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September 1983

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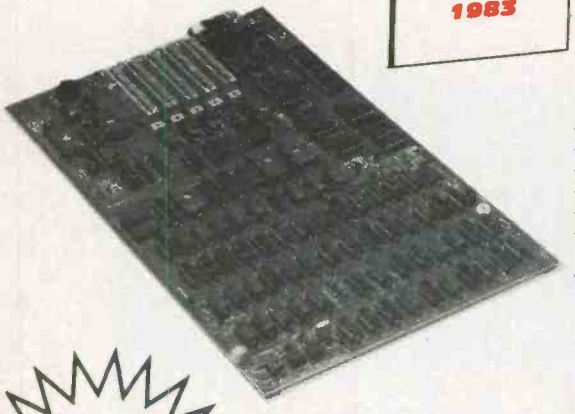

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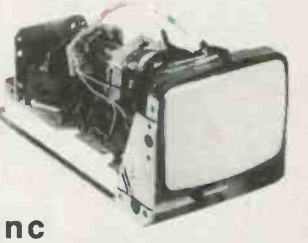

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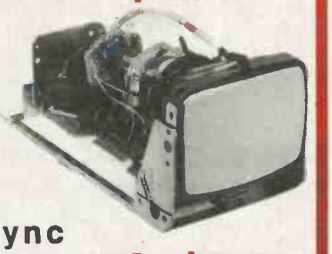

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Circle No. 7 on Reader Service Card.

The Magazine for Electronics & Computing Enthusiasts

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September 1983
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ISSN 0703-8984

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Our Cover

The Dynamic Noise Reduction Unit project, thought by some to be a device that automatically puts your children to bed, begins on p. 17. The Low Cost Printer Survey starts on p. 11. Steve Rimmer reviews another under $200.00 computer, the VZ 200. See p. 24. All cover photos by Bill Markwick.

Features

11 Low Cost Printer Survey
The ins and outs of transferring words from your video screen to a piece of paper.

20 Surplus Meters
David Thomson describes how to make useless analog meters useful again.

24 Computer Review: The VZ200
Another low-end micro poked and peeked at by Steve Rimmer.

28 Improving Your ZX-81
After you've waited around for five minutes only to see a cassette-loading error message, you'll be ready for this nifty conversion.

32 Fuses
Confused about fuses? Don't refuse this information diffused by Jim Essex.

43 Spectrum Wars
C.M. Stanbury II has come up with a sequel to Return of the Jedi. Almost.

44 Designer's Notebook
The CA3059 zero-crossing switch. It's the IC that puts the little slash marks across the zeros in your computer.

49 Designing Microsystems
A new series beginning in this issue; we look at the nuts and bolts of CPU's and their support chips.

57 Dumont
Hazy recollections of early TV with funny-shaped screens and Milton Berle? Read on . . .

58 Designing Power Supplies
If our Hi-Fi Supply in this issue doesn't quite suit your application, you can get hints on how to change it from this basic theory article.

Projects

17 Noise Reduction Unit
Reduces audio noise from any source without previous encoding. Works at least as well as earmuffs.

30 Signal Line Tester
When your PA suddenly goes dead and 2000 people turn to look at the soundman, this little dooie will at least tell you what's at fault.

34 Stabilised Power Supply Unit
Fanatics claim that the perfect amp can be made perfecter; add a regulator.

61 Sound Switch
Detects foot falls and heavy breathing, and can be used to set off dynamite or other attention-getting devices.

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We can supply photocopies of any article published in ETI Canada; the charge is $2.00 per article, regardless of length. Please specify both issue and article.

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 5.6ohms 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.

Please note we do not keep track of what is available from who so please don't contact us for information on PCBs and kits. Similarly do not ask PCB suppliers for help with projects.

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B—C—D Electronics, P.O. Box 6326, Stn. F, Hamilton, Ont., L9C 6L9.
Wentworth Electronics, R.R.No.1, Waterdown,Ont., L0R 2H0.
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Editorial Queries
Written queries can only be answered when accompanied by a self-addressed, stamped envelope. These must relate to recent articles and not involve the staff in any research. Mark such letters ETI-Query. We cannot answer telephone queries.

Speed Listening

Radio Shack, a division of Tandy Electronics Limited, introduces a revolutionary new cassette recorder/player that makes it possible for businessmen, students, hobbyists, secretaries, the visually handicapped and others to acquire information from spoken word cassettes as quickly as most individuals can read. The VSC-1000 Speech Control cassette recorder (14-1002) is available at over 800 Radio Shack locations in Canada at a retail price of $169.95.

While speeding up a normal cassette player produces a familiar high-pitched "chipmunk" sound, Radio Shack's new VSC-1000 incorporates a Variable Speech Control electronic circuit which allows you to speed up the tape without altering the pitch of the voice. At Radio Shack dealers.

Motorola announces the all new "Small-Signal Transistor Data Book." This publication presents technical information for both bipolar and field-effect transistors that comprise the Motorola small-signal transistor line. These devices are available in a variety of packages: metal can, plastic and microminiature. Complete specifications and typical performance curves are given on more than 1750 devices, which are grouped by the various families. The Small-Signal Data Book (DL126) is available for $6.25 U.S. from Motorola Semiconductor Products Inc. P.O. Box 20912, Phoenix, Arizona, 85036.

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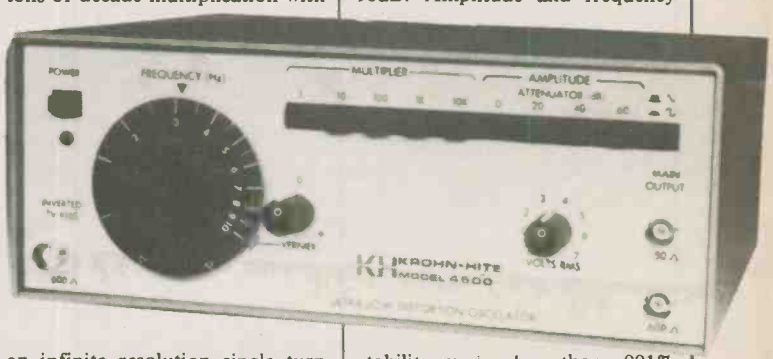

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For further information on this and other Webster products please contact: Mr. Roger Webster, President WEBSTER INSTRUMENTS LTD., 1134 Aerowood Drive, Mississauga, Ontario L4W 1Y5. (416) 625-0600.

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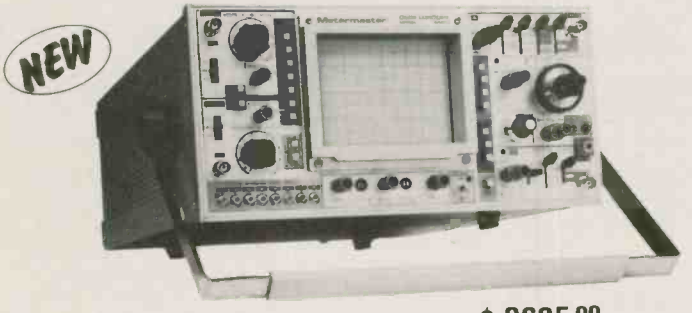

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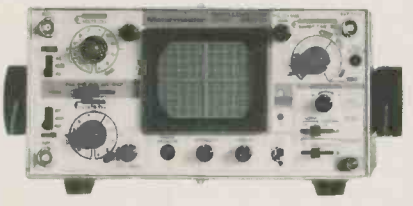

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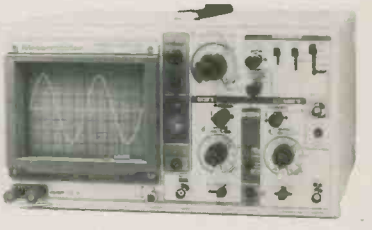

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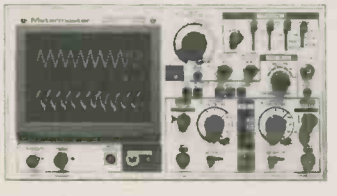

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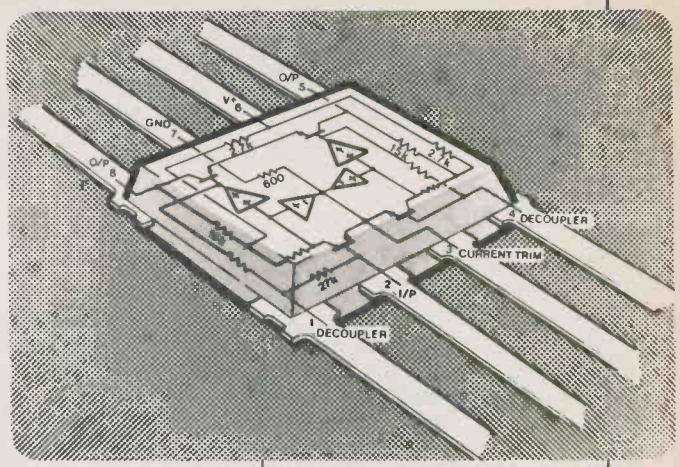
Mitsubishi Electric Corporation has developed the world's first very large, flat, full-colour liquid crystal display system. The system will be marketed from June 1. Mitsubishi Electric will exhibit its new system wi an effective picture field of 1.2 meters by 1.8 at the International Summer Consumer Electronics Show in Chicago, from June 5 to 8. The LCD display system can clearly display in full color animations, patterns and characters input from a videocassette recorder (VCR), video camera or computer. As a new medium, it has a wide variety of applications, such as advertising at shopping malls, plant monitorlng, displaying of information at stations, airports and conference halls and visual services at theaters, music halls and sports arenas.

Low Voltage AF Amplifiers

The LC/LD549 are high performance amplifiers, specifically designed for 1.0 - 1.6 V dc audio applications over a frequency range of 60 Hz - 30 kHz. The circuit consists of a 40 dB (±2 dB) feedback stabilized, high efficiency class "B" output stage, incorporating a single ended input.

With a quiescent current of .77 mA, the LC549 is capable of delivering 7 mW of power into a 250 Ω load, while the LD 549 is capable of delivering 11 mW of power into a 110 Ω load.

For limited space requirements, the LC549 is available in an 8 pin 3.65 mm x 3.65 mm PLASTIC MINIPAC, an 8 pin 2.7 mm x 3.5 mm MICROPAC and a 2.7 mm x 3.5 mm PLID, suitable for reflow soldering assembly methods. The LD549 is presently available only in the 8 pin MINIPAC.



The amplifiers are available from stock, with a price range of $3.50 to $5.00.

For more information, please contact: Bryon Nielsen, Linear Technology Inc., P.O. Box 489, Station A, Burlington, Ontario, L7R 3Y3.

An experimental Artificial Intelligence (AI) program being conducted at IBM's Yorktown Heights research facility may lead to machine recognition of social class. According to a new 167-page research report from International Resource Development Inc., a Norwalk, Connecticut-based market research firm, the IBM program can evaluate the style of a letter, document or memo and can critique the writing style, syntax and construction. Although IBM's immediate application for this technology is to highlight "inappropriate style" in documents being prepared by managers, the IRD researchers see the program being applied to determine the social origins, politeness and general character of the writer.

The AI system will be able to detect small nuances of expression and relate them to the social background of the originator. "We see the program evolving to the point at which a great deal will be able to be deduced about the writer of even a relatively short memo," comments Dave Ledecky of the IRD research staff. The experimental IBM system is named EPISTLE (Evaluation, Preparation, and Interpretation System for Text and Language Entities). Its long range objective — to provide office workers with intelligent applications for natural text processing, particularly related to business correspondence — is directed primarily toward aiding middle-level managers. Next year is 1984 . . .

Tone Ringer Circuit

A new electronic telephone tone ringer circuit, the MC34012, has been announced by Motorola. This monolithic integrated circuit drives a piezo electric transducer to replace the mechanical bell assembly in a telephone set, and to produce a pleasant warbling tone at a highly audible output level. The tone ringer generates a warbling square wave output drive to the piezo sound element when the AC line voltage exceeds 35 volts. The input diode bridge and SCR current clamp are integrated on the chip, resulting in a minimum number of external components. The ratio of output tone and warble frequencies are fixed internally. The MC34012 derives its power supply by rectifying the AC ringing signal.

Relay Catalog

Magnecraft's new relay catalog, said to be the most complete in the industry, is available free from Longman Sales Inc., 1715 Meyerside Drive, Unit 1, Mississauga, Ont. L5T 1C5, (416) 677-8100, or in Quebec, 16891 Hymus Boulevard, Kirkland, Quebec, H9H 3L4, (514) 694-3911. Relays include PCB mount power types, immersibles, time delays, current sensing, reed types, and many others.

The International Electrical, Electronics Conference and Exposition, sponsored by the IEEE, will be held September 26,27 and 28 at the Automotive Building, Exhibition Place, Toronto, Ontario. More than 150 papers will be given during 27 sessions, and for the first time the conference proceedings will have the full status of recognized scientific papers. For information, contact Southex Exhibitions, 1450 Don Mills Road, Don Mills, Ont. M3B 2X7, (416) 445-6641.

Cable Clamps

A new, moulded cable clamp design with secure screw hole alignment feature is part of a complete line of noncorrosive and nonconductive cable clamps available from W.H. Brady Inc. The combination assures extra secure holding power for a wide range of cable diameters.

Made of nylon, Brady clamps provide strength and stability under a variety of applications and environmental conditions. Test results show that the clamps remain rigid even when subjected to severe temperatures from 135 °C to -57 °C (275 ° to -60 °F).

For additional information, contact W.H. Brady Inc., 10 Marmac Drive, Rexdale, Ontario M9W 1E6.(416) 675-2112.

Communications Panels

From one communications panel you can dial, talk, and conference on POTS/Keyset lines, interbay trunks, and 4-wire test trunks. The new WILTRON 9820A and 9821 Communications Panels can outdial using dial-pulsing (DP), MF, or DTMF. The Model 9821, in addition, features a repertory dialer that stores sixteen 36-digit numbers and a 12-digit LED readout that displays the number dialed and the time of day.

Both the 9820A and 9821 provide the flexibility needed for test-position communications. A built-in speaker is included for monitoring test circuits or telephone lines. The 4x4 keypad provides all MF/DTMF tone pairs, including those used for coin collect/return and TSPS and CAMA trunks. For operator trunks, a fast-dial function provides 20 pps pulsing. Front-panel controls allow easy adjustment of MF/DTMF level, and the headset output has independent receive and transmit level adjustment. For additional information, contact: Wiltron Instruments Ltd., Suite 2, 880 Lady Ellen Place Ottawa, Ontario, K1Z 5L9. Telephone: (613) 725-1006.

"Interfacing the Real World to Your Computer," a 16 page brochure, describes a wide range of methods to interface sensors, transducers, output actuators, and digital I/O to computers. Products described include isolated and nonisolated signal conditioners, two-wire transmitters, remote and local signal conditioning subsystems, hi-lo limit alarm subsystems, microcomputer-compatible analog input/output subsystems, and remote, intelligent I/O subsystems. Free from Analog Devices, represented in Canada by Tracan Electronics, 1200 Aerowood Drive, Units, 3 and 4, Mississauga, Ont. L4W 2S7.

Continued on page 62

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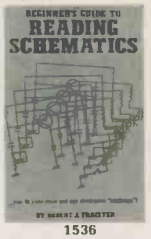

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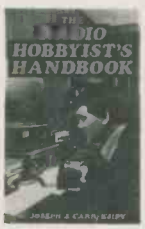

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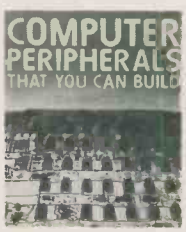

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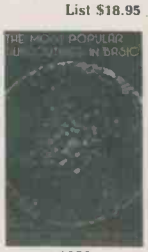

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Remember, any bare PCB is $15.00 and the following wholesale discount applies, so get together in a group. 10 PCB @ $10.00 ea., 25 PCB @ $9.00 ea., 50 PCB @ $8.50 ea., 100 PCB @ $8.00 ea., and 500 PCB at $7.50 ea. You can order any combination of PCB that reaches the discount number but they must all go to the same address.

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Printer Survey

After you've finally selected a computer from the dizzying array available, you'll have to do it all over again with the printer. A guide to the intricacies.

SELECTING A printer to go with your computer is really just a matter of setting priorities. The two most important ones will be speed and print quality. Others, like graphics and colour, may be less important.

We present, then, a quick survey of some of the printers available for under $1000, and hasten to add that prices and specifications were accurate as we went to press, but the rapid changes in computer hardware means that you should check with the dealer before taking anything as gospel.

Print Types

There are two basic types: dot matrix and daisywheel. The dot matrix forms each character by impacting the paper with fine wires under control of the electronics; these wires come in arrays of 5 x 7, 5 x 9, and so on, and the quality looks like a computer-printed form letter. They're getting better, though, and some have features such as overprinting to minimize the "dotty" look. The main advantage is high speed; 100 characters per second is not unusual.

The daisywheel has striker keys, much like a typewriter, and they're arranged in a flexible wheel like the petals of a daisy. The quality of print is as good as the best, but mechanical inertia means that it will be considerably slower than the dots. It will also be somewhat noisier.

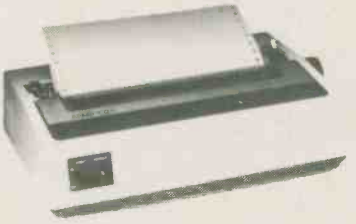
Interfacing

Again, there are two types, serial and parallel. Your computer output will determine what type you need on the printer. In general, the serial type needs a lesser number of conductors and can have longer cables. This is often irrelevant if the printer is in the same room. Some printers have both; some have the alternate type as an option.

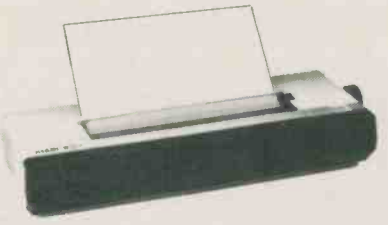
Character Sets

The dot matrix types often have several types of character sets which can be selected by computer codes, and ROM chips can often be purchased to give you others. The daisy wheel, however, can only change characters by replacing the wheel itself.

Name:	Atari 1020 Colour
Price:	$449.00
Dot or Daisy:	pen
Char/Sec:	10
# of Char. Sizes	1 (64 char. sizes avail)
# of Char. Per Line:	40 column width
Interface Type:	Centronics Parallel
Paper Width:	N.A.
Dimensions:	N.A.
Weight:	N.A.
Distributor:	Irwin Electronics



Name:	Atari 1025
Price:	$749.00
Dot or Daisy:	5 x 7 dot
Char/Sec:	40
# of Char. Sizes	3
# of Char. Per Line:	40,80,132 (cond)
Interface Type:	S
Paper Width:	8"
Dimensions:	N.A.
Weight:	N.A.
Distributor:	Irwin Electronics



Name:	Atari 1027 Letter Quality
Price:	$549.00
Dot or Daisy:	Prestige Elite 12 daisy
Char/Sec:	20
# of Char. Sizes	1
# of Char. Per Line:	80 columns
Interface Type:	Centronics Parallel
Paper Width:	8"
Dimensions:	N.A.
Weight:	N.A.
Distributor:	Irwin Electronics

Name:	Axiom Seikosha GP100
Price:	$429.00
Dot or Daisy:	5 x 7 dot
Char/Sec:	30
# of Char. Sizes	N.A.
# of Char. Per Line:	80
Interface Type:	P
Paper Width:	9.5"
Dimensions:	140 mm H x 406 mm W x 229 mm D
Weight:	5.9 kg
Distributor:	Tele-Radio

Name:	Axiom GP 250X
Price:	$499.00
Dot or Daisy:	5 x 8 to 10 x 16 dot
Char/Sec:	50
# of Char. Sizes	1
# of Char. Per Line:	80 columns
Interface Type:	S and P
Paper Width:	Adjustable up to 10"
Dimensions:	234 mm D x 420 mm W x 136 mm H.
Weight:	4.5 kg
Distributor:	Tele-Radio

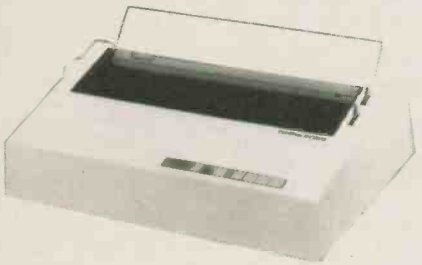
Name:	Axiom 420
Price:	$911.00
Dot or Daisy:	5 x 8 / 11 x 20 dot
Char/Sec:	6 lines/sec.
# of Char. Sizes	2
# of Char. Per Line:	46 or 92
Interface Type:	S or P
Paper Width:	5"
Dimensions:	95 mm H x 300 mm W x 280 mm D
Weight:	4 kg
Distributor:	Tele-Radio

Printer Survey

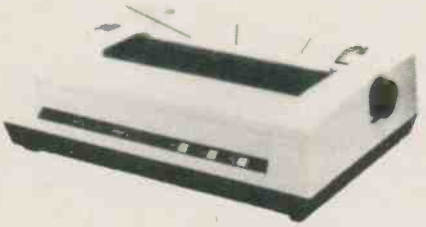
Name:	Axiom 801
Price:	$924.00
Dot or Daisy:	5 x 8 dot
Char/Sec:	160 cps
# of Char. Sizes	3
# of Char. Per Line:	80 columns
Interface Type:	Choice of parallel or serial
Paper Width:	N.A.
Dimensions:	295 mm W x 321 mm D x 111 mm H
Weight:	5.45 kg
Distributor:	Tele-Radio

Name:	Axiom 1601
Price:	$724.00
Dot or Daisy:	5 x 8 dot
Char/Sec:	240
# of Char. Sizes	3
# of Char. Per Line:	N.A.
Interface Type:	S or P
Paper Width:	8.5"
Dimensions:	95 mm H x 300 mm W x 280 mm D
Weight:	4 kg
Distributor:	Tele-Radio

Name:	Axiom 1620
Price:	$974.00
Dot or Daisy:	5 x 8 / 11 x 20 dot
Char/Sec:	240 cps
# of Char. Sizes	N.A.
# of Char. Per Line:	80 or 160
Interface Type:	S or P
Paper Width:	8½"
Dimensions:	89 mm H x 388 mm W x 273 mm D
Weight:	4.9 kg
Distributor:	Tele-Radio



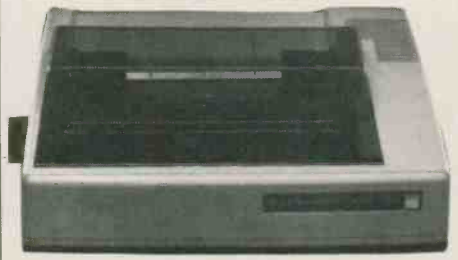
Name:	Brother HR15
Price:	$995.00
Dot or Daisy:	daisy
Char/Sec:	13
# of Char. Sizes	3
# of Char. Per Line:	up to 165
Interface Type:	S and P
Paper Width:	13.5"
Dimensions:	464 mm W x 166 mm H x 339 mm D
Weight:	N.A.
Distributor:	SAK Data



Name:	C. Itoh Pro/Writer
Price:	$895.00
Dot or Daisy:	9 x N dot
Char/Sec:	100
# of Char. Sizes	8
# of Char. Per Line:	80
Interface Type:	S or P
Paper Width:	10"
Dimensions:	120 mm H x 398 mm W x 285 mm D
Weight:	8.5 kg
Distributor:	Canadian General Electric

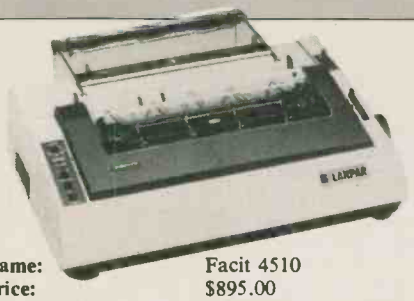
Name:	Canon A1200
Price:	$950.00
Dot or Daisy:	9 x 7 or 16 x 16 dot
Char/Sec:	120
# of Char. Sizes	3
# of Char. Per Line:	80/136
Interface Type:	P
Paper Width:	10"
Dimensions:	11 cm H x 40 cm W x 32 cm D
Weight:	8 kg
Distributor:	Canon Canada

Name:	Commodore 1526
Price:	$695.00
Dot or Daisy:	8 x 8 dot
Char/Sec:	up to 165 cps
# of Char. Sizes	1 (programmable)
# of Char. Per Line:	80 columns
Interface Type:	CBM serial, 6 pin serial
Paper Width:	N.A.
Dimensions:	N.A.
Weight:	N.A.
Distributor:	CBM

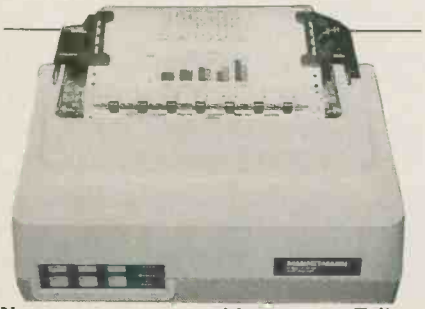


Name:	Commodore 4023
Price:	$695.00
Dot or Daisy:	8 x 8 dot
Char/Sec:	100
# of Char. Sizes	1
# of Char. Per Line:	80
Interface Type:	P
Paper Width:	10"
Dimensions:	N.A.
Weight:	N.A.
Distributor:	CBM

Name:	Epson MX-80 F/T
Price:	$799.00
Dot or Daisy:	9 x 9 dot
Char/Sec:	80
# of Char. Sizes	4
# of Char. Per Line:	132
Interface Type:	P
Paper Width:	N.A.
Dimensions:	N.A.
Weight:	N.A.
Distributor:	Essna



Name:	Facit 4510
Price:	$895.00
Dot or Daisy:	9 x 9 dot
Char/Sec:	120
# of Char. Sizes	3
# of Char. Per Line:	136
Interface Type:	S or P
Paper Width:	8"
Dimensions:	N.A.
Weight:	N.A.
Distributor:	Lanpar



Name:	Mannesmann Tally 160
Price:	$995.00
Dot or Daisy:	7 x 9 dot
Char/Sec:	160 cps
# of Char. Sizes	4
# of Char. Per Line:	80
Interface Type:	P & S
Paper Width:	10"
Dimensions:	13.7" W x 9.64" D x 6.2" H
Weight:	17 lbs.
Distributor:	SGV Marketing

Name:	NEC PC-8023A
Price:	$895.00
Dot or Daisy:	7 x 9 dot
Char/Sec:	100
# of Char. Sizes	6
# of Char. Per Line:	80
Interface Type:	P
Paper Width:	10"
Dimensions:	N.A.
Weight:	N.A.
Distributor:	Microcomputers of Canada

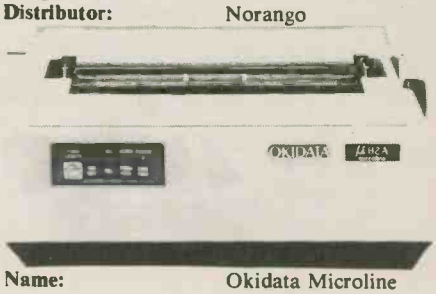
Name:	IDS Microprism
Price:	$995.00
Dot or Daisy:	9 x 18 / 9 x 24 dot
Char/Sec:	up to 110 cps
# of Char. Sizes	3
# of Char. Per Line:	N.A.
Interface Type:	S and P
Paper Width:	4" to 9"
Dimensions:	115 mm H x 405 mm W x 297 mm D
Weight:	7.5 kg
Distributor:	Ahearn & Soper Inc.

Name:	MPI 88G
Price:	$695.00
Dot or Daisy:	7 x 7 or 11 x7 dot
Char/Sec:	100
# of Char. Sizes	2
# of Char. Per Line:	80/132
Interface Type:	S and P
Paper Width:	9.5"
Dimensions:	15.9 cm H x 41.3 cm W x 27.3 cm D
Weight:	6.7 kg
Distributor:	Norango

Name:	Okidata ML80
Price:	$611.00
Dot or Daisy:	7 x 9 dot
Char/Sec:	80
# of Char. Sizes	3
# of Char. Per Line:	80/132
Interface Type:	P
Paper Width:	Friction 8.5"; Tractor 9.5"
Dimensions:	13.5" W x 9.6" D x 4.3" H
Weight:	14.3 lbs.
Distributor:	Electronetic, Hamilton-Avnet

Name:	Mannesmann Tally Spirit
Price:	$595.00
Dot or Daisy:	9 x 8 dot
Char/Sec:	80
# of Char. Sizes	4
# of Char. Per Line:	80/142
Interface Type:	P, S option
Paper Width:	10"
Dimensions:	12.5 cm H x 37.7 cm W x 32.4 cm D
Weight:	5.3 kg
Distributor:	SGV Marketing

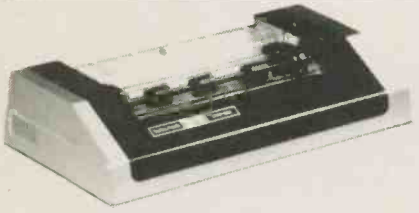
Name:	MPI 99G Omega
Price:	$995.00
Dot or Daisy:	7 x 9, 11 x 9 dot
Char/Sec:	100 cps
# of Char. Sizes	4
# of Char. Per Line:	up to 136
Interface Type:	P and S
Paper Width:	9.5"
Dimensions:	16.2" W x 10.75" D x 6.2" H
Weight:	15 lbs.
Distributor:	Norango



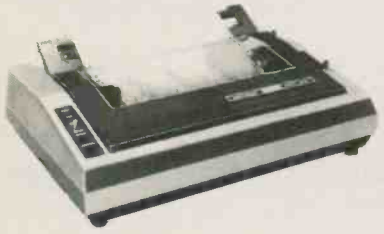
Name:	Okidata Microline 82A
Price:	$738.00
Dot or Daisy:	9 x 9 dot
Char/Sec:	120
# of Char. Sizes	N.A.
# of Char. Per Line:	80
Interface Type:	S
Paper Width:	8.5"
Dimensions:	13.2 cm H x 36 cm W x 32.8 cm D
Weight:	9 kg
Distributor:	Electronetic, Hamilton-Avnet

Printer Survey

Name:	Okidata Microline 92
Price:	$929.00
Dot or Daisy:	9 x 9, 9 x 17 dot
Char/Sec:	40
# of Char. Sizes	6
# of Char. Per Line:	80
Interface Type:	S or P
Paper Width:	8.5"
Dimensions:	13.2 cm H x 36.1 cm W x 32.8 cm D
Weight:	8.9 kg
Distributor:	Electronetic, Hamilton-Avnet



Name:	Radio Shack DMP100
Price:	$499.00
Dot or Daisy:	5 x 7 dot
Char/Sec:	50
# of Char. Sizes	2
# of Char. Per Line:	80 @ 10 cpi
Interface Type:	S or P
Paper Width:	9.5"
Dimensions:	14 cm H x 40.6 cm W x 20.3 cm D
Weight:	N.A.
Distributor:	Radio Shack



Name:	Radio Shack DMP200
Price:	$999.00
Dot or Daisy:	9 x 9, 15 x 9 dot
Char/Sec:	120 cps
# of Char. Sizes	2
# of Char. Per Line:	80
Interface Type:	S and P
Paper Width:	9½"
Dimensions:	5" x 16.5" x 13.5"
Weight:	16.5 lbs
Distributor:	Radio Shack

Name:	Sinclair ZX
Price:	$134.99
Dot or Daisy:	stylus
Char/Sec:	50
# of Char. Sizes	1
# of Char. Per Line:	32
Interface Type:	ZX81 only
Paper Width:	4"
Dimensions:	N.A.
Weight:	N.A.
Distributor:	TMX Canada Ltd.

Name:	Star Micronics Gemini 10 and 15
Price:	10: $615.00, 15: $795.00
Dot or Daisy:	9 x 9 dot
Char/Sec:	100
# of Char. Sizes	4
# of Char. Per Line:	80
Interface Type:	P
Paper Width:	10" (Gemini 15 -15")
Dimensions:	136 mm H x 392 mm W x 315 mm D
Weight:	7 kg
Distributor:	Exceltronix

Name:	Texas Instruments 850
Price:	$799.00
Dot or Daisy:	9 x 9 dot
Char/Sec:	150
# of Char. Sizes	6
# of Char. Per Line:	80
Interface Type:	S or P
Paper Width:	11"
Dimensions:	N.A.
Weight:	N.A.
Distributor:	Texas Instruments

ADDRESSES:

Ahearn and Soper, 100 Woodbine Downs Blvd., Rexdale, Ont. M9W 5S6.

Brother International Corporation, 1515 Boul. Pitfield, Montreal, Quebec, H4S 1G5.

Canadian General Electric, 396 Attwell Dr., Rexdale, Ont. M9W 5C3.

Canon Canada Inc., 3245 American Dr., Mississauga, Ont. L4V 1N4.

Commodore Business Machines, 3370 Pharmacy Ave., Agincourt, Ont. M1W 2K4.

Electronetic Systems, 785 Arrow Rd., Weston, Ont. M9M 2L6.

ESSNA, Ltd., 21 Progress Court, Unit 18, Scarborough, Ont. M1G 3V4.

Exceltronix Inc., 319 College St., Toronto, Ont. M5T 1S2.

Hamilton-Avnet International, 6845 Rexwood Ave., Mississauga, Ont. L4V 1S5.

Irwin Electronics, 165 North Queen St., Etobicoke, Ont. M9C 1A7.

Lanpar, 85 Torbay Road, Markham, Ont., L3R 1G7.

Mannesmann Tally Corporation, 703 Petrolia Rd., Downsview, Ont. M3J 2N6.

Microcomputers of Canada Inc., 3410 Midland Ave., Unit 4, Scarborough, Ont. M1V 2N1.

Norango, 2025 Sheppard Ave. E., Suite 2230, Willowdale, Ont. M2J 1V7.

Radio Shack, Radio Shack locations throughout Canada.

SAK Data, 311 Renforth Dr., Etobicoke, Ont., M9C 2L4

SGV Marketing, 1520 Trinity Dr., Unit 16, Mississauga, Ont., L5T 1T6.

Sharp Electronics of Canada, 116 Galaxie Blvd., Rexdale, Ont. M9W 4Y6.

Smith-Corona, A Division of SCM (Canada) Ltd., 29 Gervais Drive, Don Mills, Ont. M3C 1Z1.

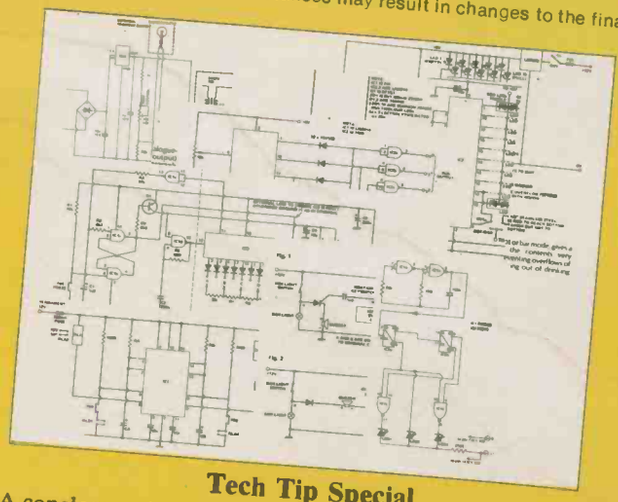
Tele-Radio Systems Ltd., 121 Hanlan Rd., Woodbridge, Ont. L4L 3P5.

Texas Instruments Inc., 41 Shelley Road, Richmond Hill, Ont. L4C 5G4.

TMX Canada Ltd., 635 Hood Road, Markham, Ont. L3R 4N6.

ETI 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.



Tech Tip Special

A conglomeration of all sorts of circuits submitted by readers. Build them, test them, debug them, plunder the ideas.

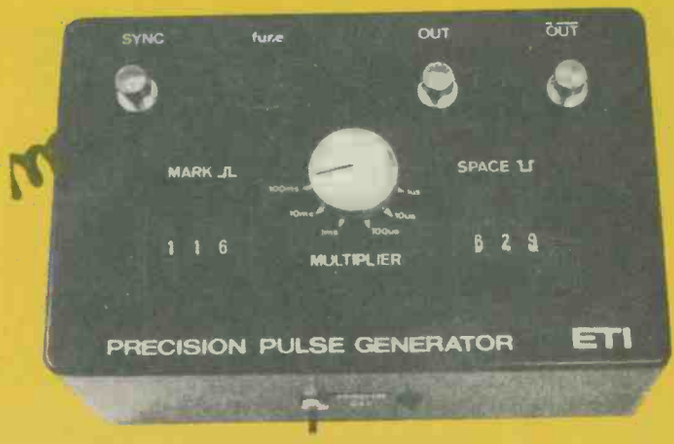
Robotics

There's a boom in both industrial and home robotics. We cover the advantages and shortcomings of both, with emphasis on the Canadian market.

PLUS!
Light Column!
Designing Microsystems!
Switched Capacitor Filters!
A look at Cellular Radio!

Precision Pulse Generator

If you've ever itched to have control over dumb old square waves, this project will let you fiddle around to your heart's content with the frequency and mark/space ratio. Crystal controlled, switch-selectable.



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MOS 248	120	4-8	<0.005%	<0.006%	± 55	120 x 78 x 80	850	154.95
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Protection: Able to cope with complex loads without the need for very special protection circuitry (fuses will suffice).
Slew rate: 20v/ps. Rise time 3ps. S/N ratio 100db
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Input impedance: 100K Damping factor: 100Hz > 400.

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Module Number	Output Power Watts rms	Lead Impedance Ω	DISTORTION T.H.D. Typ at 1KHz	DISTORTION I.M.D. 60Hz/ 7KHz 4:1	Supply Voltage Typ	Size mm	WT gms	Price $
HY30	15	4-8	0.015%	<0.006%	± 18	76 x 68 x 40	240	31.95
HY60	30	4-8	0.015%	<0.006%	± 25	76 x 68 x 40	240	34.95
HY6060	30 + 30	4-8	0.015%	<0.006%	± 25	120 x 78 x 40	420	59.95
HY124	60	4	0.01%	<0.006%	± 26	120 x 78 x 40	410	59.95
HY128	60	8	0.01%	<0.006%	± 35	120 x 78 x 40	410	59.95
HY244	120	4	0.01%	<0.006%	± 35	120 x 78 x 50	520	79.95
HY248	120	8	0.01%	<0.006%	± 50	120 x 78 x 50	520	79.95
HY364	180	4	0.01%	<0.006%	± 45	120 x 78 x 100	1030	119.95
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HY73	Guitar pre-amp	Two Guitar (Bass Lead) and M¹ + separate Volume Bass Treble + Mix	20mA	54.95
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UP2X	60W/4 Ω	Bipolar	Mono	HIFI	199.95
UP3X	60W/8 Ω	Bipolar	Mono	HIFI	199.95
UP4X	120W/4Ω	Bipolar	Mono	HIFI	259.97
UP5X	120W/8Ω	Bipolar	Mono	HIFI	259.95
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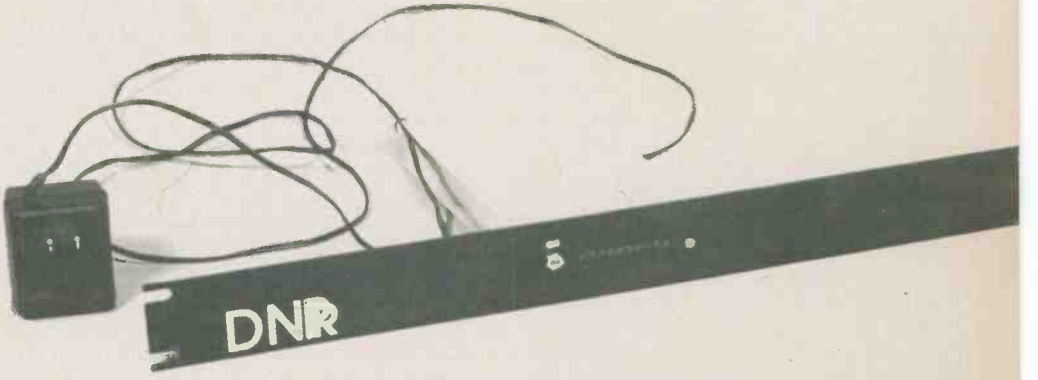
Noise Reduction Unit

A tiny, inexpensive project from National Semiconductor that does an amazing job of reducing audio hiss without the need for encoding.

by Steve Rimmer



HUM IS a great thing in a sound system . . . it masks the hiss. After a while one inevitably fixes all the ground loops in one's stereo and gets the hiss really good and audible. Sadly, hiss is not as easily removed.

Hiss is caused by random energy floating around in circuitry. In vacuum tube equipment this is produced by electrons smashing into the metal anodes of the tubes. Semiconductors produce their own variety through the action of silicon junctions. In addition to this, there are special varieties of noise, such as tape hiss, which comes from the particle coating of the tape itself.

The elimination of noise has long been a really well sought after quest, because it is the "noise floor" that ultimately determines the quality of the sound that can be had from an audio system. Quiet can be awe-inspiring . . . there is no better buzz than to turn on your system and hear nothing until the first bars of music swell out of the ether . . . or beep out, if you listen to a lot of new wave.

There is also nothing quite so difficult to come by.

Boo . . . Hiss

The problem with killing noise is that it is part of the signal you'd like to keep around. It occupies part of the same frequency spectrum, which means that simple filters won't trap it. You can reduce the apparent hiss level in a signal by turning down the treble, but this also sends all the high frequency energy to Baffin island and makes your music sound fairly dismal and muddy. Besides, this is ultra-low tech.

High tech being a universally good wrench for fixing things that seem intractable, much thought has been given to the premise that this apparent paradox could somehow be overcome if only enough transistors were added to the circuitry. In fact, this idea is somewhat true . . . if you cheat a bit.

While noise is, by definition, energy right across the spectrum of interest, it happens that the noise which tends to plague sound systems is high frequency energy. That's why turning down the treble mortifies it. Furthermore, it will be noticed that high frequency hiss is only audible when there is no periodic high frequency energy to cover it . . . that is, you only hear it during the bass solos. High tech solutions are born of observations like this one.

To begin with, most of the circuitry involved in the accidental production of noise can be viewed as being signal processors of some sort. Tape recorders take sound and delay it. FM radio transmitters and receivers move it over distances. Spring lines add reverberation, and so on. Any processor can be viewed as a box with an input and an output.

The box itself produces an effect . . . and adds some noise.

The first effective noise reduction concepts involved double ended signal processing. This meant that one altered the signal before it went into the processor in some way so as to make it less susceptible to having noise attached to it, and then "de-altered" it once it came out to make it sound the way it was supposed to.

The most successful double ended processor is, of course, the mystical Dolby box. It uses a technique called compression-expansion on the high end of the audio spectrum . . . where the noise lives. It looks at the treble bandwidth and decides if there's any sound energy up there. If it turns out that things are pretty quiet at the moment, it expands the high end, that is, turns up the gain. This expanded signal gets fed to the signal processor . . . tape recorder, transmitter, or whatever . . . and, upon emerging, ready to be listened to, enters a box that reverses the process. On quiet passages it compresses the high end . . . turns down the gain . . . so as to effectively reduce the level of the noise.

The Dolby process, and other similar approaches, have several fundamental limitations. The most obvious one is that you have to have both ends of the thing happening for the system to do any good. If you have a noisy tape which was not recorded with the Dolby switched on, you have a permanently noisy tape.

Secondly, sound which is encoded under a double ended noise reduction process has to be played back through equipment capable of handling the other half of the process, or it sounds pretty weird in places.

Finally, all of the common noise reduction processes are designed around custom chips which can't be obtained by the average dude. They like circuitry which is excruciatingly critical . . . in short, you just can't build a Dolby system from scratch.

But wait, don't unplug your soldering iron yet!

Psychoacoustic and other Hitchcocks

As noted a few paragraphs ago, you only hear the noise when there is nothing happening in the high end of the spectrum to cover it up. This is the basis of the Dolby system. However, there is another way to use this effect, one of which, as we'll see, leads to a pretty decent single ended noise reduction system.

To grossly oversimplify things, one approach to reducing the high frequency noise in a sound system utilizes a graphic equalizer and a friend who has unspeakably fast reflexes. The guy with the reflexes sits beside the equalizer wearing headphones and, should he detect that there is nothing much happening in the high end, immediately hammers all the high end faders down. If something of a more treble disposition appears, he turns 'em back up.

You could, of course, produce some sort of circuit to do this if you didn't have a friend to hang around and mind your stereo every time you felt like checking out the Grateful Dead. In fact, such circuits do exist. They're called DNRs, or Dynamic Noise Reducers.

A DNR is a voltage controlled low pass filter and a spectral content detector. The detector watches the signal and generates a voltage which is proportional to the highest instantaneous frequency at which there is any meaningful level of periodic (sound) energy happening. It holds the filter open enough so that the highest sounds can pass through unattenuated, and the noise gets chopped off.

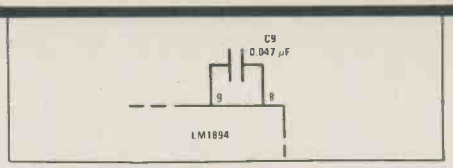


Fig. 2. If the multiplex filter is omitted, connect C9 across pins 8 and 9 as shown. Illustrations are courtesy of National Semiconductor.

The result of this is an application of a technique called psychoacoustic masking. In fact, it doesn't do anything for the sound from an electrical standpoint, but it does make things appear a lot more karmic to your ears. It stems from the observation that one sound can effectively "mask" another if the masking tone is sufficiently loud and removed spectrally from the tone to be masked. This also works with noise.

If you take a tone and add varying amounts of noise to it, it will happen that the tone will appear to vanish when the total energy of the noise exceeds that of the tone. It thus follows that if you increase the bandwidth of the noise that the overall amplitude can be smaller.

Of course, we're trying to mask noise with tones, rather than the other way around, but this is a trivial detail.

If you reduce the bandwidth of the noise that's masking the tone, with its amplitude remaining constant, then, you reduce the total noise energy, and, hence, its capacity for masking the tone. This can be interpreted as meaning that the tone becomes more audible as you reduce the bandwidth of the noise. This is effectively what the moving filter in the DNR box is for.

It is also useful to note that the ear cannot perceive distortion that lasts for less than a millisecond or so. Thus, the rapid swings of the filter one would expect to occur with complex music do gorch up the sound quite a lot . . . but your ear will never know it, because it all happens too fast.

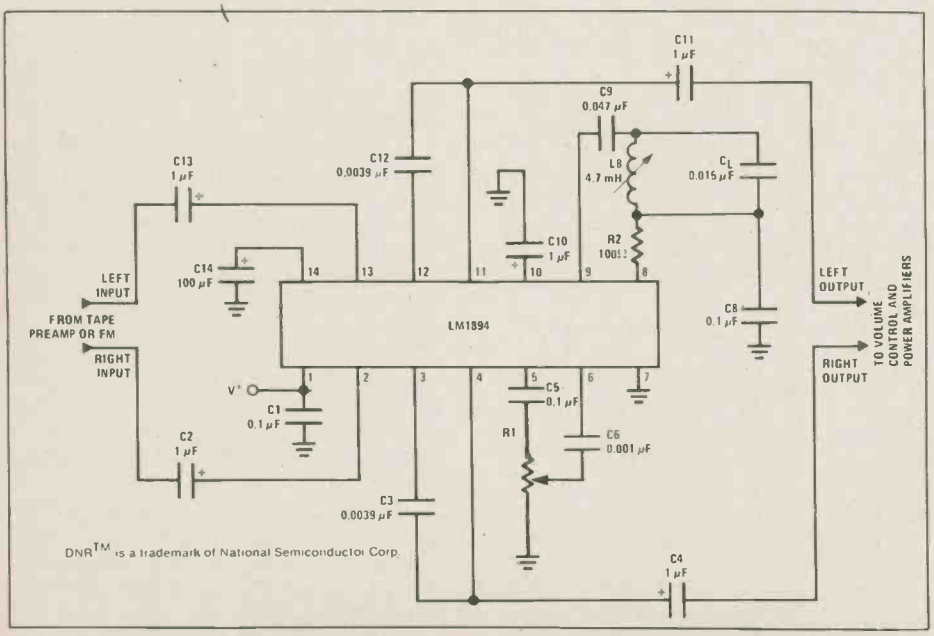


Fig. 1. The schematic diagram of the unit. L8, CL, C8, and R2 may be omitted if the FM multiplex filter is not required. See Fig. 2. ETI would like to thank Larry Clark of Canadian Micro Sales for his assistance in preparing this project.

Dynamic Tones

While DNR systems can be built from scratch, there is some fairly complex circuitry involved, and it is certainly not an easy thing to get one of them working properly unless you are really plagued with a lot of test equipment. Fortunately, it also isn't terribly necessary. Just recently, National Semiconductor turned up a specialized DNR chip, the LM1894. This little troll provides two channels of really fancy dynamic noise reduction with tight specifications, no weird parts and really simple external circuitry.

The circuit in figure 1 is a complete DNR stereo system built around a single LM1894. It produces 10 dB of effective noise reduction, although the apparent effect is rather greater. It runs on any supply voltage from 4.5 to 18 volts and has no critical adjustments. The single trimmer can be turned to its middle setting and left there for most applications. The circuit can be built on either Vero board or the PCB provided.

Figure 3 is an optional bandwidth meter. It uses a standard bargraph chip, the LM3915, and ten LEDs to show you what the instantaneous bandwidth of the filter is. It takes a bit of getting used to, because it does not show you the level of the signal.

In fact, there is no practical reason for having the bandwidth meter in the circuit at all. It can be left out entirely . . . unless you dig flashing displays.

The optional parts for the DNR circuit itself are only required if you intend to apply the box to an FM tuner. Many of these things don't filter out the 19 KHz FM pilot tone all that well and, while it would ordinarily never make it through your sound system, it will confuse the DNR box and cause it to keep its filter wide open all the time.

The DNR system can be built into any case you fancy . . . it's pretty tiny . . . or directly inside another piece of equipment. The prototype was done with a Hammond chassis box bolted to a 19 inch rack mount plate. This is a bit of a waste of space . . . you don't need anything like 19 inches to put the thing in . . . but it does keep the studio looking reasonably neat.

Plugging In

The DNR box should be patched into your system before the tone and volume controls so that it gets a line level signal unaffected by treble setting. It is remarkably forgiving of volume settings, and

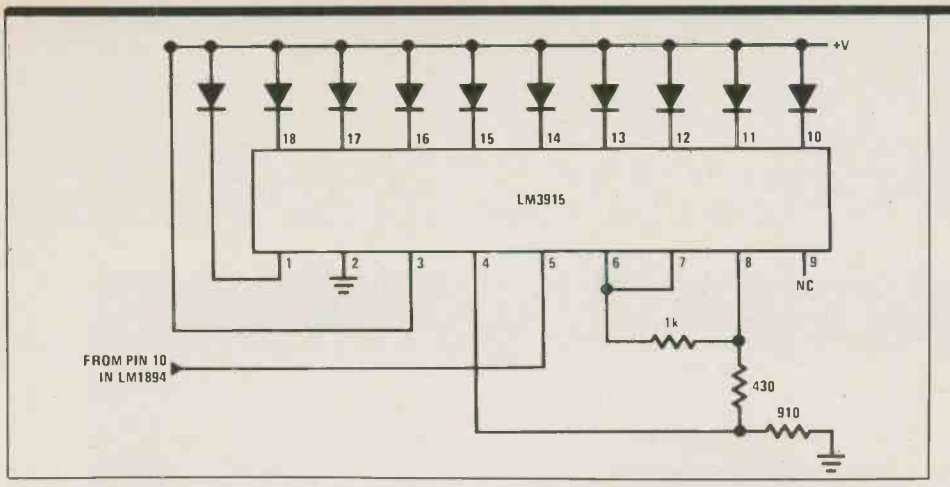


Fig. 3. The LED display circuit which displays the bandwidth of the unit. This display can be omitted.

most systems will take to it immediately. It will go a bit funny if you try hooking it in before your phono preamp or after the power amp, but most anywhere else should produce some sort of acceptable results.

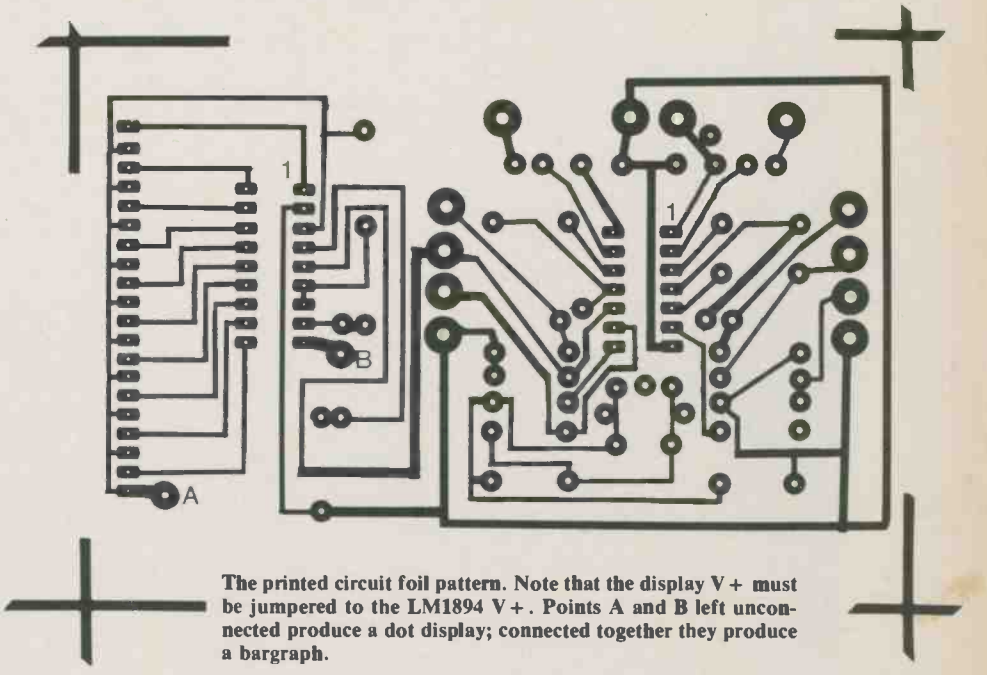
There are, obviously, no operating controls to fiddle with, with the exception of the power switch. The effectiveness of the DNR system is actually quite astounding . . . it doesn't pump, or do any of the unusual filter movement things one might expect. It also leaves the high end pretty well intact. However, it makes a great deal of difference in the perceivable noise.

Experiments using my 1946 Hallicrafters short wave radio and a really beat up Revox A77 tape recorder set to produce mega-tape echos (with well recycled noise bursts) have really given the DNR system a proper workout, and the sounds that emerged from it were a proper whiz . . . clean, sharp and without any unusual phasing noises.

There is only one really major caveat involved in using the DNR. It is tempting to try to cascade the two channels of the chip to obtain 20 dB of noise reduction. In fact, there is a National Semiconductor application note around that says you can do this. You can't. Well, okay, you can, but you'll be sorry. With both channels having a crack at the same sound source, the system does tend to pump, and the effect of the moving filter gets very, very noticeable.

The DNR box is a very simple and effective solution to a fairly complex problem. Despite its obviously short parts list, it functions very, very well. It's specifications are up to those of most home stereo equipment and semi-professional multitrack recording stuff.

Plus, the meter is neat to watch.



The printed circuit foil pattern. Note that the display V+ must be jumpered to the LM1894 V+. Points A and B left unconnected produce a dot display; connected together they produce a bargraph.

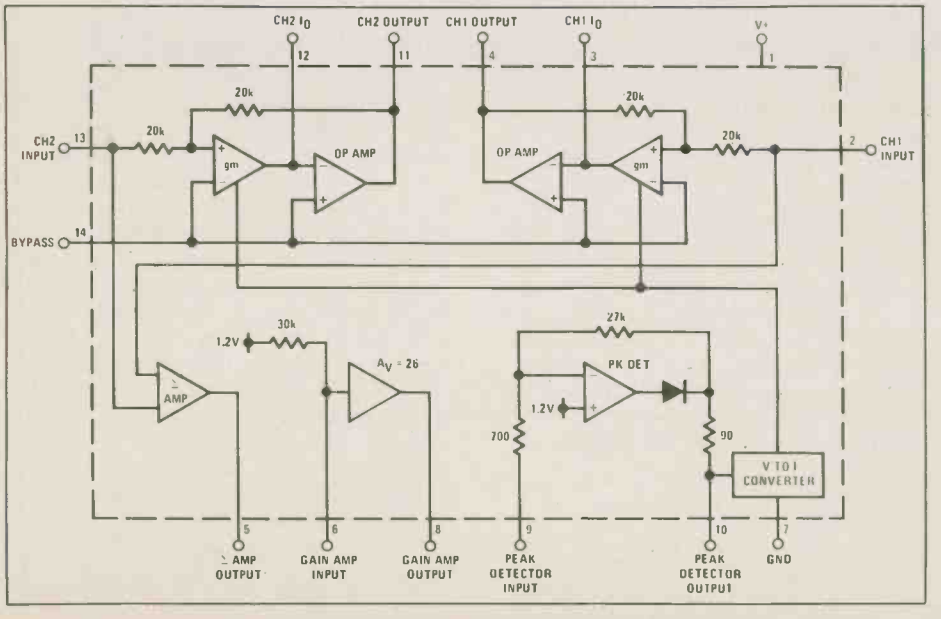


Fig. 4. The block diagram of the LM1894 noise reduction chip.

Powering Up

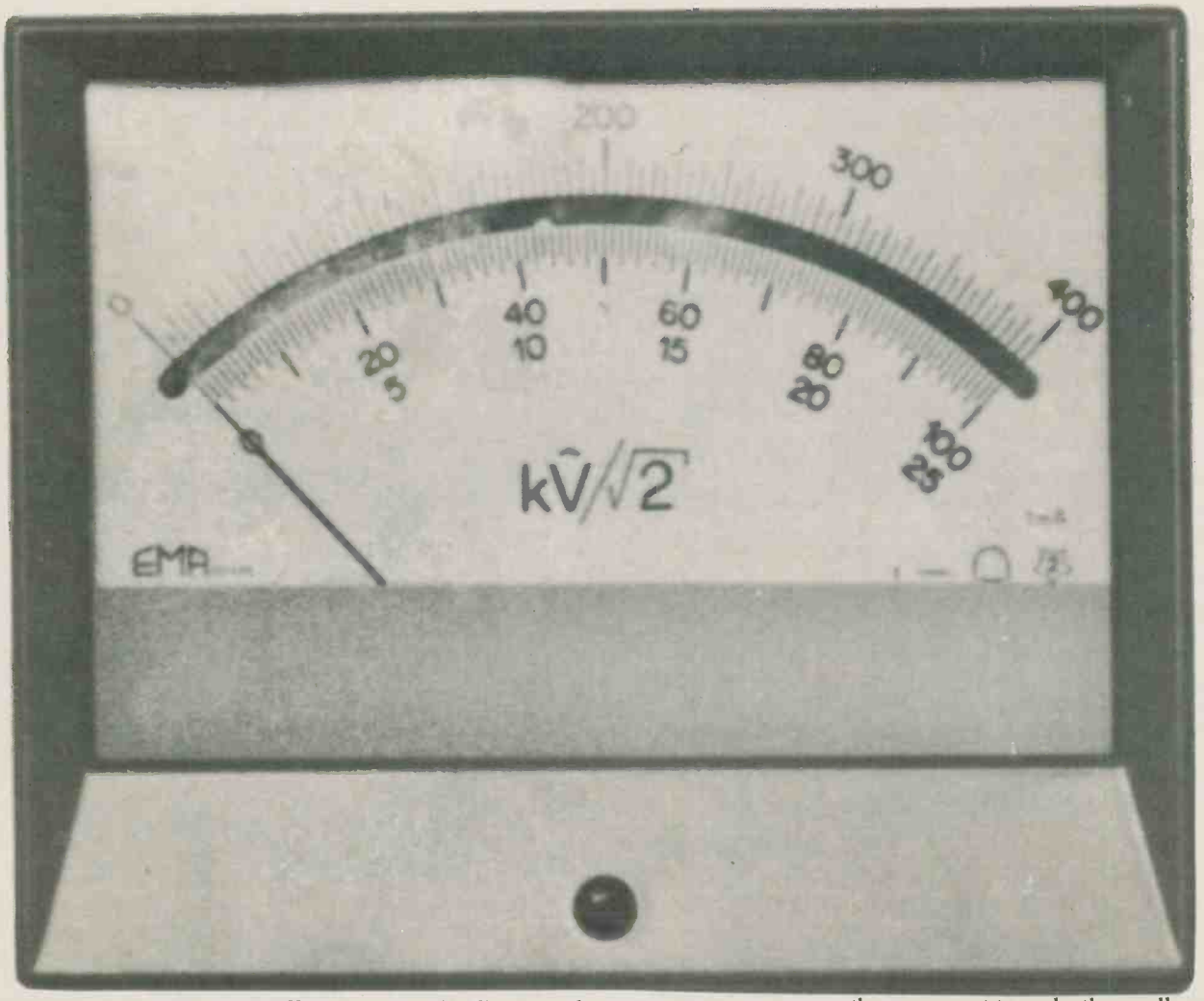
We used a 9 V DC plugpack from a portable radio, and no hum got through despite the output ripple. You can use one of these, from about 6 V to about 15 V, or you can tap off a DC feed from any preamp it gets installed in.

Calibration

This part is a cinch. As we mentioned, you can leave the trimmer set in its middle position and get good results. However, should you want optimum performance, National recommends playing tape noise (no signal) into the unit, and adjusting the trimmer until the first two LEDs come one. This sets the operation of the filter bandwidth threshold to suit the signal levels you'll be using.

Continued on page 22

Surplus Meters



Surplus stores often have a collection of various analogue meters. Here's how to adapt them to your own uses.

By David Thomson

SOME KIND of electrical measuring device is fundamental to all serious experimentation with electronics. Many readers probably own a volt - ohm -milliammeter (which I shall refer to as a VOM), costing anywhere from $10 to $150 or so. This article will dig into the construction of the meter "movement" itself, which may help you to repair that old VOM instead of buying a new one, or perhaps to make use of some cheap surplus meters for your next project.

The d'Arsonval meter movement used in most cheaper VOM's has been around for 100 years or so with very little change. It consists of a needle attached to a coil of wire pivoted so it can rotate in the field of a strong permanent magnet. Current is passed into the coil through the springs which also serve to hold it at "zero" when no current is present. Notice that I mention current, not voltage. This type of meter actually measures current, and to make it read volts, watts, degrees celsius or revolutions per minute depends upon external circuitry. The same goes for measurements of AC (alternating current or voltage).

Principles Of Operation

Two important properties of any meter movement are full-scale current and full-scale voltage drop. These refer to the current which must flow through the coil of the movement to make the needle point to the maximum reading on the scale, and the corresponding voltage across the meter movement terminals at that time.

The ideal meter movement would have a low-resistance coil, a low full-scale current, low full-scale voltage drop, low friction in the pivots and low cost. A real meter may have one or more of these qualities, but not all. For example, a low full-scale current may be achieved by increasing the number of turns of wire in the coil. However, this will increase the resistance (and voltage drop) as well as the weight. To reduce weight, we would prefer to use finer wire for the coil, which increases resistance again. A low friction suspension helps to reduce full-scale current but adds to the cost. That is why you cannot pick a meter movement at random and expect external circuitry to make it do what you want.

Now let's look at the "external circuitry", which for DC measurements consists of resistors connected in series of "shunt" (parallel) with the meter movement. Two examples should clarify what is required.

Suppose we have two identical meter movements, and for ease of calculation let's assume that each has a coil resistance of 50 ohms and a full-scale deflection current of 1 mA. The voltage across the terminals of the movement at full-scale deflection will be 50 millivolts, that is, 50 Ohms X 1 mA = 50 mV (see Table 1).

Voltmeter On The Cheap

Let's use one movement to build a voltmeter which reads 10 V at full-scale. All that we need add is one resistor in series with the movement to limit the current:

10 V / 1 mA = 10 K ohms

To be precise, we might expect to subtract the coil resistance of 50 ohms and look for a resistor of 9950 ohms, to connect to the meter movement as shown in Figure 1. In real life, you won't find a 9950 ohm resistor, but 10 K is close enough. Commercial resistors are rated at 5%, 10% or 20% "tolerance", that is, the best 10 K resistor you can buy off the shelf (5% tolerance) may be anywhere between 9500 and 10500 ohms, and the completed meter will be accurate within .5 V.

"Sensitivity", measured in "ohms per volt," is an important property of a voltmeter because it indicates how much effect the use of that meter will have upon the circuit being measured. Our meter will have a sensitivity of 1 K ohms per volt; this is a function of the meter movement itself, no matter what series resistor we use.

1 V / 1 mA = 1 K ohm per volt

A sensitivity of 20 K ohms per volt (50 micro-amps full scale) is about the best you will find in a D'arsonval meter, unless you are lucky enough to find a "taut band suspension" meter. These may have a full-scale current as low as 1 micro-amp!

Thoughts

Let's use the second meter movement to build an ammeter with a full-scale deflection of one ampere.

Since the meter movement itself cannot carry such a large current, we will provide a parallel path called a "shunt" to carry most of the current — 999 mA, to be exact (see Figure 2). Using Ohm's Law again, the shunt resistor should have a value of:

50 mV / 999 mA = .05005 ohm

You can't buy that in your neighbourhood store, but you may find it at an electrical supplier under the name of "1 Amp 50 mV shunt". For other than 50 mV, a standard value, there is no chance. A cheaper solution (why pay more for the shunt than you paid for the meter?) is to

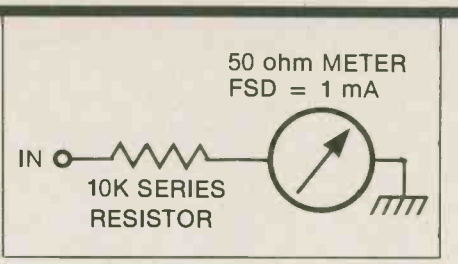


Fig. 1. A 0 to 10V voltmeter from a 1 mA meter movement.

build your own shunt. From wire tables, we can find out the resistance in ohms per 1000 feet of any gauge of copper wire we may have on hand. The trick is to be sure you know what gauge it is. If you have a choice, choose a gauge which will make the shunt wire about one foot long. And if the wire is not insulated or enamelled, it will have to be wound very carefully so the loops do not touch.

Refer to Table 2 for the next step, which is the calculation of the length of the shunt wire. (A "mil" is 1/1000 inch, that's .001).

Let's say you have bought a spool of No. 30 (30 gauge) wire-wrap wire for your shunt. From the table, you will need:

(.05005 ÷ 103.2) x 1000 x 12

which works out to 5.82 inches.

Use an ordinary resistor as a form for your shunt; pick one at least ten times the final resistance of the shunt, and a physically suitable size. Wind the shunt wire around the form and solder both ends to the resistor leads.

For greater precision in your final product, you may want to read Reference 1, which suggests a way of calibrating your meter against a second meter which you are sure is correct. That may be hard to do where currents of one or more amperes are involved; it all depends on the contents of your junk box. With patience, you can set surprising accuracy from surplus equipment, which is often of high quality, but if the meter is just a means to some other end, don't spend too much time building it.

Notice that for voltage measurements requiring high sensitivity, the full-scale current requirement of the meter movement is critical; for current measurement, the full-scale voltage drop is critical. A typical VOM is a compromise, which may not work too well on low voltages or currents over about 250 mA.

If sensitivity is important to you, read up on simple DC amplifiers (you might try Reference 2, although I have not built that project yet). It is undoubtedly cheaper than stalking the perfect meter movement.

Shopping For A Used Meter

A few suggestions, not necessarily in order of importance:

Look for small print in a corner face stating FSD = 1 mA (full scale deflection = 1 milliamp) or 001DCMA, which also appears to mean 1 mA, or FS = 200*u*A (the *u* is really a Greek "mu" meaning "micro" or 1 millionth), and if you are lucky, coil resistance in ohms. If FSD is less than 1 mA, assume the resistance is over 100 ohms.

If you can't find these figures, look at the meter scale. If it is calibrated in a milli-volts or milli- or micro-amps, that *may* apply to the meter movement itself. If calibrated in amperes, it very likely has an FSD of 50 millivolts; it may even be labelled "use 50 mV shunt". If calibrated in volts, who knows?

Look at the face and consider how easy it will be to make it look good on your project. For example, changing a 0-500 scale to read 0-5 is easy; buy some white correcting fluid and cover the zeros!

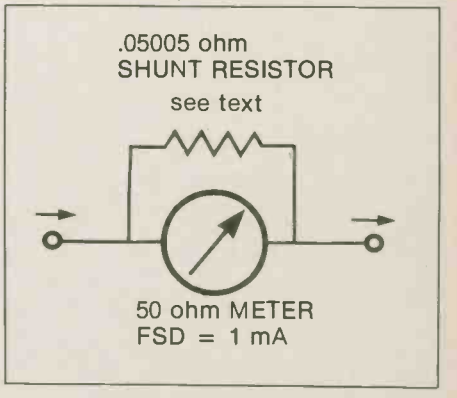


Fig. 2. A 0 to 1 A ammeter from the same movement.

Do not be too pessimistic about the funny scales which are printed on the surplus meters you find. With some patience and care, you can re-design the face of the meter to read whatever you want. I suspect the ones that are calibrated in gallons or feet above sea level are slightly cheaper because people who have not read this article don't know how to make use of them. So you are at a definite advantage! However, taking apart a meter to give it a new face must be done with care. It is very easy to bend or break the needle, bend a spring or lose a tiny screw which you can't replace. If you have more thumbs than fingers, you might be better advised to let it be, unless it was *very* cheap. I once had a perfectly good battery charger for my car which had a meter calibrated in "knots"!

Although the advent of micro-electronics has given us alternative ways of making precise measurements, the basic d'Arsonval meter still has a fascination for the experimenter. And if your budget is limited, surplus meters can give you more for less money.

Surplus meters

TABLE 1

Consistent Units for Ohms's Law

V = I x R, where all units are taken from the same line of the table:

V	I	R
V (volts)	A (amperes)	Ohms
mV (millivolts)	mA (milliamps	Ohms
V	mA	K Ohms

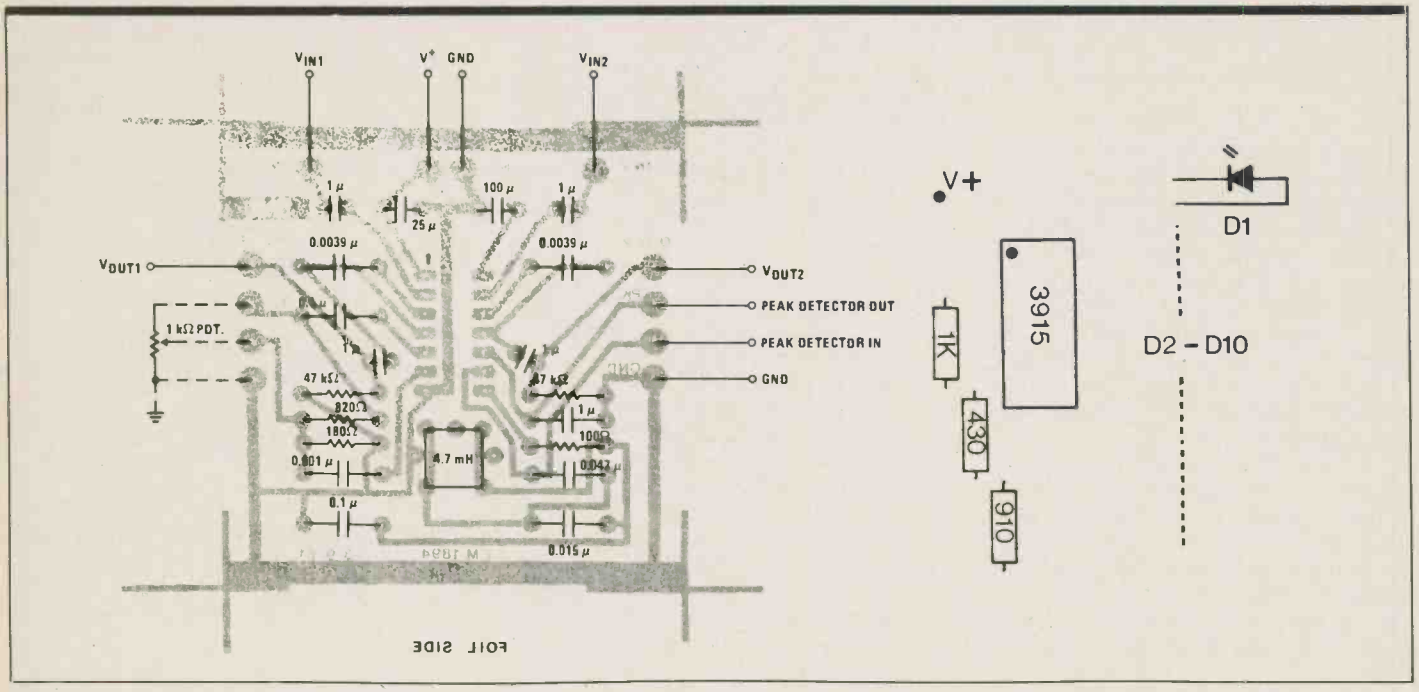
Gauge in mils	Diameter 1000 ft.	Ohms per 1000 ft.
24	20.20	25.67
25	27.90	32.37
26	15.94	40.81
27	14.20	51.47
28	12.64	64.90
29	11.26	81.83
30	10.03	103.20

REFERENCES

1. Increase Your Analog Meter's Range, by John Bailey. Popular Electronics, October 1982, page 72.

2. High Performance Op Amps, by Ray Marston. ETI, August 1982, page 50, figure 3.

Noise Reduction Unit



The component location for the noise reduction chip and display circuit.

PARTS LIST

Resistors (¼ W, 5%)

R1	1K ohm linear trim pot
R2	100 (see text)
R3	1k
R4	430
R5	910

Capacitors

C1	25 *u*, 16 V tantalum or electro.
C2,4,10, 11,13	1 *u*, 16 V tantalum or electro.
C3,12	0.0039 *u*
C5,8	0.1 *u*
C6	0.001 *u*
C7	not used
C9	0.047 *u*
C14	100 *u*, 16 V tan. or electro.
CL	0.015 *u* (see text)

Inductors

National Semiconductor designed the circuit for a coil which is unobtainable in Canada. We have substituted the Hammond 621 L. This is only necessary for the multiplex filter.

Semiconductors

LM1894 Dynamic Noise Reduction IC
LM3915 Level Indicator IC
D1-D10 Any size or colour LED

Miscellaneous

PCB, suitable case, power supply (see text), connectors if used.

HOW IT WORKS

There isn't a great deal to say that wasn't covered in the text; this very clever IC works it all out for you. The block diagram in Fig. 4 shows the interior of the chip. Both channels are summed, and the resultant signal converted to DC via various RC time constants chosen to minimize audible effects. This DC voltage then controls an electronic filter to open and close the bandwidth as necessary.

Input pins 2 and 13 like to see a signal level of about 300 mV for optimum performance. The maximum supply voltage is 18 V. Supply current will be about 17 mA for an 8 V supply. This does not include current drawn by the LED display, if used.

If the display is included, note that its power supply pin must be jumpered to the V+ of the DNR. A single-dot display results if points A and B (on the foil side of the PCB) are left unconnected; a bargraph displays results if they are linked together.

The multiplex filter may be omitted if the DNR is not used with FM broadcasts. C9 must still be included across pins 8 and 9.

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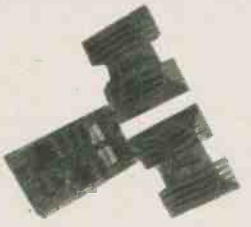

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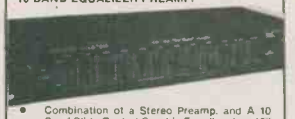

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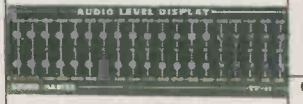

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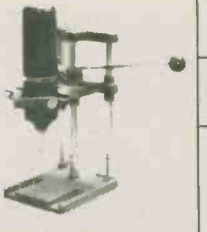

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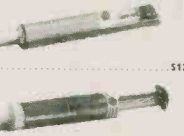

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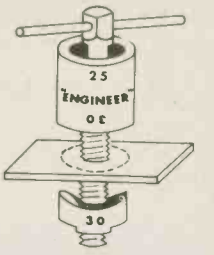

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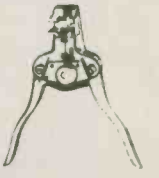

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Computer Review
VZ200

The VZ200 is a fairly efficient box for its price range, although its rubber keys make one wonder when the cartons of de-erasered pencils will begin to show up in stationery stores across the country. Steve Rimmer sat down for a closer look.

IF YOU BUILD a cheap, really powerful computer, the world will beat a path to your door. However, before you get out the pile of four-bit microprocessors you've been keeping in old shoe boxes for just this occasion, you should probably consider a few things. First, and most important, do you want a path beaten to your door? What will you do with the world when it gets to your door? Who will pay for the azaleas they trample?

You never think of these things when you're inventing stuff. That's why public relations firms make so much money.

The VZ200 is really first rate path-beating material. It has all the elements of cheapness and, unlike previous cheap computers, which shall remain black and nameless, some real power. It won't do half the things computers are said to be good for, but then it doesn't cost a tenth as much as those that will.

Eraserhead

The basic VZ200, costing about one hundred and eighty dollars, lives squarely in the range of the low cost boxes. However, unlike many such systems, it has not been trimmed to the ultra-minimum. Its Z-80 processor looks out at 4K of RAM, nine colours for its display, a sound generator, a reasonably powerful Microsoft BASIC with screen editing and something like a reasonable keyboard. It's fairly ruggedly built and overall a better trip than systems like the ZX-81 and even the Micro Colour Computer we looked at last month.

Setting up the VZ200 is about as simple as humanly possible. It can be associated with either a TV set or a monitor . . . there are RCA jacks for both eventualities. It likes a nine volt power supply and a cassette recorder . . . a patch cord, with mini-phone plugs is supplied. It powers almost instantly.

Unlike the pictures on the box which enshrouds the VZ200 at birth, the screen display does not spread across the full face of the tube, but, rather, lives in a square

that occupies about the middle two-thirds. The characters are upper case only, but the picture is pretty sharp and stable.

The standard character display is sixteen lines of thirty-two characters. The display is handled by a 6847 CRT controller, pretty well a standard worky among low cost systems. However, this little box has squeezed out rather more of its features than many.

In addition to being able to do characters on the screen, the VZ200 has real authentic bit mapped graphics in two modes. The first is a medium resolution trip which allows you a display of sixty-four blocks across by thirty-two rows. You can plot the blocks in green, yellow, blue, red, cream, light blue, magenta and orange against a background of green or orange. In the high resolution mode, you get one hundred and twenty-eight dots across by sixty-four dots down, but with a rather more restricted colour scheme.

The sound generator in the VZ200 is rather better than many in that it is programmable in intervals. That is, it only generates tones which correspond to a properly tempered scale. If you decide to play actual music, it will wind up sounding reasonably decent, and you can do things like simple transposition by just adding an offset to the sound values, since they are all sequential.

Not that the scale is all that properly tuned, but it's close.

The sound generator also features eight levels of programmable duration, plus a rest. What a trip.

The only part of the hardware which is a little funky is the keyboard. No, in fairness, it's very funky. One might even say ginchy, if one were so inclined. The keys do actually move up and down, unlike those on a membrane type keypad, but they are fairly strange. They appear to have been made from the same material as one finds in the space occupied by art erasers, making them extremely soft. They have one of the worst tactile feedback situations of any key design going, and as such, it is fairly easy to hit double characters, or to fail to hit anything if you aren't watching the screen. As is usually the case for systems which have strange keyboard designs, the thing bleeps every time a key goes down to give you some sense of what's happening, but this is of limited help. You also get sick of the bleeps shortly.

In fairness, this computer's low price-tag comes, to a large degree, because the keyboard is so slimy. In a system of this sort, the mechanical features are what cost.

One really freaky aspect of the keyboard which I happened upon is its propensity for getting some of the keys caught under the lip of the escutcheon that holds the legends for the keys. Inasmuch as the keys auto repeat, this will result in a long, rather mysterious train of characters pouring out onto the tube. This, while not serious, is a bit strange the first time you encounter it.

Draw, Sheriff

Programming the VZ200 is not nearly so uncool as you would expect it to be. First off, there is single stroke entry for the keywords. This means that one simply munches down the control key and a single alpha-numeric key and the chosen BASIC rune pops up on the screen. The runes are embossed above and below the keys, and you can get familiar with their positions soon enough.

The keywords are also fairly cleverly done up to avail one of a minimum of typing. For example, the function to plot a point on the screen is SET (X,Y). The single stroke entry types "SET (" . . . in other words, they've saved you typing the opening bracket. These sorts of things bespeak some degree of human engineering.

The other thing which will make using the system quite a lot easier is the on-screen editing. While most systems, even most of the expensive ones, require that one edit lines of BASIC program by using an EDIT command, or even, in some cases, by retyping ill thought-of lines, the VZ200 allows one to cursor up to the offending statement, make changes to it and then just hit a carriage return to enter the line back into the program memory. This makes developing programs considerably easier, and considerably less frustrating.

It also allows one to better utilize the VZ200's limited allotment of RAM, as it facilitates using multiple statements on a line without having to sweat over editing them.

The BASIC for the computer is actually fairly good, considering the price. It is fairly fast . . . the processor runs at 3.58 megahertz (one crystal fits all). It is exactly like other Microsoft BASICs in its syntax, and, as such, most extant literature will be applicable to it. It supports virtually all the standard simple BASIC statements and functions, plus, of course, a few that are peculiar to itself.

Variables on the VZ200 can be in floating point to five places; integer, with no rounding; strings of up to two-hundred-and-fifty-six characters in length and arrays of up to three dimensions with a theoretical two-hundred-and-fifty-six elements in each dimension. I say theoretical because the RAM in the system isn't anywhere near close to big enough to allow this much data to be stored. The system seems to be a bit slow handling complex floating point numbers, especially if it has to round them.

There is a full set of string variable manipulation functions on the VZ200, which allow one to find the length of a string, to chop characters off either end of one, (or out of its centre), to print characters from numeric values and to find the ASCII values of strings. Keyboard input of strings can be handled using either INPUT or INKEY$, the latter returning the status of the keyboard and one character if one was inputted while it was checking things out.

The BASIC includes moderately sophisticated screen formatting routines. Not only can it PRINT, but it can PRINT @, being printed at a specified X,Y position on the tube, and PRINT USING, for formatted output. If you associate a printer with it, it can LPRINT and it can dump a formatted screen to a printer using COPY. There is also a LLIST command to dump the program to the printer.

The system also supports and IF...THEN...ELSE decision structure, which is uncommon on cheap computers. This allows you to specify both consequences of a decision in one shot, such as

```
IF A$="FOOTBREATH" THEN B$="ARNOLD" ELSE B$="TOENAIL"
```

You can synthesize this as

```
B$="TOENAIL" : IF A$="FOOTBREATH" THEN B$="ARNOLD"
```

on other computers, but this approach is faster and takes up less RAM for variable manipulation.

The important part about any computer, however, is probably not how many nested GOSUBs you can have (it's two-hundred-and-twenty-eight when the machine's empty, actually, just in case it does turn out that this is the important thing after all). No, the real trip is how hard it is to draw aliens.

The graphics functions on the VZ200 are . . . well, "simple" seems fair. At any given time you have a foreground and a background colour, as set by the COLOR statement. Yes, that is COLOR without a "U" . . . we're being culturally trampled again. Thereafter, coloured dots, or pixels, can be plotted in the foreground colour against the background colour by using the SET (X,Y) command. They can be unplotted, or returned to the background colour, using the RESET (X,Y). You can tell which state any point on the screen is in using POINT (X,Y).

In addition to all this graphics splendour, the VZ200 has a small set of eight printable block graphics characters reminiscent of those on the ZX-81. As the system is also capable of printing in inverse video, you effectively get sixteen of them, which is a good trip for doing borders, frames or symbols.

Unlike most Z-80 based machines, the VZ200 has a memory mapped screen. What this means is that you can directly access the memory that holds characters for display on your tube. This is a splendid trip for doing games when you need a reasonable amount of speed.

One unusual thing about the screen of the VZ200 is that it is handled in much the same way as that of the Commodore machine . . . perhaps not surprising, in that Microsoft wrote both BASICs. If you PRINT character number sixty-five to the screen, this being the letter "A", you get an "A" on the screen. If you then look at the location which stores the A you've printed, you will get . . . one. There is a discrepancy in the character set that's printed and the actual values that are stored.

This is not a major problem, but it does make for some interesting programming challenges as you get into things.

What's Up, Doc

The VZ200 comes with a fairly decent manual which explains all of its commands and functions in reasonably concise English. It's a little hard to use in that it's bound cheaply and is printed on heavy paper that is hard to flick through. However, this is passing trivial, and all in all, the computer should pose no initial comprehension problems for anyone capable of figuring out which part of the TV to watch.

There appears to be a limited library of software available for the VZ200, all, at this writing, from the manufacturer. The games are fairly good . . . they won't keep you out of the arcades, but they do utilize the capabilities of the computer quite well, and are kind of neat.

The VZ200 has two "expansion" openings in the back of its case, one to accept a memory expansion box and the other for a peripheral of some unspecified nature. This would likely be a printer or a modem. I do not know of any peripherals available for the system at this time . . . some may have sprung upon us by the time you read this.

While I would not want to try to do anything serious on the VZ200, it is not a half bad beginner's system by any means. Being really cheap it can be outgrown without pain, and, at the same time, its ease of use and relatively rich BASIC will make it a pretty decent learning experience.

Argh, Billy, me boy, it'd be a fine thing te' 'ave abord the ship. If'n I be makin' any blunders in the writin' o' the captain's log ye' can erase 'em with the keyboard . . .

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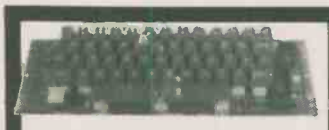

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Improving Your ZX81

In the first of an occasional series on mods to popular computers, Ian Ridout gives details of how you can improve the reliability of SAVEing programs on tape.

SINCE THE ZX81 Sinclair personal computer was introduced, over 400,000 have been sold throughout the world. In technical journals and magazines it has been acclaimed by most critics as ideal for self-tuition in the BASIC language and an excellent introduction to computing. By all accounts it represents unequalled value for money both on its own, with just 1K of RAM memory, and also when the 16K RAM plus printer are added.

However, there are three main complaints about the ZX81:

- the mechanical instability of the add-on units can cause a brief disconnection leading to the loss of either TV picture synchronisation and/or loss of the stored program and data;
- an unexplainable loss of program and data (i.e., a crash);
- unreliable tape storage of programs.

The first complaint can be overcome by making an extension lead so that movements of the individual units can be tolerated without causing momentary memory pack disconnections. However, only the 16K RAM pack should be plugged into the extension; the printer should still be plugged directly into the back of the ZX81. It is necessary to keep the extension lead short (less than 6") or the effect will be to make system crashes occur more often, probably owing to increased capacitive loading and hence memory access delay. Also it is essential to keep the rear edge connector on the computer board clean, using mineral spirits and cotton swabs.

The second problem could well be an internal software fault which is therefore not alterable by ZX81 users. Alternatively, the power supply regulator could be getting too hot because the unregulated input voltage is too high. I decided that it is better to bolt a much bigger aluminum heatsink to the existing heatsink rather than modify the external power supply. The reason for this is that reducing the regulator's overhead can spoil its functioning, and therefore you end up with the same problem. The size of the additional heatsink was such that it fitted neatly under the entire keyboard area, hence also eliminating a hot-spot under the left-hand end of the keyboard.

This article describes the steps taken to make the recording of programs onto tape and the loading from tape considerably more reliable.

The Tape Storage System

The IC pin which is used to supply a signal to the TV modulator is also used to supply the signal for tape storage purposes. Consequently, if you connect an audio amplifier and loudspeaker to the 'tape out' (i.e. MIC) socket, during normal computer usage you will hear a continuous buzzing sound. The video signal from the IC to the modulator consists primarily of high frequencies but most of what you hear is the television frame rate and its harmonics. The output level of this buzzing sound can be used as a very rough indication of whether there is sufficient signal coming out of the MIC socket to allow reliable recordings to be made with your particular tape recorder. However, this method is rather poor because the true signal that is recorded is of much higher frequency than that of the buzzing sound.

When you press SAVE (plus NEWLINE) there is a period of several seconds during which the TV screen goes blank and nothing appears at the MIC socket. After the pause, audio frequency tones are emitted from the IC output pin for recording onto the tape. The picture on the TV screen becomes alternate bands of black and white dashes (data), and black (pauses).

At the end of the recording sequence the IC output signal returns to being a compatible TV video signal, hence a buzz is recorded and the picture on the TV screen returns to normal.

The Present Circuit

The tape recording circuit used in the ZX81 consists of just two resistors and two capacitors (Fig. 1) forming a band-pass filter with a band peak at about 3.4 kHz. The filter response rolls off each side of this centre frequency at 6 dB/octave (20 dB/decade).

The response shape of this filter is perfectly acceptable for this application but the characteristic that makes recording unreliable is the low output signal level at the MIC socket. With about 4 V peak-to-peak coming out of the IC, a signal of only 2 mV appears at the MIC output socket even with this socket open-circuit. This is because the filter components give a resistive attenuation of 100 to 1 and because a further halving of the signal takes place owing to the filter shaper. The response of this filter is given in Fig. 2, the axes being plotted with logarithmic scales.

A signal of 2 mV is insufficient to drive most recorders with manual recording-level control and is not high enough to give an adequate signal to tape-noise ratio on recorders with automatic level control.

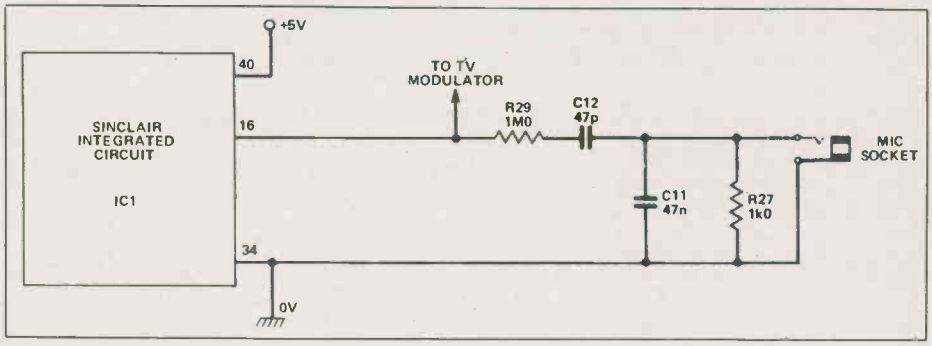


Fig. 1. Original tape-recording circuit.

Circuitry Modification

To ensure reliable tape recording, it is necessary to amplify the signal by at least 10 times and preferably 100-200 times. This could be achieved by connecting a suitable amplifier of the appropriate gain on the output of the Sinclair filter. However, with such a low signal level, it is possible to pick up interference along with the signal, so one would need to be very careful with the layout of the amplifier input wiring and the power supply to the amplifier.

Because of the high signal level and the large bandwidth of the signal at the IC output, it is not practicable to put an amplifier before the filter. It is therefore necessary to redesign the filter connected

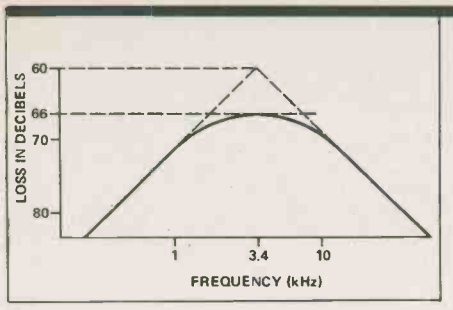


Fig. 2. Response of tape output filter.

between the IC output and MIC socket. The design has to present the original high impedance load to the IC output pin, and preferably should present the original output impedance to the MIC socket although the latter is not essential. Also, the same filter shape has to be preserved but the output signal level has to be considerably higher than the 2 mV presently available. Naturally, it is also an aim to keep the cost of the modification to a minimum.

The result of fulfilling these requirements was a circuit using a cheap junction field-effect transistor (FET) as a source follower, and a few extra resistors, costing in all less than $2. The circuit also has the advantage that the output signal at the MIC socket is not inverted, although this is not essential.

The new tape-recording circuit is shown in Fig. 3. R40 and R41 ensure that the IC is presented with the same resistive load as in the original circuit and C12 gives the same low-frequency roll-off. The DC biasing requirements of the FET dictate that with the gate connected to the negative supply rail, the value of the source resistor should be about 4k to obtain about 2 V DC on the source. Consequently, to achieve an output resistance in the order of the original 1k0, the output is taken from a tap halfway down the source resistor.

The output needs to be AC coupled, hence the need for the 22*u* electrolytic capacitor. The 47n capacitor C11 could have been connected directly across the 2k0 resistor R43 but it was more convenient to leave it in its original physical position on the PCB directly across the MIC socket.

It was not found necessary to feed the drain of the FET via an RC decoupling network, so the drain was connected directly to the regulated +5 V supply, the drain current being about half a milliamp.

The values of R40 and R41 need to be set according to whether the cassette machine is of the automatic or manual record level type (see Table 1). Most machines likely to be used for this application would be of the automatic record level type so R40 and R41 should be set to 910k and 91k respectively. If the record level is too high and overloading takes place, reduce R41 to about 15k. For manual record level machines these resistors should be set to 510k each. The sum of the values of R40 and R41 should be between 900k and 1M1 in order to preserve the filter characteristic.

Doing The Modification

Advantage has been taken of spaces for components on the PCB which are not used in the UK version, namely R30, 31, 32 and D9. Three of the original components need to be removed and only one of these will be used again. The new layout is shown in Fig. 4 but reference to the photograph will assist.

Make the modification as follows: pull off three of the four rubber feet, leaving the one nearest to the TV output socket. Remove the five screws on the back of the case and note that the two short screws come from under the feet under the keyboard. Remove the back of the case.

Remove the two screws holding the printed circuit board to the front half of the case. Carefully raise the PCB ensuring that the strip-connections from the keyboard are not strained and are disturbed as little as possible. DO NOT remove the keyboard connection strips from the PCB sockets because they are not easy to reinsert.

Locate and remove R27 (1k0) and R29 (1M0). These two resistors will not be used again. The position that R27 occupied will be left empty. Locate and carefully remove C12 (47pF, positioned between C10 and C11). This capacitor will be used in the new circuit.

Before continuing, refer to Fig. 4. Insert the two 2k0 resistors R42 and R43 into the positions marked on the PCB as R31 and R32. Insert one end of R40 (see Table 1 for the value to be used) into the left-hand hole vacated by the removal of R29. Insert one lead of C12 into the right-hand hole vacated by the removal of R29.

TABLE 1

	R40	R41
Manual recorders	510k	510k
Auto level recorders	910k	91k*

*See text

Solder together the remaining leads of R40 and C12 above the PCB, keeping their leads short.

Insert the positive end of C15 (22*u*) into the hole shown in Fig. 4. This hole is the one between EAR socket and the modulator which has a PCB track joining it to the two left-hand ends of R42 and R43. Solder the negative end of C15 to the left-hand hole vacated by C12. C15 should be positioned above, but not touching, the EAR socket. Do not be tempted to position C15 in the space between C10 and the modulator because one of the PCB support pillars occupies this space.

Solder the drain of the FET to the hole next to the right-hand end of C11.

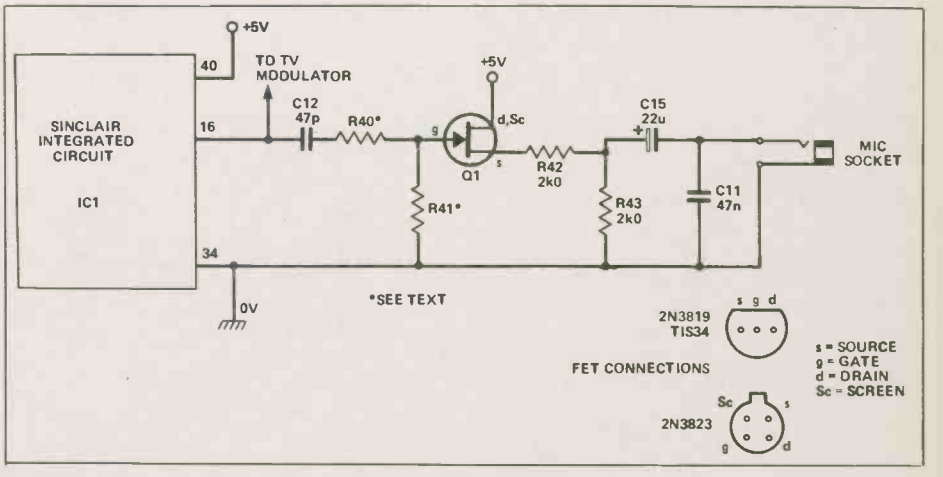


Fig. 3. New tape recording filter circuit.

This is a plated-through hole which is connected to +5 V. Solder the source of the FET to the right-hand end of the position marked on the PCB as the cathode end of D9 (not used in the UK version). Position R41 (see Table 1 for its value), so that it is to the right of the FET. Its lower lead is soldered into the left-hand hole of the component designated as R30 (not used) and its upper lead is soldered into the right-hand hole of the position previously occupied by C12. Solder the gate of the FET to the upper lead of R41.

After cutting off all excess leads and thoroughly inspecting all new solder joints for solder blobs and tracking between adjacent holes, put back the two short screws holding the PCB to the front cover. They are the ones near the regulator and half-way along the rear ac-

Continued on page 69

Signal Line Tester

If you're a PA person, here's an incredibly simple device to prevent embarrassment when all you can give them is the sound of silence. Design by Vivian Capel.

THIS PROJECT came about as a result of a very unfortunate incident. The author was in charge of a large public-address system that had been temporarily installed to cater for a public meeting with an audience of several thousand. There were spare microphones, spare inputs on the mixer, and to make quite sure, a spare mixer under the bench. Very little really could go disastrously wrong — but it did! Part way through the main speech everything went dead. Calm and reasoned diagnosis was employed (it wasn't really, but I couldn't admit to blind panic). Finally, after what seemed an age of silence from the speaker and murmurings from the audience, the fault was revealed as a dead short across the audio cable between mixer and amplifier rack.

Thus the fault-warning unit here described was conceived, embarrassment being the mother of invention! The idea was to constantly monitor the condition of a signal cable; if it should go either short-circuit or open-circuit, an appropriate LED would immediately light up to indicate what had happened.

The device could be used not only for public address applications, but any situation where a vulnerable signal cable needs protection by constant monitoring. A security intercom or telephone link, for example, could be monitored to reveal a fault or tampering as soon as it occurred, and avoid the need for frequent testing.

Requirements

To utilize the device successfully, the normal signal for which the cable is used must be AC. Furthermore there must be a DC path or load resistor at the far end of the cable to pass the small open-circuit mode sensing current. The input to the amplifiers or other equipment at the far end must be AC-coupled; otherwise the input stages could be affected by the DC monitoring potentials. As a rule, these conditions are met in most slave amplifiers by the input gain control and following coupling capacitor. Should the capacitor come first, a load resistor must be added across the input socket.

In considering the design, several features were deemed desirable. First, the value of the load terminating the line should not be critical. While false indications can be obtained under extreme load conditions with the circuit eventually evolved, there is a wide latitude in load values and no false alarms will be obtained within the specified limits. The nominal load for which the circuit was designed is 10k, but variations up to 20k and down to under 1k0 can be tolerated. This will accommodate most applications, but other values could be obtained by changing the values of the three resistors from those given.

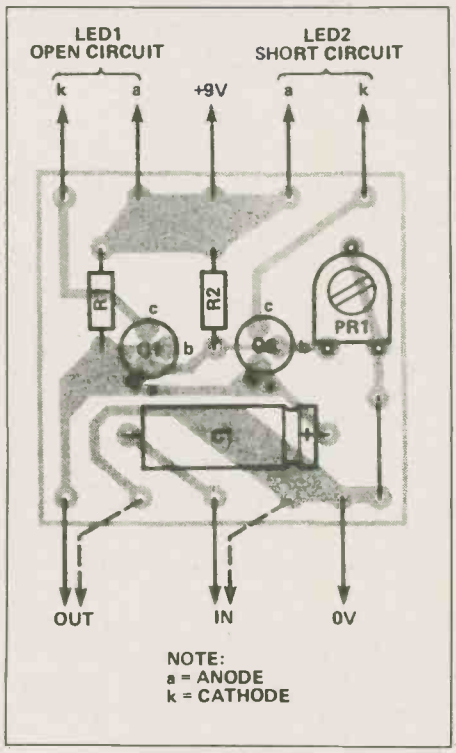


Fig. 1. Component overlay for the line checker. The line below PR1 may be replaced by a resistor — see text.

Second, the circuit must take very little current, as it is active for the whole time the mixer is switched on. A current of 1 mA was stipulated as the maximum allowable in the quiescent mode. This meant that few active components could be used, and that they had to be non-conducting until a fault condition occurred.

Third, the unit should be as simple as possible; far too many electronic circuits at present are needlessly complicated. In this case simplicity was pursued not merely for its own sake but as a fundamental necessity for fault monitoring equipment. It has to have a high degree of reliability if it is to be depended upon, and every extra component is one more that could itself break down.

HOW IT WORKS

The circuit diagram is shown in Fig. 1: we will consider the operation of the open-circuit indicator first. The emitter of Q1 is taken to the junction of R2 and PR1 which have values of 10k and 1k0 respectively, so the emitter is at a potential of one-tenth of the supply. The base of Q1 is connected to the junction of R1 (100k) and the load, which is nominally 10k; hence it too is at one-tenth of the supply voltage. Therefore there is no forward bias on Q1 as the base and emitter are at about the same potential, so no current passes through it and the LED in its collector circuit.

If the load now goes open circuit, the positive voltage on Q1 base rises since it is no longer tied down, so Q1 becomes forward biased, and current flows through LED1, illuminating it. Current limiting is provided by PR1 in the emitter circuit, which safeguards LED1.

The short circuit detector is built round Q2. The base of this transistor is taken to the R2-PR1 junction, and is at one-tenth of the supply; Q2 emitter is connected to the junction of R1 and the load, and so it too has base and emitter at the same potential and is cut off. Should the load become short circuited, the emitter voltage drops to zero which means there is a positive bias on the base. Therefore Q2 conducts and LED2 lights to indicate a short. Although there is no current-limiting resistor in series with LED2, the bias on the transistor can be adjusted by PR1 to give the correct current and desired illumination.

Note that neither fault condition affects the warning circuit of the other. If the load is short-circuited, Q1 base drops to 0 V while its emitter is still positive, so it is driven even further into cut-off. Similarly, if the load becomes open-circuit, the emitter voltage of Q2 rises above that of its base.

The capacitor C1 blocks DC from the sending equipment, should there be any, from upsetting the operation of the warning circuits and vice versa. It also prevents any DC path in the output of the sending device from shunting the load and rendering the open-circuit test ineffective.

Construction

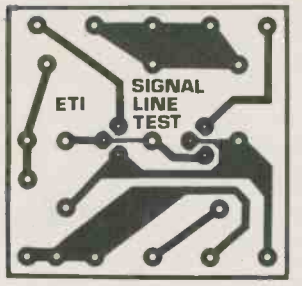
The original circuit was built into the mixer and powered from the mixer batteries, but construction and housing is by no means critical and almost any convenient form can be used. Input and output sockets can be standard jacks, Cannon XLR plugs or any suitable terminations appropriate for the equipment involved.

Before applying the battery voltage make sure that the variable preset PR1 is fully advanced so that maximum resistance is in circuit. If it should be fully the other way there will be no limiting resistance for LED1 and it could be destroyed. If preferred, the value can be split between a 500R preset and 560R fixed resistor for the sake of safety. Once set, the preset should not require readjustment, and so can be sealed with a spot of paint.

Connect a 10k load resistor across the output socket. If one is already fitted across a switched jack socket, this will not be necessary. On applying the supply, both LEDs should remain off. Disconnect the load and LED1 should light up. Now short-circuit the output; LED1 should go out and LED2 illuminate. It will be found that one LED is brighter than the other due to the differences in the h_{fe} of the resistors. Adjusting PR1 will produce equal brightness, so repeat the open-circuit and short-circuit test and adjust PR1 each time until the desired illumination is achieved. Decreasing the value darkens LED2 and brightens LED1 and vice versa.

Check that both LEDs are off with loads of 20k and 1k0. If LED 1 glimmers at 20k increase the value of R1 to 120k or even more if required. This may be necessary if Q1 has an exceptionally high h_{fe}.

ETI



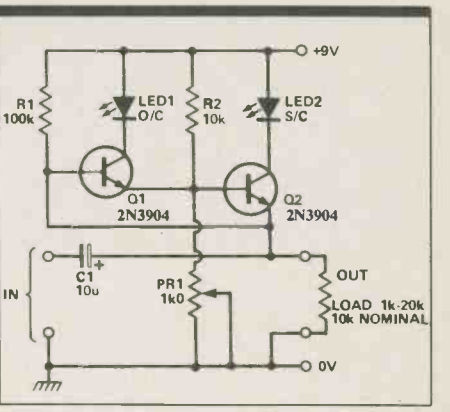


Fig. 2. Circuit diagram of the signal line tester.

PARTS LIST

Resistors (all ½ W, 5%)

R1	100k
R2	10k

Potentiometer

PR1	10k miniature horizontal trimpot

Capacitor

C1	10*u* 25 V axial electrolytic

Semiconductors

Q1,2	2N3904 or equiv.
LED1,2	3 mm red LED

Miscellaneous

PCB; case and sockets (if built separate from audio equipment).

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Fuses

A guide to the selection or replacement of the proper fuse to protect your expensive equipment. By Jim Essex.

THE HUGE growth of the electrical industry has caused the lowly fuse to almost rival the transistor in abundance and variety. There are sizes and shapes of fuses to fit any application, from circuits requiring slow-blowing types for motors to vibration-proof units for aircraft and mobile equipment. They come in a wide variety of amperage ratings: from a 2 mA SAG fuse designed to protect sensitive equipment to the 9AG with its 50 ampere rating for diesel trucks.

The purpose of the fuse is to protect against chain reaction; the failure of one inexpensive component may well cause the destruction of many others. Fortunately, we can buy protection against catastrophes for less than one dollar. Naturally, there are limitations; you must replace a blown fuse with the proper type -they aren't there just to annoy you. A friend of mine with a thousand-dollar solid-state voltmeter comes to mind. The fuse blew one day, and not having the required 1/16 ampere replacement, he inserted a *three* ampere type. As you can imagine, 48 times the current flow proceeded to melt the power transformer, rectifiers, noise filters, and some of the printed circuit. The original trouble had been a 25 cent filter capacitor; he now needed over $100 in repair parts. At least he hadn't wrapped the fuse with aluminum foil.

A Short History of Fuses

Most fuses that we see in electronic equipment evolved from the huge automotive market. Auto manufacturers have made every effort to guard against over- and under-fusing by adopting a system in which fuse lengths correspond to amperage ratings.

The longer the fuse, the higher its current rating. However, this system, good as it seems, is not universally applied. One fuse manufacturer said: "The varying length fuse is an inheritance from the past which progress has outdated. When the fuse industry first began, fuses were primarily for the automotive trade, and the Society of Automotive Engineers created the varying-length system. But the line got too unwieldy, and consequently, they reverted to a single-size fusing system."

A resistor-sized fuse with axial leads for printed circuit mounting.

There are still some of the older fuses being used today. You may find SFE 14 and SFE 20 types used in auto protection circuits. The SFE line maintains the old standard that length corresponds to amperage; as an example, the SFE 20-ampere fuse is 1¼ inches long, and the 30-amp is 1 7/16 inches.

Today, however . . .

There are a bewildering variety of fuses available, but each type has only one length for a number of current ratings. We'll concentrate only on those fuses used in common electronic equipment. Here are the three basic categories you'll come across:

Fast-acting: These are designed to protect sensitive equipment which cannot tolerate over-currents for any length of time. They are designed to blow within five seconds on a 200% overload. The time decreases very rapidly as the current increases; for instance, a one-amp fuse opens in about 80 mS at five amperes.

Slow-blowing, or Time Delay: these fuses have a fair amount of thermal inertia designed into them, and can withstand surges without opening. They're particularly useful for such applications as motor-starting and large capacitor inrush current. They'll carry 500% for about 10 seconds, and can be recognised by the spring-like dual element. Like the fast-acting types, they blow very quickly once the current exceeds the limit, assuming that the element has passed through its delay time.

Very-fast-acting: Semiconductors such as power transistors and triacs can be destroyed by an overload in the millisecond range; the very-fast-acting types can blow almost instantaneously on as little as 110% overload. They aren't as popular as the other two basic types, largely because because no excess current can be tolerated. Usually they look like a standard cartridge fuse, but with a ceramic body.

Familiar Types

AGC Probably the most common fuse found at the back of electronic equipment, the AGC is a fast-acting, ¼ x 1¼ inch type with an available range of 2 mA to 30 amperes. The voltage range is 250 up to 3 amperes, and 32 volts up to 30 amperes.

GLH Similar to the AGC series, the GLH has 7 to 10 ampere ratings, but the voltage

Continued on page 54

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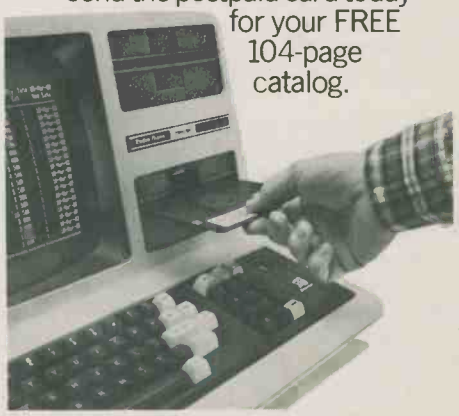

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Stabilised Hi-Fi PSU

The power supply can make the difference between an adequate amplifier and a great one. In this article, J. Linsley Hood explains the advantages of a stabilised PSU, and concludes with a simple and novel circuit to upgrade your hi-fi.

IF YOU LOOK inside the boxes of some of the top name hi-fi power amplifiers — the ones that get the rave reviews from the 'golden-eared' fraternity — you will find, more often than not, that the power supply units are stabilised, rather than being of the simple transformer, rectifier, reservoir capacitor variety. The reason for this is twofold. First, the presence of a stabilised PSU is an indication of the rather greater care that has gone into the building of these amplifiers, and if you aim at the top, as a hi-fi manufacturer, this is a necessary part of your philosophy; and second, because the stabilised PSU really does confer some valuable advantages in the operation of the equipment. Let us look at some of these.

The amount of power one can get from a power amplifier, for any given load impedance, increases rapidly as the DC power line voltage is increased. However, so does the cost of the output power transistors (in fact, all the transistors), as well as the capacitors used in the design. As an aside, the fact that 50 V capacitors cost a lot less than half that of the equivalent 100 V ones is the main reason for the popularity among the high power amplifier manufacturers of direct coupled (two power supply lines of half the voltage) output stages. If Joe Public thinks that they also sound better, so be it!

Unfortunately, the realities of life are not on our side. From the point of view of the power output, what is important is the actual supply line voltage at maximum load, but what the transistors have to support is the worst case condition of line voltage off-load, and the on-load voltage will always be a good bit less than this. If, on the other hand, one has a constant DC supply, one only needs to make sure that the transistors and capacitors will stand this, and this will also be the voltage available when one is driving to full power.

Just doing a cost assessment of stabilised versus cheap-and-cheerful gives a small overall cost advantage in favour of the simple system, which is why it is more commonly used. However, the stabilised PSU has other more subtle advantages which are of value to the discriminating user. These are those which follow from the low ripple level on the supply line of any properly designed stabiliser circuit, and its low supply line impedance. The first of these ensures that hum breakthrough is eliminated, not just at low power levels, which is easy, but also at high powers, when the voltage ripple on the reservoir capacitor is becoming significant. The second feature, that of the low line impedance, not only gives a lower degree of LF breakthrough from one channel to another (at frequencies where the impedance of the reservoir capacitors is significant) but also gives a more firm and solid bass response. In fact, in my view, this is a more important contribution to the firmness of bass response than the absence of an output coupling capacitor in a 'direct coupled' system.

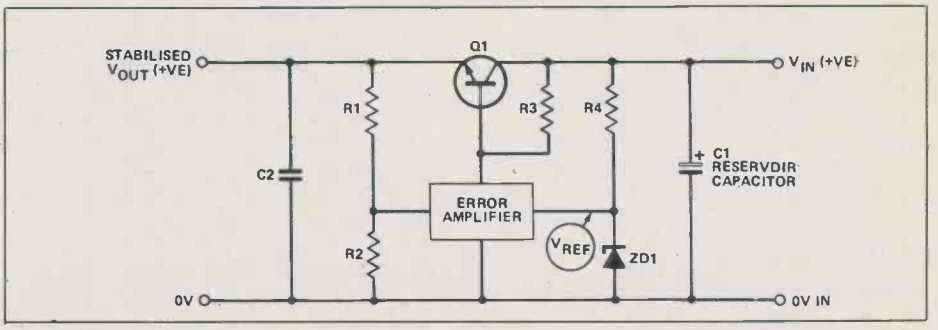


Fig. 1. Simple stabilised power supply.

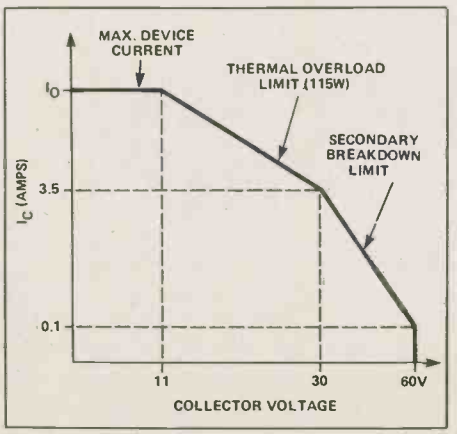


Fig. 2. Power transistor limiting values.

So, having reviewed the propaganda in favour of the use of constant, stabilised power supply lines, two questions remain: can one upgrade an existing amplifier this way, and how simply could one be built? The answer to the first question is almost certainly 'yes' provided that one uses some care. The second I propose to explore. Since this will be done by starting with a basic circuit and adding components, the usual practice of numbering components from left to right and top to bottom will not be followed, so as to achieve continuity from figure to figure.

The Stabilised PSU

These are normally designed along the lines shown in Fig. 1. In this a 'pass' transistor (Q1) is connected as an emitter follower between the unstabilised DC input and the required stabilised DC output. The base drive current to this pass transistor is controlled by some form of error amplifier which compares some proportion of the output DC voltage with a reference voltage derived, perhaps, from a zener diode (ZD1) supplied through R4. Depending on the zener voltage, the controlled DC output can be adjusted, within the limits set by the DC input and the reference voltage, by a suitable choice of R1 and R2. A small capacitor is usually connected across the output to make sure that the output impedance remains low at HF.

This is a very good circuit arrangement, and is used in a very wide range of designs. Indeed, with a little more internal craftiness, very similar systems are employed in the 'three terminal' IC voltage regulators one can now buy for around one dollar. However, there are snags.

In the case of the IC voltage regulators the main snags are that they are

usually limited to input voltages less than 50 V, that the maximum output voltages are usually less than 35 V and that at these voltages the available output currents will probably be less than 0.5 amps, which is rather too low to be of much use for audio power amplifiers. Nevertheless, where these can be used, they are the best possible solution in terms of performance in relation to cost.

In the case of do-it-yourself units of this kind built up from discrete components, though higher voltage and current operation can be organised, the most immediate problem is that of the 'safe operating area rating' or SOAR as shown in Fig. 2. This graph, which is that for a typical power transistor of the 2N3055 types, shows that there are limits on the permissible conditions of operation, and that, as a general rule, you cannot allow the transistor to pass much current at voltages above some 30 V without it blowing up, due to what is known as 'secondary breakdown.' (This arises because silicon diodes have a forward voltage which decreases as they get hotter. So, if enough current, at enough voltage, flows through the transistor, the resultant heating will inevitably cause some localised area of the base-emitter 'diode' to get hotter than the remainder, and then all the transistor current will plough through this small area, with expensive and inconvenient results!)

Two ways of safeguarding against this snag are possible. The first (and simpler, if the amount of current needed is less than that permissible at the given input voltage V_{IN}), is simply to include a current limit circuit as shown in Fig. 3.

In this, Q2 is added, with R5. If the output current taken exceeds the amount needed for the voltage drop across R5 to turn on Q2, then this will 'steal' the base current from Q1 and hold the output current to the chosen limiting value.

However, circumstances often arise where this simple answer just isn't good enough, and then it is necessary to organise a rather more cunning scheme, known as 're-entrant' short-circuit protection. In this, the protection circuit is arranged so that the full, but limited, output current is allowable up to some prearranged voltage drop across the pass transistor Q1, which is known to be within safe operating limits. If the voltage across the pass transistor exceeds this value, some supplementary circuit comes into operation to instantaneously limit the current through the transistor to some lesser value appropriate to its new collector-emitter voltage drop.

This type of arrangement is a much better scheme, and allows stabilised PSUs to be built which will give quite large current outputs at the sort of voltages which would be of use in audio amplifier systems. Moreover, the fact that the output voltage and current will both collapse rapidly in the event of an overload can allow a good measure of protection, if the limit levels are set correctly, for both the amplifier itself and also things like loudspeakers used with it.

Of course, the usefulness of a stabilised power supply is not limited to improving audio amps. This was just one of the possible uses which might appeal to the hi-fi enthusiast in pursuit of an economical and sensible route to a rather higher-fi.

If, however, we turn Q1 the other way round, as in Fig. 4, then the base bias current can be supplied from the '0 V' line, which will mean that the minimum necessary voltage drop between V_{IN} and V_{OUT} can be reduced to, say, 3 V which will reduce Q1's dissipation. Also, only as much current is fed into Q1's base as the output current calls for. This greatly reduces the quiescent dissipation in the error amp circuitry as well. Of course, we would then have to put the current limit transistor on the input side, if we were going to use the same kind of limiting system. We can, however, do a bit better than this — using the final circuitry in Fig. 5.

In this circuit, I have shown a two-transistor error amplifier (Q3 and Q4) which uses the 0 V line as its voltage reference, allowing us to delete the reference voltage circuit R4 and ZD1. In this circuit, Q4 is turned on by current flowing into its base through R8, Q2 and R10. This causes an amplified current to flow in Q4's collector circuit and turn on Q1. However, when the output voltage rises to a high enough level, the zener diodes ZD2 and ZD3 conduct and start feeding base current into Q3. This promptly gobbles up the current that was previously flowing into the base of Q4 and prevents the voltage from rising further.

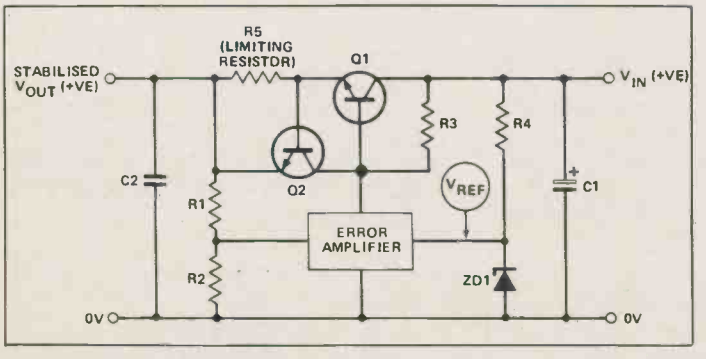


Fig. 3. A stabilised power supply with current limiter.

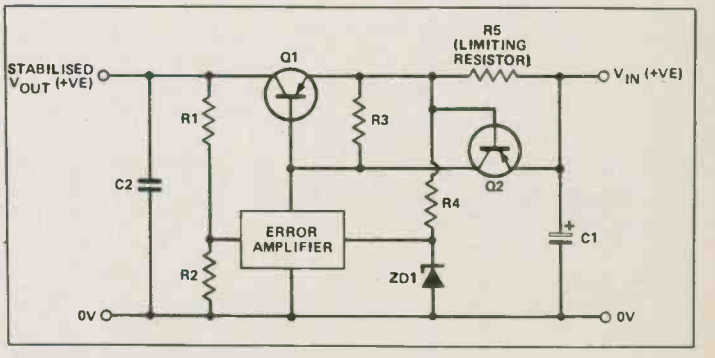


Fig. 4. An alternative arrangement to Fig. 3.

An Improved PSU

So — we want a simple PSU system, with an adequate degree of voltage stabilisation, and a re-entrant overload limit characteristic. How best can this be done?

The general scheme shown in Figs. 1 and 3 has several inherent snags, in spite of its popularity in the PSU circuit league. Of these snags, the first is that there must be a sufficient difference in voltage between V_{IN} and V_{OUT} for Q1 to be functional, and for an adequate current to flow through R3 to give the necessary output maximum current, with the lowest likely current gain in Q1. This would lead, say, in a 3 amp PSU to a value of R3 being chosen which would pass 100 mA at a 10 V input/output voltage drop. If we now have an input voltage of, say, 60 V, then when Q1 isn't asking for the full base bias current — as, for example, when the PSU was off load — the error amplifier will have to dissipate 60 - 10 V x 100 mA = 5 W, with a further 1 W being dissipated in R3.

The use of one or more zener diodes in a chain to provide the necessary output voltage — the actual output controlled voltage will be about 0V5 greater than the sum of the zener voltages — gives a simple system if one specific output voltage is required. However, zener diodes are a bit noisy (especially if their individual breakdown voltages are high, which makes it preferable to use several lower voltage units in a string), so it may be advantageous to use the modified system shown in Fig. 6, if a convenient negative line is available, which would then allow the output voltage to be adjusted between 0V5 and some 3 V less than the available voltage.

Since the total amount of gain in the feedback circuit consisting of Q1, Q3 and Q4 is quite high, it is necessary to incorporate some HF stabilising element. In

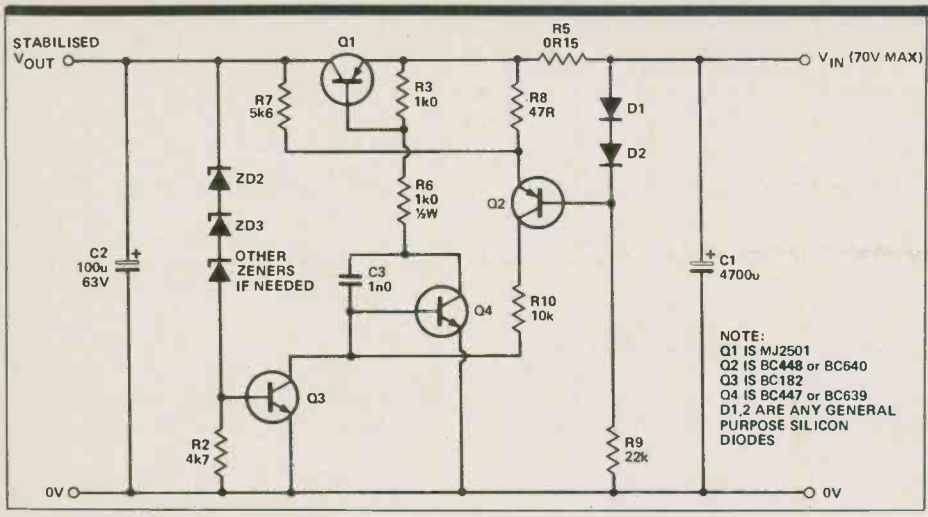


Fig. 5. A stabilised power supply unit with reentrant short-circuit protection.

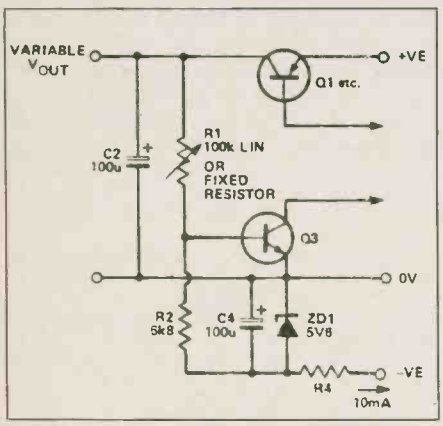


Fig. 6. This modification to the circuit of Fig. 5 allows a variable output voltage.

this case this function is performed by C3 in Fig. 7. The other part of the circuit, that of the 're-entrant' short circuit protection and current limiting action, is performed by Q2 with its associated resistors. The way this works is quite simple.

Assuming that there is no significant voltage drop across R8 and R5, Q2 will be turned on by current fed into its base by R9 & or R4 in Fig. 7), and an amplified current will be fed from the positive line into the base of Q4 via R5, R8, Q2 and R10. (R10 serves to limit the maximum current which can flow, and to reduce the amount of dissipation in Q2). The maximum forward bias potential which can be appplied to Q2 is held to about 1V1 by the two forward biased diodes D1 and D2. So — if we try to take more current from the circuit than would produce a 0V6 drop across R5 then Q2 will lose its operating forward bias and no more current will be fed into Q4 or Q1, which will limit the possible output current to a level just a little less than this value.

However, this has ignored the contribution made by R7 and R8. If there is too much voltage across Q1, which, as we have seen above, would reduce its ability to handle large currents safely, part of this voltage will also appear across R8, and this will also tend to turn off Q2, or at least make it current-limit at lower levels of voltage drop across R5. This has the required effect of tying the output current limiting value to the voltage drop across Q1, and means that, under something approaching short-circuit conditions, only a much reduced output current will flow.

Using The Circuit

So, here we have a fairly simple, low quiescent dissipation stabiliser circuit which uses standard discrete components and transistors, and which can be used to stabilise a single positive DC supply line (or if its 'mirror image' circuit is built, as in Fig. 7, a negative supply line too!) up to the maximum input voltages and currents which the components can stand. How, then, can we use this to improve an existing audio amplifier, which just uses a simple transformer-rectifier-reservoir capacitor system, as envisaged at the start of this article?

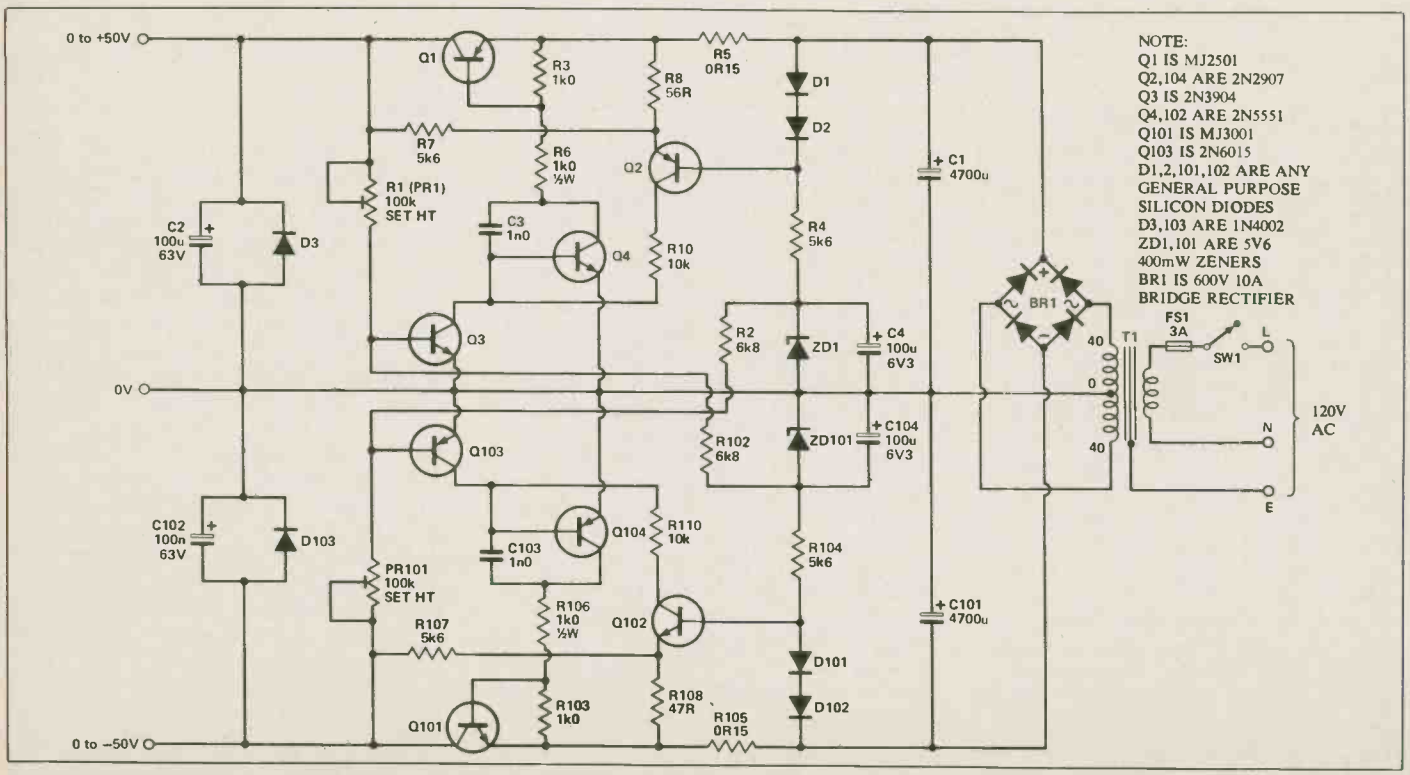
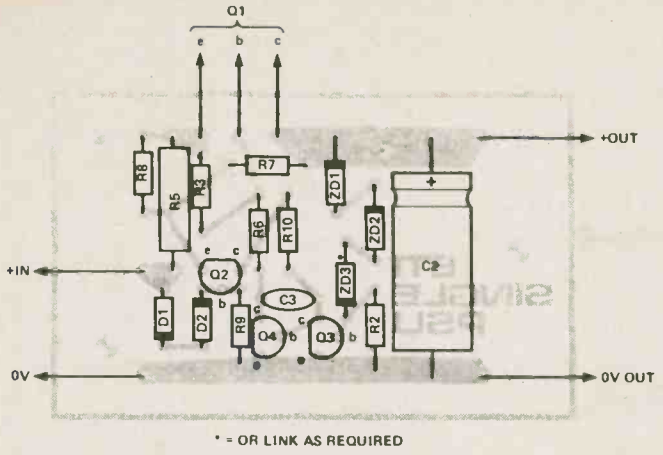


Fig. 7. Complete circuit for a twin stabilised power supply unit (current output 3 amps at 45 V).



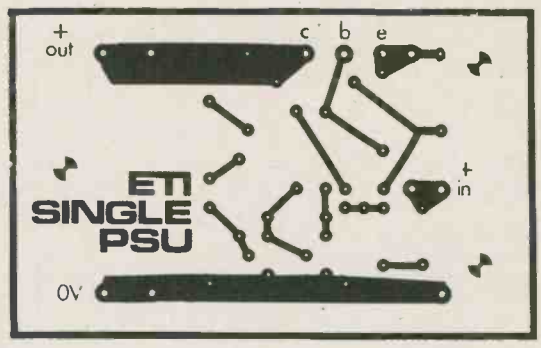


Fig. 8. Overlay for the circuit of Fig. 5.

TABLE 1

Maximum output voltage	Transformer voltage (per winding)	C1 minimum working voltage	R8
30	25	40	56R
40	33	50	56R
50	40	63	47R
60	48	80	43R

TABLE 2

Output current (amps)	Transformer secondary current rating (amps per winding)	R5
0.5	0.7	1R0
1	1.5	0R5
2	3	0R25
3	4.5	0R15
4*	6	0R12

* (not recommended above 40 V)

A single line stabilised supply is shown in Fig. 5 and a twin positive and negative supply is shown in Fig. 7: the DC output voltages and currents can be determined from the values shown in the tables. Now let us envisage a possible application. Measurement shows that on a hypothetical amplifier 'A', all of the internal DC supplies are drawn from a single power supply source which has a quiescent output voltage level of 66 V, dropping to 55 V on full load. If, at half load, which is the worst case condition, the heatsinks don't get alarmingly hot (as we must hope), and the HT line voltage is, shall we say, 60 V, then we could assume that a fixed voltage input supply somewhere between 60 and 65 V would not over-stress the amplifier components, and we could build this output voltage into the circuit of Fig. 5 by the use of an appropriate string of zener diodes.

Such a separate DC supply could then be housed in its own small box, with the DC feed being taken to the amplifier with which it is used. (This is assuming that there isn't room within the exisitng box for the larger, higher voltage transformer which will be needed, or for the other components). What sort of benefits will this bring?

First, one would expect a significant reduction in the existing amplifier 'hum' level, if it is less than perfect in this respect. Second, one could expect an improvement both in the 'solidity' of the bass response, due to the lower LF dynamic impedance of the HT line in

PARTS LIST

Resistors (all ¼W, 5% except where stated)

R1,101 (PR1,101)	suitable fixed resistor or 100k miniature horizontal preset or off-board pot
R2,102	6k8
R3,103	1k0
R4,104 7,107	5k6
R5,105	see Table 2
R6,106	1k0 ½W
R8,108	see Table 1
R10,110	10k

Capacitors

C1,101	4700uF electrolytic (see Table 1 for working voltage)
C2,102	100uF 63 V axial electrolytic
C3,103	1n0 ceramic
C4,104	100uF 6V3 axial electrolytic

Semiconductors

Q1	MJ2501 Darlington 10A, 80 V, T0-3 case
Q2,104	2N2907A
Q3	2N3904
Q4,102	2N5551
Q101	MJ3001 Darlington 10A, 80 V, T0-3 case
Q103	2N6015
D1,2,101, 102	general purpose silicon diodes eg. 1N4148
D3,103	1N4002
ZD1,101	5V6 400 mW zener
BR1	600V, 10 A bridge rectifier

Miscellaneous

PCB heatsink to suit.
centre-tapped transformer (see Tables 1 and 2); power switch; 3 amp fuse and fuseholder.

PARTS LIST

Resistors (all ¼W, 5% except where stated)

R2	4k7
R3	1k0
R5	see Table 2
R6	1k0 ½W
R7	5k6
R8	see Table 1
R9	22k
R10	10k

Capacitors

C1	4700uF electrolytic (see Table 1 for working voltage)
C2	100uF 63 V axial electrolytic
C3	1n0 ceramic

Semiconductors

Q1	MJ2501
Q2	2N2907A
Q3	2N3904
Q4	2N5551
D1,2	general-purpose silicon diodes, eg. 1N4148

Miscellaneous

PCB heatsink to suit.

See text for an explanation of the unusual component numbering.

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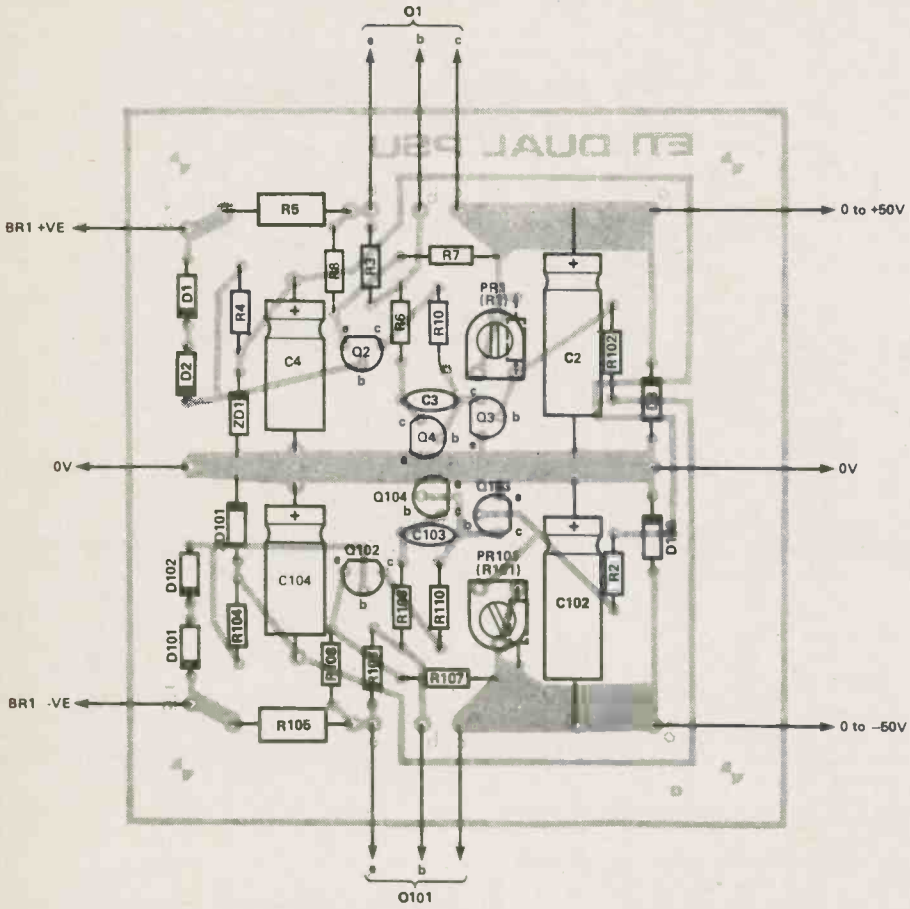
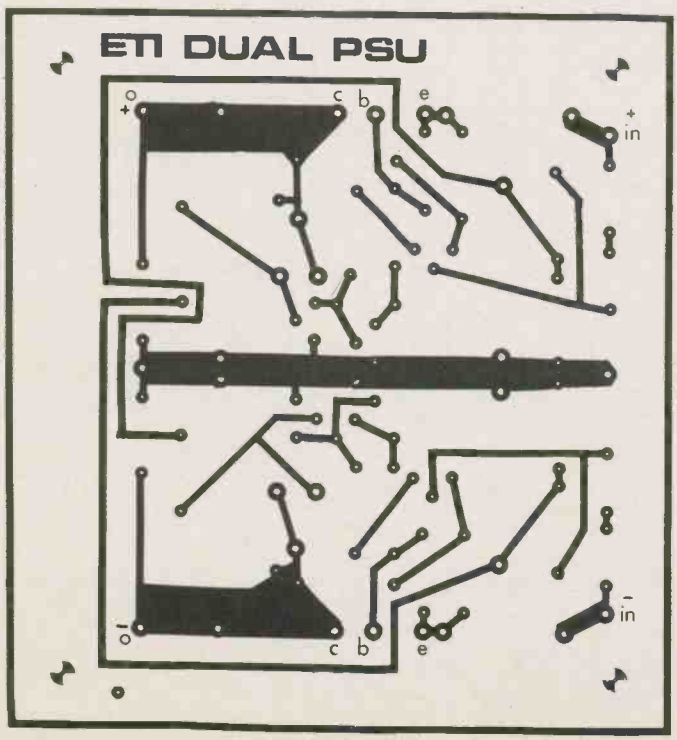


Fig. 9. Overlay for the circuit of Fig. 6.



comparison with even a large value of supply line reservoir capacitor, and this should also give a lower level of LF channel crosstalk. This latter feature is also important because most of the crosstalk signal compenents are heavily distorted in typical transistor output stages. Third, one would obtain a greater immunity from consequential damage, such as loudspeaker units burning out if failure in the amplifier caused it to switch over to some unwanted high current mode; and finally, one would get more power output from it.

This last consequence arises from the fact that output power is determined by the equation $P = V^2/R$, where V^2 is the square of the RMS output signal voltage, and R is the loudspeaker load impedance. For a 30 W amplifier with an 8 ohm load and the HT supply voltage characteristic shown above, a change in full load HT voltage from 55 V to 65 V would give an increase in power from 30 to 45 W without the need for the replacement of any other components.

PCB Layouts

It makes a tidier and more professional looking unit if the necessary small components are mounted on a printed circuit board, so I have shown two such suitable layouts, complete with component overlay, in Figs. 8 and 9. The circumstances in which a PSU of this type might be used to upgrade an existing audio amplifier are rather too varied for anything other than general guidance to be given. However, these circuit layouts also allow the experimentally inclined user to build himself a useful short-circuit protected bench supply, which is literally a unit with dozens of uses.

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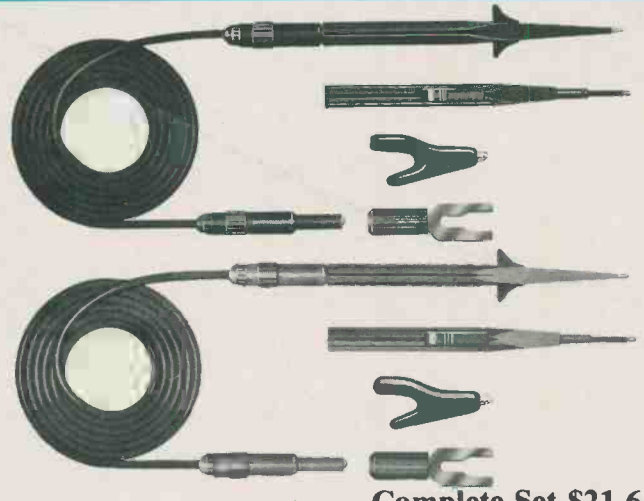

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Maximum Current 10 Amps
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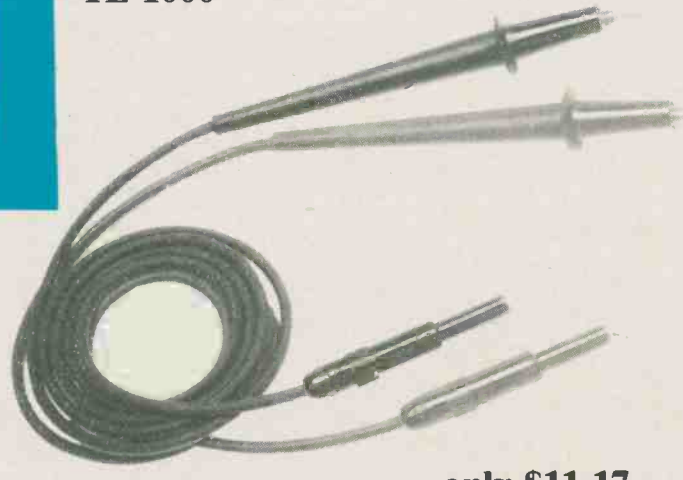

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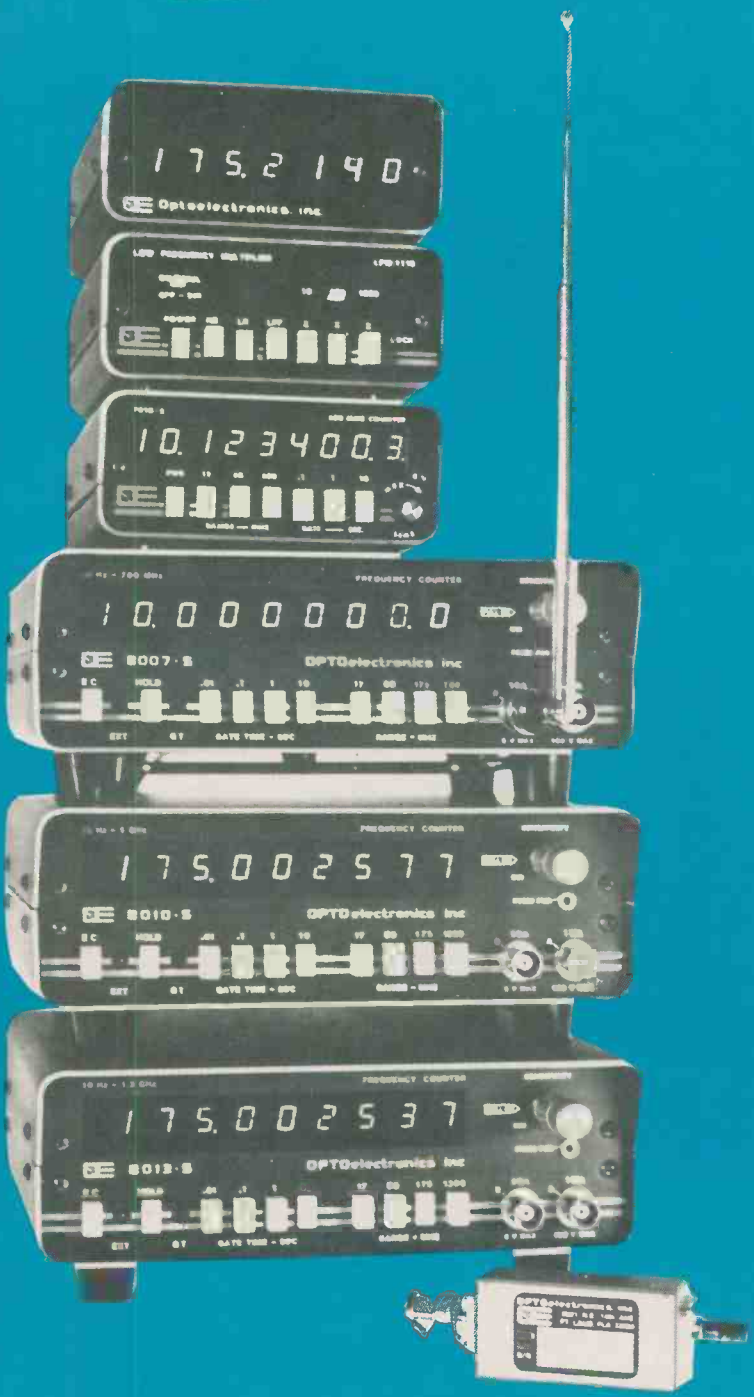

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Spectrum Wars

C.M. Stanbury II takes a look at government agencies attitudes to radio band allocation.

WITH ALL THE recent controversy about pay and satellite TV, some issues important to sound broadcasting have been largely neglected. Up until about 1980 most of the band between 1615 and 1800 kHz was empty. It was mostly used by low powered Hi-Fix, mini-Fix and other similar radiolocation systems based on the Decca phase-comparison principle. A handful of cueing units for mobile broadcast facilities were licensed while frequencies just above 1610 kHz were (and continue to be) favorite spots for North American pirate broadcasters. The situation provided an unprecedented opportunity for expansion of the standard AM Broadcast Band and, according to a 1981 international treaty, broadcast stations in the Americas will shortly be assigned frequencies up to 1700 kHz.

One reason the CRTC, the FCC and other governing bodies require broadcast stations be licensed is that, supposedly, spectrum space is limited. Thus it follows that, if we value democratic principles such as freedom of speed and diversity in the arts, a prime objective of government regulatory agencies should be the clearing (when technically possible) and allocation of additional broadcast frequencies. Yet the CRTC, following the lead of the U.S. Federal Communications Commission, went ahead and allowed portable telephones to operates on these frequencies.

Although these units are flea-powered, many can be heard at least a half mile away. As monitored at our location (between two small neighboring southern Ontario towns) much of this band can now often be described as a jungle both day and evening. The channels assigned for portable phone use include 1670, 1700, 1730 and 1760 kHz. Higher and lower frequencies have been reported but not observed by the author. Certainly, if the CRTC and the FCC go ahead with the new broadcast allocations, there is going to be chaos between 1660 and 1700 kHz.

CRTC, Phone Home

Aside from the interference, thousands and thousands of phone users all over North America will no longer have even remotely secure facilities. This band is readily tunable on many "shortwave" receivers - especially those of higher quality - and conversations go out over the air even when only the non-portable phone is in use unless the portable base transmitter is detached. A majority of base untis do use narrow band FM but some actually employ standard amplitude modulation. And even tuning in on NBFM is not that big a problem for dedicated snoops. The emphasis is definitely on narrow; therefore it's only necessary to tune a little off the nominal frequency to listen in. One has to monitor more carefully and the range is reduced slightly when this approach is used. Nevertheless such portable phones should have been assigned to VHF or UHF frequencies.

Obscuring this band's future still further, the FCC has continued to make new assignments to services which should in fact be moving to other frequencies. Most bizarre of these is the licensing of a Group W Satellite News Channel cueing unit on 1622 kHz in the Washington, D.C. area. Although power is reportedly less than 100 watts, it was heard a number of times last winter as far away as southern Ontario. I wonder how many of SNC's technical directors realise their behind-the-scenes instructions can be heard several hundred miles away?

ETI

Designer's Notebook: The CA3059

The control of line power employing triacs has wide application — light dimmers, motor controllers, etc — but the radio frequency interference (RFI) produced can be difficult to suppress. A more elegant solution is to switch the power on and off at or near where it passes through the 'zero volt' point. This article discusses the technique with reference to an IC developed specifically for this application — the CA3059.

THERE ARE TWO basic ways of switching line power to a load — either via a mechanical switch or via a solid state switch such as a triac. Mechanical switches are fairly slow-acting devices; they suffer from severe arcing at the moment of switching and generate a great deal of RFI (radio frequency interference) at switch-on and switch-off. This RFI can often be heard on domestic radio and TV sets and can cause malfunctioning of some electronic equipment (particularly digital equipment).

Triac switches are fast-acting devices and do not suffer from arcing problems. Nevertheless, they are still capable of generating considerable RFI at switch-on. Why? As the triac turns on, the load current may rise from zero to several amps in a mere couple of microseconds; since this current flows through the power line, the wiring may radiate a great 'splurge' of RFI in response to this heavy surge current. The magnitude of the RFI can be reduced by either reducing the surge current amplitude or increasing the surge current rise time, or possibly both; once the triac has turned on, the subsequent large 'rise time' of the 60 Hz signal causes virtually zero RFI even when load currents of tens of amps are being drawn.

Thus the degree of triac switch-on RFI is proportional to the value of instantaneous line voltage at the moment of triac turn-on. If a 50 ohm load is being driven from 120 Vac, the surge current will be 3.25 A if switch-on occurs at a 'crest' value of 160 V, or a mere 16 mA if switch-on occurs at a 'near zero-crossover' value of 3.25 V.

Triacs are self-latching devices. If they are turned on by a brief gate signal, they remain on until their main-terminal currents fall below a minimum 'holding' value of a few milli-amps. They automatically turn off at the end of each half cycle as their main-terminal currents fall to near-zero. They can be turned on near the start of each half cycle as soon as their main-terminal currents are capable of exceeding the minimum holding value.

Thus, a triac can be persuaded to generate virtually zero switch-on RFI by feeding it with gate current only when the instantaneous line voltage is close to the zero or crossover value at the start of each half cycle. This technique is known as 'zero-voltage switching'. Special zero-

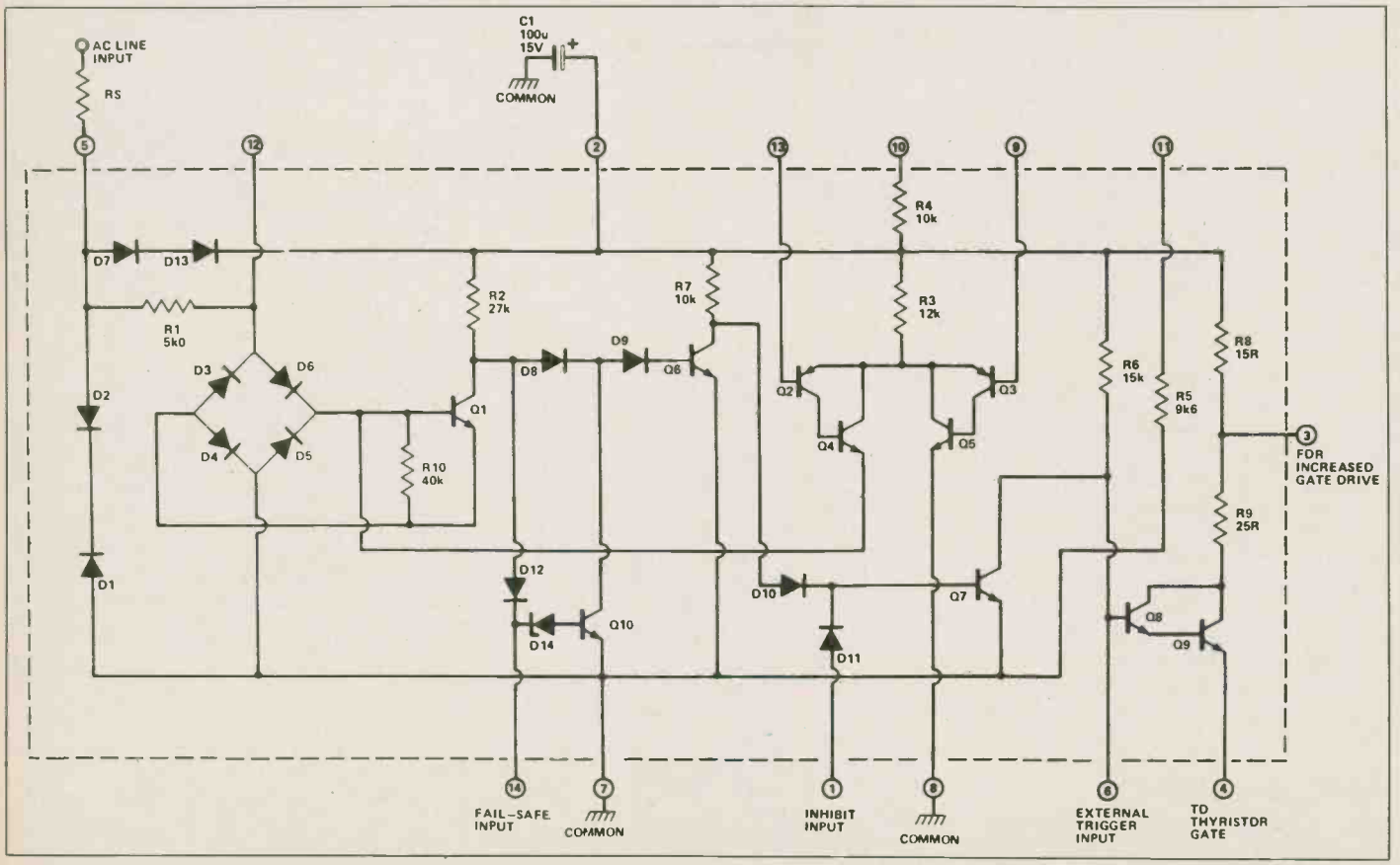

Figure 1. Internal circuit and minimum external connections of the CA3059 zero-voltage switch.

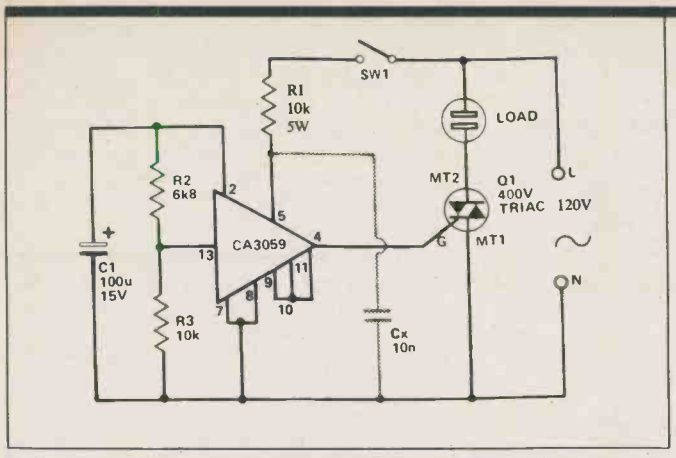

Figure 2. A simple power line-switched zero-voltage switch. Cx may be used to overcome latching defliciencies of some triacs.

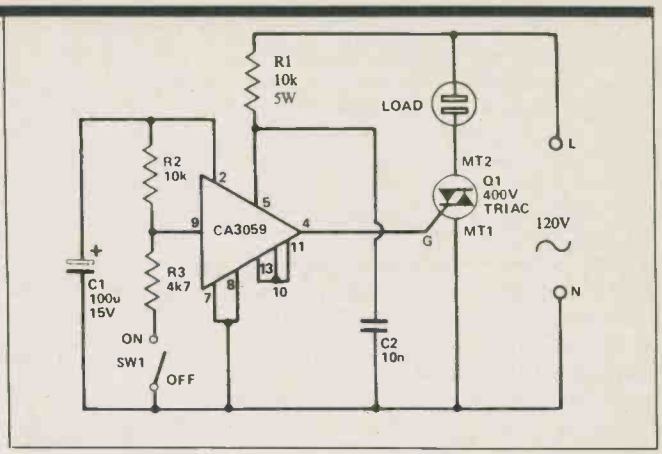

Figure 4. An alternative and very useful method of direct-switching the CA3059 IC.

voltage triac-driving ICs are available from a number of manufacturers. One such device is the CA3059, manufactured by RCA.

The CA3059 zero-voltage switch

The internal circuit and minimal external connections of the CA3059 zero-voltage switching IC are shown in Figure 1. The device is housed in a 14-pin DIL package and incorporates dc power supply circuitry, a zero-crossing detector, triac gate drive circuitry and a high-gain differential amplifier/gating network. Circuit operation is as follows.

Line power is connected between pins 5 and 7 of the device via limiting resistor Rs (10k, 5 W when 120 V mains is used). D1 and D2 act as back-to-back zeners and limit the pin 5 voltage to ±8 V. On positive half cycles D7 and D13 rectify this pin 5 voltage and generate approximately 6.5 V across the 100 uF capacitor connected to pin 2. This capacitor supplies sufficient energy storage to drive all internal circuitry and provide adequate triac gate drive, with a few milliamps or so spare drive available for powering auxiliary (external) circuits.

Bridge rectifier D3-D6 and transistor Q1 act as a zero-voltage detector, their action being such that Q1 is turned on (driven to saturation) whenever the pin 5 voltage exceeds ±3V. Gate drive to an external triac can be made via the emitter (pin 4) of the Q8-Q9 Darlington pair of transistors, but is available only when Q7 is turned off. When Q1 is turned on (pin 5 greater than ±3V) Q6 is turned off through lack of base drive, so Q7 is driven to saturation via R7 and no triac gate drive is available from pin 4. Triac gate drive is thus available only when pin 5 is close to the 'zero-voltage' or crossover value. When gate drive is available, it is delivered in the form of a narrow pulse centred on the crossover point with pulse power supplied by C1.

Vive la differential

The CA3059 incorporates a differential amplifier or voltage comparator, built around Q2 to Q5, for general purpose use. Resistors R4 and R5 are externally available for biasing one side to the amplifier. The emitter current of Q4 flows via the base of Q1 and can be used to disable the thyristor (pin 4) gate drive by turning Q1 on. The configuration is such that the gate drive can be disabled by making pin 9 positive relative to pin 13. The drive can also be disabled by connecting external signals to pin 1 and/or pin 14.

CA3059 switching circuits

Figure 2 shows the simplest possible way of using the CA3059 as a 'noiseless' switch with the zero-voltage switching provided via the IC and the triac and with on/off switching controlled by SW1. The circuit action is quite simple. The IC is connected to the line via SW1 and limiting resistor R1; dc energy is stored by C1. The IC is wired in the 'enabled' mode by biasing the pin 9 side of the internal differential amplifier at half-supply (dc) volts via the pin 10 and 11 connections and by biasing the pin 13 side above half-supply via the R2-R3 divider network. Switch SW1 passes only a few milliamps of current and thus generates negligible RFI. The circuit can power loads such as lamps and heaters via a suitably rated triac.

The 'zero-voltage' triac-gate-drive pulse of the CA3059 is very narrow. In some applications, the pulse may terminate before the triac main-terminal currents have reached their minimum holding

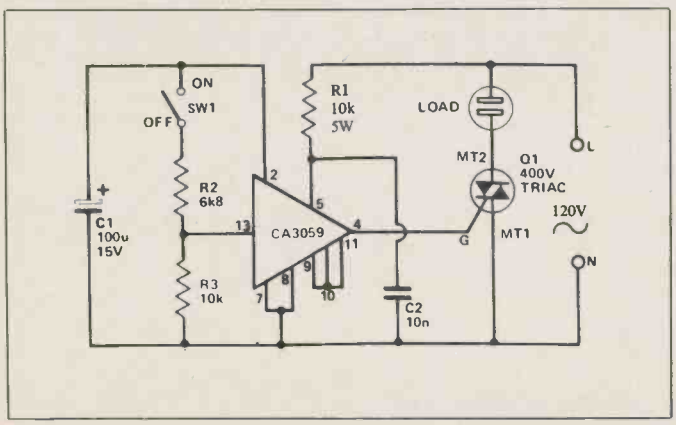

Figure 3. Direct-switched zero-voltage switch.

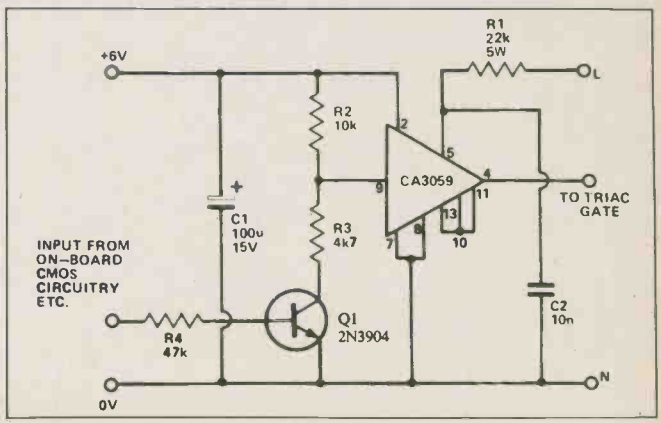

Figure 5. One method of transistor-switching the CA3059 via on-board CMOS circuitry such as one-shots, astables, etc.

levels and self-latching may fail to occur. This problem can be overcome by wiring Cx as shown in Figure 2. This capacitor, in conjunction with R1, gives a slight phase shift to the pin 5 signal and extends the 'zero-voltage' pulse further into the start of each half-cycle. A value of 10n is adequate in most applications.

The Figure 2 circuit consumes virtually zero mains power under the 'off' (SW1 open) condition. The only defect of the circuit is that SW1 operates at full mains voltage. This defect can be overcome by using the switch to directly enable or disable the CA3059 logic circuitry, as shown in Figures 3 and 4, but in this case the circuit consumes a few watts of power (via R1) when the circuit is in the off mode.

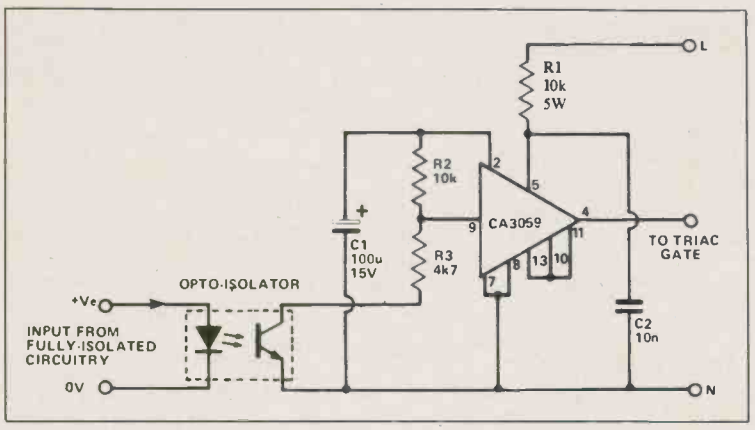

Figure 6. A method of remote-switching the CA3059 via an opto-isolator.

The Figures 3 and 4 circuits work by using the switch to enable or disable the triac gate drive via the internal differential amplifier of the IC. Remember, the drive is enabled only when pin 13 is biased above pin 9. In the Figure 3 circuit, pin 9 is biased at half-supply volts and pin 13 is biased via R2-R3 and SW1. In Figure 4, pin 13 is biased at half-supply and pin 9 is biased via R2-R3 and SW1. In both circuits, SW1 handles maximum potentials of 6 V and maximum currents of 1 mA or so.

Note in Figure 4 that the circuit can be turned on by pulling R3 low or can be turned off by letting R3 float. Figures 5 and 6 show how this simple fact can be put to use to extend the versatility of the circuit. In Figure 5 the circuit can be turned on and off by transistor Q1, which in turn can be activated by on-board CMOS circuitry (such as one-shots, astables, etc) that are powered from the 6V pin 2 supply.

In Figure 6, the circuit can be turned on and off by fully-isolated external circuitry via an inexpensive opto-isolator; the isolator needs an input current of only a milliamp or so to give the 'on' action.

CA3059 comparator circuits

The built-in differential amplifier of the CA3059 can readily be used as a precision voltage comparator that turns the triac on or off when one of the comparator input voltages goes above or below the other. If these input voltages are derived from transducers such as LDRs or thermistors, the on/off power control action can be controlled by ambient light levels or temperatures. Figures 7 to 10 show some practical circuits of these types.

Figure 7 shows the circuit of a simple dark-activated zero-voltage power switch. here, pin 9 is tied to half-supply volts and pin 13 is controlled via the R2-PR1-LDR-R3 potential divider. Under bright conditions the LDR has a low resistance, so pin 13 is above pin 9, the triac is enabled and power is fed to the load. The precise threshold level of the circuit can be preset by PR1.

Figure 8 shows how a degree of hysteresis or 'backlash' can be added to the above circuit, so that the triac does not switch annoyingly in response to small changes (passing shadows, etc) in the ambient light level. The hysteresis level is controlled via R3, which can be selected to suit particular applications.

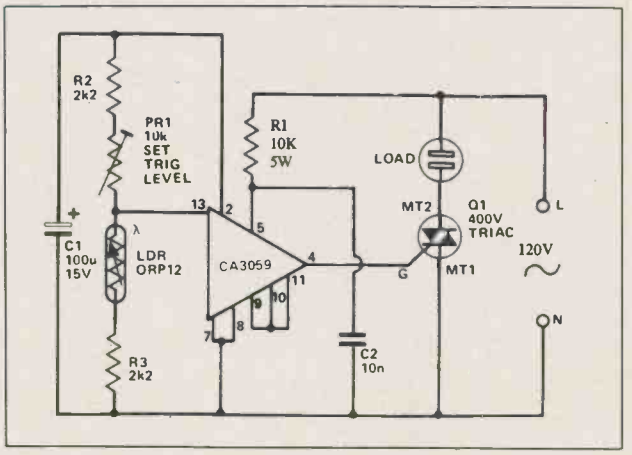

Figure 7. A basic dark-activated zero-voltage switch.

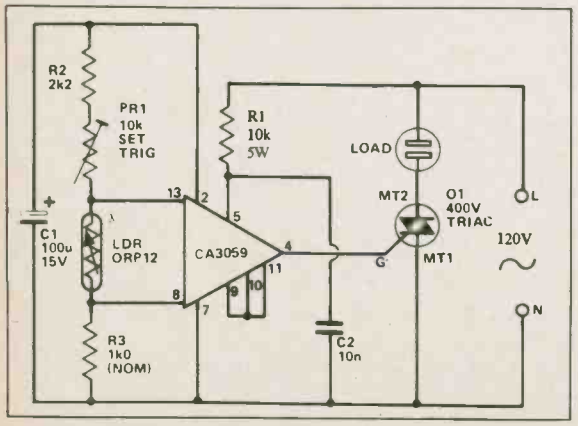

Figure 8. A dark-activated zero-voltage switch with hysteresis provided by R3.

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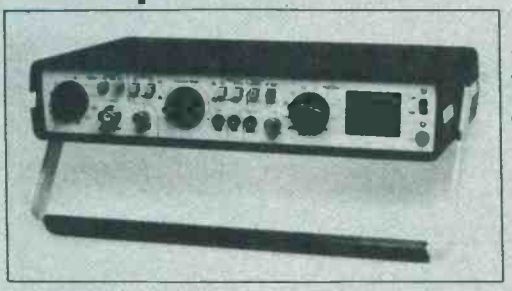

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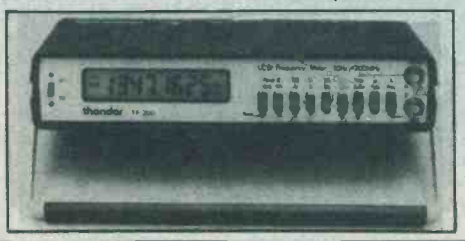

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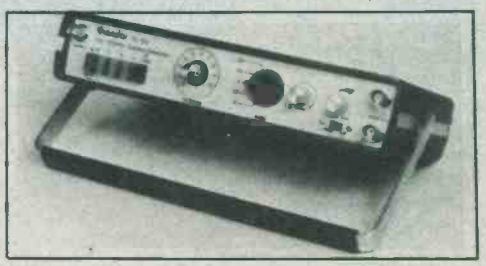

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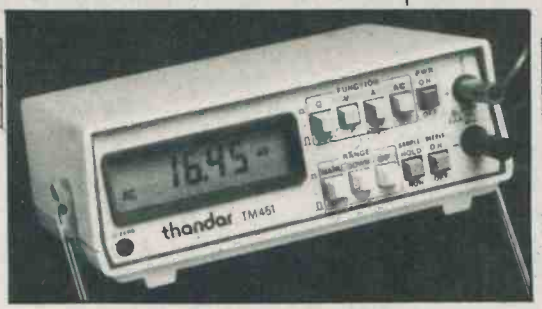

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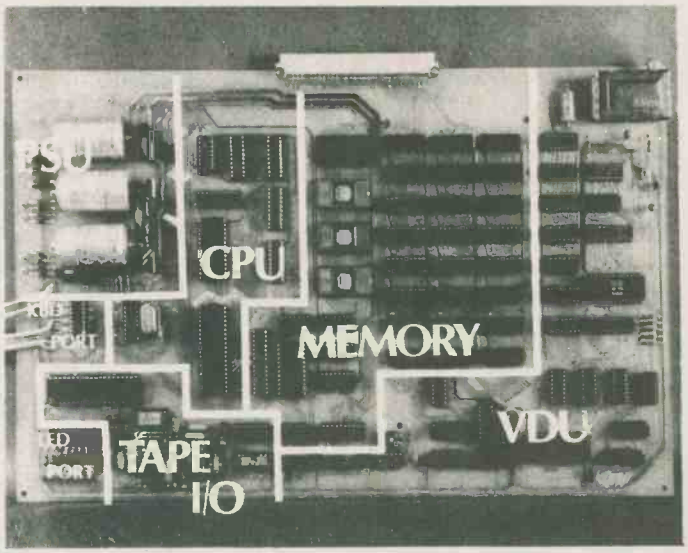


THIS SERIES is aimed at those readers who already know something about electronics, but who would like to know how electronics is being used today in perhaps its most important application of all — the computer. The series will be concerned with only one of the two types of electronic computer, the digital computer. The other type, the analogue computer, has several important applications but in the main its work has been taken over by digital computers.

We still owe something to the analogue computer, for our trusty workhorse, the op-amp, was originally designed as its building block. Whereas the analogue computer operates with precisely determined voltages which are allowed to vary continuously over their range and are analogues of continuous physical quantities, the digital computer operates with only two discrete voltage levels. The analogue computer depends on the high precision of its op-amps, and needs an op-amp for every step in its computations.

As we shall see, the electronic requirements for the digital computer are much simpler, allowing designers to concentrate on obtaining high speeds of action. The units of the circuit are simple logic gates, thousands of which can be manufactured on a single slice of silicon, already connected to form the complex logic circuits of the computer. This allows the digital computer to have great computing power combined with flexibility of function. It also allows the computer to be mass-produced cheaply so that, today, anyone with a few tens of dollars to spend can buy one.

The Heart Of The Matter

Figure 1 shows the heart of the computer to be its *central processing unit* (CPU). It is connected to a number of other devices — the peripheral devices. Input devices usually include a keyboard, so that the operator can send information to the CPU. Information may consist of instructions and data. Input devices might include sensors (eg. circuits to measure temperature) so that the CPU can obtain its data directly without need for intervention by a human operator. One essential part of this would be an analogue-to-digital converter sub-circuit, to convert the analogue quantity (in this case temperature), to its digital coded equivalent.

Output devices allow the CPU to communicate the results of its computations to the world outside. There is usually a monitor screen on which messages and the results of calculations are displayed. There may also be a printer or a chart plotter. Alternatively there may be direct control of a robot arm or similar device.

The memory is one place where information is stored. The instructions tell the CPU what to do (its program), and it is provided with data to work on. The computer is able to use part of the memory for storing other data which arises from its computations. Information can be transferred between CPU and memory very rapidly and in either direction. Memory is where the currently-used information is held. The store is for information that is not required urgently. The store may consist of a tape deck or disk drive, by means of which information is stored in magnetic form. Blocks of information can be transferred between CPU and store in either direction, but only relatively slowly. The amount of information which can be held in store is much greater than the amount held in memory.

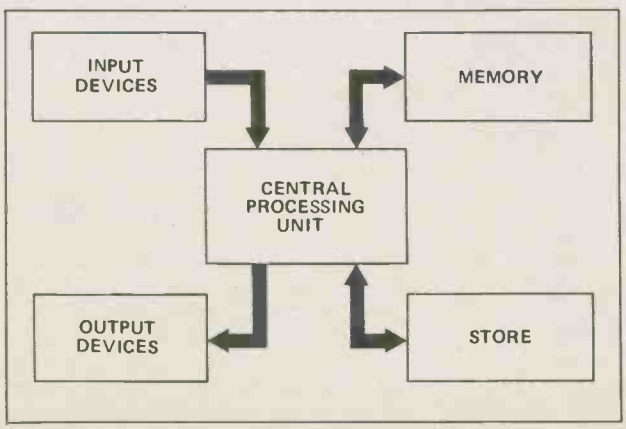


Fig. 1. Block diagram of a computer.

The CPU

This has the job of receiving instructions and data, either from input, memory or store, processing the data according to the

instructions, and then sending the results of its computation to an output device, memory, store, or possibly to more than one of these. In a main-frame computer, the CPU occipies several circuit boards, but in the personal computer the whole CPU is replaced by a single integrated circuit, the *microprocessor*. This article and the remainder of the series will concentrate on the personal computer, or microcomputer, using a microprocessor as its CPU.

We have been able to use very large scale integration (VLSI) to put all the logical parts of the CPU on to one slice of silicon. The CPU must include an oscillator, or *clock,* by means of which all its actions and the actions of other peripheral devices are synchronised. It is not possible to reduce the physical size of the components required for this, in particular the quartz crystal, so at least part of the clock circuit is external to the microprocessor. The clock circuit and microprocessor (MPU) together constitute the CPU of the microcomputer.

We Want Information

Before we look at what goes on inside the MPU we must consider the concept of information in more detail. The unit of information is the bit. The term 'bit' is a shortened version of 'binary digit'. A bit can have one of two values, '0' or '1' but not any other value. This binary concept is widespread in thought, in logic and also in electronics. Table 1 shows pairs of opposite and mutually exclusive states. A binary digit is '0' or '1'; it cannot be anything else. A statement is true or false; truth is by definition the **whole** truth, for half-truth is meaningless. A switch is either on or it is off; it cannot be partly on. If the circuits are made so that only two voltages (low and high) produce definite results and so that intermediate voltages give indeterminate results, then voltages are either high or low. Transistors are either fully off, or fully on (saturated). Given these binary states, the state of any one pair in Table 1 can be used to represent the state of any other pair.

TABLE 1

0	1
No	Yes
False	True
Absent	Present
Switch off	Switch on
Transistor off	Transistor on
Open circuit	Closed circuit
Low voltage	High voltage

For example, we can stipulate that the digit '0' is represented in a computer circuit by a low voltage, and the digit '1' is represented by a high voltage; falsity by '0' or a low voltage, truth by '1'. Here we have a system which allows numerical values and logical statements to be represented in terms of electrical signals. This is the basis of the digital computer.

Grab A Byte

In this sytem, the bit is the minimum quantity of information to be dealt with. Normally a computer deals with far more information than this. Bits are usually handled in groups. Some of the earlier MPUs handled bits in groups of four, but the majority of micros handle them in groups of eight. A group of eight digits is called a *byte*. In the computer, a byte is represented by a set of eight lines (eg. tracks on the PCB), each at high (=1) or low (=0) voltage. Or it might be represented by a set of eight flips-flops or bistables, each one either set (=1) or reset (=0). According to the interpretation placed on it, the byte could represent:

- A binary value, ranging from 0000 0000 (=0 decimal) to 1111 1111 (=255 decimal).
- The truth or falsity of eight different logical statements.

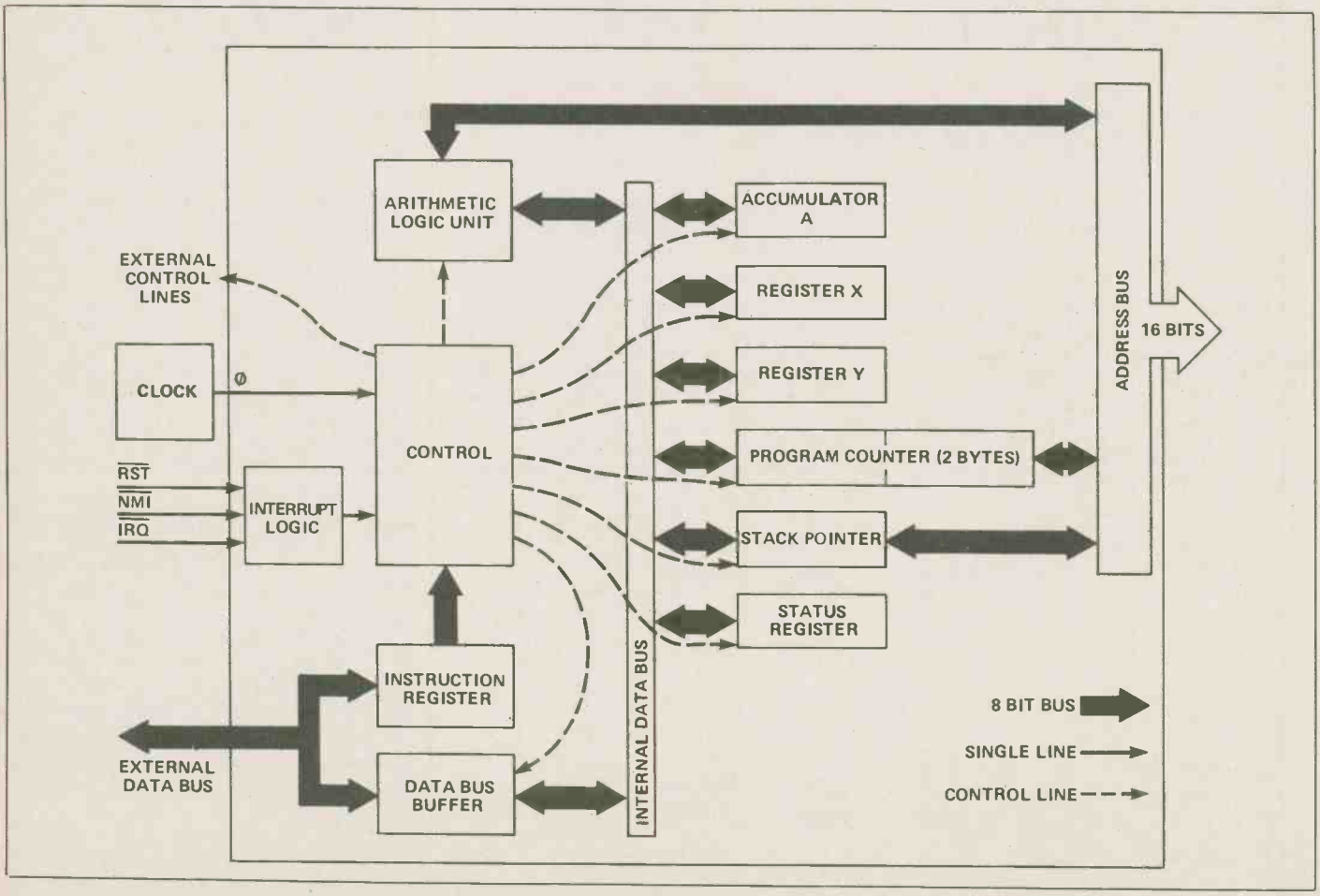


Fig. 2. The internal structure of the popular 6502 microprocessor.

● A coded instruction to the computer.

There is more to be said on this subject next month, but for the moment we will rest with the fact that the computer has to handle binary information represented in electronic form.

On The Level

For most MPUs the low and high voltages are standardised at 0 V and +5 V respectively. These are the same levels as are used in the 7400 TTL series of ICs. These values are nominal; a Z80 MPU, for example, interprets any voltage between — 0V3 and 0V8 as 'low'. Any voltage between 2 V and 5 V is interpreted as 'high'. Voltages between 0V8 and 2 V produce indeterminate results and must not be allowed to occur. The lack of insistence on precise voltage levels allows computer circuits to remain relatively simple in electronic terms, yet be highly reliable in action.

Those Important Little Places

If the CPU is the heart of the computer, the heart of the CPU is its *arithmetic logic unit*. The ALU is where data is manipulated according to the instructions stored in memory; we shall describe some of its operations next month. The ALU is able to operate on all eight bits of a byte in a single operation. We say that the *word length* is eight bits, or one byte. Some MPUs, such as the Texas 9980A, have a 16-bit word, but the general principles of its operation are the same as described below.

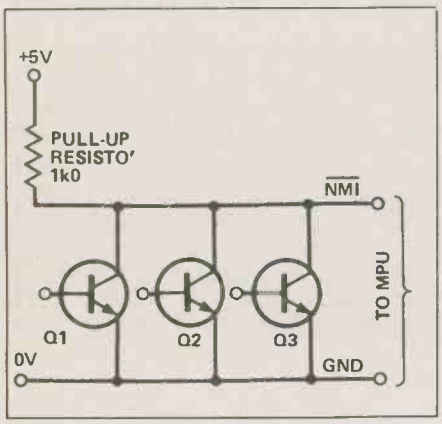


Fig. 3. Switching on any of the transistors generates an NMI .

As an example of a well-known MPU we shall first consider the 6502 (Fig. 2). This successful but relatively simple MPU is used in the Apple, the PET, and several other popular microcomputers. The ALU operates in close conjunction with the *Accumulator*. This is a set of eight flip-flops which temporarily hold a byte which is to be operated on by the ALU, or is the result of an operation performed by the ALU. The two registers known as X and Y may also be used to store one byte of data each. Data can be transferred between these registers and the Accumulator in either direction. These registers are therefore useful for storing values obtained in one stage of a calculation, ready for use at a later stage. They are also used as index registers, in which the values held in X or Y are the base addresses of selected blocks of memory. This makes it simpler to access blocks of memory; when storing a table of data, for example.

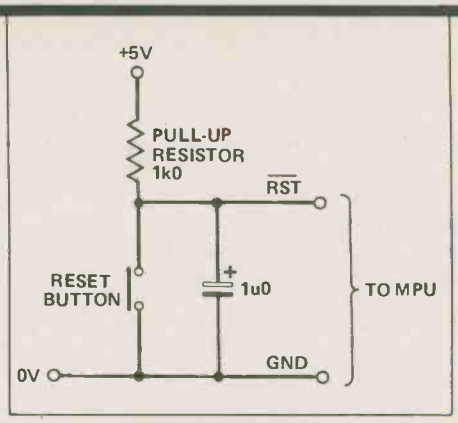


Fig. 4. A suitable circuit for generating a power-on reset pulse. A manual reset button is also provided.

Since data has to be transferred from one register to another, or from a register to the ALU, it speeds the operation of the MPU if a whole byte is transferred in one operation, rather than bit-by-bit. This requires a set of eight lines connecting all the registers and the ALU. This is called the *data bus*. To distinguish it from a similar set of lines which connect the MPU with the peripheral devices, it is more precisely known as the *internal data bus*.

It's Under Control

The *control bus* consists of several lines along which signals are sent to coordinate the actions of the various parts of the MPU. For example, if the data held in register X is to be sent to the ALU, a signal must be sent along a control line to register X, making it place the data on the data bus. Register X makes the lines go 'high' or 'low' according to the pattern of 0s and 1s held in its eight flip-flops. At the same time a signal must be sent along another control line to the ALU, making it accept the data now present on the data bus. The control lines emanate from the special part of the MPU called the *Control*.

Despite its impressive name, the Control is no more than a slave. It knows how to carry out the tasks it is allotted, but does not remember what it has just done, and does not know what task it must perform next. The list of tasks (the program) is stored in memory at a sequence of locations. The control simply fetches these instructions from memory, a byte at a time, and acts on each immediately as it is received. For this purpose it needs the *Program Counter*, a register in which it records how far it has reached in the program — a sort of 'bookmark'. Since a single byte cannot store numbers greater than 255 (decimal), and since most programs have far more bytes than this, the Program Counter is a double-byte register. Its 16 bits allow any number up to 1111 1111 1111 1111 (binary) to be stored, equivalent to 65535 (decimal).

During its calculations, the MPU often has to store data in the *Stack*, a special section of memory set aside for this purpose. As data is added to or removed from the Stack, the position in memory of the first item in the Stack (the Top of Stack) changes. The *Stack Pointer* register records the current position of Top of Stack, so that the MPU knows where to go to retrieve the stacked data.

Status Symbols

The *status register* should be considered as eight individual bits, arranged together for convenience as a byte. Each bit is *set* (made equal to 1), or *reset* (made equal to 0) individually as the result of a particular operation. For example, bit 7 is set whenever the result of an operation results in a negative value. Bit 1 is set when the result of an operation is zero. These bits, which indicate whether a particular event has occurred or not, are often known as *flags*. Bit 0 holds the 'carry' digit from additions or subtractions in the accumulator.

The remaining sections of the MPU are concerned with communicating the peripheral circuitry. There is the *data bus buffer* which detects voltage levels on the external data bus and copies these on to the internal data bus. Or it can operate in the reverse direction. If the data bus is carrying an instruction, this is accepted by the *instruction register*. From there is goes to the control which decodes it and then acts upon it. The *address bus* receives outputs from certain registers putting voltage levels on the 16 address lines, a subject which will be dealt with later.

Dealing With Interruptions

The *interrupt logic* receives signals along any of three lines. All three lines are normally held high by pull-up resistors. The lines are thus described as 'active'low'. In other words, it requires a low level on the line to make the MPU respond. Most control lines in the computer are active-low. This makes it simple for any number of devices to bring the line to its low state. If the line is connected to open-collector transistors, for example (Fig. 3), this is equivalent to a wired-OR configuration. Then if any one of these transistors is turned on, the voltage level on the line is made low. If a line is active-low, this fact

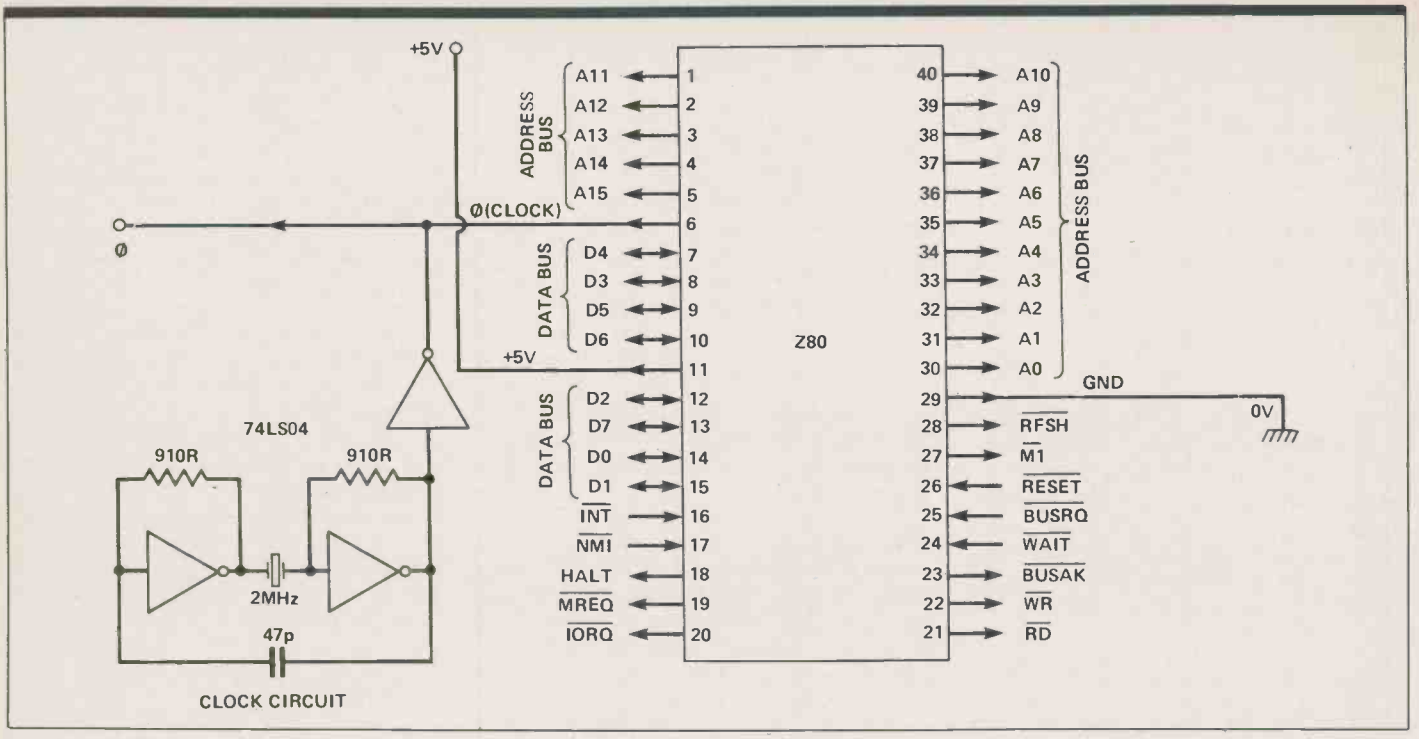


Fig. 5. Pinout of the Z80 microprocessor, with a suitable clock circuit.

is indicated by a line above its abbreviation (eg. RST for active-low 'reset').

The *reset* line is used to initialize the MPU, either when the computer is first switched on or if it gets into a 'latched-up' condition, in which normal methods of controlling it do not work. There is generally a pull-up resistor holding the voltage high, with a 'Reset' press-button hidden in a fairly inaccessible place at the rear of the computer. Pressing this button temporarily grounds the reset line.

When the computer is first switched on, resetting is usually done automatically, by having a large-value capacitor to hold the line low for a short period while the rest of the system reaches its full voltage levels (Fig. 4). There is no reset button in the Sinclair ZX-81. To reset, you simply turn off the power, wait a moment or two and then re-apply power. Resetting the MPU resets the program counter to zero, so that it returns to the beginning of the program stored in memory and starts again.

On receiving a low signal on one of the interrupt lines (NMI or IRQ) the MPU finishes whatever operation it is engaged in, then stores away (on the stack) any data relating to that operation. This takes only a few microseconds, after which the program counter is sent to the address in memory of a special interrupt service program. It performs whatever this program requires, then returns to its original program, recovers the data from the stack and continues with the original program as if nothing had happened. Interrupts are used by peripheral devices to gain the attention of the MPU when it is urgently required. The non-maskable interrupt (NMI) takes priority. It cannot be ignored by the MPU, and, while the MPU is performing the NMI task, it cannot be interrupted again. The Interrupt Request (IRQ) has second priority. The MPU can be pre-programmed to ignore an IRQ altogether. In the 6502, this is done by setting digit 2 of the Status Register to '1'. An IRQ task, can be interrupted by an NMI. After completing the NMI task, the MPU continues with the interrupted IRQ task. When this is completed (assuming there is no further NMI) it returns to its original program.

Z80 Anatomy

Most MPUs have the same kind of organization, or architecture, as the 6502. The Z80 MPU, which is the processor for a wide range of computers including the TRS-80 Models I and II, the Research Machines 380Z, and the Sinclair ZX-81, has a rather more elaborate set of registers. The main set comprises the accumulator (A), the flag register (F, corresponding to the status register of the 6502), and registers B, C, D, E, H, and L, which are general-purpose registers. There is also an alternate set of registers, A', F', B', C', D', E', H', and L'. The MPU normally begins operations by using the main set, but can be switched over to use the alternate set instead, leaving the main set unaffected. It can be switched back to the main set again later.

In addition there are two index registers (IX, IY corresponding to X and Y in the 6502), a stack pointer, and a program counter. In the Z80, IX, IY, SP and PC are double-byte registers (16 bits). Finally there's the interrupt vector register (I) in which instructions for a complex series of vectored interrupts can be stored, and the memory refresh register (R) which is used in connection with refreshing the dynamic memory of the system. This topic will be dealt with in a later article.

Making The Connection

The typical MPU is contained in a 40-pin DIL package as shown in Fig. 5, which uses the Z80 as an example. It requires a regulated 5 V DC supply, which is applied between pins 29 (system ground) and 11 (+5 V). The clock circuit supplies pulses at 2 MHz in the case of the original Z80 MPU. The newer Z80A can operate with a clock rate up to 4 MHz. The clock signal may also be taken to peripherals; for example, the circuits which control the monitor.

The eight data lines, D0 to D7, come direct from the data buffer (Fig. 2). These may act as inputs or outputs, though not in both capacities at the same time. The data bus is taken to the peripherals, to allow for transfer of data between these and the MPU. In order that the peripherals will know which one (and only one) of them is to receive or transmit data, each peripheral is also connected to the address bus. This is a set of 16 lines, A0 to A15. Address lines are outputs from the MPU. By putting various combinations of highs and lows on these lines the MPU can indicate which peripheral it is addressing. The peripheral may be a printer or a relay on a control board. It may be single location in memory. Since there are 16 lines,

there are 65536 possible combinations of highs and lows, this being the maximum number of locations which can be directly addressed. This figure is usually written in its shorter form, 64K, where one 'K' is not 1000, but 1024 ($=2^{10}$).

Peripheral Procedures

The remaining pins of the IC are connected to control lines which connect the MPU to certain of the peripherals. We will consider the input control lines first. The functions of $\overline{RST}$, $\overline{NMI}$ and $\overline{INT}$ ($=\overline{IRQ}$) have already been dealt with. A low level on $\overline{WAIT}$ causes the MPU to halt its operations. It may have asked a peripheral to send data to it but the peripheral is not ready to put the data on the bus. Instead the peripheral sends the $\overline{WAIT}$ signal, and the MPU suspends action until the peripheral has had time to put the required data on the bus and let the $\overline{WAIT}$ line go high again. The bus request signal ($\overline{BUSRQ}$) is used by certain peripherals to force the MPU to hand over control of the address bus, the data bus and certain control lines. This is used during an operation known as *Direct Memory Access* (DMA) in which blocks of data are transferred between memory and other peripheral devices without the intervention of the MPU. This is not usually implemented on the smaller microcomputers.

There are eight outputs in the control bus of which we shall mention only three now, dealing with the rest later as part of specific examples. The Machine Cycle One output ($\overline{M1}$, pin 27) indicates when the MPU is fetching an instruction from memory. Two outputs of special importance are read ($\overline{RD}$) and write ($\overline{WR}$). When the MPU is to receive data from a peripheral it puts the address of the peripheral on the address bus and makes the $\overline{RD}$ line low. This indicates to the peripheral, which is also wired to the $\overline{RD}$ line, that it is to transmit data and not to receive it. When the MPU wants to transmit data to a peripheral, it puts the address on the address bus and makes the $\overline{WR}$ line low.

Clocking On

With so many signals being passed in several directions, and with the data bus being required for transmissions into or out of the MPU, it is essential that all these activites take place to a clearly defined schedule. Although micros and their peripherals act as fantastic speeds, these are only fast according to our human scale of appreciation. To an MPU, a memory which responds in a microsecond is not particularly speedy. The MPU even has to wait a while to give it time to put the data on the bus, and for the voltages to settle to their intended levels. To keep all sections of the system operating in an orderly way, and to allow the circuits a finite (even if infinitesimal) time to react, the clock is of major importance.

As an example of the way the various parts of the system interact, let us cor

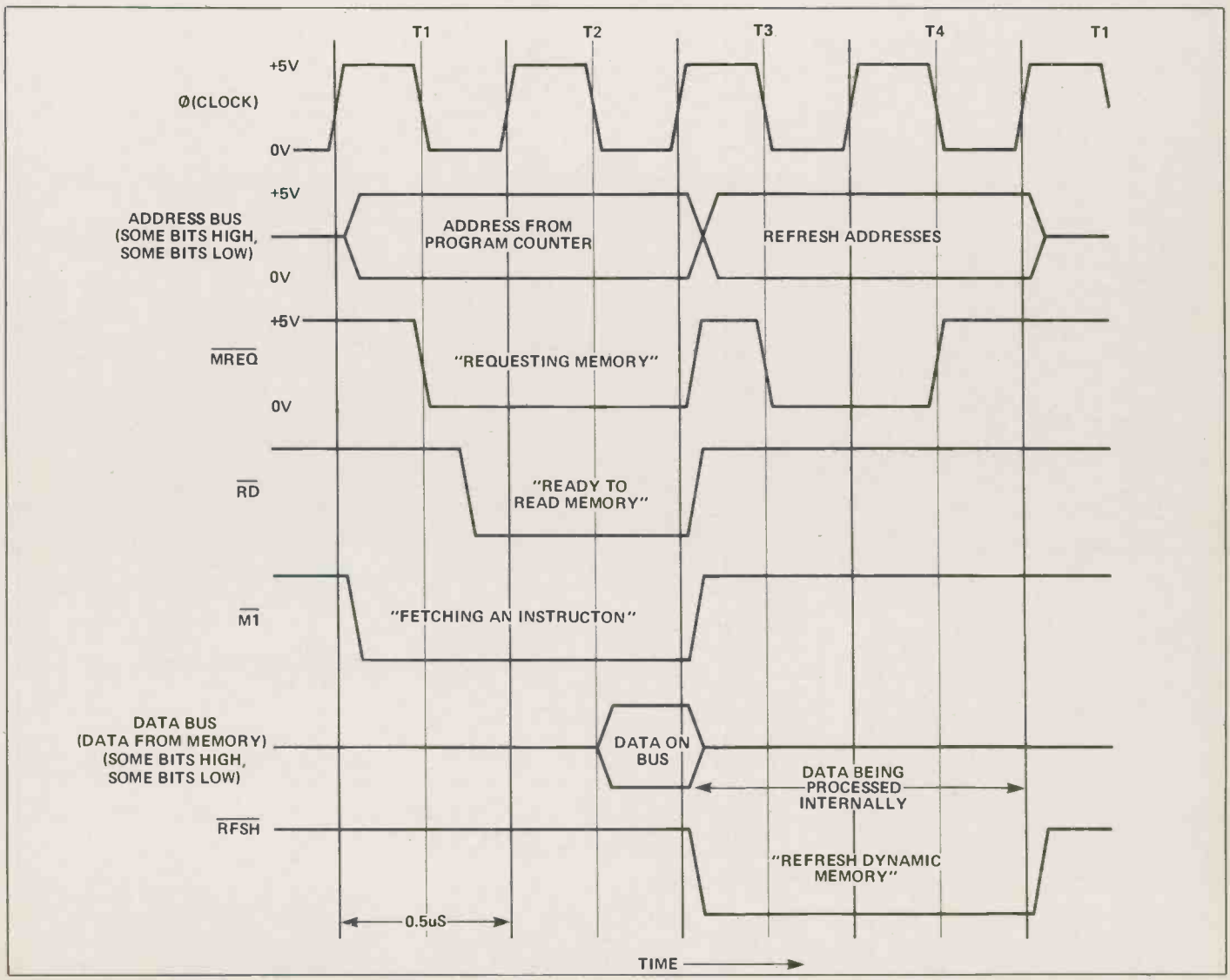


Fig. 6. The clock and control signals for the Z80.

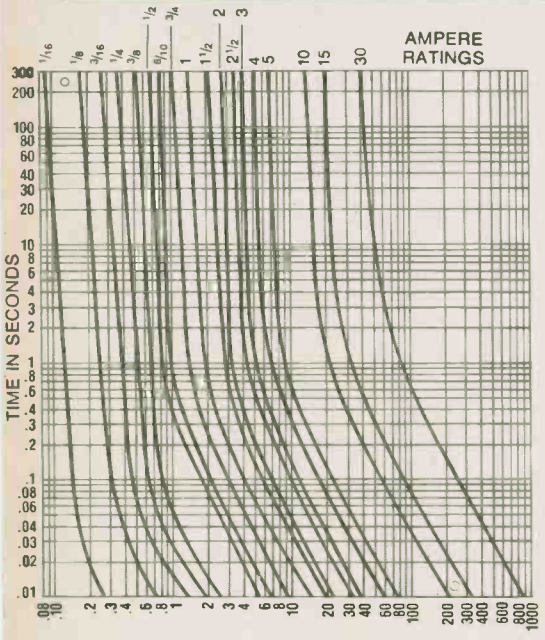
sider what happens when the MPU goes to memory to find the instruction which it is to execute next. Figure 6 shows the voltage levels on the lines concerned. The top curve shows the regular pulsing of the system clock at, say, 2 MHz. At this frequency, each of the periods T_1 to T_4 is 0.5 microseconds (μS). The MPU begins by making the $\overline{M1}$ low, indicating that it is about to fetch an instruction from memory. At the same time it puts on the address bus the address of the memory location in which this instruction is stored. It has obtained this address from its program counter, which has just been incremented following the execution of the previous instruction. The addressed location does not know at this stage whether it is to be read or written to.

On the next low-going edge of clock, the Memory Request line ($\overline{MREQ}$ indicates that this is an operation involving memory (as opposed to a printer, or monitor peripheral, for example). Immediately after this, the $\overline{RD}$ line is taken low by the MPU, indicating that this is a read operation. The $\overline{MREQ}$ signal is used to enable (or 'turn on') the memory IC so that it is ready to put its data on the bus. Since many such ICs are permanently wired to the bus and since only one can be allowed to put data on to any line at any one time, memories have *tri-state outputs.* These can be high, low or 'high impedance'. The high impedance state means that the output is virtually isolated from the bus and not able to communicate with it. Outputs are in this state until a $\overline{RD}$ signal is received by the IC. The $\overline{RD}$ signal can be fed to the memory IC so as to make its outputs change to low impedance and take the lines of the bus to high or low states.

As soon as the data has appeared on the bus the CPU reads it into its instruction register. It has until the next rising edge of the clock to do this. Then $\overline{M1}$, $\overline{MREQ}$ and $\overline{RD}$ are made high, indicating the the operation has been completed. The total time for the whole operation is 1 μS. During the next 1 μS the CPU passes the data along its internal bus to its control, where the data is decoded as an insturction then acted upon. While this is happening there is no need to take in further data and, since the instruction is still being decoded, the time for acting upon it has not yet arrived. In the Z80, this period is used for refreshing dynamic memories, as will be explained in a future issue.

ETI

Fuses



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GBB These are the high-speed types for protecting semiconductors, available from ¼ to 30 amperes at 60 volts.

About Voltage Ratings

The voltage rating doesn't refer to the fuse's ability to withstand applied voltage. It means the RMS voltage at which the fuse can safely interrupt the current without an arc restriking across the open element. Various voltage ratings account in part for the profusion of type numbers available from manufacturers.

Obviously, you can use a higher-valued voltage type in place of a lower, but you may not get satisfactory interruption of current if you try it the other way around.

Other Selection Information

If you're selecting a fuse for original equipment use, consult a fuse manufacturer's guide. Here's what to look for:

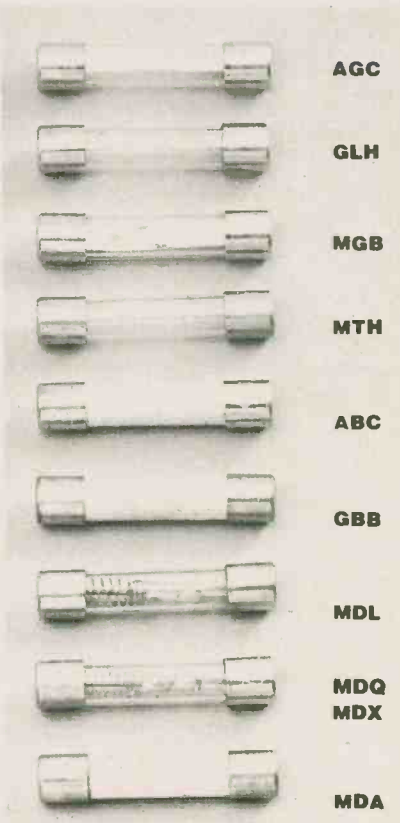
Current Rating: Select a fuse with an ampere rating of about 125% of normal current flow. For short-circuit protection only, this can be extended to about 300%.

Voltage Rating: equal to or greater than the maximum RMS voltage which will appear across an open fuse.

Time Characteristics: Resistive loads or loads with very short duration surges use fact-acting fuses. Very large surges such as can be expected from motors, solenoids, or huge capacitors require time-delay types. Sensitive components such as semiconductors may need very-fast-acting types.

Mounting Style: Sometimes case sizes or underwriter's requirements mean that you can't use the familiar old rear-panel fuseholder. There are lots of alternatives: the usual 1¼ inch cartridge fuses are available in axial or radial lead types which can be soldered onto a printed circuit, there are wide varieties of fuse blocks which can mount anywhere inside a chassis, and there are now miniature fuses the size of a quarter-watt resistor, also for PCB mounting.

It is interesting to recall that the earliest fuse was nothing more than a bare wire stretched across two studs. Modern fuses are considerably more convenient and are made to exacting tolerances. This doesn't make much difference in automobiles; you still have to stand on your head and throw your shoulder out of joint to get at the fuseboxes on cars.



Some of the many varieties of the 1¼ inch cartridge fuses.

Illustrations of Buss fuse products courtesy of GLE Inc., Toronto, Ont. ETI

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Pioneers of Electronics Series

A DuMont oscilloscope, the 304 H.

ALLEN BALCON DU MONT was born in 1901, which makes him one of the first of our pioneers of electronics to be wholly a product of the 20th Century. His engineering career started in 1924 when, as a freshly appointed graduate, he joined the Westinghouse Lamp Corporation in Bloomfield, New Jersey, as an engineer in the development laboratory. Since the invention of the triode tube (Audion) by Lee De Forest, many of the large electrical firms who had interests in both communications and in electric light had used their technical knowledge of lamp construction (particularly the use of tungsten filaments sealed into glass) to manufacture tubes. The Westinghouse plant was one which had been partly converted to tube manufacture and, in 1924, the great radio boom started when RCA pioneered the use of radio as an entertainment medium. Du Mont, like so many engineers in the field at that time, found himself in at the start of something big. He transferred to the radio tube division at Bloomfield and started to apply mass production techniques to tube manufacture. Mass production was only just beginning to make a mark on car production (thanks to the work of Henry Ford) and its use on articles which were thought of as delicate scientific instruments was unheard of. In parallel with this effort, he also started to develop the first large-scale test equipment for radio tubes, the forerunners of our modern test rigs.

The results of this truly engineering, as distinct from scientific, effort was felt all over the USA. An engineer, it is sometimes said, is one who can make for a penny what any fool could make for a dollar. Du Mont's work raised the production of the Bloomfield works to a staggering 50 thousand tubes of all types per day. This remarkable achievement established the young Du Mont as a production engineer of the first calibre and in 1928 he became Chief Engineer of the De Forest Radio Co. in Passmore, NJ, where his task was to modernise the plant and improve its productivity. This was no small job, because the Passmore plant was the 'oldest' radio tube manufacturing plant in the world; having been set up by Lee De Forest to manufacture the first ever triode radio tubes — it was full of relatively old equipment.

Du Mont gave the De Forest plant the same thorough attention he had devoted to the Westinghouse factory but then turned his mind back to research, since he was convinced that the key to success in radio was continual research and development. He had been fascinated by the patents of Charles Jenkins, one of the US pioneers of TV in the '20s. Jenkins, like Nipkow in the 1870's and Baird in the '20s, used electromechanical methods (involving rotating mirror drums) which produced very low-definition pictures. Du Mont set up a sound and vision system in 1930 but came to the conclusion that such a system could not possibly provide pictures comparable to film movies. Unlike others at the time, he was convinced that nothing else but comparability with the movies would be good enough for public use and that only a fully-electronic system could provide the quality of picture needed. This remarkably logical conclusion led him to the most important step of his life.

In 1931, on his 30th birthday, Allen Du Mont set up his own business. The Allen B. Du Mont Laboratories existed to pursue a new technology — that of the Cathode-ray Tube — as far as was possible.

At the time, the cathode-ray tube was a fragile piece of experimental glassware, a curiosity with few applications. Its design, in fact, had hardly changed since it was invented by Braun at the turn of the century. It would be hard to imagine anyone better suited to convert this primitive piece of glass plumbing into a piece of modern mass-produced scientific equipment and Allen Du Mont flung himself into his self-appointed task with relish. He re-thought the design and construction of the cathode-ray tube with the same energy and thoroughness as he had shown in the Westinghouse plant. He not only improved the primitive design of the tube, he also devised methods of production which were still in use for making experimental storage tubes in 1956. Seeing that no one else in the States was better equipped to make use of the new tubes, he went on to design his own oscilloscope, and built another production line for that.

The Du Mont oscilloscope was a landmark in the history of electronic instruments. It was the first truly commercially-available oscilloscope and was snapped up by laboratories all over the world. It had a good stable timebase, a Y-amplifier with a previously unheard of bandwidth of nearly 1 MHz and it was rugged and dependable. It was to prove, in fact, to be the most significant product of the Du Mont Laboratories, far outshining anything else, and in World War II the Du Mont oscilloscope was chosen by all three military services.

Meanwhile, however, Du Mont's work on the oscilloscope was financing TV receiver techniques. He was following closely the work of Zworykin at RCA, convinced that this line was going to result in the all-electronic TV system he had dreamed of. Zworykin, in the USA, and Schoenberg's team at EMI in England, both came up with the same answer — identical systems — in 1936 and Du Mont was able to manufacture TV receivers and offer them for sale to the public in 1937.

The glory was short-lived, however, because TV development was frozen by the outbreak of war. The Du Mont laboratories were turned over to the manufacture of radar tubes and other electronic equipment, while the production of

Continued on page 60

Designing Power Supplies

Using this simple procedure, anyone can build a simple supply for almost any purpose.

THE POWER SUPPLY is one of the most fundamental circuits in all electronics. It is also one of the easiest circuits to design yourself, once you have the 'know how'. This article is intended to give you just that skill.

This month, we feature a simple regulated supply set at 12 volts, and capable of about 400 mA. We'll use it as an example to demonstrate how component values are calculated.

The Theory

Before you can begin to design a circuit, there is certain information that you must have at your fingertips. For power supplies, it is necessary to know the peak input voltage and the output voltage. The 'input' is the voltage delivered by the transformer to the rectifier. Unfortunately, this is not the voltage usually specified by transformer manufacturers, but it is easily obtained by multiplying the RMS voltage (which is specified) by 1.4 (see Figure 2). You might expect that this is the voltage delivered by the power supply — not so. Some voltage will be lost across the bridge rectifier. Most diodes produce a forward voltage drop (i.e. when they are conducting) of about 0V7 and, since there are always two diodes passing current in a bridge, the drop across the bridge will be roughly 1V4.

The makes of voltage regulator ICs always specify some minimum voltage input to their device and it is generally about 2V5 higher than the required output voltage (eg, a 5 V regulator needs 7V5). To be on the safe side, assume that the minimum is 3 V higher. Now we know the maximum voltage which we can expect from the bridge rectifier, V_{BRIDGE}, and the minimum voltage needed to drive the regulator IC. The next step is to calculate the value of the filter capacitor, C1, which is there to 'smooth' the rectified mains voltage for the regulator IC.

The effect of the smoothing capacitor is shown in Figure 3. It charges up with each voltage peak, then discharges slowly as the rectified voltage falls to zero. The discharge time is such that C1 will not discharge completely, however, so the voltage never falls below a certain level which (aha!) must be the regulator minimum input voltage. The difference between the voltage peaks and the regulator minimum is the ripple voltage, V_R. Obviously, the value of the smoothing capacitor must be chosen so that the input voltage to the regulator never falls below the specified minimum.

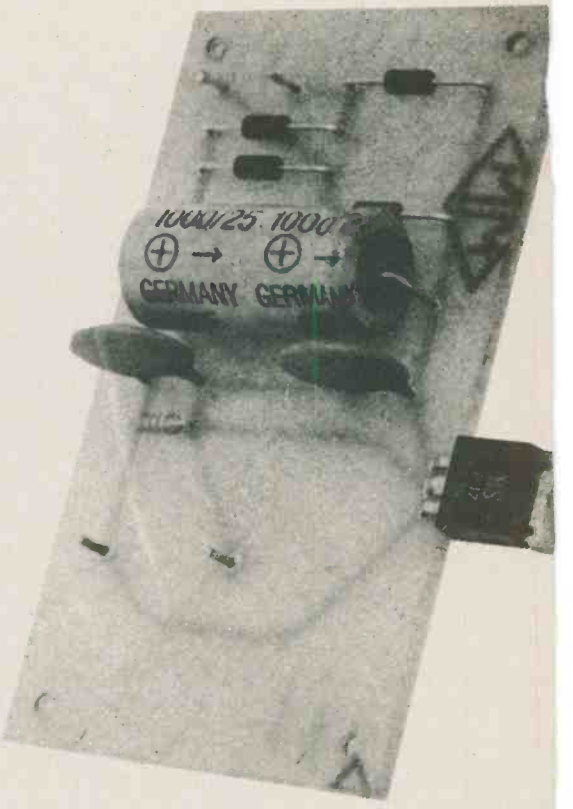
The diagram in Figure 3 shows cycles of the rectified mains voltage, enlarged. The quantity 'T' is the time (Period) between voltage peaks and it is equal to twice the line frequency of 60 Hz i.e. 120 Hz. Since the period, T, is the inverse of the frequency, T is 0.0083 seconds.

Now a capacitor in a circuit which has resistance (and every circuit will have at least some resistance) will take a definite time to discharge most of the voltage stored on its plates. This time is the familiar RC time constant:

$$t = RC,$$

where t is the time, in seconds; C is the capacitance in Farads, and R is the resistance in Ohms. Now from Ohm's Law, we also know that:

$$R = V/I,$$



therefore, substituting the second equation into the first, we get:

$$t = (CV)/I,$$

where I is the current required from the circuit; t is the time period over which the capacitor discharges and V is the voltage discharged in time t.

Now, since we don't want the capacitor voltage to drop below a certain minimum, V is the ripple voltage V_R, the difference between the rectified voltage peaks and the regulator minimum, and t is the period of the full-wave rectified mains.

For Example

The remainder of the procedure is best illustrated by a practical example. To choose a suitable transformer, select one which produces a slightly higher voltage than that required — usually the next one up in the range will do the trick, i.e., one with a 15 V winding. The current rating will be explained shortly.

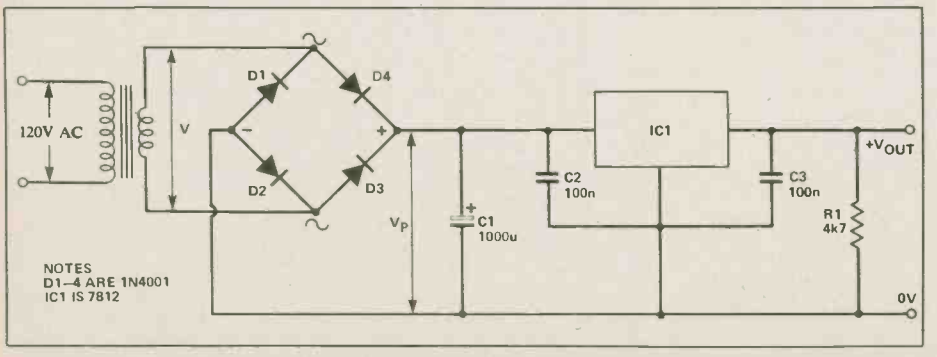


Figure 1. A simple regulated supply using one of the common three-terminal regulator ICs.

The next step is to calculate the voltage output from the bridge rectifier:

$$V_{BRIDGE} = Vp - 1.4$$
$$= (V_{RMS} \times 1.4) - 1.4$$
$$= (15 \times 1.4) - 1.4$$
$$= 19.6 \text{ volts}$$

The regulator IC needs at least 15 V, so we are on the safe side with 19V6. The difference is the ripple, V_R:

$$V_R = 19.6 - 15 = 4.6 \text{ V}$$

Now, using the formula for calculating the value of the smoothing capacitor C1, we have:

$$C = tI/V_R =$$

$$(0.0083 \times 400 \times 10^{-3})/4.6$$

$$= 725 \text{ uF}$$

This is not a preferred value, so use the next highest in the range, which is 1000 *u*F. It must cope with peak voltages of about 20 V, so use a 25 V working electrolytic type.

Now we come to the transformer current rating. Calculating the exact value required for the best efficiency is fairly complex, but there's an easy rule-of-thumb we can use.

Assume that we have 20 V on the unregulated output, i.e., across C1. This means that the transformer secondary will be supplying 20 x .400 = 8 Watts when the regulator is putting out its 400 mA. Allow a fudge factor for losses in the rectifier and transformer itself, and assume we need at least 10 Watts. The transformer current rating is then I = P/E, or 10/15, or 670 mA.

Another point to consider is that the bridge diodes must be able to handle both the current and the peak voltage; the popular 1N4001 diodes, rated at 50 V and 1 A, are quite suitable here.

Finally, there is the regulator IC. The one used for this supply is the common 7812 variety, a 12 V 1 A three-terminal device. The regulator dissipation is equal to the voltage across it times the current through it. Assume that the input voltage is on the high side at 20 V, and the current is 400 mA. The dissipation is then (20 - 15) x .4 = 2 W. The manufacturer's specification sheet says that the 7812 gains about 50 degrees Celsius for every watt dissipated without a heatsink, so the case temperature will be about 100 degrees. A further check on the sheet shows that the IC can still supply the required 400 mA at this temperature, so we can get away without a heatsink. However, the IC will be uncomfortably hot if you touch it, so you might want to bolt on a small finned heatsink, or mount it to the chassis with an insulating washer and nylon screws.

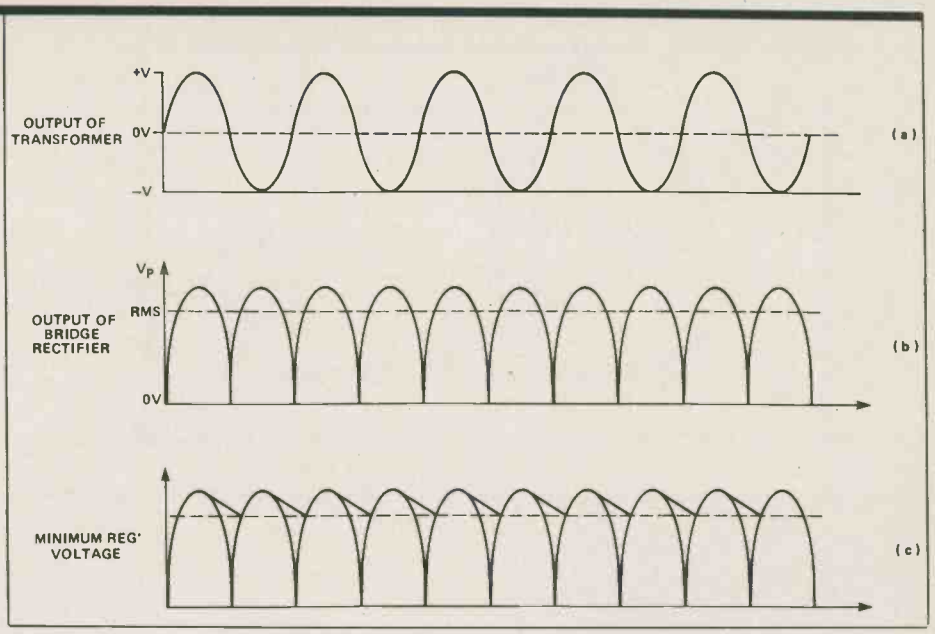


Figure 2. Power supply waveforms: (a) the output of the transformer; (b) output of the bridge rectifier; (c) input to the regulator IC.

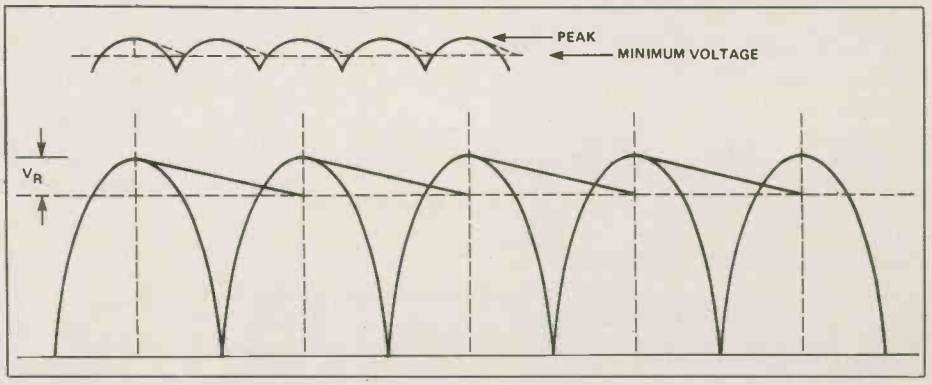


Figure 3. Power supply waveforms: (a) the output of the transformer; (b) output of the bridge rectifier; (c) input to the regulator IC.

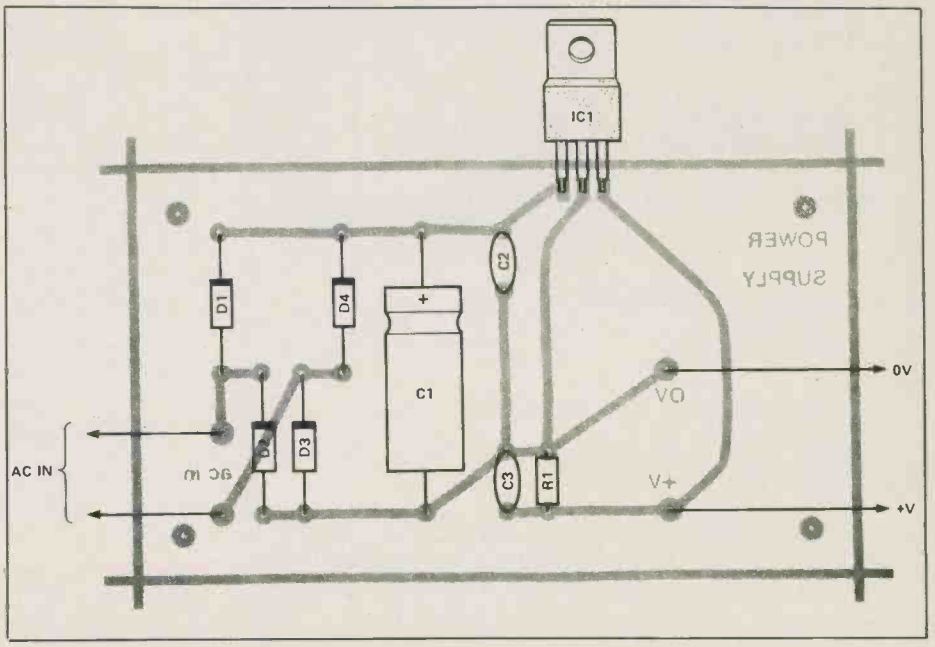
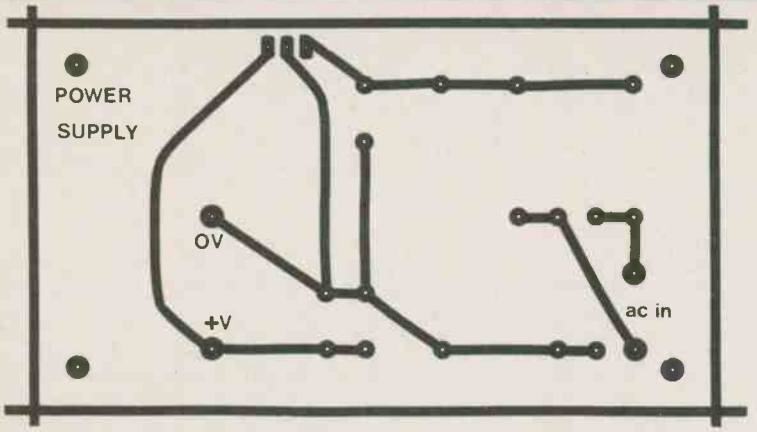


Figure 4. Component layout of the power supply.

Designing Power Supplies

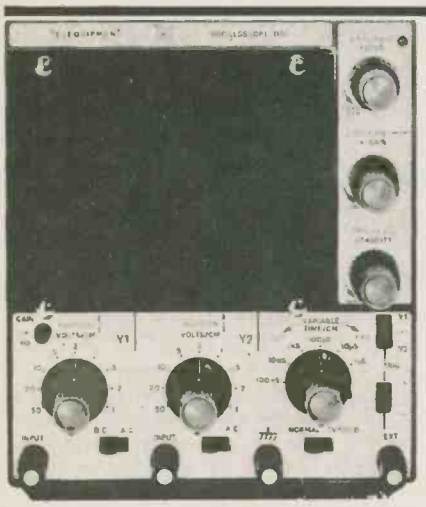


Capacitors C2,3 are essential to prevent high frequency oscillations; the values are generally specified in the maker's data so they are not a problem; the point to note, however, is that they should be mounted as close to the IC as possible.

And that completes the circuit design — it's as easy as that! Although we have illustrated this procedure with a specific supply (12 V at 400 mA), it can be used with any three-terminal regulator IC to design a supply for any voltage and current. The next step is one you must make yourself!

ETI

Dumont



A modern oscilloscope, such as this Telequipment D51, offers the kind of facilities Allen B. Du Mont must have dreamed of.

oscilloscopes was trebled. The pioneering work on TV receivers was never resumed to any extent, despite Allen Du Mont's presence on the NTSC — the National Television Standards Committee — the body which, in the late '40s, came up with the famous specification for a colour TV system. By the time the Committee saw its recommendations emerging in the shape of the first RCA colour receiver, Du Mont was a sick man. He died in 1956.

Allen Du Mont never attained the fame and glamour of some of our other subjects, but he was one of the engineers whose work laid the foundations for much that we take for granted today. For two generations of enthusiasts in the USA, the Du Mont oscilloscope was one of the attainable dreams, an instrument which made an amateur into a near-professional. For that alone, his name will be remembered.

ETI

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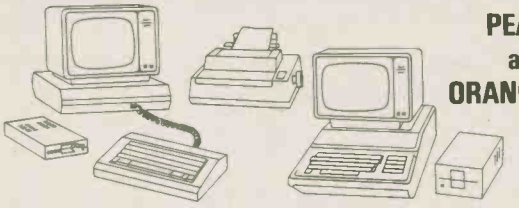

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Sound Switch

BUDGET PROJECT

SOUND ACTIVATED switches lend themselves to applications such as baby alarms, voice activated tape recorders, burglar alarms and the like. This simple design will operate from a voice of average volume at a range of about two metres or so using a high impedance microphone, or a little less than this using a low impedance microphone or with a high impedance loudspeaker as the microphone.

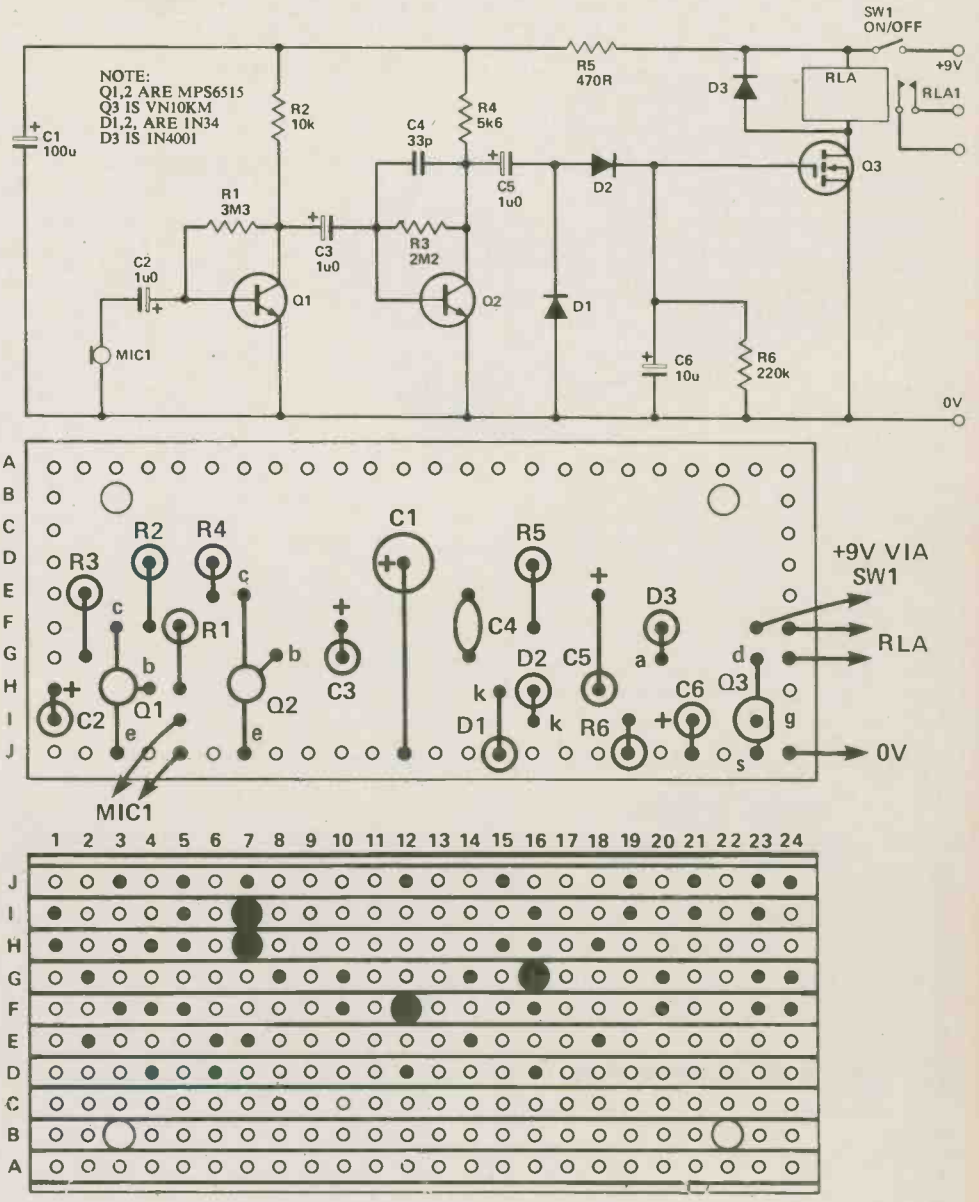
Signals from the microphone will be at a very low level and must be greatly amplified in order to operate a switching device of some kind (a relay in this case). The microphone signals are therefore coupled, by C2, to a high gain common emitter amplifier using Q1, collector load resistor R2 and base bias resistor R1. The signal level at the collector of Q1 is still inadequate, so a further and virtually identical stage of amplification is used to boost it further. The second stage is based on Q2, with C4 to attenuate the high frequency response of the amplifier and thus aid stability.

C5 couples the output of Q2 to D1 and D2 which rectify the signal to give a series of positive pulses. These are smoothed by C6 to give a positive DC bias. In the absence of an input signal there will, of course, be no significant drive, and VMOS switching transistor Q3 will be cut off. The drive will be of the order of a couple of volts or so when the unit is activated, switching on Q3 and the relay which forms its collector load. A pair of normally open relay contacts then operate the external equipment.

R6 is included so that the bias decays about two seconds after the input signal has ceased and the unit reverts to the 'off' state. Without R6 the unit would tend to latch 'on' since the input resistance of Q3, unlike an ordinary bipolar transistor, is extremely high. The attack time of the unit is very short and it switches on rapidly at the start of a signal.

The 0.1" matrix stripboard layout for the Sound Switch is straight-forward. Q3 requires no special handling precautions as it has an integral zener diode which protects it from high static charges. D1 and D2 are germanium devices and care should be taken to avoid overheating these when connecting them.

ETI



PARTS LIST

Resistors (all ¼ W, 5%)

R1	3M3
R2	10k
R3	2M2
R4	5k6
R5	470R

Capacitors

C1	100u 10 V axial electrolytic
C2,3,5	1u0 25V axial electrolytic
C4	33p ceramic plate
C6	10u 10V axial electrolytic

Semiconductors

Q1,2	MPS6515
Q3	VN10KM
D1,2	1N34
D3	1N4001

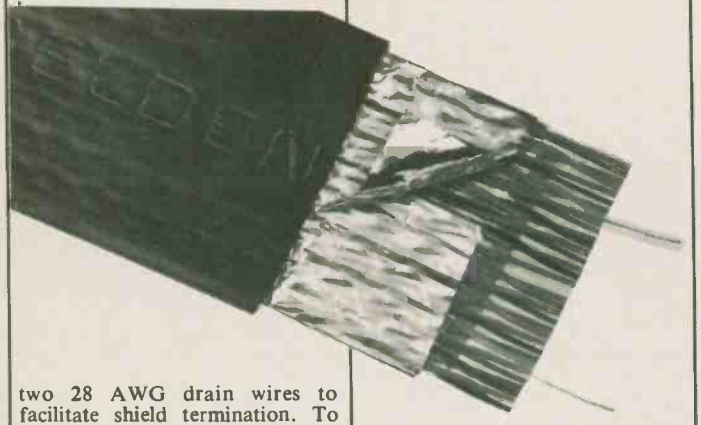
Miscellaneous

SW1	SPST toggle switch
MIC1	microphone or high impedance loudspeaker (see text)
RLA	relay 6/12 V coil 185 ohms or more
0.1"	matrix board, 9 V battery, battery clips, etc.

for your information

New Belden Cable

Belden Electronic Wire and Cable has introduced a new shielded jacketed Vari-Twist™ twisted pair flat cable series to help meet FCC EMI/RFI requirements (Belden 9V283XX). This cable is Belden's standard 9V280XX Vari-Twist™ series covered with an aluminum/polyester Beldfoil® shield which provides 100% coverage. There are



two 28 AWG drain wires to facilitate shield termination. To reduce crosstalk, each adjacent PVC-insulated pair is twisted in the opposite direction. The standard twist length is 18 inches followed by a 2 inch flat section of .050 inch spaced conductors.

Belden's shielded jacketed Vari-Twist™ is available in ten standard sizes with 5 to 32 pairs for use with 50-mil center insulation displacement connectors. The standard package contains 100 feet of cable. Non-standard lengths may be custom-manufactured to meet special requirements.

For additional information contact Belden's Canadian representative: White Radio Limited, 940 Gateway Drive, Burlington, Ontario, L7L 5K7. (416) 632-6894, tlx. 061-8618.

Timex/Sinclair 64K RAM

The Timex Sinclair TS/ZX81 was the first personal computer to break the $100.00 retail price point. Now Gladstone Electronics has announced a full 64K RAM expansion for under $100.00 for this

powerful personal computer.

The Gladstone 64K RAM expands the capacity of the TS/ZX to its maximum, transforming this small, low cost computer into a powerful tool for business, educational and household uses. The low price is made possible by volume manufacturing in the U.S.A. to fill the demand of users. Other comparable 64K RAMS are typically priced at least 50% higher.

With the Timex Sinclair Computer now being discounted to below $60.00, a combination of the computer with a Gladstone 64K RAM enables a full 64K computer system to be purchased for less than $150.00. The Gladstone 64K features a precision molded plastic case with a quality edge connector for a tight fit to the expansion port on the TS/ZX. It features a full 6-month limited warranty. Contact: Gladstone Electronics, 1736 Avenue Rd., Toronto, Ont. M5M 3Y7, (416) 787-1448.

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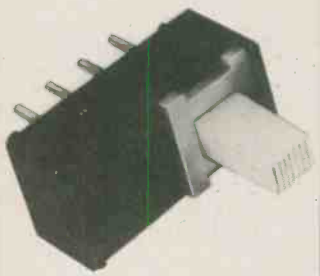
SAN FRANCISCO (AP) The National Guard had to be called in to destroy a home robot which had gone berserk and was attacking nearby shopping mall crowds with an electric lawn edger. Said Colonel Doug Stevens, "We knew this would happen someday. There's a lot of them out there."

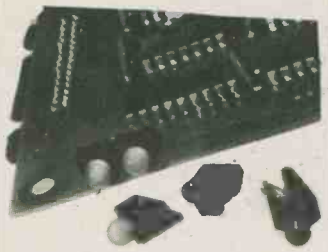
for your information



PCB Catalogue

Electronic Packaging Systems Ltd. and BICC-Vero Electronics Ltd. announce the release of their new Circuit Board catalogue, a catalogue that highlights their complete range of proto-type, Euro, microprocessor and backplane boards.

This new catalogue includes twenty two new products. For a copy, write or phone: Electronic Packaging Systems, P.O. Box 481, Kingston, Ontario. K7L 4W5. (613) 384-1142.



Right-angle LEDs

Now available from Hewlett-Packard is a series of industry-standard, right-angle LED indicators. These indicators are T-1 ¾ LED lamps assembled in black plastic housings that orient the LED at a right angle to the printed-circuit board. Called the HLMP-5000 series, these new right-angle lamps are designed to be used as back-panel diagnostic indicators and printed-circuit board logic-status indicators.

Incorporating HP's existing range of T-1 ¾ LED lamps, this new series of right-angle LEDs provides a color choice of high-efficiency red (HER), standard red, yellow and high-performance green, with or without a current-limiting resistor at competitive prices. The compact, black-plastic design allows flush seating on the PC board and may be end-stacked on 6.35 mm (0.25 inch) centers. From: Hewlett-Packard (Canada) Ltd., 6877 Goreway Dr., Mississagua, Ont. L4V 1M8.

Portable Turntable

Portable phonographs were once a must-have item for the Elvis generation, but they required a strong arm to cope with their bulk. Sony now adds to its line a sleek turntable, weighing under four pounds, that will operate vertically, horizontally — even hanging on a wall. Designed for use with headphones, radio cassette-corders or self-powered speakers, the new PS-F9 also offers such advanced features as direct drive and linear tracking. At Sony dealers.

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Continued on page 69

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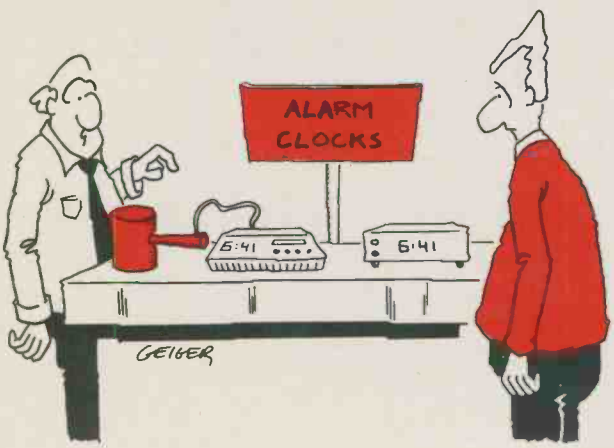

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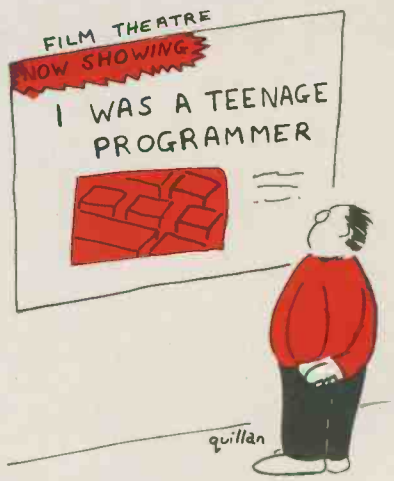
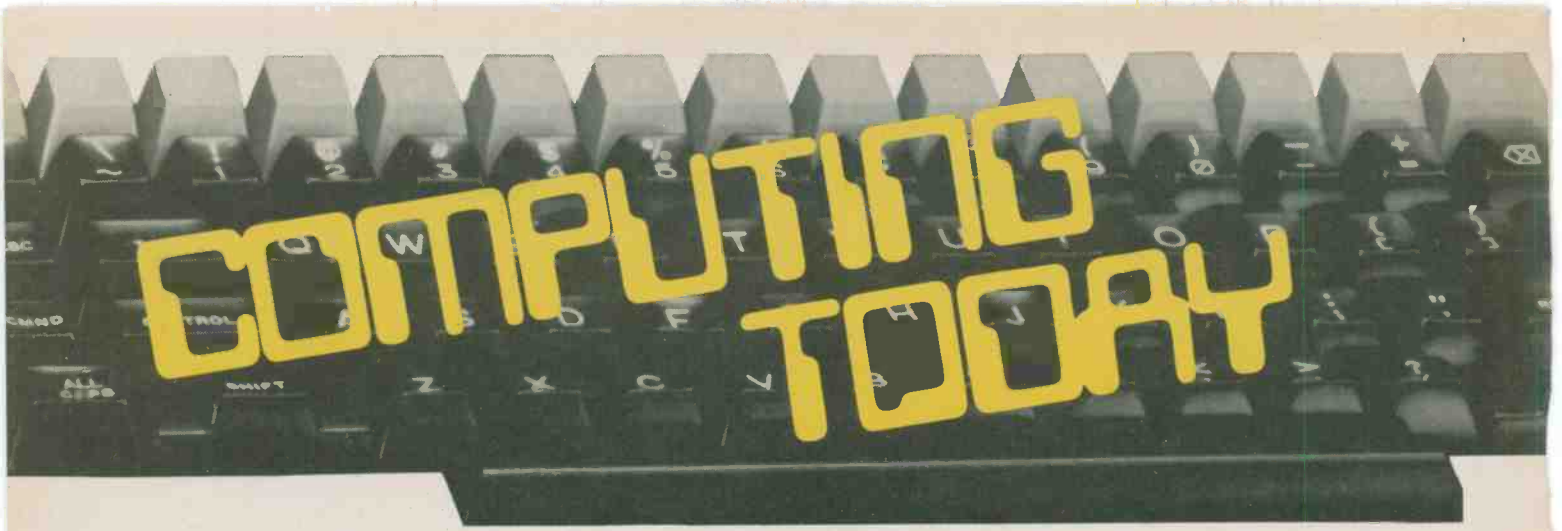




by Steve Rimmer

EVERY SO OFTEN the mysteries of industrial surplus turn up these really weird hardware things which seem like such great trips. The thirty dollar modem was one of them . . . it's hard to imagine the numbers of people who got turned on to telecommunications over these little creatures. The sixty dollar micro-monitor may be another of these phenomena.

From whence they have come, no one may imagine. However, for fifty nine dollars and tax you can be the proud owner of the Osborne eye, a five and a quarter inch video monitor complete with a protective layer of air all around it. In fact, it's better than the micro-tubes found in many Osbornes . . . it's green, and, as such, a great trip for use as a data display.

Killer Cathode Rays

Your basic sixty dollar tube consists of a small CRT, a metal frame to hold it and a driver board which generates the scanning stuff, cranks out the high voltage for the final anode of the tube and handles the video. It's made by Electrohome . . . it's even patriotic. The monitor in the photos was come upon at Exceltronics.

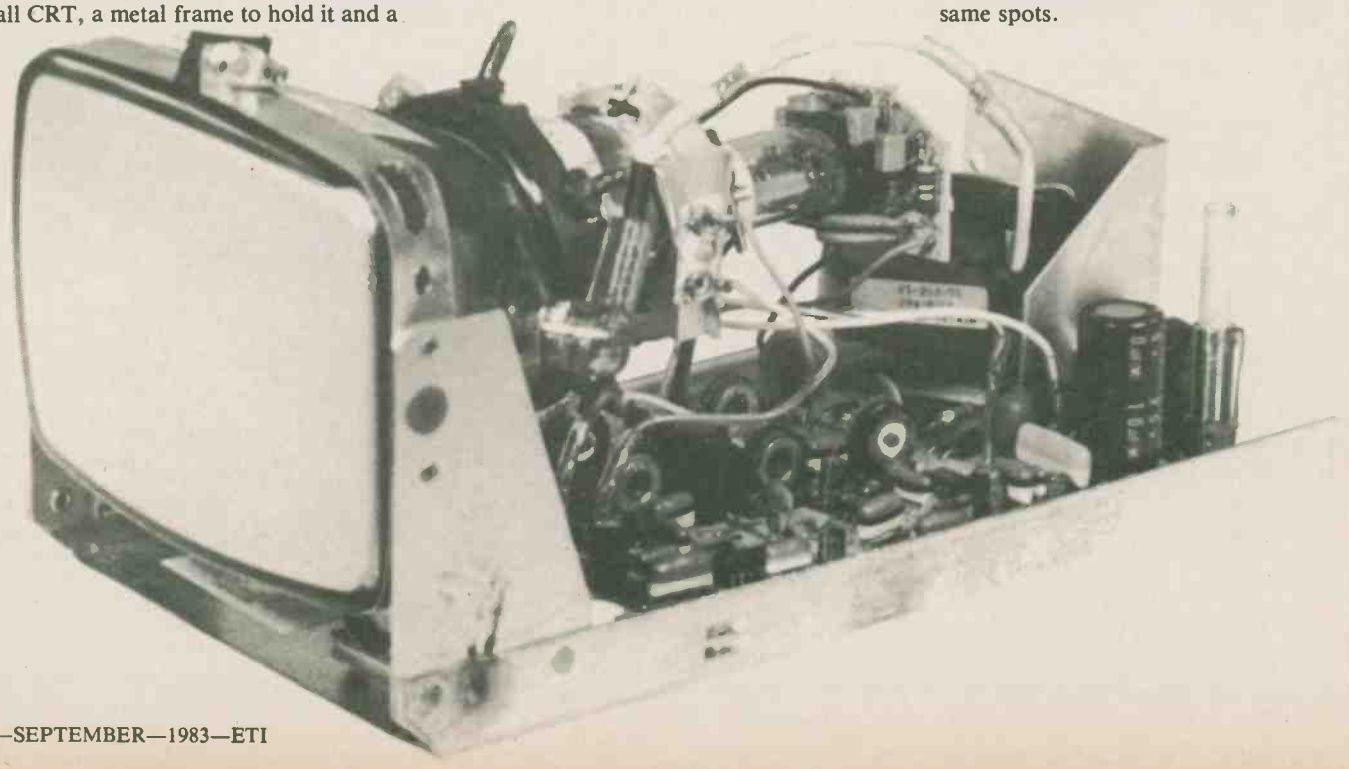
To make life doubly easy, the tube runs from a mere twelve volts. There are no weird power supplies to come up with. To thereafter confuse things a bit, the thing cannot be driven directly by composite video. It needs separate sync.

There will now follow a discussion of this.

A video signal consists of five principal components. These are the luminance, or the brightness of the picture at each instant, the chrominance, or the colour, the colour reference, a signal which the chrominance is compared to in order to keep the colour meaningful, the vertical sync and the horizontal sync. This being a discussion about a black and white . . . well, okay, green and white . . . monitor, we can ignore the chrominance and the colour reference, chopping the number down to three.

Each frame of a TV image is made up of 525 lines. You can see 'em if you look closely enough at the tube. At the beginning of each frame there is a pulse, which you can't see, which effectively tells the video circuitry "your attention please . . . we are now going to start another frame . . . get the scanning beam up here, thank you kindly." This is the vertical sync, running, as it does, at sixty pulses per second. At the same time, there is also a pulse at the beginning of every horizontal line to get them all happening at the right times. These transpire at 15,750 pulses per second.

Because the beam of the video screen is either displaying picture information or sweeping to some place to begin displaying the next bit of video information at any given time, but not both at the same time . . . this will make sense if you think about it . . . it is possible to have these three signals combined as one. The pulses and the luminance just don't occur at the same spots.



This is called composite video.

Under normal circumstances, such as those found in hundred and fifty dollar Zenith monitors, the composite video signal is separated into its three component parts by the circuitry inside the set. In the case of this tube, the circuitry is not present . . . this thing is likely surplus from some sort of display that produced the sync for it. As such, to use it one must either obtain sync for it from the computer producing the video, very often easily done, or produce a circuit which will separate out the sync externally . . . also easily done.

In getting sync from the computer, the approach will vary from system to system. In most cases, a few minutes with a schematic will help you locate the correct points in your system to tap off some pulses. The horizontal and vertical inputs to the monitor look like one TTL load each, which means that you may or may not need to have buffers in there depending upon the age of your system.

Some of the latest computers, like the Commodore 64, have all their video and sync combined in their CRT controller chips and, as such, don't make separate sync available externally.

For those needing a sync separator, one can be built fairly easily. A capacitor to ground will filter the horizontal out of the vertical and a capacitor in line with the signal will take the vertical out of the horizontal. A few transistors after these crude filters will clean things up the point where they will drive the monitor's circuitry reliably.

However, I should mention that Exceltronix is also offering a custom made sync separator kit for this thing for ten bucks . . . ahem, looks like a good trip with rather less fighting.

That Syncing Feeling

Getting the monitor working is fairly simple. There is a single card edge connector on its printed circuit board through which it can be provided with all its electrical inputs. It looks like this:

Pin	Function
1	Horizontal ground*
2	Top of optional brightness control*
3	Bottom of optional brightness control*
4	Wiper of optional brightness control*
5	Alternate heater voltage*
6	Horizontal sync pulses
7	Twelve volts DC
8	Video input
9	Vertical sync pulses
10	Signal ground

*These pins can usually be ignored.

Pin ten has a notch beside it.

The horizontal sync pulses should be five volts high and positive going. The vertical circuitry wants five volt pulses going either way. The video should be one to four volts high.

The optional brightness control is just that . . . it can be left off, in which case the brightness is set by a default resistor marked R324 on the PCB. The brightness potentiometer, if used, effectively sits in parallel with this resistor. Unless you have a fairly weird application, you will probably find that the default brightness level is satifactory, and that minor variations in the luminance level of the picture are easily handled with the contrast control, a preset pot marked R103 on the board.

You can remove R103 and run wires in from a panel-mounted potentiometer if you want to be able to conveniently fiddle with the brightness.

There is really only one other control on the monitor PCB that is likely to want adjustment, this being R203, the vertical hold adjustment. Since many low cost systems have unusual video arrangements . . . some of which generate vertical sync rates which are a mite strange . . . it might be necessary to tease this one a bit to get a stable image.

The monitor, as it comes, appears to be set up for a fairly dense display. If you are using a forty column Apple, or some other computer heaving out a fairly loose screen format you might have need to adjust R205, the vertical size pot and its attendant fudge factor, R208, the vertical linearity adjustment.

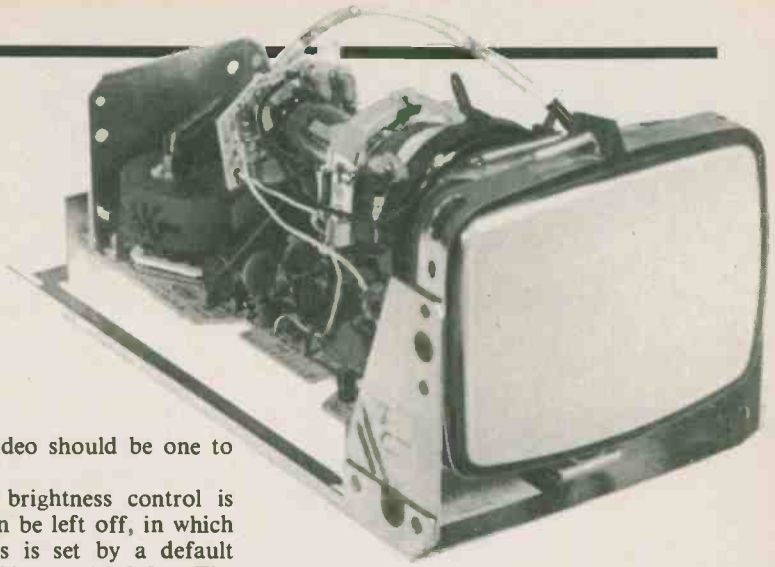
An easy way to set up the linearity is to have your computer draw a series of squares on the screen and fiddle until the squares at the top are the same size as the squares at the bottom.

It's a good trip not to harangue the remaining pots on the board. They shouldn't need adjustment, and, if you get them badly out of alignment you may have some fun getting the whole thing working again.

One Green Eye

Now, as to the all important question, namely, what can be done with this thing . . .

Unless you really like things tiny, I don't know that this thing would make the perfect system monitor. It has been said that if you have a smaller screen you



can just move closer, and this did go a long way towards selling both Osbornes and one inch oscilloscopes in their respective times . . . but your eyes do fall out sooner or later, and this is largely a bad number.

This is a good little box to use if you are into building portable equipment, of course . . . its single supply voltage . . . which corresponds nicely to that of a car battery . . . makes it a good little beast for small non-domestic boxes.

The ideal home for it, however, is as a secondary screen. It is often the case that one is forever switching between a text display and a graphics display . . . and pretty soon the patch cords begin to get a little hairy. It's a good deal more high tech to have a small screen to handle the graphics when you are developing the software and then use it to handle text when the pictures are largely working properly.

This is an ideal situation if you are running an Apple II, or anything remotely similar, with a Videx eighty column board or, coming from the other direction, a sprite card. Rather than constantly switching from the output of the auxiliary video source to the Apple itself, you can leave one or the other permanently attached to one of these mini-tubes, and just sit the thing on top of your existing monitor.

I confess to being easily beguiled by diminutive toys, but this little creature seems to be a genuinely decent value. It's easy to get working and quite handy for a number of applications. Complete commercial dogma concerning Exceltronix and the obtaining of a tube of your own can be found in their advertisement on the inside front cover of this magazine.

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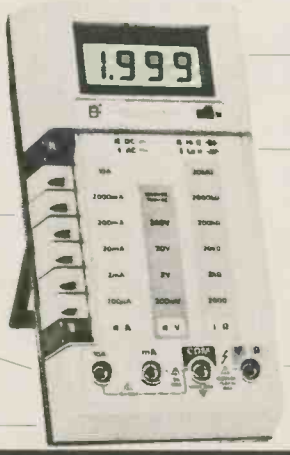

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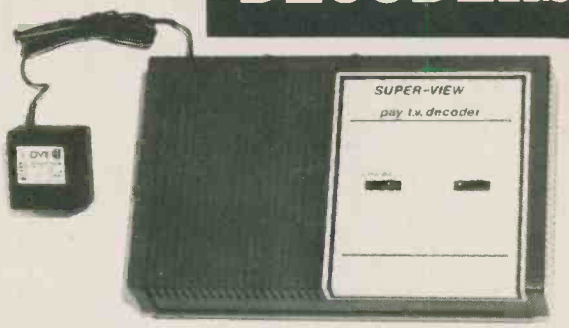

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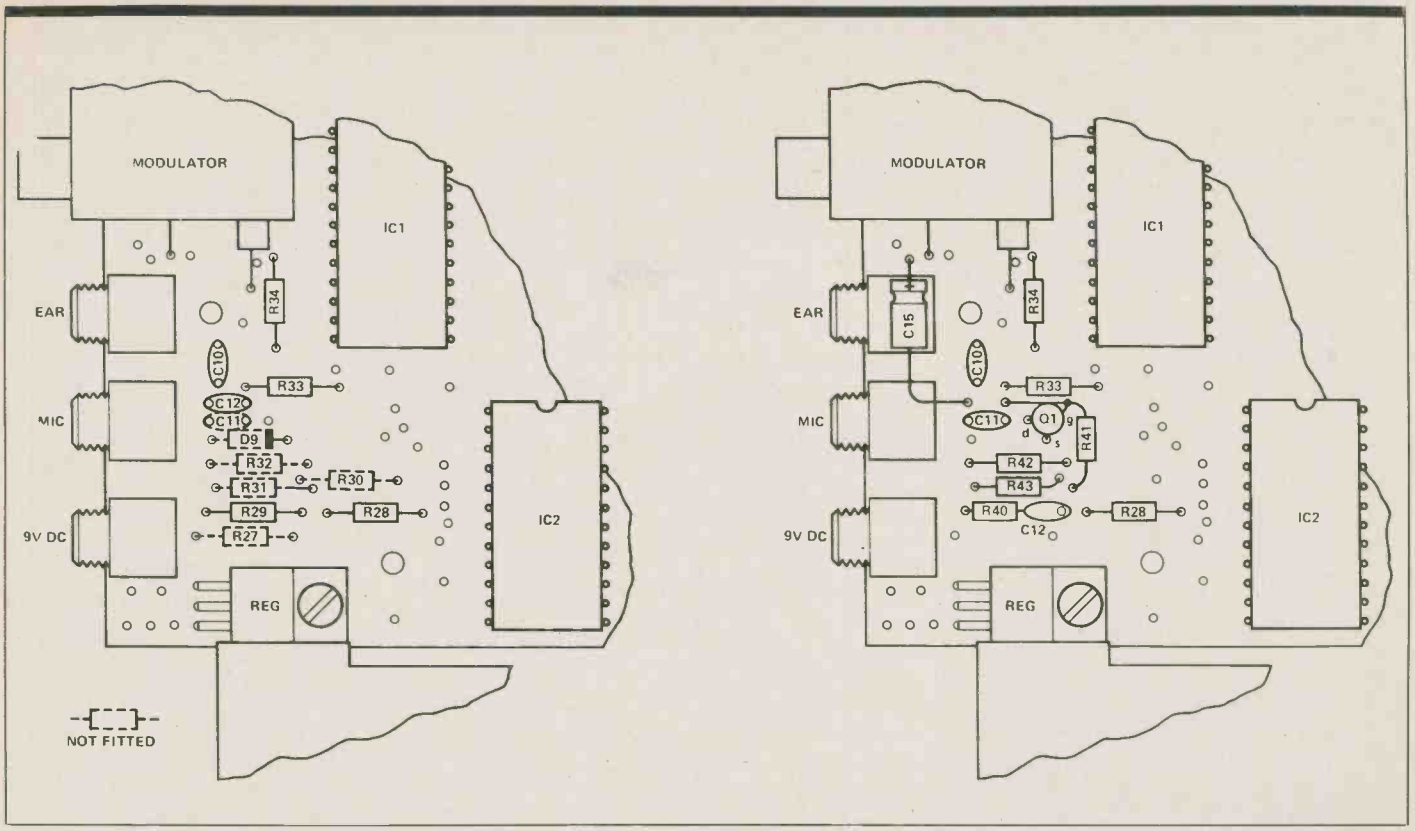

Fig. 4. The Sinclair board before (left) and after (right) the mod.

cessory socket. (You might like to use this opportunity to make the heatsink modification described earlier).

Before screwing on the back cover, connect the power, the television and the cassette recorder, write a very short program and ensure that it SAVEs and LOADs properly.

The two short screws go into the holds uner the feet behind the keyboard. The new setting for the cassette player volume control will have to be obtained by experimenting.

Fault Finding

If the television picture fails to appear, check that the television is tuned to the correct channel and that the regulator is giving out 5 V. Next, check that the FET is wired correctly and that it has 5 V on its drain and 0 V on its gate. The biasing is such that the source should be at about 2 V. If the source is at 5 V check the connections to R42 and R43 and their values with a multimeter, after disconnecting the computer power. If the source voltage is higher than 3V5 or less than 1 V you have a FET which is on the tolerance limits and the combined value of the source resistors will have to be changed to compensate. Initially, change only R42, but if it has to be varied significantly to achieve 2 V DC on the source then I would suggest replacing the FET.

The type of FET used in this circuit is a junction FET and consequently there are no handling precautions necessary beyond those normally used for bipolar transistors. A 2N3823 was used in the original and the case/screen lead was soldered to the drain before insertion into the PCB. A TIS34 or the very cheap, plastic encapsulated 2N3819 could be used instead.

PARTS LIST

Note that this is a list of the *new* components required

Resistors (all ¼W 5%)

R40	See Table 1
R41	See Table 1
R42,43	2k0

Capacitors

C15	22*u* 16 V axial electrolytic

Semiconductor

Q2	2N3819 or TIS34 or 2N3823

When a tape has been recorded from the computer, listen to it to see if it is distorted due to overloading. Naturally, it will be necessary to experiment with the playback level when loading the program back into the computer because the record level on the tape will be little higher even if recorded by an automatic record level machine. ETI

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TO ORGANIZE A RUN:

Ask your local club, PTA, school, or neighbourhood association for help. Write or call The Terry Fox Run Office below for an application form. Apply before August 15th, and we'll send you The Terry Fox Run Kit with everything you need to organize a Terry Fox Run in your area.

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Write or call The Terry Fox Run Office below. They will have a list of all run sites in your province.

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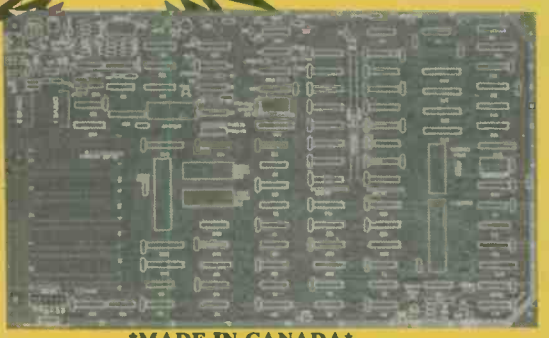

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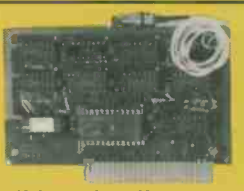

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TECH TIPS

Eight Traces On A Single Trace Scope

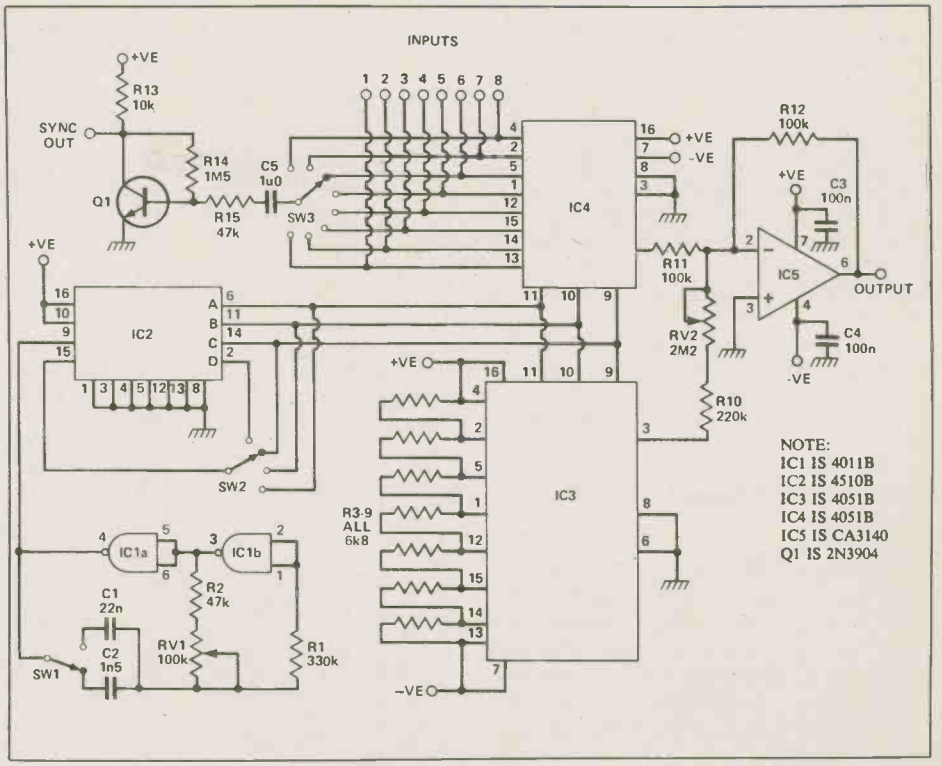
Tore Solheim

This simple and inexpensive circuit can display up to eight traces on a single beam oscilloscope. Even though the capacity of such a simple circuit is limited, it will be fine as part of a home workshop. The frequency response is DC to 100 kHz with the circuit shown, and the scope sensitivity should be 0V5 per division, preferably DC-coupled.

IC1 is the clock oscillator: SW1 selects chopped or alternate mode. RV1 allows the frequency to be adjusted over the range 10-30 kHz or 200-700 Hz depending on the setting of SW1. The counter IC2 controls the two analogue multiplexers IC3, 4. One, two, four or eight traces may be selected using SW2, which couples one of the counter outputs back to the reset pin to reset the IC after the desired count length. The analogue inputs of IC3 are connected to a voltage divider, R3-9, and the output is connected, via R10 and RV2, to the negative input of the op-amp, IC5. This allows the offset voltage of the op-amp to be adjusted over a wide range. The trace changes position by changing the offset voltage, which has no effect on the gain of the op-amp. RV2 allows the voltage offset between the upper and lower traces to be adjusted from ±0V3 to ±3 V, ie RV2 is the position control. Separate controls aren't needed here. The eight channel inputs are connected to the analogue inputs of IC4.

The circuitry around Q1 and SW3 is to allow external triggering of the scope. This circuit isn't strictly necessary, but will often give a better display. The whole circuit is designed for a ±6 V power supply, and the inclusion of IC3, 4 means that ±7V5 should never be exceeded.

Why is IC5 wired in the inverting mode, when the non-inverting mode would give better results? The offset adjustment of a non-inverting low-gain amplifier using the method shown here would affect the gain. Also, the inputs should not be left open-circuit as this will cause notches on the traces. The inputs should therefore be connected to an inverting amplifier, preferably with an attenuator due to the low sensitivity.

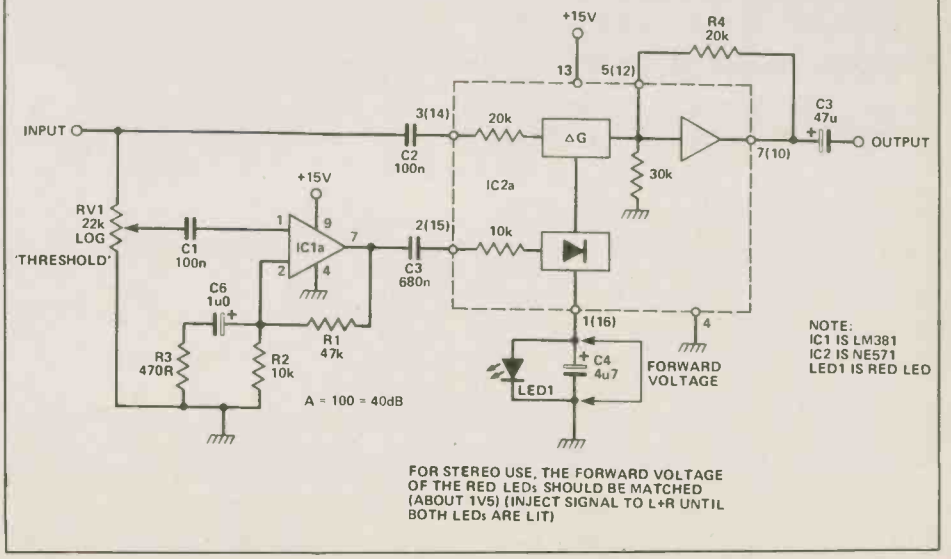


Expander Gate

W.K. Todd

This circuit is a simple expander gate and can be used to reduce the surface noise of records and tapes. It is based around an NE571 compander chip, used as an expander below the threshold set by the red LED. The LM381 amplifies the input signal by 40 dB; this is rectified in the 571 by a current mirror circuit and is smoothed by C4. When the voltage reaches the forward voltage of LED1 it draws current and hence limits the current to the gain cell. This causes linear operation above the threshold.

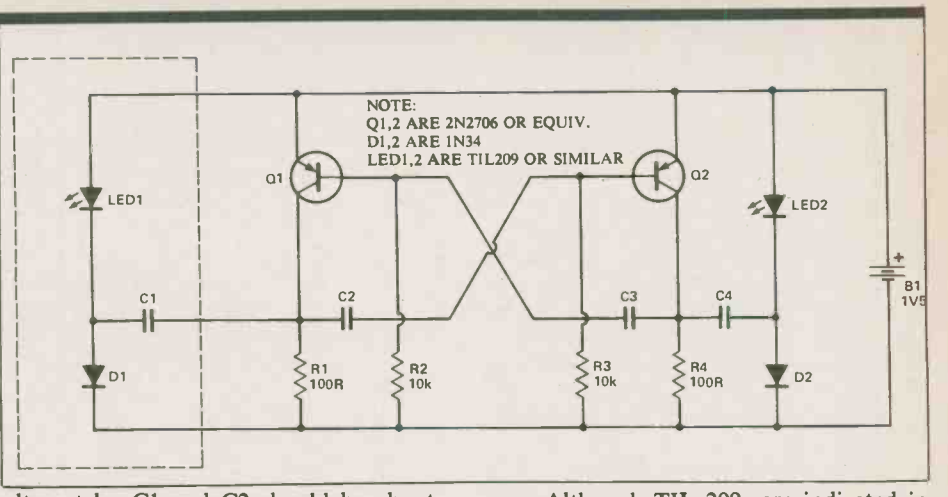
For stereo operation the LEDs should be matched for forward voltage. The circuit as shown is designed for 15 V; if other supplies are to be used R2 will have to be changed. Better DC biasing around the op-amp in the 571 will improve the DC offset.



Running LEDs From A 1V5 Battery
Andrew Marshall

Most LEDs require operating potentials of between 1V6 and 2 V, but the circuit shown here enables light emitting diodes to operate from a 1V5 battery. The circuit uses a 'voltage doubler' and an astable multivibrator. Germanium transistors and diodes are used, as these have a smaller forward voltage drop across p-n junctions than comparable silicon devices. (This is to increase the output voltage and enable the circuit to operate at lower input voltages.)

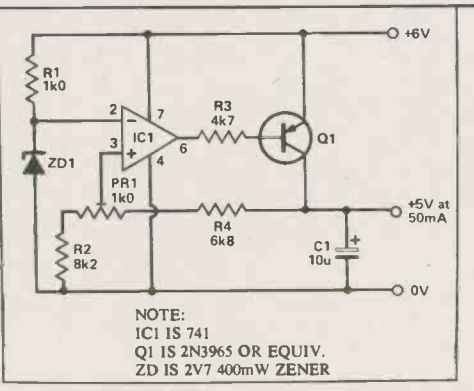
To operate the circuit to make the LEDs appear on continuously C1 and C2 should be chosen to be 47nF, and C3 and C4 to be 10uF. To make the LEDs flash alternately, C1 and C2 should be about 1000uF. To operate only one LED omit the circuitry within the dotted box.



Although TIL 209s are indicated in the circuit diagram, other LEDs may be used.

Battery Back-up Supply For RAM
R. Metcalf

Using a rechargeable 6 V lead acid battery and the voltage control circuit shown here, data can be held in a memory for a considerable length of time (governed only by the storage capacity of the battery). Nicads have a comparatively small Amp-hour rating for their package size and recharge rate.



An IC regulator would find the 1 V voltage margin between input and output too small for reliable operation. In this circuit the 741 op-amp sees a fixed 2V7 on its inverting input and subtracts the difference between this and the non-inverting input from its output. The ratio, once set by the preset, remains constant.

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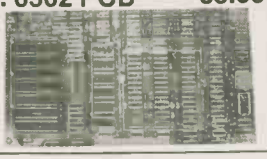

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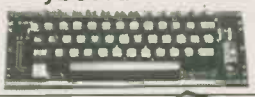

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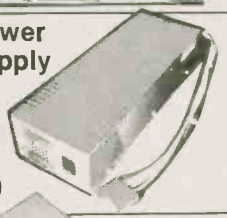

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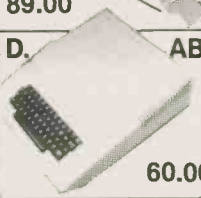

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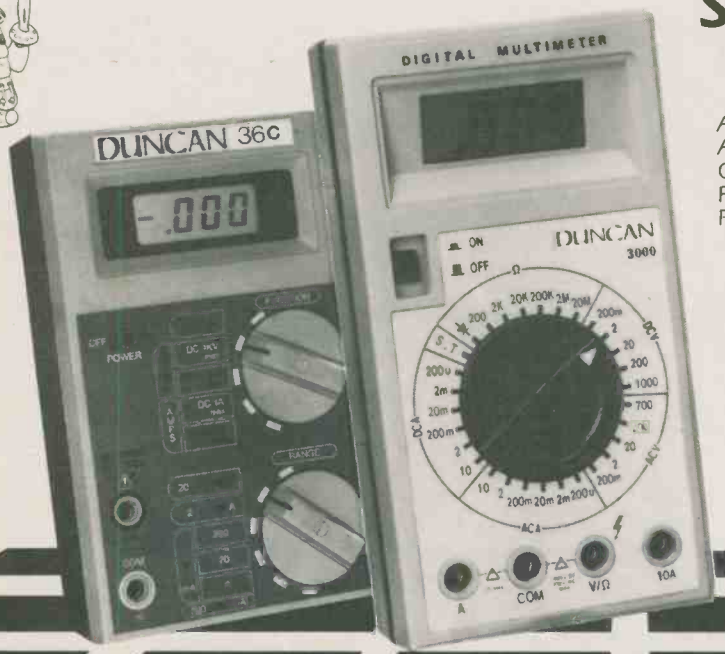

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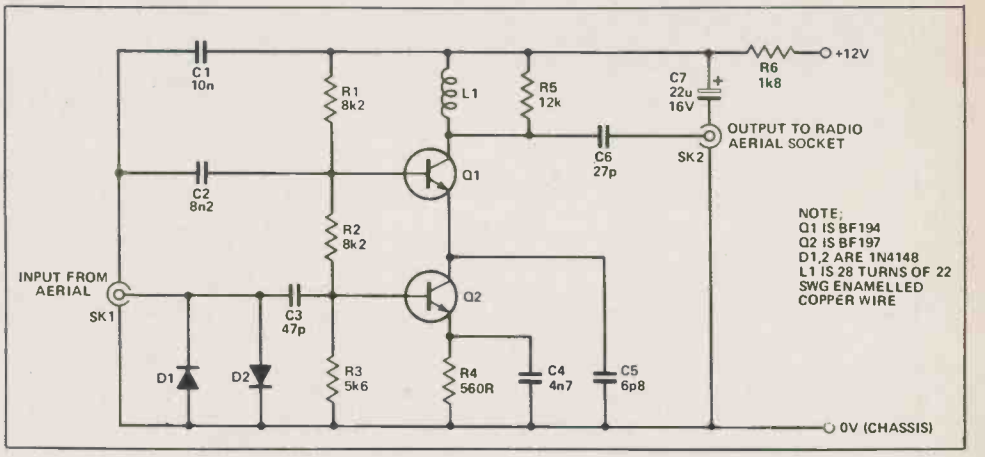

This circuit is a very high gain, high frequency amplifier using two NPN transistors in cascode. The input is taken via SK1 and C3 to the base of Q2. The amplified signal (between 200 kHz and 200 MHz) is passed to the emitter of Q1, which is connected in the common base mode, giving a very good gain at high frequencies. R1-3 set the bias voltages for the two transistors, while R4 and C4 provide negative feedback and help increase the bandwidth of the stage.

Capacitor C1 and C7, along with R6, are the supply decoupling components and also help to filter out any noise generated by the engine. Note that L1 is a radio frequency choke, which can be made by winding 28 turns of 22 swg copper wire on resistor R5; this will give a lower gain on long and medium wave, but as the desired frequency increases the reactance of L1 will increase, allowing more of the amplified signal to pass through capacitor C6.

The two diodes connected across the input socket are to protect the transistors against static discharges and overloading. If it is found that the gain is too high, then by changing C4 to, say, 500pF, the gain can be reduced to a lower level.

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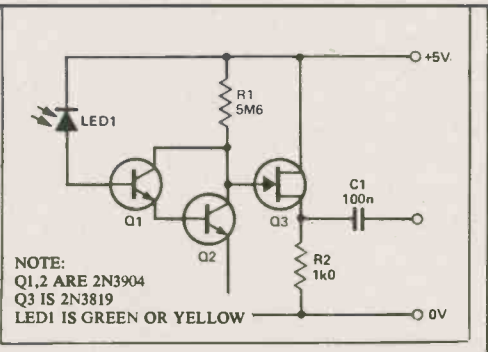
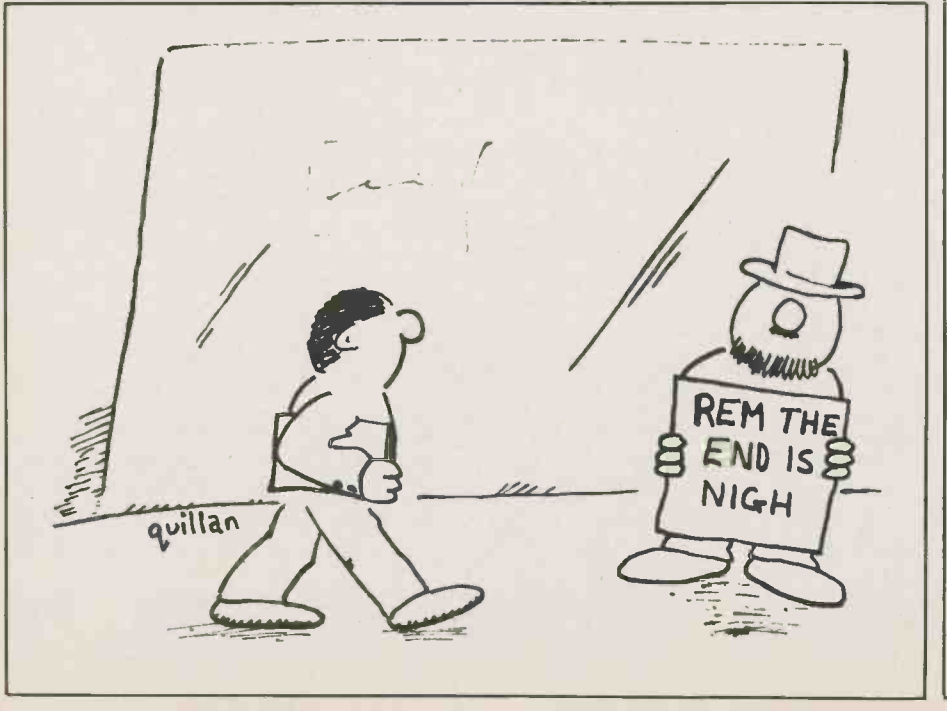
Cheap Photodiodes
Donald Hopkins



This circuit was evolved using an LED in place of a photodiode. Diode D1 can be any run-of-the-mill green or yellow LED. Red LEDs do not work, presumably because of their spectral response.

When the light source to D1 is interrupted, its reverse leakage current decreases sufficiently to cause the Darlington pair Q1, Q2 to switch off. This in turn causes the FET to conduct giving a pulse at the output.



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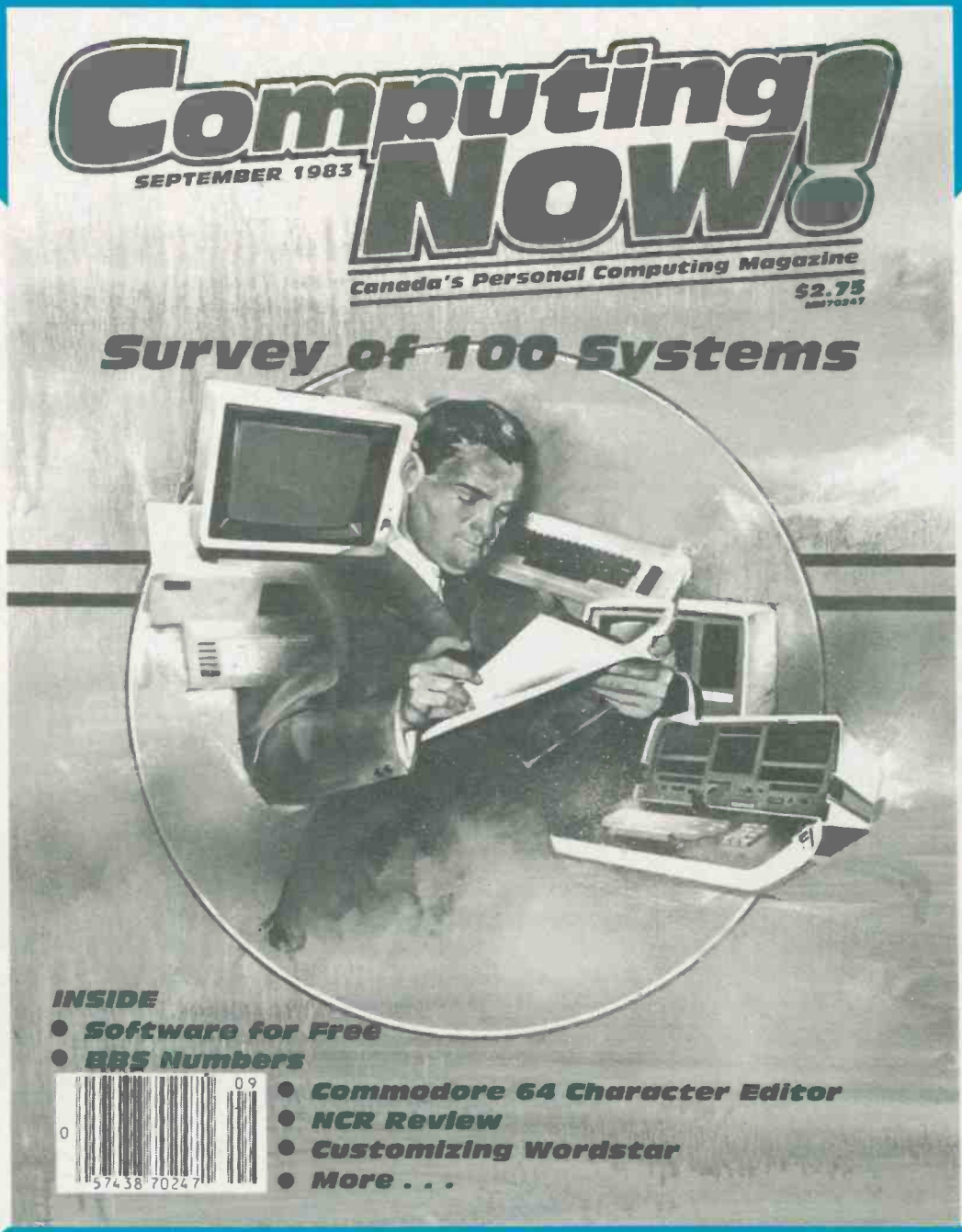

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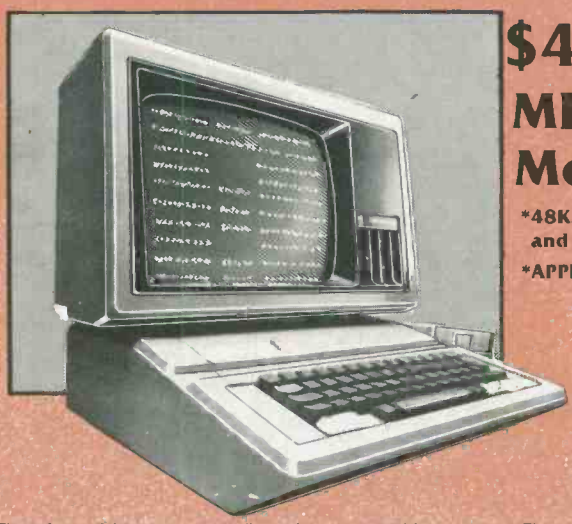

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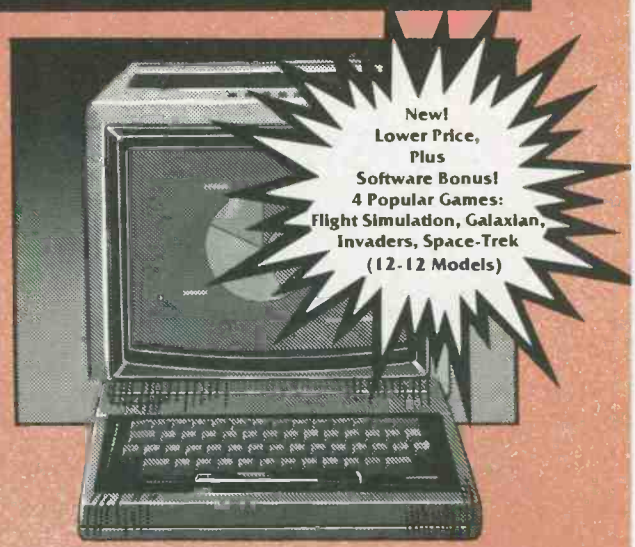

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For those serious hobbyists the **Acorn Atom** is perfect. All expansions comes in a semi-kit format with easy-to-follow instructions. You have your choice of the standard black and white 2K RAM/8K ROM, the black and white 12K RAM/12K ROM or the expanded colour 12K RAM/12 ROM. All configurations come complete with hi-resolution graphics.

The Acorn Basic interpreter is one of the only which allows you to mix **BASIC** and **6502 Assembly** language in the same program. This powerful feature lets you program sophisticated games and graphics easily from the standard full-size Qwerty keyboard. All the keys are clearly marked for the optimum ease of use.

You can use any standard T.V. set for your monitor and expand your system for cassette or 5¼" floppy disks. The Acorn Disk Pack uses a reliable Olivetti drive and has a built-in power-supply and controller card. We even have spread-sheet (AtomCalc) and word-processing (Word Pack) software available in ROM chips to make this a complete home system.

Our excellent selction of software complements the useability of the hardware. This one may be priced low but it extends the features of a REAL computer.

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INTRODUCING

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or PINGING those space creatures with the 6 octave sound generator!

The full sized key-pad accents the futuristic approach taken by Oric. Modern peripherals include a modem, disk pack, 4 color printer and Micro Drives. Full range of software include database, FORTH, and you even have the option to choose French software from our expanding selection!

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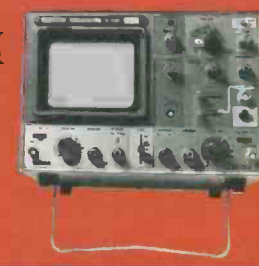

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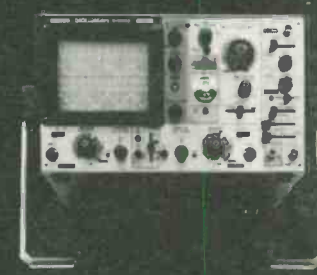

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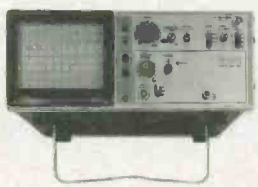

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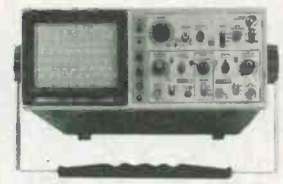

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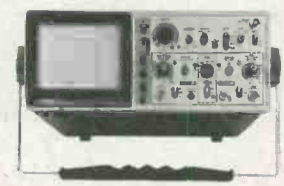

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