacers cut in halves and then reassembled to the PC board as shown in this diagram

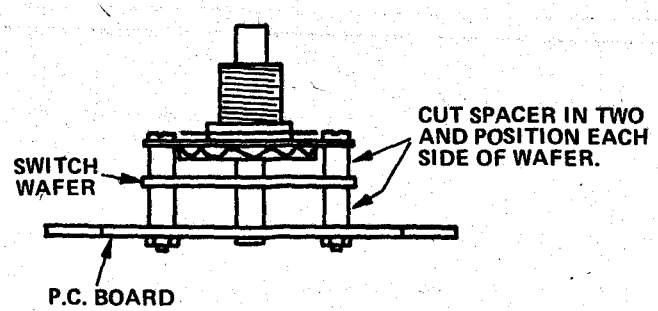
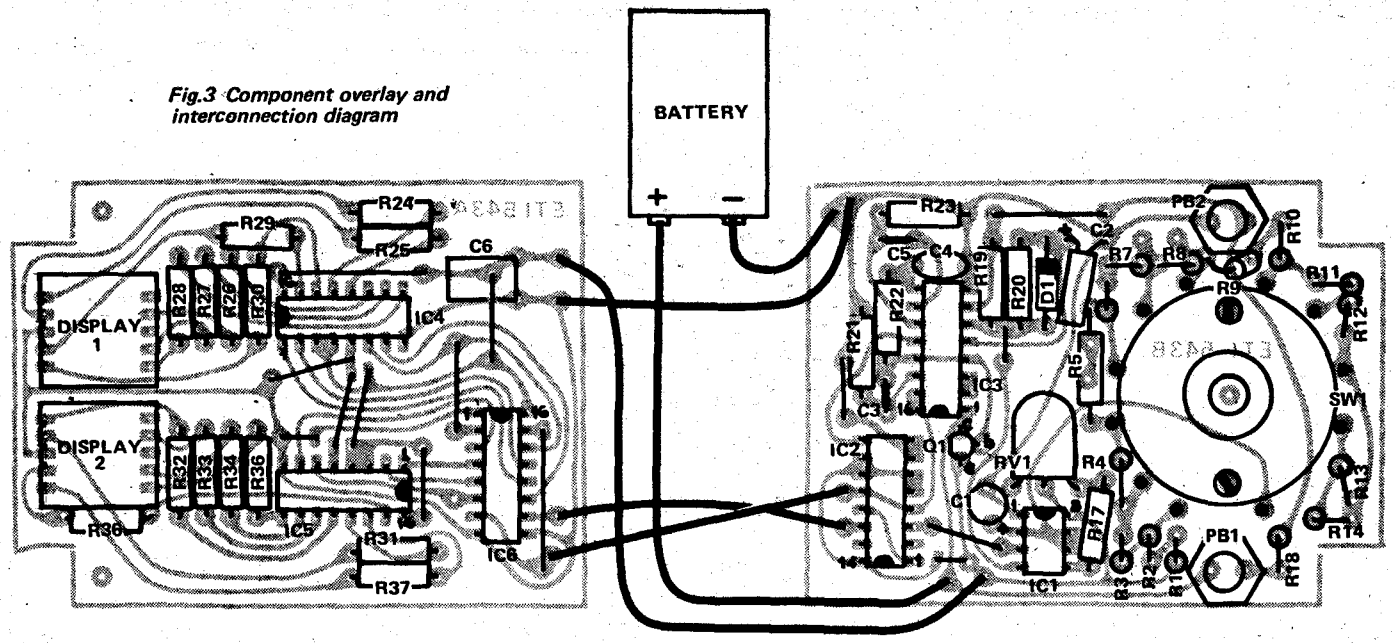


Fig.3 Component overlay and interconnection diagram



HOW IT WORKS – ETI 543

The basic timing element is the familiar timing IC, the 555. This is a convenient device as the timing may be altered by changing the value of a single resistor. The resistor in question is selected by switch SW1 to provide timing periods from one to 45 seconds in duration. As the timing of long intervals is difficult due to the leakage encountered in practical large-value capacitors, a divide by four stage is used to obtain the 6 to 180 second period require. To compensate for differences in the value of capacitor C1 a variable resistor is provided between pin 5 of the IC and the positive rail. Adjustment of this resistor varies the threshold voltage of the IC and thereby corrects the timing.

The first timing period of the 555 is about 50% longer than those following and to compensate for this the divider stage provides a by-three division, instead of the normal by-four division, on the first sequence. This is not, however, a problem: it can be an advantage. If a call is terminated just at the time the display changes the charge will be within the cheaper period.

The output of IC2 clocks the dual-decade counter IC6 which has a four-line BCD output code. This is decoded to seven-segment format by ICs four and five to drive the seven-segment LED displays. These decoders also have a store facility which is not used in this application. A link is therefore used to connect the store input to zero volts thus disabling it. The use of a link allows the store to be made available if the board is to be used for another application.

The timer is controlled by IC3 which is a hex (6) non-inverting buffer (if input is high, output is high etc). The cycle commences when pushbutton PB1 is pressed. This pulls pin 7 of IC3/1 high causing the output of the IC to go high (pin 6). IC3/1 latches in this state and stays there until the stop button is pressed — when the output goes low again. When the start button is pressed and the output of IC3/1 goes high the input of IC3/2 is also pulled high via diode D1 causing the output of IC3/2 to go high. This high turns on emitter-follower Q1 which then provides power to all circuits with the exception of IC3 which is permanently powered. The off-state current drain of IC3 on the prototype was measured at 200 nanoamps! Thus by using this technique the need to switch the unit on and off has been avoided as battery life in the OFF state will exceed the shelf-life of the battery.

When the 'start' push button is pressed the high at the output of IC3/1 is also fed to pin 4 of the 555 timer IC which starts to cycle at the rate selected by SW1. Pin 14 of IC3/4 also goes high until C3 is discharged by R21. This causes a 10 millisecond pulse to be generated at pin 15 of IC3/4 and this pulse is used to reset the display decade counter, IC6, and also IC2 at initial switch-on. In addition, after a 50 millisecond delay (due to R22 and C4) the output of IC3/3 goes high and this transition in conjunction with C5 and R23 produces another 10 millisecond pulse from IC3/5 which sets IC2/2 causing IC6 to be incremented by one.

When the stop button is pressed the 555 timer is disabled and the timing stops. However, due to the charge on C2, the power remains on for a further 5 to 10 seconds.

PARTS LIST ETI 543

Resistors

R1,2	15 k	½W	5%
R3,4	10 k	"	"
R5-R7	15 k	"	"
R8-R10	30 k	"	"
R11	47 k	"	"
R12	220 k	"	"
R13	1 M	"	"
R14	820 k	"	"
R17	1 k5	"	"
R18	10k	"	"
R19-R23	1 M	"	"
R24-R37	330	"	"

Potentiometer

RV1 2k2 Trimpot (VTU)

Capacitor

C1	33 µ	10 V Tantalum
C2	4µ7	25 V electro
C3	10 n	polyester
C4	47 n	"
C5	10 n	"
C6	47 n	"

Integrated Circuits

IC1	NE555
IC2	4027 (CMOS)
IC3	4050 "
IC4,5	4511 "
IC6	4518 "

Semiconductors

D1 IN914 or similar
Q1 BC548 or similar
Display 1,2 FND 500

Miscellaneous

SW1 single pole 11 position OAK switch
PB1,2 single make push buttons
PC Boards ETI 543A, ETI 543B
six pc board pins
plastic box
knob
4xAA size battery holder

MURPHY'S LAW

As stated earlier, we used units of local calls as a basis for calculating charge as we thought the time allowed per unit was unlikely to be changed. However, the Telecom authorities must have known what we were doing because these times *were* changed in the new phone book (which arrived after we had finished this project). The new values are included in the circuit diagram but could not be changed in time for the photographs.

If these rates are changed again in the future it is a simple matter to change the values of R1 to R14 to suit. The values required are calculated by allowing 5000 ohms per second required. Thus 10 seconds would require a value of 50k. Note that the values are cumulative. That is, the second interval is determined by the total series value of R1 and R2.

That was not the end of our troubles. Almost at the time we were due to go to press we discovered that the type of display used in the prototype was now unavailable and a hurried redesign was necessary to one which was. We make every effort to ensure that parts are readily available but often we are badly let down by suppliers who promise availability but then subsequently do not deliver.

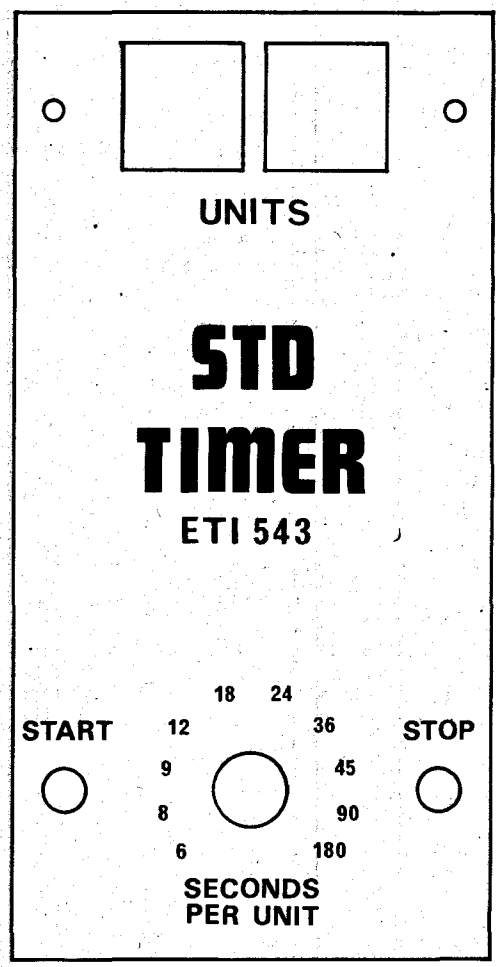


Fig.4 Front panel for the timer. Full size

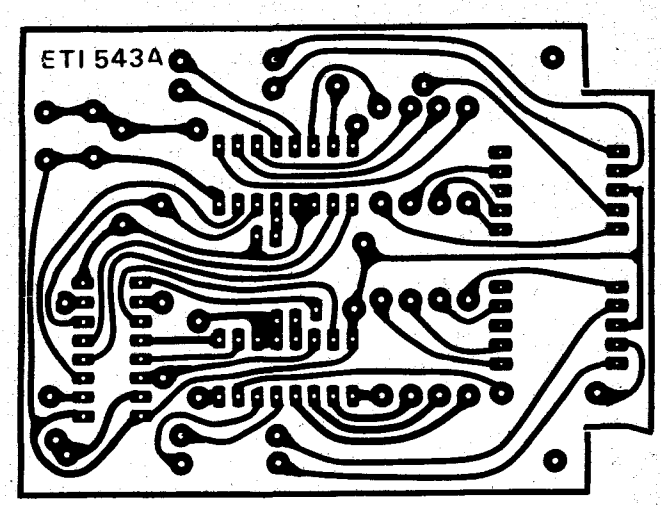


Fig.5 Printed circuit pattern for the display board. Full size 83 x 61mm

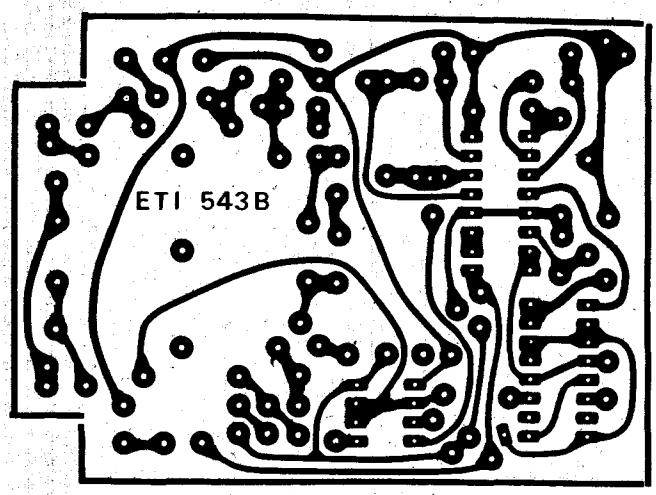


Fig.6 Printed circuit pattern for the timing board. Full size 83 x 61mm

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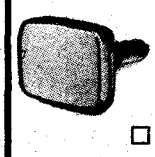

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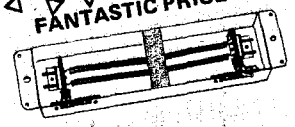

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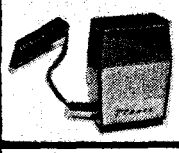

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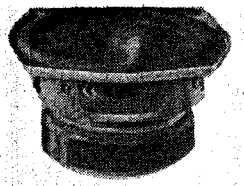

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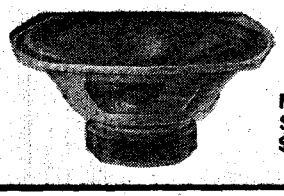

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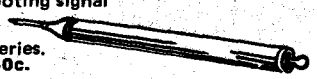

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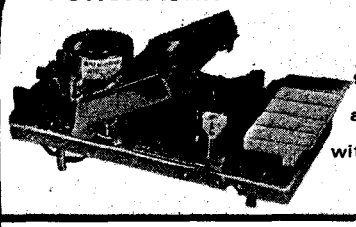

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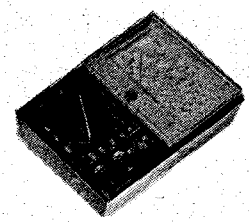

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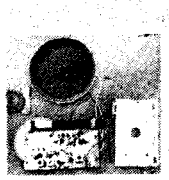

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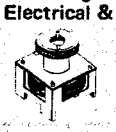

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DOUBLE DICE

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

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

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

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

Construction

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

Begin assembly of the board by fitting the links (we regret that there are so many but it was unavoidable on a one-sided pcb) then resistors and other low-height components and then finally the ICs. Drill holes in the front panel for the LEDs and for the push button. The cathode terminal of the type of LED specified is marked by a small flat on the body flange and the cathode lead is also slightly shorter Cut the leads of the LED so that they are 5-7 mm long leaving the cathode just a little shorter so that it may be identified easily after installation. Mount the LEDs and position them so that the anode lead points towards the centre of the box (between the two dice groups) and wire them in accordance with the component overlay/wiring diagram. With the leads on the LEDs cut this short they may be damaged when soldering if precautions are not taken. To prevent this use a pair of long-nose pliers or similar as a heat sink on the lead of the LED when soldering.

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

TABLE 1 Double dice odds.

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

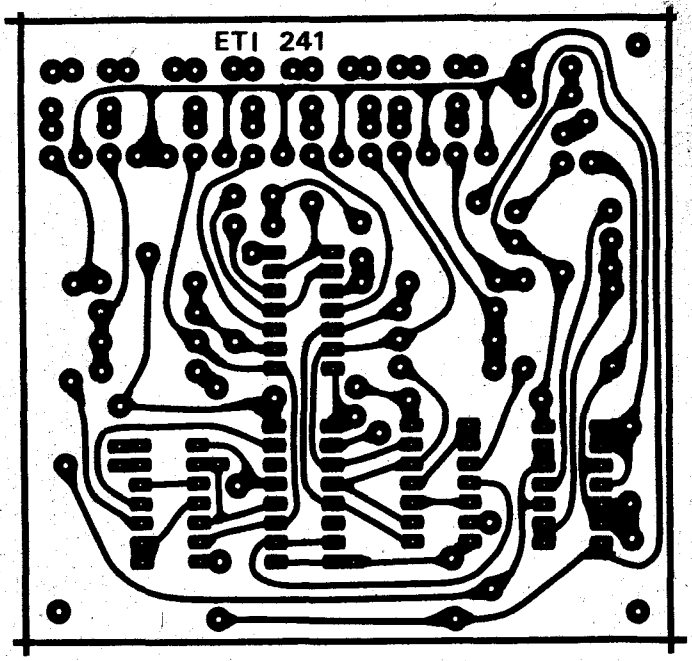
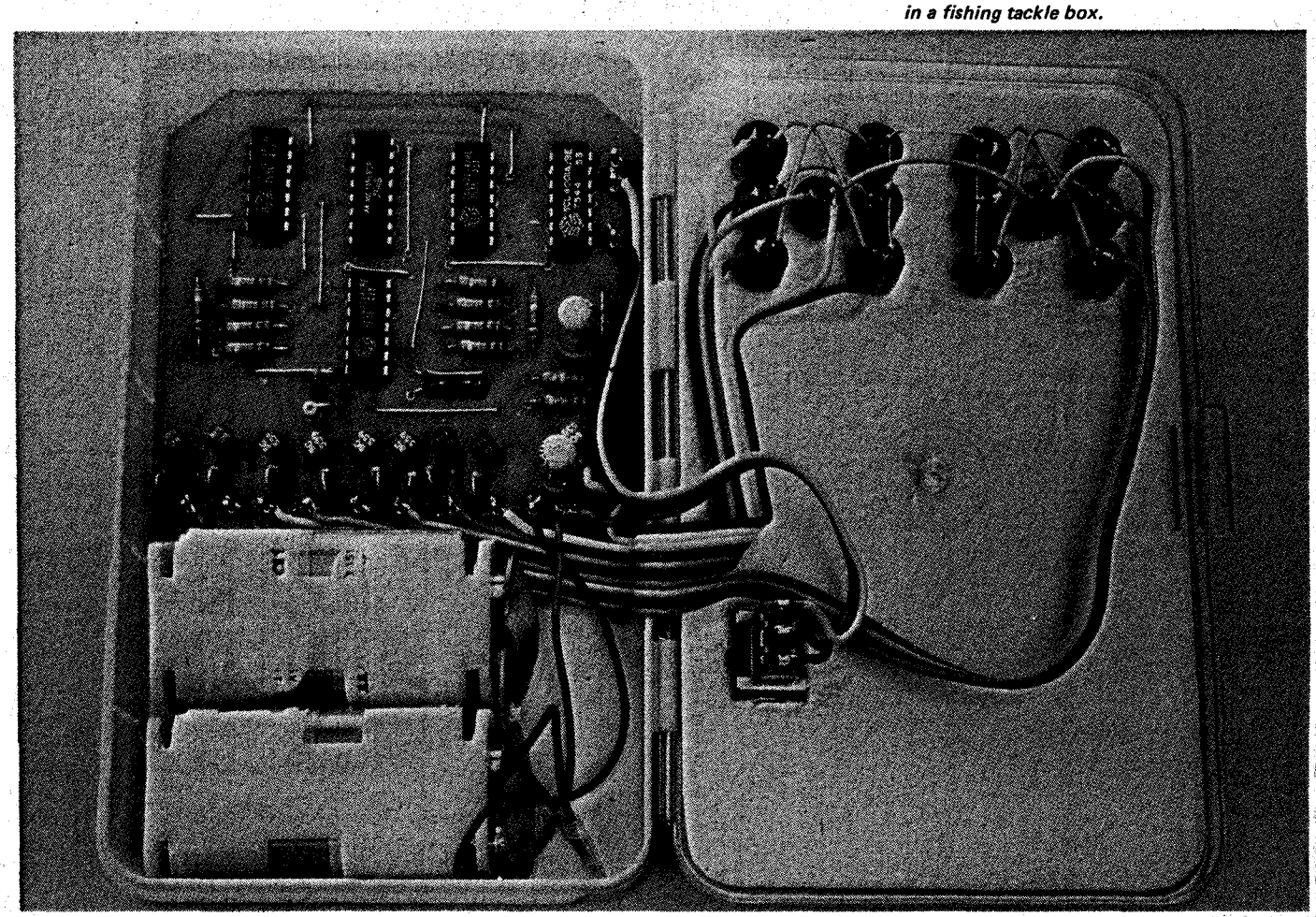
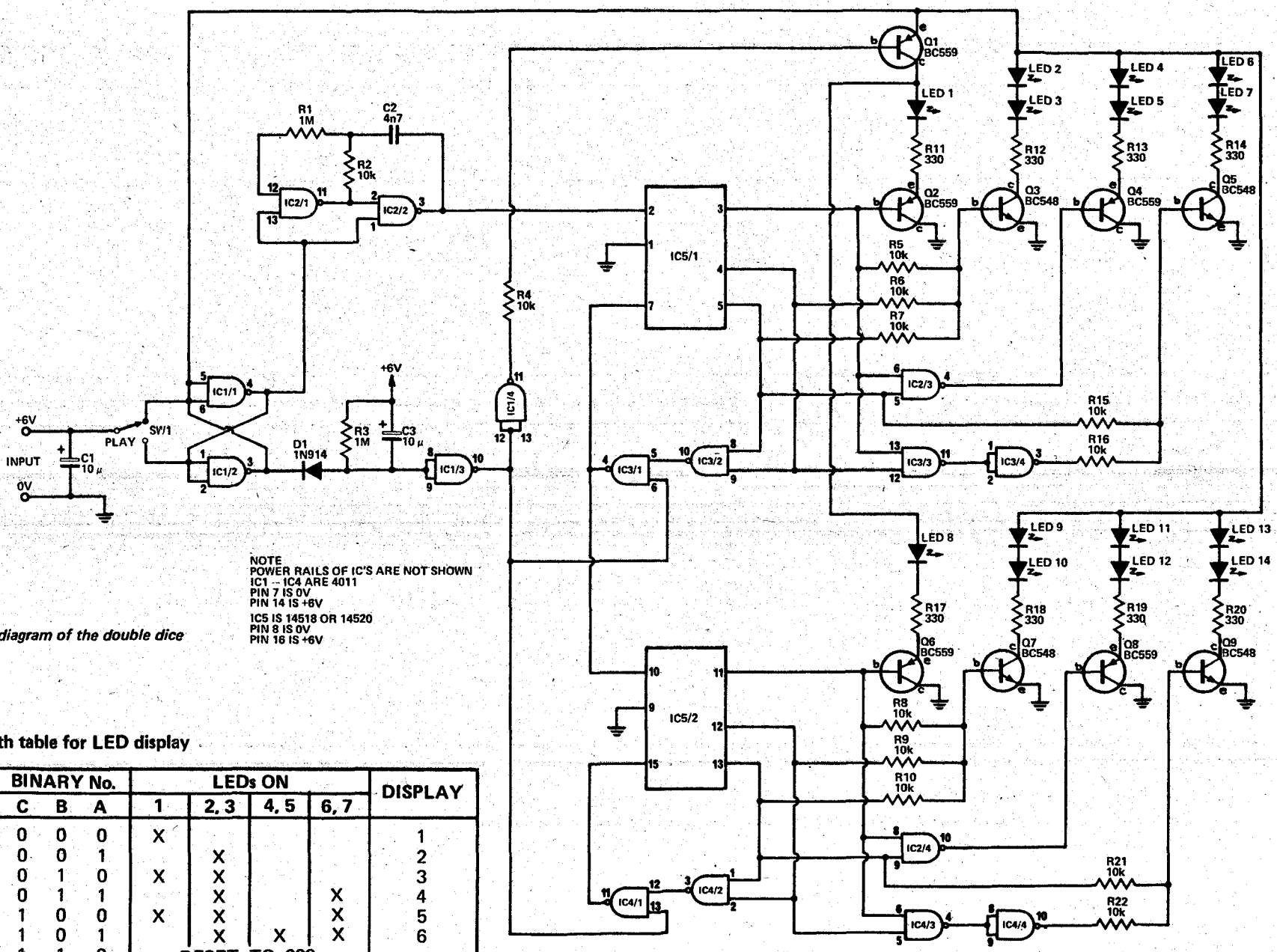


Fig. 1. Printed circuit layout for the double dice. Full size 84 x 81mm.

Internal view of the unit which is constructed in a fishing tackle box.



DOUBLE DICE



NOTE
POWER RAILS OF IC'S ARE NOT SHOWN
IC1 – IC4 ARE 4011
PIN 7 IS 0V
PIN 14 IS +6V
IC5 IS 14518 OR 14520
PIN 8 IS 0V
PIN 16 IS +6V

Fig. 2. Circuit diagram of the double dice

TABLE 2 Truth table for LED display

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

How it works ETI — 543.

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

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

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

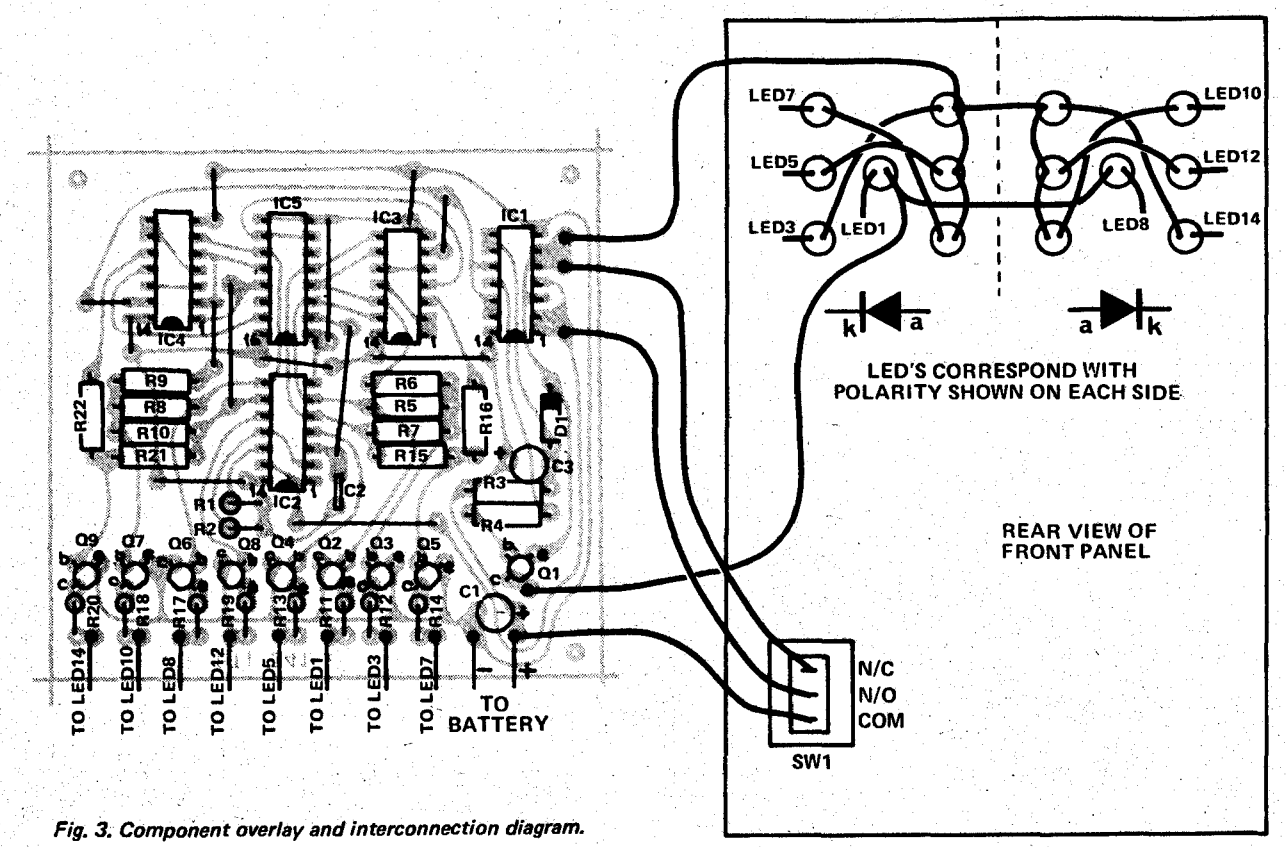


Fig. 3. Component overlay and interconnection diagram.

Parts List

Resistors

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

Capacitors

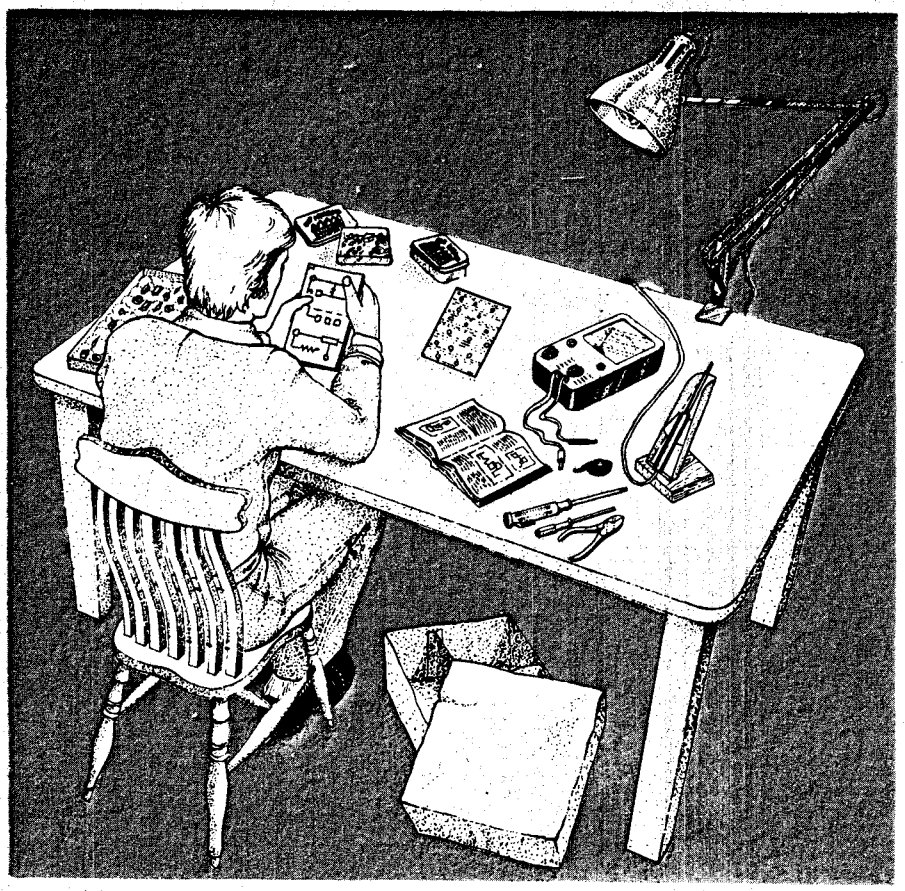
C1	10µF 25V electro
C2	4n7 polyester
C3	10µF 25V electro

Semiconductors

D1	1N914 or similar
Q1,2,4,6,8	BC558
Q3,5,7,9	BC548
IC1 — 4	4011 (CMOS)
IC5	4518 or 4520
LED 1-14	RL 4850 with clip

Miscellaneous

PB1 Push button SPDT C&K 8125 or similar
ETI 241 PC board
14 pc board pins
Case Capstan Plastics MB101 or similar
Front panel
2 battery holders 2 x AA size
2 battery clips
4 AA size batteries.



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REMOTE CONTROL TRANSMITTER

Operate up to eight devices such as the garage door, curtains or outside lighting with this remote control system. The accompanying receiver will be described next month

THERE YOU ARE IN YOUR CAR nice and dry but now you have to get out and open the garage door — and this means getting soaked. How nice it would be if you only had to press a button in your car to open the garage door. Commercial garage door openers are one answer to the problem but they cost a bomb, so we wondered if we could help. Although we can't cover the mechanical aspects, due to the variations in types of doors etc, it is possible to design a suitable electronic control system. We will also leave the detailed mechanics of motors and driven mechanisms to the builder.

Actually the electronics for opening a door by means of a remote-control radio link are relatively inexpensive, and we soon realised that by spending only a couple of dollars more the transmitter can be extended to control up to eight different devices! This means that such a controller can be used to not only open garage doors, but to switch the television on and off, to open curtains or to control lighting or sound systems etc. Can you imagine the impression that such a device will make when entertaining your friends?

This month we describe the transmitter part of the system and next month we will cover the receiver/decoder. The transmitter is designed to operate on any one of the fifteen odd channels allocated for this purpose in the 27 MHz band. The transmitter is capable of activating any of 8 different devices (or switching on and off four devices). Any combination of these two modes may be used, eg six devices activated and one device on and off. With a suitable antenna the device will operate over a range of up to five hundred metres (depending upon the terrain) with the half watt of input power provided. With a short piece of wire as an antenna reliable operation can be expected at ranges up to 30 or 40 metres.

Coding This is by means of a sixteen-bit word having bit allocations as follows: The first bit is a synchronization pulse, the next seven are part of the key code, the next three bits select the desired channel out of the 8 available and the last five bits are the remainder of the key code (12 key-code bits in all). The 12 bits allocated to the key code provide 2^{12} or 4096 possible codes and this, coupled with the choice of one of the 15 odd channels available, gives a total number of 61,440 combinations. Thus the chances of anyone cracking your code, or of a similar transmitter triggering your unit, are remote indeed. The 'security' of the unit is therefore far higher than most commercial units which typically offer only 72 key combinations. This is another pay-off of the extra cost of multi-channel control.

The key code used must be wired in by the constructor with appropriately positioned links on the printed-circuit board. Probably the best way to select a key code is to first pick any number between 1 and 4096 and then convert it to its binary equivalent (12 bits) and fit the links accordingly. When the receiver is also wired to the same key code only your transmitter will operate it.

As the transmitter operates by providing a burst of pulses for only about one quarter of a second the chances of anyone determining what frequency you are on, let alone what your key code is, are negligible.

Construction

Using a small amount of Araldite glue the coil formers to the printed-circuit board in the positions as indicated on the overlay. The coils are now wound with 24 B&S enamelled-copper wire in the following manner: Clean one end of the wire and solder it into one of the holes for the particular coil being wound. Now wind ten turns (close spaced) around the former as neatly as possible (to ensure uniformity of inductance) and then pass the end of the wire back through the second hole in the printed-circuit board, scrape the enamel off the wire and solder into position. Do this for each coil.

Next mount all components to the board commencing with resistors and capacitors and finishing with the transistors and integrated circuits. Take care to orientate any polarised components correctly and also to solder to the tracks on both sides of the board where necessary. Select your own key code as mentioned earlier and wire it in by linking the appropriate terminals to the line marked 'H' for a '1' or to the line marked 'L' for a '0'. Note that on the overlay the links are shown connected to both lines. This is done to prevent constructors from following the wiring pattern on our prototype. The terminals should be connected to one line or the other as required by your code – never to both lines. The bit positions of the code are indicated by the number next to each link on the overlay.

Coil L2 is the only one that is air-cored. All the other coils are fitted with slugs which should be prevented from moving after adjustment by locking them with a thin strip of rubber or Teflon.

When the board is completely assembled check both sides carefully to ensure that all joints have been soldered and that all components and links are in their correct positions. If an oscilloscope is available it is possible to check the operation of the board at this time by connecting a temporary link between pin 1 of IC4/1 and the +9 volt line (a larger battery should be used for continuous operation). Now observe the output at pin 11 of IC4/4 which should be a train of pulses which cycle repetitively. If the unit appears to be functioning correctly mount the board into the bottom of the box and then mount the antenna/battery bracket and the antenna as shown in the photographs. Mount the push buttons to the front panel and wire them as shown on the component overlay. The transmitter is now ready for alignment.

SPECIFICATION ETI 711

FREQUENCY	26.957–27.282 MHz crystal controlled
INPUT POWER TO FINAL STAGE	500 mW
TRANSMISSION TIME	<250 mS
CHANNEL SEPERATION RECOMMENDED	⩾15 kHz
NUMBER OF DEVICES THAT CAN BE OPERATED	8
KEY CODE	4096 (12 bit binary)
TOTAL KEY COMBINATIONS	>100,000
RANGE (depends on terrain)	500 metres (aerial up) 50 metres (aerial down)
POWER SUPPLY	9 V battery
SUPPLY CURRENT	50 mA (transmitting) 60μA (stand by)

Alignment

Connect a temporary link between pin 1 of IC4/1 and the +9 volt line so that the code generator runs continously. Measure the current drawn by the transmitter by inserting an ammeter in series with one of the battery leads. With the antenna fully extended the current should be at least 20 mA if the RF oscillator is running. Using a non-inductive tuning tool adjust the slug in L6 so that it is about half way out of the former and then adjust L4's slug for maximum current. Readjust L4 and L6 slugs for maximum current. This gives maximum drive to transistor Q1. Now with the antenna still fully extended adjust the slug of L1 for minimum current. This corresponds to maximum power output.

Note that the small 9 volt battery specified will not last long under continuous running. Therefore a larger battery or a separate power supply should be used when doing this initial alignment.

That completes the alignment at this stage. Further alignment may be necessary when the receiver has been constructed.

Operation

As said before the 16 bit word of the transmitter consists of a sync pulse, a 12-bit key code and a three-bit channel-select code. The sync pulse is 5 milliseconds long and the other pulses are pulse-width coded at 2 milliseconds duration for a '1' or 0.8 milliseconds duration for a '0'. A fixed off time of 0.24 milliseconds is employed.The first complete word allows the receiver time to settle down,the second word is used to enable the receiver by means of the key code,and the third word initiates operation of the device.Further words, if any,are ignored

The mode of operation of the transmitter is best understood by reference to the block diagram. A 27 MHz oscillator is keyed on and off by two monostables, one which determines the total transmission time and one which determines the short off periods during the transmission.

When one of the push buttons is pressed a positive pulse is generated which triggers the on-time monostable which in turn switches power to all the current consuming sections of the circuitry for a period greater than three complete cycles of the 16 bit code. The

REMOTE CONTROL TRANSMITTER

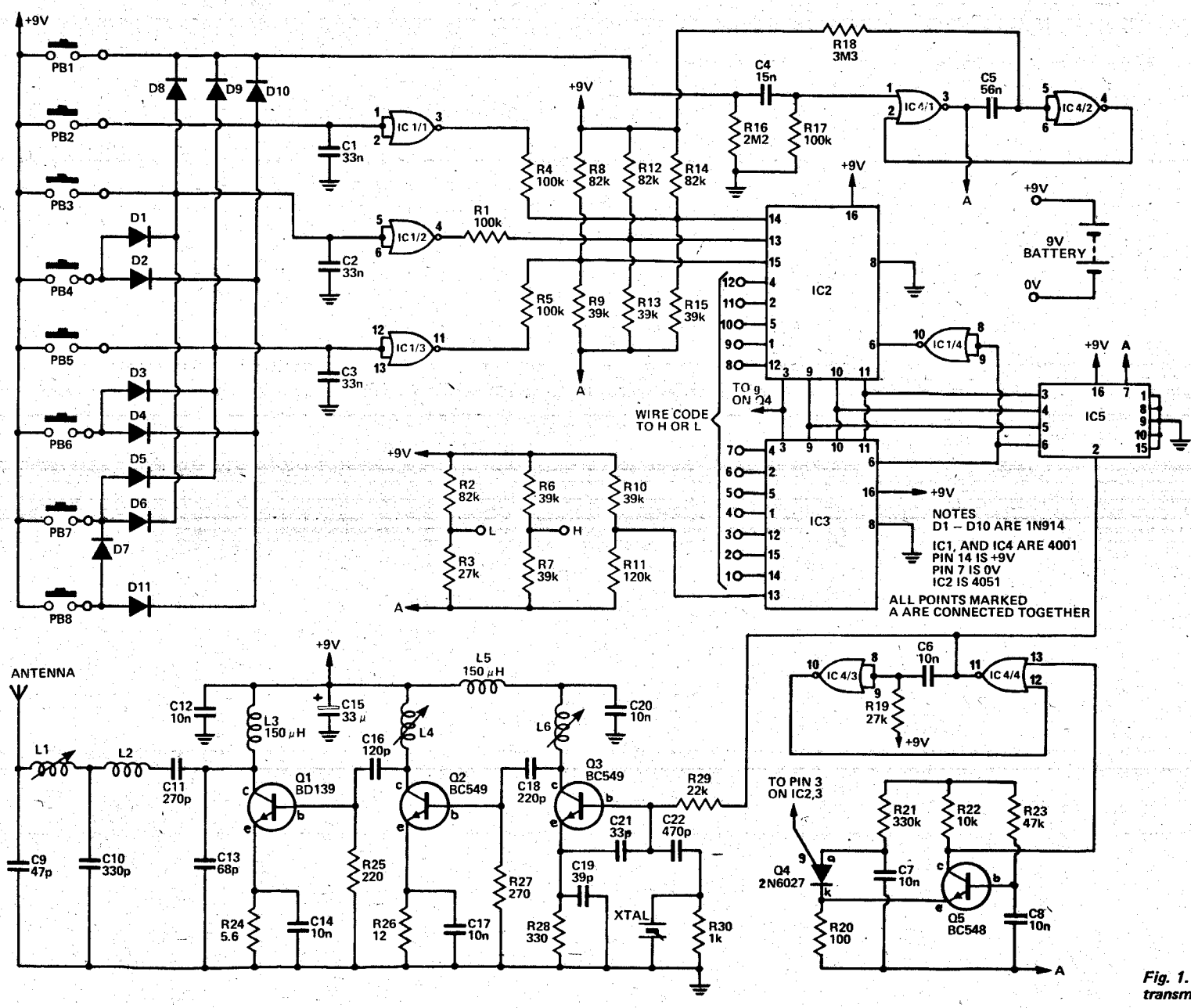

Fig. 1. Circuit diagram of the complete transmitter

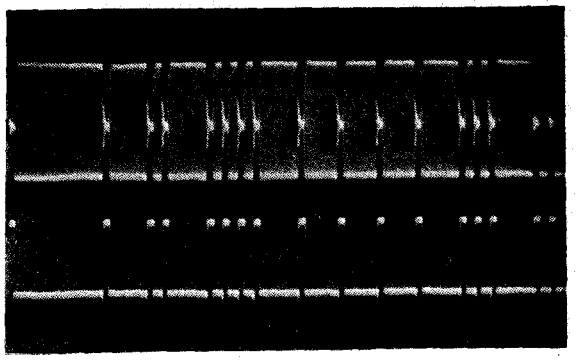

Fig. 2. One complete code word of 16 bits. At top is the gated CW as seen in the IF strip of the receiver whilst the bottom trace shows the output from the detector. The 4.8 millisecond sync pulse is at the left and is followed by the code word 101000111110010. The beginning of the next sync pulse can be seen on the right.

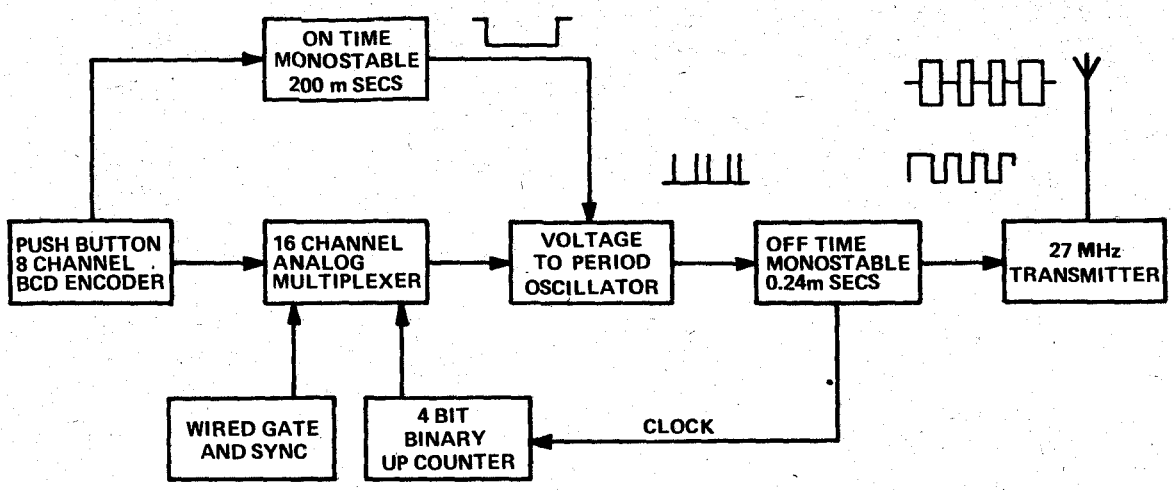

Fig. 3. Block diagram of the transmitter showing basic operation of unit.

How it works — ETI 711A.

When any one of the eight push buttons is pressed a positive voltage transistion is fed, via appropriate diodes in the diode matrix D1 to D10, to the differentiating network R16, C4 and R17. The positive going pulse produced by the network triggers the monostable formed by gates IC4/1 and IC4/2 and point 'A' which was at +9 volts is pulled down to zero volts. When point 'A' is pulled down to zero the following events occur: IC5, which was held reset by the +9 volts previously at point 'A', is released ready to commence counting; resistors R9, 13 and 15 are pulled down to zero volts allowing the binary code present at the outputs of IC1; 2&3 to be fed to IC2; R3, R7 and R11 are pulled down to zero volts thus producing 2.4 volts and 4.5 volts at points 'L' and 'H' respectively and 6.6 volts at the junction of R10 and R11 which is fed to pin 13 of IC3. Pin 3 of IC3 therefore drops to 6.6 volts (as set by R10, R11) and after C7 has charged via R21 (such that the anode voltage exceeds that on the gate) the PUT will fire.

The firing of the PUT produces a narrow pulse at its cathode which is amplified by the common-base amplifier Q5. Capacitor C7 again charges via R21 and the PUT fires every time the voltage at its anode exceeds the voltage its gate. The PUT therefore produces a train of narrow pulses; the period between the pulses is determined by the voltage at the gate of the PUT. Now as the multiplexer ICs, IC2 and IC3, scan through the input channels the output voltage at pin 3 will track whatever input voltage is selected. It will be 6.6 volts for the sync pulse, causing the PUT to provide a 4.8 millisecond period; it will be 4.5 volts for a '1', giving a 2 millisecond period; it will be 2.4 volts for a 'O' giving a 0.6 millisecond period.

The output from Q5 is thus a train of narrow pulses with a variable time interval between them, depending upon which multiplexer input is selected.

These pulses are used to trigger the 'off time' monostable IC4/3 and IC4/4. The output from the 'off time' monostable is normally high during the 'on time' period, when point 'A' is low. The oscillator is therefore normally on during this period. The 'off time' monostable, when triggered by the narrow pulses from Q5, produces lows. These each disable the oscillator Q3 for a period of 0.24 milliseconds, as set by the time constant of R19 and C6.

The 'off time' pulses are also fed to IC5 (a 4520 up-counter) which, when normally connected, increments on the positive edge of the input pulse. However, as it is required to trigger on the negative edge of the 0.24 millisecond pulse the enable input (pin 2) of the device is used for clocking instead. The outputs from IC5 are used to drive the multiplexer IC2 and IC3 so as to sequentially sample the inputs from the push-button matrix and from the wired key code.

In effect then the oscillator turns on when any push button is pressed and then turns off and on until at least three full code words have been transmitted and then switches off completely at the end of the period programmed by the 'on time' mono IC4/1 and IC4/2. As the other two stages of the transmitter operate in class C there is no power drawn by the transmitter except when a code bit is being transmitted.

The RF oscillator's collector is tuned by L6 to the crystal frequency and the output from Q5 is coupled to a class C driver stage Q2 which in turn feeds the power output stage Q1 via the tuned circuit L4 and C1. The RF output is taken to the antenna via the series resonant circuit L2 and C11, and is matched to the antenna via the pi matching network C9, L1 and C10.

sections of the circuitry which use CMOS are left permanently connected, as the current consumption of these devices (in the off state) is only 60 microamps from the 9 volt battery supply.

The particular button which is pressed causes a three-bit binary code to be generated and this together with the wired key-code is sampled by a 16-channel analogue multiplexer. The multiplexer is driven by a binary up-counter. The sequentially sampled code is now fed to a voltage-to-period converter where the various-width pulses are generated. These pulses drive the off-time monostable which gates the 27 MHz oscillator off for 0.24 milliseconds. This monostable also increments the binary counter, thus selecting the next input on the multiplexer. In this way the 16 bits are selected in turn and the unit cycles continuously until the on-time monostable switches off.

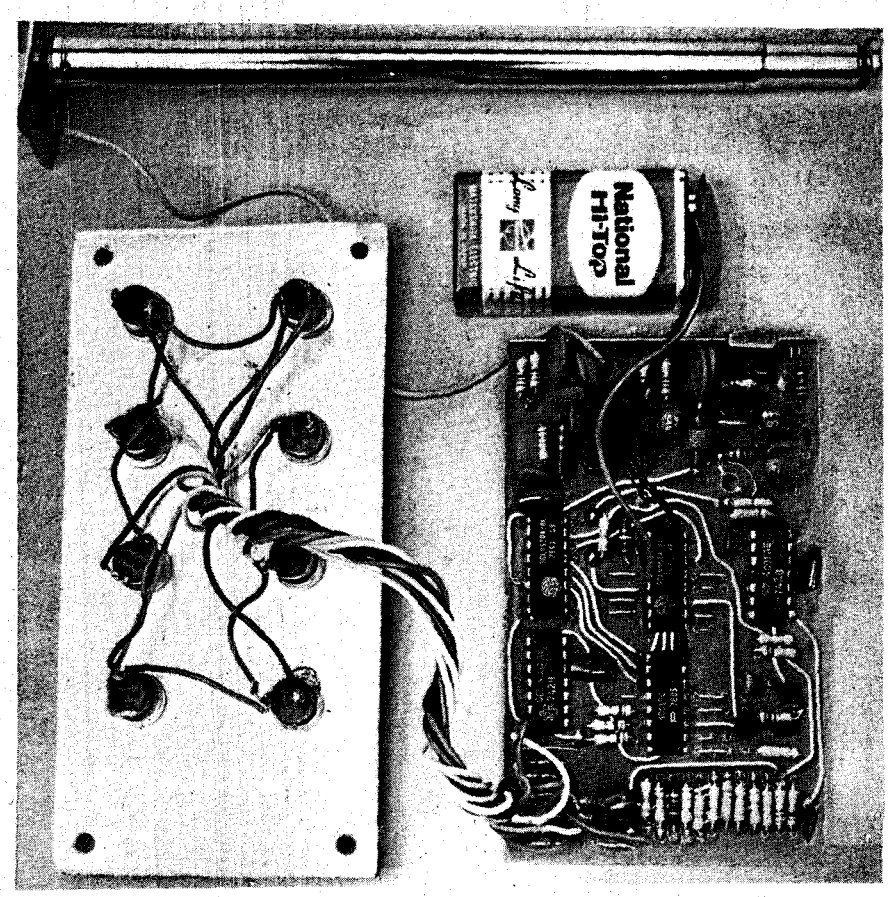

Fig. 5. The completed transmitter before installation in the box.

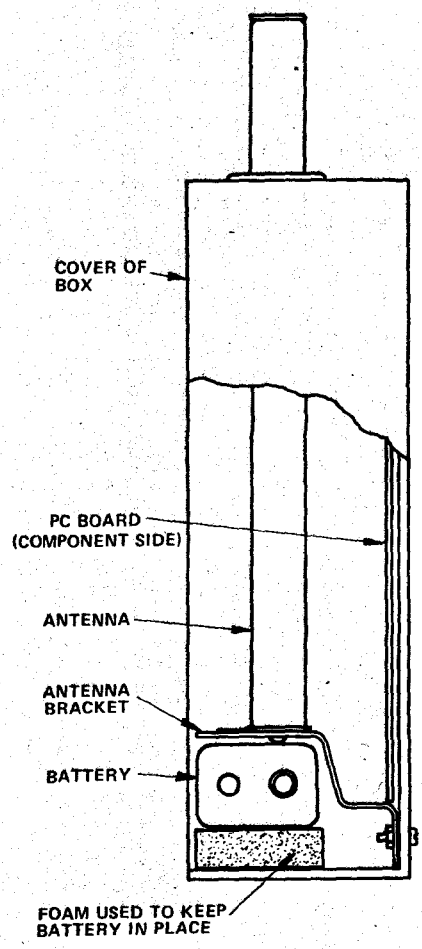

Fig. 4. Method of mounting the antenna and the battery by means of an aluminium bracket.

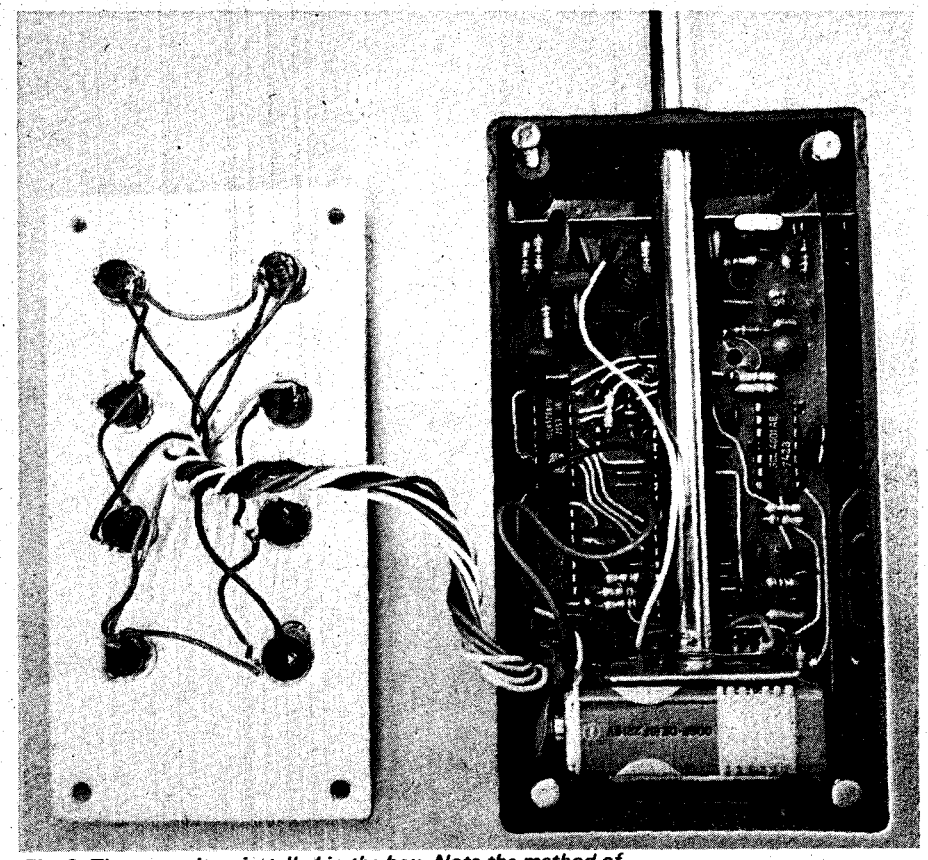

Fig. 6. The transmitter installed in the box. Note the method of mounting the antenna and the battery.

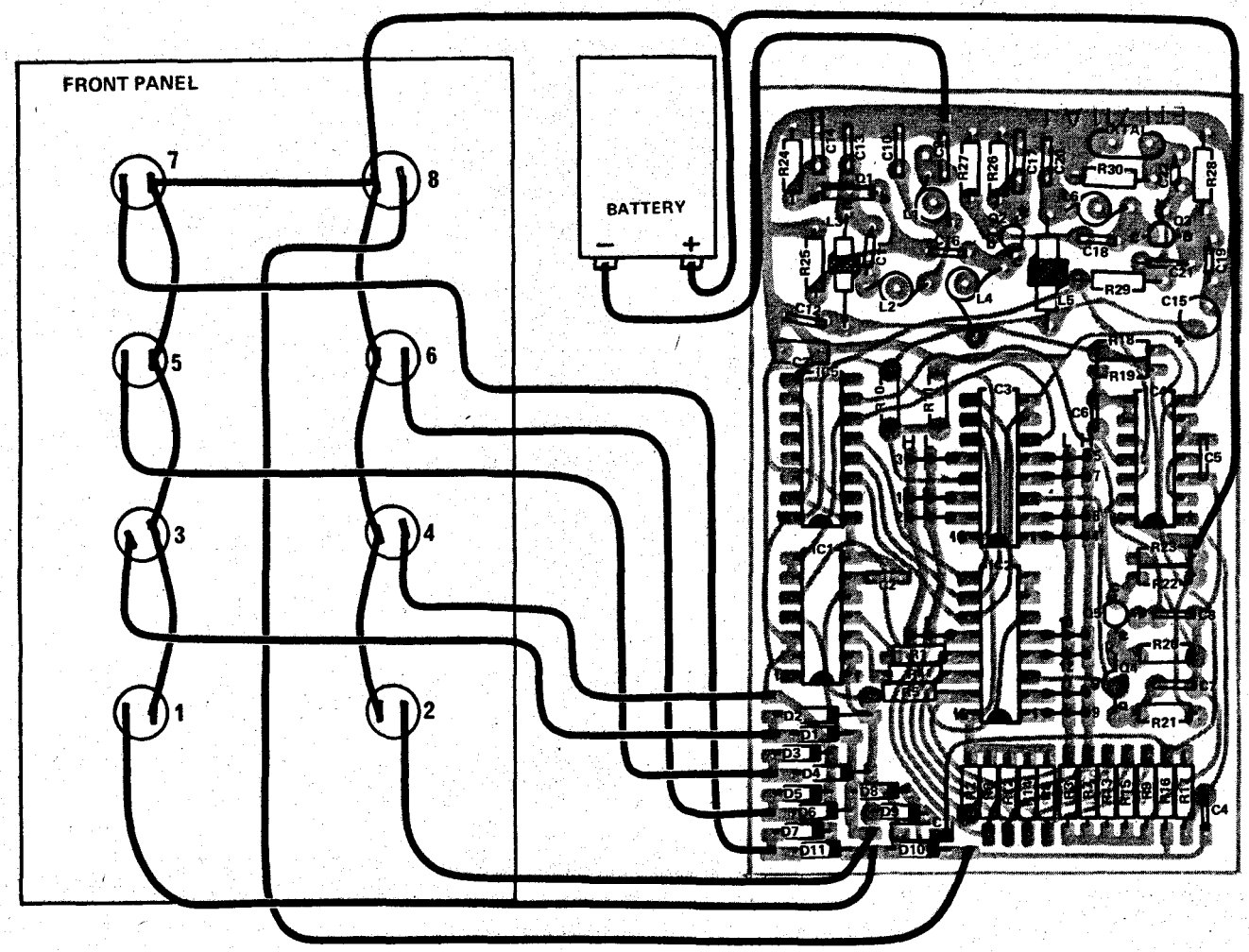

Fig. 7. Component overlay and wiring diagram. Note that links from IC2 and IC3 to the 'H' or 'L' lines. You must decide on the code word to be used and link to one or the other as detailed in the text. Overlay is shown larger than full size for clarity.

PARTS LIST ETI 711

Resistors

R1	100k	¼W	5%
R2	82k	"	"
R3	27k	"	"
R4,5	100k	"	"
R6,7	39k	"	"
R8	82k	"	"
R9,10	39k	"	"
R11	120k	"	"
R12	82k	"	"
R13	39k	"	"
R14	82k	"	"
R15	39k	"	"
R16	2M2	"	"
R17	100k	"	"
R18	3M3	"	"
R19	27k	"	"
R20	100 ohms	"	"
R21	330k	"	"
R22	10k	"	"
R23	47k	"	"
R24	5.6 ohms	"	"
R25	220 ohms	"	"
R26	12 ohms	"	"
R27	270 ohms	"	"
R28	330 ohms	"	"
R29	22k	"	"
R30	1k	"	"

Capacitors

C1-C3	33n		polyester
C4	15n		"
C5	56n		"
C6 – C8	10n		"
C9	47p		ceramic
C10	330p		ceramic
C11	270p		"
C12	10n		"
C13	68p		"
C14	10n		"
C15	33μ	16V	electro
C16	120p		ceramic
C17	10n		"
C18	220p		"
C19	39p		"
C20	10n		"
C21	33p		"
C22	470p		"

Semiconductors

D1 – D11	1N914 or similar
IC1	4001
IC2, 3	4051
IC4	4001
IC5	4520
Q1	BD139
Q2, 3	BC549
Q4	2N6027
Q5	BC548

Switches

PB1 – PB8	Miniature push buttons

Coils

L1,2,4,6	10 turns of closely spaced 24 gauge tinned copper wire wound on 5 mm diameter, 18 mm long coil formers (Neosid 722/18) with 6 mm long coil slugs.
Note L2 has no slug (Neosid 4 x .05 x 6/F29)	
3 PTFE Locking Strips	
L3, L5	150μH R.F. chokes

Miscellaneous

PC board ETI 711
Aluminium bracket to Fig. 4
Plastic box
Front panel to fig 10
Telescopic antenna
9 volt battery
2 6BA x 3/8 bolts & nuts
Battery clip
27 MHz crystal in the band 26.975 MHz to 27.282 MHz.

REMOTE CONTROL TRANSMITTER

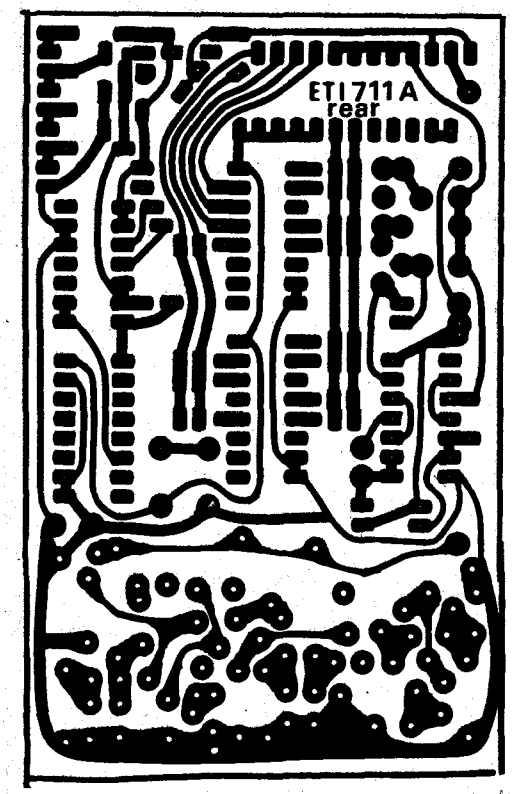

Fig. 8. Printed circuit layout for the rear side of the transmitter board. Full size 100 x 62mm

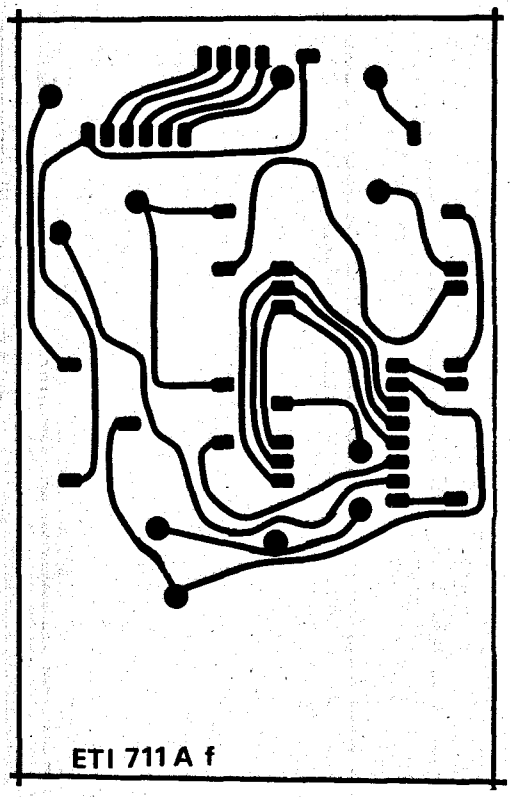

Fig. 9. Printed circuit layout for the component side of the transmitter board. Full size 100 x 62mm

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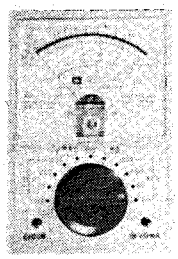
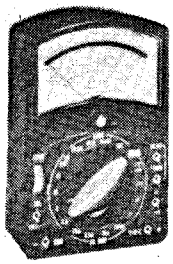


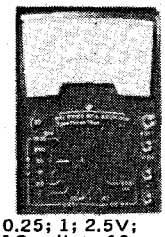
MODEL C1000M MULTIMETER Compact, handy and versatile, the C1000M is the ideal low cost pocket meter. Mirror Scale. **Specifications:** 1,000 Ohm/Volc DC; 1,000 Ohm/Volt AC; DC volts — 10; 50; 250; 1,000; AC volts — 10; 50; 250; 1,000; DC amps — 1 mA; 100 mA; Ohms — 150 KΩ; Centre scale — 3 KΩ; Decibel — 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 protested 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.

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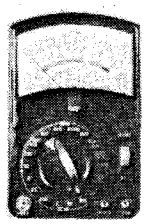

MODEL AS100 D/P MULTIMETER. This meter features double zener diode meter protection and 3½" full view easy to read 2 colour scale. It is fitted with polarity reversing switch and housed in a strong moulded case with carrying handle. **Specifications:** 100,000 ohm/volt DC. 10,000 ohm/volt AC. DC volts — 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.

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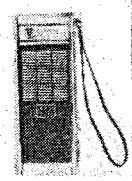

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- **EXTERNAL AERIAL CONNECTION**

SPECIFICATIONS, NC-310

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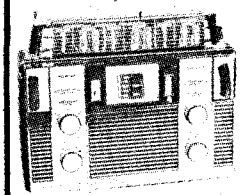

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SPECIFICATIONS: Frequency Range: 120kc/s — 500mc/s (6 Fundamental Bands and 1 Harmonic Band). Frequency Accuracy: ± 2%. Audio output: to 8 volts. Internal Modulation: Approx. 400c/s. Tube complement: 12BH7A, 6AR5, Silicon Diode and Germanium Diode. 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.

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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.

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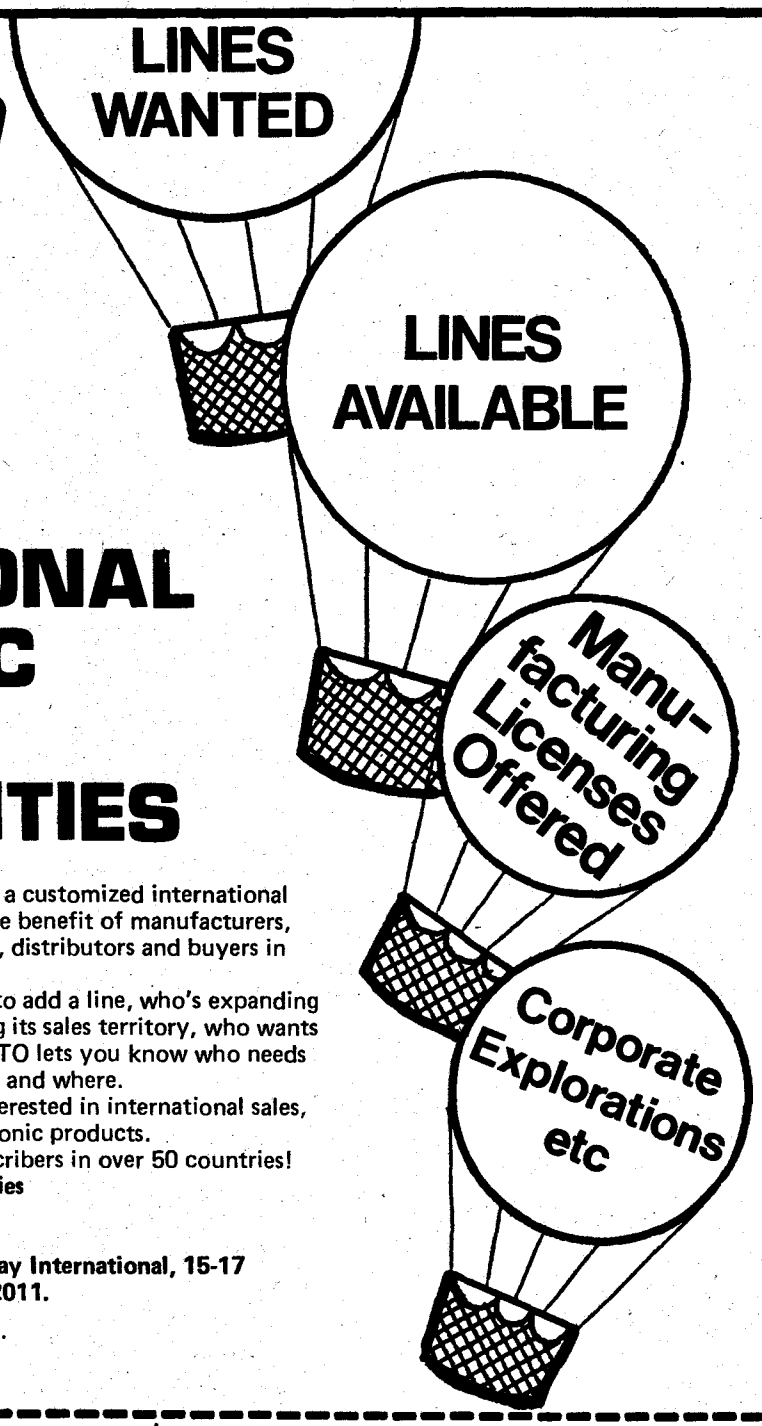

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GENERAL PURPOSE PREAMPLIFIER

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

WE HAVE HAD MANY REQUESTS for the circuit of a simple preamplifier module suitable for fitting into an existing system. The requirements differed – many people required a module to amplify a magnetic pickup, whilst others wanted a unit that could be used for a tape recorder or microphone.

Whilst these requirements usually require different circuitry, a preamplifier based on the LM382 IC can be made to do any one of these jobs simply by changing a few components around the basic amplifier circuit. As a straight preamplifier the frequency response extends to well beyond 20 kHz and gains of 40, 55 and 80 dB can be selected by means of simple component changes.

To use the preamplifier for your application select the appropriate component values as detailed in Table 1.

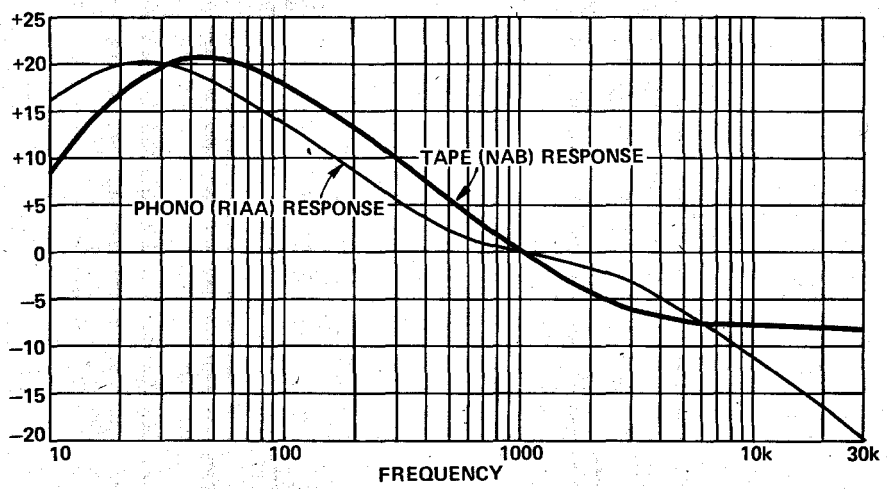


Fig. 1. Frequency response of the NAB and RIAA versions of the preamplifier.

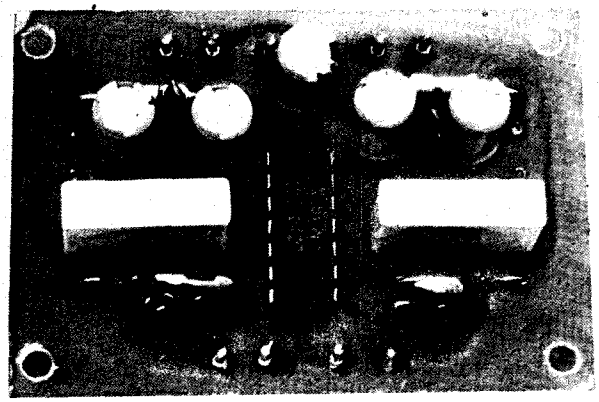
TABLE 1.

FUNCTION	C3, 4	C5, 6	C7, 8	C9, 10	R1, 2
Phono preamp (RIAA)	330n	10μ	10μ	1n5	1k
Tape preamp (NAB)	68n	10μ	10μ	–	–
Flat 40dB gain	–	–	10μ	–	–
Flat 55dB gain	–	10μ	–	–	–
Flat 80dB gain	–	10μ	10μ	–	–

Construction

Strictly speaking a printed circuit board is not necessary and any method, such as Veroboard or Matrixboard, may be used if desired. However, the neatness and ease of construction offered by the use of a proper printed-circuit board cannot be matched.

After determining what components are required from Table 1, assemble the board as shown in the component overlay diagram. The input cables must be shielded as the signals at the input are at very low levels. If trouble with hum pickup is encountered it may be necessary to mount the whole preamplifier in a metal box to shield it.



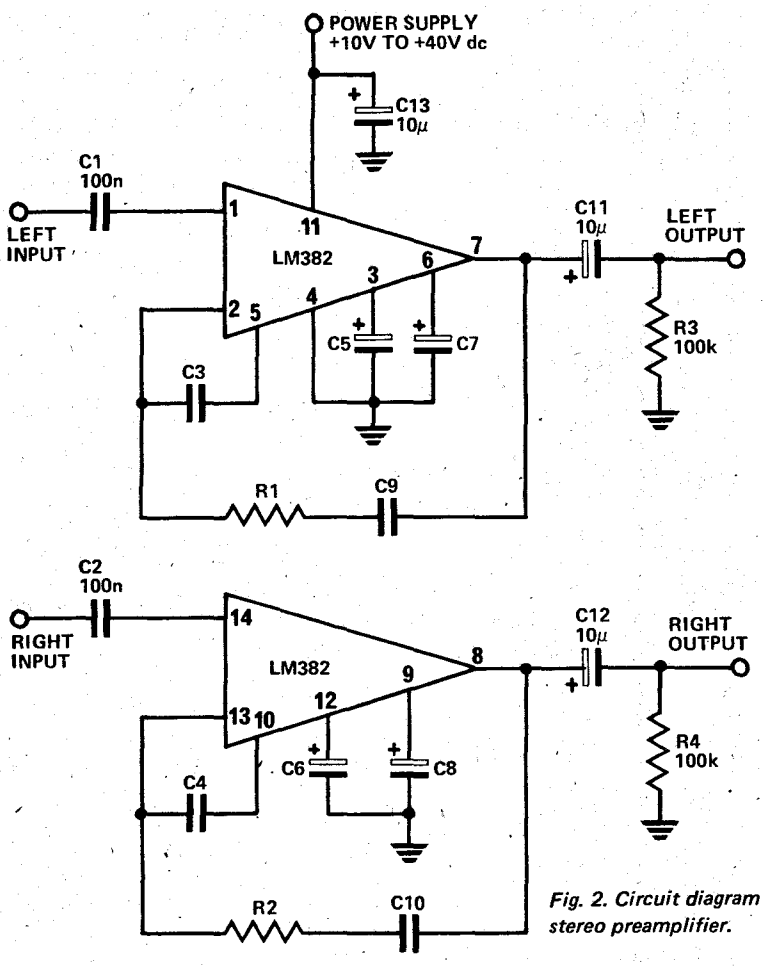


Fig. 2. Circuit diagram of the stereo preamplifier.

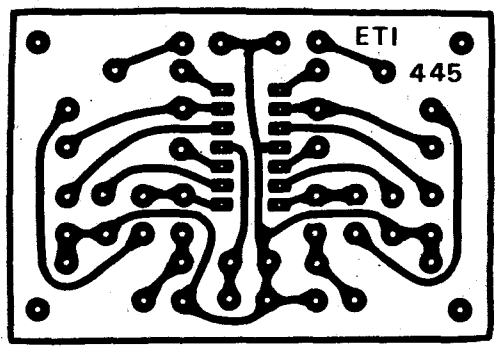


Fig. 3. Printed circuit layout. Full size.

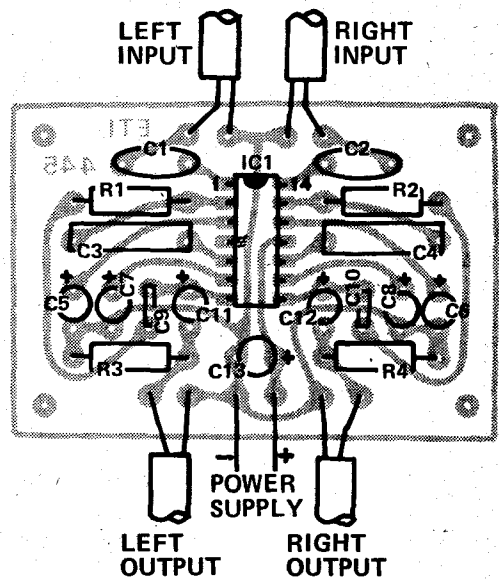


Fig. 4. Component overlay.

PARTS LIST – ETI 445

Resistors

R1, 2	see table 1	
R3, 4	100k	½watt 5%

Capacitors

C1, 2	100n polyester
C3 – C10	see table 1
C11-C13	10μ 25V electro

Note that C13 should be rated at 50 V for supply voltage above 24V

IC1	integrated circuit LM382
PC board	ETI 445

10 PC board pins.

How it works

Not much can be said about how the LM382 works as most of the circuitry is contained within the IC. Most of the frequency-determining components are on the chip – only the capacitors are mounted externally.

The preamplifier may be powered by any dc voltage between 10 and 40 volts, the output being automatically biased to about +6 volts. Due to this bias the output must be decoupled from the following stages and this is done by C11, 12 and R3, 4.

The LM382 has the convenient characteristic of rejecting ripple on the supply line by about 100 dB, thus greatly reducing the quality requirement for the power supply. Thus the power rails of the main amplifier may be used if accessible.

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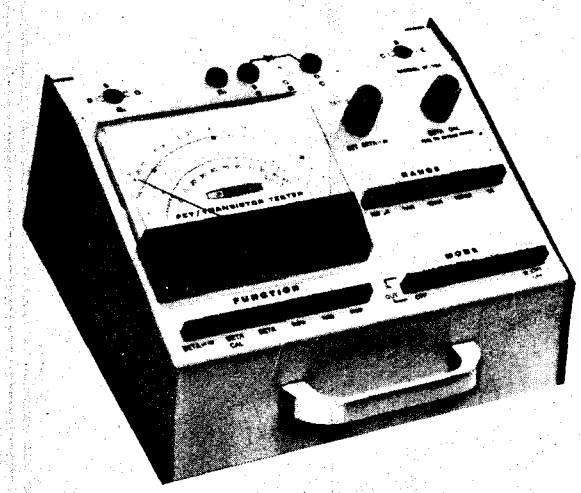

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IT-121 Specifications – DC Beta: 1 to 5000 in ranges of 1 to 50, 5 to 250, 10 to 500, 50 to 2500, 100 to 5000. **Collector currents available:** 1 mA, 5 mA, 10 mA, 100 mA, 500 mA, and 1A. Gm: 0 to 5000 μmhos. **Leakage measurements:** Five ranges, 0 to 100 μA, 0 to 1 mA, 0 to 10 mA, 0 to 100 mA, 0 to 1 A. **Out-of-circuit accuracy:** ±5% for DC beta and leakage. **In-circuit accuracy:** Indicates good or bad transistor, FET, diode, SCR or Triac. **Diode test:** Tests for forward conduction and blocking. **Unijunction transistor test:** Measures Veb_2S, Rbb, and emitter current (out-of-circuit). **Power requirements:** Two 1½ V cells, (alkaline for best performance). **Dimensions:** 5" H x 9-7/16" W x 8-1/8" D.

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TDK SA breakthrough in tape technology

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"

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 characterists 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.

TDK

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ETI data sheet

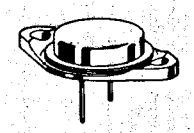
MJ2955 pnp silicon power transistor

The MJ2955 is the usual pnp complement of the 2N3055 but there are some *differences, the* most obvious being the higher thermal limit which means the maximum power dissipation of the device is 150 W (compared to 115 W for the 2N3055).

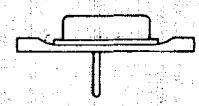
The MJ2955 is in a metal package but plastic types are available: MJE2955 (90 W) and TIP2955 (90 W). The safe operating area graphs should be studied before using these types.

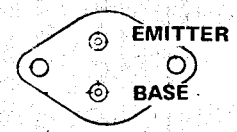
This transistor has been used in quite a few ETI projects: ETI541 Train controller, ETI Swimming pool alarm, ETI422 Fifty watt amplifier.

MJ2955 package



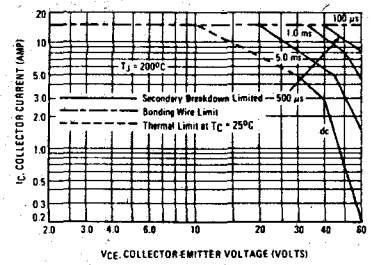
TO 3



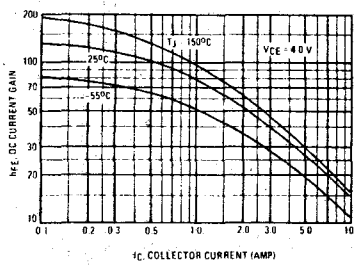


COLLECTOR connected to mounting base

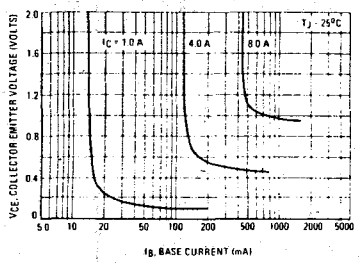
MJ2955 safe operating area



MJ2955 DC current gain



MJ2955 collector saturation region



MJ2955
QUICK REFERENCE DATA

Maximum ratings		
Collector-emitter voltage (V_{CEO})		60 V
Collector-emitter voltage (V_{CER})		70 V
Collector-base voltage (V_{CB})		100 V
Emitter-base voltage (V_{EB})		7 V
Collector current (continuous) (I_C)		15 A
Base current (I_B)		7 A
Power dissipation (P_D)		150 W
Off Characteristics		
Collector-emitter sustaining voltage (I_C = 0.2 A, I_B = 0)	V_{CEO} (sus)	min. 60 V
Collector-emitter breakdown voltage (I_C = 0.2 A, R_{BE} = 100 ohms)	BV_{CER}	min. 70 V
Collector cut-off current (V_{CE} = 30 V, I_B = 0)	I_{CEO}	max. 0.7 mA
Emitter cut-off current (V_{BE} = 7 V, I_C = 0)	I_{EBO}	max. 5 mA
On Characteristics		
DC current gain	h_{FE}	
(I_C = 4 A, V_{CE} = 4 V)		min. 20; max. 70
(I_C = 10 A, V_{CE} = 4 V)		min. 5
Collector-emitter saturation voltage	V_{CE} (sat)	
(I_C = 4 A, I_B = 0.4 A)		max. 1.1 V
(I_C = 10 A, I_B = 3.3 A)		max. 3 V
Base-emitter on voltage (I_C = 4 A, V_{CE} = 4 V)	V_{BE} (on)	max. 1.8 V
Dynamic Characteristics		
Current gain — bandwidth product (I_C = 0.5 A, V_{CE} = 10 V, f_{test} = 1 MHz)	f_T	min. 4 MHz
Small-signal current gain (I_C = 1A, V_{CE} = 4 V, f = 1 kHz)	h_{fe}	min. 15
Small-signal current gain cut-off frequency (V_{CE} = 4V, I_C = 1 A, f = 1 kHz)	$f_{\alpha e}$	min. 10 kHz

Safe operation

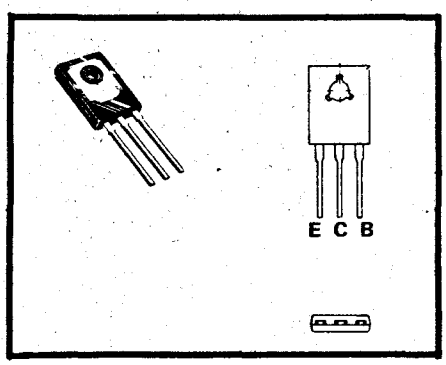
For the three types we have mentioned in this data sheet we have printed the most important graph of a transistor's operating characteristics: the active-region safe operating area graph. These graphs show the different limits on use of the plastic and metal types, and the experimenter ought to be familiar with their interpretation.

There are two limitations on the power handling ability of a transistor: average junction temperature and second breakdown. Safe operating area curves indicate IC — VCE limits of the transistor that must be observed for reliable operation, i.e., the transistor must not be subjected to greater dissipation than the curves indicate.

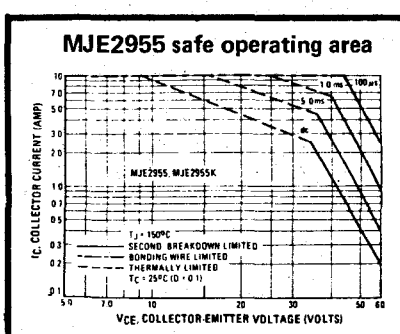
Second breakdown pulse limits are valid for duty cycles to 10%. At high case temperatures, thermal limitations may reduce the power that can be handled to values less than the limitations imposed by second breakdown.

NOTE Beware using transistors with these type numbers followed by suffix 1 or suffix 2. These are low voltage rejects and it is important to establish their limits before using them in power circuits.

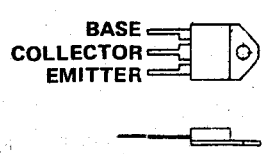
MJE2955



MJE2955 safe operating area

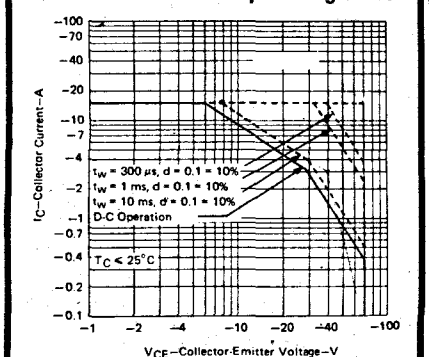


TIP2955

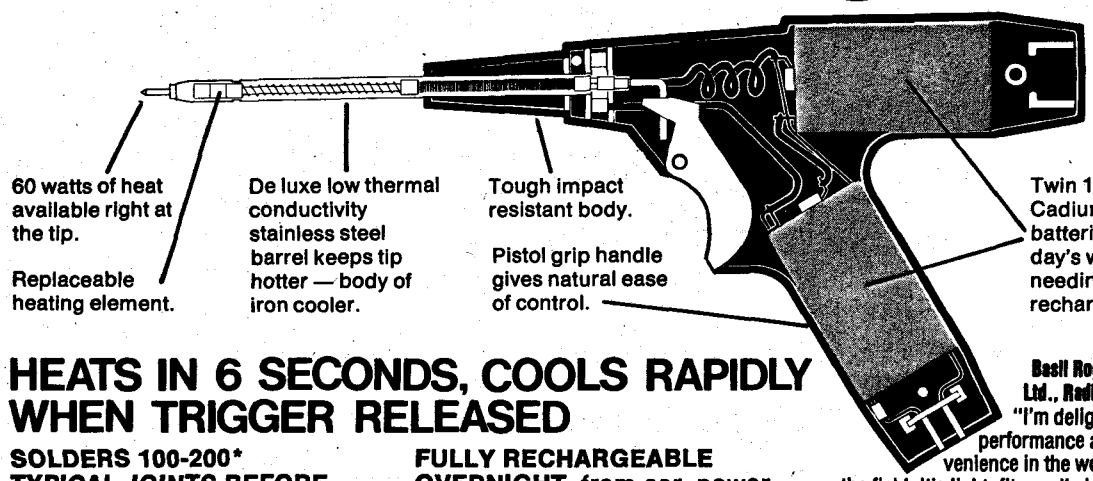


The collector is in electrical contact with the mounting tab.

TIP2955 safe operating area.



Scope Cordless 60w Soldering Tool



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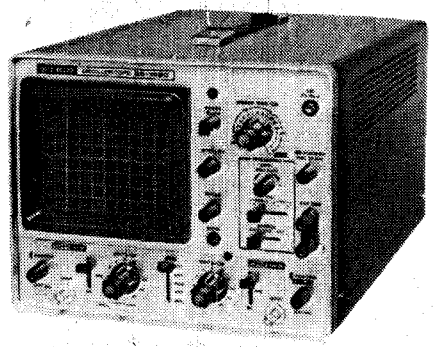

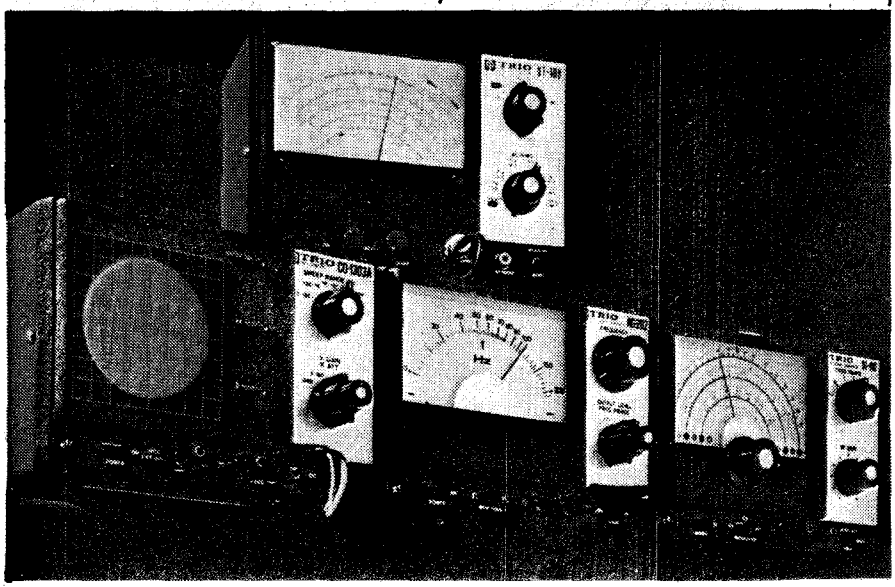

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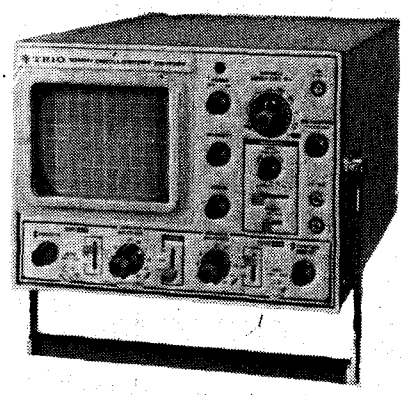

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PART 32

Transmission links and coupling.

ELECTRONIC systems consist of basic analogue and digital subsystems interconnected to provide the required overall input-output relationships. It is important for the various subsystems to be interfaced correctly if they are to perform as intended. But with this condition satisfied, one cannot just assume that subsystems merely connect together without need to consider any other parameters in the interconnection process.

In practice the individual circuit assemblies may be geographically apart — such as the remote control of off-shore oil wells by a shore-based computer, the recording of test data from a missile, the control of banking accounts by a central computer centre or the sensors of a refinery which connect to the central control room. Each of these required some form of telemetry system. (Telemetry was introduced in part 5 of this series).

When making connections it is also important, especially when noise sources are present that will interfere with the signal, to ensure that the signal is transferred from stage to stage without significant noise pick-up or signal degradation.

TRANSMISSION LINKS

Several different transmission methods exist in which the signal is confined — open wires, coaxial cables and waveguides, optical fibres etc. Alternatively, information can be transferred via open radiation paths — radio, optical or acoustic links. The required signal bandwidth is one of the primary factors deciding which method is used. In radiation methods it is often necessary to use a carrier frequency higher than the signal bandwidth dictates because low frequency carriers will not radiate as well for the same amount of transmitted power.

Confined Signal Links: The simplest links are formed using an open-wire circuit (supported on insulators) or a multicore cable (such as is used in local telephone distribution).

Although apparently trivial, lines may, in fact, be an important part of the system. They are not as simple as they first appear because they have a frequency response that must be adequate for the signal bandwidth to be transmitted. Open-wire lines would not normally be used beyond 10 MHz. Above that coaxial cables are needed — these are useful to about 5000 MHz.

When currents flow in a conducting line, magnetic and electric fields are set up around the wires. Figure 1 shows these plotted for the various kinds of cable. Open configurations radiate energy, the amount increasing with the frequency of the signal. A line is, in reality, a distributed inductance and capacitance component which also has losses due to the resistance of the wire and the resistance to ground. Figure 2 shows how lines can be considered as a lumped-element equivalent circuit which can be analysed more easily. Depending upon the factors that are negligible for a particular case the equivalent can be reduced to simpler circuits — see Fig. 3. For example, at very low frequencies (less than say 100 kHz) a medium length line may be represented by the series resistance of the cable shunted by the capacitance of the line. Typical cables may have a resistance of around 0.05 ohm per metre and a capacitance of 100 pF per metre. Hence a long length of shielded or open cable could provide a considerable shunting effect that attenuates and phase shifts the signal.

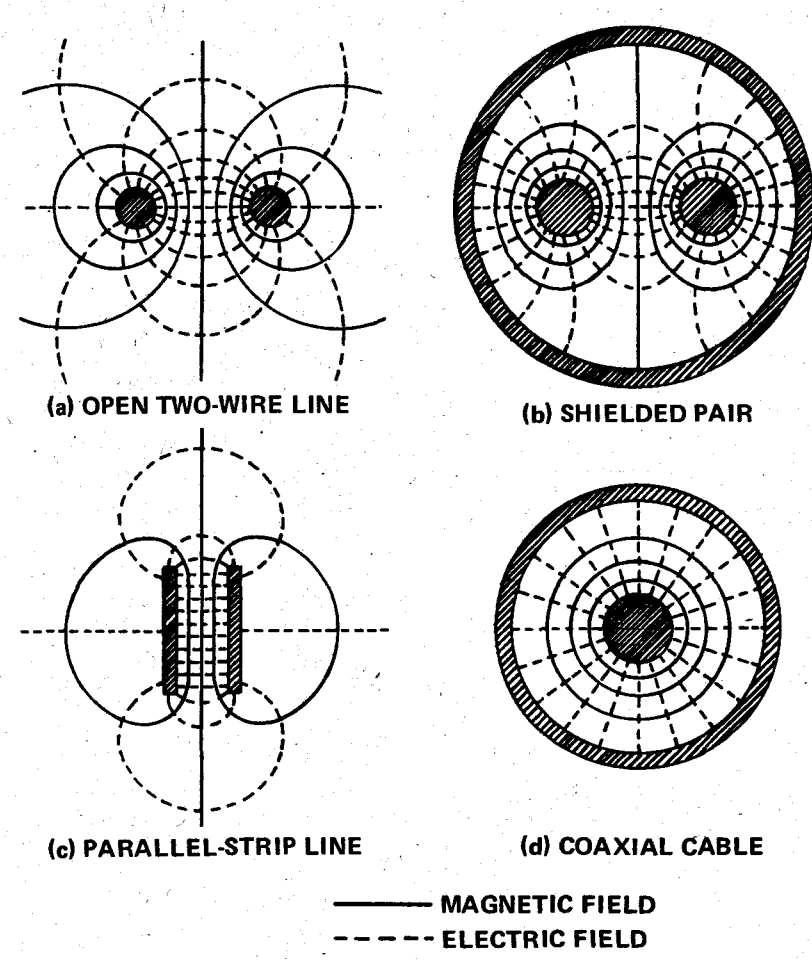


Fig. 1. Currents flowing in signal wires generate electric and magnetic fields. Enclosed configurations can be used at higher frequencies because these fields are contained.

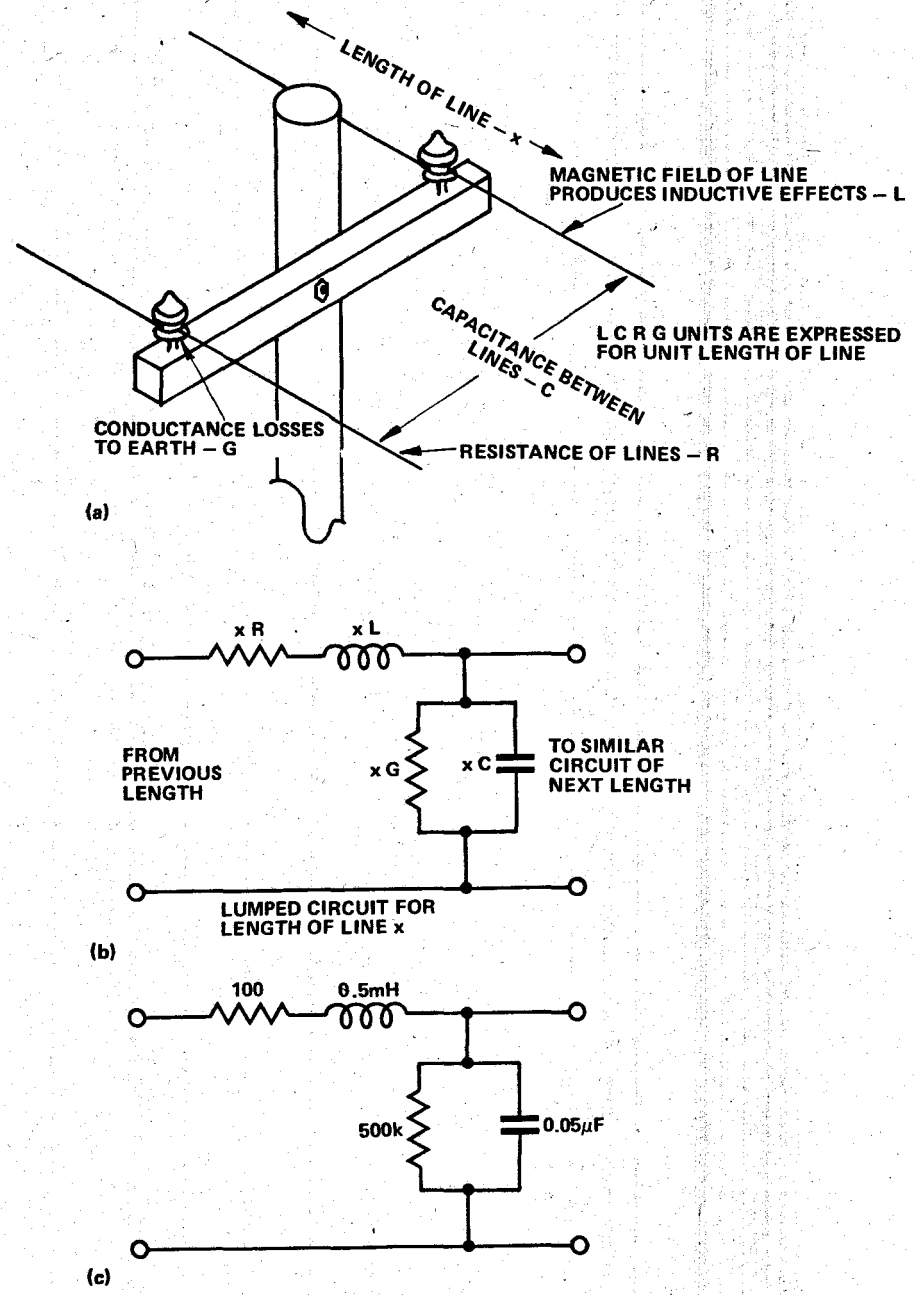


Fig. 2. Transmission links are systems in which R, L and C are distributed uniformly over the length. For convenience we can consider the line as being composed of cascaded lumped-equivalent elements.
(a) A length of low frequency telephone line.
(b) Approximate lumped-element equivalent.
(c) Representation values for 1 km. of medium-size telephone line with earth return. (Actual constants vary widely depending upon design of line).

When connecting high output-impedance sensors to lines, as little as one metre of cable may be sufficient to markedly attenuate the signal. It's a matter of applying Ohms law to the suitable equivalent circuit.

Because of the reactive effects of the cable the higher frequency signals transmitted will be degraded more than the low frequencies — for example, square waves become rounded as well as attenuated. The high-frequency performance of the line may be improved by "loading" it with inductors placed at regular intervals. The inductance value is chosen to tune out the inherent capacitive reactance at the upper frequency where response begins to fall off, a method that extends the bandwidth some way beyond the inherent unloaded upper limit. This is used, for example, to broaden the bandwidth of submarine cables.

The coaxial cable, shown in Fig. 4, by virtue of the surrounding external shield (Fig. 1) acting as the second wire, has no external field and, therefore, does not radiate energy. Because of this a well designed coaxial cable will pass from dc to microwave frequencies — that is, such a cable can have a bandwidth of about 5000 MHz. Coaxial cable is, therefore, potentially able to transfer much more information than open wires. It does however need a common earth connection (asymmetric) and can't be used in a balanced mode (see later). The bandwidth of practical coaxial cables is limited by resistive and dielectric losses. In practice waveguides are generally used at frequencies above 1000 MHz or so.

Waveguides consist of precise pipework — they look as if they had been made by a precision plumber! Waveguides carry travelling electromagnetic waves of very high frequency and behave vaguely in the same way that pipes carry water. They cannot however be used for low frequency transmission.

The cross-sectional area of a waveguide is inversely proportional to the design frequency. As a general rule of thumb guide the upper frequency limit of a waveguide is where the wavelength of the signal becomes one quarter of the guide aperture — millimetre wavelength signals (50 GHz or so) being the practical upper limit.

Beyond this, a still wider bandwidth is obtainable using optical fibre transmission elements which will pass radiation in the visible light region (10^{14} Hz to 10^{15} Hz). At our current state of technology, however, scientists have only been able to detect the frequencies of far infra-red signals (around 10^{11} Hz). We cannot, as yet, monitor individual cycles of light with electronic detectors.

When the losses of the line are insignificant (G=0, R=0, in Fig. 2b) the lumped-equivalent of the transmission lines reduces to L in series and C shunting, as shown in Fig. 3b. The nett result is, rather surprisingly, that the line exhibits only resistance of a fixed value when looking into the ends. This is called the characteristic impedance, Zo, for which Zo = (inductance per unit-length/capacitance per unit length) ½. The line appears to be purely resistive and the Zo value is decided by the design of the line or

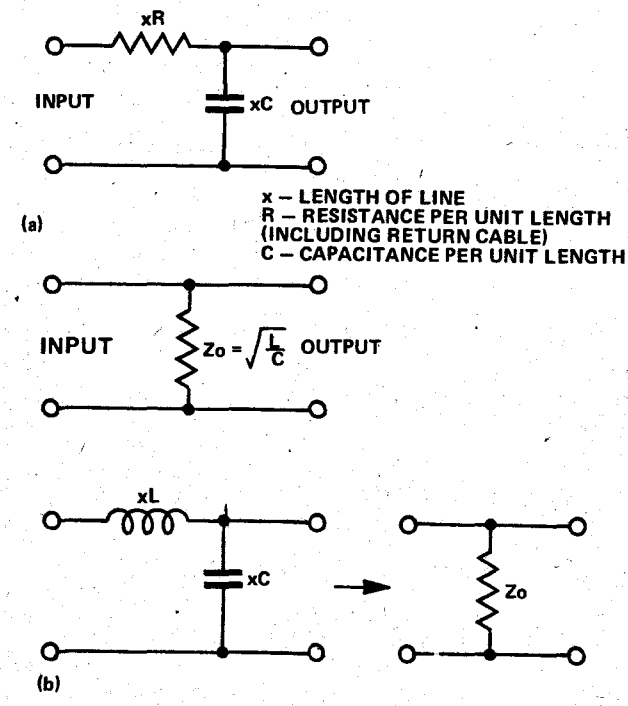


Fig. 3. In certain practical cases the lumped equivalent reduces to simpler situations situations.
(a) Low frequency (negligible L assumption) short line in which only C and R are dominant. The R, C values are found from maker's data.
(b) High frequency lossless line (negligible R and G assumptions). The input and output impedances of the line are equal and constant regardless of length.

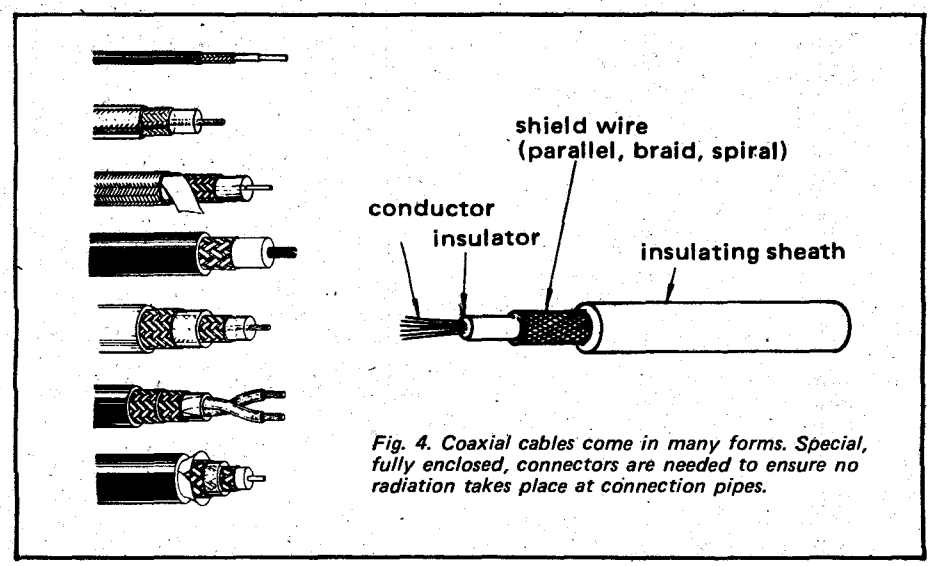


Fig. 4. Coaxial cables come in many forms. Special, fully enclosed, connectors are needed to ensure no radiation takes place at connection pipes.

cable, not by its length! Examples are 600 ohm telephone lines, 75 ohm colour TV coaxial feeder cable. This means, in practice, that we can interconnect units on the basis of matching all connections to the Zo of the cable without having to worry about the cable length. If this rule is observed, no high-frequency energy will be reflected at the termination to change the information being transmitted. (The need for correct matching was also mentioned in the previous discussion about filters). However, if the line is very long matching must still be applied to obtain maximum transfer, but account must now be taken of losses. For example a typical 75 ohm coaxial cable will have losses of the order of 2 to 5 dB per one hundred metres.

Radiation Links: Electrical signals fed into open wires radiate energy out into the surrounding medium. As well as this radiated energy there also exists a "near field" that remains established, storing energy. This is the field we associate with, say, an electromagnet. As the frequency rises, the ratio of radiated energy to stored energy increases. For this reason we are able to build efficient radio systems provided the frequency is kept above 100 kHz or so. Lower frequencies can be used as transmission systems but the power input needs rise enormously for the same distance radiated in free space. (The Omega navigation system uses extremely powerful VLF signals because of their ability to penetrate deep into the waters of the ocean) Beyond the gigahertz frequency region, circuitry becomes impracticable with current technology.

Even though the radiated energy must be at a very high frequency to operate efficiently we may not necessarily need to use the bandwidth available on the carrier. The modulation techniques we met briefly in Part 5 are used to super-impose a relatively narrow bandwidth signal onto the carrier. It might be thought that optical and infra-red links use extremely high carrier frequencies (330 000 GHz for red light) but in these applications the carrier is not modulated on an individual cycle basis but rather as variation of a continuous dc link. Figure 6 shows what might be the first electro-optical link – its bandwidth would have been barely 150 Hz. In contrast, Fig.7 is a modern link designed to transmit television plus speech commands – a bandwidth of 7.5 MHz. Acoustic links using soundwave propagation operate with frequencies as low as 10 Hz to well above the 10 MHz region. These can be modulated on the individual cycle basis.

Skin Effect: The alternating magnetic field produced around a wire has the effect of causing the current flowing in the wire to flow at a greater density in the outer region of the wire. The higher the frequency the more pronounced this so-called skin-effect. At the very high frequencies so little current flows in the centre of the cable that the centre is often omitted completely, thus a tube is used as a conductor. For example, at 1 MHZ the majority of the current flows in a copper cable to a depth of only 60μm whereas at 60 Hz the distance would be 8.6 mm depth. This also means that the effective resistance of a wire rises significantly with frequency – by factors of 100.

Process Industry Telemetry Links: Process plants such as oil refineries, paper mills, brick kilns, power stations and aluminium refining plants are monitored by using hundreds of sensors connected to the control-room area via instrumentation links. These are invariably wired using shielded wire or coaxial cable. Because of the extreme electrical noise level of such plants and low output signal level of the sensors these links could pick up significant noise thus degrading the

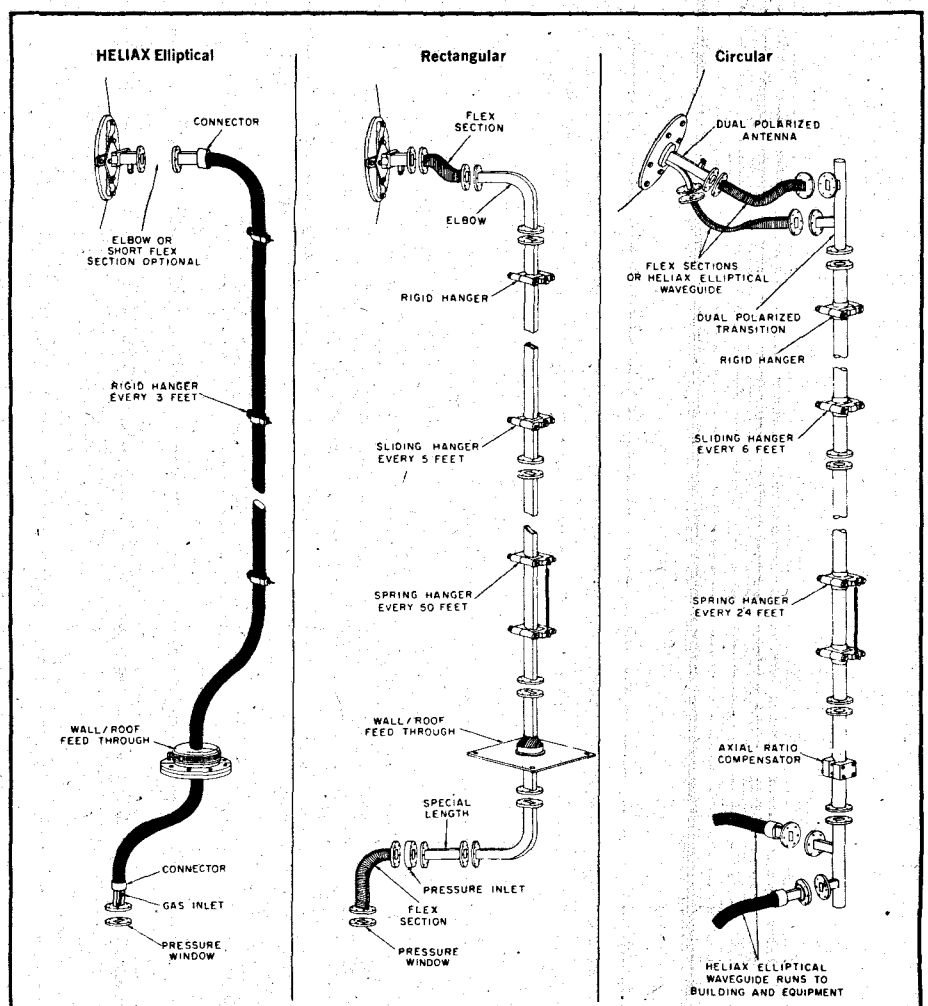


Fig. 5. Waveguides transmit electro-magnetic energy via travelling fields that are conveyed through the pipework. These are three forms of antenna feeder offered by Andrew Antennas.

sensor information. Over the years process instrument suppliers have standardised the design of the control systems, and their installation and noise pick-up by the cable has been avoided by several methods.

The first strategy is to superimpose the information signal onto a standing current or voltage thus raising the wanted signal level above expected noise levels. The two systems commonly used transmit the signal range of the data through 4-20 mA dc or 10-50 mV dc systems. An 0-20 mA system is also common. Current transmission has the advantage that the circuit is of low impedance — a few ohms — which reduces the level of induced noise power. Figure 8 is an example of these practices — Honeywell's arrangements used to test the temperature and pressure of natural gas wells in the Leman Field of the North Sea.

Safety Precautions: Often the sensor has to be placed at a location where an explosion could result from a spark or excessive overheating of a malfunctioning sensor circuit. The most obvious way of overcoming this is to place the whole unit in an explosion-proof enclosure. This, however, has disadvantages: the cost is high, and testing and maintenance difficult due to the need to shut off the power when the enclosure is opened.

The alternative, more modern, method is known as intrinsic safety. As inflammables require a specific level of energy to ignite them, explosion can be prevented by ensuring that the sensor stage cannot, under any conditions, provide enough ignition energy. No enclosures are

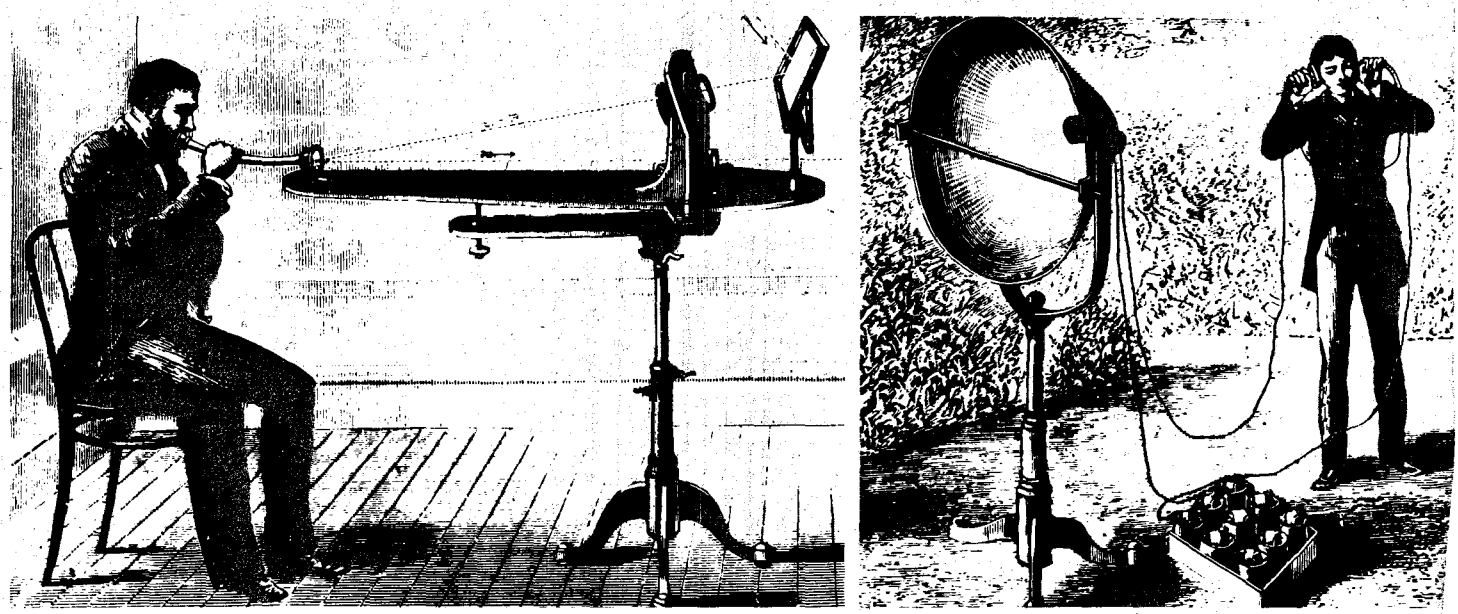
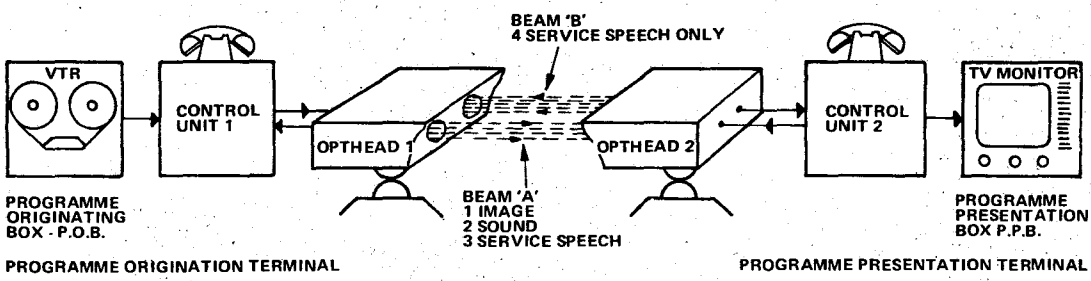


Fig. 6. This Photophone of Bell and Tainter was designed in 1881. Sunlight reflected to the receiver was modulated by acoustic waves vibrating the speaking tube mirror. Detection was with a selenium photo-electric cell driving earphones.



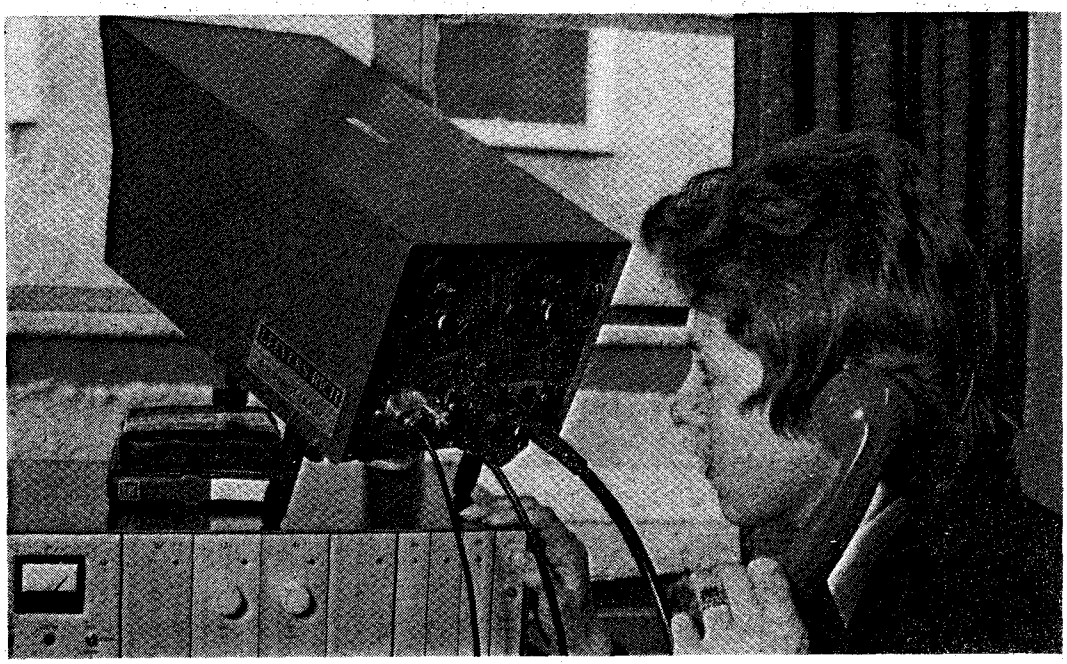


Fig. 7. Schematic with photograph of the optohead of a Leevers-Rich opto-electronic communication link. The output from a light emitting diode is modulated by the incoming signal. The receiver detects the modulation with a solid-state photo-detector.

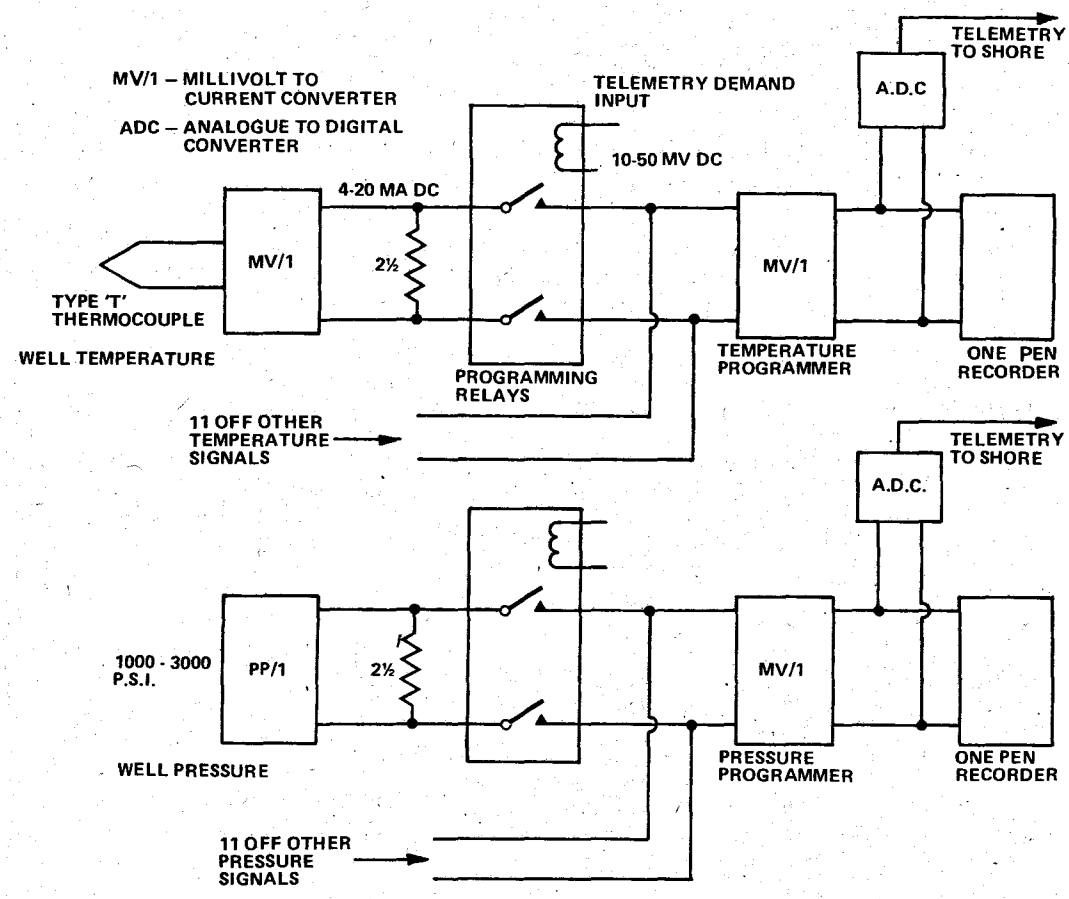


Fig. 8. Process measurement link arrangements used between the oil-well and the off-shore platform. The A/D units send the data to a shore-based computer by digital telemetry links.

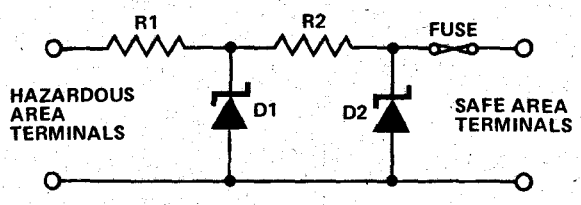
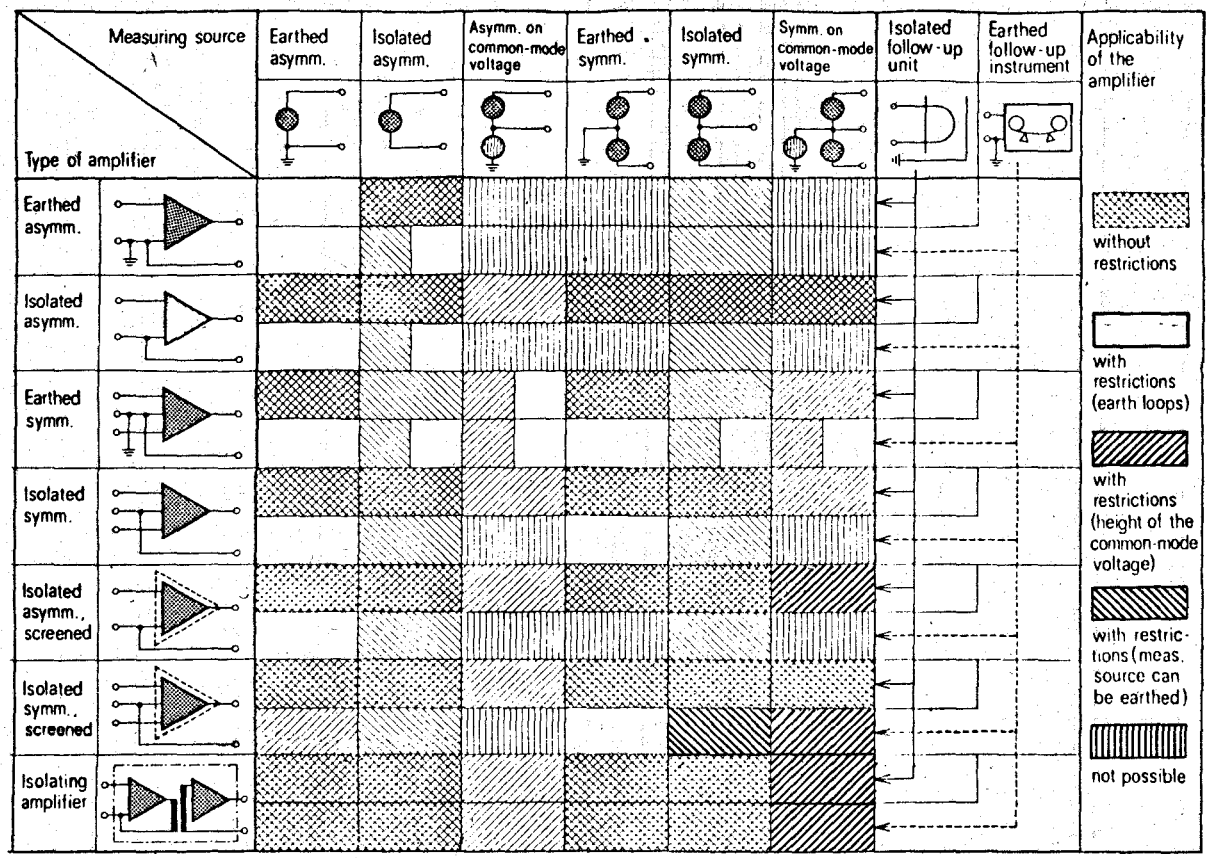


Fig. 9. Circuit used in a Zener barrier.

Fig. 10(a). Chart showing common combination possibilities of various output to input cascaded schemes incorporating amplifier stages of various kinds between the first stage and the two commonly used output recording/monitoring connections. (Courtesy Siemens Industries).



needed and the circuit can be maintained whilst it is operating. Originally the concept was implemented by ensuring the sensor circuitry could not draw, or produce via storage, more than a specified power level. This level was found by experiment in a test rig set up for the situation involved.

The more recent idea is to use "safety barriers". At the exit from the declared hazardous area, the cables terminate into a zener-diode and attenuator arrangement which ensures that the current and voltage entering the area are limited to safe values. Figure 9 shows the circuit of a zener barrier. Another safety device uses a solid-state closely-coupled electro-optic link which provides dc electrical isolation between its input and output, the information being transferred from a light-emitting-diode mounted next to a silicon photo-diode detector. These ensure that overvoltage or induced earth-loop currents cannot enter the isolated hazardous area.

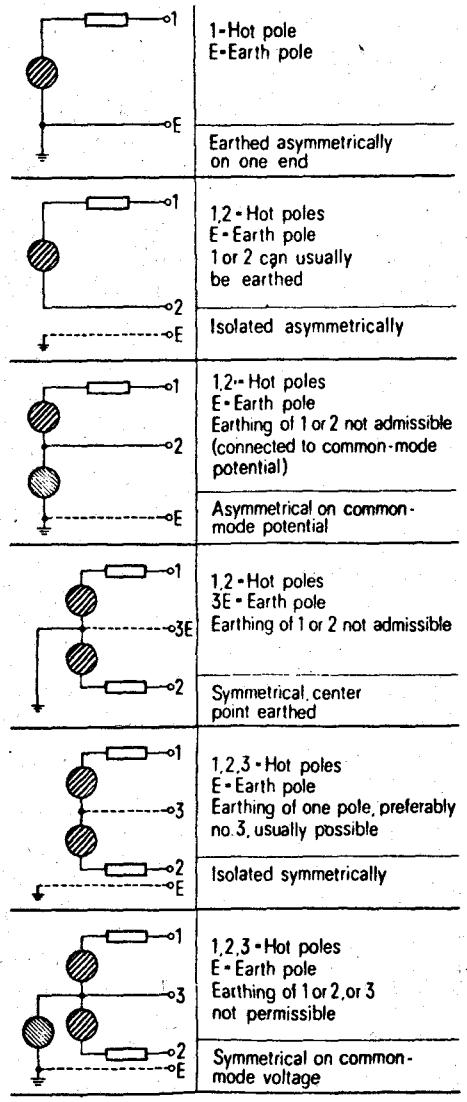
In electro-medical instrumentation, safety precautions of another kind are vital to ensure the sensor does not act as a pathway for a dangerous level of electric current into the patient. At 240 Vac the human body's resistance, hand to hand is around 2000 ohms — 100 mA will flow. If totally connected (as by a conducting fluid) the resistance reduces to 200 ohm — 1 A will flow. About 75 mA through the body will produce heart fibrillation; only 150μA, through the heart itself, is needed to produce this effect. A person can usually hold (with the fingers) and release as much as a 10 mA, 240 Vac current — beyond that the muscles become paralysed. Skin moisture largely decides the hand to hand resistance. When dry it will be (at 240 V) 2500 ohms and moist, 1000 ohms. *Thus a hand-to-hand 240 V encounter will provide a shock at least double the fibrillation level!*

The instrumentation must, where the metal parts are earthed, be wired with the active, neutral and earthing wires connected correctly. Double-insulated systems avoid this problem. Earth-leakage balanced — core breakers are worth using. These defect minute difference currents in the active and neutral, tripping a breaker if they rise above milliamperes.

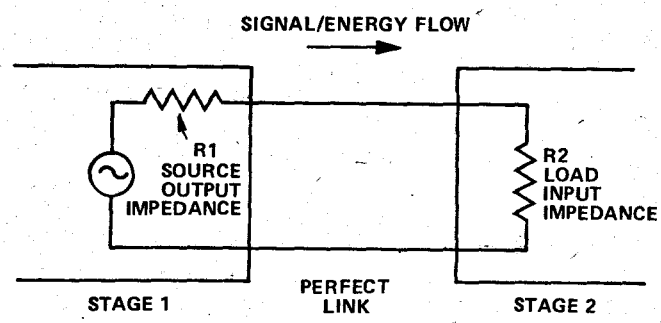
The sensor attached to the patient must not be capable of providing a lethal level of energy by means of feedback from the instrumentation. The reading list provides more detail of safety factors in electro-medical instrumentation.

COUPLING STAGES

Connection arrangements: As was pointed out in the discussion of meters, in Part 3, electronic sub-systems must be cascaded



(b) Extra detail of source arrangements.



Matching requirement	relative R1, R2 values
Maximum energy transfer	R1 = R2
Maximum voltage signal transfer (least voltage loss across R1)	R2 >> R1
Maximum current signal transfer (least current change due to R2)	R1 >> R2

Fig. 11. Summary of impedance values for various matching requirements.

intelligently or loading of the output of a stage by the input impedance of that following may degrade the signal. Output configuration of the various stages involved in instrumentation can take many forms depending on how the earth is connected and if the signal is symmetrical or assymmetrically connected. The six commonly encountered source output schemes are shown at the top of Figure 10. On the left-hand side are seven common kinds of amplifier connection (any other form of black box could be regarded similarly). On the right-hand side are leader lines that show a link between the output of the chosen amplifier and one of the two most commonly used instrument connections – fully isolated circuit with case only grounded, or one pole grounded to earth. Using the legend, the chart shows the applicability of connections between chosen combinations of source arrangement, amplifier and output device. Not-possible situations usually arise because the earth connection shorts out one of the source arms.

Matching: Three basic matching criteria exist when connecting two stages together. Figure 11 summarizes these.

If the need is for maximum power transfer, as when driving a loud-speaker from an output stage of an amplifier, the output impedance (usually thought of as an average value of resistance) of the driving stage must equal the input of the stage being driven. When maximum voltage transfer is required, as occurs when a pick-up cartridge or other voltage generating transducer is used or when measuring a voltage in a circuit, the rule is to ensure the connecting stage has a much higher input resistance than the output resistance of the stage producing the voltage signal. A factor of ten to one hundred times is usually sufficient.

The opposite situation, that is, loading a high output impedance stage with a low input impedance, arises when the maximum current transfer is required.

In many cases the appropriate buffer amplifier is required to provide the desired matching condition. In certain ac coupled systems – those which do not require a dc path between stages – a transformer can provide an adequate impedance match in an economic way. Transformers, however, have limited frequency response and must be chosen carefully to suit the signal requirements.

Eliminating noise: In the ideal situation any circuit added after another should add no more noise energy to the signal than is fed to it. We specify the ratio of the two as the signal/noise or S/N ratio. In practice

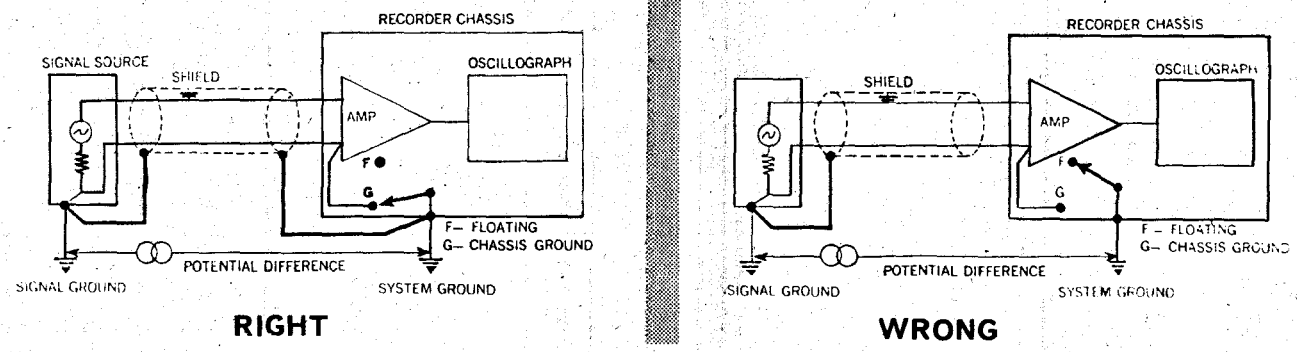


Fig. 12. Correct and incorrect methods of joining a sensor to a recorder. Most output instruments offer the user the choice of leaving the instrument floating above ground or grounding it.

all circuits, including connections, will add a finite amount of noise — degrading the S/N ratio. An amplifier or other cascaded stage should ideally increase or modify the signal amplitude without reducing the S/N ratio (input noise will be amplified equally with the signal).

A common unit used to describe the degree of degradation is the noise-figure NF which is calculated as NF = 10 log (Signal in/Noise in, divided by Signal out/Noise out); the ratio being expressed in decibels (dB). The perfect additional stage has NF = 0 dB, So-called low-noise amplifier stages will have noise figures better than 3 dB (S/N ratio reduced to half). NF is a function of device characteristics, frequency of operation, source resistance and temperature — the correct choice of components to yield a low NF is a skilled task.

Connections between stages are most common source of noise addition. Observing several basic rules will usually greatly reduce the noise pick-up in wiring between and within stages.

Grounding and Shielding: When wiring circuits and inter-connections the circuit diagram shows a signal ground. (Terms ground and earth are used somewhat synonymously). This line is assumed to be at exactly the same potential at all points where a ground symbol is indicated. From the electricity supply authority's viewpoint any good low resistance connection to mother earth is a good ground or earth point. But this is not so for instrument stages operating at millivolt and microvolt signal levels. Signals as large as volts can be induced, or dropped, between two points of a metal chassis! The rule for avoiding this ground loop problem is to attach all circuit points required to be grounded to a substantial size copper bus bar — the circuit ground — that is grounded to earth at one place. Better still, use a single common connection point.

Shields of cables are too often assumed to have the same potential at each end, both ends being presumably at ground potential. This is often incorrect for the shield becomes an earth-loop having a finite resistance when both ends are grounded. Only one end, the input end, should be earthed and the shield should be insulated against earth at all other points. Figure 2 shows the right and wrong ways to connect two stages together with a shielded two-core lead. Special quality low-level signal cables are available. These incorporate an inner twisted-pair that is wrapped inside a multi-layer metal foil along with a bare copper drain wire, the whole being well insulated.

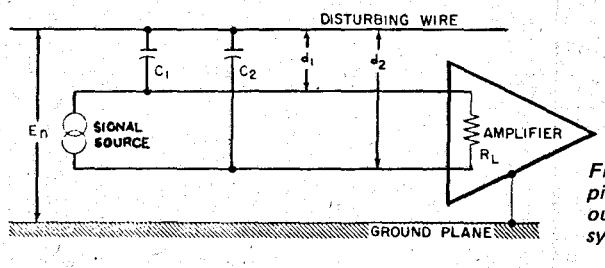


Fig. 13. Common-mode pick-up of noise is balanced out by the differential system.

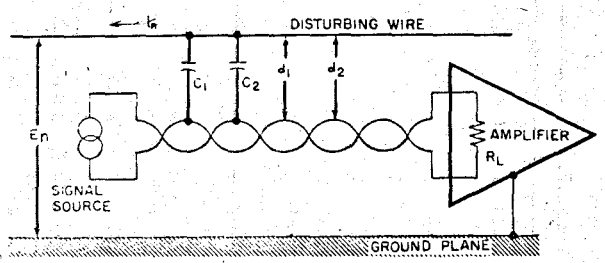


Fig. 14. Twisted wires provide best common-mode rejection when making connections between stages in which a symmetrical signal source is joined to a differential input amplifier.

Common-mode rejection: Before other aspects of connections with cables can be appreciated we need to study the principle of common-mode signal rejection.

We begin by looking at the noise pickup from supply mains radiation by two open wires used to complete a link, as shown in Fig.13. If both wires are at the same potential above earth, that is, neither is earthed, the noise pickup in each wire will be closely

similar. One wire, however, passes signal currents in the opposite direction to the other so noise induced in each wire will add to the signal in one wire and subtract in the other — the result is that the noise just about balances out. This is known as a common-mode rejection arrangement.

It is a balanced system as far as unwanted signals are concerned because of the use of a differential arrangement.

The same concept is used in low-noise, high gain, dc amplifiers — see part 11 — to eliminate transistor defects. A slight disadvantage of differential configurations is that many testing instruments operate with one grounded input. Connecting an oscilloscope to probe a differential-mode circuit may short out a line to ground in certain connections. For such work a differential input amplifier is essential in the oscilloscope.

Once the signal level has been amplified well above the ambient noise levels the symmetrical dual output can be converted to a single pole with earth output, using a suitably connected operational amplifier.

For the best low-level signal transfer, wiring between stages should observe the common-mode principle, the aim being to make each wire of the pair appear as identical as is possible to the interfering noise sources present. Figure 14 demonstrates why the twisted pair is better than two separate lines to connect a symmetrically-connected source to a following differential input stage. The distributed capacitances of the two wires are different (with resultant different pickup noise) in the open-wire case than they are in the twisted line.

Shielded two-core cables used with a symmetrical outputs source should have the shield grounded at the source, not at the following stage. The latter option degrades the common-mode rejection capability.

Common-mode principles must be carried through completely in exacting low-level signal applications, even to providing identical terminating conditions at the wire ends — similar length open wire ends, similar, dissimilar-metal, conditions at terminal posts with identical temperature for each to ensure identical thermo-electric currents are generated in each lead.

Active devices, such as amplifiers, have a limit to the common-mode signal levels that they can handle. If the induced signals are too great in amplitude they may saturate the amplifier, removing its ability to operate correctly. It is, therefore, always best to reduce interference at source rather than attempt to eliminate it by common-mode rejection alone.

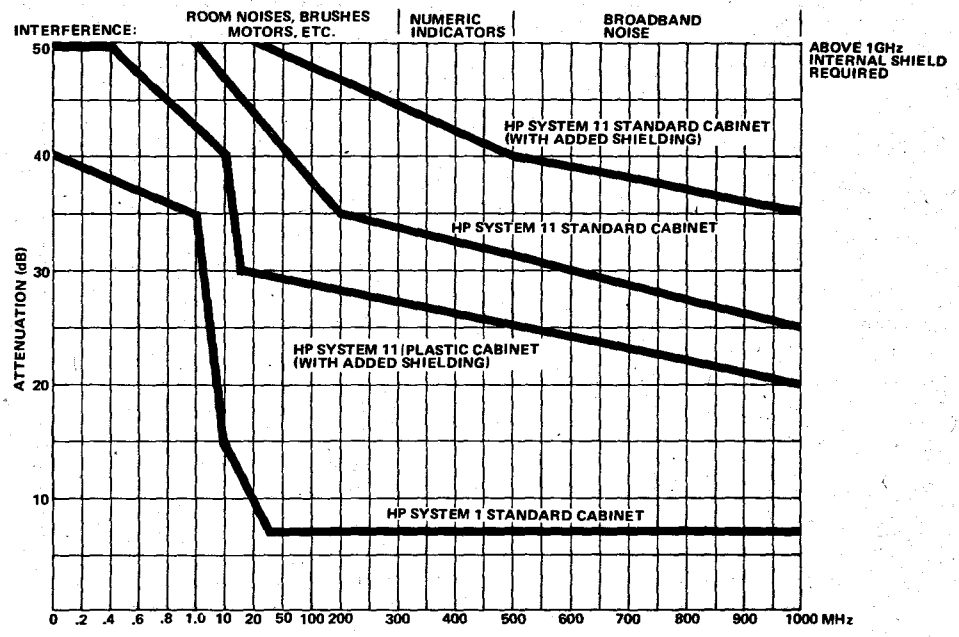


Fig. 15. Shielding of RF energy by various designs of enclosure used for H.P. instruments. The actual value of a particular unit depends upon the need for holes and shafts through the panels.

RF Shielding: Mains frequency interference (50 Hz) is comparatively easy to eliminate from or retain within equipment by using low conductivity enclosures. RF interference, however, tends to penetrate the best designed enclosure — remember waveguides transmit RF — through apertures of size similar to wavelength. Cracks, where covers join, may act as waveguides for UHF signals. As modern circuits operate with transition times of nanoseconds they too generate considerable quantities of RF energy. By way of example of what can be achieved by careful mechanical construction Figure 15 compares different instrument enclosure designs of a manufacturer. Slots introduced into frame elements form wave-traps (as opposed to wave guides) when the metal covers are bolted in. Modern instrument enclosure design is as much a case of containing RF radiation *inside* the unit as it is to prevent it entering.

FURTHER READING

In depth discussions of the theory and practice of transmission methods are to be found in works on telecommunications. "Transmission lines and Networks", W.C. Johnson, 1950 is a theoretical treatment of the use of lines.

Modulation methods are discussed in most general text books on electronics. Safety in medical electronics practice is the subject of

"Hazards of Electrical Apparatus", J.M.R. Bruner, Anaesthesiology, 28, 396, 1967, and "Electrical Hazards Associated with Cardiac Pacemaking", R.E. Whalen and others, Ann. N.Y. Acad. Sci., 111, 922, 1964.

A useful short guide to the practice of interconnecting system units is to be found in "Elimination of Noise in Low-Level Circuits", Clevite Corporation (Brush Instruments Division). A more extensive treatment is "Grounding and shielding techniques in instrumentation", R. Morrison, Wiley,967. The topic is also covered in a treatment on low-level techniques by PAR — see ETI, February 1972 for "Signal to Noise Ratio — its Optimization in Precision Measurement Systems" by T. Coor, A similar article is "Modern Signal Processing Technique for Optimal Signal to Noise Ratios", R.D. Moore and O.C. Chaykowsky, Princeton Allied Research Corporation, Technical Bulletin, No.109, 1963. "Taking noise out of Weak Signals", R. Brower, Electronics, 41, 80-90, 1968 is also relevant.

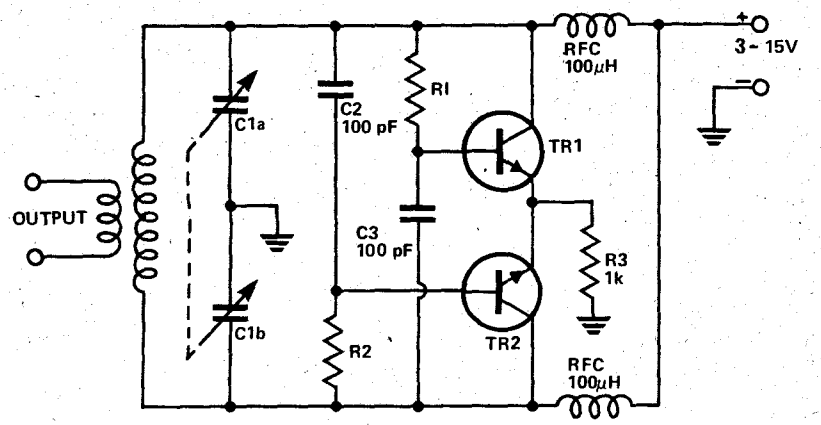
Ideas for experimenters

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.

Dipper circuits

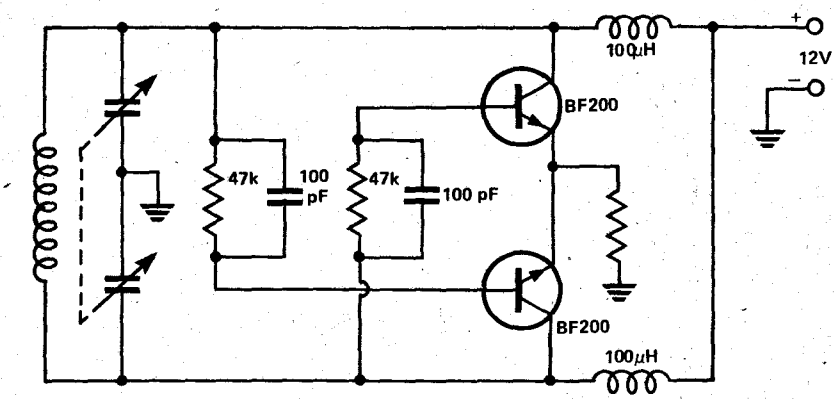
The circuit below is a dip oscillator similar to a previous item in this section — the FET Dipper. This circuit, however, uses bipolar transistors. Compared to the FET version it has inferior frequency stability but is more reliable and it works over a wider range.

Large L to C and C to L ratios can be handled, the device starts instantly, it can operate on very low supply voltages, and it can be made to be free of harmonics. A disadvantage, common to the FET oscillator, is that a dual-gang capacitor is required.



R1 and R2 are 47k but this can be varied between 10k and 1M8 to give higher or lower output (the higher the output the stronger the harmonics). C2 and C3 can be lowered in value for high frequency use. Lowering the value of R3 gives more output.

Continued on page 93.



Although this circuit ought to have an output higher in harmonic content than the circuit above, in practice there seems to be no noticeable difference.

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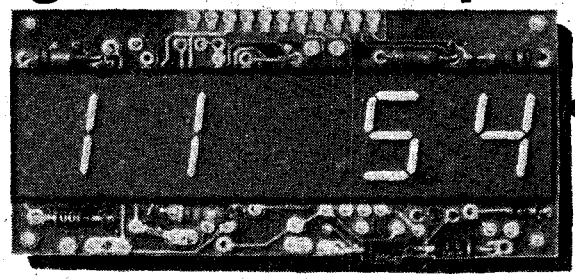

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33µF	8c	9c	10c	13c
47µF	9c	11c	11c	14c
100µF	11c	12c	13c	17c
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Ideas for experimenters

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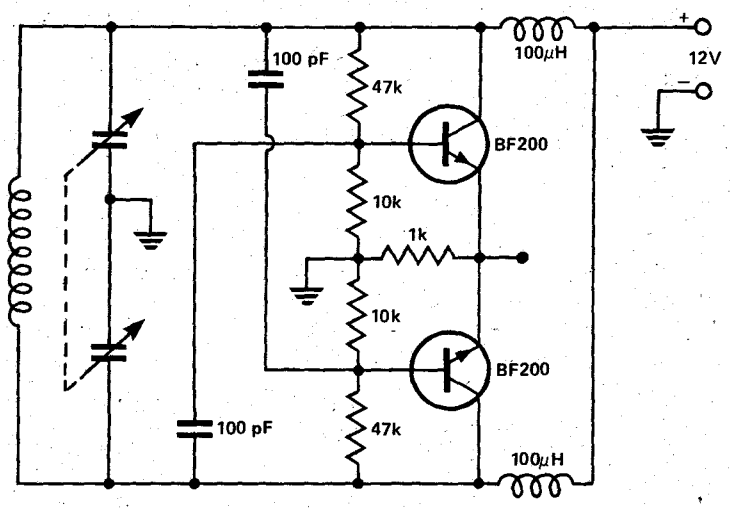
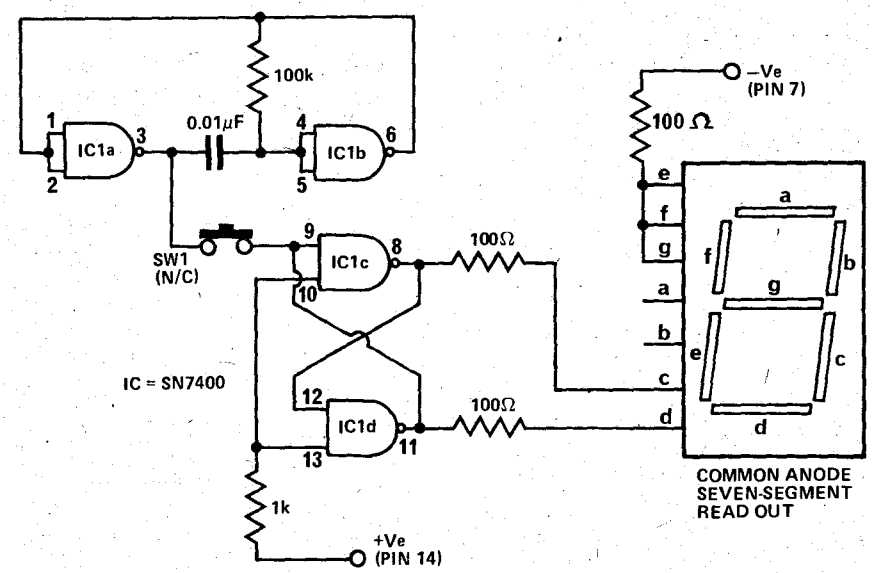


This is the most stable (frequency-wise) of the bipolar oscillators. Although here we use BF200s, other bipolar transistors will work, up to their cut-off frequency, in this circuit.

Dipper circuits, continued

Using germanium transistors in the basic circuit enables supply voltages of less than 1 V to be used (over 2 to 5 MHz).



Heads or tails

This circuit gives an 'h' or a 't' on a seven-segment display to indicate heads or tails after the player presses the 'spin' button.

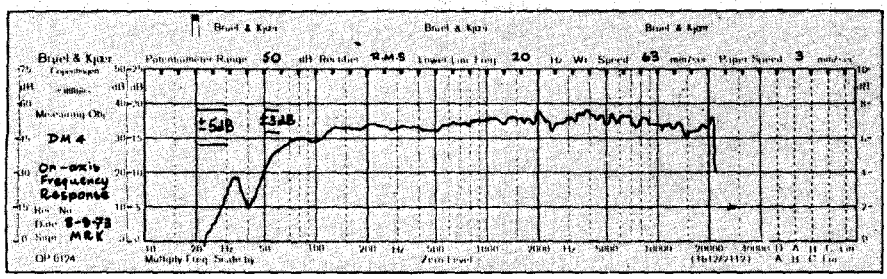
Two gates of the 7400 are used as an astable multivibrator and the other two form a bistable (a memory). The output of the multivibrator is taken, via the spin switch, to pin 9. Pin 10 is connected to a logical high, so if pin 9 is taken high the output at pin 8 will be low — causing segment 'c' to light (and thus forming the h for heads). Pin 12 will be low because it is connected to pin 8; this means that the output at pin 11 is high, so the 'd' segment does not light.

When the output of the multivibrator is low the 'tails' state is initiated: segment 'c' is off and segment 'd' lights up.

Any common-anode seven-segment display (for 5 V operation) may be used. The switch is a push-to-break type.

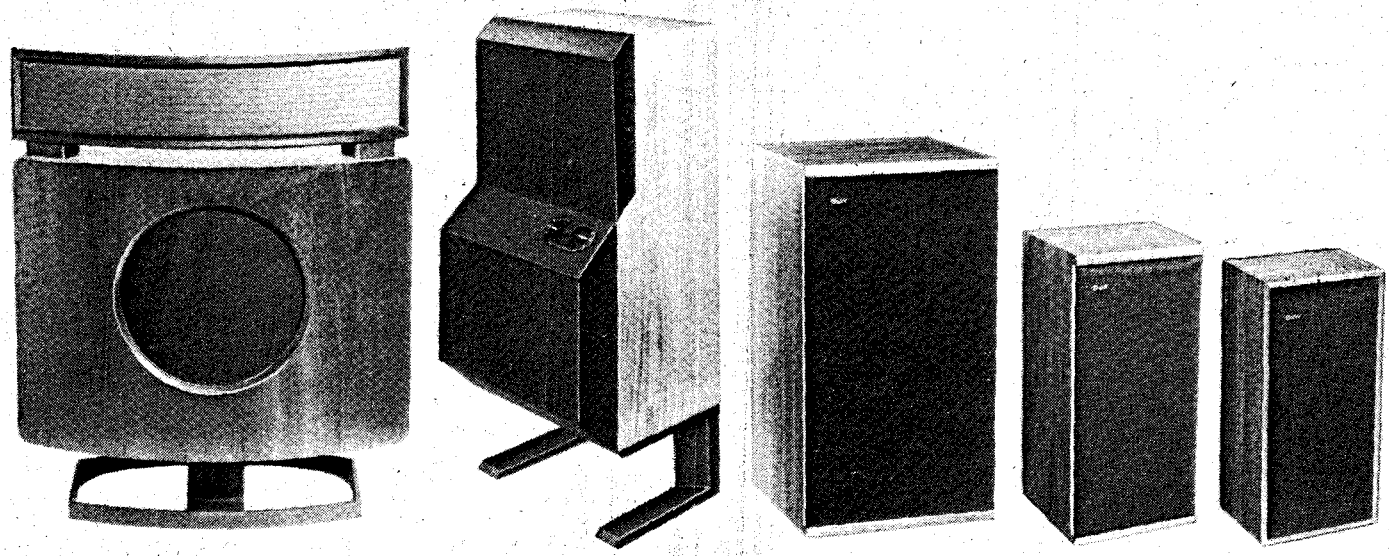
Continued on page 95

Lots of people tell you what their speakers will do.



When you buy a B&W, you get it in writing.

B&W's reputation is based on producing clean natural sound without distortion, even at low volume. Each B&W speaker is tested in an Anechoic Chamber and issued with its own individual pen graph. You know exactly the performance of the speaker you are buying.



B&W DM70 Monitor Electrostatic.
A combination of dynamic bass unit and electrostatic mid and high frequency module. One of the best speakers you can buy.

B&W DM6 Monitor.
A brand new design. A high powered dynamic loudspeaker with low colouration and very high transient performance.

B&W DM2A Monitor.
A more conventional design, utilising B&W research into acoustic line rear loading. Brilliant clarity and lack of distortion.

B&W DM4 Monitor.
A speaker with large B&W Monitor characteristics; its performance surpasses speakers of much greater size.

B&W D5.
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B&W

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

PF693

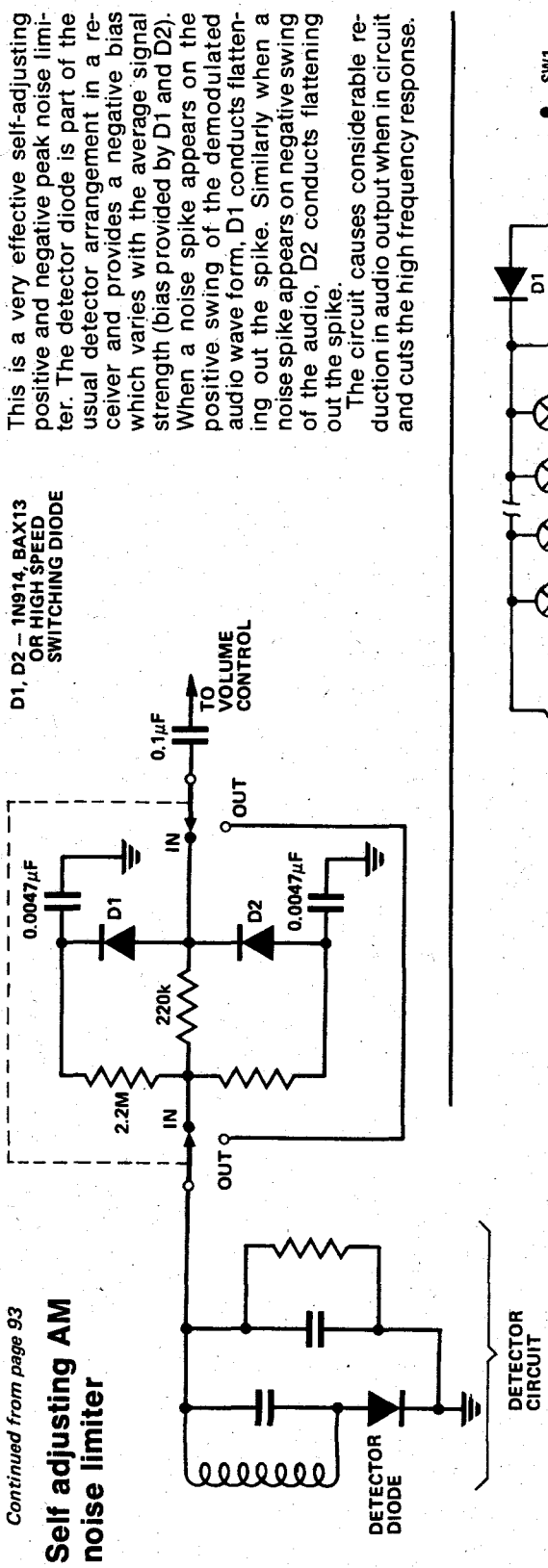
Ideas for experimenters

Continued from page 93

Self adjusting AM noise limiter

This is a very effective self-adjusting positive and negative peak noise limiter. The detector diode is part of the usual detector arrangement in a receiver and provides a negative bias which varies with the average signal strength (bias provided by D1 and D2). When a noise spike appears on the positive swing of the demodulated audio wave form, D1 conducts flattening out the spike. Similarly when a noise spike appears on negative swing of the audio, D2 conducts flattening out the spike.

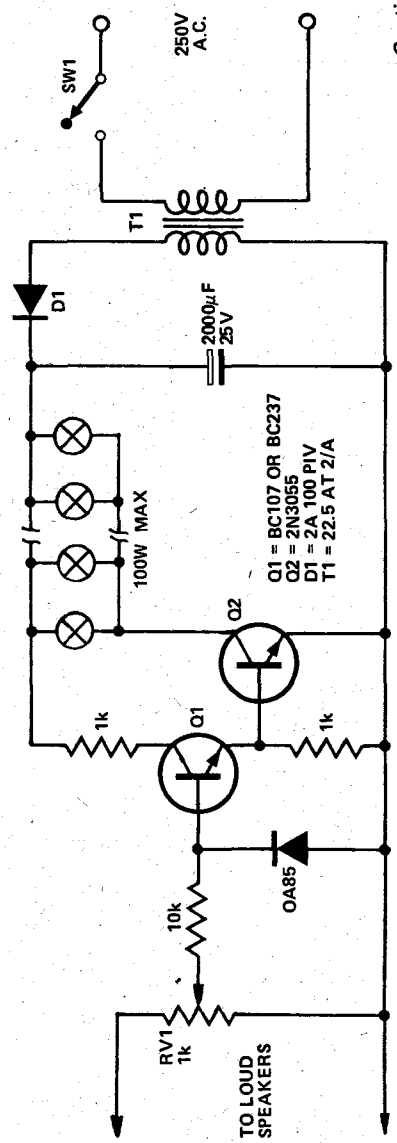
The circuit causes considerable reduction in audio output when in circuit and cuts the high frequency response.



Continued on page 97

Sound to light converter

This unit is based on a two-stage direct-coupled amplifier and it can modulate any number of globes up to a limit of 100 W. The voltage from the loudspeaker varies the conductivity of Q1 in sync with the audio. The sensitivity can be adjusted by VR1. A heatsink is necessary for Q2.



PACKAGE OF TEN — DEDUCT 15%

PACKAGE OF ONE HUNDRED — DEDUCT 25%

TTL

7400	.16	7451	.20	74153	1.14
7401	.18	7453	.20	74154	1.29
7402	.17	7454	.20	74155	1.23
7403	.18	7460	.20	74156	1.23
7404	.22	7464	.40	74157	1.14
7405	.22	7465	.40	74158	2.06
7406	.40	7470	.35	74160	1.60
7407	.40	7472	.35	74161	1.44
7408	.21	7473	.40	74162	1.71
7409	.22	7474	.40	74163	1.60
7410	.18	7475	.66	74164	1.83
7411	.29	7476	.45	74165	1.83
7413	.63	7483	.91	74166	1.71
7414	.81	7485	1.27	74170	2.65
7416	.40	7486	.46	74173	1.71
7417	.40	7489	2.48	74174	1.86
7420	.18	7490	.59	74175	1.60
7422	.30	7491	1.12	74176	1.02
7423	.33	7492	.82	74171	.97
7425	.31	7493	.69	74180	1.04
7426	.30	7494	1.08	74181	3.43
7427	.33	7495	.91	74182	.91
7430	.23	7496	.91	74184	2.29
7432	.26	74100	1.50	74185	2.29
7437	.40	74105	.51	74187	4.50
7438	.40	74107	.46	74190	1.35
7440	.20	74121	.48	74191	1.35
7441	1.13	74122	.52	74192	1.25
7442	.89	74123	.69	74193	1.19
7443	1.00	74125	.62	74194	1.25
7444	1.00	74126	.72	74195	1.02
7445	1.02	74132	1.02	74916	1.44
7446	1.07	74141	1.20	74197	1.02
7447	1.02	74145	1.20	74198	2.06
7448	1.20	74150	1.12	74199	2.06
7450	.20	74151	.91	74200	5.90
				74279	1.08

LOW POWER

74L00	.29	74L51	.33	74L90	1.71
74L02	.29	74L55	.38	74L91	1.67
74L03	.29	74L71	.29	74L93	1.94
74L04	.29	74L72	.45	74L95	1.94
74L06	.29	74L73	.56	74L98	3.21
74L10	.29	74L74	.56	74L164	3.21
74L20	.38	74L78	.91	74L165	3.21
74L30	.38	74L85	1.44		
74L42	1.71	74L86	.79		

LOW POWER SCHOTTKY

74LS00	.36	74LS32	.38	74LS95	2.09
74LS02	.36	74LS40	.45	74LS107	.59
74LS04	.36	74LS42	1.40	74LS164	2.20
74LS08	.38	74LS74	.59	74LS193	2.20
74LS10	.36	74LS90	1.30	74LS197	2.20
74LS20	.36	74LS93	1.30		

HIGH SPEED

74H00	.25	74H22	.25	74H61	.25
74H01	.25	74H30	.25	74H62	.25
74H04	.25	74H40	.25	74H74	.39
74H08	.25	74H50	.25	74H101	.39
74H10	.25	74H52	.25	74H102	.49
74H11	.25	74H53	.25	74H103	.58
74H20	.25	74H55	.25	74H106	.58
74H21	.25	74H60	.25	74H108	.60

SCHOTTKY

74S00	.38	74S08	.52	74S22	.38
74S02	.45	74S10	.38	74S32	.52
74S03	.38	74S20	.38	74S74	.38
74S04	.45				

8000 (NATIONAL)

8091	.61	8220	1.49	8811	.65
8092	.61	8230	2.19	8812	1.02
8095	1.25	8288	1.49	8822	2.19
8121	.80	8520	1.16	8830	2.19
8123	1.43	8552	2.19	8831	2.19
8130	1.97	8563	.62	8836	.29
8200	2.33	8810	.70	8880	1.19
8214	1.49				

8000 (SIGNETICS)

8263	5.79	8267	2.59		

9000

9002	.40	9309	.79	9601	.89
9301	1.03	9312	.79	9602	.79

DTL

930	.15	937	.15	949	.15
932	.15	944	.15	962	.15
936	.15	946	.15	963	.15

6 DIGIT LED CLOCK KIT

INCLUDES:
- MM314 clock circuit
- 6 FND70 LED displays (.250" red 7 segment)
- All necessary transistors, resistors & capacitors
- 1 double sided PC board accommodates LED's & clock circuitry
- Schematic & instructions
- Does not include 12V-300 ma transformer, switches & case **$12.95**

QUANTITY DISCOUNT NOT APPLICABLE ON THIS ITEM

IC SOCKETS

Solder Tail - low profile

8 pin	$ .19	24 pin	.45
14 pin	.22	28 pin	.59
16 pin	.24	40 pin	.69
18 pin	.35		

WIRE WRAP - gold plate

14 pin .59

CMOS

4000A	.30	4018A	1.39	4066A	1.02
4001A	.29	4020A	1.49	4068A	.51
4002A	.29	4021A	1.39	4069A	.51
4006A	1.55	4022A	1.10	4071A	.30
4007A	.30	4023A	.29	4072A	.40
4008A	1.79	4024A	1.02	4073A	.45
4009A	.66	4025A	.29	4075A	.45
4010A	.62	4027A	.68	4078A	.45
4011A	.33	4028A	1.13	4082A	.40
4012A	.29	4030A	.51	4518A	1.89
4013A	.52	4035A	1.46	4528A	1.84
4014A	1.49	4040A	1.39	4585A	2.10
4015A	1.49	4042A	1.69	4901A	.45
4016A	.56	4049A	.68		
4017A	1.19	4050A	.68		
74C00	.25	74C74	1.20	74C162	2.93
74C02	.30	74C76	1.54	74C163	3.06
74C04	.51	74C107	1.30	74C164	3.06
74C08	.78	74C151	3.00	74C173	2.61
74C10	.40	74C154	3.62	74C195	2.66
74C20	.40	74C157	2.02	80C95	1.35
74C42	1.55	74C160	2.85	80C97	1.13
74C73	1.20	74C161	2.93		

CALCULATOR CHIPS

CT5002	12 digit, 4 function fixed decimal — battery operation 40 pin	2.79
CT5005	12 digit, 4 function plus memory, fixed decimal 28 pin	2.99
MM5725	8 digit, 4 function, floating decimal 28 pin	1.98
MM5736	6 digit, 4 function, 9V battery operation 18 pin	3.95
MM5738	8 digit, 5 function plus memory and constant floating decimal, 9V battery operation 24 pin	4.50
MM5739	9 digit, 4 function, 9V battery operation 22 pin	5.35

MEMORIES

1101	256 bit RAM MOS 16 pin	1.50
1103	1024 bit RAM MOS 18 pin	1.95
1702A	2048 bit static PROM elect. prog. - UV eras. 24 pin	14.95
2102 (2602)	1024 bit static RAM DTL/TTL comp. 1 ms 16 pin	2.95
2102-1	Same as 2102 except 500ns	2.99
5203	2048 bit static PROM elect prog. - UV eras. 24 pin	10.95
5260	1024 bit dynamic RAM MOS 16 pin	1.95
5261	1024 bit dynamic RAM MOS 16 pin	2.19
5262	2048 bit dynamic RAM MOS 22 pin	2.25
7489	64 bit ROM TTL 16 pin	2.48
82S23	256 bit PROM SCHOTTKY 16 pin	3.69
F93410	256 bit RAM bi-polar 16 pin	1.95
74187	1024 bit ROM TTL 16 pin	5.95
74200	256 bit RAM tri-state 16 pin	5.90

TANATLUM CAPACITORS SOLID-DIPPED +20%

.1 mfd	35V	.25 ea.	6.8 mfd	6V	.30 ea.
.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.
4.7 mfd	16V	.30 ea.	47 mfd	6V	.40 ea.

SHIFT REGISTERS

MM5013	1024 bit accum. dyn. 8 pin	1.75
MM5016	500/512 bit dyn. 8 pin	1.59
SLS-4025	Quad 25 bit	1.29
2504	1024 bit multiplexed dyn 8 pin	4.95

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Silver plated copper circuit board 1-3 16" x 5-1 16". 2 rows of 2" holes for DIP IC's + space for transistors, resistors & capacitors. Versatile and simple for breadboarding IC circuitry **$1.50 ea.**

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CT5005 CALCULATOR CHIP
12 digit — 4 function with memory
$1.39

7001 CLOCK CHIP
4-6 digit, 12-24 hr. alarm, timer and date circuits — with data **$6.95**

DVM CHIP 4½ DIGIT
MM5330 — P channel device provides all logic for 4½ digit volt meter. 16 pin DIP with data **$12.95**

MM5738
8 digit multiplexed — five function — chain operation 2 key memory — floating decimal — independent constant — interfaces with led with only digit driver — 9 V batt. oper. 24 pin **$3.95**

1103	Memory	10/$10.00	100/$88
5260	"	10/$11.90	100/$104
5261	"	10/$11.90	100/$104
5262	"	10/$13.90	100/$122
5002	Calculator Chip	10/$11.90	100/$104
5005	" "	10/$13.90	100/$122
5738	" "	10/$20.00	100/$176
309K	5V Regulator	10/$10.00	100/$89
741	Operational Ampl.	10/$2.50	100/$22
3900	Quad amplifier DIP	10/$3.20	100/$29
74123	Dual Monostable Multivibrator	10/$5.60	100/$50
MAN 1	Display	10/$11.90	100/$104

CLOCK CHIPS

MM5311	6 digit multiplexed BCD, 7 seg 12-24 Hr, 50-60 Hz 28 pin	$4.45
MM5312	4 digit multiplexed BCD, 7 seg 1 pps. 12-23 Hr, 50-60 Hz 24 pin	3.95
MM5314	6 digit multiplexed 12-24 Hr, 50-60Hz 24 pin	4.45
MM5316	4 digit, 12-24 Hr, 50-60 Hz, alarm 40 pin	5.39
CT7001	6 digit, 12-24 Hr, 50-60 Hz, alarm, timer and date circuits 28 pin	7.95

MISC DEVICES

ULN 2208	FM gain block 34dB mDIP	1.39
ULN2209	FM gain block 48dB mDIP	1.59
2513	64 x 8 x 5 character generator	11.00
CA 3046	Transistor array 14 pin DIP	.86

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	15.0K	48.7K
30.9	105	205	2.49K	18.2K	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	8.25K	37.4K	

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IN 486B	Diode	250V	$ .25 ea.
IN 715A	Zener	11V	.25
IN 747A	Zener	3.6V	.25
IN 754A	Zener	6.8V	.25
IN 756A	Zener	8.2V	.25
IN 904	Sw. Diode	30V	.10
IN 914	Sw. Diode	100V	.10
IN 4858	Zener	120V	.25
IN 5230A	Zener	4.7V	.25
IN 5242B	Zener	12V	.25

DISPLAYS

MAN1	$1.95
MAN2	3.95
MAN3A	.19
MAN5	2.95
MAN6	3.95
MAN7	1.49
MAN8	2.95
MAN66	2.95
DL10A	2.19

DISCRETE LED'S

ME4	$ .29
MV50	.15
NSL100	.15
NSL101	.15
NSL102	.15
XC209-R	.18
MV5020 RED	.18
GREEN	.18
AMBER	.18
CLEAR	.18

MULTIPLE DISPLAYS

NSN33	3 digit .12" red LED	1.79
HPS082-7405	5 digit .11 red LED	3.49
HPS082-7414	4 digit .11 red LED	3.25
SP-425-09	9 digit .25 gas disch.	1.79

5% OFF ON ORDERS OVER $50.00
10% OFF ON ORDERS OVER $100.00
15% OFF ON ORDERS OVER $500.00

LINEAR CIRCUITS

300	Pos V Reg (super 723) TO-5	$ .82
301	Hi Perf Op Amp mDIP TO-5	.33
302	Volt follower TO-5	.61
304	Neg V Reg TO-5	.92
305	Pos V Reg TO-5	.82
307	Op AMP (super 741) mDIP TO-5	.30
308	Micro Pwr Op Amp mDIP TO-5	1.02
309K	5V 1A regulator TO-3	1.35
310	V Follower Op Amp mDIP	1.23
311	Hi perf V Comp mDIP TO-5	1.09
319	Hi Speed Dual Comp DIP	1.30
320T	Neg Reg 5, 12, 15 TO-220	1.60
320K	Neg Reg 5.2, 12 TO-3	1.60
322	Precision Timer DIP	1.96
324	Quad Op Amp DIP	1.75
339	Quad Comparator DIP	1.69
340K	Pos V reg (5V, 6V, 8V, 12V, 15V, 18V, 24V) TO-3	1.94
340T	Pos V reg (5V, 6V, 8V, 12V, 15V, 18V, 24V) TO-220	1.71
370	AGC/Squelch AMPL DIP	1.20
372	AF-IF Strip detector DIP	2.93
373	AM/FM/SSB Strip TO-5	2.42
376	Pos V Reg mDIP	.68
380	2w Audio Amp DIP	1.30
380-8	.6w Audio Amp mDIP	1.25
381	Lo Noise Dual preamp DIP	1.75
382	Lo Noise Dual preamp DIP	1.75
531	High Slew rate Op Amp	2.95
540	Power driver TO-5	2.95
550	Prec V Reg DIP	1.02
555	Timer mDIP	.69
556A	Dual 555 Timer DIP	1.71
560	Phase Locked Loop DIP	4.54
562	Phase Locked Loop DIP	4.54
565	Phase Locked Loop DIP TO-5	1.39
566	Function Gen mDIP TO-5	2.59
567	Tone Decoder mDIP	2.49
709	Operational AMP TO-5 or DIP	.30
710	Hi Speed Volt Comp DIP	.69
711	Dual Difference Compar DIP	.30
723	V Reg DIP	.71
733	Diff. video AMPL TO-5	1.02
739	Dual Hi Perf Op Amp DIP	1.23
741	Comp Op Amp mDIP TO-5	.37
747	741 Dual Op Amp DIP or TO-5	.82
748	Freq Adj 741 mDIP	.40
1304	FM Mulpx Stereo Demod DIP	1.23
1307	FM Mulpx Stereo Demod DIP	.85
1456	Op Amp mDIP	1.83
1458	Dual Comp Op Amp mDIP	.71
1800	Stereo multiplexer DIP	2.85
3900	Quad Amplifier DIP	.49
7524	Dual core memory sense Amp	.52
7525	Dual core memory sense Amp	1.13
8038	Voltage contr. osc. DIP	4.89
8864	9 DIG Led Cath Drvr DIP	2.59
75150	Dual Line Driver DIP	1.75
75451	Dual Perepheral Driver mDIP	.40
75452	Dual Peripheral Driver mDIP	.40
75453	(351) Dual Periph Driver mDIP	.40
75491	Quad Seg Driver for LED DIP	.82
75492	Hex Digit driver DIP	.92

Date sheets on request. Add 30¢ each if item is priced below $1.00 each.

The prices as listed are in Australian dollars. Send bank cheque with order. If international postal money order is used send receipt with order. Shipment will be made via air mail — postage paid — within three days from receipt. Minimum order — $5.00.

INTERNATIONAL ELECTRONICS UNLIMITED

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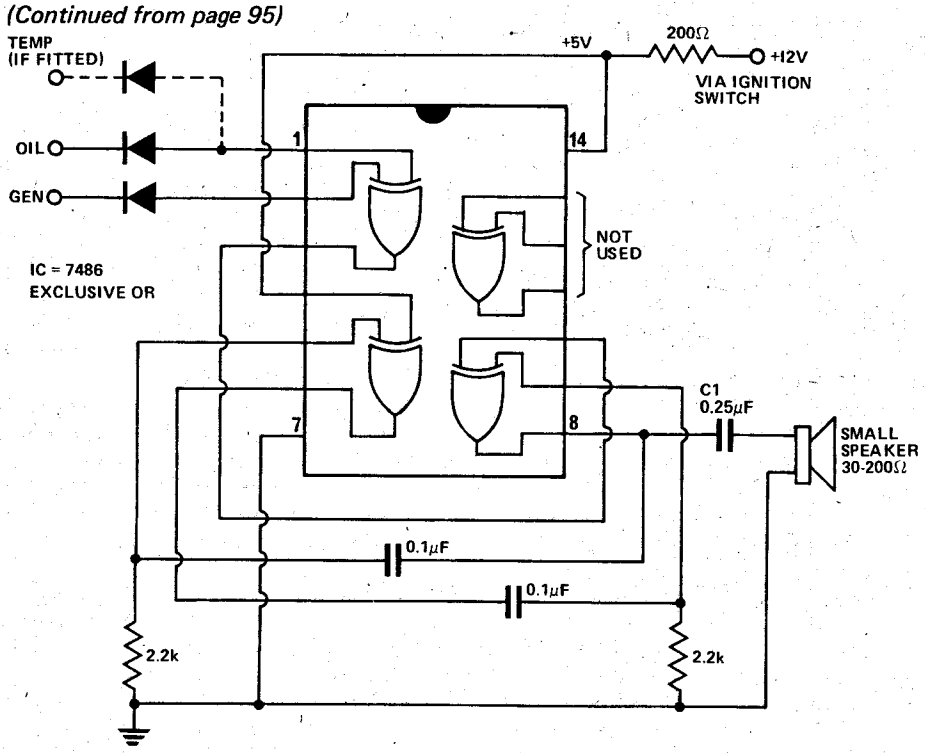
Duty may be payable on products imported.

Ideas for experimenters

(Continued from page 95)

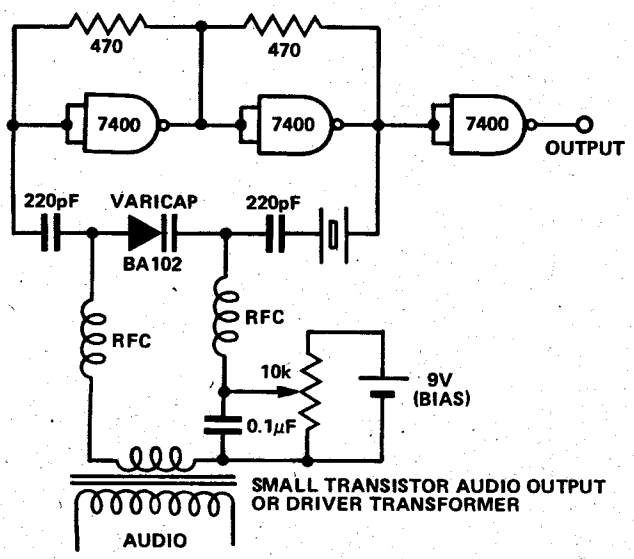


Audible warning for the car

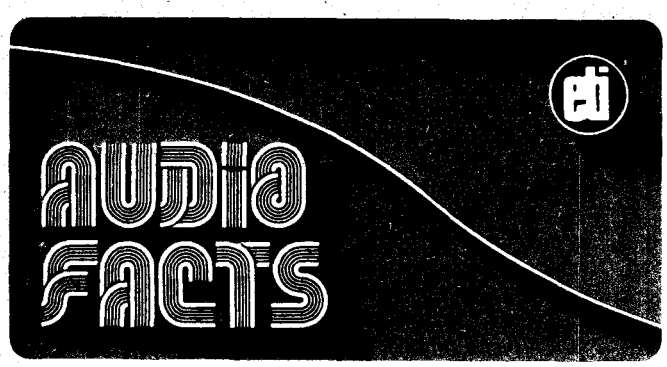
Although most cars are fitted with oil and generator lamps, drivers often don't take notice of them. This circuit helps because it gives an audible warning to accompany the lamps. However, if both lamps light simultaneously, which happens when the ignition is first switched on, the alarm is muted.

The circuit uses the 'Exclusive Or' function of the 7486. Two other gates make up the audio oscillator. Changing the value of C1 alters the output level and frequency. In practice it was found unnecessary to regulate the 5 V supply to the IC.

FM modulated TTL crystal oscillator



This TTL crystal oscillator is useful for checking FM receivers or to drive multipliers-amplifiers for an FM transmitter. It will accept crystals between 1 and 18 MHz. Output level is quite high and rich in harmonics. Audio can be provided at a low level from an audio oscillator or a microphone amplifier.



DIGITAL TIME DELAY SYSTEM

An important part of the experience of listening to music in a concert hall is the sense of space created by sound reflected by the walls, ceiling, and floor of the hall. This subjective effect, entirely lacking in home music reproduction, is one aspect of sound and its perception under study at Acoustic Research.

Visitors to the recent AES Convention had an opportunity to see and hear some of the apparatus developed by AR for this research. Of primary interest was a 16-channel digital time-delay system, used with 16 amplifiers and speakers to simulate the spatial effects produced in large halls, and a computer program that uses a mathematical model of a concert hall to provide the data needed to set the controls of the delay system.

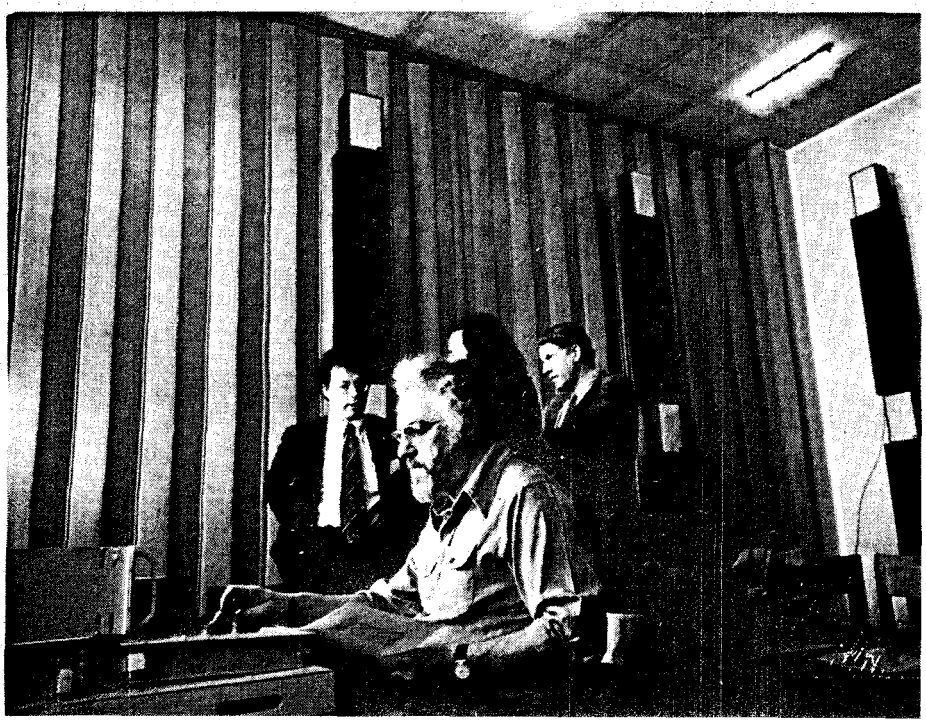
In a concert hall, the listener hears at least three effects of concert hall acoustics. One of these is the arrival of sound from a number of directions in rapid succession, first from the stage and then from various reflecting surfaces inside the hall. This creates a sense of spaciousness and the feeling that the sound source is larger than it actually is, and somewhat diffuse. Another effect is the incoherence of higher frequencies, which makes it difficult for the listener to localize the source, giving an open, airy quality to the sound. A third effect is the gradual decay of the sound after it has stopped coming from the stage. The last effect is easily enough recorded, or simulated during recording, so that there is no need to re-create it during playback.

The first two effects, however, cannot be conveyed by conventional sound reproduction techniques. Matters are made even more difficult by the subtle way in which the effects change in halls of different size, shape, and interior finish. The failure of conventional high-fidelity equipment to reproduce the two missing effects is probably the main reason for the artificial quality of the reproduction of orchestral or choral music in the home, even when the equipment used is demonstrably accurate within very close limits.

Acoustic Research, have studied the ways in which concert-hall acoustics can be electronically simulated and added to the reproduction of ordinary stereo records and broadcasts. There have been two phases to the study, carried out simultaneously.

First, it has been necessary to define the acoustical properties of large halls in order to understand the patterns of reflections and the type of sound distribution that takes place in such enclosed spaces. Although acoustic measurements are available for many concert halls, the information is far less precise than can be calculated from a mathematical model of a similar hall. In any case, since the objectives of the study are to understand the acoustics of an ideal hall, rather than how to build one of concrete and plaster, the architectural accidents and problems that influence the sound of a real hall are irrelevant. It is possible that electronic simulation, with the support of computer studies, can lead to an esthetically satisfying acoustic setting for music that cannot be realized by architecture.

The program that has been used to characterize different halls accepts hall dimensions, a sound source location and listener location (in three dimensions), absorption coefficients for each of the interior surfaces of the hall, absorption coefficients for areas of special absorption on any of the interior surfaces, the dimensions of these areas, and the time period the user of the program wishes to examine. One of several kinds of plots is automatically provided: room impulse



Robert Berkovitz, Research Director at Acoustic Research, enters computer generated data into the Digital Time Delay System during the AES Convention in Zurich, March 1976.

Sixteen Acoustic Research AR-7 loudspeakers, mounted in two tiers of eight, reproduced delayed sounds. Two AR-11 loudspeakers were used for presentation of undelayed stereo image.

For ideal simulation, the listening room should be anechoic, so that all 'reflections. come from the time-delay networks. Yet a convincing illusion was obtained in the demonstration room, which was even more 'live' than a typical home living room.

response by sector, with the hemisphere above the listener divided into sixteen sectors; a representation of the lattice formed by the hall and its images, with the reflections shown in tiers and columns; or, a "3-D" picture of the reflections in the hall, which can be viewed through special glasses, showing the azimuth and elevation of each reflection, and allowing the viewer to visualize the patterns of organization of large numbers of acoustic images in the chosen space.

The sixteen-channel delay system is a special-purpose computer designed and built at Acoustic Research. It operates by sampling the incoming music signal more than 30 000 times each second, converting the level of each sample to a number, and storing the number in the correct location of an 8 kilobyte memory. The memory contains the last quarter-second of program material fed to it. After the value of each sample has been stored, and before the next one is taken, a memory recall circuit running at about one-half million operations per second reads sixteen samples from as many different memory locations and sends each sample to one of the sixteen output channels. Each channel drives a loudspeaker system placed to cover one-sixteenth of the space around and above a listener. When the system is operating, reproduced sound comes from the conventional stereo loudspeakers in front of the listener first. Then, after delays of fractions of a second, the same information is successively reproduced from each of the sixteen delay channels. The audible sensation, to a listener sitting "inside" the system, is that of listening to music in a hall with a size, shape, and acoustical character which depends on how the system controls are set. Listeners who have heard the system at AR's laboratories near Boston, or at a demonstration in Zurich earlier this year, have reported that the illusion is quite convincing, especially if the demonstration room lights are turned off to eliminate visual cues.

Eventually, the information obtained by the experimental use of the program and system will be applied to produce a simpler system for domestic use. The experimental delay system has itself been the subject of interest among researchers in industry and at universities. It is possible that AR will make the system available in the future for their use.

NEW AKAI DECK

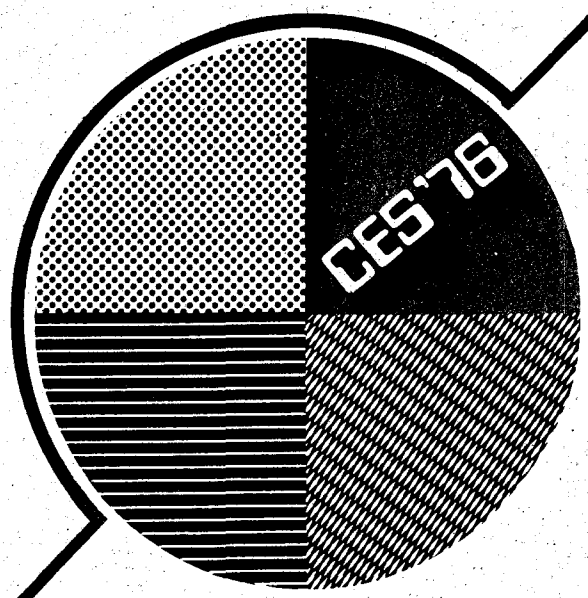
A new front-loader cassette deck has just been announced by Akai. The GXC-760D uses Akai's dual capstan transport system: one capstan upstream and one downstream of the head assembly. These move the tape with precise tension and speed, effectively decoupling the drive from vibration and oscillation generated at the reels. The wow and flutter is 0.06% or less WRMS.

A direct-drive, drives the capstan system and two newly developed "slotless" motors power the reel drive.

Electronically, the most interesting features are the 3-head monitoring assembly and the double Dolby circuits. In the head assembly the recording and playback head portions are combined in a single head holder which avoids the problems associated with separate record and playback heads (such as time lag and phase differences).

Separate Dolby processors are provided on the input and monitor output sides, so that tape monitoring already includes the effect of Dolby noise reduction, giving a precise indication of actual playback quality.

Other features of the GXC-760D are peak check level meters, built-in 400Hz calibration oscillator for tape sensitivity adjustments, 3 way tape selection (low noise, chrome and ferrichrome) effected with just two pushbuttons and an MPX low-pass filter for eliminating FM pilot signal components from the input. As an option, a cable-connected remote control unit is available. The suggested retail price is $730.00.



The 1st Australian Consumer Electronics Show

AUSTRALIA'S FIRST CONSUMER ELECTRONICS SHOW will be held at the Sydney Hilton Hotel from Wednesday August 4th through Sunday August 8th.

The exhibition will cover three entire floors of the hotel — and virtually all the industry leaders will be there — AWA, AMI, Grundig, Haco-Hagemeyer, Rank, Sony, Toshiba-EMI to name but a few.

Exhibitors will be showing not only their full range of consumer electronic goods like Hi-Fi, TV, and audio equipment but will also be announcing many exciting new products.

This is a unique opportunity to see the enormous range of consumer electronic goods available — all at the same venue at the one time.

The Show will be open to the public on Thursday 5th August from 6.00 p.m. to 10.00 p.m. and Friday 6th August from 6.00 p.m. to 10.00 p.m., Saturday 7th August from 10.00 a.m. to 10.00 p.m. and Sunday 8th August from 1.00 p.m. to 5.00 p.m.

The Show is open to TRADE ONLY on Wednesday 4th August, from 1.00 p.m. to 6.00 p.m., Thursday 5th August from 10.00 a.m. to 6.00 p.m., and Friday 6th August from 10.00 a.m. to 6.00 p.m. It is also expected that buyers will be in attendance on Saturday and Sunday..

TAA has been appointed the official co-ordinating airline and are offering discount rates for group travel. In addition, the Sydney Hilton Hotel is holding over 100 additional suites at discount rates for visitors to the Show.

HOURS

Wednesday, August 4, 1976
1.00 — 6.00 pm Trade Only.
7.30 p.m. Cocktails — Gala Banquet
Thursday, August 5, 1976
10.00 — 6.00 pm Trade
6.00 — 10.00 pm Public
Friday, August 6, 1976
10.00 — 6.00 pm Trade
6.00 — 10.00 pm Public
Saturday, August 7, 1976
10.00 — 10.00 pm Public
Sunday, August 8, 1976
1.00 — 500 pm Trade and Public

EXHIBITORS
As at 10.6.76

A.W.A. Limited
AKAI Australia Pty. Ltd.
Auriema (Australasia) Pty. Ltd.
Australian Musical Industries Pty. Ltd.
Bestek Private Limited
Convoy International Pty. Ltd.
European Electronics Pty. Ltd., Grundig
Goldring N.S.W. Pty. Ltd.
Greencorp. Magnetics Pty. Ltd.
Haco — Hagemeyer (Australasia) Pty. Ltd.
Harman Aust. Pty. Ltd.
Jacoby Mitchell
Lawrence & Hanson Pty. Ltd.
Linear Sound Pty. Ltd.
Megasound Pty. Ltd.
Modern Magazines (Holdings) Pty. Ltd.
Pioneer Electronics Australia Pty. Ltd.
Rank Industries Australia Pty. Ltd.
Rose Music Pty. Ltd.
Roland Corp. (Aust) Pty. Ltd.
Sonab of Sweden Pty. Ltd.
Sony Kemtron Pty. Ltd.
Toshiba — E.M.I. (Aust.) Pty. Ltd.
W.C. Wedderspoon Pty. Ltd.

for the love of music

dynamic range enhancer

dbx 117

The dbx 117 is an incredible piece of equipment that will give you greater listening pleasure than you ever thought possible to achieve.

It does this in two extremely efficient ways; by literally expanding the material deliberately compressed in the recording studio, so that full dynamic range is restored, and by effectively limiting the background noise inherent in most recorded product to the extent that it becomes, in most cases, totally inaudible.

This is what Electronics Today said. *"We first used the dbx unit by playing ordinary records with average background noise . . . and the background noise all but vanished. The music sounded far cleaner with a presence that was unquestionably better than the original unexpanded record."*

"Our next evaluation involved a piece of newly recorded orchestral music . . . when played in the normal manner, tape hiss was quite prominent . . . when played through the dbx 117 . . . the problem all but completely disappeared . . . the music had a quality which could genuinely be described as sounding comparable with the original."

Australian Hi-Fi discusses the remarkable dbx 117 in detail. Here are a few direct quotes. *"And it does work well, giving back a 'sparkle' to some recordings which have always sounded over-compressed. Its action is particularly impressive during pauses—the disc's surface noise and any tape hiss disappear completely."*

"The dbx 117 uses true RMS level sensors which respond to the overall level in ***both*** *stereo channels even though the signal paths themselves are separate. This technique is necessary for dynamic range enhancement or there would be a wandering of the stereo image."*

Hi-Fi Review expressed their findings of the dbx 117 this way: *"Yet another way of 'quieting' noisy records is to use a clever little device called the dbx 117, dynamic range enhancer.*

This device 'expands' the program material so it sounds more like the real thing, and reduces background noise so effectively, that it all but disappears. It's particularly effective with old or antique records."

dbx 117 restores up to 20 dB of the dynamic range missing from records, tapes and FM broadcasts.

Rediscover the beauty and excitement of an actual performance. Write for full details and list of stockists to

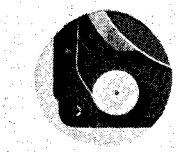
Auriema (A'asia) Pty Ltd, 15 Orchard Rd Brookvale, NSW 2100.
Telephone: 939 1900

Introducing the revolutionary UD-XL EPITAXIAL cassette

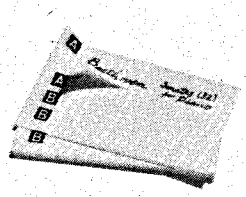
UD XL

Developed by MAXELL this completely new EPITAXIAL magnetic material combines the advantages of the two materials (gamma-hematite and cobalt-ferrite): the high sensitivity and reliable output of the gamma-hematite in the low and mid-frequency ranges and the excellent performance of the cobalt-ferrite in the high-frequency range. The result is excellent high-frequency response plus wide dynamic range over the entire audio frequency spectrum.

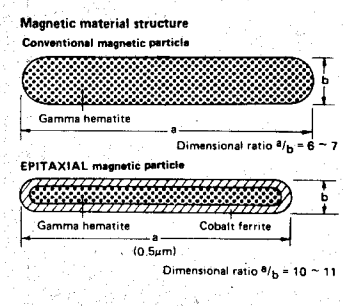
Compared to chrome tape, sensitivity has been improved by more than 3.5dB. Because EPITAXIAL is non-abrasive, it extends to the life of the head. Consequently, the UD-XL delivers smooth, distortion-free performance during live recording with high input. When using UD-XL it is recommended that tape selector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

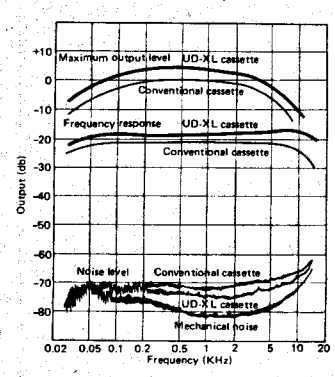


Fidelity is also ensured by a precision-manufactured cassette shell with a special anti-jamming rib that provides smooth tape travel and helps eliminate wow and flutter.



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.





maxell®

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

WT.GD. 76M

It's very gratifying when you start at the bottom and work your way to the top.

At AKAI, we concentrate on being better. Not bigger. So you'll probably find bigger hi fi ranges than ours.

But you'll have your work cut out finding a better range. For quality. Performance. And reliability.

All our equipment is listed below. And each and every piece of hi fi equipment distributed by AKAI Australia is covered by the 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.

So, whether you're new to hi fi, or an old hand at it, you'll find something exactly right. We'll stack our reputation on it.

PORTABLE	$
CT-5	160.00
CASSETTE RECORDERS	
CS-34	298.00
GXC-39	380.00
CASSETTE DECKS	
CS-34D	239.00
GXC-36D	270.00
GXC-39D	360.00
GXC-325D	570.00
GXC-710D	460.00
GXC-760D	730.00
CARTRIDGE RECORDERS	
GXR-82	395.00
CR-80SS*	528.00
CARTRIDGE DECKS	
CR-83D	272.00
GXR-82D	352.00
CR-80DSS*	458.00

OPEN REEL RECORDERS	
1730SS*	535.00
GX-1820	620.00
OPEN REEL DECKS	
GX-230D	555.00
GX-265D	598.00
GX-270D	575.00
GX-400D	1290.00
GX-400DP	1360.00
GX-600DP	656.00
GX-630D	656.00
GX-630DB	740.00
GX-630DSS*	930.00
GX-1820D	575.00
4000DB	375.00
AMPLIFIERS	
AA-5210	199.00
AA-5210DB	299.00
AA-5510	299.00
AA-5810	375.00

RECEIVERS	
AA-810	265.00
AA-810DB	310.00
AA-1010DB	350.00
AA-1020	340.00
AA-1020DB	470.00
AA-1030	385.00
AA-1040	442.00
AA-1050	477.00
AS-1070*	780.00
AS-1080*	870.00
AS-1080DB*	998.00
TURNTABLES	
AP-001C	168.00
AP-003	245.00
AP-005	298.00

N.B. All turntables complete with cartridge, stylus, base and lid.

SPEAKERS	(per pair)
SW-30	75.00
SW-35	119.00
SW-42	150.00
SW-126	245.00
SW-136	310.00
SW-156	385.00
SW-176	580.00

*4 Channel.

DB in model name signifies Dolby System.
Prices quoted are the recommended retail prices only.

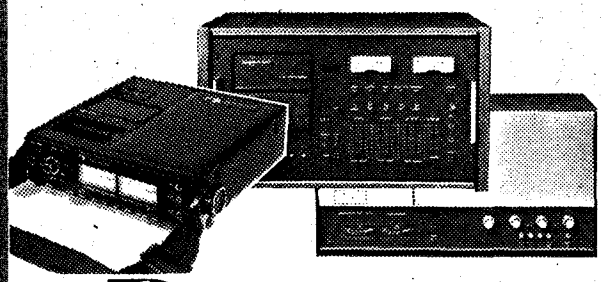
†The AKAI Complete Protection Plan warranty does not cover equipment purchased outside Australia.

70634

AKAI

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

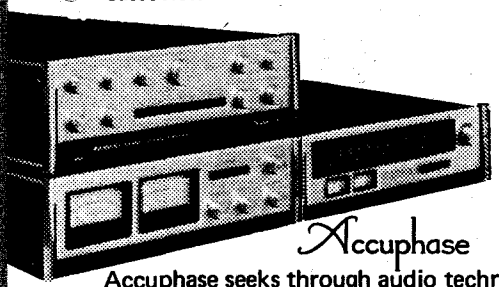
Convoy presents the four aristocrats of sound...



NAKAMICHI

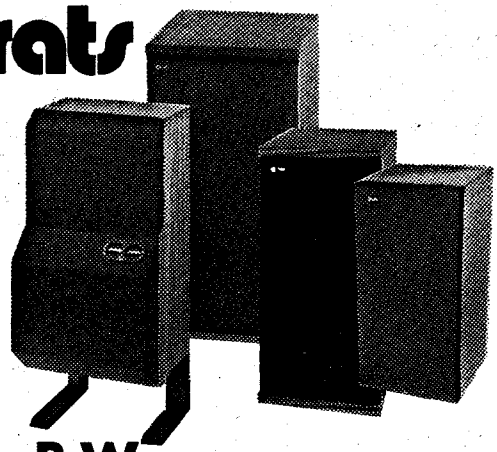
Revolutionary new Cassette Systems.

The advanced design of Nakamichi tape decks includes many special features that take them well beyond the capabilities of other cassette recorders and into a range that makes possible professional applications and standards of recording previously considered out of reach of cassettes.



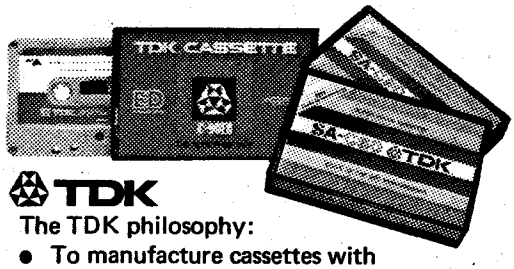
Accuphase

Accuphase seeks through audio technology, music that's exciting and inspiring, that moves our hearts and enriches our lives. This is the idea behind the slogan, "Enrich Life through Technology." It is the basic guiding principle behind all Accuphase audio components whose high grade can even be considered to be extravagant. Accuphase intends, however, to avoid non-audible frills, and concentrates engineering on how best to reproduce the musical contents of program sources.



B&W... the loudspeaker for the perfectionist.

Bowers & Wilkins, manufacturers of the famous B & W range of loudspeakers, are a Company while large enough to be able to achieve the economics of quantity production are small enough to still enjoy the full benefits of a compact research team of dedicated sound enthusiasts.



TDK

The TDK philosophy:

- To manufacture cassettes with magnetic characteristics compatible with all makes and models of cassette decks and portable recorders.
- To offer cassettes which are capable of capturing and faithfully reproducing the real essence of music.

TDK Super Avilyn Cassettes

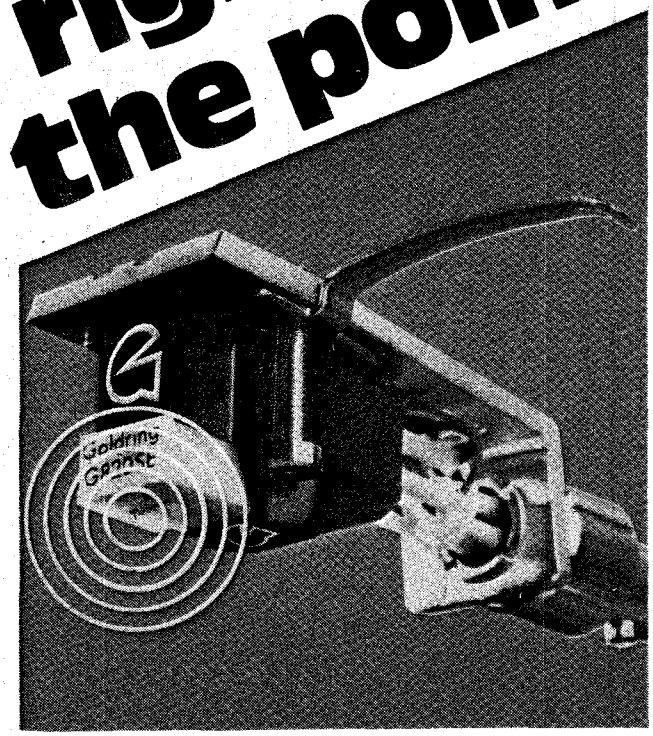
Super Avilyn (SA) cassettes provide an ideal balance of performance characteristics to give the most demanding recordist unprecedented clarity and vividness of sound.

Convoy INTERNATIONAL

On display 8th level Farm Cove Room

Convoy International Pty Ltd., 4 Dowling Street
Woolloomooloo 2011 Sydney. 357 2444
Convoy Sound City Showroom
387 George Street Sydney. 29 1364

let's get right to the point



The point is this!
No matter what type of hi-fi equipment you own - unless the stylus is in good condition, not only will the reproduction quality be less than it should be but continued use of a worn stylus will damage your records.

Generally a sapphire stylus should be replaced after about 50–80 hours of normal use – (that's about 100 LP's) while a diamond stylus will give its best for up to 500 hours.

To maintain top performance from your equipment your worn stylus should be replaced with a genuine Goldring replacement stylus or cartridge.

Manufactured from actual Jewel chips – not paste compounds. There's a Goldring stylus or cartridge to suit your equipment.

Goldring also offer a range of quality hi-fi accessories such as headphones, leads, record and tape cleaning equipment.

GOLDRING

GOLDRING SALES & SERVICE * 26-28 RICKETTY ST. MASCOT NSW 2020 PH. 669 6088 * 162 PELHAM ST. CARLTON VIC 3053 PH. 347 5177 * 40D MILSOM ST. COOPAROO QLD PH. 398 8044 S.J. PONTAGUE & ASSOC * 415 ROKEBY RD. SUBIACO WA 6008 PH. 81 6044 W.L.D. DISTRIBUTORS * 83-85 WOLLONGONG ST. FYSHWICK ACT 2609 PH. 95 8248.

CES'76

THE FIRST AUSTRALIAN CONSUMER ELECTRONICS SHOW

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hi-fi REVIEW

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audio News

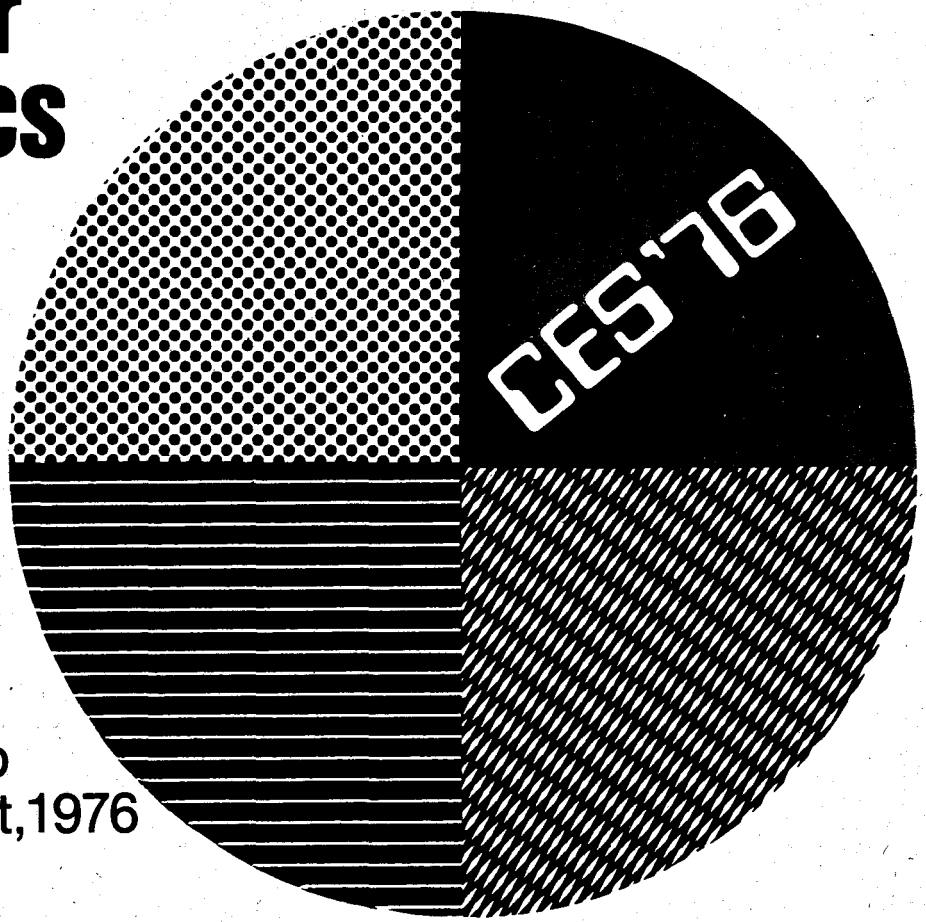
COME UP AND SEE US SOMETIME

ROOM 10, 30TH FLOOR

If you're into Hi-fi don't miss the ultimate experience...

RP177

The 1st Australian Consumer Electronics Show.



Hilton Hotel, Sydney

Wednesday 4, to Sunday 8 August, 1976

Under the sponsorship of the High Fidelity Industry Association.
Supported by Hi-Fi Review

An experience indeed! By far the most comprehensive show of its kind ever held in Australia. All under one roof, at the one time. Compare over 100 different brands of top hi-fi equipment and accessories from market leaders such as . . . AWA, Akai, Auriema, AMI, Convoy, Grundig, Haco-Hagemeyer, Harman, Jacoby-Mitchell, Linear Sound, Pioneer, Rank, Sonab, Sony, Toshiba-EMI.
Also you can view an enormous range of other consumer electronics equipment such as colour TV, Radio, cassette decks, calculators, Digital watches, etc.
The 1st Australian Consumer Electronics Show is based on similar exhibitions which have been held most successfully for many years in the United States.
Although this is primarily a show for the Consumer Electronics Trade, special hours have been allotted for the general public. This is a unique opportunity to view the latest equipment from all over the world, a preview of the products which will soon be on the market.

HOURS
Wednesday, August 4, 1976
1.00-6.00 pm Trade Only
7.30 pm Cocktails—Gala Banquet
Thursday, August 5, 1976
10.00-6.00 pm Trade
9.30-4.15 pm Industry Conference
6.00-10.00 pm Public
Friday, August 6, 1976
10.00-6.00 pm Trade
6.00-10.00 pm Public
Saturday, August 7, 1976
10.00-10.00 pm Public
Sunday, August 8, 1976
1.00-5.00 pm Trade and Public

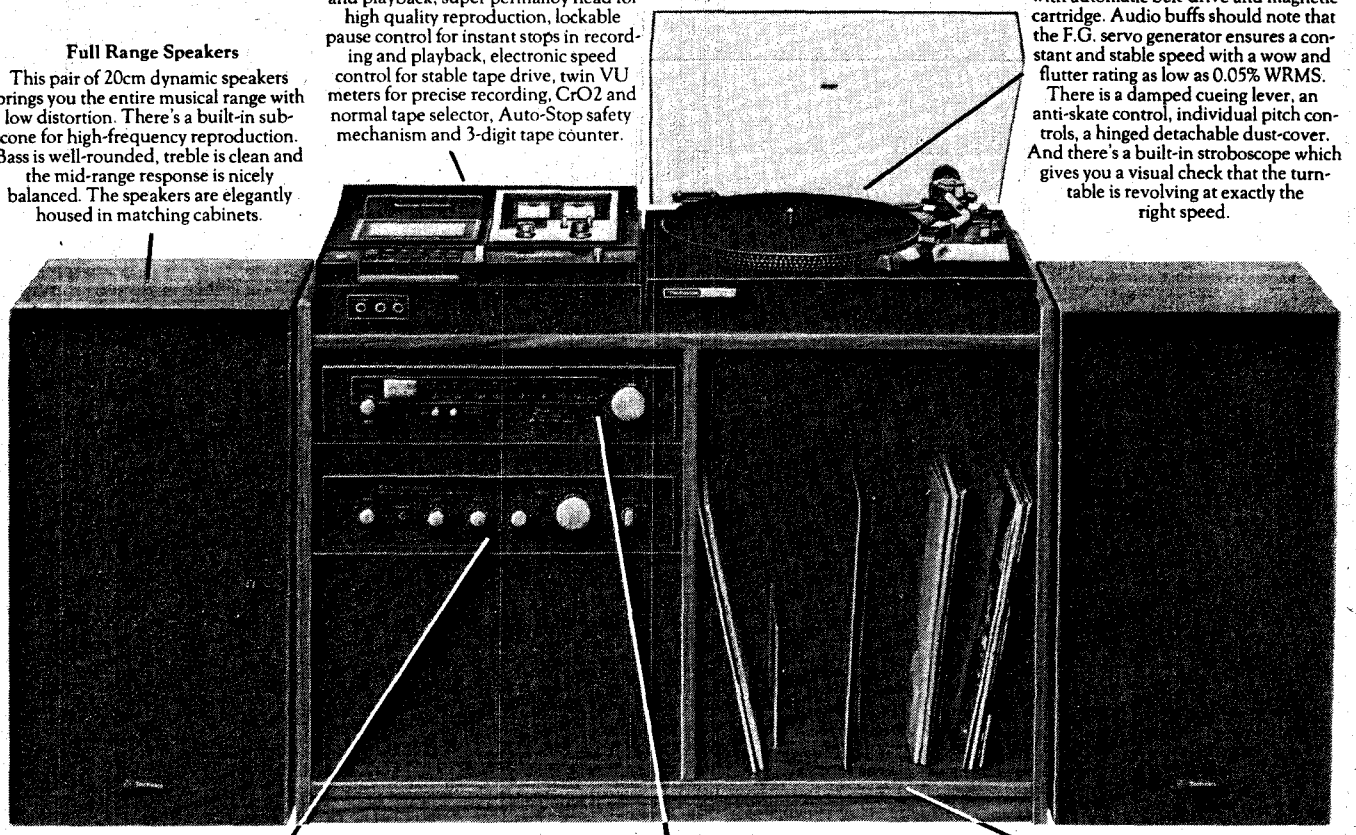
ADMITTANCE IS FREE

Riddell Exhibition Promotions Pty. Ltd.
166 Albert Road, South Melbourne 3205
Phone: 699 1066

Full Range Speakers
This pair of 20cm dynamic speakers brings you the entire musical range with low distortion. There's a built-in sub-cone for high-frequency reproduction. Bass is well-rounded, treble is clean and the mid-range response is nicely balanced. The speakers are elegantly housed in matching cabinets.

Optional Dolby Cassette Deck
Everything for tape enjoyment is here: Dolby circuitry for noise-free recording and playback, super permalloy head for high quality reproduction, lockable pause control for instant stops in recording and playback, electronic speed control for stable tape drive, twin VU meters for precise recording, CrO2 and normal tape selector, Auto-Stop safety mechanism and 3-digit tape counter.

F.G. Servo Automatic Turntable
This turntable is brilliantly equipped down to the little details. It's 2-speed with automatic belt-drive and magnetic cartridge. Audio buffs should note that the F.G. servo generator ensures a constant and stable speed with a wow and flutter rating as low as 0.05% WRMS. There is a damped cueing lever, an anti-skate control, individual pitch controls, a hinged detachable dust-cover. And there's a built-in stroboscope which gives you a visual check that the turntable is revolving at exactly the right speed.



Low-distortion, High-Output Amplifier
The power output from this unit is a big 20 RMS. There is a built-in noise filter on both treble and bass. And because it is good to have accurate and sensitive control over volume, there is a 41 notch control knob.

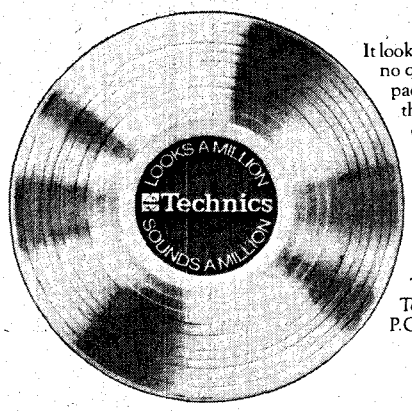
Optional AM/FM Stereo Tuner
This tuner has been specially designed to match the amplifier. Now that the joys of FM stereo broadcasting have come to Australia, a good tuner like this is a "must". It's equipped for super-sensitive and accurate reception with automatic muting of unwanted noise.

Optional Shelving
This shelving is an attractive furniture piece and a good way to organise your hi-fi system. There's lots of storage space for your records and cassettes. In colour and design it's a perfect match to the speaker cabinets.

New Special Value Technics Hi-Fi The Basics plus options.

Technics
HF 2000 SYSTEM

DOLBY SYSTEM * Under licence from Dolby Laboratories Inc.



It looks a million, sounds a million and there's no question about the value of this offer. We've packaged this system to give you good hi-fi without the hassle of mixing and matching your own components. We match them for you to ensure the very best in hi-fi performance. You can buy the complete set or just the basics. We see the basics as the turntable, the amplifier and the speakers. The options are the Dolby cassette deck, AM/FM tuner and audio shelving.
This Technics equipment is in the stores now but if you would like to know more about the whole Technics range write to
Technics Advisory Service,
P.O. Box 49, Kensington, 2033.

Kenwood amplifiers. For people who care about "clean" power.

When you select an amplifier, you're selecting the heart of your audio system. And there's no more reason than that to pick a Kenwood.

You see, Kenwood has earned its fine reputation by building integrated amps that deliver "clean" power. In other words, low total harmonic distortion over a wide band. The result is superb levels of clarity that let you really enjoy the music.

No matter which model you choose, you'll be getting an amp that features the best in technology, performance and styling in its class.

KA-3500. With ample power reserves of 40 watts RMS per channel (8Ω) 20—20,000Hz, and a THD of 0.1%, this model is truly outstanding. Convenient features include intertape dubbing, loudness control and precise, flexible controls.

KA-5500. Tremendous value. A low-distortion amplifier with ICL, (Input Capacitorless) low-noise FETs and large power meters for professional quality sound reproduction. Delivers 55 watts RMS per channel (8Ω) with less than 0.1% THD throughout 20—20,000Hz.

KA-7300. Two completely independent power supplies dramatically reduce dynamic crosstalk. Delivers a marvelously heightened and clear stereo spread. ICL equalizer circuit. 65 watts RMS per channel (8Ω) from 20—20,000 Hz, with less than 0.1% THD throughout the audio spectrum.

KA-8300. Kenwood's giant. 80 watts RMS per channel (8Ω) throughout 20—20,000Hz and a whole host of distortion-reducing features for purity in sound, including a unique pure complementary Darlington Power Block with ASO protection circuitry. Direct reading accurate Power Meter. A true professional.

the sound approach to quality

KENWOOD

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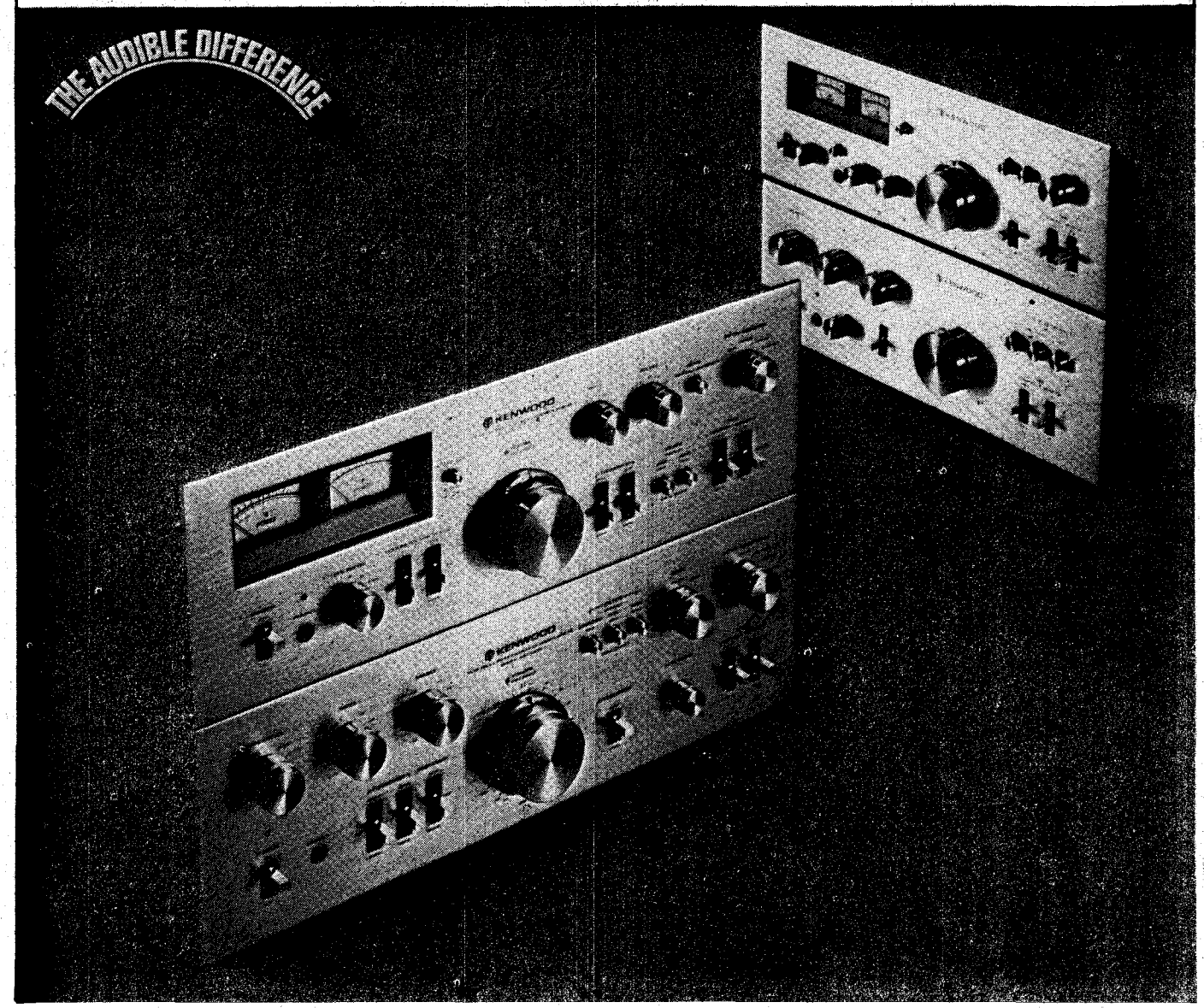

MEGASOUND Pty. Ltd.

220 West Street, Crows Nest.
N.S.W. 2065. Australia.

Phone: 922 3423.
Telegrams, Cables:
Megasound Sydney.

July, 1976.

Dear fellow audiophiles,

We very much hope we will have the pleasure of seeing you sometime between the 4th and the 8th August at the first Consumer Electronics Show, in our Demonstration Rooms Suite 6 on the 30th Floor of the Sydney Hilton.

Many of you know already that we are the Australian distributors for ESS, Inc., Phase Linear Corporation, Win Laboratories Inc., Tapco (Technical Audio Products Corporation) and Sheffield Lab Inc. We have something new and excitingly unique from each one of these U.S. manufacturers.

From ESS we have the full-range Heil headphones, and several very interesting newly-produced AMT speakers - including a new bookshelf and a "Disco" model. And we hope to have on demonstration the long-awaited ESS Heil Bass Driver, specially flown from the factory for the C.E.S.!!

From Phase Linear we will have a new smaller power amplifier and perhaps a demonstration model of the new FM Tuner. In addition you will be able to evaluate all the established Phase Linear units.

Many of the Tapco products (mixers, reverb. units) are of professional interest, but their new graphic equalizer is interesting to audiophiles as well as to professional users.

From Win Laboratories we will have the newly developed Win pickup cartridge and the Win tone arm; and from Sheffield Lab we have a test-pressing of the very latest direct-to-disc album - "The King James Version", which features Harry James and his band - and trumpet sounds like you've never heard on disc before!

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Yours sincerely,

MEGASOUND PTY. LTD.

Paul Jones
(Managing Director) Paul

Warren Stolmack
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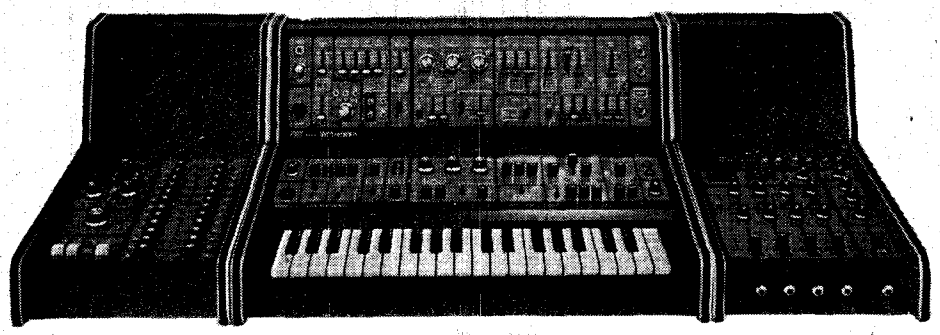

Roland System 100: for the home studio or serious electronics buff. Around $1599.

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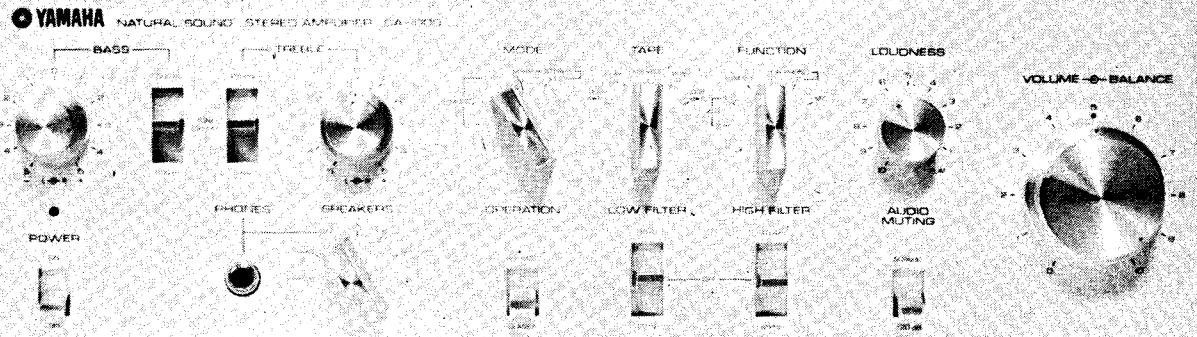

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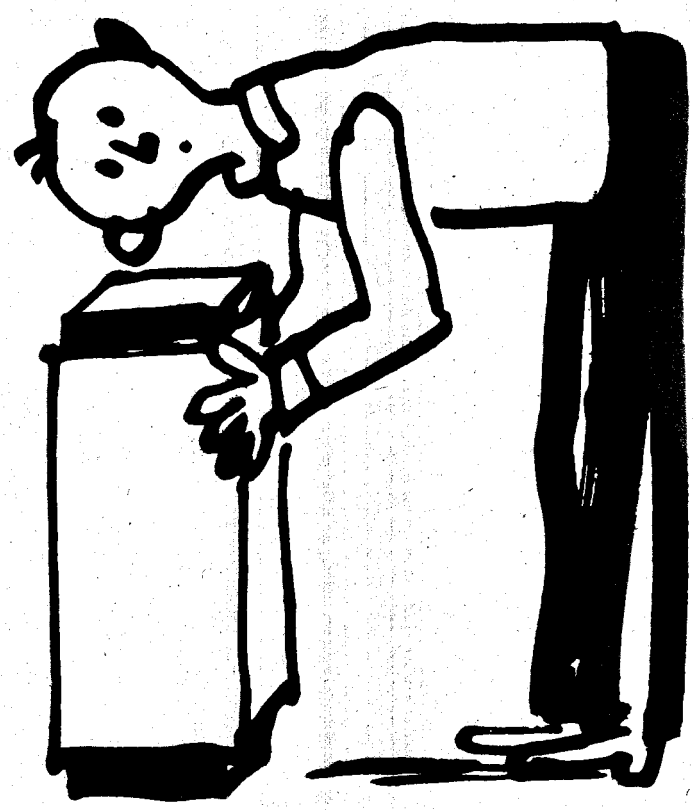


Sonab Sound is not a Loudspeaker Sound

Sonab sound is built around the loudspeaker construction of Swedish researcher Stig Carlsson.
This design uses the room to reproduce sounds. The speakers do not add anything - nor do they take anything away. They are not built for testing laboratories, but for an ordinary living room.
Sonab speakers are made entirely for stereo reproduction, two or four channel. They are not two mono speakers made singly but stereo loudspeakers made in pairs.
Even the cabinets are chosen for a pair at a time. Then they are tested together and tuned together. In fact they're twins - the left being a mirror-image of the right.

Not Only Loudspeakers.....

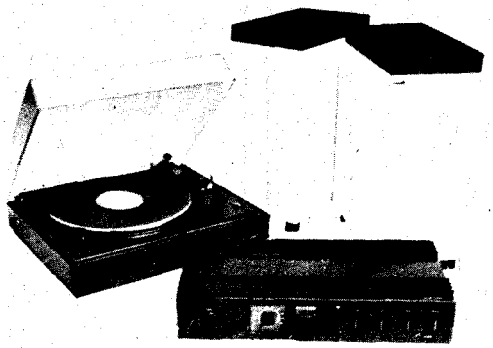
Sonab also has amplifiers, receivers, turntables, cassette deck and headphones - all of the same high quality as the loudspeakers.

Music Is Not Technology.

Distortion, anti-skating, intermodulation, ohms and watts.....it's endless. the hi-fi dictionary is filled with jargon, curves, figures and tables. It's as if it is more important to listen to terminology rather than music.
But music is not technology. It shouldn't be difficult to listen to music. Something is wrong when the equipment is so sophisticated that you need to technically examine it to be able to understand and appreciate the quality. So listen to the sound - not the technicalities. Above all - listen to Sonab sound and try to do it in your own home. Just ask any Sonab dealer - he'll be happy to arrange it for you.

Sonab Sound Wallpapers Your Room With The Music You Love.

When you have a Sonab system in your home you can take a trip to a concert hall whenever you like. Close your eyes and you'll hear each and every instrument. It doesn't matter how much you move around - wherever you sit or stand. Just listen to it.



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B.I.C. Venturi can handle lots of power, too. Feed a typical low efficiency speaker more than about 50 watts, and you're likely to push it into distortion — even self-destruction!

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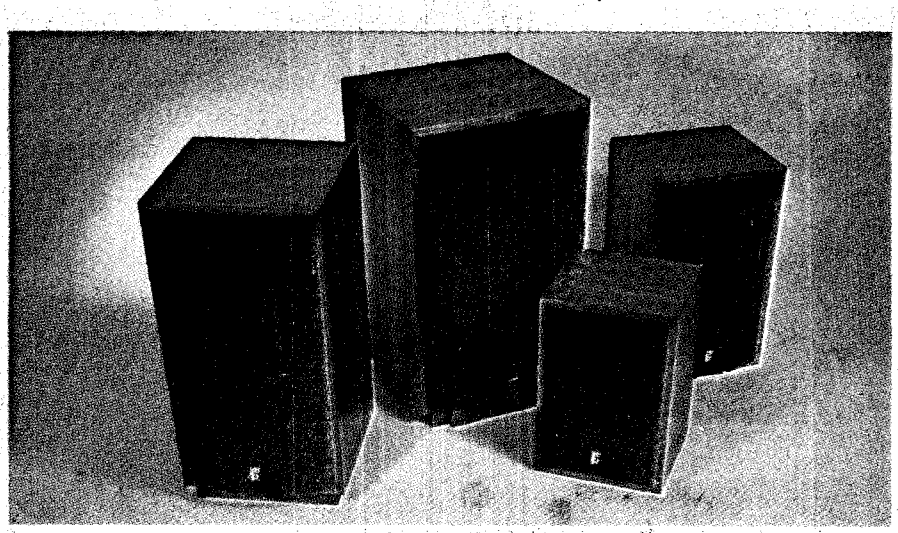

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