

FREE INSIDE! AUDIO DESIGNER'S HANDBOOK CIRCUIT SECRETS UNFOLDED

... NEWS.... PROJECTS.... MICROPROCESSORS.... AUDIO...

TRANSCENDENT 2000 SINGLE BOARD SYNTHESIZER

All kits also available as separate packs (e.g. P.C.B., component sets, hardware sets, etc.). Prices in FREE CATALOGUE.

LIVE PERFORMANCE SYNTHESIZER DESIGNED BY CONSULTANT TIM ORR (FORMERLY SYNTHESIZER DESIGNER FOR EMS LIMITED) AND FEATURED AS A CONSTRUCTIONAL ARTICLE IN ELECTRONICS TODAY INTERNATIONAL.

possess a synthesizer comparable in performance and quality with ready-built units selling for many times the price!

COMPLETE KIT ONLY £168.50 + VAT!

Comprehensive handbook supplied with all complete kits! This fully describes construction and tells you how to set up your synthesize with nothing more elaborate than a multi-meter and a pair of ears!

WE'VE MOVED! **NEW FACTORY UP! PRICES DOWN!**



Cabinet size 24.6" × 15.7" × 4.8" (rear) 3.4" (front)

INCREASED CAPACITY AT OUR BIG NEW FACTORY MEANS MANY PRICES DOWN! ALL OTHERS FROZEN!

DIGITALLY CONTROLLED, TOUCH SENSITIVE, POLYPHONIC, MULTI-VOICE SYNTHESIZER ANOTHER SUPERB DESIGN BY SYNTHESIZER EXPERT TIM ORR — PUBLISHED IN ETI

The Transcendent DPX is a really versatile new 5 octave keyboard instrument. There are two audio outputs which can be used simultaneously. On the first there is a beautiful harpsichord or reed sound — fully polyphonic, i.e. you can play chords with as many notes as you like. On the second output there is a wide range-of different voices, still fully polyphonic. It can be a straightforward piano or a honky tonk piano or even a mixture of the two! Alternatively you can play strings over the whole range of the keyboard or brass over the whole range of the keyboard or should you prefer — strings on the top of the keyboard and brass at the lower end (the keyboard is electronically split after the first two octaves) or vice versa or even a combination of strings and brass sounds simultaneously. And on all voices you can switch in circuitry to make the keyboard touch sensitive! The harder you press down a key the louder it sounds — just like an acoustic piano. The digitally controlled multiplexed system makes practical touch sensitivity with the complex dynamics law necessary for a high degree of realism. There is a master volume and tone control, asseparate control for the brass sounds and also a vibrato circuit with variable depth control together with a variable delay control so that the vibrato comes in only after waiting a short time after the note is struck for even more realistic string sounds



Cabinet size 36.3" × 15.0" × 5.0" (rear) 3.3" (front)

COMPLETE KIT ONLY £299.00 + VAT!

To add interest to the sounds and make them more natural there is a chorus / ensemble unit which is a complex phasing system using CCD (charge coupled device) analogue delay lines. The overall effect of this is similar to that of several acoustic instruments playing the same piece of music. The ensemble circuitry can be switched in with either strong or mild effects.

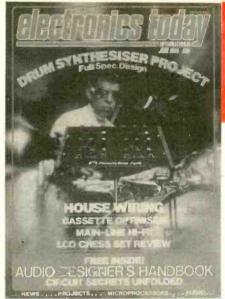
As the system is based on digital circuitry digital data can be easily taken to and from a computer (for storing and playing back accompaniments with or without pitch or key change, computer

Although the DPX is an advanced design using a very large amount of circuitry, much of it very sophisticated, the kit is mechanically extremely simple with excellent access to all the circuit boards which interconnect with multiway connectors, just four of which are removed to separate the keyboard circuitry and the panel circuitry from the main circuitry in the cabinet

The kit includes fully finished metalwork, solid teak cabine, professional quality components (all resistors 2% metal oxide), nuts, bolts, etc., even a 13A plug.—you need buy absolutely no more parts before plugging in and making great music! When finished you will possess an instrument comparable in performance and quality with ready-built units selling for over £1,200 to the finished you will possess an instrument comparable in performance and quality with ready-built units selling for over £1,200 to the finished you will possess an instrument comparable in performance and quality with ready-built units selling for over £1,200 to the finished you will possess an instrument comparable in performance and quality with ready-built units selling for over £1,200 to the finished you will possess an instrument comparable in performance and quality with ready-built units selling for over £1,200 to the finished you will possess an instrument comparable in performance and quality with ready-built units selling for over £1,200 to the finished you will possess an instrument comparable in performance and quality with ready-built units selling for over £1,200 to the finished you will possess and the finished you will possess and the finished you will possess and the finished you will possess an instrument comparable in performance and quality with ready-built units selling for over £1,200 to the finished you will possess and the finished you will be finished you will

ORDERING INFORMATION AND MORE KITS

INCLUDING THE BLACK HOLE



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(MIDLAND TRADING COMPANY)

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BRITAIN'S FINEST SELLING RANGE

ZETRON

NEW ZETRON L.C.D. CALCULATOR NEW

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Four basic functions, chain and mixed operations, constants for four functions, % calculations including discounts and mark-ups. Automatic accumula tion in four functions. *PLUS*

Square Root facility *PLUS*

Memory facility #PLUS#

Auto Power Off (7 minutes)
ALL THIS FOR A MODEST £4.95



GENTS MELODY ALARM CHRONO DUAL TIME

Brand new Melody Alarm, Chrono. Con-stant display of hours, mins, secs, weekday, am/pm and mode square flag indication.

The chrono runs to a 1/10th sec (running horse style) split and lan mode facilities are standard. Dual timing facilities. The alarm system is unique in the fact that it plays the tune "Yellow Rose Of Texas" for 20 seconds.

The tune can be actuated at any instance by the press of a button. Backlight, infinitely ad-justable stainless steel strap.

LOWLY PRICED

£17.75



NEW NEW **OUARTZ L.C.D. TIMER**

A new style timer incorporating split second accuracy. The timer is finished in a strong black plastic case with large L.C.D. readout of hours, mins and secs. A further optional display mode of month, date and weekday is available. The timer incorporates a 1/100th sec chronograph v numerous facilities. with (i) The timer can be frozen.

(ii) Two people can be timed simultaneously. (iii) Split and lap mode facilities are available. A strong black cord is attached to the timer which aids movement at sporting events



Battery replacement is made easy with a screw

OFFERED AT ONLY £19.95

GENTS FRONT BUTTON CHRONO ALARM

Latest style! Constant display of hours, mins, secs, am/pm, weekday and alarm indication. A further two optional display modes are available. The watch comprises of 7 digits, 12 function and is programmed to the year 2009. The alarm can be set to any time within 24 hours and operates for 30 sec. Back-light and a closely woven adjustable stainless steel strap finish the watch off with a really superb sleek look, only 8mm

£13.25



GENTS ALARM CHRONO (12/24 CYCLE)

A really superb watch and module. It can be set as a 12- or 24-hour watch with hours, mins, secs, am/pm and weekday indication always on display. A unique calendar is built into the watch. You can have month followed by date or date followed by month, it's entirely up to you. A 24-hour alarm can be set to any time within a 24-hour within a

The chronograph has a 12-hour capacity and runs at 1/10's. Split and lap mode facilities are available.

Battery hatch. mineral glass, long-life battery and a closely woven adjustable stain-



less steel strap finish the watch off with impeccable looks.

ONLY £16.50

LADIES COCKTAIL

Elegance and style for the lady with the discerning taste. In gold or silver finish with matching bracelet. Constant display of hours and mins with month, date, secs, auto calendar and back-light.

VERY SPECIAL £10.50



LADIES SUGAR COATED

Another superb ladies watch with that extremely popular sugar frosted finish. Links can easily be removed from the strap and the clasp has a spring mechanism built in to give a comfortable fitting. Constant display of hours and mins, with month, date, secs, auto calen-dar and back-light.

£10.50



GENTS CHRONOGRAPH

Probably the best looking chrono on the market. Constant display of hours, mins, secs with am/pm indication. Also month, date and weekday indication. 1/100th and 1/10th sec with split and lap mode facilities. Back-light, closely woven adjustable stainless steel strap.



SPECIAL £8.95

GENTS MELODY MULTI-CHIME ALARM CHRONO

Latest technology! Constant display of hours. mins and secs, week day, date and month with mode and chime indication display. The musical alarm once actuated plays the tune "Oh Suzanna". Two further alarm systems are incorporated in this outstanding watch: (i) 24-hour alarm; (ii) count-down alarm. The watch can be set to chime on every full hour. A 1/100th sec chrono is standard to the watch. Can be switched off. Mineral glass face. The watch also has a battery hatch backlight and infinitely adjustable stainless



100,000

steel strap. VALUE AT £19.95

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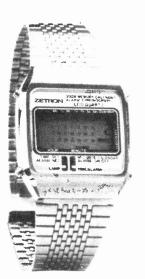
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(MIDLAND TRADING COMPANY)

THREE OF THE FINEST SELLING WATCHES ON THE BRITISH MARKET

GENTS MEMORY CALENDAR ALARM CHRONO



A really successful watch incorporating all the latest technology.

Hours, mins, secs, weekday and snooze alarm indication on constant display.

A further two optional display modes are available, one being the calendar and month, which can be increased or decreased to give the appropriate month of the year.

A 1/106th second chronograph with split and lap mode facilities are built into the watch with a 12-hour capacity.

A 21-hour alarm with a 10minute snooze function is also standard to this watch. A further feature is the backlight and fully adjustable stainless steel bracelet.

*
STAR VALUE
£19.95

GENTS QUARTZ ANALOGUE

A truly superb timepiece with extreme accuracy. A choice of two colours on this outstanding watch are available, blue or white.

The calendar in the watch can be set to give a readout in either French or English with date indication being automatic.

An infinitely adjustable stainless steel strap is built in as part of the

The watch is fitted with a longlife battery and comes with luminous markings to aid nighttime vision.

YES ONLY £19.95



GENTS DIGITAL ANALOGUE CHRONOGRAPH

Just look at this outstanding watch:

i) 6 functions (hours, mins, secs, month, date, week-day); ii) chronograph resolution; iii) automatic 4-year guarantee; iv) five buttons control all functions; v) back-light available.

ONLY £29.95 + P/P



The above watch is a new style digital analogue featuring complete up-to-date modern technology. The watch basically constitutes a traditional hand watch plus a modern digital watch, both battery powered.

Hours, mins and seconds are on constant display and with the press of a button, month, date and weekday is displayed.

This unique timepiece also has a chronograph built in which runs to a 1/100th sec, and has a 12-hour capacity. Features include: i) the chronograph can be frozen; ii) two people can be timed simultaneously, and iii) split and lap mode facilities are available.

The watch is finished off with an elegant infinite adjustable stainless steel strap.

ORDER NOW TO AVOID DISAPPOINTMENT!!!

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THE UNRIVALLED RANGE

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- (ii) Full instructions and 12 month manufacturers guarantee.
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- (v) Free felt presentation case with each watch.

M I T R A D

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We stock thousands more items. It pays to visit us, We are situated behind Watford Football Ground. Nearest Underground/BR Station: Watford High Street. Open Monday to Saturday. Ample Free Car Parking space available. POLYESTER CAPACITORS: Axial lead type.	ACY41 39 8C547 10 AD149 75 8C548 10 AD161 42 8C549C 15 AD162 42 8C556 15 AF114 80 8C557 10	BFR98 105 OC140 110 BFX29 26 OC170 85 BFX81 45 OC171 45 BFX84 26 OC200 48	40594 98 2N3879 150 40595 90 2N3903 20 40603 67 2N3904 18 40636 130 2N3905 18 40673 68 2N3906 17	TIS59 50 TIS74 47 UC734 50 40324 91
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- 0-150MHz in 5 ranges. Large 8-digit display for high accuracy Period and time interval facility. Unit counter up to 99,999,999
- 10MHz crystal timebase Hold and reset buttons plus built-in PSU.

All these features and more for less than half the price of an ordinary frequency meter. The DFM2000 has all its components including the displays, switches and transformer mounted on one double sided PC board. Assembly is simplicity itself especially since interwiring has been eliminated. This is a high quality design and will make a truly professional digital frequency meter that any constructor will be proud to own.

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DIGEST

Vending Over Backwards

A source of constant frustration to many people is vending machines. Invariably they have run out of what you want, or give you chicken soup flavoured coffee, or refuse to refund your money. The average vending machine certainly bears signs of the dislike its customers have for it. mostly in the form of dents, framed by boot marks. The framed wonderfully inscrutable Japanese have, of course, developed a cure in the form of the machine pictured here not particularly beautiful to look at, but with a heart of gold. When the customer approaches it, a sensor picks up the infra-red rays emitted by

him, and a 'soft female voice' says "Welcome" and lists the merchandise in the machine. It also tells the customer when there is no change available, when items are out of stock and reminds him if he has not fed enough money into it for the item he requires. Finally the machine says a cheer-ful "Thank you" and reminds the buyer to pick up his change. This machine, although a novelty at the moment, has quite inter-esting possibilities, but there are no marketing plans for it as yet. Wouldn't it be nice to walk away from a vending machine, clutching exactly what you asked for and with the echoes of that warm welcome ringing in your ears? The system was developed by Mitshushita Reiki, a Mitshushita Electric subsidiary, which specialises in refrigeration equipment.

Solid Security

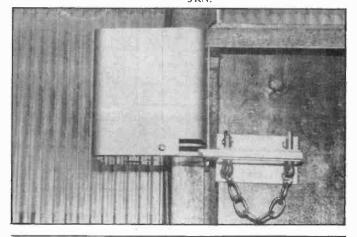
This is Clarke's Instruments Ltd motor driven door lock type 838. It is a remotely operated door lock, which is last to be released on strong doors that give public access to high security areas. After the dead locks have been unlocked by key, the door is held by the motor lock, whose double shear action gives 4 to 6 tonnes of shear strength. When relocking the door, the motor lock is first to be operated. The new microswitching system ensures greater reliability of operation and permits positive indication of full lock closure. Automatic locking of the door each time it closes can also be arranged. It is mains operated and needs no other power supply, great if you don't live in a high risk area for power cuts, although there is an integral manual emergency release on the inside of the door - unless of course, you're trying to get in! Further information is from Clarke Instruments Ltd, 91a High Street, Camberley, Surrey GU15

Ex-Static

piscguard' from Metrosound is an everlasting anti-static treatment for records. In the kit you find a spray pump, a bottle of 'special' fluid and a record cleaner for buffing.

The makers claim that there is no detectable change in sound quality except as we found that the treble sounds cleaner, as it should. We extensively tested it of course, sneakily spraying some of the Editor's prized record collection, and then waiting for a response! In fact there were no adverse reactions, so we think this kit could prove quite useful to audiophile freaks. For £4.50 there is sufficient fluid in the kit to treat both sides of 40 LP records. For further information contact Metrosound, 4/10 North Road, London N7 9HN.

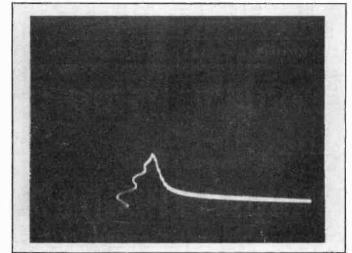




Doctor Who

one of our readers, Mr. S. Knowles of Hampshire, sent us a scope picture he took whilst

designing with a Textronix 7403 on 500 nS/div with x10 expand. It seems he was looking for a pulse, but he may well have discovered the secret of time travel!



CHROMATHEQUE 5000



5 CHANNEL LIGHT EFFECTS SYSTEM

COMPLETE KIT

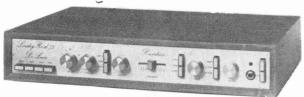
ONLY

£49.50 + VAT!

Panel size 19.0" × 3.5". Depth 7.3"

This versatile system featured as a constructional article in ELECTRONICS TODAY INTERNATIONAL has 5 frequency channels with individual level controls on each channel. Control of the lights is comprehensive to say the least. You can run the unit as a straightforward sound-to-light or have it strobe all the lights at a speed dependent upon music level or front panel control or use the internal digital circuitry which produces some superb random and sequencing effects. Each channel handles up to 500W and as the kit is a single board design wiring is minimal and control in the resign of the produces some superb random and sequencing effects. and construction very straightforward

Kit includes fully finished metalwork, fibreglass PCB controls, wire, etc. — Complete right down to the last nut and bolt!



DE LUXE EASY TO BUILD LINSLEY HOOD 75W STEREO AMPLIFIER £99.30 + VAT

asy to build version of our world-wide acclaimed 75W amplifier kit based upon circuit boards interconnected with gold plated contacts resulting in minimal wiring and construction delightfully straightforward. The design was published in Hr-Fi News and Record Review and features include rumble filter, variable scratch filter, versatile tone controls and tape monitoring whilst distortion is less than 0.01%. All kits also available as separate packs (eg PCB, component sets, hardware sets etc). Prices in our FREE CATALOGUE.



T20+20 20W STEREO AMPLIFIER £33.10+VAT

This kit, based upon a design published in Practical Wireless, uses a single printed circuit board and offers at very low cost, ease of construction and all the normal facilities found on quality amplifiers. A 30-watt version of this kit (T30 + 30) is also available for £38.40 + VAT.

Above 2 kits are supplied with fully finished metalwork, ready assembled high quality teak veneer cabinet, cable, nuts, bolts, etc and full instructions — in fact everything! Matching TUNERS

LAST MONTH'S

The BLACK HOLE designed by Tim Orr, is a powerful new musical effects device for processing both natural and electronic instruments, offering genuine VIBRATO (pitch modulation) and a CHORUS mode which gives a 'spacey' feel to the sound achieved by delaying the input signal and mixing it back with the original. Notches (HOLES), introduced in the frequency response, move up and down as the time delay is modulated by the chorus sweep generator. An optional double chorus mode allows exciting antiphrase effects to be added. The device is floor standing with foot switch controls. LED effect selection indicators, has variable sensitivity input, has high signal/noise ratio obtained by an audio compander and is mains powered — no batteries to change! Like all our kits everything is provided including a highly superior, rugged steel, beautifully finished enclosure.

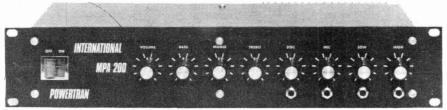
COMPLETE KIT ONLY £49.80 + VAT (single delay line system)

De Luxe version (dual delay line system) also available for £59.80 + VAT

100 WATT (rms into 8Ω) MIXER/AMPLIFIER

Featured as a constructional article in ETI, the MPA 200 is an exceptionally low priced — but professionally finished — general purpose high power amplifier. It features adaptable input mixer which accepts a wider range of sources such as microphone, guitar, etc. There are wide range tone controls and a master volume control. Mechanically the MPA 200 is simplicity itself with minimal wiring needed making construction very straightforward.

The kit includes fully finished metalwork, fibreglass PCBs, controls, wire, etc. — complete down to the last nut and bolt.



Panel size 19.0" \times 3.5". Depth 7.3"

COMPLETE KIT ONLY

£49.90 + VAT!

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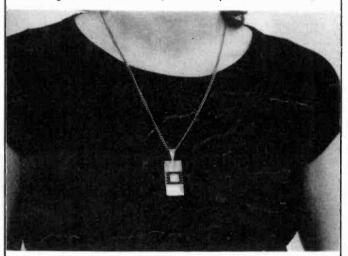
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SPECIAL VT PENDANT OFFER

All ETI readers are kind, generous people with an impeccable sense of taste. Witness their choice of electronics magazine. With this in mind, we thought we would give them a chance to exercise all three attributes simultaneously by purchasing an excellent gift for the woman (or women) in their life.



Our pendant contains a (working — but what a shame to ruin it by wiring!) chip with quartz window, beautifully clasped in either silver or gold, depending just HOW generous you're feeling.

The price is pretty tasteful too and as the holder is emblazoned with the ETI logo, there is no better way of advertising the extent of your appreciation of the

finer things in life.

In silver:

£30 all inc.

gold:

E69 all inc.



To. E Road,												lo	d	m	ag	s	S	al	es	5	ō	ffi	ici	e,	1	4	5	c	h	- ar	ir	ıg	•	r	os	s
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Invasion Monitor?

monitor from Tektronix. It is a high resolution display for anyone needing critical sharpness for displays or display photographs. This monitor gives a spot size of only 0.079cm, and the manufacturers are aiming this at areas

such as medical multi-imaging and electron microscopy. For further information contact Tektronix UK Ltd, Beaverton House, PO Box 69, Harpenden, Hertfordshire.

But what we'd like to know is what is being displayed on the screen! A free subscription to whoever out there can tell us what it is!



Instant Surgery

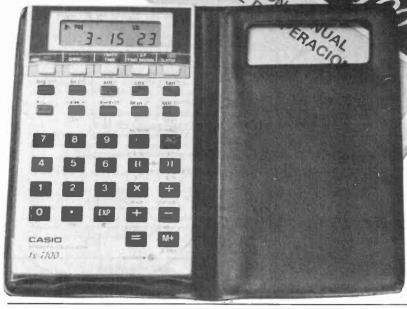
This may look like the surgical equipment of a mad doctor, but we are assured that this isn't its only function. Alternatively it can be used for DIP JC insertion and extraction. The kit has extractors for 14-16 pin

devices, 24-40 pin chips plus inserters for 14-16, 24-28 and 36-40 pin ICs. All the surfaces that could engage conductive surfaces are CMOS safe. It is available from OK Machine & Tool (UK) Ltd, Dutton Lane, Eastleigh, Hants SO5 4AA, and costs £22.35, a small price to pay for budding Dr. Frankensteins.





Count On It



t was on a Monday morning that a small package arrived at ETI, It was greeted with the usual Monday morning enthusiasm - we ignored it-until suddenly... it went off. The entire ETI staff enly. . . dived for cover (we needed an excuse for a lie down anyway).

the package, and there, to our surprise. . . Yes, it was yet another member of the ever growing family of Casio, which has produced a new infant in the form of the fx-7100. A veritable baby, it measures 5mmH x 55mmW x 91.5mmD and weighs only 44gms. It incorporates a scientific calculator with 39 built-in functions, a continual display alarm clock accurate to 3 seconds a day under normal temperatures, a count-down alarm (repeater timer), a 1/100 sec stopwatch and an hourly on the hour time signal — a useful extra for clock-watchers (this had been the cause of the trouble that morning, and still causes the more somnambulant staff members to say 'wot dat?' every hour of the day).

The power consumption is 8mW, which gives a life of approximately 1 year for the two sliver oxide batteries it uses. The package includes the usual data cards and a 70-page operation manual (cough). This little gem normally costs £27.95, or £24.95 from

Tempus.

Metal Locator (March)

Well, the world famous ETI mistake maker has struck again, this time his mistakes were located (!) in the Metal Locator project from our March edition. These were many and varied so here goes: In figure 1 the circuit diagram, starting from the left, the unmarked resistor is R4 18k, at top centre V/2 is not +18V and underneath that R19 100k does not go to +18V but to Vs. IC4d should be labelled IC4a

and at bottom centre the common line to C2 470n, L1 and R2 15k should be connected to 0V. C18 10n and C20 470u should be transposed, and transistor Q9 is BC158. In figure 3, the component overlay, the tag which says White/WH should be White/ BLK and the unmarked IC should be 1C4, Q8 and Q9 should be transposed and the missing resistor value is R45. Track C17 should go to pin 13 and not to 12. Figure 4 connection for front panel, lead marked Blue/BLK should be Blue/WH.

Radio Control Protector (April)

We made an incorrect state-ment last issue with regard to the PPIM-4CH from Chromatronics. We said that their device

would not operate if one of the decoder outputs locked high. Well it does and we were wrong. Sorry Chromatronics.

B&B 1537 VCA Article

Here they are again. Errors. Rearing their ugly heads amongst the otherwise unsullied pages of ETI. But wouldn't you miss them if they weren't there?

The first error was on the schematic on figure 5. R6 and R9 should be shown as joined at pin 3 of the 1537A and R8 and R10

should be similarly joined at pin 6. In figure 6, the trace connecting pins 1 and 2 of IC1 is slightly

obscured by the IC outline, so take note all of you out there who are making there own PC board!

Also the titles for figures 14 and 15 are exchanged and a noninverting VCA configured as per figure 15 would have a minimum gain of unity, whereas the inverting VCA of figure 14 could attenuate to the common mode limits of the op amp used, OK?

DISPLAY ELECTRONICS ADVERTISEMENT - MAY ISSUE

Due to a printing error a photograph of the Super 77 Key Keyboard wrongly appeared under the 10W price chassis heading. We apologise for any inconvenience caused to our customers.

Sounds Interesting

How does an extremely easy to make organ utilising "advance circuit techniques" strike you?

Aura Sounds have imported full organ kits which range in price from £1499 to £7546, but each complete organ is made up of smaller kits which can be bought individually, so that you can spread the pain of parting with your hard-earned over a

greater period of time. Aura Sounds assure us that the finished product is of superb quality, both sound and visual. Each kit comes complete with assembly manuals and they even supply the solder! The parts are in numbered containers so that the contents can be easily checked against the parts list. If you're interested contact: Aura Sounds, 14-15 Royal Oak Centre, Brighton Road, Purley, Surrey.

Towers' Reaches New Heights

f you deal with transistors whether as a student, a hobbyist, a circuit engineer, a buyer, a teacher or a serviceman - you often want data on a specific transistor of which you know only the type number (that's what it says in the

preface, anyway!)
All joking apart Towers' International Transistor Selector, is a veritable bible of over 20,000 British, American, European and Japanese transistors and available substitutes. All necessary infor-

mation is shown in a neat tabular form including package outline, lead info., European and American equivalents etc, etc, etc. Published by W.Foulsham and Co. Ltd., this is the Revised Edition Update Two, and is well worth the outlay.

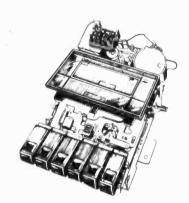
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Included in the kit are two fibreglass PCB's, drilled and plated for immediate assembly, two VU meters. Dual LED Peak Meters, Variable Bias system, Power Supply, over 10 micro-circuit IC's for the most up-to-date performance, as well as monitoring amplifier, test and calibration cassette, etc.

Price of Kit (without transport mech.)

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Price of Case £9.75 VAT Inc. plus £1.00 P&P

Readers will know of the original LINSLEY HOOD CASSETTE DECK design, published in May 1976. Subsequent articles by Mr. Linsley-Hood have confirmed that the design far exceeded his original expectations, so much so that he published a number of improvements, modifications, and additional feature's to the original design, which are now incorporated in this Kit

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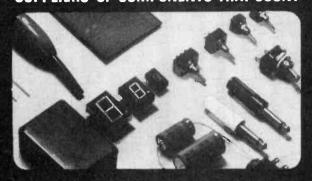




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FM MAINS DISTRIBUTOR

A system for distributing a Hi-Fi or other audio signal to any number of remotely-located speakers, using the mains wiring as the communication link.

his unusual project is designed to distribute an audio signal to any number of speakers that are remotelylocated throughout a house or office building, using the mains wiring as the communication link. The system has an overall audio frequency response that extends to 20 kHz, with typically less than 0.5% total harmonic distortion and is designed to deliver a maximum of about 2 watts to each speaker. The system rejects all unwanted mains noise and has an overall audio sensitivity of about 10 mV for 2 watts output on each

The system comprises a single transmitter unit and any required number of remotely-located receiver/amplifier units. The transmitter unit generates a 200 kHz carrier signal, which is frequency modulated by the audio input signal and which the transmitter superimposes on the neutral line of the 230 volt AC mains wiring. At each receiver unit, this FM signal is picked up from the mains, is amplified, demodulated and the resulting audio signal is then fed to an external eight ohm speaker via a 2 watt power amplifier IC.

The transmitter and each receiver unit is provided with its own volume control. Each receiver unit is also provided with an automatic mute facility, which disables its audio output when the transmitter is turned off. All units are mains powered and simply plug into existing mains sockets via fused (1 amp) plugs, no other interconnections being required. All units incorporate a variety of safety features, but it is essential for correct operation that the mains sockets be wired in the correct polarity: each socket should thus be tested with a neon indicator or similar device before plugging a unit into place.

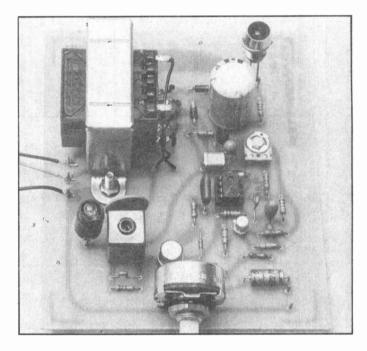
The Mains-Line system can readily distribute an audio signal throughout an entire house or office building and has a variety of practical applications. In the home, it can be used to transmit the output of a music centre or other audio source to all rooms in the building. Alternatively, the transmitter can be fitted with a microphone and pre-amp and used as a baby alarm, enabling the baby to be heard from any part of the house.

In an office, the transmitter can be coupled to a mixer unit and used to distribute music signals and announcements throughout the entire building without the expense of having to fit additional wiring.

Construction: The Transmitter

The entire transmitter unit, including the power transformer, is assembled on a single PCB. Construction should present few problems if the usual precautions are taken to ensure that all semiconductor devices and electrolytics are fitted in the correct polarity.

When construction is complete, set the core of L2 and the slider of RV1 to mid position. If you have a 'scope, give the



unit a functional check by checking that a signal of a few hundred mV at about 200 kHz is present across the output terminals of T2: set the frequency to precisely 200 kHz via RV1 and trim the core of T2 for maximum output.

You can, if you wish, case the complete unit; our own prototype is uncased, as it is intended to be built into an existing audio amplifier system.

Construction: The Receiver

Most of the receiver unit (except T1, RV2, SW1 and LED 1) is wired up on a single PCB. Construction should present few problems if the overlay is followed with care. When construction is complete, fit the PCB and remaining components into a suitable case and complete the interconnections to T1, RV2, SW1 and LED 1, as indicated on the overlay and the circuit diagram.

When construction is complete, set the core of T2 and the slider of RV1 to their mid position, connect the output of the unit to an eight ohm speaker and switch the unit on. With mute switch SW1 on, little noise should come from the speaker: with SW1 off, lots of 'white' noise should come from the speaker, indicating that the system is functional. If you have a 'scope, monitor pins 4-5 of IC1 and adjust RV1 to obtain a frequency of about 400 kHz.

15

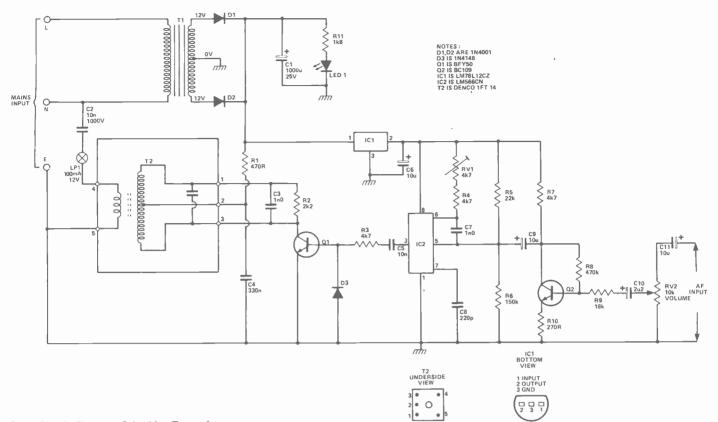


Fig.1. Circuit diagram of the Line Transmitter.

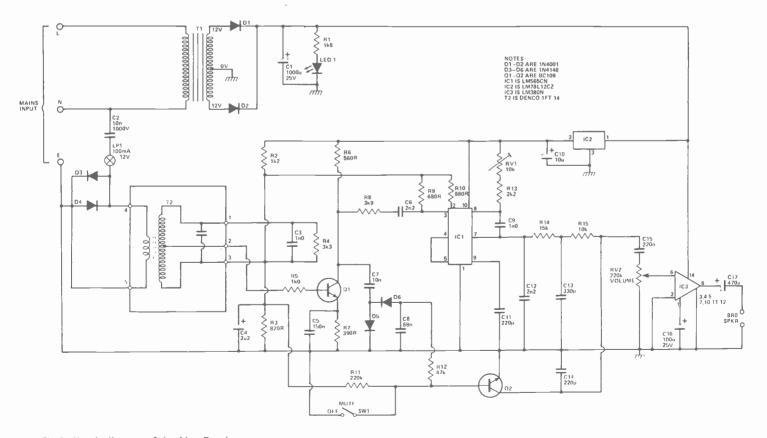


Fig. 2. Circuit diagram of the Line Receiver.

HOW IT WORKS.

The system is designed to transmit an audio signal to any number of remotely-located receiver/speaker units, using the mains wiring as the communication link. The transmitter produces a low-level 200 kHz carrier signal, frequency modulated by the audio signal, which it superimposes on the neutral line of the mains wiring. At each receiver unit, the carrier signal is picked up from the mains, amplified, demodulated and the resulting audio signal is passed on to a speaker via a 2 watt audio amplifier IC. The use of an FM link ensures a good audio response and excellent noise rejection.

System operation relies on the fact that the mains wiring is highly inductive and acts as a fairly high impedance to a 200 kHz signal. At this frequency, the wiring can be regarded as an inductive potential divider, with the power sub-station at its 'low' end. This 'divider' normally produces relatively little signal attenuation between power points that are separated by scores or hundreds of metres of wiring and can be used as an excellent built-in 'data link' in any home.

The Transmitter

IC2 is a voltage-controlled oscillator, or VCO. Its operating frequency is determined by the values of RV1—R4 and C8 and by the voltage on pin 5. With the component values shown, the VCO operates at a centre frequency of 200 kHz and produces a square wave output at pin 3. This output is used to drive common emitter amplifier Q1, which uses a standard IF transformer (T2) as its collector load; the centre frequency of T2 is shifted to 200 kHz by C3 and its 'Q' is reduced to a fairly low value (to give a broad-band response) by R2. The output signal on T2 secondary (pins 4 and 5) has an amplitude of a few hundred mV rms.

Audio input signals to the unit are fed to volume control RV2 via C11 and then subjected to about 20 dB of amplification via Q2. The output of Q2 is used to frequency modulate the VCO via C9 and pin 5. Consequently, the output of T2 is a 200 kHz 'carrier' signal frequency modulated by the audio signal. This output is coupled into the neutral line of the mains wiring via low-value capacitor C2 and current-limiting 'fuse' LP1. Note that one side of T2 output is wired to the Earth line of the mains, thereby ensuring that standing DC potentials of only a few volts exist between the primary and secondary windings of the transformer. C2 and LP1 ensure that the system will not be damaged if the output signal is accidentally fed to the live, rather than the neutral, side of the mains.

 $Q2\ and\ IC2$ are powered from a stabilised supply via IC1, a 12 volt regulator.

The Receiver

The 200 kHz frequency-modulated mains signal is picked up on the input of T2 via C2 and current-limiting 'fuse' LP1; D3 and D4 are used to limit the T2 signal amplitudes to a few hundred millivolts. T2 is tuned to 200 kHz via C3 and has its 'Q' reduced to a fairly low value via R4, to give a broad-band response. The isolated output signal of T2 is fed to the base of common emitter amplifier Q1 via current-limiting resist or R5.

The base of Q1 is biased to 4V5 via the R2-R3 divider network. Q1 is overdriven by the input signal and has its output clipped at about 6 volts peak-to-peak. The output of Q1 is fed to the pin 3 input terminal of IC1 via R8-C6-R9. IC1 is a phase locked loop and is used to demodulate the 200 kHz FM carrier signal. This IC contains a reference oscillator, which is set to the same centre frequency as the carrier via RV1-R13 and C11. The demodulated audio signal appears at pin 7 of IC1. C12-R14-C13-R15-C14 are used to filter out any vestiges of the carrier and the resulting 'clean' audio signal is passed on to volume control RV2 via C15. The output of the volume control is fed to 2-watt audio amplifier IC3 and is then passed on to an external eight ohm speaker via C17. Most of the circuit (other than IC3) is powered from a stabilised supply via IC2, a 12 volt regulator.

The receiver unit is provided with an automatic 'mute' facility, which kills the audio output in the absence of a carrier signal, via Q2 and its associated network. Q2 is wired across the input to the volume control and kills the audio signal when biased on. Q2 is biased from two independent sources. It is positively biased (biased on) via R11 and the R2-R3 potential divider and can also be negatively biased (biased off) from the output of Q1 via the C7-D5-D6-C8-R12 rectifier network. The values of R11 and R12 are chosen so that the negative bias is predominant and Q2 is turned off in the presence of a carrier signal that has sufficient strngth to produce a peak-to-peak signal in excess of about 1V5 at Q1 collector. In the absence of a suitable carrier signal the negative bias falls to a negligible value and Q2 is turned on via R11.

The automatic mute circuit can be disabled by closing SW1, in which case the phase-locked loop tries to lock on to noise signals in the absence of a carrier and consequently produces very high noise levels at the output of IC3.

BUYLINES

The Denco IF transformer used in this project is available from Watford Electronics. The other components should be readily obtainable.

Setting Up The System

Access to a 'scope is needed when initially setting up the system, as follows.

Switch on both units and apply a suitable audio (music) signal to the input of the transmitter. Turn the transmitter volume control to zero, use the 'scope to monitor pin 2 of T2 in the receiver and adjust T2 core for maximum signal. Next, monitor pins 4–5 of IC1 in the receiver and set RV1 to the mid position at which locking to the 200 kHz carrier occurs. Finally, set the receiver volume control to mid value and adjust the transmitter volume control so that the music signal is heard at the receiver without apparent clipping. The system is then complete and ready for use throughout the house or office.

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Right:a fully assembled line receiver PCB. Note the polarity of the ICs and polarised components.

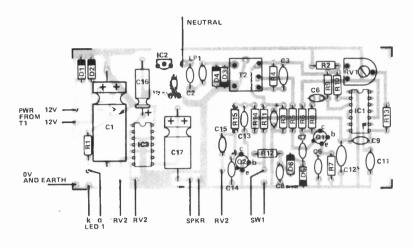


Fig. 3. Component overlay for the transmitter board.

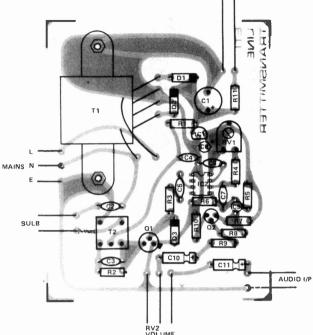


Fig.4. Component overlay of the receiver.

PΔ	R1		П	IST	
	- FO	. 7			

	PARTS		
TRANSMITTER		R4	3k3
Resistors All ¼W, 5%		R5	1k0
R1	470R	R6	560R
R2	2k2	R7	390R
R3,4,7	4k7	R8	3k9
R5,4,7	22k	R9.10	680 R
R6	150k	R11	220k
		R12	47k
R8	470k	R13	2k2
R9	18k		15k
R10	270R	R14	
R11	1k8	R15	10k
Potentiometers		Potentiometers	
RV1	4k7 min horiz preset	RV1	10k min horiz preset
RV2	10k log	RV2	220k
IX V Z	I OK 108	13.7.2	
Capacitors		Capacitors	
C1	1000u 25V PCB electrolytic	C1	1000u 25V electrolytic
C2	10n 1000V disc ceramic	C2	10n 250V AC ceramic
C3	1n0 polyester	C3	1n0 polystyrene
C4		C4	2u2 tantalum
	330n polycarbonate	C5	150n polycarbonate
C5	10n polyester	C6	2n2 ceramic
C6,9	10u 16V tantalum		
C7	1n0 ceramic	C7	10n polyester
C8	220p polystyrene	C8	68n polycarbonate
C10	2u2 16V electrolytic	C9	1n0 ceramic
C11	10u 16V electrolytic	C10	10u tantalum
		C11,14	220p polystyrene
Semiconductors		C12	2n2 polystyrene
IC1	78L12	C13	330p polystyrene
IC2	LM566CN	C15	220n polycarbonate
D1,2	1N4001	C16	100u 25V electrolytic
D1,2 D3		C17	470u electrolytic
	1N4148	0.7	
Q1	BFY50	Semiconductors	
Q2	BC109		LM565CN
LED 1	0.2" red LED	IC1	
		IC2	LM78L12CZ
Miscellaneous		IC3	LM380N
T1 12-0-12 6VA tran	sformer, T2 Denco IFT 14, 12V 100 mA	Q1,2	BC109 .
bulb.	, , , , , , , , , , , , , , ,	D1,2	1N4001
		D3,4,5,6	1N4148
RECEIVER		LED 1	any LED
			•
Resistors All ¼W, 5%		Miscellaneous	
R1	1k8	12 0 12 transformer	6VA, 12V 100 mA bulb, T2 is Denco IFT
R2	1k2	14 0 -	10 th, 12 t 100 mm build, 12 is belied it i
R3	820R	14, 8 ohm loudspeal	Ker.

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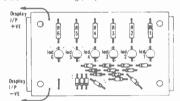
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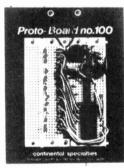
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HOUSE WIRING

Ray Marston discusses house wiring systems of the past, present and future, presents some useful 're-wiring' aids and talks about some facinating line-based gadgets for the '80s.

odern house wiring circuits are designed to conform to regulations laid down in 1947, that far-distant time when valves were in vogue and the word 'electronics' was used only in Sci-Fi movies. Consequently, modern house wiring works fine when used to power simple devices like flourescent lamps and electric toasters, but presents distinct problems if you want to use modern electronic lamp dimmers, FM power-line audio distribution systems, power-line remote control systems, or similar '1980s' devices.

If you happen to live in a house built before 1947, when 'modern' wiring was first introduced, it's a fair bet that your wiring is not only highly inefficient but is downright dangerous, with its rubber insulation perished to the point where total breakdown is imminent and the whole shambles is in danger of bursting into flames! So you'd better think about a rewire. And if you are going to rewire, you may as well rewire for the '80s.

In the next few pages we'll tell you how 'modern' wiring systems work, explain the wiring needs of the '80s, give a few hints on how to conduct a rewiring job and tell you about some of the wiring-based electronic control and data distribution systems that you are likely to see in the next year or so.

Conventional Power Wiring Systems

Electric power is fed into the house from the outside mains and passes to the building's electricity meter. It is then fed to the individual household circuits via individual fuse units or, in the latest systems, via a multi-fused 'consumer' unit.

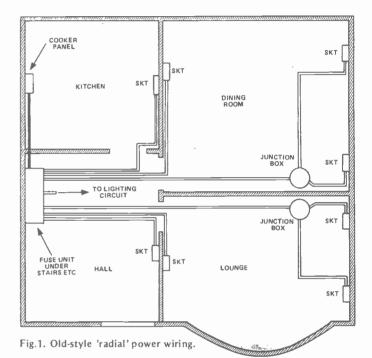
The household circuits are, for convenience, classified as three distinct types, (a) power circuits (feeding sockets, etc), (b) lighting circuits and (c) accessory circuits (individual heavy-duty circuits feeding immersion heaters, cooker panels, etc). Let's look first at 'power' circuits.

Old-style (pre 1947) electrical systems use a 'radial' system of power wiring, as shown in Fig.1. Here, each individual power socket or small group of sockets is treated as an individual circuit and is connected to the mains via its own specific fuse; often, the live and neutral lines of each circuit are individually fused.

Sometimes, different circuits have different fuse ratings (sometimes the cable gauges may also be different), so that an electric fire (for example) may work on one socket but blow the fuses (or the wiring) when connected to another socket.

The radial wiring system is clearly inefficient and requires the use of excessive amounts of cable and an excessive number of fuses.

'Modern' (post 1947) electrical systems use a 'ring' system of power wiring, as shown in Fig.2. Here, a power cable is run from the fuse box to the first (hall) socket, then sequentially to all of the sockets on (say) the ground floor and finally back to the fuse box again, so that a 'ring' of cable is formed. The ring is treated as a single circuit and provided with a single



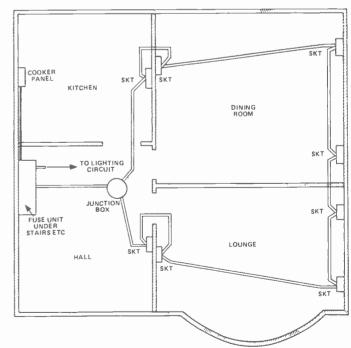


Fig. 2. Modern-style 'ring' power wiring circuit. The 'ring' is shown here connected to the fuse unit via a junction box, but in practice the 'ring' may be connected directly to the fuse unit.

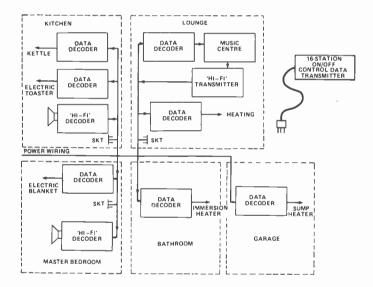
master fuse, but all socket plugs are individually fused. Most modern houses are provided with two ring circuits, one for each floor. On the upper floor, the ring may be connected to the fuse unit via a junction box and feeder cable.

The ring system is very efficient in the use of cable. Power is fed to each individual socket via both sides of the ring, which are thus effectively wired in parallel and share the socket current. This factor enables a relatively light gauge of ring cable to be used. In practice, 2.5 mm² PVC sheathed cable is used for ring circuits. Any number of sockets can be fitted on a ring serving a surface area of less than 100 m² (1000 ft²): the ring must be fitted with a 30 A (max) fuse and can handle up to 7.2 kW. The feeder cable to such a ring (if used) must be 4 mm² type.

Power Wiring For The 80s

The most important 'house wiring' innovation of the '80s will be the widespread use of the mains wiring as a high frequency (a few tens or hundreds of kHz) data link between different parts of the house. The live and neutral lines of the house wiring each contain very considerable lengths of cable and consequently have substantial inductance. The reactance of the wiring is negligible at 50 Hz but can be quite significant at frequencies of a few tens or hundreds of kHz.

High frequency signals can thus readily be superimposed



on the power wiring at any power socket in the house and can then be picked off again at any (or all) of the remaining sockets throughout the household.

Cable Music

You have two 'sets' of cables in the power wiring (earthneutral and earth-live), giving you two indpendent data links throughout the house. One link can be used for distributing hi-fi signals via an FM system of the type described elsewhere in this issue. The other link can be used for distributing control data instructions to remote units: a 6-bit data word can be used to address any one of 16 different devices and convey up to four different instructions to those devices.

Figure 3 shows an example of the degree of control that can be obtained via a data-link system: only seven of the 16 available remote control channels are shown in use. On a cold and frosty morning you can, from the comfort of your bed, switch on the sump heater in the garage, activate the hi-fi distribution system and turn on the kettle and toaster in the kitchen. In the evening you can turn on the immersion heater and the electric blanket while sitting in your armchair in the lounge.

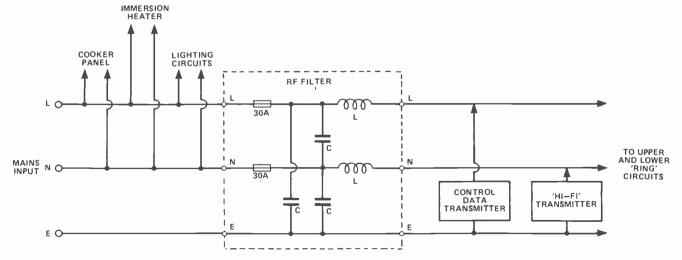
Absolute Luxury.

In the diagram we've shown a single 16-station transmitter unit that can be plugged into any convenient socket. In practice, you may prefer to have individual transmitter units permanently fitted into the lounge, kitchen and master bedroom. If you are really lazy, you can have a single 16-station infra-red transmitter unit that can pump signals into the mains via infra-red receiver/re-transmitter unit built into each room.

These high frequency distribution systems have considerable range and will work perfectly with all existing house wiring. This range is so great that signals can easily be picked up in neighbouring houses as well. If your neighbour happens to have a similar distribution system (it's a fair bet that he will within the next few years) the systems will interact. To overcome this problem you'll have to fit an efficient RF filter to the feeder lines, as shown in Fig.4, so that the unwanted external signals see the low impedances of the filter capacitors, while the signals on the internal rings see the high impedances of the filter inductors and do not escape.

Fig. 3. (left) Hi-Fi signals are fed to all power sockets in the house via an FM distribution system. Kettles, toasters, heaters, etc can be activated from any room in the house fitted with a power socket via a 16-channel remote control system: only seven channels are shown in this diagram.

Fig.4. (below) When power-circuit data distribution systems become widespread, it will be necessary to fit efficient RF filters to the feeder lines of the ring circuits.



Ring For Roses

A major problem with the Fig.4 circuit is that suitable (30 A) filter inductors are not readily available at the present time. When planning a rewire for the '80s, space should, however, be left in the fuse box area for the eventual fitting of such a filter when suitable components become available. Note that high-current 'accessory' circuits such as the cooker panel and immersion heater are not fed by the filter: nor are the lighting circuits, which generate a good deal of electrical noise when used with lamp dimmers, etc.

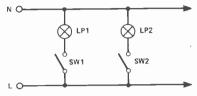


Fig.5. The basic lighting circuit (earth wiring not shown).

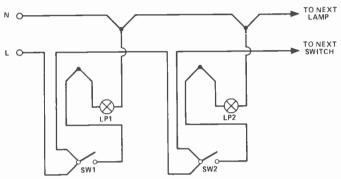


Fig. 6. Old-style implementation of the lighting circuit (earth wiring not shown), with three wires (plus earth) running down to each switch.

In summary, then, power wiring for the '80s will take the form of 'modern' (post 1947!) ring circuits except that the feed line to the rings should be fitted with RF filters.

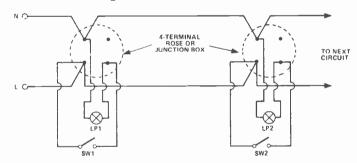


Fig.7. Modern-style implementation of the lighting circuit (earth wiring not shown), with two wires (plus earth) running down to each switch.

Conventional Lighting Circuits

The basic lighting circuit of a domestic system is deceptively simple, as shown in Fig.5. Note that the light switch is used to connect the lamp to the live side of the circuit, thereby ensuring that a shock cannot be received from the lamp holder (when changing a bulb) when the switch is open or off.

The physical implementation of the Fig.5 circuit is not a simple task. Fig.6 depicts the old-style (pre 1947) method of implementation, in which Neutral goes to one side of each lamp and the Live line is looped from one switch to the next. Note that this method requires three wires (plus Earth) to be run down to each switch. In practice, the old-style wiremen tended to disregard the 'polarity' rules and often switched the

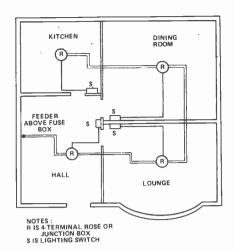


Fig. 8. Typical ground-floor lighting circuit of a medium sized house.

Neutral line, so that the lamp holder remained permanently (and dangerously) 'live'.

Once again, the system in Fig.8 looks deceptively simple. In practice, the system may, if you are unlucky, take a full weekend to implement, particularly if you are changing the positions of light switches and have to cut new down-channels in the plaster to accommodate new cable runs.

Lighting The Way

Figure 9 shows the circuit and implementation of 2-way light switching. In practice 2-core, plus earth, cable is used to connect SW1 to the ceiling rose and 3-core plus earth is used to interconnect SW1 and SW2. A lot of channelling work may be required to implement the system. Note that changeover switches are required for 2-way switching.

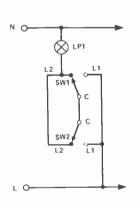
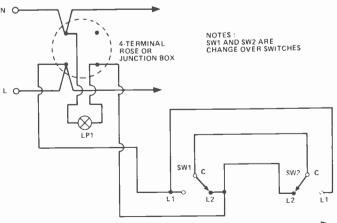


Fig.9. Circuit (left) and implementation (below) of modern 2-way light switching (earth wiring not shown). Note the large number of wires running down to the switches; in practice, a total of seven wires run down to SW1. The switching is shown in the OFF position.



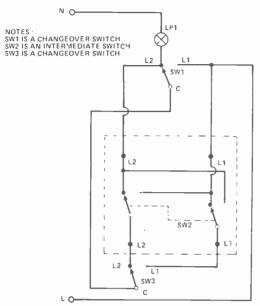


Fig. 10. The electrical circuit that is used in 3-way light switching.

Lighting Circuits

A major deficiency of 'modern' lighting systems is the physical difficulty that is involved in initially installing the light switch wiring or in converting the system to multi-way switching. An ideal '1980s' solution to this problem is offered by the push-button-activated lamp dimmer/on-off circuit of Fig.11.

4-TERMINAL ROSE OR JUNCTION BOX

PUSH OIMMER UNIT SB

TO PUSH-BUTTON SWITCHES

Note that the control (push-button) switches of the above circuit carry maximum currents of only a few mA and that any number of switches can be wired in parallel, enabling multi-way control to be readily implemented.

Ideally, this unit should be connected into the house wiring in a position that is close to the 4-terminal ceiling rose (but readily accessible for maintenance purposes): the push-button control switches should then be installed in the desired 'wall switch' positions and connected to the unit via low-power twin flex, shallowly buried in the plaster.

Note that the circuit uses components L1 and C1 for RFI suppression. All lamp dimmer circuits generate substantial RFI and should therefore incorporate suitable suppression networks: in practice, the very limited size of the conventional 'plaster-depth switch box' precludes the fitting of suitable filters, so most of todays 'manual' dimmer circuits generate unsuppressed RFI. A major advantage of the remote-controlled dimmer/on-off circuit of Fig.11 is that its physical size is not significantly constrained, so excellent filtering can readily be incorporated.

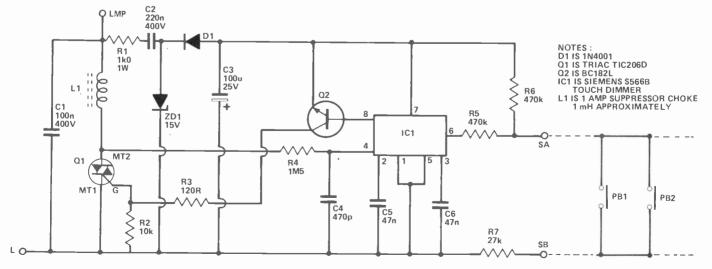
Practical Rewiring Hints

Electrical re-wiring is a technically simple but physically arduous and time consuming task. Floor boards have to be raised to gain access to the wiring and holes have to be drilled through joists and beams to facilitate wiring runs: plaster has to be channelled to accept new cable runs and must be remade afterwards.

Essential tools for the job include 2½" bolster chisels, a lump hammer and a decent power drill. Before starting the job, plan your new wiring layout with care, giving thought to the sensible positioning of new power sockets, light switches and ceiling roses. Your task may be simplified by using the conduit of the old wiring system.

Figs.12 to 14 show some useful rewiring aids. The Fig.12 and 13 circuits are used for tracing old wiring and conduit. The Fig.12 wire tracer works on the magnetic-field detection principle and is used to trace 'live' wiring. The Fig.13 circuit acts as a simple 'metal' detector and is used in conjunction with a hand-held pocket radio to trace cables, conduit and

Fig.11. This push-button-activated dimmer/on-off unit (below) can accept any number of parallel-connected inputs and offers a state-of-the-art solution to the multi-way light-switching problem. The unit can be wired into the domestic lighting circuit (left).



plumbing. These two circuits are described in greater detail in the June '79 issue of ETI.

Finally, the Fig.14 'marker beacon' circuit is useful for indicating the loft or under-floor break-through positions of pilot holes drilled through ceilings when installing new feeder cable runs or when re-positioning ceiling roses.

The cable used for rewiring will be 1.0 mm T & E for the lighting circuits, 2.5 mm T & E for power rings and 4 mm T & E for the ring feeders. All metal switch boxes and metal conduit, etc, must be earthed; the earth cable must be connected to the earth line of the mains feeder into the house.

Fig.12. This wiring tracer works on the magnetic-field detection principle.

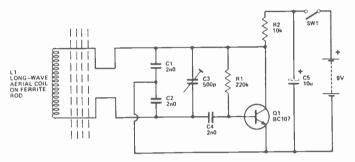
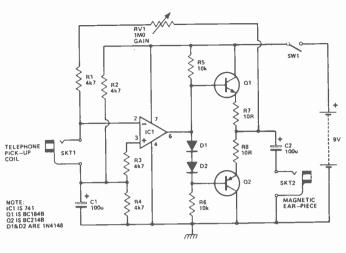


Fig.13. Circuit of a simple BFO-type mains and plumbing seeker; the unit is used in conjunction with a hand-held pocket radio.



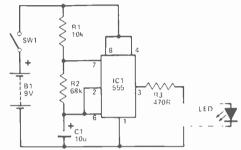


Fig. 14. This 'marker beacon' circuit can be used to indicate the position at which pilot holes break through into dark places.

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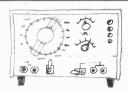
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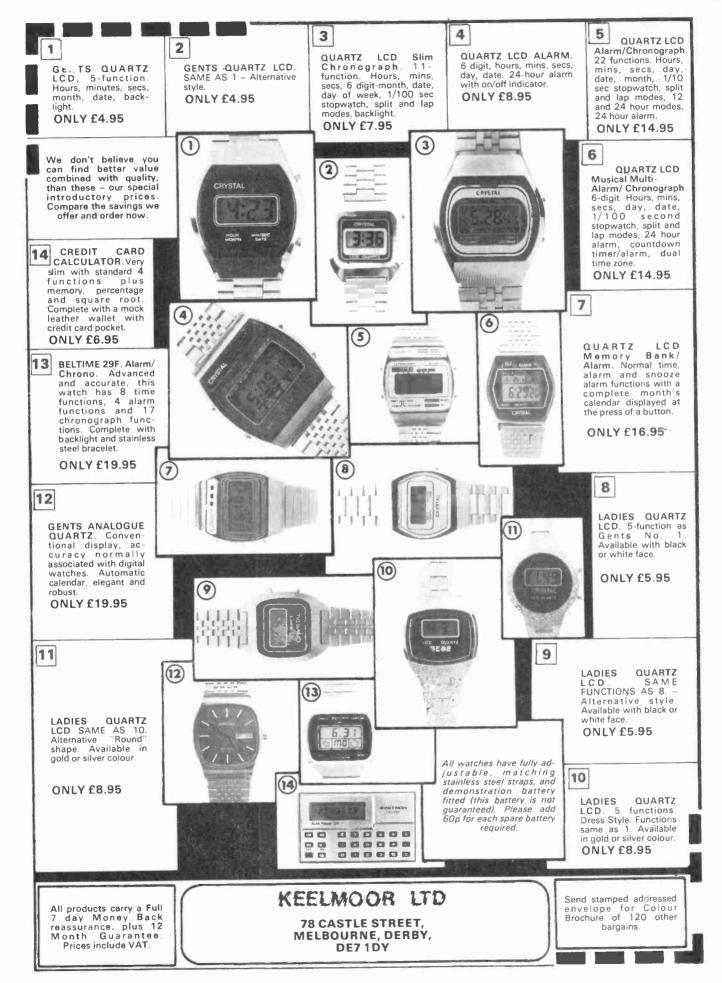




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AUDIOPHILE

Lost in a haystack full of needles (stylii?) Ron Harris presents a review of Shures new M97 cartridge range and compares two other two moving-magnets from Stanton and Ortofon.

have to start this month with two apologies. The first goes to Videotone who had two pieces of equipment in my £300 system a while back. Seems that while the issue was going to press, they had their bright idea of going direct mailorder, with the result that their prices took a tumble. Being nice helpful people they rang me up to tell me this of course, but being the worlds worst file keeper I promptly lost the piece of paper with the facts scrawled across its tatty, crumpled face.

So, a little belatedly I admit, I have the somewhat unusual task of reporting a price FALL. GB2 loudspeakers can be purchased now for £60 and not the £100 or so they used to cost. The Coral 555E cartridge also comes down, from £25 to around £14. Good news indeed for those shopping in that area and reason enough for me to begin filing things properly.

My second apology goes to everyone, including me, who has the sense of beauty to appreciate the lovely Felicity Kendal. Last month's Audiophile was *supposed* to contain an excellent photograph of the lady, provided by Mr. Rickwood. Sometime between leaving my desk, bound for our printers, and reappearing in the issue, someone or something GOT to it. thing GOT to it.

When I find out who, there will be set abroad in the night such things that the miserable wretch will lie shivering and cowering in his repentance......

Tale Of Four Cartridges

To hear some of the disciples speak, you could be excused for thinking that moving-coil cartridges were the only things fit to waggle a cantilever across a record. There are, however, not a few companies still producing some excellent units in the higher price brackets, whose coils remain remarkably static.

Immediate claims to such fame could be made by Shure, Goldring, Stanton, Ortofon, Empire and Grado. Units which earn such accolades might be V15 IV, 900 IGC, 881S, LM30, EDR9 and G2. Might be. That is what I determined to find out. The first two units, the Shure and Goldring, will be no strangers to Audiophile readers as both have been reviewed herein already. This month I have a report on the Stanton 881S and the Ortofon LM30H — SME style. Empire were invited to participate but still had not supplied an EDR9 by the time this magazine went to press. Should they ever awaken down there and one appears over my horizon you'll be hearing about. Until then — a pity.

As more than adequate compensation I can offer a first-ever review on two of the new Shure M97 series of pickups—the top model, the 97HE and the middle of the road M97EJ. Let's start with these Shures then.

V15's For All?

This new range from Shure is based upon the technology of their V15 IV model. All inherit the "dynamic stabiliser" affair from their predecessor — a carbon fibre brush set in damped pivots which rides ahead of the stylus and provides a

good deal of isolation from shock — and the 97HE model even has the same stylus contour as the V15 itself.

A feature which I am positively NOT going to test is their 'side-guard'. Shure claim that a 'lateral deflection assembly' allows the cantilever to accept impact in a sideways direction without damage, with the stylus simply withdrawing into the cartridge body. This might occur, say, when the cartridge hits the side of an LP accidentally, or is knocked across a record. Shure — I'll take your word for it, my courage fails me.

These are large cartridges, which look superb set up (in any arm). As usual for Shure the packaging and presetation is magnificent and the finish on the cartridges faultless.

The HE will take its place beneath the V15 IV in Shure's range, but with the incredible number of cartridges Shure now have on the market, it is difficult to be sure — and they show

Audiophile has acquired a new pair of reference speakers — KEF 105 Il's, shown below and (in cutaway) right. These are probably the best speakers on the market today for home use. As you can see the 'head' contains the mid-range and HF units, each in its own little enclosure. This can be tilted and tumed through a limited angle laterally, such that the stereo image can be optimised for the listener.



no signs of rationalising. More power to them if they can sell them all.

It should be said, though, that this M97 series is a significant step ahead of their other ranges in terms of sound quality and should outsell them all with ease. Originally I hadn't intended to include either of these two models in with the Stanton and Ortofon — after all the price is noticably lower — but the HE performed well enough for me to think it worthwhile. In fact one of the surprises awaiting me amid this forest of cantilevers, was how close the M97HE came in performance to the exalted V15 IV!

Shure-fire Test?

Under test conditions both the M97s proved themselves worthy of their predigrees. Both are top-flight performers in their respective classes and in fact the EJ is capable of tracking higher recorded velocities than the HE — but at a gram more weight. The HE cleared all my traps at 1g actual tracking force (the brush means that you set up for 0.5g more) and the EJ had an optimum force of 2.2g. Have a look at the table for more details of the results.

(Throughout these ramblings, "optimum tracking force" is that downforce at the stylus above which no improvement in tracing ability is obtained for increased weight). The 97EJ gave a creditable account of itself all around. Set up in a JVC QLA5R deck it performed very competently and gave a good

solidity to the sound, with a warm balance and smooth treble. It would match most good loudspeakers in the £100-£200 class that exhibit a clean top and its powerful bass could be a decided asset, especially to impercunious rock fans.

On the debit side it has a tendency to impose too much of itself upon the music at times and could be tipped over the edge into hardness (surprisingly) by very complex material. Still, these are minor effects — and more minor than you'd expect at the price. Not a serious worry and overall a good design, one which does credit to its designers.

Set up in an SME III the M97HE played very well with all types of music. It is a good cartridge by any standards, having a smooth easy-to-listen-to approach to its task, and is tolerant of material of lesser stature than itself. As I said earlier it is very difficult at times to distinguish this pickup from the V15 IV — it has that same confidence in its own infallible tracking ability, never putting a diamond wrong. Distortion is low and the base possesses a good punch. Detail is well portrayed, but it is here that the V15 shines through with superior mid-range quality. A more refined performance is bought with the extra cash, it seems.

It would take a good system to justify the classier performance though, a careless matching of components could easily obscure the differences. Good enough then, I thought to bear comparison with the Ortofon and Stanton and so included the M97HE in the tests, about which you'll be hearing more later. Remember the price difference though.

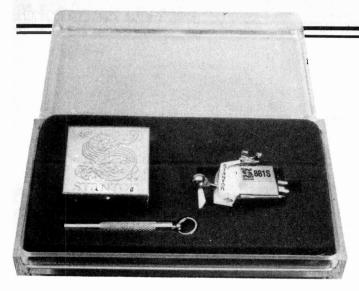


Above: the Shure M97EJ and, below, the M97HE still reclining in its box. Both the cartridges are identical in appearance — so there was little point in showing photos of them both!

Note the dynamic stabiliser clipped down into position as a stylus guard on the EJ.







Stanton On It's Merits?

The Stanton 881S. Doesn't seem so long ago that the 681 and V15 III were considered the two best cartridges around — long were the nights spent arguing over the relative merits of the pair of them.

Stanton seem to have taken something of a low profile lately and this unit has never received the publicity it deserves. Having now auditioned it at greater length, I feel it has a lot to offer, albeit with a few vices amongst its virtues.

The 881S is also very well presented and its appearance is very striking indeed, with the silver finish and white stylus carrier. All preceded, of course, by the inevitable brush — and this I cannot refrain from condemning, both as a cleaner and an aid to the cartirdge as a whole. Thank decibels it is at least removable.

At a time when great effort is being expended to *remove* static, and to ground any charges present on records; listen to Stanton's own description of how the brush does its work:—

"It operates on the principle that the rubbing action of the nylon bristles against the vinyl record surface creates an electrostatic charge which attracts dust particles like a vacuum cleaner".....Oh.

I'll bet it does. And charges up the record surface nicely too. (Dust sticks to LPs very well under charge conditions.) The stylus is trailing along just behind the brush — straight into that charged patch of vinyl prepared for it. What odds on increased snap, crackle and pop? Why, why, why, why, why, when you have a pickup this good, lumber it with a built-in static generator? I despair of humanity sometimes, I really do.

This is a well engineered unit, as the test results prove. Channel balance is beautifully maintained and resonances tightly controlled. As is Stanton's way, the cantilever is amazingly short and durable. The mass, minus brush, is about average

The sound of the 881S is best described as rich and detailed. There always appeared to be a lot going on in the music, with the cartridge obscuring little of it. The bass is good but not as extended as it might be. Mid-range is sharp and clear but can be a little too sharp in the 2kHz – 5kHz range at times. Treble was well extended and crisp and overall the sound was well balanced and exciting to listen to.

A cartridge more than worth its asking price, but capable of being improved still further, I feel.

Ortofon/SME 30 H

Now this is something really different. Part of the new ultra-low mass range from Ortofon, the Ortofon/SME 30H is the LM30H cartridge adapted for use with an SME Series III pickup arm. Adaptation here means 'building into'. A normal

Left: the Stanton 881S in its plush little box. That relatively huge container holds the fixing hardware for the Stanton cartridge, and everything else you want to hold in the headshell. What looks like a police whistle, in the foreground, is in fact a screwdriver. Very nice presentation.

CA1 arm has been shorn of headshell, and the 30H fitted as part of the new one.

The overall effect is to bring down the effective mass of cartridge and arm to 4.2g and create the most striking pickup around. It looks superb in operation.

Low mass like this has great advantage in the bass registers. Used in the SME, the system resonance — the frequency at which it is easiest to put a peak in the response — lies at 13Hz, which is too high to be effected by record warps, or ripples and too low to let acoustic feedback from the speakers influence it.

So much for the theory of it, in practice we have a very attractive, pencil slim, cartridge with built-in finger lift. Just about every aspect of operation has been well thought out. An alignment tool is provided for setting up the individually shaped cartridge for vertical tracing angle. Without it, it would be virtually impossible. Even the stylus guard will help with lateral balance adjustments! (Try and work *that* one out.)

In play the Ortofon proved to be as much of a contrast to the Stanton in sound as it had been in looks. The bass was nothing short of phenominal. The extension went way down, more importantly though the energy was controlled very well, with no sign of looseness or tendency to 'boom'. The low mass and integrated head were responsible for this, I think. The midrange was restrained but open. No sign of brightness or sharpness here. Some people would think it too bland I suppose, but then since when does 'neutral' mean 'striking'?

Overall the Ortofon presents a smoothly blended face to the world, with perhaps a slight veiling of the extreme high frequencies.

If ever there was a cartridge that was at home with a certain type of music, it is this one. On classical music of the symphonic variety, the Ortofon really soars. Things simply sound "in place" and natural. It is probably the best pickup I have ever heard on this type of material. The difference between its performance with say, Wagner and with the Floyd is very marked and not a little puzzling. On the former it is staggeringly good, on the latter — simply good.

Listen Here

It was this which started me off on what developed into a full blown comparison session, with the resultant exponential increase in people, equipment and headaches. All though the listening so far I had been using my usual cartridge as a reference against which to measure the others, simply because I am well used to it and know its foibles well enough.

The pickup in question is a Coral MC81 moving coil, which I have been in love with ever since reviewing it in these pages many LPs ago. I consider it one of the best around at any price and as it costs only about £48 these days, affording a head-amp is not the bank-robbing job it might be.

Anyway I digress. What transpired in the end was that I set up a listening -panel type of comparison between the Stanton, Ortofon, Shure M97HE and the Coral as reference.

I have not the space, or inclination, here to go on about the steps taken to ensure impartiality. They were taken, believe me. If you don't you're probably a PE reader anyway!

The rest of the disc playing system comprised. Technics/SMEIII configurations feeding a Lecson amplifier and being relayed to the waiting ears by that same pair of KEF 105 II loudspeakers. Some use was also made of a Sony TCK 55 II cassette.

Right: and below is the amazing Ortofon SME 30H. As you can see there is no real headshell, just the cartridge itself. The unit looks extremely elegant in use, but the one thing they don't tell you is that it is so light that you need to remove ALL the lead weights from the SME III to balance it -- which means that you need more spacers.



After it was all over I took the scores, and 'normalised' the reference at 15 for everything, adjusting the other scores to create the (average) figures obtained below. (Table Two)

Material varied from Wagner to Rickie Lee Jones, via Grieg, Holst, Stravinsky, Thelma Houston, Sky, Alan Parsons and the inevitable Pink Floyd. Each listener was asked to mark the cartridge playing, out of 20, on the parameters shown in Table Two, without knowing which unit was operating.

Not much to choose really is there? The Shure comes out least well, but then its price bracket lies well below the other two and this is in reality a creditable showing indeed. As such I can confidently recommend both examples of the M97 range, secure in the knowledge that few (if any) will be disappointed with the purchase. Yet another nice one Shure.

The Stanton and the Ortofon are a different matter. Both provide ample evidence of the excellence obtainable from moving-magnet methods, but are totally different in their sound balance.

They scored identically in this respect in the test, as you can see, so both are appealing designs.

The Ortofon is to be preferred for classical material and the Stanton for rock. Perhaps that, undoubtedly over-simplified statement is as close as I'll get to defining the differences

for you. Comparing the two is entertaining stuff - try it yourself if you plan to spend around £80 on a cartridge. The time will not be wasted and neither will the money!

Back to amps next month, with a look at an offering from Quantum Electronics. Their 102 pre-amp matched to the 110W per channel 204 power amp. You can obtain the units as either kits or ready-built equipment and amplifier modules are available separately. The main question is though - what do they sound like?

Table One						
	Stanton 881S	Ortofon/ SME 30H	Shure M97HE	Shure M97E J		
Output: 1kHz 5cm/sec	5mV	3.2mV	4.5mV	5mV		
Channel Balance	< 1.5dB	< 2dB	< 1.5dB	< 2dB		
Optimum tracking force	1.1g	1.3g	1g	2.2g		
Frequency Response Limits, 20Hz-20kHz	±1dB	±2dB	±2dB	±2dB		
Separation (LonR) 1kHz	32dB	30dB	35dB	28dB		
Cartridge Weight	6.7g (inc brush)	10.5g (inc arm)	6.4g	6.4g		
Recommended Loading Typical selling price	47k // 275p £80	47k // 400p £85	47k // 250p £45	47k // 250p £27		

Table One: objective test results. Note the Ortofon specified load is a good deal higher than normal, and a padding capacitor could be used to advantage here. Although its mass looks higher, it includes the pickup arm — effective mass is actually close to 4g, well under the figures for the rest of the

Table	Two	:	subj	ective	results.
These	figure	25	are	the	arranged
respons	es glea	ıne	d fro	m the	listening
panels i	ndivid	ua	l mar	kings.	

	Bass Extension	Bass Quality	Mid-range Quality	e I wo Rendition of Detail	Balance of Sound	Treble Extension		Neutrality
CORAL MC81	15	15	15	15	15	15	15	15
STANTON 881S	17	14	12	14	14	14	13	13
ORTOFON 30H	18	15	14	14	14	10	12	15
SHURE M97HE	18	13	12	13	13	14	13	13 FTI

31

Britain's first comp

A complete personal computer for a third of the price of a bare board.

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Until now, building your own computer could easily cost around £300 - and still leave you with only a bare board for your trouble

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- FREE course in BASIC programming and user manual.

Optional extras

- Mains adaptor of 600 mA at 9 V DC nominal unregulated available separately - see coupon.
- Additional memory expansion boards allowing up to 16K bytes RAM. Extra RAM chips also available—see coupon.

Use a 600 mA at 9 V DC nominal unregulated mains adaptor. Available from Sinclair if desired, see coupon



The Sinclair ZX80 is not just another personal computer. Quite apart from its exceptionally low price, the ZX80 has two uniquely advanced components; the Sinclair BASIC interpreter; and the Sinclair teach-yourself BASIC manual.

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- Unique syntax check. Only lines with correct syntax are accepted into programs. A cursor identifies errors immediately. This prevents entry of long and complicated programs with faults only discovered when you try to run them
- Excellent string-handling capability takes up to 26 string variables of any length. All strings can undergo all relational tests e.g. comparison. The /X80 also has string inputto request a line of text when necessary Strings do not need to be dimensioned
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- FOR/NEXT loops nested up 26.
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- Exceptionally powerful edit facilities, allows modification of existing program lines.
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- High-resolution graphics with 22 standard graphic symbols.
- All characters printable in reverse under program control.
- Lines of unlimited length.

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ETI JUNE 1980

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The display shows 32 characters by 24 lines.

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LINEAR OHMMETER

Well suited to either the lab or hobbist bench this accurate little project will provide an inexpensive answer to many resistive problems.

his instrument is an inexpensive semiprecision ohm meter that can be used to give accurate readings of resistance from a few tens of ohms to one megohm. The unit has four decade ranges covering 1k to 1M full scale and has a full scale accuracy of 2% if low tolerance range resistors are used.

Conventional moving coil ohmmeters have non-linear scales which typically cover two to four decade ranges of resistance value on a single scale. With such a range of resistance it is impossible to obtain an accurate reading, especially at the higher values. To measure resistance values with reasonable accuracy, the usual method is to use a Wheatstone Bridge, often very expensive and time consuming.

By contrast, this ohmmeter gives resistance readings on a linearly calibrated scale and covers only a single decade of resistance on each switched range. The instrument thus gives inherently more accurate readings of resistance than multimeter type ohmmeters.



Construction

The ohmmeter can either be constructed as a completely contained unit, with its own moving-coil meter, as we have done, or it can be built as an add-on to an existing multimeter having a 1 mA DC range.

Take care with the polarity of the zener diode. The 301 op-amp cannot be substituted by a 741 as it has been selected for its low input current. The overall accuracy of the instrument is determined by the tolerance of the range resistors (R3 to R6) and the accuracy of the meter. If 1% or 2% resistors are used the accuracy of the instrument will be about two percent.

When the board assembly is complete, fit into the box and complete the wiring to the major components. If you are making an add-on version of the meter, fit a couple of screw terminals in place of the meter for connection to your multimeter.

Calibration

When construction is complete, switch the unit on and check that the LED lights up. If it doesn't, check the wiring and the polarity of the LED. When all is well connect an accurately known resistor (having a value within the range of the instrument) across the terminals and adjust the trimpot for the correct reading. The unit is then ready for use and should not require further calibration. You could purchase a 1k, 1% resistor specifically for this purpose.

BUYLINES

There are no components here which will prove difficult to obtain. Casing is not critical in the slightest, and all the mail-order advertisers within this issue should be able to provide all the bits and pieces required.

PARTS LIST

Resistors All 1/2W	
(*see text)	
R1	2k7 5%
R2	1k0 5%
R3	1k0*
R4	10k*
R5	100k*
R6	1M0*
R7	560k 5%
RV1	5k0 (minimum) vertical
Capacitors	
C1	100p ceramic
Semiconductors	
LED 1	TIL220
ZD1	5V1 400 mW
Q1	BC109, BC549
IC1	301
Miscellaneous	

SW1 DPDT toggle switch, SW2 one pole four position wafer switch, M1 1 mA FSD meter, SK1,SK2 screw terminals.

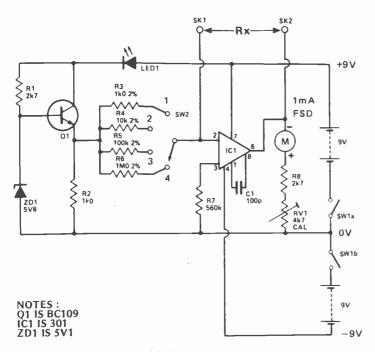
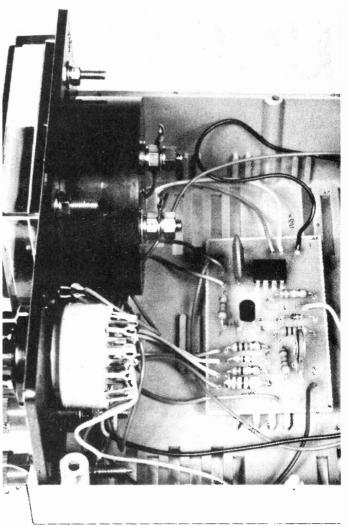


Fig.1. Full circuit diagram of the instrument.

HOW IT WORKS

The linear scale ohmmeter circuit is divided into two parts: a reference voltage generator and a readout unit that indicates the value of the resistor under test. The reference voltage generator section of the circuit comprises zener diode ZD1, transistor Q1, and resistors R1 and R2. The action of these components is such that a stable reference of about 5 V is developed across R2. This reference voltage is fed to the op-amp resistance-indicating circuit via range resistors R3 to R6.

The op-amp is wired as an inverting DC amplifier, with the 1 mA meter and R8-RV1 forming a voltmeter across its output, and with the op-amp gain determined by the relative values of ranging resistors R3 to R6 and by the negative feedback resistor Rx. RV1 is adjusted so that the meter reads full scale when Rx has the same value as the selected range resistor. Under this condition the op-amp circuit has a voltage gain of precisely unity. Since the values of the reference voltage and the ranging resistors are fixed, the reading of the meter is directly proportional to the value of Rx, and the circuit thus functions as a linear-scale ohmmeter and has a full scale value equal to the value of the selected range resistor.



A peek inside at the PCB. Make sure it doesn't foul the range switch or meter.

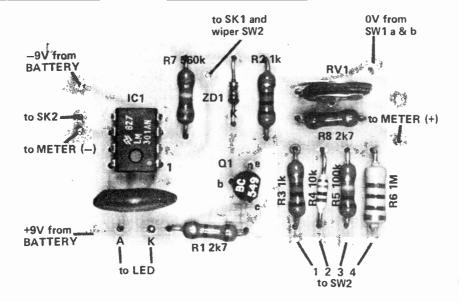


Fig.2. Component overlay.

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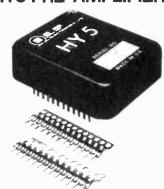
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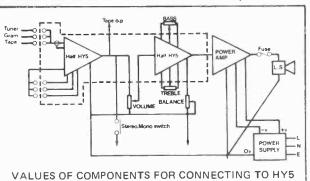
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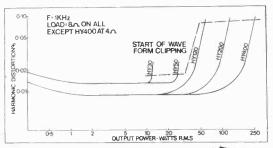
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THE POWER AMPLIFIERS



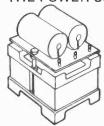
	M	
772		
		APAC

Model	Output Power R.M.S.	Dis- tortion Typical at 1KHz	Minimum Signal/ Noise Ratio	Power Supply Voltage	Size in mm	Weight in gms	Price + V.A.T.
HY30	15 W into 8 Ω	0.02%	80dB	-20 -0- +20	105×50×25	155	£6.34 + 95p
HY50	30 W into 8 Ω	0.02%	90dB	-25 -0 +25	105×50×25	155	£7,24 + £1.09
HY120	60 W into 8 Ω	0.01%	100dB	-35 -0- +35	114×50×85	575	£15.20 + £2.28
HY200	120 W into 8 Ω	0.01%	100dB	-45 -0- +45	114×50×85	575	£18.44 + £2.77
HY400	240 W into 4 Ω	0.01%	100dB	-45 -0- +45	11 4 ×100×85	1.15Kg	£27.68 + £4.15

Load impedance – all models 4 - 16 \(\Omega\) Input sensitivity – all models 500 mV Input impedance – all models 100K \(\Omega\)

Frequency response - all models $10 \text{Hz} - 45 \text{KHz} \cdot 3 \text{dB}$

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2 HY120's £13.61 + £2.04 VAT PSU 90 with toroidal transformer for

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100 to Hobby Electronics

The June issue will be on sale May 16th

HE RADIO CONTROL

Can it be true? Yes, of course it is, all the problems have been sorted out and next month we will be presenting what must be the last word in terms of simple to build, 2 channel proportional R/C systems.

The Tx, Rx units are based on just two, that's right, two, purpose-built ICs External circuitry has been kept to an absolute minimum, consequently it will cost a fraction of a commercial system. Designed primarily for land-based vehicles, boats, cars etc it will enable even the most un-skilled constructor to put together a really first-class R/C combo in just a couple of

relaxed evenings
More than that we're not prepared to say, we are keeping the system under close wraps. We're sure it's going to revolutionise constructional radio control. Make sure you place your order early as the June issue is sure to be a sell-out. You have been warned!

CATALOGUE SURVEY

Do you buy components through the services of mail-order companies? If you do then you cannot afford to miss this survey into the various companies, the cost of their components, the service they offer and the quality of their catalogue. Who is the cheapest? Last year we came up with some pretty surprising results, find out if things have changed

METRONOME

Don't miss a beat with this nifty, state-of-the-art little gadget. This revolutionary design has completely done away with cumbersome ICs. Yes, that's right, absolutely no Integrated, Circuits. In fact we have used just four components and if that isn't state-of-the-art, what



FOG HORN

We're shore you'll build this circuit once you sea it. But be warned your popularity will be at a very low ebb if you use it in the car. It is LOUD, very LOUD, so loud in fact, the only place you'll be able to use it is at sea.

Some day all power transistors will be made this way

	CHAN	VDS max V	ID max A	PDISS max W	RDSON Type Ω	Case	Price
3D512	P	60	1.5	10	†(3.5)	T0202	85p
3D522	N	60	1.5	10	2.5	T0202	80p
MP4	N	60	2.0	25	2.0	380-50E	1250p
/N10KM	'N	60	0.5	1.0	4.0	T092†	55p
/N64GA	N	60	12.5	80	0.3	T03	750p
N67AF	-N	60	2.0	15	2.0	T0202	75p
25,149	P	140	7.0	100	1.0	T03	395p
2SK134	N	140	7.0	100	1.0	T03	395p

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LM3900	43p	1
MC3401	30p	1
NE529	145p	
NE555	25p	٠
	1050p	
SD532	30p	
TDA1022	600p	
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CITIZENS BANNED II

Next month is something of an anniversary for us. It will be exactly one year since we published our feature 'Citizens Banned'. In those twelve months we have carried the campaign for CB (sometimes struggling) into the open. Our petition (which around half our readers signed) gained Government recognition, generated national Newspaper, TV and Radio coverage and was the catalyst for forming CB clubs up and down the country. Something like 250 000 people are actively engaged in the campaign for legalisation MPs, Government Officials, Doctors, in fact everyone and anyone who wants the right for free

In our second major feature we will be looking back over the past year and seeing how the campaign has fared.



EGG TIMER

Something really different for the gadget fans next month. Our Egg Timer is a solid-state version of the 'sand-in-a-glass' egg timer that has been around for hundreds of years. Shake it and set it down and depending upon whether you want a hard or soft boiled egg it will warble at the appointed time. No switches to worry about, is it magic? Find out next month

The items mentioned here are those planned but unforeseen circumstances may affect the actual contents

DESIGNER'S NOTEBOOK

Project editor Ray Marston discusses the uses and practicalities of voltage regulator circuits.

ne of the most common and mundane tasks facing the electronics engineer is that of designing voltage regulator circuits, ie circuits that produce a stable and well defined DC output voltage over a wide range of load current variations. These circuits may vary from simple Zener networks, designed to provide load currents up to only a few mA, to fixed-voltage high current units for powering logic boards, etc, or to variable-voltage high current units designed to act as general-purpose pieces of test gear.

Zener Based Circuits

A Zener diode can be used to produce a fixed reference voltage by using the connections shown in Fig.1. Often, the supply voltage (V_{in}) may be subject to fairly wide variations, causing the Zener current to vary over a similarly large range. As long as V_{in} is always more than a few volts greater than the Zener voltage and provided that the Zener power rating is not exceeded this variation has only a moderate influence on the output voltage of the Zener, which typically has an effective output impedance of a few tens of ohms.

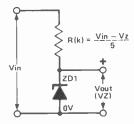


Fig.1. This basic Zener 'reference' circuit is biased at about 5 mA. A current of roughly 5 mA is passed through the Zener diode from the supply line via limiting resistor $R. \$

A Zener can be used as a very simple voltage regulator, providing load currents up to a few mA, by merely selecting the value of 'R' as shown in Fig.2.

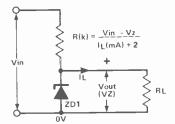


Fig. 2. This basic Zener 'regulator' circuit can supply load currents of several milliamps. When the maximum load current is being drawn only 2 mA flows through the Zener. When zero load current is being drawn the Zener passes 2 mA plus the maximum designed load current and thus dissipates maximum power.

In most practical voltage regulator applications the Zener is simply used to apply a 'reference' voltage to a high-gain non-inverting buffer amplifier, which then supplies the required output power. The simplest example of this type of circuit is shown in the series-pass regulator circuit of Fig.3.

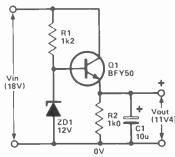


Fig. 3. This series pass Zener-based regulator circuit gives an output of 11V4 and can supply load currents up to about 100 mA. Q1 is wired as a voltage follower, its emitter remaining at about 600 mV below its Zener-defined base voltage under all loading conditions. The Zener network provides the base drive current to Q1, this current being equal to the output load current divided by the current gain of Q1. Clearly, the higher the gain of the Q1 'buffer' stage, the better will be the output regulation of the circuit.

Op-Amp Regulators

One way of improving the regulation of the Fig.3 circuit would be to use a Darlington or Super-Alpha pair of transistors in place of Q1. An even better solution is to use the op-amp plus transistor buffer stage shown in Fig.4.

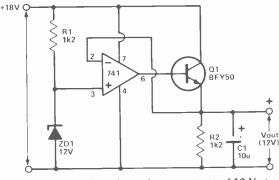


Fig. 4. This op-amp based regulator gives an output of 12 V at currents up to 100 mA and gives excellent regulation. The op-amp and Q1 are interconnected as a unity-gain non-inverting DC amplifier with an overall current gain of about one million. The output voltage tracks within a few mV of the Zener reference value and the output impedance is less than one milli-ohm. The safe output current driving capacity of the circuit is limited to about 100 mA by the power rating of Q1; higher currents can be obtained if Q1 is replaced with a power Darlington transistor.

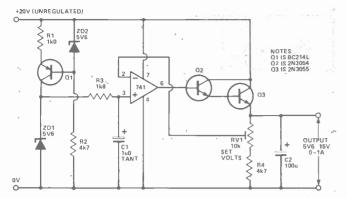


Fig. 5. This variable-output 0-1 A circuit gives excellent regulation.

The performance of the basic op-amp circuit of Fig.4 can be improved in a variety of ways, some of which are shown in Fig.5. The first improvement that can be made is to make the Zener reference voltage (ZD1) independent of supply voltage variations by powering ZD1 from the output of constantcurrent generator Q1-R1-ZD2-R2. Next, the Zener noise can be eliminated by feeding the reference voltage to the opamp via low-pass filter R3-C1. Thermal drift effects can be eliminated by making ZD1 a 5V6 type, with near-zero (actually about $-0.2 \text{ mV/}^{\circ}\text{C}$) temperature coefficient; the op-amp output voltage can then be set to the desired value (greater than 5V6) by using feedback components RV1-R4 to set the op-amp's voltage gain at some appropriate value.

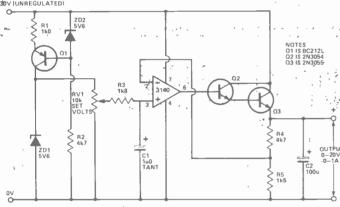


Fig. 6. The output of this circuit is fully variable from zero to 20 V. The effective reference voltage is made variable from zero to 5V6 via RV1 and the op-amp is given a fixed voltage gain of about four via R4-R5. Note that a CA3140 op-amp, which can handle input signals down to ground volts, is used in this application.

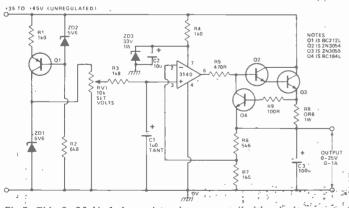


Fig. 7. This 0-25 V, 1 A regulator has current limiting in its output resistor R8. The op-amp is protected against excessive supply rails and the common, terminal of the IC, which is normally grounvoltages via R4 and ZD3.

Finally, the load current capacity of the circuit can be set to a fairly high value by using a Darlington-connected power transistor in the series-pass output stage.

Three Terminal Circuits

Three-terminal regulators are remarkably easy to use, as shown in the basic circuits of Figs.8 to 10, which show the connections for making positive, negative and dual regulator circuits respectively; the ICs shown in these examples are 12 V units with current ratings of one amp. Note that a 270n or greater disc (ceramic) capacitor should be connected close to the input terminal of the IC and a 10u or greater electrolytic to the output.

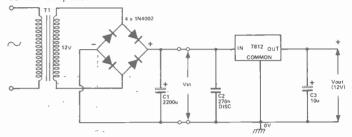


Fig.8. Connections for using a 3-terminal positive regulator IC, in this case a 12 V, 1, A type.

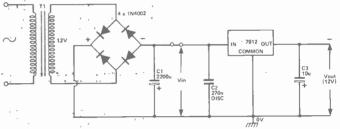


Fig.9. Connections for using a 3-terminal negative regulator IC, in this case a 12 V, 1A type.....

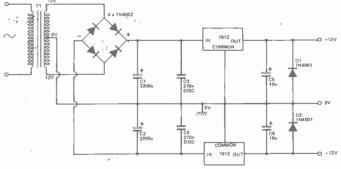


Fig. 10. Complete circuit of a 12 V, 1 A dual power supply.

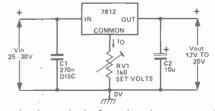


Fig.11. A very simple method of varying the output voltage of a 3terminal regulator. The bias voltage is obtained by passing the IC's quiescent current (typically about 8 mA) through RV1. This design is adequate in most applications, although the output voltage obviously hifts slightly with changes in quiescent current.

The output voltage of a 3-terminal regulator is referenced ded. Most regulator ICs draw quiescent currents of a few mA, which flow to ground via the common terminal. The regulator output voltage can thus be raised above the designed value by simply biasing the 'common' terminal with a suitable voltage.

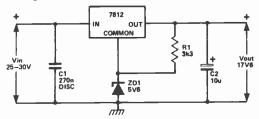


Fig. 12. The output voltage of a 3-terminal regulator can be increased by a fixed amount by wiring a suitable Zener in series with the common terminal.

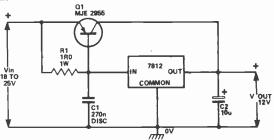


Fig.13. The output current capacity of a 3-terminal regulator can readily be boosted via an external transistor. This circuit can supply 5 A at 12 V. At low currents insufficient voltage is developed across R1 to turn Q1 on and all of the load current is provided by the IC. At currents of 600 mA or greater sufficient voltage (600 mV) is developed across R1 to turn Q1 on, so Q1 provides all currents in excess of 600 mA.

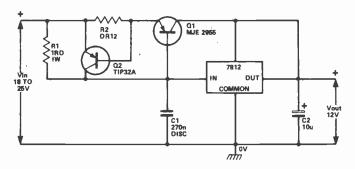


Fig.14. This 5 A, 12 V regulator has overload protection provided via O2.

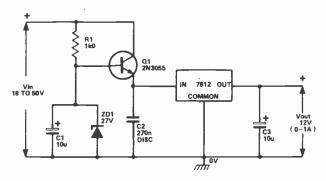
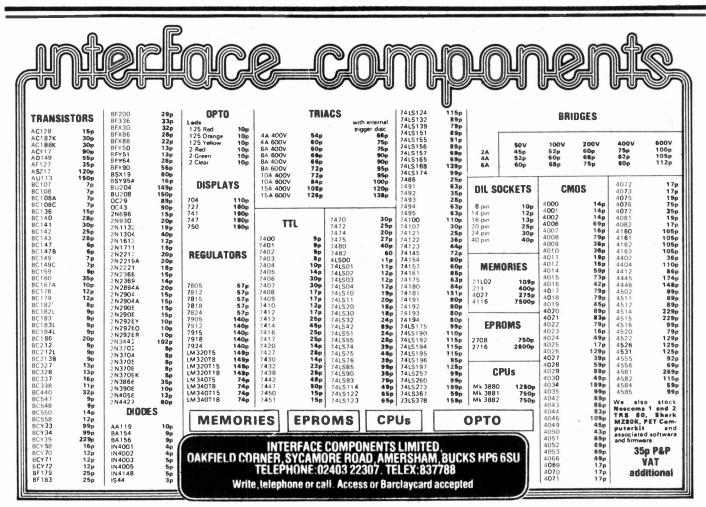


Fig. 15. This 12 V lamp regulator circuit is fully protected against excessive input supply line voltages.



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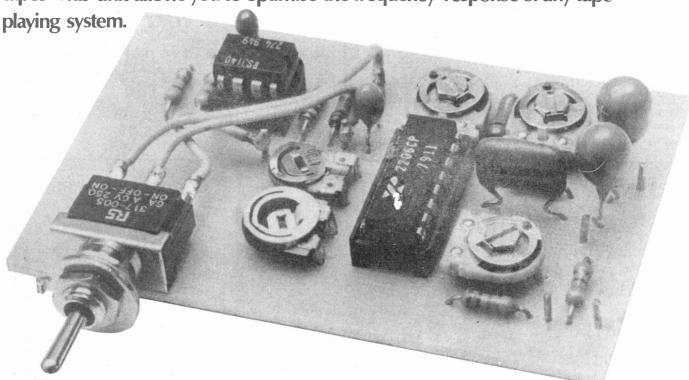
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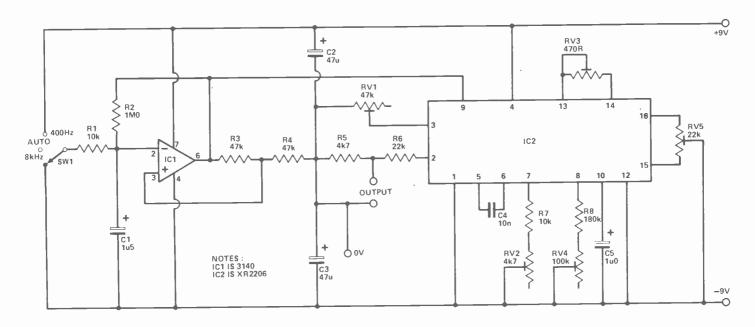
Construction And Use

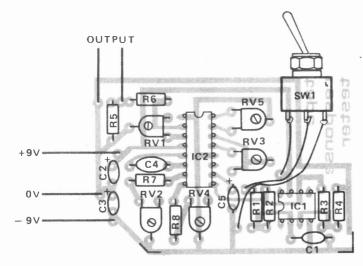
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An oscilloscope is an invaluable aid when setting up the unit. However, if one is not available, connect the output to a monitor amplifier and do it by ear. Preset RV5 should be set to mid position and RV3 to maximum resistance. With power applied, RV1 may now be adjusted to produce a 4 V peak to peak triangle waveform at pin 2, IC2. Then RV3 should be adjusted for the best sine wave. Small adjustments of RV5 may now be made to further improve the waveform. You should now have a fairly good sine wave of about 2 V peak to peak at pin 2, IC2.

The frequency of the two tones is set by adjustment of RV2 and RV4. A frequency meter makes this a doddle. If you do not have one, then R7,RV2 and R8,RV4 may be replaced by fixed resistors. The calculated values using C4,10n are 250k (400 Hz) and 12k5 (8 kHz).

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PARTS LIST

RESISTORS	
R1,7	10k
R2	1M0
R3,4	47k
R5	4k7
R6	22k
R8	180k
POTENTIOME	TERS
RV1	47k min horiz preset
RV2	4k7 min horiz preset
RV3	470R min horiz preset
RV4	100k min horiz preset
RV5	22k min horiz preset
CAPACITORS	
C1	1u5 tantalum
C2,3	47u tantalum
C4	10n polyester
C5	1u0 tantalum
SEMICONDUC	CTORS
IC1	3140
IC2	X R2206
MISCELLANE	OUS

Fig.1. (above) Circuit diagram. RV2 and RV4 are used to set the frequency of the two tones.

Fig. 2. (left) Component overlay. The rate of switching between the two tones is set by C1 (0.3 Hz here, with C1, 1u5).

HOW IT WORKS

Most of the work is taken care of by IC2. This chip generates a triangle waveform which is shaped internally to produce the sine wave output. Frequency is controlled by the value of C4 and choice of resistance from pin 7 or 8 to the negative supply. Only one resistor is actively connected at any moment. Selection is achieved by controlling the voltage applied to pin 9. When the voltage at pin 9 is above two volts, or if the pin is open circuit, then the timing resistor connected to pin 7 is selected. When the signal at pin 9 drops below one volt, control is transferred to the resistor at pin 8.

Changeover is accomplished automatically by connecting the output of IC1, an op-amp configured as an astable oscillator, to pin 9. A high or low output can be 'forced' by switching R1 to either supply rail via SW1. With SW1 in the 'centre-off' position, the op-amp will switch at slightly less than 1 Hz producing alternating tones from the unit. Frequencies are set by adjustment of RV2 and RV4.

The output signal is developed across R5,6. Any convenient ratio may be chosen for these components to provide any desired output level up to a few volts peak to peak. A split supply was chosen as it facilitates circuit design. In any case IC2 needs at least a ten volt supply, precluding the use of a single battery. Current consumption is low and two PP3 type batteries provide a convenient source of power. Frequency stability with falling battery voltage is good and standard dry (Leclanche) batteries are quite adequate. Capacitors C2,3 provide overall decoupling.

BUYLINES _

The XR2206 is available from Technomatic Ltd or Stevenson Electronic Components. The other parts should be readily available.



Z80A 8 bit. This will run at 4 Mhz but is selected between 1/2/4/Mhz On-board, addressable memory. 2K 2K Monitor - Nas-sys 1. 1K Video RAM (MK 4118). 1K work space/User RAM (MK 4118), 8K Microsoft Basic (MK 3600 ROM). 8K Static RAM/2708E Pr.

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The RS232 and 20mA loop connector will interface directly into any standard teletype.

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output on the printer. PIO There is also a totally uncommitted Parallel I/O (MK 3881) giving 16, programmable, I/O lines. These are addressable as 2 x 8 bit ports with complete handshake controls.

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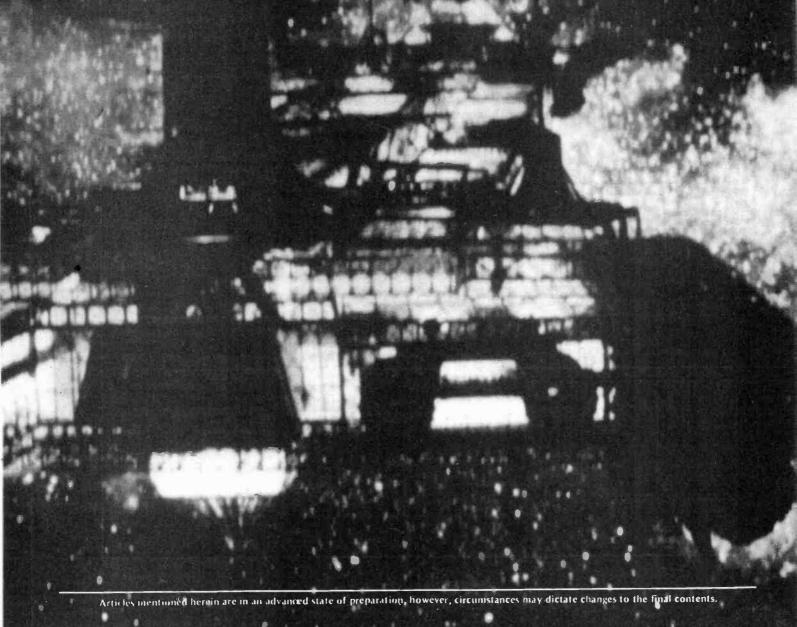
ETI JULY 1980

WHAT TO LOOK FORWARD TO IN OUR JULY ISSUE! ON SALE JUNE 6TH.

Next month ETI presents the definitive history of the spacecraft. Ian Graham our permanently high spaceman talks us through the hardware of the fastest man-made vehicles to date and takes a look at those which take flight only in our imaginations. For everyone who has looked up at the stars and longed.

Also next issue we have the long awaited Image Co-ordinator which will allow you to do things with your stereo image that your mother wouldn't approve of! Moreover Tim Orr follows up his Handbook of this month, with an article in similar vein, this time on his favourite subject, Active Filters. Find out how to design them yourself in the July issue of ETI.

For the audio men there is our first look at one of the rising stars of hi-fi, the Quantum amplifier system. It can be bought as a kit, as modules, or as a fully built and working piece of equipment. As an example of their range we examine the 102 pre-amp and the 204 (110W per channel) power amp. Stand by your speakers.



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4366	0.52	748 (14 pin)	0.45	LM380N	0.75	SD6000V		ZN4231 ZN424E		74LS91		74LS242			
4367	0.52	748 (TO99)	0.48				2.98		1.15				2.08		
4368	0.52	753 (8 pin)		LM3B1N	1.45	SN75491N	0.75	ZN424P	0.80	74LS92	0.69	74LS245	2.50	32 fo	
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Sargon: the ultimate chess ma-

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SARGON AND THE LCD CHESS-SET!

The ultimate chess machine?
Well this must come
pretty close. Ron
Harris has been
getting beaten
regulary this month.
Recovering some
confidence he reports.

Sargon is the latest in the long line of chess playing boxes. It is neatly presented, with the keyboard and piece storage telescoping out from within the board itself. As with most of these offerings, the provided chessmen are abysmal. I really do not know why they bother providing them — surely anyone who can afford a machine like this will have their own decent set anyway?

I digress. Returning to the machine, it is a development of the well known 'Boris', an opponent I crossed pawns with some time ago. Sargon inherits the ability to comment on the games, albeit with a little more reticence. However the chess playing ability of Sargon is far superior to Boris, who would be hard pressed indeed to take a game from his offspring I suspect. (Response times being equal of course.)

Model Modules

The basic concept of Sargon is a modular one. When the program is updated, changing the machine to a 'new' one means nothing more than unplugging the module and replacing it.

The keyboard is provided with different overlays to allow the machine to be used for pursuits other than chess. Backgammon and draughts are to be the first expansions, but here I shall restrict myself to the oldest wargame in history.

Features include a 'Restore' facility which allows you to replace the last move as though it had never happened — handy for training and cheating. A 'Best' button which cancels any random factor in Sargon's play and leads to a totally logical opponent. Frighteningly efficient, predictable (maybe — if you're good enough). Also there is a 'Hint' mode which allows you to obtain an idea of what to do next from the machine

itself without having to listen to it if pride rises up and bites

Fine thing pride. Makes you feel noble while Sargon cleans up your end of the board better than Domestos. Kills all known opponents. Dead. Naturally included are also full board review and alteration facilities.

Level With Me

you at the last minute.

Sargon is always on the level. Well some level or other, anyway. You set his response time by choosing a level from 0 (instant response) to 6 (postal chess). In between we have:—

Level one : 10 seconds Level two : 20 seconds Level three : 45 seconds Level four : 2 minutes Level five : 20 minutes

At two minutes thinking time Sargon is formidable indeed and will give a club player an energetic run for his pawns. I only ever beat the infernal thing once at this level — and I lost more than I won at level three.

Sargon is good. Very very good. At instant response it is better than the first generation chess machines and at level three becomes the best chess playing robot available for home use. For those who wish to trace it through I give an example game overleaf. Sargon set at Level 3 and plays Black. If you're interested in buying one, read it through — see if you would have done any better. I got a draw!

1. 2. 3. 4. 5. 6. 7. 8. 9. 10. 11. 12. 13. 14. 15. 16. 17.	E2 E4 G1 F3 B1 C3 F1 C4 F3 G5 E1 G1 D2 D3 D1 D2 C3 D5 C4 x D5 C2 C3 D5 x C6 F2 F3 D3 D4 D4 x E5 G1 H1 F3 F4 F1 E1	E7 E5 B8 C6 G8 F6 F8 C5 E8 G8 D7 D6 C8 G4 D8 E7 F6 x D5 C5 B4 B4 A5 B7 x C6 G4 D7 E7 F6 A5 B6 F6 x E5 E5 B5 A8 E8	21. 22. 23. 24. 25. 26. 27. 28. 29. 30. 31. 32. 33. 34. 35. 36. 37.	C1 - E3 E1 x E3 A1 - E1 F4 x E5 G5 - H3 G2 x H3 E5 - E6 E3 x E6 E1 x E6 H3 - H4 E6 - E3 B2 - B3 E3 x E8 H1 - G2 G2 - H3 H3 - G4 G4 - F3 H2 - H3	B6 x E3 C7 - C6 D6 x E5 E8 - E7 D7 - H3 F8 - D8 E7 x E6 D8 - C8 G8 - F7 C8 - B8 B8 - E8 E7 x E8 E7 x E8 E7 x E8 E7 x E8 E7 - F6 F6 - E5 C6 - C5 D5 - D4
40.	UL A UJ	OU A DJ	10.		0. 05

DRAW?

Figure 1. Playing Sargon at Level 3. Machine plays black. At the end of forty moves it's heading for a draw — providing neither of us does anything stupid!

Summing Totals

There is not much more to say. Sargon is a well presented games machine which is potentially expandable to better chess—or anything else a module appears for. As a player it is the best we've ever seen inside a ROM and will give any player food for thought. Its power is not to be scorned, consider it a toy and you're beat before you start. Tread carefully, oh ye of little faith, lest ye be divested of all manner of men!

Chess Champion

Just when I thought I'd done with chess (for this month at least) and was about to retreat back to wargaming, to regain a little composure, this box of tricks was placed mid-desk with its printer and LCD board — sufficiently interesting I think to hold off the counters a while longer and raise pawns once more.

Chess Champion is a dedicated chess machine. Expansion comes in the form of a printer, LCD board and game memory. A full chess clock will be added later.

Rather than me trying to describe what it looks like, or has to offer, take a look at the photos. It features a fairly standard chess game keyboard with full board checking facilities. You can put back aught that has been removed — and remove what has not.

Display of move and status is via an LCD 'clock-type' display with piece verification symbol. Strength of game played is selected by varying response time. In seconds this time, not levels. In practice you have to double the time to get any appreciable increase in ability from the box.

Board Decision

As I can't see anyone using this unit without the LCD chessboard let me quickly add that to the consideration.

Packaged as a clip-on extra — the data bus edge connects — the board is powered from the main unit and is a complete chess set in itself. The chessmen are based around one symbol, which when displayed in its entirety is a Queen and assumes



The Chess Champion printer unit. Price: £104.95.

the guise of everything else as different segments are left unenergised. The photo shows how effective this can be.

Backlighting is available when running from the mains and the board flashes a proposed move until the ENTER key is pushed. As the game progresses the board provides a continuous updated read-out and totally eliminates the need for a separate chess set with all the attendant errors of misinterpretation and mismanagement. Sheer magic! At last a self-contained intelligent chess set! I could forgive a lot of failings in the machine just for this beautiful facility.

As it happens there is little wrong with Chess Champion anyway. I disliked the sloppy keyboard and having to go through the involved key sequence to change level is frustrating, but so what? Sargon's board is touch-switched and an absolute pest. And you have to move men around to play it. Fair exchange?

Mating Ritual

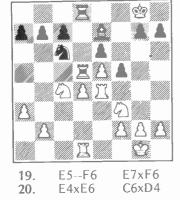
As a chess player, Chess Champion is no match for Sargon (at equal response). Witness the game below. Sargon is set to Level one (10 secs) and Chess Champion to 30 seconds response time. Although Sargon wastes what should have been a winning position later on in the conflict it still manages an



FEATURE: Chess Machines

1.	D2-D4	D7-D5
2.	C2-C4	D5xC4
3.	G1-F3	B8C6
4.	B1-A3	C8-E6
5.	E2-E4	G8-F6
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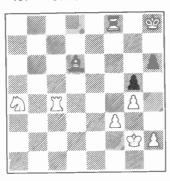




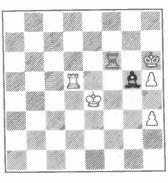
26. D6-B7 D8-F8	21.	F3xD4	D5xD4
24. C4-D6 B7-B5 25. G2-G4 A7-A5 26. D6-B7 D8-F8	22.	D1xD4	F6xD4
25 . G2 -G4 A7-A5 26 . D6-B7 D8-F8	23.	B2-B3	C7-C6
26. D6-B7 D8-F8	24.	C4-D6	B7-B5
	25.	G2 -G4	A7-A5
27 . E6–E2 A5–A4	26.	D6-B7	D8-F8
	27.	E6-E2	A5-A4

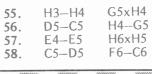


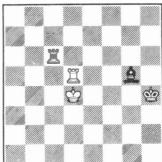
28.	B3xA4	B5xA4
29.	B7-A5	C6-C5
30.	G1-G2	G7-G5
31.	F2-F3	H7-H6
32.	E2-E6	G8-H7
33.	A5-C4	F8-A8
34.	G2-F1	A8-B8
35.	C4-B6	B8-F8
36.	F1-G2	D4-B2
37.	E6-E7	H7-H8
38.	B6xA4	B2xA3
39.	E7C7	C5-C4
40.	C7xC4	A3-D6

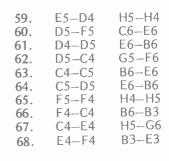


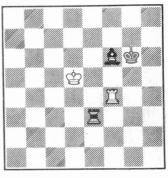
	1	
41.	A4-B6	F8-E8
42.	H2-H3	D6-F4
43.	B6-D5	F4-D6
44.	G2-F2	H8G7
45.	C4-C6	E8-E6
46.	C6-C4	E6-E8
47.	C4-C6	E8-E6
48.	F3-F4	G5xF4
49.	F2-F3	H6-H5
50.	G4xH5	E6-H6
51.	D5xF4	D6xF4
52.	C6-C5	H6-F6
53.	F3-E4	G7-H6
54.	C5-D5	F4-G5



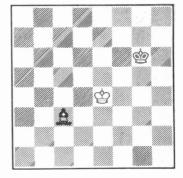








69. F4-E4 E3xE4 70. D5xE4 F6-C3



71. E4-D3 C3-E5 72. D3-E4 G6-F6 73. E4-D3 F6-F5 74. D3-E3 F5-G6

Figure 2 (above) the same between Sargon at 10 second response (white) and Chess Champion at 30 seconds. A draw in the end. Sargon should have won.

Below: the complete Chess Champion, with the LCD board in operation. Fascinating. The main unit will cost you £154.95 all inc. So Sargon costs about the same as the main unit plus LCD board in Chess Champion.



However, please don't think I'm decrying Chess Champion's ability. I wouldn't dare. With the possible exception of the Voice Challenger, I know of no other machine that could best it bar Sargon. Given a little longer Chess Champion will still pin you to the back rank should that be your desire.

It is just that it takes a little while to get over the advanced presentation (i.e. gadgets!) that comes as part of the system. Talking of which I haven't mentioned the printer yet,

so let us rectify that immediately.

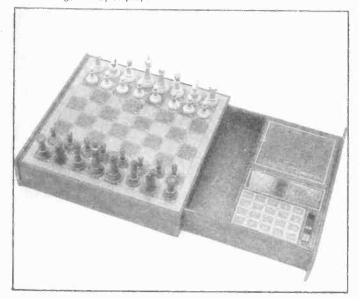
Packaged as another clip-on extra, the printer is a thermal unit with twenty characters per line capability. Shown below is the display of the full board which can be obtained, at any point during a game, by pushing LIST on the printer. Moves are recorded with a "symbol--move from--move to" sequence.

In order to give an example of the printer's output — and because I couldn't resist it — below I have given the ending from a game of Sargon vs Chess Champion at equal response times (20 secs). It's a massacre so don't look if you can't stand the sight of blood! (facing page).

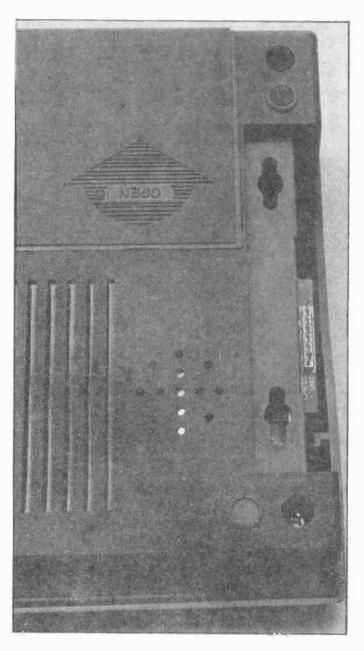


Above: the Chess Champion master unit with its clock-type display. To the right is shown the bus connection for the slave printer-board units.

Below: Sargon ready to play.



Above: Sargon ready to play.



Which Machine?

Choosing between the two is by no means straightforward. If you're a dedicated high-level chess player who will always use his own chess-set anyway, then Sargon will be your best choice for its superior playing ability. On the other hand the LCD board is a huge advantage (and error eliminator) and provided you don't mind waiting that extra time for equal ability Chess Champion is an attractive proposition.

The difference between the machines, in ability, diminishes as the thinking time is increased past 2 minutes, with Sargon always retaining the edge. For my own part I'd tend to go for Chess Champion as that still beats *me* often enough to be challenging and that board fascinates me! I dare say though Sargon will receive heavy support from the better players of this world.

My thanks to Kramer & Co. for lending us the machines for this article. Prices of the units from them are given in the

captions.

	16 5E3×F2 *≝A8×H8	26 ∆H2 H3 *≜A7 A6	
	17 9B1 C3	27 ∆92 94 *•96 95	() () () () -()∰(♠) () ()
*≜D7 1 05 07 4F3×55	*≜E6 E5	28 482 83	
- ≜85×E4	() () () (*)	*≜H7 H5 29 8G4 H6	
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15 BE2XE3 ** ##E8 E7	25 世F1 E1 * ≛ E6 F5	* 1 C1×B3 42 2 A5 B5	・・・・()() ・・・・・・・・・・・・・・・・・・・・・・・・・・・・・・
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Figure 3. Sargon vs Chess Champion (black) with both machines on 20 seconds think time. The print-out is courtesy of Chess Champ's printer.

All the reliability, accuracy and style you would expect from the most expensive

watches.

Metac have become synonymous with quality and extreme good value.

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03272 76345 or (01) 723 4753 and place orders immediately, without completing the coupon.

Credit card holders may telephone



Highly functional, but beautifully designed watch, suitable for those special occasions

Displaying hours, mins, secs, day and date, the watch also has an auto calendar and a backlight.

The slim but strong bracelet is fully adjustable and is available in a silver or gold finish.

Mans dual time quartz alarm M64 chronograph with 6 digits, 5 indicators and 22 functions.

For business people with overseas contacts and responsibilities this is the ideal watch.

Local time is always visible, but in addition the watch can be set, and recall, a second time zone, in either 12 or 24 hour formats, and displays a day and date for each zone.

The chronograph/stopwatch displays up to 12 hours, 59 minutes and 59.9 seconds.

On command, the stopwatch display freezes to show intermediate (split/lap) time while the stopwatch continues to run and neither function affects the normal timekeeping.

The alarm can be set to any time within a 24 hour period.

To complete the functions, there is also a 4 year calendar and a fully adjustable stainless steel strap.



Ladies quartz 5 LCD Day Watch

This slender watch displays hours, mins, secs, day and date and has an auto calendar and a backlight.

Only 25mm × 20mm × 6mm thick this elegant watch has a bracelet, in silver or gold finish, and is fully adjustable to suit very slim wrists.



Ladies quartz LCD Fashion Watch



Mans dual time quartz alarm chronograph with 6 digits, 5 indicators and 22 functions.



M17 Ladies quartz LCD Cocktail Watch

Only 6mm thick, the watch displays hours, mins, secs, day, date and has an auto calendar and backlight.

The fully adjustable bracelet has a bronze/gold or silver finish.



M30 Mans dual time melody alarm chronograph with count-down timer, 34 functions

A very impressive new watch at a superbly low price and with so many useful functions.

There are 5 independent working modes; normal watch, count-down alarm, alarm, dual time zone, 1/100th sec. chronograph.

In addition, the watch can display the day of the week in French, German or English.

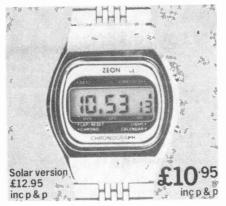
The count-down timer can be used for a variety of applications from boiling an egg to reminding you your parking meter time has expired. Both the count-down alarm and the normal alarm have a clear musical tone.

For the businessman the time zone feature could be a real advantage. Just programme the second time zone and it will be permanently recorded for easy reference.

And as a stop-watch here's a great timepiece for sporting events and for timing recordings.

There's the conventional stop/start counter plus a lap timer which enables first and second places to be timed.

Longer timing intervals, such as journey times can be recorded while the watch is reading its normal time.



Mans quartz LCD with 6 digits and 11 functions

Only 7mm thick and with a fully adjustable stainless steel bracelet, this watch is ideal for all ages.

The normal functions are hours, mins, secs, day, date, and day of week.

But as a stop-watch, which does not affect normal timekeeping you also have 1/100th and 1/10th secs.. split, lap and journey timing, a four year calendar and a backlight.

Also available is a solar version. This is the same watch but incorporated is a solar energy panel which

converts normal daylight into electricity.

During periods of darkness the watch instantly operates by battery without losing its accuracy.



Mans quartz LCD alarm with 6 digits and 9 functions

A very useful watch with an effective, loud alarm but still only 8mm thick.

The normal functions are hours, mins, secs, date, day of week, four year calendar and a backlight.

In addition, there is a 24-hour alarm, a 5-minute snooze feature and a 4 second pre-alarm conference bleep.

The conference signal is a bleep. 4 seconds before main alarm to give advance warning and the option to cancel.

After the main alarm stops the snooze repeater alarm sounds 5 minutes later, unless previously cancelled.

To complete the functions, there is also a 4 year calendar and a fully adjustable stainless steel strap.



Mans dual time quartz alarm chronograph with 6 digits, 5 indicators and 22 functions.

This watch has the same functions as M64 except the time is in the 24 hour format only.

A solar version is available.
This is the same watch but
incorporated is a solar energy panel which
converts normal daylight into electricity.

During periods of darkness the watch instantly operates by battery without losing its accuracy.



Callers may buy from our shops in: **London**, 327 Edgware Rd, W2 **Daventry**, 67 High St, **Northampton**, St. Giles Square.

hease send r	ne the followin	g watches
Model No	Quantity	Colour if applic
enclose PO	/Cheque for £ .	
Barclaycard/		
Vame		

OPTO

LED's	0.125in.	0.2in	each
Red	T1L209	T1L220	10p
Green	TIL211	T1L221	15p
Yellow	T1L213	TIL223	15p
Clips	3р	3р	
DISPLAYS			
DI 704	0.3 in CC		120=

0.3 in CA 0.5 in CC

SKTS

DL707



PCBS

VEROBOARD

Size in.	0.1in.	0.15in,	Vero
25 x 1	16p	_	Cutter 110p.
2.5×3.75	60p	53p	
2.5 x 5	70p	65p	Pin insertion
3.75 x 5	75p	75p	tool 150p.
3.75 x 17	275p	240p	
SS pins/100	45p	45p	

45p Fibreglass board, 203 x 95mm: 80p each. Alfac - 38p per sheet.

RESISTORS

ors. High Stability,

130p

		1000 11015	
E12 series.	4.7 ohms	to 10M, Ai	ny mix:
	each	100+	1000+
0.25W	1p	0.9p	0.85p
0.5W	2p	1.5p	1.3p
Special dev	elopment	packs cons	isting of
10 of each	valué fror	n 4.7 ohms	to 1 Meg-
ohm (650 r	es) 0.5W	£8.50, 0.25	W £5.30

METAL FILM RESISTORS very high stability, low noise rated at 1/4W

1%. Availa E24 series	ble from 5		330k in
0.2510	each	100+	1000+

POTENTIOMETERS Preset vertical or horizontal 100 ohms

Rotary 5K-2M2 Log or Lin single . Rotary 5K-2M2 Log or Lin double Slide 60mm travel 5k-500k Log or Lin, single Suitable kook

or Lin, single 60c Suitable knobs for above with coloured caps in red, blue, green, grey, yellow and black. Rotary controls 16p each. Slide type 12p each.

MISC.

Murata Ultrasonic Transducers	350p	pair
64mm 8 ohm speakers	100p	each
64mm 64 ohmspeakers	100p	
SRB 17W soldering iron	430p	each
Reel of 22swg solder (39.6m)	320p	each
Desoldering tool	510p	each
Precision screwdriver set	170p	
Titan Electric drill	1095p	each
Minaiture 606 and 909		
at 100mA transformers	105p	each

SWITCHES

THE RESERVE OF THE PERSON NAMED IN			
TOGGLE			
Standard	SPST	36p	DPDT 50g
Miniature	SPDT	75p	DPDT 85
Subminiature	SPST	58p	DPDT 78p
SLIDE			
Standard			DPDT 17p
Miniature			DPDT 16
ROCKER (10A	rating)		
SPST 34p each.		SPST	46p each
POTARY			

1P12W, 2P6W, 4P3W or 3P4W Key operated DPDT (Yale key) 395p each PUSH Non locking - push to make push to break SPST

DPDT

REGULATORS

LM309K	140p
LM317T	220p
LM323K	480p
LM723	40p

51p each

100p each

	L	41122 40b
100m A + ve	1A + ve	1A - ve
78L05 30p	7805 70p	7905 85p
78L12 30p	7812 70p	7912 85p
78L15 30p	7815 70p	7915 85p

TRANSISTORS

THE ALL		101.70		111 320	oup
TRAN	ا داوا	01.5		TIP2955	66p
100	7-8-			TIP3055	53p
AC127	22p	BC548	11p	ZTX107	12p
AC128	22p	BCY71	16p	ZTX108	12p
AC176	22p	BCY72	15p	ZTX300	14p
AD161	40p	BD131	40p	ZTX500	15p
AD162	40p	BD132	40p	2N3053	25p
BC107	10p	BD139	33p	2N3054	56p
BC108	10p	BD140	33p	2N3055	50p
BC108C	12p	BFY50	23p	2N3702	9p
BC109	10p	BFY51	23p	2N3704	9p
BC109C	12p	BFY52	23p	2N3706	9p
BC147	9p	MJ2955	100p	2N3819	20p
BC148	9 p	MPSA06	16p	2N3904	10p
BC177	16p	MPSA56	16p	2N3905	10p
BC178	16p	TIP29C	60p	2N3906	10p
BC182	10p	TIP30C	48p	2N5459	33p
BC182L	10p	TIP31C	50p	2N5777	50p
BC184	10p	DIODES			
BC184L	10p	1N914	4p	1N4006	7p
BC212	10p	1N4148	3p	1N5401	14p
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1N5401 14p BZY88ser, 8p

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1N4148 £1.50 per 100.

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10p 10p

CAPACITORS					
POLYSTY	'RE	NE			
High quality foil type, 63V wor	king	1, 5	% t	ol.	
22pf to 100pf				7p	each
1500pf to 0.01uF				9p	each
TANTALUM BEAD					
0.1, 0.15, 0.22, 0.33, 0.47, 0.68					
1 & 2.2uF @ 35V			. 1	Op :	each
4.7, 6.8, 10uF @ 25V					
22 @ 16V, 47 @ 6V, 100 @ 3V			. 2	2p	each
MYLAR					
0.001, 0.01, 0.022, 0.033, 0.047				4p (each
0.068, 0.1				5p 6	each
POLYESTER					

1N4002

Mullard C280 series 0.01, 0.015, 0.022, 0.033, 0.047, 0.068, 0.1. 6p ea 0.15, 0.22 8p each 8p each 12p each 0.33. 0.47 0.68 1.0uF 17p each CERAMIC

Plate type 50V. Available in E12 series from 22pF to 1000pF and E6 series from 1500pF to 0.047uF MINIATURE TRIMMERS

Miniature film type, in 1.4pF – 5pF, 2pF – 22pF, 2pF – 22pF, 2pF – 22pF, 2pF – 10pF, 5.5pF – 65pF. 22p each RADIAL LEAD ELECTROLYTICS

	IVE FF	-AD L	LLCIF	OLII	103	
63V	0.47	1.0	2.2	4.7	10	6p each
			22	33	47	8p each
	100				-	16p each
			220			20p each
25V	10	22	33	47		6p each
	100					-8p each
		220				. 12p each
				470		18p each
	1000				-	28p each

PACKS

Specially developed packs intended for development

¼W CF resistor, 10 each value E12 serie	es
4.7 ohm to 1 Megohm (650 total)	530p each
%W CF resistor, 10 each value E12 serie	es
4.7 ohm to 1 Megohm (650 total)	850p each
¼W MF 1% resistor, 10 each value E24	
series 51 ohms to 33oK (930)	2950p each
Preset potentiometers 5 each value	
from 100 ohms to 1 Megohm (65)	390p each
Polyester capacitors 5 each value	
0.01 to 2.2uF (70)	690p each
Ceramic plate capacitors 10 each value	
22pF to 0.01uF (310)	575p each

CONNECTORS

DIN PLUGS AND SOCKETS

	plug	chassis	line
		socket	socket
2 pin	8p	8p	12p
3 pin	12p	10p	12p
5 pin 180°	12p	11p	17p
5 pin 240°	14p	11p	22p
JACK PLUGS	S AND SOC	KETS	

	socket
2 Em	
	80
3.5mm 10p 16p	9p
Standard 16p 30p	19o
Stereo 23p 39p	22p

1mm PLUGS AND SOCKETS

Suitable for low voltage circuits, Red & Black. Plugs: 8p each. Sockets: 9p each.

4mm PLUGS AND SOCKETS

Available in blue, black, green, brown, red, white and yellow. Plugs 18p each. Sockets: 15p each.

Electronic Components

(Cone	27 (4)		3				
4000 4001 4002 4006 4007 4008 4011 4012 4013 4014 4015 4016 4017 4018 4020 4022	20p 25p 20p 90p 90p 25p 100p 25p 40p 85p 90p 40p 70p 90p 110p	4023 4024 4025 4026 4027 4028 4029 4031 4033 4040 4041 4042 4043 4046 4048 4049 4050 4051 4053	25p 55p 20p 160p 45p 90p 100p 220p 150p 350p 350p 110p 85p 95p 110p 95p 10p 50p 50p 50p	4054 4060 4063 4066 4068 4069 4070 4071 4072 4073 4075 4076 4077 4078 4081 4086 4093 4095 4098	120p 120p 120p 60p 25p 25p 25p 25p 25p 25p 90p 25p 25p 25p 90p 15p 25p 10p 110p 120p	4502 4507 4508 4510 4511 4512 4516 4529 4529 4529 4531 4532 4532 4533 4566 4558 4558 4558 4558	120g 60g 330g 90g 90g 90g 110g 160g 150g 140g 410g 410g 320g 115g
74LS00 74LS01 74LS02 74LS03 74LS03 74LS08 74LS10 74LS13 74LS14 74LS20 74LS21 74LS27 74LS30 74LS32 74LS37 74LS32 74LS37 74LS42	16p 22p 16p 22p 16p 24p 22p 45p 70p 22p 22p 30p 45p 75p	74LS47 74LS48 74LS73 74LS73 74LS76 74LS76 74LS83 74LS83 74LS85 74LS90 74LS90 74LS91 74LS91 74LS114	75p 100p 25p 40p 45p 50p 45p 85p 100p 50p 70p 85p 60p 70p 45p	74LS12; 74LS13; 74LS13; 74LS13; 74LS15; 74LS15; 74LS15; 74LS15; 74LS16; 74LS16; 74LS16; 74LS16; 74LS16; 74LS16; 74LS16; 74LS16; 74LS16; 74LS16;	2 95p 6 60p 8 80p 1 75p 6 80p 7 55p 7 55p 7 75p 8 7 75p 1 75p 2 95p 1 75p 2 95p 1 90p 1 90p 1 90p	74LS17E 74LS190 74LS191 74LS192 74LS192 74LS196 74LS196 74LS196 74LS221 74LS226 74LS266 74LS366 74LS366 74LS366 74LS366	90p 90p 90p 90p 90p 90p 70p 70p 55p 90p 60p 60p 60p 60p
7400 7402 7404 7408 7410 7413 7414 7420 7427 7432	12p 12p 16p 18p 14p 30p 55p 14p 25p 28p	7442 7445 7447 7448 7473 7474 7475 7476 7485 7486 7490 7492	50p 65p 55p 55p 30p 35p 35p 65p 25p 35p 35p	7493 7496 74121 74123 74125 74126 74132 74141 74145 74148 74150 74154	35p 55p 35p 45p 45p 45p 55p 70p 70p 120p 65p 80p	74157 74164 74165 74174 74177 74190 74191 74192 74193 74194 74196 74197	50p 70p 70p 70p 70p 70p 70p 70p 70p 70p 7
709 741 747 748 7106 AY-1-0212 CA3046 CA3080 CA3130 CA3140 FX209 ICM7556 LF347 LF351 LF353 LF355 LF356 LF357	40p 18p 50p 35p 850p 660p 70p 70p 50p 820p 100p POA 135p 45p 92p 95p 92p	LM10 LM301A LM308 LM318 LM324 LM339 LM348 LM377 LM378 LM3795 LM380 LM381 LM382 LM383 LM386 LM387 LM389 LM389 LM389 LM389 LM389 LM389 LM3992 LM3992 LM3990	400p 30p 70p 85p 85p 52p 55p 170p 230p 410p 200p 90p 120p 120p 120p 120p 140p 120p 120p 140p 120p 120p 120p 170p 170p	LM3909 LM3914 LM3915 LM3911 LM13600 MC1496 LM1458 LM1458 LM1830 MC3340P MC33600 NE531 NE555 NE556 NE5667 NE567 NE571 NE5537 RC4136 SAD1024 SN76477	80p 40p 180p 135p 135p 650p 110p 23p 60p 120p 120p 420p 460p POA 100p	TBA800 TBA810S TDA10028 TDA10224 TDA10224 TDA10220 TL071 TL072 TL074 TL081 TL082 TL084 TL170 XR2206 XR2207 ZN414 ZN419 ZN424 ZN425E ZN460 ZN1034	80p 110p 350p 630p 120p 75p 135p 200p 45p 85p 125p 60p 390p 450p 80p POA 150p 420p 360p 230p
MICRO)	2112 2114LP 4116 2708	420p 620p 680p	6800 8080A	650p 610p 1090p	6810 6821 6850	350p 600p 550p

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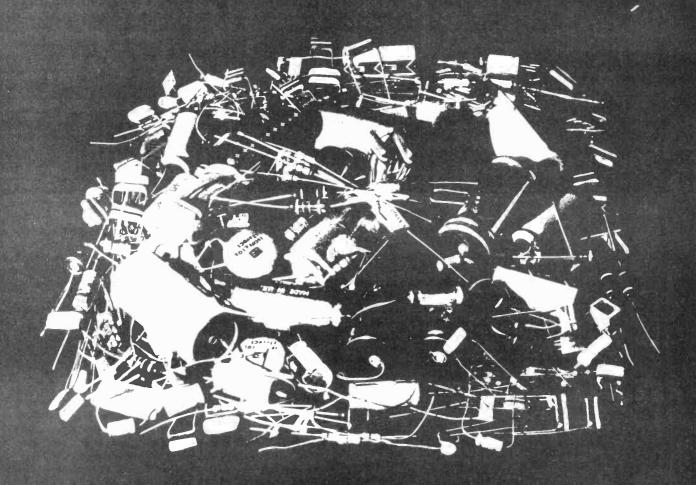
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ETI CIRCUIT DESIGN HANBOOK

NO.1: AUDIO AMPLIFICATION AND OSCILLATORS.



A step by step guide to doing it ALL yourself — by Tim Orr. This is the first of what will become an occasional series of easy to read reference works. Mathematics will be kept to a minimum with the emphasis upon producing practical circuits — quickly. Just the thing you always wanted, but thought no-one was ever going to produce! Future subjects will include radio circuitry, digital logic and signal processing.

SECTION ONE:
small signal and pre-amplifiers
SECTION TWO:
large signal, or power, amplifiers
SECTION THREE:
audio frequency oscillators

SMALL SIGNAL AND PRE-AMPLIFIERS

reamplifiers are used to convert low level signals into higher level signals with low output impedances. The primary design considerations for preamplifiers are input impedance, signal gain, equalisation, noise performance and distortion. It is now possible to buy integrated circuits that will perform virtually all common preamplifier functions. Only rarely, (and with a lot of skill), will one be able to improve upon a monolithic 'best' solution with a discreet component design. However, it is necessary to fully understand the operation of the IC if optimum results are to be obtained.

The Op Amp Building Block

Most IC preamplifiers operate as op amps. They have a single or differential input, a low impedance output and a large frequency dependent voltage gain, (Fig.1). Note that the

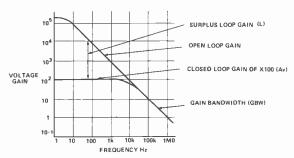


Fig.1. Typical frequency response for the 741 op amp.

open loop voltage gain rolls off at -6 dB per octave. By applying feedback around the op amp (closed loop), the gain is stabilised and is held constant by the resistor ratio until the device runs out of bandwidth. The difference between the open and closed loop gain is known as the surplus loop gain. This surplus loop gain is the negative feedback that is used to iron out non-linearities in the op amp. As the size of the surplus loop gain decreases with increasing frequency, the distortion and output impedance increase. Fig.2 compares the performance of inverting versus non-inverting configurations.

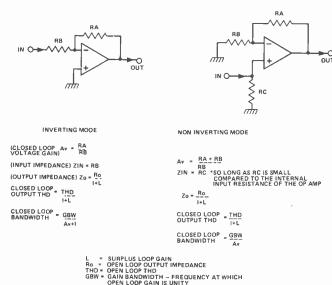


Fig.2. A comparison of the performance of inverting versus noninverting configurations.

Note that for unity gain the non-inverting mode has twice the closed loop bandwidth of the inverting mode. Also note that the output impedance rises as the surplus loop gain decreases. This can cause a sharp increase in distortion when the op amp is driving a low impedance load at high frequency.

Design Example

Q. Design an amplifier with a gain of 60 dB, a closed loop bandwidth of at least 20 kHz and input impedance of 10 k.

A. First, try the inverting mode as shown in Fig.2. Zin = 10 k = RB.

$$Av = 60 dB = X1000 = \frac{RA}{RB}$$

Therefore, RA = $10 \text{ k} \times 1000 = 10 \text{ M}$ If we use a 741 then the input offset voltage will be multiplied by the closed loop gain. The offset is typically ± 1 to 5 mV. Therefore, the output offset will be ± 1 to 5 V! It is possible to null out the input offset (Fig.3a) with a preset. This circuit

will not be very satisfactory.

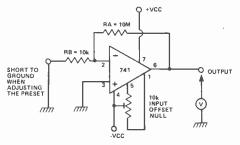


Fig. 3a. The input offset can be nulled with a preset.

Its DC output offset will probably drift with temperature and time. If stable high DC gains are required then a 741 should not be used. A high performance instrument op amp should be selected in its place. Another problem in using the 741 is its 1 MHz gain bandwidth product. A closed loop gain of 60 dB will result in a closed loop bandwidth of 1 kHz, and not the 20 kHz needed. An op amp capable of giving 60 dB of gain at 20 kHz would need a gain bandwidth product of 20 MHz.

Although there are some op amps with this performance, they are generally difficult to stabilise and are relatively expensive. A cheap solution is to use two 741s, both with gains of 30 dB (x 33), (Fig.3b). The 741 has a bandwidth of 30 kHz at

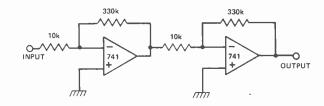


Fig.3b. A cheaper way to achieve higher gain at, say, 20 kHz without incurring a huge bandwidth is to use two 741s.

a closed loop gain of 30 dB. The DC offset still remains a problem, but it could be removed with a nulling preset on the first op amp. However, if the amplifier is to be used for audio then a DC response is not needed and so AC coupling can be used to reduce the final DC offset, Fig.3c. Yet another problem still exists. With the input short circuited the circuit would probably produce about 10 mV of noise at its output. The subject of noise will be dealt with later; suffice it to say that the 741 is not a low noise device. Low noise operation can be obtained by using one of the low noise op amps that are now available.

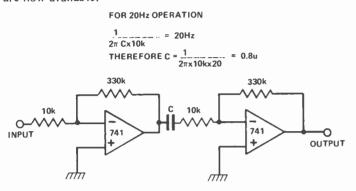


Fig.3c. AC coupling can be used to produce the final offset in audio applications.

Input Offset Voltage And Bias Current

When using op amps as DC amplifiers there are several sources of errors, Fig.4. The input to an op amp is usually an NPN differential pair. To make the device operate, a base current must be supplied (input bias current). Also, to balance the op amp the current through both transistors must be

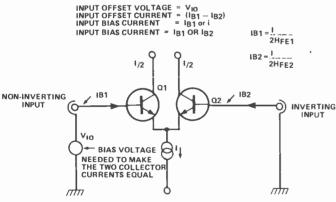


Fig.4. Typical differential op amp input.

equal. The transistor pair is 'matched' for parameters such as Hfe and Vbe versus ICE. However, small differences are caused by the manufacturing process, resulting in the base currents being different (input offset current) and also the base-emitter voltage parameter (input offset voltage). The input offset

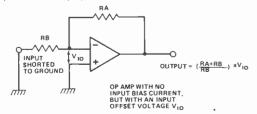


Fig.5. The effect of V_{IO}.

voltage is multiplied by the closed loop DC gain of the op amp (Fig.5) and the input bias current sets up a DC offset across any resistors it flows through (Fig.6). Typical parameters for the 741 op amp are; 2 mV (VIO), 80 nA (IB) and 20 nA (IB1-IB2). These parameters vary from device to device and from manufacturer to manufacturer. The purpose of successful design is to produce circuits that are insensitive to these

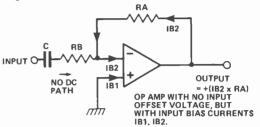


Fig.6. The effect of IB.

variations. Generally, for audio designs, the DC offsets may be eliminated by AC coupling and other methods (Fig.7). Note that the DC output offset may be reduced by inserting a resistor from the non-inverting input to ground. Without that resistor the DC offset may well have been ± 26 mV (IB2 x RA) as opposed to ± 6.6 mV ((IB1-IB2)xRA). A DC voltage on the output would generate a disturbing crackle when the level pot is adjusted.

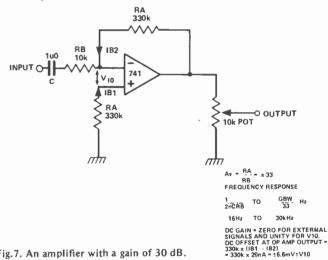
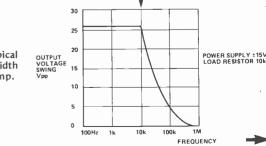


Fig. 7. An amplifier with a gain of 30 dB.

Voltage Swing, Power, & Bandwidth

The voltage swing at the output of an op amp is limited in many ways, Fig.8. Most op amps can only swing within a few volts of either supply rail. Also, the speed at which the output voltage can move is limited by the slew rate of the device, which is typically 0V5 per microsecond for a 741. This is the limiting factor in designing amplifiers for high level large signal voltages. ONSET OF SLEW LIMITING



Typical Fig. 8. power bandwidth for a 741 op amp.

Design Example

Q. Design an amplifier with a gain of 4 to amplify a 50 kHz 5 V squarewave.

A. First try a 741, Fig.9. The required output swing is \pm 10 V. The 741 can only move at 0V5/uS and so in the half period of the square wave, it can only move 5 V. If the 741 is replaced with a faster device, the TL081 (13 V/uS) then a 'square' wave is produced. The TL081 would take approximately 1.5 uS to travel the 20 V distance, thus generating a

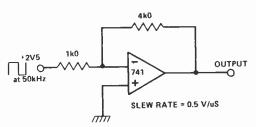


Fig.9. The difference in slew rate between a 741 and a TL081.

rise and fall time of 1.5 uS. Note, that if the resistors were increased in value to say 250 k and 1M0, then the squarewave output would ring. This is because the feedback would have to charge up the stray capacitance at the inverting input, thus generating a lag between the output and the feedback, which in turn would generate an overshoot.

Noise

Noise is always a problem in electronics. The presence of noise degrades the quality of the signal we are interested in. Everytime we amplify, process, transmit, record or replay a signal, noise is introduced thus worsening the signal to noise ratio. Some common signal to noise ratios are shown below.

Telephone 20 to 40 dB Cheap cassette player 30 dB Good tape recorder 60 dB

Professional studio equipment 80 dB

The calculations of noise produced by electronics is complex, but with a few short cuts it is possible to get some useable calculations.

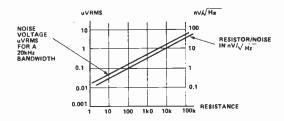


Fig. 10. Thermal noise generated by a resistor.

All resistors generate noise due to thermal agitation (Fig.10). Noise is also generated when a voltage is applied to them. Manufacturers generally express this latter noise in uV/V typically 0.1uV/V for metal film devices. For most purposes resistor noise is not a dominating noise source although low level amplifiers perform slightly better with metal film devices. Keeping the resistor values low, helps to obtain low noise operation.

An op amp has several sources of noise generation, Fig.11. there are two noise current generators which both generate noise by flowing through the resistors in the circuit. The resistors themselves generate noise and there is an input voltage noise generator. The total output voltage Eo is given by

Eo =(

RA+RB) xv (noise voltage source)²+(noise from In+Source)²+

(noise from In-source)²+(noise from RC)+(noise from RA//RB

nv/ Hz

In+ + RB

FOR LOW NOISE OPERATION, RC
IS A SHORT TO GROUND.

Fig. 11. Model of op amp noise generation.

The noise performance curves for a low noise op amp, the SE5534, are shown in Fig.12a,b,c. Graph a shows the input noise voltage density, En (ie total RMS noise in a 1 Hz bandwidth at that particular frequency), as a function of frequency. To convert this input noise voltage, $(4nV/\sqrt{Hz})$ into an equivalent input noise generator, we must define the bandwidth of interest. As the noise spectrum is relatively flat above 100 Hz then we can say,

Fig.12a.The SE5534 low noise op amp input noise voltage density.

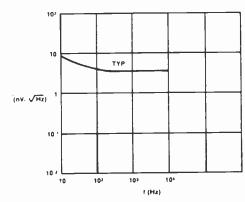
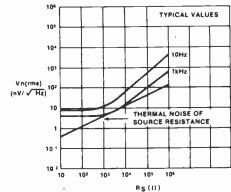
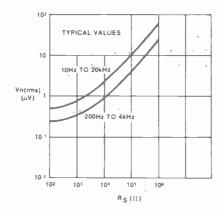


Fig.12b. The variation in total input noise density with source resistance for two frequencies.



.HANDBOOK: Audio Design

Fig.12c. The equivalent input noise voltage for two bandwidths as a function of frequency.



The equivalent input noise voltage $Ein = \sqrt{(En^2xbandwidth^2)}$ For 20 kHz bandwidth

$$Ein = \sqrt{(En^2 \times 20,000^2)}$$

$$Ein = (En \times 141) \text{ nV}_{RMS}$$

But En =
$$4nV\sqrt{Hz}$$

Therefore Ein = $4x141 = 0.564 \text{ uV}_{RMS}$ (20 kHz)

Design Example

Q. Calculate the output noise in a 20 kHz bandwidth for the circuit in Fig.13. Assume the voltage and current densities have a flat spectrum (which is not too far from the truth!).

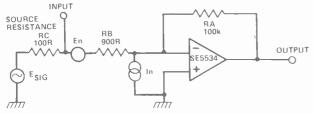


Fig.13. A low noise amplifier.

A. Calculate the individual noise sources.

Resistor Noise

Effective resistor is RA//(RB+RC) 1k0

Therefore thermal noise (from Fig. 13b) = $3 \text{ nV}/\sqrt{\text{Hz}}$

Noise Voltage

 $a = 4 \text{ nV} / \sqrt{\frac{1}{H_7}}$

Noise Current

 $c = 0.5pA/\sqrt{Hz}$

which sets up a noise voltage through (RB + RC). This noise voltage is $0.5 \, \text{pA} \times 1 \, \text{kO} = 0.5 \, \text{nV} / \sqrt{\text{Hz}}$

Therefore the total noise voltage

Eo =
$$\left(\frac{RA + RB + RC}{RA + RB}\right) \times \sqrt{(4)^2 + (0.5)^2 + (3)^2}$$

 $= 101 \times \sqrt{16 + 0.25 + 9}$

 $= 101 \times \sqrt{25.25}$

500 nV/√ Hz

For 20 kHz bandwidth, the output noise = 500×141

= 70,500 nV_{RMS}

= 70.5 uV_{RMS}

A 7 mV_{RMS} input signal from, say, a low impedance microphone would result in a 700 mV_{RMS} output signal and give a S/N ratio of 20 Log $(\frac{700}{0.0705})$ = 80 dB

Note that most dominant source in this circuit is the noise generator En. As long as the input impedance levels are kept low, then it is the noise generator En on its own that can be used as a rule of thumb for calculating absolute and comparative noise performance. For high input impedance applications a FET op amp (with virtually no input noise current) should be used.

Noise Measurements

The noise current voltage psectrums of Fig.12 were measured using a mobile analysing filter (1 Hz bandwidth) plus an RMS meter. A simpler measurement can be performed using the system shown in Fig.14. This will measure the



Fig.14. Noise measurement.

equivalent input noise in a specified bandwidth. The low pass filter should be high order device with a steep roll off slope. If a single pole low pass filter is used, then the RMS reading should be corrected by the following equation,

'True' RMS noise =
$$\sqrt{\text{measured RMS noise}}$$

(for a one pole lowpass filter) 1.57

(An RC 20 kHz low pass filter would be made from an 820 ohms resistor with a 10 n capacitor to ground).

Sometimes the signal to noise ratio is quoted in dBA. This means that the noise measurement has been modified by an A weighted curved.

A short chart of op amp performance has been drawn up in Fig.17. It is difficult to compare device performance merely from the noise voltage at one frequency in the spectrum, as the noise spectrum shapes are different from device to device. It is best to refer to the manufacturing data sheet and then to actually breadboard the devices.

DEVICE	NOISE VOLTAGE AT 1kHz nV/√ Hz	UNITY GAIN BANDWIDTH MHz	SLEW RATE V/uS	
NATIONAL SEMICONDUCTORS LM381A	5 0 NOT OPTIMISED	15	4 7	
SIGNETICS SE5534	4 0	10	13	
SIGNETICS SE5534A	3.5	10	13	
741	20 to 50 NOT USUALLY SPECIFIED	1 to 1.5	0.5	
RAYTHEON RC4136	10	. 3	0.5	
RAYTHEON RC4558	10	3	0.5	
TEXAS TL071	18 *FET INPUT VERY LOW INPUT NOISE CURRENT 0,01 PA /\ Hz	3	13	
FERRANTI ZN459T	4.5 (Rs = 510R)	15	_	

Fig.15. Op amp performance.

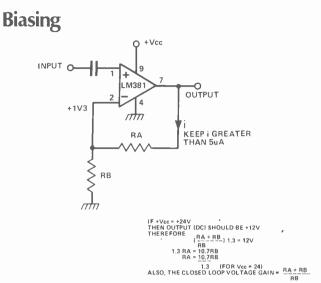


Fig.16. Biasing the LM381 (differential mode).

The base of Q1 is held at +1V3 by a pair of diodes. This preamplifier is often run from a single supply rail and a simple resistor network can be used to bias the output voltage to ½ Vcc (Fig.16). Also a single ended amplifier can be constructed (Fig.17). The resistor pair RA,RB determines the DC output level and gain. To increase the AC gain resistor RB can be shorted to ground with a series R,C network.

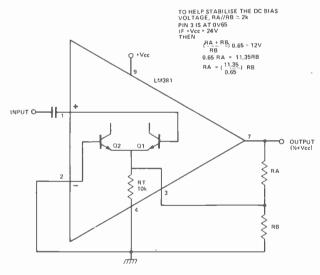


Fig.17. Single-ended biasing.

Design Example

Q. Design a preamplifier using the LM381 with a gain of 30 dB and a low frequency roll off of 20 Hz running from a +24 V power supply.

A. The design calculations are shown in Fig.18.

Record Preamplifier

When replaying a record from a magnetic cartridge it is necessary to have a preamplifier with an RIAA playback equalisation (Fig.19). A magnetic pick up generates a voltage

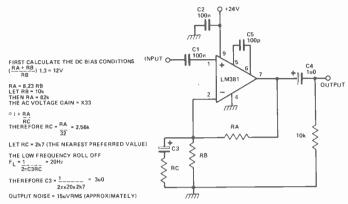


Fig. 18. A 30 dB amplifier.

that is proportional to the velocity of the sideways movement of the stylus. So high frequencies produce large outputs and vice versa. Also, to assist replay electronics, the recording is given a 12 dB de-emphasis from 500 Hz to 2120 Hz. Thus, to restore a flat output it is necessary to equalise the signal from the pick up with an RIAA curve. As a rule of thumb,

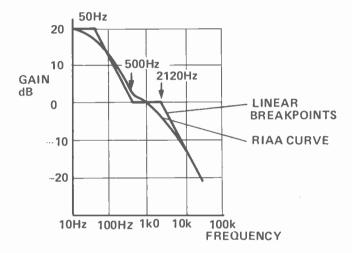


Fig. 19. RIAA equalisation.

a typical magnetic pick up will generate 5 mV_{RMS} at 1 kHz, although the recording level and make of pick up will effect this figure.

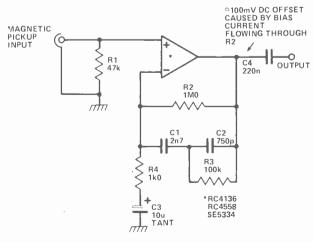


Fig. 20. An RIAA-equalised preamplifier.

Low frequency gain =
$$\frac{R2}{R4}$$
 = 60 dB

Low frequency rolloff =
$$\frac{1}{2\pi R4C3}$$
 = 15 Hz

50 Hz breakpoint
$$\frac{1}{2\pi R2C1}$$

The gain drops at --6 dB/octave beyond this point 500 Hz breakpoint
$$\frac{1}{2\pi P_3 C_1}$$

Now the gain remains constant until the next breakpoint AC gain at 1 kHz = R3 = 40 dB

2120 Hz breakpoint
$$\frac{R4}{2\pi R3C2}$$

The gain now falls at -6 dB/octave beyond this frequency.

A 5 mVRMS signal at 1 kHz will result in a 500 mVRMS

(1V4 pp) at the preamplifier output. If the amplifier is powered from ±12 V, then there is an overhead margin of

$$(\frac{\text{maximum output swing} = 20 \text{ V}}{\text{typical swing} = 1\text{V4}}) = 14,$$

which is 23 dB. The noise spectrum of the op amp will be multiplied by the RIAA curve which would complicate any noise performance calculations. However, an op amp with an equivalent input noise of 0.5 uV should give a signal to noise performance of better than 76 dB which is superior than that of the disc itself. Because of the large low frequency gain care must be taken to avoid mains hum pick up. Keep the input wiring away from the mains cables and transformers, use low noise screened cable and wire this cable as close as possible to the preamplifiers.

Problems

Often a preamplifier will pick up radio signals. Usually, the radio signal is picked up by the input wiring to the preamplifier and is rectified by the transistor input stage. Then it is amplified by the rest of the audio amplifier and you end up with permanent broad band radio reception. There are several solutions that can be tried, Fig.21. A low pass filter made from an LC or an RC section will attenuate the 'pick up' interference. These devices must be physically close to the op amp. If possible use a PCB ground plane. Also, a conductive metal screen (metal foil is often used) surrounding the preamplifier will help.

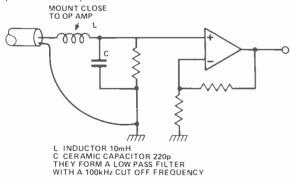


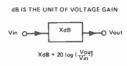
Fig.21. Removing RF interference.

Hum can also be a problem. If the hum is at 50 Hz then the source of it is probably magnetic. Check the wiring to see if any signals pass near to the mains section. Magnetic screening is difficult to implement. The best design solution is to put as much distance between the sensitive input and the mains

section as possible. If it is possible try rotating the mains transformer (using a gloved hand, the other hand in your pocket). Often the size of the hum can be reduced by reorientating the transformer. If the hum is 100 Hz, then the source is either the supply rails or the power supply layout. A larger smoothing capacitor will reduce the power supply ripple. If the hum has a sharp buzz then the problem is probably the charging current pulses in the power supply. If the layout is bad, these current pulses generate voltage pulses that get added into the ground reference voltage, thus causing the hum.

Gain

When designing an audio system it is necessary to know what the normal signal level at any point will be and also the signal gains and attenuations of various units. It has been found that the most useful way to describe levels and gains is with the logarithm decibel, Fig.22. Signal gains in dB are additive. That is, a signal passing through a series of gains of +10, +20, -30, +6 dB will end up with an overall gain of +6 dB.



dB	APPROXIMATE RATIO
+60	1000 100 100 3 2 2 1.4 10 0.7 0.5 0.33 0.1 0.01
1	

dBm	Vpp	VRMS	
+20	21.9V	7.75V	
+ 6	4.38V	1.55V	
+ 0	2.19V	0.775V	
-6	1,09V	0.387V	
-20	0.219V	0.077V	
-40	21.9mV	7.75mV	

dBm IS THE UNIT OF VOLTAGE LEVEL 0dBm IS 1mW OF POWER INTO A 600R LOAD

Fig.22. The dB and dBm story.

A typical audio system is shown in Fig.23. A low impedance microphone might typically give a -50 dBm output signal which will have to be given a 56 dB (x 600) gain to bring it up to line level (about +6 dBm). The line driver should

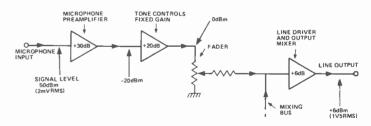


Fig.23. One channel of a mixing desk.

be capable of driving +20 dBm into 600 ohms at 20 kHz without generating significant distortion. Some line drivers are, in fact, capable of driving 30 ohm loads, but these units are small high quality power amplifiers.

2. LARGE SIGNAL, OR POWER, AMPLIFIERS

power amplifier must deliver power into a load without generating significant distortion or bursting into oscillation or burning itself out. Power amplifiers are, however, prone to all these effects and great care is needed during their design.

Power

Power is measured in watts and is defined as the product of VRMS x IRMS (Fig.1c), where RMS is the equivalent DC value. That is, a 2 Vpp sinewave has the DC value of 0V7. The 2 Vpp sinewave will generate as much heat in a load as a 0V7

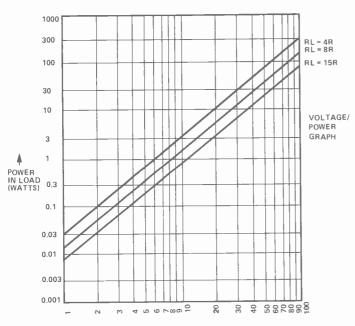


Fig.1a. (above) Graph of voltage against power.

Vpp ACROSS LOAD -

		4R	8R	15R	RL
	1V	0,031	0.015	0,008	
ĺ	3V	0.28	0.140	0,075	
	10V	3.125	1.562	0.833	
	30V	28.15	14,062	7.50	
	100V	312.5	156.25	83.33	
	Vpp				

Vpp ACROSS POWER IN RI

Fig.1b. (left) The power dissipated in a load against drive voltage.



Fig.1c. (left) The measurement of power.

DC voltage. The chart in figure 1b shows the power dissipated in a load against drive voltage. If you have an amplifier that has a maximum output voltage swing of ±10 V, then the maximum power output will be 12.5 watts into a 4 ohm load (from Fig.1a). Note that the amplifier must be able to deliver a peak current of 2.5 Amps. Whilst dumping power into the load, the amplifier will be dissipating heat itself. Most monolithic devices are documented with design graphs of output power versus amplifier dissipation of power efficiency. These will enable you to determine the amplifier's maximum power dissipation. As a rule of thumb, this equals the maximum sinewave power that can be dumped into the load. A 10 watt amplifier may have to dissipate a maximum of 10 watts of heat, although this level of dissipation would not be normal in general use. Manufacturers information usually gives the thermal resistance of the junction to case. If this was say 3°C/watt then a 10 watt dissipation would raise the junction temperature by 30° above ambient (25° raising to 55°C). This is only true if the case temperature remains at ambient temperature, that is if the case is contact with an infinite heat sink. The heatsink may be anything from nothing (free air dissipation) to near infinite. It is important that the amplifier chip junction does not get very hot (above 100°C). The power chips of the amplifier age very quickly at elevated temperatures suffering from deteriorating characteristics and a short life time. This is why power amplifiers and power supplies are common failures in equipment. When the chip is heated up it expands. The chip is glued to its case and so by expanding it stresses the glue and eventually causes it to fracture. This thermal cycling increases the thermal resistance of the chip to the case and so the chip ends up operating at an even higher temperature.

Other heatsinking materials are used in the construction of power devices such as heat conducting plastics and pastes (Beryllium oxide). Manufacturers often provide design graphs of maximum dissipation versus temperature for various heatsink thermal resistances. These help to select an acceptable heatsink. Often if you are using the chassis as a heatsink it is impossible to calculate the temperature rise and it has to be done by trial and error. (As a rule of thumb I am satisfied if I can place my finger on the device for 5 seconds indicating that case temperature is no more than 80°C).

Distortion

A simple power amplifier is shown in figure 2. An op amp provides the voltage gain and a NPN, PNP transistor pair forms a current amplifier. Any distortions or nonlinearities are ironed out by the surplus loop gain of the op amp. The transfer characteristic of Q1,Q2 shows that there is a dead zone of

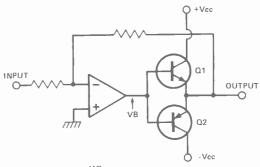


Fig. 2. A simple power amplifier.

HANDBOOK: Audio Design

±0V6 where neither transistor is ON. If a low frequency sinewave is connected to the input (the op amp having a surplus loop gain of 1000 at this frequency) then the output will be a sinewave with a small amount of crossover distortion. The distortion level will be

$$\pm 0V6 = \pm 0.6 \text{ mV}.$$

However, as the frequency is increased, the surplus loop gain will decrease causing the distortion to rise. At higher frequencies the slew rate of the op amp becomes noticeable (Fig.3). When the input signal crosses 0 V the output of the op amp has to change from ± 0.0000 to ± 0.0000 then the time taken to travel the ± 1.0000 to ± 1.0000 to ± 1.0000 to ± 1.0000 to ± 1.0000 then the time taken to travel the ± 1.0000 to ± 1.0000 to ± 1.0000 the signal is missing out of each half cycle. The problem may be overcome by biasing the

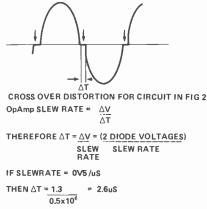


Fig.3. The effect of slew rate at higher frequencies.

two transistors so that they are both conducting. Then the crossover distortion becomes reduced to a reasonable level. The slew rate still needs to be considered. An amplifier delivering a 40 Vpp sinewave at 20 kHz has a fastest slew rate of 2V5/uS (this represents a power of 25 watts into 8 ohms). If the amplifier has not enough slew rate the output will become distorted. Manufacturers generally provide graphs of distortion (THD) versus power output and frequency (Fig. 4). For the power curve, the onset of distortion is caused by the amplifier clipping at its power rails, whereas for the frequency curve the distortion rises as the surplus loop gain falls.

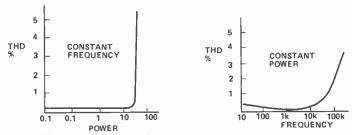


Fig.4. THD versus power and frequency.

Distortion is measured at various power levels and frequencies using the equipment shown in figure 5. A deep notch removes

the test sinewave leaving behind the distortion products. Generally 0.1% THD is common for monolithic amplifiers.

Stability

Power amplifier performance is very similar to that of op amps. They have a large open loop gain that is stabilised by resistive feedback (Fig.6). Note that the amplifier described in this graph is normally inverting (180° DC phase shift) but that it suffers a phase shift as the frequency increases. The phase shift at the unity gain frequency is shown as the phase margin. If the phase margin falls to zero anywhere before the unity gain frequency then the amplifier will oscillate. This is simply because the loop phase shift will be zero at a loop gain of greater than unity, which are the conditions for an oscillation. A large phase margin is desireable.

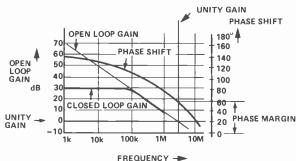


Fig.6. Gain and phase response.

Various techniques are available for preventing instability. Often a series RC network is connected from the amplifiers output to ground. This reduces the high frequency gain and thus reduces the unity gain frequency. Local power supply decoupling should be used. Current loops, whereby the output current generates a voltage in the signal ground wire which gets fed back to the input can cause bursts of high frequency oscillation. Also high input impedances can capacitively pick up the output signal and burst into oscillation. Increasing the closed loop gain may prevent some forms of instability, swearing will not! Figure 7 shows some typical instability problems.

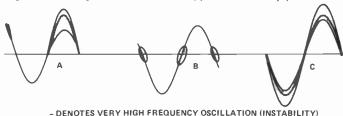


Fig. 7. Instability; A, on one half cycle; B, at crossover; C, at all points.

(a) The sinewave oscillates on one half cycle. Really a power amplifier is two amplifiers, one half handling positive signals, the other, negative signals. Thus it is quite possible that the amplifier can be stable for negative signals but not positive ones.

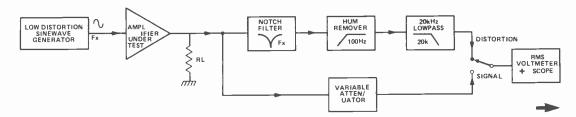
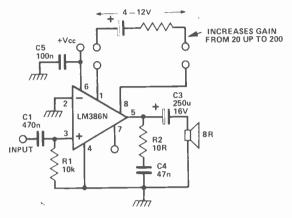


Fig.5. THD measurement.

(b) The sinewave is unstable at crossover. This may be caused by the loss of feedback at crossover. Increasing the bias current may eliminate it. Alternatively it might be caused by slew limiting manifesting itself as an extra phase shift.

(c) The amplifier is never stable. Check the layout for current loops, increase the gain, increase the output CR loading, even try removing it, reduce the impedance levels.

You may not hear the effects of high frequency oscillation but it does cause RF interference and generates waste power. It



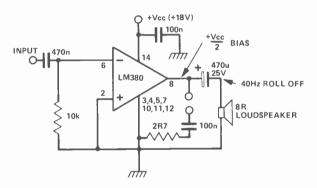
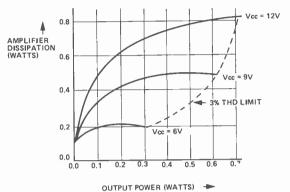


Fig. 9. Medium power audio amplifier. The LM380 will work with a supply voltage range of 8 to 22 V. It can deliver 4 watts of power into 8 ohms at 20 V, although a good heatsink is needed for this level. The inputs are ground referenced and the output is automatically biased to ½ Vcc. The voltage gain is fixed at 34 dB. It also has a short circuit proof output and internal thermal limiting.

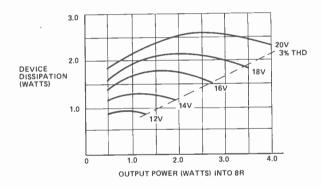
can burn out output stages and even loudspeaker crossovers.

The following five design examples demonstrate how to produce a solution to an amplifier problem. It is now possible to buy an amplifier for most general purpose uses. A wide selection of monolithic devices and modules cover the 0.25 to 100 watt power range. It is rare to have the time or the ability to improve upon this range. The art of designing is to select the most suitable solution on the basis of size, cost and performance.



LM386 DEVICE DISSIPATION VERUS OUTPUT POWER INTO AN 8R LOAD

Fig. 8. Low voltage, low power battery operated amplifier. The LM386N operates over a supply range of 4 to 12 V. It can deliver 0.7 watts into 8 ohms at 12 V, although, at this level, some heatsinking would be advisable. The typical battery drain is 4 mA. The voltage can be varied from 20 to 200, as shown it is 20. An AC short across pins 1 and 8 will increase the gain to 200. With a resistor in series the gain can be set to anything from 20 to 200. For gains greater than 20, a bypass capacitor (100n to ground from pin 7) should be used. Even with a supply voltage of only 4 V, there is an output voltage swing of greater than 2 V.



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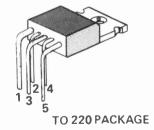
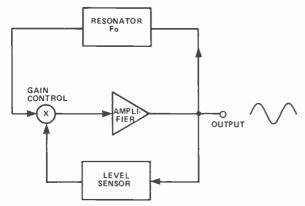


Fig.10. 9 to 14 watt amplifier. The TDA2030 is a Hi-Fi audio amplifier which has short circuit protection and thermal shutdown. It can operate from supply rails of \pm 6 to \pm 18 V. At a \pm 14 V supply the guaranteed output power is 12 watts into 4 ohms and 8 watts into 8 ohms. Harmonic and crossover distortion is low being typically 0.05% at 1 kHz for 7 watts of power output. The recommended closed loop gain is 30 dB. The two diodes protect the amplifier from back EMF voltages from the speaker.

3. OSCILLATORS

t seems to be a fact of life that amplifiers oscillate and oscillators won't! Generally there is little difference between the two. Both devices are amplifiers with feedback. The conditions for stable sinusoidal oscillation are shown in Fig.1. The higher the Q of the resonator the more stable is the resonant frequency, and the purer the sine wave. To stabilise



CONDITIONS FOR OSCILLATION

- * PHASE SHIFT AROUND LOOP = 0°
 * LOOP GAIN = UNITY
 * IF SINEWAVE FALLS BELOW SET AMPLITUDE, GAIN INCREASES
 * IF SINEWAVE INCREASES ABOVE SET AMPLITUDE, GAIN DECREASES

Fig. 1. Conditions for a stable sine wave oscillator.

the signal level an automatic gain control circuit is used. This can be anything from simple diodes or thermistors to elaborate AGC systems. The smoothness with which the AGC works will determine the sine wave purity. A thermistor circuit might well introduce distortion at low frequencies by changing its resistance during one half cycle of oscillation. Very pure sinewave oscillators (better than 0.001% distortion) employ slow acting AGC systems to control the loop gain.

Wien Bridge

The well known Wien Bridge oscillator is shown in Fig.2a. A frequency sensitive feedback network is constructed from R1, C1 and R2, C2. This network has a peak in its amplitude response which also corresponds to zero phase shift. At this frequency the attenuation is x1/3 and so to ensure oscillation

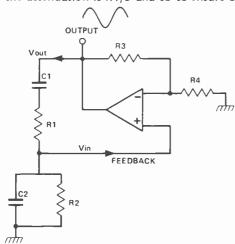


Fig. 2a. A Wien Bridge oscillator.

the amplifier must have a voltage gain of at least x3. To stabilise the amplitude a thermistor is used in the feedback

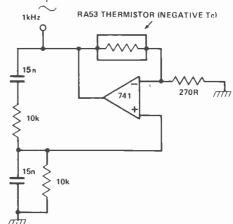


Fig.2b. To stabilise the amplifier a thermistor is used in the op amp feedback loop.

loop of the op amp. As the oscillation amplitude increases, the thermistor heats up, drops in resistance and so reduces the gain. The circuit suffers from amplitude bounce when the frequency is altered. Also, the op amp phase shift, which increases with increasing frequency, must be taken into consideration when designing this oscillator. Another sine wave oscillator is shown in Fig.3. This generates both sine and cosine outputs. The circuit is a state variable filter with posi-

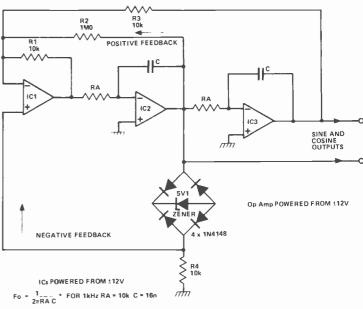


Fig.3. A state variable sine/cosine oscillator.

tive feedback (R2) to ensure oscillation and amplitude limiting (the diode bridge) to stabilise the sine wave level. The distortion may be trimmed by adjusting the amount of positive feedback. The oscillation frequency is set by RA and C.

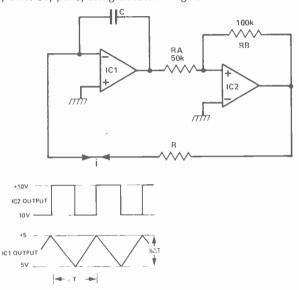
A triangle/square wave oscillator may be constructed from a pair of op amps (Fig.4). IC1 is an integrator, the output of which ramps up and down between the hysteresis levels set by the Schmitt trigger, IC2. If the output of IC2 can swing to \pm 10 V then the hysteresis level will be \pm 10 x RA volts

RB

The oscillation frequency and triangle symmetry is linearly proportional to the output swing of IC2. If a variable frequency oscillator is wanted, then resistor R can be connected to the wiper of a potentiometer fed from IC2 output.

Design Example

Q. Design a triangle oscillator with a 2 Vpp triangle output, oscillation frequency of 1 kHz, operating from \pm 12 V power supplies, using circuit in Fig.4.



INVERTING INPUT OF ICT IS A VIRTUAL EARTH THEREFORE
$$_{1}$$
 = . . . 10V $_{R}$ CURRENT CHARGES AND DISCHARGES CAPACITOR C IN THE INTEGRATOR GOVERNED BY THE RELATIONSHIP $_{C}$ $_{dT}^{dV}$ = . . $_{1}$ THEREFORE $_{2}$ 4V = . . = 10 $_{dT}$ C $_{RC}$ $_{dT}^{dV}$ = . . $_{1}$ $_{0}$

$$dT \qquad T$$

$$SO, \quad 1 = dV \times 1 = 10$$

$$T = dV \times 3V = RC V$$

Fig.4. A triangle/square wave oscillator.

A. Assume an output voltage swing at IC2 of \pm 10 V.

For
$$\pm$$
 1 V Hysteresis,
RA = RB
10
Let RB = 100k, then RA = 10k
Fo = 1 kHz = $\frac{1}{\Delta T}$ = $\frac{i}{i\Delta v}$ = $\frac{10}{CxRx4}$

Therefore CR =
$$\frac{10}{4 \times 1000}$$
 = 2.5 x 10⁻³

Let
$$C = 100n$$

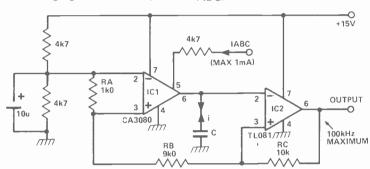
Then R =
$$\frac{2.5 \times 10^{-3}}{10^{-7}}$$
 = 25k

ΔV

Note that $\overline{\Delta T}$ is 4000 V/sec. When designing this type of oscillator the slew rate of the integrator and Schmitt trigger need to be considered, although tin this case virtually any op amp will be OK.

Linear VCO

A linear voltage controlled oscillator (VCO) is shown in Fig.5. This again is a triangle square wave oscillator although the squarewave is the only buffered output. The CA3080 is used as a current source for charging and discharging C. The charging current is equal to IABC, which is true for several



CURRENT : THAT CHARGES C = + 1ABC
VOLTAGE AT PIN 3 IC2 IS A 6.5Vpp SQUAREWAVE
THEREFORE, THE TRIANGLE WAVEFORM IS ALSO 6.5Vpp
EQUATION FOR CHARGING C,

* IF C = 680p, IABC = 250uA,

THEN Fo = 250 x 10 ^ = 28.28 kHz 680x10 12 x6.5x2

Fig. 5. A linear VCO.

decades of current. The Schmitt trigger uses a TL081 which has a slew rate of 13 V/uS. As the squarewave output voltage is 13 V then the rise and fall times are 1 uS each. This enables the VCO to run at frequencies up to 100 kHz. As this frequency is approached the VCO loses its linearity, due to time delays in the circuits.

Another VCO is shown in Fig.6. This has two buffered outputs, a triangle and a square wave. Again, the oscillation frequency is dependent on the output voltage swing of the Schmitt trigger, IC2. However, if a stabilised power supply is used this circuit behaves very well. Superior performance can be obtained by replacing Q1 with a switching FET. The abberations caused by saturation voltage and storage time are then removed. Also fast FET op amps will improve high frequency performance.

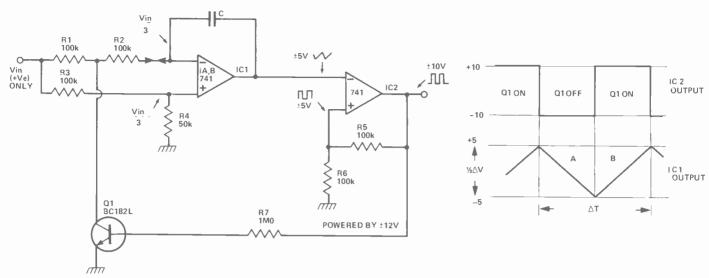


Fig.6. A linear triangle/square wave VCO.

The 555

The 555 timer chip (Fig.7) can be used as an oscillator (Fig.8). Capacitor C is charged up via RA and RB. When the voltage at pin 6,2 reaches 2/3 Vcc the discharge transistor is turned ON. When the voltage falls to 1/3 Vcc the discharge

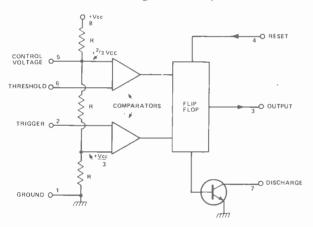


Fig. 7. The timer chip.

transistor is turned OFF and the charging process repeats itself. As power supply voltage terms appear in both the numerator and demoninator of the charging equation, it drops out and so the oscillation frequency is hardly effected

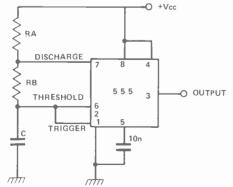
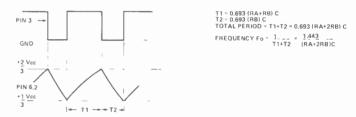


Fig.8. A simple oscillator based on the 555.

by supply voltage changes (typically 0.3%V). Also the temperature stability is good, typically 50 ppm/°C.



A low power 555 oscillator is shown in Fig.9. This employs a CMOS version of the chip which consumes a mere 120 uA. Capacitor C is slowly charged by current i and rapidly discharged by Q1.

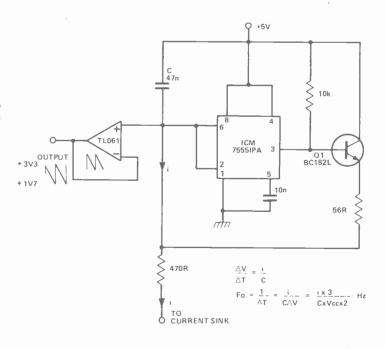


Fig.9. A linear VCO built around the ICM7555, the CMOS 555.

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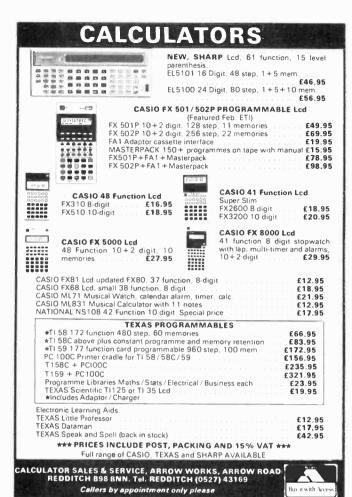
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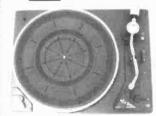
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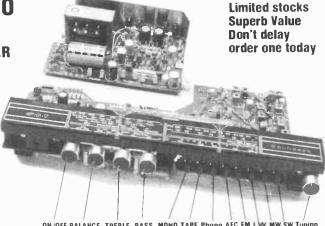
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INFRA-RED REMOTE CONTROL

This concluding part of our IR60 remote control project covers construction of the transmitter and setting up the system.

he transmitter circuit is constructed on two PCBs, a single-sided board being used to hold most of the electronic components and a double-sided board being used to hold the matrix of 16 keypad switches. The double-sided board is best tackled first.

The double-sided PCB has 16 pin-through connections, which are used to connect the tracks on different sides of the board and to make external connections. Start construction by fitting Veropins through these 16 positions, remembering to solder the pins on both sides of the board where appropriate. Next, solder diodes D1 to D4 into position on the PCB and then solder the bodies of the 16 keypad switches into place: the switch caps and bezels can now be snapped on to the switch bodies.

The completed keypad assembly can be mounted to the front panel of the transmitter case (see Buylines) via four 12mm x 6BA-tapped stand-off pillars, after first providing a suitable cut out in the front panel. Use ¼ inch 6BA screws to fix the four pillars to the PCB, then pass the keypad through

the cutout so that the switch tops protrude slightly and finally epoxy the four pillars to the back of the front panel.

The single-sided PCB can be built next. First, insert all Veropins and the single wire link. Next, fit the resistors, IC socket, semiconductors, capacitors and L1. Note that C1 is a PCB-mounting capacitor with its legs bent at right angles so that it lies flush on the PCB. The completed board can be fitted in the case with stickypads.

The two infra-red transmitter diodes can be fitted next. They are mounted through the back of the case, approximately 32 mms apart. Take special care to fit these diodes in the correct polarity.

The final stage of construction is the inerwiring of the two boards and the LEDs, etc. Take special care here, particularly when wiring the switch board to the main circuit. The battery is wired directly to the transmitter circuitry and can be fitted into the case with stickypads.

When construction is complete, activate each of the 16 keypad switches in turn and check in each case that the front-

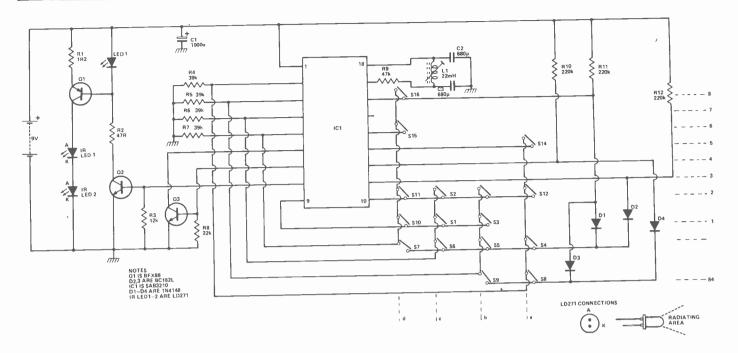


Fig.1. Circuit diagram of the IR60 transmitter unit.

HOW IT WORKS

The heart of the transmitter is IC1, a highly sophisticated P-MOS LSI chip. This chip receives input 'instructions' via an 8-row (pins 9 to 16) by 4-column (pins 2 to 5) matrix that can be activated via contact 'key' switches. The circuit is 'clocked' at about 60 kHz via the R9-L1-C2-C3 oscillator when the IC is

When the transmitter is in the quiescent state the IC is disconnected from the battery via turn-on transistor Q3 and the complete circuit (including the clock oscillator) is de-energised. Under this condition the entire circuit draws a total leakage current of only a few microamps from the supply battery. When any of the key switches are actuated, negative potential is applied to one of the 'row' pins via one of the R4 to R7 resistors and pin 7 goes high and turns Q3 on, thus energising the IC and its clock oscillator.

Whenever the IC is energised via a key-switch operation a keyboard scanner comes into operation, detects the 'code' of the actuated key and converts this information into a clock-related serial output code that appears on pin 8. This serial code signal is fed to the infra-red transmitter LEDs via Q2 and Q3.

The transmitter serial code is rather unusual. It consists of a start bit, followed by six information bits, which are read out in biphase code at half the clock frequency. 'Biphase' in this case means that a 'bit' prior to a clock reference point is read as a '0' and a 'bit' after a clock reference point is read as a '0' and is repeated at a time-base rate of about 130 mS throughout the duration of a key press. When the instruction key is released a single seven-bit 'end of signal' code frame is transmitted and the transmitter is then automatically deactivated again via Q3.

The serial output code from pin 8 is amplified by Q2 and is used to pulse constant-current generator Q1 on and off via R2 and LED 1. Q1 feeds 'on' pulses of several hundred milliamps to the two series-connected infra-red transmitter LEDs, this high current being supplied via storage capacitor C1. Although the PEAK IR LED currents are very high (thus ensuring a good operating range), the MEAN IR LED currents (averaged over one time-base period) amount to only 5 mA or so.

Considering that the transmitter will normally only be required to operate for about half a second per instruction, it can be seen that roughly 100,000 instructions can be transmitted from a single PP3 can be expected to transmit 250 instructions per day for roughly a year. Clever?

panel LED illuminates, indicating that a code signal is being transmitted. If the LED does not illuminate, re-check the circuit wiring.

Setting Up The IR60 System

When construction is complete, set the adjustable core of L1 in the transmitter and in the receiver to mid-position, place the transmitter a metre or so from the receiver and alternatively operate transmitter buttons 1 and 2. With luck, receiver relay RLA will switch alternately on and off, indicating that the system is functioning correctly. If this action is not obtained, try twiddling the core of L1 in the receiver. If you still have no luck, use a 'scope to see if a coded signal is reaching the output of Q1 in the receiver: if not, recheck the transmitter circuitry and the polarity of IRD1 in the receiver.

Once you've got the system working, adjust L1's core in the receiver to find the extreme positions at which control is lost, then reset the core to half way between these two positions. You can then adjust RV1 in the receiver to obtain maximum possible range consistent with reliable operation: our prototype system gives a range of about 15 metres.

Finally, you can use a 'scope or voltmeter to monitor the individual outputs of the receiver while you check that they can be controlled via the transmitter buttons in accordance with the information given in Tables 1 and 2 last month. Your system is now complete and ready for use.

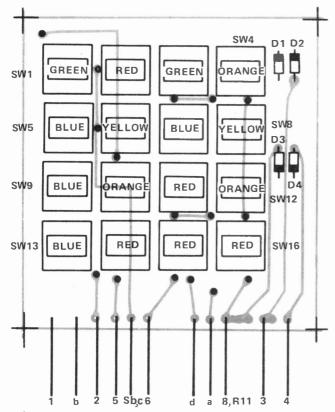
BUYLINES.

The case for this project was chosen from the BIM Console range supplied by Boss Industrial Mouldings Ltd. (order code BIM6005

A full kit of parts including the Mec switches (order SRM plus switch cap colour) can be obtained from Watford Electronics.

Ambit International are suppliers for L1, order as 87BN, 22 mH.

The SAB3210 transmitter IC is available from Electrovalue and Watford.



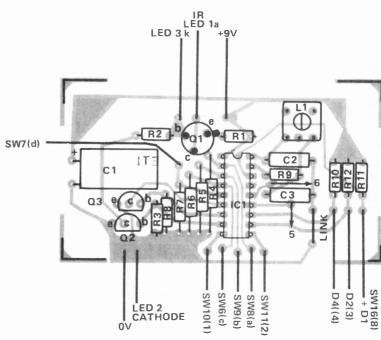


Fig. 2. (left) Component overlay for the control board.

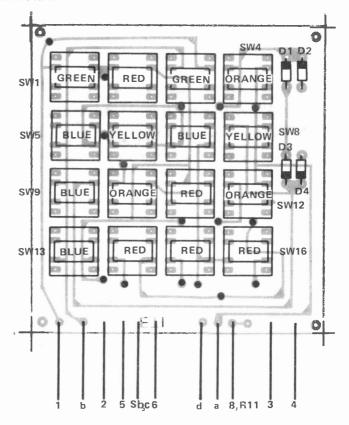
Fig.3. (above) Component overlay for the second board.

e.g. GREEN INDICATES COLOUR OF SWITCH CAP

= PIN THROUGH

PARTS LIST

Resistors				
R1	1R2			
R2	47R			
R3	12k			
R4,5,6,7	39k			
R8	22k			
R9	47k			
R10,11,12	220k			
Capacitors				
C1	1000u 16V electrolytic			
C2,3	680p polystyrene			
Semiconductors				
IC1	SAB3210			
Q1	BFX88			
Q2,3	BC182L			
IRLED 1,2	LD271			
LED 1	0.125" dia. red LED			
D1,2,3,4	1N4148			
, - , -				
Miscellaneous				
SW1-16 momentary	switches (see Buylines), PP3 battery,			
	1 22 mH variable, Mec switch cap colour:			
green(2), red(5), orang	ge(2), blue(4), yellow(2).			



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NOTE for use with 4 to 8 ohms speakers.

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RAVEN ON

Dave Raven takes the lid off his domestic computer scene and sounds alarm bells for the British computer scene.

owards the close of 1979 it was announced in China that they had developed high speed emitter-coupled logic circuits that will permit construction of a super computer capable of 20 million operations per second. This is equivalent to ten times faster than any device they have produced to date. It was also announced that they would be

exporting computers in the future.

Since this piece of breathtaking information must, by now, have brought you to the edge of your chair I will concentrate the mind further. The significance of China's declaration to enter the international computer market would be lessened if viewed in complete isolation and certainly does not pose any immediate threat to the western computer manufacturers. When, however, it is considered along with that of other emerging nations like Brazil, India and South Africa, who are all eager to develop independent computer industries, it serves to illustrate how different the international computer market will look at the end of the 1980's.

The USA, Europe, Japan, USSR and China will all be aiming to produce computer equipment for their 'in-house'

requirements and also capture export markets.

The potential military role of computers is of major significance. However, other sectors of high technology such as telecommunications, aircraft, satellites and nuclear industry are all critical to the maintenance of an industrially based military complex.

Backing Britain

The ability of Britain to maintain our industries in all the above technological areas is vital if we wish to remain independent and it would surely be crazy if we were to waste the years of experience built up in this country in high technology only to import computers made in Brazil or China. Japanese computer manufacturers are already embarking on a long term programme to penetrate the USA computer market. This will be accomplished in much the same way as the establishment of cars in the UK; with good service centres and software requirements fully catered for.

In Britain, after seeing the end to our industry for manufacturing small motorbikes, we are now witnessing a slow takeover of the (cheap) family saloon market. Consumer electronic goods is of course well underway with virtually all the UK manufacturers killed off. Remaining are a few TV producers that will be fighting for their lives now that the PAL patents protection is soon to be lost.

The Video Story

Video Recorders could well reach the sort of sales levels which have been achieved by Colour TVs during the next ten years, since everyone with a TV has an application for a recorder. Guess how many of these quite straightforward pieces of hardware will be made in Britain, 12 million? 5 million? 1,000? How about 100? Sorry, not ONE. With the exception of a few home made models built in garden sheds and by lost souls in university development labs.

Watch This Space

Having debated involving myself in small computers for the last two years, I have at last purchased a home computer. The significance of this is that it is intended primarily for home use and, therefore, had to compete with other domestic demands on my home budget, as distinct from a business expense.

The decision to buy a home computer is not to be taken lightly, even at the knock down price of under £400, since this must be compared against other competing products which are just as attractive. My desire to buy a video recorder has not receded and the demands made by my wife for £400 worth of (quite unnecessary) furniture still continue. So what was the final overriding reason that made me rush out and buy a small computer?

Like most enthusiasts of electronics I usually desire new electronic goodies quite early in their evolution and home computers were to be no exception. All the products I have bought to-date such as TV games, digital watches, calculators etc, have all had clearly defined uses. However, a computer takes just a little more justifying as the following script shows:

Picture this domestic scene

Freak "Darling I have decided finally to buy a home computer".

Wife "That will be nice dear".

Freak "I have come to this decision after many months of careful thought and feel it will bring a greater understanding between man and machine. The involvement of the human brain with a computer will expand our memory capacity allowing us to be more creative thinkers".

Wife "That will be nice dear".

Freak "Through the tips of my fingers will be unleashed a storm of interlectual and statistical power man has not previously enjoyed. It can be incorporated with art, music, science, finance and with imagination it will probably iron my shirts".

Wife (looking slightly more interested) "That will be nice dear".

Freak (now standing looking out of the window with a glazed look on his face) "With the right level of software and peripherals it could organise many of our daily needs. A telephone link would enable it to order the shopping. Cooking, cleaning and remembering birthdays could all be carried out with the aid of a little robotics".

Wife "Darling is everything alright?".

Freak (not hearing) "With the right robotic design it could develop a human form. Feelings of compassion and warmth could be available to me at the press of a button. Love and understanding always there to satisfy my every whim".

Wife "But if the computer can be made to do all these things what will be my place in your life?".

Freak (now facing wife with manic expression) "And it all costs less than £400!"

The most frequent question asked by the few remaining people that have not yet bought a computer (sic) is - "What does one use it for?". Well, after going around the houses a few times, I can - with a little arm waving - come up with

quite a convincing answer.

Life will of course continue without small computers. However, I doubt if small businesses will after a few more years. The pressures from larger competitors who use all the latest tools to beef-up their profit margins will force smaller competitors to follow suit. Don't ever kid yourselves that small companies are cheaper to operate. It requires nearly the same sized operation to print this one magazine as it does to print half a dozen. Ask the Managing Director of Modmags, if you don't believe me. Small computers can be used to speed the flow of management information required on a daily basis. They can put off the day when it is necessary to increase the size of office premises and produce more output without increasing staff numbers (not a bad objective when one considers that the birth rate is declining in Britain).

Joining The Revolution

Having extolled the virtues of computers and my fears that Britain may not enjoy the full fruits of their manufacture, I am rather excited by the future prospects of our own Prestel system. For once this very British innovation cannot easily be pinched and sold back to us at a cheaper price since it consists of a system rather than a single manufactured product.

My grateful thanks to Rediffusion Manager Tim Jaggard for allowing me to be present at a demonstration of both the Teletext and Viewdata systems. I must openly confess that although I am aware that much has already been written about these new systems, I have previously found it difficult to muster any interest. Perhaps this is because I am more familiar with Teletext, which interesting and useful as it is, remains an extention of the more traditional information services.

Clearly consumers in the next few years will demand Teletext as a standard on their TV sets in the same way that colour is now required. Viewdata (or Prestel), however, is a different ball game which links together a domestic telephone with the television and converts this to a traditional video display unit as used with a computer. At the press of a button connection is made through the GPO exchange to indpendent organisations who contribute information directly from their own offices.

The Post Office, who provides the Prestel computer and exchange equipment are not involved in editing or interfering in any way with the material supplied to the subscriber. The computer is capable of providing over one million pages of information which can also be of a highly confidential nature and only available to subscribers who have access to a certain code — for example, private company information to members of staff, bank statements, credit checks on potential customers for loans. On the direct selling side it is possible for subscribers to book tickets on planes, ships and trains using their credit cards. The possibilities for mail order are endless with customers buying directly after seeing TV adverts and not even leaving their front room.

Small Viewdata printers are available producing a hard copy of what you see on the screen. This is all British, you have to remind yourself, and according to the Post Office by 1986 Prestel services would be called on by 95 per cent of telephone users. One other interesting observation is of the uses which may be made of the three as yet unused Viewdata channels. I cannot see the problem in providing software and memory for use by the consumer - which would rapidly make redundant all the small home computers.

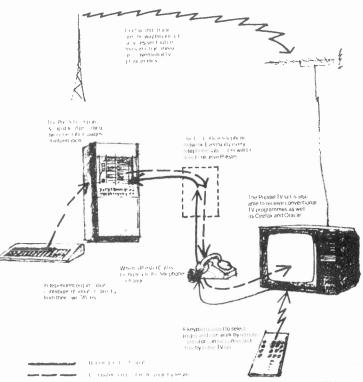


Fig.1. Ceefax and Oracle are broadcast in the same way as TV programmes. Prestel allows independent organisations to put information in. You receive it by telephone and the information is available on your telly at the touch of a button or two.



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SL 1620	2.50	SL6600	4.31
SL1623	2.80	SL6640	3.16
SL1624	3.77	SL6690	3.68
SL1625	2.50	MC1496	1.44

VARICAP DIODES BA102 BB105 BB109 0.31 KV1225 25v tri MVAM2 1.93 BB212 9v dual



POWER MOSFETS 100W PA's made simple

Since pioneering the 100W complementary MOSFET technique. Hitachl have developed a range of output devices and drivers that ought to revolutionise opinions and attitudes towards the design of all LF amplification systems. We have a new 48 page application note [£1.50 inc) and complete sets of parts, modules and now the new complete PA system (see above).

25K133 120v N-ch 100W MOSFET £6.33 2SJ48 Pch complement £6.33
25K135 160v N-ch 100W MOSFET £7.29 2SJ50 Pch complement £7.39
PA101B Kit for 100W MOSFET PA less Heatsink £16.10. (£23 inc heatsink/bkt)

ULTRA LOW NOISE PU PREAMPLIFIER

The HA12017 is the last word in PU preamps, and general low noise audio design. It is an SIL IC, with 86dB S/N in R1AA configuration, 10v RMS output capability, 0.002% typ THD at 10v RMS output (imagine the overload margin !!). It comfortably supercedes discrete circuit designs in terms of price/performance, and takes the art beyond the TDA1042's capabilities. (Replaces HA1457) £1.80 each or an RIAA applications PCB with two ICs for £5.75. Complete with Rs&Cs £9.95.

Radio Control ICs We have various RC ICs, including NE544 NE5044, and two new ones from OKI KB4445 4 Channel dig.prop. FM TX IC. 30mW out (amplifyable) £2.30 inc
 KB4446 4/5 ch. dig. prop FM RX IC. Suits KB4445 or RCME syst. £2.65.
 KB4445/6 pair: £4.75. New 8 page data sheet 35p + SAE. More RC ICs in list

CMOS, LPSNTTL, TTL, MPU: Listings in the new pricelist.

Most CMOS is available in low volume - also LPSN, Standard linears and TTL OK.

Things like ICM7216B, ICL8038, 8080A, 6800P, 2708, NE555, NE556, etc

Coming Soon........... Contain yourselves, RF fans! Not yet ready for a hill launch until autumn, but previewed here:

SSB transceiver system : 10kHz to 1000MHz !!

A modular VLF to UHF SSB TX/RX system at last. With the correct first mixer, the basic PCB covers 10kHz to 1000MHz - using LO fed from ext. source (Our 2 IC Mullard synth for instance and RF PA for TX OP 0.2 uV basic sensitivity in HF. Typ cost for HF synth SSB RX will be less than £200. Add an RF PA for full TRX for another £50. See one in our foyer, and marvel.

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LW-MW-SW-SW DC tuned and switched

91072- All switching of bands by a single pin to gnd. Varicap tuned, with LO output for synth. MW/LW version or MW/LW plus 1 or 2 SW bands MW/LW: £15.58

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Pilot Cancel PLL Stereo decoders

Again, Europe's widest range of stereo decoders including pilot cancel PLL types. The pic shows the 944378 - pilot cancel including post decoder a pilot cancel including post decoder the pilot cancel pilot pilot cancel pilot cancel pilot p 26/38kHz filtering and muting preamp output

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Broadcast FM IF strips for all occasions, including the new 911225 Broadcast FM IF strips for all occasions, including the new 911225 - with diode switched narrow filter option, ultra linear phase ceramic filters, 8ddB S/N, and 0.04% THD (40kHz deviation). Plus usual things like AGC, AFC, dev. mute, level meter drive. £23.95 (supplied in screen can with 0.1 edge connection system). Also the 7230 hyperfi series - as the 911225, but with slope controlled AFC that operates in conjunction with signal level and an extra IF amp stage for DXing.

Various digital frequency displays

The World's largest range of receiver DFMs is now joined by the DFM7 (shown) - and L shaped version of the DFM3 with remote display mount connector possibility . 1kHz SW resolution with 455kHz or 10.7MHz offsets, 100Hz res up to 3.9999MHz, VHF to 299.99 MHz in 10kHz steps : £41.75



944378-2 £26.45

Components

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Monolithic dual roofing filter 1.3dB loss, 80dB stopband HF first filter in synth. RX 34.5MHz

FM pairs (no spilts) AM pairs
USB/LSB Xtals for 10.7SSB filter £36.80 £3.74 £3.57 £2.88 ea

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Most popular types are available



10.7MHz

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at 15uA only. DVM 9v/1mA

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DRUM SYNTHESISER

At last, ETI's own machine which peecom-peecoms, bim-bams, whizeees or boo-coms in all its onomatopoeic glory. Here is Roger Shore's original design for



All 42 ways of the control board (above) are used. Cut a slot at pin 37 for identification.

ware for the project, which is a two channel synthesiser, forming a stereo output with the added facility of a monitor amplifier circuit to power a pair of stereo headphones (allow-

ing setting up of the synth without being overheard) comes to

around £60. This approximate price is inclusive of what we feel is a very nice housing (see Buylines) suiting the synthesiser down to a tee. A comparable price for a similar commercial unit is over £360 - OUCH.

The modular construction means that any number of channels can be built as required and perhaps the most enterprising of you out there can envisage a complete electronic drum kit of bass, snare, tom-toms, high hat and cymbals for about half the price of a standard kit. Of course the extra drum sounds of the synthesiser are also there as required.

The ETI Staccato is a mains powered device, none of those nasty batteries running out on you half way through a gig. A simple microphone or miniature loudspeaker acts as the trigger sensor and can be positioned inside an existing drum, on the underside of a simple wooden block or, as in the prototype, inside or underneath a practise drum pad. The drum pad is probably the ultimate as it means a permanent and compact method of holding the sensor whilst maintaining a goodlooking and functional appearance.

Also featured is a sensitivity control which adjusts for a very wide range of trigger sensors and levels which means that virtually any combination of microphone, or speaker and holder will trigger the synthesiser.

The ETI Staccato Drum Synthesiser

Our aim was to incorporate a systematic approach to interwiring connections, therefore providing a unit that could easily be expanded. The most favoured compromise combined three PCBs; a power supply unit and monitor board, controlcircuit and a function board which holds all PC mounting potentiometers, switches and LEDs for a single channel synth.

Begin construction by building the power supply unit and monitor PCB, insert all pins and wire links followed by IC sockets, resistors, diodes, capacitors and semiconductors. Next in line is the control circuit; follow the same procedure as above. Take care when you come to wire the edge connector as all of the 42 ways have been used right down to the last pin! A slot will need to be made at pin 37 of the circuit board

Construction

Before assembling the function board, it is wise to use it as a template for marking out the front panel. This will give a physical representation of the layout and will enable easy alignment of the potentiometers, etc after drilling. Mount all right angled, inter-PCB sockets (3 ways or 5 ways) around the edge of this board. Be sure to mount all potentiometers from the copper side of the PCB with their tags bent at right-angles. It is highly recommended that the specified switches are used (see Buylines) as they offer various switchable pinouts, especially in the case of SW3. To accommodate the switch bezel, a cutout of 14x14 mms is required. Finally to save any embarrassment whatsoever, check the orientation of all polarised components before switch on!

Now you've built the staccato drum synth how about joining a band? At least one hour's practice should put you 'on the road' — not necessarily to stardom!

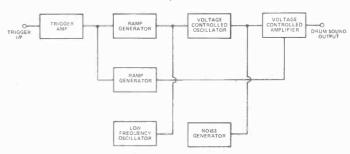
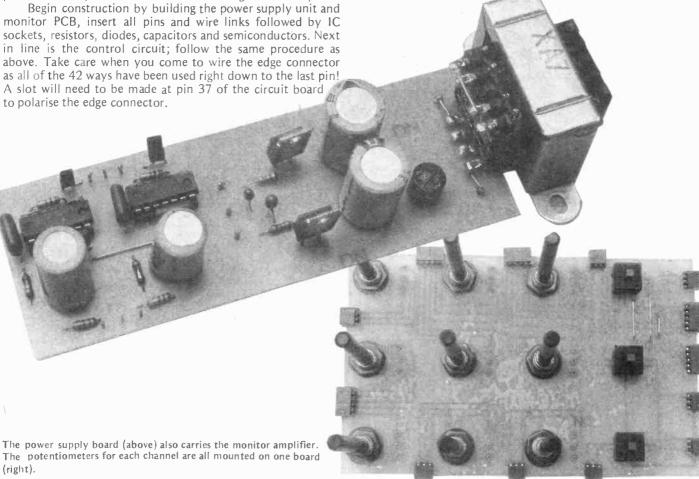


Fig.1. Block diagram of the ETI Staccato.



Setting Up

There are only three presets (RV5, 6 and 7) to adjust. Start by setting them all to mid-position then turn the noise control to minimum and switch the noise on. This effectively disconnects the sine filter from the circuit. Now switch the VCO to sine output. Switch the device on and adjust RV7 preset until a continuous signal is heard at the output. If an oscilloscope is available, adjust RV5 and 6 for minimum sinewave distortion. If no oscilloscope is available, simply adjust

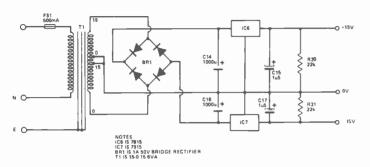


Fig.2. Circuit diagram of PSU.

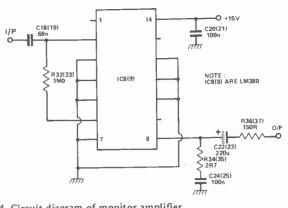
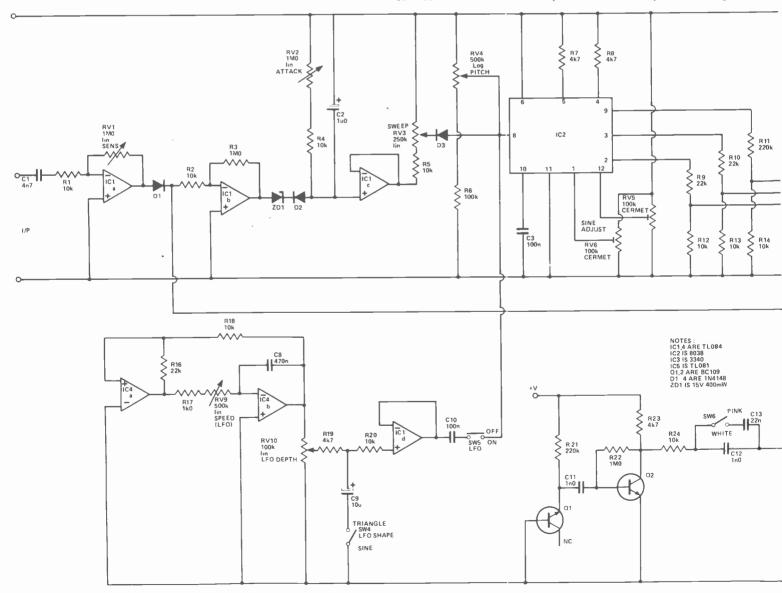


Fig.4. Circuit diagram of monitor amplifier.

the presets for minimum audible distortion. This may seem somewhat haphazard, but the human ear is very discerning where sine distortion is concerned! Once the minimum distortion position has been established, it only remains to adjust RV7 until the signal just disappears from the output and that's it!

Now, the golden rule is to experiment. Apart from the sounds for which the drum synth is well known, a whole range



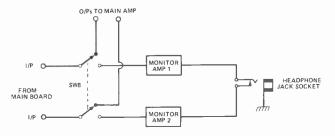


Fig. 5. Connecting details of monitor amplifiers.

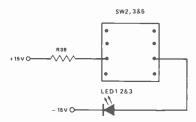
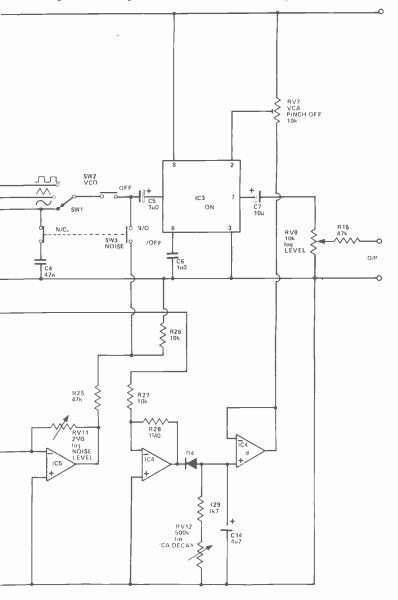


Fig. 6. Connecting details of switch LEDs.

Fig.3. Circuit diagram of the ETI Staccato Drum Synth.



of strange and wonderful sounds is possible, particularly if the LFO and noise generator are used. Vibratos, warbles, chimes and gongs are obtained using the LFO. Surf, wind, applause, snare drums and cymbals are obtained using noise.

HOW IT WORKS

The block diagram (Fig.1) shows the main principle of operation of the synthesiser. It can be seen very simply as a voltage controlled oscillator followed by a voltage controlled amplifier. This means that the frequency of the final signal and its amplitude ie its pitch and envelope, are controlled by DC voltages derived from the original trigger. Two separate ramp generator circuits provide these DC voltages and all necessary parameters of these ramps are externally controllable. A low frequency oscillator can be applied to modulate the VCO if desired and a generator produces noise for cymbal or snare sound, etc.

The voltage controlled oscillator is based on the 8038 waveform generator chip, IC2. Its frequency is varied by adjustment of the pitch control RV4, allowing the initial frequency to be set to the required level. Alternatively, the frequency can be controlled by a varying DC voltage applied via D3, from the VCO ramp to be described later. The oscillator works over the frequency range between about 10 Hz and 1k5 Hz. All three output waveforms available from the 8038, sine, triangle and square waves, are used.

The trigger for the synthesiser is provided by a microphone (virtually any microphone will do) fitted inside a suitable drum or holder, even a tin can will do! The signal from the microphone is differentiated by C1, R1, so that surrounding sounds do not cause false triggering. The pulse generated when the drum is struck is then amplified by IC1a, the gain being varied by RV1. The output of this amplifier is then rectified by D1 to provide a positive going pulse which is fed to further amplifiers IC1d and IC4c. These op amps are connected as inverting amplifiers to provide negative going pulses to drive the VCO and VCA ramp generators.

The anode of ZD1 is normally at zero volts and the cathode at +15 volts. When the output of IC1b is driven negative by a trigger pulse the cathode of D2 approaches zero. This negativegoing pulse is rectified by D2 and charges C2 rapidly. C2 discharges through RV2 and R4, the value of RV2 varying the rate between a few milliseconds and several seconds. This DC ramp is buffered by IC1c connected as a voltage follower, to prevent RV3 affecting the C2, RV2 discharge time. As both ends of RV3 are normally at +15 volts, D3 is biased off. When the output of IC1c swings negative on receipt of the trigger, D3 is turned on and allows the ramp waveform to control the sweep input of the VCO. RV4 sets the lower frequency of the oscillator and as pin 8 goes more negative, the frequency rises. The range of this frequency sweep is determined by RV3 whose setting limits the negative swing of D3 cathode. However, C2 charges quickly and discharges more slowly. The characteristic falling sine sound of the drum synth is created at the output of the VCO. By use of RV4 pitch, RV3 pitch bend and RV2 slope a whole range of sweeps are possible.

The voltage controlled amplifier is based on the Motorola 3340 voltage controlled attenuator IC. The selected output from the VCO is fed to the IC and the output is fed to the volume control, RV8. The voltage controlling input is fed to pin 2 via RV7, which is preset so that with no trigger present there is no output. The VCA ramp generator functions in a similar manner to the VCO ramp generator. The base-emitter junction of Q1 is reverse biased to provide the noise source. This noise is amplified by Q2 and further amplified by IC5 whose gain is variable via RV11, determining the noise level to be fed to the VCA input.

Notice that when the noise is switched in, the sine filter, C4, is switched out. This is to ensure that when noise and sine are used together, this filter does not attenuate the useful part of the noise spectrum required. Although this marginally increases the sinewave distortion this is not noticeable above the deliberately introduced noise.

The low frequency oscillator uses IC4b as an integrator and IC4a as a Schmitt trigger, together making a triangle wave oscillator. The speed is varied by RV9 between about 0.5 Hz and 1 kHz, and the amplitude is varied by RV10. C9 can be switched in to integrate the triangle wave to provide a sinewave approximation for vibrato effects.

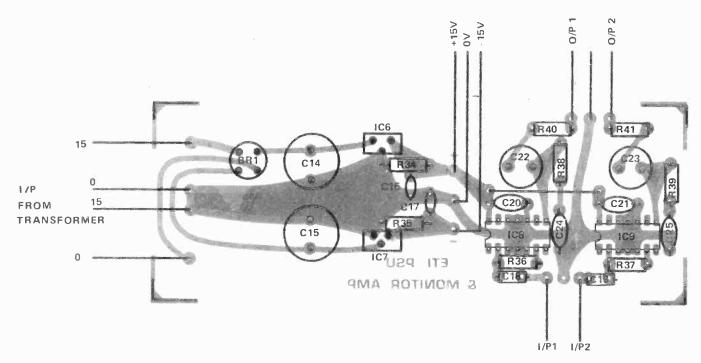
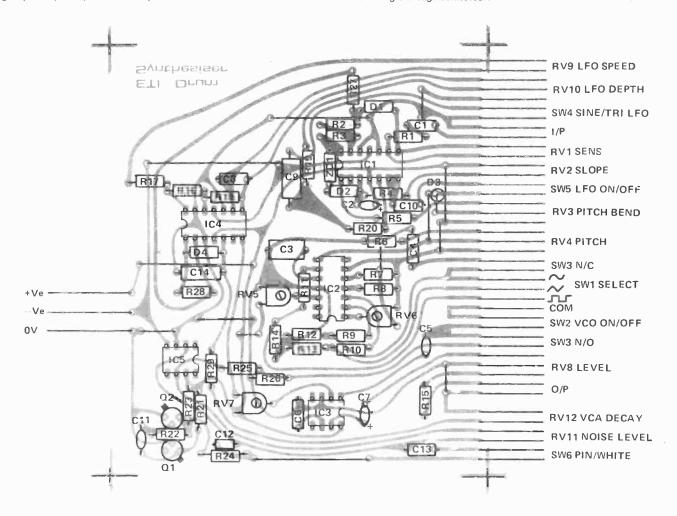


Fig.7. (above) Component overlay of the PSU and monitor amplifier board.

Fig.8. (below) Component overlay of the control circuit board. Take care when wiring the edge connector.



BUYLINES

A varied buylines, as certain components have been selected for easy construction. The exceptional case is part of a range (larger

easy construction. The exceptional case is part of a range (larger sizes available on request) supplied by Campbell Clarke Cabinets, 2 Arden Court, Church Road, Perry Barr, Birmingham, B42 2LF, Tel: 021-356-0890 — a very stylish wooden ended cabinet which is attractively priced at £11.50.

The MEC switches are only available from Watford Electronics (order code SRL plus colour of switch cap) along with the knobs. Also state cap colour when ordering the knobs. The micro toggle switches can be-purchased from Marshall's. Electrovalue stock the PC mounting potentiometers. For the inter PCR value stock the PC mounting potentiometers. For the inter PCB sockets, plugs and shells, Technomatic are suppliers. Our Remo practice drum pads were obtained from The Rhythm Box (Drum Store), 5 Denmark Street, WC2 8HLP, Tel: 01-240-3836. A crystal insert fits neatly inside these pads and acts as the trigger

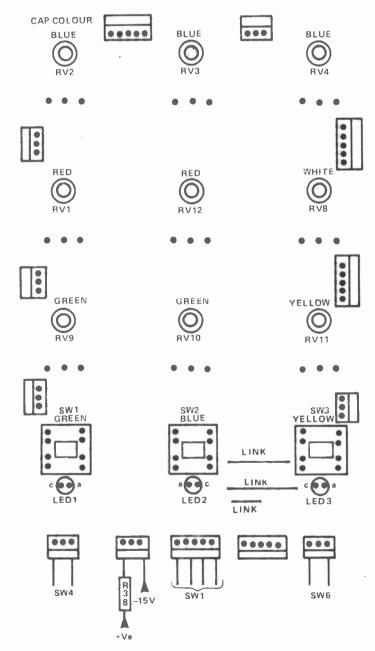


Fig.9. Component overlay of the function board.

DADTS LIST

PARTS LIST					
Components For One (Resistors R1,2,4,5,12,13,14,18,	Channel				
20,24,26,27	10k				
R3,22,28	1M0				
R6	270k				
R7,8,19,23,25,29	4k7				
R9,10,16	22k				
R11,21	220k				
R15	47k				
R17	1k0				
R38	2k2 1W				
Potentiometers RV1,2 RV3	1M0 lin PCB mounting 250k lin PCB mounting				
RV4 RV5,6 RV7	500k log PCB mounting 100k miniature horizontal cermet preset 10k miniature horizontal cermet preset				
RV8	10k log PCB mounting				
RV9,12	500k lin PCB mounting				
RV10	100k lin PCB mounting				
RV11	2M0 log PCB mounting				
Capacitors C1	4n7 polycarbonate				
C2,5	1u0 tantalum 35V				
C3	100n polyester				
C4	47n polyester				
C6,11,12	1n0 polycarbonate				
C7	10u tantalum 35V				
C8	470n polycarbonate				
C9	10u 25V electrolytic axial				
C10	100n polycarbonate				
C13	22n polycarbonate				
C14	4u7 16V electrolytic				
Semiconductors IC1,4	TL084				
IC2	8038				
IC3	3340				
IC5	TL081				
D1-D4	1N4148				
ZD1	15V 400 mW				
Q1,2	BC109				
Miscellaneous	0.125" dia red LEDs				
SW1, DP 3 position slide switch (one pole used only) SW2,3,5, MEC 2 N/O, 2 N/C latching push button (see Buylines), SW4,6, SPST micro-miniature toggle, 43-way edge connector, 8 x 3-way right angle inter PCB connectors including plugs, sockets, shells, 5 x 5-way right angle inter PCB connectors including plugs, sockets, shells, case (see Buylines), 9 knobs, input and output sockets, 4 6BA tapped spacers (length), 4 6BA plastic spacers, trigger sensor, drum pads (if required), MEC switch cap colour green, blue and yellow, knob cap colour 3 blue 2 red, 2 green, 1 white, 1 yellow for a single channel drum synth.					
Additional Component Resistors					
R30,31	22k				
R32,33	1M0				
R34,35	2R7				
R36,37	150R				
Capacitors C14,16 C15,17	1000u 25V PCB electrolytic 1u0 16V tantalum				
C18,19	68n ceramic				
C20,21,24,25	100n polyester				
C22,23	220u PCB electrolytic				
Semiconductors IC6 IC7	7815 7915				
IC8,9	LM380				
BR1	1A 50V bridge rectifier				
Miscellaneous T1 15-0-15 6VA tran FS1 500 mA fuse, ste cable.	sformer, SW7,8 DPDT miniature toggle, ereo jack socket, length of 3 core mains				



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1 - Aux (40mV)



L81 10W MEGAPHONE

Power: 10W Range: | mile Batteries: 6 - 12V



A60 SHOULDER PA SYSTEM



Power: 5W RMS, Range 4 mile Batteries: 6 - 12V

83 MEGAPHONE (SEP. MIKE)

Power: 16W, Range: ½ mile Batteries: 8 - 12V



A56 50W A.C./D.C.

All Salid State Power: 50W RMS S.N.R.: 55dB Rotary & Slider Controls V.U. Meter

Inputs: 3 - Mic (0.5mV)

1 - Mag Phono (3mV) 1 - Aux (200mV)

The A-56 is a SOW A.C., D.C., all silican solid later P.A., amplifier. Its outstanding performance and versatile operating features make it ideal for use in a wide range of applications, such as in schools, factories, restandant and shapping camers. The amplifier is shaped in any epithible matel cubiert, well complicance with a black and silver han facile panel. I few inspections integrated and integrated consistent in the first of their paints of the complication of the consistence in the first of their paints of the complex of the consistence in the first of their paints of the complex of the consistence in the first of their paints of the complex of the consistence in the consistence of the consistence o

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1 - Mag Phono (3mV) 1 - Aux (200mV)

Designed and develaged to meet - and surgasis - European performance standards, this P.A., amplifier boasts a power handling of 175 W (R. N. S.). It is protected against a share circuit couplar and increme battery connections. Such of the feet input channels has it there recovery point or and and individual sides with operating FLA/I/O filters. Overall Bass and Treble levels are st by siltic controls; overall volume levels is abstained by observing the inset? V. U. meter and operation of the extra large Moster control. Operation is from A.C. mains or from 24V D.C. 4 largus are los impedance with a flav insatistivity, magnetic phosin injuried accepts signation from two. The proposal control of the contr

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M48	ELECTRET PAGING, CARDOID. (CAST BASE) - 600 OHM	£26.22			
M50	COMMUNICATIONS, OMNI-DIRECTIONAL. (HAND HELD) - 600 OHM	€ 6.90			
		B=-			
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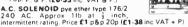
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MICROFILE

Henry Budgett leafs through the latest Vero catalogue to case his computer collection.

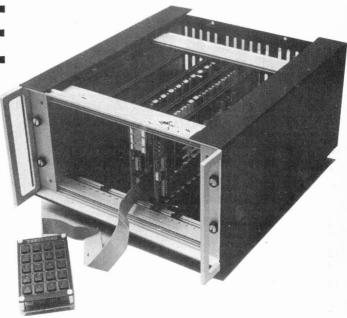
elcome, once again, micro-fans to the world of small systems. I see that the ZX 80 topped the ratings for interest value last month, more on that in just a minute. Our busy network of spies has been burrowing deep into the fabric of both government and industry to bring you the following news items at great personal risk.

Micros For Schools

A mole, deep within the echelons of the Department of Industry, has revealed the existence of an intrepid plot to give microcomputers to schools. Naturally there is a catch, or 22, you have to enter a competition. Seriously though, a competition – in essay form — will be shortly announced for secondary schools with, currently, 100 British micros as prizes. Talks are being held with local industry and banking institutions in the hope that more finance — and hence more prizes — will be forthcoming. Your Headmaster should have received details by now and a full Press release will shortly be given so watch this space for further details wild horses wouldn't make us reveal what system is being considered!

The Case For Nascom

One of Microfile's more intrepid investigators recently emerged, smiling, from the latest Vero catalogue. It seems that the range of parts is so vast that you can box and house anything. The outcome of this is that if you order a 3D-N card frame you will be able to house your Nascom (1 or 2) for a mere £24.28. Added extras, such as modules, card fronts, Veroboards, edge connectors and a whole lot more can also be purchased along with a nice case to fit round it all.



Also discovered, and now in full-time use, is a card frame/case to house a Tangerine system along with all the extras such as a module to fit the necessary power supply into. This is a half width, extended System KM4C with card guides for International boards (whew). The same frame can also take Acorns by fitting Eurocard guides and an indirect connector plate. Subtle stuff all this, and much more fun than just asking for "the box"!

Research Into Sinclair

It appears that the author of this column may have been led a trifle astray during his research into the insides of the ZX 80. Shortly after the issue hit the streets a letter arrived from Clive Sinclair which refuted a number of points raised in the item. Here, in its entirety is the letter and readers who seek a fuller insight into the workings of the machine should either stifle their impatience or rush out and buy a copy of June Computing Today, which contains a full review.

Dear Mr. Harris,

The news item in the Microfile column of your April issue says some nice things about our ZX80 computer, for which many thanks, but unfortunately there are one or two errors of fact which I would like to correct.

The first is that the operating language is not Tiny BASIC but quite a powerful true BASIC with, we believe, better editing facilities and greater speed than any of our competitors.

Again, contrary to the news item the ZX80 has full machine code facilities. Although it is true that RAM extension is limited to 16K bytes, this is no small quantity when the tight packing the ZX80 achieves in its RAM is considered. Indeed, I suspect that more lines of BASIC can be accommodated on the ZX80 than on any of the competitors, all of which cost several times the price. At the other extreme the excellent Hewlett Packard machine costing around £3,000 accommodates a maximum of 32K bytes of RAM.

The final remark in the column doubts the practicality of adding new ROM's, extra languages and discs to the machine on the grounds that "the CPU is already rather overworked". The only thing the CPU does in our machine which it does not do in others is to drive the display, thereby saving integrated circuits, board area and costs, which is reflected in our selling price. It is not "overworking" the CPU in any sense as it would otherwise be idle during the display period.

A new plug-in ROM will soon be available at an additional cost of around £20, extending the maths, capability of the computer to include log, and trig, functions, and also increasing the data handling capacity and incorporating a floppy disc facility.

Yours sincerely, Clive Sinclair.

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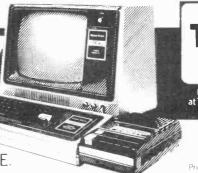
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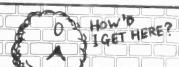
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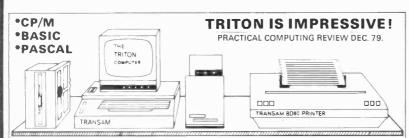
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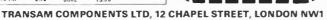
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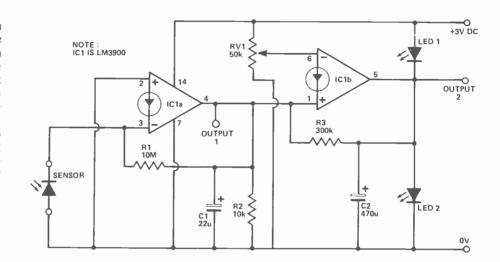
TECH TIPS

Light/Temperature Indicator

M Miller, Reading

Using half a LM3900 quad Norton amplifier, either light or temperature can be monitored with this device. In the light monitoring mode a reverse biased LED was used (a clear type, not opaque) at output 1. The light value can be measured with a high impedance voltmeter, approximately 0-30 V FSD

RV1 sets a threshold voltage to IC1a, so that either LED 1 or LED 2 will be on depending on whether output 1 exceeds the threshold voltage or not. In the temperature mode a 1N4148 diode was used, also reverse biased. Any small glass diode can be used. The amplifier outputs are the same as in the light monitoring mode.



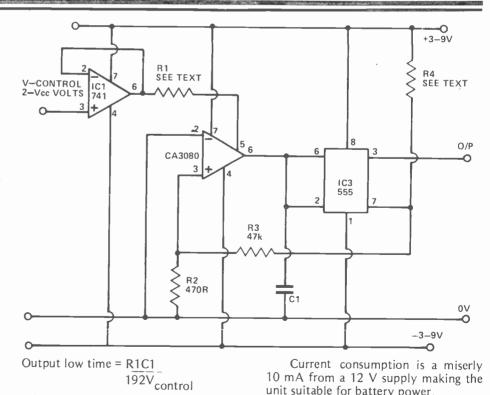
555 Voltage Control

S Draper, Lincoln

his circuit was developed to provide a cheap, reliable and accurate voltage controlled oscillator. It uses readily available components and the control over mark-space ratio common to other 555 circuits is retained. Frequencyvoltage response is linear over approximately one decade making the circuit useful in timing applications. Operation is as follows:

IC1 buffers the input voltage and produces the control current for IC2. IC2 is an operational transconductance amplifier and produces an output current proportional to the control current multiplied by the differential input voltage. This output current is used to charge and discharge the capacitor C1 in the normal way. The equation for output high and output low times are given

Output high time = R1C1(47.5+R4) 9024 V_{control}



unit suitable for battery power.

18 k.

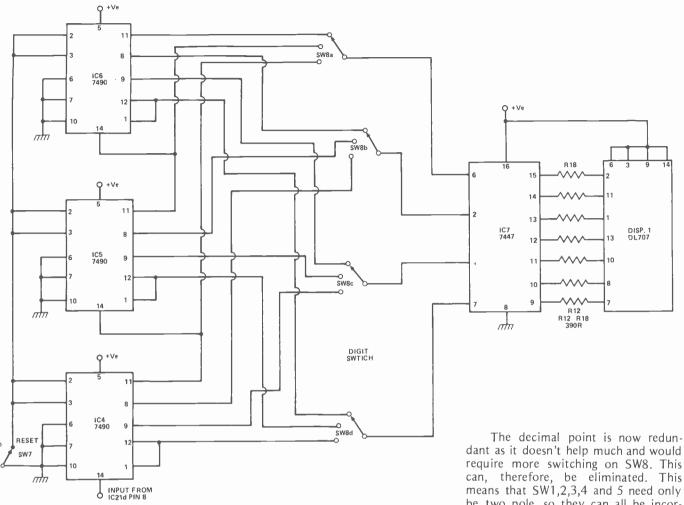
N.B. - R1 should not be less than

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

ETI is prepared to consider circuits or ideas submitted by readers for this page. All items used will be paid for. Drawings should be as clear as possible and the text should preferably be typed. Circuits must not be subject to copyright. Items for consideration should be sent to ETI TECH-TIPS, Electronics Today International, 145 Charing Cross Road, London WC2H 0EE.

where all resistances are in kilohms and

all capacitances are in microfarads.

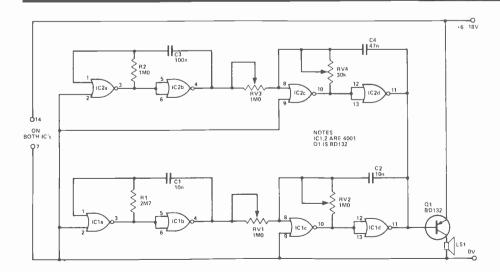


DFM Mods R Lea, Amersham

This is a simple, cost reducing modification to the DFM published in ETI June 1977. The need for three decoders and displays has been reduced to one.

The outputs from the counters (IC4-6) are switched via SW8 to a single 7447 decoder (IC7) driving a DL707 display. In use, the 'test' button on the original unit is pressed. When counting is complete, SW8 can be cycled through the digits to obtain a reading.

dant as it doesn't help much and would require more switching on SW8. This can, therefore, be eliminated. This means that SW1,2,3,4 and 5 need only be two pole, so they can all be incorporated one 2p 6w rotary switch, further reducing cost. These two modifications do make the meter slightly less convenient in use, but this is outweighed by the reduced cost. To modify the existing PCB the tracks to pins 1,2,6 and 7 of IC7 are cut and it is then a simple matter to insert SW8 as shown.



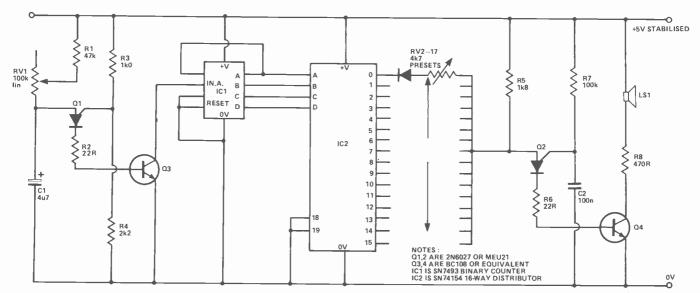
Sound Effects Unit

P Layzell, Sandy

This circuit consists of four CMOS oscillators gated together in a configuration that will produce a multitude of effects from white noise to a multibanked Trimphone.

Each IC is connected as a warble tone generator and mixed together at the base of Q1. LS1 can be from 8 – 100 R, but the transistor tends to get a bit hot below 30 R, so a small heatsink may be needed.

None of the component values are critical and if desired, RV1,3 can be replaced by ordinary resistors without affecting the variety of sound effects too much.



16 Note-Sequencer

P Gatehouse, Buckingham

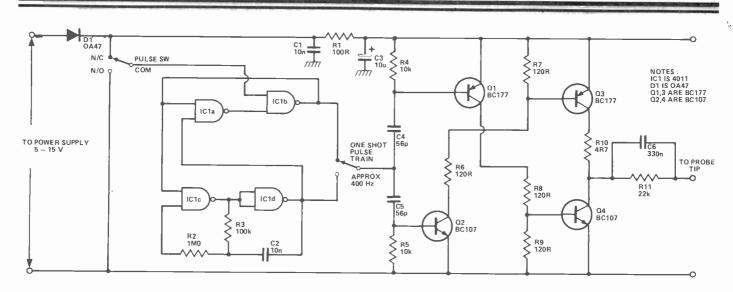
This circuit is designed to play a repeating sequence of 16 notes which are programmed by variable resistors. IC1 is a binary counter which runs off a PUT oscillator. The oscillator is built around Q1, which can be a 2N6027 or MEU21. The RC time constant connected to the anode charges up, causing the voltage at the anode to rise. At a certain voltage, controlled by R3 and R4, the PUT conducts. This allows the capacitor to discharge through Q3 as a good clean clock pulse. Q3 inverts the pulse to suit

the TTL requirements. The frequency of these events is easily changed by altering the time constant - a 100 k variable resistor was used.

IC1 generates a binary count on its four outputs — only if you ground both the reset terminals. IC2 selects a single output line for each of the sixteen possible input combinations. The result is that the presets are connected one-byone, in sequence. Q1 is the audio frequency oscillator, whose frequency can be changed by altering the resistors which determine the anode voltage of the PUT. Don't be tempted to leave out the diodes in series with the presets as

they block the normally 'high' outputs from interfering with the selected 'low' output. The type of diode used is not critical. 1N914s are probably the best (and cheapest).

Interesting results can be obtained by connecting a fairly large capacitor to various parts of the gate terminal of the second (AF) oscillator. Connect the other terminal ground or positive line — watch the polarity, if it's electrolytic. Another oscillator can be connected to the same outputs provided it is fitted with diodes isolating it from the first oscillator. If the outputs are mixed, polyphonic effects are possible.



CMOS/TTL Pulser

C T Morris, Mid Glamorgan

For a small extra outlay, a pulse trian facility can be added to the ETI Pulser that appeared in December 1975. The

NAND gates form an astable, which is gated by a flip-flop. When the pulse switch is pressed the flip-flop changes state and turns on the astable. Single shot or pulse trains are selected by a

change-over switch connected to the flip-flop and astable outputs.

The OA47 diode protects the pulser against reversal of the power supply leads.

3

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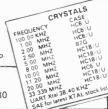
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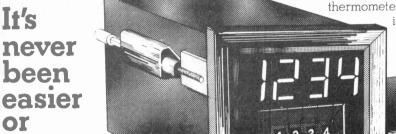
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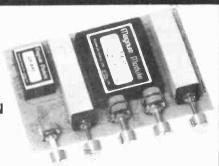
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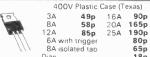
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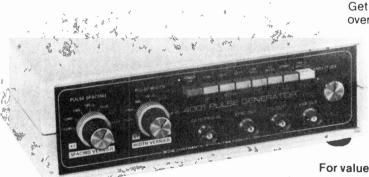
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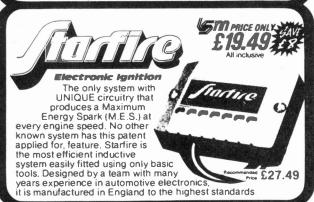


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development system is almost essential, however in the past to understand more than one several separate development systems have had to be purchased. The reason that separate systems, one for each processor, have been necessary is due to the fact that individual microprocessors have their own individual features in one case to access memory a separate read stobe and write strobe is required, in another a read/write hine is used or combination with a combined strobe called 'yalid memory adelare read stobe and write strobe is required, in another a read/write hine is used or combination with a combined strobe called 'yalid memory address and or minimation with a combined strobe called 'yalid memory address and or minimation with a combined strobe called 'yalid memory address and or minimation with a combined strobe called 'yalid memory address and or minimation with a combined strobe called 'yalid memory address and or hind memory and input/output ports under the control of a memory request or an input/output ports under the control of a memory request or an input/output ports under the control of a memory request or an input/output ports under the control of a memory request or an input/output ports under the control of a memory request or an input/output ports under the control of a memory request or an input/output ports under the control of a memory request or an input/output ports and processor. This makes it more difficult to graft some other unrelated proprocessor onto the same bus at a later date. A Universal Micro System provides a basic bus structure on which any one microprocessor called proprocessor onto the same bus at a later date. A Universal Micro System provides a basic bus structure on which any one microprocessor called proprocessor onto the same bus at a later date and an input of the same with a spearate from the rest of the system and this allows the same memory and interface. Port System uses together with read and write strobes by locating the data input (Revbboard) and output (VDU) in th

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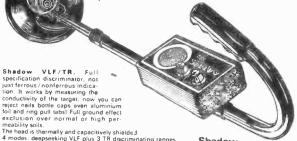
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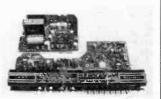
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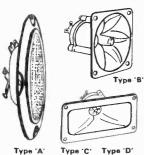
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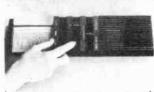
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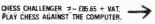
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MAINS TRANSFORMERS 6-0-6V 100ma 80p, 1½a £2.60, 9-0-9V 75ma 80p, 1a £2.40, 2a £3.94, 12-0-12v 100ma 99p, 1a £2.90, 15-0-15V 1a £13.15.

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IN4148 0.09p. 1N4002 2.9p 723 14 kil 33p. NE555 8 dil 24p. 741 8 dil 18p. bc547. bc549 4.9p. bc182. bc184. bc122. bc14. bc548 5.5p. tp31c. up32c 38p. up41c 40p. bd132 27p. plasik equiv bcy72 4.5p. luses 20mm x mm carridge 15, 25 5 1 2 3 5 Amp quekblow 1p. 1sessions 5% kW E12 10R to 10M 1p. 0.8p for 50 + 6 nor value polyester capacitors 160V 015. 068ml 2.6p. 1ml 4.0p. p. 0.p. 02 2 033ml 3.3p. 047ml 3.5p. 15 2 33. 47ml 4.9p. polystyrene capacitors 160V 01 to 1000pl 3p. 1n2 to 10n 4p. clear operations 50V 5 1.2ml 3p. 25V 5. 10ml 5.p. 8b 22 33ml 5p. 47. 68ml 3.p. 100ml 6p. 300 42 37 ml 5p. 10ml 5p. 1 potentiometers ¼W 4K7 to 2M2 log or 1 in single 27p, dual 71p. ½" red LEOS 9.7p. ic sockets 8 dil 8.7p, 14 dil 10.1p, 16 kil 12p.

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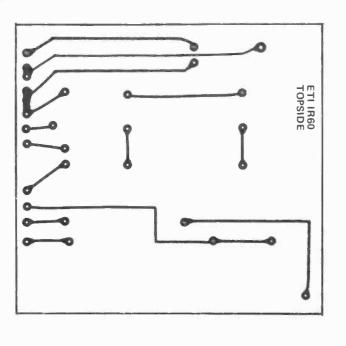
3-way types with switched output and 4 way mult jack:— 3/4½/6V 100ma £2.67, 6/

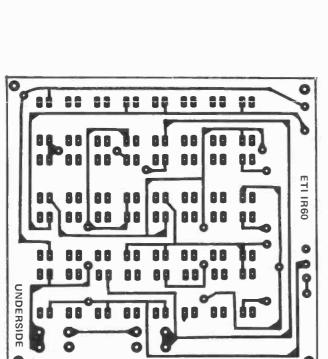
100ma £2.67, 67
7½/9V 300ma £2.34. 100ma radio types with press-stud connectors 9V £3.57, 6V £3.57, 9+9V £3.57, 9+9V £4.79, 6+6V £4.79, 6+6V £4.79, 679, 4½/9 400ma £3.57. Fully stabilized type 3/6/7½/94/400ma £3.57. Car convertors 12V dc input, output 9V 300ma £1.19, output 7½/9 800ma £2.66.

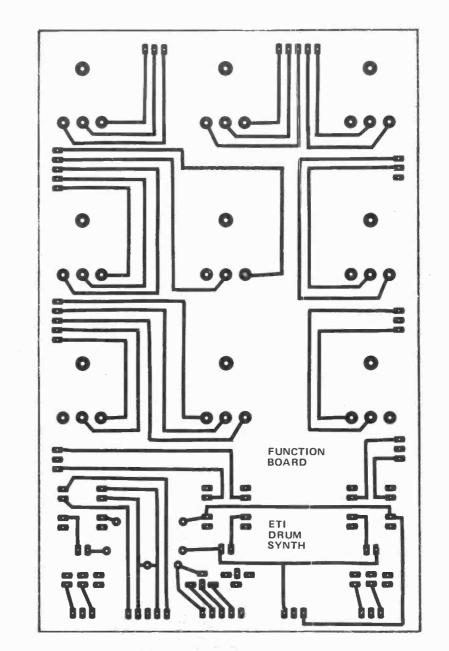
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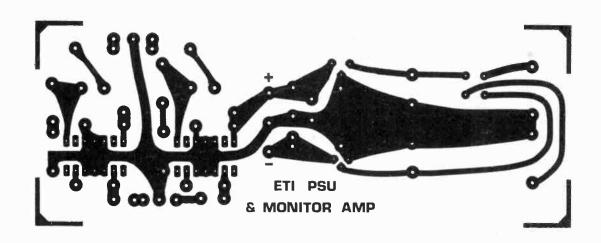
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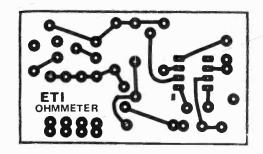
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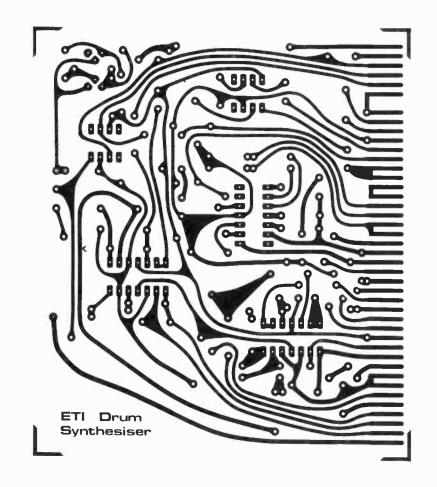




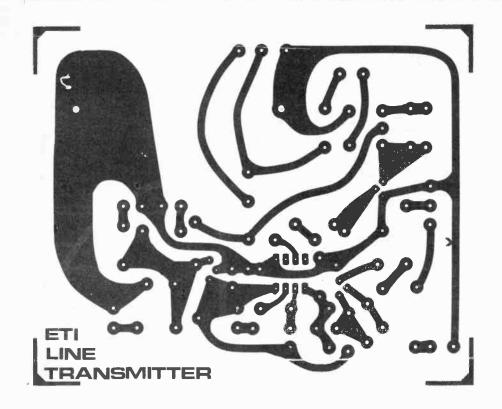


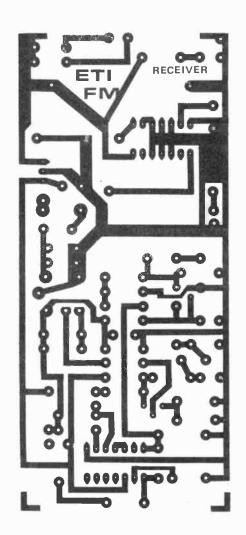


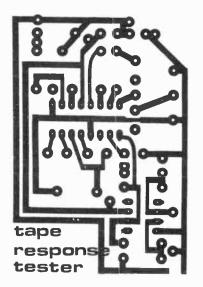


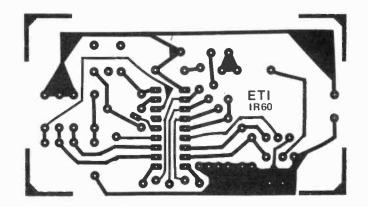


ETI JUNE 1980









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035	Oven Leakage Detector Pinball Wizard	Nov 79	038A	Long Period Timer Rain Alarm	Dec 79	049A	ETI 80 — VCO and VCLFO	Feb 80
036A	3 x Display Board Relay Activator Points Controller	Nov 79		Touch Switch Flash Trigger Pseudo Random Noise Gen		040B	ETI 80 — PSU Tuning Fork Filter Coin Toss	Feb 80
036B	Data Distributor (double sided)	Nov 79	038B	Hum Filter Dice	Dec 79	041A	ETI Audiophile ETI VCA	Mar 80
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	Track Cleaner & Electronic Pot (double sided)		038C	Function Generator	Dec 79	041B	Electromyogram VCM Heater Controller	Mar 80
036D	Power Switch	Nov 79	039	Buffer Moving Coil Preamp	Jan 80	042A	300W Amp Module	Apr 80
0300	Selector (double sided)	1100 75	1	Process Controller	D 70	033	Fuel Level Monitor, Alarm, Screen Controller	Sep 79
0274	,Encoder	Dec 79	039A	Hum Filter Logic Probe	Dec 79		Dynamic Noise Reducer	
03/A	(double sided)	Dec 75	039B	Long-Period Timer	Dec 79	042B	Touch Dimmer, Battery Charger,	Apr 80
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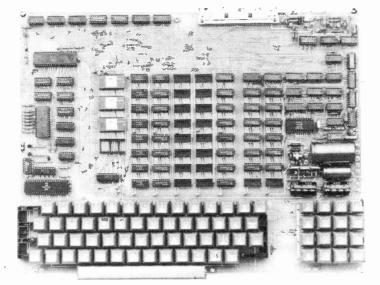
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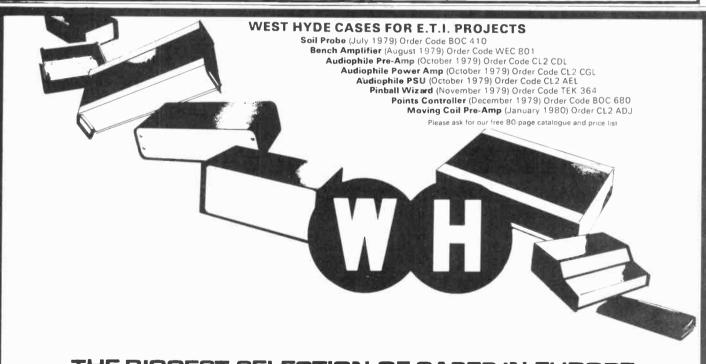
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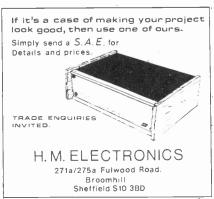
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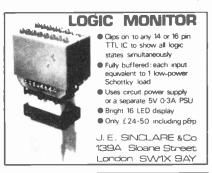
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