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- Northants NN11 4JP
- Telephone: 03327 76545

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Electronics Today International - April 1979
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</table>

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Call for analysis?

Hughes Packard's new HP 3779 is a microprocessor based instrument for checking multi-line telephone equipment. The operator sees a comparison of the test parameter and two large displays of measured values, which automatically displays its results in minutes rather than days.

Over time, different measurements from gain to inter-channel crosstalk and local alarm can be assembled into a test sequence defined by the user.

The results are displayed in tabular form on the instrument's own CRT. The information can be fed to a computer printer through an integral IEEE 488 (HP-IB) digital interface.

In two models — the 3779A for the 3778A Europe and the 3779B for Bell system users. Further details from Hewlett Packard Ltd King Street Lane Winsford Cheshire Wirral RG7 5JX.

Telltext — A load of rubbish...

The most intriguing aspect of telltext from the viewer's standpoint is trying to decipher the occasional sentence or word in a page that may look like this example: "This week premium bond winner is 11-10th.

The above statement emphasizes a need for a device which could eliminate these annoying factors usually raised by multipart reception problems. A new, large scale integrated circuit developed by Toshiba and NHK has shown successful in attenuating ghosts of up to 27 dB. In a reduction of up to 30 dB.

The principal method of circuit operation is as follows:

The circuit examines the eye pattern of the video channel and eliminates excessive signals in the composite video to reduce the presence of ghosts. These ghosts would actually appear as smaller trailing pulses through multiplexing and can be eliminated without any loss of information.

The video pulses are applied to the gain on each of the 64 MOS/E weighting circuits fed in parallel with each of the video signals. These outputs are then added and the result is a reduction of up to 30 dB.

Telltext was a sample of the video signal. These outputs of the weighting circuits in turn feed to a video delay line having a predetermined delay time. The outputs of the delay lines are added and then applied to negative feedback to the composite video signal in a form having sufficient amplitude to cancel the ghosts.

Do not, however, expect to see this ghost eliminator available yet. It is still in months before the full production.

Gerald Chester

And Also...

An exciting American TV station has finally decided to use a software package allowing American television to link up with British video.

In what is believed to be the first US attempt to interface the two systems, station KSL TV (Salt Lake City) hopes to use the combination of the two video tools to store and edit in coming US international video copy in its General Automation ITC video computer.
ELK, nics Today INT DT.PTID, - APRIL 1979

WATFORD ELECTRONICS

ILP MODULES 15-240 WATTS

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CORE ASSEMBLY MODELS 20-2400 WATTS

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DIGITAL & ANALOGUE INSTRUMENTS

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<tr>
<td>HY120</td>
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</tbody>
</table>

MIGHTY MINI-SWITCH

Digitron's new series of miniature push buttons are built to last. The Series 12000 Mini-Button is designed for use in applications where severe environmental conditions are expected.

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CHROMATRONICS

ELECTRONICS TODAY INTERNATIONAL — APRIL 1979

news digest . .

DIL SWITCHES

The popular DIL program making switches from AB Controls has been extended to include SPST, DPDT, and DPDT version switches. Applications in discos, stage, functions, in computers and test equipment switches are available with two trigger sections and plunger type contacts and also ensure long term electrical resistance. Further details from AB Electronic Products Group Ltd. Aberdeen, Yel Agnew Lane, C45 4DT.

IN BF7E1 LFD?

This new display bezel from Vero Electronics comes with your choice of neutral or opal clear lens (polished or unpolished). The bezel is constructed in a single rectangular cut out in four removable parts and finished by two screw out clamps which also secure the display mounting board or the spacers provided. A full range of suitable mounting boards for LED and LCD displays is available.

Prices range from £1.50 for a 4x7 digit model to £22.50 for a six digit with coloured lens. Further details on Display Bezel AB066 from Vero Electronics Ltd. Industrial Estate Chandler Ford Eastleigh Hampshire 503 12R.

OOPS AND ALL THAT . .

Disco Lightshow — Dec 78

Page 46 - CL 19 24 29 34 are shown upside down (factions 11 R53 12 R43 T3 R51 T4 Rob T3 R58 all should be shown going to 12V)

Page 47 - R71 1k (between D19 and D25) was not shown on circuit diagram (or was however shown correctly on the text).

Transformer Page 47 — ZD7 ZV06 not 4V7 Page 48 - (Par L61) R75 is 4k7

Page 48 — Switch 3 the two brown wires should be shown on tag 3 not 4. On the output terminal blocks N and L are interchanged.

Stage Dimmer — March 79

We omitted details of the choice 1) from the Parts List. On our printed page this was wound on a one inch square core with a 80 thou gap. The lead version is wound full of 18 SWG wire and the D1A is wound full of two parallel windings of 16 SWG. T1 can be wound as 40 primary and 11 secondary on two core 14/290/3. F77 LC if available
STEVENSON
Electronic Components

SWITCHES
- Sub-miniature toggle - 2A 250V
- SPDT - 60mA SPST centre off .5A
- DPDT 75mA SPDT centre off 90mA
- Standard Toggle
- SPST 34p DPDT 45p
- Warehousing to order: 1A 125V 2P3W, 3A 2W or 4P3W at 30p each
- Miniature switches from stock:
  - Push to make: 1.5p
  - Push to break: 20p

POTENTIOMETERS
- 5K 2M2 single 26p each 100Ω 2+2 horizontal/vertical
- 5K-2-2M2 stereo (ideal) 55p each or vertical preset 6p each
- 6K 2x20 OF switched 6p each

KNOBS
- Ideal for use on meters & dials
- Push on type: supplied in standard black, green, blue, yellow and grey
- Pot rim type marked 14p each

MICROPROCESSORS
- 6800 87p 6800 135p 8110 110p
- 8080A 52p 6800 363p 8110 175p

REGULATORS
- 7810 50p 7910 70p LV300K 110p
- 7812 30p 7912 100p 3V2 225p
- 7814 30p 7914 80p 3V2 700p

THYRISTORS AND TRIACS
- Plastic encased thyristors 4A 8A 12A
- Plastic encased triacs 100V 95p, 200V 86p, 400V 86p

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news digest......

INFRARED EYES

We believe that you have announced the introduction of a new reflection devices sensor. Opticon types OPB180s and OPB280s are reflective transducers incorporating a gallium arsenide infrared emitting diode and a planar silicon photodiode (OPB180) or paraldarlington (OPB280).

With a reflective surface of magnetic tape 0.110 inches from the read head, typical values of reflected intensity are 00 encoder (OPB180) and 50 encoder (OPB280).

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Cut the copper conductor of a wire free stop off a length of insulation and strip several times around the terminal to remove thickness. A one regular operation using any electric or pneumatic tool. The tool is simple and easy to use.

The bit and sleeve setting designed to use a specific gauge of conductor and insulation diameter is available in the range 22-30 AWG. The strip reduces to the specified size with these bits and sleeves is available to suit all cables. A set of cutters and a tool is included.

DOING TIME?

Are you one of the select few whose calculator is doing six months in Pickhurst? Have you been ordering digital watches from the Lord Chancellor? What is his position in the right mind would do that?

It seems that Milsaundine's old phone number was similar to that of the Lord Chancellor's Union Office. Perhaps the confusion is similar.

If you still have a piece of paper, we shall attach a new one. Use it to pack our RST back to the Lord Chancellor. If you don't, it might give your calculator some

AUDIO MODULES

- Stereo Cassette Deck N999
  Complete with electronics and music centre 4 x 350 watts. Cartridge 10W. Price £29.95
  Includes preamp transformer £12.95 (Carvin 1979 PA).

- Preamp. Amp - PSU Wmms200s 110 per channel

- AMP D41
  B Ware RMS per channel amp. Preamp supplied with unit. Fully programmable: accepts 24 VDC. Price £99.

RF MODULES

- 8 MHz 200MHz Filter Fitting 2 stage FET & ceramic filters 3000s £150. Bender £10. Section built around 2102E 2 stage circuit comes with 4 way switch - £69.

- 7 RF 030
  Improved version of above with additional stages, improved S/N ratio and 1.5 V sensitivity for 2000 S. N.W. 

- 8 MHz 200MHz Filter Fitting 2 stage FET & ceramic filters 3000s £150. Bender £10. Section built around 2102E 2 stage circuit comes with 4 way switch - £69.

- 4 AMP D20 Stereo power amp. 0 W, RMS per channel, class AB, 44 A, 44 T, amplifier input 15W - 18 KHz. Price: £79

- 10 MHz Matching LF Preamp 10 AMP 150MHz MOSFET front end and 25dB gain 10 FM 1F, £99

- ESE RAILWAY HOUSE, HARDHAM CROSSING, PULBOROUGH, SUSSEX

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- Kansas City standard audio cassette interface for high reliability
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- Normal TV with over scan display about 20 rows of 24 characters, without overscan up to 30-35 characters

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- Assembler/monitor and extended machine code monitor available
- Fully built and tested. Requires only 5V at 3amps and a video monitor or TV and RF converter to tune in and running Phone or wire for further details. Full line specifications

INTERNATIONAL - APRA I

ELECTRONICS TODAY INTERNATIONAL — APRIL 1979
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It can be a nuisance isn’t it, going from newsagent to newsagent? ‘Sorry, square don’t have it — next one should be out soon.”

Although ETI is monthly, it’s very rare to find it available after the first week. If it is available, the newsagent is going to be sure to run the order for the next issue — but we’re glad to say it doesn’t happen very often.

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<td>TMO10</td>
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LED AND LCD DIGITAL MULTIMETERS

- 2 range 2 digit (£200)
- 2 range 3 digit (£200)
- 2 range 4 digit (£400)

MULTI-METERS — GENERAL PURPOSE & ELECTRONIC

- 7.5V, LED (£50)
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AUDIO ELECTRONICS
301 EDGWARE RD, LONDON W2 1BN
01 724 3554 OPEN 9-6, MON-SAT
ALSO AT 240 TOOTING BARNET ROAD W1
## Transistors

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## Integrated Circuits

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## Ordering

16 New Road, Chatham, Kent
Tel: Medway (0634) 811119 (2 lines)
POWER AMP SURVEY

The Americans would describe it as a 'crowded marketplace'. Power amplifiers appear almost daily and the resulting choice can easily lead to confusion. Ron Harris attempts an overview.

UPGRADING HI FI is a costly business using commercial units as better can somehow read dealer once over the threshold into a hi fi emporium. Once contracted however the improving bug is no respector of price and pocket.

Quite commonly the malady can be caught via the cones of new loudspeakers which are crying out for more watts to drive them. The amplifier just has to go!

The Modular Connection
One method of gaining the extra power — if you're quite content with facilities etc — is to replace output stages of your present equipment with two power amplifier modules. There are certainly enough on the market to choose from.

This will certainly be cheaper and most of these modules outperform similarly priced commercial units so performance need not suffer. Since you need not necessarily have to pay for a PSU and case you don't need it must be cheaper. Very often too the existing case can be utilised to house the new boards with attendant saving in that most onerous of tasks — metalwork.

Judging by the continuing popularity of the audio projects which appear within these pages do-it-yourself hi fi continues to abound even though building up from scratch is often no cheaper than buying commercial units. Modular construction — with most designs being pre tested — can make this task easier and more certain.

With kit construction however there is obviously more to go wrong and this tends to mean the results are more dependent (at times!) upon the constructor than the supplying company. We have been told by several reputable kit suppliers that the greatest single reason for non functioning units is poor soldering.

Board Decision
With the large number of available kits for power amplifiers in mind we decided to exclude them from our deliberations and concentrate on modules alone. This was defined as a unit in which the amplifier is supplied completely pre assembled in other words as a PCB which can then be utilised.

Undoubtedly there are some modules we have missed out in our scan across the adverts — and if you know of any we have missed please let us know so that as few injustices as possible are perpetrated.

ELECTRONICS TODAY INTERNATIONAL — APRIL 1979
Advantage Points

Using these units is very straightforward. The manufacturers will have set up the amplifier already and hopefully tested a few in specification. All that should remain for the purchaser to do is connect up a PSU, some input and output sockets and a case. Music should then flow forth — usually amplified.

One hint for wiring up a unit from modules is to keep an eye on the earthing arrangements. Insufficient attention to this can — and will — lead to monumental amplification at 50 Hz alone in hum. Use a split earth technique, taking loudspeaker PSU and board earths to a common point. The Reservoir capacitors are a convenient place to work upon.

Connect all the earth legs on the input phone sockets together and take out a single lead to the PCBs only. Make sure there is only a single path to ground earth as this will alleviate any noise problems which may otherwise arise.

When laying out the case, keep the transformers far away from the amplifiers as possible and always shield properly. Positioning the PSU board between modules and windings will ensure that some distance is maintained.

Choosing

If you’re using new units to replace an ageing or new underpowered predecessor remember that to obtain a barely perceptible increase in sound volume (3 dB) you will need to DOUBLE power output. It is no good going from 40 W to 60 W and expecting to rock neighbours out of bed — if they could sleep through your 1912rendezvous before that extra 10 W is going to add significant punch to your performances.

It is better to choose too high a power output for your application and be gentle with volume control than to underpower and regret it later. The correct rating depends upon the volume of the room you intend to play your music in.

Allow 25 W for the first 1000 ft², and add 10 W per 1000 ft² thereafter. This will add up a minimum figure for normal listening levels with a decent reserve assuming average efficiency loudspeakers.

If you use transmission line designs add 15 W to every 25 W of your estimate to allow for the basic efficiency of this loading method.

Table A: Motive

The table shown here lists some thirty odd modules ranging in power output from about three watts (a well over 150W. A list of manufacturers is given at the end of the article.

All the companies produce their own power supplies to power the amplifiers, and it is at least convenient to employ those where needed. One common failing of these is that the PSU tend to underpower the modules in that not enough reserve is allowed for in the PSU. Quite often the same PSU is recommended for stereo design, as for driving a single module.

At the high power end of the range, where cost is pretty high anyway it is well worth powering each module from a separate PSU board. This reduces dynamic crossover — where a peak on one channel drains the supply thus distorting the second channel by clipping the signal. If you use a single transformer make sure it is generously rated at least 50% above the current you expect to draw.

Wot Happened?

One part of this survey which somehow never materialized was the proposed listening tests with one sample from each range. Most manufacturers seemed unable to respond within the time required — approx. two weeks. We were left with BFAK Crimson and two ILP H150s borrowed from a neighbour. The idea had been to select a power output which was common to all ranges — 60W seemed reasonable and build up a unit from each suppliers modules. This would have told us much about the sound quality, reliability and overall standard of the amplifiers.

Would have

Press On

In fairness to Magnum Audio they came upon the scheme late and were very quick indeed sending us information and a sample of their excellent instruction manuals. The scheme is not however dead and buried yet — it is at least possible that our samples are reposing...
## COMPARISON TABLE

<table>
<thead>
<tr>
<th>MODEL</th>
<th>POWER OUTPUT</th>
<th>THD at given load (dB, kH)</th>
<th>FREQUENCY RESPONSE</th>
<th>SIGNAL TO NOISE RATIO</th>
<th>DAMPING FACTOR</th>
<th>SENSITIVITY (for rated output)</th>
<th>SETTLING TIME (µS 2%f)</th>
<th>OUTPUT PROTECTION REQUIRED</th>
<th>POWER SUPPLY (DC)</th>
<th>SIZE (mm)</th>
<th>PRICE incl VAT</th>
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<tbody>
<tr>
<td>BI-PAK</td>
<td></td>
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<tr>
<td>AL30A</td>
<td>10W (8R)</td>
<td>0.25% (25W)</td>
<td>50Hz 20kHz + 3dB</td>
<td>–</td>
<td>–</td>
<td>75mV</td>
<td>–</td>
<td>–</td>
<td>15V</td>
<td>72 x 69 x 28</td>
<td>4.70</td>
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<td>AL60</td>
<td>25W (8R)</td>
<td>0.1% (25W)</td>
<td>20Hz 30kHz + 2dB</td>
<td>–</td>
<td>–</td>
<td>250mV</td>
<td>–</td>
<td>–</td>
<td>30.50V</td>
<td>103 x 54 x 150</td>
<td>10.46</td>
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<td>–</td>
<td>–</td>
<td>250mV</td>
<td>–</td>
<td>–</td>
<td>40.50V</td>
<td>103 x 54 x 150</td>
<td>10.72</td>
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<td>0.05% (50W)</td>
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<td>–</td>
<td>600mV</td>
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<td>–</td>
<td>65V</td>
<td>192 x 84 x 49</td>
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<td>–</td>
<td>450mV</td>
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<td>50.80V</td>
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<td>CRIMSON</td>
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<tr>
<td>CE608</td>
<td>55W (8H)</td>
<td>All models</td>
<td>All models</td>
<td>110dB</td>
<td>–</td>
<td>775mV</td>
<td>–</td>
<td>–</td>
<td>36.036V</td>
<td>All models</td>
<td>16.10</td>
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<td>CE1004</td>
<td>81W (4P)</td>
<td>0.0% (full)</td>
<td>20Hz 20kHz + 1/2dB</td>
<td>–</td>
<td>40</td>
<td>–</td>
<td>20 µS</td>
<td>–</td>
<td>61.061V</td>
<td>80 x 120 x 195</td>
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<tr>
<td>CE100B</td>
<td>92W (8R)</td>
<td>0.035% (10W)</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>28.12</td>
<td>–</td>
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<tr>
<td>CE1704</td>
<td>160W (8R)</td>
<td>–</td>
<td>–</td>
<td>–</td>
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<td>–</td>
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<td>61.061V</td>
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<td>145W (8R)</td>
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<td>–</td>
<td>61.061V</td>
<td>80 x 120 x 195</td>
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<tr>
<td>HY30</td>
<td>15W (8R)</td>
<td>0.1% (15W)</td>
<td>10Hz 16kHz + 3dB</td>
<td>75dB</td>
<td>–</td>
<td>–</td>
<td>All models</td>
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<td>18.0-18V</td>
<td>PCB mounted</td>
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<td>0.4% (25W)</td>
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<td>–</td>
<td>–</td>
<td>50mV</td>
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<td>–</td>
<td>25.0-25V</td>
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<td>0.3% (50W)</td>
<td>10Hz 45kHz + 3dB</td>
<td>–</td>
<td>–</td>
<td>90mV</td>
<td>–</td>
<td>–</td>
<td>35.0-35V</td>
<td>114 x 50 x 85</td>
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<td>0.0% (120W)</td>
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<td>–</td>
<td>–</td>
<td>96mV</td>
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<td>–</td>
<td>45.0-45V</td>
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<tr>
<td>HY400</td>
<td>245W (4R)</td>
<td>0.1% (240W)</td>
<td>10Hz 45kHz + 3dB</td>
<td>94dB</td>
<td>–</td>
<td>–</td>
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<td>–</td>
<td>45.0-45V</td>
<td>114 x 100 x 85</td>
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<td>ET1100</td>
<td>100W (4R)</td>
<td>0.1% (100W)</td>
<td>5Hz 50kHz + 0dB</td>
<td>100dB</td>
<td>–</td>
<td>500 mV</td>
<td>–</td>
<td>–</td>
<td>40.0-40V</td>
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<td>CP2/16</td>
<td>2x20W (8R)</td>
<td>0.0% (20W)</td>
<td>20Hz 25kHz + 3dB</td>
<td>10dB</td>
<td>–</td>
<td>1000 mV</td>
<td>20 µS</td>
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<td>20.0-20V</td>
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<tr>
<td>SS103</td>
<td>3W (8R)</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>100 mV</td>
<td>–</td>
<td>–</td>
<td>20V</td>
<td>–</td>
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<td>SS105</td>
<td>6W (3R)</td>
<td>0.3% (1W)</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>30 mV</td>
<td>–</td>
<td>–</td>
<td>14V</td>
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<td>10W (4R)</td>
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<td>–</td>
<td>–</td>
<td>–</td>
<td>60 mV</td>
<td>–</td>
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<td>14V</td>
<td>82 x 50 x 25</td>
<td>£5.65</td>
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<tr>
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<td>20W (4R)</td>
<td>0.3% (10W)</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>80 mV</td>
<td>–</td>
<td>–</td>
<td>34V</td>
<td>82 x 50 x 25</td>
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<td>SS125</td>
<td>25W (8R)</td>
<td>0.1% (1W)</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>140 mV</td>
<td>–</td>
<td>–</td>
<td>50V</td>
<td>82 x 50 x 25</td>
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<td>SS140</td>
<td>40W (4R)</td>
<td>0.0% (20W)</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>300 mV</td>
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<td>–</td>
<td>45V</td>
<td>125 x 80 x 25</td>
<td>£8.50</td>
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<tr>
<td>SS160</td>
<td>64W (8R)</td>
<td>0.1% (30W)</td>
<td>20Hz 20kHz + 3dB</td>
<td>70dB</td>
<td>–</td>
<td>350 mV</td>
<td>–</td>
<td>–</td>
<td>50V</td>
<td>125 x 80 x 25</td>
<td>£8.50</td>
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<tr>
<td>SS1100</td>
<td>100W (4R)</td>
<td>0.1% (50W)</td>
<td>20Hz 20kHz + 3dB</td>
<td>70dB</td>
<td>–</td>
<td>500 mV</td>
<td>–</td>
<td>–</td>
<td>70V</td>
<td>125 x 80 x 25</td>
<td>£10.00</td>
</tr>
</tbody>
</table>
securely in the cavernous bosom of the GPO and should they ever be designed. Audiophile will be more than pleased to follow up and complete the project.

Anyway, only slightly daunted we shall proceed with what we have and consider the two amplifiers which did arrive (and the one on loan!).

Our source for the listening tests was to be a Sony EL7 Elcaset machine which gives reel-to-reel quality of reproduction without all the time consuming drawbacks of that medium. When you’re trying to compare several pieces of equipment such luxurious convenience is not to be scorned lightly.

I could never understand why Elcaset has not done better for itself. The Sony machines in particular offer a standard of reproduction far above that which any cassette machine achieves.

The reference amplifier was a Lecson AP3 II.

AL-120 BI-PAK

This unit arrives three quarters wrapped in a black heatsink with connection being made to pads at one end and which protrude beyond the edge of said heatsink. The output pair (2N3055s) are bolted to the back of the heatsink and are hard wired into the circuit.

The quality of construction was generally high and in use the AL120s gave us no trouble at all. They drove the required speakers (Celestion/KEF) with no apparent distress and gave a sound technical account of themselves.

Crimson CE608

There is not really a lot to say about Crimson Elecktrik that has not been said already. Their products are well constructed, well thought out and well thought of. The CE608 is no exception.

Crimson supplied us their unit completely assembled within the superb metalwork shown in the photograph which includes a PSU and stabiliser board to run one of their pre amp modules.

The metalwork is black and in style looks not unlike a Quad 405 power amplifier unit.

ILP HY50

Since these are completely encapsulated we can offer no real comment on constructional finish. A mere five pins protrude from the metalwork along which travels all communication between the HY50 and the world.

Three in A Testbed

Once introduced to their proper PSUs all three amplifiers functioned well and gave no real problems at all. The ILP gave a poorer than the others regardless of how we tried to wire it so the problem must lie within the black box.

Of the three the Crimson gave what must be regarded as the best overall performance. Its sound is very clean and it possesses good attack. However the BI-PAK A2 120 was not far behind and loses out mainly due to a slight lack of transparency when directly compared to the CE608. It has a warmer sound overall too and one that many people may well prefer.

Also the ILP HY50 did not produce reproduction of the same quality as the other two. The test modules are about three years old though — our new review samples of having turned up in time — so things may well have improved here. We hope to give a listen to some more recent samples as soon as possible to confirm or deny this but as it is the impression's one of a hard, noisy sound which was immediately distinguished in comparison.

Conclusions

Well there it is. Not as complete as might have been but very interesting two hopper nonetheless. As for the comparisons we never got if the manufacturers agree we’ll follow those up in the next few issues in Audiophile.
**FEATURE: Power Amps**

Left: the Sony EL-7 Class A amplifier which proved the source for the testing. Somehow the machine has never received the attention it deserves for its performance.

Below: remind you of anyone? Looking like a squeezed 40B in the Crimson unit all boxed and set to go.

---

**Suppliers**

- **Magnum Audio Ltd**
  - 13 Hazelbury Crescent
  - Linton
  - Beds
  - LU7 1PD

- **Bi-Pak Semiconductors**
  - Dept: EIT
  - FPO: 8-06
  - W 1128
  - Hurst

- **Crimson Elektron**
  - 1A Stamford Street
  - Luton
  - LU1 1NL

- **Sterling Sound**
  - 37 Vanguard Way
  - Sedgebury Ness
  - Essex

- **LP Electronics Ltd**
  - Graham Bell House
  - Roper Close
  - Canterbury
  - Kent
  - CT2 7EP

- **Kingsley TV**
  - 40/42 Shields Road
  - Newcastle upon Tyne
  - NE6 1DR

---

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<table>
<thead>
<tr>
<th>Value</th>
<th>Code</th>
<th>Value</th>
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PROJECT

VIDEOGRAPH

Turn your colour television into a dual trace oscilloscope with this UHF colour modulator and video display generator.

THE PURCHASE of even the simplest oscilloscope is probably unjustified for most amateur electronics constructors. Other amateurs feel rightly or wrongly that their money is better spent on projects which other members of the family can appreciate.

Which ever category you belong to or even if you are in the scope league already Videograph will be found to be a fascinating and useful piece of equipment which will give many hours of pleasure.

Principle Of Operation

The Videograph makes use of the fact that the television screen is scanned from top to bottom every 20 ms. This is used as the effective oscilloscope timebase. trace modulation being obtained by varying the timing between start of each line and a fixed-length bright up pulse.

Two complete circuits are required to produce a twin trace and these are colour coded blue and orange respectively. These circuits are triggered by a common sync pulse generator and further components generate an eight-stage background colour change triggered by peak signals. There is also an internal frame-locked square wave generator which serves as a test waveform for injection into amplifiers and tape recorders.

Controls are provided for inverting one channel, freezing the background colour and switching a filter to give a relatively smooth music display.

Complete kits can be obtained from William Stuart Systems Ltd who hold the PCB copyright. They also produce a ready drilled cabinet. The heavy gauge anodised face plate is screen printed to improve finish and the PCBs are silk screened to aid construction.

Construction

Two printed circuit board assemblies are involved; one consisting of a UHF Colour Modulator and the other the...
Fig 1. UHF Colour Modulator circuit diagram
HOW IT WORKS - MODULATOR

Q3 forms a crystal oscillator, generating the precise 4.3368 MHz subcarrier for colour information. The transformer produces outputs which are suitably phase shifted by R24, C15, C11 and R23. Diodes D1 and D2 modulate these signals which are now at 0, −45 and 180 degrees respectively. Colour hue is dependent on the subcarrier phase and in the PAL system 180 degrees gives blue, white and red alternately by the three IC's, IC1 being the controller. IC2 generates a squarewave at half line frequency, and this is also used to generate sync bursts via C22 and C21. Q2 amplifies the colour bursts via C22 and C21. Q2 amplifier colour information and feeds it into the main Videograph Display Generator. Both are printed with detailed legends so that components can be inserted direct from the parts list. Note that each board has a separate list.

The IC's should be inserted last of all and IC7 on the generator board should be left out initially instead insert a link between pins 3 & 12 as shown. This gives a fixed green background and results in easier setting up and tuning. IC7 can be inserted later on to give the automatic colour change.

The boards are connected to each other by short lengths of wire between the points labelled OV, Field, +ve, Video, B, R, G, X and Sync.

All the controls can be board mounted and the only other wires needed are for connection to the aerial and DIN sockets, and 9 volt power.

The aerial socket can be connected directly to the modulator via two closed loops, one on the board and one on the socket. The loops are simply bent to couple closely with each other. This method ensures that no 'earth loop' can exist between the TV and the hi-fi system, causing undesirable hum on some equipment.

Setting up

The modulator tuning capacitor is set to 30% of maximum. Generator board presets are set fully anticlockwise. The GAIN controls should be at minimum and the LOCATE controls at mid position.

Connect a TV set via low-loss coax cable and switch on both TV and Videograph. Tune the TV to obtain a good signal, searching from channel 21 upwards. The picture will be unstable.

Adjust RV9 (Line sync) to give an unbroken background, and adjust RV7 (frame sync) to give vertical stability. Provided that the TV tuning is exact the picture should now be uniformly green. If the top of the picture is red then adjust RV8 (frame pulse width) for best position.

Adjust RV2 and RV5 to give blue and orange vertical stripes; these should appear from the left as the black and white composite video signal is applied to the synchroniser. Harmonics in the 0.14F band are extracted via C23 and D7. These are then filtered through a long length of wire which acts as a high pass filter.

C20 and IC1 expand the Sync pulse to give the colour burst. The Sync pulse is then used to control background illumination FIFI.1/10th of the transmitted light is coupled to the background when it is unblanked. This feature allows objects which are to be displayed (e.g. the Videograph stripe) to cancel the background whenever they are on screen.

Fig. 2 Colour modulator component overlay.

PARTS LIST - MODULATOR

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Note: D1-D2 04-04-06-08 matched parts
IC7 40016
IC8 40078
A typical Videograph television picture.

Fig. 3 Videograph generator circuit diagram

Fig. 5 Generating graphics with the Videograph.
HOW IT WORKS - GENERATOR

Q2 drives a clamp diode D3 via C1, RY2 (preset) determines the mean DC voltage while RV3 (Y/NCASE control) gives a fine adjustment. Gates 1 and 2 of IC4 form a monostable, triggered by positive sync pulse 'F'. Thus at the start of each line, the output of gate 2 goes low, and C8 provides positive feedback to gate 1, but is clamped to an initial value of 3V by the clamp diode. C9 now charges via R9 until gate 1 switches back (at approximately 4V) and the monostable resets itself. Note that the charging is nearly linear over the range 3 to 4V and R9 can be considered as a constant current source. Since the initial clamp voltage is modulated by the audio signal, the monostable period is also linearly modulated.

At the end of the above period a second, fixed duration monostable is triggered via C11. This produces a positive pulse which triggers the termination gate. IC6 is an emitter follower which drives the Modulator with Video (brightness) and sync information, and it generates the background by putting 0V high. Line and Field blanking are ensured by R14, R15, R11 and C7, which connect the line and frame pulses and prevent trace generation when necessary.

The left-hand channel is identical, except that the output drive is to a different colour and the inverter stage is changed. Q6 detects such signals and, if the right hand channels are not selected, switches the left and right hand outputs to identical channels.

Fig. 4 Twin channel VideograpM1 audio driver circuit.
Fig. 6 Videograph generator component overlay

Circuit boards completed and installed in the Videograph chassis.

No, it's not something from outer space!

BUYLINES

A complete kit of parts is available for this project from William Stuart Systems Ltd, Dower House, Herongate, Brentwood, Essex CM13 3SD. The PCBs remain their copyright and will be available only from them. All components are available separately, and the PCBs are normally supplied as a ‘mini-kit’ along with IC1-3 and ready wound coils. See advert elsewhere in this issue for prices.

Pots are turned clockwise. Position both stripes centrally, then separate them using the LOCATE controls. At this stage the line sync (RV9) should be fine-adjusted to give perfect colour registration on the stripes.

IC7 may now be inserted (and the link removed!) to give the background colour change function. The sequence being black, white, cyan, yellow, green, mauve, blue, red.
PROJECT: Videograph

PARTS LIST - GENERATOR

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</table>

WHAT'S MISSING?

PROJECT: Videograph

Above and below Videograph's two colour traces

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**ELECTRONICS TODAY INTERNATIONAL — APRIL 1979**
FEATURE

Gm REVISITED

Nothing to do with American car manufacturers Gm is in fact a throwback from the days of valves, now finding a new lease of life with up-to-date semiconductor devices. K. T. Wilson explains.

MANY A LONG YEAR ago, when transistors were an item which hadn't been dreamed of by science fiction writers we all used valves and we all knew the magic letters Gm. Gm stood for a quantity called mutual conductance and it measured an important feature of the valve from which we could work out how much voltage gain we could get out of a given valve. Well the years have passed and valves are dead for many purposes but Gm lives and is back working for us.

It's odd that Gm should have gone out of fashion for so long because the idea of Gm is even more useful in transistor amplifier circuits than it ever was in valve circuits. Still the idea seems to be coming back in a big way; so let's take a look at it.

Mutual conductance of any electronic device means the ratio of signal current at the input to the output signal voltage or the ratio of collector current to the voltage between base and emitter. Fig 1. The squiggle above the letters means that it's AC signal voltage and current we're talking about not the steady bias voltages and currents.

Using Gm therefore allows us to consider a valve or transistor as a generator of signal current, the amount of signal current being Gm x v. Now a current generator means a device which will deliver its current into any load, however low. No valve or transistor is really like this but for most of the uses we make of transistors, the idea of a current generator is not far from the mark.

Current Generators

If a transistor were a perfect current generator it would have an infinite resistance at its output. That means just that a signal voltage applied between the collector and the base would cause the collector signal current.

![Fig 1 Mutual con conductance, ie Vbe for a transistor](image)

Once again it's not quite correct but not far from the truth. But if collector signal current does flow, but not vbe either then what does it do? There were a resistor of around 40k between collector and emitter.

Now the usefulness of all this is that it allows us to draw an equivalent circuit for a transistor. An equivalent circuit is a circuit made of simple components which behaves in just the same sort of way as some device which is in reality much more complicated. A simple equivalent circuit for a transistor is therefore as shown in Fig 2. It consists of a current generator which generates a signal current Gm vbe and a resistor of about 40k in parallel. This simple circuit accounts for the size of the signal current at the output (the collector) and the output resistance between collector and emitter. How does this help us? Quite a lot if we remember all the time that equivalent circuits are about signal currents not about bias currents. As far as signal currents are concerned the positive supply line of an amplifier is just as earthed as the earth line. Why? Because in the power supply there's a smoothing capacitor of several thousand microfarads connected between the +ve and -ve lines. As far as DC is concerned this capacitor is an insulator but for AC signals the capacitor is just a short circuit, shorting the +ve line to the -ve line. When we connect a load resistor between the collector terminal of a transistor and the positive line then as far as signals are concerned the load resistor is connected between collector and emitter. D aw this to the equivalent circuit and the result is Fig 3. Back in the old days of valves (nostalgia corner this!) we found the sum of those two resistors in parallel which was

\[ \frac{1}{R_{CE+RL}} = \frac{1}{R_{CE}} + \frac{1}{R_{RL}} \]

and then the voltage signal output was just the current signal times the resistance (Gm x Law still rules OK) giving

\[ V_{out} = Gm x v_{be} \frac{1}{R_{CE+RL}} \]

![Fig 2 An equivalent circuit for a transistor](image)
Simple Silicon

One of the things that makes life simpler in these days of silicon transistors is that the quantity $R_e$ the output resistance of the transistor is, is quite a large value compared to most of the load resistors we use. An output resistance (the usual symbol nowadays is $h_{fe}$ or $40 k$Ω) quite a bit larger than the $3 k$Ω so we use as a load, so that most of the signal current from the transistor is through this resistor in the equivalent circuit. That simplifies the output voltage to $G_{m}R_L$ so that the gain of a transistor amplifier is just $G_{m}R_L$.

If it's as easy as that, why don't we see it in text books? The reasons are historical — we didn't start with $h_{fe}$ transistors and a transistor unlike a valve doesn't have a constant value of $G_{m}$. If we plot a graph of collector current against base voltage as in Fig. 1. the result is not the nice straight line we get when we plot such a graph for a valve or the not too crooked line we get when we plot the graph for an FET but a very flat line indeed. This indicates that the value of $G_{m}$ is not constant but a value which changes as the current through the transistor changes. This coupled with the rather low output resistance of the early germanium transistors seemed to seal the fate of $G_{m}$ for good.

Ebers Moll

A few years back though the Ebers Moll equation was noticed. You've never heard of it? You're not alone. Few text books mention it, and some mention it without explaining it. Very briefly, it is an equation which links the collector current $I_C$ to the base voltage $V_{BE}$ for a transistor. In other words it is the equation for finding $G_{m}$. Now the full equation is a bit more complicated but full of mathematical symbols you may never have seen before. It repays close attention though because most of the symbols are of quantities that are pretty well constant and only two of them vary very much. One of them is the steady bias current $I_B$ and the other is temperature. As it happens temperature for the purposes of the Ebers Moll equation is measured in the Kelvin scale, which starts at the absolute zero of temperature around $-273^\circ C$ Room temperature is therefore around $293 K$ (no degrees sign) in the Kelvin scale and a few degrees above or below doesn't make much difference to the equation.

That leaves $I_B$ as the one thing that really affects $G_{m}$ and the relationship works out at approximately

$$G_{m} = 40 I_B$$

Put in words that means we can take a $G_{m}$ value of 40 times the steady bias collector current in milliamps. For a bias current of 1 mA the $G_{m}$ value of a transistor is 40 mA. A too good to be true? Looks like it but it really does apply to any silicon transistor apart from a few freak types.

This brings back the $G_{m}$ idea in a big way, and we can forget a lot of the old formulae we once used in calculating the design of transistor amplifiers. The fact that $G_{m}$ is not constant but varies with the bias current is oddly enough a help rather than a hindrance.

Gain

Going back to our equivalent circuit and ignoring the large output resistance of the transistor we can now write $40 R_L$ in place of $G_{m}$ in Fig. (4). This makes the gain of an amplifier with load resistor $R_L$ become $40 I_B R_L$. But in this equation is the steady bias collector current and so $I_B R_L$ must be the steady DC voltage across $R_L$, the load resistor. This makes calculating the gain of transistor amplifiers with resistive loads a bit easier than failing off a log. Pick a value of voltage across the load resistor multiply by 40 and that's your value of gain.

For example we very often design voltage amplifiers so that about half of the supply voltage is dropped across the load resistor. For a 9 V supply that's 4.5 V. Do this and you can expect a voltage gain of $40 \times 4.5 = 180$ times. Don't believe it? It works all right; and tests on a single transistor amplifier confirm it as a rule of thumb. You don't of course expect to get a gain of exactly 180 in the case we illustrated. There are still voltages on load resistors apart from anything else, but you're never far out if that is what a rule of thumb is for.

When you couple a single transistor amplifier to another stage of course that's another story. You may have set the gain of the first stage to 180 times but not all of its output signal ends up usefully at the input of the...
Fig. 5. Calculating how much signal is passed on to subsequent stages.

Reason? The next stage has a rather low input resistance, and feeding signal from the collector of one transistor into the base of another, even if they are directly connected, is rather like feeding signal through a voltage divider. There are, in fact, two ways of calculating how much of the signal is passed on. One simple way is to imagine a voltage divider (Fig. 5) in which the load resistance of the first stage forms the upper resistor and the input resistance the of the second stage. The quantity $h_{r1}$ (in k ohms) is equal to $h_{r2} \cdot G_m$ where $h_{r2}$ is the current gain of the transistor; a quantity which does vary between one transistor and another. For a transistor with $h_{r2} = 1000$, $G_m$ set to $40 \, \text{mA} \, \text{collector current}$, $h_{r1}$ is $100 \cdot 40 = 2 \, \text{k}$. If we feed this from a transistor with a 4k7 load resistor, the amount of signal reaching the second transistor is

$$\frac{2.5}{2.5 + 4.7} = 35\%$$

of the signal at the output of the first. This brings the gain of the first transistor stage down to $180 \times 35\% = 63$ which is the sort of value we usually measure for one stage of a multi-stage amplifier.

With all this going for it $G_m$ is coming back, folks. As Sam Goldwyn is supposed to have said, "Simplicify and add lightness." Let’s hope we’ve added a bit of lightness today.

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Part two of the Click Eliminator article, presented here, is in fact a redesign of the project leading to better performance and lower cost.

In the January issue of ETI we presented a design for a click eliminator unit. However, between that issue and the time for the February ETI — in which we were to complete the project we found several disturbing inconsistencies which would have rendered the design's repeatability doubtful — to put it mildly.

These problems mainly concerned the area around Q1, IC9 and IC10. The biasing arrangement for Q1, and its function within the circuit means that the adjustments are very critical indeed. Our prototype operated satisfactorily, especially in its breadboarded form, but was too dependent upon too many variables for us to be happy with the project.

Taking Aim
The aim then, as now, was to present a design for a unit which would remove the clicks and scratches from damaged LPs without impairing the music material contained therein.

However, as we said, development work has continued since initial publication, and while we felt that there was nothing wrong with the aims of the project, our method of realising them left something to be desired.

Change Of Track
Accordingly we are presenting here an alternative design, and recommend our readers to construct this in lieu of the design shown in Part One of the article. A comparison between both circuits will show this version to be greatly simplified, and using components which will make construction cheaper.

For example the 570 has been replaced with a 4016, which is closed to the signal for a short period of time to blank the 'click' signal.

![Fig 1. Basic block diagram for Click Eliminator Mk 2]
HOW IT WORKS

The full circuit of the right pre-amp and delay line block is shown in Figure 2. The left channel circuit block is identical.

The input signal from the pick-up is fed to IC1a, which is wired as a 510 inverting amplifier with an input impedance of 47k. The output of this stage is fed to the click detector circuit and to IC1b, which is wired as a second order low pass Butterworth filter with a turnover point of about 10 kHz. This stage also has a small amount of gain in its pass band.

The output of the Butterworth filter is fed into input pin 5 of IC2, which is a TDA1022 512-stage charge-coupled delay line. The R9-RV1-R11-R12 and R10 network at the input of the IC is used to set pin 13 at about 1 volt above ground to ensure maximum dynamic range on the delay line, and to bias pin 6 into class A at minimum distortion. The delay line is clocked by symmetrical +/− phase signals to pins 3 and 4 at a few hundred kHz, to provide a total delay of about 1 ms.

The output of the delay line is taken via C13 and is used second order Butterworth filter (IC3), which removes undesired high frequency clock signals that are imposed on the audio signal by the delay line, and the cleaned-up signals are then passed on to the click blanking circuit via volume control RV2.
As the block diagrams of Fig. 1 will show, the basic remains unchanged. The incoming audio is delayed by a TDA 1022, long enough for the circuit to detect the 'click' and generate a pulse which shuts off the transmission gate (4016) as the 'click' arrives.

The waveforms shown in Fig. 8 give an indication of the timing of the circuit, and the manner in which the blank period is made to straddle the click signal.

Circuits and Components

Figures 2-6 show the schematic for the Click Eliminator. Figure 2 is the audio input and delay line circuit; Figure 3 shows the click detection and blanking pulse generation components. Inputs A and B come from points A and B marked on the left and right audio inputs respectively.

Circuits 5 and 7 are the output blanking (and bypass) and system clock respectively. The latter is referred in the audio circuit simply as Q and Q.

Construction

The unit is assembled onto a single PCB, and so construction is really quite straightforward. Assemble the board carefully, remembering to fit resistors and capacitors first, and ICs last. Sockets are best used for these devices, especially the high cost items. This will facilitate checking and servicing should this be needed.

The easiest place to make a mistake is in fitting the polarised components — electrolytics, diodes, ICs etc so check these carefully. It is best to build up the PSU first and check this before connecting to the rest of the circuit.

Fig. 3. Circuit of the click detector section of the Mk 2 Click Eliminator. The LED flashes to indicate operation.

HOW IT WORKS

The full circuit diagram of the click detector block, which incorporates a click identifier, a threshold detector, and a blanking pulse generator, is shown in Figure 3.

A 'click' or scratch has a number of unique characteristics. It has fast attack and decay times, and its output is consequently rich in high-frequency components. Also, it appears to a stereo pick-up head as a set of recorded anti-phase signals, since it causes purely vertical displacement of the stylus, whereas normal recorded signals tend to be in phase and cause predominantly horizontal movement of the stylus. The ETI Click Eliminator uses these unique phase characteristics to provide its primary means of click identification.

In the circuit, the amplified pick-up signals are taken from the outputs of the audio pre-amplifiers (IC1A, D, Fig. 2) and are passed to one or other of the two input terminals of IC4 in Fig. 3. IC4 is wired as a differential amplifier or 'subtractor,' and has a gain of about five on each input. The output of this IC is such that it amplifies the anti-phase 'click' signals but tends to cancel the predominantly in-phase recorded signals, so that the output of the IC consists of an audio signal, with greatly emphasised 'clicks.' This signal is passed to the threshold detector (IC5), which is wired as an open-loop voltage comparator, with its output normally at negative saturation.

The 'threshold,' level of IC5 can be adjusted via panel-mounted control RV3, so that the output of the IC is just held high throughout the passage of a 'clean' record. Then, each time that a 'click' arrives, the output of IC5 switches to negative saturation, to produce a large negative-going pulse. This pulse is used to trigger the monostable multi-vibrator (IC6), which has a period of about 5 milliseconds, and which drives 'click indicator' LED 1 (or 2) and drives output transistor Q1 to switch off for the duration of the 5 millisecond pulse. The output of Q1 appears as a blanking pulse, and is fed to the 'click' blanking circuit of Fig. 4.
HOW IT WORKS

The circuit of the click blanking block is shown in Figure 5. Circuit operation is fairly straightforward. The output of each channel is taken from the volume control (Fig 2) and is fed through a times-ten inverting amplifier (IC1 or IC9), and then passed to one half of IC8, a 4015 bilateral switch. In each channel, two of the internal switches of the 4015 are wired in series, and are normally held open by the high control signal from the collector of Q1 (Fig 4), but turn off for 5 ms when a blanking pulse arrives from the click detector circuit. The output of each channel is then fed to the outside world via a divide-by-ten attenuator network.

Thus, during "clear" parts of the record the output signal from the delay line is passed through the click blanking circuit of Fig 5 via the two series-connected switches of IC8 with negligible loss or gain, but in the presence of a "click" the two series-connected switches of IC8 open LmS before the arrival of the click and remain open for about 5 ms, thus replacing the click with an imperceptible blank.

The power supply is a straightforward design based on a pair of three-terminal IC regulators, which provide plus or minus twelve volt outputs. LED 2 is a panel-mounted component, which indicates the power on state.

Next assemble and check the audio circuitry. Make sure a signal is present at the level control RV2a and RV2b. Normally IC8 gates will be open, and so an audio output should be present at the phone sockets if all is well.

If no output is present, check the audio through to RV2, and if a signal is present here, the fault probably lies with IC6 and Q1. Disconnecting the base of Q1 will restore output if this is the case.

Over the Threshold

In use, the unit is connected between the output of a record player pick-up and the input of a stereo amplifier. Volume control RV2 should be adjusted so that no perceptible difference occurs in audio sound levels when the bypass switch is switched in and out. Pre-sets RV1 and RV101 should be adjusted for minimum distortion on the Right and Left channels respectively. Threshold control RV3 should be adjusted in use so that LED 1 just operates in the presence of a "click".

It should be noted that the relative amplitude of a "click" is proportional to the velocity of the record track past the pick-up head, and decreases as the head moves towards the centre of the disc. The threshold control may consequently need occasional readjustment as the record progresses through its play.

There is no equalisation circuitry within our design, and so it cannot be used in place of the preamp in your system. It must be used in front of it instead.

When playing damaged LP's simply advance the Threshold control RV3 from its minimum setting until the click is removed. This is the correct setting LED 1 will indicate the unit operation and if it flashes on musical peaks chances are you have the threshold control set too high and are removing some of the signal as well.
Being composed mainly of 'standard' components, the Eliminator should pose most component shops no problems. The LF 356 is available from Watford in case of difficulty.

**Fig 7. Component overlay for the Click Eliminator unit. Note that all the components bar the potentiometer mount on this PCB. The operation LED is also front panel mounted.**

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Resistors 101-118 for RH channel identical to R1-18

ELECTRONICS TODAY INTERNATIONAL — APRIL 1979
HOW IT WORKS

Pin 1 and 2 of the TDA 1022 delay line IC must be provided with identical clock signals for correct operation. Each clock signal is a few hundred kHz generated by a CMOS astable multivibrator formed by IC10a and IC10b. The clock signal is taken to each channel via a buffer stage (IC10d or IC10c) and a D-type flip-flop (IC11a or IC11b), which provides the required anti-phase drive signals (from Q and Qhundred kHz is generated by a CMOS outputs) for the delay line. The clock generator has RF decoupling provided by IC8, which is mounted close to the supply pins of IC10 and IC11.

Fig. 9. Some typical waveforms which illustrate the timing of the circuitry within the general block of the Click Eliminator. Blanking pulse width is fixed.

Close up of the socket wiring for the Click Eliminator. Keep these as close to the boards as possible, and use screened leads if this is not possible, earthing only one end of the screen.
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<tr>
<td>005</td>
<td>Op-Amp Supply</td>
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<tr>
<td>006</td>
<td>CMOS Switched Preamp</td>
</tr>
<tr>
<td>007</td>
<td>Star Trek Radio</td>
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<tr>
<td>008</td>
<td>Tank Battle</td>
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<tr>
<td>009</td>
<td>AM/FM Radio</td>
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<tr>
<td>010</td>
<td>Bench Amplifier</td>
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<tr>
<td>011</td>
<td>Noise Generator</td>
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<tr>
<td>012</td>
<td>Disco Lightshow</td>
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<td>013</td>
<td>Amplifier Module</td>
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<td>014</td>
<td>Skew Game</td>
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<td>015</td>
<td>UFO Detector</td>
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<td>016</td>
<td>Scale Timer</td>
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<td>017</td>
<td>Complete Sound Gen</td>
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<tr>
<td>018</td>
<td>RF Power Mover</td>
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<tr>
<td>019</td>
<td>Car Alarm (2)</td>
</tr>
<tr>
<td>020</td>
<td>Digital Tacho</td>
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<tr>
<td>021</td>
<td>Tape-PCB Switch</td>
</tr>
<tr>
<td>022</td>
<td>Large Trigger</td>
</tr>
</tbody>
</table>

**Earliest sheets are available, ring Tim Salmon for details.**

### HOW IT WORKS

Lay down the ETIPRINTS and rub over with a soft pencil until the pattern is transferred to the board. Peel off the backing sheet carefully making sure that the resist has transferred. If you've been a bit careless there's even a 'repair kit' on the sheet to correct any breaks!

### BUY LINES

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ETI PRINT, E. T. MAGAZINE
25/27 OXFORD STREET, LONDON W1 1RF

75p INC P & P
**Operational Amplifiers (Op Amps)**

There are many different types of Op Amps, and they are manufactured by several different companies. Most of these companies produce standard Op Amp devices but they put their own twist on them.

In recent years, the trend has been to design ICs with more than one Op Amp inside. This has resulted in a range of dual and quad Op Amp packages. Texas Instruments brought out a range of 128 Op Amps. These are pin-compatible with standard ICs but they differ in that they have full input giving them higher input impedance.

**Chart I** shows comparative performance for several standard Op Amp types. The parameters chosen are the most important ones when selecting Op Amps.

**Audio Amplifiers.** Several manufacturers produce monolithic medium power amplifiers for audio use. This makes the design of small audio amplifiers easier. There are some pitfalls to watch out for in OP Amps, however, the designer of the power stage is often unaware of the limitations of the power stage when designing for efficiency and ease of use.

**Multiplexers**

The range of multiplex ICs has never been so large, but recently a few more have been added to the last list of ICs used in non-linear electronic systems. These systems produce a stable output signal and noise ratio over the line. Another very common stage is the D/A chip. The combination of these two devices is difficult to obtain without an error.

**Oscillators**

Oscillators are in many oscillators (CLC) that can produce a waveform with periods of several hours to tens of seconds. For high frequency work there is the 50/60Hz line, and the 50/60Hz line is the 50/60Hz line. These are used in the design of the power stage that is often used for audio purposes. The 50/60Hz line also makes a wide range of CO modules. The 50/60Hz line and the 50/60Hz line are often used for audio purposes. The 50/60Hz line is a complex system that produces the output waveform and sounds like noise. Chart 3 details the most common types.

---

**CHART I**

<table>
<thead>
<tr>
<th>Op amp type</th>
<th>Input Offset voltage</th>
<th>Input bias current</th>
<th>Type of input structure</th>
<th>Bandwidth MHz</th>
<th>Slow roll off V/VNS</th>
<th>Voltage gain dB</th>
<th>Maximum power supply voltage V</th>
<th>CMRR dB</th>
<th>C1</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>709</td>
<td>2</td>
<td>300</td>
<td>NPN</td>
<td>1</td>
<td>0.25</td>
<td>90</td>
<td>±18</td>
<td>90</td>
<td>S</td>
<td></td>
</tr>
<tr>
<td>707</td>
<td>2</td>
<td>70</td>
<td>NPN</td>
<td>1</td>
<td>0.25</td>
<td>10</td>
<td>±18</td>
<td>90</td>
<td>S</td>
<td></td>
</tr>
<tr>
<td>704</td>
<td>2</td>
<td>70</td>
<td>NPN</td>
<td>10</td>
<td>0.5</td>
<td>106</td>
<td>±18</td>
<td>90</td>
<td>S</td>
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</tr>
<tr>
<td>703</td>
<td>2</td>
<td>80</td>
<td>NPN</td>
<td>1</td>
<td>0.5</td>
<td>106</td>
<td>±18</td>
<td>90</td>
<td>S</td>
<td></td>
</tr>
<tr>
<td>702</td>
<td>1</td>
<td>120</td>
<td>NPN</td>
<td>10</td>
<td>0.5</td>
<td>103</td>
<td>±22</td>
<td>90</td>
<td>S</td>
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<tr>
<td>308</td>
<td>2</td>
<td>1.5</td>
<td>NPN</td>
<td>3</td>
<td>0.5</td>
<td>110</td>
<td>±18</td>
<td>100</td>
<td>D</td>
<td></td>
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<tr>
<td>318</td>
<td>4</td>
<td>150</td>
<td>NPN</td>
<td>15</td>
<td>50</td>
<td>106</td>
<td>±20</td>
<td>100</td>
<td>S</td>
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<tr>
<td>747</td>
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<td>4135</td>
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<td>110</td>
<td>±18</td>
<td>100</td>
<td>D</td>
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<tr>
<td>3900</td>
<td>2</td>
<td>30</td>
<td>Current</td>
<td>25</td>
<td>0.5</td>
<td>70</td>
<td>±18</td>
<td>20</td>
<td>D</td>
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<td>324</td>
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<td>1</td>
<td>12</td>
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<td>1</td>
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<td>90</td>
<td>Q</td>
<td></td>
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<td>348</td>
<td>1</td>
<td>30</td>
<td>NPN</td>
<td>1</td>
<td>0.5</td>
<td>103</td>
<td>±18</td>
<td>90</td>
<td>Q</td>
<td></td>
</tr>
</tbody>
</table>

*Notes:* Needs frequency compensation

- Internal frequency compensation
- Wide input voltage range
- Low noise
- Balanced input amplifier
- Grounded input amplifier
- Output voltage can go to ground
- Low power 3.0mA drain per IC
- Class A output
- Class AB output
- Low power 2.4mA drain per IC
- Class A output
**MONOLITHIC PREAMPLIFIER AND POWER AMPLIFIER SURVEY**

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Part No</th>
<th>Description</th>
<th>Voltage Gain</th>
<th>Input Bias Current mA</th>
<th>Frequency Range MHz</th>
<th>CMRR dB</th>
<th>100 kHz Gain dB</th>
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</thead>
<tbody>
<tr>
<td>Texas Instruments</td>
<td>745-24</td>
<td>JFET - 500k to 100MHz</td>
<td>80 dB</td>
<td>100</td>
<td>2.5 to 3.5</td>
<td>100</td>
<td>80</td>
</tr>
<tr>
<td>Exar</td>
<td>10-1000</td>
<td>NPN - 20kHz to 1kHz</td>
<td>100</td>
<td>20</td>
<td>50 to 25</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>RCA</td>
<td>1222DC</td>
<td>JFET - 10kHz to 30kHz</td>
<td>100</td>
<td>100</td>
<td>50 to 25</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

**OSCILLATOR SURVEY**

<table>
<thead>
<tr>
<th>Oscillator</th>
<th>Frequency Range MHz</th>
<th>CMRR dB</th>
<th>100 kHz Gain dB</th>
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</thead>
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<tr>
<td>50 VCO</td>
<td>10 to 200</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>50 kHz</td>
<td>10 to 200</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

**ELECTRONICS TODAY INTERNATIONAL - APRIL 1979**

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  - **777**
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  - **771**

**REMARKS**

- **PNP**
- **NPN**
- **MOSFET**
- **JFET**

**APPLICATIONS**

- **Video**
- **Audio**
- **Microwave**

**COMMENTS**

- **Filtering devices only**
- **Low noise audio amplifier**
- **Low noise video amplifier**
- **Amplifier amplifier**
- **High frequency compensation**
- **Ground sensing inputs**
- **Very high input impedance**
- **Needs frequency compensation**
- **Ground sensing inputs**
- **Very high input impedance**
- **Needs frequency compensation**
- **OTA device programmable gain**
- **Current output**
- **OTA device programmable power switch amplifier**

**CIRCUITRY**

- **JFET**
- **MOSFET**
- **JFET**
- **CIRCUIT**

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- **Resistors**
- **Capacitors**

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- **LED or Cathode**
- **Noise**
- **Random Noise**

**INDEXING**

- **USA University**
- **NC**
- **Frequency**
- **Switching mode**
TELEPHONE CALL TIMER

Submitted by Mr. A. M. Tucker of Dorchester

TO CARRY OUT its function, which is to display the cost of individual calls, and also to keep a running total of all metered calls, the circuit must add the amount of the unit charge (at present 3p) to each register when the call commences, and subsequently at the end of each charge period. This period will vary for peak, standard and cheap times, and with distance. Provision should be made for altering the settings of the counting circuits if there is a change in the Post Office charges.

Various circuits were considered, and this was considered to be as cheap to make as any for the facilities provided, as although there is a large number of ICs the bulk are low priced.

The two sets of figures are circulated in a single shift register, the shift being reversed so the least significant figure in one register is followed by the most significant figure in the other register, and then by the next figure in the first register, and so on.

In order to be able to adjust the unit charge, and the number available per unit, the outputs of the dividers are connected to two sets of relays, which leads from the inputs of the resetting gates are plugged. These gates plus the locking gates for spare gates, can be made from IC sockets or soldering pads in plastic supports. To prevent damage, the pins of sockets when cutting into sections, push into a piece of rigid foam plastic. The wiper leads are just lengths of connecting wire. Solid core is suitable if stranded wire is used on the end and check that it is thin enough to insert into the socket.

In the interests of economy, small low consumption displays have been used. If larger displays are required, it will probably be necessary to add segment drivers. The drivers should then be supplied from the unregulated side of the supply, and S1 made a double pole switch.

The 9-volt standby battery is essential, as otherwise the total cost register would be cleared in the event of a mains failure. In order to reduce consumption during idle time, the counters IC1 and IC2 and their associated gates, the oscillator IC21 and the display buffers and driver IC23 IC26 are switched off by S1. It is unusual to try to include other ICs as some inputs may be high. In any case, with the oscillator off, power consumption is very low in the remaining circuits.

It may simply be wired of a 4001 and a 4011 are substituted for the 4069. One NOR gate can be used instead of IC20a and IC22a, and a choice of ICs is available for the other inverters.

The meter can be adapted for battery power only by including a 4518 to divide the 10 kHz oscillator frequency down to 100 Hz and doubling the division in IC1 by shifting each line up one place to the right. Setting the oscillator frequency exactly can be carried out either by comparing the 100 Hz output with 50 Hz from the mains on an oscilloscope, or by varying the setting until the charges are incremented at 10 second intervals for long distance calls at peak rates.

Decoupling capacitors for pulses in the supply lines may be required, while CMOS is less than 10 l in the respect. 10 nF non-inductive capacitors should be fitted across the supply pins of ICs at the end of supply lines.

A flashing LED is provided as an indication and reminder that the timing circuits are operating.

HOW IT WORKS

PARTS LIST
This new feature is open to all our readers. It exists as a showcase for projects YOU have designed and built. We pay full ETI page rates for any designs we publish. We must stress that these designs must have been built by you. To further this end, we are giving preference to those which arrive at our offices with photographs, or which can be photographed by us. Initially a simple draft outlining the idea behind the project and what the unit can do is all that is required. Photographs should be included at this stage.

Write to 'Readers Designs,' ETI Offices, 25-27 Oxford Street, London, W1R 1RF.

Fig. 1. Call timer circuit.
## Capacitors

<table>
<thead>
<tr>
<th>Type</th>
<th>Order Code</th>
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</thead>
<tbody>
<tr>
<td>Electrolytic</td>
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<tr>
<td>Ceramic</td>
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<td>Paper</td>
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<tr>
<td>Tantalum</td>
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## Resistors

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## Vero Electronics Products

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<td>Vacuum Tubes</td>
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## Hardware

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<tr>
<td>Adapters</td>
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## Cases

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</tr>
<tr>
<td>Piano Black Case</td>
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## Pricing

All prices in pence each unless otherwise stated.
## Digital Integrated Circuits

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<th>Quantity</th>
<th>Price</th>
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<td>IC101</td>
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<tr>
<td>IC102</td>
<td>74LS244</td>
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## Linear Integrated Circuits

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<td>74HC164</td>
<td>4-Bit Parallel-in, Serial-out</td>
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<td>74HC165</td>
<td>4-Bit Serial-in, Parallel-out</td>
<td>30</td>
<td>1.75</td>
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</tbody>
</table>

## GMT Electronics

- **Free Post On Orders**
- **Barclaycard**
- **Cash**
- **Cheque**
- **VAT Inclusive Prices**

**Add 30p P&P**
**24 hr Telephone Answering Service**
**Tel Orders Welcome**

**Address:**
Birmingham B19 1BR

---

**Switches**

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<td>DPDT 10A 125V</td>
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**Semiconductors**

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<tr>
<td>PNP Transistor</td>
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**Communications Integrated Circuits - Flexivar**

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<tr>
<td>MAX232</td>
<td>MAXON 232</td>
<td>25</td>
<td>1.75</td>
</tr>
</tbody>
</table>

---

**Contact:**

**GMT Electronics**
Freepost
Birmingham B19 1BR
You probably won't believe us as we're selling the goods but we're going to tell you anyway! We have selected eight clock radios for the marketplace. They were all cheap enough but the quality was so poor that we couldn't have lent our name to them. However, we are now able to offer a portable LCD clock radio to you which meets our standards.

The clock is a 12-hour one with AM/PM indication and a back light. The radio is Medium Wave and FM with very nice quality for a small speaker — for FM there's a telescopic aerial. The alarm can be either a beep-beep type or the radio there's also a snooze facility.

The case is very rugged and is painted on the back with a World Time Zones map; a bit unusual really, especially as the time is relative to Japan!

We won't even mention the RRP — but just check on comparable prices — you'll find ours a bargain.

An example of this clock radio can be seen and examined at our Oxford Street offices.

£20.50
(Inclusive of VAT and Postage)

To
CLOCK RADIO Offer
ETI Magazine
25-27 Oxford Street, London W1R 1RF

Please find enclosed my cheque for £20.50 (payable to ETI Magazine) for my Clock Radio.

Name
Address

Please allow 28 days for delivery

LADIES LCD WATCH

And don't you ever say we don't listen to you again! Ever since we first did a gentleman's watch, we have been dealing with a constant never-ending stream of requests for a ladies model. Well at last we can claim to have done something about it.

It wasn't easy arranging the sort of price on a product like this — but ETI is known for giving value for money and the watch is no exception. The watch is small enough to look good on the prettiest wrist, and accurate enough to satisfy the most fussy lady. Normal display shows time of day, with both date and day displayed as a push of a button. A backlight is also included. Battery life should be in excess of a year, and the case is constructed of a strong stainless steel.

An example of this watch can be seen and examined at our Oxford Street offices.

£9.95
(Inclusive of VAT and Postage)

To
LADIES LCD WATCH Offer
ETI Magazine
25-27 Oxford Street, London W1R 1RF

Please find enclosed my cheque for £9.95 (payable to ETI Magazine) for a ladies LCD watch.

Name
Address

Please allow 14 days for delivery

DIGITAL ALARM

This is the third digital alarm clock that we are offering (we regret that the earlier versions are no longer available). We have sold thousands and thousands of these and our buying power enables us to offer a fast new branded product at a really excellent price.

The Hamex HC-1100 is designed for mains operation only (240V/50Hz) with a 12 hour display, AM/FM and Alarm Set indicators incorporated in the large display. A switch on the top controls a Dim Bright display facility.

Setting up both the time and alarm is simplicity itself, as buttons are provided for both fast and slow setting and there's no problem about setting these accurately as a locking switch is provided under the clock. A 9 minute snooze switch is located at the top.

A example of this clock can be seen and examined at our Oxford Street offices.

£8.95
(Inclusive of VAT and Postage)

To
Hamex Alarm Offer
ETI Magazine
25-27 Oxford Street, London W1R 1RF

Please find enclosed my cheque for £8.95 (payable to ETI Magazine) for a Hamex Digital Alarm Clock.

Name
Address

Please allow 28 days for delivery

ELECTRONICS TODAY INTERNATIONAL — APRIL 1979
LCD CHRONO

We feel we've got to tell you carefully about this offer which we're introducing for the first time. Why? Because our price is so enormously lower than anywhere else you may suspect the quality.

The exact same watch is currently being offered by another magazine at a special at \$2.55 — some of the discounters are selling it at \$2.65! The price to ETI readers for exactly the same watch is \$12.95.

The display is LCD and shows the seconds as well as the hours and minutes, so you'll get the date and the day of the week.

A sample of this watch can be seen and examined at our Oxford Street offices.

£12.95
(Inclusive of VAT and Postage)

DIGITAL ALARM MK2

Both ETI and Hobby Electronics have sold a lot of digital alarm clocks — over 10,000 in fact! — so that's something to do with the fact that we sell at retail bargain prices. Now we can offer you a truly modern space age model.

It includes all the facilities expected in a good design — fast, slow setting, snooze facility, etc. plus two unusual features — automatic brightness control and a weekend alarm cancel.

An example of this clock can be seen and examined at our Oxford Street offices.

£10.50
(Inclusive of VAT and Postage)

ALARM CHRONO LCD

Currently this watch is being discounted elsewhere for typically £33.95. We don't quote RRP as this is meaningless and the watch is a Chinese copy of a very famous one in the £100 range.

The features are exceptional:

- Normal hours and minutes
- Continuous seconds or data display
- Day of the week
- Stopwatch with 0.1 second resolution
- Lap time facility with automatic return to stopwatch after 8 seconds
- Different time zone setting with independent clock hands
- Sleep alarm
- Easy time correcting; automatic time compensation

Press a button and it's reset in 60 seconds as long as watch is plused or moved 20 seconds.

An example of this watch can be seen and examined at our Oxford Street offices.

£27.95
(Inclusive of VAT and Postage)

To:
LCD Watch Offer
ETI Magazine
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Electronics Today International — April 1979
AMBUSH! is bound to rate as the most fascinating, exciting, and addictive space game of the year. It gives visual and sound effects of a space battle, and is loaded with realism. Impress your friends and enemies by building this unique and fascinating game.

AMBUSH! is a space game par excellence. It represents a space ship (yours) that is about to be attacked by a fleet of suicide craft. The craft can attack you on one of four randomly selected quadrants. The attacks come one at a time at random, and are selected from one of four intervals that vary between zero and five seconds. Your ship has a limited store of ammunition, and you can defend the vessel with one of four FIRE buttons. You have to hit the correct one of those buttons to stop the attack; if you hit more than one button at a time you use up ammunition at an excessive rate.

The game continues until all the attacking craft are destroyed or until you are wiped out. You can be wiped out by being too slow in hitting a FIRE button, or hitting the wrong FIRE button, or by running out of ammunition through incorrect operation of the FIRE buttons. You can choose to face an attack by either a DEK or a CENT. A DEK suicide craft carries four missiles, and a CENT carries only one missile, but ammunition storage is automatically selected to suit the type of game chosen. A DEK game typically takes less than one minute to play. A CENT game takes several minutes.

Sound and Light

The game is loaded with audio and visual effects. On the sound side, there are individual notes to represent an attack, or the firing of FIRE weapons, and to indicate the winning or losing of a game. The level of the ATTACK sound varies with the quadrant of attack. Attacks from the front are heard more clearly than those from the rear, and vice versa. The sound volume and those from all are adjustable.

The visual effects are also quite impressive. The attacks are shown by an array of LED's arranged in the form of a cross with arms of varying lengths. The upper arm represents the forward attack quadrant and comprises five orange LED's. The lower arm represents the aft attack quadrant and comprises seven green LED's. The port and starboard arms each comprise six yellow LED's. At the centre of the cross is a red LED, representing your own ship. The game is also provided with an ammunition level indicator in the form of a three colour column of ten LED's and with a two-digit attack counter with seven-segment LED readouts. There are individual LED's set to indicate the GAME WON and GAME LOST states.
Science Project

Ambush! is a CMOS based design of considerable technical interest, and should make an excellent educational project for schools and colleges. It uses seventeen IC’s plus a couple of transistors. The IC types range from simple NAND and NOR gates to complete decade counter-decoder chips, and include flip-flops, data latches, 12-stage ripple counters, and multiplexers.

Playing The Game

Game Start. The game starts as soon as power is applied to its circuits. A game can be restarted by pressing the RESET switch.

Attacks:
1. The game can be set for play against either ten (a DEK) or a hundred (a CENT) attacks.
2. Attacks come at random intervals, variable between nought and approximately five seconds.
3. The quadrant of each attack is randomly selected, except for the first attack of the game, which always comes from the aft quadrant.
4. The speed of attack can be pre-set by the player to suit skill levels. A ‘respectable’ attack speed is equal to about 50 mS per LED division on the quadrant attack indicator.
5. At ‘respectable’ attack speeds, the player has approximately 250 mS of attack warning on the forward quadrant, 300 mS on the port and starboard quadrants, and 350 mS on the aft quadrant.
6. Attacks on the aft quadrant are accompanied by a full volume staccato sound. Port and starboard attacks are at reduced volume, and those from the forward quadrant are silent.
7. The accumulated number of attacks is registered on a 2-digit display throughout the game.

HOW IT WORKS

SIMPLIFIED BLOCK DIAGRAM OF THE AMBUSH GAME

The heart of the unit is the Display Matrix Driver and Logic block, which in reality takes the form of a 4017 decade counter with ten decoded outputs. Outputs 1 to 7 of the counter are fed to the LED display matrix, and outputs 6 and 7 are selectively fed via a multiplexer to the GAME LOST indicator block and to the CLOCK DISABLE pin of the 4017. The input of the 4017 is derived from a clock generator via a gate, which in turn is controlled by a simple START-STOP (Reset-Set) bistable.

The operating sequence of the above six blocks is fairly simple. Initially, the bistable is in the STOP mode, the gate is closed, the 4017 is in the RESET state, and all LED’s in the display matrix are off. At some randomly determined time, a START pulse is fed to the bistable; the gate opens, clock pulses start to reach the 4017, and LED’s are sequentially switched on in one of the arms of the display matrix. If the gate remains open, one of the selectively chosen 6-7-R outputs of the 4017 eventually goes high and operates the GAME LOST indicator and disables the clock input line of the 4017.

Alternatively, the bistable can be set to the STOP mode before the game terminates by operating the appropriate FIRE switch. In this case, the bistable closes the clock gate, and the 4017 reverts to the zero state. A new sequence of operations starts when another random START pulse is fed to the input of the bistable. Note that output 1 of the 4017 is fed to the ATTACK COUNTER, so that the counter advances by one count each time the clock generator gate opens. The game ends shortly after the attack counter reaches its full (at 10 or 100) state, at which point the GAME WON indicator circuits come into operation.

The START signal to the bistable is derived from the random delay generator, which is integral with the FIRE switch circuitry. In each attack, the appropriate one of the four FIRE switches is selectively coupled to the STOP side of the
DEFENCE

(a) The player has four FIRE buttons for defence. The buttons are marked F (forward), P (port), S (starboard), and A (aft). To stop an attack, the player must press the FIRE button appropriate to the prevailing attack quadrant before the attacking vessel reaches its target (the red LED at the centre of the display). A correct firing is accompanied by a rasping sound. No sound is produced if the wrong button is pressed.

(b) The ship has sufficient ammunition to fight off attacks only if each FIRE duration is limited to about 100 ms or less. Thus, there is sufficient ammunition for about one second of continuous fire in the DEK game, and ten seconds of fire in the CENT game. The ammunition state is shown on a register throughout the game.

(c) When the correct FIRE button is pressed, the rate of ammunition usage is directly proportional to the total number of FIRE buttons that are pressed at that time. Thus, if all the fire buttons are pressed at once, the ammunition supply will exhaust in 0.25 seconds in the DEK game or 2.5 seconds in the CENT game. The audio frequency of the FIRE sound is proportional to the rate of ammunition usage. When the ammunition store is exhausted, the player has no defence, and loses the game after the next attack.

GAME LOST. The player loses the game by having his starship hit by an attacking suicide craft. When the game is lost the red LED at the centre of the attack quadrant indicator turns off, and simultaneously a loud droning noise is generated and a red GAME LOST LED flashes on the control panel.

GAME WON. The player wins the game by defeating all attacks. At GAME WON a green LED illuminates on the control panel, and a coarse beating or throbbing sound is generated.

Electronics Today International — April 1979
HOW IT WORKS

RANDOM DELAY and 'FIRE' SOUND GENERATOR, plus 'FIRE' RATE SELECTOR and FIRE SWITCH MULTIPLEXER

This is probably the most complex 'block' in the entire game, because most of its individual sections are independent. Fig. 2 shows the circuit diagram of this major 'block'.

THE FIRE SOUND GENERATOR

Let's deal first with the FIRE SOUND GENERATOR. IC2 is one half of a 4017 dual 4-channel multiplexer. This connects a selected one of its four inputs to its output, depending on the \( S \) - \( 1 \) binary code signal that is fed to its \( S \) inputs (pins 9 and 10) terminals. Thus, when the appropriate one of the four FIRE switches is pressed, a logic 1 signal appears at output pin-4 of the multiplexer. This signal is debounced by R8-C6 and R9, and is passed to the signal input of the INHIBIT GATE formed by IC3/3 and IC3/4. It passes signals only when its \( G \) input is at logic 0; pin-1 is the \( G \) terminal of this particular gate, and is tied to ground via R5 but can be driven high by the inputs of the LOSE and OUT OF AMMO detectors. The gate thus passes on the FIRE switch signals only when the game is not lost and the ammunition store is not exhausted.

The output of the inhibit gate is used to activate a gated FIRE sound oscillator designed around IC3/3 and IC3/4. The main timing components of this oscillator are C2 and R12 to R15. These timing resistors are connected via IC1, which is a 4016 quad bilateral switch, which has each of its four internal switches activated by one of the four FIRE switches. These internal switches are normally open, and close when their appropriate FIRE switch is closed.

Thus, the complete action of the 'FIRE' sound generator is such that a sound is produced only when the correct FIRE switch is pressed, and only when the game is not lost or the ammunition exhausted. The frequency of the sound is proportional to the total number of FIRE switches pressed and varies from about 800 Hz for one switch, to about 320 Hz for four switches.

The pin 4 output of the 'FIRE' oscillator is low in the normal quiescent state, and its signals are passed to the input of an audio amplifier for sound effects, and also to the inputs of the ammunition register and the Random Delay generator. An inverted output (normally high) is also taken from the output of the oscillator and is fed to the WIN LOGIC circuitry. Note that the gate input signal of the oscillator is also fed to the STOP side of the bistable.

THE RANDOM DELAY GENERATOR

The heart of the random delay generator is IC4, a 4017 decade counter with ten decoded outputs (numbered 0 to 9); the '9' output of the counter is coupled to the START side of the bistable via a normally-ON inhibit gate. The clock input to the counter is derived from a slow oscillator IC10-1 and IC10-2 and from the 'FIRE' oscillator output via an OR gate formed by D1-D2 and R3.

Whenever the correct FIRE button is pressed during an attack a logic 1 signal is fed to the '6' (pin 13) terminal of the inhibit gate, which turns off and blocks the signals from the 4017 counter. Simultaneously, fast clock signals are fed into the counter from the 'FIRE' sound generator. Consequently, when the FIRE switch is released and the inhibit gate returns to the ON state the counter is an unknown or random number of steps from the '9' count (which is the one that provides the START signal to the bistable). Clock signals are then fed to the counter from the slow oscillator only after a delay that is infinitely variable from zero to about five seconds, the counter reaches the '9' state and feeds a START command to the bistable.

THE BISTABLE, CLOCK GENERATOR, 'ATTACK' SOUND MULTIPLEXER and 'GAME LOST' INDICATORS

The bistable is a simple R-S type, made from a pair of NOR gates (IC1W and IC1X). Its 'START' input is driven from the random delay generator via C4, and 'STOP' inputs are obtained from the 'FIRE' logic or the GAME LOST detector circuit via the D6-D7-R30 diode OR gate. The pin-1 output of the bistable is normally high but goes low in the 'START' mode, and is fed to one input of the IC1W NOR gate, which provides the clock input signal to IC12 (the display matrix counter driver). The other input of the NOR gate is obtained from the variable-speed CLOCK GENERATOR (IC10-1 and IC10-2) or from the WIN DETECTOR circuit via the D4-D5-R23 diode OR gate.

Thus, input pin-8 of the NOR gate is normally high and its output is locked low, so it is unable to pass clock signals. When a 'START' signal is fed to the bistable from the random delay generator, input pin-8 of the gate is driven low, and it does pass clock signals. The gate is turned off again when a 'STOP' signal is fed to the bistable from the 'FIRE' logic circuitry. Note that the gate gets locked into the off state if a logic 1 signal is fed to its pin 8 input from the WIN detector (via D4) or if a logic 1 'GAME LOST' signal is fed to the 'STOP' side of the bistable.

The IC10-1 and IC10-2 clock generator determines the speed of any attack, and its frequency is variable via RV1. The clock signal appearing at the pin-11 output of the IC10-3 NOR gate provides the basic 'ATTACK' sound of the game. The amplitude of this sound is determined by multiplexer IC2/2 and resistors R31 and R32. Attacks from the aft quadrant are at full volume, those from port or starboard are at reduced volume, and those from the forward quadrant are silent.

The 'GAME LOST' indicators use four NAND and one NOR gates: their basic input signals are obtained from pin-10 of IC12, which is normally low but goes high under the game lost condition IC9/3 wired as a simple inverter, and drives the
THE AMMO REGISTER, RANDOM MULTIPLEX CODE GENERATOR AND LATCH, AND RESET LINE CONTROL

This block is relatively simple in its theory of operation. IC7 is a 4040 12-stage ripple counter, and takes its clock input from the output of the 'FIRE' sound generator. ICS is a 1013 dual D flip-flop, which is wired as a dual data latch with its clock signal taken from the output of the bistable and its data taken from the Q2 (Q2) and Q2 (Q1) outputs of IC7. Thus, whenever a FIRE button is pressed and then released, IC7 sets randomly determined states on the data inputs of ICS. The next time that the output of the bistable goes high (as an attack begins, on receipt of the bistable START command), these states are latched into the 4013 and are pressed on to the games multiplexers as a 2-bit binary code.

HOW IT WORKS

DEK (ten attack) game the Q7 (Q7) output is fed to the clock input of IC6, giving a clock signal of about 6.2 Hz when a single FIRE button is operated, and thus causing the register to empty in about 1.5 seconds. When SW2 is set for a CENT (hundred attack) game the Q10 (Q10) output is fed to IC6, giving a clock frequency of about 0.8 Hz from a single FIRE button, and causing the register to empty in about 11.2 seconds. Thus, to win a DEK game the average FIRE duration must be limited below 150 mS in each attack and in the CENT game it must be limited below 112 mS.

The games main reset line is activated automatically at switch-on via SW2. The line can be operated manually at any time via RESET button PBS.
The main part of the LED display matrix is made up of four lines of LED's arranged in the form of a cross. The upper (forward) line is five LED's long, the lower (aft) line is seven LED's long, and the other two lines are each six LED's long. The individual LED's in each line are selected by IC12, a 4017 decade counter with ten decoded outputs, and the lines are selected by multiplexer IC13/1. Note that diodes D15 to D25 are used to eliminate sneak paths in the matrix, and ensure that only a single selected LED turns on at any one time. Figure 6b shows the positions of the LED's in the actual display. Note that LED 11, at the centre of the display, is normally on and represents the player's own vessel.

Prior to the start of each attack IC13 is in the RESET state, so all LED's in the matrix (except LED 11) are off. As soon as an attack starts IC13 selects a line of length 'n' in the display matrix, and IC13/1 selects a line of length 'm' in the matrix. Figure 6d shows the positions of the LED's in the actual display. Note that LED 11, at the centre of the display, is normally on and represents the player's own vessel.

The attack is not defeated, pin-13 of IC12 is driven high as the counter reaches the 'n+1' state, and all further clock signals are inhibited and all GAME LOST indicators are activated.

The game is powered by a 12 V battery supply, and typically consumes 50 mA to 150 mA of current, depending on the state of play. Readers can, if they wish, power the game via a mains adaptor.
HOW IT WORKS

The attack counter and game

TLI output of IC12 (the display matrix driver) briefly goes high at the start of each attack. This 'I' signal provides the clock signal to the IC14-IC15 attack counter. These two ICs are 4026 decade counters with decoded outputs suitable for directly driving common cathode 7-segment LED displays at low power levels. The two counters are cascaded to give 00 to 99 indications.

Leading zero suppression is not used in the counter.

The 'GAME WON' detector is designed around IC16, a 4013 dual D-flip-flop, and IC17, a NOR gate. IC16/1 is connected as a bistable divider stage and is clocked via one or other of the attack counter outputs. The action is such that its Q output is normally high, but switches low at the start of the 10th attack in a DEK game or the 100th attack in a CENT game. The Q output is fed to one of the inputs of the IC17 NOR gate, which has its other input provided from the normally-high output of the IC9 'FIRE' sound generator. The output of the NOR gate is fed to the SFY (pin 8) terminal of IC15-2, which is wired as an R-S flip-flop. Both bistables are reset at the start of each game.

The action of the complete 'GAME WON' detector is such that 'FIRE' signals are fed to one input of the NOR gate each time a 'FIRE' signal is generated but are unable to reach IC16/2 until IC16/1 changes state after the start of the 10th (in a DEK game) or 100th (in a CENT game) attack, at which point the Q output of IC16/2 goes low and drives green 'WIN' LED 37 'ON' via IC9/4, and the Q output goes high and activates the 'WIN' sound generator.

The 'WIN' sound generator is designed around IC17, and consists of two virtually identical medium-frequency gated astable multivibrators which are operated in parallel and have their outputs fed to the audio amplifier via the D26-D27-R46 diode OR gate. Because of inevitable slight differences in timing component values, these two astables oscillate at slightly different frequencies, and produce a coarse 'beating' or 'throbbing' sound when they are activated by the 'WIN' detector.

Next month we conclude the project with full constructional details and component overlays. In addition we'll show you the act of inspired heroism which led to the saving of the starship Eatyeigh and the designing of this project! For those who to get started the parts List and circuit diagrams given here are complete.
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ELECTRONICS TODAY INTERNATIONAL — APRIL 1979
3080 CIRCUITS

The 3080 is not a run of the mill op amp. These ten circuits from Tim Orr show you why.

The CA3080 is known as an operational transconductance amplifier (OTA). This is a type of op amp: the gain of which can be varied by use of a control current, \( I_{AC} \). The device has a differential input, a control input known as the Amplifier bias input, and a current output. It differs in many respects from conventional op amps and it is these differences that can be used to realize many useful circuit blocks.

Voltage Controlled Amplifier

The CA3080 can be used as a gain controlling device. The input signal is attenuated by \( R_1, R_2 \) such that a 20 mVpp signal is applied to the input terminals. If this voltage is much larger, then significant distortion will occur at the output. In fact, this distortion is put to good use in the triangle-to-sine wave converter. The gain of the circuit is controlled by the magnitude of the control current \( I_{AC} \). This current flows into the CA3080 at pin 5. If you connect pin 5 to 0 V, then this diode will get zapped, (and so will the IC!) The maximum value of \( I_{AC} \) permitted is 1 mA and the device is linear over 4 decades of this current. That is, the gain of the CA3080 is linearly proportional to the magnitude of the \( I_{AC} \) current over a range of 0.1 \( \mu A \) to 1 mA. Thus, by controlling \( I_{AC} \), we can control the signal level at the output. The output is a current output which has to be 'dumped' into a resistive load (\( R_5 \)) to produce a voltage output. The output impedance seen at IC1 pin 6 is 10k \( \Omega \), but this is 'unloaded' by the voltage follower (IC2) to produce a low output impedance. The circuit around IC3 is a precision voltage-to-current converter and this can be used to generate \( I_{AC} \). When \( V_{IN} \) (control) is positive, it linearly controls the gain of the circuit. When it is negative, \( I_{AC} \) is zero and so the gain is zero.

This type of circuit is known by several names: it is a voltage controlled amplifier (VCA), or an amplitude modulator, or a two-quadrant multiplier.

One problem that occurs with the CA3080 is that of the 'input offset voltage'. This is a small voltage offset between its input terminals. When there is no signal input and the control input is varied a voltage similar to the control input will appear at the output. By adjusting \( R_1 \) it is possible to null out most of this control breakthrough.
Triangle To Sinewave Converter

By overloading the input of a CA3080 it is possible to produce a 'sinusoidal' transfer function. That is, if a triangle waveform of the correct magnitude is applied to the CA3080 input, the output will be distorted in such a way as to produce a sinewave approximation. In the circuit shown, RV1 is adjusted so that the output waveform resembles a sinewave. I tested this circuit using an automatic distortion analyser and found the sinewave distortion to be only 1.8%, mostly third harmonic distortion, which, for such a simple arrangement, seems very reasonable indeed. This could be used to produce a sinewave output from a triangle/square wave oscillator.

Schmitt Trigger

Most Schmitt trigger circuits prove to be very complicated when it comes to calculating the hysteresis levels. However, by using the CA 3080 these calculations are rendered trivial plus there is the added bonus of fast operation. The hysteresis levels are calculated from the simple equation:

\[ V_{\text{Hyst}} = (I_{\text{ABC}} \times R2) \]

The output squarewave level is in fact equal in magnitude to the hysteresis levels. The circuit operation is as follows:

Imagine the output voltage is high. The output voltage will then be equal to \((R2 \times I_{\text{ABC}})\) which we will call \(+V_{\text{Hyst}}\). If \(V_{\text{in}}\) becomes more positive than \(+V_{\text{Hyst}}\), the output will start to move in a negative direction, which will increase the voltage between the input terminals which will further accelerate the speed of the output movement. This is known as regenerative feedback and is responsible for the schmitt trigger action. The output snaps into a negative state, at a voltage equal to \(- (R2 \times I_{\text{ABC}})\) which is designated as \(-V_{\text{Hyst}}\). Only when \(V_{\text{in}}\) becomes more negative than \(-V_{\text{Hyst}}\) will the output change back to the \(+V_{\text{Hyst}}\) state.

The Schmitt trigger is a very useful building block for detecting two discrete voltage levels and finds many uses in circuit designs.
Voltage Controlled Oscillator

By using two CA2080’s and some op amps it is possible to make an oscillator, the frequency of which is voltage controllable. This unit finds many applications in the field of electronic music production and test equipment. The circuit has been given a logarithmic control law, that is, the frequency of operation doubles for every volt increase in the control voltage. This makes it ideal for musical applications where linear control voltages need to be converted into musical intervals (which are logarithmically spaced) and also for audio testing where frequencies are generally measured as logarithmic functions.

IC2 is an integrator. The base current that drives this IC is used to charge or discharge C1. This produces triangular waveforms which are buffered by IC3, which then drives the Schmitt trigger IC4. The hysteresis levels for this device are fixed at -1.5V, being determined by R6, R7.

The output of the Schmitt is fed back in such a way as to control the direction of motion of the integrator’s output. If the Schmitt output is high, then the integrator will ramp upwards and vice versa. Imagine that the integrator is ramping upwards. When the integrator’s output reaches the positive hysteresis level, the Schmitt will flip into its low state, and the integrator will start to ramp downwards. When it reaches the low hysteresis level the Schmitt will flip back into its high state. Thus the integrator ramps up and down between the two hysteresis levels. The speed at which it does this, and hence the oscillating frequency is determined by the value of IC2 into IC2. The larger the current, the faster the capacitor is charged and discharged. Two outputs are produced, a triangle wave (buffered) from IC3 and a squarewave (unbuffered) from IC4. If the squarewave output is loaded then the oscillator frequency will change.

The log law generator is composed of Q1, 2, 3 and IC1. The emitter current of Q1 flows through Q3 and into IC2 thus controlling the oscillator frequency. It is possible to get a control range of over 1000 to 1 using this circuit. With the values shown, operation from 10 Hz to 10 kHz is achieved. Reducing C1 to 1 nF (non-polarized) will give a maximum frequency of 0.1 Hz.
Fast Comparator

The high slew rate of the CA3080 makes it an excellent fast voltage comparator. When pin 2, IC1 is more positive than Vref the output of IC1 goes negative and vice versa. Vref can be moved around so that the point at which the output changes can be varied. As long as the input sinewave level is quite large (1 V say) then the output can be made to move at very fast rates indeed. However, care must be taken to avoid overloading the inputs. If the differential input voltage exceeds 5 V, then the input stage breaks down and may cause an undesired output to occur.

One use of a fast comparator is in a tone burst generator. This device produces bursts of sinewaves, the burst starting and finishing on axis crossings of the sinusoid. The comparator is used to detect these axis crossings and to produce a square wave output which then drives a binary divider (IC3). The divider produces a “divide by sixteen” output which is high for eight sinewave cycles and then low for the next eight. This signal is then used to gate ON and OFF the sinewave. The gate mechanism is a pair of transistors which short the sinewave to ground when the divider output is high and let it pass when the divider output is low. The resulting output is a toneburst. However, if the comparator is not very fast, then there will be a delay in generating the gate and so the tone burst will not start or finish on axis crossings. Using the circuit shown, operation up to 20 kHz is obtainable.

![Diagram of tone burst generator](image-url)
Slew Limiter

The current output of a CA3080 can be used to produce a controlled slew limiter. By connecting the output current to a capacitor, the output voltage cannot move faster than a rate given by:

\[ \text{slew rate} = \frac{I_{\text{sec}}}{C_1} \text{ Volts per sec.} \]

Note that \( I_{\text{sec}} \) determines the slew rate and as \( I_{\text{sec}} \) is a variable then so is the slew rate. The output voltage is buffered by a voltage follower, IC2. This is a MOSFET op amp which has a very high input impedance, which is necessary to minimise the loading on \( C_1 \).

When an input signal is applied to IC1 the output tries to move towards this voltage but its speed is limited by the slew rate. Thus the output produces a linear ramp which stops when it reaches the input signal level.

### FASTEST SLEW RATE

<table>
<thead>
<tr>
<th>R2</th>
<th>C1</th>
<th>SPEED</th>
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<tr>
<td>150k</td>
<td>100n</td>
<td>1.5V/mSec</td>
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<tr>
<td>150k</td>
<td>10n</td>
<td>15V/mSec</td>
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<tr>
<td>150k</td>
<td>1u</td>
<td>0.15V/mSec</td>
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<tr>
<td>1M5</td>
<td>1u</td>
<td>15V/Sec</td>
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Sample And Hold

The slew limiter can be modified so that it becomes a sample and hold unit. In this circuit \( I_{\text{sec}} \) is either hard ON (sample) or completely OFF (hold). In the sample mode, the output quickly adjusts itself so that it equals the input voltage. Thus enables a short sample period to be used. In the HOLD mode, \( I_{\text{sec}} \) is zero and so the voltage on \( C_1 \) should remain fixed. The circuit is in fact an analogue memory. It is used in music synthesisers (to remember the pitch), in analogue to digital converters and many other circuits.
4 Quadrant Multiplier

The CA3080 is a two quadrant multiplier but, with the addition of a few extra bits of electronics, it can be made into a four quadrant circuit. A two quadrant multiplier has two inputs, one can accept bipolar signals (the inverting or non-inverting input) and one can only accept a unipolar signal, (the non-inverting current). However, a four quadrant multiplier can accept bipolar signals on both of its inputs which enables it to perform frequency doubling and ring modulation.

The circuit is fairly similar to that of the two quadrant multiplier described earlier except for two differences. IC3 is used to generate a signal (IC1) in such a way that the Y input can go both positive and negative, thus the Y input is bipolar, when Y is at 0 V and there is a signal on the X input the desired output (X X Y) should be zero. This is achieved by adjusting R1 so that the signal via IC1 (this is inverted) is exactly cancelled out by that via R3. Now, when Y is increased positively, a non-inverted value of X is produced at the output and, when Y is increased negatively, an inverted value of X is produced. When Y is zero, so is the output. This is known sometimes as ring modulation, if a speech signal is connected to the X input and a variable frequency oscillator to the Y input the resulting sound is that of a 'deek'. Also, if a sinewave is connected to both the X and Y inputs, the XY product is a sinewave of twice the frequency. This is known as a frequency doubler, but it only works with sinewaves.

Single Pole Filter

A singlepole lowpass filter can be constructed using a CA3080 as a current controlled resistor. The filter is, in fact, just a simple RC low pass section where the R, which is controllable, is constructed out of IC1, R4, R5. Varying R(1) changes the amount of current drive to C1. This would normally make the circuit a slew limiter, but because the signal level that IC1 (pins 2 and 3) handles is so small, the CA3080 works in its linear mode. This enables it to look like a variable resistor. When this resistor is varied, the break frequency of the filter also varies. By applying some positive feedback around the filter (R6, C2) it is possible to produce a peaky filter response. The peak actually increases with frequency making the circuit useful as a guitar Wah Wah unit.
Voltage Controlled Filter

A standard dual integrator filter can be constructed using a few CA3080s. By varying $I_{AC}$ the resonant frequency can be swept over a 1000 to 1 range. IC1, 3 are two current controlled integrators. IC2, 4 are voltage followers which serve to buffer the high impedance outputs of the integrators. A third CA3080 (IC5) is used to control the $Q$ factor of the filter. $Q$ factors as high as 50 can be obtained. The resonant frequency of the filter is linearly proportional to $I_{AC}$ and hence this unit is very useful in electronic music production. There are two outputs produced, a low pass and a band pass response.
At last, DIY HiFi which looks as if it isn't.

This is not to say it doesn't look the HiFi just that it doesn't look like the usual sort of thing you have come to associate with DIY HiFi. True, it looks a bit like an old-fashioned kit, but it is a kit made from a kit and is not a typical kit. If you put it in a drawer or on a shelf and it doesn't do anything... well, it will look like that.

And now previewing the matching 60W channel VMOS amplifier.

Matching look, the style and design of the Astra Pak 60W channel VMOS amplifier. The amplifier module has been designed specifically for this amplifier. The 60W channel VMOS amplifier is fully protected by a robust metal frame and is suitable for use in any installation where a high-power output is required.

The PW Dorchester-LW, MW, SW, FM stereo tuner

When the new range of CW40 40W frequency display ICs was announced, the original prototype of the PW Dorchester had been made but since it was only a limited edition, the DI-2000 was released in 1979 which came with a limited edition and became a perfect match for the original 40W IC. The Astra Pak is the PW Dorchester with 40W ICs and became a perfect match for the original 40W IC.

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2 Gresham Road, Brentwood, Essex.
Gary Evans looks at PLT add-ons, a Simon that's not simple and has news on superboard II.

WITH THE PLETHORA of new small computer systems appearing on the market, it's not to see some of the old warhorses beginning to meet this onslaught by supporting the user with a broad base of hardware. Surely one of the oldest warhorses is Commodore's PET. A month ago, which has to date been poorly supported by its manufacturer in the PET.

A number of companies have stepped into the void caused by lack of commodore peripherals, everything from RS232 interfaces to PET compatible floppy drives are available but not from Commodore. The latest issue of the PET User's Club newsletter indicates that this situation is about to change.

The most exciting of the PET add-ons from Commodore is their 2040 Dual Drive Floppy Disk. Details are sketchy at present but all outline the user of the 2040 as presented in the newsletter.

The drive will allow 360K bytes of data to be stored on two standard 5-Inch disk drives (Sugar SA390). This is accomplished without rescoring or double tracking or double density. This is achieved with the use of two MPU's — 6504 and 6502, and fifteen memory IC's within the 2040.

Formatting is by the drive itself and any mini floppy disk may be used. 35 tracks with a constant density recording on each track provide 171520 bytes for user storage per disk side.

The 2040 requires only one connection to the PET an interface cord connecting the unit to PET's IEEE port.

Good news that we don't have to wait for is a price reduction in the PET model 801 B. The 8K machine that until now has been the only PET computer is down in price to £594.00.

The 8K machine is to be joined by a 4K machine at £495.00 and two modes featuring 16K and 32K of memory. The memory used in these larger systems is dynamic — a departure from the static RAM used in the 8K and 4K versions. The 16K and 32K machines will also feature a full typewriter style keyboard in place of the calculator keyboard that was one of the most persistent criticisms of the 8K 2001 B. In order to make room for the larger keyboard the integral cassette deck has been omitted and a separate deck will have to be obtained in order to record programs.

The 4K PET is due in February, 8K PET's are expected to be here in May.

The last addition to Commodore's hardware is the 2023 printer. This will replace the ill fated 120 printer — announced but not seen — and is to quote a significantly better quality and more expensive at £495.00. The 2023 is due in April.

Well there are so many PET peripherals. Let's hope that Commodore manage to meet the promised delivery dates as in the past 10% is the area in which Commodore have been distinctly lacking in performance.

If you can 1 wait for Commodore a floppy disk unit. This product from Compu-think is available now and plugs into a PET that has been fitted with a minimum of 16K additional memory.

microfile
Toying With MPUs

At last the MPU has found its way into the toy market. Christmas saw a number of electronic games introduced. Mastermind being one of the most popular and the new year is seeing many more games added to the shops' shelves.

The current rage in America is a game called Simon. Presented with four buttons of different colours the player has to remember the sequence in which the machine calls them. The sequence starts with just two colours but rapidly extends this until the player must press all four buttons in a sequence that as it extends will eventually defeat the user.

Not very easy to explain, but its all the rage in the US and will be over here soon — you'll be able to see it for yourself then.

Super Ohio

I am assured that the long awaited Ohio Scientific's Superohc II will be available "off the shelf" within the next 45 days. Needless to say I am trying very hard to get hold of one of these boards and will report on its performance soon.

ETI

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**WHAT'S IN THE APRIL ISSUE**

### NASCOM ADD ONS

The NASCOM 1 computer has been one of the most successful of the DIY computer kits on the market recently. NASCOM introduced a number of extras that allow the basic machine's potential to be considerably enhanced. We take a look at the expansion board and RAM card as well as the TINY BASIC Nascom are now offering.

### EXPANDA PET

The commodore PET has been with us for over a year now but peripherals for the computer have been slow to appear. One of the essential devices in many applications is a floppy disk to provide a system of mass storage that is faster in operation than the tape system of the standard machine. Next month we review the Compu/Think disk drive and diskmon operating system that will plug straight into your PET.

### AMBUSH GAME

The April issue of our sister magazine, ETI, carries a project called Ambush. Ambush is an exciting space war game. Computing Today will carry a program that will allow those of you who don't dabble in electronics to play Ambush on your computer.

### CONSUMER SHOW

The recent Winter Consumer Electronic Show in Las Vegas saw the introduction of many new MPU based products including a chess challenger that talks. Gerald Chevin was there for Computing Today and his report appears in the April issue.

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Plus all the regular features, news, softspot, hardlines and next month, a new regular letters page.
WIND METER

Here is the project all you amateur meteorologists have been waiting for. When this meter gets the wind up you’ll know how fast and where it’s coming from.

TRADITIONALLY THE FOUR primary elements are fire, earth, water and air. At ETI we've designed projects concerned with the first three (temperature meters, soil moisture indicators, rain alarms) but not much for the last. The major property of the air, apart from the fact that it is necessary to support life, is the movement of the air — wind. Light winds generally aren’t of terribly much significance except to meteorologists but stronger winds can be useful as a source of power for traditional milling, for electricity generation or as a means of propulsion for sailing yachts.

Stronger winds such as hurricanes, can be destructive, causing damage to life or property. So for all the private pilots, yachtsmen, amateur meteorologists and general weather watchers who read ETI, here is a device which will tell you the wind’s speed and direction, with a remote indication of both quantities. Our design is, we’d like to think, both stylish and unusual but there are simpler methods of mechanical construction which you can follow if you wish.

The Head

The drawings along with the photos will give the general design that we used. The actual dimensions have to be left to the individual constructor as components such as the ball races and light bulbs may vary in size.

While we used a single head for both speed and direction, it may be simpler to use separate heads.

The discs we used were 1.5mm thick clear plastic with a piece of photographic film glued onto it. It may be easier to make it out of thin aluminium and cut out the slots. For the speed disc simply drilling holes will suffice.

The most important part of the design, apart from ensuring that the disc rotate with a minimum of friction, is the shielding of the light and preventing light scatter striking a transistor which should be dark. As can be seen from the photos and diagram the bulbs and transistors are embedded in aluminium blocks with small holes providing a passage for the light beam.

The wiring of the head is shown in fig. 3. Note that the base lead is not used and can be cut off close to the body. Insulate the joints onto the transistors to ensure that they do not short on the aluminium blocks. The bulbs may touch the block with their outer connection but this is the 0 volt line and does no harm. In fact it provides some electrical shielding for the leads. The bulbs we used were 12V but they were bright enough on 6V giving a much longer life.

Design Features

When we started design on this project it was to have a digital readout of wind direction with a resolution of either one or two degrees. This would also make it useful in a sailing boat to tell the wind direction relative to the heading.

Difficulties however soon became apparent. The first of these was the sensor head. The only accurate method is a digital head, probably optical. Two methods could have been used: one using a disc with a single optical track of 360 slots and an updown counter and the second using eight or nine tracks in a grey code. The first is simpler in head design but the second is less prone to error. The problem, and the reason for rejecting both, is that with such resolution, the reading would move around so much when the wind is gusty to be unreadable. What is needed is an averaging circuit which unfortunately becomes
difficult when the wind is changing from just west of north to just east of north, i.e. 355 to 005. How do you average these (use a microprocessor?)

As this was intended to be a simple project we relaxed our original specification, deleting the use in a boat (we may get back to this)

A four track 'Grey scale allows the wind to be given to within 1° of its true heading, without the complexity of a nine track one, and the use of LEDs to give direction solves the problem of averaging as the variations can be seen and averaged by the brain.

**Construction**

The electronics is relatively simple provided the PCB described is used. Due to a height limitation C1 should be mounted on the rear of the board. The LEDs should be mounted about 7mm from the board with care being taken not to damage them as the leads have to be bent out slightly. The regulator also has to lie down to give clearance.

We mounted the unit behind an aluminium front panel with the LEDs protruding through holes if this is to be done it is preferable not to solder the LEDs until after alignment with the front panel.

The head is more difficult as some mechanical ability is necessary to ensure good results. The requirements are basically simple. A disc is to be allowed to rotate either continuously with the wind, or aligning it to the wind with a bulb on one side and phototransistors on the other.

The method used by us is shown in fig 4 with the aluminium blocks providing the shielding necessary to give accurate results. As the unit will be exposed to the weather it must be made waterproof otherwise the ball races will corrode. The races used...
HOW IT WORKS

Wind Direction

Wind direction is indicated by a series of 16 equally spaced LEDs around a circle. These represent the main points on the compass. These are controlled by IC2 and IC4 which are in turn controlled by the direction sensor head.

The sensor head, which is described in Fig. 3, consists of a disc which has four optical tracks and four bulbs and phototransistors. The phototransistors sense either a clear disc (logical "1") or a black disc (logical "0") and thus control IC2 and IC4. The code used is special in that only one bit is changed at each location eliminating gross errors which occur with the binary code if the heads are not perfectly aligned. An example of this is going from location 1 (0011) to location 2 (1100). If this is not done simultaneously almost any location can be specified. With the grey code the same change is from 0100 to 1000. Here there can be no ambiguity as only one bit is changed. Remember these bits are not weighted similarly to binary and a lookup table must be used to decide what number (decimal) a particular code is.

The decoder, IC2, is an eight output analogue demultiplexer with the common line joined to the +5V line. When a particular 3 bit code is presented to its control inputs one of the eight outputs will be joined to the +5V line. The fourth output from the sensor head controls IC1 which gives two inverted outputs to drive either bank of LEDs. The complete four bit code therefore specifies a particular LED to be lit. By placing the LEDs correctly around the circle the grey code is decoded.

Wind Speed

This is a simple frequency counter measuring pulses from the sensor head. The head consists of a disc with eight holes which breaks a light beam to its associated phototransistor. The output of this phototransistor is squared up by a Schmitt trigger formed by IC5a and IC5b.

The counting is done by IC4a and IC4b (a dual decade counter) with IC8 and IC9 providing the store and LED drivers necessary to drive the seven segment display. Time base is provided by IC3 which gives a 3 ms wide negative pulse about every second. We say about as it is adjustable by R11 as individual heads will have different responses and calibration will be necessary.

This negative pulse opens the store to allow the number reached by the counters to be displayed while simultaneously stopping any further counting by disabling the Schmitt trigger. On the completion of the 3 ms pulse IC3a and IC3b generate a 500 ms wide pulse which resets the counter IC5 to recommence the sequence.

Power Supply

This is simply a full wave rectified supply with IC1 giving a regulated +6V output. This regulation is needed to ensure that the time base (IC3) remains accurate.
Fig. 2. Component overlay for the Wind Meter

PARTS LIST

RESISTORS all 466 544.

SEMICONDUCTORS 81.4, 8.9 10k

IC 7806 1166, 13-26 6800

IC2 4051 07, 10, 12 100k

IC3 555 11, 12

IC4 5

IC5 4011

IC6 7

IC7 4511

IC8 4518

POTENTIOMETER 01-05 20577 0.1 10440 1M 1000

LED TIL 209 or Superbright 0141112111.2

Common cathode seven segment (high brightness)

C1 1000u 16V

C2 6

C2 6

C3 250V

C4.58206 ceramic

CAPACITORS 5000u, 16V

MISCELLANEOUS Four miniature 12V bulbs, PCB1 240V/5

Four miniature 12V bulbs, PCB2 240V/5

18V transformer box, head assembly

Fig. 3. Connection to the head. Note that transistor bases are not used.
PROJECT: Wind Meter

Discs used in the sensor head — 1.5 mm thick, clear plastic with photographic film glued on.

will normally have to be washed out to give low enough friction with a light spray of WD40 or similar to give some protection.

While our housing is a little ornate, it did work but the more usual half ping pong balls may be more suitable.

**Calibration**

Wind Speed.
The easiest method for wind speed calibration is to provide the unit with a DC supply (via the common and one of the AC inputs) and to take a drive in the car with the unit supported above the vehicle. Providing there is no wind the potentiometer should be adjusted until the reading corresponds to the speedo.

Direction alignment is simply a matter of aligning the vertical rod so that it gives the correct results.

**BUYLINES**

The metalwork for this project we must leave to our readers, as this will be fabricated to suit individual requirements. The displays can be any type no's really, just observe polarity. Similarly with the LEDs. The photodarlington s can be supplied by Marshalls.
START YOUR OWN ARMoured DIVISION

Ever fancied driving your own tank across the battlefields? Or taking a Porsche around a racetrack at 140mph? Well, much as we'd like to build a Chieftain as a project it would never go into one issue and so we offer you a fully proportional six-channel radio control system for models instead.

The design offers joystick control (or switched position) and special attention has been paid to metalwork and setting up procedure. A kit of metalwork (and ready wound coils) will be available, and alignment requires nothing but a simple voltmeter.

We're confident this system will be the standard by which others are judged! Don't miss it!
How It Works - AM/FM

The second in our occasional series by Gordon King. This time he turns his attention to radio, and goes in and out of the ins and outs in great, easily explained, detail. Masses of circuits to illustrate the points, and a must for anyone remotely interested in the field.

SAW POINT

It's goodbye to the faithful IF strip as we know it. SAW will soon be found in TV receivers, replacing the usual array of coils and capacitors. You can expect to see and hear a lot more about them in the future, be one jump ahead and read the expose in next month's EET P.S. SAW - Surface Acoustic Wave!

DOUBLE DICE

OK, so you've seen them before. Ours have a novel method of display decoding, switchable odds to allow adaptation for wargaming, etc. Single board construction makes life easier and overall we think it's a nice one!

See what you think next month.

HEADPHONE AMPLIFIER

A project to warm the ears and please the rest of the universe. Based on a high quality Class A design, this unit provides hi-fi drive for one or more pairs of dynamic headphones, allowing you to wallow within an undisturbed sound field, and leaves everyone around free to do their own thing without having to listen to yours.
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With this unit you can select either a conventional fuzz effect or our new struzz effect. A depth control allows you to alter the sustain rate of the effect. If the neighbours start banging the wall, you can instantly cut out the crunchy effects with a bypass switch.

Make-up

Construction should not pose any problems. It’s even easier if you use our PCB. Make sure the electrolytic capacitors are put in the correct way round. As always, don’t plug in the ICs until you have checked the circuit thoroughly. Happy fuzzing and struzzing.

Smashing sound

Now you are wondering what struzz sounds like, aren’t you? Well, it is a distortion of fuzz. The fundamental frequency of the input is full wave rectified but the numerous harmonics are not. The result sounds rather like an antique piano finally succumbing to the ravages of woodworm and collapsing. If you play the guitar (we don’t you will, no doubt, find many more musical uses for this effect than we could.

Switching between fuzz and struzz while playing produces an interesting sound. You might like to use a footswitch for this purpose.

BUYLINES

The only component that may be difficult to find is the LF306 FET op-amp. Watford Electronics can supply this IC.
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Fig.1. (above) PCB component overlay

(Above right) Completed PCB

Fig.2. (Below) Circuit diagram
HOW IT WORKS

THE SIGNAL from the guitar pick-up is fed to a common-emitter amplifier Q1, via blocking capacitor C1. Q1 has a voltage gain of about twenty-five, and brings the guitar signal up to a reasonable level for driving the fuzz and fuzz circuitry. The upper frequency response of Q1 is restricted by C2, in the interest of circuit stability.

Operational amplifiers IC1 and IC2 are wired together as a "pre-amp" for wave rectifier, with its true output signal appearing at pin 8 of FET op-amp IC3. A very heavily clipped version of the input signal (C1 collector) signal appears at pin 8 of IC1, and has a peak-to-peak amplitude of about 13 volts. R24 enables the small-signal voltage gain of IC1 to be varied from 3 to 10, and controls the depth and sustain characteristics of the overall effect unit. IC1 has a "larger" signal gain of unity.

The fuzz output of the unit is taken from the output of IC1 via potential divider R8-R9, and is a perfectly conventional, heavily clipped, fuzzy signal, with variable depth and sustain. The direct output, on the other hand, is very unusual, and is taken from the output of IC2 via potential divider R13-R14. In the "vertical" mode the original guitar signal is full-wave rectified, so that its fundamental tone (which passes through zero at cross-over points in each cycle) has its frequency doubled, but the overshots (which modulate the fundamental and do not pass through zero) are clipped off at the crossover points. The signal output signal now has amplitude distortion imparts itself to it, due to the full-wave rectifier action.

Thus, the fuzz output signal has very heavy amplitude distortion and the direct output has both amplitude and frequency distortion. The overall effect unit can be switched in and out via bypass switch SW1, and should be interposed between the guitar and the main amplifier.

The PCB and batteries, mounted in the case, showing one of the jack sockets on the side of the case.

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Calculator Radio Alarm

T Corrigham

This very simple circuit, used with a Sinclair Cambridge Programmable calculator, enables a transistor radio to be turned on after a predetermined time, (within the range of a few seconds to five months).

None of the components are critical, but the SCR should have a sufficiently high voltage and current rating for the radio used.

If a transistor radio is used the SCR is connected in series with the battery, but if a cassette recorder/player is used it can be connected to the remote socket.

The LDR is placed above the left hand three digits of the display. RV1 is adjusted so that the circuit is triggered by '888' being displayed, but not by the background light only.

Using the program given, the time in minutes of the required delay is put in and /RUN/ pressed to start the timing period.

To stop the program prematurely /+- CE/ is pressed.

The calculator should be used with a mains adaptor.

The timing is accurate to within five minutes in eight hours.

If a buzzer or similar alarm is used the same circuit can be used to give an audible indication of the termination of long programs.

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, 2/27 Oxford St., London W1R 1HF.
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This circuit can be used in several modes. It can provide quantized feedback (a distinct improvement over the normal single 'beep') from the key actions made on a calculator-type keyboard. It can be used to give a sound translation of a digital display or completely replace the display when sound would be a better communication medium.

The keyboard or display information (a maximum of 16 bits with one 16-line 74150 multiplexer) is translated into a series of 16 high or low frequency tone pulses, corresponding to the high or low logic state of the 16 bits.

The circuit illustrated was used in conjunction with a digital multimeter, requiring three 4-bit words for the digits and three additional bits for over-range, negative and decimal point. Thus 15 lines only were required, the 16th being used for resetting.

The 15 bits are latched on to the inputs of the 74150 multiplexer. Presentation of the enable pulse results in a logic '1' appearing at the output of gate B, allowing clock pulses to pass via gates A and H to the 7493 counter. Gates B, E, D and C form a latch which remains 'set' until all 15 bits have been sampled. As each bit is sampled, the inverse state appears at the multiplexer output opening gate J or K and thus operating one of the two reed relays. As a count of 1111 appears from the counter, the output of F drops low, resetting the latch and counter. The operation of either relay results in a tone appearing at the loudspeaker (or earpiece), the tone frequencies being set (1 2 kHz maximum) by the 1 megohm pots. The tone pulse length is governed by the clock rate.

Digital Pulse Compressor
N. C. Hall

Whilst constructing a digital frequency meter the author found it necessary to be able to accurately trim the width of a gate pulse. The circuit shown uses only two ICs and can reduce the width of a pulse applied at its input by up to a few milliseconds. The table shows the reduction achieved by using different values of C1.
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**Readers' Circuits**

**Darlington Drivers for a few pence**

C. J. Ramey

This circuit offers a very efficient way of driving a pair of transistors in Darlington configuration from CMOS. The circuit in Fig. 1 shows how two loads of up to 1A may be driven from a single 14007 chip with no external resistors. Using a 2N3055 in place of the BFY51 will enable loads of up to 3A to be driven at voltages limited only by the $V_{CE}$ of the transistors ($V_{CC}$).

Fig. 2 shows the internal circuit of one section of the 14007. A high on pin 6 switches the lower CMOS transistor on, holding Q2 off and sinking the leakage current of Q1. A low on pin 6 drives Q1 and switches the lower CMOS transistor off and the upper CMOS transistor on.

The result is fast switch off at low cost and efficient switch on. A bonus is the inverter between pins 10 and 12. Note: $V_{CC}$ should be 5-6V to prevent excessive current being drawn from the CMOS chip.

**Precision Rectifying with the LM3900**

A. Winsor

The LM3900 is different from most op-amps in that it is current differentiating and operates from a single supply rail, which means that the inputs bias at one base-emitter voltage above ground. Hence standard techniques are not applicable as the diode would always be forward-biased. Two feedback paths are therefore provided—R3 for DC stability, and R4 for the AC signal after C2 and R5 have filtered out the DC bias. When $R2 = 2 \times R3$, point A will be at $V_{CC}/2$, allowing the diode to be reversed at will. For large positive input returned to ground, input impedance equals $R1$, and voltage gain equals $-R4/R1$ since $R4$ is made very much smaller than $R3$. C1 and C3 are DC blocking capacitors and determine the low frequency roll-off. Component values quoted are those used on the prototype and may be altered to suit individual requirements.

This circuit has obvious potential, especially in portable equipment where the 4 amps in one package and single supply rail yield a more compact, more convenient unit.

---

**Figure 1**

![Circuit diagram](image)

**Figure 2**

![Circuit diagram](image)
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GATHERED HERE are all the PCBs for this month's projects. From now on the boards will be grouped together like this in order to facilitate their use by the readers wishing to produce their own PCBs from these patterns.

All are shown foil side up, and full size. Companies wishing to produce these for sale as ready made PCBs should note that where the board carries a copyright symbol, the designer retains that copyright to himself so his company, and that particular board may not be produced on a commercial basis.

These pages form the basis of our ETIPRINT sheets which are etch resistant transfers of the foil patterns designed to simplify one-off PCB production. See the ad on page 49 for further details.
Below left: Wind Speed Indicator PCB
Below right: Click Eliminator Mk 2 board
Right: Struzz effects unit
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