Electronics Today

$3.75
MM70924

September 1986

Canada's Magazine for Electronics & Computing Enthusiasts

Circuit Special

Our annual collection of schematics

Multimeter Project

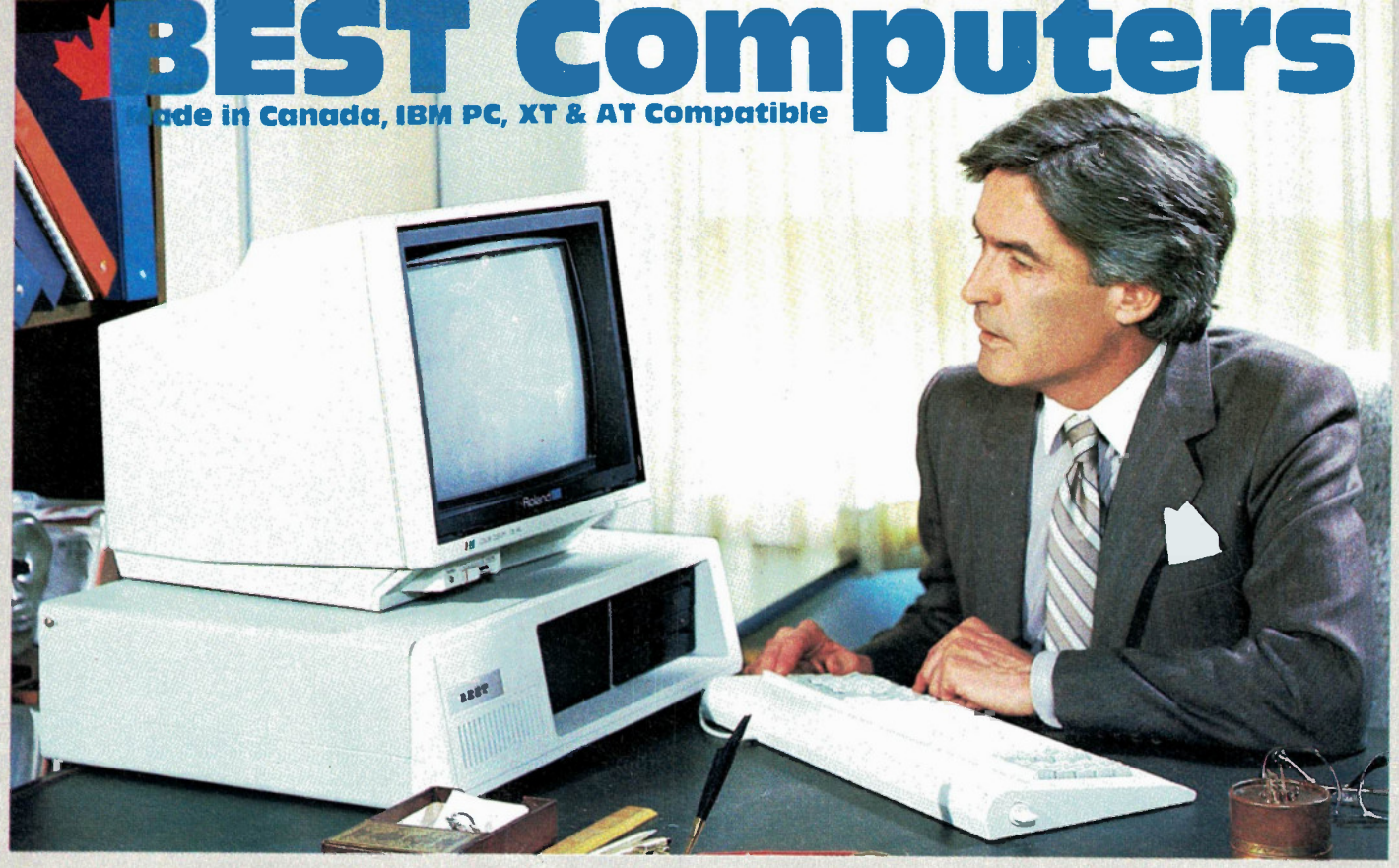
Low-cost lab quality

Perpendicular Recording

Increasing the density

BEST Computers

Made in Canada, IBM PC, XT & AT Compatible



Monitor not included. IBM, IBM PC, IBM XT and IBM AT are registered trademarks of IBM Canada Ltd.

Features common to BEST MK II, MK III & MK IV

- Superb IBM PC & XT Compatibility
- Canadian Made
- 256K RAM Standard minimum (uses 41256K RAM chips)
- Expandable on board to 640K RAM
- Parallel Port (for printer)
- Serial Port (for communications)
- Real Time Clock/Calendar (with Battery Backup) Presocketed for optional co-processor — such as 8087 Math Processor
- IBM Compatible Keyboard
- Reset Switch
- Phoenix BIOS as used in many major brand IBM compatible systems.
- 150 Watt Power Supply which will handle a Hard Drive without upgrade.
- 7 Slots
- Flip top case
- 2 Slimline DS,DD 5¼", 360K Disk Drives
- Colour Video (RGB & Composite) Board or HI-Res Monochrome Card (customer choice)
- Disk Controller Board

Warranty

We have such confidence in the time tested reliability of the BEST that we offer a ten (10) month warranty which is way above the industry standard. On-site service plan available at extra cost Nation-wide through 3M of Canada Ltd.

BEST MK II. Regular $1695. This Month:

Two 350K DS,DD disk drives, Serial and Parallel Ports, Real Time Clock, Phoenix BIOS, uses 8088 processor — full specifications given above.

$1595.00
TEN MONTHS WARRANTY

Other Configurations:
With 640K RAM $1695
With 10 Meg Hard Drive/1 Floppy/256K . . . $2495
With 10 Meg Hard Drive/1 Floppy/640K . . . $2595
With 20 Meg Hard Drive/1 Floppy/256K . . . $2795
With 20 Meg Hard Drive/1 Floppy/640K . . . $2895

4.77/8MHz DUAL SPEED

The FAST BEST MK III

As BEST MK II plus speed selectable: 4.77 and 8MHz (most software will run on the higher speed), uses 8088-2 processor.

$1895.00
TEN MONTHS WARRANTY

Other Configurations:
With 640K RAM $1995
With 10 Meg Hard Drive/1 Floppy/256K . . . $2795
With 10 Meg Hand Drive/1 Floppy/640K . . . $2895
With 20 Meg Hard Drive/1 Floppy/256K . . . $2895
With 20 Meg Hard Drive/1 Floppy/640K . . . $2995

SPECIAL

SUPER-FAST BEST MK IV

As BEST MK III plus TRUE 16-Bit machine, 8086-2 processor, IBM compatible 8-Bit I/O channel bus, even faster than MK III due to 16-Bit architecture. With 256K standard.

REGULAR $2400
$2095.00
TEN MONTHS WARRANTY

Other Configurations:
With 640K RAM $2195
With 20 Meg Hard Drive/1 Floppy/640K . . . $3195
The BEST Mk IV Main board processes data approx. 2.1 times faster than the IBM PC/XT or BEST Mk II.

IBM AT Compatible

AVT-286

Superb IBM AT compatibility, 640K RAM, Two 5.25 in disk drives (one high density 1.2 Megabyte, one standard 360K), serial and parallel ports high quality keyboard, keyboard lock and status monitor.

$3495.00
TEN MONTHS WARRANTY

With 20 Megabyte fast stepping Hard Disk and Controller:
$4950.00

40 Megabyte systems also available at reasonable prices.

Exceltronix

319 College Street, Toronto, Ont. M5T 1S2
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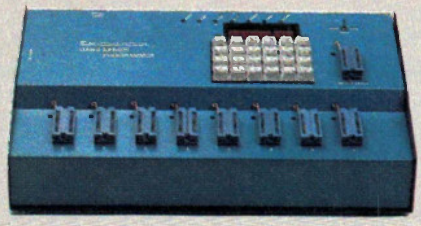
Visa, Mastercard and American Express accepted

Circle No. 1 on Reader Service Card

Spectacular Gang EPROM Programmer & Emulator



Totally self-contained (has its own display, entry keypad and power supply).

Based on the Z-8 microprocessor.

Can program up to 8 EPROM simultaneously (anywhere from one to 8 EPROMs at the same time with the information in its own memory or master EPROM).

The Gang Programmer can handle a wide selection of EPROMs: 2716, 2732, 2732A, P2732A, 2532, 2764, 27128, 27128A and optionally upgradeable to handle 27256, 27512, 2758 and 2724.

Complete package with EPROM Emulator, 8 ZIF sockets, Gang Programmer with 16Kx8 of RAM and RS232. ..... **$995.00**

Gang EPROM Programmer with 8 ZIF sockets, 16Kx8 RAM and RS232, without Emulator **$695.00**

EMPROM Programmer with only one ZIF socket, 16Kx8 RAM and RS232, without Emulator. Able to do all the functions describe but can handle only one EPROM at a time **$499.00**

Zenith Monitors

NEW
ZVM1220A
12in. diagonal screen – non-glare amber display • composite input • 25 lines x 40/80 characters **$135.00**

NEW
ZVM1230A
12in. diagonal screen • non-glare green display • composite input • 25 lines x 40/80 characters **$135.00**

NEW ZVM 1240 • 12" diagnoal screen • glare amber display • PC monochrome input (TTL) • 25 lines x 80 characters • 720 x 350 pixels • IBM PC & compatibles **$229.00**

Hyundai
TTL Monitor 12" diagonal screen **$189.00**

EPROM PROGRAMMER
(IBM COMPATIBLE)

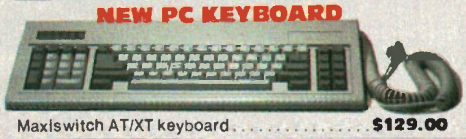
MAIN EPROM PROGRAMMER CARD (WITH SOFTWARE)
With 2 standard EPROM sockets ..... **$ 99.00**

EPROM PROGRAMMER WITH ZIF SOCKETS (WITH SOFTWARE)
With one 24-pin. ZIF socket and one 28-pin ZIF socket with provision for serial port **$139.00**

EXTERNAL CARD
Ready to plug into the main EPROM Card (includes one 24-pin and 28-pin ZIF socket and cable). Saves you from opening the computer each time you want to program your EPROMS ..... **$ 69.00**

SERIAL OPTION
For your main EPROM programmer. Provides you with a second RS232 serial port ..... **$ 49.00**

NEW PC KEYBOARD



Maxiswitch AT/XT keyboard **$129.00**

MEMORY & PARTS

Untouchable Prices!
Guaranteed Prime Stock
Call for large quantities prices.

Dynamic RAMs

4116 1x16k (150ns)	$0.75
4164 1x64k (150ns)	$1.99
4164's (150ns). Set of 9	$16.99
41256 1x256k (150ns)	$4.99
41256 (150ns). Set of 9	$44.00

Static RAM

2114L 4x1k 200ns	$ 2.25
6514 4x1k CMOS 450ns	$ 1.20
6116 8x2k 150ns	$ 4.95
2016 8x2k 150ns	$ 3.99
6264 8x8k 150ns	$ 7.95

EPROMS

2716 300ns 8x2k	$ 6.50
2732A 250ns 8x4k	$ 6.99
2764A 300ns 8x8k	$ 5.99
27128 350ns 8x16k	$ 6.95

Commonly used parts for your IBM compatible (8088) systems and peripherals.

Only prime quality parts sold.

Quantity Discounts Available.

8088 CPU	$10.99
8087 Math Processor	$209.00
8237A-5 Prog. DMA Cntrl.	$8.49
8250 Serial Port	$11.99
8253A-5 Prog. Interval timer	$5.89
8255A-5 P.I.A.	$4.89
8259A Prog. Interrupt Cntrl.	$4.95
8284A ADC clock gen & driver	$5.95
8288 Bus Controller	$8.95
8272 Floppy Disk Controller	$8.95
NEC 765 Floppy Disk Controller (equivalent to 8272)	$8.95
8086 CPU	$13.50
Set of 8088, 8255A-5, 8237A-5, 8288, 8284, 8253A-5 and 8259A	$43.95
100ns delay line	$4.95
7ns delay line	$12.45
62 pin edge con (high quality)	$1.79
5 pin Din conn	$ .99
Power conn	$1.25
Dip switch 8 pos	$1.75
4.7k x 6 sip	$ .39
4.7k x 8 pin sip	$ .44
8.2k or 10k 16 pin Resistor	$ .99
330hm x 8 network	$ .99
Small speaker	$1.99
Trimcap	$ .99
34 pin card edge con.	$5.85
74LS322	$5.49
74LS629	$3.30
74LS670	$1.70
74S280	$3.19
74LS125	$ .60
74S157	$1.59
74LS244	$ .99
74LS245	$1.19
74LS273	$1.14
75477	$1.19

We now carry a wide selection of 80286 parts at most competitive prices.

BEST MODEM

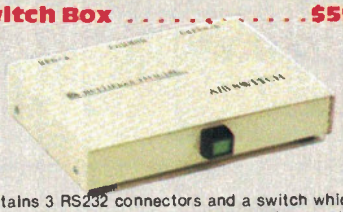
The BEST modem is a smart 1200/300 direct connect modem. It can either be a stand-alone unit in which case it requires a small wall adaptor, or it plugs in one of the IBM slots. When used as a stand-alone unit, the modem looks like a Hayes 1200 Smart Modem, that is, it emulates the same instruction set. When it is used in the IBM, it looks like an intelligent serial communictions port which also supports a super-set of the Hayes instruction set.

The modem supports auto-dial, auto-answer, and auto-speed select directly from software control. The modem also has a speaker so that aural monitoring of the call is possible. There are also LED monitors so that the state of the modem can always be known. These LEDs are: Modem Ready, Auto-Answer enabled, Carrier Detected, Transmitting, Receiving, Data Set ready.

Software packages such as Crosstalk, PC-talk and Hayes' Smartcom II also will run with this modem.

300/1200 Baud **$249.00**
300/1200 Baud, Stand-Alone Unit, Attractively Packaged **$299.00**

Switch Box $59.00



Contains 3 RS232 connectors and a switch which switches all lines between input and one of two outputs.

DISK DRIVES

NEW SILENT JU455 Shugart/Panasonic
5.25" slimline DS/DD Disk Drive with 360K
Ideal for IBM Computers **$159.00**

JU475 Shugart/Panasonic
5.25" slimline Disk Drive with 1.2Meg
Ideal for AT Compatibles **$239.00**

Hard Drives
Seagate 20 Meg with controller **$895.00**
Special: Toshiba 80Meg hard drive with controller **$2595.00**

AT Compatible
High Speed Seagate Hard Drives with controller
20Meg **$1495**
30Meg **$1895**

Call or Write for our Full Colour Catalogue

Our Spring 1986 catalogue gives full specifications on our IBM AT and XT compatibles, AVT-286, MK II, Mk III and MK IV computers plus detailed specifications, with prices on our other products, made or distributed by us.

Colour Monitor

TVM Model MD-3A 14 Inch
- Multi-Display Amber/Green/Full Colour
- Compatible with PC/XT/AT using RGBI TTL level • 640x400 interlace
- One Year Warranty **Only $599.00**

Zenith ZVM 1330
13" diagonal screen 640 x 240 pixels **$699.00**

Zenith ZVM 1350
13" dia screen 640 x 240 pixels RGB/Composite **$839.00**

Copal Printers

• Epson Compatible • Supports both IBM and Apple systems • Centronics Parallel Interface • Both Draft and Near Letter Quality (NLQ) modes

SC1200
- 120 cps draft quality
- 24 cps NLQ
- NLQ available in all print sizes
- 11 inch carriage
- Pin and friction feeds
- One Year Warranty

$329.00

SC1500 $499.00
- 180 cps draft quality
- 36 cps NLQ
- 3k Buffer

SC5500 $699.00
- 15 inch carriage
- 3K Buffer

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Toronto Computing Centre Inc.

Formerly Surplustronics

8088 Computer Systems with 90 day Warranty

From $995

Includes:

- 8088 motherboard
- High quality legal Bios
- One DS,DS 360K Drive
- Power Supply with Fan
- Keyboard
- Flip-Top case
- Disk Controller
- With plenty of spare slots

All you need for complete System is Video Board

$339 8088 motherboard with 256K (expandable on board to 640K) Fully assembled and tested with Phoenix Bios, Flow soldered provision for 8087.

AT Compatible Motherboard call for Best Price.

256K Memory

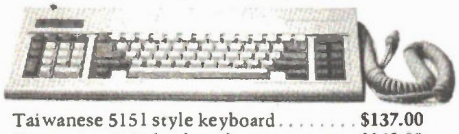
41256 (150nS) ..... $ 4.99
Set of 9 ..... $44.00

64K Memory

4164 (150nS) $1.99

Set of 8088, 8255A-5, 8237A-5, 8288, 8284, 8253A-5, 8259A $45.00

IBM Compatible Keyboards



Taiwanese 5151 style keyboard $137.00
Keytronics 5151 keyboard $249.00
Taiwanese 5150 style keyboard ..... $ 97.00
Keytronics 5150 keyboard $149.00
Maxiswitch Super Keyboard. Switch selectable between XT and AT compatibility $139.00

Hard Drives

Half-height, with Controller and Cables

20 Meg Seagate $699.00

Disk Drives for your IBM or Compatible

JU455 Shugart/Panasonic 5.25in. Silent DS/DD, 360K $149.00
JU475 Shugart/Panasonic 5.25 in. Silent AT Compatible 1.2Meg. $199.00

Monitors

Zenith ZVM1230 Green and ZVM1220 Amber $135.00
Tatung, TTL, Hi-Res, 22MHz $199.00
Tatung Colour Switchable to green or amber $649.00
JIL 14in, composite RGB and NTSC $549.00

Complete 6502 Board

- Assembled and fully tested (flow sloderĕd)
- 64K, 80 x 24 video with soft-switch, floppy controller.
- System comes with blank EPROM's on board, does not come with any proprietary software or Basic $239.00

Complete System

- Using 6502 board above in IBM style flip-top case, using powerful 75 watt power supply with fan, programmable serial keyboard adaptor, IBM style keyboard

As above with one built in disk drive $699.00
As above with two drives $879.00

Power Supplies

Apple II + Compatible. CSA approved
5V 5A, 12V 2.5A, -5V, 0.5A, -12V 0.5A $69.00

IBM Compatible. Hydro approved
150W 5V 15A, 12V 5.5A, -5V & -12V 0.5A $137.00

As above. CSA approved
150W 5V 15A, 12V 5.5A, -5V & -12V 0.5A $137.00

Panasonic Printers — Sale

Open Frame $29.95
Ideal for experimenters. No warranty.

Printers

Copal SC550001
180 cps, 132 column $699.00
Copal SC1500T
180 cps, 80 column $499.00
Copal SC1200L
120 cps 80 column $329.00

Apple Compatible Boards

Clearance Sale

Canadian Made, Flow Soldered, Super Quality. Boards fully socketed with all components except IC's and software.

80 column with hardware for softswitch $29.00
Super Serial Card $29.00
Parallel Card $18.00
Z80/64K $29.00
Deluxe Modem $59.00

As above but with all IC's except EPROMS and software.

80 column with hardware for softswitch $49.00
Super Serial Card $49.00
Parallel Card $29.00
Z80/64K 69.00
Deluxe Modem $109.00

All above boards come with schematics and component layout.

Apple Compatible Cards

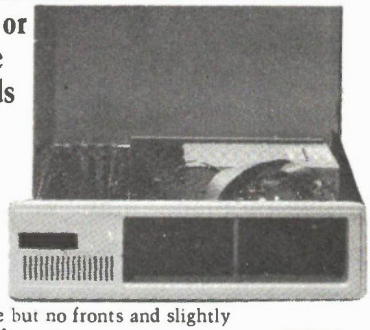
Assembled, flow soldered/cleaned and 100% tested
16K RAM $37.00
Z80A Card $44.00
128K (with 128K RAM) $79.00
EPROM Programmer with software $79.00
(programs 2716, 2732, 2732A, 2764)
Floppy Controller $45.00
Prototyping Board $14.95

Modem Bargain!

Apple Compatible plug-in Autoanswer, Autodial, Touch Tone or Pulse Dial. Excellent for use with most Bulletin Boards. 300 Baud. Final Sale as is $39.95

Apple Compatible Slimline Disk Drives 5-1/4" $159.00

IBM Style Case Suitable for 8088 or Apple Boards $75.00



As above but no fronts and slightly scratched $19.95
As above with fronts and slightly scratched $29.95
These items final sale.

AT Style Case $169.00

IBM Peripheral Cards

Colour Video Board $124.00
Monochrome Video Board $159.00
Floppy Controller with RS232 ..... $139.00
Floppy Controller ..... $ 99.00
Modem 300 Baud $179.00
Multifunction Floppy Board $199.00
Multi I/O card with cables $175.00
384 MF-FL $289.00
384 MF W-OK $155.00
Parallel and Game Port Card ..... $ 59.00
Cable and connector extra

Peripheral Interface Card $159.00
Includes two serial ports, parallel port, game port and provision for (but not including) real time clock.

Clock/Calendar Option ..... $ 29.00
With battery backup.

256K & Multifunction Board.
Includes: Serial port, parallel port, game port, provision for optional real time clock/calendar and socketed for up to 256K RAM.
With 64K RAM $149.00
With 256K RAM $299.00

512K Board. Socketed for 512K including:
64K RAM $149.00

We carry a wide selection of PC and AT Peripheral Cards.

Mail Orders add $7.50 minimum for shipping & handling. Ontario residents add 7% P.S.T. Visa, Mastercard and American Express cards accepted: send card number, expiry date, name of bank and signature. Send certified cheque or money order, do not send cash. All prices on this page are final sale. No warranty, No returns, No refunds but HUGE savings. Warranties available at extra cost.

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The PC board representing our Circuit Special was photographed in all its backlit splendour by Ed Zapletal.

Electronics Today is Published by:
Moorshead Publications Ltd.
(12 times a year)
1300 Don Mills Road,
Don Mills, Toronto, Ont. M3B 3M8
(416) 445-5600

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Moorshead Publications Ltd.
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Newsstand Distribution:
Master Media, Oakville, Ontario

Subscriptions:
$22.95 (one year), $37.95 (two years).
Please specify if subscription is new or a renewal.

Outside Canada (US Dollars) U.S.A. add $3.00 per year. Other countries add $5.00 per year.

Postal Information:
Second Class Mail Registration No. 3955.
Mailing address for subscription orders, undeliverable copies and change of address notice is:
Electronics Today, 1300 Don Mills Rd., Toronto, Ontario, M3B 3M8

Printed by Heritage Press Ltd., Mississauga
ISSN 07038984.

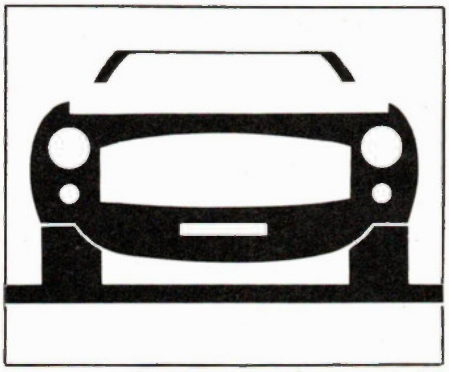
Moorshead Publications also publishes Computing Now!, Computers in Education, and Pets Magazine.

Circulation Independently Audited by MURPHY and MURPHY Chartered Accountants.

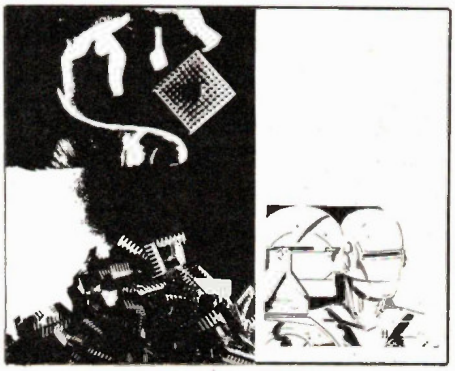
Electronics Today

September 1986
Vol. 10 No. 9

Canada's Magazine for Electronics & Computing Enthusiasts



Auto Light Reminder page 10



Circuit Special page 20

Features

Projects

Product Review

Series

Columns and Information

The Editor's Corner

Hello. I just read last month's column, hot off the press, and it's a good thing I stopped writing when I did, what with ranting and raving and foaming at the mouth and all.

Mind you, my contention that many IBM-compatible computers are over-priced at $4,000-$10,000 came out just before the introduction of the Lanpar PC-1, mentioned in the new products listings. It starts at about $1000, with a package deal at about $1600. Makes you wonder what you get from the big-name companies for your $4,000. I've even heard that a firm in the US has brought out a PC clone for under $500, US price, for the members of their merchandising club.

Hardly a week goes by without several textbooks being sent to the editorial department for review. Most of them are highly specialized, being on such gripping topics as how to prevent substrate fractures when you're making your own microprocessor chips. Instead of reviewing these, I decided to do some unsolicited rave-ups of books I've bought for myself and found really excellent.

First, *The Existential Pleasures of Engineering* by Samuel C. Florman, St. Martin's Press. It's a bit misnamed, not being quite as concerned as you'd expect with the beauty of science or the delights of analysis. Mr. Florman spends a large number of pages on defending the engineer and engineering against the charges made by anti-technology people in the late 60s and early 70s, but then the book was written in 1976. By then there had been quite a backlash as people discovered that the establishment was lying to us left, right and centre: the wonders of the future turned out to be pollution, the nuclear threat, world hunger, etc. Mr. Florman does a creditable job of exonerating technology of all the blame and placing it on politics where it belongs. However, the whole book isn't like that. It's an incisive, readable look at the human's preprogrammed urge to create and build. One of the chapters has as its name a wonderful quote: "Look long on an engine. It is sweet to the eyes."

Then, for one of the most enjoyable reads you'll have in years, pick anything by Lewis Thomas, a biologist who is surely one of the best essayists to ever publish a collection. His topic is always science and our relation to it, his style always impeccable but always witty, and his clear-headed thinking on all the diverse branches of applied and pure science should be required reading for technocrats and politicians alike. Few writers can match his incisive eloquence, and fewer yet can be so entertaining. One of my favourites among his humourous essays is a satire titled "Transcendental Metaworry (TMW)" in which he suggests that the meditation technique of clearing the mind may not be the answer, and that we should try sitting in a uncomfortable position and worrying about as many things as possible all at once, thus getting it over with for the day. Among his books: *The Medusa and the Snail, The Lives of a Cell*, and *Late Night Thoughts on Listening to Mahler's Ninth Symphony*, all Bantam Books. Don't miss him.

With some reservation, I'd recommend *Zen and the Art of Motorcycle Maintainence* by Robert Persig, and *Physics As Metaphor* by Roger Jones. Both authors take themselves *very* seriously, and churn through some ponderous (and doubtful) philosophy. On the other hand, they bring a refreshing humanistic viewpoint to the dryness of technology and physics. It's high time that we integrated science, philosophy, eastern mysticism, etc. Just keep TMW in mind.

For a thoroughly practical book, try *Assembly Language Primer for the IBM PC and XT* by Robert Lafore. Another publication from the Waite Group, publishers of the excellent *CP/M Bible* and *Soul of CP/M*, the Primer is a guided tour of PC-DOS (or MS-DOS), starting with simple two-byte instructions and moving through interrupts and segments to file handling. Each example is shown with a printout of what your screen will look like, what can go wrong, and how every step works. All you need is a computer, DOS, Debug and the usual assembler utilities (MASM, Link, etc.) It's one of the best tutorials I've ever used.

Having eagerly read Jerry Pournelle's monthly column in *Byte* magazine, I was surprised to find that he has authored and co-authored quite a few science-fiction novels. Although I'm not a true fan of SF, believing that it deserves its reputation of "comic books without pictures", I thought I'd give him a try. Mr. Pournelle's writing is fast-paced and imaginative, though like most SF, lacking in character development, good dialogue and so on. The best SF novel I ever read, one that qualifies as real literature, is *Canticle For Liebowitz* by Walter Miller.

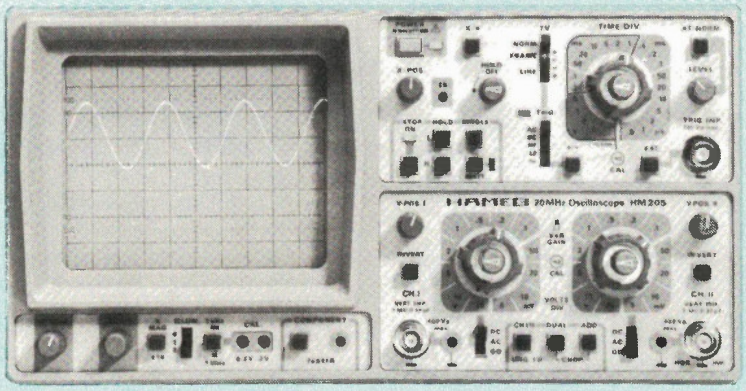
Continued on page 31

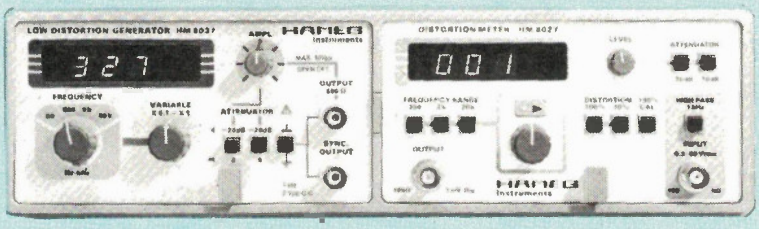
HAMEG 20MHz

Digital Oscilloscope

In addition to providing the impressive features of a well-designed **20 MHz** real-time oscilloscope, the new **HM 205** permits storage and display of slow-occurring signals and events **(from 50 sec to 0.1 msec).** None of the usual problems associated with long-persistence screens, such as trace flicker, streaking, and relatively short view time (max. 10 sec in Single-Shot mode) due to unavoidable loss of brightness, are present in the **HM205.**

HM205 **LIST $1250**





DISTORTION METER & AUDIO GENERATOR

Ideally suited to fit under either of these Oscilloscopes and other Hameg Models

HM8001 WITH HM8037 & HM8027 MODULAR SYSTEM

Analog Oscilloscope

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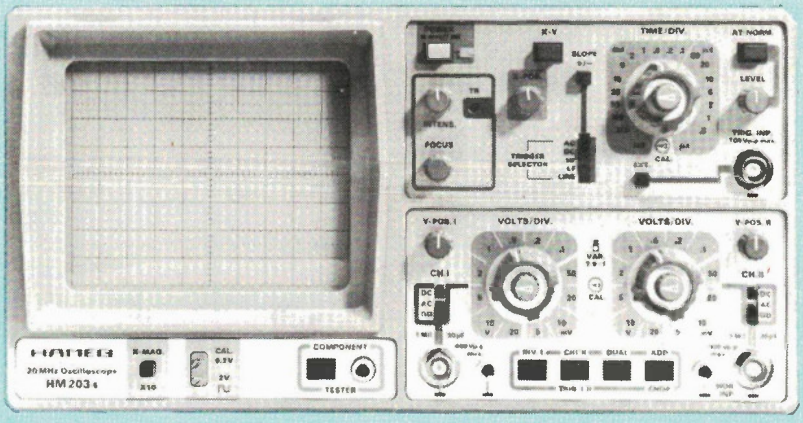

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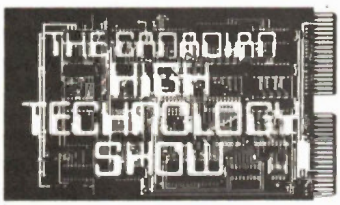

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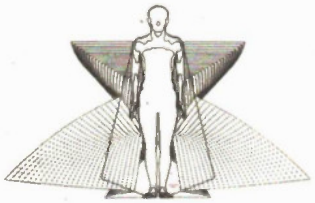

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Auto Light Reminder

If you've ever left your headlights on after parking the car, you might try this simple, inexpensive unit.

By Michael Perrow

IT IS PROBABLY just a matter of time before anyone who drives a car gets caught with a flat battery as a result of leaving their lights on. In winter this can happen all too frequently, having set off to work in pitch darkness and arriving at work in broad daylight. Beware, though, I have been caught in summer, too. A sudden downpour, dull skies, poor visibility, etc., on go your lights. You continue driving and the weather gradually improves but of course you forget about your lights. When you park, your battery is slowly drained of energy and when you return the engine won't even turn over.

Having been caught many times I decided to bring some electronics to the rescue. This unit was conceived as a simple but effective lights-on reminder. The PCB has deliberately been designed to be large so that even if this is your first attempt at a project you will stand a very good chance of success. It is also an ideal project to try your hand at making your own printed circuit board, if you so wish.

How It Works

Transistors TR1 and TR2 (**Fig. 1**) form a very basic audio frequency oscillator which will generate an audio note of about 800 Hz (with the component values shown) providing that there is a potential difference of about 10 volts between points A and B.

Switch S1 is shown in the 'Light Reminder' position. With the ignition switch on but with the sidelights off, +12 volts from the car battery is fed via the ignition switch and S1a to point A; point B also assumes +12 volts. If the sidelights are now switched on there is still no change because of the +12 volts via the light switch, S1b and D1 still leaves point B unchanged. In both these conditions there is no output from the oscillator. However, if the ignition is now switched off with the lights still on, point B stays at 12 volts but point A goes down towards ground via R2. There is now a potential difference between points A and B and the oscillator functions giving an audio output through the speaker, indicating that your lights have been left on.

Should you wish to park with your lights on — no problem — just switch S1. This will remove the 12 volts from point B because S1b is now open. In this condition when you return and switch on the ignition then point B will again assume 12 volts via S1a and D1 and the oscillator will sound. This will remind you to switch the circuit back into the "Light Reminder" position.

Construction

Referring to **Fig. 2**, mount the switch, capacitors and resistors in their correct positions. Note capacitors C2 and C3 are polarized and must be oriented properly, as must the diode. The two transistors can then be mounted. Any available loudspeaker with an impedance of 50 ohms or above can be used; the smaller the size the better. The fuse is simply a single strand of wire taken from a length of multi stranded hook-up wire. This saves having to buy a fuse and fuse holder and helps keep down costs while still providing a measure of protection.

The casing and mounting is left to the individual and will vary depending upon the type of car and mounting position. When the unit has been built, the oscillator can be tested out by connecting 12 volts between points A and B (B is positive).

Using the coloured wire indicated, connect the orange lead to the switched side of the ignition and the brown lead to the switched side of the sidelights. The blue wire should be connected to any suitable ground. You may need to refer to the electrical wiring diagram for your car to establish the most suitable positions to connect the wires.

Once the unit is connected, test it by switching the lights on with ignition off, the unit should sound. By switching S1 over, the unit should go quiet. Next, turn on the ignition and the unit should sound again, until S1 is reset.

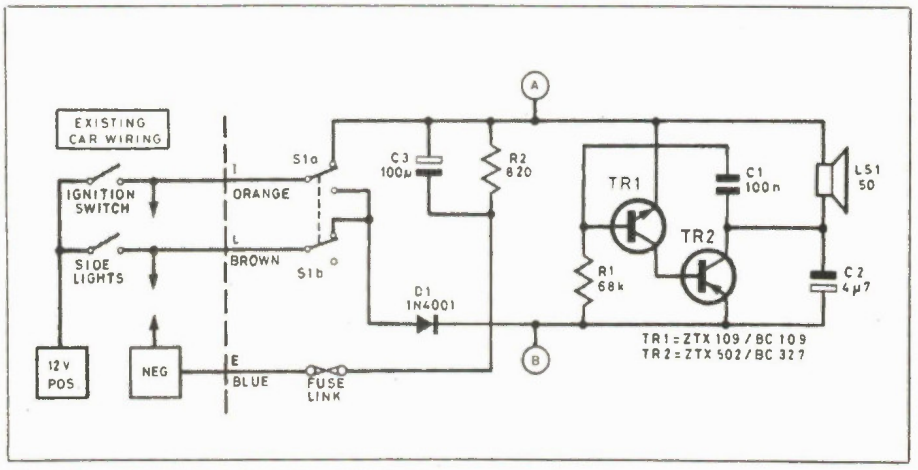


Fig. 1 The circuit diagram of the Light Reminder.

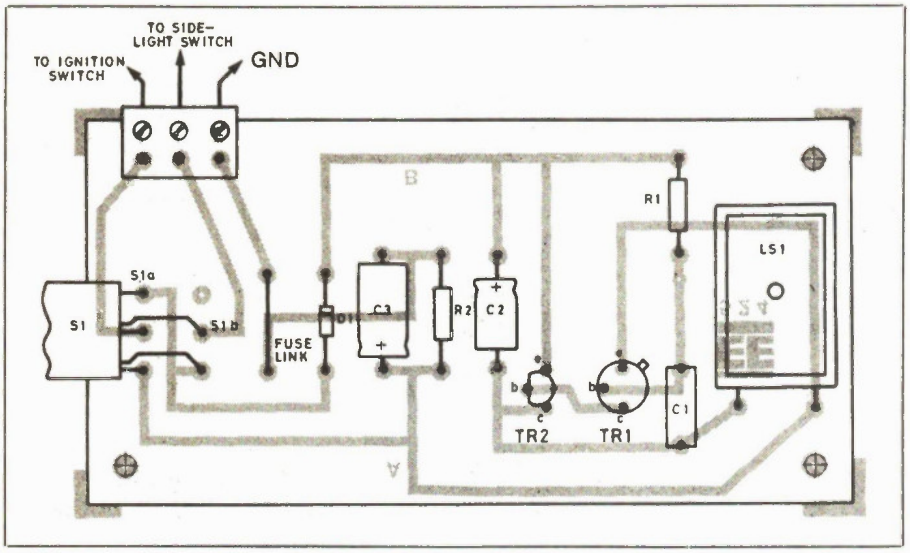


Fig. 2 The parts overlay of the unit.

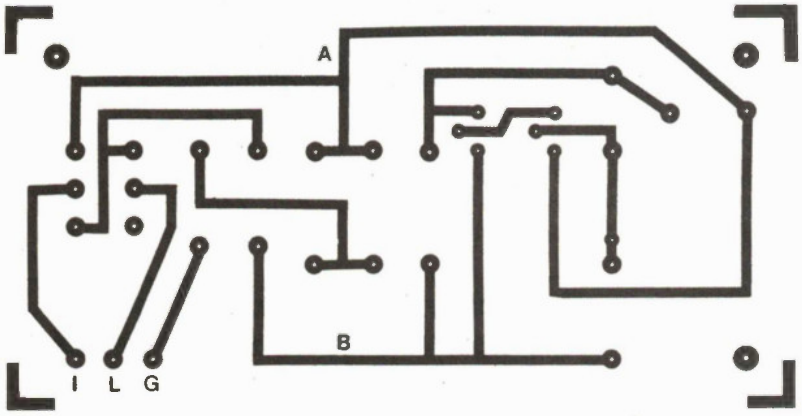


Fig. 3 The PC artwork for the Light Reminder.

Parts List

Resistors
1/2W carbon ± 10%
R1 ..... 68k
R2 ..... 820R

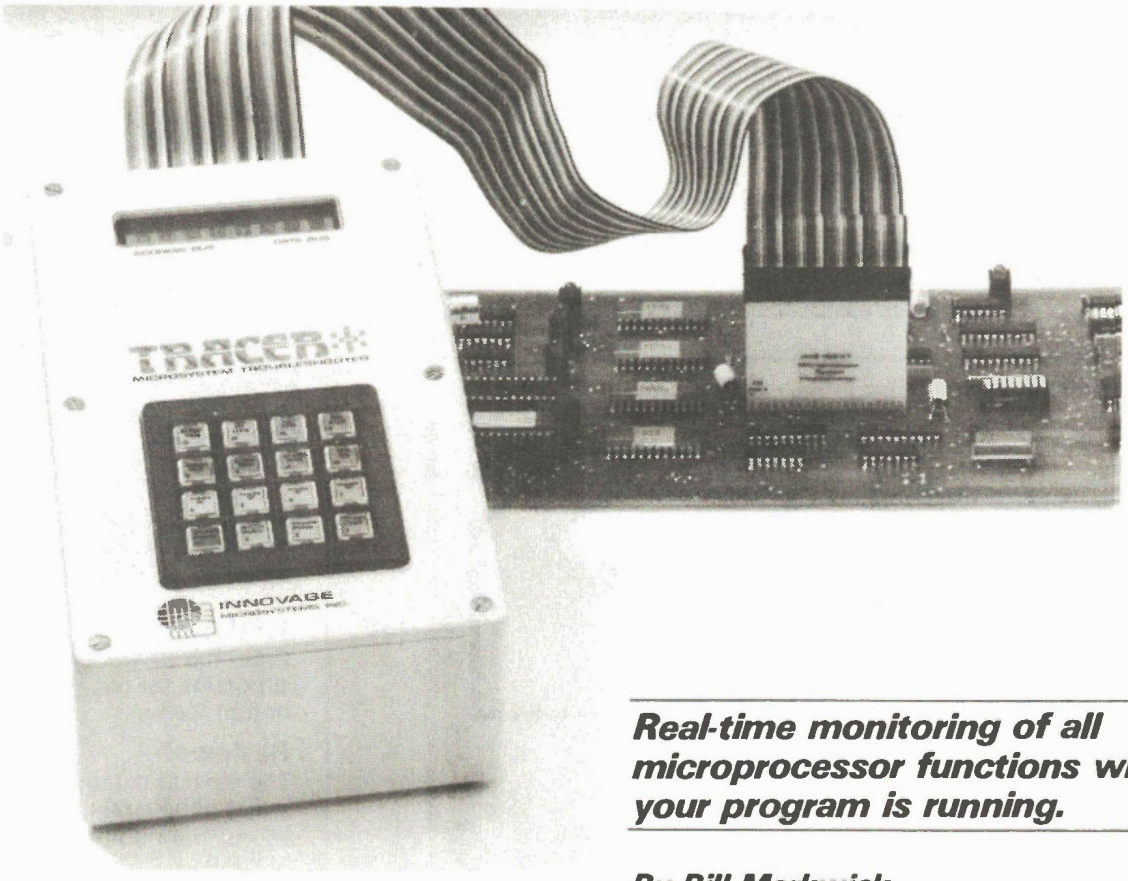
Capacitors
C1 ..... 100n
C2 ..... 4.7u elect. 15V
C3 ..... 100u elect. 15V

Semiconductors
TR1 ..... ZTX109 or 2N930
TR2 ..... ZTX502 or 2N5819
D1 ..... 1N4001

Miscellaneous
LS1: 50R (or greater impedance) loudspeaker; S1, 2-pole changeover switch; connecting wire; three-way connector block; PCB; case to suit.

■

Tracer 100XT Troubleshooter



Real-time monitoring of all microprocessor functions while your program is running.

By Bill Markwick

WHEN you're trying to extract information from a microprocessor circuit, the regular testbench gear falls behind. The oscilloscope will show you anything you need to know about a bit or byte, but only in isolation. This also applies to the various types of handheld logic probes and bit-detector devices. What you really need is something that will read or write a byte and tell you something about the effect it's having on the program.

Just such a device is the Innovage Tracer 100XT microsystem troubleshooter. It's a small box about the size of a utility box, with a ribbon cable and a clip for direct connection to the CPU chip under test. An 8-character LCD readout displays address and bus values in hex notation, and 16 multi-function pushbuttons control it. Power (5V, 125mA) comes from the circuit under test.

It's available in versions for testing the Z80, 8085, 6502, 6800 and other 8-bit CPUs; both the internal software and the ribbon clip have to suit the particular IC. We tested the Z80 version, which arrived complete with the demonstrator board shown in the background of the photograph.

The demonstrator consisted of a Z80 and support chips, a short program in ROM, four RAM chips and various LEDs to show the 8-bit output and the states of the various read/write points.

On powering up, the sign-on and prompting messages appear one word at a time. In general, each function button reveals a tiny menu of other available functions; the menu is stepped, selected and operated by pressing the **Reset** and **Step** buttons. Here are some of the many tests that you can do:

Memory Test: this is subdivided into a Ramtest, a Checksum test, a Memory Examine (to read out the contents of any cell), Memory Store (to change the contents of any cell) and I/O Examine and Store. The Tracer performs the Memory functions (and all the others) by using the HALT pin on the CPU during program execution; this lets the Tracer look around or insert codes without upsetting normal operation. In general, the only effect on the program will be a slight slowing down; some of the functions suspend the program for a while, but it never failed to restart where it left off.

Here's what the operation looks like, using Memory Store as an example: when you get to Mem Stor, you press the Step button to select it; "Enter Memory Address" appears one word at a time, followed by four question marks above the Address Space and two asterisks above the Data space. The pushbuttons are now automatically shifted for typing in hex values from 0 to F.

The demonstrator board's program consisted of stepping eight LEDs one at a time; by writing different bytes into memory location 8400, the display pattern could be changed. "8400" is entered in the Tracer's address space; the Data space now waits for a hex byte. Let's enter

"AA" and see what happens. The Tracer display says "Writing", and the LEDs are now flashing four at a time. By pressing Step, the display is cleared and waits for a new value to be entered.

The **Bus Test** gives you a choice of Ramp or Shift modes; these step a value through the address and data buses while temporarily suspending the program. Aside from being able to watch the signal's progress on a scope, you can detect shorts or opens in the PCB or hardware.

The **Mode** buttons set one of four operating modes: the simplest, Mode A, is used for single-stepping through the host program, without any qualifying address or data. For instance, **Memory Read** will display information every time there's a memory read cycle in the program.

Mode B lets you specify an address or I/O port. A breakpoint is then set at this value.

Mode C lets you key in a particular data byte. The selected function then looks for this byte.

Mode D lets you set both the address and a data byte. This is useful if you want to know whether or not a specific byte ever appears at a specific address.

There are two ways of setting the breakpoint function. If you select the **Breakpoint** button, program execution is halted when the desired condition of address and/or data occurs. If you select **Framepoint**, the display will tell you that the desired condition has happened, but the program continues on its way.

Other functions on the keyboard include **Port Read, Port Write**, and **Op-Code Fetch**. The latter, in conjunction with the Mode controls, will tell you if any particular op-code ever occurs, and where. Other hardware functions include a BNC trigger output which can be used to synchronize your scope to changing logic levels, and a hardware-reset button to reset and reinitialize the host CPU. There is also an internal memory to remember your keystrokes; this lets you change various settings without rekeying a lot of the information.

The Tracer goes a long way toward revealing the mysteries of a microprocessor circuit. The ability to read and write specified bytes from anywhere in a program while it runs is tremendously useful. Software and hardware can be debugged in far less time than, say, modifying your object code to see what's going to happen if you change something.

At present, the Tracer is available in three versions. The 100X, at $1,750, lacks the internal memory and Bus tests. The 100XT we tested costs $2,450, and the 100XTR at $2,795 adds an RS232 port for downloading or uploading data; this port is available as an option on the others for $400.

The RS232, incidentally, allows the 100XT to perform as an emulator in conjunction with an IBM PC and optional Innovage-supplied software. Downloading and uploading code from your target system simplifies developing code for PROM-based systems.

The Tracer performed as promised, eliminating all sorts of unknowns from the Z80s we tried it with. An exception has to be made in the case of the Z80 card in an Apple-compatible computer; some of the functions wouldn't work due to the interrupt structure used with the Z80/6502 hookup. Another minor complaint is the lack of a keyboard buffer; between the natural slowness of the LCD display and the required wait states that are inserted into the program, some of the keystrokes get ignored. If you get impatient and hit the key a few more times, you sometimes get extra key entries that you didn't want. It's also difficult to get out of certain functions if you make an entry mistake; since the Reset key doubles as a Zero, the machine just thinks you're entering more data. Eventually you get to a point where Reset will actually reset, but it slows you down a bit.

Though it's expensive, the Tracer is the equal of some logic analyzers that we've tested, units that cost considerably more. If you do development work with 8-bit hardware or software, it's well worth looking into. In addition, Innovage is working on interfaces for 16-bit microprocessors, and these will be available towards the end of the year, and may be ready by the time you read this.

Contact:
Innovage Microsystems Inc.,
5-6125 12 Street S.E.,
Calgary, Alberta T2H 2K1
(403) 255-9590. ■

A Versatile Multimeter

Theory and construction tips for a precision multimeter.

By Lloyd MacHattie

HERE'S an analog multimeter that the author designed and built for himself after retiring as a research physicist about five years ago. It should appeal to the do-it-yourselfer who needs a dependable meter to do his electronic sensing for him. Since labour nowadays is a major expense in a ready-made instrument, building one's own makes it that much more affordable; it also allows the builder to decide whether any particular refinement is worth the necessary investment of his time.

No hard-to-get or short-lived parts are used. Despite the use of a rugged 200uA d'Arsonval movement, 10mV will produce full scale on the most sensitive range, done by means of an operational amplifier in such a way that stability is very good and the zero adjust seldom needs touching. A single 9V battery powers the entire instrument, including the ohms scales, and the battery drain never exceeds 3.5mA (on voltage scales it is less than 1 mA). In addition, the input impedance for direct volts is extra high (111M) and the ohms scales are stable without adjustment over the useful life of the battery (down to 6.0V).

In this meter, on both resistance scales, the red lead is positive and the black lead goes to the case for all functions. The red lead test prod has a reversible tip which allows insertion of 100k at will, useful when measuring direct voltages in the presence of radio frequencies. Two small alligator clips separated by an inch of flex wire allow the prod to be clipped on to a connection as well.

The meter scales have been made as simple and easy to read as possible: two for voltage (0-10 and 0-30) and two for resistance measurement. The basic op amp and meter produce full scale for 10 mV or 30 mV input, depending on a slide switch setting, and, together with the 6 decade settings of the input divider, provide 12 voltage ranges. There are two sets of resistance ranges, one with a 30 mV source, good for in-circuit measurements without turning on any semiconductors, and one with a 3V source. Together they range from 10 ohms centre scale to 100M centre scale.

The meter movement is protected by a series constant-current FET which will limit the current to 1.25 times full scale even if the driving op amp output shorts to the positive supply. A slide switch offers a choice of left-scale-end or centre zero when the function switch is set to DCV.

The meter can be self-checked as follows: when the function switch is on '10 O' and the leads are unshorted, the needle should read full scale; when the function switch is on 'direct volts' and the zero switch on 'centre', the needle should read half scale. Several ohms scales can be checked by the 100 K resistor in the probe by turning the red tip out and shorting the leads.

The instrument is designed to stand on its own when out of its case, a convenience when calibrating or servicing. Instead of a pilot light which consumes power, a red flag shows in a window when the instrument is turned on. The dimensions of the metal case for the meter are: height 9'', width 6$\frac{5}{8}$'', depth 5$\frac{3}{8}$''. It could be made considerably smaller if this were desired.

The Op Amp

The CA3130 was chosen for its features: (a) FET inputs for very high input impedance, (b) single-ended power supply capabilities, (c) low quiescent supply current (considerably less than 1mA), (d) low cost. A minor disadvantage is that with a 5V supply, the regulating zener in the CA3130 does not turn on, so one must regulate the power supply. Fortunately this can be done with very little further expenditure of current and it is even possible for a CA3130 operated as a regulator to control its own supply, as will be shown below.

Four op amps were found necessary: one to regulate the 5V supply for all the op amps; one to regulate a 3V supply for the ohms circuit; one to be a voltage follower to drive the meter movement, and one to convert alternating voltage into direct voltage before it is measured.

Reference Voltage

The stable reference voltage in a regulator is usually derived from a zener diode run at several mA. At currents which are fractions of 1 mA, a constant-current FET circuit is preferable both as to cost and performance. A 2N5457 FET is inherently temperature compensated at a current in the neighbourhood of 400 uA. It is possible to reduce the current to one tenth of this and retain temperature compensation if one adds a diode and a few resistors (see Temperature Effects Section). Resistors with good stable characteristics should be used, such as Philips 1 metal film resistors. In this multimeter a temperature-compensated reference voltage of 2.5V for high impedance loads is provided which consumes only 40 uA.

Regulators

Fig. 1 shows the regulator circuit which takes power from the battery at any voltage in the range 6 to 10 and delivers 5V to the four op amps used in the instrument. Over this range of supply voltage and for load currents from .9 to 5mA the regulation was found to be within 1mV. The FET T1 should be chosen to operate at a gate bias of one volt or more, which means that a higher bias unit should be selected from several 2N5457s. This is the trick that allows the op amp to control its own regulated supply. With the FET used as a source follower, the op amp output can be at + 4.6V and be coupled to the base of the series regulating transistor T2 and + 5.6V.

The .1uF from the battery + line to the 5V regulated line is for giving a transient boost to the latter when turning on. Otherwise the CA3130 may never receive any supply and can stay turned off.

A second regulator, operating on similar lines and using the same 2.5V reference, drops the 5V regulated to 3V regulated for supplying the ohms circuit.

Voltage Follower Meter Drive

The heart of the multimeter is the basic 10mV or 30mV measuring circuit shown in **Fig. 2**. The 10M 10nF low pass filter in the input lead largely prevents alternating voltages from reaching the input. It is also used to measure offset as explained below. The op amp causes the input voltage to be impressed across 150 ohms (R6) or 50 ohms (R6 and R7 in parallel), the necessary current being supplied by the op amp through the meter movement. The drop across the meter movement may be more than 1/3 volt but the op amp takes care of this since it is within the negative feedback loop. The diode between op amp and the FET is put in to improve the offset slightly near zero input, which it does by having the op amp output no longer approach so close to zero.

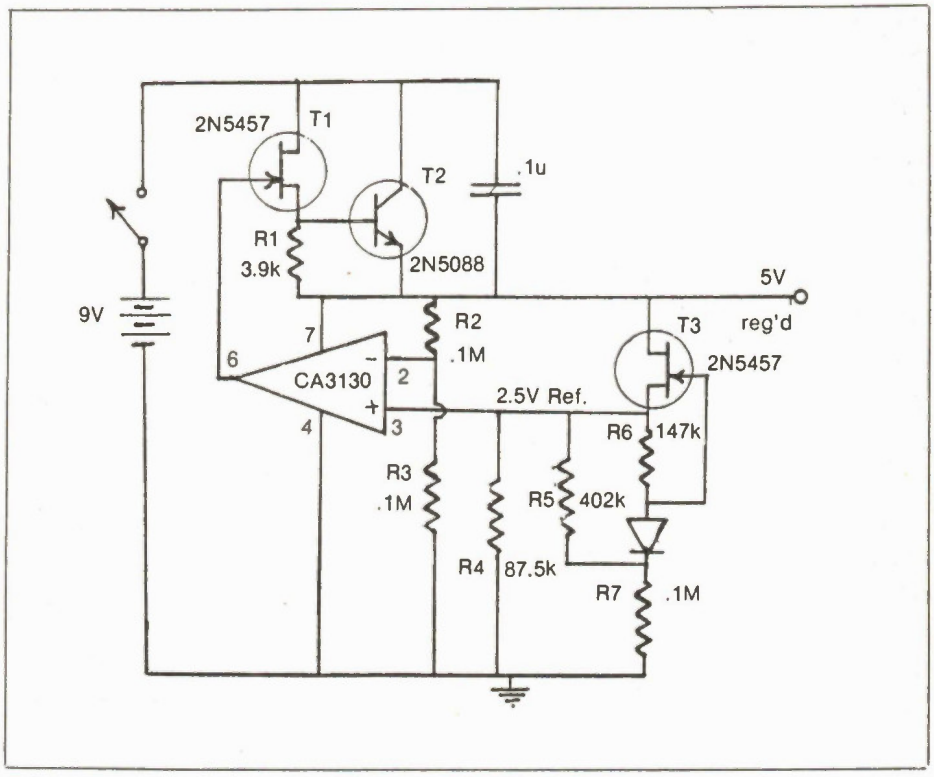


Figure 1. The regulator circuit.

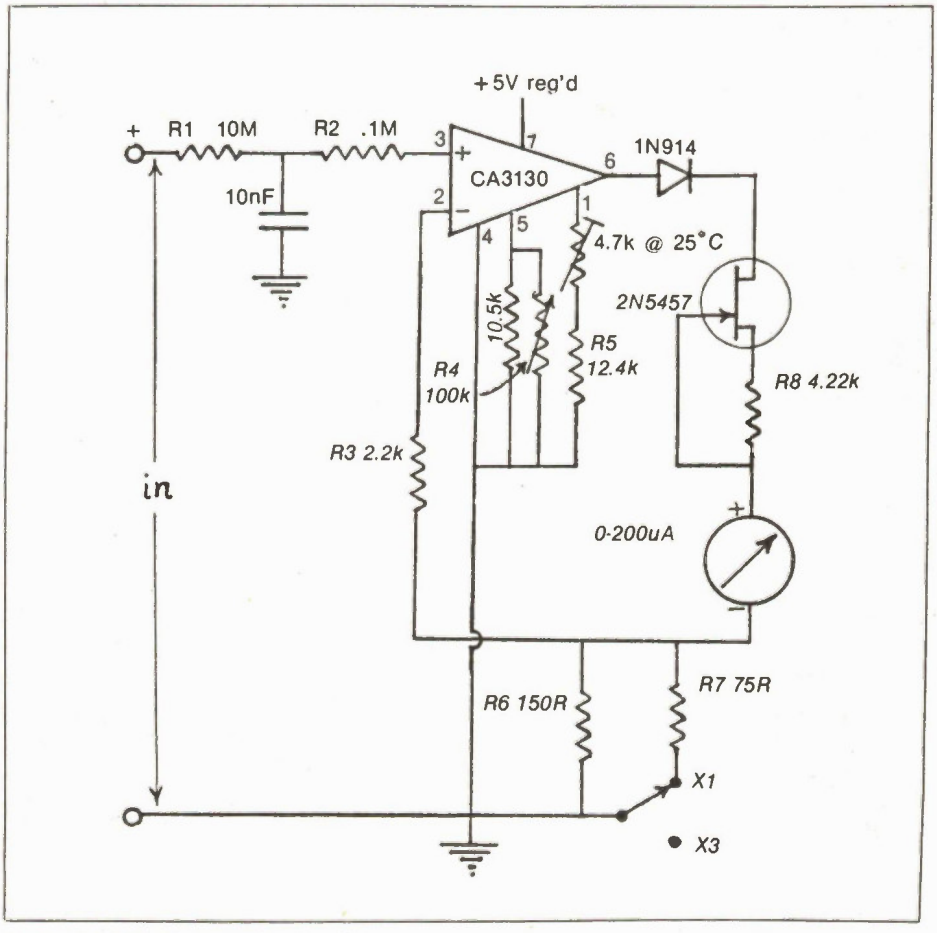


Figure 2. The basic measuring circuit.

Movement Protection

The FET which limits current through the meter movement has a source resistor which must be determined by trial with each particular FET. That value is chosen which gives a drain current of about 250uA with a 5V supply. This method of meter protection is cheap and very effective.

Offset Null

The offset is just the output (DC voltage) minus the input. The offset null adjustment is most simply a 100k pot connected between op amp pins 1 and 5 with the tap to ground. However, the necessary setting will generally vary with the ambient temperature. A refinement which allows the zero control to be banished from the front panel is to temperature-compensate the op amp by introducing a thermistor as shown in Figure 2. Since individual op amps differ even if they have the same type number, the values of the thermistor and associated resistors should be determined by experiment as described in the Temperature Effects section.

The offset may be measured accurately without the use of another voltmeter in the following way. The positive input lead is connected to the negative terminal of the meter movement, and the 10mV scale with centre zero is selected. This impresses the offset voltage across the 10M in the input filter and begins to change the voltage on the 10nF capacitor and hence the meter reading. The rate may be determined by timing the needle across the scale. The offset voltage is the product of this rate by the input filter time constant, that is Vo = RC (dV/dt). Here RC is 0.1 sec., so a rate upscale of 1mV/sec means an offset of +0.1mV.

Negative Inputs

A separate stage is devoted to converting alternating into direct voltages. For measuring negative direct voltages, the zero may be shifted to centre scale, or else the function switch may be thrown to D.V., which interchanges the multimeter circuit connections to the input divider.

Ohms Circuit

For resistance measurements, the type of circuit used is shown in **Fig. 3**. The eight-resistor divider with two ganged taps can provide a constant ratio of 100:1 while changing its impedance level over 6 factors of 10. If a regulated supply of 3.00V is connected to the upper tap, the lower tap will be at 30mV, sufficient to produce full scale on the meter movement. An unknown resistor shunting the lower tap to ground will register as some reading between 30 mV and 0. This is the basis of the 6 decades of resistance scales using a 30mV source (Lo scale). A second way to connect the unknown resistor is between the 3V supply and the upper tap. The voltage across the unknown can now range from 0 to 3V and the resulting 6 resistance scales run the other way (Hi scale). Actually the two kinds of scale are very nearly but not quite reciprocal images of each other (with a factor of 100 thrown in). The fraction of full scale corresponding to any resistance reading 'r' on the 'lo' scale is 1/[(1.100/r) + 1] while on the 'hi' scale it is 1/(1 + r/111.1). The value of the unknown resistor is obtained by applying to r decade multipliers from 10 to 1M for the different scales.

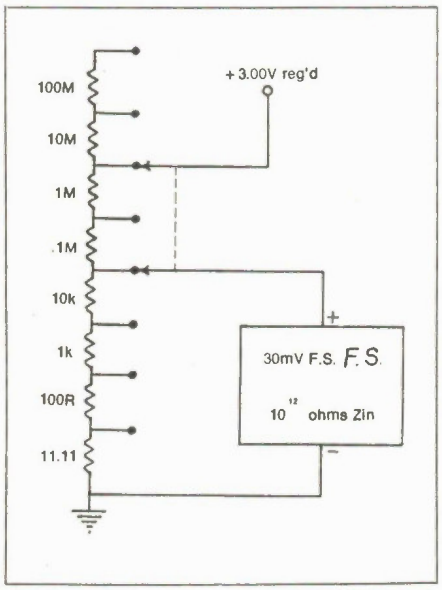


Figure 3. The resistance divider.

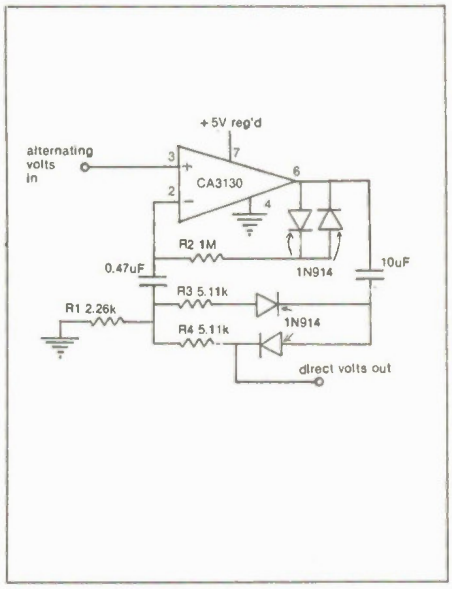


Figure 4. The AC/DC converter.

Accurate Resistors

The eight resistors in the input divider and the two range resistors (150 ohms and 75 ohms) should be of ±.1 accuracy or better. They can be made up from 1 resistors if these are sufficiently stable and one has the necessary facilities and patience. The 1k resistor, for example, can be made up of two resistors in series: a nominal 976 ohms and whatever 1 value near 24.3 ohms will bring the sum the closest to 1000 ohms. For this one should have the use of an accurate digital ohmmeter, or refer to the Special Uses section

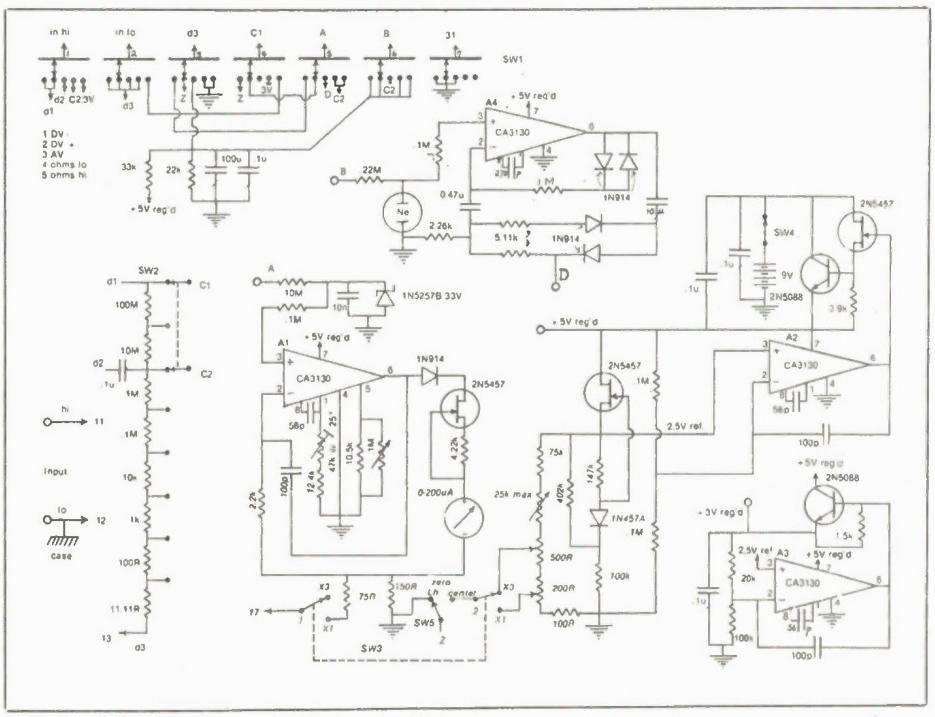


Figure 5. The complete circuit.

for a means of circumventing this difficulty.

With the lowest two resistor values it is better to take the next higher 1 value and shunt it (102 ohms shunted by 5.11k or thereabouts, and 11.3 ohms shunted by 665 ohms or thereabouts). Unfortunately, the highest two resistors are more costly than the others, not as close in tolerance and not available in closely spaced values. Shunting to lower the value by small amounts is impractical and one should obtain, if possible, resistors whose values are on the low side. Failing all else, one may consider accepting the 100M resistor as is and adjusting the other resistors to have the right ratios. This would cause a slight error in the ohms scales. In any case it is easy to check the highest two resistor values for accuracy at any time by the ohms circuit 100:1 ratio. On 'lo' ohms with the leads unplugged, as the range switch is stepped up from the lower values, any deviation from full scale reading that first appears can be attributed to the highest resistor being used. After that is remedied, the next higher step can be taken.

Alternating Voltage

The AC/DC voltage converter is an op amp voltage follower which applies the positive and negative halves of its output waveform to two largely separate load resistors. Taking the signal from one of these resistors and measuring the average direct voltage gives a measure of the input alternating voltage. The gain is adjusted so that 1VAC in gives 1VDC out. **Fig. 4** shows the circuit. The two 1N914 diodes connected with R3 and R4 should be well matched (selected from a group of diodes).

Due to capacitive problems with the input divider when measuring alternating voltages, the divider impedance has been lowered by a factor of 100 as compared with direct voltages. The lower of the two ganged taps is used (see Figure 3) and the input connection to the divider is at the top of the 1 MO resistor. The op amp used for the converter must be biased well away from ground, therefore the input divider is returned to +2.0V from a bypassed divider across the 5V supply.

Complete Circuit

Fig. 5 shows the complete circuit of the instrument. A judicious placement of capacitors is necessary to curb the parasitic oscillations that can be expected to crop up when op amps and feedback are involved. A4, the AC/DC voltage converter, has just a capacitor from pin 1 to pin 8, but it was found advisable for the other three op amps to have each an additional 100pF from output to negative input.

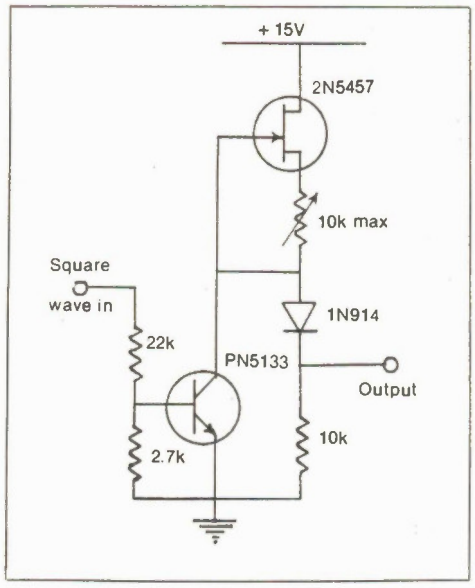


Figure 6. A squarewave calibrator.

Input overload protection for A1 takes the form of a 33V zener diode to ground which, together with the 100K to pin 3, limits input current to .3mA, well within the allowed 1 mA. For A4, however, two zeners in series opposition proved to have too much capacity, severely limiting the high frequency response. A small neon bulb was therefore put in their place which should still hold the input current within bounds during an overload.

Switch 5 allows the normal left hand zero to be moved to centre scale. This is done by including two trimpots in the divider across the 2.5V reference whose sliders can be set to 5mV and 15mV; one or other of these is connected to the input divider return, depending on which of the two basic sensitivities is being used. Another trimpot is also connected so as to be able to vary the resistance of this divider as a fine adjustment of the reference voltage and hence of the two regulated outputs.

In order to clear the diagram of long connections that the eye has difficulty following, letter and number codes have been used to indicate some connections. In a number code the first digit indicates the switch and the second the pole. Certain resistors are adjusted to fit the individual semiconductor device being used and these have been indicated by an asterisk. Their values must be determined by experiment.

It should be noted that while the maximum input direct voltage is limited by the voltage rating of the function switch (in the author's case about 2000V), the maximum input alternating voltage is further limited by the dissipation rating of the 1M resistor in the divider which would be to about 700V for 1/2 watt rating and to 1000V for 1 watt rating.

Mechanical Design

Most of the circuit is held on a circuit board mounted on the meter movement terminals. The input divider resistors are carried naturally by the lugs of the range switch, while a few components are best accommodated on the function switch.

The instrument case is a metal box with one face missing where there is a border flange to which the front panel can be screwed. Modification to one-screw closure consisted of making a new front panel which would hook over the case flange at the bottom and had a 90 degree lip overlapping the top of the case and held down to it by one screw. For a passive on-off indicator, a window is cut in the front panel above the on-off slide switch and a cardboard flag linked to the switch with a toothpick and cement. A fluorescent red square thus shows in the window when the switch is on; otherwise it shows black.

The positive or red external lead of the instrument ends in a probe which has been modified as follows. The metal tip is removed from a traditional plastic probe handle which is then drilled and the axial

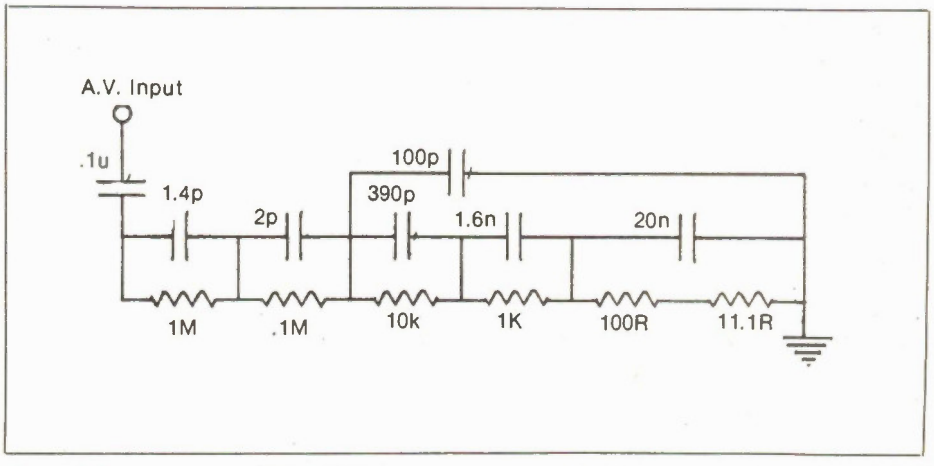


Figure 7. The compensated input divider.

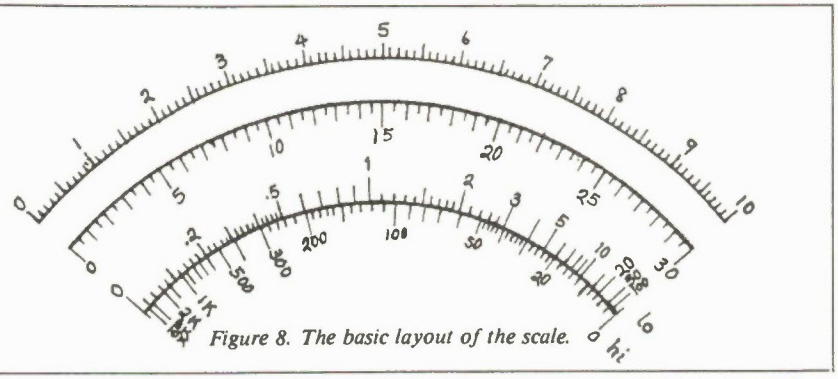


Figure 8. The basic layout of the scale.

hole lined with brass shim stock connecting to the lead, to form a socket for the reversible probe tip. This is made from a 1 3/4 inch length of 3/16 inch O.D. brass tubing. A regular probe tip coded white is soldered into one end while a 100K 1 resistor connects inside the brass tube to another probe tip coded ret at the other end which is insulated and cemented in place by epoxy. Thus the 100K may be inserted or removed from the electrical circuit simply by reversing the probe tip. The colouring of the tips is done by wrapping with coloured thread then saturating with epoxy cement. A couple of small alligator type clips separated by an inch of flex wire facilitate clip-on connections. A groove filed around the probe tip keeps the alligator clip from sliding off too easily.

Calibration

It is essential, before any calibration, to make certain that all parasitic oscillations are squelched. **Fig. 5** shows the capacitors found to do the job satisfactorily in one case and these will likely be sufficient. If a voltage standard or accurate voltmeter is available, check the offset, then set the 30mV scale accurately to full scale by adjusting the 150 ohms range resistor or by shunting the meter movement or both. Otherwise accept the accuracy given by the meter movement full scale current (nominally 200 uA) and the 150 ohms resistor. At the same time (if the input divider is accurate) adjust the 3 volt regulator output to make the meter read exactly full scale on 'lo' ohms with the leads open circuit. This same adjustment fixes the value of the 5 volt regulated supply as well. With the possible need to readjust the 75 ohms resistor to be one half of the 150 ohms resistor, this completes calibration of direct voltage and ohms scales.

There is an additional source of error which must be taken into account with alternating voltage measurements, namely the stray capacity between segments of the input divider. The most serious instance of this is the capacity between the input lead and the lower parts of the divider mounted on the range switch. It is advisable to shield the input lead to the function switch and to erect a metal partition to help shield the lower parts of the divider from the rest of the system.

Two independent methods were used to calibrate alternating voltage ranges from direct voltage measurements. In the first, a photographic exposure meter was used to indicate equal heating of a bulb filament by alternating and direct currents. In the second, a square wave, derived from a measured direct voltage which was then chopped (at 50 duty ratio), provided an alternating voltage reading which could be compared with the theoretical response. The fact that results from the two methods agreed gives one confidence that no serious error is involved.

For a correct calibration, alternating and direct voltage readings should be the same, in the first method. In the second, because of the changed waveform, this is no longer the case. The meter is designed to read correct root-mean-square value on a sine wave, but actually responds to the average value of the positive half wave. Since, for a sine wave, the positive half wave averages .900 of the RMS value, while for a square wave it averages the same as the RMS value, one would expect a square wave to give a reading 1.111 times the true RMS value.

The direct voltage is chopped at around 400 Hertz to form a good square wave by the circuit shown in **Fig. 6**. The source of square waves should be adjustable as to duty ratio, but the adjustment fortunately is not too critical. With no square wave input, the direct voltage V at the output is adjusted to the desired value by means of the adjustable source resistor. Then the square wave is turned on to chop it, giving an output of V/2 RMS volts. This will give a reading of V/2 x 1.111 F2'F1 .555VRMS volts on the alternating voltage scale of a correctly calibrated meter.

Frequency Response

In an effort to make the frequency response of the different scales more uniform, a series of capacitors selected by trial was put across various segments of the input divider. The values arrived at, shown in **Fig. 7**, are only meant to give a general idea as they depend on geometry difficult to specify, which moreover will not be the same in one case as in another. The best way to go about determining the value appeared to be to proceed from top to bottom on the divider with the rough capacitor values already in place. The first or smallest capacitor value is more or less arbitrary and makes little difference to the frequency response of the 10 mV scale, only setting a proportion between capacitive reactance and the resistance it shunts, which proportion should be roughly maintained throughout the divider. But from there on, the capacitor next below is the important one for the next scale; that is, the 2 pF is adjusted to get a frequency response on the 100 mV scale reasonably similar to that obtained on the 10 mV scale. The 390 pF (and 100 pF to ground) are next adjusted for the 1V scale and so on down the line. After these capacitive adjustments, frequency response measurements were made on four scales of the author's meter (10 mV, 100 mV, 1V, 10 V). The resulting frequencies for 3dB down all fell in the range 95 ±5 kilohertz.

Meter Scale Plate

If a satisfactory scale plate is unavailable commercially, take one from a meter and modify it. If possible, obtain a meter which, besides being 200 uA full scale, has a uniform scale having 100 divisions (or 50). This can be used for reading in all the calibration, and the other scales can be laid out with respect to it. The scale plate is removed from the meter movement and the unwanted scales and lettering blanked out with a white poster paint (Speedball Acrylic Titanium White (Hunt No. 6640) obtained in an art supply store worked well without any dilution. Liquid Paper typewriting correction fluid should do as well).

Temperature Effects

To monitor the effects of ambient temperature on any piece of equipment it is almost essential to have a controlled temperature enclosure. This can be made from a cardboard carton inverted on a table and supplied with a heater and a blower. The author has found that a hair dryer slightly modified makes an inexpensive solution that works very well. Compensation of the multimeter power supplies works as follows (see Figure 1). At T3 currents of 40uA or so, the T3 source voltage would increase with temperature increases, were it not for the action of the compensating diode which increases the gate bias as the temperature rises. The compensating action is increased by increasing the current in R5. The source voltage can be adjusted by varying R4 as it carries out most of the drain current.

"The meter when switched to centre zero makes an excellent balance indicator."

The procedure adopted was to vary the temperature coefficient by juggling with the ratio of currents in R5 and R6. Various fixed resistor values were tried and each time the 100K trimpot in R4 was adjusted to give close to 3V output from the regulated supply. The second item to be dealt with is the multimeter offset voltage whose compensation allows one to eliminate the zero adjust from the front panel. The multimeter should have its case removed and its positive input lead connected to the negative terminal of the meter movement. Drift rate measurements on the meter needle can be made at several steady temperatures. The needle can be reset t any time by switching to a higher voltage scale then back to the 10 mV scale. In the author's instrument a .6 W. rod type thermistor (4.7K at 25 degrees C) was found to be satisfactory as the compensating element. It is inserted in the leg from op amp pin 1 to ground if the offset goes more positive as the temperature is raised; but in the leg from pin 5 to ground if the offset goes more negative as the temperature is raised.

Special Uses

Besides the usual measurements of voltage and resistance, the multimeter, along with a few homemade instruments which are rather easily put together, can be used for the following operations: (a) Wheatstone bridge measurements including calibration of the multimeter input divider, (b) more accurate voltage measurements, using a Voltage Standard, which allows one to measure and adjust temperature coefficients. Two instruments, convenient to have on hand, are: a regulated power supply, adjustable from .1 to 50V and rated for currents up to 1A, and a square wave generator. Both of these can be built cheaply from RCA's descriptive literature on the CA3130 op amp.

With a little patience it is possible to build up a string of eleven 1k resistors matched to within .03% or so, using the Wheatstone bridge shown in Figure 9. The multimeter when switched to centre zero on the 10mV scale, makes an excellent balance indicator. The string can be mounted on a rotary switch and used for known ratios as two arms of a bridge or for accurate subdivision of a calibrating voltage or for checking linearity, say of a meter scale.

Obtain one .1% 1k resistor (to be used as a standard) and eleven 976 ohm 1% resistors and an assortment of 1% values clustered about 24.3 ohms. R1 and R2 can be two of the 976 ohm resistors which are matched well enough that their junction is within 5mV of one half the bridge supply voltage E. R3 can be the standard reference 1k while R4 can be any of the other 976 ohm resistors in series with 24.3 ohm. Make two readings of the balance indicator, say L when the reversing switch is thrown to the left and R when the switch is thrown to the right. Then the amount by which the 24.3 ohm resistor must be changed in order for R4 to equal R3 is given by:

$$R3 - R4 = (R - L)/E\ (R3 + R4)$$

If E is 10 V, (R3 + R4) is 2000 ohms and the smallest value of (R - L) distinguishable from zero is 0.1mV, then the accuracy with which R4 may be compared is .0001/10 x 2000 = .02 O. It depends on the stability of the 1% resistors how far it is worthwhile to push this. All the author means to suggest, and what he has found useful with Philips 1% resistors, is to pick the best 1% value near 24.3 ohms and put it in series with a given "976 ohm" to get a result which should be 1000 + .3 O. When two of the resistors have been done they can be used for R1 and R2. Then the rest of the 11 resistors are processed and the string assembled.

The first thing to do in calibrating the multimeter input divider is to separate the divider from the rest of the multimeter, so that a bridge can be set up and the multimeter 10mV scale still used as the detector. One way to do this is to disconnect switch lug 152 from 142 (third digit refers to throw) and use 152 as the plus input of the 10mV scale. Similarly switch terminal (Switch 5) can be disconnected from 132 and used as the minus input of the 10mV scale. To isolate the divider from the multimeter case, d3 must be disconnected from 122 as well. With the red external lead removed and the function switch set at D.V.+, the bridge can be connected up with clip leads using the string of 11 resistors already made as a 10:1 ratio for bridge arms R1 and R2. (The bridge reversing switch can no longer be used as before). Neighbouring pairs of resistors in the multimeter divider are then systematically checked for their ratios. The smallest resistor is checked with the string set for a ratio of 9:1. The highest three resistors are probably best checked by the ohms circuit 100:1 ratio as described at the end of the "Accurate Resistors" section.

A Voltage Standard at whose terminals one could produce accurate voltage values, would allow voltage measurements

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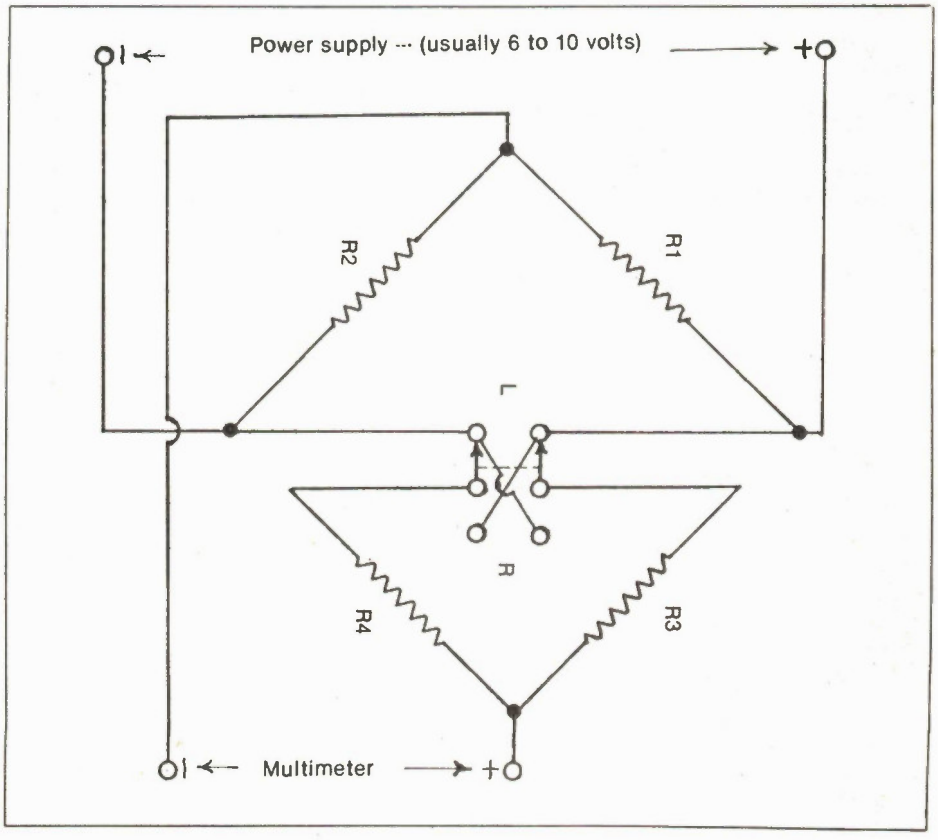
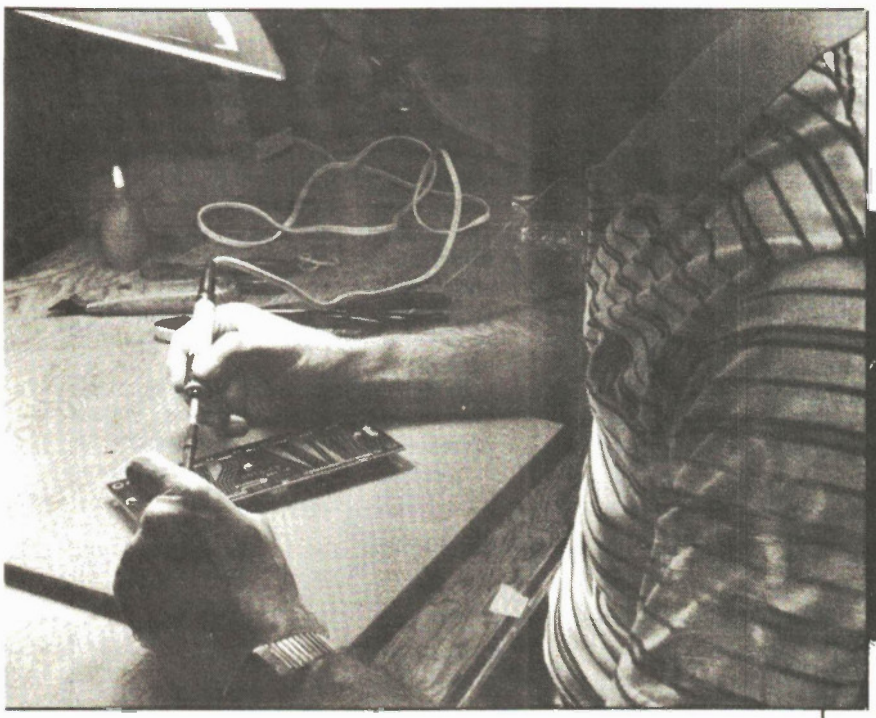
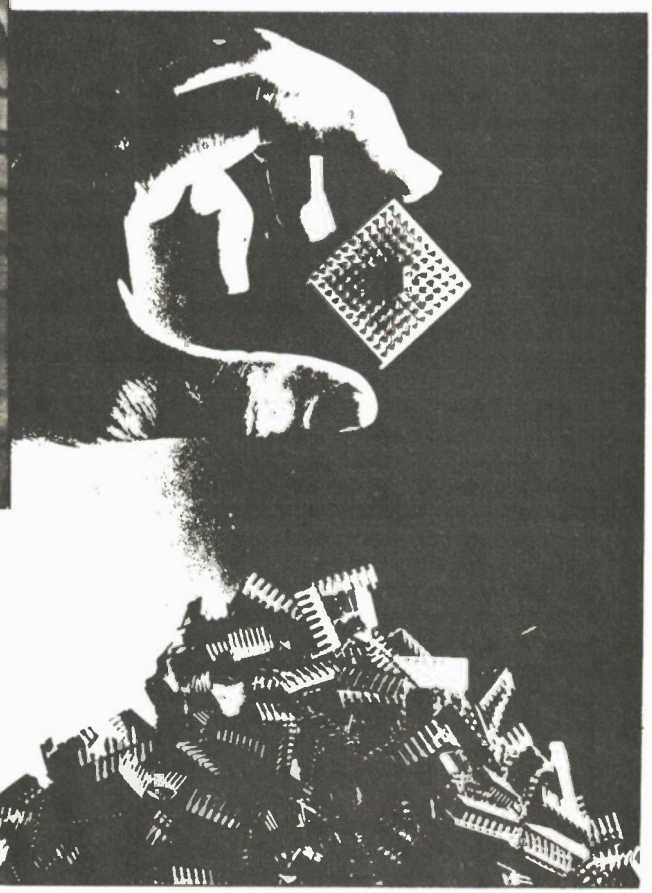
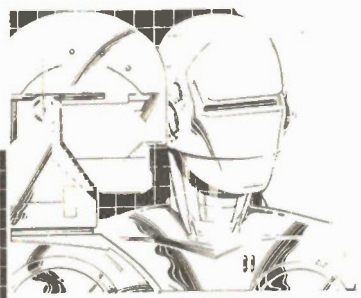


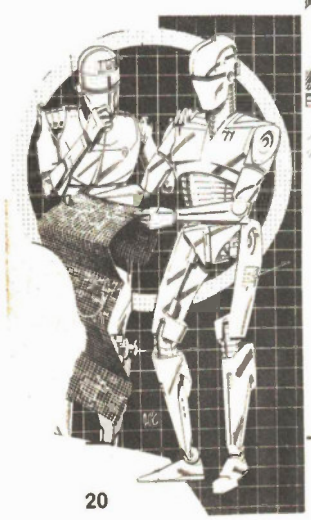
Fig. 9 A Wheatstone bridge calibrator.

Circuit Special

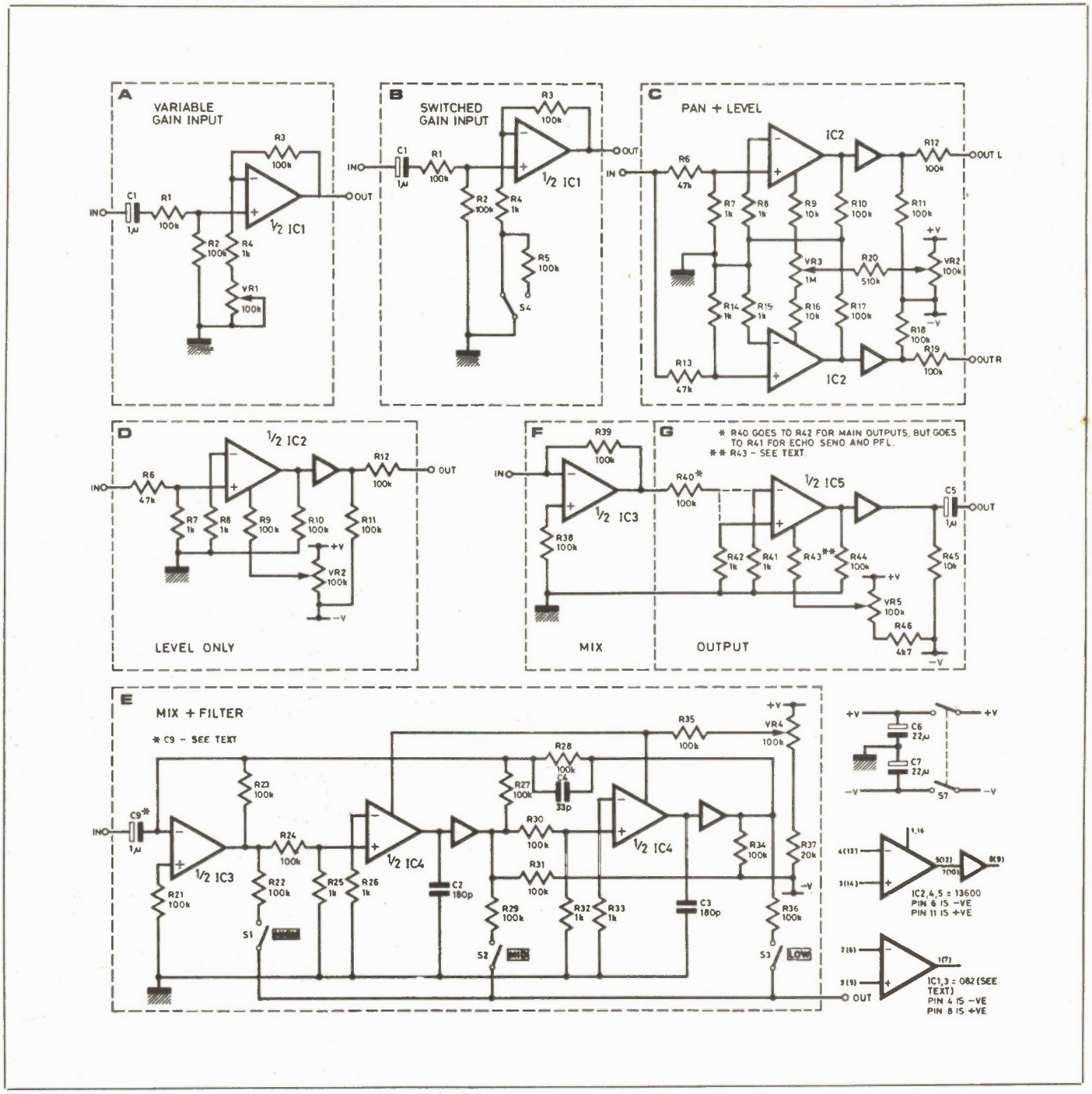








A fall harvest of circuits that will keep you busy during the autumn evenings - schematics of all types waiting to test your soldering skills.



Variable Audio Input Stages

By John Becker

TWO OPTIONS of variable gain input stages are shown in **Figs. a & b.** In each, the phase polarity is maintained by using the non-inverting ports, and the gain is dependent on the ratio of the feedback resistance to the resistance on the inverting input ports. In **Fig. a** this is constantly variable by VR1, whereas in **Fig. b** the gain is switch selected between high and low. In both, the gain spread is about X1 to X50.

The circuit in **Fig. b** is more suited to conditions where gain change versatility is less important. The IC used is a normal BIFET dual op-amp, and may be any of the TL062, TL072, TL082 series. The 082 is the standard version, 072 is low noise, and the 062 is a low power consumption version.

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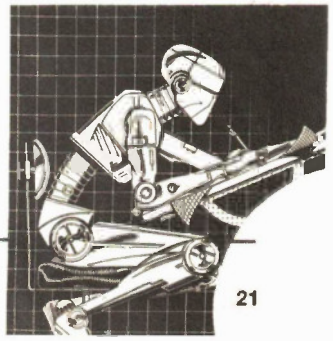

Perpendicular Magnetic Recording

Recent work on cobalt-chromium films has reawakened interest in perpendicular recording, and sets the scene for the development of a new technology that promises significantly improved information densities.

By P. Saunders

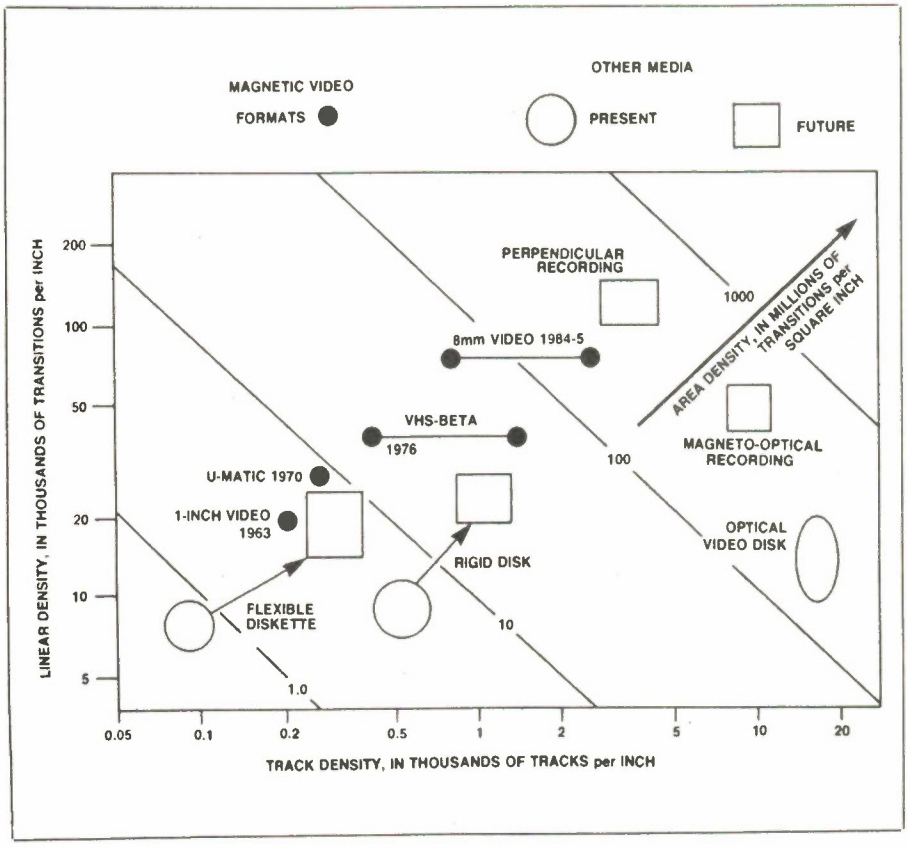

Fig. 1 Density of information on the surface of various recording media. Area density is the product of linear density and track density. A "transition" is either a magnetic reversal or the corresponding change in optical media.

PERPENDICULAR MAGNETIC recording is a relatively new technological procedure. As the name suggests, the direction of magnetization is predominately perpendicular to the plane of the tape or disk, and this innovation promises information densities significantly higher than those now used. New recording media and heads are being developed, and already impressive results can be demonstrated. However, just as in conventional magnetic recording, the head design and the proximity of the head to the recording surface remain factors of critical importance to high-density information storage.

The goal of any research and development in magnetic recording is, of course, to increase the information density stored on the surface of tapes and disks. An increased density can then be used by the video system designer to achieve various objectives including higher image resolution, a more compact physical format or the implementation of digital technology.

Information density in magnetic recording is related to the number of magnetic flux reversals, or transitions, per unit area of the tape or disk and also to the detected signal-to-noise ratio. We are concerned here only with the enhanced transition density and signal strength; minimizing noise is an additional matter which involves control of magnetic domain size and surface irregularities.

With conventional magnetic recording technology, magnetization directions lie predominately in the plane of the medium, whether tape or disk. Dramatic improvement in information density has come about largely through improved head design and the use of media with higher coercivities and smoother surfaces.

Since the coercivity of a magnetic material is the field needed to reverse the direction of its magnetization, it is closely related to the stability of a high-density recording pattern. Surface smoothness determines how closely the recording or playback head can approach the magnetic surface. The 30 year achievement of increasing surface information density in various recording systems and volume storage density in video media is illustrated in **Figs. 1 and 2.**

Advantages

An area of potential improvement in magnetic recording media is the magnetization intensity of materials. Most of the presently used media are of particulate construction, that is, they employ small discrete magnetic particles dispersed in a tough, flexible binder. The presence of the organic binder dilutes the magnetization of the recording material, reducing the available signal strength. Advanced media, now being developed, use continuous thin films of magnetic metal alloys to achieve higher magnetization intensity and also exceptionally smooth surfaces.

Hand-in-hand with the increased attention to continuous films has come a strong interest in perpendicular recording (also called vertical recording) as a possible route to acceptable signal strength at higher densities than can be achieved by the longitudinal, or in-plane, method. Some thin metallic films, especially cobalt-chromium alloys, have ideal magnetic properties for perpendicular recording; moreover, the vertical mode is highly suitable for productively using the high magnetization intensities afforded by the metallic films.

There are significant differences between the two modes of recording. In longitudinally recorded media small magnetized regions are positioned with their like poles in close proximity and repelling each other; in perpendicular recording, the magnetized regions are arrayed with unlike poles together, an intuitively more stable situation — and one that provides motivation for moving towards the perpendicular mode.

Comparison can also be made from the point of view of the so-called 'demagnetization' field, a self-generated internal field by which every magnet opposes its own magnetization. This field depends upon the magnet's shape, becoming stronger if the magnet is made shorter along its direction of polarization (see **Fig. 5**). The demagnetization field is proportional to the material's magnetization intensity, and so will become increasingly important if recording technology moves away from particulates and towards metallic films.

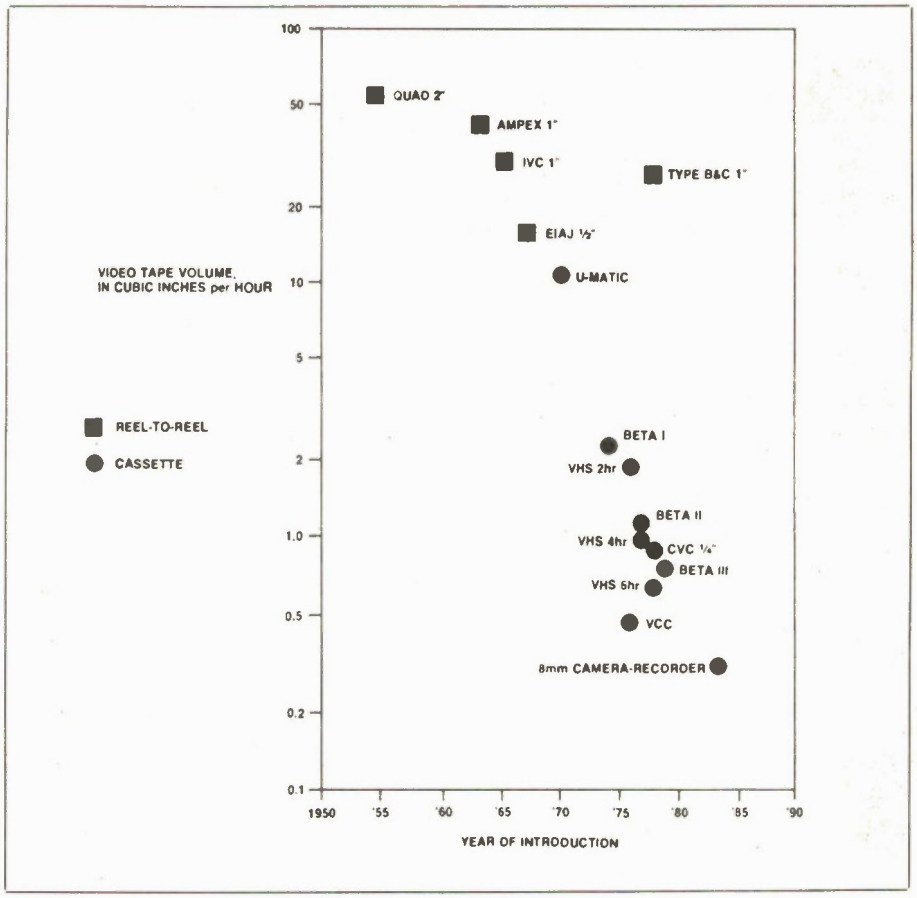

Fig. 2 Volume storage density of video media, expressed in terms of tape volume per hour of playback plotted against year of introduction.

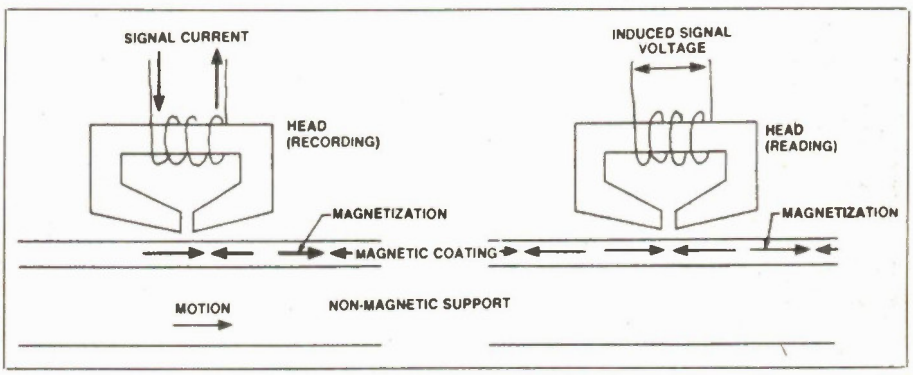

Fig. 3 Schematic diagram of conventional, longitudinal magnetic recording.

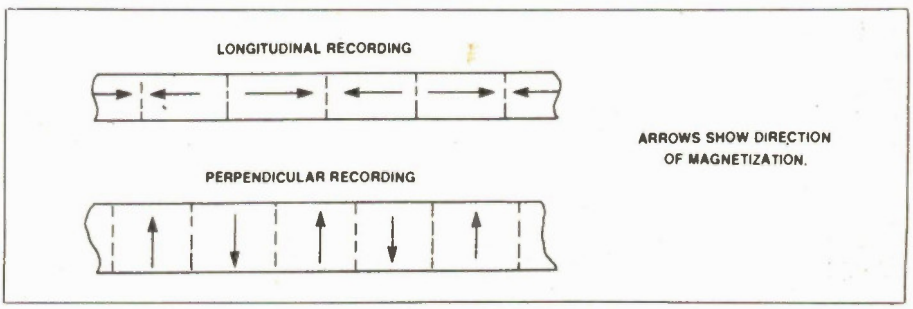

Fig. 4 The geometries of longitudinal and perpendicular magnetic recording. For simplicity, only the magnetic coating is shown, without its support material.

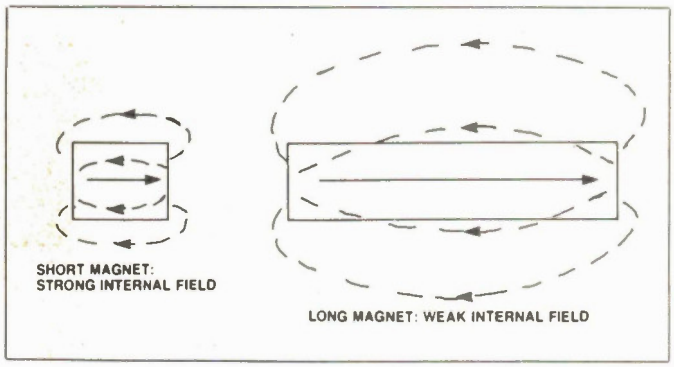

Fig. 5a The concept of the internal demagnetization field and its dependence on magnet shape.

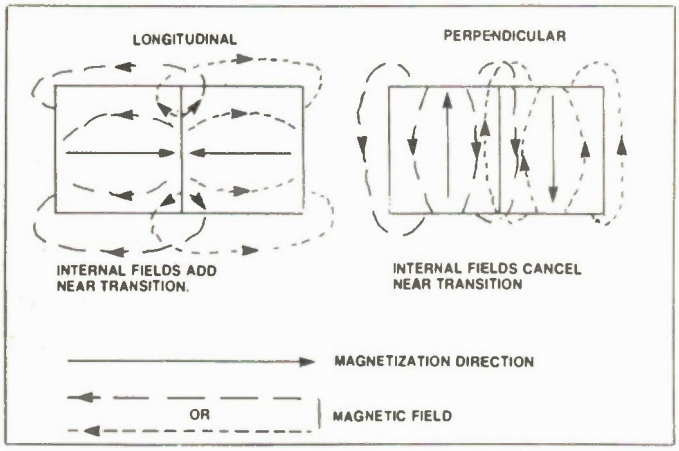

Fig. 5b The demagnetization fields in high-density longitudinal and perpendicular recording. Two adjacent, oppositely magnetized regions are shown for each method.

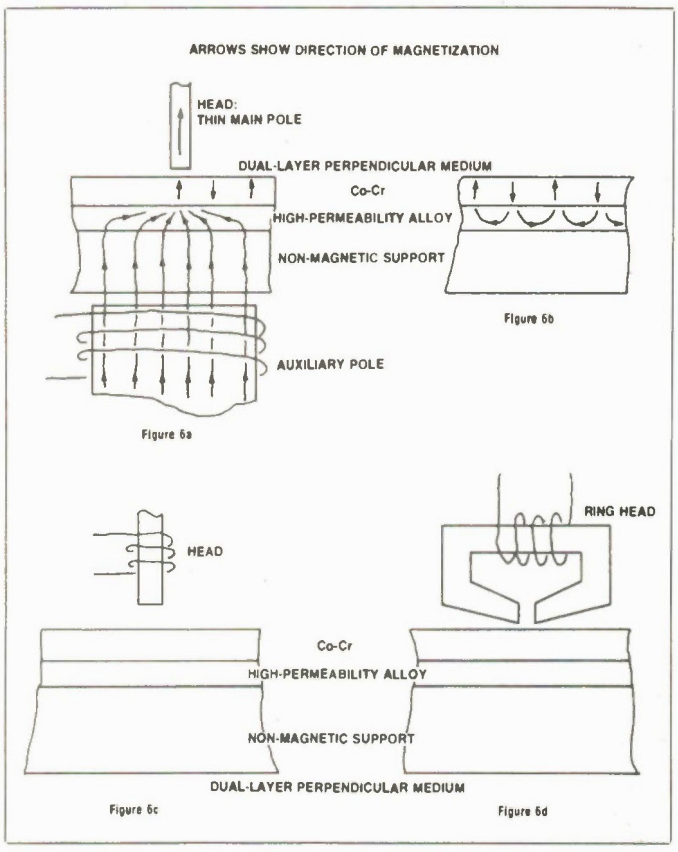

Fig. 6a Perpendicular recording head and dual-layer medium in the recording process.
Fig. 6b Dual-layer medium in the recorded state.
Fig. 6c Single-pole head used with dual-layer perpendicular medium.
Fig. 6d Conventional ring head with dual-layer perpendicular medium.

In longitudinal recording, the self-demagnetization effect in each magnetized region is not only compounded by the fields of the nearest neighbours, but becomes more intense as the recording density increases and the regions between transitions become shorter. Reduction of the magnetic coating or film thickness decreases demagnetization effects, but also tends to weaken the signal. In perpendicular recording, however, the self-demagnetization effect in one magnetized region is opposed by the fields of its nearest neighbours and actually becomes weaker if the distance between transitions is made smaller compared to the coating thickness. Increasing the coating thickness thus tends to decrease demagnetization as well as to enhance signal strength.

Since the demagnetization phenomenon weakens with increased transition density in the perpendicular recording mode, one might expect that conversely it could become highly unfavourable at relatively low densities, where the distance between the transitions becomes large compared to the magnetic film thickness. This is true, but only at positions far from the transitions. The transitions themselves remain sharp and distinct and thus useful in systems of interest for video recording, where the information is contained in the timing or frequency of transitions. Thus a large, useful bandwidth is available. If using a direct analogue format to record a low-frequency signal such as the audio track that accompanies video, a pulse-width modulation scheme can be used, which is comparable to AC-bias in conventional recording.

Developments

Perpendicular recording was first proposed and discussed decades ago but the recent intense development began with the work of Iwasaki and co-workers on cobalt-chromium films. This group also pioneered the use of a high permeability metal film beneath the Co-Cr layer; the composite structure provides magnetic flux linkage, which reduces demagnetization and enhances the effectiveness of the special head used. Numerous other laboratories have since become active in developing Co-Cr media, both with and without the underlayer, and a variety of head designs have been used.

Fig. 6 shows the double-sided head and the dual-layer medium developed by Iwasaki and co-workers (Figs. 6a and 6b), and a simpler perpendicular head (Fig. 6c), less efficient than the Iwasaki configuration, but which requires access from only one side of the tape or disk. A conventional ring head (Fig. 6d) can also be used with a perpendicular medium. This combination has been found effective in both theoretical modelling and experiment, and has been incorporated into a practical flexible-disk system.

Although the ring head is a very sensitive device for reading signals, questions have been raised concerning its effectiveness in recording truly perpendicular magnetization patterns. The use of two separate heads, a single perpendicular pole for recording and a ring head for reading, has been found advantageous. This combines the perpendicular recording abilities of the single pole with the reading sensitivity of the ring, and the arrangement gives a high output amplitude requiring access from only one side of the recording medium.

If one head is to be used for both recording and reading, then the ring head has a number of advantages. It apparently offers adequate recording performance, and when made with a very small gap has

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good reading sensitivity up to very high densities. The technology of ring head design and manufacture is well established.

Current materials research for perpendicular recording involves the use of continuous thin films other than Co-Cr as well as barium ferrite particles. The latter are dispersed in a binder and coated on a flexible backing as in conventional videotapes. They thus may have some economic advantages over continuous metal films, which are made by plating, sputtering, or vapour deposition. Efforts are also being made to produce recording tapes that have needle-shaped magnetic particles similar to those used in conventional audio and video tapes, oriented perpendicular to the surface.

Current Directions

Proponents of perpendicular recording on Co-Cr claim that it not only has a relative freedom from demagnetization effects, but also a magnetic microstructure that lends itself to sharp, well-defined magnetic transitions. Some longitudinally magnetized metal films, in contrast, have been observed to form jagged, 'sawtooth' transitions between regions of opposite magnetizations (see **Fig. 7**); this characteristic, if applicable to longitudinal media generally would tend to limit transition sharpness and thus the achievable recording density.

Despite the importance of demagnetization phenomena and magnetic microstructure, a major limitation on magnetic recording density is the inherent resolution with which the head can record or read. This resolution necessarily deteriorates with increased spacing between the head and the medium, but it is also affected by the head design. Head-to-medium spacing, which depends upon the smoothness of the recording surface, is a consideration that is common to perpendicular and longitudinal recording and may well prove to be the ultimate limiting factor in both.

But while all methods of magnetic recording operate under limitations imposed by head-to-surface spacing, they need not be equally sensitive to this aspect. There is some evidence that the use of a ring head with a perpendicular medium is subject to a stronger dependence upon spacing than that encountered

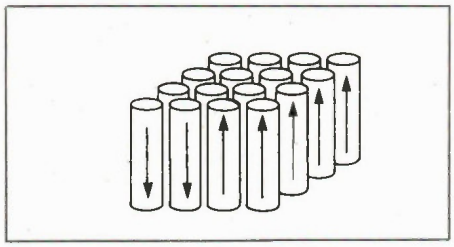

Fig. 7a Idealized diagram of magnetic domains in Co-Cr film, showing a sharp transition between upward and downward magnetization.

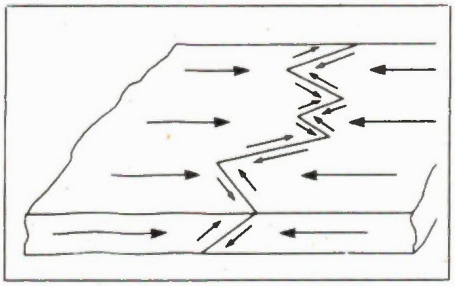

Fig. 7b Simplified drawing of 'sawtooth' magnetic transition in longitudinally oriented film. Arrows show direction of magnetization.

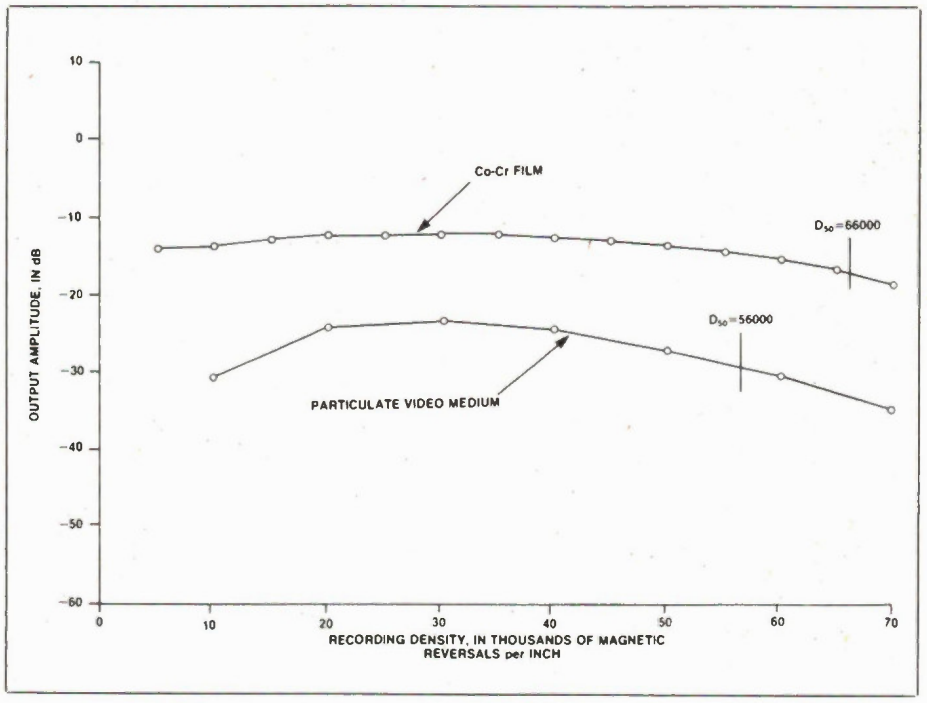

Fig. 8a Plot of output amplitude vs. linear transition density for a dual-layer Co-Cr sputtered flexible disk recorded with conventional ferrite ring head with large (18 micro-inch) gap.

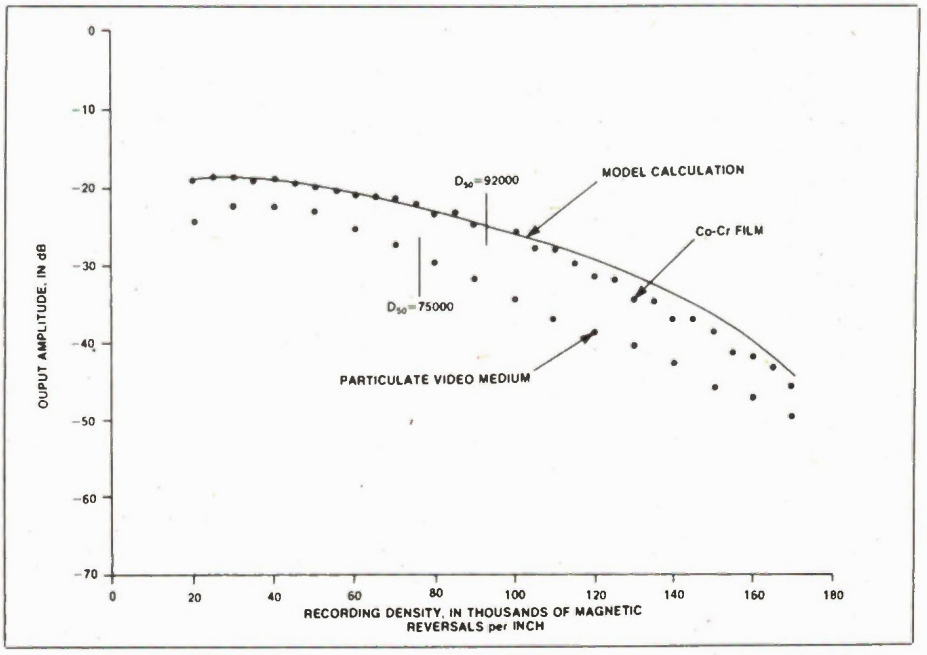

Fig. 8b Plot of output amplitude vs. recording density for the same medium as in Fig. 8a, with an advanced video head with a small (10.5 micro-inch) gap.

with other head-medium combinations. The extra sensitivity to spacing appears to be involved in the recording, as opposed to reading, process. These findings do not imply that the ring head is undesirable for perpendicular recording, but they do emphasize the importance of the spacing phenomena and the need for further research in head design.

Research and development work on Co-Cr films, as well as other advanced recording materials, was begun at 3M some years ago. **Fig. 8a** shows a plot of output amplitude vs. transition density for a Co-Cr coated flexible disk. It was recorded and read with a conventional ferrite ring head of the type used in VHS video cassette recorders. Performance is clearly superior to that of a disk coated with typical particulate material designed for VHS cassette tape, with respect to both the maximum output and the rate at which the output falls off with increasing density. **Fig. 8b** shows results for the same media with an advanced video head of very small gap but still of conventional ring construction.

So what of the future? The competition between the various modes of recording is to some extent a competition between the practical characteristics of the materials that make them possible. These characteristics include wear properties, chemical stability, and the economics of manufacturing. Also important are freedom from information 'drop-outs', due to defects, and noise properties, which depend upon surface smoothness and magnetization structure. Almost certainly, no one material will be found best for all applications.

The advanced materials designed for perpendicular magnetization have achieved impressive recording densities in the laboratory and are now moving into practical applications. The first will apparently be in the area of disks for digital data. However, only further development and extensive testing in the field will be able to determine the ultimate impact of materials such as Co-Cr upon video recording. ■

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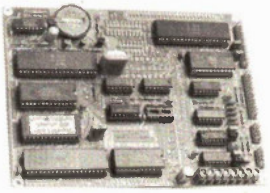

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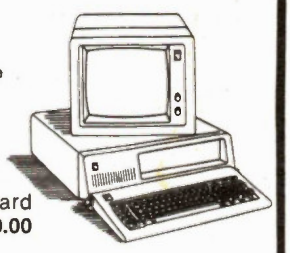

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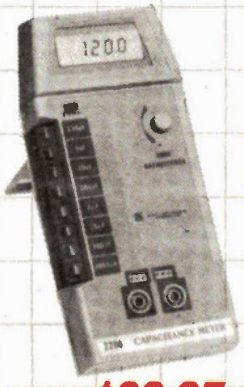

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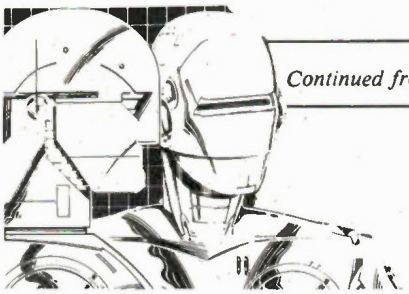

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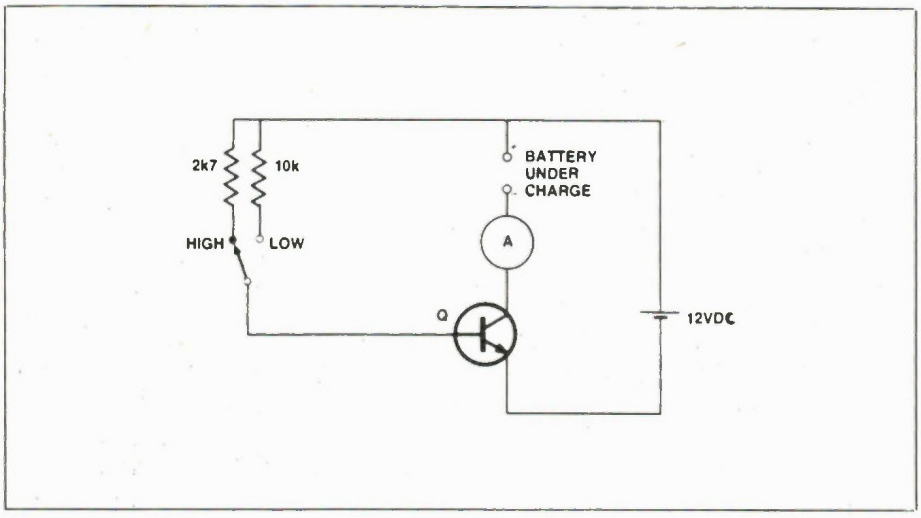
By N. Jackson

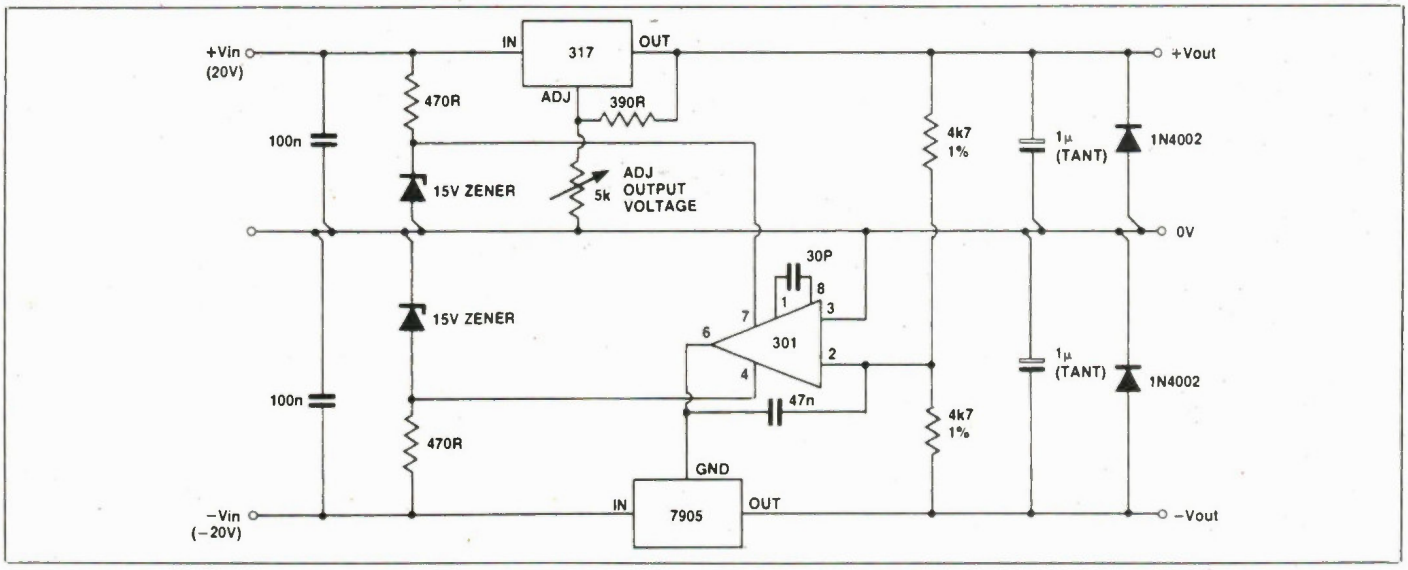


The switch selects a resistor to set the base current of the transistor, and the resulting collector current will charge the battery. Charging current will be reasonably constant regardless of the number of cells in series being charged; up to 8 cells may be charged at one time.

Once the circuit has been tested, the ammeter could be omitted, or a multimeter switched to an appropriate current range could be plugged in to the circuit.

The 12 volts DC could be provided by a plugpack or by a suitable 120V transformer and rectifier.

In theory, the collector current will rise as the transistor's temperature increases, but this was not noticeable in the prototype. The transistor could be mounted on a heatsink if desired. Exact values for the resistors will depend on the transistor used and the required charging currents.



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By H. Nancinovich

THIS POWER SUPPLY is particularly suitable for powering op-amp circuits which usually require both positive and negative supply voltages.

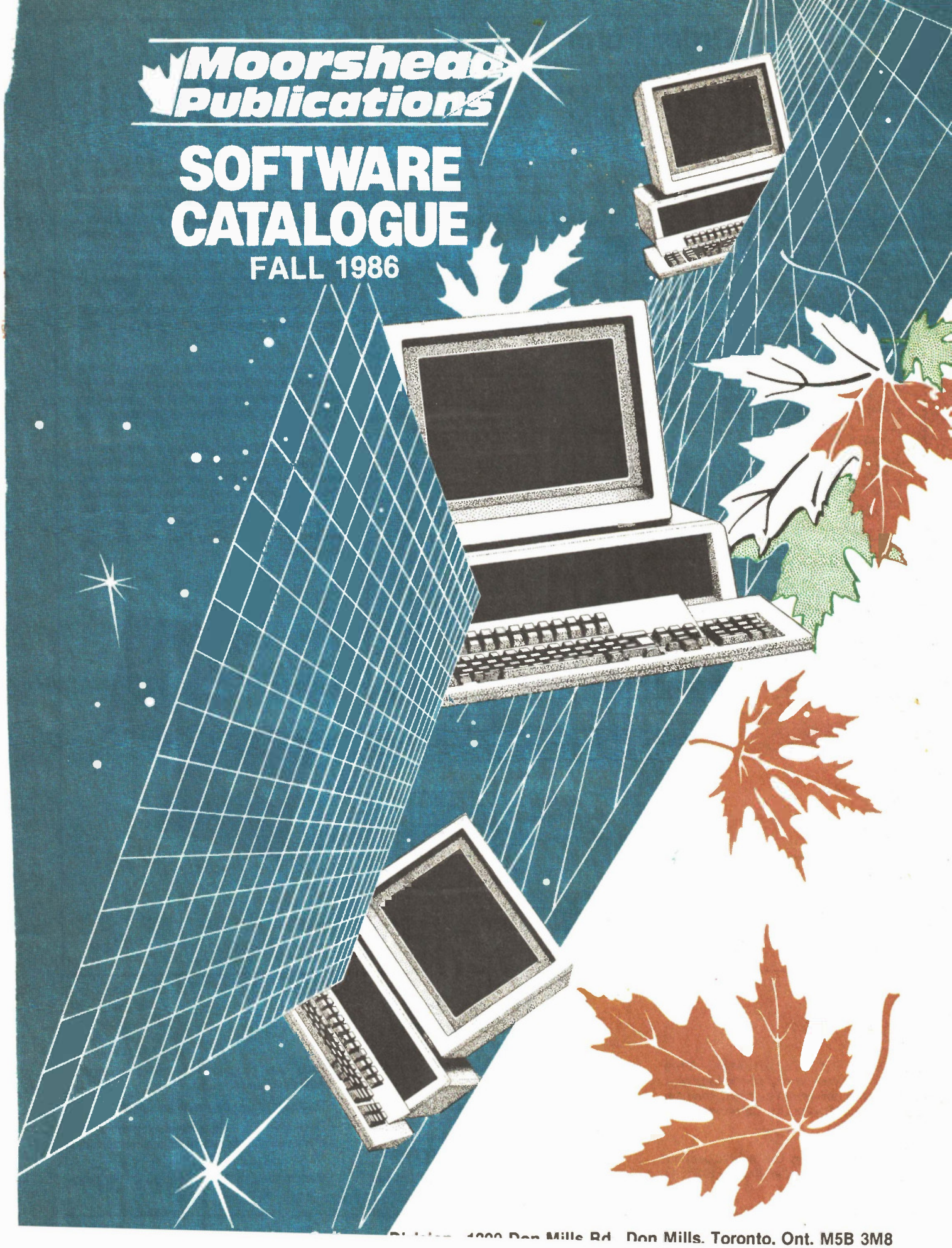
The circuit consists of a positive regulator which gives a positive output voltage variable from 1.2V to approximately 16.6V. The negative regulator tracks the positive output voltage to give a negative output voltage of equal magnitude.

The positive regulator is made up froom an LM317 IC which maintains a constant 1.2V between its 'out' and 'adj' terminals. This voltage appears across a 390R resistor which, together with a 5k variable resistor, forms a voltage divider. The positive output voltage is equal to:

1.2V x (1 + R/390) where R is the value of the variable resistor in ohms.

The negative regulator is made up from a 7905 IC and a 301 IC op-amp. The 7905 maintains a fixed -5V between its 'out' and 'gnd' terminals. Its 'gnd' terminal is connected to the output (pin 6) of the op-amp. The latter compares the voltage at the junction of two 4k7 resistors across the positive and negative output lines with that at the 0V line and produces a proportional voltage at its output. By negative feedback action, the voltage at the junction of the two 4k7 resistors is maintained equal to that at the 0V line. Since these two resistors are equal, the negative ouptput voltage is maintained equal and opposite to the positive output voltage.

The 1u tantalum capacitors across the outputs and the 47n capacitor between pins 2 and 6 of the op-amp ensure stability, while the 1N4002 diodes across the outputs protect the regulators against possible reversal of the output voltages. Both the positive and negative regulators feature current and thermal limiting.



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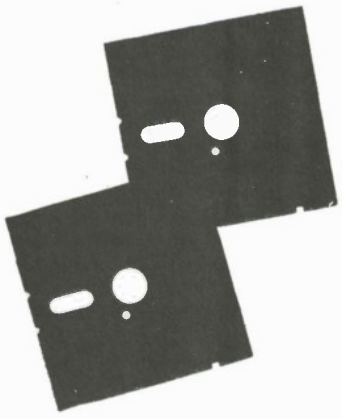

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Almost Free PC Software

Moorshead Publications

Volume 1

PC-Write An earlier, compact version of this well-known word processor - perfect for program editing. PC-Write comes extremely close to equalling the power of commercial word processors costing several hundred dollars. With full screen editing, sophisticated cursor movement, PC-Write also boasts features such as user-definable help screens and a 'printer ruler file' which can be customized to work with virtually any printer.

```
   ===PC-TALK III  COMMAND SUMMARY===

 †PrtSc =  print screen contents
 ^PrtSc =  contin. printout (or ^PgUp)
  Alt-R =  Receive a file  (or PgDn)
  Alt-T =  Transmit a file  (or PgUp)
 transmit: pacing '=p'  binary '=b'
tran/recv: XMODEM '=x'
  Alt-V =  View file   Alt-Y = delete
  Alt-D =  Dialing directory
  Alt-Q =  redial last number
  Alt-K =  set/clear Func keys (Alt-J)
  Alt-=    set/clear temp Alt keys
 Alt-E = Echo toggle  Alt-M = Message
 Alt-S = Screendump   Alt-C = Clearsc
  Alt-P =  communications Parameters
  Alt-F =  set program deFaults
  Alt-L =  change Logged drive
  Alt-W =  set margin Width alarm
  Alt-Z =  elapsed time/current call
  Alt-X =  eXit to DOS
Ctrl-End = send sustained Break signal
```

SOLFE is a small BASIC program that plays baroque music. While it has little practical use, it's a lot of fun. It's also a fabulous tutorial on how to use BASICA's sound statements.

PC-TALK Telecommunications packages for the IBM PC are typically intricate, powerful and huge. This one is no exception. It has menus for everything and allows full control of all parameters. It does file transfers in both ASCII dump and MODEM7/XMODEM protocols. And, it comes with a large documentation file.

SD This sorted directory produces displays which are a lot more readable that those spewed out by typing DIR.

FORTH This is a small FORTH, written in Microsoft BASIC. A good tool for teaching the ideas and concepts of this esoteric, but useful language.

LIFE This is an implementation of the classic ecology game written in 8088 assembler code. While you may grow tired of watching the cells chewing on each other, the source code provides a good example of how to write assembler applications.

MAGDALEN This is another BASIC music program. We couldn't decide which of the two we liked better, so we wound up putting both of them on the disk.

CASHACC is a fairly sophisticated cash acquisition and limited accounting package written in BASIC. It isn't exactly BPI, but its a lot less expensive and suitable for use in many small business applications.

DATAFILE is a simple data base manager, written in Microsoft BASIC.

UNWS WordStar has an unusual propensity for setting the high order bits on some of the characters in the files it creates. Here's a utility to strip the bits and 'unWordStar' the text. The assembler source code is also provided.

HOST2 This program includes BASIC source and documentation files to allow users with SmartModems to access their PC's remotely.

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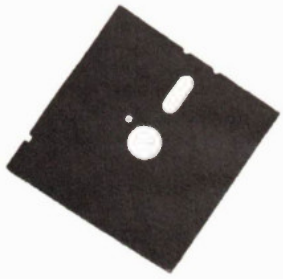


Volume 2

SWEEP is a disk utility which virtually replaces the DOS Copy command. It lets you COPY, REN, TYPE and DEL files quickly and easily from a simple menu.

Worldmap is a sophisticated graphics program which draws a very detailed map of the world. It can display its wares on your monitor, or send them out to a dot-matrix printer.

ANITRA plays Anitra's Dance by Edvard Grieg. A beautiful addition to your computer music collection.

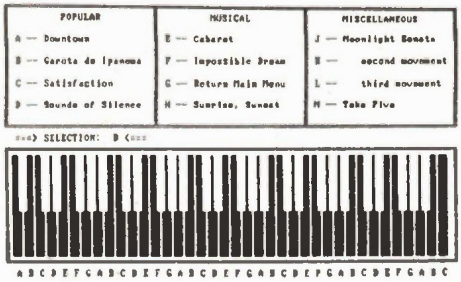
RAMDISK is one of the most useful utilities you'll ever plug into your PC. Once installed, it creates a virtual drive in memory on your PC. Files can be copied to the RAM-disk and accessed in less time than real drives take to turn on their LEDs.

Alien plays a bizarre adventure game and will lead you into some of the most exotic spots in the universe. It comes with a massive data file for an adventure that you won't get tired of 'til the dragons come home for the evening.

BREAKOUT plays a PC version of the popular game. It will accept input from either a joystick or the keyboard. The graphics are good and the action is adjustable from a beginner's level right up to 'fast and nasty'.

PRTSC replaces the internal PC screen dump code with something more suited to reality. It allows one to hit the PrtSc* key and then select the print quality from a menu. It supports a number of popular printers.

UTIL is a collection system utilities which can be accessed from a single menu. Among its many talents are a sorted directory, keyboard redefinition and the facility for scrolling up and down through a text file.



Jukebox represents yet another PC music system. This one comes with a host of songs to play and some really electric graphics.

FOS is a well designed personal finance manager which will do much to help you tame your cheque books.

ASMGEN is one of the best text disassemblers we've come across. It takes any executable COM or EXE file and produces an assembler listing. It's surprisingly good at distinguishing between code and embedded data or text.

STRUCT will appeal to the rabid programmer in everyone. It enables MASM to be used to assemble a higher level language. Included also is a test file to illustrate the syntax.

Only $19.95

Volume 3

FIXWS is a simple utility which modifies WordStar files so that they can be used by programs which work with ordinary ASCII files.

WRT DOS 2.0 allows for each file to have a 'read only' flag, but it lacks a way of manipulating them. This pair of utilities allows you to set and unset this flag, protecting important files from accidental erasure.

BROWSE is a timesaving program which provides a useful alternative to the DOS 'TYPE' command. BROWSE allows you to easily scroll up and down through text files, saving you the effort of running your word processor just to get a quick look at a text file.

CAT If the DIR display is too dull for your taste, CAT may be just what you need. It will tell you everything you could possibly want to know about the files on your disks.

CGCLOCK is a simple little program which displays the running time in the upper right hand corner of your screen. In addition, the program has lots of display options and works with the colour graphics card.

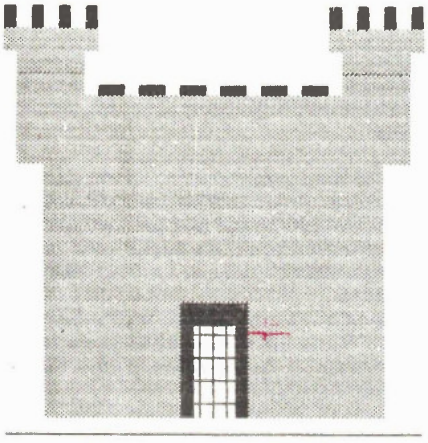
CURSOR A tiny twenty-four byte program which displays a large cursor on your monitor.

CMP This program does a very elaborate comparison of two files and reports their differences. It can for example, spot corrupted files and may prove useful when dealing with files created by redirection.

JUMPJOE A bit like "Miner 2049'er", this game is certain to damage your mind. You get to be the janitor of a space station and must deal with berserk robots and other weirdness. It's a hoot!

CASTLE Wander through a deserted castle collecting treasures... but mind you don't get killed by the nasties. A solution is included should frustration set in.

78INT This is a small BASIC program to calculate interest using the rule of seventy-eight.



MOON is one of the nicest lunar lander games we've come across. This version uses high resolution graphics and startling sound effects to hurl you to your doom in style.

PERTCHT is a BASIC program which prints PERT charts. It should interest anyone involved in project management and scheduling.

DATNOIDS is one of the strangest games ever put on a disk. In fact, mere words don't serve to describe it: you'll have to try it for yourself.

NUK-NY This is one of the nastiest bits of software we've ever seen. It produces a full color high resolution simulation of a nuclear attack on New York City.

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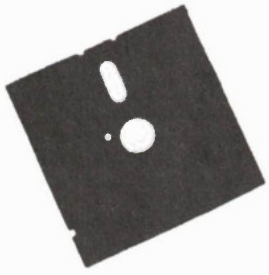

Volume 4

BACKSCROLL Perhaps one of the cleverest DOS utilities, BACKSCROLL hooks itself into the PC and buffers whatever scrolls by. Using a well-thought out command structure, it allows one to scroll back and forth through text which would normally have scrolled off the screen into oblivion.

BIGCAL is a BASIC program which performs calculations on extremely large numbers. Using floating point form instead of scientific notation, very accurate calculations can be made.

BUGS is an off the wall ASCII game in which a player uses the cursor pad keys to move a 'nuclear fly swatter' around the screen blowing up a long crawling bug.

DEFRAG is a utility that lets you "defragment" your disks to make your applications run faster. The utility reorganizes a disk, connecting up the fragments of files created by DOS.

DOSEDIT is one of the most useful DOS utilities available. it enhances the command line facility of MS-DOS by creating a command stack. Instead of merely being able to recall a command with the F3 key, DOSEDIT lets you use the cursor arrow keys to scroll through a whole stack of previously entered commands, re-executing the ones you need.

DUmp is a utility program designed to produce Hex dumps of object files. Useful in its own right, the program also serves as a good example of how to use DOS disk service calls. The ASM file is also included.

FREE is a tiny file which tells you how much space is left on a disk... without having to view an entire directory listing. Its especially handy for hard disk systems.

KBFIX displays the status of the keyboard lock keys on the screen and expands the size of the keyboard character buffer to avoid losing bytes.

LABEL changes the labels on disk drive volumes. It's a simple utility, but useful if you use volume labels to keep track of your disks.

MEMBRAIN is the most sophisticated RAM disk program we've seen yet. It lets users install variable sized disks and provides control over several other parameters.

NUSQ is a file un-squeezer. Its a useful utility for people who download compressed files form bulletin board systems.

SPACE INVADERS A fast variation of this popular arcade game. the graphics are superb.

SP is a clever print spooler which lets you 'print' files into a RAM buffer. The PC then sends the file to the printer at its leisure, leaving the user free to move on to other tasks using the computer.

SPEED is a simple program which changes some of the PC's floppy disk parameters and effectively speeds up disk accesses for some applications.

VDEL is a multiple deletion program that queries the user prior to erasing each entry. Similar to MOVE, but much smaller.

WHEREIS will locate a file on a disk even if it lurks in a subdirectory. Most useful on hard disk systems.

WIZARDS is an adventure game in the classic style, except that it ranks as one of the most sarcastic programs in creation. The program is vast... you can wander about its darkened corridors for hours.

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Volume 5

AREACODE is a useful tool if you use the telephone a lot. Give it an area code and it will match it with the city in which the code is used.

D in another sorted directory program. This one emulates the CP/M style D, which is arguably more useful for most applications.

FRACTALS An amazing implementation of the Mandlebrot Microscope, which generates unearthly images on your screen.

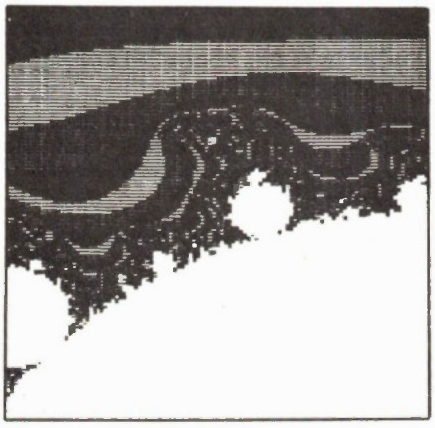
HIDE is a set of utilities which let you create, enter and remove invisible DOS directories. This allows you to set up a hard drive system with secure areas which can only be used by people who know about them.

LAR is a library utility that allows you to concatenate several small files into a library to save on disk overhead. Individual files can be extracted as they are needed.

MAIL1 is a mailing label utility written in BASIC.

MORERAM This is an assembler program. You need MASM and LINK to make it work. It lets you alter the memory setting on the PC's motherboard to enable it to use more than 640K RAM. It will even let you set the switch settings to 64K to speed up disk boots and then change the RAM setting after bootup.

MORTGAGE generates amortization charts.



MXSET lets you control the parameters of Epson printers form the DOS command line. It's a lot easier than LPRINTing characters from BASIC every time you want to change print modes.

NUSQ unsqueezes files that have been previously compressed to save space. Should be of primary interest to bulletin board users.

PARCHK is an assembler program which requires MASM and LINK to work. It installs a trap for parity errors in your computer. A vital aid to help locate suspect RAM chips.

VDEL is a Delete with Verify program. You could type VDEL *.BAK and it would show them name of every .BAK file in the current directory and ask you if you want it deleted.

WHEREIS finds files in a complex hard disk system.

ZAXXONPC This is an incredible implementation of one of the most popular micro games ever created.

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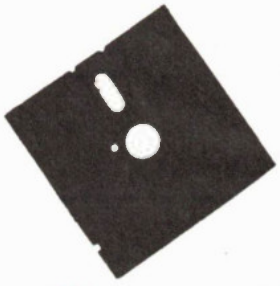


Volume 6

3-DEMON is one of the most interesting variations on Pac-Man in the known universe. Instead of simply looking at a map of a maze, this program shows you a three dimensional view of it. You wander through endless corridors, munching food pellets or granola bars... your choice... and avoiding the deadly ghosts.

DU was one of the most powerful CP/M-based disk utilities ever created. This version for the PC captures much of its power and flexibility. It allows you to see what the tracks and sectors on your disks look like, recover erased or damaged files, and meddle with the system tracks.

General Ledger This is a complete general ledger accounting program. Written in BASIC, the program possesses most of the features found in commercial packages. An enormous documentation file is also included.

PC-CHESS is a slick chess program which makes good use of the PC's colour graphics abilities and boasts a running chess clock.

RAMDISK is the assembler source code for a memory disk program. If you've always wanted to know how these things work, or have a secret desire to write your own variation of this useful utility, here's your chance.

VFILER is a file management utility which lets you view files in a directory and allows you to COPY, TYPE and even run programs... in short, it does almost everything DOS does but it's user-friendly.

QMODEM is unquestionably the best telecommunications package in existence. The most recent version of it is replete with windowing, multiple protocols, definable function keys. And the code is unspeakably well debugged.

ARC is a sophisticated file archiving program which stores several files in single library files. As an added bonus, ARC applies one of four data compression techniques to each file in order to optimize disk space.

ZAPLOAD is a utility for programers to handle Intel standard HEX files. Very fast and well documented.

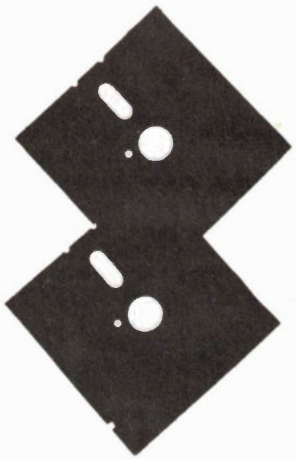
SOPWITH Using superb graphics, SOPWITH lets you pilot a World War I biplane on dangerous bombing missions.

JSB Another BASIC music program for your collection. This one plays a soothing sonata.

STAR is one of a growing breed of small... somewhat silly... novelty programs. This one, as you might guess, draws stars.

SURFACE demonstrates the complexity of the "hat" function by graphing it on a monitor screen.

OP is the operator program from the November '85 issue of Computing Now!



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Volume 7

BLACKJACK is a BASIC implementation of this popular card game. It's both interesting to play and enlightening to dismantle. It can, of course, be easily listed so you can see how it works.

EDSCR is a screen editor which can be used with virtually any programming language from assembler to dBase III. The program lets you 'paint' PC screens with block graphics and saves them as .DAT files which can be easily adapted to work in most languages. An example screen is included.

FK allows you to make the function keys of your PC do more useful things under DOS. They can be redefined to execute commonly used commands and command sequences.

FXMASTER is a printer program for the popular Epson FX Series and compatible printers. It uses a full screen menu to enable you to easily change printer settings and modes.

INDEX allows you to generate indexes from WordStar documents... or text files from any other text editor. It's an invaluable writer's tool.

KEYCLICK is a memory co-resident program which will make your keys click. Small and easily included in an AUTOEXEC file, KEYCLICK solves many problems associated with clone keyboards.

PCBW is a small utility which makes colour screen displays show up in monochrome video. Great for users with colour graphics cards and monochrome monitors.

PINBALL is a pinball simulation that is easily worth the cost of this disk all by itself. The game plays much like a real pinball machine... but its hard to tilt.

QUICKGRAF is a powerful business graphics package which generates complex bar, line and scatter charts in medium and high resolution. An Epson with GrafTrax or compatible printer is necessary to produce hardcopy.

SERPENT is a variation on the classic snake game. Written in BASIC, this one is weird, but very fast.

SHOWCLK is yet another clock program... its the smallest one yet, and it beeps to chime the hour.

VTREE is a graphic TREE program that shows you how the subdirectories are set up on your disk... in a fashion more easily understood than the MS-DOS TREE utility.

WORLD is a remarkable program which incorporates a world map. It allows you to zoom in on specific areas of the globe, locate major cities and perform a number of useful calculation. It also has a feature for tracking hurricanes... tracked any good hurricanes lately?

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Volume 8

Load-Us allows users of the popular Lotus 1-2-3 and Symphony programs to run them on a hard drive. This preboot program does not "crack" Lotus's copy protection scheme, but it does help legitimate users overcome the inconvenience of keeping a "key" disk in a floppy drive while running Lotus or Symphony on a hard drive.

DDCal is a very clever perpetual calendar and desk diary. It keeps track of your appointments and performs several other functions that you probably thought could only be done on the backs of match books.

PC-Key Draw is a remarkable public domain paintbox program which compares favorably with many commercial applications. It'll handle multiple screen images, business graphics and superb computer art - all in full colour. It's worth the cost of this disk all by itself.

CPU is a tiny program which tells you the effective speed of your system.

Xray is a remarkable co-resident utility which monitors what a program is doing while it's busy doing it. It allows you to interrupt the execution of your code and have a look inside.

Game - well, there are no words for this program, or, at least, none that are printable. This game is a bit rude - depending on just how weird your mind is, it can get pretty bizarre. This program does use some suggestive language, and we recommend that young or sensitive users not boot it.

Tune is a very small music generator which makes noises from within batch files. It's useful to see where things are in a complex process.

Jul			7		1986	
Sun	Mon	Tue	Wed	Thu	Fri	Sat
29	30	1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31	1	2
3	4	5	6	7	8	9

Chasm, or cheap assembler, is just the thing if you want to get into assembly language programming but don't want to spring for the Microsoft macro assembler package. It's reasonably fast, not too huge - it'll run in as little as sixty-four kilobytes - and, above all, it's cheap.

Getdir is a resident directory utility. It allows you to see what files are on your disks, even if you're in the middle of doing something else.

CopyPC, not to be confused with the commercial Copy II PC, is a quick disk backup utility.

Lookit is a full screen browsing program which lets you scroll forward and backwards through text files - sort of like a tiny word processor with no editing features.

Syslock is a security device for hard disk users. By running this utility on your XT or compatible, access to your computer will only be granted to users with a valid password.

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Volume 9

Small C If you've ever wanted to try writing programs in the C language, this compiler will fascinate you. It's a restricted implementation of C, producing code which is compatible with Microsoft's MASM and LINK programs -you'll need these to get it going.

Map is an interesting little utility which will check how DOS is situated in the memory of your computer and tell you a number of things about it. It's a useful programming tool, especially helpful if you're debugging software which interacts directly with DOS.

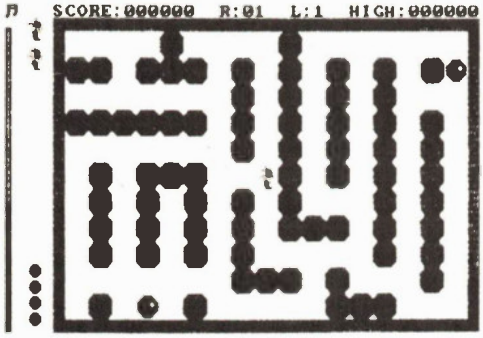
Note is the source file for the memory resident note pad which appeared in the March 1986 edition of Computing Now! It requires MASM and LINK to use. It will create a resident memo page that you can call up from within any application.

Pango is one of the wildest games we've come across for the PC. While its premise is a bit improbable, it's fast and *weird* - hours of fun.

PC-Spell is a spelling checker written in BASIC. Despite its pedestrian sounding origins, it's fast, accurate and easy to use. It can be listed if you want to see how it works, and comes with a large dictionary file and a utility to assist you in customizing it.

Peacock is a memory resident program which allows you to change the colours of your screen with alternate function keys. It's useful, for example, if you run software which insists on using eye-straining screen colours.

Recover is a utility which assists you in getting data back from damaged files. It lets you look at your files one sector at a time in order to put the pieces back together.



First Time Advertised

SDB is a small relational database. It isn't dBASE III, but it also doesn't cost quite as much. It's still pretty powerful and is eminently suitable for many business applications. It features on line help.

Tally is a program which accurately counts the number of characters, words and lines in a file -all within your lifetime.

Xeno edits the tracks and sectors of your disks in a user friendly format - or, at least, one that doesn't lunge for your throat every time you boot it. You can use it to explore DOS, fix trashed disks, unerase files and do all the other low level magic that sector editors are renowned for.

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Volume 10

Monopoly is the first working implementation of the classic board game that we've come across - and we've had several that bombed pretty colourfully. This one is great, though, with fast and occasionally sarcastic play, a graphic board display and pretty good sound effects.

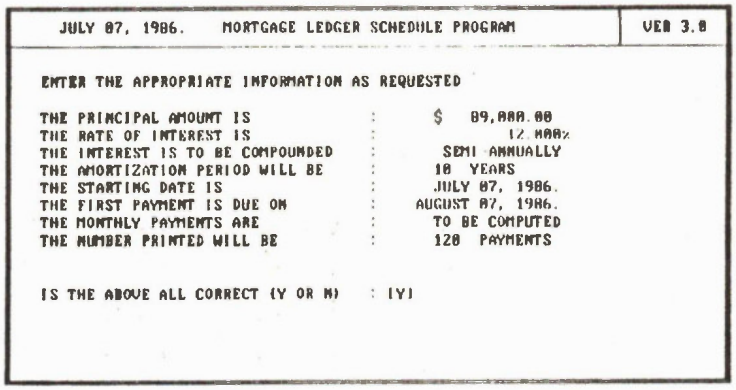
D20 is the latest version of Steve's sorted directory program. This one uses DOS two calls and handles subdirectories.

Edit is a lightning fast full screen editor, ideal for editing program source files, dBASE stuff or other ASCII phenomena.

Banner takes mere text and prints it sideways on your printer - in gargantuan block letters that can be read from miles away if you have a good set of binoculars. It's not the sort of thing that you'd want to publish a book with, but sign makers will love it.

Mortgage is another utility to help you understand just what you've gotten yourself into. Its one of the nicest mortgage programs we've seen so far - lifelong debt and ruination has never been so well formatted.

Quick speeds up your PC quite a bit. It hooks into the video and makes it run a great deal faster, eliminating at least some of the glacial slowness that makes an IBM what it is.



Speech is a rather remarkable little germ of code. It talks through the PC's internal squeaker speaker. The voice isn't exactly human, but it's understandable on most machines. This is an interesting bit of work, one that can be accessed from within other programs to create talking applications.

PC-AR is an accounts receivable package for the PC. While not the equal of some of the commercial software that handles this function, it will take care of the records for a small or medium sized business quite well.

Only $19.95

Volume 11

Pac Girl is, predictably, a variation on the almost mythical Pacman game. This one moves fast, and plays much like the arcade version.

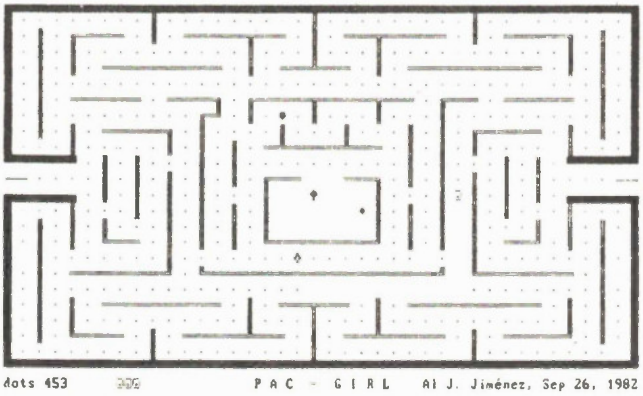
Menu lets you create a menu-driven tree-strctured environment that is friendlier and more manageable than is DOS. It's ideal creating interactive systems for non-technichal users.

Z80MU is one of the most brilliant pieces of software we've ever encountered - free or not. It actually emulates a Z80-based computer running CP/M on the PC with no additional hardware - you don't even need a V20. It will run almost all CP/M software, including old favourites like WordStar and dBase. However, Z80MU also includes features lacking in both C/PM and MS-DOS operating systems.

SERIO is the assembler file from the July edition of Computing Now! that implements an interupt-driven terminal in higher level languages such as C. It's also suitable for use with compiled BASIC. Both MASM and Link are requred to use SERIO.

Breakdown is a peculiar program which takes meaningful text, analyzes it and generates meaningless, but profound-sounding prose from it. If you've been wondering if your co-workers *really* read your office memos and reports, try filtering your prose through this program. The effects will be astounding.

GRABIT is the screen grab program from the July 1986 edition of Computing Now!. It will make a useable text file from the contents of ones screen at the touch of a key. MASM are Link are required.



XMODEM is a C language implementation of the XMODEM file transfer protocol, from the July 1986 edition of Computing Now!. It can be integrated into other programs to allow easy access to telecommunications facilities. This code requires SERIO (see above) and version three Lattice C.

Only $19.95

Volume 12

CV is a small utility for changing the volume name on disks. Since most of us never bother to specify volume names when formatting disks, this six hundred byte program provides a second chance.

Breakout Box is an assembly language program that hides in memory and shows you what your serial ports are doing. It's a valuable trouble-shooting utility for pin pointing serial printer and modem problems.

Icon Maker allows you to generate sophisticated bit-mapped images. Its' easy to use and extremely colourful, producing data that can be incorporated into other programs.

Shell is another DOS menu program. This one is very fast, free of 'snow', and provides easy access to virtually all DOS features.

Striker is an experience. It's a brilliantly written helicopter game in the style of Choplifter, complete with professional high resolution graphics and running spies. This is one of the best public domain games we've ever encountered.

Ramset is a RAM expansion program from the July 1986 edition of Computing Now!. It allows you exceed the PC's 640K memory limit. Ramset also lets you bypass the PC's time-consuming memory check.

Trap is the high-resolution Gemini patch program from the May edition of Computing Now!. It makes the Gemini 10x suitable for use with Personal Composer, but is easily modified to fix most bit-mapped printing problems. MASM and Link are required to assemble the program.

Almost Free PC Software Volume 12

Only $19.95

To order use order form or call (416) 445-5600 for Visa, Master Card and American Express orders.

Volume 14

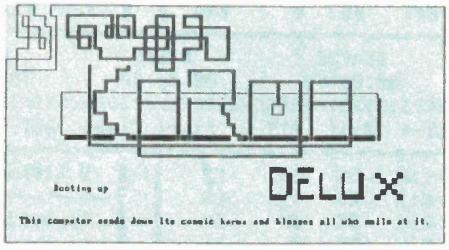
Cut and Paste is a memory resident program that allows you to grab text from the screen of any application and paste it into any other application that accepts characters for input. You could, for example, copy part of a Lotus spreadsheet and paste it into a WordStar document.

INT13 will help you unravel the copy protection schemes of your software so you can make archive copies - just in case the cat takes a fancy to your masters. It prints a log of direct disk accesses and where they're called from so you can check out the code that's going after specific tracks, the heart of most protection systems. Includes the assembler source code.

PMAP tells you what's living in the memory of your system - and where. It will help you to find the resident utilities you have loaded and, more important, is great for sorting out peculiar interactions between multiple resident programs.

SoftTouch is a keyboard macro program not unlike ProKey. It allows you to store up to twenty five thousand key strokes, has a built in screen blanker and great wandering herds of other features.

Sub Chase is a first rate graphics arcade game. One sails across the clear blue sea - or green sea, depending on what sort of monitor you have - heaving depth charges off the stern to blow up subs. It's extremely well done and it has a panic button to clear the screen should the boss walk in. Requires a colour graphics card.



TheDraw is an ANSI screen editor. It allows you to create and edit full colour screens of text and graphics which can subsequently be typed to make them appear - in full colour - or integrated into programs. Requires DOS two or better, ANSI.SYS and is more fun with a colour monitor.

Trek is the best Star Trek game anyone has yet devised for the PC. The graphics are stunning, the complexity is intense and the action scoots along at warp nine as soon as the program gets going. Requires a colour card.

Crossword is a utility which translates text files from one application to another. It supports several popular word processors, including WordStar, WordStar 2000, Multimate, XYwrite, SideKick and standard ASCII. It saves ages worth of reformatting and does some useful things besides.

Only $19.95

Volume 15

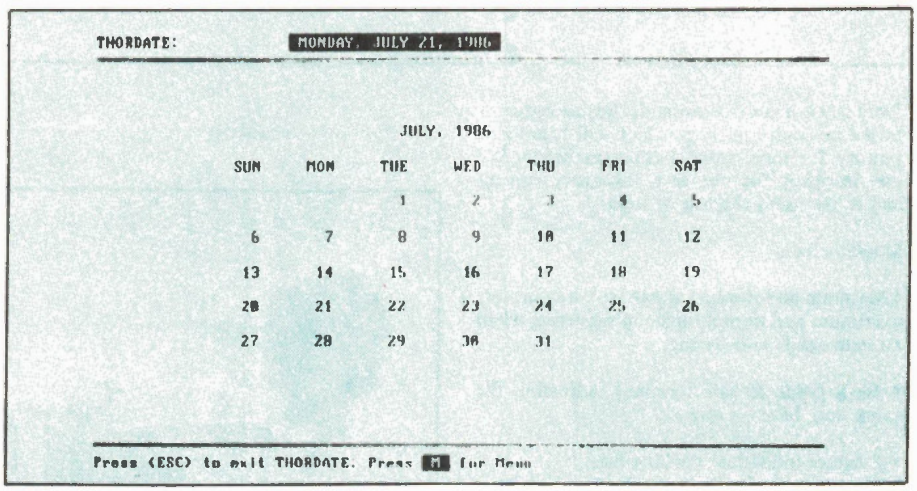
There is a lot of good stuff on this disk... but most important, there are two dynamite games herein. We could get into the graphics package, the CP/M emulator, the fractal program in C... however, it's the games that do it. Plan to lose at least a weekend over this one.

Altamira is one of the nicest public domain paint box programs available for the PC. Unlike most of the so called graphics packages available for the PC, this one isn't restricted to doing bar charts and graphs. It does first rate pictures. Requires a colour card.

Fractal is the source code for the fractal generator in C that we looked at in the August edition of Computing Now!. It's useful even if you don't like fractals, as it illustrates the use of high resolution graphics in C. Requires a C compiler and a colour card.

NEMON is a really weird game. You get stuck in the catacombs of king Nemon with nothing more than your wits and a flashlight. You have to find some keys, some treasures and, hopefully, a way around a host of arcade game nasties.

Thor used to be the god of thunder. Now he appears to be the world's most sophisticated desk calendar program. He'll remind you of appointments, keep track of your agenda and do things that would usually require a host of low tech objects, like pencils and note pads.



Round 42 is a wholly bizzarre variation on the theme of space invaders. No longer the dusty arcade game that it once was, this thing breaths new and rather ichorous life into the ceaseless battle between you and the phospore aliens. This is one of the best computer games in creation. Requires a colour graphic card.

V20 is a CP/M emulator for users of the NEC V20 chip. Replace your existing 8088 with a V20, score this little program and most CP/M software will run on your system as if someone had stolen half the bits out of your PC. Regular MS-DOS isn't affected. Requires a V20.

Only $19.95

MA.BAS The Micro Accountant is a complete, working accounting and check register program, with a 25K documentation file.

PCWNDW22 A "Sidekick"-like co-resident window utility. Pop-up window functions include ASCII table, stopwatch, alarm, printer setup utility and notepad. The entire program takes up less than 30K of space on your disk.

PSHIFT A time saving and convenient 'memory partition' utility. Lets you define up to nine memory areas. Load programs such as dBase II and WordStar into separate partitions and 'flip' between them instantly with simple keystrokes.

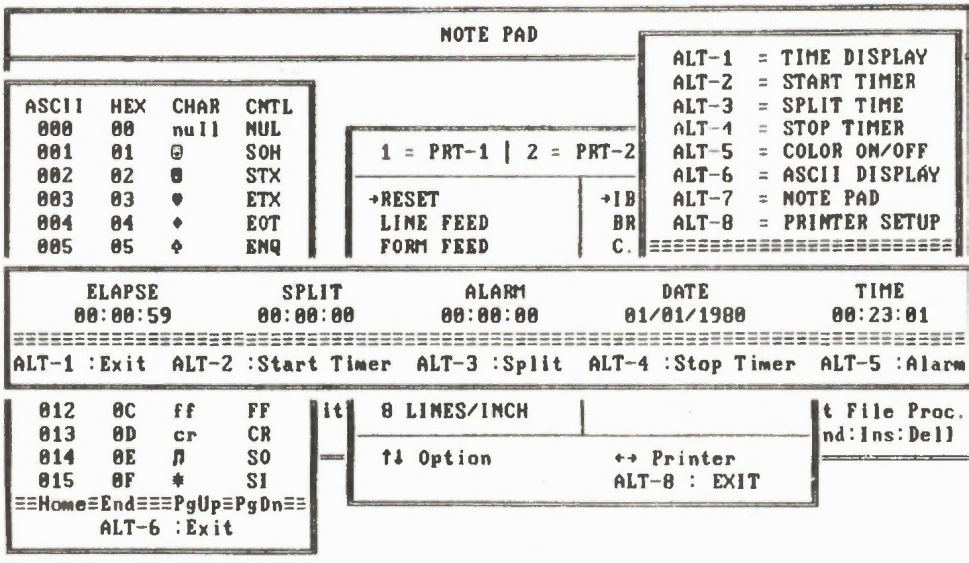
PC-TOUCH.BAS Increase typing speed and accuracy with this easy-to-use typing tutor. Also provides accuracy and speed statistics.

PCYEARBK.EXE Appointments and reminder program to help you keep track of your time.

TASKPLAN.BAS Project management software which lets you track up to 50 tasks over 50 time periods (days, weeks or months).

NOCOLOR A handy little utility for users with monochrome monitors and colour software.

MAXIT A simple but subtle game for two human opponents, or one player and the computer. Hours of fun!



PERTCHT A sophisticated project management tool using the Program Evaluation Review Technique (PERT).

PLUS More utilities to help organize maintain and copy your files, including a "monitor saving" program which blanks out your screen when it is not in use.

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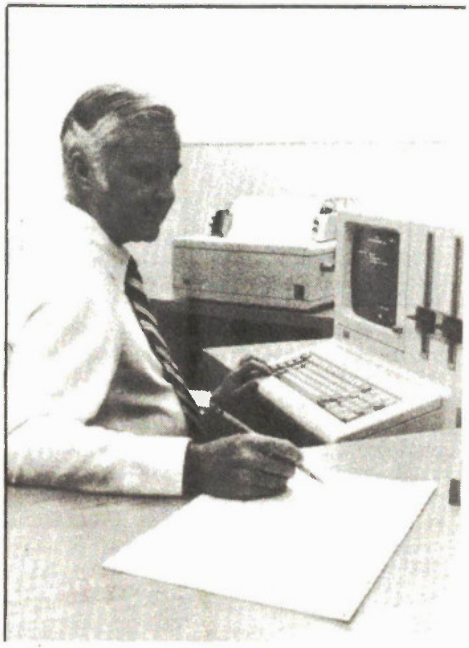
Stockboy Inventory

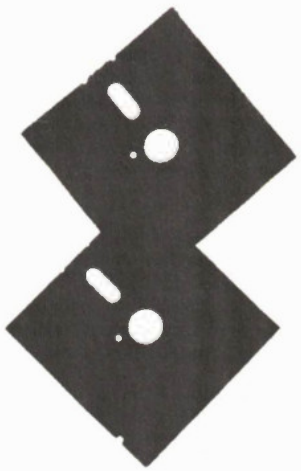
Stockboy is a good, powerful, flexible bargain-priced inventory package which will handle inventory for most small businesses needs. We use *Stockboy* for our own inventory control and it has stood the test of time.

Stockboy can:

- Maintain an inventory database with current, maximum and minimum stock reporting when an item needs re-ordering.
- Be a point of sale terminal, adjusting the stock data base on line.
- Produce individual packing lists.
- Generate a customer list to be used in mass mailings.
- Run on any CP/M or MS-DOS based computer, including Apple II systems with a Softcard.

Stockboy is written in Microsoft BASIC and is designed to be easily altered to suit your needs. It can be compiled using BASCOM if desired and is designed to be used by non-technical operators. Available for MS-DOS/PC-DOS and many CP/M systems.





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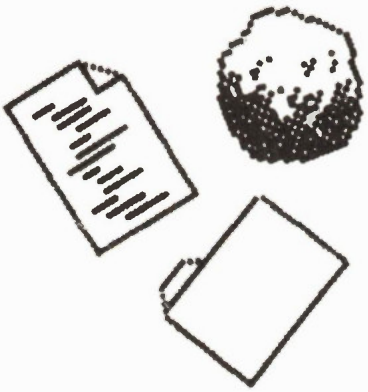
Volume 1

ASTEROIDS This is a splendid implementation of one of the most popular arcade games of all time. The graphics and sound effects are amazing.

RED RYDER Telecommunication on the Mac has never been this easy. RED RYDER includes XMODEM and Kermit protocols and many other features.

MacCLONE Many users have found the Mac's disk copy routine to be less than perfect. This is a vast improvement. It even defeats a number of copy protection schemes.



BINHEX is a utility for RED RYDER which converts applications files to binary files and back again to allow them to be transferred over phones lines.

LIFE is one of the classic computer programs, and this version is exceedingly well done.

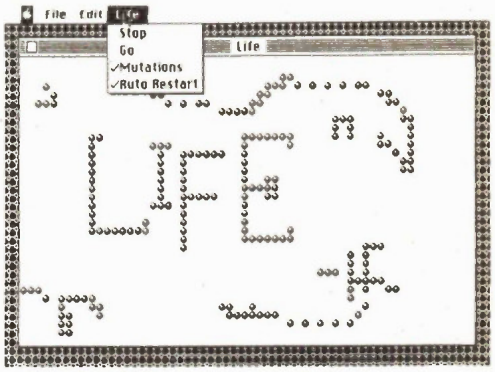
VIEW PAINT Ever wanted to look at a MacPaint drawing without getting into MacPAint. This utility lets you sneak peeks at your drawing files without fussing about.

RESOURCE EDITOR Macintosh icons and other resource items just cry out to be personalized. This little tool will help you make your Mac look its best for you.

SCREEN MAKER Moving text from MacWrite to MacPaint can be a bit disappointing... something gets lost in the clipboard. This utility helps your words make the trip unscathed.

FONT EDITOR For those longing to make their own fonts... and for those who just want to adjust the ones they have... this editor lets you shuffle fat bits to your heart's content.

MENU EDITOR A handy utility for editing the words in Macintosh application menus.



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Volume 2

FONT LIBRARIAN A splendid alternative to the Macintosh system font mover, this utility makes it easy to create custom collections of Macintosh fonts.

WIZARD'S FIRE This is a lively game which comes with still more lively games tucked away in the desk accessories. Get the magic rays before they get you!

SWITCHER Multitasking on a Mac? Why not. SWITCHER lets you run up to four applications concurrently on a 512K 'Fat Mac'.

RAMSTART Creates a RAM disk of any size on a fat MAc, and effectively increases the speed of most applications several times over.

MADONNA A MacPAint picture of the popular pop star.

MOCK CHART A desk accessory to handle the creation and printing of small business charts.

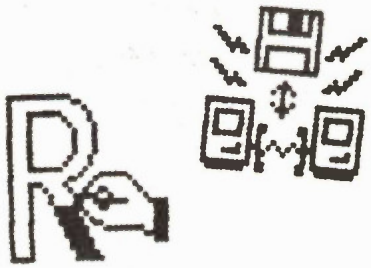
DAM A *D*esk *A*ccessory *M*anager for setting up the Apple menu on your Macintosh the way *you* want it.

MOCK TERMINAL A desk accessory for telecommunication functions from *within* another application.

HP CALC Add a simulated Hewlett-Packard calculator to your Mac.

REdit A slick resource editor. See the December 1985 issue of Computing Now! for an in depth look at this esoteric art form.

ORION This one is worth the price of the disk all by itself. It simulates a star ship cruising around the galaxy at the speed of light. Stars fly past like white lines on the highway ... with or without star names fluttering like celestial flags. The heavens are accurately mapped and the star ship handles like any other warp drive star Chevy.



Only $24.95

Volume 3

Icon Collector is a peculiar program that allows you to locate icons in applications and capture them to disk for use in other programs.

Billiard Parlor is worth the cost of this disk all by itself. It's an excellent simulation of a billiard table. It will play most of the usual variations of pool and billiards, and simulates the movement of the balls with unspeakable realism.

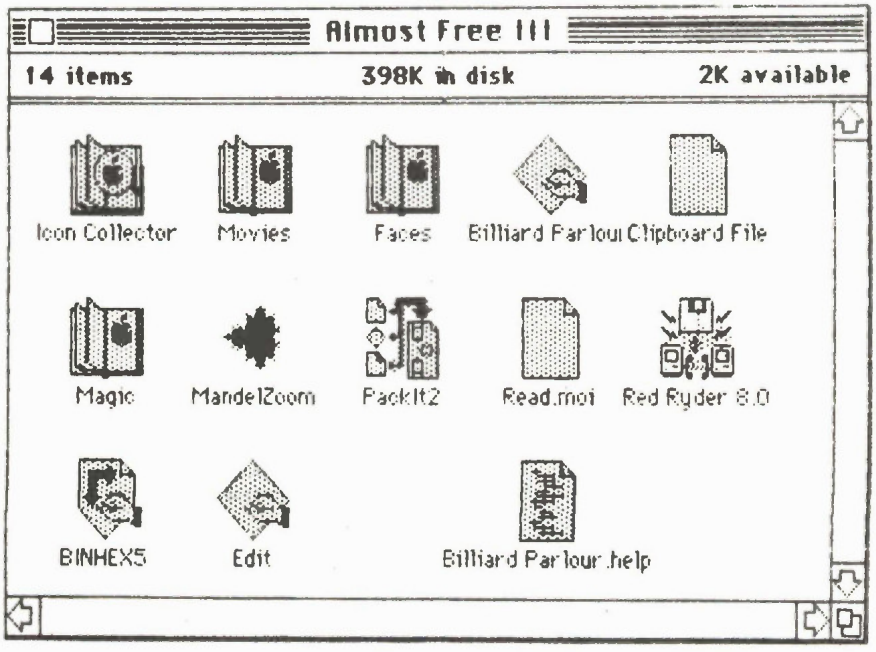
MandelZoom is the nicest Macintosh fractal generator we've come across. It's surprisingly fast, considering the nature of the Mac's floating point library.

Red Ryder This is the latest version of this popular communications program. It runs perfectly, giving you a sophisticated terminal with download facilities, macros and dozens of other features.

PackIt2 - not to be confused with PackIt - will compress and uncompress P2T libraries which have been downloaded from bulletin boards. An essential utility for telecommunications.

BINHEX5 is a file manipulation utility which allows Mac files to be sent over a modem.

Edit is the most sophisticated text editor available for the Mac. Operating similar to MacWrite, it allows you to edit documents in multiple windows. Ideal for program editing, Edit produces clean text files which can be compiled.



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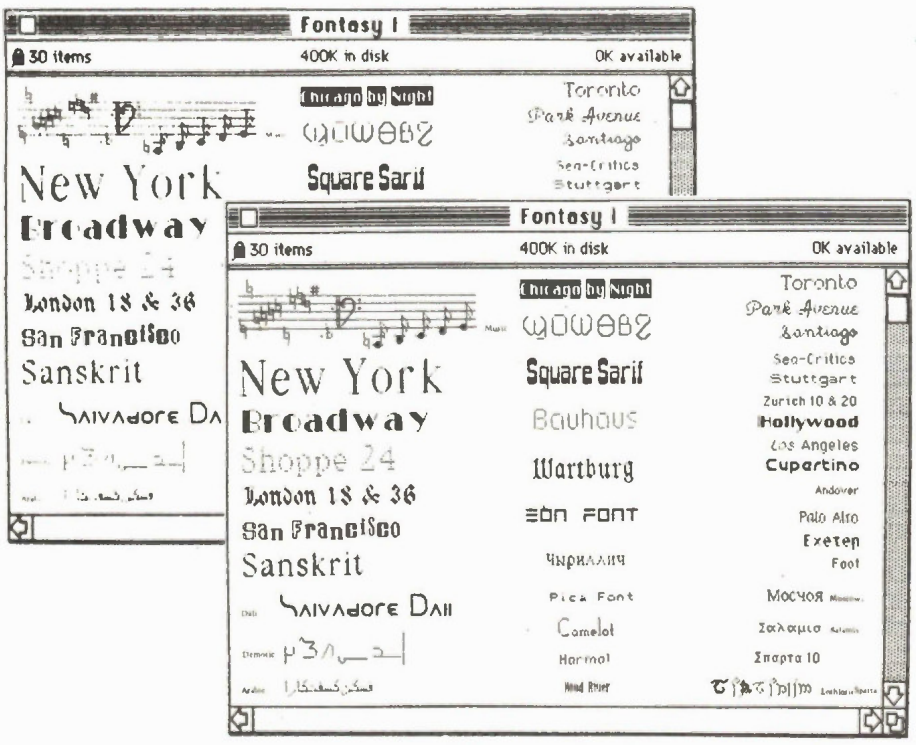
Volume 4

One of the most interesting aspects of the Macintosh is its ability to use software-based character sets. While there are a number of commercial font packages for the Mac, we feel that this collection of public domain fonts ranks among the best. This disk is filled - to the last byte -with thirty-eight unique fonts. We've selected a variety of body copy and display typefaces, spanning traditional and avant garde designs, along with a number of special purpose sets.

Bid fairwell to the placid exterior of Chicago, the mild amusement of Geneva, the unadventurous disposition of Athens and plug your Mac into this typesetter's pipe dream.

A powerful font librarian is also included to assist in adding the fonts you want to your system.



Only $24.95

Volume 1

MODEM 7 Allows you to communicate with any CP/M-based system to download and upload files. Complete details for this program first appeared in the November 1983 issue of Computing Now!

PACMAN You really can play PACMAN without graphics... and it works pretty fast.

FORTH An up-to-date version of FIG FORTH, complete with its own internal DOS.

DUU The ultimate disk utility, DUU lets you recover accidentally erased files, fix corrupted files, and modify the system.

D A sorted directory program that tells you how big your files are and how much space is left on the disk.

USQ/SQ Lets you compress and un-compress files. You can pack about 40 more data on a disk with this system.

FINANCE A fairly sophisticated financial package written in Microsoft BASIC.

BADLIM Ever had to throw out a disk with a single bad sector? BADLIM isolates bad sectors and allocates them to an invisible file, making the rest of the disk useable.

DISK Allows you to COPY, MOVE, DELETE and VIEW files with a simple command structure.

QUEST Similar to "Dungeons and Dragons", QUEST provides hours of glorious adventure.

STOCKS A complete stock management program written in BASIC.

SEE Also known as TYPE17, this utility will TYPE any file, compressed or not, allowing you read documents which are stored in a compressed form.

Only $19.95

Call or write for available formats.

Volume 2

BISHOW is the ultimate file typer. This version will type squeezed or un-squeezed files and allow you to type files which have been archived with utilities such as LU (see below). BISHOW even lets you scroll up and down through typed files.

LU is a library utility which stores multiple files under a single file name in order to save disk space. Files can be removed from the library as they are needed.

MORTGAGE is a fancy mortgage amortization program which produces a variety of useful tables.

NBASIC Large, commercial BASIC's are powerful, but expensive. This one however is free, and every bit as flexible as many commercial packages. It's also compatible with North Star BASIC.

Z80ASM is a complete assembler package which uses true Zilog Z80 mnemonics. It has a rich vocabulary of pseudo-ops, permitting you to use features of your Z80-based machine which are unavailable with ASM or MAC.

VFILE Easily the ultimate disk utility, VFILE gives you a full screen view of the files on your disk and allows you to do mass COPY and DELETE operations using a two-dimensional cursor. It has lots of 'extras', a built-in help file and it's fast.

ROMAN Though some say it's silly, this novel little program is a fun way to convert ROMAN numerals into decimal numbers.

CATCHUM If you like the fast pace and incredible realism of Pacman, you'll go quietly insane over CATCHUM... which plays basically the same game using ASCII characters. Watch little "C"'s gobble periods, while you try to avoid the delay "A"'s.

Only $19.95 each or $39.95 for all 3

Call or write for available formats.

Volume 3

OIL An interesting simulation of the working of the oil industry. It can be approached either as a game or as a fairly sophisticated model.

CHESS This program really does play a mean game of chess. It has an on-screen display of the board, a choice of colours and selectable levels of play.

DEBUG The DDT debugger is good, but this utility adds many new facilities, including symbolic debugging. It's almost like being able to step, trace and disassemble through a source listing.

DU87 This version overcomes several limitations of the older DUU program and adds some new features. It will adapt to any system and can search, map and dump disk sectors or files. Its invaluable in recovering damaged files too.

ELIZA Written in MBASIC, this classic program is a microcomputer analyst. With a little imagination you will be able to believe you are conversing with a real psychiatrist.

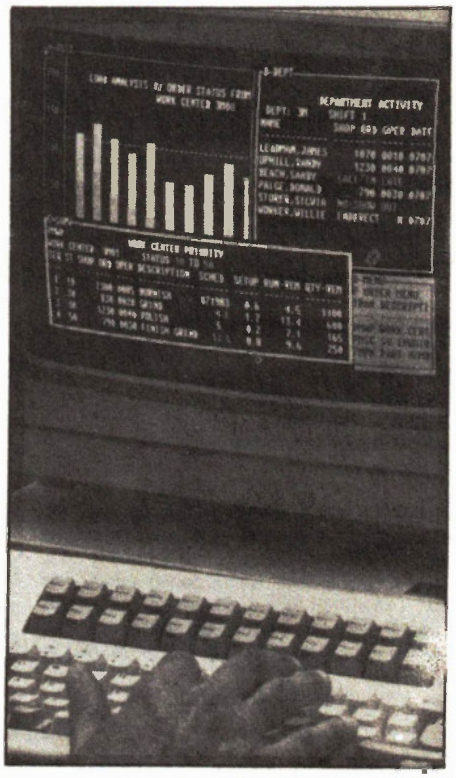
LADDER Fast, bizarre and probably a major cause of eye strain. This program plays like Donkey Kong with ASCII characters.

QUIKKEY Programmable function keys let you hit one key to issue a multi-character command. This tiny utility lets you define as many "macros" as you want, with seldom used control codes. Keys can be redefined at any time... even from within another program.

RESOURCE While a debugger will enable you to disassemble small bits of code easily enough, only a true text based disassembler can take a .COM file and make source out of it again. This is one of the best ones available.

Only $19.95

Call or write for available formats.



A Teacher for the Apple

Specifically developed for the educational market, this disk introduces both teachers and students to the Apple II series and compatible systems.

It is designed to show you how to make the computer work for *you*.

After introducing you to the computer, it goes on to explain the BASIC programming language. With step-by-step instructions it shows you the ins-and-outs of Apple programming and explains the workings of DOS and high resolution graphics.

Designed for new computer users, just turn on the computer, slide in disk, and enter the world of Apple programming.

Requires Applesoft BASIC, 48K RAM and one disk drive.

Only $19.95

Almost Free Electronics Design.

Contains BASIC utilities for attenuators, highpass and lowpass filters, series and parallel resistors, slew rate prediction, resonant circuits, power transformer selection, audio transformer selection, RMS-average-peak conversions for full and half-wave, transistor selection, and more. Also contains a program for determining the parameters of strobe light circuits; it determines power ratings, time constants, capacitor size, resistor sizes, operating voltages, dissipation and other necessary calculations. Written by Bill Markwick, the editor of Electronics Today, the utilities are not copy-protected and are easily modified to suit the user's requirements.

Available for MS/PC DOS with GWBASIC or Apple II systems with Applesoft BASIC.

Only $19.95

Steve's Wunderdisk

Over the years many first rate program listings have graced the pages of Computing Now!. And we have many which have never been published. We've collected the best of these and put them on one disk. Included are programs like STAR, for setting up a Gemini 10 printer, the Last WordStar Unhook, CPMAP and the CP/M HOST program, complete with several unreleased support programs.

The Wunderdisk is an excellent collection of tricky CP/M routines. It's deal for anyone who wants to make their CP/M system sing! And the programs on the disk are well documented... most of them have been explored and explained in the pages of Computing Now!

Only $19.95

MDM730 for Apple CP/M

First featured in the July 1984 issue of Computing Now!, MDM730 is one of the most powerful MODEM7 programs available. Our version incorporates features not available in the public domain. MDM730 is an efficient, easy-to-use software tool for anyone interested in telecommunications, bulletin boards and downloading software. Consider these features:

- Terminal program which works at any baud rate.
- Ten programmable macro function keys.
- A Phone number library for 36 numbers.
- Christensen software transfer protocol.
- User selectable toggles for linefeeds, ON-XOFF, etc.
- Extensive help menus.
- Baud rate selection on the fly.
- ASCII dump and capture.
- Status menu.

In addition, we've added dialing support for the Apple version. While the standard MDM730 can not dial unless it's hooked to a Hayes Smartmodem, we've added patches to allow it to do pin twenty-five pulse dialing and to dial through the Hayes Micromodem II and the SSM card. The Computing Now MDM730 will also:

- Select a number form the library and dial it.
- Dial manually entered numbers.
- Log you on to a remote system if it's free.
- Optionally autodial if the remote system is busy.
- Keep track of the number of re-dial attempts.

The Computing Now! MDM730 package is available for:

- The Hayes Micromodem II card.
- The SSM 300 Baud modem card.
- The PDA 232C serial card with external modem.

The PDA 232C package includes versions supporting both the Smartmodem and a dumb modem with pin twenty-five control, such as the Novation AutoCat.

Each package also includes utilities for updating the phone number library and redefining the function key macro strings, as well as an extensive help file.

The source code for this program is over one hundred and fifty kilobytes long and can not be hacked on a standard Apple system. We patched it on a larger machine and downloaded it. We're confident you won't find MDM730 with these features anywhere else.

Only $19.95

Available for Apple II series and compatibles with CP/M

THE BOOK OF

Computer Music

MIDI may be the most significant advance in music technology since the discovery of sound. However, if you can't understand what it's capable of... or can't comprehend the cacaphony of manufacturers' claims that surround it... it might as well have been a new revolution in food processors.

We understand MIDI better than anyone. We're comfortable with both the computers in all their confusing technological glory and with the music that makes them all worth while. If you read the **Book of Computer Music** you'll understand MIDI too.

And you'll realize that it's as magnificent a trip as everyone says it is.

Whether you're an amature musician with a cassette deck and a keyboard, a working performer or a studio artist, the **Book of Computer Music** will turn you onto MIDI as no other reference work can. By the time you hit the back cover you'll be wholly comfortable with system exclusives, tracks, MIDI messages, FM synthesis, through boxes and all the other mystifying technological mind games that accompany this powerful new musical instrument.

You'll be able to play MIDI as easily as you play keyboards for guitar... or flute or violin or percussion or nose harp... right now.

Included in the **Book of Computer Music** are articles about

The Yamaha DX-7 • The IVL Pitch Rider • Personal Composer • The Yamaha RX-21 • Total Music for the Macintosh • The Yamaha CX5M Music Computer • The Akai AX-60 • The Roland GR Instruments • Computers Fopr Musicians • The Roland SDE 2500 MIDI effects system • The Yamaha DX-100 • The Nexus FM Drawing Board • The Akai S612 Sampler • Building a MIDI Through Box • The Roland Alpha Juno • DX-7 Voice Editing • Writing Your Own MIDI Software.

Plus a complete introduction to MIDI in a number of in depth, easy to understand articles that won't leave you feeling like your head got lost in the Twilight Zone.

Almost Free DX7 Voices

for the IBM PC

The Yamaha DX-7 is one of the most powerful MIDI equipped synthesizers on the planet. One of the things that makes it so unspeakably slick is its capacity for having its preset voices loaded through the MIDI port. You can store banks of voices on disks and send them to the DX-7 almost instantly when you want them.

While there are numerous DX-7 voice librarians available, many replete with pots of voices to use, these things are nasty and expensive and very often fairly complex to operate when all you really want to do is to port voices. As such, in the tradition of almost free software, we've assembled a collection of almost free DX-7 voices. This includes a whole disk full of voice libraries and a really snappy little utility to send them over to the DX-7.

If the voices that came with your DX-7 blew you away, these libraries will send your brain into several other higher order dimensions at once. They range from the most sublime recreations of acoustic instruments to freaky, bizarre effects certain to be overused at least once. We've assembled them into performance groups to make them immediately useful, and made them compatible with the DX-Archive voice librarian software to make them easy to re-organize if you want to. The DX-Archive program is available separately... check out the details below.

There are libraries on the disk of percussive effects, woodwinds, a whole set of pianos, heavy metal noises, string and brass sections, funk collections, baroque collections, rock collections, jazz collections and a few collections that defy description. There are enough voices here to keep your DX-7 confused for your lifetime and that of your immediate descendants.

The DX-Archive voice librarian software is available separately for $39.95 from XLelectronix Computer Music Centre, 317 College Street, Toronto, Ontario M5T 1S2. It provides complete voice bank transfer facilities plus a convenient method for re-organizing the voices in multiple libraries.

Fine Print: These voices have been designed for the Yamaha DX-7 synthesizer. While they will probably work on other, similar Yamaha instruments, they have not been tested on anything other than the DX-7. Instruments with synthesizers having fewer operators, such as the DX-9, may experience sonic peculiarities in using some of these voices.

The use of this collection presupposes the availability of an IBM PC or compatible computer, DOS 2 or higher and a Roland MPU-401 MIDI interface.

Moorshead Publications warrants that these voices will be readable when you get them. The post office, however, may have ideas of its own. If your disk doesn't function properly when you receive it please contact us for a prompt replacement.

Buy the best of both worlds: for just $22.95

Get the Book of Computer Music **AND** the Almost Free DX7 Voices disk for only $22.95.

The Book of Computer Music is available separately for $4.95. The Almost Free DX7 Voices disk is available for $19.95.

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There was a time when shopping for computer supplies and accessories meant a lot of calling around. It took one supplier for computer furniture, another for cables or modems, and still others to handle computerized forms, printer labels, ribbons or diskettes.

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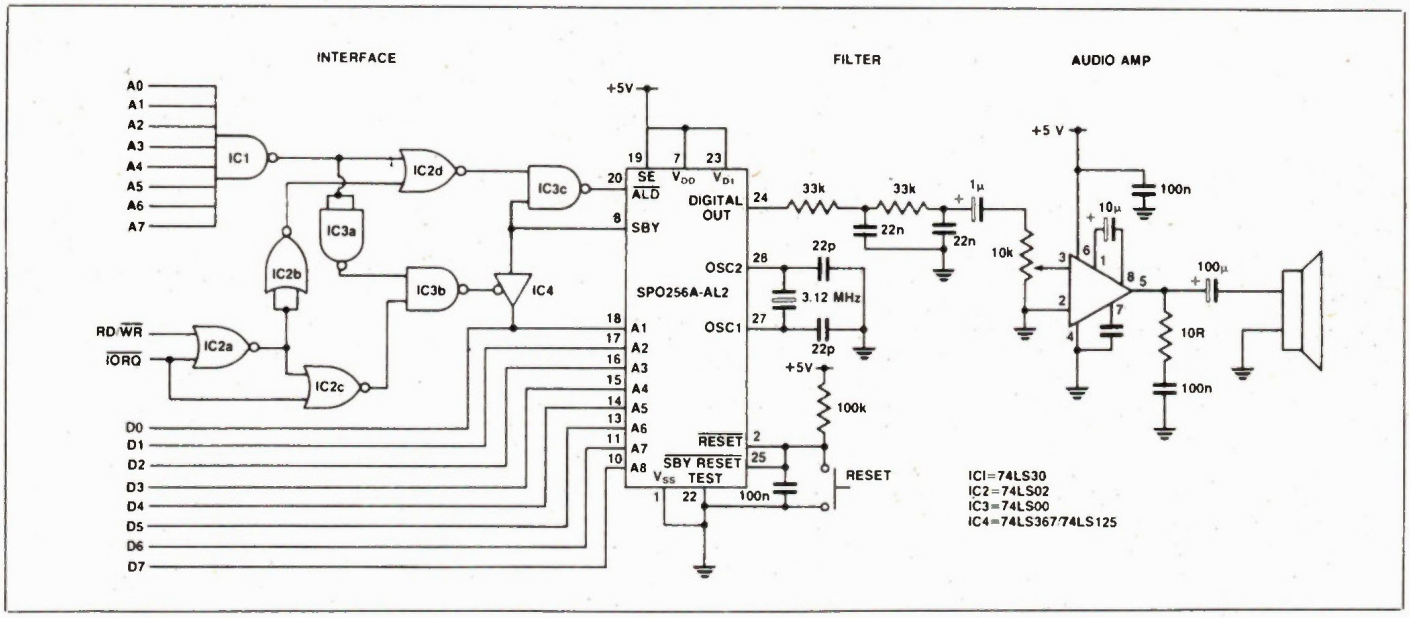


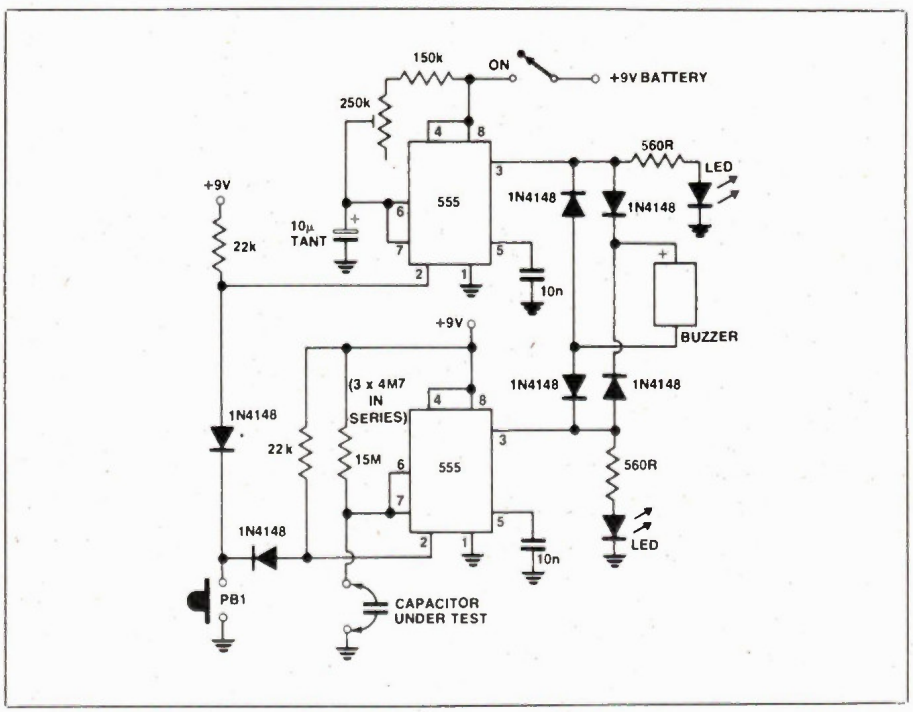
Speech Processor

By Matthew Bennets

THE FOLLOWING circuit could be adapted to any computer where you can control seven address and seven data lines, plus two control lines.

The centerpiece of the circuit is the popular SPO256A AL2 monolithic speech processor. The interface circuitry is designed such that an address of FFH is required on the port, with R/W and IORQ both logic '0' in order to access it. SDY (active low) is only active when speech is being output from pin 24. To input data into the chip the ALD pin must be active.

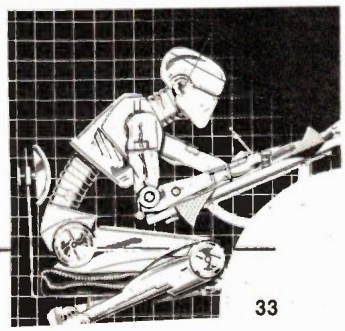
Output from the chip is taken from pin 24 to a low pass filter that removes the high frequency components from the output. It is then sent to an amplifier built around a suitable op-amp.

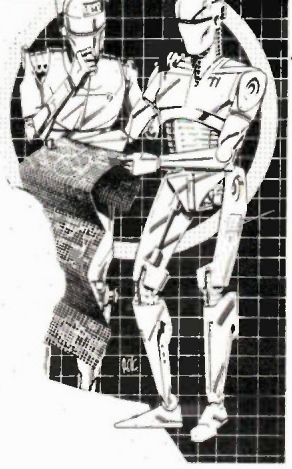


Capacitance Tester

By A. Glover

LOW COST and simplicity are the keys to this circuit which works by comparing the value of a known capacitor with one under test. The amount of time the voltage on pin 3 of the 555 is high, is proportional to the value of the capacitance hanging off pins 6 and 7. When the two capacitors are of the same value the LEDs will be on for the same length of time and buzzer will not sound. Any discrepancy in value will result in one LED being on for longer than the other and the buzzer will sound.





Lapsed Timer

By Lewis Dixon

LAPSED TIME photography has been made relatively easy in recent years with the readily available auto-wind 35mm camera. The only trouble is that commercial lapsed timers are very expensive.

With this in mind, a simple, inexpensive lapsed timer was devised around the XR2240 programmable timer/counter.

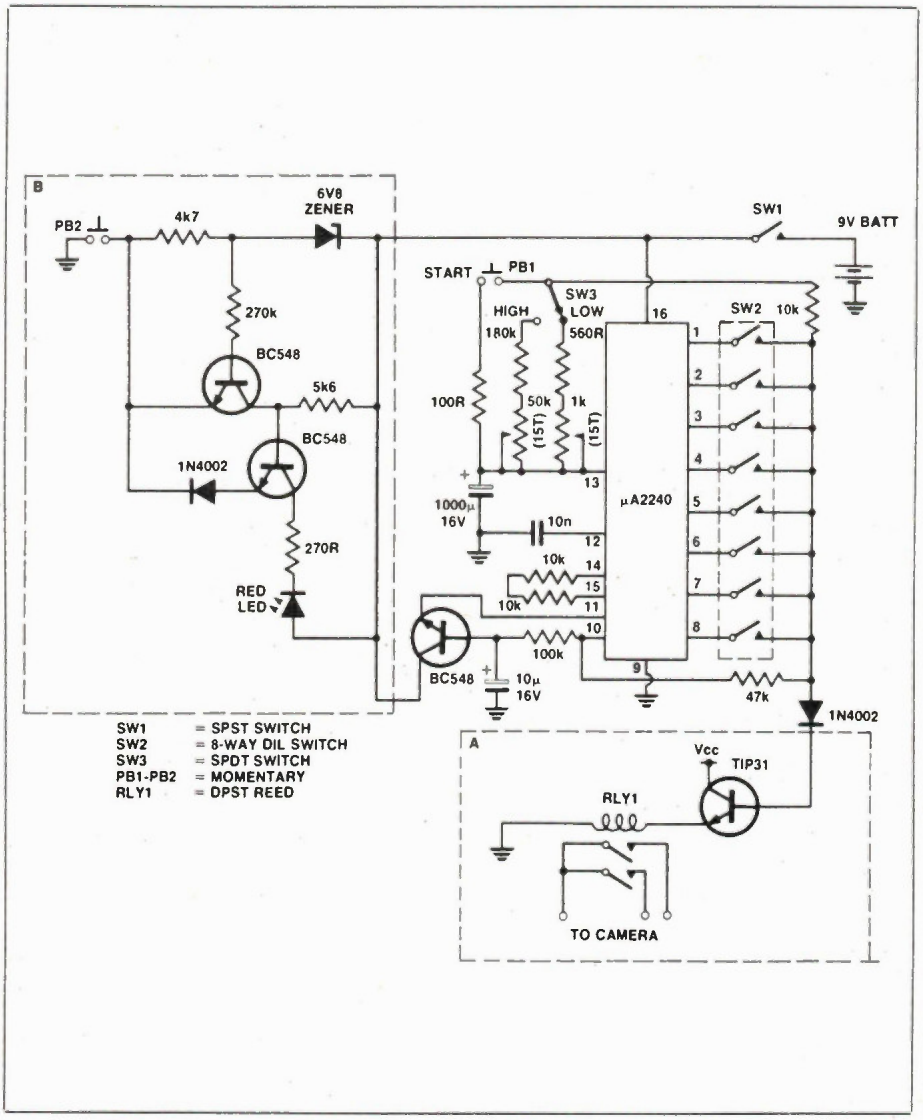
The external resistors and capacitor at pin 13 use 15 turn variable resistors for fine adjustment. Low gives 1 second at output 1, high gives 4 minutes. The binary output is wired to provide a wired-or function. The combined output will be low as long as any one of the outputs is low.

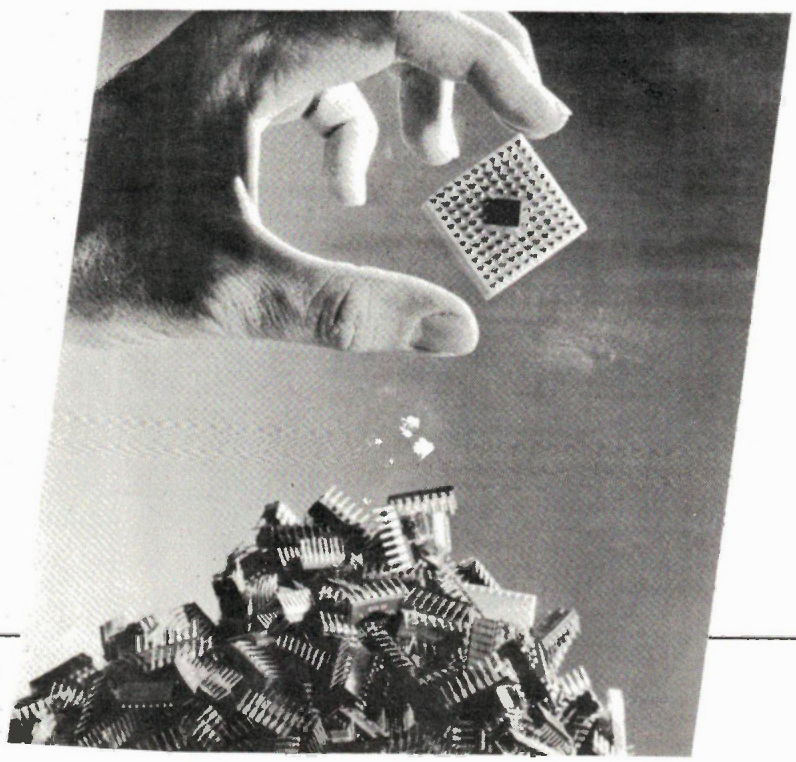
When switched to low, one can have exposures from 1 second to 4 minutes-15 seconds, at 1 second intervals; when set to high, 4 minutes to 17 hours in 4 minute intervals.

The XR2240 is used in its monostable application and is activated by pressing the start button, SW2, switching on SW1, and immediately releasing SW2. This will allow the camera to fire once only and to start the IC counting (output low). At the end of the selected time the camera will fire again as the output goes high, putting a high on the reset, pin 10, while the trigger, pin 11, is momentarily held low by R9, C3, and Q3. The camera will therefore repeatedly fire at the fixed interval until switched off.

Section A is the camera firing mechanism for a Konica camera, the double reed switch being the most convenient. Other types of cameras may require other types of relays depending on whether three or two leads are used. Power to fire the camera is supplied by the camera's own batteries, and only the connection of two, three or four leads is required to make an exposure.

Power for the circuit is from a 9V battery; section B is a simple battery tester.





Flasher

By M. Howe

THIS CIRCUIT is a variation on the common LED flasher theme in which the amount of light available in a room etc. controls the flasher. It could be set up in a darkroom situation to indicate whether or not it is safe to enter.

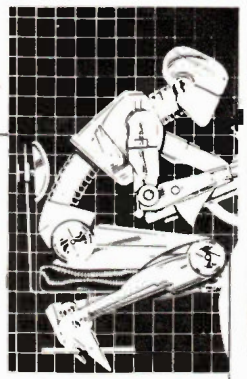
In a lit room situation, RV2 is adjusted to keep voltage at pins 2 and 6 of IC1 just below 2/3 Vcc. When the lights are turned dimmed or turned off, the resistance across the LDR increases until pin 6 sees 2/3 rail voltage and the 555 begins to operate flashing the light via Q1.

When the lights are turned on the opposite occurs and C1 is effectively shorted out, stopping the 555.

The prototype, using a 6V battery, flashes every 1 to 2 seconds. Current consumption in a "lights on" situation is about 2.4mA. Operating current depends on the type of bulb used. When the lights are on, RV2 holds pins 2 and 6 at 3.8V.

Any suitable PNP, high power, 80 VCE ' 3A transistor should do fine for Q1. The LDR can be any garden variety type providing that voltage ratings are taken into consideration.

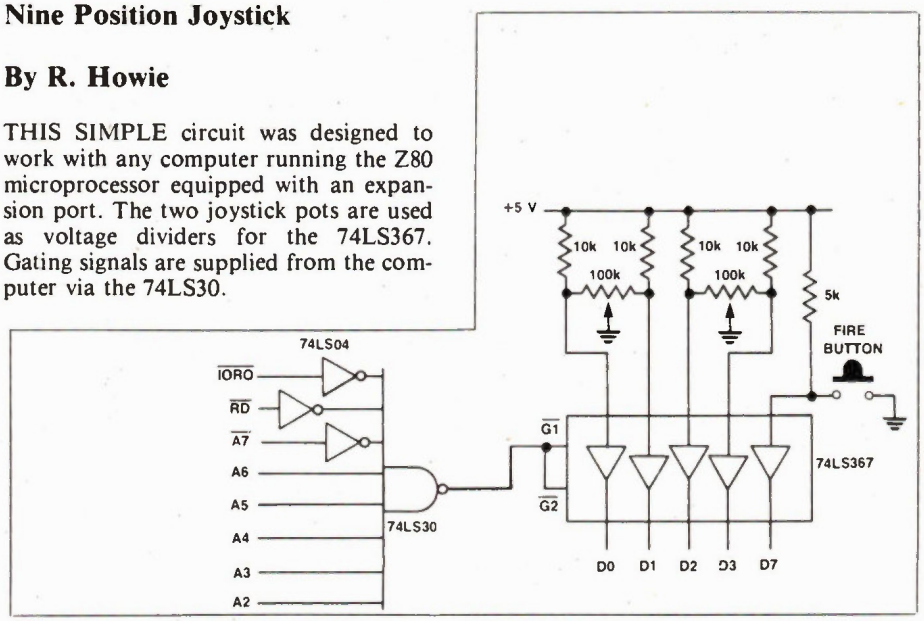
All components except the LDR and the light-bulb will fit on a PC board only 25mm square. The LDR is not affected by the operation of the light-bulb and they may be mounted side by side.



Nine Position Joystick

By R. Howie

THIS SIMPLE circuit was designed to work with any computer running the Z80 microprocessor equipped with an expansion port. The two joystick pots are used as voltage dividers for the 74LS367. Gating signals are supplied from the computer via the 74LS30.



Continued on page 44

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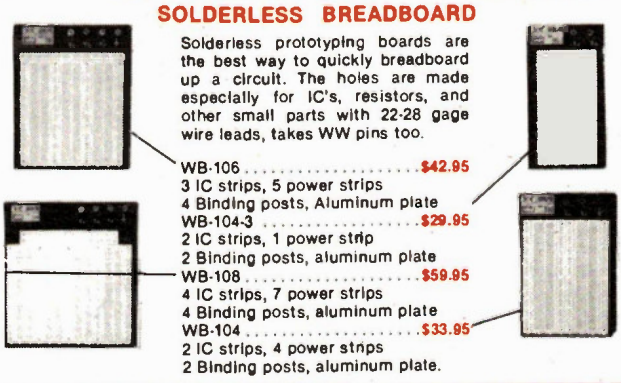

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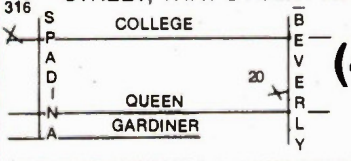

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Marine Security Alarm

An expandable safety and security system for your boat, houseboat, or cruiser.

BY Harold Wright

THE PROJECT described here is an inexpensive, easily built and expandable safety and security system for boats. It will warn the operator of abnormal engine conditions such as coolant overheating, blocking of water flow to the engine, high oil temperature and other engine hazards. It serves as a warning center for smoke, fire, fumes or a leaking hull; it also doubles as a standby security system whether the owner is on board or away from the boat.

Circuitry for the Central Control Unit (CCU) is simple using the familiar 339 comparator and a few inexpensive transistors and resistors. It can be built with as few or as many sensor inputs as are needed. It therefore suits the smallest power boat to the largest cruiser. **Fig. 1** is a block diagram of the system, showing only one sensor input channel and the common display and warning blocks.

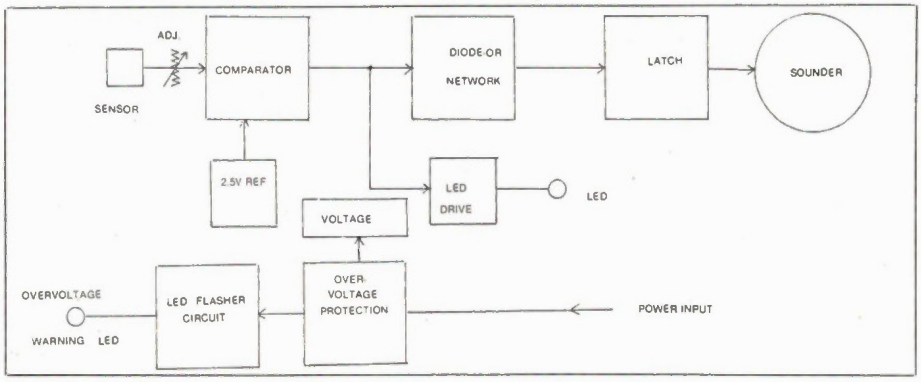


Fig. 1 Block functional diagram.

How It Works

Sensors throughout the boat monitor various functions and conditions and provide output voltages in the positive going direction. These are adjusted to their critical value and applied to the non-inverting inputs of LM339 quad comparators. If a dangerous condition develops, as detected by one of the sensors, the output voltage rises high enough to exceed the comparator reference voltage, turning the comparator on. The resulting high at the comparator output lights an LED indicator and latches an SCR to drive an audible warning.

Fig. 2 shows the schematic diagram for the CCU. Eight inputs are shown wired and the basic board can accommodate a total of twelve inputs. Addition of a second board allows the system to handle up to twenty-four inputs in multiples of four. In a large cruiser the number of inputs can easily reach and even exceed twenty-four. We will follow the operation through input Channel 1.

Input voltage from the sensor is applied to R2, a 50K multiturn trimmer. This provides fine adjustment of the trip point because all the sensors will not necessarily provide the same output voltage to indicate a dangerous condition. The adjusted voltage from R2 is connected through R10 to pin 5 of comparator IC1. The inverting input (Pin 4) is connected to IC3, an LM336Z, 2.5 volt stable reference; this integrated circuit behaves much like a zener diode. IC3 provides a common reference for all the comparators. The Channel 1 comparator turns on Q9 through diode D10. Diode D10 is part of a diode-OR circuit connected to all the comparator outputs. When Q9 turns on, its emitter goes high, turning on SCR1 which in turn drives the warning sounder. Each comparator also drives a transistor (Q2 for Channel 1) to provide an interface for the channel LED indicator. The diode-OR network is a simple way to tie all the comparator outputs to the base of Q9 and has the advantage of allowing infinite expansion without complications.

Switch S2 gives a choice of alarms. Either a Sonalert or similar sounder at the Captain's berth, at the CCU or both, or a heavy duty relay to drive a loud siren or klaxon. Ry 2 is mounted off the circuit board and must be equipped with a diode across the coil to protect the electronics from the back EMF generated when the re-setting of the SCR interrupts the relay coil current abruptly. The normally-closed push button switch S3 is the re-set button for both modes of operation.

Because most of the comparator input voltages will be slow-rising, feedback is used to provide hysteresis or 'snap' action during turn-on. This avoids oscillations that may occur with slow-rising input voltages. For Channel 1 the feedback resistor is R18 and R25 is the pull-up resistor. When a sensor output trips a comparator, one LED lights to show where the emergency exists. At the same time SCR 1 is latched, sounding the alarm.

The voltage input to the CCU from the battery/alternator system can vary from 12.6 volts to as high as 14.5. To take these variables into account, the CCU and the sensor circuitry are powered through IC4, a standard three terminal adjustable 1.5 amp voltage regulator. R60 and R61 are 5% resistors in parallel to provide close to the required resistance of 1680 ohms. This will set the output very close to 10 volts. The regulator will hold to this voltage whether the engine is running or stopped.

IC6 is a protective device to shut down the system and initiate an alarm should the regulator fail, allowing the alternator to run wild. IC6 has an adjustable trip point set by R57, and should be set to trip at 16 volts. The protective system is also a warning of alternator/battery trouble that could cook the battery plates or damage other electronic equipment that might be installed in the boat. A runaway alternator can generate voltages as high as 22 volts.

If IC6 trips, pin 8 goes high, turning on SCR 1. This energizes Ry 1, breaking the power input line to the CCU. The second relay contact closes supplying power to the LM3909 flasher IC. This IC flashes a red LED on the front panel to warn the operator that the protective system is disabled and that a problem exists in the engine room. C1 delays the trip point slightly to prevent false alarms caused by transients. The GE-MOV varistor across the power input line assists by absorbing many of the transients. The varistor is desirable even if the protective IC were not used, because transients can cause false triggering of the SCRs. Automobile and boat engine electrical systems are notorious generators of transients. After the system is installed and there are still too many false alarms, it is usually an indication that your boat's electric system is in need of a tune-up or overhaul. If a tune-up does not overcome the problem, the value of C1 may need to be increased. In the prototype a value of 0.01 uF was used to give a delay of 0.10 ms. Increasing this capacitor to 0.10 uF would produce a delay of 1.0 millisecond. Other values and delay times can be extrapolated between these two. Switch S4 is the normally closed push button for re-setting SCR1.

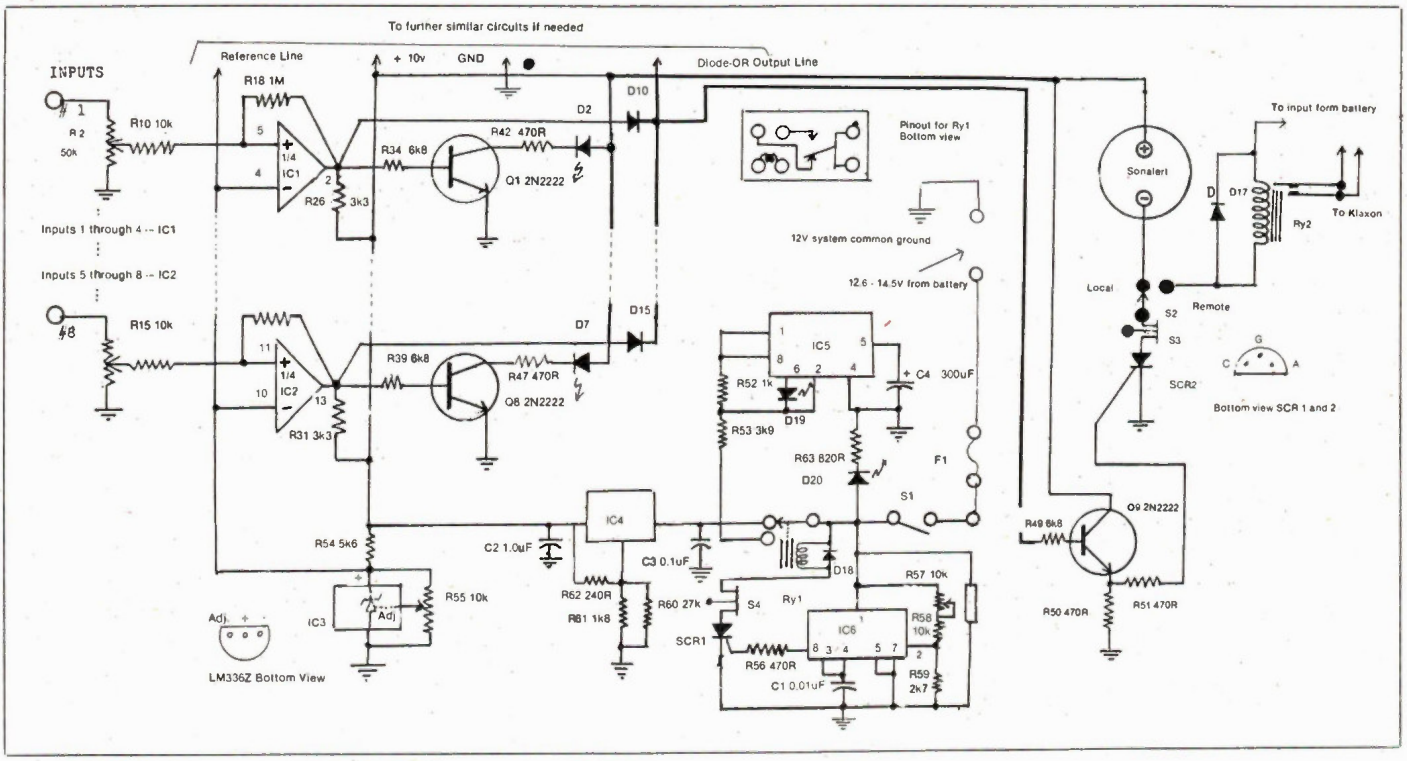
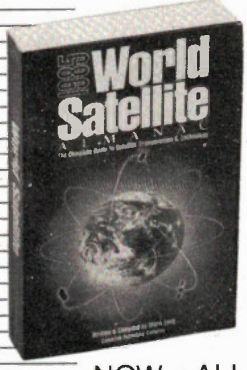


Fig. 2 Schematic diagram of the CCU.



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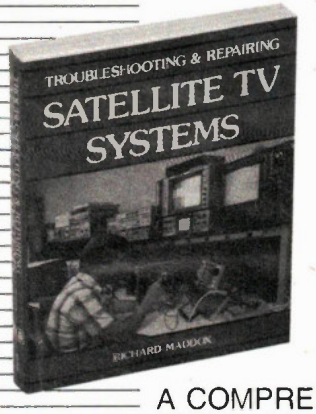

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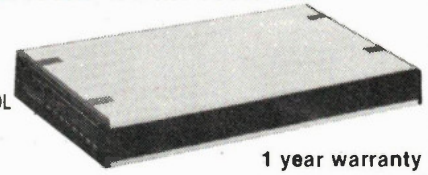

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Circle No. 26 on Reader Service Card

Construction

Construction is simple. The entire circuit, apart from the Sonalert, switches, fuse and LEDs will fit on a 4.5' x 6.5' perforated board with 0.10' hole spacing. **Fig. 3** is a diagram for wiring the circuit with the Bishop Graphics E-Z System of copper tapes and patterns. This is easily converted into a pattern for a chemically produced printed circuit if you are equipped for that method. **Fig. 4** shows the component placement. **Fig. 5** is a photograph of the prototype CCU wired for twelve inputs. If more than twelve are contemplated, make two of these circuit boards, using only the comparator and interface part of the first board. There will be no need to duplicate the SCR and protective circuitry. The positive 10 volt supply bus, the common ground bus, the diode-OR bus and the 2.5 volt reference can all be tied to their counterparts on the first board with short lengths of stranded, insulated hook-up wire.

All switches, the labelled row of LED indicators, the fuse, power pilot light and one Sonalert are mounted on the front panel. Radio Shack Cat. No. 270-274 cabinet will hold the basic CCU board and a similar board to hold the sensor circuitry. There are no bulky transformers or power supply capacitors to take up space in this system. **Fig. 6** is a suggested panel layout. If a second CCU and sensor board are needed, then a larger cabinet would be required. The boards can be stacked above each other on the cabinet base using short sleeve spacers and 4/40 bolts. Space for Ry-2 should be easy to find inside the helm box of the boat.

Take the usual precautions during assembly. Use heat sinks when soldering ICs, transistors, diodes and SCRs. The small pointed clip-on heat sinks (Hunter - Electrosonic - Cat.63506) are the best. Install staking pins at all points where flex leads must leave the board. Use barrier type screw terminals on the rear panel for connections to sensors, power and alarm circuits.

Support the leads of the LM317T regulator with needle nose pliers next to the body of the IC and using a second pair of pliers, bend the leads at right angles so that the regulator lies flat on the board. There is not room on this board for a commercial heat sink for the regulator so make a small one the width of the regulator body and bend it up and over in a box shape. It goes between the IC and the board. A touch of heat sink compound on the back of the IC will make a more efficient heat sink. Bolt it firmly in place. Finally, install Ry-1.

Checking and Calibration

Using clip leads or temporarily connected flex wires, connect the ground and main power input to a bench power supply set at 13.5 volts. With a voltmeter, check the

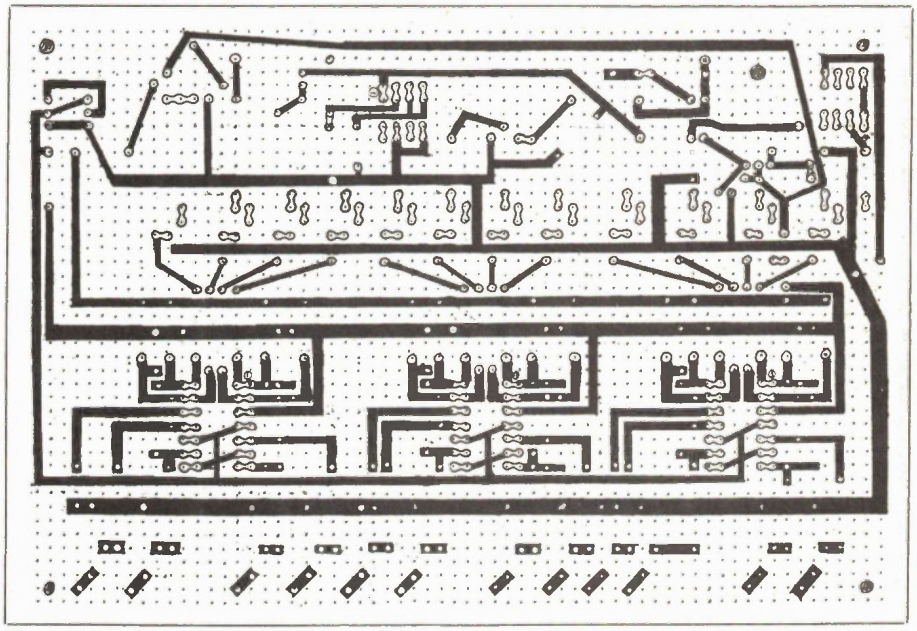


Fig. 3 Circuit layout for copper tape and pattern method of producing a printed circuit.

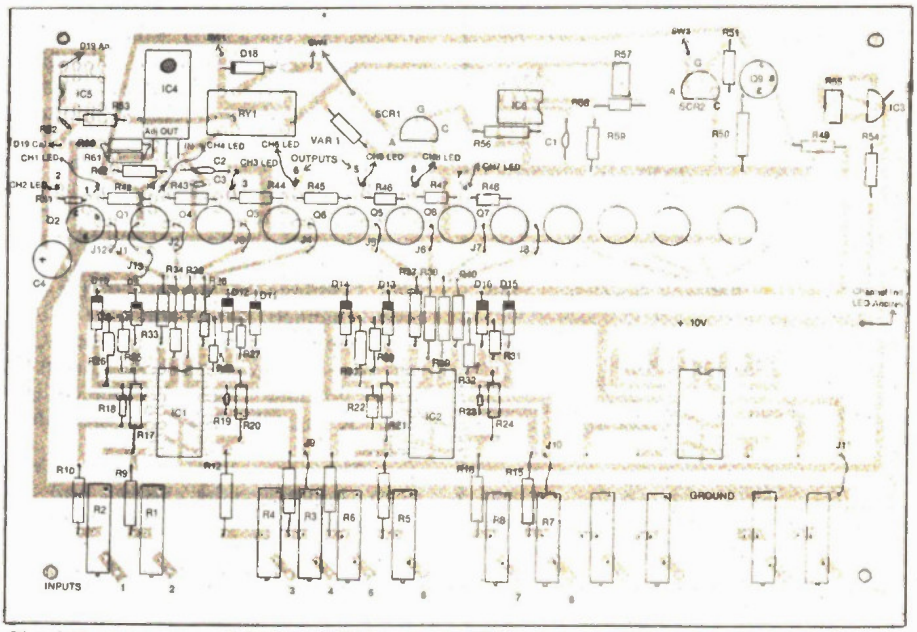


Fig. 4 Component placement diagram.

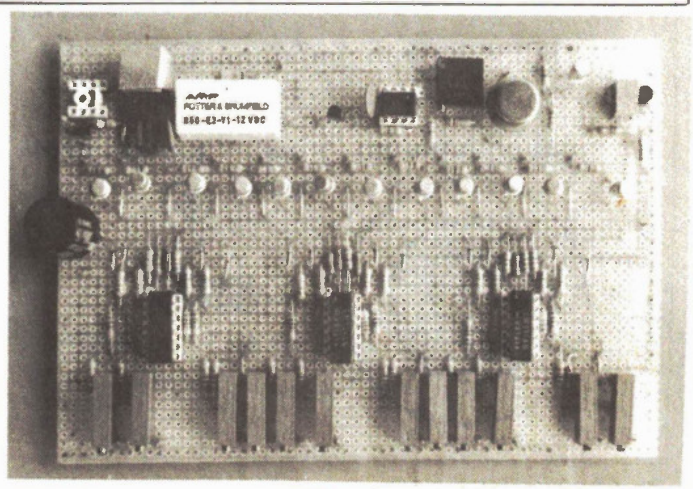


Fig. 5 Photograph of a finished prototype CCU board.

Parts

Resistors

R1 - R8 ..... 50k trimpots
R9 - R16, R58 ..... 10k
R17 - R24 ..... 1M
R25 - R32 ..... 3k3
R33 - R40, R49 ..... 6k8
R41 - R48, R50, R51, R56 ..... 470R
R52 ..... 1k0
R53 ..... 3k9
R54 ..... 5k6
R55 - R57 ..... 10k trimpots
R59 ..... 2k7
R60 ..... 27k
R61 ..... 1k8
R62 ..... 240R
VAR1 .... GE-MOV Varistor (V33MA1A)

Capacitors

C1 ..... 0.01uF ceramic
C2 ..... 1.0uF solid Tantalum
C3 ..... 0.1uF ceramic
C4 ..... 300uF 16V elect.

Semiconductors

Q1 - Q9 ..... 2N2222
D1 - D8, D19 ..... High effic. red LEDs
D20 ..... green LED
D9 - D16 ..... 1N914
D17, D18 ..... 1N4004
IC1, IC2 ..... LM339 Quad Comparators
IC3 ..... LM336Z
IC4 ..... LM317T
IC5 ..... LM3909
IC6 ..... MC3423
SCR1, SCR2 ..... 2N5064 (ElectroSonic)

Miscellaneous

Ry1 ... T81P5D211 (Potter and Brumfield, from ElectroSonic)
Ry2 ..... Radio Shack 275-8218 5Amp
S1 ..... SPST toggle 3A min.
S2 ..... SPDT light duty toggle
S3, S4 ..... SPST pushbutton norm. closed R.S. 275-1548
Cabinet Radio Shack 270-274 or Hammond 1411R (ElectroSonic)

Copper tapes, donut pads, double-hole DIP patterns (Bishop Graphics - widely available); 12 terminal barrier terminal stip; panel-mount fuse holder for 3A, 32V fuse.

output of the power regulator. It should be close to 10 volts. Small differences are not important here. Now connect the voltmeter between the positive lead of IC3 and ground. Adjust R55 until the meter reads 2.5 volts. If you do not have a bench power supply, use a fully charged car or boat battery. Connect a small 6 volt or 9 volt battery between ground and input 1. Set the voltmeter to the range nearest above 10 volts and connect it between board ground and the base of Q2. Now you will see why we pre-set the trimpots. Half of either of the small battery voltages will overcome the 2.5 volt reference voltage and turn on the first comparator. So you should get a positive high at the base of Q1.

The following test will check out the individual channels, the diode-OR/ SCR-2 circuit and the LED indicators simultaneously. Connect the Sonalert temporarily between the pin that connects it to SCR-2 and the +10 volt bus. The Sonalert is a polarized device so watch the polarity. Make temporary connections to the re-set switch for SCR-2. Solder a pair of leads to a spare LED. Make the anode lead longer than the cathode and solder it temporarily to the +10 volt bus. Connect the cathode lead temporarily to the output end of R42. Now touch the test battery to the input pin of Channel 1. The sounder should start and the LED should light. If nothing happens, run a point to point check through the channel and locate the trouble. It will most likely be a bad solder joint. Continue this test through the other seven channels. Move the test LED to each channel as you do it and re-set SCR-2 between each test. This seems like an elaborate procedure, but it is much easier to clear the bugs BEFORE the board is in the cabinet.

The over-voltage protection circuit (IC6) should also be checked and calibrated before the board is installed. The re-set button switch should be temporarily connected to SCR-1 through the pins provided. The spare LED referred to earlier will need to be temporarily connected to the pins provided at IC5.

For the calibration a variable voltage supply will be needed and initially set at 16 volts. Use the same power input connections as for the previous channel tests. If the flasher starts to flash immediately connect the voltmeter between pin 8 and ground (IC6). It should read high. Adjust R57 until the voltage at pin 8 drops to zero. Reduce the input voltage to about 14 volts. The LED will, of course, continue to flash until the re-set button is pushed. After re-setting SCR-1, raise the input voltage slowly and at a point very close to 16 volts, SCR-1 will turn on and restart the flasher. These adjustments ensure that any voltage from the engine battery/alternator system that exceeds 16 volts will shut the CCU down and warn the operator.

When you start this calibration, R57 will have some random setting. If D19 fails to flash, increase the voltage to about 18 volts. Adjust R57. If no adjustment will start the flasher, connect the voltmeter between the lower end of R53 and ground. Repeat the adjustment of R57, with the input voltage re-set to 16 volts. If the voltmeter jumps to 16 volts at some point in the adjustment, it shows that SCR1 and Ry-1 are both working and there is a fault in the flasher circuit. After this fault is cleared, recheck the calibration procedure as before. The board is now ready to go into the cabinet.

The CCU board can be mounted on the bottom of the case using four short sleeves and 4/40 bolts. There will be room above this board for the sensor input circuitry board. The base part of the Radio Shack cabinet is 'U' shaped with a matching 'U' shaped cover. One leg of the base U forms the front panel, the other leg the rear panel. A row of holes for the LEDs must be drilled in the front panel near the top. They can be drilled for a push fit for the LEDs and the LEDs secured by a dot of

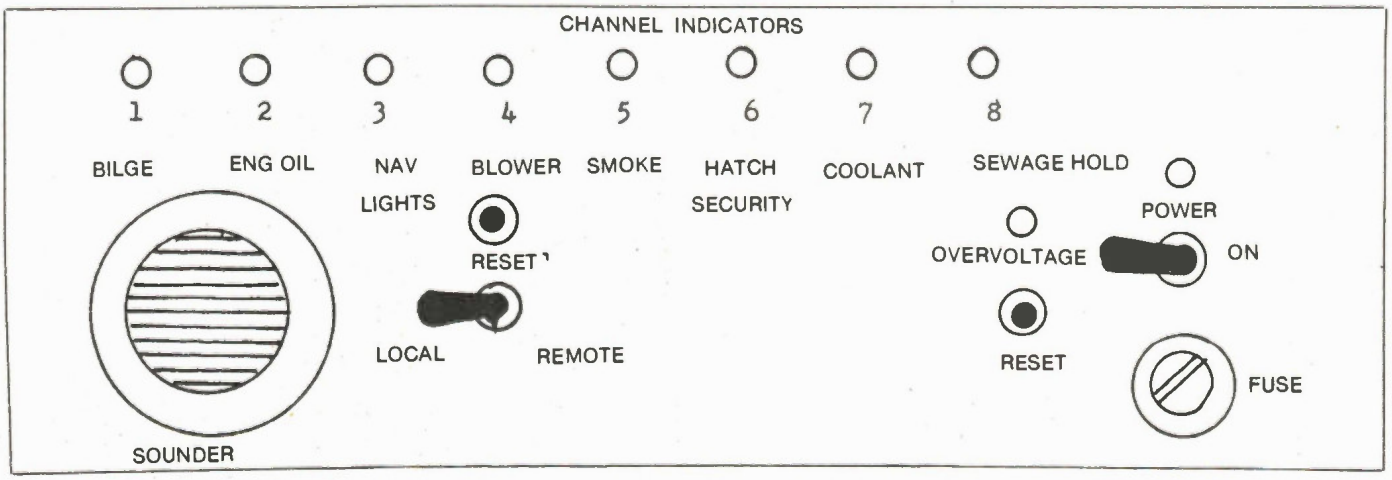


Fig. 6 Suggested layout panel.

five minute epoxy cement or the holes can be drilled slightly larger to accommodate the LED mounting grommets. This latter will look more professional. The common anode connection to all the LED indicators can be made by a straight length of 18 or 20 gauge tinned copper wire stretched across the top of the LEDs and just touching the anode leads. All the LED anode leads must be uppermost in their mounting holes. The bus bar is terminated at each end with a single insulated tie point. Support each anode lead with pliers and carefully bend it around the bus bar. When all are in place they can be soldered. Use a heat sink clip on each lead and when it is soldered, snip off any excess lead material. Solder a length of stranded, red insulated wire to end of the bus bar nearest where the +10 volt bus staking pin is located and make it long enough to reach the pin. Solder lengths of stranded, insulated wire to each of the eight LED cathode leads to connect them with the transistor outputs. A long barrier type terminal block is used to connect with the sensor inputs, the power inputs and the output to the loud klaxon external relay. A row of holes must be drilled in the back panel to pass the solder pins at the back of the terminal block. A long narrow slot will do the same thing. The front panel will require holes for the switches, fuse holder, LED.

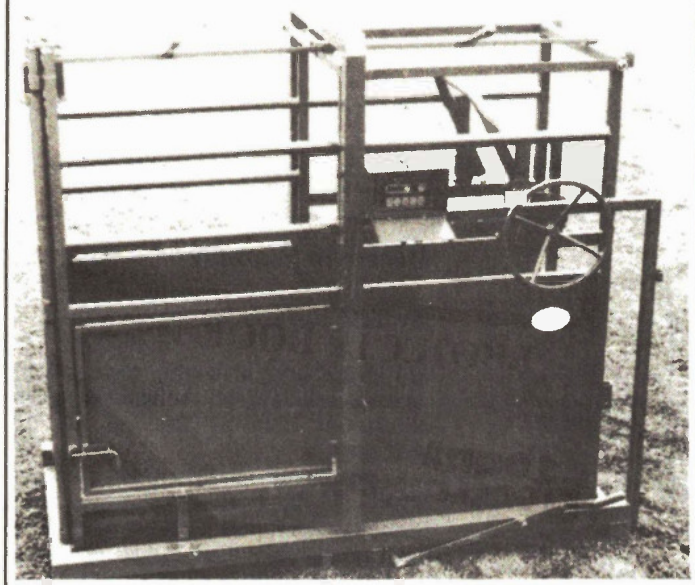
Sensors

The value of a monitoring system for boats cannot be overemphasized. This is particularly true for larger boats with inboard or inboard/outboard power plants. If there is trouble in a boat you cannot pull off to the side of the road and call a tow truck. Every year in North America, boats blow up or burn to the water line, killing or seriously injuring the occupants. The sailor's horror, fire at sea, can be avoided if a good monitoring system is in place.

For the above CCU project, some of the sensors will be as simple as a switch, others may require some simple electronic circuitry. In an upcoming part of this article a number of the most important sensors will be described along with a layout for them on a second board the same size as the CCU board. ■

For Your Information

Continued from page 31



Whaaa?

The above photograph was sent to us by an electronics firm in the UK, and was listed on both the press release and the photo caption as a "16-module system for teaching the principles of modern digital communications techniques". If that's what it really is, it looks as if you could plow and harvest the back 40 while you learn.

Scientific Software

Tektronix is distributing Macmillan's ASYST Scientific Software for use with two of its 7000-series digitizing oscilloscopes. ASYST is a high-level programmable software package for the IBM PC, used for advanced processing and analysis of data. It interfaces directly via the GPIB bus to the TEK 7D20 waveform analyzer or the 7854 scope, providing such data processing functions as smoothing, curve-fitting, integration, differentiation, statistics, etc. From Tektronix dealers, or contact the Macmillan Software Company, 630 Third Avenue, New York, NY 10017, (800) 348-0033 or (212) 702-3241.

Drill

The Oryx PC Drill is designed for low-cost precision drilling in the workshop or lab. It features a 9 1/2 inch throat, a vacuum dust extractor system, and an automatic switch which starts the unit when the drill handle is lowered. Both motor and vacuum can also run continuously. The precision chuck accepts drill bits from 0.5mm to 4mm. Oryx, 4 Columbus Avenue, Mt. Kisco, NY 10549, (914) 241-0237.

BV Engineering, producers of excellent software for circuit analysis, announce a Plotter Driver Program for sixteen different plotters running under MS-DOS or CP/M. The sample plots we received were first-rate, with crisp graphs and coordinates in multiple colours. The software lists for $72.95US. Contact them at 2200 Business Way, Suite 207, Riverside, CA 92501, (714) 781-0252.

The General Electric Silicone Products Division has a fact file available on their line of silicone resins developed for the electrical industry for insulating and impregnating wire and cable assemblies, motor windings, etc. The file and engineering samples are available by contacting them in Waterford, NY 12188, (518) 266-3505.

The Technical Service Council, as always, reports that technical job openings are slack. Particularly hard hit is the oil industry and related companies. Employers are acting cautiously during the 1986 economic slowdown, hiring people on a temporary or contract basis. The occupations most in demand are systems analysts, programmers and organic chemists. Openings for university and community college graduates vary with the speciality, with business and computer science graduates doing the best. Some recruiters are "critical of the inability of many university graduates to express themselves in writing and to spell". Amen, amen.

Continued on page 60

Continued from page 35

Envelope Generator

By James Moxham

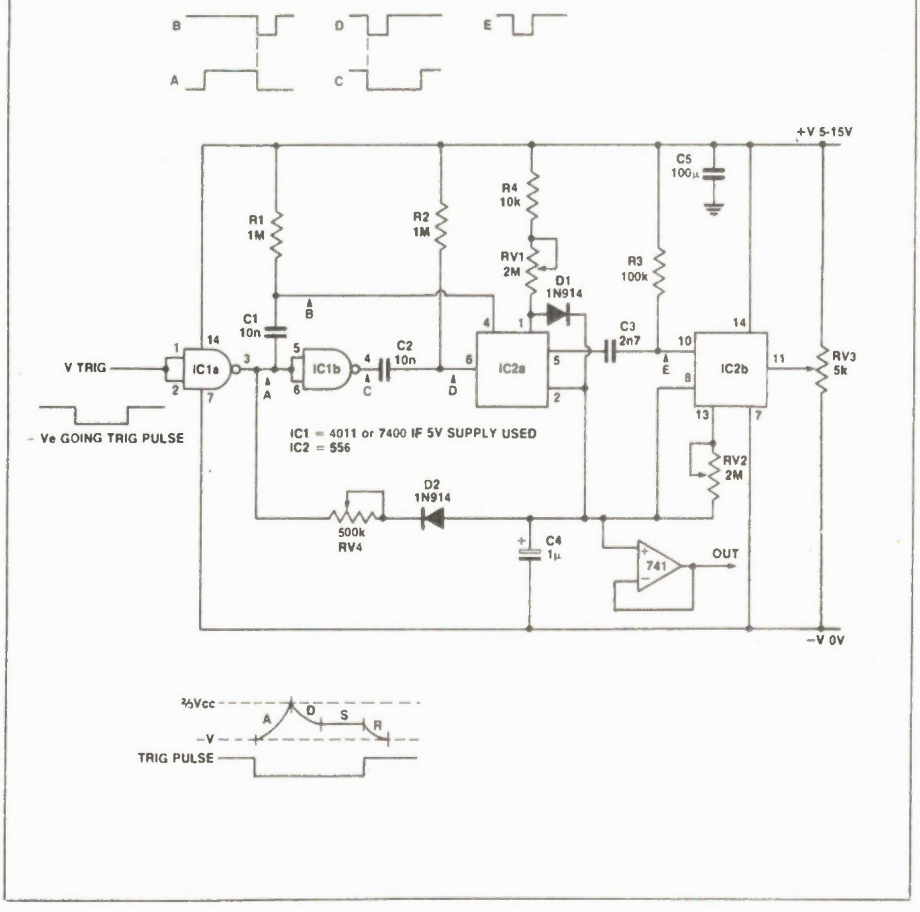
THIS CIRCUIT is based on the 556 dual timer and half of a quad NAND gate. Operation starts with a trigger from a keyboard. Notice that if the keyboard gives a positive voltage it will be necessary to invert it using one of the spare NAND gates. The existing inverter, IC1a, buffers the signal for delivery to a matrix of three RC networks, one of which is inverted by the other NAND gate, IC1b.

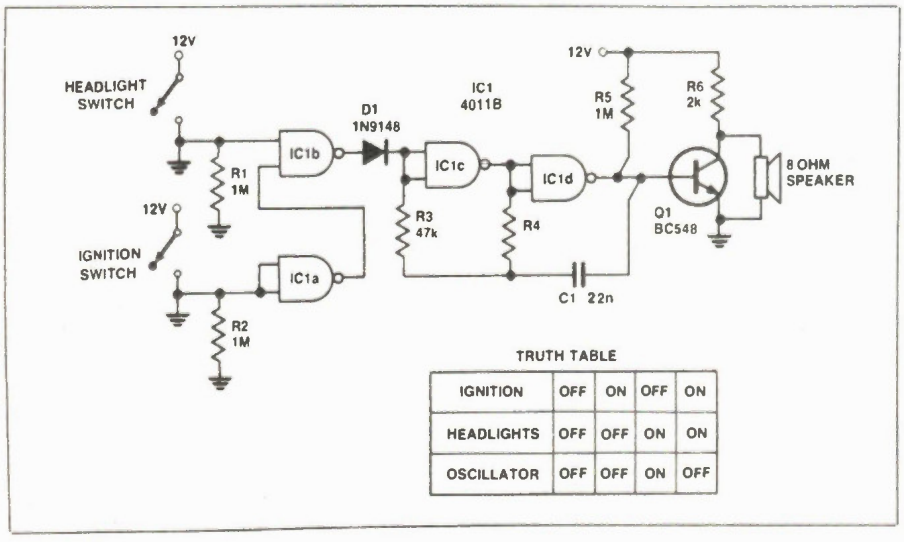
As soon as a trigger pulse arrives at IC1 it is turned into a narrow negative going pulse and applied to pin 6 of the first timer, IC2a. The discharge switch is turned off so C4 can charge up via RV1 and D1. This forms the attack section of the envelope, and it is set by RV1. When the voltage reaches two-thirds of Vcc the comparator inside the timer resets the flipflop, and the discharge transistor behind pin 1 is turned on. However, C4 doesn't discharge because of the action of D1.

The negative going output from the timer is fed via another RC network to pin 10 of IC2; the reset pin of the second timer. When it's pulled low the discharge transistor in the second timer turns on and C4 discharges through RV2. This will continue until the voltage level reaches the trigger level which is set by RV3, so the sustain level can be adjusted.

The circuit holds this voltage until the key is released. When this happens, IC2a is reset via pin 4, and C4 discharges through D2 and RV4.

The output must be coupled via a high impedance input, or via a voltage follower where a buffered output is required.





TRUTH TABLE

IGNITION	OFF	ON	OFF	ON
HEADLIGHTS	OFF	OFF	ON	ON
OSCILLATOR	OFF	OFF	ON	OFF

Headlight Warning

By Jeff Lefaro

TO HELP prevent leaving the car lights on after switching off the ignition, a simple circuit such as this can be implemented.

The circuit consists of an oscillator which can be enabled or frozen with respect to the inputs on IC1b. If both inputs are high then there will be no current passing through D1 and the oscillator can produce the desired tone.

The frequency output is proportional to R4 and C1, and can be varied to suit, although R4 should not be reduced to less than 5k. The value of C1 should not be changed drastically as the output may become inaudible. ■

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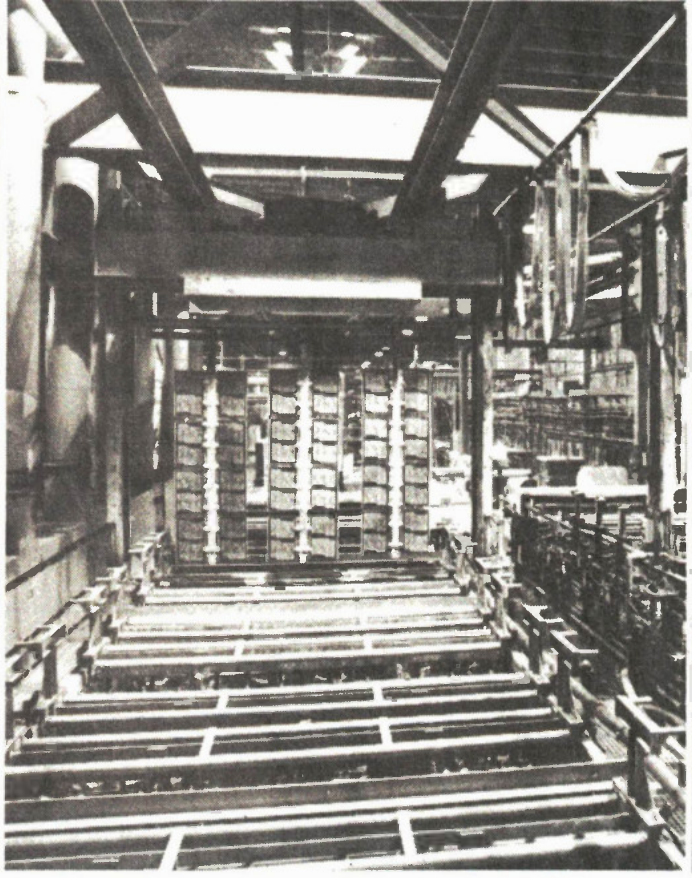

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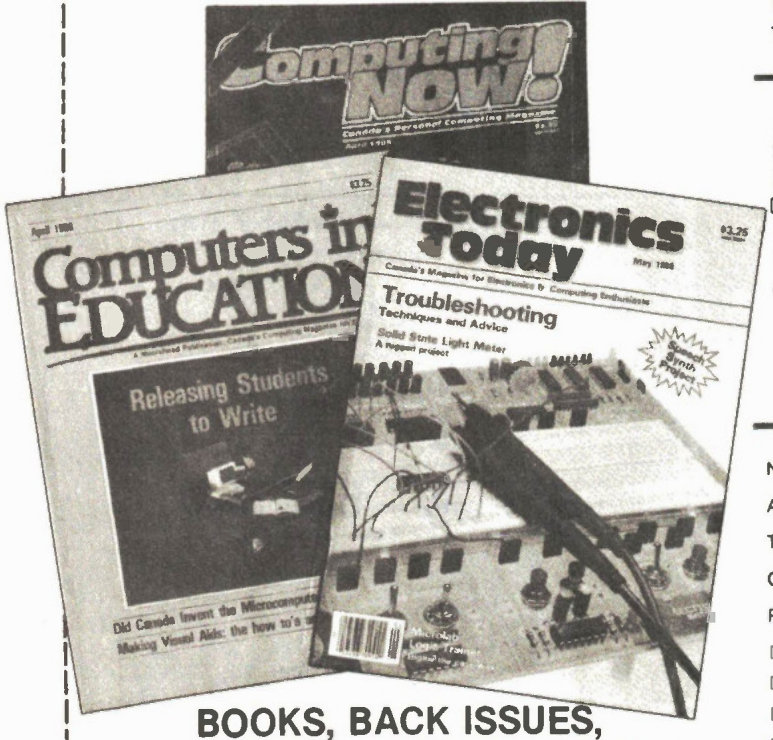

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A Versatile Multimeter

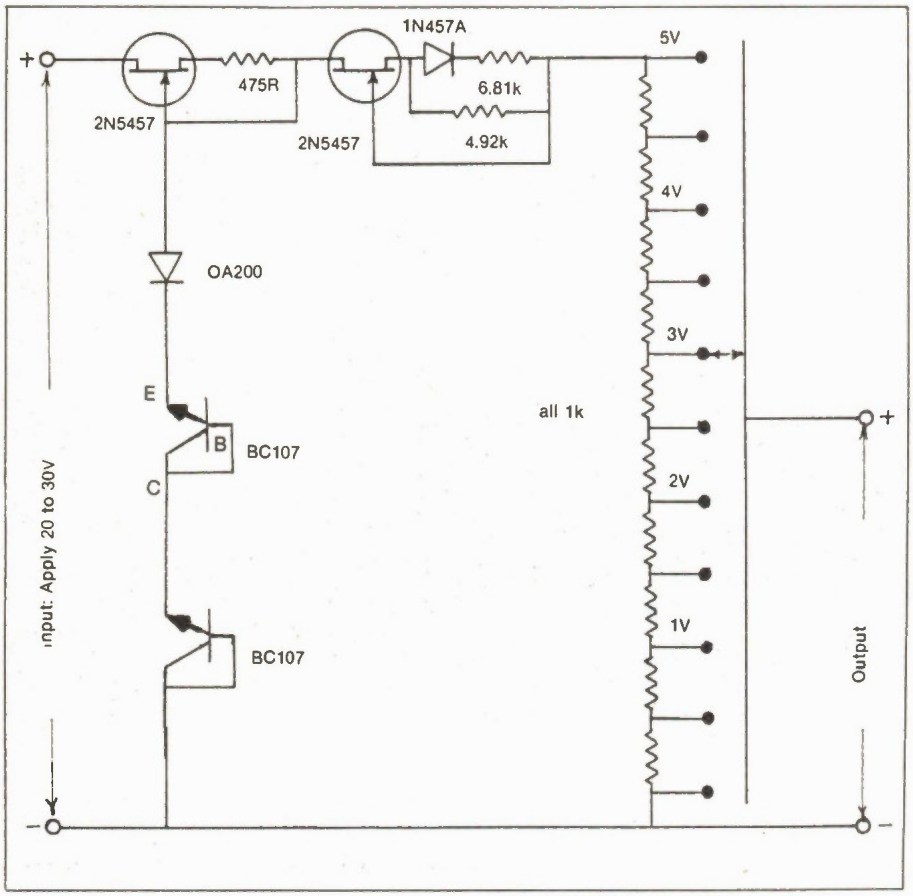

Figure 10. A voltage source calibrator.

to be made with greater accuracy. The multimeter would only have to measure the small difference between the unknown and the standard value. The string of ten accurate 1K resistors could be combined with a constant current of .5mA to produce standard voltages every half volt from 0 to 5V. Any unknown in this range could then be measured by the Voltage Standard and a multimeter reading on the plus or minus 300 mV scale. Near the standard values even smaller multimeter scales could be used. A successful instrument grew out of these ideas.

The circuit is shown in **Fig. 10.** Since the load shunts the output, accuracy is best only for high impedance (50M or more). Two constant-current FETs are used, one supplying the other. Input voltage requirements are very loose. The first FET, operating at 1mA, feeds a string of two transistors used as zeners and an ordinary diode. The drops add up to about 16V. The collector junctions are included, as three forward diodes are needed to bring the temperature coefficent of the string close to zero. This stabilized voltage feeds 500uA into the drain of the second FET which is biased to make the current exact as well as temperature-compensated.

The 500uA drain current of the second FET is higher than the usual current at which the 2N5457 is naturally temperature-compensated, so the diode compensation must work the other way, that is, decrease the gate bias as the temperature goes up. Two resistors in the source lead have to be adjusted to get the output voltage to match an outside standard and have a minimum temperature coefficient at the same time. The temperature coefficient was measured by bucking the Standard, set at 3.00 V., against 3.005V in the multimeter with the difference shown on the 10mV scale. The Voltage Standard was put in the controlled temperature enclosure while the multimeter remained at room temperature.

A convenient vernier action, useful to get the standard voltage just right, can be called into play by varying the drain voltage of the second FET. Since the current is constant, this can be done by introducing a resistor in series with the drain. In the author's instrument, a decrease of 1V on the drain caused a 3.3mV decrease in source voltage. After final adjustment, the output at the 3V tap would not vary more than 1/4 mV as the temperature went from 70 to 90 degrees F. ■

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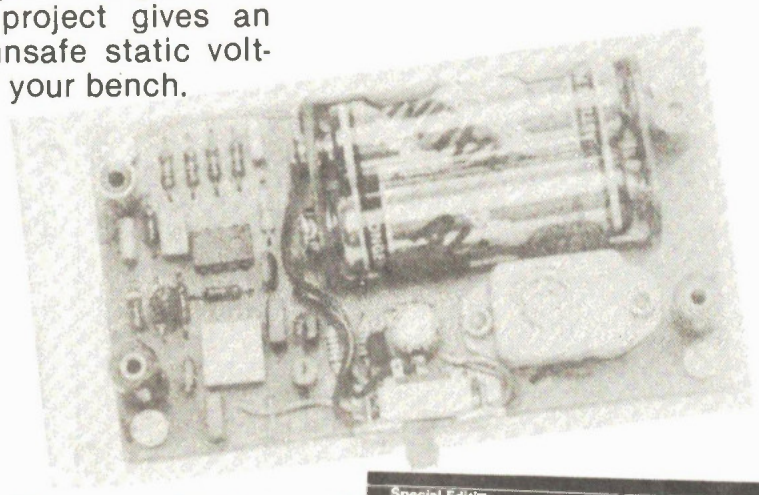

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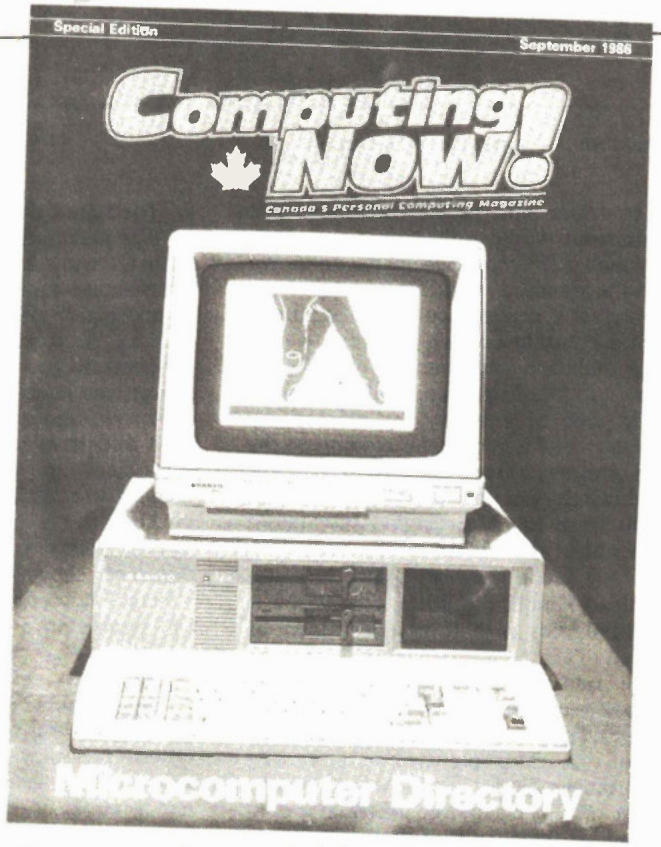

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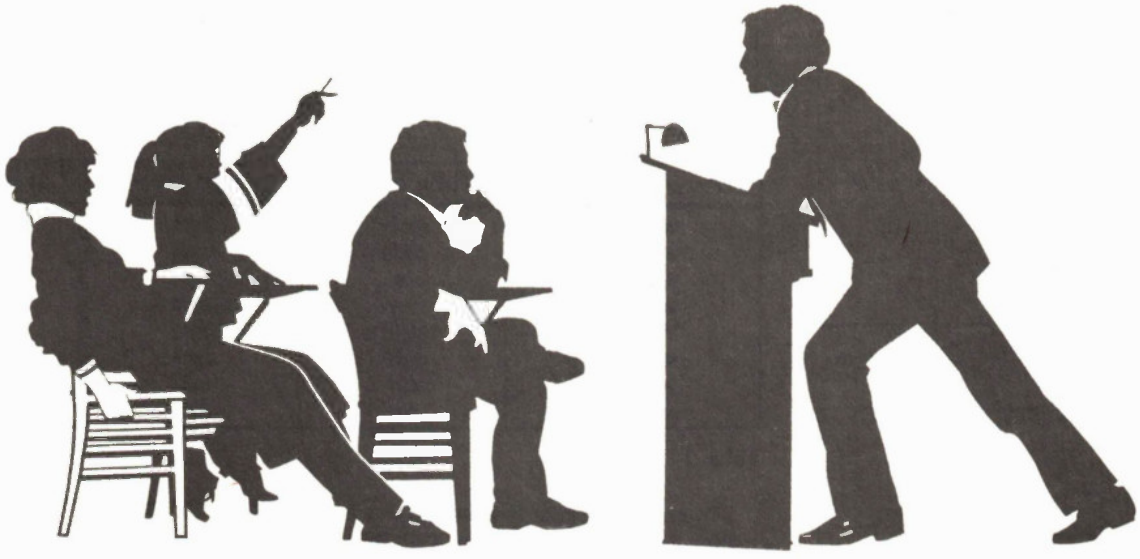

Continuing on with digital technique and a look at bistables.

By Michael Tooley and David Whitfield

LAST MONTH we introduced some basic TTL gates, now let's consider a practical application of these gates. Suppose, for example, that we've been given the task of designing an automatic lighting system for an office car park. We would first examine the criteria for switching the lights "on", which would be something like this:

Monday to Friday
8.00am to 8.00pm — Lights "on" whenever the amount off daylight falls below a certain value. Otherwise lights "off".
8.00pm to 8.00am — Lights "off" regardless of the light level.

Saturday and Sunday
Any time — Lights "off"

It would be far better to express these conditions in the form of a truth table, as shown in **Table 1**. This will be handy when we come to design the logic and will also help us to avoid any states which we may otherwise forget to allow for.

Day of the week	Time of day	Light level	Car park light
weekend	night	light	off
weekend	night	dark	off
weekend	day	light	off
weekend	day	dark	off
weekday	night	light	off
weekday	night	dark	off
weekday	day	light	off
weekday	day	dark	on

Table 1

In order to correctly control the lights we need to be aware of three things:

(a) Day of the week; is it a weekday or is it a weekend?

(b) Time of day; is it day or night?

(c) Light level: is it dark or is it light?

Each of these parameters can be considered to be an input to our logic system (shown in outline form in **Fig. 1**). The light level input can be derived from an appropriate transducer fitted with a digital output from what is essentially an analogue input.

In addition, we would probably want to incorporate some means of adjusting the light threshold. A suitable circuit could be based on a light dependent resistor and an operational amplifier comparator. The weekday/weekend and time of day inputs can be derived from a conventional digital clock. In this case the outputs would already exist in digital form.

The next step involves assigning a logic level to each of the three input signals so that we can determine the logical function

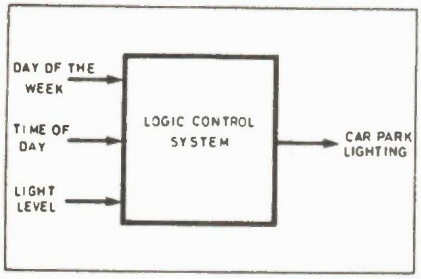

Fig. 1 Outline logic for the lighting control system.

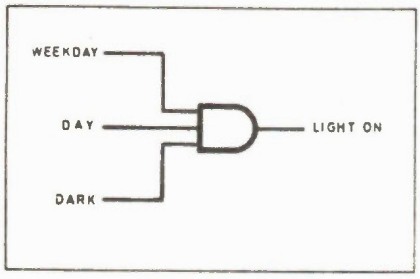

Fig. 2 Logic circuit for the lighting control system.

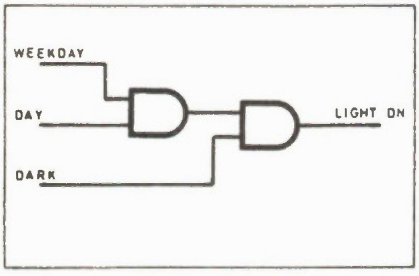

Fig. 3 Practical realization of Fig. 2 using two two-input AND gates.

of our gate arrangement. In practice the logic levels would depend upon those provided by our digital clock and transducer signal conditioning and this might take the following form:

(a) Day of the week: 1 = weekday, 0 = weekend.
(b) Time of day: 1 = day, 0 = night.
(c) Light level: 1 = dark, 0 = light.

We are now in a position to draw a truth table showing all of the possible input conditions together with the resulting output (the logic for which is assumed to be: 1 = light "on", 0 = light "off"). This truth table is shown in **Table 2** and shows that the required logical function is nothing more than AND. Hence, to control the car park lights we only need to combine our input signals using a three-input AND gate to provide a signal for switching the car park lights "on" and "off".

The logic circuit shown in **Fig. 2** should solve the problem nicely provided that we have a three-input AND gate handy. Such things do exist but suppose that we only have access to the simple two-input gates. How could we solve the problem?

Day of the week	Time of day	Light level	Car park light
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	0
1	0	0	0
1	0	1	0
1	1	0	0
1	1	1	1

Table 2

Day of the week	Time of day	Light level	Car park light
weekend	night	light	off
weekend	night	dark	off
weekend	day	light	off
weekend	day	dark	on
weekday	night	light	off
weekday	night	dark	on
weekday	day	light	off
weekday	day	dark	on

Table 3

The arrangement shown in **Fig. 3** is a possibility. Here we are using two two-input AND gates (this could be realized using just one IC package and still leave two gates unused) to simulate the action of a three-input AND gate.

Now, let's suppose that business is booming and we need to allow for a night shift during weekdays and work during the days at weekends. We would need to amend Tables 1 and 2 so that they look like Tables 3 and 4. These are obviously a little more complex than before since there are now three input conditions in which we require a logic 1 output. The lights should come "on" whenever any one of these conditions is satisfied but go "off" for all other conditions. We could simply OR the three conditions together.

Let's attempt to put this into words before we develop the logic.

Lights "on" whenever:
weekend AND daytime AND dark.
OR weekday AND daytime AND dark.
OR weekday AND nighttime AND dark.

Let's solve each condition separately **(Fig. 4)** and then OR the results together **(Fig. 5)**.

This arrangement works but it is certainly not the most elegant solution. **Fig. 6** shows another possibility. While there is a strong case for designing logic arrangements so that they use the minimum number of gates, the solution you finally adopt in practice is usually conditioned by the logic gates which you have available or which would otherwise be redundant

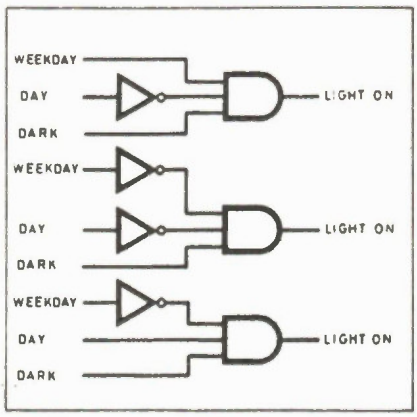

Fig. 4 Partial solution of the modified lighting control system.

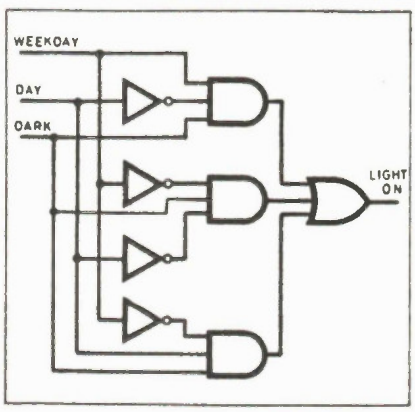

Fig. 5 Final solution for the modified lighting control system.

from the unused sections of IC's within an existing logic system. In any event, the ultimate arbiter of whether a logic arrangement is any good is whether, or not, it actually works!

The subject of minimization of logic gate arrangements is beyond the scope of this series. However, readers seeking further information should be aware that

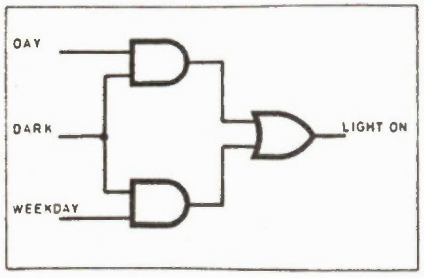

Fig. 6 More elegant alternative to Fig. 5.

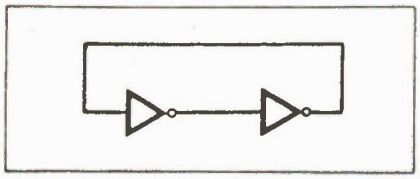

Fig. 7 Simple form of bistable using two inverters.

Day of the week	Time of day	Light level	Car park light
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	1
1	1	0	0
1	1	1	1

Table 4

there are two methods which can be used for tackling this task: one is based on Boolean algebra while the other is based on Karnaugh maps. Many books on digital logic adequately describe both of these techniques.

Bistables

In any other than the most elementary of logic circuits, one sooner or later realizes the need for a device which can remember a logic state in the form of a logic 1 or logic 0. Such a device should possess the ability to remember a transitory logical condition and therefore it constitutes a simple form of electronic memory, the most fundamental form of which is the bistable. The name simply indicates that the device has two stable states corresponding to outputs of either 1 or 0.

Another word synonymous with bistable is "latch". To explain the significance of this term let's consider the difference between two commonly available types of switch: "momentary" and "latching".

A momentary switch is one in which the switch contacts make (or break if it is a normally closed rather than a normally open type) only when the switch is actually being operated. This is, for example, the case with a doorbell. We only want the bell to sound when the button is actually being pushed. It should not be possible for persons to walk away leaving the bell ringing.

A latching switch is one in which the contacts make (or changeover) whenever the switch is operated: the mechanical design of the switch ensures that it remains biased in that state until it is operated again. A word sometimes used to describe this action is "toggle". An example of a switch having a mechanical latching action is that normally associated with a room light. Once the switch is operated, the room light must stay "on" allowing one to move away from the switch without being plunged into darkness.

A Simple Bistable Latch

The simplest form of bistable arrangement uses nothing more than two inverters, as shown in **Fig. 7**. Readers should, by now, be very familiar with the way in which an inverter operates; a 1 input produces a 0 output, and vice versa.

The logical state of the outputs of the two gates in Fig. 7 must, therefore, always be complementary. If the first gate is producing a 1, the second gate must produce a 0. If the first gate produces a 0, this must result in a 1 from the second gate.

If we were to assemble such a circuit the state of its outputs would, initially at least, be indeterminate. It would be impossible to say which of the outputs would assume a logic 1 state and which would assume a logic 0 state.

Worse than that, there is no obvious method of changing the state other than by shorting one, or other, of the outputs to logic 0 in order to force the logical state at that particular point to become a 0. Such an arrangement is not considered good design practice but, don't worry, we'll show how this disadvantage can be overcome later.

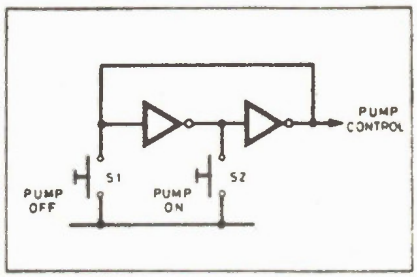

Fig. 8 Pump control system.

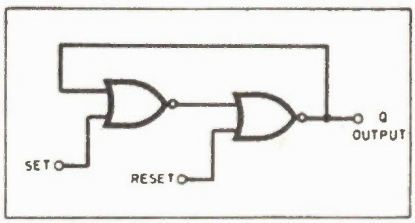

Fig. 9 RS bistable latch using two NOR gates.

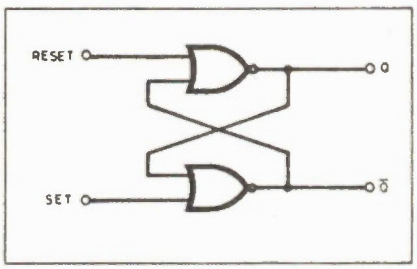

Fig. 10 Alternative form of Fig. 9.

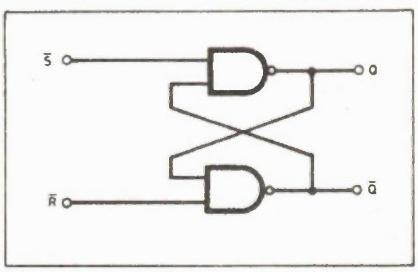

Fig. 11 RS bistable using two NAND gates.

The time has now come to introduce a practical example of the use of a bistable. Let's imagine that we require a logic system to control the operation of a pump. We wish to use two push-buttons to control the pump; one to switch it on (PUMP ON) and one to switch it off (PUMP OFF).

The arrangement shown in **Fig. 8** shows how these switches can be added to the simple bistable latch of Fig. 7. We simply pull-down the input voltage of one, or other gate, to 0V momentarily whenever the appropriate switch is operated.

Note that, when the power is first applied, the output of Fig. 8 may be in either

state. Disconnecting the power supply and then reconnecting it again may sometimes effect a change of state but this cannot be relied upon. It will, therefore, be necessary to re-set the bistable latch into the inactive condition by first pressing S1 (PUMP OFF) as soon as the supply has been connected. (On real logic systems there are, of course, simple methods of achieving this automatically.) When S2 (PUMP ON) is operated the output should go to logic 1 regardless of its earlier state. Furthermore, depressing S2 for a second time will have no further effect on the logical state of the circuit.

By now, the perceptive reader may have counted three quite different logical input conditions. These may be summarized briefly as:

(a) S1 "off" and S2 "off".
(b) S1 "on" momentarily while S2 remains "off".
(c) S2 "on" momentarily while S1 remains "off".

There is, however, one further possible input condition which we should consider. This occurs when S1 and S2 are both "on" and would arise if we were foolhardy enough to operate both push-buttons at the same time (i.e. operating PUMP ON and PUMP OFF simultaneously). This situation, however, should be clearly avoided.

An Improved Bistable Latch

A much better solution to the problem of constructing a bistable is with the use of two two-input gates rather than inverters. Such an arrangement eliminates the need to short the gate outputs in order to effect a change of state. It should also be obvious that the gates we choose must be inverting types since a non-inverting gate will not produce the complementary state that we require in order to latch the bistable.

It is necessary then to choose between two-input NOR or two-input NAND gates but, happily, we can use either and we'll describe bistable arrangements using both types. The bistable constructed from NOR gates is slightly easier to describe and so we'll start with this type.

Fig. 9 shows how a bistable can be constructed from two two-input NOR gates: We've labelled the inputs "SET" and "RESET". The reason for the choice of these terms is that a 1 on the SET input produces a 1 at the output. We would say that it "sets the output" (to logic 1). Conversely, a 1 on the RESET input produces a 0 at the output. It can thus be said to "reset the output" (to logic 0). The output is labelled "Q". There is no particular significance in the choice of this letter other than that it satisfies the convention adopted for bistable elements generally. Since the inputs are named SET and RESET, this simple form of bistable is called an "RS bistable".

We've already learned how useful truth tables can be for describing the logical function of a gate. Let's take a look at a partial truth table for the RS bistable which is shown in **Table 5**.

Another way of drawing the bistable arrangement using NOR gates is shown in **Fig. 10**. This symmetrical circuit shows clearly how the gate outputs are cross-coupled to the inputs. It also shows that

RESET	SET	Q
0	0	0
0	1	1
1	0	0

Table 5

RESET	SET	Q	$\overline{Q}$
0	0	0	1
0	1	1	0
1	0	0	1
1	1	0	0

Table 6

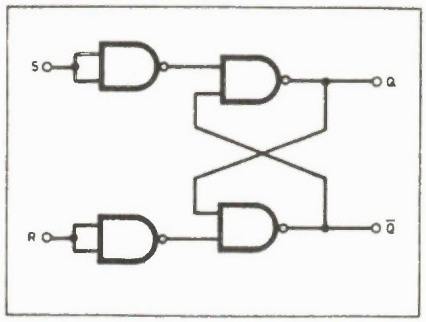

Fig. 12 NAND gate equivalent to Fig. 9.

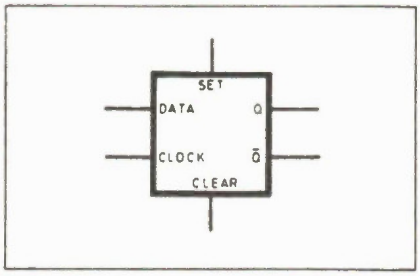

Fig. 13 Symbol for D-type bistable.

happens when both the SET and RESET inputs are simultaneously taken to logic 1? The answer, as you might have suspected, is that the arrangement behaves in an unpredictable manner (see Table 6) as the Q and $\overline{Q}$ outputs both go to logic 0.

We should clearly identify this as a "disallowed" input condition and, while not wishing to pretend that such a condition never arises, we should take positive steps to ensure that it is unlikely to happen. At the very least, if it does occur, we should be aware and not place any reliance on the output.

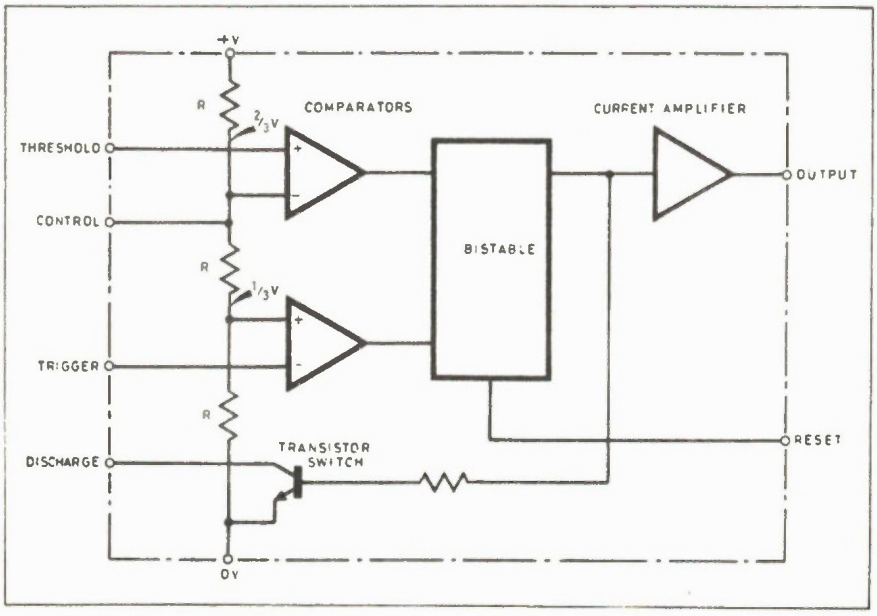

Fig. 14 Simplified internal arrangement of a 555 timer.

we are only using one, of two, possible outputs. It would be a very simple matter to obtain a complementary, $\overline{Q}$, output from the gate which may be useful in a more complex logic system.

Unfortunately, our improved NOR gate bistable still has one shortcoming: we would normally expect the Q and $\overline{Q}$ outputs to be always complementary. What

RS Bistable Using NAND Gates

Simple RS-bistables can also be constructed using two-input NAND gates as shown in **Fig. 11**. The important difference between this arrangement and that of the NOR gate equivalent is that the SET and RESET inputs are logically inverted, i.e. they are active when they are at logic 0 rather than when they are at logic 1.

This is an important point and one which often confuses the newcomer. Such inputs are referred to as "active low" (on some logic diagrams a circle is used at the input of more complex logic gates to indicate this). However, we shall simply refer to them as (NOT SET), $\overline{S}$, and (NOT RESET), $\overline{R}$. If it is essential to have conventional SET and RESET inputs to the bistable it is, of course, a relatively simple matter to invert these signals prior to the bistable stage.

With a quad two-input NAND we could, for example, achieve this by using the remaining two gates in an arrangement similar to that shown in **Fig. 12**. The operation of the bistable is then identical to that of the NOR gated bistable which we met earlier.

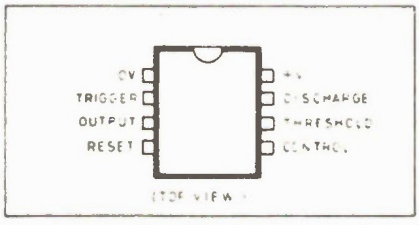

Fig. 15 Pin connections for a 555 timer.

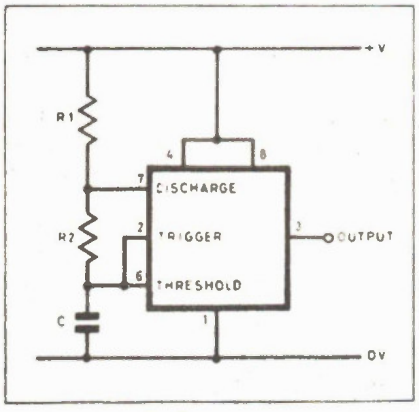

Fig. 16 Astable pulse generator using a 555 timer.

Clocked Bistables

While the simple RS bistable element is useful in a number of applications, it does have very severe disadvantages when several such stages are to be incorporated in a complex logic system. These problems arise from the way in which changes of state occur in the system. Earlier, we assumed that the RS bistable changed state immediately when the correct SET and RESET inputs are received. At first this may sound quite acceptable, after all one of our chief aims with the design of electronic circuits is to produce the fastest possible speed of operation.

The difficulty with RS bistables is that such rapid changes are not very predictable. In many cases we have what is known as a "race condition" in which the logical output from a system may well be determined by the speed at which individual gates operate rather than the logical rules which they should obey.

What we really need is a system in which the changes occur in a controlled fashion. In such a system we can accurately predict the output states, all we need is a means of synchronizing the changes within the system. This leads us to the very important concept of "clocked logic"; a logic system which employs a clock signal to control the transfer of logical information from one stage to the next.

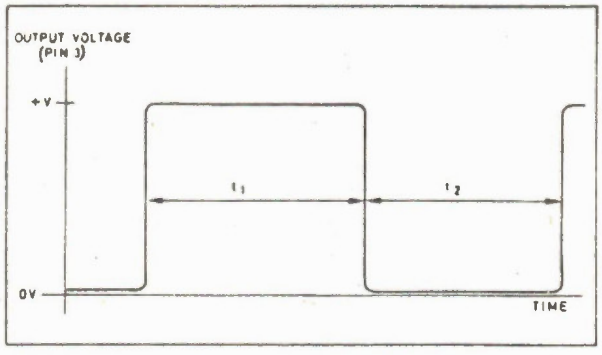

Fig. 17 Output waveform for the astable pulse generator shown in Fig. 16.

D-Type Bistables

A further improvement on the RS bistable can be obtained by adding an additional input which determines the state of the outputs at the instant the clock changes. This, edge triggered, bistable is referred to as a "D-type". The "D" stands for "data" which is effectively loaded into the bistable stage when the clock transition occurs.

The symbol for a D-type is shown in **Fig. 13**. This has four inputs and, as usual, two outputs. The inputs are: SET, CLEAR, CLOCK and D. The outputs are our old friends, Q and Q.

The D-type is rather difficult to construct using individual logic gates (one can be constructed from no less than six three-input NAND gates) and thus a purpose-made integrated circuit version is always preferable.

The 555 Timer

This device neatly combines modern analogue and digital techniques within a single integrated circuit and has found an enormous range of applications in today's electronic circuits.

The simplified internal arrangement of the 555 timer is shown in **Fig. 14**. Essentially, the device comprises two operational amplifiers (used as comparators) together with an RS bistable. In addition an output buffer is incorporated so that a considerable current can be supplied to a load (such as a relay). A single transistor switch, TR1, is also provided in order to discharge an external timing capacitor.

The 555 timer is housed in an 8-pin DIL package, the pin connections for which are depicted in **Fig. 15. Fig. 16** shows how the device can be used as an "astable" pulse generator. (The word "astable" simply refers to the fact that the output does not remain in a stable state, i.e. it continuously alternates between logic 0 and logic 1 and can be considered to be another form of free-running oscillator).

In order to understand how the astable pulse generator works, assume that the output (at pin-3) is initially at logic 1 (high) and that TR1 is not conducting. The capacitor, C, will begin to charge with current supplied by means of the series resistors, R1 and R2.

When the voltage at the threshold input (pin-6) exceeds two-thirds of the supply, the output of the comparator will change state and the bistable will toggle, making the output go low and turning TR1 "on" in the process. The capacitor will now discharge with current flowing through R2 and into the collector of TR1.

At a certain point, the voltage appearing at the trigger input (pin-6) will fall to one-third of the supply voltage at which point the other comparator will change state and return the bistable to its original condition. TR1 then switches "off", the final output (pin-3) goes high and the entire cycle is repeated.

The output waveform produced by the circuit of Fig. 16 is shown in **Fig. 17**. The

Continued ...

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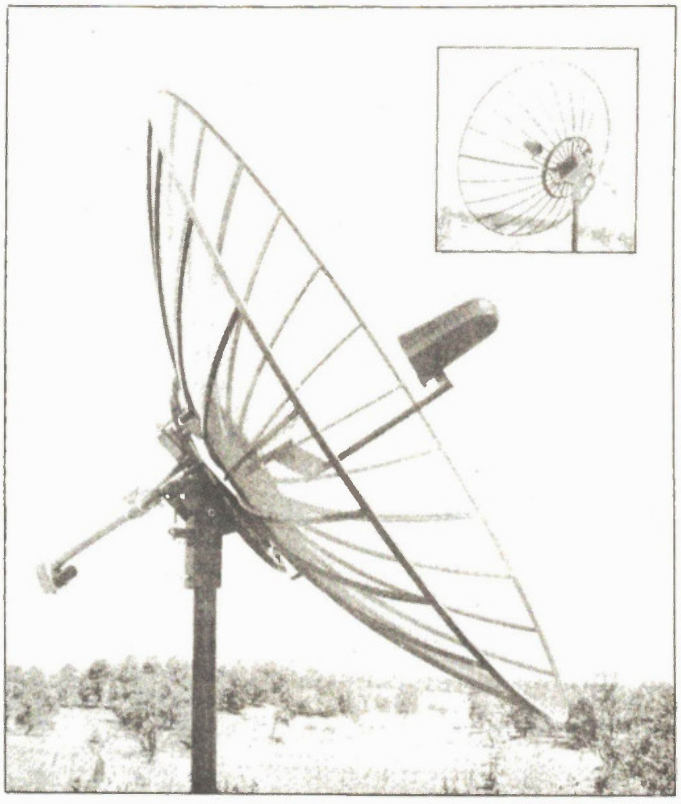

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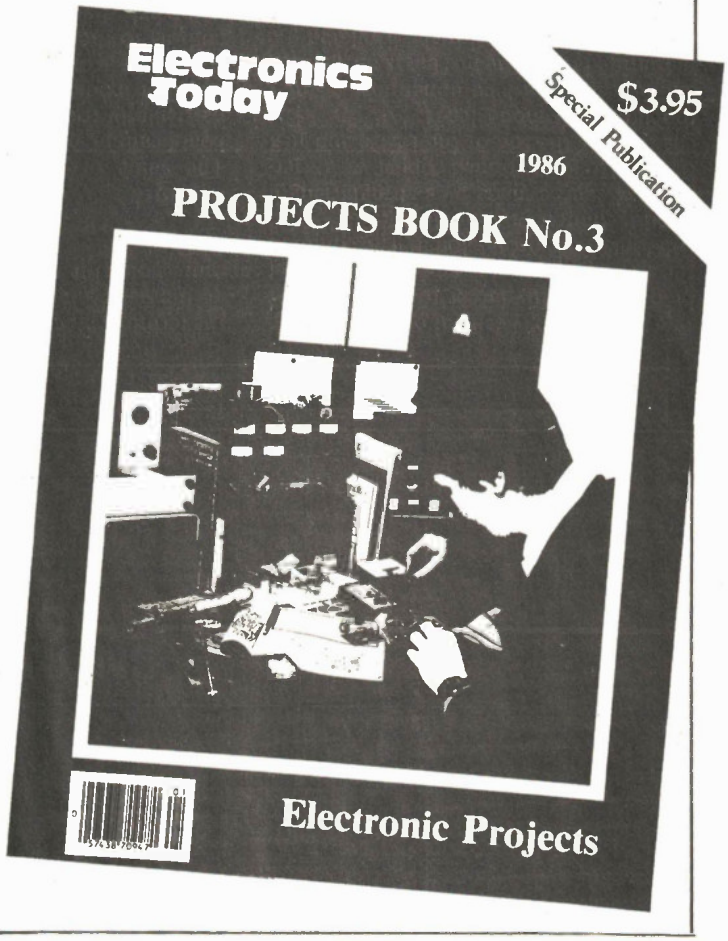

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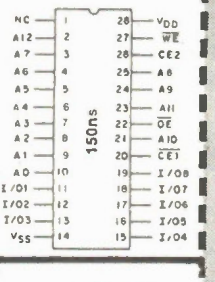

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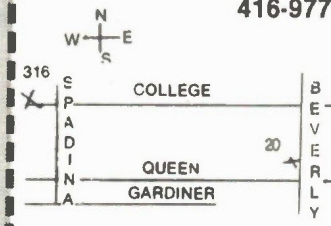

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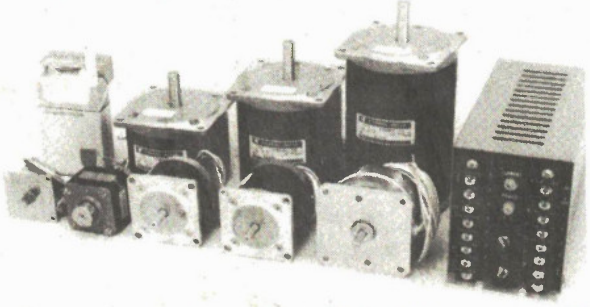

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Continued from page 53

essential characteristics of this waveform are:

Period for which output is at logic 1: t1 = 0.693 (R1 + R2) C
Period for which output is at logic 0: t2 = 0.693 R2 C
Period of output signal: t1 + t2 = 0.693 (R1 + *1 2R2) C*
Frequency of output signal: f = 1.44/(R1 + 2R2) C
Duty cycle of output signal: t1/t2 = (R1 + R2)/R2

Typical limits to the range of component values employed in conjunction with the circuit shown in Fig. 16 are as follows:

Minimum value of R1 or R2: 1k
Maximum value of (R1 + R2): 3.3M
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Maximum value of capacitance, C: limited only by leakage current.
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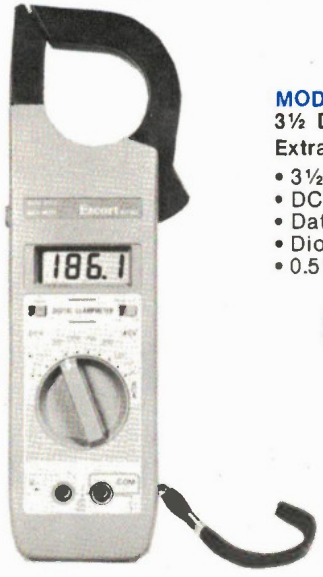

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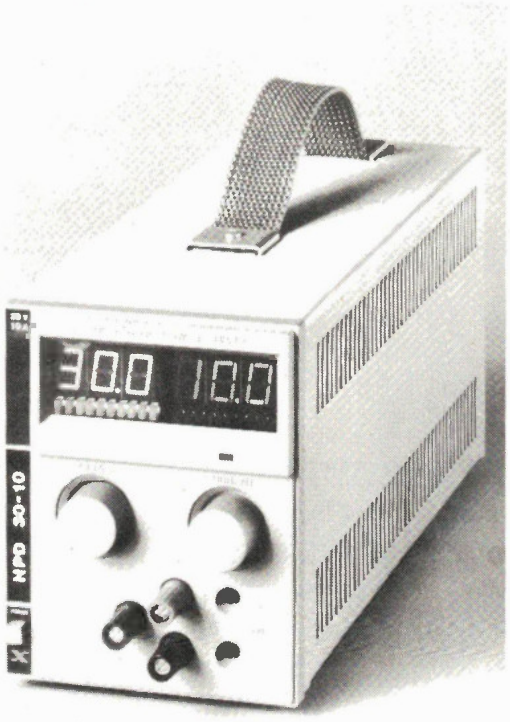

Canadian PSU

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A directory of 800 Service (toll free) numbers in Canada is now available. The directory, published by the member companies of Telecom Canada, provides reference to the products, services and general information available to the public through these toll free numbers. It can be purchased from local telephone company Phone Centres, or by calling 1-800-361-6077, at a cost of $6.95.

Reader Dennis Skakum is looking for service manuals or operator's manuals for a Television Signal Generator Model TVG-2, manufactured by Jackson Electrical Instruments, now apparently out of business, and also a Model 690 VHF-UHF Marker Calibrator originally made by Hickok in Ohio, who weren't much help. Readers who have any helpful information can drop Mr. Skakum a line at 15811 115th Street, Edmonton, Alberta T5X 2M6.

Reader Yvon Nowlan of Moncton would like to see an article on capacitive fuel quantity measuring systems used in aircraft, with perhaps some idea on converting a car float gauge to the capacitive method. If anybody feels qualified to write about this, contact the editor and we'll see what we can come up with.

K&H Products is offering a range of universal project boxes for use with PCBs. The PX series are available in four sizes and features grooves molded into the four inside walls for supporting circuit boards or breadboards. The standard colour is neutral gray and the aluminum lid is fastened with four screws. From Duncan Instruments. (416) 742-4448.

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The Canadian computer industry is said to have suffered through its worst year in 1985, according to International Data Corporation of Canada. While the domestic market reached a record $7.3 billion dollars, the annual growth rate dropped to a low of 6.4 percent compared to 14.8 percent the previous year. The industry was used to double-digit growth rates, and 1985 brought them back to reality. IBM Canada, leader in EDP, performed significantly below average for industry growth.

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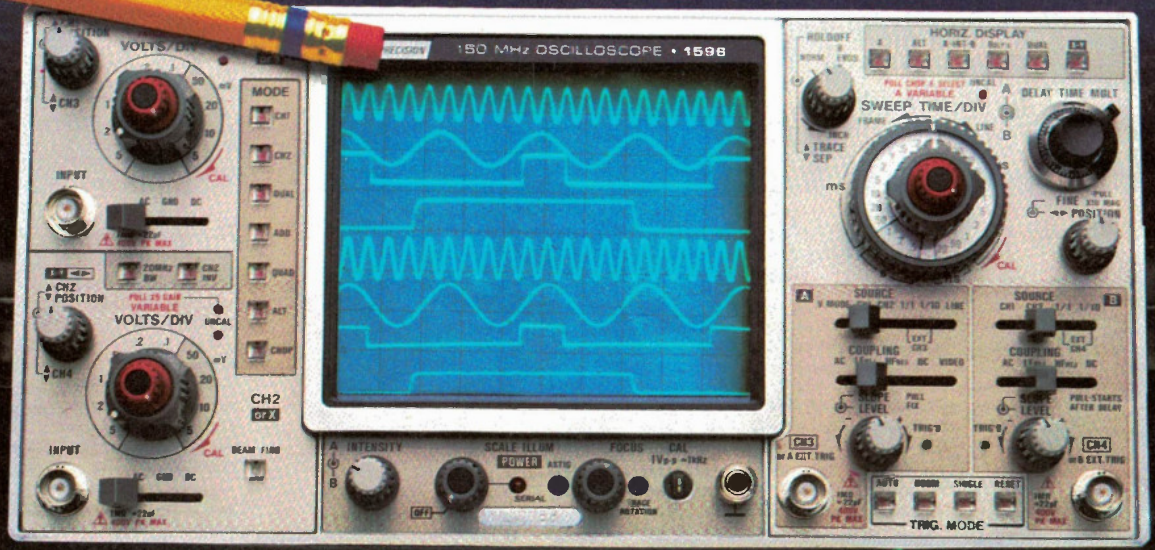

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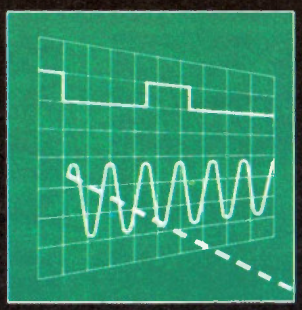

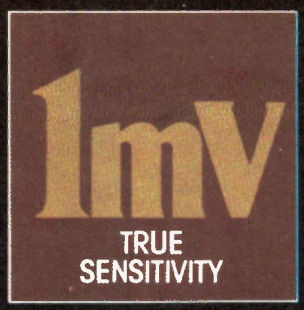

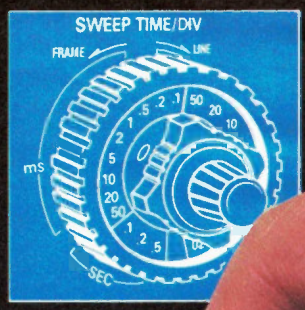

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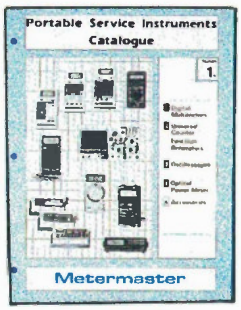

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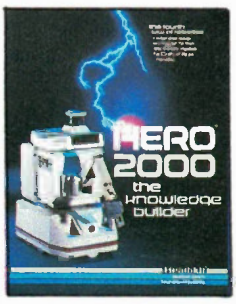

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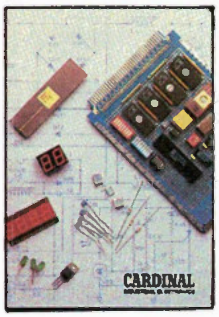

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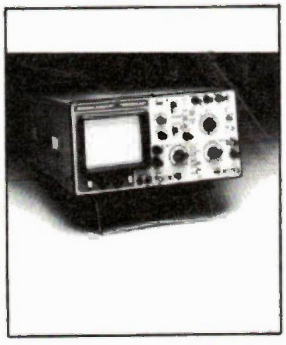

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