Electronics Today INTERNATIONAL

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MM70924

Antenna Extender

October 1981

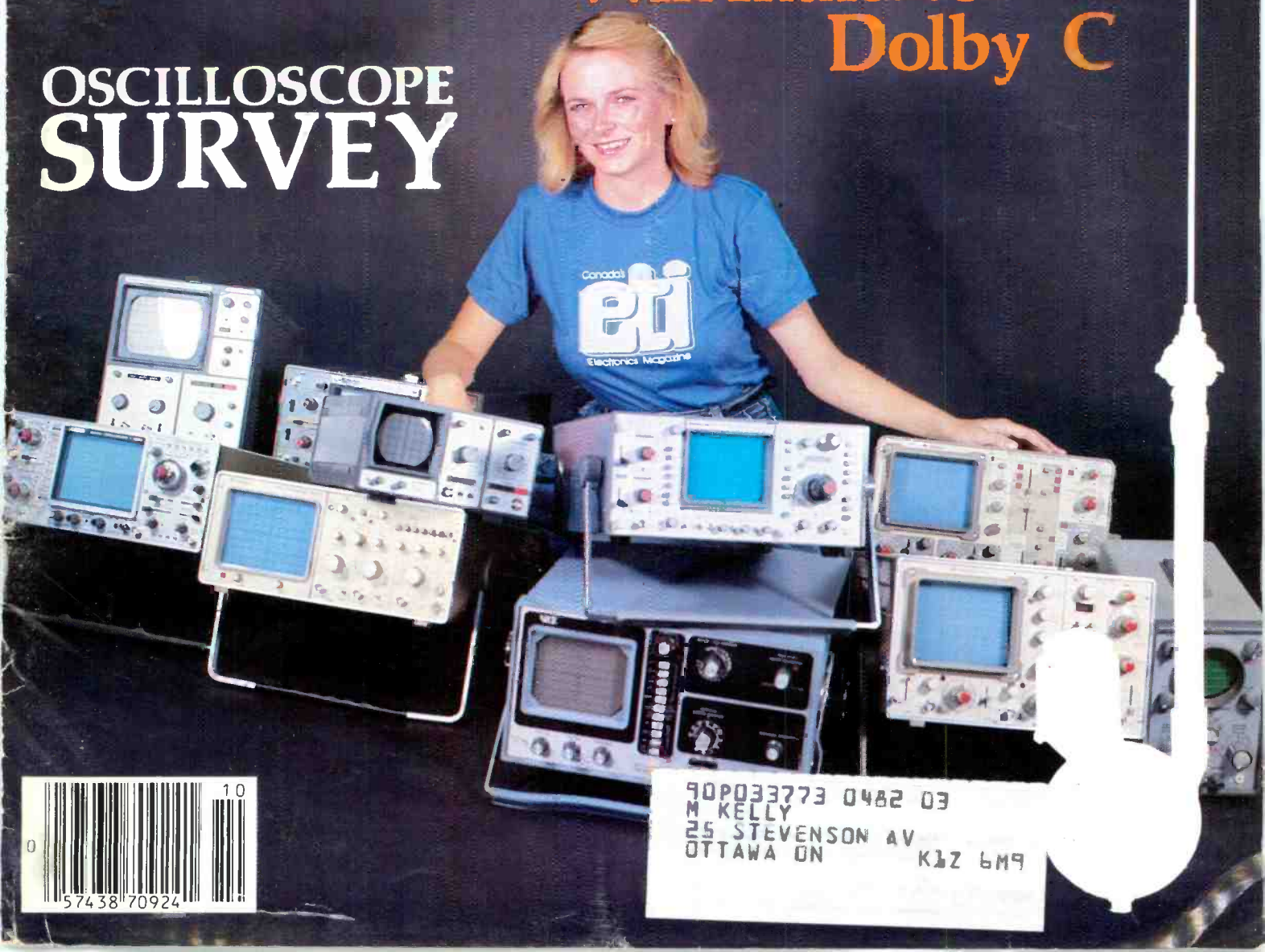
Black Hole Theory

Pulse Generator

Win Indicator

Dolby C

OSCILLOSCOPE SURVEY



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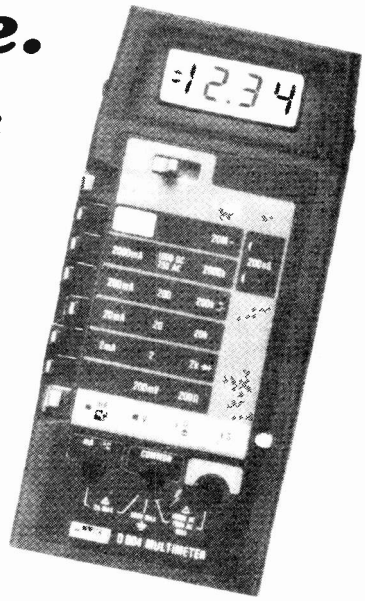

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  - dc voltage
  - ac voltage
  - dc current
  - ac current
  - resistance
  - diode test
  - conductance (1/R)
  - logic level and continuity detect
  - temperature (K-type thermocouple)
- Peak hold on voltage and current functions
- Selectable audible indicator for continuity or level detection
- 3 1/2-digit resolution
- 0.1% basic accuracy
- LCD display
- Overload protection
- Safety designed test leads
- Full year parts & labor warranty

FLU-D804 ***$339.95***

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  - ac voltage
  - dc current
  - ac current
  - resistance
  - diode test
  - conductance (1/R)
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- 0.1% basic dc accuracy
- Overload protection
- Safety-designed test leads
- Full year parts & labor warranty

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  - ac voltage
  - dc current
  - ac current
  - resistance
  - diode test
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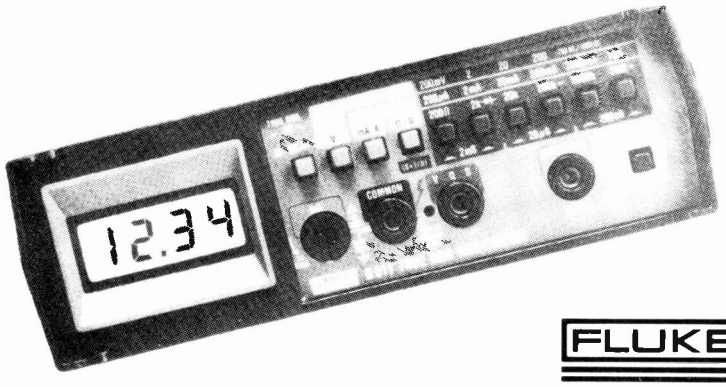

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HM312	$855.00	$769.00
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HM512	$2000.00	$1795.00

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MPB100 CPU Board	$348
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MPC4 4-Channel Serial I/O Board	$685
EXPANDOPROM EPROM Board	$197
Z80 Starter Kit	$485

For descriptions and photos, refer to ETI June 1981.

We also provide assembled and tested S.D. Systems boards at $85 extra. Versafloppy 2 is $130 extra since it requires critical tuning.

Complete systems based on S.D. boards are also available now. Starting at under $2000, these feature the SBC 200, the Versafloppy 2 and Expandoram 2, and the VDB 8024 boards, fully assembled and tested and mounted in a card cage with heavy duty power supply. Also available with CP/M software up-and-running. Please contact Exceltronix for full details.

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This month's Specials:

*Extra 2k of RAM with every Multiflex Z80A Computer — see May 81 ETI for full description.

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*(ISC) Colour Monitors, 13" $350, quantity discount available
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*4164-15 $17.95. 10% discount 16 pieces or more.
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74LS10	22	74LS145	1 38	74LS253	69		
74LS11	25	74LS147	2 50	74LS257	69		
74LS12	25	74LS148	1 59	74LS258	72		
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74LS75	43	74LS175	75	74LS367	65		
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74LS85	95	74LS191	82	74LS374	1 59		
74LS86	49	74LS192	82	74LS375	83		
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74LS92	59	74LS195	69	74LS390	1 25		
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Electronics Today INTERNATIONAL

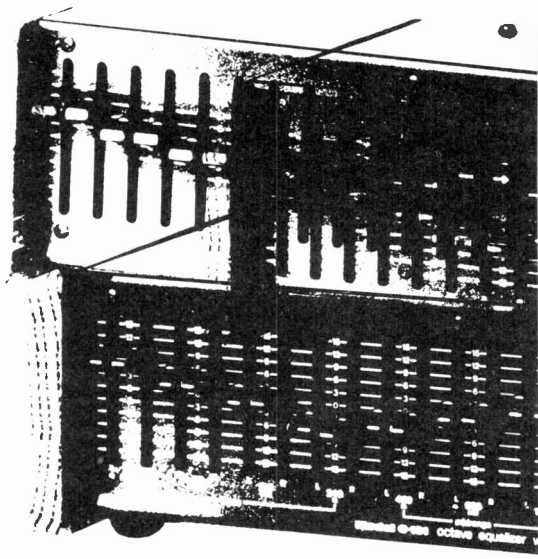
OCTOBER 1981 Vol. 5 No. 10.

Features

Oscilloscope Survey 8
An oscilloscope lets you look inside circuits so that all the electrons have no privacy, get paranoid and go mad with time. Steve Rimmer surveys 'scopes and subatomic particle sized straight jackets.

Graphic Equalizer Design . . 19
A multi-band equalizer can do amazing things with sound. You can balance your stereo for your listening room, compensate for variations in frequency response in your system, or turn up the bass and use your speakers to mix paint. In this article, Tim Orr explains how to design your own.

I/O Devices 25
If you take the logical, straightforward approach to interfacing peripherals to your computer you will have more pieces of old phone wire and lamp cord hanging off the back than you can count, even in hexidecimal. Henry Budgett explains the more sophisticated approach.



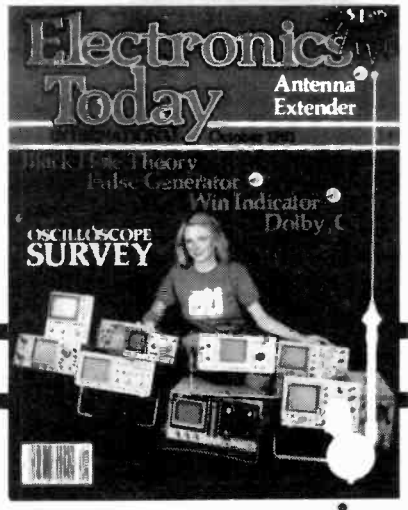
Graphic Equalizer Design, p.19

Dolby C 27
Yes, it's another noise reduction system, a further technological approach to the really obvious expediant of just disconnecting the speakers. Ian Graham charts the vanishing hiss.

Black Hole Theory 31
If you compressed the Earth to the size of a pea, its gravity would be so intense that light itself would be unable to escape. What you'd have is (a) a black hole, and (b) a total inflationary spiral in real estate. Ian Graham considers the market

TV Quality Control 45
If the people on the eleven o'clock news have green faces, you can be sure that it's really just ol' Knowlton broadcasting from Mars again, because the station keeps track of the state of its signal. Ron Baynes explains

Black Hole Theory, p.31



Our thanks to the companies who supplied 'scopes to look at. These would be BCS, Duncan Instruments, Omnitronix, Atlas, Metermaster Allan Crawford, H.W. Cowan and Hewlett Packard. The oscilloscopes are those square things in the foreground of the picture ... new the girl. Oh, you've spotted the girl without any trouble. Very predictable.

ISSN 0703-8984

Projects

PROJECT

Tape Optimizer 35
If you're not getting really great sound from your cassette deck, you may not be using a tape that matches your bias setting. Rather than buying a truckload of different tapes to find one that works, generating scores of C-60 doorstops in the process, use our optimizer to adjust your recorder.

Antenna Extender 41
If your automatic antenna motor fails to stop on time, the antenna may retract until it has compressed itself into a black hole, subsequently sucking in your car. Build ETI's power antenna controller while you've got the chance.

Win Indicator 50
The next time you and the lads get really wasted, three sheets to the wind likkered up, you'll want to have this useful little circuit to see who was the first to pass out and hit the bar.

Pulse Generator 54
Actually, the fair lass on the cover would probably do admirably in this application. Our pulse generator, however, is of the transistorized sort.

Antenna Extender, p.41

Tape Optimizer, p.35

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ETI is available for resale by component stores. We can offer a good discount when the minimum order of 15 copies is placed. Readers having trouble in obtaining the magazine could ask their local electronics store to stock the magazine.

Component Notation and Units
We normally specify components using an international standard. Many readers will be unfamiliar with this but it's simple, less likely to lead to error and will be widely used everywhere sooner or later. ETI has opted for sooner!
Firstly decimal points are dropped and substituted with the multiplier: thus 4.7uF is written 4u7. Capacitors also use the multiplier nano (one nanofarad is 1000pF). Thus 0.1uF is 100nF, 5600pF is 5n6. Other examples are 5.6pF = 5p6 and 0.5pF = 0p5.
Resistors are treated similarly: 1.8Mohms is 1M8, 56kohms is the same, 4.7kohms is 4k7, 100ohms is 100R and 5.60hms is 5R6.

PCB Suppliers
ETI magazine does NOT supply PCBs or kits but we do issue manufacturing permits for companies to manufacture boards and kits to our designs. Contact the following companies when ordering boards.
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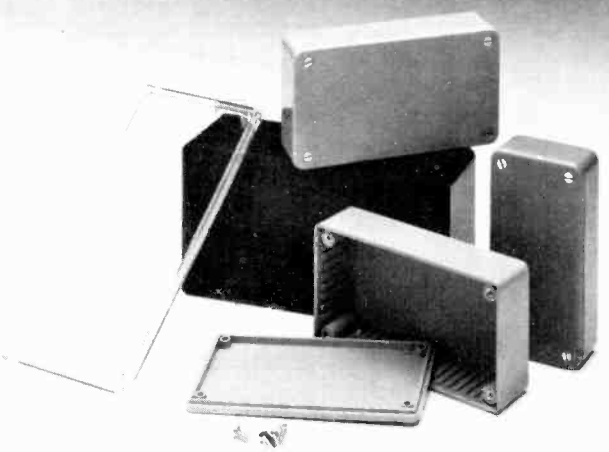

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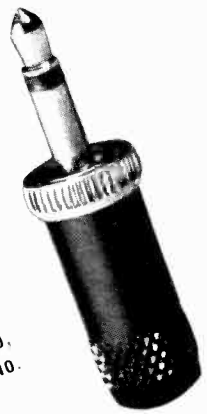

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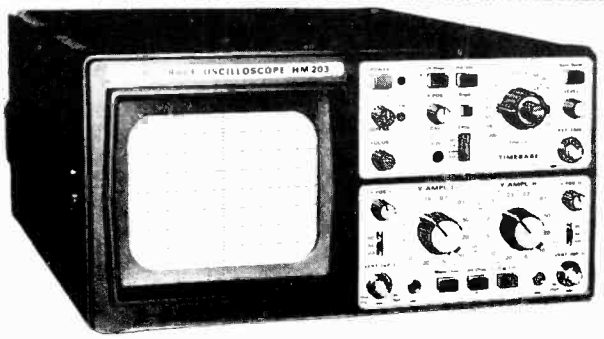

HM 203

Specification

Vertical Deflection (Y)

Bandwidth of both channels
DC-20 MHz (−3dB), DC-28 MHz (−6dB)
Risetime: 17.5 ns (approx.)
Overshoot: 1% (maximum)
Deflection coefficients: 12 calibr. steps, 5 mV/cm-20 V/cm (1-2-5 sequence), accuracy better than ± 3%
Input impedance: 1 Megohm // 25 pF
Input coupling: DC-AC-GND
Max. Input voltage 500 V (DC + peak AC)
Operating modes
Channel I, channel II, channel I and II, alternate or chopped (approx. 120 kHz)
X-Y operation: ratio 1 : 1 (X input via ch. II)

Timebase

Time coefficients: 18 calibrated steps, 0.5 µs/cm-0.2 s/cm (1-2-5 sequence), with magnifier ×5 to 100 ns/cm, with variable control uncalibr. to 40 ns/cm, accuracy better than ± 3% (in cal. position)
Ramp output: 5 V (approx.)

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- 8cm x 10cm Display
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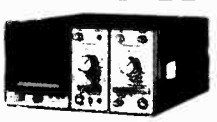
HAMEG



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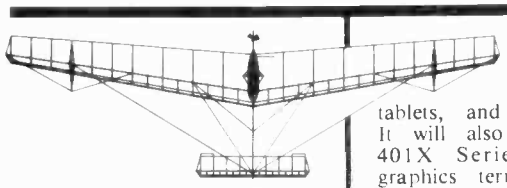
NEWS



New Graphics

Hewlett-Packard's new Graphics/1000-II graphics software for the HP 1000 family of real-time computers provides increased support for a wide range of graphics peripherals, as well as the addition of interactive and three-dimensional design capabilities.

Graphics/1000-II software initially includes two packages: a Device-independent Graphics Library (DGL), and an Advanced Graphics Package-3D (AGP-3). DGL is a two-dimensional package that enables users to use different graphics peripherals by means of a common set of commands, without requiring programming changes. It requires minimal memory space and system overhead. The AGD-3 is a three-dimensional package that builds upon DGL to enable users to communicate interactively with graphics peripherals.

Graphics/1000-II is based upon the CORE Graphics System of the ACM SIGGRAPH Graphics Standards Planning Committee. The software may be used for applications including data display graphics for pie charts, bar charts, and line graphs; dynamic display graphics for monitoring process control systems and other applications requiring constant status updating; and interactive design graphics for computer-aided drafting, mapping, and design.

DGL is made up of graphics subroutines which may be called from FORTRAN, PASCAL, and ASSEMBLY language programs. AGP-3 is made up of a set of subroutines that are called from user programs and a work station program that processes graphics commands concurrently with a user program.

At introduction, Graphics/1000-II will suport a range of Hewlett-Packard graphics devices including vector refresh displays, raster graphics terminals, graphics tablets, and graphics plotters. It will also support Tekronix 401X Series storage tube graphics terminals. A skelton device handler help users add other graphics peripherals to their systems.

The Device-independent Graphics Library (DGL) is Canadian priced at $2,796.00. The Advanced Graphics Package-3D (AGP-3) which requires DGL for operation is $5,592.00. The Skeleton Device Handler is $280.00.

For more information, contact Inquiries Manager, Hewlett-Packard (Canada) Ltd., 6877 Goreway Drive, Mississauga, Ontario L4V 1M8.

New Modem

The ESE Limited 208A/B is a 4800 bps modem which is compatible (in a single unit) with both Bell 208A and 208B modems simply by setting internal "strap" switches. The modem is capable of full-duplex synchronous data communications on a four-wire private line network, and on the public switched telephone network, it operates in half-duplex mode.

Features of the 208A/B include a microprocessor-controlled automatic adaptive equalizer for greater error-free throughput, a wide range of fault isolation and error detection capability in operation. With its low price and many features, the UDS 208A/B is a versatile and economical modem for both the large and small system user.

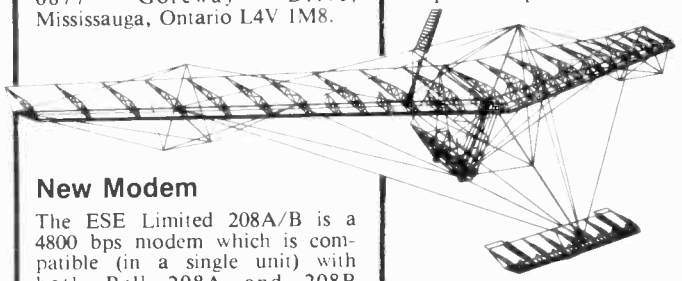
For more information contact: Sharron Elliott, ESE Limited, 1780 Albion Road, Rexdale, Ontario, M9V 1C1, (416) 749-2271.

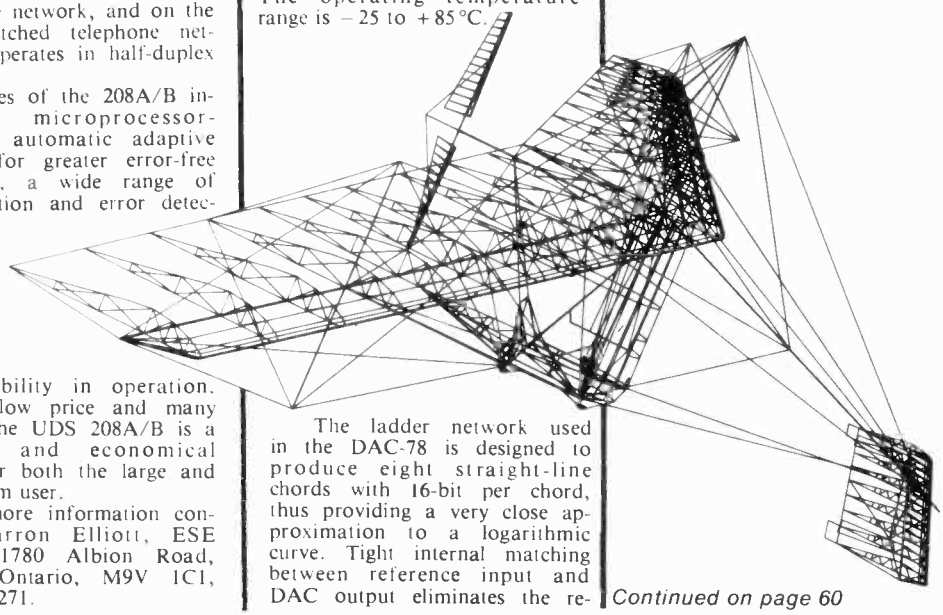
8 Bit DAC

The DAC-78, a new 8-bit companding digital-to-analog converter IC, developed by Precision Monolithics, Inc., is intended for use in industrial applications such as digital recording, speech synthesis, audio attenuation, light level control, data transmission, and servo positioning systems requiring a wide dynamic range, fast settling time and low cost.

A sign-magnitude-coded companding DAC, the DAC-78 is a bipolar device which provides a straight-line approximation of a logarithmic curve rather than a linear response. It has a dynamic range of 72 dB with 12-bit accuracy in chord zero — the critical low-signal-level area; this makes it especially useful in "linearizing" outputs from transducers which have logarithmic response curves, such as photodiodes.

The DAC-78 offers true output compliance of −5 to +18½v 500-nanosecond settling time to within ½ step and full-scale drift is a low 1/16 step. Power dissipation is 114 mW with +5, −15V supplies. The operating temperature range is −25 to +85°C.





The ladder network used in the DAC-78 is designed to produce eight straight-line chords with 16-bit per chord, thus providing a very close approximation to a logarithmic curve. Tight internal matching between reference input and DAC output eliminates the requirement for full-scale adjustment in most cases.

The DAC-78 is supplied in an 18-pin hermetic dual-in-line package.

For more information contact Bill Pascoe, Precision Monolithics Incorporated, 1500 Space Park Drive, Santa Clara, California 95050, (408) 727-9222.

INMARSAT Set

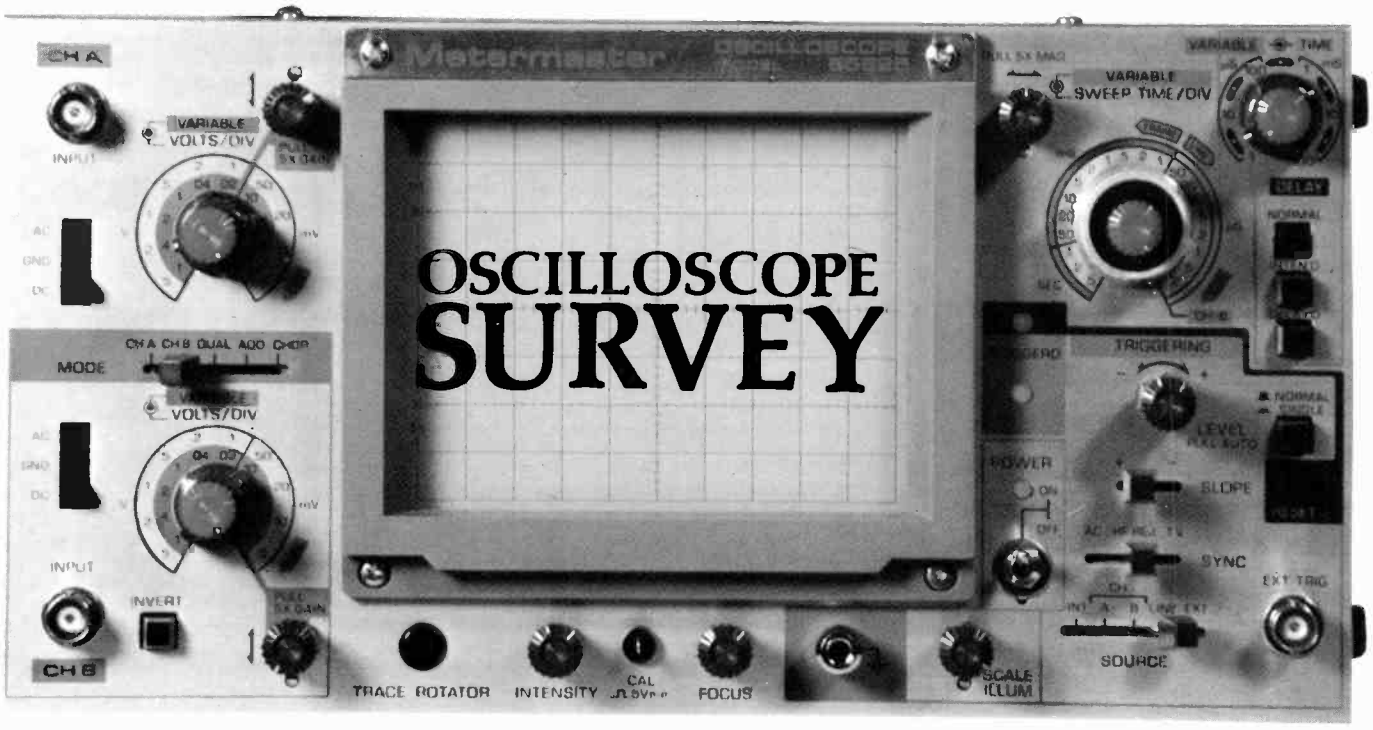
A new, high quality global satelite communication system for ships at sea, run by INMARSAT, will come into operation on February 1, 1982. INMARSAT is the International Maritime Satellite Organization, which has 36 member-States.

Later next year, new satellites on which INMARSAT has leased capacity will start to replace those of the MARISAT system. The new satellites, which are needed to meet expected growth in calls, are:

— MARECS, maritime version of the European Communications Satellite, leased from the European Space Agency (ESA). The first MARECS will be placed in orbit over the Atlantic Ocean by the end of this year. Its launch vehicle is the European Ariane Rocket.

— INTELSAT V maritime communications subsystems (MCS) leased from the International Telecommunications Satellite Organization (INTELSAT) and launched by Atlas Centaur and Ariane rockets.

Continued on page 60



Maybe it's finally time to put your WW II surplus cathode ray tube back in its crate, quit trying to get the 12AX7's out past 400 KHz and start thinking about actually buying a 'scope. Steve Rimmer enumerates the choices.

THE USEFULNESS OF A 'SCOPE is second only to a multimeter in getting around the measurement hassles in electronics. There's really no substitute for seeing what you're doing. However, there's more to an oscilloscope than a CRT and a couple of amplifiers. The current generation of instruments are, for the most part, about as complex and sophisticated as a small computer . . . one or two, in fact, being small computers. Odds are we'll never actually run a 50 MHz, dual trace triggered sweep 'scope as a project; this is one gadget that each of us must eventually bite the bullet for and buy.

None of the 'scopes we looked at for this survey were poorly designed or built, and none seemed to have exaggerated specifications, or any of the heavy Consumer's Reports stuff. However, all of them were fairly expensive, and one would not want to wind up having destroyed the packing material, even though they tell you not to, only to realize that one has bought an instrument not in keeping with what one wanted to do.

This survey should give you an idea of what is available, and what it all costs. We should point out, however, that it is, by design, incomplete. We have tried to check out all the 'scopes that could be of interest to our readers; there are just as many that are really esoteric and specialized (and really ghastly expensive) that no one outside a well funded university, a major corporation or the government would have much use for.

Likewise, in order to keep things down to a manageable hugeness, we haven't listed every feature of every instrument, but have tried to select those that form a useful basis for comparison.

The 'scopes listed here should cover a wide variety of interests and applications. There are simple instruments for the hobbyist, specialized bench 'scopes for servicing and fairly sophisticated ones for research. The distinctions should be fairly clear. . . if you can't afford it, its specifications are more than you need.

All of the information for this survey was provided by the manufacturers and distributors listed, as were the instruments we got to look at. If you'd like more data on a particular model, all of them would be just overjoyed to be besieged with requests.

A Few Words

There are a few terms which it might be useful to get together on, in dealing with the intricacies of 'scopes. This will be helpful in fusing together the almost meaningless jumble of manufacturers' literature . . . which seeks, for example, to convince one that this particular instrument far surpasses' all others, as it has a time base, while the rest of the flock only has sweep.

Time Base. This is the same as sweep, essentially. It is the circuit which moves the beam across the X axis of the tube. These come in two types; triggered and recurrent. Triggered sweep uses a monostable of adjustble period, which is triggered by some voltage level (adjustable) at the vertical or external trigger input. Recurrent sweep uses a free running oscillator of a variable frequency which can be dragged slightly, or made to fire prematurely, by an incoming signal. The advantage of the former is that the monostable periods can be very accurately set, providing pretty good frequency measuring capacity (within about 3 to 5 % in practice). Triggered sweep is found on all but the simplest 'scopes.

Bandwidth. The bandwidth of a 'scope usually extends from DC to whatever frequency produces a vertical trace 3 db lower than the DC level. In fact, after this point, most 'scopes have great rolling pastures of bandwidth left; it's just that the frequency response may be a bit unpredictable. A 20 MHz 'scope may well be useful out beyond 40 MHz. This will vary from model to model, and, in fact, between individual instruments.

CRT. This, of course, is the cathode ray tube. CRTs may be round

or square, with white faces that glow green, or blue faces that glow lighter blue. The screen size is usually five inches, with smaller 'scopes having three inch tubes. The tube is usually ruled in an eight by ten division grid, which may either be on the inside surface of the glass, or overlayed on a sheet of plastic or clear glass. The latter, because it is a finite distance from the actual trace, induces parallax errors.

Vertical channels. Dual trace 'scopes allow you to view two waveforms simultaniously on the face of the tube. These have two vertical input channels, whereas single trace 'scopes only need one.

Trace Magnifier. One way of getting a bit more out of the high end of the timebase is to spread the trace out. This has the effect of making the sweep time seem shorter. If the amount of magnification is known, the 'scope can still be used to measure frequency, even with the magnifier. Hence, magnifiers are usually specified as 10X, 20X, etc.

Delay. There are two kinds of delay. Signal delay makes the signal to be displayed wait about 40 nS, until the trace has gotten well on its way, so the leading edge is visible. Delayed sweep holds the sweep back for a variable length of time after the event which has caused the trigger to take place to permit viewing events which occur more than one sweep period after the triggering event.

Storage. There are a few 'scopes that can store waveforms on thier CRTs. This utilizes a phenominon called persistence, whereby after the initial trace has gone by, the phosphor retains a fainter image for a period of time, as much as several minutes. Storage 'scopes are useful in viewing low frequency, non-periodic events.

Metermaster

Metermaster makes three 'scopes, all rugged looking little brutes with the sorts of features you'd want in a 'scope. No frills, though; you can't get electric can opener options or the like. Metermaster is distributed by R.H. Nichols, 214 Dolmite Drive, Downsview, Ontario, M3J 2P8.

The Models 65310 and 65610, at $775.00 and $795.00 respectively, are very similar electrically, the major difference being in the size of the tube. The former is about three inches across, and the latter five. Both are dual trace, having 15 MHz of bandwidth, and .5 uS/ div. to .5 S/div. of sweep, plus 5X magnifiers. Both can run on either regular wall power AC or 11 to 30 volts of DC, making them fairly ambulatory. Probes are not included.

The Model 65625 is a dual channel, 45 MHz 'scope. Both the signal and the sweep can be delayed,. The sweep runs from .2 uS/div. to .5 S/div., plus a 5X magifier. The tag is $1630.00, probes extra.

Hameg

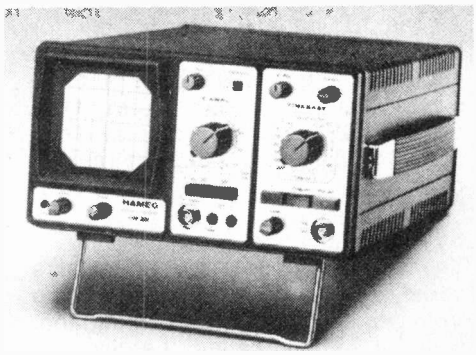
Hameg 'scopes are of German origin . . . they're solidly built, well laid out, and we really didn't want to give the review sample back in the slightest. Dispite their rather rugged construction and abundance of useful features (on-off switches, CRTs, jacks and suchlike), they are quite light and compact. Hameg is distributed by BCS Electronics Limited, 980 Alness Street, Unit 35, Downsview, Ontario M3J 2S2, who warrants them for one year.

The HM 307 is a 3 inch 'scope , with 10 MHz of bandwidth and a single vertical channel. The sweep runs from .5 uS/div. to .2 S/div. The CRT is a 3RP1A, which is an unusually easy to find beast; something to consider if you flang a lot of test gear down stair cases. There's also a 60 Hz waveform output, which will test things like capacitors, diodes, and so on. A mere $550.00, in your choice of colours, all of which are dark grey.

The HM 312 HM 412 and HM 512 are all similar. The HM 312, at $855.00, has a 20 MHz bandwidth, and .5 uS/div. to .2 S/div., plus a 5X magnifier. The HM 412 adds sweep delay of 100 nS to 1 S, and variable gain controls for the vertical inputs, for $1,277.00. The HM 512 increases the bandwidth out to 50 MHz, for $2,070.00.

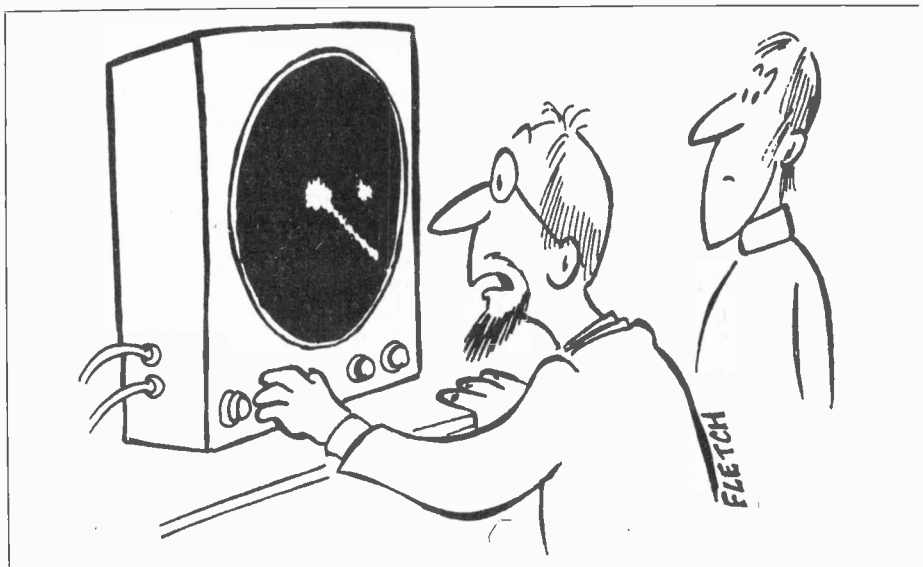
The HM 812 is similar to the HM 512, but with the addition of storage capacities. The tube will persist for up to 5 minutes. The price, $4,630.00, may persist longer.

The HM 203 is a brand new 'scope, with two channels, 20 MHz of bandwidth, and .5 uS/div. to .2 S/div. sweep, plus a 5X magnifier. The price is $850.00



Tektronix

Tektronix is something of the Rolls Royce of 'scopes. Readers considering buying one should also seriously think about taking out a few dozen lifetime subscriptions to wonderful ETI magazine; clearly, you can afford it and we'd certainly like the bread. To the best of our knowledge, Tektronix doesn't make a 500 KHz recurrent sweep hybrid 'scope, although, if you need an ultra high resolution

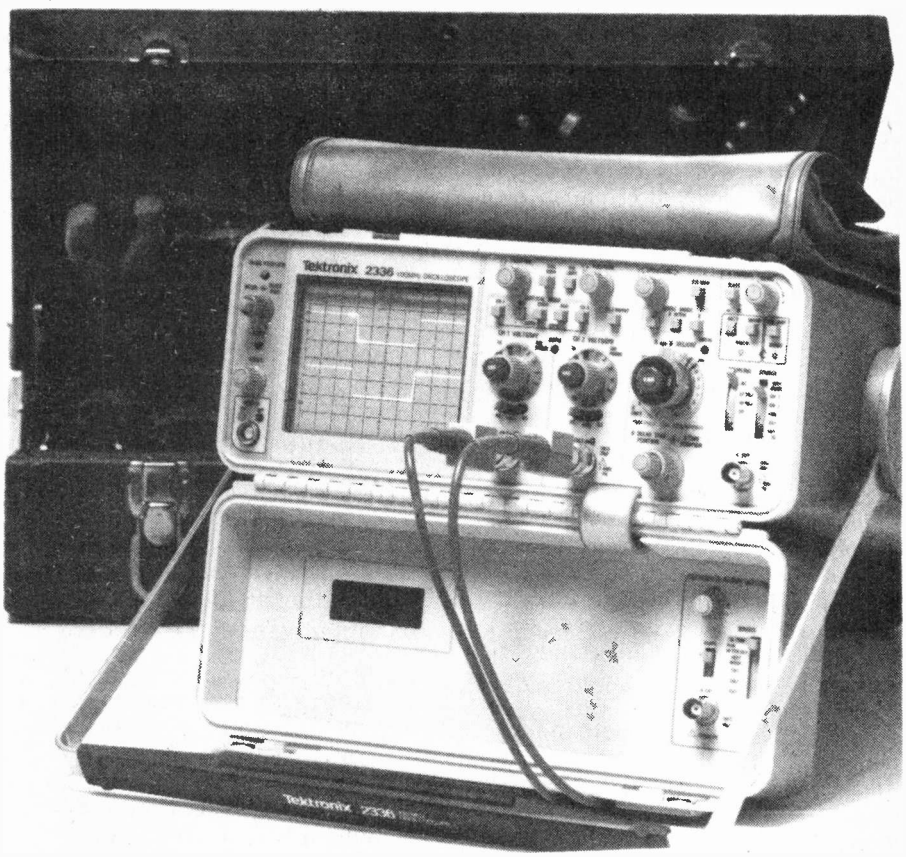


"According to this, there's a submarine approaching through the living room!?"

graphics monitor . . . Tektronix is located at P.O. Box 6500, Barrie, Ontario, L4M 4V3.

The Models 2213 and 2215 have price tags of $1375.00 and $1650.00 without duty. They both have dual trace, 60 MHz bandwidth and niceties such as auto intensity and auto focus. They sweep from .1 uS/div. to 5 mS/div. for the "B" channel and .2 S/div. for the "A". The 2213 has one time base, the 2215 two. Both have delayed sweep.

The models 2335 and 2336 are dual trace, 100 MHz instruments with delayed sweep, 5 nS/div. to 50 mS/div. for the "B" channel and .5 S/div. for the "A". There is also a 10X sweep magnifier. The delay range is 50 nS to 5 S. The 2336 has delta time capabilities, via an LCD display. They cost $4475.00 and $4955.00 respectively.

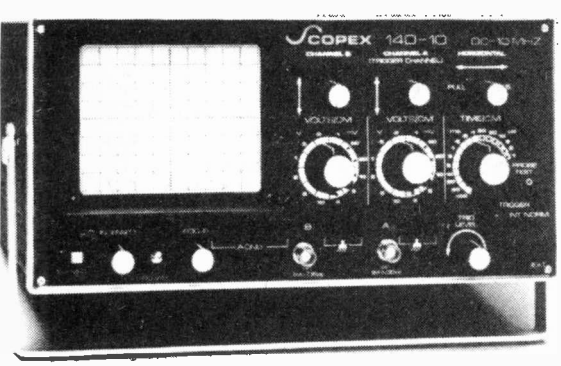


Scopex

You'd probably guess that these folks make oscilloscopes. They come to us from way across the pond in England, from a place called Letchworth. British road maps are always good for an afternoon of amusement. Scopex is distributed here by Jerome & Francis Co., 1015 Prospect Avenue, North Vancouver, British Columbia V7R 2M5.

The Scopex 4D-25 is a dual trace, 25 MHz instrument with sweep from 200 nS/div. to 200 mS/div. It has a rather handy feature as well, this being a trace locator, which will drag the beam back to the screen even if it has become overscanned. The signal can be delayed. $1523.00 each.

The Scopex 14D-10 has 10 MHz of bandwidth, and sweeps from 100 uS/div. to 100 mS/div. There are two channels, and a 5X sweep magnifier. The price is $1033.00.



Bach-Simpson

Legend has it that Bach-Simpson came into being when the late composer (and, thereafter, decomposer) Johann Sebastian Bach went out looking for an oscilloscope to find the distortion in his pipe organ. It's not the sort of legend you really should go around repeating, though. Bach-Simpson is also responsible for those big, black 260 multimeters that seem to be built to survive nuclear attacks. They live at P.O. Box 5484, London, Ontario, N6A 4L6.

Bach-Simpson makes two 'scopes, the Model 452 and the model 454. Both have 15 MHz of bandwidth and are dual trace. The 452 has a 5 inch screen and .2 uS/div. to .5 S/div. sweep plus a 5X trace magnifier. The 454 has a 3 inch screen, and sweeps from .5 uS/div. to .5 S/div. The 454 is $675.00, and the 452 is $890.00.

HP

Hewlett Packard probably has one of the largest assortment of 'scopes going . . . we're not going to check out the really weird ones here, as few of our readers have expressed interest in fixing the family TV with a hundred thousand dollar instrument. As it is, most of these little fellows will set you back some even without the microprocessor and the full time computer scientist to operate the controls. Hewlett Packard (Canada) Ltd. is at 6877 Goreway Drive, Mississauga, Ontario L4V 1M8.

The Models 1740A to 1743A are all very similar dual trace, 100 MHz 'scopes. The 1740A has such features as third channel operation to let you see an external trigger on the screen, signal delay, 5X vertical magnifier, sweep from 50 nS/div. to 2 S/div., with delayed sweep to 20 mS/div. It is transmuted into a 1742A with a digital readout on top, which serves as an automatic ranging multimeter (AC/DC volts, ohms and current), which also operates in a delta time mode, whereby it will measure the interval between two events on the 'scope screen. The 1743A incorporates a crystal time base for improved accuracy of sweep, and has the same sort of delta time scene as the 1742A, although the readout is on the front panel, not on top. The prices . . . 1740A is $4278.00, 1742A is $4728.00 and 1743A is $5891.00. Yes, they do like large numbers, don't they.

The Model 1727A is much like the 1743A, with the multimeter and delta time readout on top, but with

storage capabilities and a 275 MHz bandwidth. Very nearly useful for measuring the frequencies of light, it goes for $10,807.00.

Now, back down on Earth, we have the models 1220A and 1222A. These two are identical 15 MHz, dual trace 'scope, except that the latter has a signal delay line and a switchable inverting stage for the second channel. The sweeps are from .1 uS/div. to .5 S/div. The prices are $1388.00 and $1494.00 respectively.

There are also three basic 500 KHz oscilloscopes, the models 1200A/B, 1201B and 1205B. All three are dual trace beasties, with 1 uS/div. to 5 S/div. sweeps. The 1201B is a storage 'scope, with a maximum of 1 minute persistence. The 1200A is a regular upright 'scope style 'scope; the other two are rack mountable. The prices are $3077.00 for the 1200A, $4653.00 for the 1202B and $2852.00 for the 1205B. A lot of money for a TV set that won't get bugs Bunny, but less than the cost of a South American country.

Hewlett Packard also makes a plethora (or so) of 'scope accessories and party favours, including scopemobiles, cameras, and probes in all races, creeds and denominations.

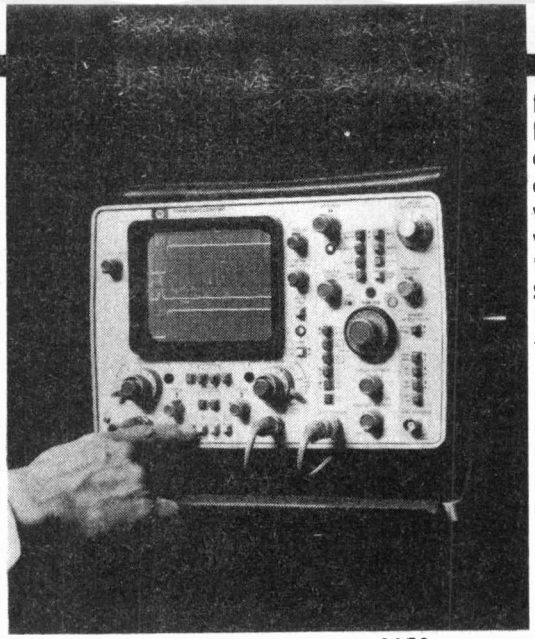
Soar

The Soar line of 'scopes is rather simpler of control than most, although the instruments have all the features you'd expect to find on 'scopes of their class. Soar is distributed by Duncan Instruments Ltd., 122 Millwick Drive, Weston, Ontario, M9L 1Y6.

The Model MS 3015 is a portable 15 MHz dual trace 3 inch 'scope, with .5 uS/div. to .5 S/div. sweep, plus a 5X sweep expander. The 'scope can run on AC, 11 to 30 volts of DC at less than 8 watts, or an optional internal nicad pack. When used on AC, the nicad is automatically kept fully charged. The price is $995.00.

The Model MS 6020 is a 20 MHz dual trace 'scope, having a five inch tube and .5 uS/div. to .5 S/div. sweep. There's also a 5X magnifier. The price is $775.00.

The models MS 6021, 6040, and 6045 are all similar instruments, being dual trace 'scopes, with signal delay. The MS 6021 has 20 MHz of bandwidth and .5 uS/div. to .5 S/div. sweep, plus 5X magnification. It costs $865.00. The MS 6040 has 40 MHz of bandwidth, and .2 uS/div. to .5 S/div., plus 5X magnification. It goes for $1665.00. The MS 6045 is essentially the same as the MS 6050, except for a 45 MHz bandwidth, and a $1775.00 sticker price (power windows optional).

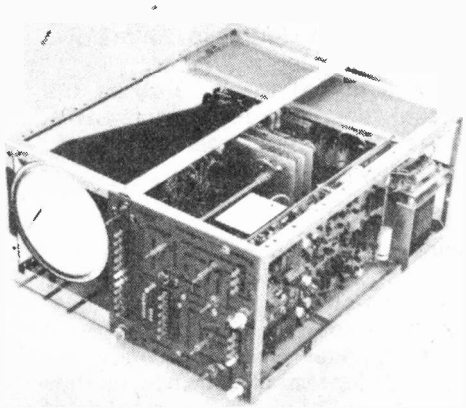


Viz

Viz makes 2 'scopes, both with nice large screens, and really simple control layouts. Both are ideal as bench 'scopes for servicing. Viz is distributed by H.W. Cowan Canada Ltd., 99 Coons Road, P.O. Box 268, Richmond Hill, Ontario, L4C 4Y2.

The model W0-555 is a 15 MHz dual trace 'scope, with .5 uS/div. to .5 S/div. sweep, plus two presets that display 2.5 vertical TV frames and 2.5 vertical TV lines, respectively. There's a 25 nS sweep delay line as well. The cost of this one is $1190.00.

The model W0-527 is a single trace, 15 MHz instrument, with .5 uS/div. to .5 S/div. sweep. There's a triggering preset to automatically display one line of video. The total bill, not including a tip for the waiter, is $925.00.



Kikusui

Kikusui, or "Kik", make a broad range of 'scopes, plus an assortment of accessories and lily-guildings. All are well laid out, and will grace any lab, workshop or dining room table. Kikusui is distributed by Interfax Systems Incorporated, 5955 Airport Road, Suite 105, Mississauga, Ontario L4V 1R9.

The model COS6100 is a 100 MHz 'scope, with three vertical input channels. There's a 40 nS signal delay, and the triggers for the sweeps can be viewed as two additional channels on the tube. The dual time bases run from 20 nS/div. to .5 S/div., plus 10X magnifiers. The B timebase has .2 uS to 5 S variable delay. Enough knobs and buttons to keep even the most jaded facinated for days; if you lose the manual you're dead. All for just $3448.00.

The models 5650 and 5630 are similar dual trace 'scopes, except for the bandwidths, these being 50 MHz for the former, and 35 MHz for the latter. Both have .1 uS/div. to .5 S/div. of sweep, and variable sweep delay from 1 uS to 5 S. There's also a 10X sweep magnifier. The are $2524.00 and $2170.00 respectively.

The model 5516ST is a 10 MHz storage 'scope, with .5 uS/div. to 1 S/div. of sweep, and a 5X magnifier. The writing speed is 5 uS/div. $2468.00.

The models 5531 and 5530 are both 35 MHz dual trace 'scopes, the former having 2 uS to 5 mS delayed sweep. The time bases run from .2 uS/div. to .5 S/div., plus 5X sweep magnification. The prices are $1806.00 and $1601.00.

The model COS3010 TW is a 15 MHz dual trace 'scope, with a choice of AC, Nicad and external 11 to 30 VDC operation. The time base runs from .5 uS/div. to .5 S/div., plus a 5X magnifier. The screen is about three inches across. The price is $1314.00, including battery pack.

The models 5519 and 5520 are similar, except that the 5519 is a single channel 'scope, and the 5520 dual. Both have 20 MHz of bandwidth, and .2 uS/div. to .5 S/div. of sweep, plus 5X sweep magnification. The price tags are $785.00 for the 5519, and $987.00 for the 5520.

The models 5509 and 5513 are similar, with the 5513 having two input channels, and the 5509 one. The time bases run from 1 uS/div. to .1 S/div., plus 5X magnification. The prices are $651.00 and $810.00 respectively.

All models come with probes.

Eico

Eico makes quite a bit of test equipment, much of which can also be had in kit form. They make three 'scopes, all of which use vacuum tube circuitry, which makes them fairly inexpensive, and quite reliable. Eico is distributed by H.W. Cowan Canada Limited, 99 Coons Road, P.O. Box 268, Richmond Hill, Ontario, L4C 4Y2.

The model 465 is a single trace, recurrent sweep 'scope, with a 5 inch tube and 8 MHz of bandwidth. The sweep ranges from 10 Hz to 100 KHz, plus presets for television vertical and horizontal frequencies. The price is $630.45.

The model 460 is similar to the model 465, except that it has a 4.5 MHz bandwidth. The price is $554.65.

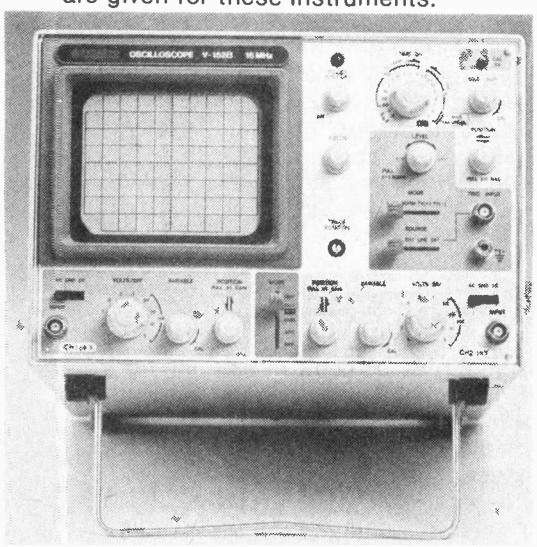
The model 435 is a 3 inch, 4.5 MHz instrument, which is extremely compact, even by solid state standards. It has sweep ranging from 10 Hz to 100 KHz, plus two presets for TV. It costs $529.70.

Eico 'scopes are sold without probes; all will use test leads, or any of the several special purpose probes available from Eico.

Hitachi

Hitachi, which makes everything any human being could ever want, in four popular colours (tone control optional on some models), also makes 11 different 'scopes. Very nice 'scopes they are, too, with many of the features found on the really expensive Tektronix and HP type instruments. Hitachi Denshi, Ltd. (Canada), lives at 922 Dillingham Road, Pickering, Ontario L1W 1Z6.

At the time of this writing, Hitachi was in the process of raising their prices, and would not supply us with the new ones. As such, no prices are given for these instruments.



To start things off, there is the model V-1050, which has 100 MHz of bandwidth, and four, count 'em, traces. The second two channels permit one to peer at the triggering waveforms, which allows all sorts of useful timing measurements to be made. The dual timebase runs from 20 nS/div. to .5 S/div., or to 50 mS/div. for the second channel. There's a signal delay line and variable calibrated delay triggering.

The model V-758 is a 75 MHz dual trace 'scope, with dual time bases running from 50 nS/div. to .2 S/div. for the A channel and 20 mS/div. for the B. There's also a 10X sweep magnifier. The sweep can be delayed.

The model V-358 is a dual trace, 35 MHz 'scope, with dual time bases running from .1 uS/div. to .5 S/div. for channel A and 50 mS/div. for channel B. The sweep can be delayed, and there's a 10X magnifier.

The V-550B is a dual trace, dual time base instrument, with 50 MHz of bandwidth, variable sweep delay, and swep from 50 nS/div. to .5 S/div. for channel A and 50 mS/div. for B.

The models V-302B, V-152B and V-151B are all very similar. The V-302B has 30 MHz of bandwidth, signal delay and sweep from .2 uS/div. to .2 S/div., plus a 10X sweep magnifier. The other two are 15 MHz 'scopes, having the same time base. The V-152B has a signal delay.

The models V-202 and V-352 are both similar, the former having 20 MHz of bandwidth, and the latter 35 MHz. Both have .2 uS/div. to .2 S/div. sweep, plus 10X magnifiers. The V-352 has signal delay.

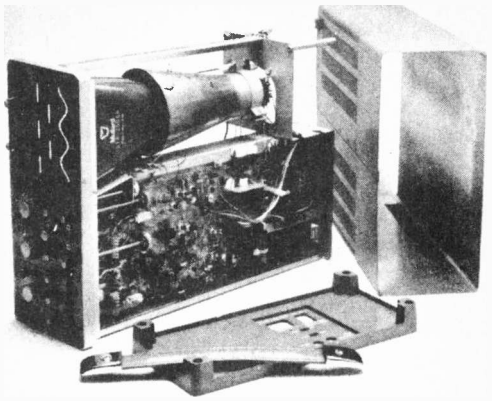
The model V-158 is a 15 MHz, dual trace 'scope, with .2 uS/div. to .5 S/div. sweep. The sweep can be delayed.

The model V-059B is a 7 MHz, 3 inch single trace 'scope, which can run on AC, 11.5 to 14 VDC, or on an optional battery pack. The sweep runs from 10 uS/div. to 20 mS/div., plus a 10X sweep magnifier.

Except for the V-059B all the Hitachi 'scopes have 5 inch CRTs, and all come with the appropriate numbers of probes.

Gould

Gould's 'scopes have a rather subtle European styling, probably because they're made in England. Caution should be excercised in driving them on North American highways, as they tend to want to use the wrong side of the road. However, they handle nicely in hilly terrain. Gould is distributed by



Allan Crawford Associates Ltd, 6503 Northam Drive, Mississauga, Ontario L4V 1J2.

The model OS255 is a 15 MHz, dual trace 'scope with a 100 nS/div. to .5 S/div. time base. There is sum and difference display provision for the Y inputs. The screen is 8 x 10 cm. The 'scope is unusually small and light for its type. $839.00.

The model OS3350 is a 40 MHz, dual trace 'scope, which can also be used as a TV monitor, giving an actual television picture on its tube, and as a line monitor, permitting one to check out any selected line in the picture. It's available for either NTSC or PAL standards. It sweeps from 100 nS/div. to 1 S/div., plus a 5X magnifier. It costs $5109.00.

The model OS4020 is a brand new digital storage 'scope. It has pretrigger viewing, a 2 MHz storage rate, and is compatible with the IEEE-488 bus. Its digital sweep speed is .2 mS/div. to 20 S/div. It can also be used as a conventional 10 MHz 'scope, with sweep from 1 uS/div. to 20 S/div., plus a 10X magnifier. It costs $5580.00.

Leader

Leader makes over nine different 'scopes for the basic 'scope market (ten, actually), plus a few other esoteric types for specialized applications. They all have genuine knobs, authentic buttons and come with official packing material around every one. Leader is distributed in Canada by Omnitronixs Ltd. 6295 Shawson Drive Unit 7, Mississauga, Ontario L5T 1H4.

All the 'scopes come complete with an appropriate number of probes, except for those that use test leads . . . where in one would expect to get leads, now wouldn't one.

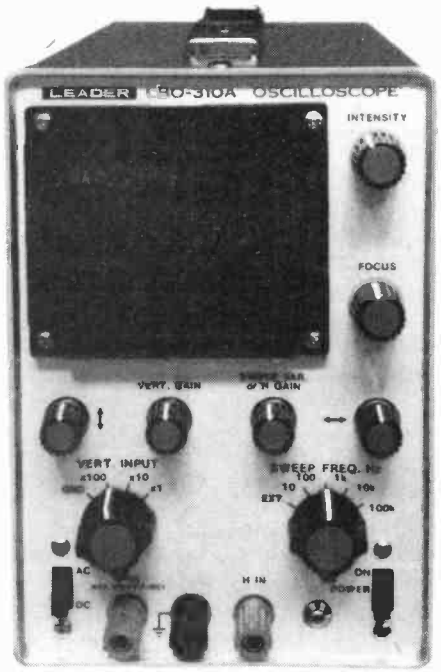
The LBO-517 is the ultra delux mondo expensive top of the line

Leader 'scope, having two channels, 50 MHz bandwidth, dual time bases with delayed triggering from .05 uS/div. to .1 S/div., and sweep from .05 uS/div. to .5 S/div. There's a 10X magnifier, which effectively extends the sweep down to 5 nS/div. The screen size is five inches. For the mere price of $3280.00 you can have one too. They probably won't let you put one on your Visa.

The LBO-515B is very similar to the LBO-517, except that it has 30 MHz of bandwidth instead of 50. The main time base goes from .2 uS/div. to .5 S/div., and the delay is from .2 uS/div. to .1 S/div. The CRT is a 4 inch type. The price is $2275.00.

The LBO-520A has 35 MHz of bandwidth, and two channels of vertical deflection (only one time base, though). The sweep runs from .2 uS/div. to .5 S/div. There is no trigger delay, but the signal can be delayed by 120 nS. The graticule is 8 x 10 cm. The price. . . a trivial $1750.00. Well, it's trivial to me; I haven't got anywhere near that much.

Next, we come upon the LBO-308S, with 20 MHz of bandwidth and a three inch screen. There is an optional 120 nS delay line available, and an optional internal battery pack. The sweep is from .5 uS/div. to .2



uS/div., with a 5X magnifier. It's $1394.00 for one, or twice that much for two. If you need ten just move the decimal over one place. Math is neat sometimes.

The LBO-508A has a five inch screen, but very nearly the same specifications as the LBO-308A above, without the delay or the battery pack. It's $1149.00. It is also available as a single channel instrument, the LBO-507A, for $905.00

The LBO-514 is a 10 MHz 'scope, with most of the other assorted numbers and features similar to the LBO-508A. It goes for $985.00. It, too, comes in a single trace model, the LBO-513, for $814.00

Lastly, there are the LBO-510A and LBO-310A, differing only in that the former has a 5 inch screen, and the latter 3. Their bandwidths are 4 MHz, making them suitable for most experimenting if you aren't into heavy radio or real narrow sneaky pulses. The sweeps are of the recurrent type, ranging from 10 Hz to 100 KHz. Their cabinet styling is vertical, reminicent of the older Dumont scopes (although they're much smaller and lighter). The prices are $487.00 and $368.00 respectively, including 3 test leads.

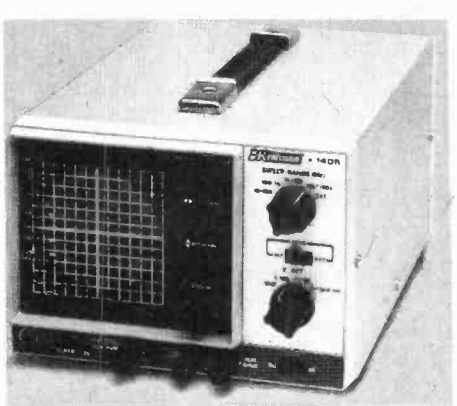
Lab Volt

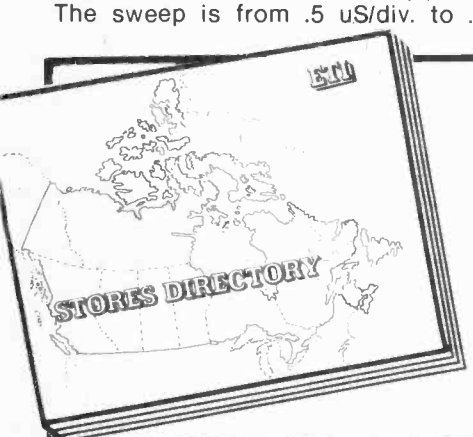
All of Lab Volt's 'scopes are built by Leader, and are identical to the Leader instruments.

B&K

B&K makes nine different 'scopes at the moment, all with amazing spacey blue CRTs. All of them are very sophisticated looking, and if you buy one and tell your great Aunt Remora that it can be used to contact methane monsters on the eighth planet of Proxima Centauri, she will unquestionably believe you. B&K instruments are distributed by Atlas Electronics Limited, 50 Wingold Avenue, Toronto, Ontario, M6B 1P7.

The Model 1535 is the grando delux dual trace, with 35 MHz response, and sweep speeds from .1 uS/div. to .5 S/div. The signal can be delayed by 10 nS. There are various ways of combining the two channel traces, and handy extras like LEDs that come on when something is switched out of the calibrate mode. The grando delux dual trace price is $1956.00.





Who Do You Buy From?

Buying electronic parts in Canada can be a nuisance, nobody knows this more than we do. To help some of our more isolated readers we are compiling a list of stores in Canada for inclusion in the magazine in a future issue.

Tell us who you shop from. By doing so, you'll be helping readers like yourself and the stores you patronize.

We have included a list of the stores that appeared in the January 1981 Directory. Please do not send us names that appear there, we already know about them. Please send store names and addresses to:

ETI

Stores Directory
c/o Electronics Today
Unit 6
25 Overlea Blvd.
Toronto, Ontario
M4H 1B1

STORES DIRECTORY

BRITISH COLUMBIA
Kamloops
Cam Gard Supply Limited
Trail
IUS Electronics Ltd.
Vancouver
Active Component Sales Corp.
Cam Gard Supply Ltd.
Conit Electronics
Glenwood Trading Company Limited
Heath Company
Intek Electronics Ltd.
R-A-E Industrial Electronics Limited
Victoria
Quasie Electronics Ltd.
ALBERTA
Calgary
Active Component Sales Corp.
B & E Electronic Supply Limited
Visions
Edmonton
Cardinal Industrial Electronics Ltd.
Heath Company
R-A-E Industrial Electronics
Medicine Hat
Base 2 Consulting Limited
SASKATCHEWAN
Moose Jaw
Sonic Supplies Ltd.
Regina
Radio Supply & Service (1977) Limited
Saskatoon
Cam Gard Supply Limited
Swift Current
G W Colortronics Ltd.
MANITOBA
Winnipeg
Cam Gard Supply Ltd.
Heathkit Electronic Center
J & J Electronics Limited
W.E.S. Electronics Limited
ONTARIO
Brampton
Bryan Electronics
Georgetown
Inventories Unlimited
Guelph
Neutron Electronics Limited
Kitchener-Waterloo
K-W Surplus Clear Inghouse
Waterloo Electronic Supply Co. Inc.
Computer Innovations Limited
London
R.J. Buckland Company
Forest City Surplus Ltd.
Mississauga
Atwater Electronics Limited
Heath Company
K.S.K. Associates
Ottawa
Active Component Sales Corp.
Compumart
Computer Innovations Limited
Gervais Electronics Limited
Heath Company
Kris Electronics
Videoland
Wackid Radio
Owen Sound
North Western Electronic Supply Limited
North Bay
Videoland
Sarnia
Videoland
Simcoe
Norfolk Electronics Limited
Toronto
A-1 Electronics
Active component Sales Corp
Active Surplus Annex
Arkon Electronics Limited
Batteries Included
Cesco Electronics Ltd.
Dominion Radio and Electronics
Elstonscience Inc.
Electro Sonic Inc.
Electronics 2001
Excelltronix Components & Computing incorporated
General Electronics
Gladstone Electronics
Home Computer Centre
House of Computers Inc.
M & W Computer Stores Inc.
Radio Trade Supply Limited
Videoland
Zenith Radio Canada Limited
Waterford
Copeland Electronics
QUEBEC
Blainville
Surplus Electro Quebec
Amitex Electronique Inc.
Longueuil
Masier Vox Ltd.
Mont-e-Joli
Distribution JMC
Distribution Inc
Montreal
Active Component Sales Corp.
Addison Electronic Ltd.
Cite Electronique
Cesco Electronics Ltd.
Eleo Electronics
Hamilton Avnet Electronics
Heath Company
North American Electronics Co Limited
Payette radio
Radio Hovsep
Products Electroniques Ltee/ Electronic Wholesalers Co. Limited
Standard Electronics
Super Electronic
St. Romuald
Selco Electronics
Thetford Mines
Elektronicxe Enr.
Trois Rivieres
Matteau Electronique
NEW BRUNSWICK
Moncton
Amphion Electronics Limited
NOVA SCOTIA
Halifax
Amphion Electronics Limited
Basic Computer Sales Ltd.
Cam Gard Supply Limited
Mini Comp Systems Limited
Sydney
Fisher Electronics Limited
PRINCE EDWARD ISLAND
Charlottetown
Island Radio Centre Limited
NEWFOUNDLAND
St. John's
Electronic Centre Limited

The Model 1530 is very much like the 1535, except that it has 30 MHz of bandwidth, and the fastest sweep is .2 uS/div. It also has delayed sweep. The cost? Funny you should ask. $2045.25.

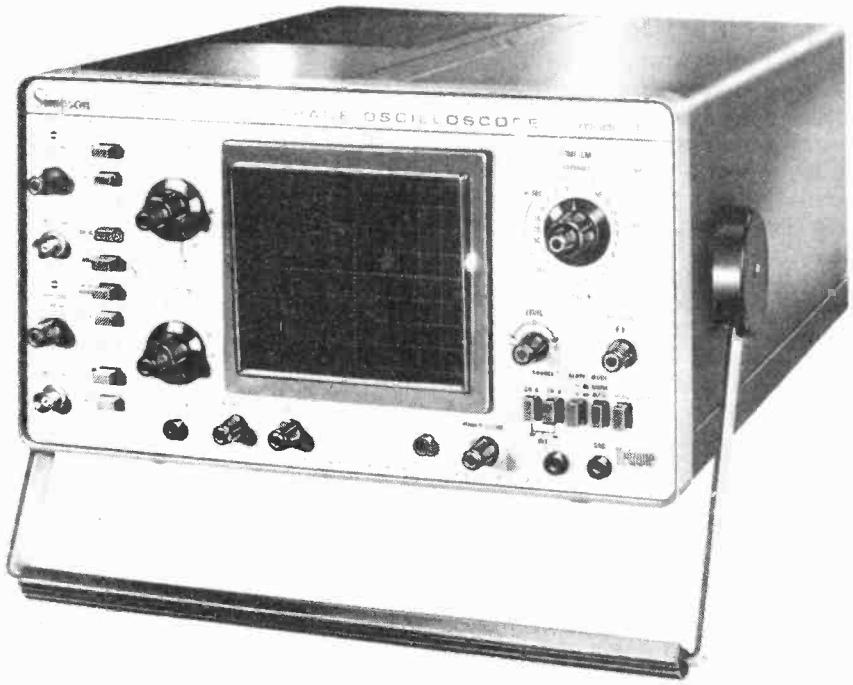
The Model 1520 is a 20 MHz instrument, with a sweep range of .5 uS/div. to .5 S/div. While is doesn't incorporate delays, it does have a 10X trace magnifier, and things like differential input capacity for the two Y channels. The price includes a packing carton of their choice. $1348.05.

The Model 1479A is a dual trace, 30 MHz instrument, with built in high pass and low pass filters, a video sync seperator, and .2 uS/cm to .5 S/cm sweep. It also has an internal RF demodulator. $1675.65.

The Model 1477 has dual traces and 15 MHz of response, useable to 30 MHz. It can also be used as a vectorscope, for fidgeting with colour TVs. It sweeps all the way down to .1 uS/div. with a 5X magnifier. Getting down there, at $1285.05.

The Model 1476 is a 10 MHz instrument. The sweep control automatically selects the 'chop' or 'alternate' modes of two channel display, and the appropriate video line or field sync. The sweep runs from .5 uS/div. to .5 S/div. $1009.95.

The Model 1466 is essentially the same as the Model 1476 except that it is a single trace 'scope. Oddly, cutting the number of channels in half doesn't halve the price. $852.45.

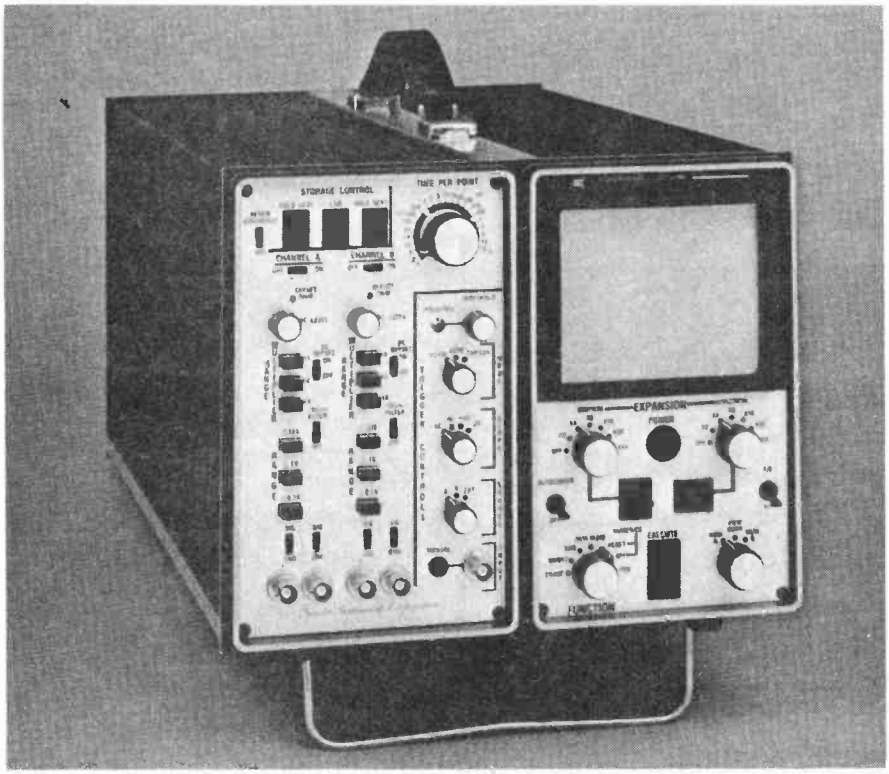


The Model 1435 is a 3 inch dual trace 'scope with 15 MHz of bandwidth, and battery operation for portability. The sweep runs from .5 uS/div. to .5 S/div. It can be ported for $1208.40.

The Model 1405 is a 3 inch, single channel recurrent sweep 'scope, with 5 MHz of bandwidth. The CRT plates are directly accessable, and can display waveforms up to 150 MHz with external amps. It uses test leads, which are supplied. Just $390.45.

There are also two new B&K 'scopes. The first is the model 1420, a 15 MHz dual trace mini 'scope, with battery operation. It's small enough to fit into a brief case. The sweep runs from 1 uS/div. to .5 S/div. There's also a 10X magnifier. The size is 11 x 22 x 30 cm with the handlle. The price is $1332.30. Fortunately, cheque books are portable, too.

The other new addittion is the model 1500, a 100 MHz quad trace 'scope, with dual time bases going down to 20 nS/div. There's a 30 nS signal delay, and knobs and buttons like mad. $3891.15. Not in Canadian Tire money.



Nicolet Explorer

Nicolet 'scopes have some features infrequently found in your basic five inch recurrent sweep tube 'scope. Disc drives, for example. And the CRTs are all blue. Blue CRTs are a decided improvement over the regular green type, because they make you feel like you're in the twenty second century. The thing with these instruments is that they're all digital, and sophisticated as all get out. Just the thing for fixing those nasty transistor radios and tuning up the Edsel. Nicolet 'scopes are distributed by

Nicolet Instruments Canada Ltd, 1-1200 Aerowood Drive, Mississauga, Ontario, L4W 2S7.

Nicolet builds three 'scopes, which they call Explorers I, II and III. They also do a raft of accessories and associatable wizzbangs.

The Explorer I is the basic digital oscilloscope. It has two 500 KHz channels, with a digital writing rate of about 5 cm/sec. It has complete storage capacity, can display live and stored waveforms, mid signal trigger capacity, and can drive an XY plotter for hard copy. Each point on the screen can represent between 1 uS and 20 S. The price is $6345.00. If you have to ask you can't afford one.

The Explorer II is like its predecessor, but with additional wonderfulness. First off, it's modular, making it adaptable to a wider variety of applications. There are three vertical channel plug-ins available, with rise times to 50 nS. Nicolet will add interface or disc drive options for up to two years after the purchase of the 'scope. The price. . . $4935.00.

Still got something left in the budget? Wow. . . you must work for the government. In that case, you need an Explorer III. It is exactly the same as the Explorer II, but with an additional mainframe to take all the digital interfacing stuff, and/or a disc drive. The disc drive, of course, can be used to record any of the digital information in the 'scope, including the actual waveform, for future edification. The instrument is also interfacable with the IEEE-488 bus. This means that this $7755.00 can be easily plugged into any $500.00 PET computer.

Both the Explorer II & III require additional plug in modules.

ETI

PULLING THE PLUG

IF THE LAST mail strike caught you a bit off guard, you'll probably be really impressed by a project we're in the process of developing to ward off just this situation the next time they all go for a powder. (Yes, the inside workers are happy, but, lest you forget, there's always the the letter carriers, the post office window washers, the lads that print the stamps and the ever present Union of People Who Have Keys to the Front Door.) Shortly, for a nominal investment, you will be able to have the security of knowing when the mail is about to come to a grinding, nationwide halt with the ETI Mail Strike Alert. The principle of operation, as shown in the accomanying block diagram, is splendidly simple. IC1, a 555 connected as an astable, generates pulses at a rate of one per hour. These are divided down by IC's 2 and 3 to one pulse per day, and by IC4 to one pulse per four days. At the end of four days Q1 gets switched on, illuminating I1, the Mail Strike Alert lamp. This should be suitably mounted, with a bezel and filter marked with an appropriate legend.

ETI POSTAL STRIKE ALERT

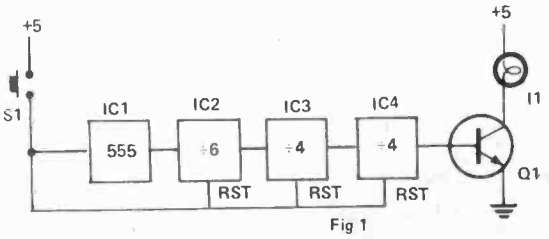


Fig 1

However, as can be seen, the whole writhing mess can be reset, by S1, a micro-switch whose leaf is adjusted such that pushing mail through the door of the mail slot momentarily closes the switch contacts. Thus, if the mail keeps coming, Q1 will never be switched on.

Perhaps the most attractive feature of this design is that it actually makes some use of junk mail. Obviously, the reliability of the concept is based upon the premise that even the most pathetic, reclusive hermits in the land get some mail, of some sort, within the space of four days. Now, naturally, a fellow with a mail order face and postal halitosis, whose hobbies include breeding dancing scorpions...well, let's face it, he just isn't going to get much personal mail. However, the system will still work for him because he, like everybody else in the country with a postal code, will be constantly deluged with literature about retirement communities in Bolivia, half price pith helmet sales, religious groups offering God's 1-800 number for a nominal charge, and all the other interesting flotsam awash in the mails of this great nation.

There are a few simple improvements to this circuit which you may wish to try. Figure 2 illustrates a simple power booster, should you wish to build either a mail strike alert 25,000 candle-power searchlight, or to drive an air raid siren. You might also feel like adding a seven day pulser that shuts the thing down over the weekends.

Now actually, we were intending to publish this circuit this month. However, the lad who put it together for us, our own Wilber Roehampton Soxmender IV, lives out in Burnaby, B.C., from where he . . . mailed us the diagram.

Have you got any idea how many opportunities the post office has for losing a letter between British Columbia and Ontario? Can you conceive of the almost limitless possibilities for missending it to Manilla? Are there numbers large enough to count the machines through which it must pass, each capable of neatly shredding it to molecule-size particles, and automatically depositing it in a plastic bag marked "accidentally damaged in transit"?

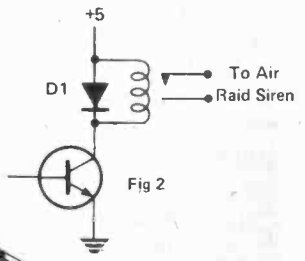


Fig 2

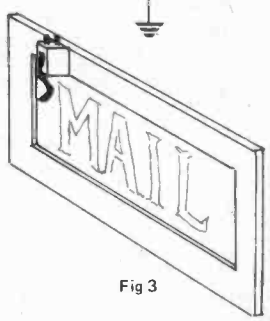
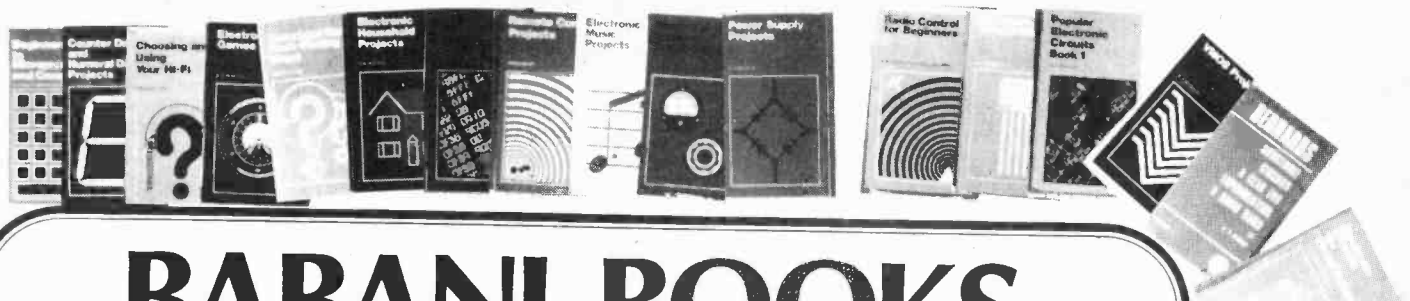


Fig 3

Yes, you guessed it. If it shows up, we'll print it.

ETI



BABANI BOOKS

SPECIALLY IMPORTED FROM ENGLAND

BP35: HANDBOOK OF IC AUDIO PRE-AMPLIFIER AND POWER AMPLIFIER CONSTRUCTION $5.50
F.G.RAYER, T.Eng.(CEI),Assoc.IERE
This book is divided into three parts. Part I, understanding audio IC's. Part II, Pre-amplifiers, Mixers and Tone Controls. Part III Power Amplifiers and Supplies. Includes practical constructional details of pure IC and Hybrid IC and Transistor designs from about 250mW to 100W output.

BP37: 50 PROJECTS USING RELAYS, SCR's & TRIACS $5.50
F.G.RAYER, T.Eng.(CEI),Assoc.IERE
Relays, silicon controlled rectifiers (SCR's) and bi-directional triodes (TRIACs) have a wide range of application in electronics today. This book gives tried and practical working circuits which should present the minimum of difficulty for the enthusiast to construct. In most of the circuits there is a wide latitude in component values and types, allowing easy modification of circuits or ready adaptation of them to individual needs.

BP39: 50 (FET) FIELD EFFECT TRANSISTOR PROJECTS $5.50
F.G. RAYER, T.Eng.(CEI),Assoc.IERE
Field effect transistors (FETs), find application in a wide variety of circuits. The projects described here include radio frequency amplifiers and converters, test equipment and receiver aids, tuners, receivers, mixers and tone controls, as well as various miscellaneous devices which are useful in the home.
This book contains something of particular interest for every class of enthusiast — short wave listener, radio amateur, experimenter or audio devotee

BP42: 50 SIMPLE L.E.D. CIRCUITS $3.55
R.N. SOAR
The author of this book, Mr. R.N. Soar, has compiled 50 interesting and useful circuits and applications, covering many different branches of electronics, using one of the most inexpensive and freely available components — the Light Emitting Diode (L.E.D.). A useful book for the library of both beginner and more advanced enthusiast alike.

BP44: IC 555 PROJECTS $7.55
E.A. PARR, B.Sc.,C.Eng., M.I.E.E.
Every so often a device appears that is so useful that one wonders how life went on before without it. The 555 timer is such a device. Included in this book are Basic and General Circuits, Motor Car and Model Railway Circuits, Alarms and Noise Makers as well as a section on the 556, 558 and 559 timers.

BP46: RADIO CIRCUITS USING IC's $5.90
J.B. DANCE, M.Sc.
This book describes integrated circuits and how they can be employed in receivers for the reception of either amplitude or frequency modulated signals. The chapter on amplitude modulated (a.m.) receivers will be of most interest to those who wish to receive distant stations at only moderate audio quality, while the chapter on frequency modulation (f.m.) receivers will appeal to those who desire high fidelity reception.

BP47: MOBILE DISCOTHEQUE HANDBOOK $5.90
COLIN CARSON
The vast majority of people who start up "Mobile Discos" know very little about their equipment or even what to buy. Many people have wasted a "small fortune" on poor, unnecessary or badly matched apparatus.
The aim of this book is to give you enough information to enable you to have a better understanding of many aspects of "disco" gear.

BP48: ELECTRONIC PROJECTS FOR BEGINNERS $5.90
F.G. RAYER, T.Eng.(CEI), Assoc.IERE
Another book written by the very experienced author — Mr. F.G. Rayer — and in it the newcomer to electronics will find a wide range of easily made projects. Also, there are a considerable number of actual component and wiring layouts, to aid the beginner.
Furthermore, a number of projects have been arranged so that they can be constructed without any need for soldering and, thus, avoid the need for a soldering iron.
Also, many of the later projects can be built along the lines as those in the 'No Soldering' section so this may considerably increase the scope of projects which the newcomer can build and use.

BP65: SINGLE IC PROJECTS $6.55
R.A.PENFOLD
There is now a vast range of ICs available to the amateur market, the majority of which are not necessarily designed for use in a single application and can offer unlimited possibilities. All the projects contained in this book are simple to construct and are based on a single IC. A few projects employ one or two transistors in addition to an IC but in most cases the IC is the only active device used.

BP66: BEGINNERS GUIDE TO MICROPROCESSORS AND COMPUTING $7.55
E.F. SCOTT, M.Sc., C.Eng.
As indicated by the title, this book is intended as an introduction to the basic theory and concepts of binary arithmetic, microprocessor operation and machine language programming.
There are occasions in the text where some background information might be helpful and a Glossary is included at the end of the book.

BP67: COUNTER DRIVER AND NUMERAL DISPLAY PROJECTS $7.55
F.G. RAYER, T.Eng.(CEI), Assoc. IERE
Numeral indicating devices have come very much to the forefront in recent years and will, undoubtedly, find increasing applications in all sorts of equipment. With present day integrated circuits, it is easy to count, divide and display numerically the electrical pulses obtained from a great range of driver circuits.
In this book many applications and projects using various types of numeral displays, popular counter and driver IC's etc. are considered.

BP68: CHOOSING AND USING YOUR HI-FI $7.25
MAURICE L. JAY
The main aim of this book is to provide the reader with the fundamental information necessary to enable him to make a satisfactory choice from the extensive range of hi-fi equipment now on the market.
Help is given to the reader in understanding the equipment he is interested in buying and the author also gives his own opinion of the minimum standards and specifications one should look for. The book also offers helpful advice on how to use your hi-fi properly so as to realise its potential. A Glossary of terms is also included.

BP69: ELECTRONIC GAMES $7.55
AUTHOR: R.A. PENFOLD
In this book Mr. R. A. Penfold has designed and developed a number of interesting electronic game projects using modern integrated circuits. The text is divided into two sections, the first dealing with simple games and the latter dealing with more complex circuits.

BP70: TRANSISTOR RADIO FAULT-FINDING CHART $2.40
AUTHOR: CHAS. E. MILLER
Across the top of the chart will be found four rectangles containing brief descriptions of these faults, viz — sound weak but undistorted; set dead, sound low or distorted and background noises. One then selects the most appropriate of these and following the arrows, carries out the suggested checks in sequence until the fault is cleared.

BP71: ELECTRONIC HOUSEHOLD PROJECTS $7.70
AUTHOR: R. A. PENFOLD
Some of the most useful and popular electronic construction projects are those that can be used in or around the home. The circuits range from such things as 2 Tone Door Buzzer, Intercom, through Smoke or Gas Detectors to Baby and Freezer Alarms.

BP72: A MICROPROCESSOR PRIMER $7.70
AUTHOR: E.A. PARR, B.Sc., C.Eng., M.I.E.E.
A newcomer to electronics tends to be overwhelmed when first confronted with articles or books on microprocessors. In an attempt to give a painless approach to computing, this small book will start by designing a simple computer and because of it simplicity and logical structure, the language is hopefully easy to learn and understand. In this way, such ideas as Relative Addressing, Index Registers etc. will be developed and it is hoped that these will be seen as logical progressions rather than arbitrary things to be accepted but not understood.

213: ELECTRONIC CIRCUITS FOR MODEL RAILWAYS $4.50
M.H. BABANI, B.Sc.(Eng.)
The reader is given constructional details of how to build a simple model train controller; controller with simulated inertia and a high power controller. A signal system and lighting for model trains is discussed as is the suppression of RF interference from model railways. The construction of an electronic steam whistle and a model train chuffer is also covered.

221: 28 TESTED TRANSISTOR PROJECTS $5.50
R.TORRENS
Mr. Richard Torrens is a well experienced electronics development engineer and has designed, developed, built and tested the many useful and interesting circuits included in this book. The projects themselves can be split down into simpler building blocks, which are shown separated by boxes in the circuits for ease of description, and also to enable any reader who wishes to combine boxes from different projects to realise ideas of his own.

223: 50 PROJECTS USING IC CA3130 $5.50
AUTHOR: R.A.PENFOLD
In this book the author has designed and developed a number of interesting and useful projects which are divided into five general categories. I — Audio Projects. II — R.F. Projects. III — Test Equipment. IV — Household Projects. V — Miscellaneous Projects.

224: 50 CMOS IC PROJECTS $4.25
R.A. PENFOLD
CMOS IC's are probably the most versatile range of digital devices for use by the amateur enthusiast. They are suitable for an extraordinary wide range of applications and are also some of the most inexpensive and easily available types of IC.
Mr. R.A. Penfold has designed and developed a number of interesting and useful projects which are divided into four general categories. I — Multivibrators. II — Amplifiers and Oscillators. III — Trigger Devices. IV — Special Devices.

BP1: FIRST BOOK OF TRANSISTOR EQUIVALENTS AND SUBSTITUTES $2.80
B.B. BABANI
This guide covers many thousands of transistors showing possible alternatives and equivalents. Covers transistors made in Great Britain, USA, Japan, Germany, France, Europe, Hong Kong, and includes types produced by more than 120 different manufacturers.

BP14: SECOND BOOK OF TRANSISTOR EQUIVALENTS AND SUBSTITUTES $4.80
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The "First Book of Transistor Equivalents" has had to be reprinted 15 times. The "Second Book" produced in the same style as the first book, in no way duplicates any of the data presented in it. The "Second Book" contains only additional material and the two books complement each other and make available some of the most complete and extensive information in this field. The interchangeability data covers semiconductors manufactured in Great Britain, USA, Germany, France, Poland, Italy, East Germany, Belgium, Austria, Netherlands and many other countries.

BP24: 50 PROJECTS USING IC741 $4.25
RUDI & UWE REDMER
This book originally published in Germany by TOPP has achieved phenomenal sales on the Continent and Babani decided, in view of the fact that the integrated circuit used in this book is inexpensive to buy, to make this unique book available to the English speaking reader. Translated from the original German with copious notes, data and circuitry, 'must' for everyone whatever their interest in electronics.

BP33: ELECTRONIC CALCULATOR USERS HANDBOOK $4.25
M.H. BABANI, B.Sc.(Eng.)
An invaluable book for all calculator users whatever their age or occupation, or whether they have the simplest or most sophisticated of calculators. Presents formulae, data, methods of calculation, conversion factors, etc., with the calculator user especially in mind, often illustrated with simle examples. Includes the way to calculate using only a simple four function calculator. Trigonometric Functions (Sin, Cos, Tan); Hyperbolic Functions (Sinh, Cosh, Tanh) Logarithms, Square Roots and Powers.

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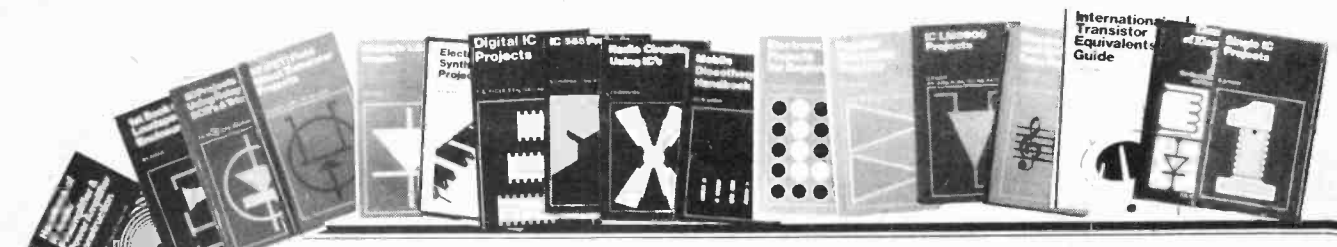

BP81: ELECTRONIC SYNTHESISER PROJECTS $7.30
M.K. BERRY
One of the most fascinating and rewarding applications of electronics is in electronic music and there is hardly a group today without some sort of synthesiser or effects generator.

Although an electronic synthesiser is quite a complex piece of electronic equipment, it can be broken down into much simpler units which may be built individually and these can then be used or assembled together to make a complete instrument.

BP83: VMOS PROJECTS $8.20
R.A. PENFOLD
Although modern bipolar power transistor give excellent results in a wide range of applications, they are not without their drawbacks or limitations. This book will primarily be concerned with VMOS power FETs although power MOSFETs will be dealt with in the chapter on audio circuits. A number of varied and interesting projects are covered under the main heading of: Audio Circuits, Sound Generator Circuits, DC Control Circuits and Signal Control Circuits.

BP84: DIGITAL IC PROJECTS $8.11
F.G. RAYER, T.Eng.(CEI),Assoc.IERE
This book contains both simple and more advanced projects and it is hoped that these will be found of help to the reader developing a knowledge of the workings of digital circuits.

To help the newcomer to the hobby the author has included a number of board layouts and wiring diagrams. Also the more ambitious projects can be built and tested section by section and this should help avoid or correct faults that could otherwise be troublesome.

An ideal book for both beginner and more advanced enthusiast alike.

BP85: INTERNATIONAL TRANSISTOR EQUIVALENTS GUIDE $12.25
AUTHOR: ADRIAN MICHAELS
This book will help the reader to find possible substitutes for a popular user-orientated selection of modern transistors. Also shown are the material type, polarity, manufacturer selection of modern transistors. Also shown are the material type, polarity, manufacturer and use. The Equivalent are sub-divided into European, American and Japanese. The products of over 100 manufacturers are included.

An essential addition to the library of all those interested in electronics, be they technicians, designers, engineers or hobbyists.

Fantastic value for the amount of information it contains.

BP86: AN INTRODUCTION TO BASIC PROGRAMMING TECHNIQUES $8.25
AUTHOR: S. DALY
This book is based on the authors own experience in learning BASIC and in helping others, mostly beginners, to program and understand the language.

Also included are a program library containing various programs, that the author has actually written and run, these are for biorhythms, plotting a graph of Y against X, standard deviation, regression, generating a musical note sequence and a card game.

The book is complemented by a number of appendices which include test questions and answers on each chapter and a glossary.

BP87: SIMPLE L.E.D. CIRCUITS $6.25
AUTHOR: R.N. SOAR
Since it first appeared in 1977, Mr. R.N. Soar's book has proved very popular. The author has developed a further range of circuits and these are included in Book 2. Projects include a Transistor Tester, Various Voltage Regulators, Testers and so on.

205: FIRST BOOK OF HI-FI LOUDSPEAKER ENCLOSURES $3.55
B.B. BABANI
This book gives data for building most types of loudspeaker enclosure. Includes corner reflex, bass reflex, exponential horn, folded horn, tuned port, klipschorn labyrinth, tuned column, loaded port and multi speaker panoramic. Many clear diagrams for every construction showing the dimensions necessary.

BP80: POPULAR ELECTRONIC CIRCUITS — BOOK 1 $8.25
R.A. PENFOLD
Another book by the very popular author, Mr. R.A. Penfold, who has designed and developed a large number of various circuits. These are grouped under the following general headings; Audio Circuits, Radio Circuits, Test Gear Circuits, Music Project Circuits, Household Project Circuits and Miscellaneous Circuits.

Babani Books are now available from Arkon, CESCO, Dominion Radio and General Electronics.

BP49: POPULAR ELECTRONIC PROJECTS $6.25
R.A. PENFOLD
Includes a collection of the most popular types of circuits and projects which, we feel sure, will provide a number of designs to interest most electronics constructors. The projects selected cover a very wide range and are divided into four basic types: Radio Projects, Audio Projects, Household Projects and Test Equipment.

BP50: IC LM3900 PROJECTS $5.90
H.KYBETT,B.Sc., C.Eng.
The purpose of this book is to introduce the LM3900 to the Technician, Experimenter and the Hobbyist. It provides the groundwork for both simple and more advanced uses, and is more than just a collection of simple circuits or projects.

Simple basic working circuits are used to introduce this IC. The LM3900 can do much more than is shown here, this is just an introduction. Imagination is the only limitation with this useful and versatile device. But first the reader must know the basics and that is what this book is all about.

BP51: ELECTRONIC MUSIC AND CREATIVE TAPE RECORDING $5.50
M.K. BERRY
Electronic music is the new music of the Twentieth Century. It plays a large part in "pop" and "rock" music and, in fact, there is scarcely a group without some sort of synthesiser or other effects generator.

This book sets out to show how electronic music can be made at home with the simplest and most inexpensive of equipment. It then describes how the sounds are generated and how these may be recorded to build up the final composition.

BABANI BOOKS

ELEMENTS OF ELECTRONICS — An on-going series
AUTHOR: F.A. WILSON, C.G.I.A., C.Eng.
BP62: BOOK 1. The Simple Electronic Circuit and Components $8.95
BP63: BOOK 2. Alternating Current Theory $8.95
BP64: BOOK 3. Semiconductor Technology 8.95
BP77: BOOK 4. Microprocessing Systems And Circuits $12.30

The aim of this series of books can be stated quite simply — it is to provide an inexpensive introduction to modern electronics so that the reader will start on the right road by thoroughly understanding the fundamental principles involved.

Although written especially for readers with no more than ordinary arithmetical skills, the use of mathematics is not avoided, and all the mathematics required is taught as the reader progresses.

Each book is a complete treatise of a particular branch of the subject and, therefore, can be used on its own with one proviso, that the later books do not duplicate material from their predecessors, thus a working knowledge of the subjects covered by the earlier books is assumed.

BOOK 1: This book contains all the fundamental theory necessary to lead to a full understanding of the simple electronic circuit and its main components.

BOOK 2: This book continues with alternating current theory without which there can be no comprehension of speech, music, radio, television or even the electricity mains.

BOOK 3: Follows on semiconductor technology, leading up to transistors and integrated circuits.

BOOK 4: A complete description of the internal workings of microprocessor.

BP73: REMOTE CONTROL PROJECTS $8.58
OWEN BISHOP
This book is aimed primarily at the electronics enthusiast who wishes to experiment with remote control. Full explanations have been given so that the reader can fully understand how the circuits work and can more easily see how to modify them for other purposes, depending on personal requirements. Not only are Radio control systems considered buy also Infra-red, visible light and Ultrasonic systems as are the use of Logic ICs and Pulse position modulation etc.

BP74: ELECTRONIC MUSIC PROJECTS $7.70
R.A. PENFOLD
Although one of the more recent branches of amateur electronics, electronic music has now become extremely popular and there are many projects which fall into this category.

The purpose of this book is to provide the constructor with a number of practical circuits for the less complex items of electronic music equipment, including such things as Fuzz Box, Waa-Waa Pedal, Sustain Unit, Reverberation and Phaser-Units, Tremelo Generator etc.

BP75: ELECTRONIC TEST EQUIPMENT CONSTRUCTION $7.30
F.G. RAYER, T.Eng. (CEI), Assoc. IERE
This book covers in detail the construction of a wide range of test equipment for both the Electronics Hobbyists and Radio Amateur. Included are projects ranging from an FET Amplified Voltmeter and Resistance Bridge to a Field Strength Indicator and Heterodyne Frequency Meter. Not only can the home constructor enjoy building the equipment but the finished projects can also be usefully utilised in the furtherance of his hobby.

BP76: POWER SUPPLY PROJECTS $7.30
R.A. PENFOLD
Line power supplies are an essential part of many electronics projects. The purpose of this book is to give a number of power supply designs, including simple unstabilised types, fixed voltage regulated types, and variable voltage stabilised designs, the latter being primarily intended for use as bench supplies for the electronics workshop. The designs provided are all low voltage types for semiconductor circuits.

There are other types of power supply and a number of these are dealt with in the final chapter, including a cassette power supply, Ni-Cad battery charger, voltage step up circuit and a simple inverter.

BP78: PRACTICAL COMPUTER EXPERIMENTS $7.30
E.A. PARR, B.Sc., C.Eng., M.I.E.E.
Curiously most published material on the microprocessor tends to be of two sorts, the first treats the microprocessor as a black box and deals at length with programming and using the "beast". The second type of book deals with the social impact. None of these books deal with the background to the chip, and this is a shame as the basic ideas are both interesting and simple.

This book aims to fill in the background to the microprocessor by constructing typical computer circuits in discrete logic and it is hoped that this will form a useful introduction to devices such as adders, memories, etc. as well as a general source book of logic circuits.

BP79: RADIO CONTROL FOR BEGINNERS $7.30
F.G. RAYER, T.Eng.(CEI),Assoc.IERE.
The aim of this book is to act as an introduction to Radio Control for beginners to the hobby. The book will commence by dealing with the conditions that are allowable for such things as frequency and power of transmission. This is followed by a "block" explanation of how control-device and transmitter operate and receiver and actuator(s) produce motion in a model.

Details are then given of actual solid state transmitting equipment which the reader can build. Plain and loaded aerials are then discussed and so is the field-strength meter to help with proper setting up.

The radio receiving equipment is then dealt with which includes a simple receiver and also a crystal controlled superhet. The book ends with the electro-mechanical means of obtaining movement of the controls of the model.

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An excellent textbook for those interested in the fundamentals of Electronics. This book covers all major aspects of power supplies, amplifiers, oscillators, radio, television and more.

Digital ICs — How they Work and How To Use Them
AB004 **$10.45**
An excellent primer on the fundamentals of digital electronics. This book discusses the nature of gates and related concepts and also deals with the problems inherent to practical digital circuits.

Brain Ticklers
AB005 **$8.00**
If the usual games such as Bug Stomp and Invaders From the Time Warp are starting to pale, then this is the book for you. The authors have put together dozens of stimulating puzzles to show you just how challenging computing can be.

How To Program Your Programmable Calculator
AB006 **$10.45**
Calculator programming, by its very nature, often is an obstacle to effective use. This book endeavours to show how to use a programmable calculator to its full capabilities. The TI 57 and the HP 33E calculators are discussed although the principles extend to similar models.

Experimenter's Guide To Solid State Electronic Projects
AB007 **$9.45**
An ideal sourcebook of Solid State circuits and techniques with many practical circuits. Also included are many useful types of experimenter gear.

Pascal Programming For the Apple
AB008 **$16.45**
A great book to upgrade your programming skills to the UCSD Pascal as implemented on the Apple II. Statements and techniques are discussed and there are many practical and ready to run programs.

Apple Machine Language Programming
AB009 **$16.45**
The best way to learn machine language programming the Apple II in no time at all. The book combines colour, graphics, and sound generation together with clear cut demonstrations to help the user learn quickly and effectively.

Z80 Users Manual
AB010 **$14.45**
The Z80 MPU can be found in many machines and is generally acknowledged to be one of the most powerful 8 bit chips around. This book provides an excellent 'right hand' for anyone involved in the application of this popular processor.

The Essential Computer Dictionary and Speller
AB011 **$9.45**
A must for anyone just starting out in the field of computing, be they a businessman, hobbyist or budding computerist. The book presents and defines over 15 000 computer terms and acronyms and makes for great browsing.

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How To Troubleshoot and Repair Microcomputers
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AB016 **$10.45**
This practical handbook enables you to take advantage of the vast range of applications made possible by integrated circuits. The book tells how, in step by step fashion, to select components and how to combine them into functional electronic systems. If you want to stop being a "cookbook hobbyist", then this is the book for you.

How To Get the Most Out Of Low Cost Test Equipment
AB017 **$9.45**
Whether you want to get your vintage 1960 'TestRite'signal generator working, or you've got something to measure with nothing to measure it with, this is the book for you. The author discusses how to maximize the usefulness of cheap test gear, how to upgrade old equipment, and effective test set ups.

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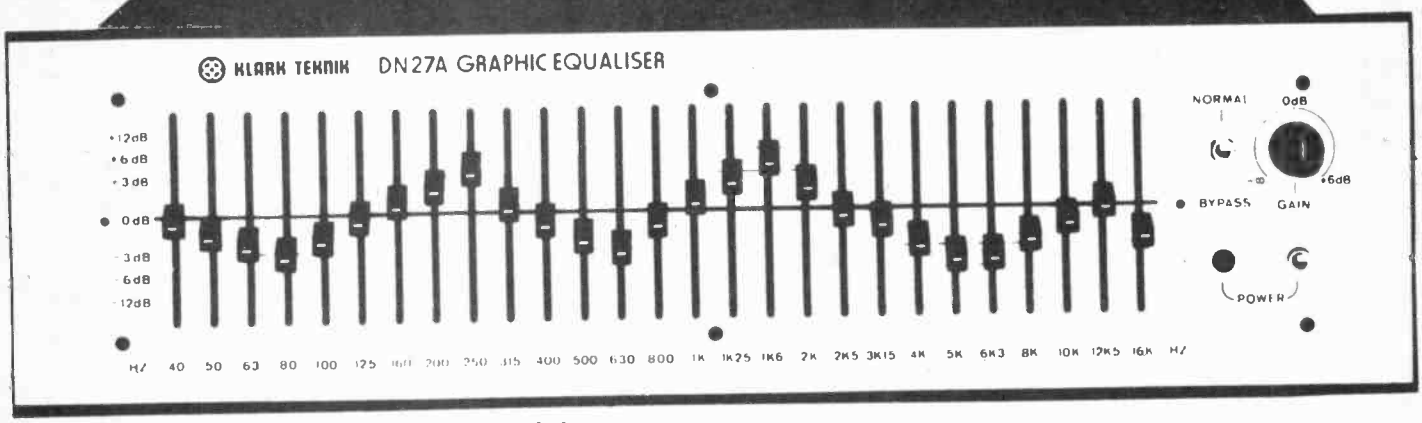
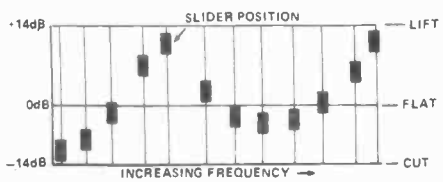
EQUALISER CIRCUIT DESIGN



Everything in life has its little ups and downs, and the frequency spectrum of an audio signal is no exception. Tim Orr gives you a whole bunch of circuits for ironing out the bumps.

AN EQUALISER IS a signal process device used to modify the frequency spectrum of an audio signal. A graphic equaliser is an equaliser that graphically displays the frequency response curve being imposed upon the audio signal, as shown in Fig. 1 and the photograph. The frequency spectrum is split up into bands, the gain of each band being controlled by a slider pot. The normal control range is about ± 14 dB. Each band or channel is, in fact, a filter which can be controlled so as to give a continuously variable response from a peaky band-pass to a notch (Fig. 2). Note that the Q factor of the filter reaches maximum at maximum lift and cut, the response being flat in the central position. If a bank of these filter networks is employed to process an audio signal, then their individual responses may be concatenated to define an overall frequency response. The control sliders will graphically dictate the signal gain at their respective frequencies.

There are of course problems involved in using such a method. The precision with which the sliders can define the frequency response will depend upon number of sliders used; more sliders will give a better resolution and vice versa. Also, the band-pass response of the individual channel is not ideal. Perhaps a rectangular response would be best, but this would be impossible to construct and would suffer time domain ringing effects.



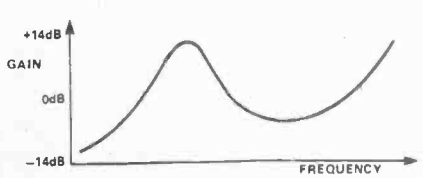


Fig. 1 Operation of a graphic equaliser. The slider positions correspond to the overall frequency response.

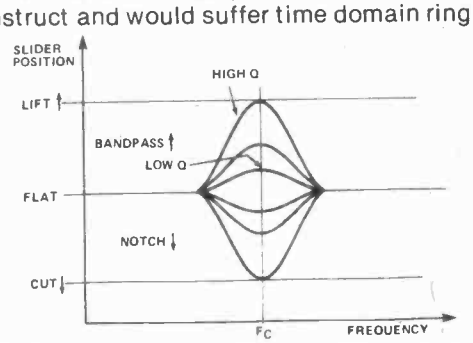
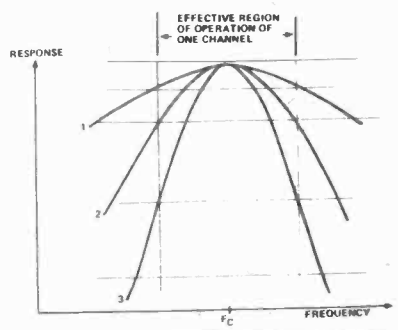


Fig. 2 the frequency response of a single channel. Note that the q factor increases as the amount of cut of lift increases.



SPACING IN OCTAVES	2	1	1/2	1/3
TYPICAL Q	1 TO 1.1	2.7 TO 4	5	7 TO 8

Fig. 3 choosing Q factors. Curve 2 shows how optimum Q results in the best compromise between channel interaction and inter-channel ripple. The chart gives typical Q factors that are used in graphic equaliser design.

Q Dips

There are two interlinked problems associated with using the band-pass response. To reduce interaction between adjacent channels the filter response must be relatively sharp (high Q), but a high Q response will cause large dips (ripple) to occur between the filter peaks when all the sliders are set to maximum or minimum positions (Fig. 3). The chart in Fig. 3 shows the best compromise for Q factor versus the frequency spacing of the filter channels. This assumes a control range of ± 14 dB. It is relatively easy to change the design so that the control range is ± 40 dB for individual channels taken in isolation, but the whole system would have severe interaction between channels, thus destroying the 'graphic' feature, and would also suffer from a large amount of ripple. Figure 4 shows the frequency responses for several Q factors.

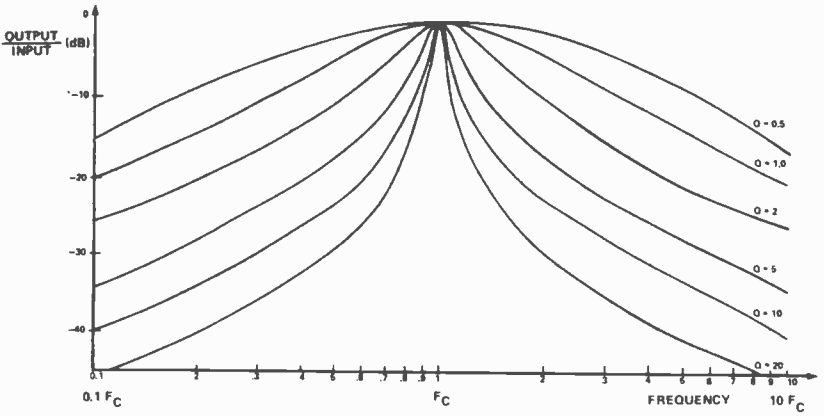


Fig. 4 Transfer characteristics for a band-pass filter. The responses for various Q factors have been normalised.

A Passing Phase

Figure 5 shows the classic equaliser circuit. The band-pass resonator is a series resonant circuit having minimum impedance at the resonant frequency F_C and also zero phase shift (Fig. 6). The amount of cut and lift can be calculated as follows. Let the resonant impedance of the filter be R_F. The phase shift at resonance is zero and so this impedance may be treated as a resistance. With the slider in the cut position, the input signal is attenuated (shunted to ground) by the resonator. The attenuation is 20. log $(R_F/(R_F + R_A))$ dB.

At frequencies other than resonance the attenuation will be defined by R_A and the complex impedance of the resonator; the attenuation will thus follow the frequency response, eventually ending up at zero. In the cut mode the circuit behaves as a voltage follower; whatever signal is seen at the non-inverting terminal of the op-amp appears at its output. With the slider in the lift position the feedback signal is attenuated, with the result that the output signal must be proportionally larger. The gain at resonance is also 20. log $(R_F/(R_F + R_A))$ dB. With the slider in the central position there is an equal attenuation of both input and feedback signals and so the overall response is flat (Fig. 2).

Shifting Shifts

Graphic equaliser designs suffer from all the usual circuit design problems plus a few that are unique to themselves. Stability is a problem. If several high Q resonators are introduced into the feedback loop of an op-amp then their accumulated phase shift may push the network into instability. This is usually overcome by splitting up odd and even resonators into two separate networks so that the phase shifts of adjacent channels do not add up in the feedback loop of one op-amp. Noise is also a problem. The more treatments that operate upon a signal, the worse the signal-to-noise ratio becomes. A graphic equaliser with lots of channels introduces more noise than one with fewer. Noise problems may be minimised by using low noise op-amps and by operating at as high a signal level as possible.

Once a design has been selected for Q factor, frequency spacing and absolute centre frequencies, the component values for the resonators are calculated, and guess what; not a single one of them is a preferred value! It is usual to find that the capacitors are constructed from two components in parallel, and the resistors are precision types. The component accuracy is dependent upon the channel spacing. For a one-octave spacing design, a tolerance of better than 5% is recommended. Component tolerance errors will manifest themselves in two ways; as a spread in Q factors and centre frequencies. Both of these will cause the overall frequency response to be arbitrary and lumpy. Yet another problem that affects the overall response is band-width limiting in the op-amps. This causes active resonators to go flat in frequency at high frequencies.

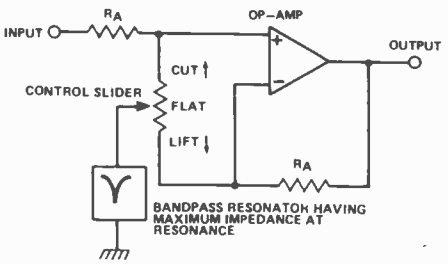


Fig. 5 A typical graphic equaliser section.

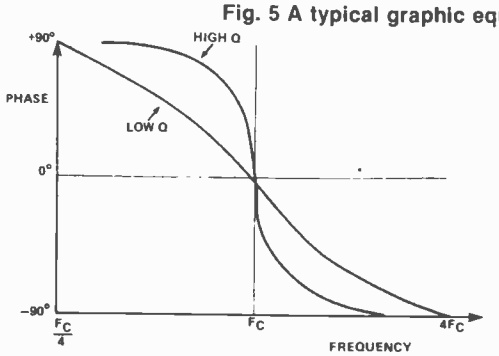


Fig. 6 The phase response of a simple band-pass resonator.

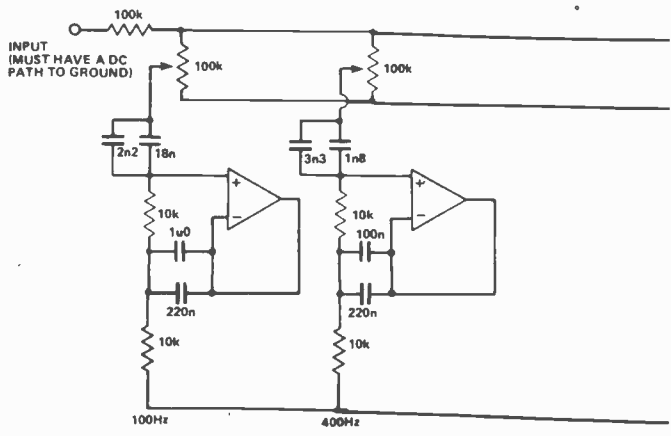
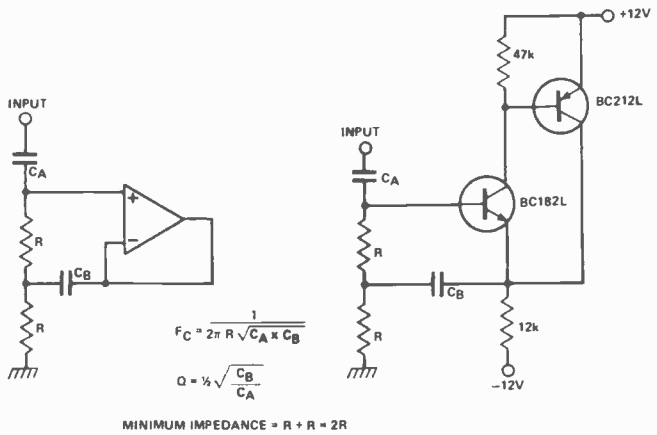


Fig. 7 A multiple feedback band-pass resonator using an op-amp (left) and discrete components (right). As a rule of thumb the op-amp should have a gain bandwidth product in excess of 20 = Q^2 = F_C.



Active Designing

A simple multiple feedback filter can be made to simulate a series resonant LCR network (Fig. 7). This is known as a gyrator, an active simulation of an inductance. Note that the two capacitors define both the Q factor and the centre frequency. This circuit makes very heavy demands upon the bandwidth of the op-amp. A resonator with a Q of 4, operating at 12.8 kHz, needs a bandwidth in excess of 20 × 4 × 4 × 12.8 × 1000 = 4.096 MHz. Even with this bandwidth its performance would not be perfect. Figure 8 shows the complete circuit for a five-section, two-octave equaliser. The design procedure is as follows. The centre frequencies and spacing are arbitrarily selected. For two-octave spacing the Q is 1.1 (Fig. 3). Therefore the component values may be determined from the equations in Fig. 7. For low noise and wide bandwidth operation, RC4558 op-amps were used.

Another equaliser is shown in Fig. 9. this is the same circuit as before, although the channel spacing is now one octave and so the Q factor is higher, having a value of 4. Note that the odd and even channels have been split up into two sections so that filter interaction may be minimised and stability maintained. The actual centre frequencies were measured and compared against the calculated ones (Fig. 10). The graph shows a random distribution caused by component tolerances plus a strong underlying trend caused by the bandwidth limitation effect of the op-amps.

Yet another active resonator is shown in Fig. 11. Again this network looks like a series resonant LCR filter, and is often found in active graphic equalisers. It has the same problems and advantages as the previous design. Active resonators possess several advantages. They are cheap, small, non-mechanical, they work well at low frequencies, and can be implemented using small capacitor values. However, they don't work well at high frequencies.

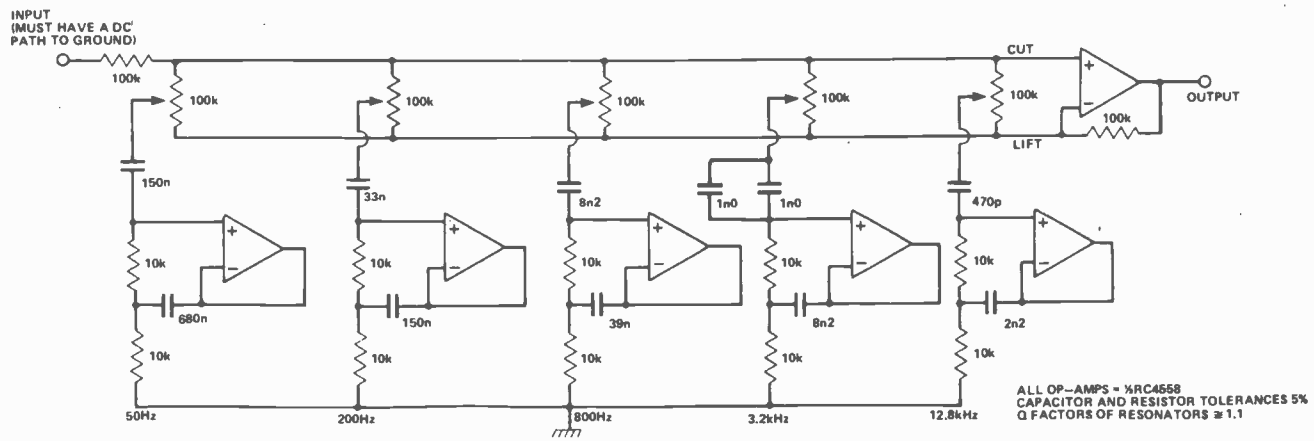
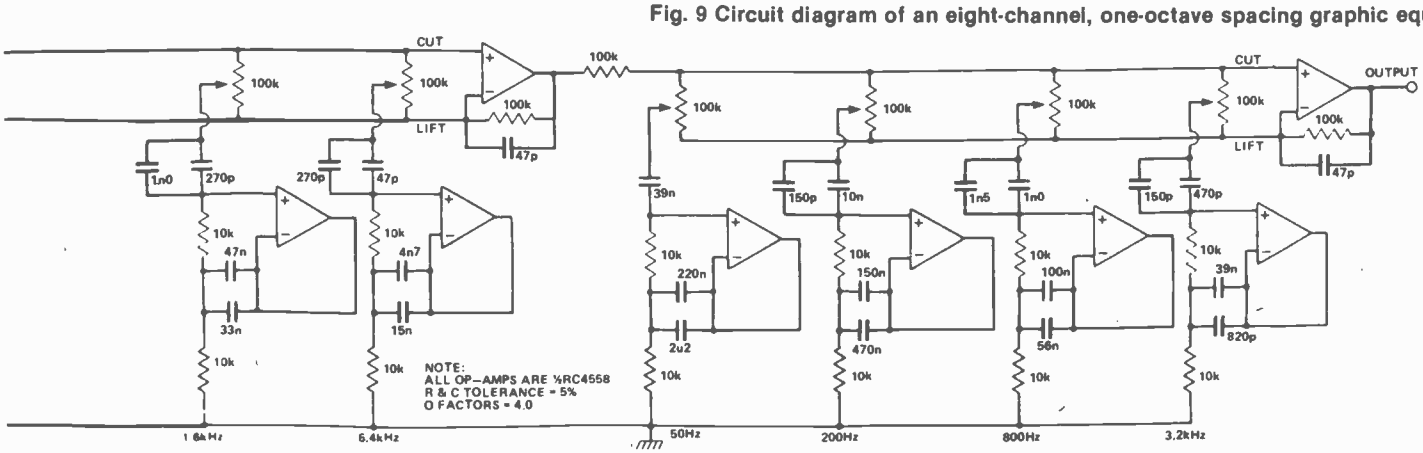


Fig. 8 Circuit diagram of a five-section, two-octave graphic equaliser (Courtesy of Powertran Electronics).

Fig. 9 Circuit diagram of an eight-channel, one-octave spacing graphic equaliser.



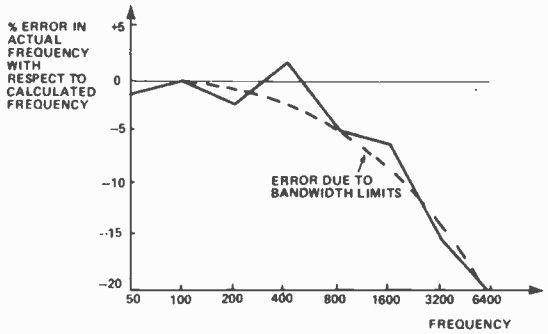
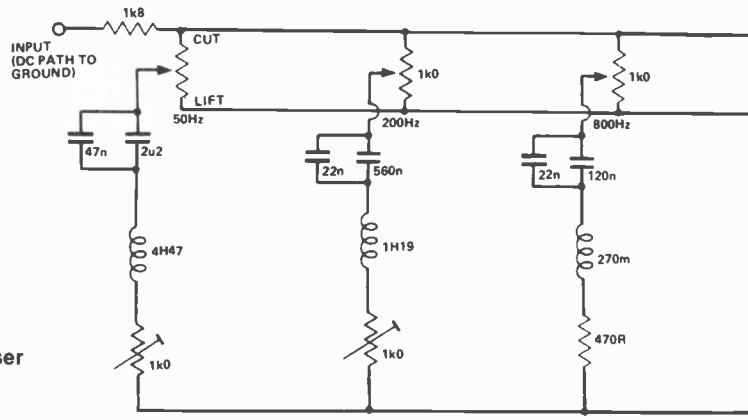


Fig. 10 The frequency error performance of the eight-channel equaliser shown in Fig. 9.



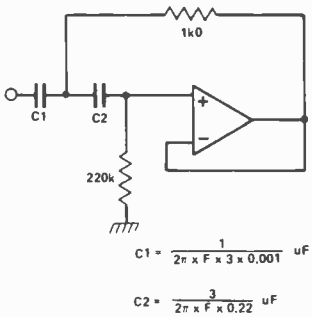
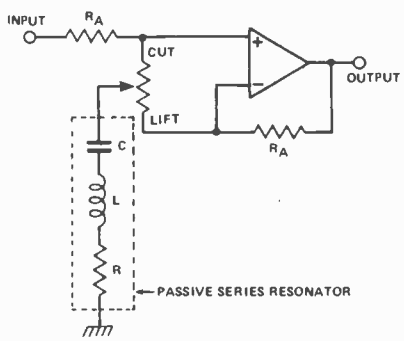


Fig. 11 Another active resonator designed for one-octave spacing and a Q of 3; equations are given for the required capacitor values. If C1 = 390nF and C2 = 18nF, the resonant frequency is 125 Hz. Doubling the values of C1 and C2 halves the resonant frequency and vice versa.



$$F_C = \frac{1}{2\pi\sqrt{LC}}$$

$$Q = \frac{1}{R}\sqrt{\frac{L}{C}}$$

$$\text{CUT/LIFT} = 20\log\left(\frac{R}{R_A + R}\right)\text{ dB}$$

WHERE F_C = RESONANT FREQUENCY IN HERTZ
C = SERIES CAPACITOR IN FARADS
L = SERIES INDUCTANCE IN HENRYS
R = TOTAL SERIES RESISTANCE INCLUDING THE RESISTANCE OF THE INDUCTANCE IN OHMS

Fig. 12 Circuit diagram and design equations for one stage of a passive equaliser.

Passive Parts

Figure 12 shows a passive design for an equaliser channel. A passive design works well at high frequencies because the resonators do not suffer from bandwidth problems, but at low frequencies the sizes of the inductors become rather large, several Henries in some cases. The inductors will have to be specifically wound; no-one supplies a range of precision high value inductors. The inductors are also very large, heavy, expensive and sensitive to AC hum pick-up. However, they work very well at high frequencies, they are relatively insensitive to signal levels and are low noise. Also, if the inductance has a tuning slug, then the resonator may be frequency tuned. Because of these advantages, passive resonators are often used in professional studio equalisers.

Figure 13 shows a design for a nine-channel equaliser using passive components. Note that the capacitors are made by paralleling up standard values, but the inductors are wound to the exact value. Also note that the series resistor is a preset on the four largest inductors (due to the significant resistance of the windings) and that the resistance values are very low, 1k8 compared with the 100k of the active design. The component values are designed as follows. The channel frequencies and spacing are arbitrarily selected. A Q factor of 3 is selected from the chart in Fig. 3. Therefore using the equations shown in Fig. 12 we have

$$Q = \frac{1}{R}\sqrt{\frac{L}{C}}$$

which is held constant for each resonator at a value of 3. Select a reasonable value for R, 470R in this case. Rearranging,

$$\frac{L}{C} = (QR)^2 = (3 \times 470)^2 = 1{,}988{,}100$$

$$\text{Therefore } L = 1.988 \times 10^6 \times C$$

$$\text{But } F = \frac{1}{2\pi\sqrt{LC}}$$

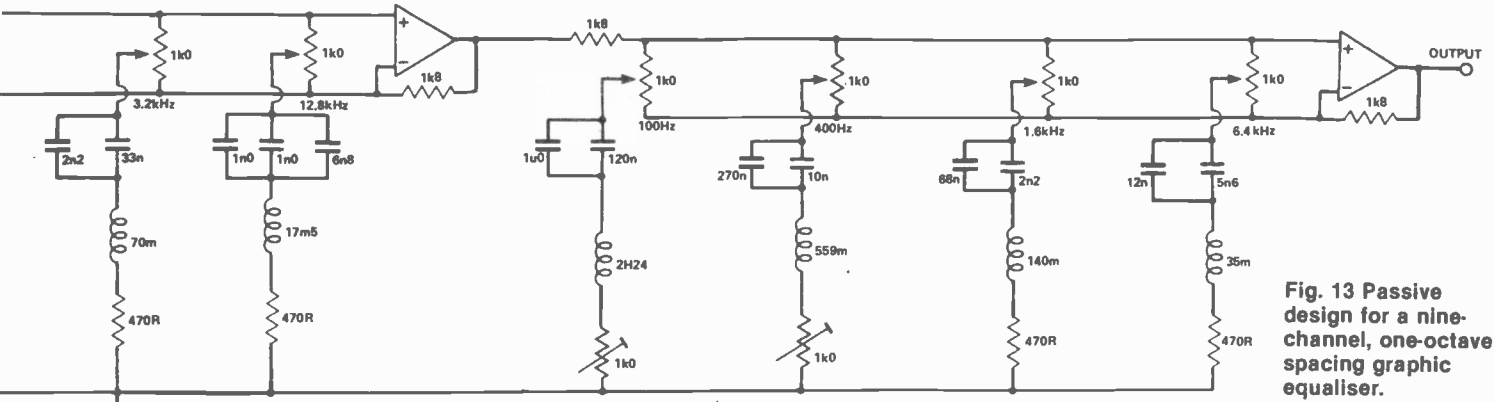
Substituting for L and rearranging,

$$C = \frac{1}{2\pi \times 10^3 \times F \times \sqrt{1.988}}$$

Calculate the values of C for all frequency values. Then calculate the values of L from the equation

$$L = 1.988 \times 10^6 \times C$$

Now that all the component values have been calculated, all we need is a source of the inductors. The 'Winding Inductors' box gives details for calculating the number of turns necessary to produce a particular inductance. It is important that the ferrite you use is suitable for the selected operating frequency; the manufacturer's data will tell you this. Select a ferrite core and calculate the required number of turns for its particular A_L value.



ALL OP–AMPS, WIDE BANDWIDTH, RC4558 OR NE5534 (COMPENSATED)
COMPONENT TOLERANCE 5% OR BETTER
Q FACTOR OF ALL RESONATORS = 3
USE THE FOUR PRESETS TO ADJUST THE CUT AND LIFT
OF THE BOTTOM FOUR FREQUENCIES

Fig. 13 Passive design for a nine-channel, one-octave spacing graphic equaliser.

Next, decide which wire gauge will fit the core size; again manufacturer's data. Wind the inductor, and measure its inductance and DC series resistance. Subtract this resistance from the calculated external series resistor, to give you the value of the external component.

WINDING INDUCTORS

$$L = N^2 \times A_L$$

where

L = inductance in nanohenries (ie 10^{-9}H).

A_L = inductance factor. This is usually printed on the side of the ferrite core, and is a constant.

N = the number of turns of wire on the inductor.

Rearranging the equation,

$$N = \sqrt{\frac{L}{A_L}}$$

Example: construct a 5mH inductance to work at 8 kHz. Pick a suitable ferrite core, let's try one with $A_L = 250$. Therefore

$$N = \sqrt{\frac{5 \times 10^6}{250}} = \sqrt{2 \times 10^4} = 141.4 \text{ turns}$$

Pick a suitable wire gauge that will fit the core size. An RM6 ferrite core, for example, can take 160 turns of 34 swg wire and has a recommended operating frequency range of 5.5 kHz to 800 kHz.

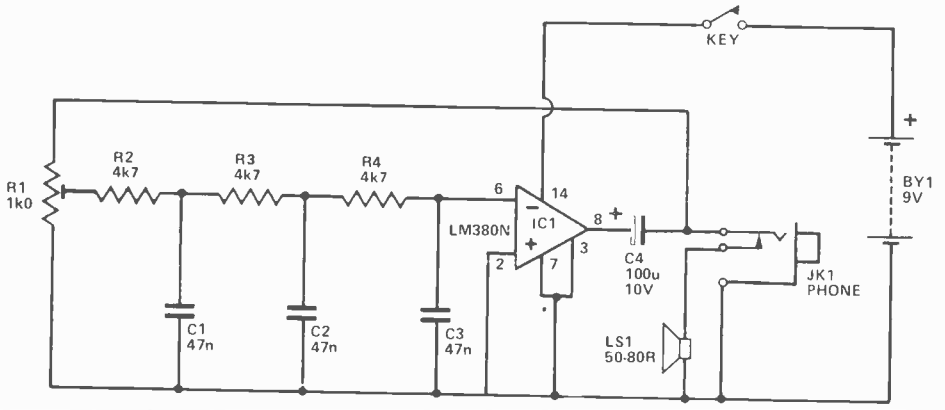
MORSE PRACTICE OSCILLATOR

Although not essential, a Morse practice oscillator can be of considerable help when learning the Morse code, particularly if it is employed in conjunction with a cassette or tape recorder so that it can be used for both sending and receiving training. The simple unit described here has provision for an internal loudspeaker, and also has an output for a crystal earpiece, high impedance headphones, or a recorder.

The circuit is based on an audio power amplifier device (IC1) which is used in a phase shift oscillator circuit. Feedback is applied between the output and inverting (−) input of IC1 by way of three section phase shift network. The purpose of this network is to invert the signal so that positive feedback is applied to the amplifier, and the required oscillation is produced. The three sections are formed by R2 — C1, R3 — C2, and R4 — C3, each of these sections providing 60 degrees of phase shift at a certain frequency. Thus, at this frequency there is a total phase shift of 180 degrees through the three sections, and the inverting action is obtained. The circuit therefore oscillates at this frequency, which is approximately 1.5kHz with the specified values.

Ideally a circuit of this type should provide a sinewave output, as a pure tone is easy to listen to for long periods, and is the waveform produced by an actual CW (Morse) transmission when it is resolved by a receiver. This type of circuit will provide a reasonably pure sinewave signal if the gain of the amplifier just slightly more than compensates for losses through the feedback circuit. This is achieved in this case by adjusting R1 to give the appropriate loss level through the feedback path. In practice this is merely backed off close to the point where oscillation ceases due to a lack of feedback. Do not be tempted to back off R1 too far, as although this will give a very pure output, the circuit may become unreliable.

The output signal is fed to the loudspeaker via C4 and a break contact on the output socket. The latter automatically cuts of the speaker when a plug is inserted into the socket. The unit provides an output power of about 100 mW RMS, and has a current consumption of approximately 20 mA with the key down.



Cassette Preamplifier

Used in conjunction with one of the cassette mechanisms currently available on the surplus market (or a mechanism removed from an old recorder or player) this preamplifier circuit makes an inexpensive but useful cassette player for use with a hi-fi system. The circuit is for a mono player, but for a stereo unit it is, of course, merely necessary to make one preamplifier for each channel.

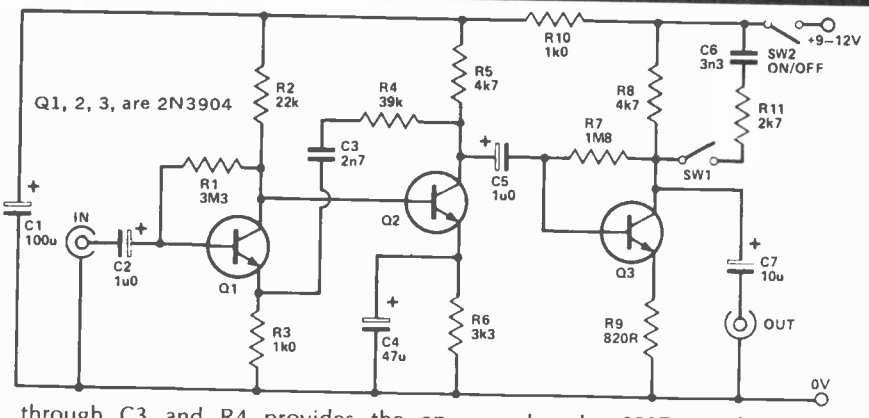
The output signal level from a cassette tape head is typically about 500 uV or so at middle audio frequencies for a mono head and only about half this level for a stereo type. The preamplifier must, therefore, provide a considerable amount of voltage in order to match this to a hi-fi amplifier, as these require a signal level of about 1 000 times higher than this. It is also necessary for the preamplifier to provide equalisation, because the output from a tape head rises with frequency at a rate of 6 dB per octave. However, at higher audio frequencies tape heads are not very efficient and require a much lesser degree of roll off.

Q1 and Q2 are used in a conventional two stage, direct coupled, common emitter amplifier and the frequency-selective negative feeback through C3 and R4 provides the appropriate equalisation. These also set the midband voltage gain of the input stages at about 46 dB (200 times). With such a low input signal level it is obviously necessary to use low noise transistors (such as the MPS6515) in order to obtain good results. Running Q1 at a low collector current of about 200 uA also helps to give a low noise level.

Q3 is used as a low gain common emitter stage, which provides the additional amplification needed to give a suitably high output level. R9 introduces negative feedback, which controls the voltage gain of Q1 and the specified value gives a gain of about 14 dB (five times). For a stereo unit R9 should be reduced to 390R in order to give increased gain to compensate for the lower output of a stereo tape head.

When playing a Dolby B encoded cassette SW1 can be closed. This gives a small degree of treble cut which provides a reasonably flat overall response, with a small excess of treble at low signal levels and a slight deficit at the highest levels. A useful level of noise reduction is obtained, although only about half that provided by a proper decoder.

The circuit is capable of excellent results and the output quality is largely dependent on the quality of the tape head, the tape used in the cassette and so on.



I/O DEVICES

This month we look at the Ins and Outs of interfacing with computers and the special chips used. Henry Budgett explains the initials and the innards.

Byte Sized Pieces

PARALLEL INTERFACES ARE generally used for local communication. They are extremely useful for transferring large amounts of data over reasonably short distances at high speed. Each transfer consists of a complete byte of data (hence the term parallel) and the interface must therefore consist of at least nine connections (the ninth being ground). In most cases there are more connections. These are controls which ensure that the data is sent only when needed and not sent when the receiving device isn't ready. This controlled transfer of data is known as 'handshaking' and varies in complexity from a simple strobe line, as is commonly found with ASCII keyboards, to a full-blown, defined standard such as the IEEE-488 interface.

Versatile Interface

In implementing a parallel interface on a micro one generally uses a device such as a PIA (Programmable Interface Adaptor) or its close relative the VIA (Versatile Interface Adaptor). These come in a wide variety of guises but are essentially the same. The device contains a number of registers which can be directly accessed as memory locations by the programmer. Into these one may load information which will control the way the device behaves. A block diagram of a typical device is shown in Fig. 1. Basically it consists of two 'ports' (a fairly obvious comparison) which may be set to operate as either inputs or as outputs. This behaviour is determined by the information set into the DDR (Data Direction Register). A logic '1' will select output and a logic '0' will select input.

To control the handshake there are usually two control lines provided per port. Each may be programmed to operate in a variety of modes, but a typical set-up is to have one line operating as a strobe. This signal is generated internally by the device and signals the data acceptor (that's the thing at the other end of the wire) that the data present on the lines at that instant is 'valid'. When the acceptor has taken the data off the lines it then signals back on the other control line that it has done so. This is the 'handshake'.

The programmer can monitor all these goings on by looking at the various registers within the device (they appear to be memory locations) and inspecting the various data patterns. The job is thus made very easy for the programmer and the computer designer, unlike the days of minis.

Prior to the development of these devices, I/O, the ubiquitous acronym for Input and Output, was a complicated job involving logic to decode the various address and control busses and using the mildly complicated system of interrupts to find out which device needed to be serviced.

Bits Of Information

The second interfacing method is serial connection. This, in theory if not in general practice, requires only two wires — one signal and one ground. A typical example of the species in the RS 232C interface, defined by the international telecommunications body CCITT. This (and most other examples) is driven from another fiendishly clever device acronymically known as a UART or Universal Asymchronous Receiver Transmitter.

In many of the modern devices this appears, like its parallel relative, as so much memory to the programmer and all the functions may be predefined in software rather than hardware. A typical device is shown in Fig. 2.

Serial transmission has to follow a definite pattern or protocol, its version of handshaking. A typical set-up would be to transmit logic '1' until ready to go, then a single 'start' bit of logic '0' followed by the data and its associated parity bit and then to ter-

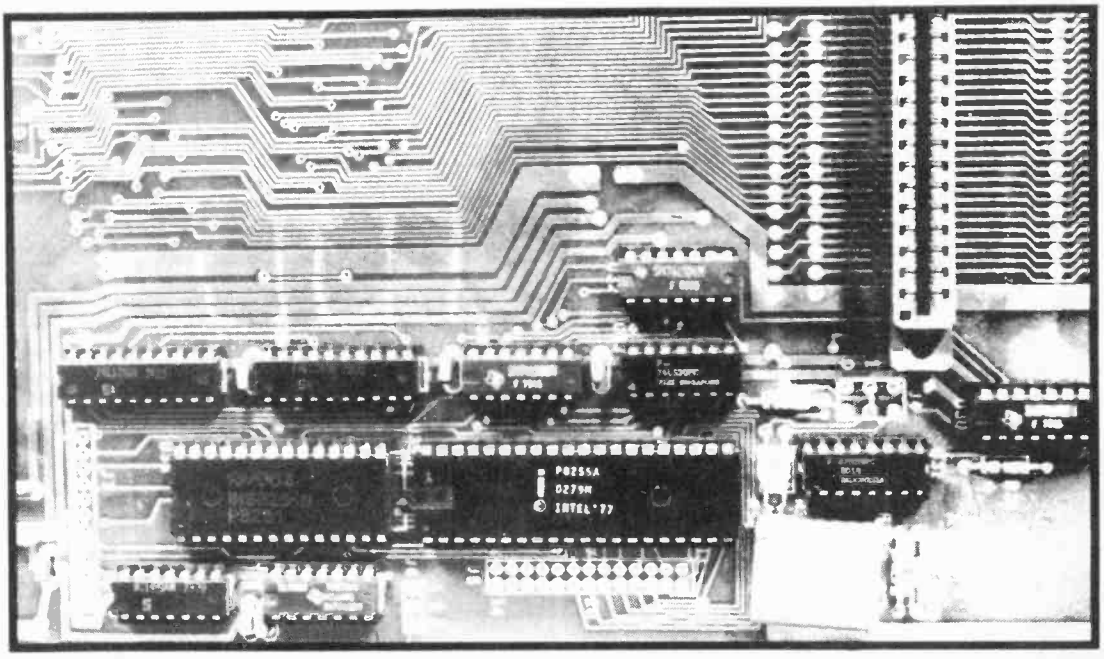


Fig. 1 The peripheral interface of the Multiflex Z80A, a typical small computer.

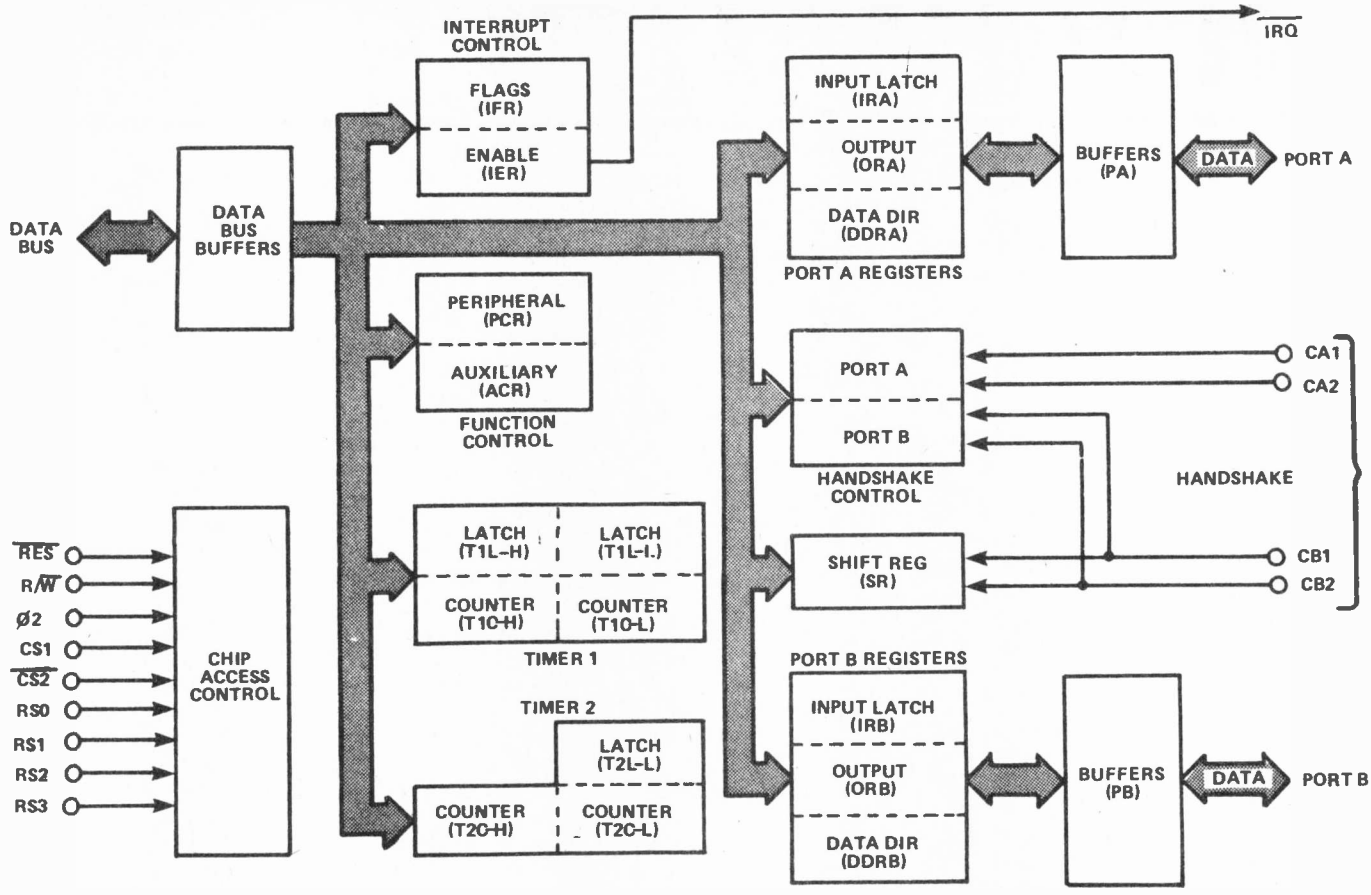


Fig. 2 The 6522, a Versatile Interface chip.

minate with two bits of logic '1'. This pattern is shown in Fig. 3. It allows the receiving device to synchronise itself to the data.

The heart of any serial device is its clock. This generally runs at 16 times the actual speed of the transmission. The data is actually sampled at the eighth cycle which allows a certain percentage difference between the transmitter and receiver frequencies.

Serial transmissions are often made via the "common carrier", or the telephone. This is done with a piece of equipment known as a MODEM. Yes, that's right, it's an acronym for Modulator/Demodulator. The device converts the serial data stream into two precise audio frequencies, which are sent over the telephone line and detected by a similar unit at the other end, which reconverts them into meaningful data.

Systems On The Move

The system interface is generally called the bus. It is a parallel collection of all the necessary data, address and control signals required to operate not only the main CPU board but all the memory and peripheral devices as well. By rights the system

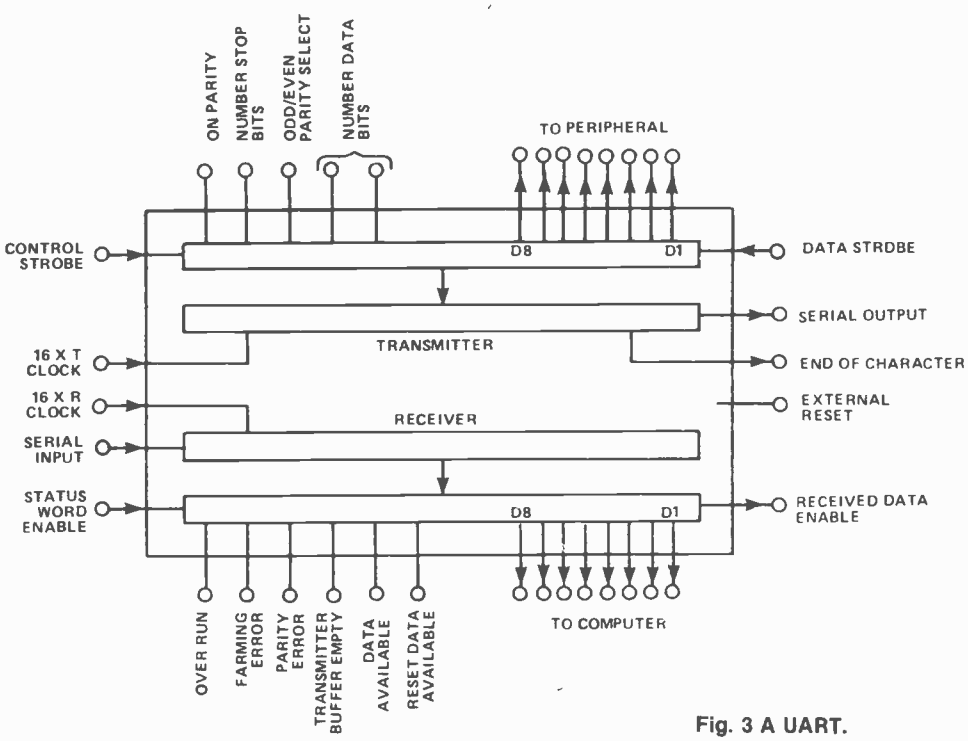


Fig. 3 A UART.

Continued on page 52

DOLBY C

No, it won't make Rush sound musical, but Dolby C is a new developement in keeping tape noise down.

IF YOU'RE IN the habit of reading the blurb on tape cassettes, then you're already familiar with the double D trademark of Dolby Laboratories. Perhaps you even have a posh tape deck with a Dolby selector switch. The system universally used in consumer hi-fi now is Dolby B, providing 10 dB of noise reduction above about 4 kHz. Tape noise has already been reduced a great deal — try listening to your favourite Stones tape with the Dolby system switched out. The noise tends to destroy the full esoteric impact of Jagger's lethal lyrics. Come to think of it . . .

A,B,C,. . .

Dolby C, as the new system is called, will provide 20 dB of noise reduction above about 1 kHz (Fig. 1). The obvious question is — is it just a stretched version of Dolby B? The operation of the two systems is certainly similar. Dolby C uses existing B-type chips. However, a stretched Dolby B giving 20 dB reduction was found to be impractical. The subjectively much cleaner high frequencies revealed a muddy mid-frequency band at higher listening levels. Hence, the new C-type design achieves it full 20 dB reduction above about 1 kHz. It reaches the maximum B-type reduction of 10 dB at only 300 Hz, offering (subjectively) uniform noise reduction across the whole audio band.

Design Points

If you already know how Dolby B works, then the new system holds few surprises for you. In principle, lower level high frequencies are selectively boosted just before the signal is recorded onto the tape. When the encoded tape is played back, the boosted frequencies are attenuated back to where they were originally, reducing the noise added by the recording process.

Signal processing is tackled in two stages in series, each supplying 10 dB of compression during recording and of expansion during playback (Fig. 2). The high level stage (Fig. 3) is sensitive to signals at about the same levels as are processed by a Dolby B network. The low level stage deals with signals in the previously unprocessed frequencies below the Dolby B region. Although the two stages are working together, at no time is a signal subjected to a full 20 dB compression or expansion with its accompanying undesireable side effects and inaccurate signal control.

Noise News

In addition, the C-type system incorporates a number of further innovations. Two are shown in Fig. 3. The anti-saturation and spectral skewing networks are frequency response modifications to reduce encode/decode errors, upper-middle and high frequency losses and intermodulation distortion. The end result is a new noise reduction system which is at least as free of side effects as the B-type system and just as practical in everyday use.

Compatibility

There's no point in producing a new noise reduction system if it is not compatible with existing tapes and hardware, so Dolby C has been designed with the universal use of Dolby B in mind. Recordings made using a C-type processor can be replayed on a B-type cassette machine with acceptable results and on machines without any noise reduction system. So, you don't have to rush out and buy a new tape deck tomorrow. Prototype C-type machines have already been on show so production models from all the major hi-fi manufacturers shouldn't be far behind. Because one half of the new system is essentially a B-type processor, tape decks can easily incorporate push-button selection of either B or C-type processing. Perhaps the first generation of cassette machines will feature this until Dolby C is as universal in use as its predecessor. Professional C-type encoders are being produced, so C-encoded cassettes will be available in stores too. Dedicated Dolby C chips should be in production in about a year.

How Much?

Good question. Dolby C is about 2½ times as complex as existing B-type circuitry, so, in terms of component cost only, a C-type NR processor will

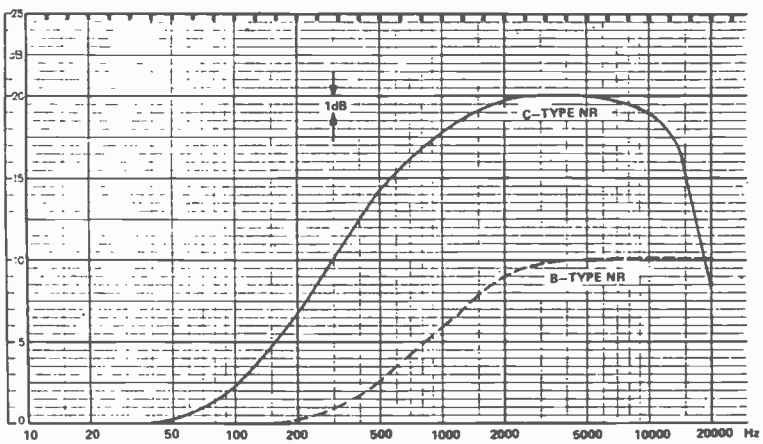


Fig. 1 These curves show the maximum low level boost imparted by both C-type noise reduction in the absence of high frequency signals. Dolby C NR imparts more boost in recording and more cut in playback, thus providing more noise reduction. The effect also extends about two octaves lower with the C-type NR to maintain subjectively uniform noise levels across the spectrum. Processing at very low frequencies is not required with either system because low frequency noise is insignificant in properly engineered cassette recorders.

be about 2½ times as expensive as existing units. In addition, Dolby C demands first class electrical and mechanical performance from the recorder incorporating it, including very low noise levels in the circuitry surrounding the processor. I guess you've heard the moral before — it pays to buy the best you can afford. The new system will be most useful for recording material of a wide dynamic range to be replayed at very loud listening levels.

Revolution Or Rehash?

The truth probably lies somewhere between the two extremes. Dolby C represents the next stage in the evolution of noise reduction. It employs a new approach (dual level processing) to noise reduction yet it is fully compatible with existing tapes and hardware.

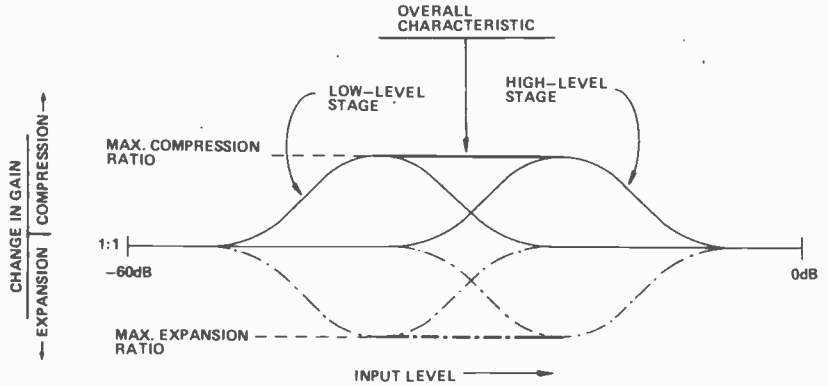
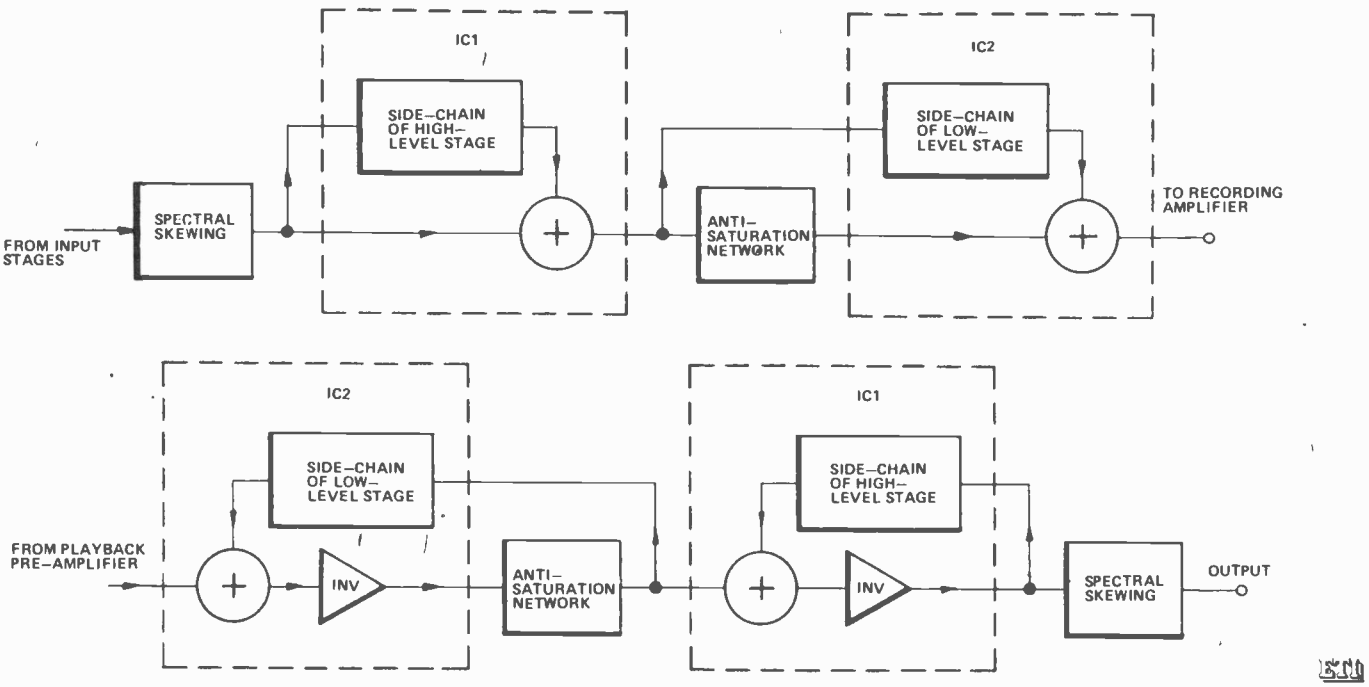
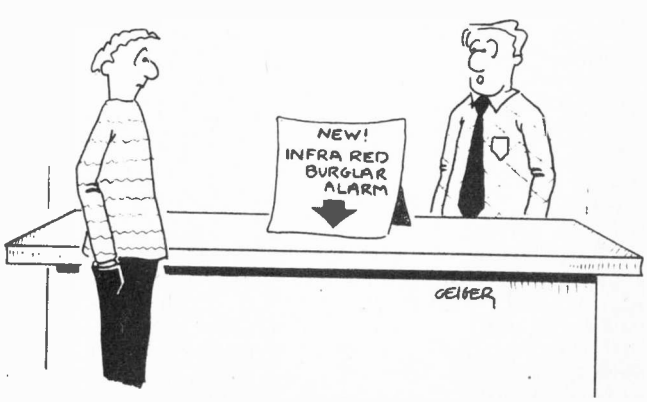


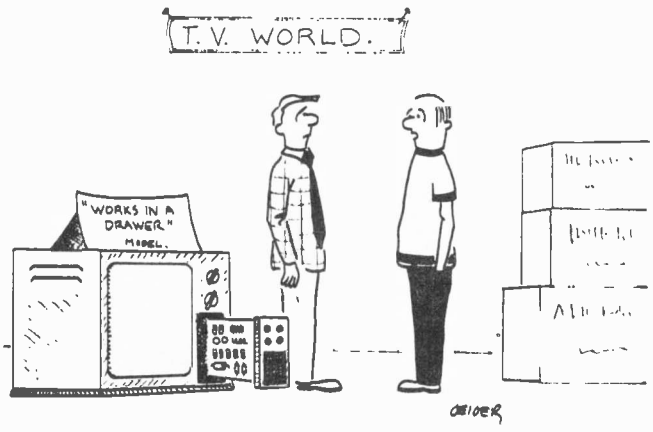
Fig. 2 The two-level, two-stage configuration. At no time is the signal subject to significantly more than the maximum compression or expansion effect of a single stage. Yet the effects of the two stages multiply (add in decibels) to achieve the full 20 dB of processing required for C-type noise reduction.

Fig. 3 Block diagram of the Dolby C noise reduction system showing the encoder (below) and decoder (bottom).





Of course you can't see it; it's infra-red.



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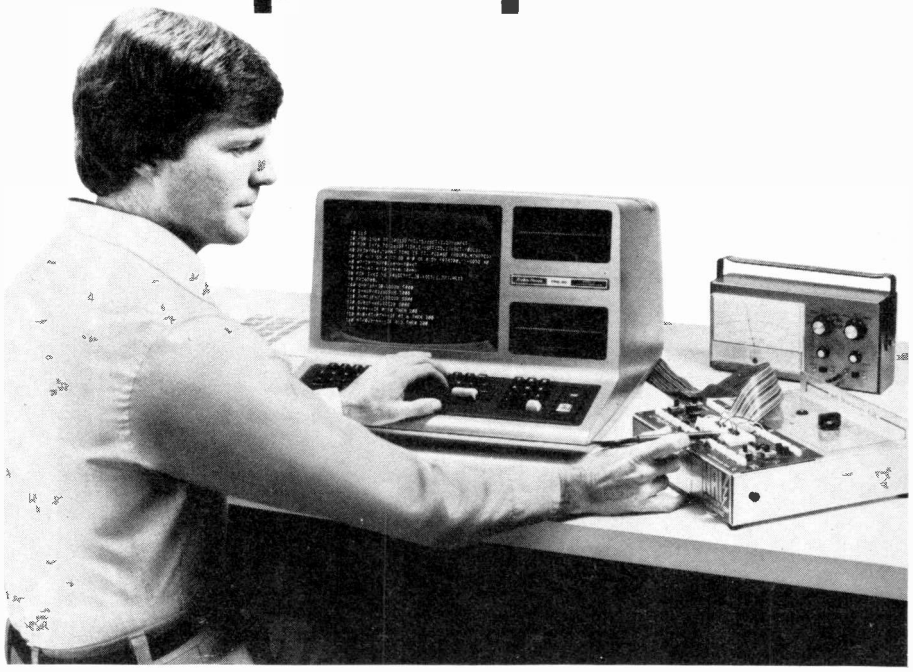

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BLACK HOLE THEORY

A black hole is an object so dense that light itself cannot escape. Like a politician. Ian Graham explains.

TO UNDERSTAND WHAT a black hole is and how it is formed, let's first have a look at the life of a star, for under the right conditions, the death of a star may herald the birth of a black hole. The birthplace of stars is within the clouds of material between the stars. These clouds collapse under their own gravitational fields. Local regions of increased density form condensation nuclei whose gravitational fields grow gradually stronger as more and more material is attracted towards them. As these embryonic stars (protostars) continue to contract their temperatures begin to rise; producing internal heating and emitting radiation into the surrounding space. When the temperature is high enough for hydrogen fusion to begin, contraction ceases.

The greater part of the star's lifetime is then occupied with burning its hydrogen fuel, forming helium which sinks deep into the core. Eventually, when the hydrogen is almost exhausted, the star's temperature begins to fall and the core begins to contract. We must now look at the star, not as a homogeneous ball of burning gas, but as a relatively heavy core surrounded by a lighter envelope. There is a constant battle between thermal forces trying to blow the star apart and gravitational forces trying to crush it. Contraction of the core causes a rise in temperature, temporarily halting contraction and causing an expansion of the envelope ie. the star appears to be growing larger. The remaining hydrogen is burnt off in the outer layers, sending more helium to the core. Eventually the core collapses under the immense pressure of the upper layers and this is accompanied by an enormous exparsion of the envelope, forming a red giant.

Great Balls Of Fire

The final episode in the star's life depends on its mass. Let's take the route that will take us to a black hole. The core continues contracting, helium fusing to form carbon and successively heavier elements. Eventually it collapses rapidly, blowing off the envelope in a supernova explosion during which the single star may outshine an entire galaxy.

The explosion may destroy the core completely or it may leave a small core. However, if the star was more than two or three times as massive as our own Sun, the core surviving a supernova will rapidly collapse. Theorists predict that the collapse will continue until the core radius reaches zero. This hugely massive, but dimensionless point in space is called a singularity.

No Escape

The singularity has such a strong gravitational field that light itself cannot escape, ie the escape velocity of the body is greater than the speed of light. The further we are from the black hole, the lower is the escape velocity (the gravitational force decreases with the square of our distance from the body). At a particular distance from the singularity, the Schwarzschild radius, the escape velocity equals the speed of light. Within this event horizon nothing escapes.

For a body of mass (M), the Schwarzschild radius (R), is given by:

$$R_s = \frac{2GM}{C}$$

(G is Newton's gravitational constant and C is the speed of light)

If we let M be the mass of our own Sun, R_s turns out to be 3 kms. So why isn't the Sun a black hole? Its radius is much larger than 3 kms, so beyond this event horizon the Sun's hydrogen fusion reactor can radiate its energy out into space, but if the Sun's mass was to be compressed to a diameter of less than 3 kms, it would become a black hole.

If we look at our own Earth and the bodies around us in the solar system and even the Milky Way galaxy as a whole we find that they all rotate ie. they all have angular momentum.

The angular momentum (L) of a rotating body of mass (m) radius (r) at an angular velocity of w is given by

$$L = mwr$$

If a rotating body such as the remnant of an exploded star begins to contract ie, r gets smaller, the angular velocity (w) must increase in order that angular momentum may be conserved. Depending on its mass a black hole may rotate at about 1000 times a second. A black hole is such a dense body that one the size of a proton would weigh in at about ten thousand million tonnes!

Just as the Earth bulges slightly at the equator and is flattened at the poles due to centrifugal force, the much greater rotation of a black hole results in a much more severe deformation. The equations predict that a black hole is not a sphere at all. It may be similar in profile to a spiral galaxy (like the Milky Way), a disc with a bulge at its centre.

All this speculation on the formation and structure of a black hole may seem to be purely academic. After all, how do you go about finding a black hole to prove that it exists and verify its structure and behaviour? Even if you knew where to look how would you observe something from which no light can escape?

Stellar Striptease

You may not be able to see the black hole itself, but it should be possible to observe what it does to any matter near it. The best candidate for detection would be a black hole and a star orbiting each other — a binary system. Material should be stripped from the star and wind its way round the black hole, forming a disc, finally disappearing beyond the Schwarzschild radius like water funnelling down your bath tub drain. As the matter crowds together for its last dive to

oblivion, its temperature rises until it is hot enough to radiate at X-ray wavelengths.

The search for X-ray sources could not begin until the space age because radiation in the X-ray region of the spectrum cannot penetrate the Earth's atmosphere. One of the earliest X-ray sources discovered by orbiting telescopes was Cygnus X-1 in the constellation of Cygnus. The X-ray source accompanies a visible blue giant star. The visible star's speed was found to be varying along a sine wave, so it must have an invisible companion around which it is orbiting.

Most of the light emitted by the system appears to arise, not from the visible blue star, but from helium gas sucked from it and circulating around its invisible companion. The companion's mass has been calculated as more than the critical three solar masses, so it is likely to be a black hole.

Another system likely to become a household name among black hole hunters is V861 Scorpii (the V indicates that its brightness appears to vary). This variation over a period of about eight days is due to a dark body orbiting (and eclipsing) a blue supergiant. Like Cygnus X-1, V861 Scorpii is a binary system.

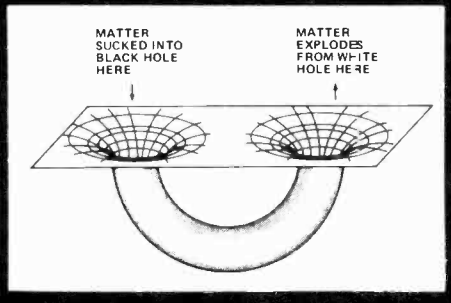
Dark Star

In both these cases, the dark star could be either a black hole or a neutron star. A neutron star is a body where the matter from a collapsed star core is compressed so tightly that electrons and protons are pushed together to form neutrons. Again, mass is the determining factor. If the mass is less than about three Suns, the body will be a neutron star. If it is above the critical mass, it should be a black hole.

Shaking The Edifice

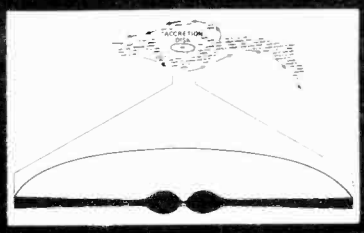
Life was much simpler for scientists in Victorian times. Through classical Newtonian physics, everything under the Sun (and beyond it) seemed describeable and predictable. It was just a matter of time before the scientists achieved a comprehensive understanding of the universe and determined the physical laws to describe all the processes therein, from the subatomic level upwards. Then along came trouble-makers like Planck and Einstein, who showed that an electromagnetic wave could behave like a stream of particles. In classical physics a wave is not the same as a particle and never the twain shall meet. Not content with shaking the foundations of prevailing physics, Einstein (leader of the popular front for the liberation of physics) went on to predict the effects of very dense bodies on time itself.

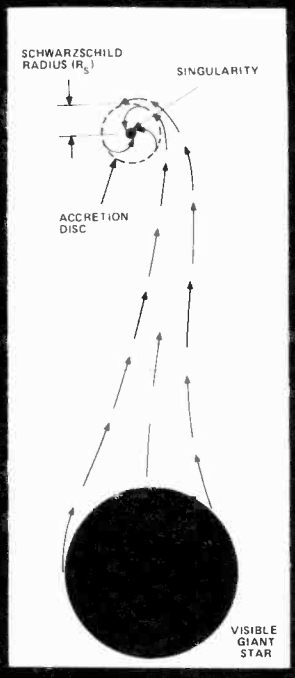
Space and time are inextricably intertwined. Close to a black hole space is curved so severely that time itself loses its meaning. Stephen Hawking and Roger Penrose working at Cambridge saw the possibility that any object (including a spacecraft) falling towards a rotating black hole may not fall into the murderous singularity, but may miss it, to reappear elsewhere in our universe (or another universe) an instant later. Einstein's theories predicted the possibility of bridges between the warped planes of space. However, black holes were then believed to be non-rotating bodies, so that any matter falling over the event horizon could not help but hit the singularity.



Instant Travel

If only a small fraction of the matter falling into a rotating black hole misses the singularity, what becomes of it? It must reappear at the other end of the tunnel an instant later, maybe light years away from where it disappears. So, there must be points in space where matter appears to be spewing forth from nowhere — white holes. Now, if black holes are almost undetectable because of their blackness, the detection of white holes should be simplicity itself. Indeed there are galaxies, known as Seyferts (after the man who identified them in 1943) which resemble galaxies like the Milky Way, but for one characteristic. The centre of a Seyfert is very bright and smaller than usual, and it emits radiation at frequencies which the Milky Way absorbs. The galactic nucleus seems to be an exploding ball of matter and energy — possibly a white hole.





Sci-Fi

The black hole may seem to be a futuristic concept. In fact, Laplace realised that if a body was massive enough, its escape velocity would exceed that of light, as far back as 1798. That black holes might make possible travel across light years of space in an instant (or even time travel) sounds more like science fiction.

Before we can verify the theories and check out the equations we will have to get the hang of interstellar travel, or find a black hole in the solar system. Cygnus X-1 is about 600 light years away. As for black holes in the solar system — it's not as crazy as you might at first imagine. The Big Bang, from which the universe is believed to have begun, would have produced the magnitude of pressures necessary to produce black holes in their millions. Our galaxy could be sprinkled with these tiny Big Bang black holes. When a study of the Sun, looking for neutrinos produced in nuclear reactions at its centre, found none, one researcher suggested that a small black hole in the Sun itself may satisfy the findings.

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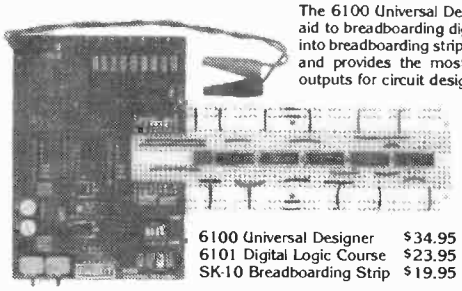

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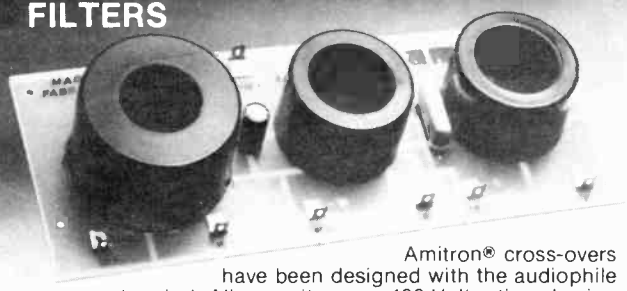

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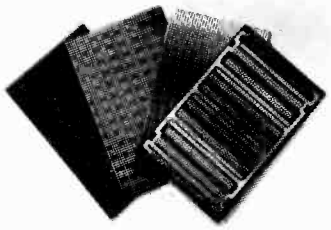

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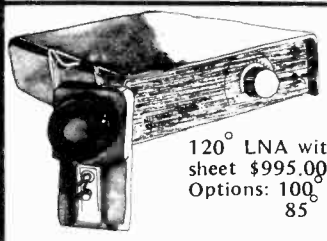

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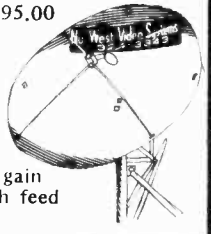

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You should also keep in mind that a slight readjustment of the bias of your tape recorder may be required in order to make full use of the properties of this new tape.

Iron Filings

Magnetic recording tape is usually a plastic ribbon, often not having been discovered by a Mongolian gerbil farmer, coated with a magnetic material, such as iron oxide. There are several other mediums currently in use, such as chromium dioxide, and so forth, but they all work in much the same way. When you buy the tape, the particles of the recording medium are arranged in a random pattern on the backing. When you run it through the recorder, they get positioned so as to represent the change in flux density corresponding to the audio you're trying to record. They get set up this way by the changing magnetic field of the recording head.

Fig. 1. The complete optimizer.

It would be handy if you could just fire some audio into a tape head and have it impressed on the tape, but, sadly, this is not where it's at. The particles on the tape have to be physically repositioned by the recording head's field, which requires a fair bit of energy at first, in order to get them going. Thus, the tape would be very non-linear when small signals were happening, and would produce something similar to cross over distortion on larger ones. A drag, to be sure

Therefore, we have bias. Bias is an ultrasonic sine wave which rides into the recording head along with the audio. It is much too high in frequency to be recorded, but it doesstir up some unrest among the particles, and makes them much more receptive to being influenced by the audio signal. The result is that the tape becomes much more sensitive, and much more linear.

The level of the bias signal is actually quite critical; too little, and the tape will not be as sensitive as it could be, and too much, and the high frequency component of the signal will actually partially erase itself. The optimum bias point, on modern cassette recorders, can be found by simply setting the level for a reasonably flat frequency response.

In fact, this can be simplified even more, for most situations, by getting the machine to be equally sensitive to two carefully chosen frequencies. In other words, if the low frequency response is equal to the high frequency response, we're laughing. This little project will do just that, with no fiddling around with the ol' function generator and 'scope. It will allow you to quickly check the bias setting for each type of tape you use in

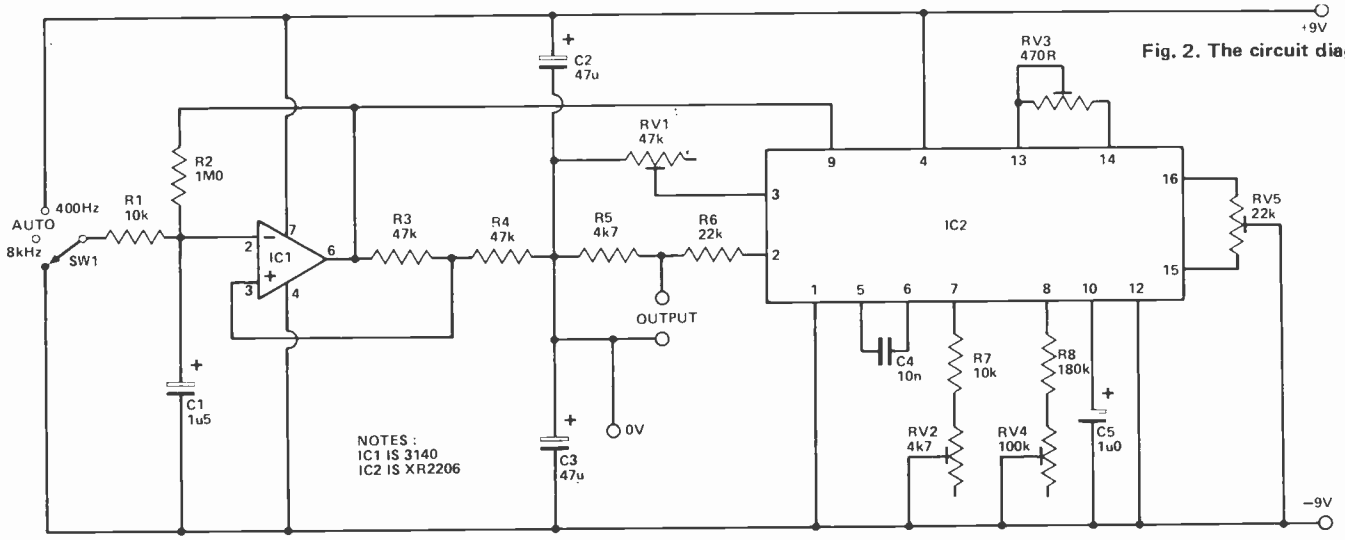

Fig. 2. The circuit diagram.

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22	30	30	35	1.5			35
33	30	35	35	2.2			35
47	35	35	35	3.3			35
100	35	40	50	4.7	35		35
220	35	40	55	6.8	35		35
330	40	50	65	10	45	50	55
470	45	55	75	15	50	55	85
1000	60	70	100	22	55	65	1.35
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7405 ... .75	7430 ... .45	7476 ... .70	74151 ... .98
7406 ... .85	7440 ... .45	7485 ...1.40	74154 ...2.50
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7410 ... .39	7447 ...1.65	7492 ... .85	74190 ...1.65
7411 ... .55	7448 ...1.75	7493 ... .85	74191 ...1.60
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IN751A	5.1	1W	IN964B	13	.5
IN4733A	5.1	1W	3E216D5	14	1W
IN4734	5.6	1W	IN966	16	1W
14-515-04	6.2	1W	BZX61-C18	18	1W
114574	6.2	.5	HZ20C	20	1W
IN753A	6.2	1W	BZX61-C20	20	1W
IN754A	6.8	1W	GE5028	20	1W
IN752A	5.6	1W	14-515-31	22	.5
17-515-35	6.8	1W	IN4751A	30	1W
HZ7B	7	1W	BZX61-C30	30	1W
IN755A	7.5	1W	BZX79-C36	36	½ w
IN74738A	7.5	1W	BZX61-C56	56	1W
IN757A	9.1	½ W	IN5045	56	5W
IN4739A	9.1	.5	BZX61-C68	68	1W
BZX61-C9V1	9.1	1W	IN4764A	100	1W
IN757A	9.1	1W	IN5593B	183	1W

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1			25
2.2			25
3.3			25
4.7		25	25
10	25	25	25
22	25	25	25
33	25	25	30
47	25	30	35
100	30	30	35
220	30	35	45
330	35	40	60
470	40	50	85
1000	60	75	
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your deck, and, if you want to crawl inside with a screwdriver, to optimize the settings for your favourite tapes.

Getting It Together

The easiest approach to building the optimizer is to use our PCB. For one thing, it holds the trim pots. There isn't anything tricky in building the project. A 'scope would be helpful in setting it up, but you can get by without one.

Set RV5 to mid position, and RV3 to maximum. With the circuit running, twist RV1 to produce a 4 volt triangle wave at pin 2 of IC2. Then rotate RV3 until you get it looking like a clean sine wave, at about 2 volts. RV2 sets the low frequency tone, and RV4 the high. These should be 400 Hz and 12.5 kHz, repectively. If you haven't got a way to measure these frequencies, you can use fixed resitors for these pots, 250K for the low and 12k5 for the high, which will get you pretty close. The absolute frequencies aren't too important.

Using it

Using the optimizer is simple. Drop in the tape you want to check, and set your tape bias selector switches to the appropriate positions. Leave the Dolby off. Record the two tones at 0 vu, and then play them back. The levels of playback, as shown on the recorder's meters, will indicate whether the two tones have, in fact, come off the tape at equal levels. If they differ significantly, you should adjust the bias setting to get them as close as possible.

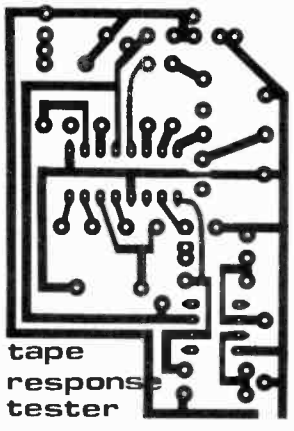
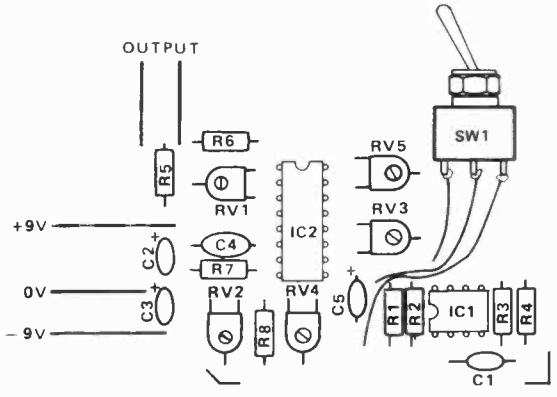


Fig. 3. The PCB for the optimizer.

Fig. 4. The PCB overlay.



PARTS LIST

RESISTORS

R1,7	10k
R2	1M
R3,4	47k
R5	4k7
R6	22k
R8	180k

POTENTIOMETERS

RV1	47k min horiz preset
RV2	4k7 min horiz preset
RV3	470R min horiz preset
RV4	100k min horiz preset
RV5	22k min horiz preset

CAPACITORS

C1	1u5 tantalum
C2,3	47u tantalum
C4	10n polyester
C5	1u0 tantalum

SEMICONDUCTORS

IC1	3140
IC2	XR2206

MISCELLANEOUS

PCB, IC sockets, single pole centre-off change-over switch.

HOW IT WORKS

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

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

The output signal is developed across R5, 6. Any convenient ratio may be chosen for these components to provide any desired output level up to a few volts peak to peak. A split supply was chosen as it facilitates circuit design. In any case IC2 needs at least a ten volt supply, precluding the use of a single battery. Current consumption is low and two 9V batteries provide a convenient source of power. Frequency stability with falling battery voltage is good and standard dry batteries are quite adequate. Capacitors C2, 3 provide overall decoupling.

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DESIGNER CIRCUITS

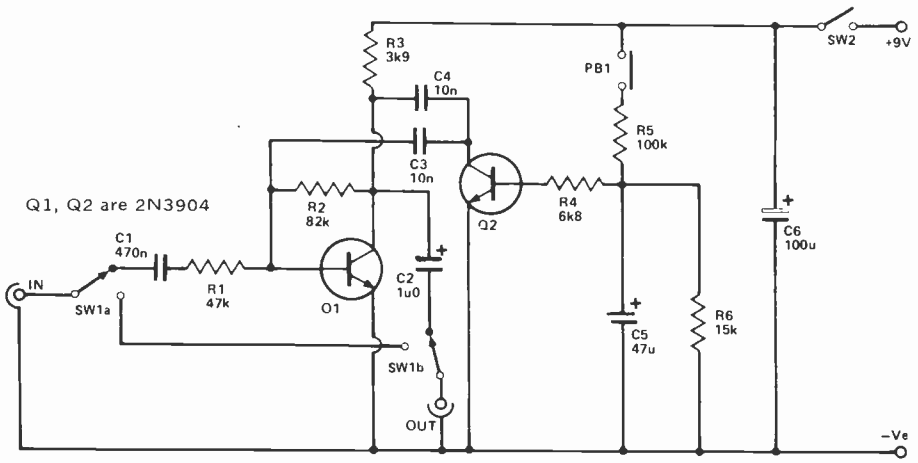
Waa-Waa Unit

An unusual feature of this circuit is that the Waa-Waa efect is obtained by operating a foot-switch, rather than the more usual method of operating a potentiometer via a pedal mechanism. This method is slightly less versatile than a proper Waa-Waa pedal, but is far simpler for the home constructor to build since it avoids the need for any pedal mechanics.

The basic Waa-Waa circuit uses a quite conventional arrangement based on common emitter amplifier, Q1. Frequency selective negative feeback is provided by C3, 4. These provide little feedback at a certain frequency. A peak in the response of the amplifier is produced at this frequency, as the lack of feedback enables virtually the full voltage gain of Q1 to be realised. The actual frequency at which the peak is produced can be controlled by means of a resistance between the junction of C3,4 and the negative supply rail. With a high resistance here the peak is produced at a high frequency. By varying the control resistance the peak can be swept up and down the audio frequency spectrum, producing the familiar Waa-Waa effect.

The control resistance is formed by the collector to emitter impedance of Q2. Under quiescent conditions Q2 is switched off and the peak is at such a low frequency that it is effectively non-existent. If PB1 is operated, C5 charges up via R5 and, as the voltage across C5 increases, Q2 is biased harder into conduction by the base current it receives through R4. This causes the peak to be swept up through the audio band until C5 becomes fully charged. If PB1 is then released C5 gradually discharges through R4, Q2 and R6, causing the bias on Q2 to decrease and the peak to be swept down the audio spectrum. Thus the required effect is produced by closing and opening PB1. The Waa-Waa frequency is partially controlled by the frequency at which PB1 is operated, but C5 restricts the range of frequencies that can be obtained in practice. However, the value of C5 can be altered to suit individual requirements, or several switched components of different values could be used.

SW1 enables the Waa-Waa circuit to be quickly and easily bypassed. R1 is needed to reduce the gain of the unit which would otherwise be excessive. Current consumption is about 2 mA.



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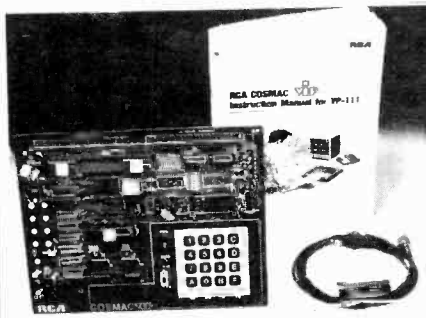

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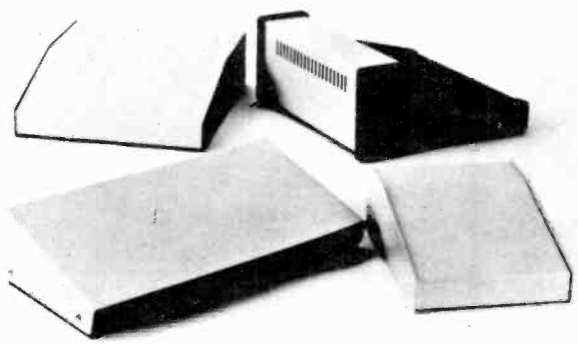

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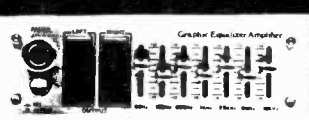

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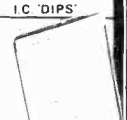

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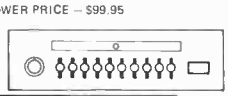

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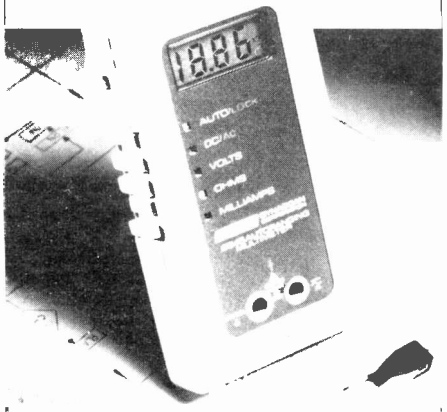

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7417	40	74LS00	29	74LS266	54
7420	32	74LS01	29	74LS279	62
7427	40	74LS02	29	74LS290	1.12
7430	30	74LS03	29	74LS365	79
7432	40	74LS04	32	74LS367	85
7437	40	74LS05	32	74LS368	85
7440	30	74LS08	31	74LS373	1.82
7441	1.20	74LS09	31	74LS374	1.83
7442	85	74LS10	29	4000	40
7445	1.10	74LS11	32	4001	32
7446	1.05	74LS12	32	4002	32
7447	90	74LS13	55	4006	1.38
7448	95	74LS14	1.10	4007	40
7450	30	74LS20	29	4008	1.25
7451	32	74LS21	29	4010	55
7472	44	74LS27	35	4011	32
7473	44	74LS30	29	4012	32
7474	44	74LS32	33	4013	58
7475	56	74LS37	36	4014	1.05
7476	44	74LS38	36	4015	1.05
7483	90	74LS42	80	4016	54
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74123	75	74LS126	63	4034	2.90
74125	60	74LS136	55	4035	1.38
74132	80	74LS138	88	4040	1.19
74145	88	74LS139	88	4042	1.05
74148	1.25	74LS151	79	4043	1.05
74150	1.50	74LS153	79	4044	1.05
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74155	75	74LS161	98	4051	1.05
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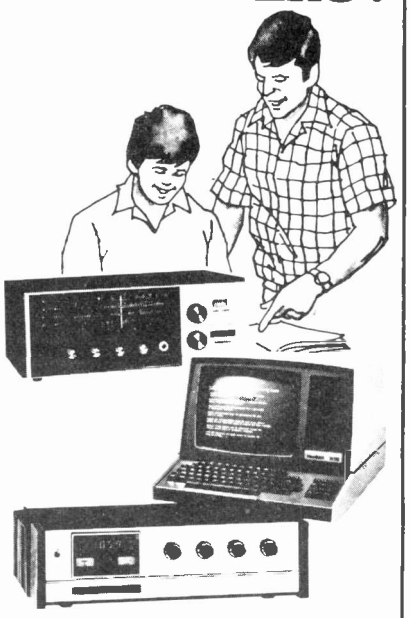

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ANTENNA EXTENDER

If you intend to buy (or already own) a motorised antenna then you shouldn't be without this intelligent gadget which automatically controls your aerial's ups and downs.

THERE IS A LARGE PROPORTION of motorists who have had the misfortune of losing their car aerial through a car-wash, through accidental breakage or maybe to the young vandal eager to add another victim to his list.

Judging by the number of coathangers that have found their way out of the family wardrobe and into the orifice where the chrome rod once stood, one only has to wait anxiously for the coathanger industry to replace the car aerial. It is not surprising that with these catastrophic events prevailing, drivers are reluctant to replace their aerial. However, if you install a motorised antenna incorporating the ETI antenna controller, it will reduce the risk of losing your aerial.

The unit is designed to replace the manual operation of 'holding' the antenna switch in the 'on' position to activate the aerial. The ETI controller overcomes this hindrance by sensing whether the radio is 'on' or 'off' state and automatically extending or retracting the aerial.

Better Safe Than Sorry

There are also certain fail-safe features which are incorporated to comply with the manufacturer's instructions. These are:

(i) when the antenna has extended it should not be switched from up to down or vice versa without waiting for at least 3 s before the next operation.

(ii) switching the radio on and off repeatedly will have no effect while the aerial is operation.

With these features our project supersedes most commercial units already available.

Construction And Setting Up

Construction is straightforward. All components, including the relays, are mounted on a single PCB. Begin construction by inserting all low profile components, ie wire links, Veropins and sockets, followed by resistors, diodes, capacitors and transistors, observing the orientation of all polarised components. R15 is soldered underneath the PCB between the junction of PR2/PR3, and the positive end of C5.

Before you fit the PCB in its box the following setting-up procedure should be carried out:

1) Fit IC1 and link points B and C. (This is used for setting up only.)
2) Connect a 12 V power supply to the PCB supply terminals.
3) Adjust PR1 until LED1 just turns on; mark this position.
4) Connect R_{TEST} as shown on the circuit diagram. Adjust PR1 until LED1 turns off; mark this position.

HOW IT WORKS

IC1 is configured as a voltage comparator with a fixed reference voltage at pin 3; pin 2 is arranged in the same way except that D1 is included as the sensor. If a load is present (ie the car radio is switched on), the voltage at pin 2 will fall to a value of (V_{cc} – 600) mV, this being the forward voltage drop of the diode. This change of voltage is now compared to the reference at pin 3. As the voltage has decreased the output of IC2 will switch to approximately the supply voltage.

PR1 is incorporated in the circuit to balance the tolerances of R4, 5, 6 and 7 so that with any extreme changes of voltage or temperature, the comparator will reliably detect a change at pin 2.

The output of IC1 is fed to IC2a and b (bilateral switches). These switches are normally closed, but with a low signal at their controls (pins 12 and 13) the switches will open, breaking the connection to the rest of the circuit and providing the necessary inhibit facility. ZD1 is added to suppress transients that might cause false triggering.

If the car radio is switched on the output of IC2b is high; this voltage is fed to the input of a non-inverting gate (IC3a). The output of this gate determines the relay direction via Q3, as well as providing the input to the edge detector IC3b. The function of this gate is to give a positive-going pulse whenever its input changes state. R14 and C4 are added for protection against spikes that occur during switching. IC3 squares the output of the edge detector, so a reasonably narrow pulse is available to trigger the first monostable (IC4a, IC4b). The output of IC4b energises RLB via Q4 for a period set by PR2 and C5 (this is not more than 5s). RLB is now supplying power to the motor antenna with a polarity determined by RLA, so while the monostable is turned on the antenna will extend. When this period has ended, pin 4 of IC4a will assume a high state, triggering the second monostable (IC4c, IC4d). The outputs of both monostables are fed to a diode OR gate and inverted by Q2 to open the bilateral switches. This gives a total inhibit time of approximately 6 s, allowing 3 s for the antenna to extend, plus a further 3 s delay before the next operation can take place.

D6 ensures that C5 is fully discharged at the end of the monostable period, to prevent false triggering by residual charge.

When the radio is switched off, the output of the comparator and IC3a will be low. As pin 8 of IC3d is at 0 V, its output will be high which closes IC2c; at the same time IC2d opens and the down sequence is activated. The monostable and RLB follow the same mode of operation as already described.

Q1 and associated components (R3, C1 and ZD1) provide a regulated supply for the CMOS devices.

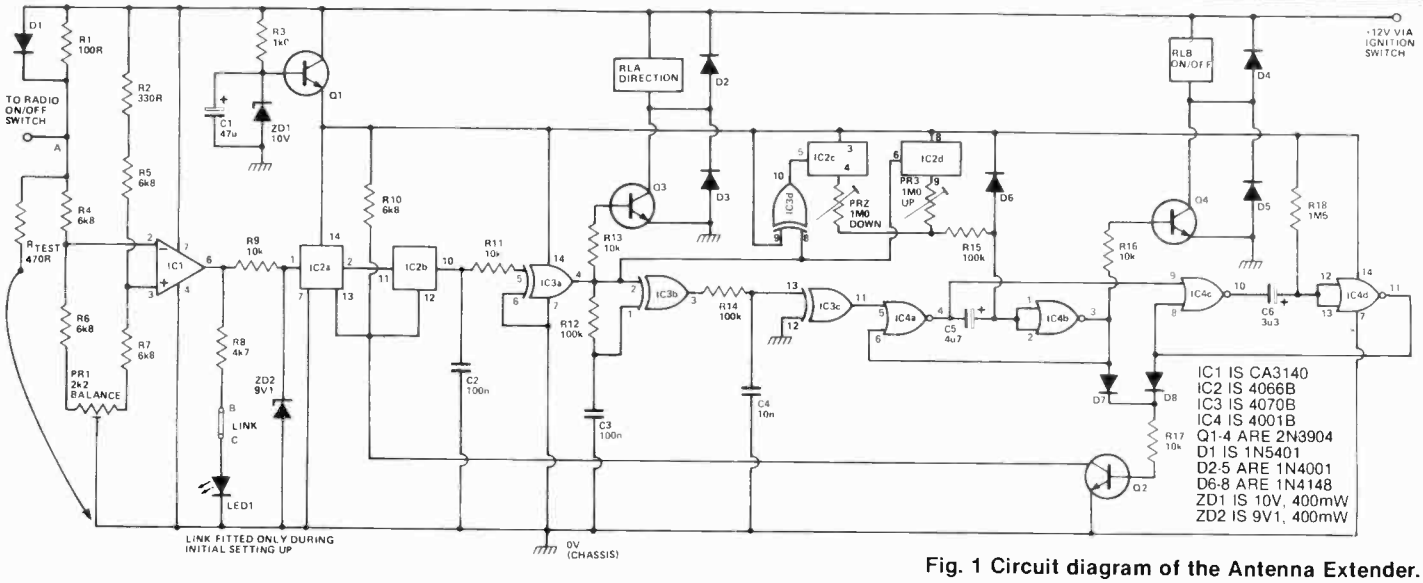
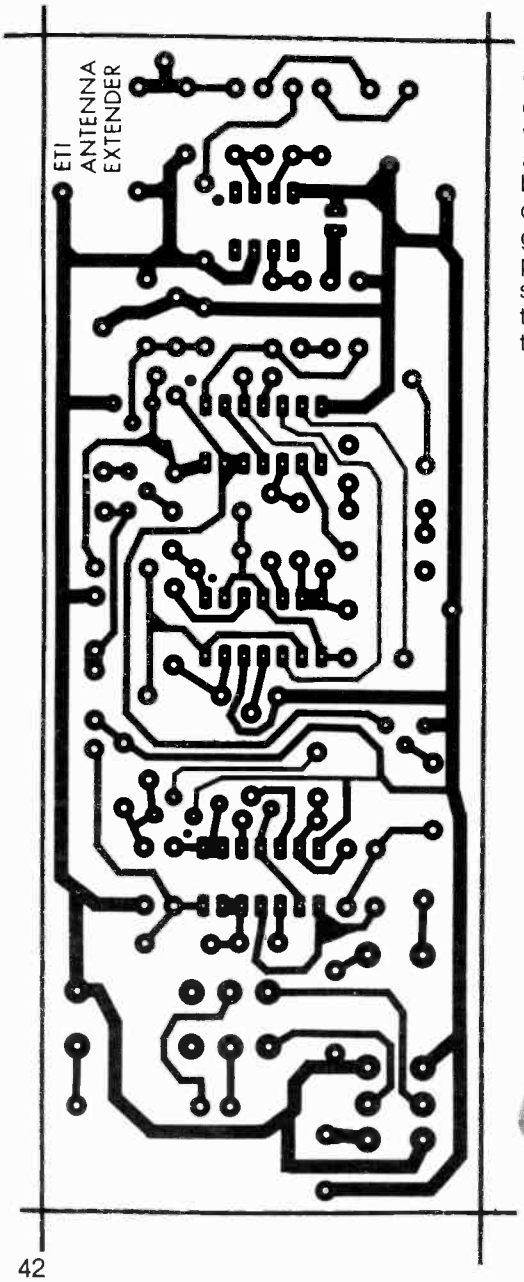
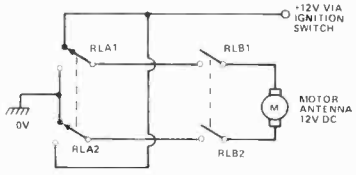


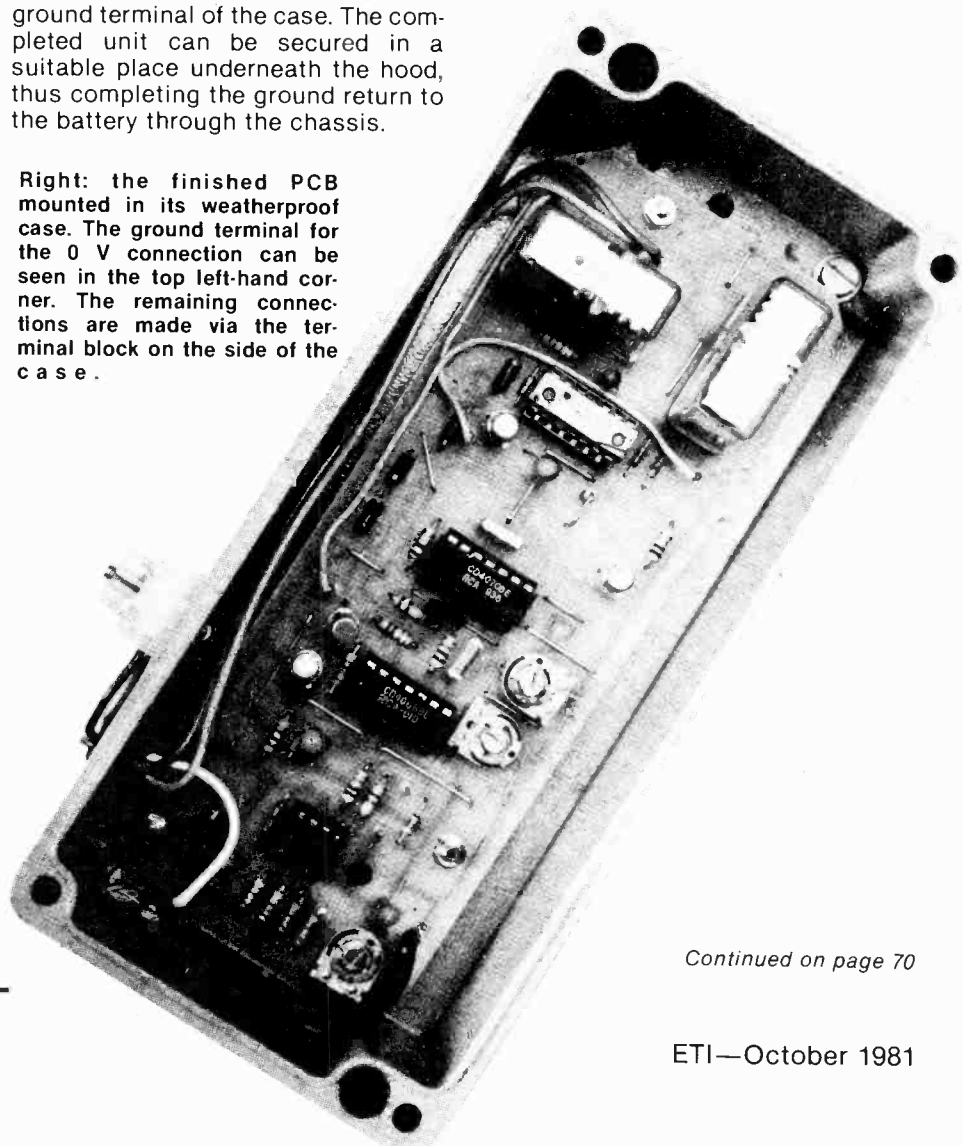
Fig. 1 Circuit diagram of the Antenna Extender.



We mounted our PCB on three ¼" spacers. When it comes to hooking up the unit, there should be no complications as there are only four wire connections to consider. These are made via a four-way terminal block on the side of the case. The 0 V connection is made to the internal ground terminal of the case. The completed unit can be secured in a suitable place underneath the hood, thus completing the ground return to the battery through the chassis.



Right: the finished PCB mounted in its weatherproof case. The ground terminal for the 0 V connection can be seen in the top left-hand corner. The remaining connections are made via the terminal block on the side of the case.



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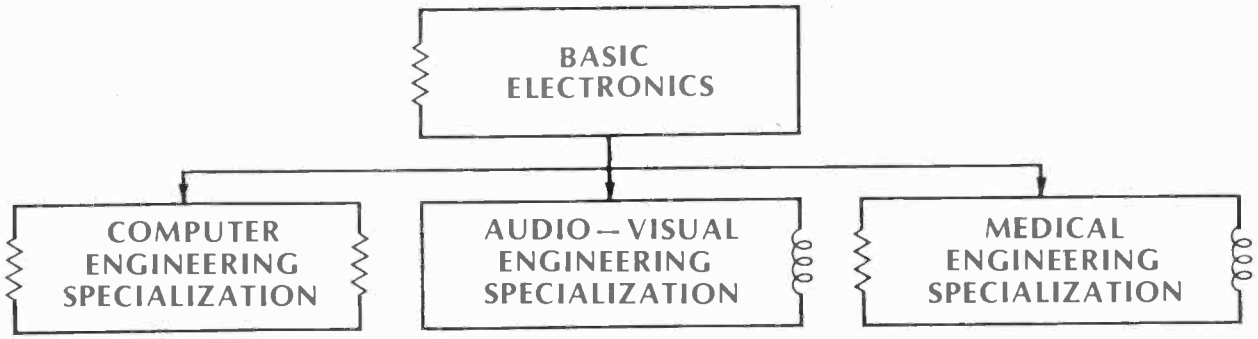

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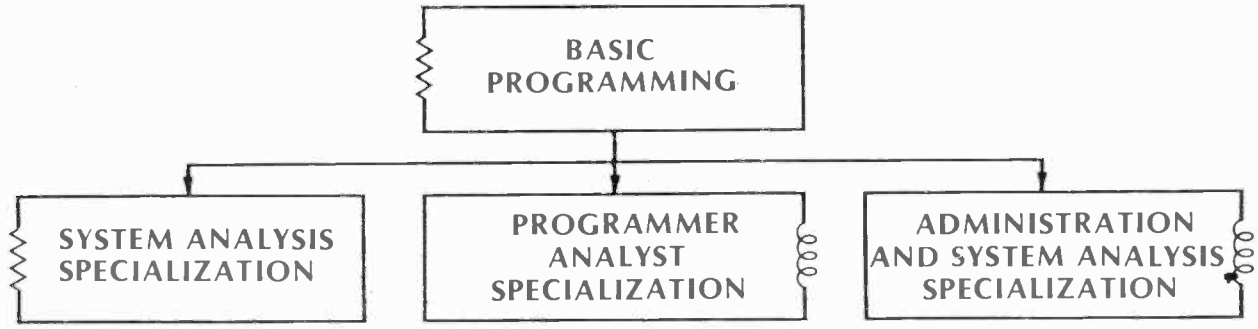

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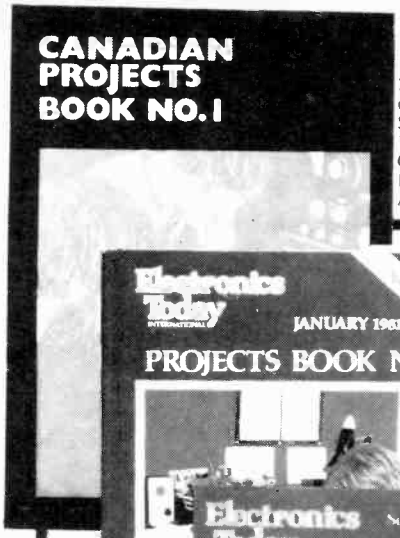

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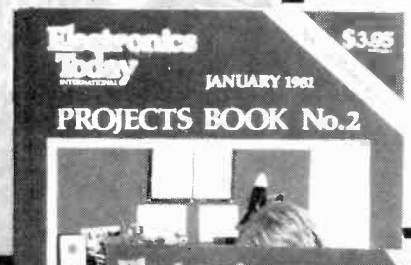

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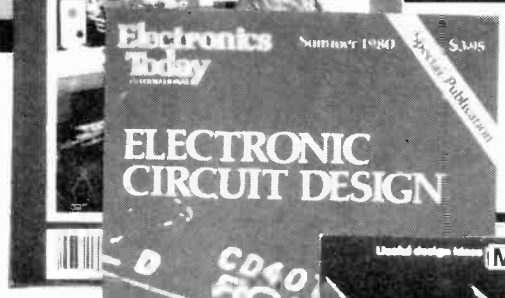

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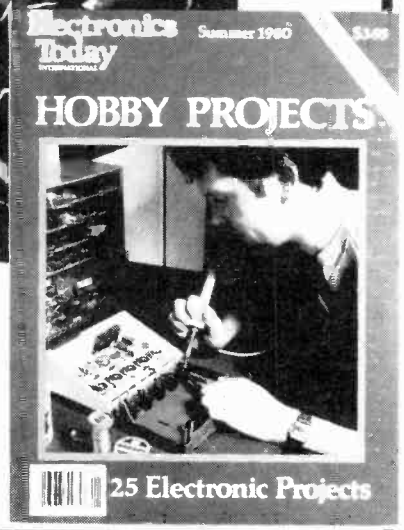

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TV QUALITY CONTROL

Maintaining stable video colour quality over long periods of time isn't easy. Ron Baynes tells how the CBC keeps their chroma correct.

THAT CLEAR, steady TV picture you enjoyed on prime time last night and all the nights before doesn't just happen. It's the product of a transmitter blessed with tender loving care by skilled technicians working 24 hours a day, monitoring, adjusting, repairing as the need arises — and at regular intervals — taking Polaroid pictures.

The Canadian Broadcasting Corporation whose operating standards for TV transmitters are among the highest in the industry, operates exactly this kind of program throughout its network, aimed at keeping its equipment operating not just in accordance with government specifications, but above them. In this process, Polaroid photographs play an essential part.

As Al Stapleton, Technical Supervisor of Transmission Systems for the Corporation's Ontario Region explains it, a perfect TV transmitter is one that stays out of the final picture itself; one that doesn't bring its own mechanical hangups and electronic eccentricities into your living room. "The aiming point of our maintenance programs," says Stapleton, "is to make sure CBC transmitters are transparent as far as the viewer is concerned.

The task is not easy. Television transmitters are complex and potentially temperamental creations. Relatively small lapses in adjustment or failures in any one of a multitude of components can cause highly visible picture trouble — rolling, for instance, color changes or the appearance of ghostly multiple images. Technicians charged with keeping transmitters in shape do so not simply by reading dials but by monitoring the equipment's vital functions, usually on oscilloscopes, in somewhat the manner of a medical team keeping watch on a patient in an intensive care unit.

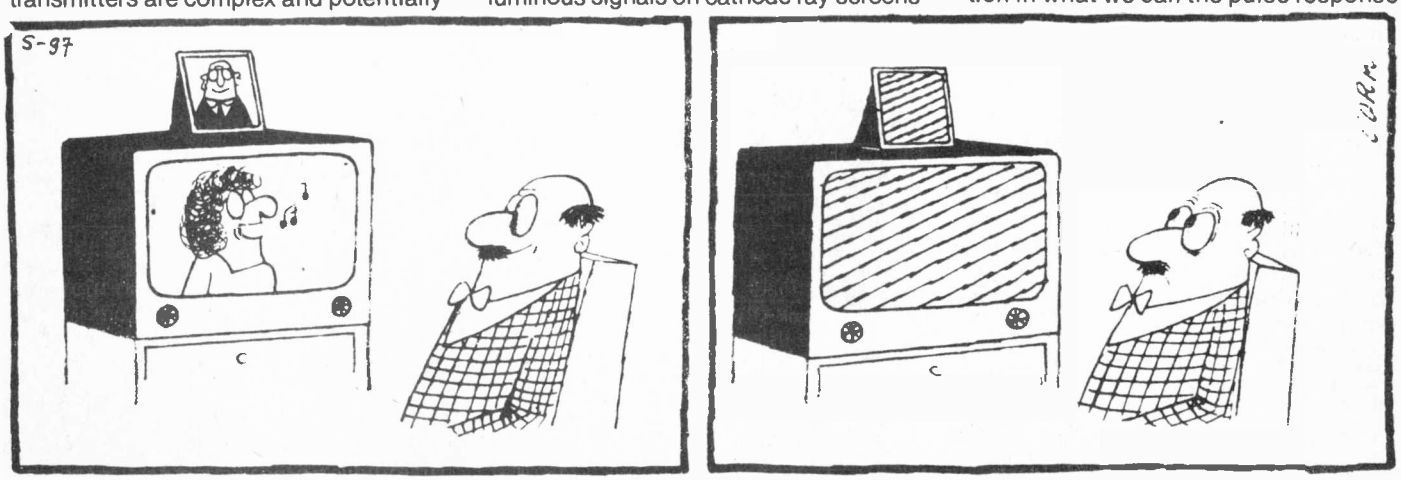
Broadcast technicians do this using two electronic benchmarks. During regular programming hours they can get most of the information they need about transmitter condition monitoring Vertical Interval Test signals. These unobtrusive markers are visible on a television set only when the picture rolls and are easy to miss if you don't know where to look for them (they're spaced along the frame line at the top of the picture). After sign-off, technicians can also work with full-screen test signals, the color-banded displays that come on after the Late Late Show.

At CBC transmitter control centers, these signals are fed into wave-form monitors — specialized oscilloscope units — where they appear as distinctive luminous signals on cathode ray screens — and on other CRT-equipped test instruments. These displays give technicians information about how transmitters are performing in terms of "upper bandwidth", "group delay", "pulse response" and other arcane traits which make the difference between a good picture and a bad one.

At regular intervals, CBC technicians attach Shackman 7000 cameras to these CRT screens and photograph them on Polaroid Type 667 films, a professional panchromatic film designed specifically for this kind of work and used to make picture records of CRT screens in medical and diagnostic settings. The resulting pictures have a multitude of uses in CBC's maintenance program.

Explains broadcast technologist Roger Viner, one of eight technicians stationed at the CN Tower transmitter control center, "Transmitter maintenance involves us in a great deal of now-and-then comparison. Our objective is not simply to meet government specs for signals but to maintain a safety margin — to keep performance at levels even higher than required. That way we can spot many problems developing before something fails.

"One example could be degradation in what we call the pulse response



of the picture. If this progressed too far, the result, as far as the viewer at home was concerned, would be ghosting, smearing or multiple images. The spec we keep to for pulse response is well below the point at which that kind of effect would be visible. And within this safety margin we can look at pictures taken at different intervals and if there's any degradation in that part of the signal we can see it."

More Than Just Family Snaps

Technicians photograph every image twice, once for the local album, the other for headquarters use. Al Stapleton, whose job makes him responsible for all CBC transmitters in Ontario, says the pictures are in constant use at the region's headquarters in Toronto. Apart from keeping managers on top of signal quality throughout the province the pictures are particularly useful when CBC is breaking in a new transmitter, or bringing an old unit into line with revised specifications. In either case the process can involve fine-tuning and other adjustment over a period of days or weeks. "Some of the parameters we are governed by are fairly fine and what you can see in one of these photographs is worth the proverbial 1000 words," Stapleton comments.

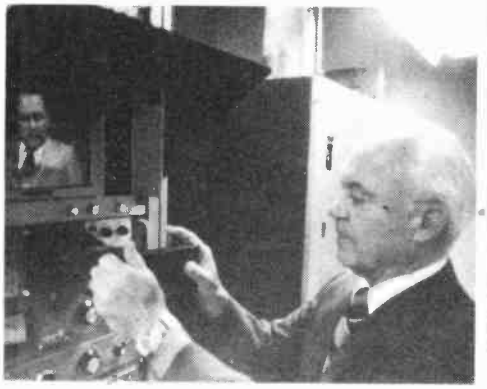
At larger centers, Shackman cameras are part of the local equipment inventory along with costly spectrum analyzers, waveform monitors and other testing instrumentation. At smaller centers transmitters are checked by technicians who fly in from a local maintenance base, bringing in test equipment and making Polaroid photographs on the spot. Sixty technicians are engaged in this kind of work in Ontario alone and Stapleton estimates they use 1500 packs of Polaroid Type 667 film a year.

To make these visual records, technicians attach the camera, fitted with a light-proof spacer (see picture) to the screen of the oscilloscope carrying the test signal. Exposures are made at apertures ranging from f/8 to f/16 and at shutter speeds from one to five seconds. With a speed equivalent to ASA 3000, Polaroid Type 667 film produces a print that requires no coating prior to use.

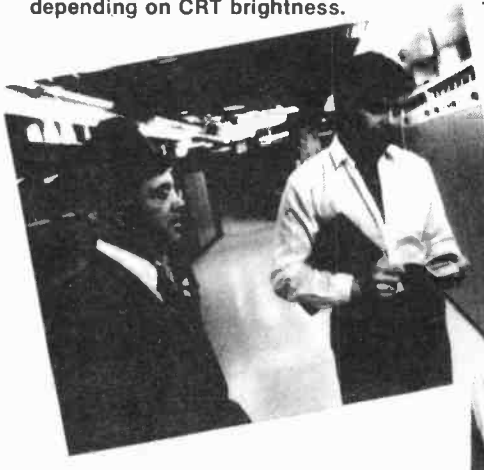
As Stapleton explains, recording of TV and other broadcast waveform images calls for a high level of performance by both camera and film. "We're observing rather fine and subtle phenomena. We need very good resolution in the film to pick up lines and sometimes to make judgements on linearity. The fidelity we need is so high that factors such as parallax become extremely important. Any aberrations, distortions or image failure would throw us off very badly."

Apart from these emulsion characteristics, the most important advantage of the Polaroid film in this kind of work is its ability to deliver a finished print 15 seconds after the shutter has clicked. This allows technicians to compare the photograph with the image still on the screen, verifying its quality and making sure that details of the wave form are safely on record. "It's *got* to be instant," says Stapleton. "That's the only thing we can check on the spot."

Another advantage is simplicity of use. "Our people are trained in electronics, not photography," says Stapleton. "Everyone is expected to be able to take these pictures whether or not he or she has ever taken a picture before. So far, no one has had any trouble doing so. The camera and the film are things we use as naturally and as frequently as reaching for another screwdriver."



Al Stapleton sets up Shackman 7000 camera for test shot of cathode ray tube on test instrument at the CN Tower. Most pictures are shot at f/8 to f/16 and exposures are from one to five seconds depending on CRT brightness.



Transmitter room, at the 1,150 foot level of Toronto's CN Tower makes regular Polaroid records of transmitter TV signals including monthly series on the ANIK Communications Satellite. Here, Broadcast Technician Ray Newell (right) checks Polaroid print with Ontario Region Transmission Systems Supervisor Al Stapleton.

CBC's CN Tower album contains test shots of images appearing on wave form monitors, spectrum analyzers and other oscilloscope images. All photographs are dated and timed for future reference.

About the Shackman 7000 Oscilloscope Camera

An oscilloscope display, by its very nature, is not a permanent record of the waveform under consideration. The phosphor tends to die out after a quarter of a second. To solve this, researchers usually hang some form of instant camera of the display. Instant film is ideal in this application because the image can be attached to lab notes or reports almost immediately.

Polaroid manufactures a number of products for laboratory use, the most recent of these being the Shackman 7000 oscilloscope camera. Unlike most cameras, the Shackman 7000 can be moved from 'scope to 'scope, even if they are of different type or make.

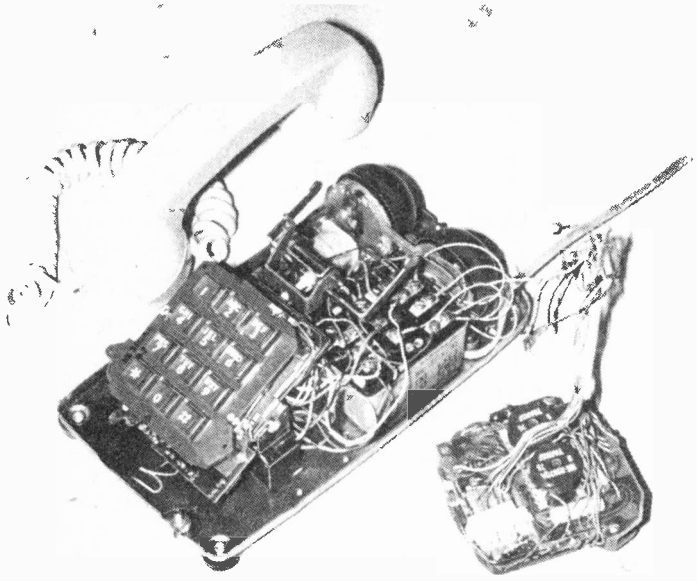
The complete unit has three parts; the camera, a spacer body, and light tight hood. There are over 60 such hoods to fit most oscilloscopes with 6x8, 6x10, and 8x10cm screens. The camera is attached to the hood with hinge pins that allow it to be swung to either side to facilitate viewing. The hood positions the camera for correct focus. Interchangeable hoods allow the camera to be carried from location to location.

The camera uses Polaroid type 667 high speed black and white film. The magnification ratio is 85% which allows a complete 8x10 cm display to be recorded. Development time is 15 seconds. A 70mm f/3.5 lens is used (minimum aperature, f/32). Shutter speed varies from 1 to 1/125th of a second and, as well, there's a 'B' setting. There's also an 'X' sync contact for remote triggering.

The Shackman 7000 camera is priced at approximately $400 with basic hood. A pack of film (8 exposures, ASA3000) is priced at $62.50. If you want to know more, write to Polaroid Corporation of Canada Ltd., 350 Carlingview Dr., Rexdale, Ontario.

John Van Lierde

The Joy of Phone Mutilation . . .



We had a really neat article that we were going to run in an upcoming issue that dealt with all the techniques and skills required to branch out into the exciting and challenging world of phone mutilation. This story was going to teach even a complete novice how to remove the plastic shell, unbolt the dial and pull its wires out of the spade lugs, bend all the little copper contacts back so they wouldn't work anymore, pry off the top of the big potted coil, and completely ablate and fry the ringer by hooking it up to the 120V line. Part two was to get into advanced headset incineration, and part three was going to be the grand finale, the results of which would have been a tiny little puddle of molten phone, in your choice of ten designer shades. Alas, it will now never come to light. Ma Bell got wind of it and sent us an advisory notice to the effect that, were we to actually run the piece, we would shortly be communicating via two dixie cups and a string.

Saddened though you may be at this obvious loss, be cheered and made joyous. ETI will still be running many other fascinating features, construction projects, columns, and pages of up-to-the-second news. If you'd like to get it sent directly to your door, you can subscribe. $16.95 for one year. $29.95 for two. You'll save quite a bit over the newsstand price and, better still, your money won't be winding up in the greedy hands of the phone company (it'll wind up in ours).

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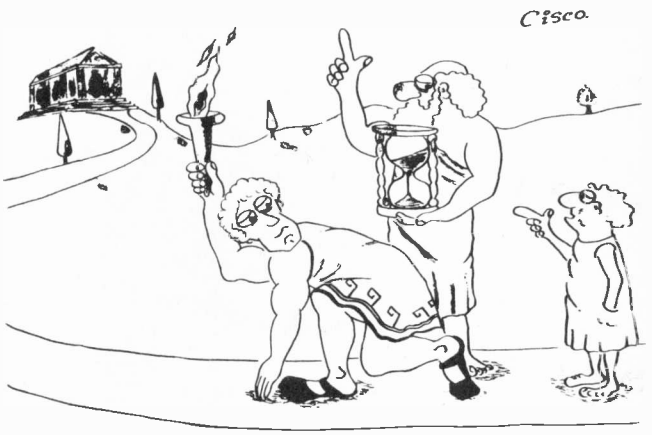
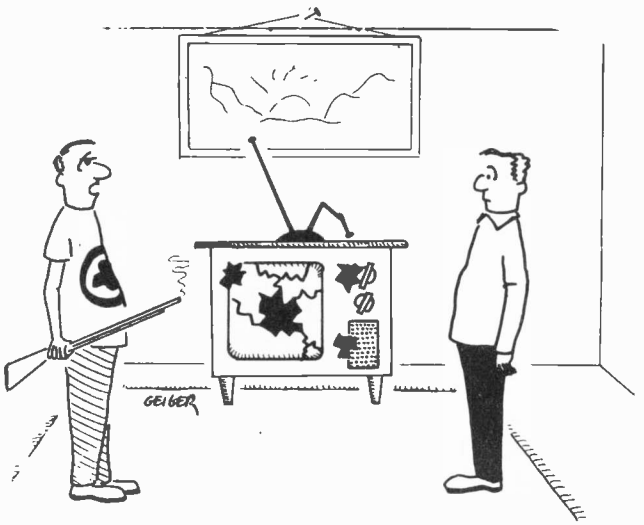


'I still say you need more sophisticated equipment if you're trying to measure the speed of light'



'It's broken down four times this week, so we decided to do a little troubleshooting'

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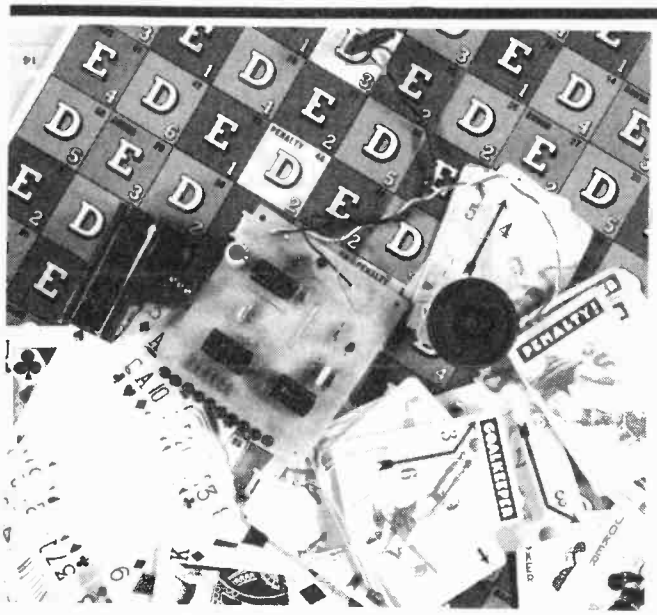
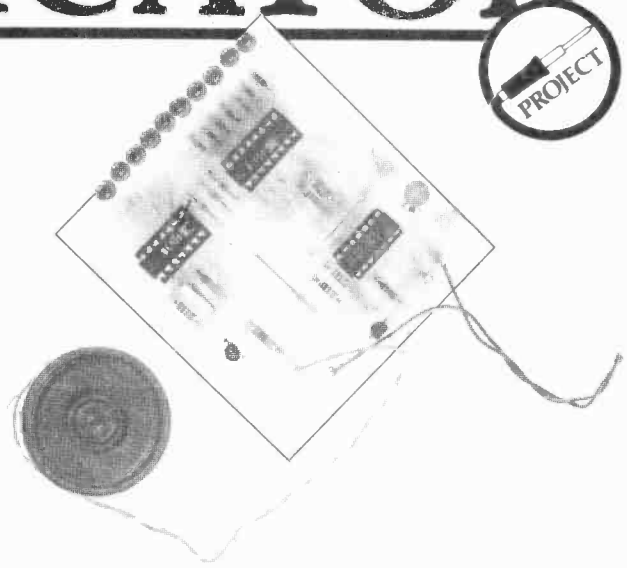
WIN INDICATOR



An inexpensive and easily-built project that is bound to be a winner with all games enthusiasts with ten or fewer arms.



As you can see we have left the choice of a box up to the individual constructor, similarly the LED panel may be used as a separate board for remote applications.

THIS PROJECT IS DESIGNED TO BE USED in those 'first-person-to-press-the-button-wins-the-game' types of activity that are so popular at parties and fund-raising functions. The device enables up to ten contestants to participate in such games and gives a virtually infallible audio-visual indication of the true winner of the game, even when all contestants seem to operate their push-buttons simultaneously.

In this project, each contestant is assigned a numbered push-button, with which an identically numbered LED (light-emitting-diode) is associated. Prior to the start of each game, the game referee presses a RESET button, which causes all LEDs to turn off and causes an electronic scanning circuit to start sequentially inspecting the state of each switch at a rate of several thousand scans per second. The 'game' switch to be subsequently operated causes the scanning action to lock at the switch position and activate a simple memory circuit, which energises an audible alarm and latches on the individual numbered LED that is associated with the winning switch; all subsequent switch operations are ignored by the unit. The alarm and the winning LED remain on until the referee again operates the RESET switch.

The ETI Multi-Input 'Game Won' Indicator circuit is powered from a single 9 volt battery and is an easy and inexpensive project to build. It can be used with any number of GAME switches up to a maximum of ten. Unwanted switches are simply omitted from the circuit.

Construction

All components except the switches and speaker are mounted on a single PCB. Construction should present few problems, provided that normal care is taken to ensure that all components are fitted in the correct polarity. The following minor points should, however, be noted.

(1) The ten indicator LEDs are mounted close to one edge of the board. The LEDs should be given individual funtional checks (by connecting them across a 9 volt supply via a 470R limiting resistor) before soldering them into place.

(2) Five under-board links are used to connect the LEDs to the output of IC1.

(3) Connections to the 'top' terminals of the ten external GAME switches are made via three topboard Veropins and seven under-board connections. The 'bottom' terminals of all ten switches are wired together and taken to R2 via a single Veropin connection.

When construction is complete you can connect the unit to a speaker and a 9 volt battery and give it a simple functional test, as already described. The completed unit can then be fitted into a suitable case of your own choice.

PARTS LIST

RESISTORS

R1,4	27K
R2,3,6	12K
R5	68K
R7	82R

CAPACITORS

C1	180p polystyrene
C2	100u 25 V PCB electrolytic
C3	47n polyester

SEMICONDUCTORS

IC1	4017
IC2	4001
IC3	4011
Q1,2	2N2925
D1,2	1N4148

Led1-10, are standard 0.2in. Red leds

MISCELLANEOUS

PB1-11 are momentary push buttons.

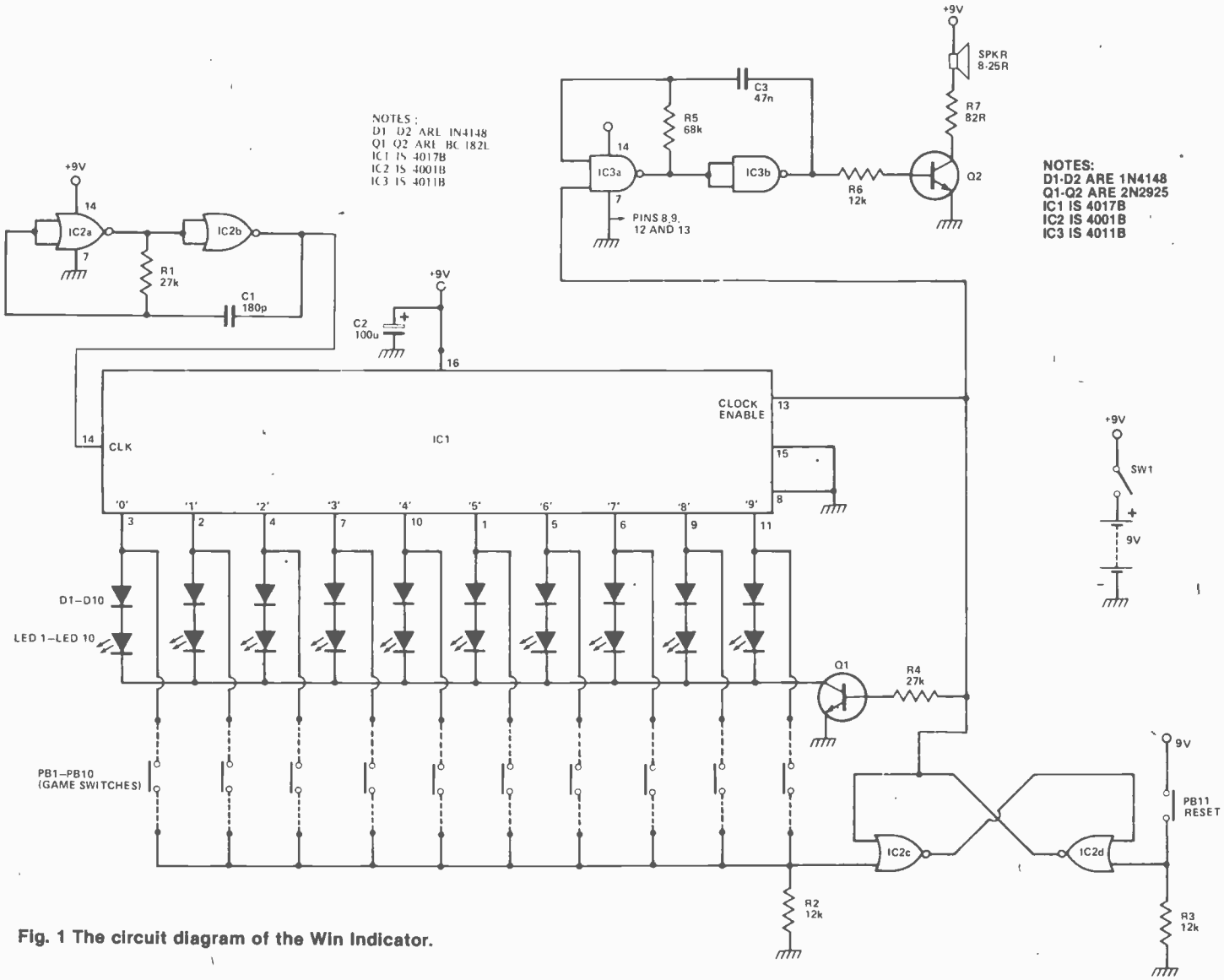
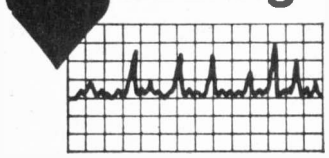


Fig. 1 The circuit diagram of the Win Indicator.

Will it keep beating?



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HOW IT WORKS

IC1 is a 4017 'decade-divider-with-ten-decoded-outputs'. When this IC receives clock signals its ten decoded outputs sequentially go high in synchrony with the clock signals, with only one output being high at any given moment of time. An indicator LED is wired between each of these current-limited outputs and ground via switching transistor Q1. IC2a-IC2b are wired as a fast astable 'clock' generator that is permanently operational when on/off switch SW1 is closed. IC2c-IC2d are wired as a simple bistable that can be SET by a brief positive pulse across R2 or RESET via PB11. The output of the bistable is fed to the CLOCK ENABLE terminal of IC1, to the base of Q1 via R4 and to the input of a gated sound generator that is built around IC3 and Q2.

At the start of each 'game' the IC2c-IC2d bistable is reset via PB11. Under this condition IC1 accepts clock signals but Q1 is turned off, so none of the LEDs are operational. The IC3-Q2 sound generator is also turned off. In this mode of operation, sample or 'scanning' pulses are sequentially applied to one side of each of the normally-open game switches at the 'clock' rate.

If any of the PB1-PB10 GAME switches become momentarily closed during this operation the scanning pulse will pass through the switch to the SET position. Under this condition the CLOCK ENABLE terminal of IC1 goes high, causing the IC to lock at that scan position. Simultaneously, Q1 turns on, causing the LED associated witht he winning switch to illuminate and give a visual indication of the game winner. The sound generator also activates at this time, giving an audible indication of the 'game won' state. The audio/visual indication then remains on until the bistable is reset via PB11 or until the circuit is turned off via SW1.

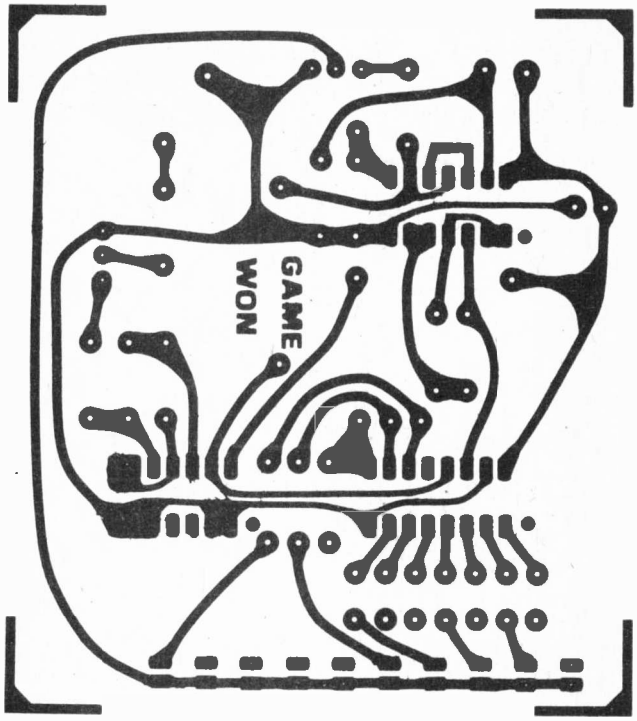


Fig. 2 Left. The PCB foil pattern for the Game Win Indicator. As was mentioned earlier the use of an all-in-one design is purely a matter for personal choice. The unit will function equally well with the LED Indicator panel on a separate board.

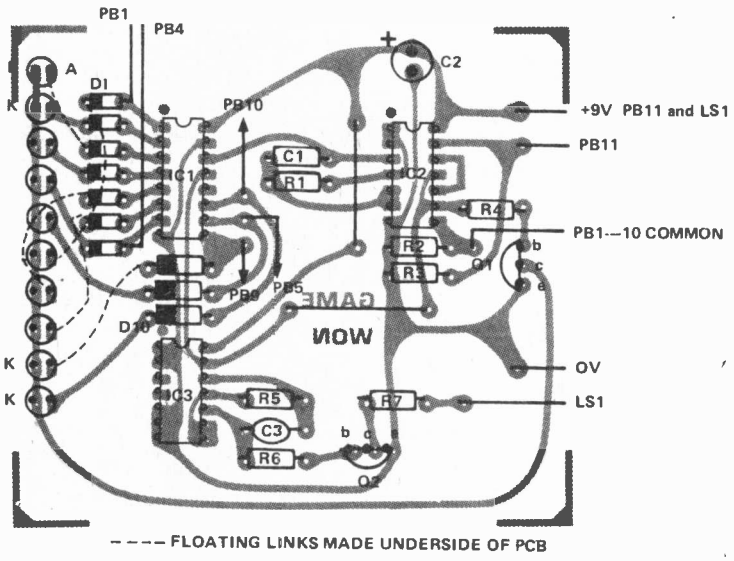


Fig. 3 Overlay diagram, ensure that all polarised components, ie ICs, diodes etc are inserted the right way round. This causes more 'dead' projects than any other factor.

I/O Devices *Continued*

bus should be rigidly defined in both its operation and useage. One of the main reasons that the S100 had a bad name until the IEEE (Institute of Electronic and Electrical Engineers, of course!) got hold of it was its flexibility. This rigid defining process unfortunately takes time.

Special Cases

A brief word must be said at this point about some special cases, namely the IEEE-488 and 20 mA interfaces. The IEEE-488 or General Purpose Interface Bus came to the micro world in a rather mutilated form as the Commodore PET. Designed originally as a high speed data highway it allows multiple talkers (sources) and listeners (acceptors) to communicate along a single eight eight bit data bus. The bus is controlled by a number of signals and can be accessed by any of the devices. The original useage was in the laboratory where various recording instruments were connected to a single event recorder or data logger. In the case of the PET version, the pruning has resulted in one or two headaches among hardware designers, but it can be genuinely useful.

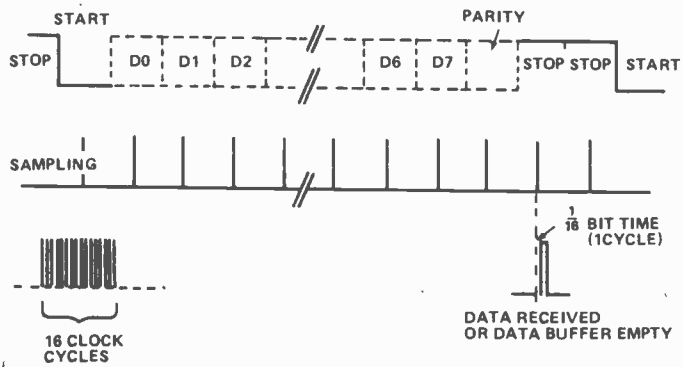


Fig. 4 Serial Transmission timing diagram.

The original serial interfaces were designed around the teleprinter and teletype devices that are mainly built from solenoids. The device which controls these solenoids is a current driven device. The 20 mA interface is built around a closed loop current source where the drive of 20 mA is turned on or off by a transistor which is in turn controlled by an external voltage. This allows the interface to be electrically separated from the device, a considerable benefit as the back EMF generated by the coil of a solenoid could fry modern ICs and transistors if it escaped into the bowels of the computer.

Electronics Today INTERNATIONAL

NEXT MONTH

At the time of going to press, the articles mentioned are in an advanced stage of preparation. However, circumstances may result in changes to the final contents of the magazine.

November 1981

Canada In Space

Aside from making the legs for the lunar modules, for which every Canadian is justifiably proud, this country has done quite a lot to promote orbital littering. Next month, Roger Allen will check the strange new worlds.

Picture shows NASA launching the Anik B communications satellite.

PWM Explained

PWM is pulse width modulation. That's not actually the whole explaination; we'd hardly be running a one line article, now would we? PWM is a process whereby analog information can be handled in a digital form, producing some very useful results. The secrets unveiled, in just 30 days.

James Clark Maxwell

Another look at one of the pioneers of electronics. A little history is good for you. It gives one a sense of tradition, and something to show off with at parties.

Digital Design Handbook

There are always more uses for integrated circuit logic, even barring pendants and paperweights. Next month we present a double handfull of circuits that will go through at least a half roll of solder and strew perf board all over your place. A trove of digital wizzbangs to drive your friends mad with.

Headlight Delay

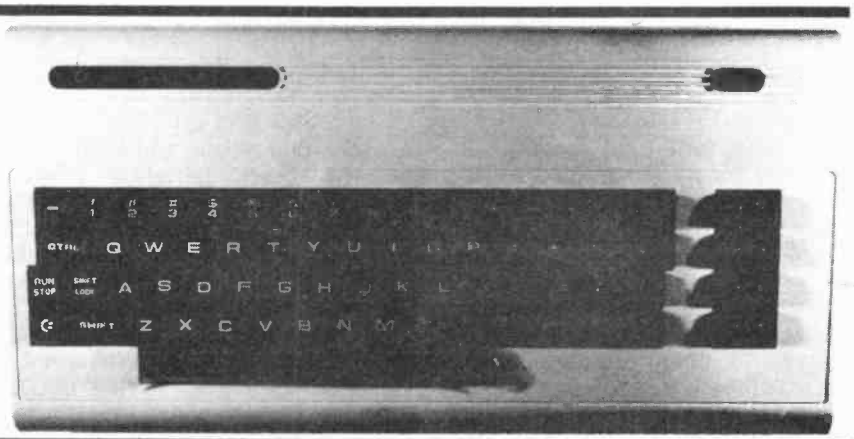
Ever stepped out of your car late at night and been set upon by werewolves before reaching the house? Hey, it's happened to all of us at one time or another. This project will keep your headlights on for a while after getting out of the car so they'll keep their distance. Peace and security on a PCB.

Alien Attack

This is a really neat electronic game that you can use to simulate what will happen if the Martians get upset over Canada In Space.

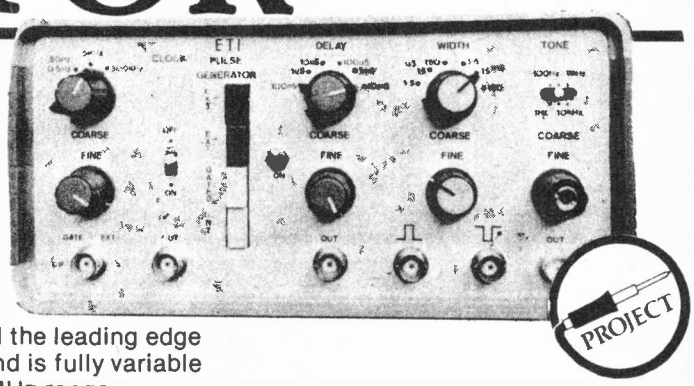
VIC The Computer

Even as you read this, Commodore, the creators of the PET computer, are preparing to launch their new machine, the VIC. It has programmable characters, four voice sound, a full size keyboard, I/O ports, 2 A/D converters, full colour graphics with a high resolution option . . . all for only $450.00 Canadian. The whole works revealed in living black and white, next month.



PULSE GENERATOR

A versatile piece of test gear that can be used as a single or dual pulse generator, a delayed-pulse generator, or a direct or delayed tone-burst generator.



PULSE GENERATORS HAVE a variety of applications in the modern electronics workshop/laboratory. In its simplest form, a pulse generator can be used for testing the performance characteristics of a common digital circuit or for testing the transient responses of AF or RF amplifiers. In a more advanced form, as a delayed-pulse/toneburst generator, the instrument can be used for simulating or implementing sophisticated systems such as ultrasonic movement detectors, range-finders, or RADAR systems.

The ETI pulse generator is the most versatile instrument that you could possibly wish for. It has two built-in pulse generators (a delay and a width generator), which can be effectively clocked in parallel or series. When parallel clocking is used, the unit simultaneously generates two independently controlled pulses from each clock pulse. When series clocking is used, the unit generates an output pulse that is delayed from the clock pulse by a period set by the delay generator. The pulse width and delay times are both fully variable over the range 100 nS to 150 mS.

The two pulse generators can be clocked from either internal or external signals. The internal clock generator spans the full range of 0.5 Hz to 500 kHz and can be used directly or can be gated by external signals. The clock signal is made available externally via an output socket.

The delay pulse of the unit is made externally available via a single output socket, while the main width pulse is available in direct and inverted form via a pair of sockets. The main pulse can also be used to trigger and gate an internally generated tone burst signal, which is available via another socket. The tone burst signal is fully synchronised to both the clock signal and the leading edge of the main pulse and is fully variable over the 1 Hz to 1 MHz range.

All outputs of the unit are buffered and short-circuit proof. The outputs are driven by TTL and are fixed-amplitude with typical rise and fall times of about 20 nS. The complete unit consumes a mean current of about 40 mA and can be powered from either a 6 V battery pack or from a line-derived 5 V regulated supply.

Construction

First, wire up the PCB as shown on the overlay, noting the use of a large number of Veropins for making external connections. Take the usual precautions over the polarity of semiconductors and electrolytics. Note that two connecting links are used on the top of the PCB and that, on the underside of the board, insulated wire links are made from pin 1 of IC3 to pins 1-2 of IC5 and from pin 6 of IC3 to pins 9-10 of IC5.

When construction of the PCB is complete, fit it into a suitable case, make the interconnections to all switches/pots/sockets, connect the circuit to a suitable power supply, and test/debug the circuit as follows.

Testing

Turn SW2 to the INT CLK position, monitor SK2 on channel 1 of a two-channel 'scope and switch SW7 on. If the clock generator circuitry is operating correctly, a rectangular clock signal should be visible on the 'scope and should be variable over the 0.5 Hz to 500 kHz range using RV1 and SW1. If a clock signal is not visible, check through the SW2-IC6 and IC1 circuitry to find the error. If all is well, turn SW2 to the GATED CLK position and check that the generator

PARTS LIST

Resistors all ¼W 5%

R1	22k
R2	10M
R3	1k0
R4	4k7
R5,7,10, 11,12	47R
R6,8	1k5
R9	10k

Potentiometers

RV1	22k logarithmic
RV2,3	22k linear
RV4	2M2 logarithmic

Capacitors

C1,8,14,16	1u0 polycarbonate
C2,6,12,17	10n polyester
C3,18	47p ceramic
C4,10	82p ceramic
C5,11	1n0 polycarbonate
C7,13,19,20	100n polyester
C9,15	10u 16 V tantalum
C21	1000u 10 V axial electrolytic

Semiconductors

IC1,4	CD4046B
IC2,3	74121
IC5	7408
IC6	7414
Q1	2N4123
D1,2	1N4148

Miscellaneous

SW1,3,5	1 pole rotary switch
SW2	2 pole changeover (4 off interlocking pushbutton type)
SW4	SPDT miniature toggle
SW6	3 position slide switch
SW7	SPDT slide switch
SK1,2,3, 4,5,6	BNC 50R sockets

7 knobs, Case

can be gated on and off by SK1 signals. Finally, check that external clock signals (from SK1) are available at SK2 when SW2 is turned to the EXT CLK + or – positions.

Now, with SK2 still connected to channel 1 of the 'scope and with SW2 in the INT CLK position, monitor SK3 on channel 2 of the 'scope. With the 'scope synchronised to channel 1, check that a delay pulse is synchronously generated at SK3 and is fully variable by RV2 and SW3.

Next, monitor SK5 output on channel 2 of the 'scope, turn SW4 to the DELAY OFF position and check that a width pulse is synchronously generated at SK5 and is fully variable by RV3 and SW5. If all is well, turn SW4 to the DELAY ON position and check that the width pulse can be delayed relative to the clock using the RV2-SW3 delay controls. Check that an inverted version of the output pulse is available at SK6.

Finally, check that a tone burst pulse-controlled signal is available at SK4 and that the tone frequency is fully variable by the RV4-SW6 tone controls.

When making the above functional tests, note that the pulse period (or the sum of the pulse periods in the delay mode) must always be less than the period of the clock signal and that the period of the tone signal must be less than that of the width pulse.

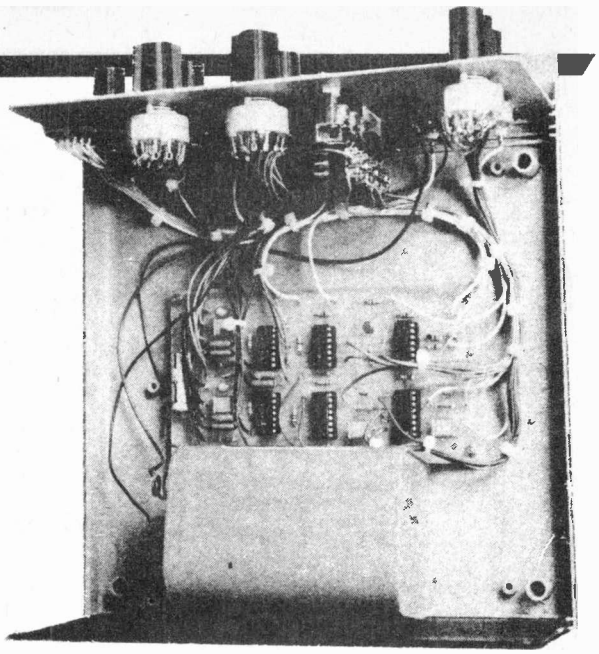


Fig. 3 Pulse timing diagram.

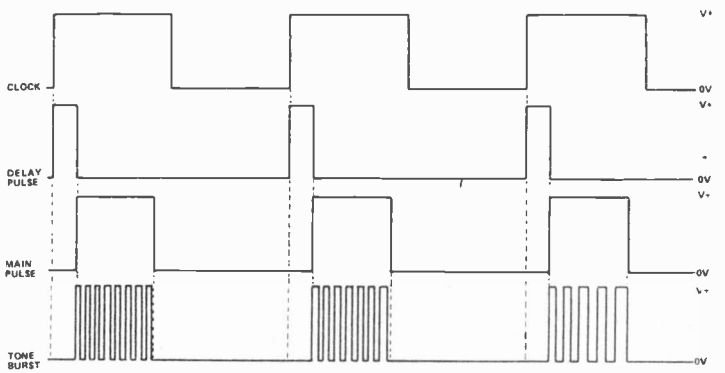
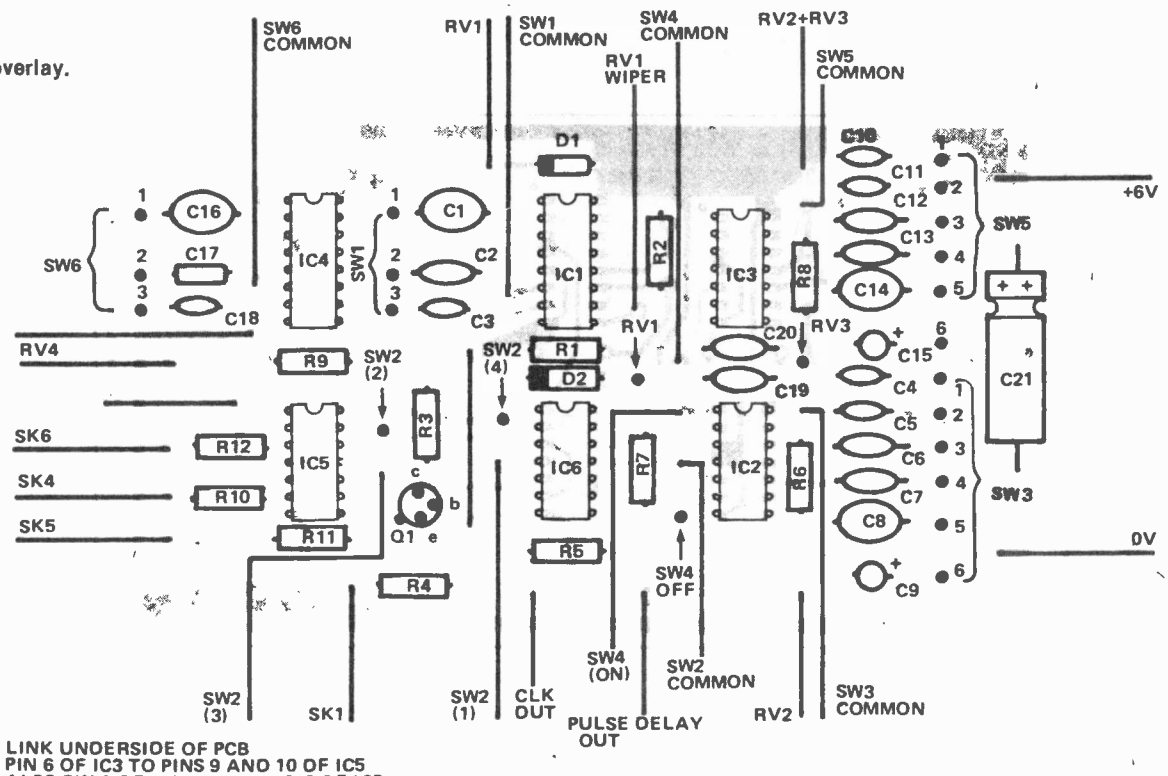


Fig. 1 Component overlay.



LINK UNDERSIDE OF PCB
PIN 6 OF IC3 TO PINS 9 AND 10 OF IC5
ALSO PIN 1 OF IC3 TO PINS 1 & 2 OF IC5

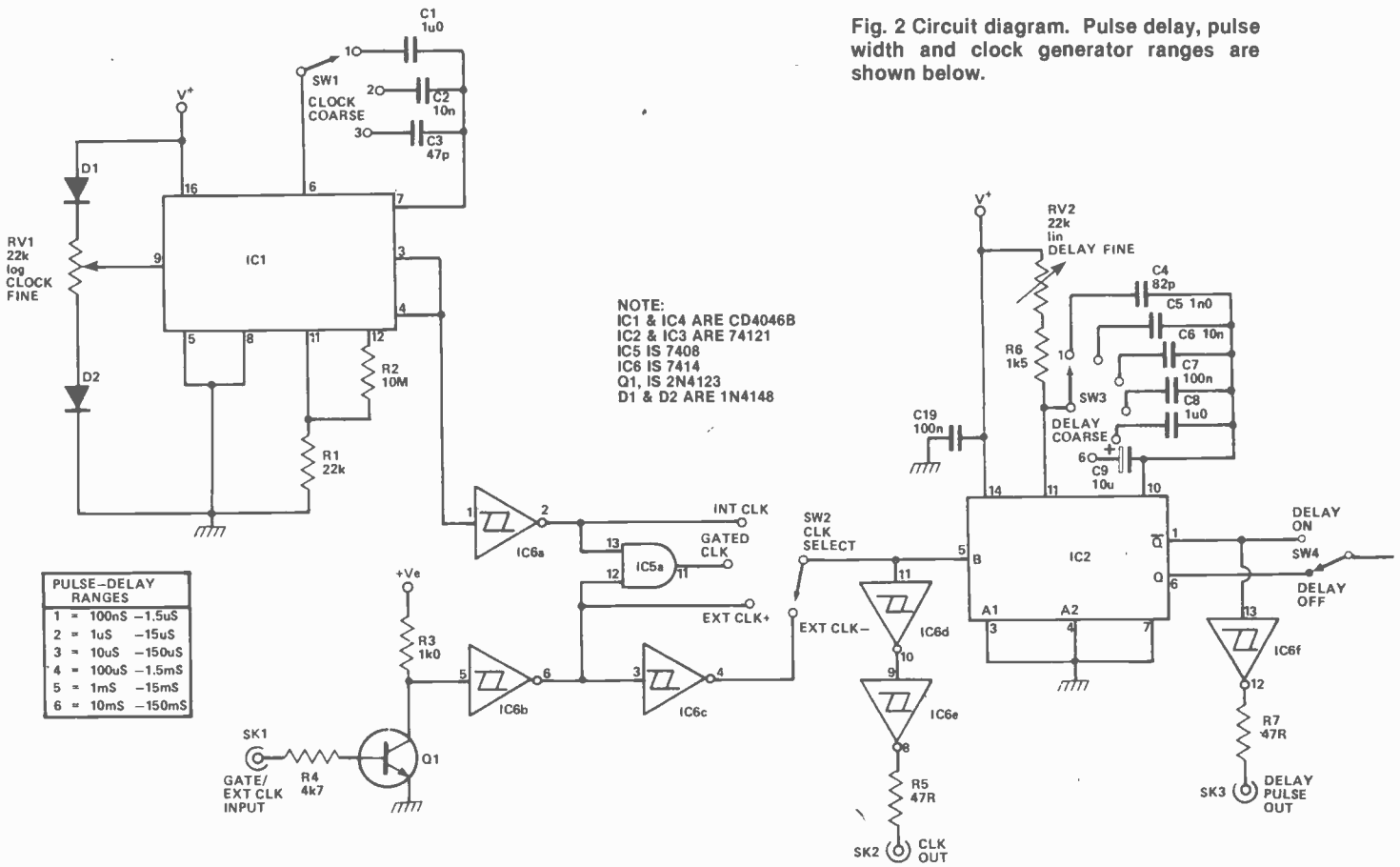


Fig. 2 Circuit diagram. Pulse delay, pulse width and clock generator ranges are shown below.

HOW IT WORKS

The circuit comprises a clock generator (IC1), two pulse generators or monostables (IC2 and IC3), one gated tone generator (IC4) and a few gates and inverters. The most fundamental elements of the project are the two pulse generators, which are designed around 74121 TTL monostable ICs. In our particular application, these monos are triggered by the positive transition of a clock signal applied to pin 5 and then generate an output pulse with a duration determined by the R-C timing components connected to pins 10 and 11.

Note that these monostables generate a positive output pulse at pin 6 and an inverted or negative pulse at pin 1. Thus, if IC3 is triggered by pin 6 of IC2, both monos will effectively trigger at the same time (effective parallel clocking) and the IC3 pulse will not be delayed relative to the main clock signal. If IC3 is triggered by pin 1 of IC2, on the other hand, the IC3 pulse will be delayed relative to the main clock signal. In practice, both the delay and the main pulse widths are fully variable over the range 100 nS to 150 nS by independent controls.

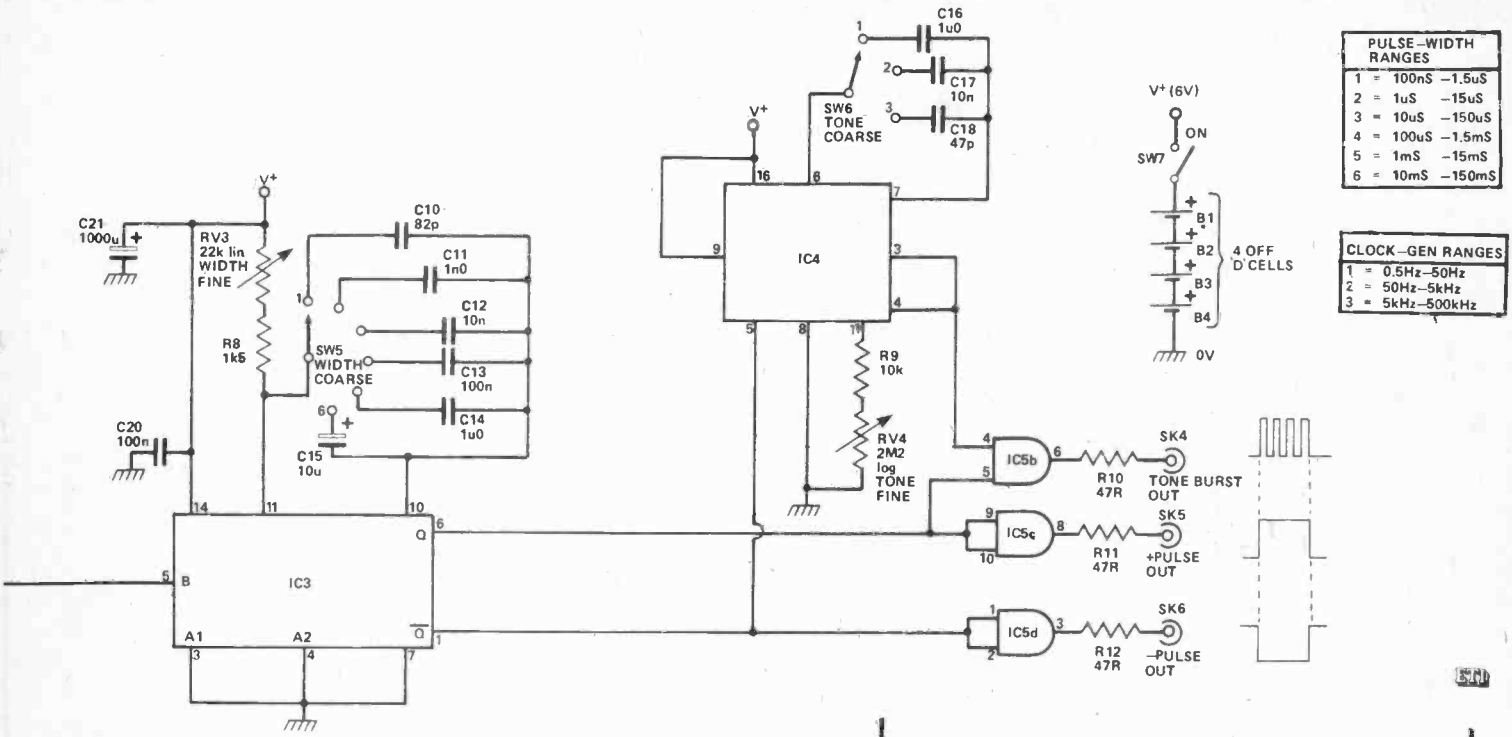
The pulse generators can be clocked by an internal clock generator (IC1) or by external clock signals. The internal clock generator is designed around the VCO section of a 4046B phase-locked loop and can span the range 0.5 Hz to 500 kHz in three switch-selected overlapping bands. Each band spans a range of roughly 200:1 controlled by RV1. The output of this generator is buffered by IC6a (a TTL Schmitt inverter) and can be used to clock the pulse generators either directly or by AND gate IC5a. In the latter case, the gate signal must be gated on by an external signal applied to socket SK1.

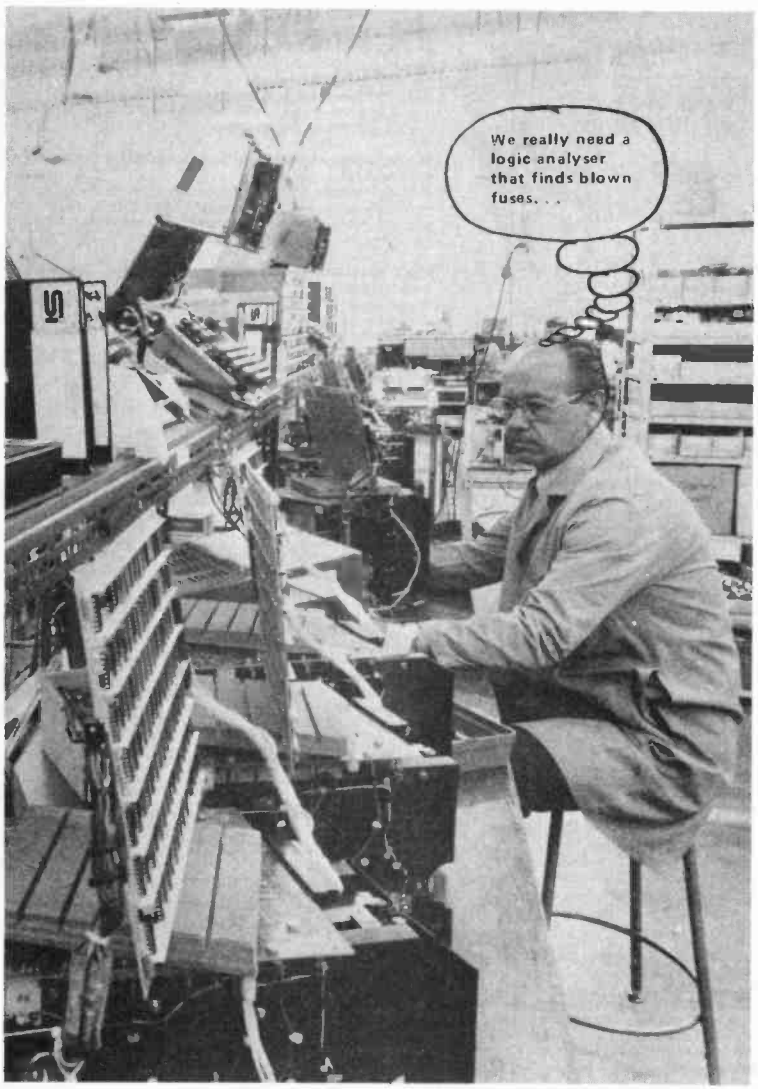
External gate or clock signals can be applied to SK1. These signals are amplified and inverted by Q1 and re-inverted and cleaned up by IC6b. The resulting signals can be used either to gate the internally-generated clock signals via IC5a or to directly clock the pulse generators via SW2. In the latter case, the pulses are generated in phase with the external clock signals when SW2 is in the EXT CLK + position, or in antiphase in the EXT CLK − position. The final clock signals to IC2 are double-inverted by IC6d-IC6e and made externally available at SK2.

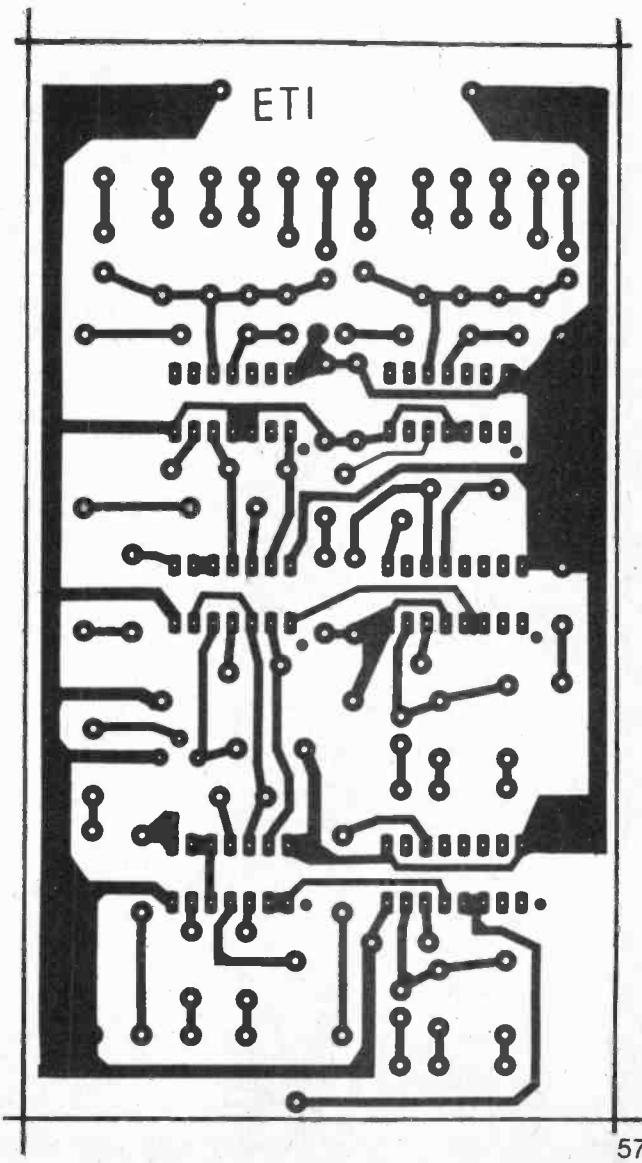
The pulse output of the IC2 delay circuit is buffered and made externally available at SK3 by IC6f. Simultaneously, the direct and inverted main-pulse outputs of IC3 are made available at sockets SK5 and SK6 respectively by buffer stages IC5c and IC5d. A tone burst signal is also available at SK4 and is generated as follows.

IC4 is a wide-range square-wave generator designed around the VCO section of a 4046B CMOS IC. This generator can span the range 1 Hz to 1MHz in three switch-selected overlapping ranges, with each range spanning a 200:1 band controlled by RV4. The output of this oscillator is fed to one input of AND gate IC5b and the positive pulse output of IC3 is fed to the other input of the AND gate. IC4 is enabled only when pin 5 is pulled low. In our circuit, pin 5 is coupled directly to the inverted pulse output of IC3. consequenctly, the IC4 signals and have a burst duration equal to the pulse width of IC3.

The complete pulse generator project consumes a mean current of about 40 mA and can be powered from a 6 V battery pack or from an external 5 V regulated supply.


C16
1u0
C17
10n
C18
47p
SW6
TONE
COARSE
V+
IC4
R9
10k
RV4
2M2
log
TONE
FINE
V+ (6V)
ON
SW7
B1
B2
B3
B4
4 OFF
'D' CELLS
0V
PULSE–WIDTH RANGES
1 = 100nS –1.5uS
2 = 1uS –15uS
3 = 10uS –150uS
4 = 100uS –1.5mS
5 = 1mS –15mS
6 = 10mS –150mS
CLOCK–GEN RANGES
1 = 0.5Hz–50Hz
2 = 50Hz–5kHz
3 = 5kHz–500kHz
C21
1000u
RV3
22k lin
WIDTH
FINE
R8
1k5
C10
82p
C11
1n0
C12
10n
C13
100n
C14
1u0
SW5
WIDTH
COARSE
C15
10u
C20
100n
IC3
A1
A2
B
Q
IC5b
IC5c
IC5d
R10
47R
R11
47R
R12
47R
SK4
TONE BURST
OUT
SK5
+PULSE
OUT
SK6
–PULSE
OUT


We really need a logic analyser that finds blown fuses. . .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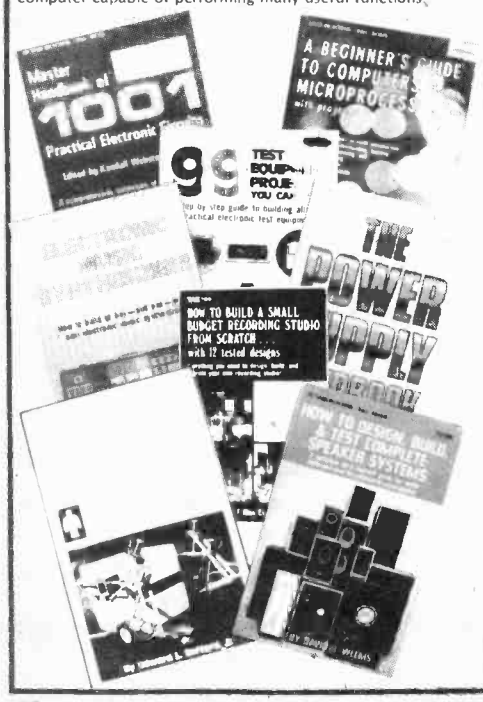

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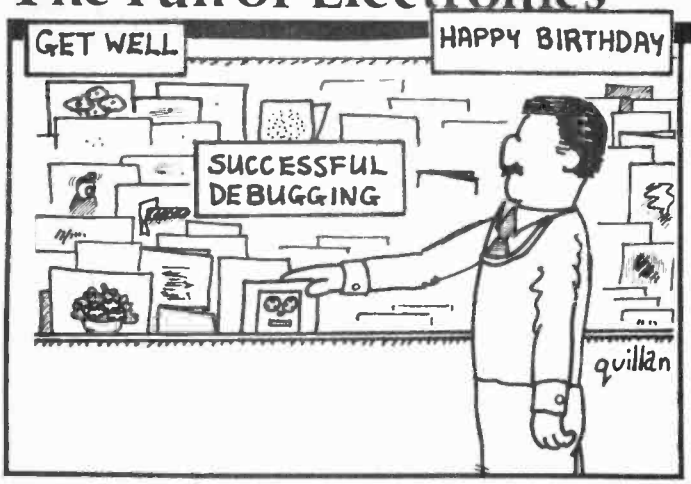
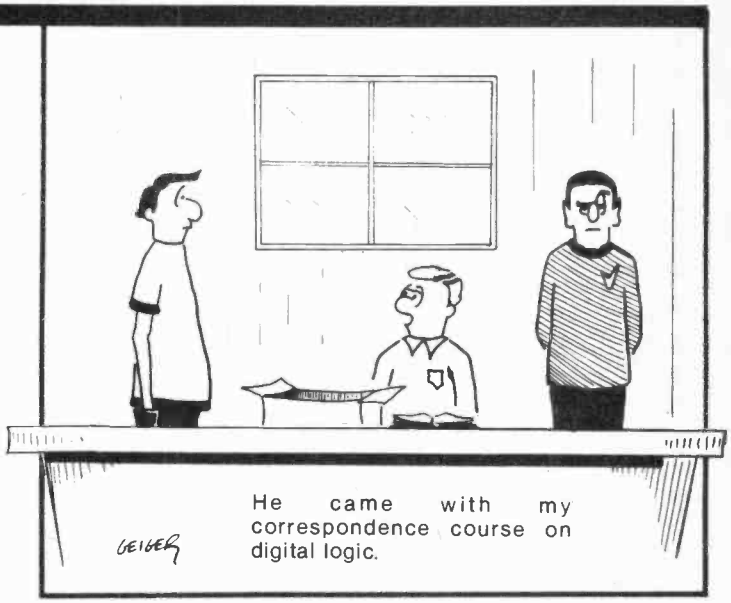
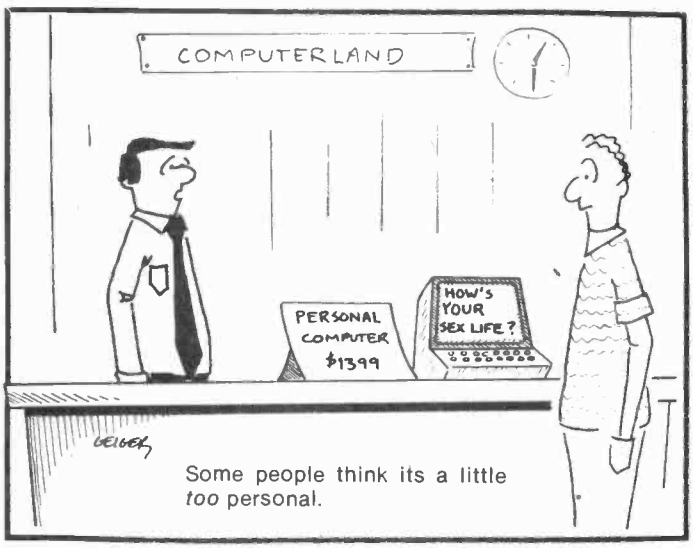
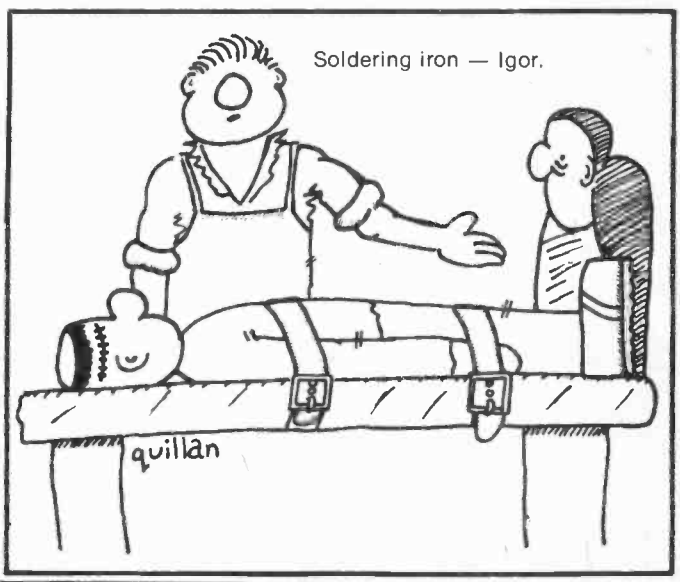
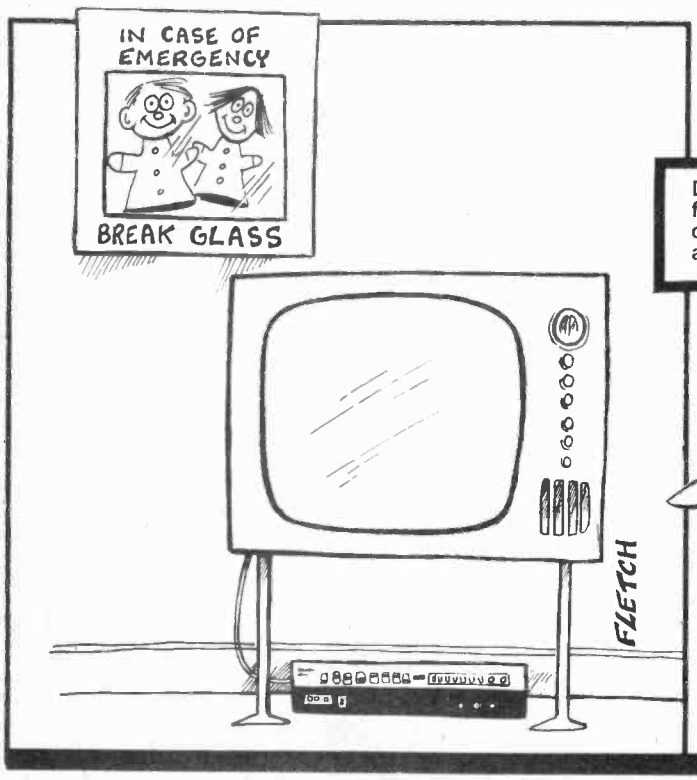
The Fun of Electronics

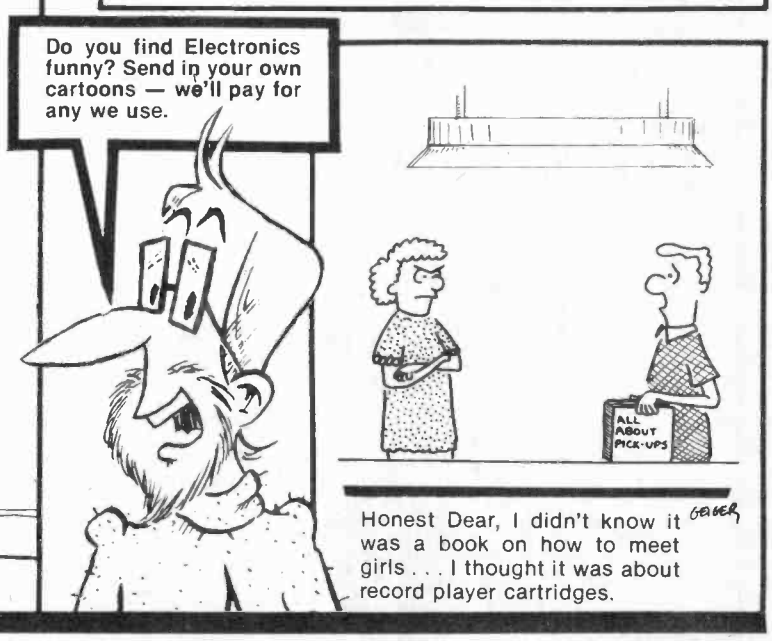








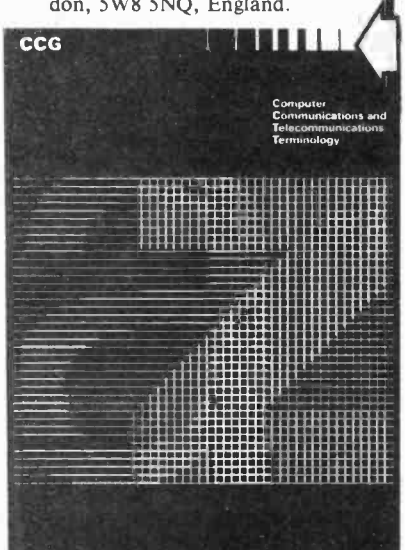




Over 700 ships throughout the world are now fitted with earth stations enabling them to send and receive calls by satellite. By the time INMARSAT takes over from the MARISAT system on February 1, 1982, the number of ship earth stations in use is expected to be nearly 1,000. Technical arangements agreed by the INMARSAT Council and Comsat general will ensure that the transition from MARISAT to INMARSAT is accomplished without interruption to service to users and with minimum inconvenience to ship earth station manufacturers.

In addition to telephone, telex, facsimile and low-speed data, the INMARSAT Council has agreed specifications for high-speed data to be available from the outset of the INMARSAT system. The specifications agreed, affecting coast and earth stations, will ensure that ships using MARISAT high-speed data services will be able to transfer to the INMARSAT system without interruption. The high-speed data facilities are expected to be particularly valuable to the oil exploration industry.

International Maritime Satellite Organization, Maket Towers, 1 Nine Elms Lane, London, 5W8 5NQ, England.



New Wurdz

A "public dial port" isn't a telephone booth, "operating time" doesn't have anything to do with surgery, and "password" isn't just a game, according to CCG's new glossary of computer communications and telecommunications terminology.

First published in 1977, the new edition contains definitions of almost 900 words used on a daily basis in computer communications and telecommunications. The 36-page booklet defines commonly used terms and acronyms at a semi-technical level, providing thumbnail definitions rather than exhaustive technical ones.

The glossary arose out of the recognized need by CCG for a comprehensive reference book of computer communications terminology. The definitions are a product of a number of sources: the knowledge and expertise of CCG, definitions developed by the International Telegraph and Telephone Consultative Committee (CCITT), the International Standards Organization (ISO), and consultation with recognized experts in the field.

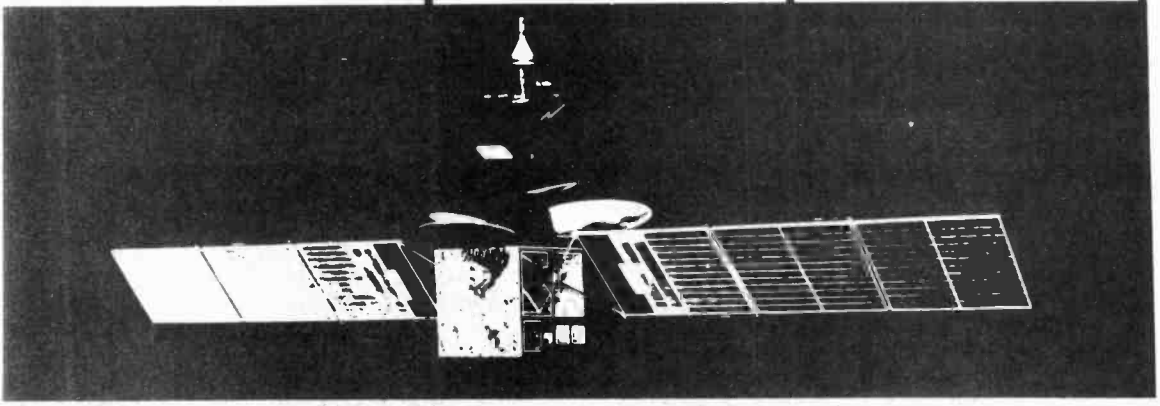
For further information, please contact: Denise Sarazin, CCG Public Relations. (613)567-378.

Know What You're Doing

The Superior Institute of Electronics, a division of the International School of Electronics, offers a broad range of studies in general electronics, medical electronics, Audio-Visual areas, computer programming, systems analysis, word processing and keypunching. The school has two campuses, in Montreal and Ottawa.

If you live in Burnaby or Manatouage, you may be thinking that the commute out to the institute might be a bit much. Actually, they'd probably agree with you. Thus, it's now possible to get many of the courses offered at the school on video tape, to be played in the comfort of your own home, tent, packing crate, or wherever you kep your set. These tapes offer complete courses in the programs offered by the institute, just as if you were actually in class. In fact, there are advantages to learning by video tape; if you don't understand something, you can rewind the tape and have another go at it.

The courses are complete, with all instruments and other materials required, and are available in English and French. For more information, contact the Superior Institute of Electronics, 1435 Bleury, Suite 501, Montreal, Quebec, H3A 2H7.



300 Watt Heatsinks

The cover feature of our August 1980 issue was a glorious 300 watt amplifier, capable of entirely decimating not only your immediate neighbours, but several houses down the street in either direction. Suitable for either stereo or musical instrument use, a sustained low organ note through it at full power was capable of knocking small animals off their feet at distances of up to one hundred yards with only moderately efficient speakers. It has numbered among our most popular projects to date.

The only difficulty experienced by some readers in building the amp was in making the huge, multi-finned heatsink for the output transistors. The metalwork, while not complex, still called for a bit more than can be done with a mini-hack and the hammer from a Sears all purpose tool kit. Fortunately, it is now possible to get the thing, all pre-bent and ready to go, with the PCB, for about twenty dollars.

For a limited time only (until the Earth runs out of aluminum), Dacor Limited will be offering the heatsink kit and printed circuit board together for $19.95. The heat sink only requires a few holes to be drilled in order to assemble it.

Yes, it's time to stop trying to flatten out those old beer cans. Dacor Limited, P.O. Box 683, Station Q, Toronto, Ontario, M4T 2N5.

Atlas Electronics

In our May 1981 issue on page 83 the prices shown on the B & K Precision Dynascan Corporation advertisement were incorrect. The price for the 2830 should read $374.85 and for 2810, $225.85.

Atlas Electronics Limited, 50 Wingold Ave, Toronto, Ontario M6B 1P7.

Note to Subscribers

ETI was affected by the Canadian Mail Strike like all magazines; we were lucky in some ways however, our record of issue dispatch was:

July issue was mailed 10 days *before* the start of the strike. We know from contacts with readers that very few were not delivered before the strike (we had queries from three readers who had not got theirs).

August was published as usual. Newsstands and component stores received copies on time but this could not be mailed to subscribers until August 12th.

Our September issue was mailed a few days later. We're sorry readers were inconvenienced but of course we couldn't do anything about it. ETI's policy during mail interruptions is to continue publishing — we did not skip an issue, nor do we ever plan to.

AUDIO TODAY

Wally Parsons

SEVERAL MONTHS ago I ran a letter from a reader who asserted, among other things, that each component in a system should be designed by the same man. That way, he could be certain that input/output impedances would come out right, as well as sensitivities, slew rates and all the other factors which affect the compatibility of components. I didn't think much of that argument at the time, and said as much, and I still don't think much of it. However, this idea does seem to be rather common, and certainly has contributed to the popularity of the component package approach currently in vogue among the major manufacturers. In all fairness, there is some advantage to purchasing a system this way, especially for the novice. It certainly ensures that all units are mutually compatible, thus eliminating this problem for the buyer, and generally ensures aesthetic co-ordination.

Anyone who believes that such a system has been designed entirely by one man is undoubtedly travelling with a light load tenuously held together by cobwebs. Modern R & D methods in large corporations emphasize design by teams, and different teams are likely to work on each product, with yet another team co-ordinating their efforts.

In any case, we have been talking about fairly standardized parameters, with which any engineer is competent to deal, and to suggest otherwise is absurd.

Interconnects

Barring gross mismatches in quality, most compatibility problems relate to interface. The most common interfaces are those between amplifier/speaker, preamp/amplifier, preamp/tuner, and pickup/preamp. In addition tape recorders must interface their inputs and outputs with programme sources and with preamps.

Examining each in order, let's consider first the speaker/amplifier interface. At first glance, this would appear to be a fairly straightforward matter. As long as the speaker impedance is the same as the rated load of the amplifier, and as long as the amplifier has sufficient power to drive the speaker to its maximum desired acoustic output level all should be well. One of the assumptions widely accepted holds that, since modern amplifiers are designed with low output resistance, the impedance characteric of the loudspeaker is of no significance.

This assumption fails to consider the significance of the method by which a low impedance is achieved, its effect on amplifier performance and on loudspeaker damping.

The power delivered to the loudspeaker loads comes from the power supply and is controlled by the output transistors in series with the load. The total source resistance is the series sum of the output transistors and the power supply. The maximum current available for the load is mostly a function of the source resistance in series with the load. If the source resistance is high, load variations will have little effect. But the voltage at the load terminals will vary considerably with load impedance variations.

The significance of these factors will depend very much on the design of the output stage and the power supply, with the result that some amplifiers may suffer severe loss of maximum output capabilities with load impedance variations while others will not, even though they exhibit identical performance under identical resistive loads.

Feedback

With few exceptions, the majority of modern amplifiers use negative feedback from the output stage. Many use large amounts of feedback, in an attempt to achieve ultra low distortion specifications. One of the effects attributed to negative voltage feedback is the reduction of output resistance. While the amplifier may behave *as if* it possessed low output resistance, in reality the output resistance has not changed. What has actually happened is that the gain has changed as a result of a change in feedback voltage due to some change in that part of the amplifier within the loop. Since the load is in series with the output resistance, they form a voltage divider. The load is thus part of the feedback loop, and any change in its impedance will change the ratio of output resistance/load impedance and thus the amount of feedback voltage, hence the feedback factor and loop gain.

If the output stage has a high inherent resistance this variation can be quite substantial. Moreover, if the speaker exhibits a high impedance peak at resonance it will also contain a substantial reactive component on either side, a condition which will also exist with any impedance variation due to cross-over design.

If such a speaker were driven by such an amplifier, and that amplifier had very large amounts of feedback, it wouldn't take much to push such an amplifier close to its stability margin, or set up conditions which bring about slewing induced distortion. If, in addition, we try to operate such an amplifier near its maximum output, but its maximum output has been reduced due to load characteristics, the results can be quite discordant.

This helps to explain the fact that a very modest, simply designed speaker will often outperform more elaborate, costlier units with some amplifiers.

Compounding the Problem

If you think that's complicated, consider the effect of connecting two feedback amplifiers in cascade, as when a power amplifier is driven by a feedback preamp.

Bi-polar transistors suffer from poor output isolation. Thus, a signal applied to the base of a device not only appears at the collector and emit-

ter, but a signal applied to the emitter also appears at the base. Thus, whether a feedback signal is applied to the emitter or the base of an input stage, or to the emitter via the second side of a differential stage, it will also appear at the output of a preamp which may be connected to it. If that is also the take-off point for a feedback loop around part of the preamp, then the feedback signal of the power amp will also appear in the preamp. Since this signal is affected by the speaker characteristics, it's quite possible for the speaker to be incompatible even with the preamp, even though they have no apparent connection.

Those of you who enjoy such diversions may wish to spend your spare time tracing such interrelations through all the possible inter-connects in an elaborate system. Generally speaking you are not likely to come up with the dog's breakfast of inter-actions implied by the foregoing if only because such extreme cases of pushing the limits for specmanship purposes seldom go that far. But it does demonstrate that matching involves more than impedance and level.

Of greater concern is the difficulty in finding useful information on products. Too many of today's manufacturers act as if they had just discovered some hitherto unknown law of nature every time they come up with some small refinement on a standard circuit. Consequently, one practically requires a security clearance before being permitted to know anything about what's between the front panel and the rear apron. And then it costs a small fortune to obtain a service manual for a product for which you may have shelled out a three figure cheque with a second mortgage on the children and the family dog.

Equipment reviewers are seldom in a better position. Consequently, the equipment is treated as a two-port black box which might as well have phlogiston between the input and output terminals.

But enough for now. In later months we shall delve further into this business, and see what educated guesses can be made by reading between the lines of published specifications.

A small error crept into Wally's August '81 column. The copy at the bottom of the second column on page 60 says "... using X as the value for L." It should read"... using infinity as the value for L."

AUDIO TODAY PRODUCTS

Avalon Audio Ltd. is not the name of a product, but a source of all kinds of goodies related to audio. Originally formed as a division of Ring Sound, a high end Toronto Audio Dealer, they started by importing Audax drivers (see their advertisements elsewhere in ETI) and expanded into other areas. The lines handled include several loudspeaker kits, connector panels, wool (long fibre type) acoustic felting, and vibration absorbing panels. Other products include Crimson Elektrik amplifier modules, electronic crossovers and power supplies, Falcon crossovers, low loss capacitors and coils for crossovers.

All this plus the Dutch manufactured Audiostatic ES240 electrostatic speaker panels. They look like four foot high screens, and sounded quite impressive, at least on a brief audition.

The speaker may be Dutch but the only substantial literature is in French, probably the result of something Trudeau said to Queen Juliana. Perhaps if he can take time off from solving the rest of the world's problems he'll also give us a translation.

Otherwise, I'll have to have a chat with Gary Nicholson of Avalon.

Or you can do that by writing Avalon Audio, 571 Queen St W. Toronto, Ont, M5V 2B6, phone 1-416-861-1031.

Any other dealers out there specializing in audio parts should drop me a line, some product brochures, etc. Henceforth, such dealers shall be described in these pages along with audio products. But I have to know you're out there, and that means you must tell me.

PSB Project B2 Speaker

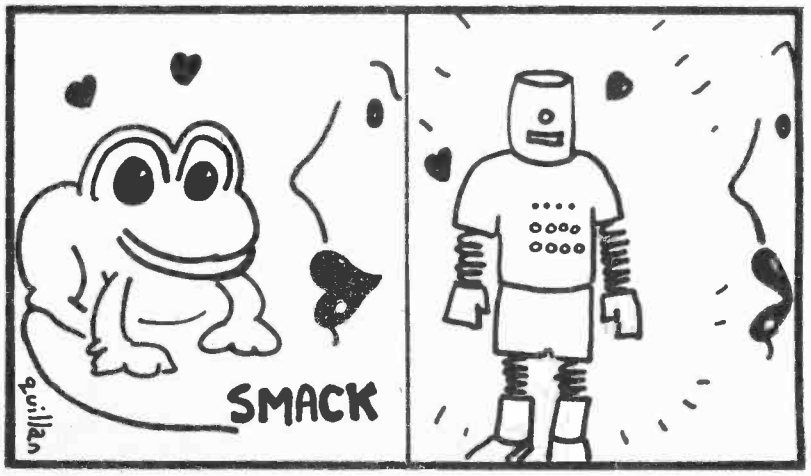
Back in May of this year I received a letter from Paul Barton announcing a new speaker said to act as a linear point source, and having no influence of its own, converting one form of energy precisely to another. It was described as being *sonically aerodynamic,* whatever that is.

Anyway, I did get a chance to see and hear this speaker briefly at the July audio trade show, and it turns out to be a two way system designed for conventional placement, although it looks more like a corner system. No information is given as to the woofer's operating principle, although the tower-like structure has a port in the rear section and could be either a bass reflex or a tuned pipe. Claimed anechoic response is from 80 Hz to 20 kHz, extending down to 28 Hz in a "typical" home listening room.

It sounded like a well designed, well balanced system, with a smooth top end, thanks to the ferrofluid damped tweeter retained from last year's metronome speaker, and a well defined, if not too solid, bottom end.

Frankly, I rather wish they had kept the metronomes, and developed them into three-way systems. Both seemed to have that peculiar "pinched" quality which results from pushing the woofer too high (2200Hz, in this case), but this is, after all, a first impression.

Contact PSB Speakers, Inc., 480 Dutton Dr., Waterloo Ont., N2L 4C6. or phone 1-519-884-5440.



CLASSIFIED ADVERTISING

ETI's classified advertising section allows you to reach 30,000 Canadian readers nation-wide for 75¢ per word. For as little as $15 per insertion (there's a 20 word minimum) you can promote your business from coast-to-coast.

WHAT DO YOU DO?
Send us your typewritten or clearly printed words, your permanent address and telephone number, and your money (no cash please). Make your cheque or money order payable to 'ETI Magazine'. We're at Unit 6, 25 Overlea Blvd., Toronto, Ontario. M4H 1B1.

WHAT DO WE DO?
We typeset your words (and put the first word and your company name in **BOLD** capital letters). If we get your message by the 14th of the month, it will appear in ETI 1½ months later. For example if we receive it by October 14th you (and thousands more) will see it in the December issue.

FOR sale, new and used video & pinball game printed circuit boards (large scale integration) from $20-$200. Boards & parts are readily adaptable for other applications. Schematics available. Call Dorian of **NEW-WAY SALES** 416-746-2255.

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WE do printed circuit boards - single sided, double side, through holes and masked. For a quotation, artwork or negative required. For any information call or write to: **BEYER & MARTIN ELECTRONICS LTD.,** 2 Jody Ave., Downsview, Ontario. M3N 1H1 Tel: (416) 743-3010.

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WE are clearing some of our rental inventory. Here is your chance to pick up excellent terminals at a super price. All units have been maintained by Lanpar and are warranted for 3 months.
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ETI August 1980 — "BRUTE" 300 W Amp — Special Heatsink & PCB Package $19.95. Ask your favourite local dealer about it. **DACOR LIMITED,** P.O. Box 683, Station Q, Toronto, Canada, M4T 2N5.

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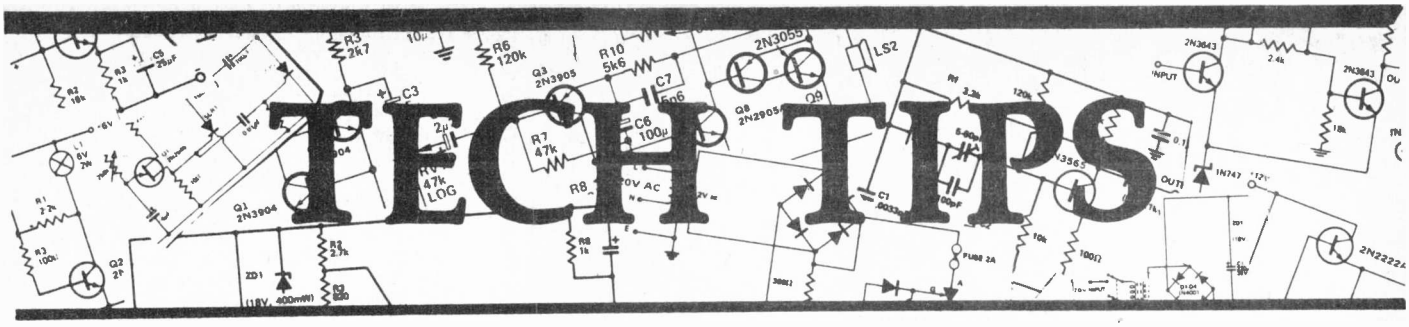
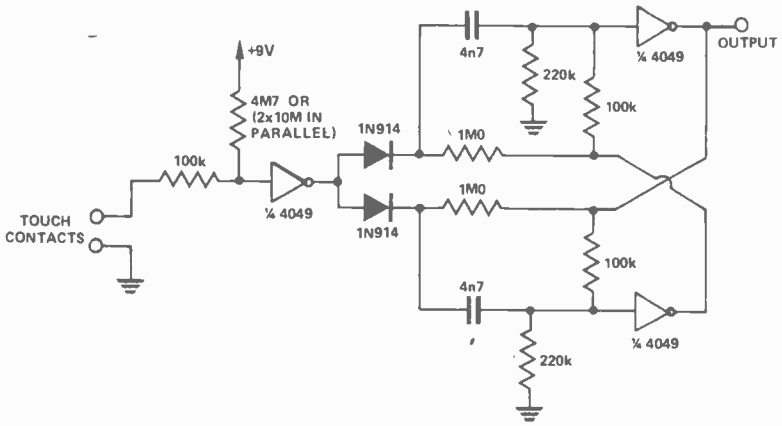


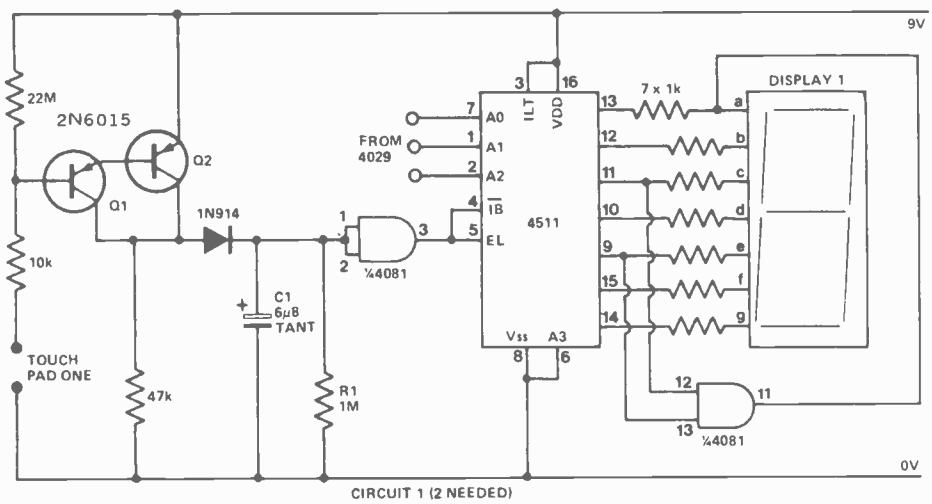
Touch Switch

Paul Tannard

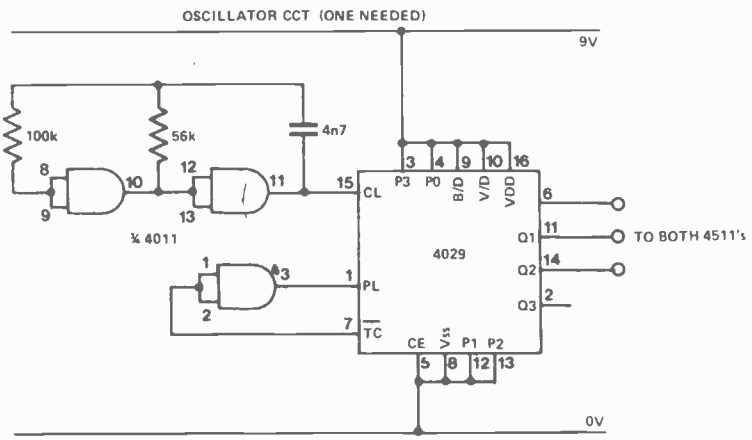


A nice simple little circuit – a touch switch and flip-flop built from one CMOS IC.

The advantage of having a flip-flop on the output of a touch switch is that it then becomes touch-on, touch-off. A further gain is that, if you're inputting single pulses to some sort of counting circuit, it makes a very positive debounce circuit. Remember that if you are using it for this purpose and you wish to hang a LED off the end to show you what's happening at the output, you can drive the LED by using one of the unused gates in the package as a buffer and connecting it to the other output of the flip-flop. That is, unless you want to build two of the switches from one package!



CIRCUIT 1 (2 NEEDED)



Dual Digital Dice

Russel Sharp

Two identical seven-segment display driver circuits, driven from a common counter circuit, provide the numerals for this dice.

The counter is driven from a 2 kHz oscillator, the 4011, and generates a count sequence from 1001 to 1110. The terminal count (low on output 1111) is inverted to load 1001 into the parallel input of the 4029. When your finger is pressed on the touch pad the collectors of Q1 and Q2 go high and pins 4 and 5 on the 4511 are held high for about three seconds after your finger is removed from the touch pad. The delay is provided by C1 and R1, together with the 4081 gate. The high on pin 5 of the 4511 loads the last data present on the address inputs (A0 to A2) into the latch of the 4511, whilst a high on pin 4 releases the display from the 'blank' mode to display the contents of the latch. The number is then displayed. When pin 4 goes low again after three seconds, the display is blanked to conserve battery power.

The high clock frequency ensures that the dice has a random result. Even if you attempt to touch both pads simultaneously, each die shows a different throw.

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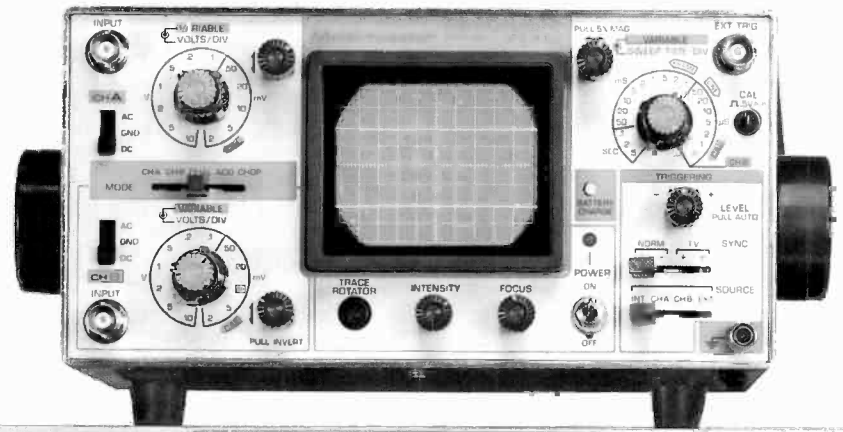

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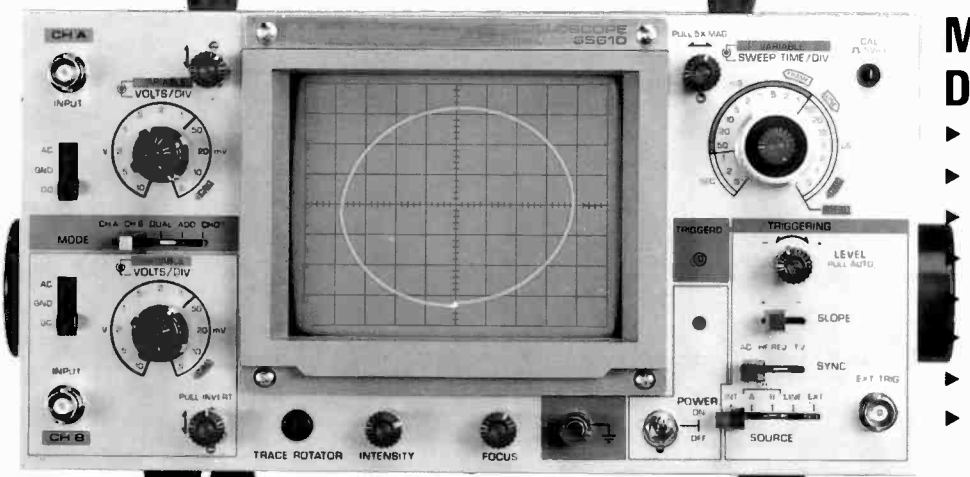
Dual Trace Portable

- 15MHz (-3dB) Bandwidth
- X5 Sweep Magnifier
- Battery, 12VDC & AC Operation
- 2mV Vertical Sensitivity
- Trace Rotator
- Price $775.00 taxes not included



Model 65610
Dual Trace Bench

- 15MHz (-3dB) Bandwidth
- 5″ CRT Display
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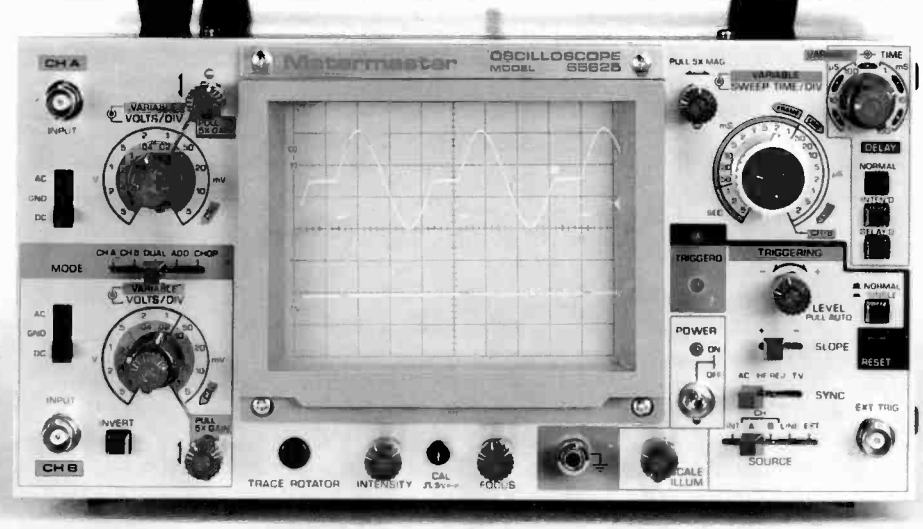

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Circle No. 11 on Reader Service Card.

TV Opto-Islolator

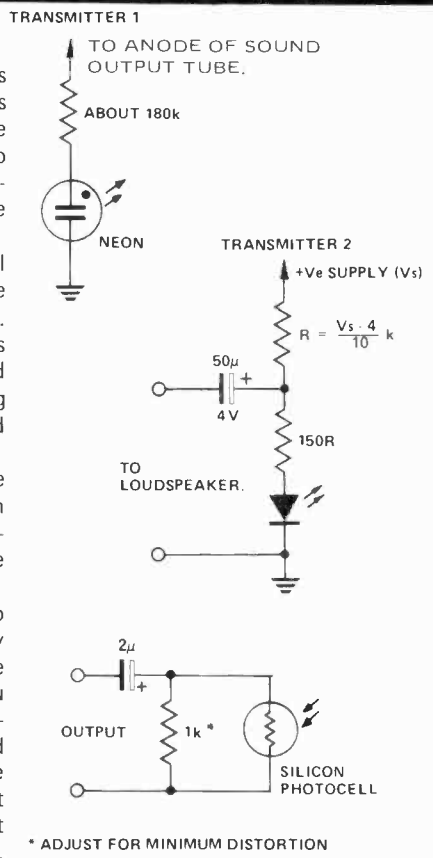
The problem of how to connect a TV's sound to an amplifier or tape recorder is basically one of safety – TV sets use very high voltage. One approach is to pick up the IF from the set, but this requires that you strap a coil onto the back.

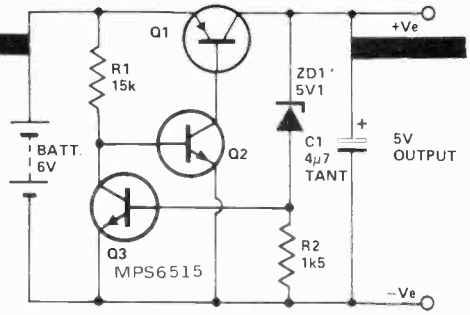
One way of getting an audio signal out without the risk of high voltage outside the set is to use an opto-isolator.

This uses circuitry which converts the audio into a changing light level, and then detects this modulated light using another stage – electrically isolated from the first.

Two types of light modulator are shown here – the one with the neon attaches to the anode of the sound output tube and the other attaches to the loudspeaker terminals of the set.

The photocell has to be very close to the light producing part of te circuitry (it's a good idea to tape the cell to the neon or LED – but be careful that you preserve the electrical isolation) and preserve the electrical isolation) and shielded from outside light sources. The output of the detector is probably best fed to the most sensitive amplifier input you have, as the amplitude will be small.





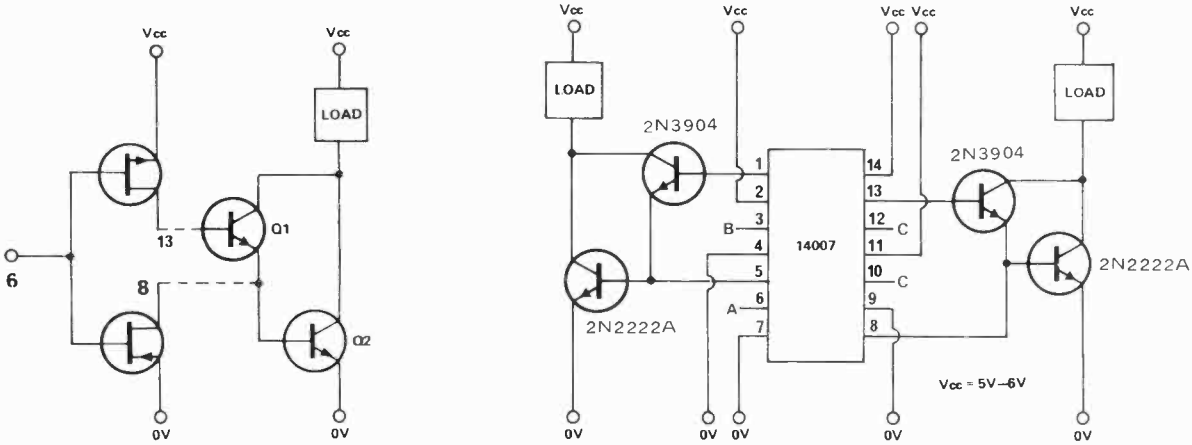
Q1. Any PNP power transistor

Stabiliser For Battery Supplies

The accompanying circuit, is useful when voltage sensitive devices (such as TTL ICs) must be battery operated. It uses very little power from a good battery; whilst with a flat battery, the output voltage is within 0.1V of the battery voltage.

ZD1 should be selected to obtain approximately the desired output voltage; for fine trimming, R2 may be selected between 470 ohms and 3k3. With the components shown, the output voltage varies less than 2% for battery voltages from 5V to 8V and output currents from zero to 200 mA. For higher currents, R1 may need to be decreased.

Always use a power transistor for Q2 or it will overheat when the battery is nearly flat. Both Q1 and Q2 should have a current gain of as least 40, while the gain of Q3 should be as high as possible.



Darlington Drivers

C. J. Ramey

This circuit offers a very efficient way of driving a pair of transistors in Darlington configuration from CMOS. The circuit at right 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 2N2222A will enable loads of up to 3A to be driven at voltages limited only by the Vceo of the transistors.

The circuit at left 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: Vcc should be 5-6 V to prevent excessive current being drawn from the CMOS chip.

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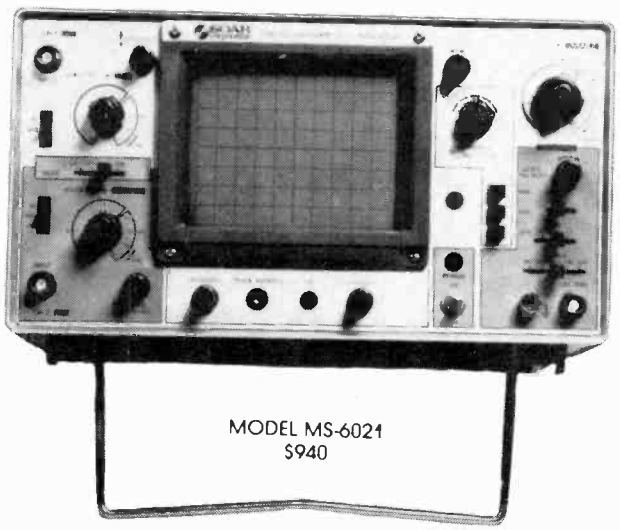

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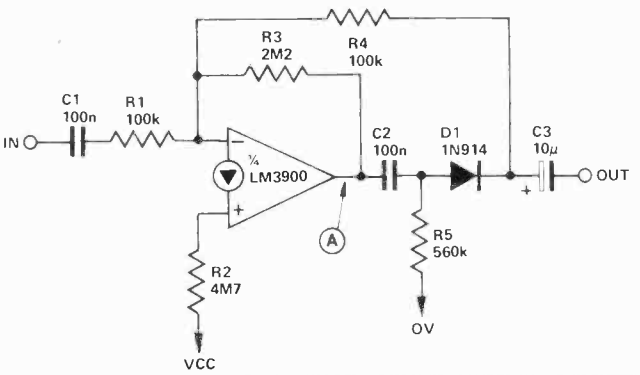
Circle no. 18 on Reader Service Card.

Precision Rectifier

The LM3900 is different from most op-amps in that it is current-differencing and operates from a single supply rail. Standard precision rectifier circuits are not applicable for this device but the circuit shown here works well.

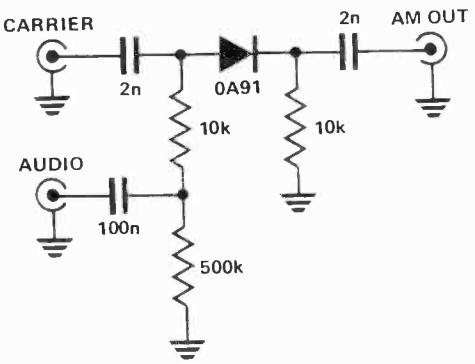
Two feedback paths are provided – R3 for dc stability and R4 for the ac signal after C2 and R5 have filtered out the dc bias. When R2=2 x R3, point A will be at half the supply voltage, allowing the diode to be reversed by the input signal.

For large positive input, input impedance equals R1 and voltage gain is – R4/R1, since R4 is made much smaller than R3, C1 and C3 are dc blocking capacitors and determine the low-frequency roll-off.



All-Round Modulator

G. J. Armitage



A very handy device around any hobbyists workshop or serviceman's bench is a simple modulator. For aligning IF amplifiers, receiver front ends etc – especially with only basic test instruments, it's a must.

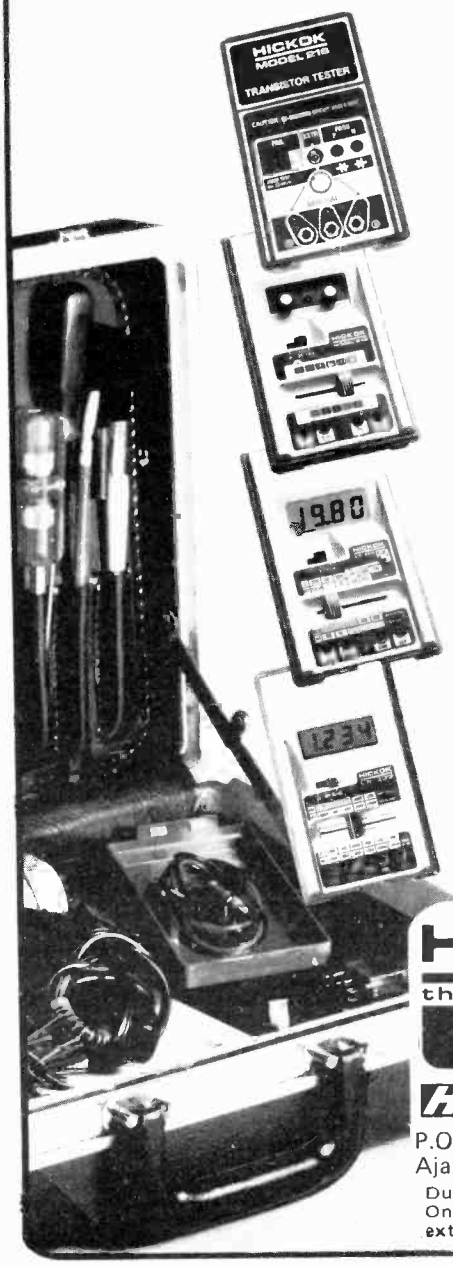
A common signal diode is used as a 'mixer'. You'll need to drive the audio input with more signal than the RF input to get good modulation depth.

The circuit will work across a very wide frequency range, from very low frequencies to well into the VHF region. The diode can be any germanium signal diode, such as 1N34. The RF drive will need to be around several hundred millivolts.

A silicon signal diode, or a hot-carrier, diode may be used, but you'll need around half a volt of RF drive.

The circuit may also be used as a product detector. BFO injection should be fed in the 'Audio' input and the resultant audio taken from the output (add a 'pi' RF filter using two 1n capacitors and a 1mH RF choke).

Your Toolbox Test Bench



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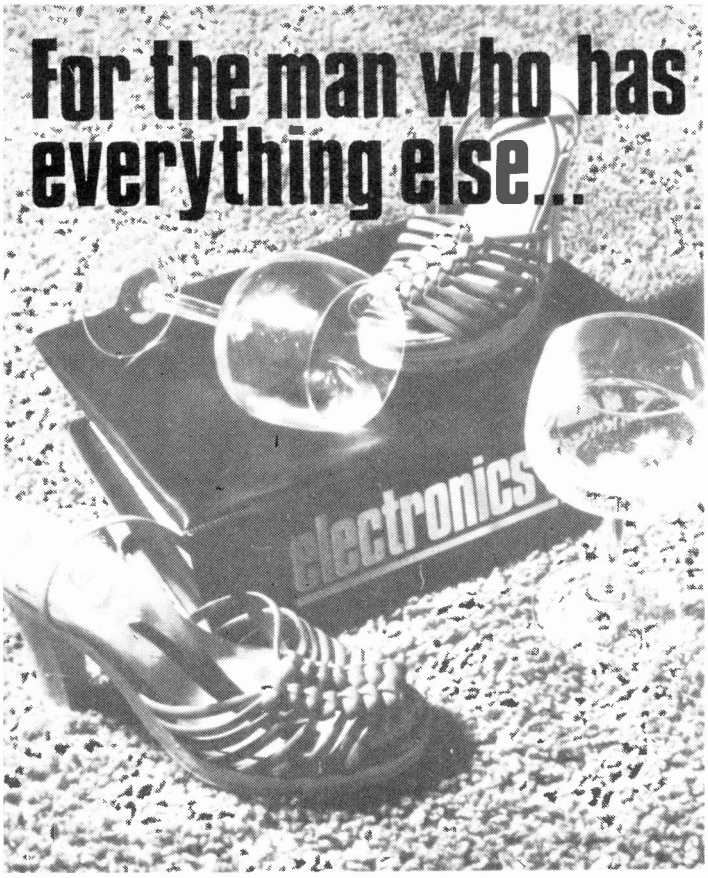

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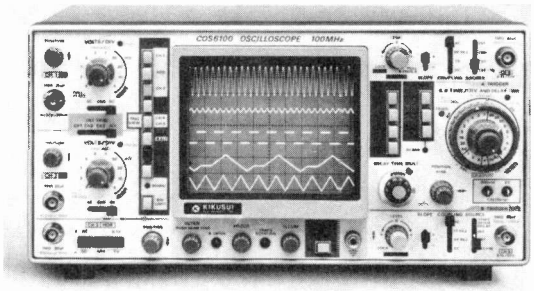

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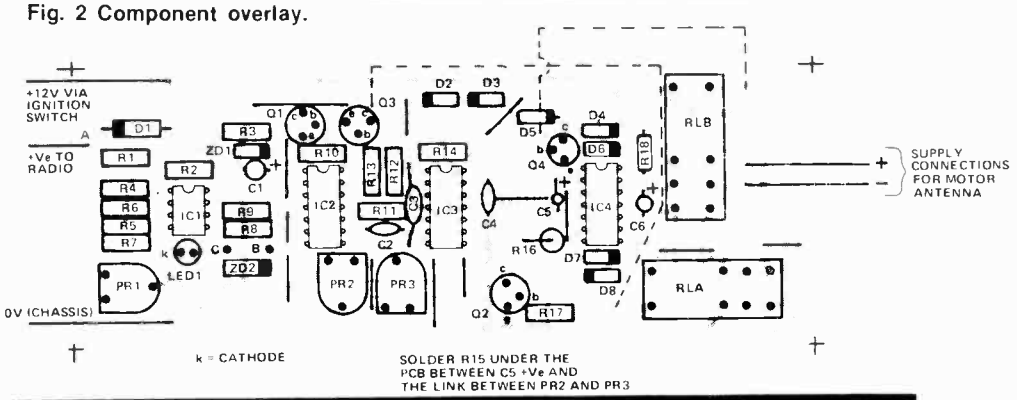
Fig. 2 Component overlay.



5) Diconnect R_{TEST}. PR1 should now be adjusted to the mid-way setting of steps 3 and 4.
6) For a final check, R_{TEST} can be reconnected and LED1 will switch on; if all is well the remaining ICs can now be fitted.

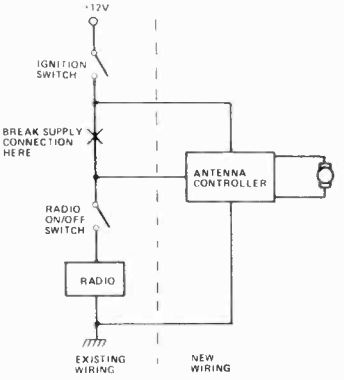


Fig. 3 How to wire up the unit. The radio power supply is taken via the controller board.

PARTS LIST

Resistors (all ¼ W, 5%)

R1	100R
R2	330R
R3	1k0
R4,5,6,7,10	6k8
R8	4k7
R9,11,13 16,17	10k
R12,14,15	100k
R18	1M5

Potentiometers

PR1	2k2 miniature horizontal preset
PR2,3	1M0 miniature horizontal preset

Capacitors

C1	47u 16V tantalum
C2	100n polycarbonate
C3	100n ceramic
C4	10n polycarbonate
C5	4u7 35 V tantalum
C6	3u3 16 V tantalum

Semiconductors

IC1	CA3140
IC2	4066B
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IC4	4001B
Q1-4	2N3904
D1	1N5401
D2-5	1N4001
D6-8	1N4148
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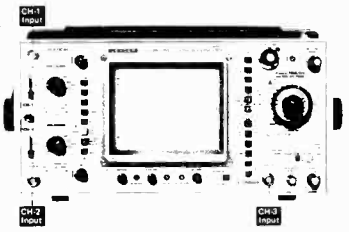

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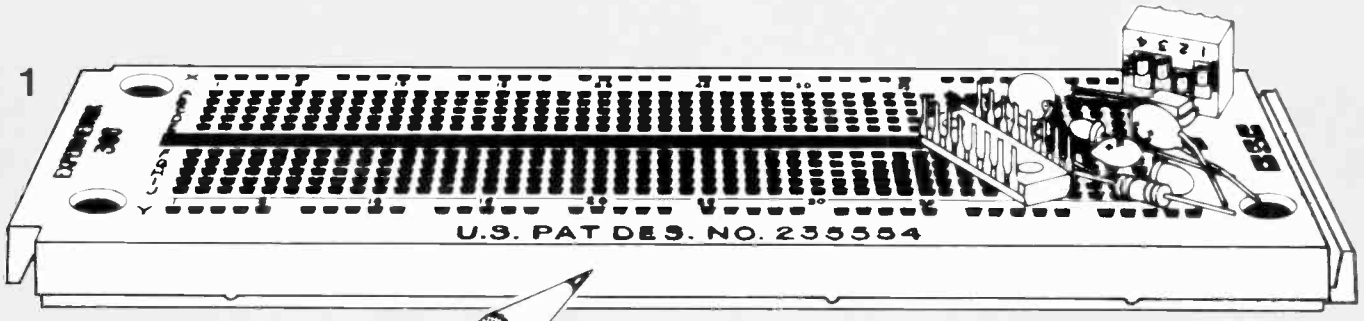
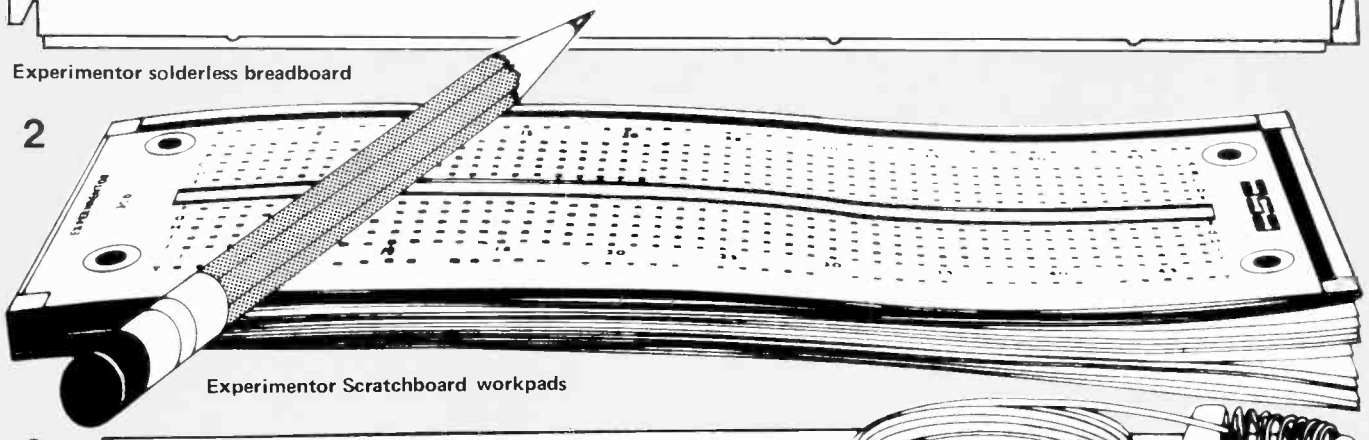


Experimentor solderless breadboard

2



Experimentor Scratchboard workpads

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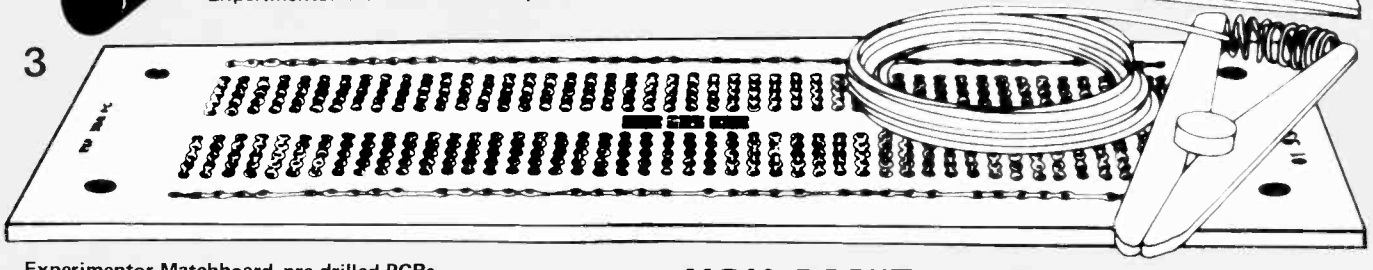

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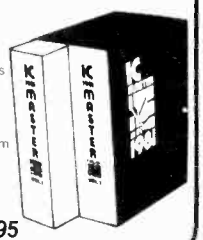

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Microprocessor Real-time Clock/Calendar — 16.84

MICROPROCESSOR CHIP SETS

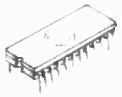
8035 CPU	7.74	6800 CPU	6.05
8039 CPU	10.34	6802 CPU	9.04
8080A CPU	5.14	6808 CPU	8.39
8085 CPU	7.28	6809 CPU	25.94
8155	8.39	6810	3.45
8212	2.15	6820	4.75
8214	4.49	6821	3.45
8216	2.15	6845	22.69
8224	3.84	6850	3.45
8226	2.15	6852	3.45
8228	5.14		
8251	5.72	6502 CPU	9.69
8253	8.65	6504 CPU	9.95
8255	5.72	6505 CPU	9.95
8257	9.04	6520	7.44
8259	9.04	6522	10.34
8279	9.69	6432	14.11
8748	36.40	6551	14.24
8755	36.40		

PROM'S

74S288	2.44	256 bit, 16 PIN
74S188	2.44	256 bit, 16 PIN
93427/82S129	3.58	1K, 16 PIN
93417/82S126	3.58	1K, 16 PIN
93446/7621	6.44	2K, 16 PIN
93436/7620	6.44	2K, 16 PIN
93453/7643	9.04	4K, 18 PIN
93448/7641	10.34	4K, 24 PIN
93451/82S181	23.34	4K, 24 PIN
82S185/7128	23.34	8K, 18 PIN
74S478/7132	25.79	8K, 24 PIN
82S191/7138	101.40	16K, 24 PIN

EPROM'S

C1702A 2K 1US — $ 10.39
C2708 1K x 8 450 ns — $ 5.17
C2716/TMS2516 (Intel version) 16K 450NS Single 5V Supply — $ 9.07
TMS2532 (TI Pin Out) 32K (4096 x 8) 450 ns — $ 25.94
C2732 (Intel version) 32K (4096 x 8) 450 ns — $ 24.38
TMS2564 64K (8K x 8) 450 ns — $115.70



16K STATIC RAM
TMM2016-3 16K (2K x 8) (300NS) — $ 21.39

16K MOS DYNAMIC RAM'S (16 PIN)
4116-20 (200NS) — $ 3.45
4116-30 (300NS) Ceramic — *Special* $ 2.93

4K MOS DYNAMIC RAM's
TMS4060-30 — *Special* $ 3.45
4K (4K x 1) 300NS 22 PIN

16K CMOS STATIC RAM — *Special*
6116 16K (2K x 8) 150NS 16 PIN — $ 31.20

64K MOS DYNAMIC RAM
4164 64K (64K x 1) 200NS 16 PIN — $ 31.20
4164 64K (64K x 1) 150NS 16 PIN — $ 38.94

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CMOS

CD4001BE	.23	CD4040BE	.83	CD4108BE	2.20
CD4002BE	.23	CD4041BE	1.16	CD4510BE	.75
CD4006BE	.77	CD4042BE	.70	CD4511BE	.73
CD4007BE	.31	CD4043BE	.70	CD4512BE	.94
CD4008BE	.87	CD4044BE	.62	CD4514BE	2.18
CD4009BE	.51	CD4046BE	.96	CD4515BE	2.00
CD4010BE	.51	CD4047BE	.90	CD4516BE	.98
CD4011BE	.23	CD4049BE	.49	CD4519BE	.68
CD4012BE	.23	CD4050BE	.42	CD4520BE	.73
CD4013BE	.38	CD4051BE	1.03	CD4522BE	1.01
CD4014BE	.73	CD4052BE	1.03	CD4526BE	1.03
CD4015BE	.73	CD4053BE	1.03	CD4527BE	2.07
CD4016BE	.42	CD4060BE	1.16	CD4528BE	.94
CD4017BE	.70	CD4066BE	.62	CD4531BE	1.09
CD4018BE	.68	CD4068BE	.31	CD4532BE	1.09
CD4019BE	.62	CD4069BE	.23	CD4539BE	.77
CD4020BE	.88	CD4070BE	.31	CD4543BE	1.87
CD4021BE	.74	CD4071BE	.31	CD4553BE	3.76
CD4022BE	1.03	CD4072BE	.25	CD4555BE	.75
CD4023BE	.25	CD4073BE	.31	CD4556BE	.75
CD4024BE	.57	CD4075BE	.31	CD4581BE	2.46
CD4025BE	.26	CD4076BE	.70	CD4582BE	.90
CD4026BE	1.89	CD4078BE	.31	CD4584BE	.55
CD4027BE	.55	CD4081BE	.23	CD4585BE	1.03
CD4028BE	.70	CD4082BE	.27	CD4702BE	11.64
CD4029BE	.90	CD4085BE	.57	40097PC	.94
CD4030BE	.49	CD4086BE	.70	40098PC	.94
CD4033BE	2.17	CD4093BE	.75	40161PC	1.56
CD4034BE	3.17	CD4099BE	2.26	40174PC	1.27
CD4035BE	.90	CD4104BE	3.07	40175PC	1.27

LINEAR IC'S

LM301AN-8	.42			LM741CN-8	.36
LM307N-8	.38			LM747CN-14	.65
LM308N-8	1.14	XR2206CP	4.49	LM748CN-8	.51
LM308CH	1.24	LM348N-14	1.29	LM1458N-8	.47
LM309K	2.03	LM358N-8	.62	LM1488N-14	.83
LM310HC	1.94	LM555N-8	.33	LM1489N-14	.83
LM311CH	1.03	LM556N-14	.68	LM1495CN-14	2.54
LM311N-8	.62	LM567CN-8	1.09	LM1496CN-14	1.77
LM318N	1.55	LM709CH	.77	LM2211CN-14	3.58
LM318CH	1.92	LM714CH	3.84	LM2240PC	1.95
LM323K	6.05	LM723CH	.94	LM3081DC	2.03
LM324N	.62	LM723CN-14	.62	LM3403N-14	1.11
LM339N	.62	LM725CN-8	1.46	LM3524PC	3.71
N8T26N	1.68	LM733CN-14	1.77	LM3900N	.62
N8T28N	4.75	LM739CN-14	2.20	LM4136N-14	1.14
SN76477NF	2.57	LM741CH	.77	ULN2003AN	1.09

TTL — STANDARD, SCHOTTKY AND LOW POWER SCHOTTKY

7400N	.29	7438N	.47	74104N	.83	74159N	1.98	74197N	.94	74S05N	.62	74S153N	1.25	74S280N	2.57	74LS26N	.51	74LS109N	.47	74LS170N	2.07	74LS259N	1.68	74LS375N	.83
7401N	.29	7440N	.29	74107AN	.57	74160N	.62	74198N	1.81	74S08N	.62	74S157N	1.25	74S283N	3.84	74LS27N	.38	74LS112N	.47	74LS173N	.77	74LS260N	1.16	74LS377N	1.63
7402N	.31	7442N	.57	74109N	.57	74161AN	.83	74199N	1.81	74S09N	.77	74S158N	1.25	74S299N	7.61	74LS30N	.23	74LS122N	.62	74LS174N	.51	74LS266N	.47	74LS378N	1.29
7403N	.31	7445N	1.09	74110N	.59	74162N	.83	74221N	.88	74S10N	.62	74S161N	3.71	74S373N	3.87	74LS32N	.38	74LS123N	.77	74LS175N	.51	74LS273N	1.55	74LS379N	1.42
7404N	.31	7446N	1.09	74111N	.75	74163AN	.83	74246N	1.77	74S11N	.62	74S162N	4.81	74S374N	3.87	74LS37N	.38	74LS125N	.57	74LS181N	2.57	74LS275N	5.14	74LS390N	1.27
7405N	.31	7447AN	.85	74116N	1.56	74164N	.83	74247N	1.61	74S15N	.62	74S163N	4.60	74S381N	7.74	74LS38N	.38	74LS126N	.57	74LS189N	5.79	74LS279N	.62	74LS393N	1.27
7406N	.47	7450N	.29	74120N	1.63	74165N	.83	74251N	.99	74S20N	.62	74S168N	5.79	74S412N	3.87	74LS42N	.57	74LS132N	.68	74LS190N	.94	74LS280N	2.57	74LS395N	1.55
7407N	.47	7451N	.38	74121N	.62	74166N	.88	74259N	2.46	74S30N	.47	74S169N	5.79	74S471N	8.39	74LS47N	.88	74LS133N	1.27	74LS191N	.94	74LS283N	1.01	74LS447N	.48
7408N	.31	7453N	.38	74122N	.68	74170N	2.57	74273N	2.59	74S32N	.83	74S174N	1.25	74S472N	10.99	74LS48N	1.29	74LS136N	.55	74LS192N	.83	74LS290N	.94	74LS490N	2.46
7409N	.31	7454N	.38	74123N	.62	74172N	6.44	74276N	1.27	74S37N	1.16	74S175N	1.25	74S474N	12.55	74LS51N	.27	74LS138N	.62	74LS193N	.83	74LS293N	.49	74LS630N	110.50
7410N	.31	7472N	.47	74125N	.62	74173N	1.03	74278N	3.09	74S38N	1.16	74S181N	5.14	74S476N	7.74	74LS54N	.27	74LS139N	.62	74LS194N	.83	74LS298N	1.14	74LS669N	1.09
7412N	.47	7473N	.47	74126AN	.62	74174N	.75	74279N	.77	74S40N	.51	74S182N	2.20			74LS55N	.31	74LS145N	1.42	74LS196N	1.14	74LS299N	3.25	74LS670N	2.13
7413N	.51	7474N	.47	74128N	.83	74175N	.75	74283N	1.27	74S51N	.62	74S189N	5.79	**74LS00N**	.22	74LS73N	.42	74LS147N	2.57	74LS197N	1.14	74LS320N	3.58		
7414N	.51	7475N	.51	74132N	.59	74176N	.99	74293N	.94	74S74N	.75	74S194N	2.18	74LS01N	.22	74LS74N	.42	74LS148N	1.77	74LS221N	1.16	74LS321N	5.14		
7416N	.47	7476N	.49	74136N	.68	74178N	1.42	74298N	1.09	74S85N	2.57	74S195N	2.18	74LS02N	.29	74LS75N	.46	74LS151N	.55	74LS240N	1.16	74LS322N	6.44		
7417N	.47	7483AN	.62	74141N	1.09	74179N	1.42	74351N	2.86	74S86N	.94	74S201N	7.61	74LS03N	.29	74LS76N	.49	74LS153N	.46	74LS241N	1.16	74LS323N	6.44		
7420N	.38	7484AN	.47	74142N	3.87	74180N	.98	74365AN	.75	74S112N	.94	74S225N	6.44	74LS04N	.29	74LS78N	.38	74LS155N	.87	74LS242N	1.16	74LS324N	3.25		
7422N	.47	7485N	.86	74143N	4.47	74182N	.68	74366N	.90	74S114N	1.68	74S240N	3.84	74LS05N	.29	74LS83N	.90	74LS156N	.94	74LS243N	1.16	74LS348N	3.45		
7423N	.47	7486N	.51	74144N	4.47	74184N	3.07	74367AN	.75	74S124N	3.33	74S241N	3.84	74LS08N	.22	74LS85N	1.09	74LS157N	.62	74LS244N	1.16	74LS352N	1.76		
7425N	.42	7490AN	.42	74145N	.87	74185N	3.07	74368AN	.75	74S132N	1.61	74S244N	3.84	74LS09N	.31	74LS86N	.49	74LS158N	.62	74LS245N	2.15	74LS353N	2.15		
7426N	.51	7491AN	.55	74147N	1.61	74190N	.88	74390N	1.25	74S133N	.62	74S251N	1.55	74LS10N	.25	74LS90N	.51	74LS160N	.90	74LS247N	.99	74LS362N	12.94		
7427N	.42	7492AN	.49	74148N	1.16	74191N	.88	74393N	1.68	74S134N	.70	74S253N	2.54	74LS11N	.31	74LS91N	1.16	74LS161N	.75	74LS248N	1.42	74LS365N	.68		
7428N	.55	7493AN	.49	74150N	1.63	74192N	.88			74S135N	1.68	74S257N	1.42	74LS12N	.31	74LS92N	.62	74LS162N	.94	74LS249N	1.25	74LS366N	.68		
7430N	.29	7494AN	.88	74151N	.55	74193N	.83	**74S00N**	.47	74S138N	1.25	74S258N	1.42	74LS13N	.33	74LS93N	.51	74LS163N	.75	74LS251N	.70	74LS367N	.68		
7432N	.51	7495AN	.70	74153N	.47	74194N	.83	74S02N	.49	74S139N	1.25	74S260N	1.27	74LS14N	.51	74LS95N	.62	74LS164N	.75	74LS253N	.70	74LS368N	.68		
7433N	.51	7496N	.77	74154N	1.68	74195N	.62	74S03N	.49	74S140N	.96	74S274N	20.61	74LS20N	.23	74LS96N	.75	74LS165N	1.16	74LS257N	.73	74LS373N	1.63		
7437N	.47	7497N	2.46	74155N	.62	74196N	1.01	74S04N	.57	74S151N	1.29	74S275N	20.61	74LS21N	.23	74LS107N	.47	74LS166N	2.13	74LS258N	.73	74LS374N	1.63		
		74100N	1.79	74157N	.62																				

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