Electronics Today

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MM70924

October 1986

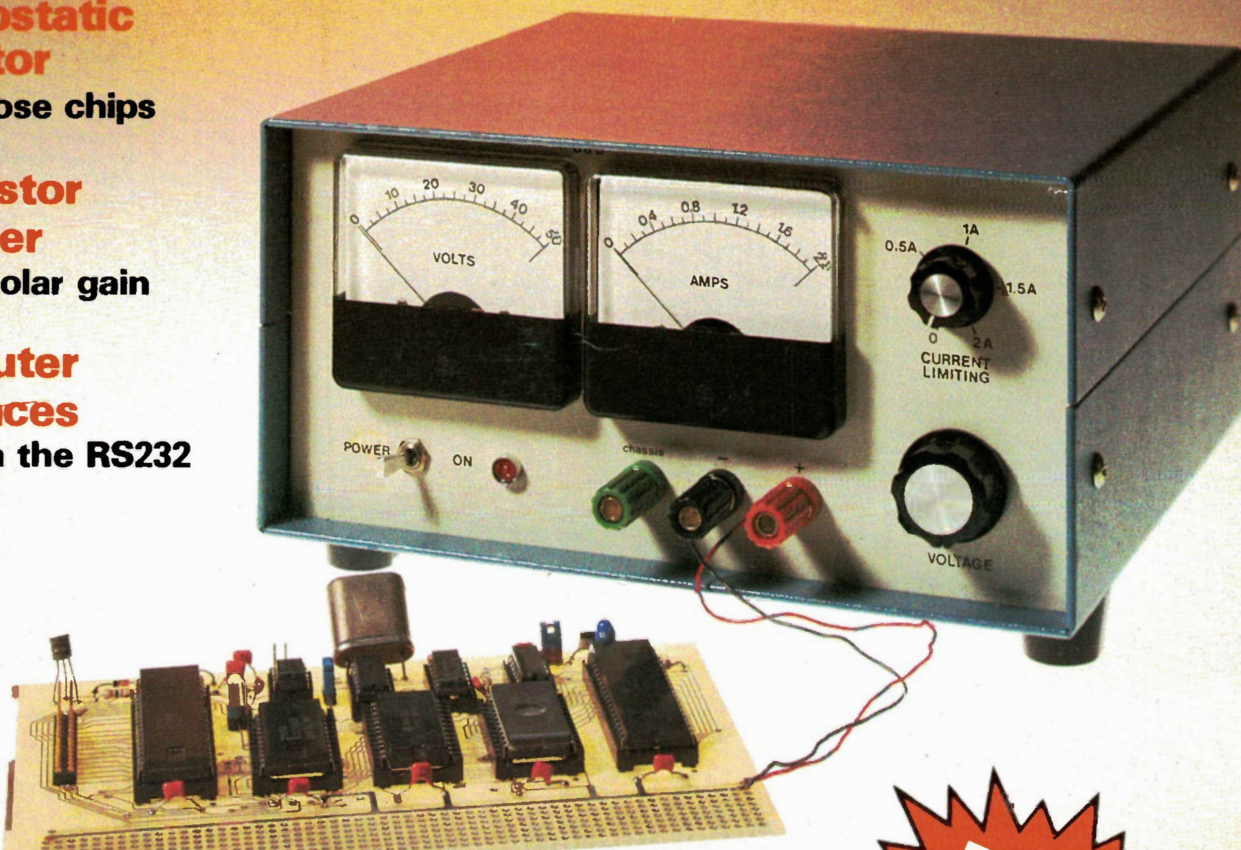
Canada's Magazine for Electronics & Computing Enthusiasts

Precision Power Supply
Low cost, easy to build

Electrostatic Detector
Save those chips

Transistor Checker
Test bipolar gain

Computer Interfaces
More on the RS232



Radio Basics

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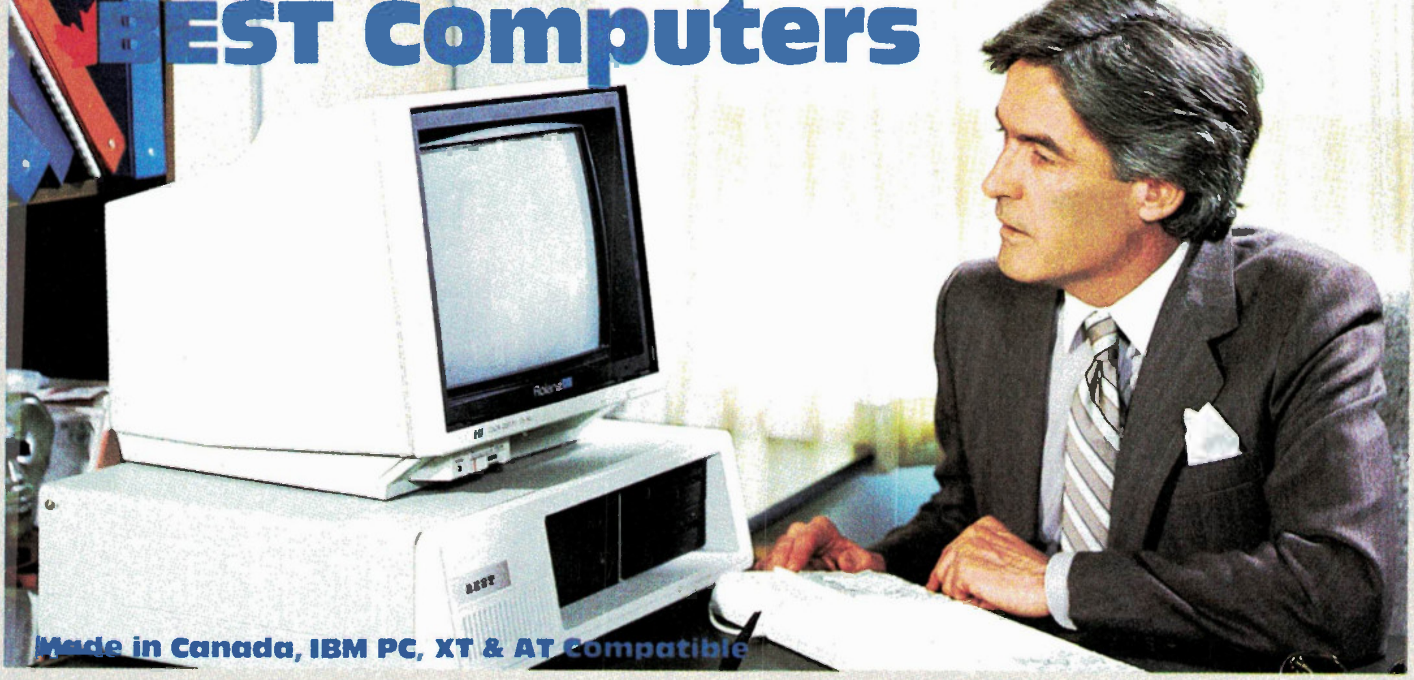

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Features common to BEST MK II, MK III & MK IV

- Superb IBM PC & XT Compatibility
- Canadian Made
- 256K RAM Standard minimum (uses 41256K RAM chips)
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- Reset Switch
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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.

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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 MONTH WARRANTY

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With 640K RAM	$1695
With 10 Meg Hard Drive/1 Floppy/256K	$2495
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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.

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TEN MONTH WARRANTY

Other Configurations:

With 640K RAM	$1995
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With 10 Meg Hard Drive/1 Floppy/640K	2895
With 20 Meg Hard Drive/1 Floppy/256K	$2895
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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

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TEN MONTH WARRANTY

Other Configurations:

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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 MONTH WARRANTY.

With 20 Megabyte fast stepping Hard Disk and Controller:

$4950.00

40 Megabyte systems also available at reasonable prices.

New, TURBO IBM AT compatible.
- 10 MHz CPU
- Up to 4 Meg RAM.

AXT-286

Superb IBM AT compatibility plus more:
- Standard 640K RAM and optionally up to 4 megabytes of RAM on main board.
- 6 MHz, 8 MHz, and 10 MHz selectable system speed.
- (2) 5¼" disk drives (1 high density 1.2 meg, one standard 360K).
- Serial and parallel ports, high quality keyboard, keyboard lock and status monitor.

With 640K RAM and 10 MHz CPU

$4995.00

TEN MONTH WARRANTY

2 Meg RAM	$6695.00
4 Meg RAM	$8395.00
2 Meg RAM with 30 Meg Hard Drive	$8695.00
4 Meg RAM with 30 Meg Hard Drive	$10,295.00
2 Meg RAM with 40 Meg Hard Drive	$8995.00
4 Meg RAM with 40 Meg Hard Drive	10,595.00
4 Meg RAM with 80 Meg Hard Drvie	$11,395.00

Scorpion Tape back-up (60 Meg) for any of the above system ... $1595.00

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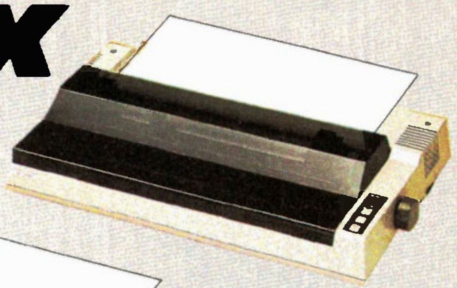
COPAL PRINTERS!



ECONOMY

COPAL ACCESSORIES

SC 1200 Ribbons	$12.00
SC 1500 Ribbons	$12.00
SC 5500 Ribbons	$16.00
Serial interface for SC1200	$95.00
Serial interface for SC1500/5500	$80.00

PROFESSIONAL

SC1200 . . . $329.00

- 120 cps. bi-directional
- dual mode, NLQ & draft standard
- tractor and friction feed
- parallel interface
- 1 year warranty
- 10 in. carriage
- foreign language characters
- IBM & Apple compatible

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15" carriage **$699.00**

For FREE Exceltronix 1986 Catalogue or FREE comprehensive Copal Brochure, please call or write to Exceltronix Inc.

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SC 1500

10" carriage **$499.00**

- 160 cps, bi-directional
- dual mode NLQ & draft standard
- tractor & friction feed
- 3K buffer
- parallel interface
- 1 year warranty
- IBM & Apple compatible

SAS Approved
1 year warranty.

Toshiba Printers
P321

Impact Wire Dot Matrix, 24-pin overlapping. Letter quality 72 c.p.s; Draft quality 216 c.p.s. (12 cpi), 180 c.p.s. (10 cpi). Accepts Font Cartridges and downloadable font disks, Qume Sprint 11 emulation, 4" to 11" paper widths, PC compatible and more.

Parallel and serial interface **$1079.00**

P351

Impact wire dot matrix 24-pin overlapping 4" to 15" paper width.
Accepts font cartridges and downloadable font disks, Qume Sprint 11 emulation, IBM PC compatibility, and more. Parallel and serial interface.

- Letter quality at 100 cps
- High-speed drafts at 288 cps
- Superb graphics at 360 x 180 and 180 x 180 dots per inch. **$2095.00**

NEW P351C

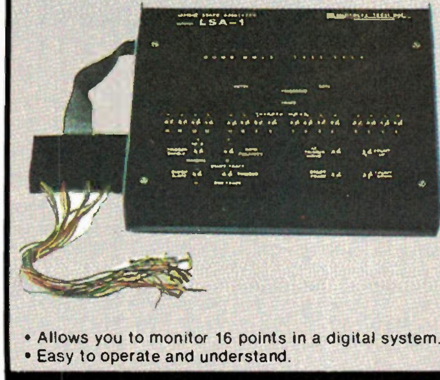
- Colour printer **$2295.00**

Multiflex Low-Cost Logic State Analyzer

Ideal for educational institutions and hobbyist.

Complete, assembled and tested

$369



- Allows you to monitor 16 points in a digital system.
- Easy to operate and understand.

Cable Assemblies

DB25 Male to DB25 Female **$35.00**

RS232 Cable (6ft of round conductor) $39.00

RS232 other lengths and connector configurations available on request.

Parallel cable 36 pin Centronics type connectors, male joined by 6ft of ribbon cable to female **$35.00**

Parallel Cable for IBM interface DB25 through 6ft of ribbon to 36 pin centronics with appropriate connections **$35.00**

Cable Assemblies for two 5-1/4in drives and controller (e.g. IBM) using three 34 pin connectors and appropriate length of 34 conductor cable **$35.00**

20 pin Female header 24in. to 20 pin for Apple drives **$6.95**

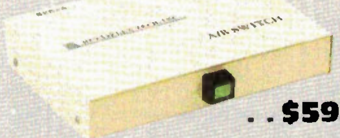
EPROM PROGRAMMER

External Card.

This card can program any one of the following EPROMs: 2716, 2732, 2732A, 2764 and 27128s. Two sockets are available on the adaptor board, one for the 28-pin EPROMs, the other for 24-pin types. These sockets are standard sockets, however as an option ZIF sockets can be used (we recommend ZIF sockets if large numbers of EPROMs will be programmed). Also as an option an extension board is available. This board attaches to the adaptor via a ribbon cable and extends out the back panel. This is to allow EPROMs to be programmed without removing the cabinet cover every time programming is to be performed. Also as a standard feature, the source software is supplied to allow users to modify the program to suit their needs.

As an option a serial port can be included on the card; this serial port has the same features as the port described with the floppy disk controller (see the floppy disk description for documentation of the serial port).

Serial Switch Box



. . **$59.00**

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

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**

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**

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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

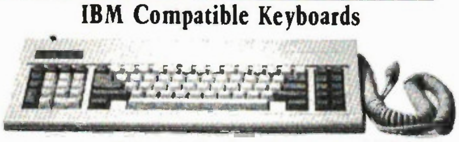
41256 (150nS) .... $ 4.99
Set of 9 .... $44.00

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 sloderéd)
- 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

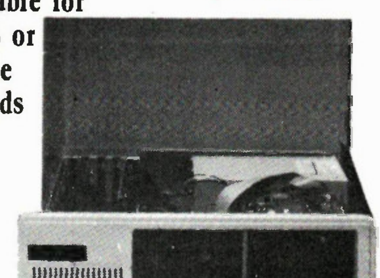
Assembled, flow soldered/cleaned and 100% tested
16K RAM $37.00
Z80A Card $44.00
128K (with 128K RAM) $79.00
EPROM Programmer with software $79.00
(programs 2716, 2732, 2732A, 2764)
Floppy Controller $45.00
Prototyping Board $14.95

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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Doug Bedrosian's Precision Power Supply was photographed by Bill Markwick. The printed circuit used as a prop was stolen from the Computing Now! offices.

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Canada's Magazine for Electronics & Computing Enthusiasts

October 1986 — Vol. 10 No. 10

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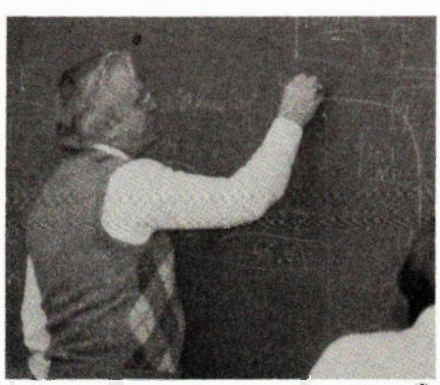
Columns and Information



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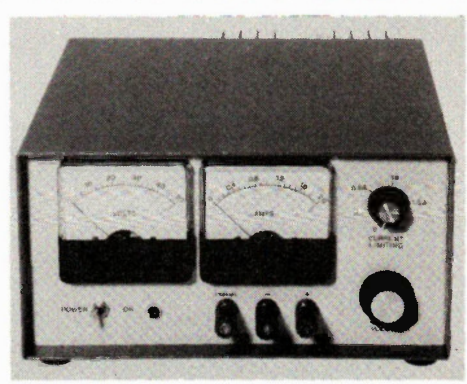

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For Your Information

The Editor's Corner

I was thumbing through some 1983 books for a friend of mine who has just acquired a computer, and I was reminded of the hysteria that accompanied the introduction of the personal micro in the early 80s. All the computer companies decided to use the same advertising approach that's used by deodorant and toothpaste sellers: buy our product or you're going to be left out of the human race, you squalid little toad. This worked for a while, until word spread that people's closets were filling up with dusty computers after the kids got bored with PacMan.

Gradually the dust began to settle after a bit of desperation in which the computer companies told you to buy a micro or they'd come around to your house late at night and beat you up.

During this hysteria, I recall watching an educator's forum in which two teachers discussed the computer language of the future. Each presented a coherent, believable argument, one for BASIC and the other for LOGO. The argument for the school's concentrating on teaching BASIC was that it's the standard beginner's language on every small machine, and the defence for LOGO was ease of use, the fact that the user can define the commands to suit the purpose.

Both points of view were wrong. The "language" of the future is turning out to be a good operating system, misnamed Disk Operating System (DOS) because it actually runs everything from disk accesses to screen display. The early systems such as Apple DOS or CP/M have been succeeded by really sophisticated comprehensive DOS types; the two most popular are MS-DOS (or PC-DOS, the same thing) and various flavors of UNIX.

The majority of people who use personal computers are not programmers and don't care to learn programming. The usual situation is that they run commercial software for word processing, spreadsheets, databases, etc., programs that are very difficult to create or modify unless you're a specialist. There's more of a need to understand the file-handling features of DOS. If you can get a grip on the basic shuffles going on in the memory map, you can implement small utilities to make computing faster and more flexible; the use of RAMdisks, key-changing macros and windowing comes to mind.

What I've been coming to is this: I'd like to start a series in ET on how MS-DOS works. The aim is not to turn people into programmers, but to demonstrate the writing of simple utilities in 8088 assembly language. All that's needed is a PC-compatible running PC-Dos or MS-DOS, and the assembler programs (MASM, LINK, DEBUG, etc.).

We'll start next month with a program written, dissected and analyzed by Ellery Henn, notable software explainer and former BBS entrepreneur. Then, in the following issues, we'll back up a bit and start from the very beginning, watching some bytes go through the 8088 registers.

We regret that due to production difficulties, the second part of the Marine Security Alarm will be delayed until next month. Our apologies for the inconvenience.

Soltech Systems Inc., formerly Soltech Industries, would like to announce a move to their new premises at 3083 Grandview Hwy., Vancouver, BC 5M 2E4, (604) 439-1289. Please note the new telephone number as well.

In our July test equipment special, we listed some out-of-date information. The distributor for the NORMA line of test gear is in fact Mesurina Ltd., 57 Hyde Park, Beaconsfield, Quebec H9W 5L7, (514) 697-6581.

Under catalogs, we neglected to mention the line of Polar test instruments, represented by Atlas Electronics, 50 Wingold Avenue, Toronto, Ontario M6B 1P7, (416) 789-7761. We'll have more coverage of Polar equipment in an upcoming issue.

32-AMP Insulated Gate Transistor

General Electric Semiconductor has introduced the industry's highest-current MOS-gated bipolar power transistors, rated at 32 amperes.

The devices, designated IG-8E20, 8D21 and 8E21, are ideally suited to power switching applications at 20 KHz and below, where low conduction losses are essential. Applications could include AC and DC motor controls, power supplies and drivers for solenoids, relays and contactors.

The IGT series provide the high input impedance of MOSFETS, and the low on-state conduction losses of bipolar transistors.

For more information on the IGT series contact: Zentronics, 8 Tilbury Court, Brampton, Ontario. (416) 451-8445.

Circle No. 35 on Reader Service Card.

Liability
While every effort has been made to ensure that all constructional projects referred to in this magazine will operate as indicated efficiently and properly and that all necessary components are available, no responsibility whatsoever is accepted in respect of the failure for any reason at all of the project to operate efficiently or at all whether due to any fault in the design or otherwise and no responsibility is accepted for the failure to obtain component parts in respect of any such project. Further no responsibility is accepted in respect of any injury or damage caused by any fault in design of any such project as aforesaid.

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

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

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

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

K.S.K. Associates, P.O. Box 266, Milton, Ont. L9T 4N9.

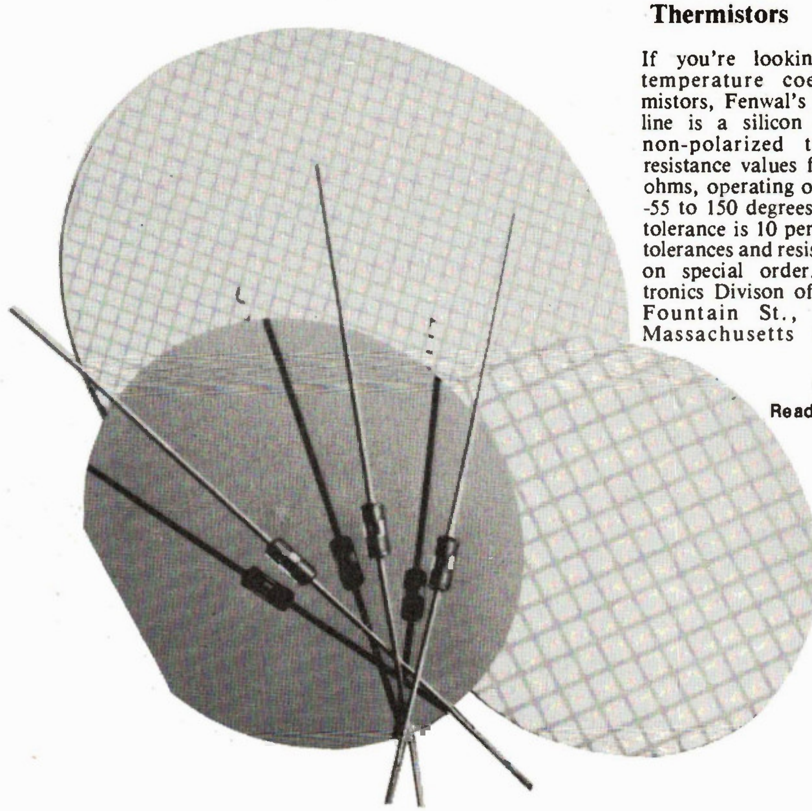
B—C—D Electronics, P.O. Box 6326, Stn. F., Hamilton, Ont. L9C 6L9.

Wentworth Electronics, R.R. No. 1 Waterdown, Ont. L0R 2H0.

Danocinths Inc., P.O. Box 261, Westland MI 48185 USA.

Arkon Electronics Ltd., 409 Queen Street W., Toronto, Ont., M5V 2A5.

Spectrum Electronics, 14 Knightswood Crescent, Brantford, Ontario N3R 7E6.



Thermistors

If you're looking for positive temperature coefficient thermistors, Fenwal's PTC Posi-Chip line is a silicon semiconductor, non-polarized type in seven resistance values from 50 to 2000 ohms, operating over the range of -55 to 150 degrees C. The normal tolerance is 10 percent, with other tolerances and resistances available on special order. Fenwal Electronics Divison of Kidde Inc., 63 Fountain St., Framingham, Massachusetts 01701, (617) 872-8841.

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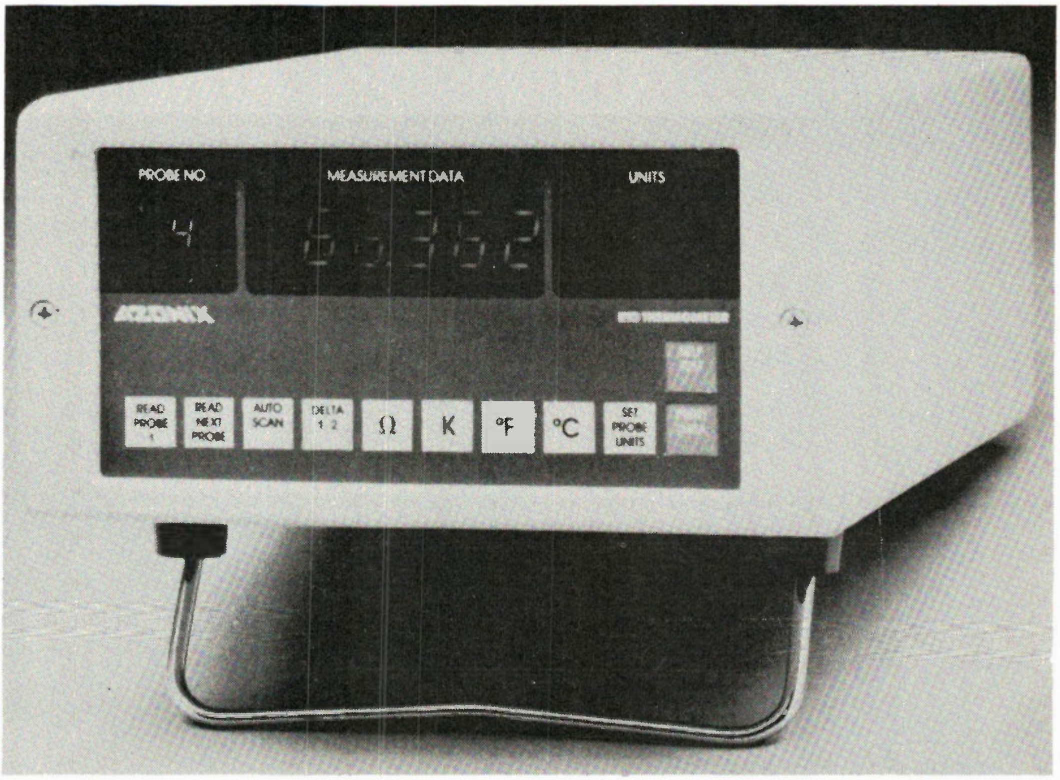
Circle No. 4 on Reader Service Card

Precision RTD Thermometer



The model A1011 Precision RTD Thermometer from Azonix, is a compact, user oriented instrument designed for precision temperature measurements.

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Circle No. 5 on Reader Service Card

Futures Looks To The Future

A training program in electronics with emphasis on practical experience.

By James W. Essex

AS they put it in today's paper: "'Futures' means opportunity for youth." Involving a new Provincial program, it offers eligible young people training, even educational upgrading, to prepare for work experience. This is something new to young Canadians who want to work but can't because they lack training and experience. This isn't easy, especially in electronics. Can the government do it?

The history of offering radio/TV courses is not a long one, nor are the years we've actually had electronics many. The heyday of the do-it-yourselfer repairman, however useful at the time, has long since passed. For those of us oldtimers who for years watched government indifference it wasn't easy. This changing attitude towards the "forgotten man" of the trade was emphasized, for this writer at least, by a local electronics company who faced the problem of what to do to increase the fund of knowledge soon to be required by the advent of colour TV in the 60s. This change in attitude by the larger electronics firms was a precursor of what was to come. It favoured the technician helping himself and thereby gaining fairer and better returns for effort, not to mention gaining a better knowledge of the product serviced. Nor was this limited to their own franchised dealers as one might have thought, but was a carefully designed, concerted educational program for all interested would-be technicians, as well as those already trained. There was, of course, a selfish interest here much as the Futures program incorporates today, though one I find commendable in that Ontario will be able to assure customers top service for their products no matter where in all of Canada. And this is not slanted to one particular electronics company, but runs the whole gamut of electronics anywhere.

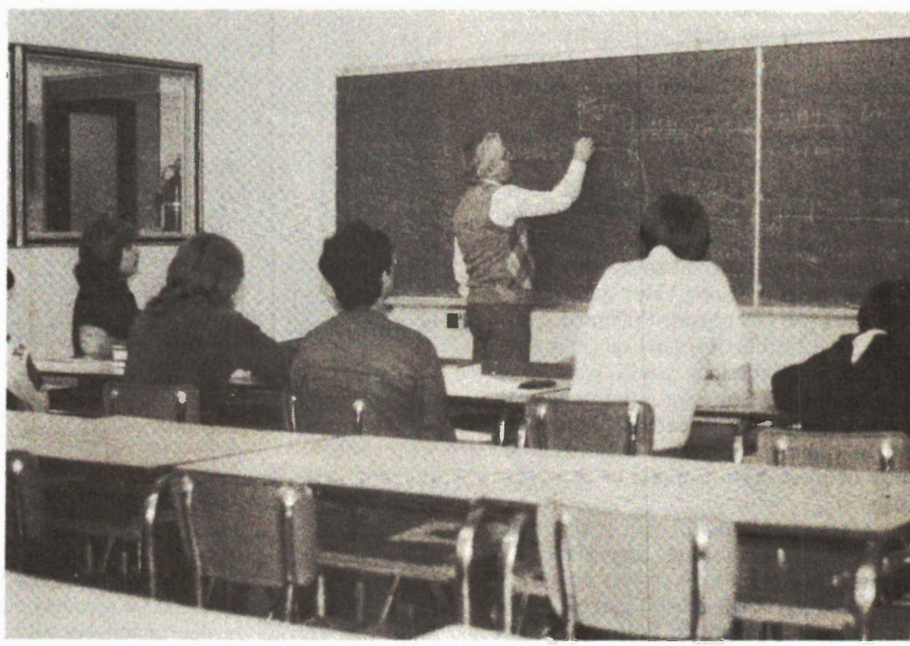

Photo by: Dave Essex

Ray Pierce instructs class.

A practical application might include instructional material mailed regularly to students. These are people, remember, just off the streets, who may have been out of school for several years and must take a quick turnaround from their perhaps get-rich-quick aspirations and return to the books. As the late Al Kleeger, service engineer for Electrohome's Commercial Service Department and Director of Education in early 1960 put it: "One subject per bulletin per page." This may have included Forward and Reverse AGC, How to identify various transistor circuits, or How to Quick-check the Schmitt Trigger and so on. This way he made the point clear without "a lot of jargon added which may have only confused rather than enlightened". I am pleased to note today many of the late Al Kleeger's Bulletins are utilized by Conestoga College's Futures Program in the 1980s.

I believe this augurs well for this new government program which has taken a leaf from industry's books. This is appropriate, for industry eventually benefits. However, apart from using local College educational facilities, the Youth Futures Program is not an employment agency. As Mr. Ron Morgan, Co-Ordinator for the Waterloo Region's effort, "We aim to put the young (ages 16 to 24) into a Training environment." At the same time, Morgan points out "we don't want to put youth back into the classroom 'just for learnin' but to help them get a job." From this it follows the hiring company has to agree to help further train the person on the job and monitor each and everyone's progress. Which brings me back to Electrohome when color TV emerged as the number one challenge for Canadian electronics industry. The corollary still holds. For example, the upheaval in the color TV industry can be appreciated by a report which appeared in an influential U.S. journal at that time (mid 1960s) "The positive-negative attitude that many service technicians have taken against color has also been a strong sales deterrent." How does the Government propose overcoming this hurdle of similar ignorance on the part of Canadian youth who have come to believe Sony were the only ones to make a color TV or capable of making the ubiquitous earphone receivers so many of them have clapped to their ears today?

First, despite what you may think, there will be no wholesale importation of personnel to man our factories now built or a-building. (Mitsubishi currently are building a local plant in Waterloo which (they claim) will eventually push out over 100,000 color TVs a year, with Canadian help. Aside from their Japanese offices (who will send personnel to learn pertinent points about us) it will be Canadians doing the work. This means training, and lots of it.

The local program is administered from downtown Kitchener. It has started from scratch, although backed by a qualified roster of trained people, and Conestoga College provides the facilities.

Full use is to be made of slides and projection equipment in putting the course across. When I called at Conestoga recently, I watched a course in actual preparation. Mr. Ray Pierce (who I subsequently learned attended HMCS Signal School in St. Hyacinthe where I was an instructor during WW2 and which was then the largest Signal Establishment in the British Empire) lectured at the blackboard, a reverse of roles when he was the student and I the teacher. What I saw best illustrates the educational look of today's electronics. Pierce took time to explain the latest approach to teaching TV, something only glimpsed on the horizon in 1943.

I watched fully "projectionized" slides, larger than life, and which more than adequately illustrated every detail of the emerging world of solid state. This was not even dreamed of in our time. "Experience is the Best Teacher" is not just an empty phrase here, because teachers of the caliber of Pierce can today easily bridge the gap of what went before and what new developments we now have. This helps provide the new technician with powerful new tools helped by a perspective bridging the old and new.

It is primarily, as Morgan put it, "to train men and women adequately to assure the pre-eminence of their skills. If this philosophy spills over and helps deserving technical aspirants, the Futures Program (electronics is just one facet of a wide range of subjects) is happy to contribute."

However, it is too early to gauge just how well this new effort will assist industry. They have already had to pull the program on Service oriented electronics because consumer electronics had become saturated. And because the industrial electronics program only began in November of 1985, it's too soon to tell if the industrial approach will do better, even if early indications suggest it will.

Lack of publicity, only now surfacing, has hurt the embryo program. When I visited Raytheon, about to embark on a multi-million dollar Airport Radar rehabilitation program, their communications co-ordinator Susan Cousineau said, "I can't imagine any technician wanting to work for $4.00 per hour." But Morgan counters with the argument that minimum wage is paid over a 16 week period by the government in return for placing an aspirant in a job. Morgan adds, "By getting them in the door, we hope they will reflect the time and training we've spent on them and convince the prospective employer they can profit by this pre-training, at no cost to them." Nor are prospective employers obligated to keep trainees if they find they don't measure up. But by the government taking the initial step at their expense, the 'Futures' Program believes it can sell the product of 'future' trainees better. Hence the title.

Several succeeding visits to perspective employers still left the impression that there's still a lack of understanding for the program. Hopefully training, combined with job experience, will lower the gates of prejudice. As one person put it, "We're not looking at Wendy's for job training; we want to be sure with the government bearing the tab, the student

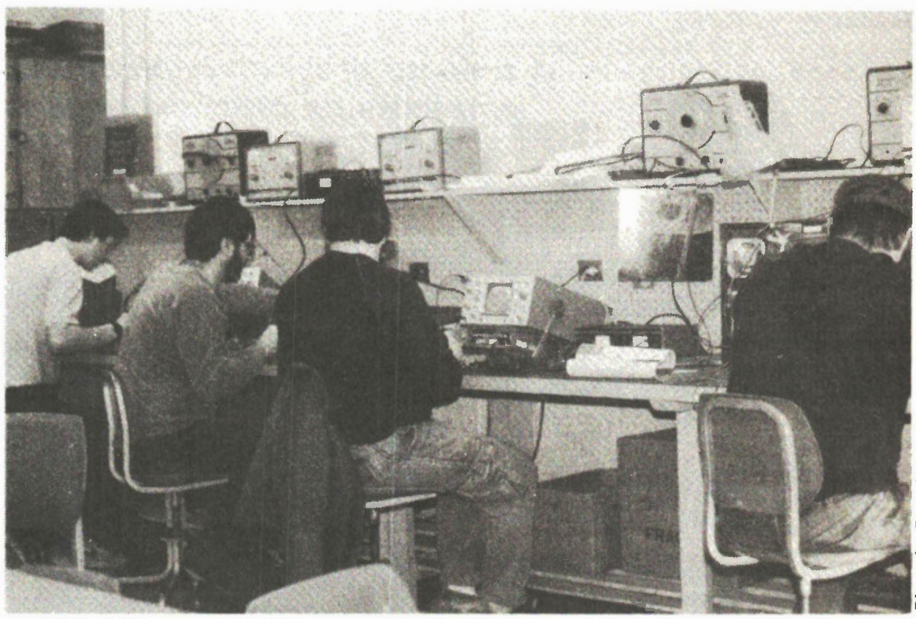

Photo by Dave Essex

Students in "Futures" Program are shown getting "hands-on" experience with an industrial slant...

will get the training which will benefit the applicant..." There's no Journeyman's program for electronic technician, for example, unlike Mechanical and Electrical Trades which have had them for years. Apprenticeship programs were the stock-in-trade in the railways for years and "This program is a close approximation of that, only in electronics and on that basis it's a selling job we must do," he said.

If I have any criticism for the Program, it would be over the manner of grades. For example, what do you do with a student (and this actually happened recently) who receives a grade mark of over 71 percent, only to receive a failing mark since a pass required a mark of 75. Remember, these are kids, young people, just off the street; many have been out of school nearly a decade. Yet, despite the fact that they indeed passed (in any High School, 63 is usually a pass) they are rejected from acceptance into a Technical Association merely by the fact they didn't get what is to me an arbitrary pass mark of 75. Think what it must do to their confidence when setting out for the first job in this hi-tech world not to have that backing which comes from knowing you passed.

I suggest a provisional membership be allowed if the examining body (which incidentally is based in the U.S.) insists on a mark greater than a First Year Engineering grad, who, with some I've seen, may take upwards of several years to cover essentially the same subject spread as 'Futures' aspirants who do it in just under a year. ■

NEXT MONTH IN Electronics Today

Fifty Years of the CBC!

Author Jack Brickenden shares his wealth of anecdotes and photographs of Canadian radio and TV broadcasting to mark the 50th anniversary of the CBC.

A Tube Preamp!

Are vacuum tubes really dead? Well, yes. But you can have a bit of fun and nostalgia with the Electronics Today one-tube hybrid hifi preamplifer.

RF Oscillators!

The know universe doesn't end at 20KHz. Here's a look at the ways and means used to generate high frequency signals.

What famous cowboy actor was originally known in Canada in the 1940s as the "Voice of Doom"?

ESD Hazard Detector

This device gives warning of any moving electrostatic field which might zap your components.

By Ian Thomas

EVERYONE is aware that on a cold dry winter's day you tend to build up an electrostatic charge on your body so that when you touch some metal object such as a tap or door knob you cop anunpleasant shock. This zap is called an electrostatic discharge and if it happens to jump onto a lead of an IC or transistor, the poor device is never quite the same again. In the last few years it has become more and more commonly recognized that semiconductor devices are extremely sensitive to these stray high voltage transients, and MOS devices more than most. From a manufacturing point of view it isn't so much the outright broken bits that matter (they can be found during test) but the bits that are somewhat bent. They appear to work but will go toes-up after the equipment has been in use for a few days or weeks.

IC manufacturers are aware of this problem and go to great pains to build protection into the devices where pins are connected out. There is, however, a limit to what you can do without degrading the device performance. In general the distributors are pretty good and try to do the right thing; but you, dear reader, may not.

An electrostatic charge is generated when two insulating dissimilar materials are rubbed together or even touched together and then pulled apart. The degree of dissimilarity and the amount of charge generated is a function of the posi-

Continued on page 17

AN OLD RESPECTED NAME.
A BOLD NEW LOOK.

Computer Mail Order is one of the oldest computer mail order companies in the country. We've succeeded where others have failed, because year after year, we've delivered to you the most product performance for your dollar and given you the attentive service you deisre and deserve.

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tion of the two materials in an order known as the Triboelectric Series, part of which is given in Table 1. It is also a function of the humidity of the air, intimacy of contact of the two materials and the rate of separation and is in general a pretty inexact sort of thing but there are clear trends. You can see from the table that cotton is pretty much neutral (and hence cotton shirts don't charge up and zap you). In general it's the materials that tend to reject moisture that create the worst charge problems as moisture tends to conduct and bleed charge away.

To give you an idea of the sorts of potentials that can be built up, Table 2 shows the effect of various actions on a dry day and a relatively humid one. It's easy to see why you can get a belt by walking across a carpet on a cold winter's day! A normal human body insulated by your average sort of running shoes has a self capacitance in the order of 100pF. A few quick prods at a calculator shows that the stored energy in your delicate body is about 60 millijoules. A piece of silicon, the dimensions of which are measured in micrometres, is blown to a thin haze!

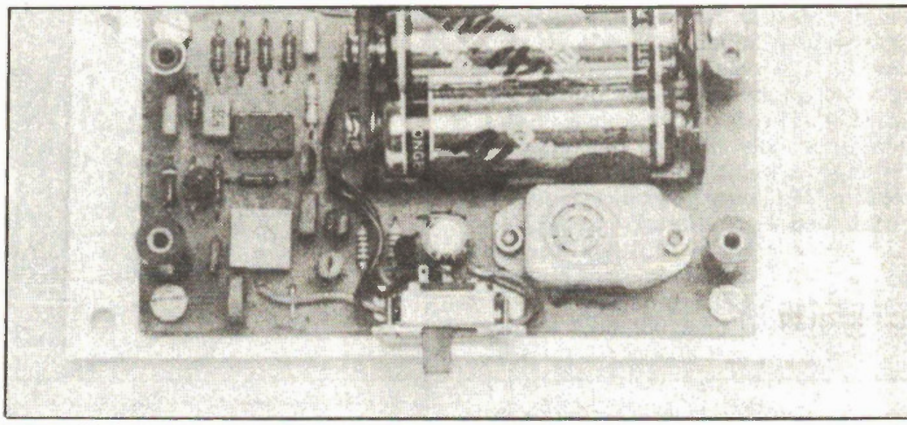
In general, MOS devices tend to be the most delicate as a fundamental part of their structure is a very thin layer of silicon dioxide which can be absolutely guaranteed to rupture at the order of 100 volts or so. For this reason even power MOSFETs that can cope with tens of amps at hundreds of volts can be ruined by one little zap on the gate lead. This certainly doesn't mean that you can do what you want with bipolar devices. If sufficient energy is dumped into the input junction then the device will fail.

Design

Whenever a body is charged up to a high potential then it is surrounded by an electrostatic field normally expressed in volts/meter, and if the body moves then the field moves with it. If you've just been dancing on your lovely new nylon carpet and charged yourself up to 10 zillion volts then the field from that charge spreads out from your body quite a long way.

It seemed to me that an instrument that detected the approach of this field and sounded an alarm would go a long way to avoiding blasted silicon. At least you would be warned to discharge yourself. It's extremely difficult (read expensive) to detect a completely static electrostatic field, but a moving one is not such a great problem. A simple thought experiment will explain the problem and show how a detector could be built.

Suppose we have two parallel plates of a capacitor magically suspended in space 25mm apart and with an area of about 5000 square mm, a not inconvenient size for a detector. The capacitance between



Air	POSITIVE
Human skin	
Glass	
Human hair	
Wool	
Fur	
Paper	
Cotton	
Wood	NEGATIVE
Hard rubber	
Acetate rayon	
Polyester	
Polyurethane	
PVC (vinyl)	
Teflon	

Table 1

its plates works out to be very roughly 2pF. Suppose a field of 500 volts/metre is suddenly imposed across these capacitor plates (definitely ESD hazard conditions!). The potential between the plates will immediately rise to 12.5 volts (500 volts/metre times 2.5/100 metres). The problem is that any attempt to measure the voltage (cheaply) will immediately bleed the charge away. Even a 10 megohm resistor gives a time constant of only 20 microseconds.

This transient could possibly be detected except for another major problem. The whole world is filled with (it would seem) literally thousands of volts/metre of 60Hz power line hum and if a detector was built with a bandwidth sufficient to detect the spikes then it would be continually set off by 60Hz fields. This means that the detector needed to operate on our parallel plate capacitor must have a filter that cuts off fast before 60Hz. If the detector doesn't respond to frequencies then the input RC time constant needs to be very long, about a second! Hence the problem in building such a device. It must have an incredibly high input impedance or alternatively huge capacitor plates to up the sensing capacitance. With 2pF input capacitance this gives a detector input resistance of 500 gigohms. Even though the input impedance of some MOS input op amps approaches this figure, it isn't a lot of use as an actual resistor is needed to define reference voltages. As 500 gigohm resistors are just a little hard to buy this basic approach won't work.

It then occurred to me that we were trying to detect voltages in the order of tens of volts. This combined with the fact that these days gain is cheap gave me the clue. If one plate of the sensor capacitor plates was connected to the other through say a 5000pF capacitor then the input tens of volts would be attenuated to fours of millivolts, but then the detector capacitor forms a potential divider with the 5000pF and increases the size of the source capacitance. In this case the needed detector input resistance drops to around 100 megohms to be usable. This is still a bit gross but getting closer. From an engineering point of view you can get 100 megohm resistors but they are expensive and hard to procure. About the largest I could find easily was 10M. There are 22 meg resistors, but I settled for 10M for reasons I'll go into later.

The next problem is how one can magically change a 10 meg resistor into a 100 meg resistor. The method goes by the delightful term *bootstrapping*. Consider a resistor with a voltage applied to one end as shown in Figure 1. The current through the resistor due to the imposed voltage is I. If a buffer amplifier with a very high input impedance is connected to the top of the resistor with a gain of say 0.9 and its output is connected to the ground end of

Means of generation	Humidity 10-20%	Humidity 80-90%
Walking across carpet	35,000	1500
Walking on vinyl floor	12,000	250
Worker at bench	6,000	100
Vinyl envelopes as per work instructions	7,000	600
Common poly bag picked up from bench	20,000	1200
Work chair padded with polyurethane foam	18,000	1500

Table 2

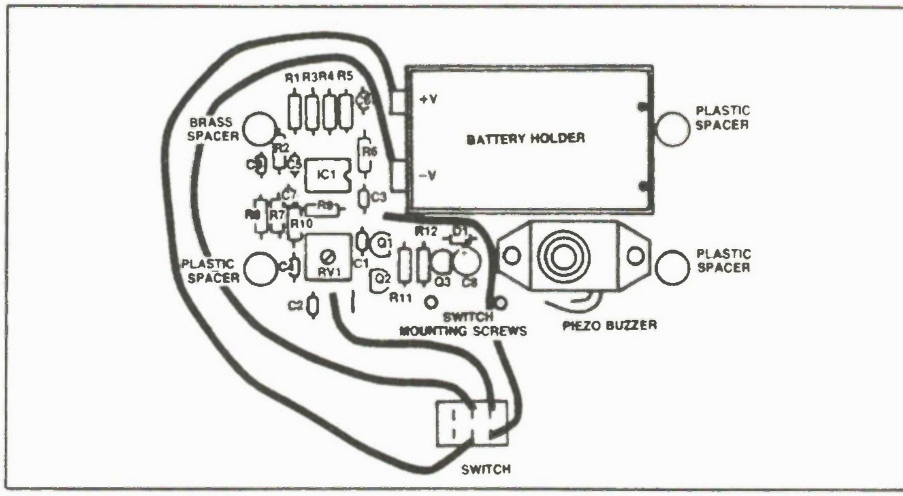
the resistor then the voltage drop across the resistor is no longer V as in Figure 1 but V-0.9V or only 0.1V. This means that even though the full V volts is being imposed on the resistor, the current flowing into it is only 0.11 so the effective resistance is multiplied by 10. This would seem to be a pretty good trick to use. It does have bad side effects like multiplying all offset problems by 10, but if these can be managed then a 10 meg resistor can be changed into a 100 meg resistor.

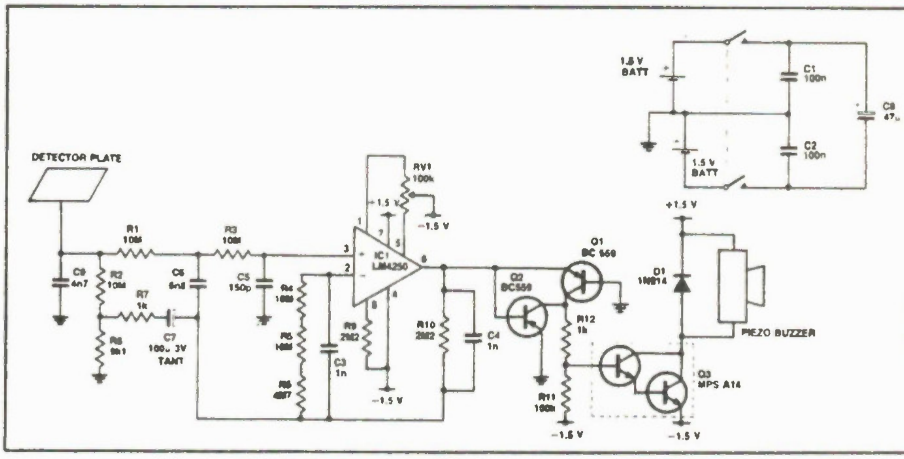
As the detector does not need a large bandwidth (in the final device there is a lot of circuitry to reduce it) a very low power op amp such as the National LM4250 can be used. The power drawn by this IC can be set to almost any value required by an external resistor. The op amp bandwidth varies accordingly but even at microamp levels has more than enough. The LM4250 is specified down to 3 volts total supply voltage so the detector could be powered off two penlight cells. If the total IC power drain is kept below a few microamps then the life of the cells in the detector is effectively their shelf life.

Circuit details

The actual filter used to attenuate the 60Hz is straightforward and 10M resistors were used throughout. As there is effectively 30 megohms between the positive input and ground it is necessary to add in about 30 megohms between the negative input and the output to balance the effect of bias currents in the op amp. For the LM4250 operating at a few microamps the offset current (that is, the difference in bias currents of the op amp inputs) is still up to 5 nanoamps. With 30 megohms this generates a differential offset voltage at the input in the worst case of 150 millivolts. This could be adjusted out with an offset adjust pot but the problem is further aggravated by the bootstrapping with R7 and R8. C7 had to be added to remove both the bootstrapping and the high gain for very low frequencies or the input simply floated all over the place.

However, for frequencies between 0.5Hz and 15Hz the detector gain is pretty much flat and set by the ratio of R10 to R7 + R8. When I slogged through the algebra to calculate the transfer polynomial for the circuit, one very interesting fact emerged: the gain of the detector is proportional to the size of C8. You will recall that the input to the detector is actually a capacitive divider made up of the detector plates and C8 so the larger C8 is the higher the input capacitive divider attenuation but then so is the amplifier gain! They cancel out. Most serendipitous. Once again, there are always limits like offset problems that don't show up in the mathematics but basically it's whatever is convenient in the filter for C8.





The parts overlay (top) and schematic diagram.

Transistors Q1 and Q2 act to turn on the Darlington transistor Q3 when the op amp output exceeds one Vbe. I wanted a nice loud alarm when there was a hazard situation so I used one of the small 3 volt self contained alarms. They're nothing if not loud. A quick estimate of the board area showed it would fit nicely into a plastic utility box 130mm x 70mm x 40mm with a metal bottom. The metal case bottom serves as one plate of the sensing capacitor so plastic cases aren't any good.

Construction

Everything is mounted on the PC board, including the batteries. You can copy the artwork provided. However you do it, try to stick exactly to the layout given.

Mounted over the board on 25.4mm spacers is the second plate of the sensing capacitor. Three of the spacers are made of insulating material and the fourth is metal and carries the received voltage to the detector input. The switch is included in case a situation arises where high fields can't be avoided.

Before the board components are assembled it's a smart idea to use it as a template to drill the holes for the base plate and the detector plate.

Make sure that the IC and the electrolytic capacitors are in the right way. The battery case I used was one which held four penlight cells. You can get battery holders that only take two cells but if you look at where the holder is mounted you'll see that it would be impossible to get one of the cells in. The four cell holders come in various brands, some with nickel plated steel contacts and some with aluminum. The aluminum ones aren't so good here as it's necessary to solder to the springs and you can't solder aluminum! It's difficult enough with the nickel.

Carefully cut away the side of the battery holder that doesn't have terminal clips. This will leave you with a spring protruding which should be straightened out. On the piece of holder that was cut away there is a second spring still riveted to the plastic. Drill, bash or bend the rivet out and retrieve the spring. Straighten out the end of the spring that was riveted so it can be inserted in a hole in the printed circuit board. Mix up some epoxy or similar and glue down the battery holder then insert the straightened out spring so as to make a neat two cell battery holder as pictured.

The next and nastiest bit is to solder the nickel plated springs on to the large ground area of the printed board. Nickel is a beast of a material to solder. The buzzer is screwed down and both its leads soldered into the relevant pads. Be careful as the polarity must be right. Finally the board must be cleaned absolutely scrupulously of all flux and residue. There are a lot of high impedances and leakage could be a nuisance.

Testing

Testing is really quite easy. Insert two batteries and turn it on. The alarm should sound for about 20 seconds or so as C7 charges to the offset voltage then it shuts off. Let it settle for a few minutes then measure the voltage between pin 6 of the IC and ground. Adjust RV1 until it averages out to zero. This is a fiddly and odious task as you only have to (literally!) wave your hand near the detector input and pin 6 slams up against the rails. Fortunately, it isn't all that critical. Once this is done, screw on the detector plate and the unit is ready to go into the box.

Finally before fitting the unit together you'll have to cut a hole for the power switch. It makes sense to drill a few holes to let the buzzer sound out. Slip the unit into the box and screw it in place with the four screws provided then turn it on. If you keep well away from it, it should sound for 10 seconds or so then go quiet. Just waving your hand close over it or touching the box will set it off. Then you may leave it on in a corner of your workbench and breathe a bit easier!

The Circuit

The alarm detects electrostatic fields by sensing the potential difference they generate on a parallel plate capacitor. One plate is the base plate of the case and the other is a plate held by spacers above the detector.

Resistors R1 and R3 form a low pass filter with C5 and C6 to attenuate AC hum. Further attenuation is provided by C4 which rolls off the operational amplifier IC1's response. R7 and R8 serve two purposes. The first is to act as a gain determining element which, together with R10 sets the gain of the op amp at 220. Also the node of R7 and R8 has a voltage of 0.9 times the voltage on the positive input of the amplifier (and the negative input too; such is the nature of operational amplifiers). R2, the input bias setting resistor, is connected to this node so that any signals that appear at the input to the detector are also imposed, multiplied by 0.9, on the other end of R2. This is known as bootstrapping and effectively multiplies the value of R2 by 10.

The overall effect of this is that any voltage that would be induced on a capacitor with plates about 20mm apart appears with a low source impedance at the output of the op amp, attenuated 10 times when everything is taken into account.

Transistor Q1 is turned on if the op amp goes more than 0.6 volts positive and Q2 is turned on if it goes negative. Both collectors drive the base of the Darlington transistor Q3 which in turn powers the alarm. Thus excursions of 0.6 volts set off the alarm or, tracing back through the circuit, the detector will pick up fields of greater than 300 volts/metre. ■

Parts List

Resistors

All ¼W, 2% metal film

R1, 2, 3, 4, 5	10 megohm
R6	4M7
R7, 12	1k0
R8	9k1
R10, 9	2M2
R11	100k
RV1	100k trimpot

Capacitors

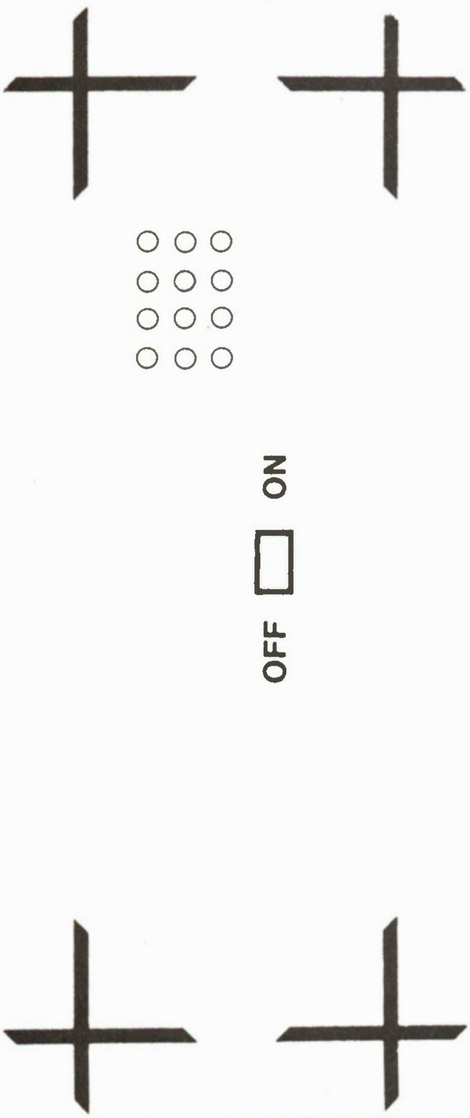
C1, 2	100n 10% met poly*
C3, 4	1n 10% met poly*
C5	150p 10% met poly*
C6	6n8 10% met poly*
C7	100u 10% 3V tag tantalum
C8	47u Al electro
C9	4n7

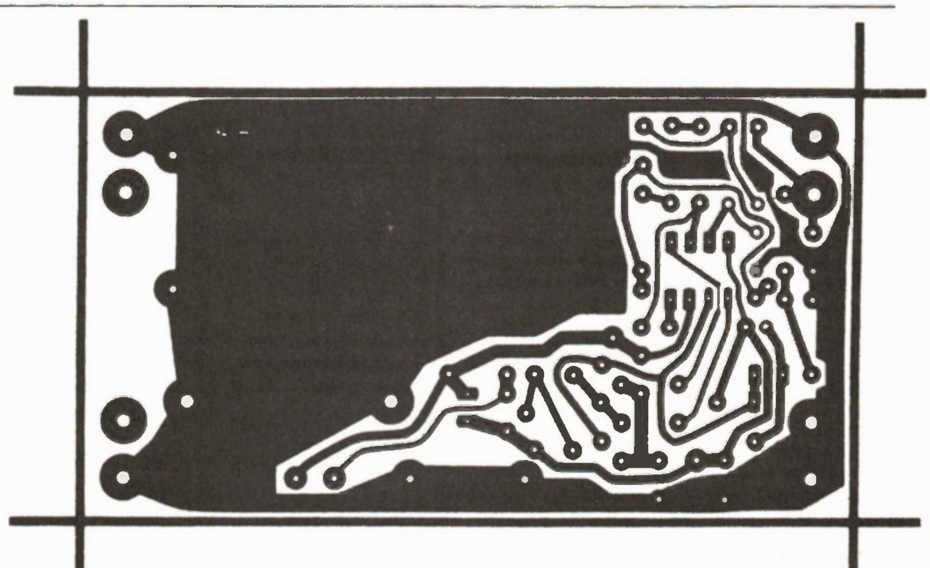
Semiconductors

IC1	LM4250
D1	1N914
Q1, 2	2N6003
Q3	Motorola MPS-A14

Miscellaneous

2 x AA batteries; battery holder; Piezo buzzer; slide switch; 3 x 25.4mm insulated spacers; 1 x 25.4mm metal spacer; hookup wire; 130mm x 70mm x 40mm case with metal bottom; 5cm x 100cm metal plate.



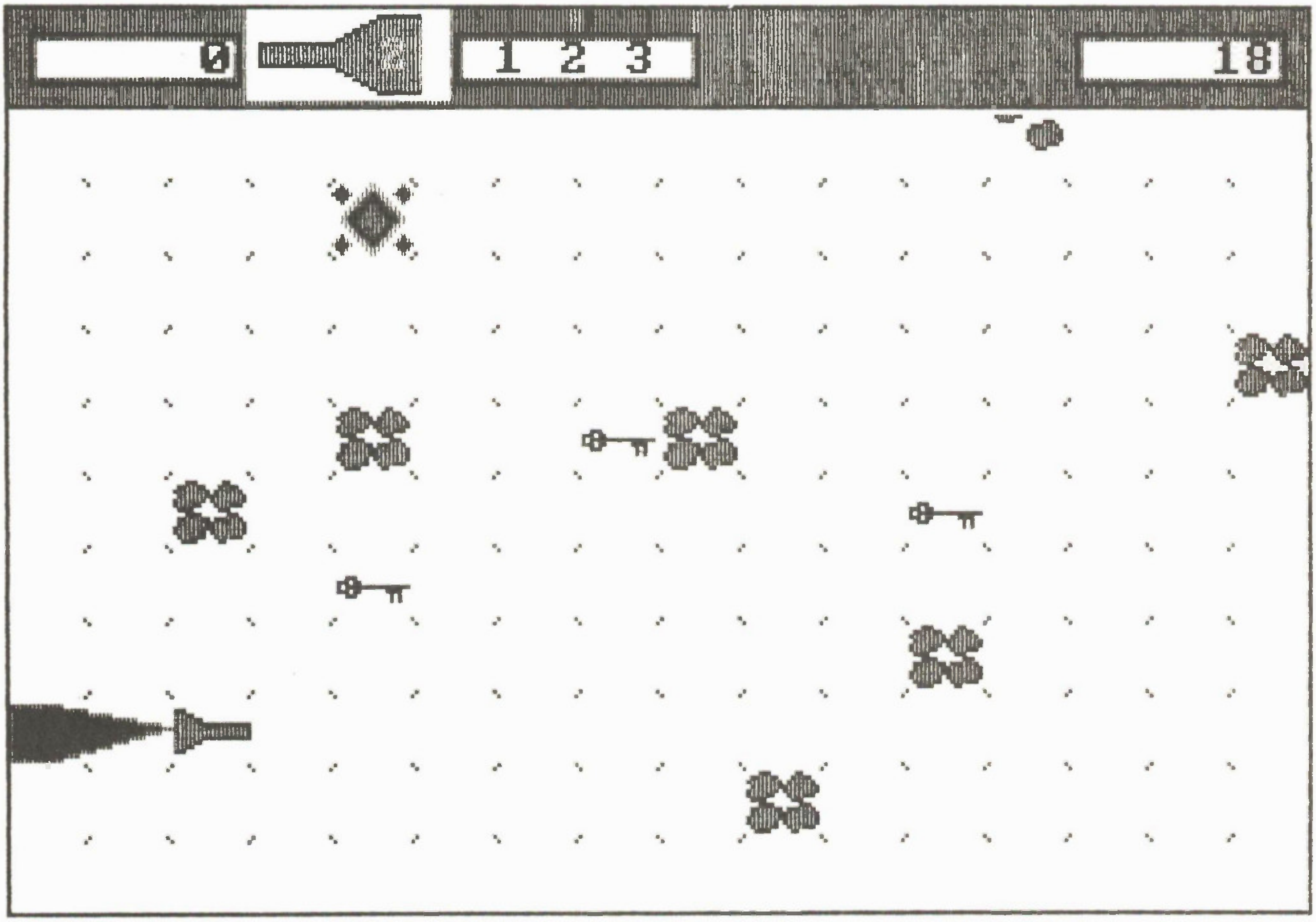


The front panel artwork (left) and the PCB foil pattern.

Almost Free PC Software

Volume XV

Programs to Blow Up Your Monitor With



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 bizarre variation on the theme of space invaders. No longer the dusty arcade game that it once was, this thing breathes new and rather ichorous life into the ceaseless battle between you and the phospor aliens. This is one of the best computer games in creation. Requires a colour graphics 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.

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Designer's Notebook: Computer Interfaces

The operation and connection of the three most common standard computer interfaces: Centronics, RS232C and IEEE488.

By R.A. Penfold

COMPUTING can be confusing, especially when you try to expand a basic system into something a little more elaborate and useful. There are probably as many different types of interfaces as there are computers, and although there is a vast array of computer add-ons available, only a few percent of these can be used directly with most computers. In fact many machines only have the manufacturer's own variety of interface or interfaces, and will only operate directly with add-ons manufactured specifically for the particular computer (or make of computer) concerned.

However, there are some standard computer interfaces, and fortunately there is a trend towards the inclusion of at least one of these on newly introduced computers. With one of these interfaces fitted there is usually a wide range of suitable peripherals to choose from, and not just one or two manufacturer's-own units. A standard interface does not overcome all interfacing difficulties though, and there can be problems when connecting two supposedly standard and identical interfaces. This s usually just a problem with connecting leads, and is caused by the use of inexpensive connectors at the computer (often just an edge connector formed by the printed circuit board) instead of the correct type called for by the interface specification. For instance, I have come across several home computers equipped with a Centronics-type printer port, but I have yet to see one which has the correct 36-way connector.

In this article we will look at the operation of the three most common standard computer interfaces, the Centronics, RS232C, and IEEE488 types. Hopefully this should help any prospective users to obtain good results when using any of these interfaces, and also to decide which is the most suitable for their requirements.

Centronics

The Centronics printer interface, or 'parallel' printer interface as it is often termed, is probably the best starting point as it is the most simple of the three types. It differs in one important respect from the others in that it is only usable as an output, and it cannot be used to feed data into the computer. This is perfectly satisfactory for use with printers of course, and for some other computer peripherals, but it is unsuitable for an application where two-way communication is required, such as a modem interface.

With the Centronics system the data is sent in parallel form. In other words, each byte of data is sent on eight wires plus a ground line, with all eight bits being transmitted simultaneously. It is worth noting that some computers do not actually implement all eight bits, and that in

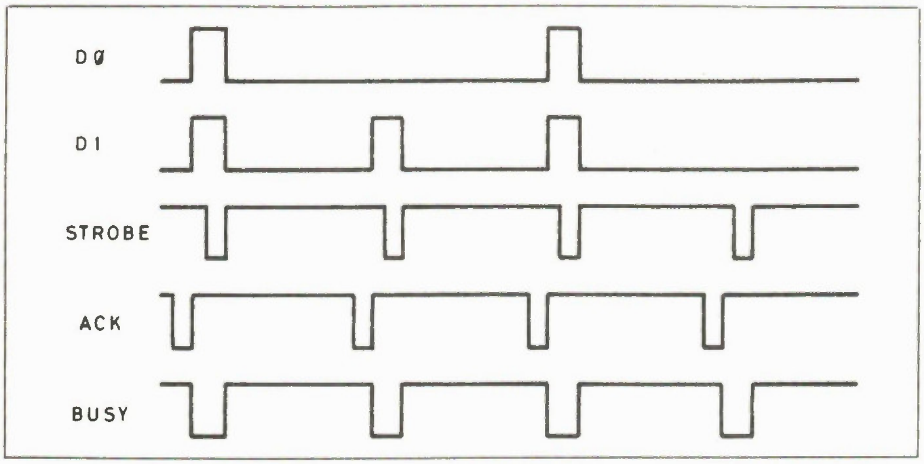

Fig. 1. Centronics timing diagram.

some cases the most significant bit is simply connected to ground. This method is usually satisfactory in practice as the ASCII Codes and ASCII based codes used in most computers only use the seven least significant bits. It can sometimes lead to problems though, as some printers use the eighth bit for control codes, and if the most significant bit is not implemented it is not possible to send these codes.

In practice a simple eight data line plus ground system cannot function properly, as the printer would have no way of determining when fresh bytes of data were available and waiting to be printed. This is overcome by the inclusion of a negative Strobe line, which is another output from the computer. This briefly pulses low each time a fresh byte of data is available, indicating to the computer that the data for the next character to be printed is available on the data lines. The timing diagram of Fig. 1 helps to show the way in which this operates. The printer has an eight bit data latch at its input, and this uses the strobe signal as the latching pulse.

Most computers drive the data lines from latching outputs which remain static between bytes, but this is not strictly necessary as the states on these lines between strobe pulses is irrelevant, and these lines could be used for other purposes during these periods. On the other hand, some home constructor add-ons which are driven from parallel printer ports rely on the port providing latching outputs, and will not work at all with those that do not.

Handshake

The system as described so far will only work if the printer can accept data as fast as the computer can send it. As the computer is likely to be able to send data at a speed of many kilobytes per second it is unlikely that the printer could do so, as even fairly high speed types can only print at around a couple of hundred characters per second. Even if the printer has a buffer, it is still possible that the computer could output data at an excessive rate for the electronics in the printer, and the buffer might have an inadequate capacity to hold all the data from the computer anyway.

Some means of regulating the flow of data to a rate that can be handled by the printer is therefore essential, and the Centronics system gives two 'handshake' options. These are the Busy and Acknowledge lines. Note that it is only necessary to implement one or the other of these, and while connecting both might not actually cause a malfunction, it would be pointless. Although most (probably all) printers have both Busy and Acknowledge outputs, many computers only have an input for one or other of these.

If we start with the Busy line, this is normally low. When the computer outputs a byte of data the printer sets the Busy output high, and it holds it in that state until processing of that byte of data has been completed. The computer uses a software routine to monitor the Busy line and provide a hold-off until it returns to the low state. The next byte of data is then written to the port, the printer sets the Busy line high again, and so on, until the transfer of data has been completed.

The Acknowledge line is normally in the high state, and when a byte of data is received by the printer it stays high. It is not until the byte of data has been processed and the printer is ready for the next byte that the Acknowledge line is pulsed low. The software routine in the computer must therefore monitor the Acknowledge line and provide a hold-off until the negative pulse is detected.

In practice you might find that the handshake input of the computer, regardless of what it is called, will operate with either handshake output of the printer, or even that it will only operate with the wrong one. This occurs because, as can be seen from Fig. 1, the Busy and Acknowledge signals are quite similar. What tends to complicate things slightly is that there seems to be less than total agreement on the correct polarity for the handshake signals. In some cases it might be necessary to invert the handshake signal in order to obtain satisfactory results, but in most cases a suitable handshake connection (even if it means resorting to cross coupling of Acknowledge and Busy) can be found.

Connector

The standard connector for the Centronics printer interface is a 36-way Amphenol type, but these are often sold simply as 'Centronics' plugs and sockets. Printers are fitted with sockets incidentally, and a 36-way Amphenol plug is therefore needed to make connections to a printer fitted with a Centronics interface.

Fig. 2 shows connection details for a standard Centronics interface (and 36-way Amphenol connector). There are several connections here which have not been discussed so far, but probably the only ones of these that you will need to use ar

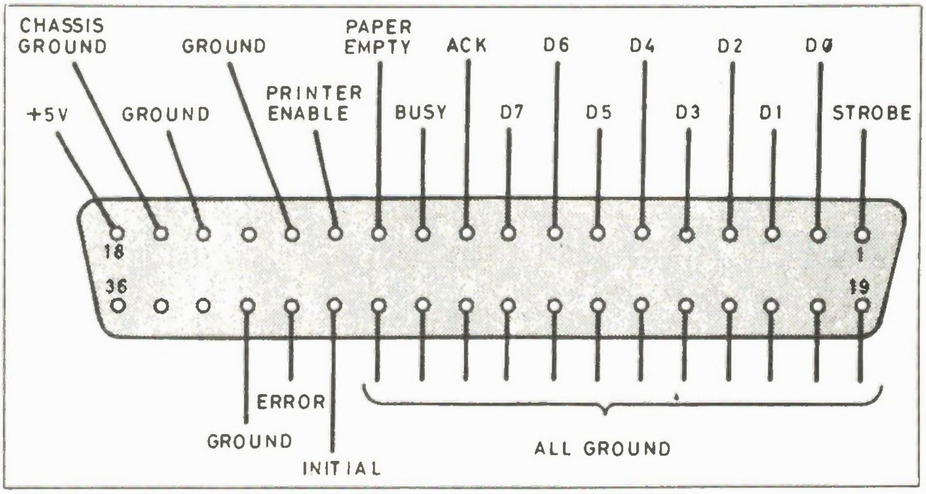

Fig. 2. Connection details for a standard Centronics interface.

the ground connections. There are a number of these, and this is done purposely so that they provide shielding between the signal lines of the ribbon cable used to connect the computer to the printer. Otherwise there is a danger of stray capacitance in the cable causing signals to be coupled from one lead to another, generating corruption of the data. Even with these shielding leads the maximum recommended cable length is only two metres. In practice there is usually no problem if a single ground lead is used, but the cable length is restricted to only about half a metre or so.

The other lines are provided on most printers, but are all absent from the printer ports of most home computers. The Error line is an output from the printer which simply goes low if an error condition occurs. This can be monitored by the computer and used to halt the flow of data when an error occurs. The Initial terminal is an input to the printer, and after an error condition has occurred the printer can be reset by a low pulse fed to this input. An alternative which can be used where Initial is not implemented on the computer is to just turn the printer off and then on again.

Paper Empty (or Paper End as it is sometimes termed), as its name suggests, goes low to indicate that the printer is out of paper. This feature is one which is only likely to be implemented on a printer with a cut sheet feeder, although it is a feature of some tractor feed printers. Print Enabled is an output which goes high when printer is selected (if it has a select-/deselect switch). The output is a +5V DC supply which can normally provide currents of up to about 100 milliamps.

The facilities available vary slightly from one printer to another, and a clock signal of some kind is sometimes available at one of the normally unused pins. An input to give an automatic double line feed is another line which is sometimes included, either at one of the normally unassigned terminals or in place of one of the other minor facilities. Every printer should be supplied with a manual which gives at least basic details of its input port and the exact facilities it provides.

Serial Interfaces

The RS232C is the best known type of serial interface, but there are several other types that are really just variations on the same basic system. The RS232C and RS423 systems are compatible with one another and it makes little practical difference which one your computer has.

With a serial interface the signal is carried on just one data line plus a ground lead. Obviously no more than one bit at a time can be carried by the single wire, and each byte therefore has to be transmitted literally bit-by-bit. The convention is for the least significant bit to be transmitted first, running in sequence through to the most significant bit which is transmitted last. Simply transmitting bursts of data in serial form is of no practical value, since there is no way for the receiving equipment to correctly interpret what would appear to be just a random series of pulses. One way around the problem is the synchronous approach where a third line is used to carry some form of synchronization signal. For instance, this could be a sort of clock or strobe signal to indicate the times when the data line should be sampled to determine the state of each bit.

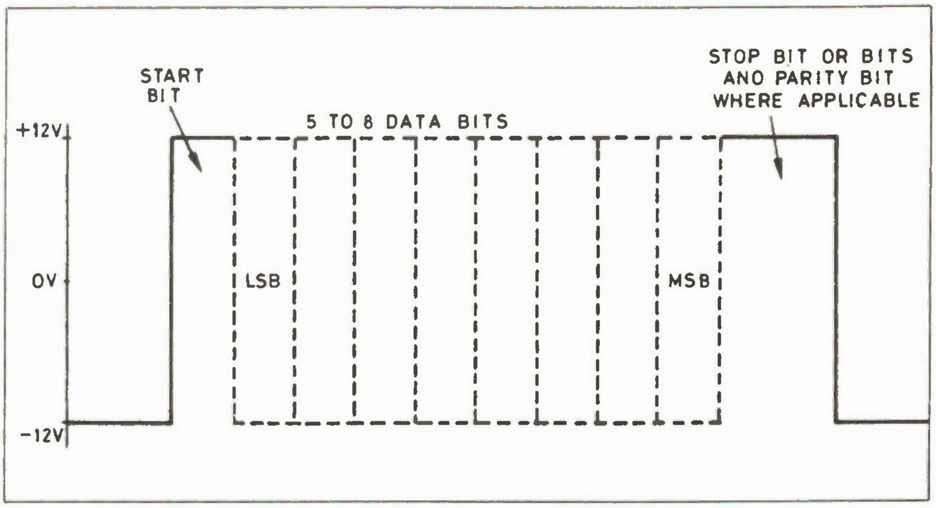

Fig. 3. The make up of an RS232C byte.

Asynchronous

Synchronous interfaces are used in practical systems, but they seem to be in the minority, and most serial systems, including the RS232C and RS423 ones, use the asynchronous approach. Rather than relying on an additional signal line an asynchronous system uses extra signals on the data line. The most important one of these, and the only really essential one, is the start bit. Under standby conditions the data line is in the low logic state, but at the start of a byte it goes high for a certain period of time. This change in state indicates to the receiving equipment that a byte of data is about to commence, and that it must sample the data line at regular intervals thereafter until the state of each bit has been determined.

All practical asynchronous systems seem to use an additional bit or bits at the end of each byte, and these serve as a form of error checking. There is always at least one stop bit, and sometimes two stop bits are used. The data line is simply set high for a period of one or two bits, as appropriate.

Some systems use parity error checking, or at least have the facility to do so. It is a system which seems to be little used in practice. With parity error checking each byte always contains either an odd number of 1s or an even number of 1s, depending on whether odd or even parity has been selected. Obviously either an odd number of 1s in every byte or an even number of 1s in every byte is something that will not happen without some assistance from the hardware, and this assistance takes the form of an additional high bit (the parity bit) added between the last data bit and the first stop bit, when necessary. A simple flip/flop circuit at the receiving equipment is practically all that is required to provide parity checking and to indicate any errors that occur. Parity checking is not infallible, and a double glitch can preserve correct parity but corrupt the data.

Fig. 3 helps to clarify the way in which an asynchronous system operates. An important point to note here is that the voltage levels are not ordinary 5V logic types, but are nominally -12V and +12V. In fact the maximum acceptable voltages are +25V and -25V, but the standard calls for a minimum of just +3V and -3V. The RS423 system has nominal signal levels of plus and minus 5V (plus and minus 4V to 7V is the acceptable range), together with higher drive current (150mA maximum instead of 10mA) and less stringent demands with regard to rise and fall time. This gives somewhat greater operating range for a given baud rate, but the RS423 system is compatible with RS232C equipment. In practice standard 5V logic levels will often drive RS232C and RS423 inputs satisfactorily, but this cannot be guaranteed to work in every case. An RS232C or RS423 output should not be used to directly drive an ordinary logic input as this could lead to the destruction of the input device.

Signal Polarities

Incidentally, serial interface explanations sometimes show the signal polarities as the opposite of those shown in Fig. 3 with the signal at +12V under quiescent conditions, and going to -12V during the start bit. Measurement on RS232C and RS432 interfaces seem to confirm the polarity indicated in Fig. 3. The confusion probably arises because serial interface devices do require and generate signals of the opposite polarity to that shown in Fig. 3. However, they are intended for use with line drivers and receivers that provide the necessary level shifting, and also provide and inversion of the signal. Not all serial interfaces use special interface devices to generate and decode signals, but instead rely on ordinary digital input and output lines plus suitable software routines to generate and decode the signals.

As will probably be apparent, wiring two serial interfaces together correctly will not necessarily give a proper transfer of data from one unit to another. To ensure correct data transfer both pieces of equipment must be set to use the same word format. The most common of these is one start bit, eight data bits, one stop bit, and no parity (which is the standard format for RS423 equipment). There are several others in common use though, and apart from the options of one or two stop bits, and odd, even, or no parity, five, six, seven or eight data bits can be used. In computing applications only seven or eight data bits are normally encountered, since ASCII and ASCII-based character codes require at least seven data bits; five data bits might also be encountered though, as five-bit word formats are used in radio communications (RTTY) systems.

There is another factor to take into account, and this is the rate at which data is sent. Obviously the receiving equipment must sample the data line at the appropriate intervals after the start bit has been detected if each bit is to be decoded properly. In order to ensure correct synchronization of the transmitting and receiving circuits there are a number of standard transmission/reception rates. These are 45.45, 50, 75, 150, 300, 600, 1200, 1800, 2400, 4800, 9600 and 19200 baud. The baud rate is the number of bits sent per second if a continuous data stream is transmitted. It is no coincidence that the higher baud rates are multiples of the lower ones (with the exception of 45.45 which is only used in amateur RTTY systems), and this enables a single clock oscillator plus binary divider chain to provide virtually a full range of baud rates.

The RS232C system is guaranteed to operate at up to 20k baud over a distance of 5 metres. Capacitance in the connecting cable could distort the signal and cause corruption of the data if higher baud rates and (or) longer cables were to be used. On the other hand, at low baud rates of around 75 to 1200 baud it is feasible to use connecting cables much longer than 15 metres. For communications over very long distances the serial signals are normally tone encoded at the transmitter and then decoded again at the receiver, as in a modem system. There is actually a form of serial interface (the RS422 system) which can handle baud rates of up to 10M baud over short distances, or up to 100k baud over a range of up to 1200 metres. This is achieved using a balanced (two signal wire) system, but it has made no impact in the home computing field as yet, and for most purposes the RS232C and RS423 systems are perfectly satisfactory.

Interconnections

At the most basic level RS232C interconnections just consist of two wires, one to connect the two signal grounds, and the other to connect the data output of the transmitting device to the data input of the receiving device. For two-way communications three wires are required, a ground connection and two leads to cross-couple the data inputs and data outputs of the two devices. In other words, a separate signal wire is needed to carry signals in each direction.

Serial data systems are relatively slow, and handshaking to control the flow of data is sometimes unnecessary. Typically ten bits per byte are transmitted, which at 300 baud corresponds to a maximum transfer rate of just 30 characters per second. However, at high baud rates the transfer rate can be around one kilobyte per second or more, and some applications do require handshaking to be implemented. THE system of handshaking is very simple, and just requires one extra connecting lead (or two in a two-way system).

At the receiving equipment the handshake line normally implemented is DTR (data terminal ready) which connects to CTS (clear to send) of the transmitting equipment. DTR goes positive to indicate that the receiving equipment is ready to receive data, or negative to provide a hold-off. RTS (request to send) may be implemented in place of DTR, and DSR (data set ready) may be present instead of CTS, or you may have all four available. At a practical level it is often a matter of trying out a few options to determine which handshake arrangement gives correct operation, but a typical setup providing two-way communication with full handshaking would use a five-wire arrangement something like that shown in Fig. 4.

A point which is well worth noting is that it is sometimes necessary to implement handshaking even where it will not provide any regulation of the data flow. This occurs where a piece of equipment will not provide any output unless its handshake input is taken to the appropriate signal level.

RS232C Connectors

The standard RS232C connector is a 25-way D type, and this uses the method of connection shown in Fig. 5. Some of the pins are unused, and in practice, even if the port uses the proper type of connector, only the ground, main signal, and main handshake lines are likely to be implemented, with the other terminals just being left open circuit. The Sinclair QL, for example, only implements ground, data in and data out, CTS, DTR, and a +12 volt line to act as a dummy DSR line (for use with equipment that requires the handshake input to be taken positive in order to enable output). While this falls well short of the full RS232C standard, it

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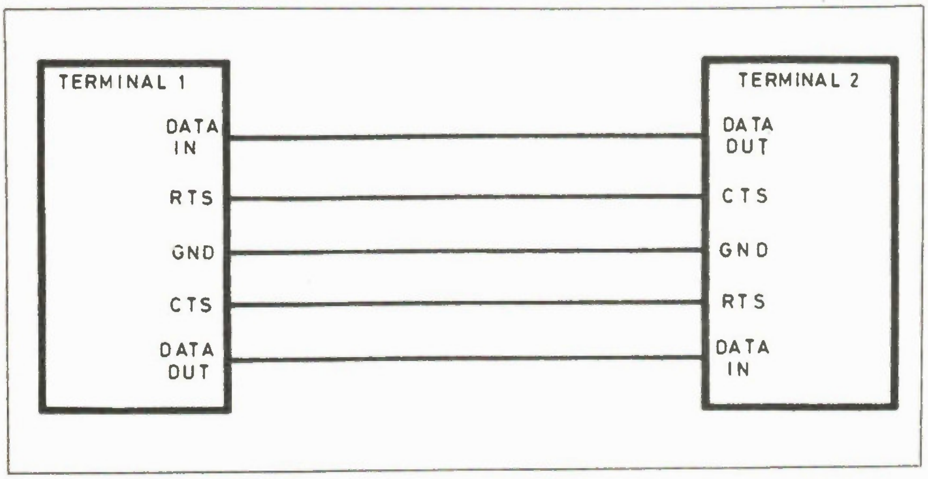

Fig. 4. A typical five wire serial interconnection system.

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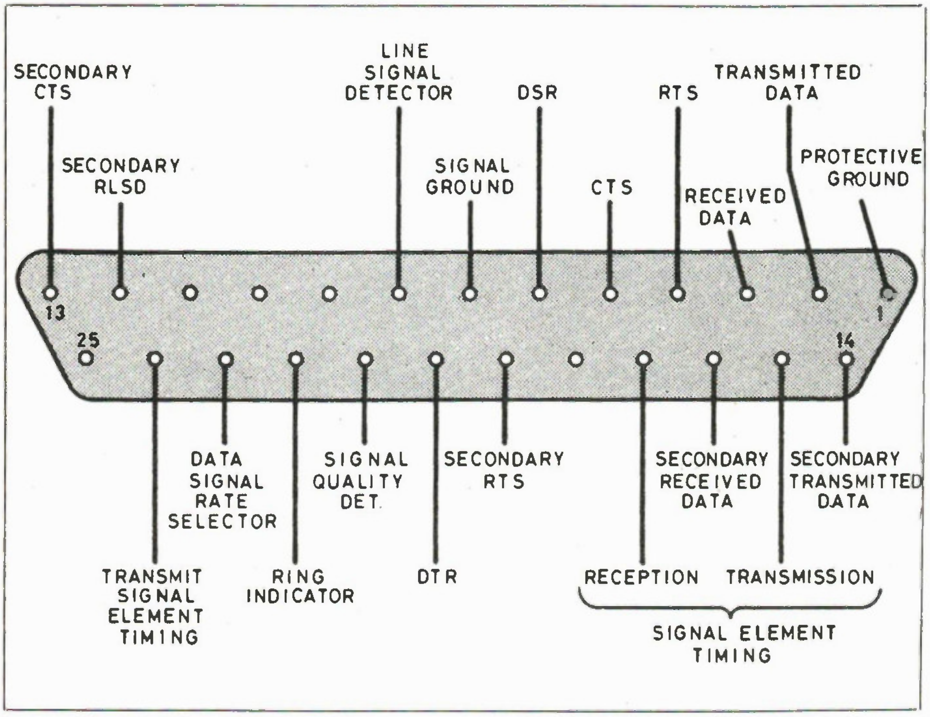


Fig. 5. A full RS232C interface uses a 25-way "D" connectors as shown here.

is perfectly adequate in normal use.

The original idea of the RS232C standard was to have two types of equipment, data communications equipment (DCE) and data terminal equipment (DTE). Data terminal equipment is the normal type, and it transmits on the data output and receives on the data input. With data communications equipment things are reversed, with transmission on the data input line and reception on the data output. The handshake lines are similarly reversed. This may seem a rather strange way of doing things, but the idea is to enable a piece of DTE equipment to be connected to a piece of DCE equipment using a standard 25-way D to 25-way D cable without the need for any crossed connections. This works fine if you have two suitable pieces of equipment, and some computers helpfully provide two serial ports, one DTE configured and the other DCE connected, so that they can be connected to any item of RS232C equipment (provided it has the correct type of connector) using a standard lead and the appropriate one of the two ports. Obviously some care needs to be exercised when interconnecting serial ports, but outputs have current limiting and if two outputs should be accidentally connected together it is unlikely to cause any damage.

IEEE488

The IEEE488 (or IEE488 as it is often but incorrectly called) is a much more complex form of interface than those described previously. Paradoxically it is the one which, on the face of it, readers of this magazine would find most useful, but is also the one which few are ever likely to use. Its main application is in the field of automatic test gear and other scientific equipment, but the cost of the sophisticated equipment which uses this interface is quite high and beyond the means of most amateur users. Hopefully, the cost of such equipment will fall to a more affordable level in the future, or low cost surplus equipment will become available.

This type of interface is also used to some extent with such things as plotters and disc drives. Although I know of no home computer that is equipped with an IEEE488 interface, add-on types are available for some computers.

The IEEE488 interface is a parallel type with data carried on eight lines. It permits up to fifteen devices, including the controlling computer, to be interconnected in either the linear or the spider arrangement. There are three categories of device which are termed 'talkers', 'listeners', and 'controllers'. The controller is the one at the heart of the system which would normally be a microcomputer or minicomputer, and there can only be one controller per system. A talker is one which is set to output data onto the eight-bit bus, and a listener is one which is set to receive data.

Many devices are actually talkers and listeners (including the controlling computer), but they can only provide one action at a time, and there can only be one talker in the system at any one time. This is analogous to the internal structure of a microcomputer where various input/output devices are connected to the data bus, and the control and address buses ensure that only one device at a time outputs data onto the data bus.

Being a parallel system only short connecting leads are permitted, with a maximum individual cable length of four metres. In a system the maximum cable length is two metres per device or a total of 20 metres, whichever is shorter. The advantage of using a parallel system is the high maximum data transfer rate of up to 1M byte per second.

In addition to the data lines there are three handshake lines and five control lines. This may seem to be rather a lot, but it is a sophisticated setup in which each device has an individual address so that data can be directed to just one device. Furthermore, devices can have secondary addresses. One way in which this can be used is to enable the operating mode of a device to be varied, depending on the

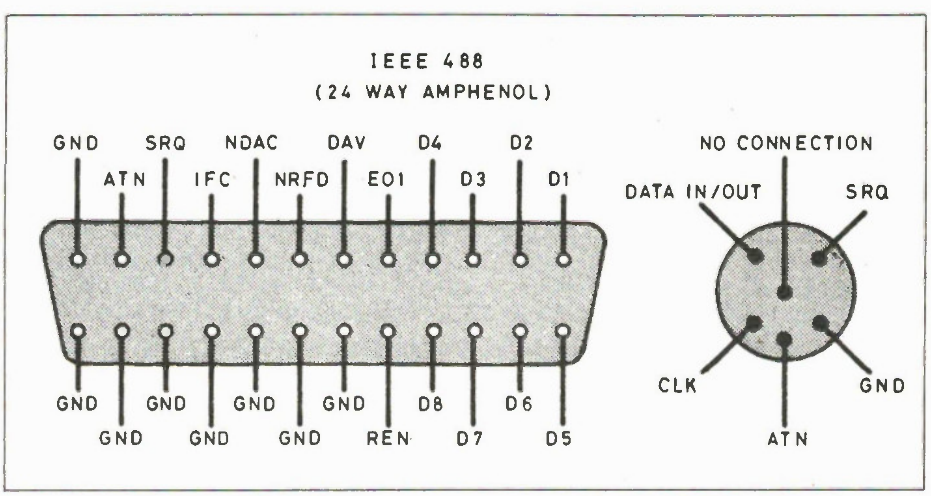


Fig. 6. The IEEE488 parallel port connections, and the "cut down" Commodore serial version.

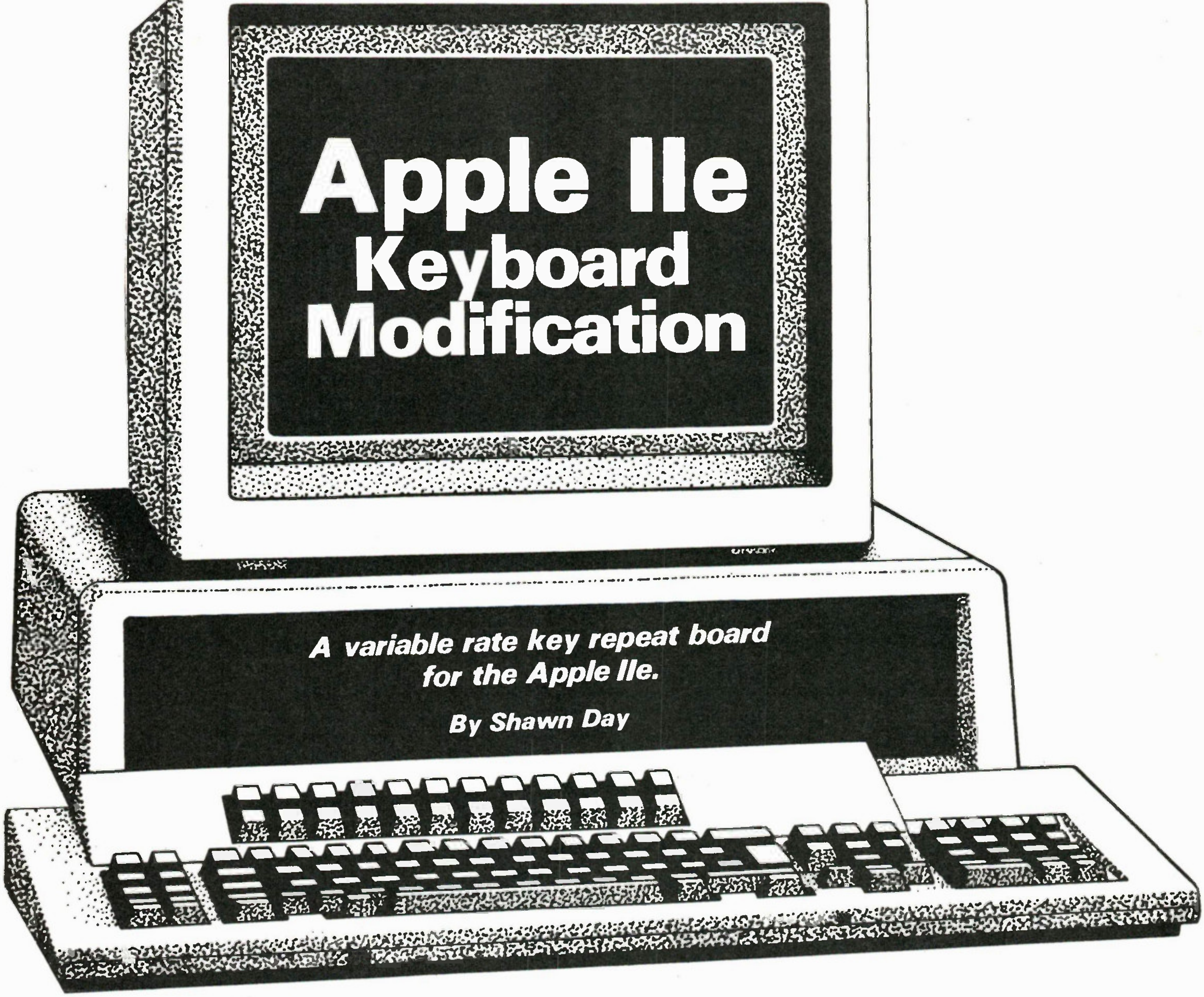
secondary address to which data is written. For instance, a multichannel digital analogue converter could have a different secondary address for each channel, giving easy access to each channel. Remember that this is a two-way system, and it could equally well be used to read a multichannel analogue to digital converter.

Connectors

The standard IEEE488 connector is a 24-way Amphenol type and connection details for this are given in Fig. 6. Perhaps of more relevance to microcomputer users is the greatly cut down version used in the Commodore serial bus, as fitted to the VIC-20, Commodore 674, C16, and Plus 4 machines (the PETs have the full IEEE488 interface incidentally). The Commodore serial version is a synchronous type with the clock signal providing a synchronization signal. This is not a clock signal in the sense of a straightforward clock oscillator, and it provides information such as positive transitions to indicate when valid bits of data are present on the bidirectional data line. The clock line is a bidirectional type, as the talking device and not the controller always provides the synchronization signal.

The SRQ (Serial Service Request) is an input to the computer which any device on the bus can pull low in order to indicate to the computer that it requires servicing. ATN (Attention) is used to start a command sequence. The computer takes this line low in order to set all devices on the bus as listeners, and it then sends the appropriate address. If the selected device fails to respond within a certain period of time, it is assumed to be absent and the computer provides a 'Device Not Present' error message.

Further details of this interface, including some timing diagrams, can be found in 'Commodore 64 Programmer's Reference Guide', published by Commodore. Although the Commodore's serial version can probably do everything that the full IEEE488 interface can achieve, and an IEEE488 adapter can be obtained, the serial nature of the interface and simplified control and handshaking arrangement inevitably result in greatly reduced maximum operating speed. ■



Apple IIe Keyboard Modification

A variable rate key repeat board for the Apple IIe.

By Shawn Day

HAVE YOU EVER been frustrated by the slow speed of the keyboard repeat function on the Apple //e? It is especially tiresome when copying over text using the arrow keys, and it's sometimes also useful to have audible feedback for each key press. These concerns led to the design of this variable rate key repeat board with audible key-click. It's designed to work with the Apple //e, but it should also be compatible with any computer which uses the AY-5-3600-PRO as a keyboard encoder.

How it Works

To understand the operation of this circuit, you must first understand how the normal repeat function on the Apple //e works. The //e uses an AY-5-3600-PRO keyboard encoder to read the keyboard. This chip sends two control signals (AKD and KBDSTRB) to the computer. A high pulse on KBDSTRB (keyboard strobe) is sent every time a key is pressed,and AKD (any key down) is normally low, but goes high whenever any key on the keyboard is held down. After detecting a pulse on KBDSTRB, the Apple waits for about 1 second, and then checks to see if AKD is still high. If so, the last key pressed is repeatedly made available to the currently executing program.

The circuit presented here intercepts the KBDSTRB signal between the AY-5-3600-PRO and the computer (see **Fig. 1**). The KBDSTRB pulse from the keyboard encoder triggers the monostable multivibrator (A), which has an adjustable pulse width via R1 (see **Fig. 2**). This pulse width determines the length of the pause after a key is struck, before it will begin to repeat. On the falling edge of this pulse, the J-K flip flop is set, allowing the pulse train from the astable multivibrator to be sent to the computer, causing the last key to repeat. As soon as the AKD signal goes low (the key is released) or another key is pressed, the flip flop is reset, and the repeat pulses stop.

Monostable (B) simply lengthens the KBDSTRB pulse so that it can be heard on the piezo buzzer. R3 is used to adjust the length of this pulse, effectively adjusting the volume of the key clicks. R2 adjusts the key repeat rate.

Construction

The easiest way to construct this project is to use wirewrapping techniques. This offers a unique solution to the problem of where to put the resulting circuit (see **Fig. 3**). The AY-5-3600-PRO is a 40-pin DIP IC located on the far right of the motherboard of the Apple //e (when looking into the case from the front). The chip must be removed and inserted into the key-repeat circuit. However, all lines from the chip (except KBDSTRB) must still connect with the socket in the motherboard. To accomplish this, mount the chip in a 40-pin wirewrap socket as shown in Fig. 3. To prevent the long pins of the wirewrap socket from being inserted too deeply into the original socket on the motherboard (and perhaps shorting together as a result), it is a good idea to solder a 40-pin DIP header or attach a low profile DIP socket to the pins, and then insert this header into the motherboard (see **Fig. 3**). Be sure to finish wirewrapping the board before this piece is attached, however, or it will get in the way of your work.

The necessary +5V can be taken from pin 30 of the AY-5-3600-PRO, and ground from pin 15. The KBDSTRB pin (pin 16) on the IC must be bent outwards so that it does not contact the wirewrap socket. This allows the signal to be intercepted. Pin 16 should be connected to pin 1 of U1. The corresponding KBDSTRB pin on the wirewrap socket must be connected to pin 4 of U4 (see **Fig. 2**).

Before soldering the 40-pin wirewrap socket into the project board, check that it will fit comfortably into the computer case without impeding any cards in slot 7. You may have to adjust the position of this socket relative to the project board until you have a comfortable fit. If you choose to wirewrap the other IC's, you must first trim their wirewrap leads to about half their original length, so that they will clear the tops of the other components on the mother board. If you use a Radio Shack board (276-158) to mount the components, they will all fit comfortably, including the piezo buzzer. Try to find miniature, top-adjust, pc-mount potentiometers for R1, R2, and R3. Mount them where they will be easily adjustable from the computer case opening.

An alternative method of construction is to mount all the components, excluding the AY-5-3600-PRO on the project board. Remove the AY-5-3600-PRO from its socket on the motherboard, bend out pin 16, and then reinsert it into its original socket. Connect wires from pins 5 (AKD) and 16 (KBDSTRB) to the inputs of your project board, and connect the KBDSTRB output of your project to the vacated hole number 16 in the motherboard socket. The +5V line and ground can be taken from any convenient place on the motherboard. This method of construction is probably simpler, but you must now find a place inside the computer case to mount the project. Please note that either method of construction will probably void your warranty.

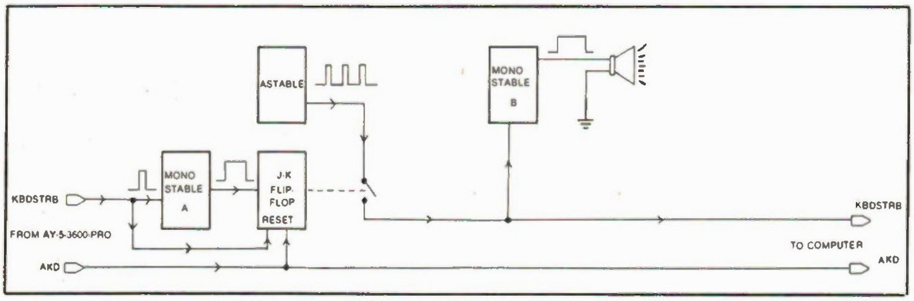


Fig. 1 The block diagram of the variable rate, key repeat board.

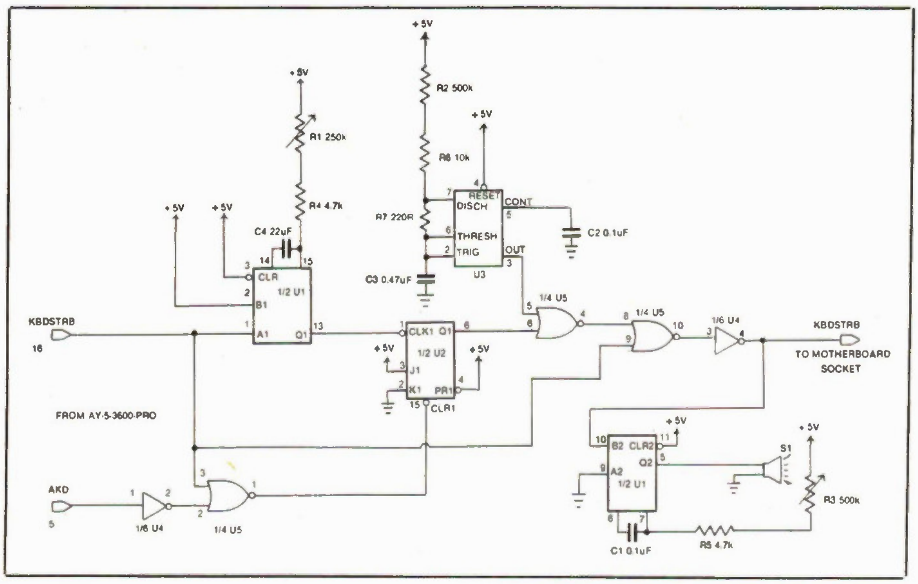


Fig. 2 The circuit diagram of the keyboard modification.

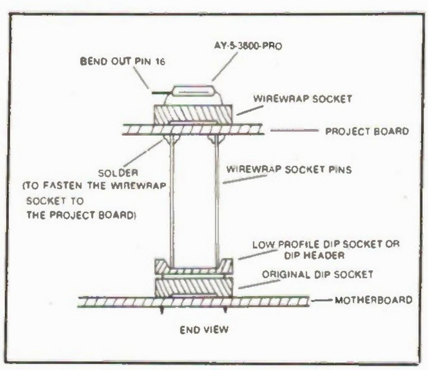


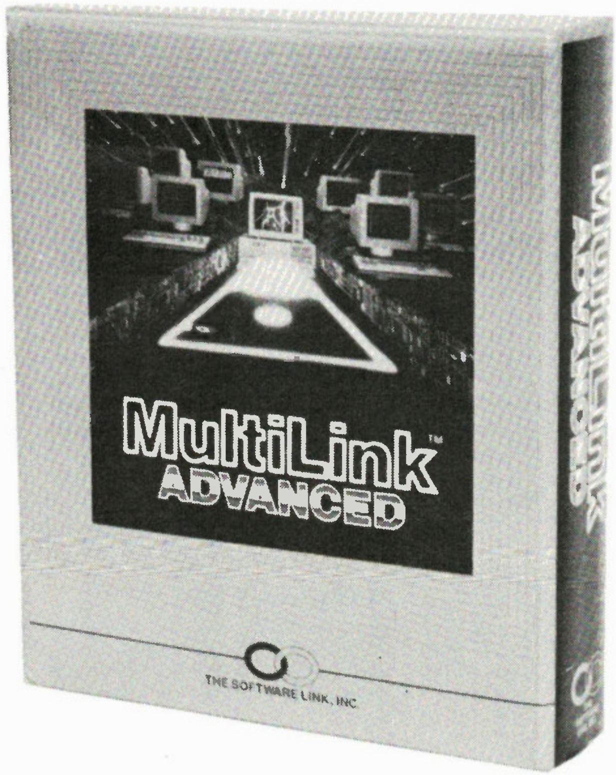
Fig. 3 Details of the wirewrap construction.

Parts List

R1	250K trimmer potentiometer
R2, R3	500K trimmer potentiometer
R4, R5	4.7K 1/4 watt carbon resistor
R6	10K 1/4 watt carbon resistor
R7	220 ohm 1/4 watt carbon resistor
C1, C2	0.1 uF ceramic capacitor
C3	0.47 uF electrolytic capacitor
C4	22 uF electrolytic capacitor
U1	74LS123 Dual retriggerable one shot with clear
U2	74LS112 Dual J-K negative edge triggered flip flop
U3	NE555 timer
U4	74LS04 Hex inverter
U5	74LS02 Quad NOR gate
S1	Piezo buzzer (RS 273-060)

Miscellaneous parts:

Grid board (RS 276-158), 40-pin wire wrap IC socket, 8-pin wire wrap socket, 2-14 pin wire wrap sockets, 2-16 pin wire wrap sockets, wire, solder, mounting bolts. ■



MultiLink Network Software

Connect your computers together with nothing more than a wire and a single floppy disk.

By Bill Markwick

IF you have a typical small company that uses a number of IBM PCs or compatibles, you probably have them sitting on various desks doing independent tasks. This means a fair amount of legwork to transfer files or programs from one to another, and it also means that your computers are probably spending a fair amount of time waiting idle. Another possibility is that you've discovered the usefulness of computers by buying one or two PCs and you'd like to install a lot more, but you're intimidated by the high cost of the hardware.

It's possible to hook some or all of your computers together in a network, allowing easy transfer of software from one station to another, but it usually means adding more printed circuit cards to each computer, a fair investment in capital. Also, the hardware method may or may not allow multi-tasking, in which a single computer can work away on one program in its memory while the operator runs a second, independent program on the screen. Furthermore, it's possible to expand the number of stations without purchasing full-featured computers; using a network, the main computer supplies software and control, allowing the stations to use less expensive terminals instead of PCs.

A novel method of giving you these facilities is MultiLink Advanced, a multi-user, multitasking software from Software Link. All you need is the floppy disk and 3-conductor serial cable to really put those PCs to work.

Basic MultiLink

Even if you don't use a network, the multitasking feature alone is worth it. The system is booted and the MultiLink program loaded in. It then divides up the available memory into the number of partitions you've specified. Each partition is like an independent computer, and all partitions share the CPU, the keyboard, the screen and the drives. We tested Version 3.3, which allows up to nine partitions; as we went to press, Version 4 was being released with up to 17 partitions.

You can specify which keys toggle the partitions, but if you don't, the ALT and function keys are the default settings. ALT-F1 will access the first partition, ALT-F2 the second and so on; ALT-F10 is always the main or foreground partition.

I made two partitions, the main and the background, and loaded a spelling checker into the background. While I ran WordStar in the main partition, the spelling checker went through a textfile in memory; at any time I could type ALT-F1 to see how it was doing. It's just like switching one monitor and keyboard between two different computers.

Then we ran a serial cable over to another office (ain't suspended ceilings wonderful) and installed it in the serial port of another PC compatible. We could have used a simpler terminal; for the time being we loaded the compatible with a short emulator program (supplied with MultiLink) that makes the computer think it's a Televideo 910 terminal.

Now the "terminal" could be installed as one more partition in the main PC. It could then load and save programs using the main computer's disks and files, and we could even type messages from one office to another. MultiLink sorts out the demands on the common CPU and prevents serious clashes. Of course, if you're both running the same program in the same partition, such as a word processor using the same file, keystrokes from both computers appear on both screens. Two editors can have a keyboard fight over a point of grammar.

Hardware

First, it should be obvious that the main computer is going to have serious demands put on its CPU. If you have three partitions, all going at once, each partition runs at only one-third the normal speed. Even though computers spend most of their time waiting around for keyboard entry, it wouldn't hurt to have the fastest computer you can afford for the main unit. We used ordinary 4.7MHz compatibles for the review, and while they were adequate for two stations, we'd advise the 8MHz version for the main computer on larger setups, and an AT or compatible would be best of all.

The required memory size for the main computer isn't critical, but you need enough RAM in each partition to handle whatever programs you plan on running in that partition. You'll also need about 35K for DOS, 23K for MultiLink, and 7K extra for each partition, plus 3K in each partition itself. For example, if you have four background partitions of 100K each, you need 412K for these, plus 58K for DOS and MultiLink, plus 28K for partition control. This is 498K, leaving 142K free in the foreground if you have a 640K machine. Of course, you can divide up the memory any way you prefer, giving each partition only as much as necessary for the intended programs.

You'll also benefit from a hard disk. Although we used only floppy drives, we didn't begin to get maximum usefulness out of our network, and as you find more and more applications for it, you'll want lots of mass storage.

The wiring requires only a 3-wire cable terminated in a serial connector to suit your computer. This is far less expensive than a full multi-pair cable.

As mentioned, you can use a PC or compatible as a terminal, but there'll be a cost saving if you only need a dumb terminal. Software Link provides an excellent terminal called the PC Shadow; this features an PC-compatible keyboard and a monochrome monitor.

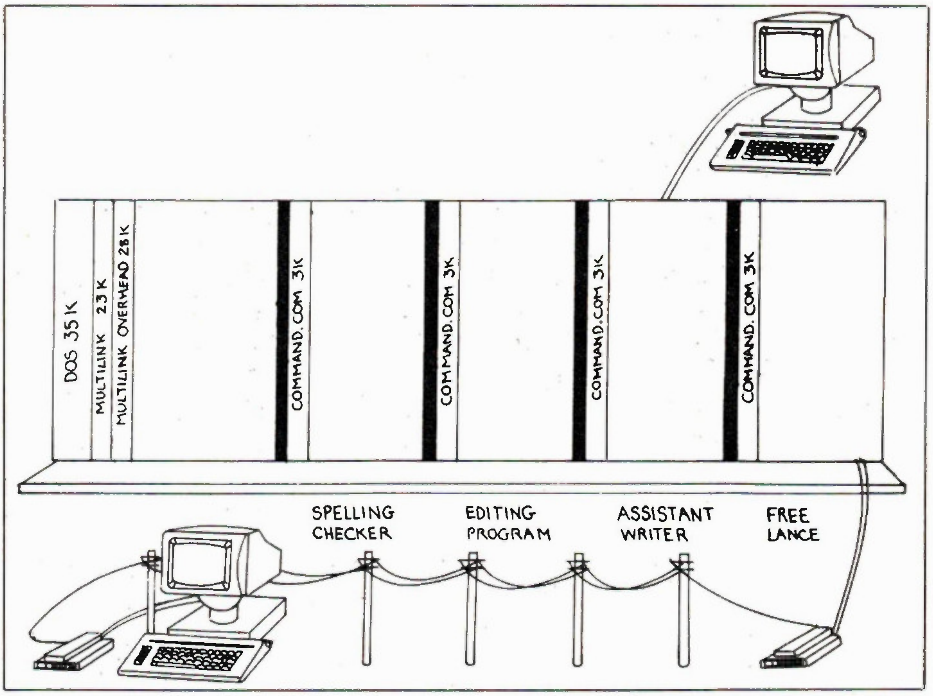


Fig. 1. The memory map of the main computer using MultiLink. In the example, there are two programs and two remote computers in the four partitions. 63K of memory is used for MultiLink with the rest divided to suit the user. (courtesy of Software Link).

Installation

Other than running the serial wires between computers, installation consists mainly of manipulating a bit of software. There are a few problems, most of which have been anticipated by the authors of MultiLink. The main difficulty arises from programs which use unconventional ways of writing to the video screen. No doubt you've noticed that the IBM PC and compatibles have very slow screen scrolling when using the PC-DOS interrupt method; TYPE and DIR are examples of this. The screen speed can be increased considerably by writing bytes directly to the screen RAM, but if you have multitasking activated two or more programs may fight each other for video access.

Three utilities are provided on the MultiLink disk to smooth out concurrent programs. These can be used to either patch the program itself or modify the RAM area to increase compatibility during multitasking. We found that WordStar was initially unhappy, but the included MLVIDFIX program soon had it running. Still, the programmers can't cover every possible type of available software, so there's no guarantee that you won't have problems. We found that video games which use the 40-column display mode and the high-bit graphic set would scramble both themselves and the main partition, and the utilities were no help. Naturally, you'd have no reason to run video games at work, would you? In any case, all popular word processors and spreadsheets have been accounted for, and Software Link will try to provide solutions for incompatibility problems.

Software Link can provide a hardware solution to software problems if you have an AT compatible. Called the AT Gizmo card, it remaps video output right at the processor, ending the software fixing.

Limitations

Most of the limitations you'll run into will be hardware types. Murphy's Law for Memory states that you will always come up with applications requiring more RAM than you have (remember a few short years ago when you thought a 64K Apple was more than you could ever use?). And, of course, the CPU is never fast enough.

As far as limitations to MultiLink itself, a major drawback to Version 3 is that it does not support color or bit graphics. This has been cured on Version 4, though we didn't have time to test it before press time.

The transfer rate for Version 3 is only 19,200 baud. While this is respectable for file transfers, it's a bit slow for full-screen work, particularly if you want to page up and down through a textfile. The new Version 4 has doubled the transfer speed, which should make working with word processors more convenient.

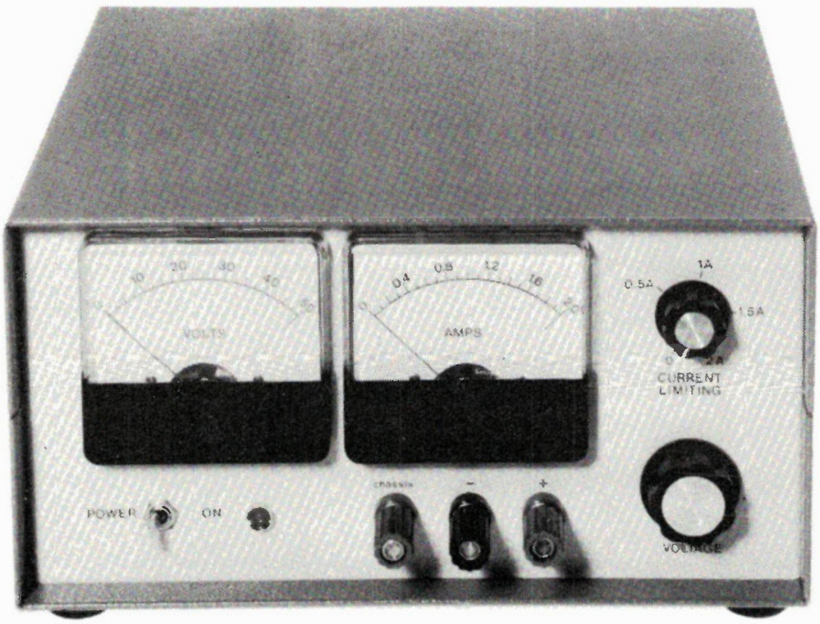
LANLink

LANLink, a Local Area Network, is another product from Software Link and is compatible with MultiLink, i.e., it can be run as a program in one of the MultiLink partitions. With LANLink one main computer can become a file server, or host, located as the hub with up to eight satellite computers as the spokes. Thus any operator can load a program, work on it, and send files to any other operator. The data transfer is 115,200 bits per second, with data compression giving an effective rate of up to twice as fast. Expansion boards are available for the serial ports on the file server computer. When used with MultiLink, it becomes possible to have a hybrid network linking both regular computers and dumb terminals.

In conclusion, MultiLink offers a great expansion of your computing facilities, letting various workstations do much more at a considerably reduced cost compared to buying more computers. Combined with LANLink, the hybrid network and file serving capability gives you the equivalent of a minicomputer installation for far less expense.

For further information, contact Software Link, 250 Cochrane Dr., Suite 12, Markham, Ontario L3R 6B7, (416) 477-5480. ■

Precision Power Supply



Zero to 40V and 2A with adjustable current limiting.

By Doug Bedrosian

TEST instruments are considered to be some of the most useful tools available when constructing a project. They are also considered to be the most expensive tools one could buy. For instance, a power supply of any quality and usefulness can range from several hundred dollars to several thousand dollars. The alternative to buying a power supply is to build one. The power supply in this article has a voltage range from 0 to 40 volts and a current range from 0 to 2 amps with current limiting set by the user. The quality of the supply is determined by the time and care the builder takes while constructing it.

Construction of PCB

The printed circuit board is highly recommended to be used when constructing the power supply, as it will save time and reduce the risk of wiring errors. It is also recommended that the PCB be assembled in the order that the instructions are given.

The first step is to check the PCB for any oxidation on the copper traces. If the copper looks oxidized, use some fine steel wool to remove it. Now JP1 can be installed and soldered. Next is the 14 pin IC socket, making sure that the pin 1 marking on the socket is aligned with the pin 1 marking on the PCB. Now Br_1 and Br_2 are soldered in place. Special care should be taken so that the positives on Br_1 and Br_2 are matched with the positives on the PCB. C_1, C_2 and C_3 are next. Again care should be taken so that the positives on the capacitors are matched to the positives on the PCB. Before anymore parts are installed the power supply sections of the board should be tested. Temporarily wire the 36 volt transformer to the appropriate section on the PCB. With the transformer on, measure the voltage across C_1 or C_2, the voltage should be approximately 50V

Continued on page 34

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± 5V. Now the 36 volt transformer can be disconnected and the 17 volt transformer can be connected to the appropriate section on the PCB. With the transformer on, measure the voltage at pin 14 and pin 7 of the IC socket; pin 14 being positive, pin 7 being negative. The voltage should be between 22 volts and 28 volts. If the voltage across pin 7 and 14 is out of this range the power supply will not work! It should be noted that the transformer(s) for the 17 and 36 volt supplies must be electrically isolated from each other. This can be achieved by using two separate transformers (which is recommended) on one transformer with two completely isolated windings. If this is not the case the power supply will fail to work.

With both power supply sections on the board functioning, construction of the board may continue. The seven diodes can be soldered in place; and care should be taken when installing them, so they are oriented correctly on the board. Next the eight resistors can be installed, then the four trimpots. The board has been laid out for two types of timpots, the choice is left up to the builder as to which are used. Now the remaining capacitors can be installed Q_1 is next to be installed, for proper orientation of Q_1 refer to **Fig. 1.** Finally IC_1 can be inserted.

With the board now complete, refer to the External Wiring Section for the remaining connections to the board.

External Wiring

The construction and choice of cabinet is left up to the builder. The cabinet used in this article was a Hammond 1458 series. This makes a compact, professional looking power supply. Once the cabinet work is completed the wiring of the supply may begin.

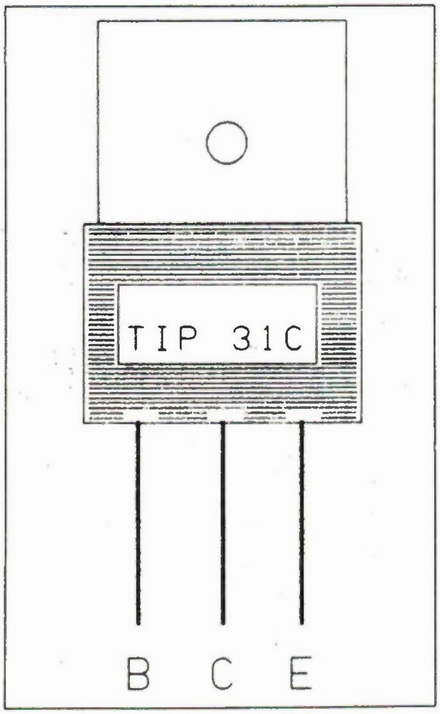
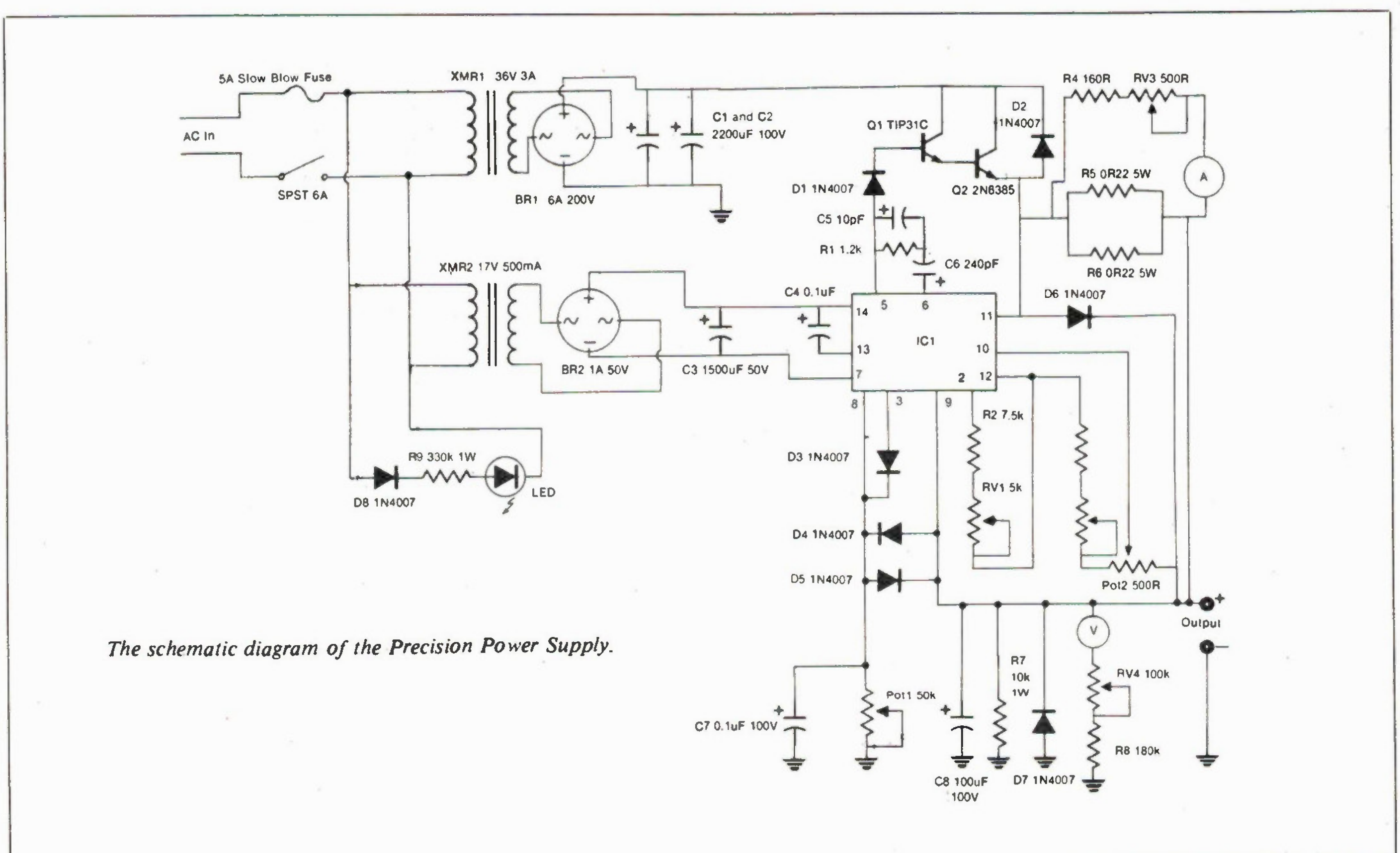


Fig. 1. Pin orientation of the TIP 31C.

The first step is to wire the line cord with the power switch and fuse. Next the power indicator is wired, an LED is used for this. Refer to the wiring diagram and schematic for these two steps. Now the primary of the transformers should be wired to the switched 110VAC. Next the secondaries of the two transformers can be connected to the main PCB. Now the two meters plus the voltage and current controls can be wired to the PCB. Refer to the wiring diagram for proper connections. Next Q_2 should be mounted to a heatsink, the heatsink used should be of appropriate size in order for proper cooling of Q_2 under high loads. The transistor should be mounted using an insulated wafer coated on both sides with heatsink compound. The insulating wafer is used to electrically isolate the transistor from the heatsink and the compound is used to improve the heat transfer from the transistor to the heatsink. When wiring Q_2 to the PCB a minimum of 18 gauge wire is recommended. The output terminals are wired to the PCB next. Again a minimum of 18 gauge wire is recommended.

The construction of the power supply is now complete. Refer to the Testing and Adjustment section for proper set up of the power supply.

Continued on page 41



The schematic diagram of the Precision Power Supply.

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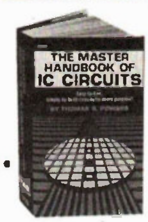

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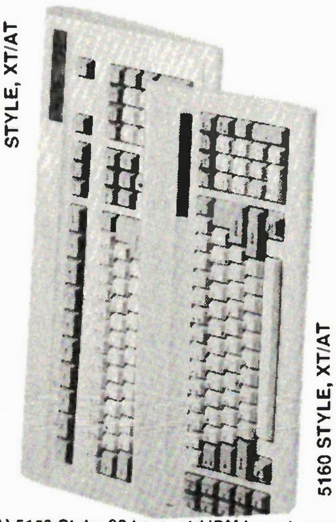

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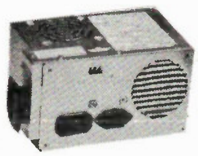

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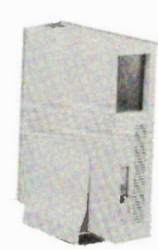

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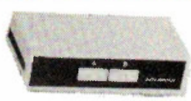

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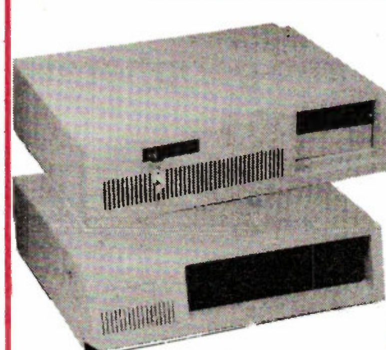

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Semiconductor Processing Advances

Various techniques for etching semiconductors are being developed to get more circuitry in less space.

By Dr. Keith Ryan

ONE area where surface modification technology is developing very rapidly is the etching of semiconductors for the fabrication of microelectronic devices.

The never-ending desire to pack greater numbers of circuits onto one chip has required pattern definitions to approach the submicron (that is less than one-thousandth of a millimetre) range. This has resulted in the abandonment of traditional wet chemical methods because of the inherently low resolution of those processes.

Plasma etching

The solution being applied now to this problem is the technique of plasma etching. A wafer containing more than 100 chips is placed on an electrode inside a radio frequency discharge. The electrical energy consumed by the discharge is used to generate a range of active species in the gaseous plasma.

A very important feature is that the charged species (ions and electrons) are constrained to move in the direction of the field and impact the wafer at normal incidence.

The photoresist is chosen to be impervious to attack, but those areas not covered by the resist are stimulated by ion bombardment, thus initiating chemical attack. This provides a mechanism for the evolution of a pattern with vertical side walls.

One intriguing aspect of plasma etching is the rapidity with which the technological advances have been made, notwithstanding how little is known about the underlying science. The spectacular progress which has been achieved so far has arisen mainly by empirical approaches with most attention being paid to silicon-based semiconductors.

To find an explanation for the relative merits of various gas mixtures, which have been found effective in etching one silicon compound selectively in the presence of the other, is quite difficult. It is acknowledged that progress will be limited ultimately by the lack of scientific understanding of the problem.

The major difficulty is how to unravel the complex processes that occur both in the gas phase and at the gas-solid interface.

We have taken the view that the gas phase chemistry controls the identity of the species which arrive at, and etch, the surface. Thus a knowledge of the chemistry allows one to focus attention on the gas-surface interaction mechanisms of clearly identified species.

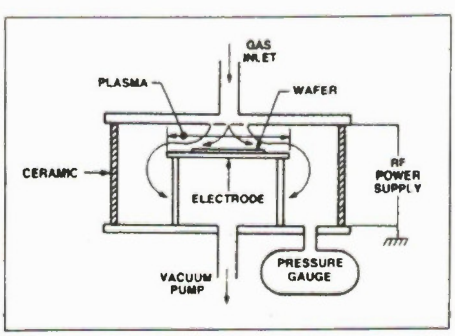

Figure 1. Plasma etching equipment. Active species (ions and electrons) generated in the gaseous plasma move in the direction of the field and impact the wafer.

Work in this area has provided very encouraging results. Potentially important gas-phase reactions were studied under carefully controlled conditions so that the rate of each of these reactions could be established. Armed with this vital experimental information, it has then been possible to build up a model which reproduces conditions employed for the etching of silicon.

Work from this laboratory has done much to remove uncertainties associated with gas-phase phenomena and is complemented by work in progress in other laboratories aimed at understanding the reactions of selected species on the surface.

There are many exciting scientific problems in the future of semiconductor processing. For example, the increasing preoccupation with gallium arsenide technology is certain to require a much better understanding of its etching chemistry.

One inherent disadvantage of plasma etching (apart from the complex chemistry mentioned above) is that damage can occur to the device because of ion bombardment. This can be more of a problem for devices with dimensions of less than 1 micron and has prompted the search for other methods. One possibility which is receiving a lot of attention is the use of lasers.

Laser Chemistry

Laser chemistry offers a number of new methods that have advantages over plasma processes for altering the morphology (shape and contours) of a solid surface. One of the major attractions of this approach is that, with a suitable choice of materials, the chemistry is much less complex than when plasmas are used. Basically there are two different ways in which lasers can be used to induce surface reactions, pyrolytic and photolytic.

In the pyrolytic method the laser is focused on the surface where intense heat induces reactions between surface species and impinging gas molecules. The spatial resolution that can be achieved depends both on the size of the laser-heated spot and the thermal properties of the heated material. By using a pulsed laser of short duration compared to the relaxation time of the irradiated material, high spatial resolution can be obtained.

Most examples of laser-induced pyrolytic deposition so far have been adaptations of known chemical vapour deposition processes. These older processes have been used predominantly for growth of thin films and large surface-area coatings.

Lasers provide the opportunity to select a small portion of the surface and to deposit with high precision. Laser-induced pyrolity deposition is clearly a powerful extension of existing coating methods.

Perhaps of greater potential are those deposition and etching processes which depend upon photolysis. In the photolytic method a focused laser beam interacts with gaseous molecules above the substrate surface. Careful choice of the gas species, the pressure and the laser wavelength ensures that only the required free radicals are produced and survive to interact with the surface. Active species generated in the laser pulse diffuse to the surface where etching occurs. Resolution is defined both by the focusing of the laser and the effect of a buffer gas which controls the diffusion of the active species.

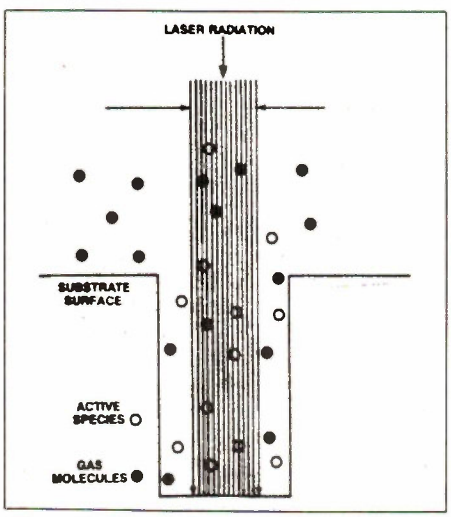

Figure 2. Photolytic laser etching. A focused laser beam interacts with gas molecules forming active species which diffuse to the surface where etching occurs. The mean distance over which the active species survive outside the irradiated zone is dependent on the density of bulk gas molecules.

Because silicon compounds and many fluorine-containing compounds that react with silicon absorb strongly in the infrared, the etching of silicon and silicon dioxide is particularly suited to investigation by infrared laser photochemistry.

Laser photolysis is equally powerful as a means of selective deposition. For example, cadmium, tin, aluminum, zinc, and germanium have all been deposited on ceramic substrates following laser photolysis of the metal-alkyl (that is, metal linked to single-bonded hydrocarbon group) compounds.

Using a laser operating at 275nm, photolysis produced a supersaturated metal vapour near the surface of the substrate. Metal-alkyl molecules adsorbed on the substrate are also dissociated and act as a nucleation centre for metal atoms arriving from the gas phase. Because this nucleation increases dramatically the sticking coefficient of the impinging metal atoms, the initially adsorbed molecules are an important factor in achieving highly localized decomposition.

MOCVD

One can attempt to predict important future developments in technology by examining how technologies, which are being established now, have themselves developed. In the semiconductor field, rapid and intense technological change is occurring through the application of metalorganic chemical-vapour deposition (MOCVD) of III-V compounds (that is, those formed from elements of Groups III and V in the Periodic Table, e.g., Gal 1xAlxAs).

These materials are used to produce lasers, solar cells, quantum well lasers, bipolar heterojunction transistors, photocathodes and pin detectors.

The interest in MOCVD arises from the fact that, of all the known epitaxial techniques, it has been demonstrated that MOCVD has the capability to grow the widest variety of III-V compounds with excellent uniformity.

The pioneering research in this area was performed in the late 1960s. It seems quite evident that important advances in this and related areas will come from the application of laser-induced photochemistry. Those communities which invest the scientific effort now will be in the best position to exploit the technology later. ■

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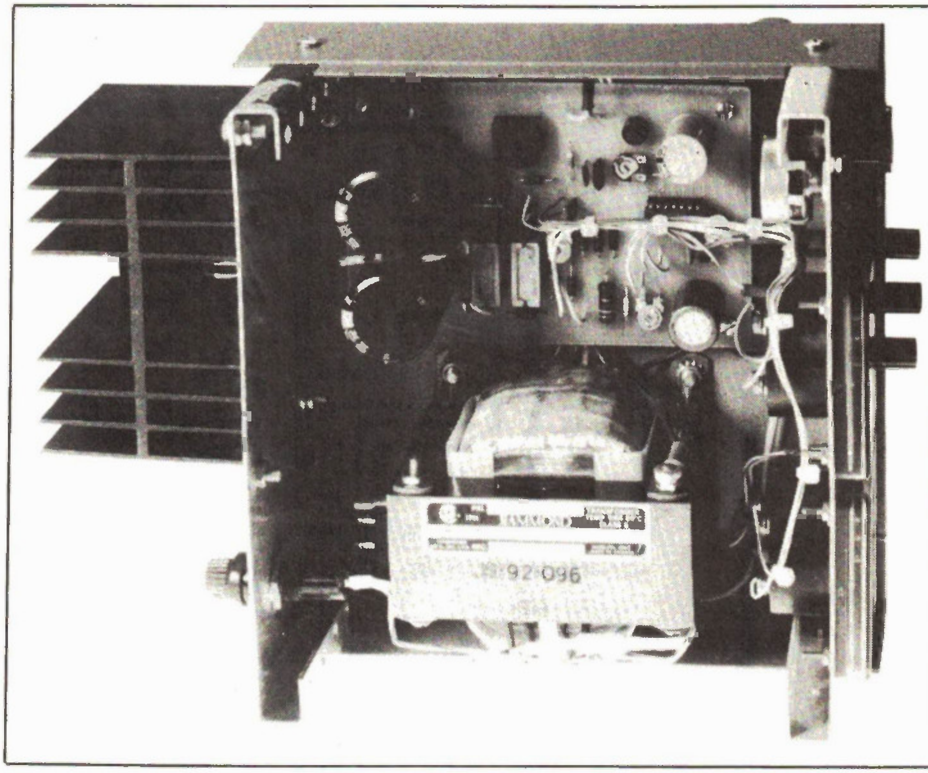


Interior of the completed power supply.

Testing and Adjustments

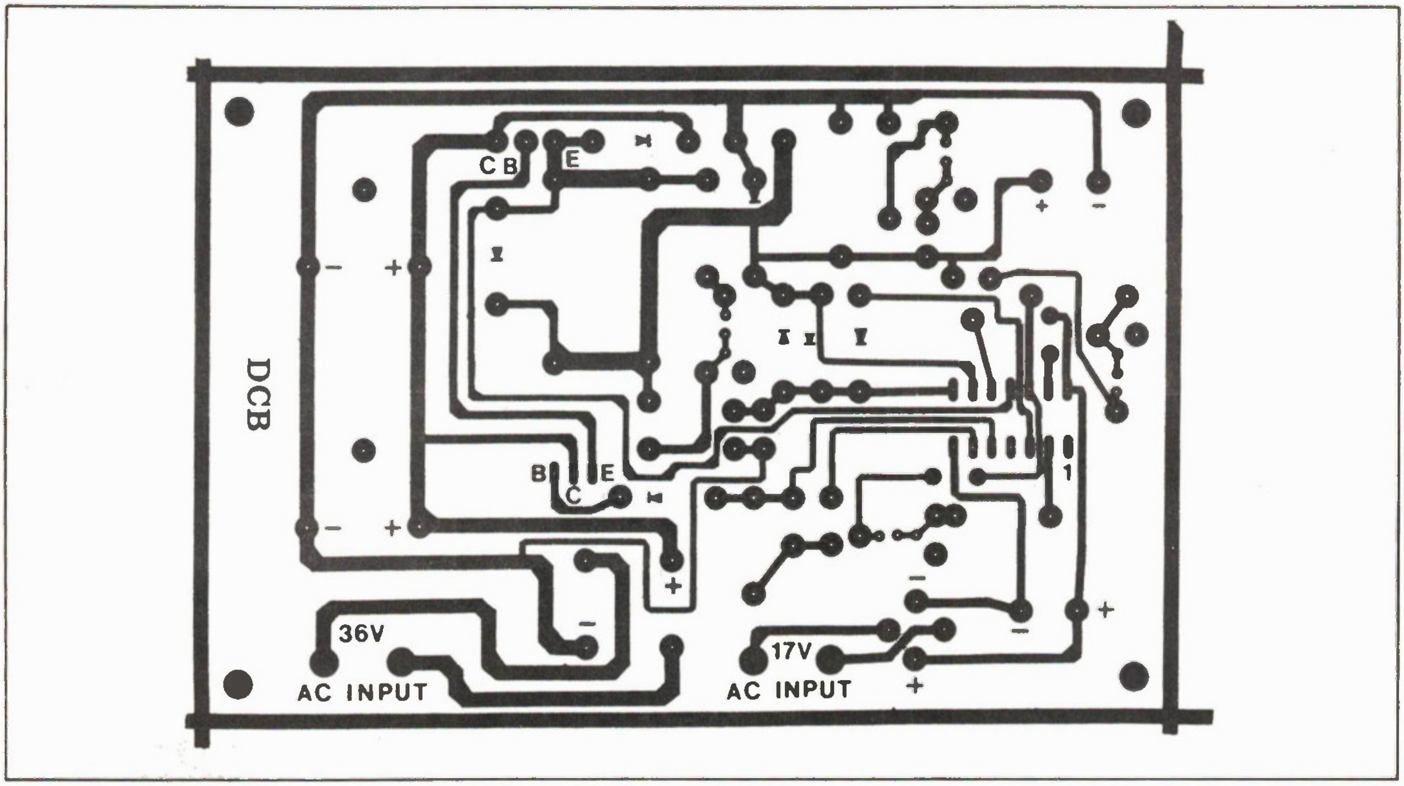
With the PCB and wiring completed the power supply is ready for testing. The first step is to set all trimpots to the midway position. Now turn the voltage and current controls to the midway position as well. Power may now be applied to the board. If all is working properly there should be a voltage reading at the voltmeter. If the needle of the volt meter is going in the wrong direction reverse the wires to the meter. If there is no voltage reading at the meter check to see if the current control is set at zero, if so turn it to the midway position. If the supply still appears to not function properly, use an external volt meter to measure the voltge at the output terminals. If there is a voltage then a problem with the supply's voltmeter is likely. If there is no voltage at the output or if there is a very small amount, measure the voltage across pins 7 and 14 of IC_1. If it is not between 22 and 28 volts the supply will not function. If the proper voltage is across pins 7 and 14 and the supply is not functioning properly then it is recommended that the PCB and wiring be thoroughly checked for flaws.

With the supply working properly it can now be adjusted for use. The first step is to set the maximum output voltage. With an external voltmeter connected across the output the voltage control should be turned for maximum output. Now adjust RV_1 on the PCB until the external voltmeter reads 40 volts. Now adjust RV_4 so the power supply's voltmeter also reads 40 volts.

Next the maximum current should be set; an external ammeter capable of handling 2 amps is connected across the output. With this ammeter connected, the output will be driving close to a dead short. Now set the current control for maximum current; with the power supply on, adjust RV_2 until the external ammeter reads 2 amps. Once this is completed RV_3 should be adjusted so the ammeter of the power supply reads 2 amps.

Now the meters on the supply should be checked for accuracy. Using an external voltmeter connected across the output, adjust the voltage control for different readings on the supply's voltmeter. If the readings of the two voltmeters are inconsistent then the voltmeter of the supply should be readjusted using the procedure already given. With an external ammeter connected across the output adjust the current control for different readings on the supply's ammeter. If the two meters are inconsistent the ammeter of the supply should be readjusted using the steps given previously.

Assuming everything is adjusted properly the supply is ready for use.



PCB artwork for the Precision Power Supply.

How it Works

The power supply is best understood when divided into separate parts.

The first parts to look at are the two power supply sections. The output supply section consists of $XFMR_1$, Br_1, C_1 and C_2. They supply the appropriate voltage and current required at the output. The IC supply consists of $XFMR_2$, Br_2 and C_3. The two power supply sections must be separate from one another because a floating ground is required for IC_1.

The next section is the voltage control section. RV_1 and R_2 determine the operating point of a constant current source out of pin 3 of IC_1. By varying RV_1 the maximum output voltage will be set. Pins 8 and 9 are inputs to a high gain differential amplifier contained in IC_1. By adjusting pot 1 the voltage at pin 8 will vary; this will cause the voltage at the output to change until it is equal to the voltage at pins 8. Due to the high gain of the differential amplifier the voltage at pins 8 and 9 will always remain equal.

The current control section is next. Pin 12 of IC_1 is an internal voltage reference, used with RV_2 and R_3 they set the maximum output current. RV_2 is adjusted to limit the maximum output current to 2 amps. The inputs to the high gain differential amplifer of the current control section are pins 10 and 11 of IC_1. By adjusting pot 2 the maximum voltage across R5 and R6 before current limiting is set. This voltage is proportional to the output current, therefore the maximum output current will be set.

Constant current/constant voltage is the next section to look at. The outputs from the voltage and current high gain differential amplifiers are fed through an OR gate. The output that is choosen by the OR gate will then be the output of the IC, which is at pin 5. This causes the supply to switch between the constant voltage or constant current mode.

The next sections to describe are the compensation and protection circuits. C_4 is used for internal compensation of IC_1. The RC network of C_5 and C_6 plus R_1 is also used for internal compenstion of IC_1. D_4 and D_5 prevent the input voltage to the highgain differential amplifier from exceeding 0.7V. D_2 and D_7 protect the supply from damage that may be caused when an external power supply is connected.

The output section is next, Pin 5 is the output of IC_1. This drives Q_1 which inturn drives Q_2. The main power dissipated by the supply will be by Q_2, this is why an appropriate sized heatsink is required.

Use

The power supply is very easy to use. There are only two controls, one being the voltage, the other being the current. By adjusting the voltage control the output voltage varies. By adjusting the current control the maximum amount of current which the supply will generate is set. By understanding the function of each control the user will be able to operate the power supply for maximum performance in each situation.

Continued on page 58

A Guide to IC Numbering

An attempt to unravel the mystery behind the numbering systems used on ICs and other semiconductors.

By John Linsley Hood

INTEGRATED CIRCUITS are the easy route to circuit design, since many clever engineers have thought of ways of achieving the desired end, in conveniently packaged and often quite inexpensive circuit blocks. However, there are two main snags. The first of these is knowing which is the right IC to use, and the second is to decide which version of the IC in question is the device that you want.

The circuit diagram may show a 741, but the catalogue lists a whole range of these from MC1741SCG to LM1741CJ-14. What does this mean? And the problem doesn't stop there either, there are all the digital ICs as well.

To start with, the first two letters in the specification refer to the maker of the device. MC, for example, refers to Motorola, uA to Fairchild, and so on. The letters at the end of the specification refer to the packaging, the temperature range for permitted operation, or the reliability guarantee.

Transistor type designations are a bit simpler since they don't usually have a prefix identifying the maker or a suffix specifying one of a range of package forms. The package is usually implied by the actual type number of the transistor. Unless they are very popular devices, like a 2N930 or a 2N6015, a particular transistor will only be available from one or maybe two manufacturers.

The USA JEDEC listing, 1N-, 2N-, 3N-, only refers to the time at which that particular device was registered with the US military authorities, so a 2N5068 is a much more recent device than a 2N697. There is, however, a small measure of type identification in that 1N-refers to diodes, 2N-refers to bipolar or junction field-effect transistors, and 3N-means MOSFETS.

The European type designation actually gives a description of the general type of the device in its letters. The letters at the end of the type number, for small signal devices, usually denote the current gain range or the pin configuration. Table 5 outlines the classification system used to describe these types of discrete semiconductors.

North American sourced transistors (and ICs) are usually second-sourced (meaning that there are at least two manufacturers), whereas the European devices may come from one manufacturer alone. This is awkward if a designer specifies a favourite device which is not stocked by a particular store, but that same store might have been able to supply a substitute, which in a pinch, could have done the same job.

Prefix	Manufacturer
AD	Analog Devices
AM	Advanced Micro Devices
CA	R.C.A.
DS, LM, LF, LH	National Semiconductor
DG	Siliconix
H, HA, HI	Harris
HA	Hitachi
ICL, ICM	Intersil
IR	International Rectifier
MC	Motorola
OP, PM	Precision Monolithics
N, NE, SE	Signetics (Mullard)
RC, RM	Raytheon
SG	Silicon General
SL, SP	Plessey
SN, TL	Texas Instruments
μA	Fairchild
UCN, UDN, ULN	Sprague
XR	Exar
Z, ZD	Ferranti

Table 1 The codes used in the manufacturers prefix. These form the first group of letters in an IC type number, appearing before the number itself.

In digital ICs, the device classification, if it isn't standard TTL or CMOS, is tucked into the middle of the part number. The LS in 74LS68 indicates a low power Schottky device, while the HC in 74HC160 refers to high speed CMOS.

As a general rule, plastic encapsulations are cheaper than metal can or ceramic dual-in-line packages, and commercial temperature range devices are cheaper than the industrial or military versions. Although I have my favourite brands, my experience is that most modern devices from Western Europe, Japan, or the United States (including *off-shore* factory sites such as Taiwan and San Salvador) are reliable in performance and packaging. The companies in question would have gone bust in this competative age if this were not the case.

Finally, while there are very few magic differences between one device and another for a given voltage, power and current range, an NPN small signal transistor tends to be much the same as the next. Nevertheless it is fairer to the designer if you try to use the particular device specified; there may be a good reason for the choice.

Suffix	Temperature range
1 (Harris only)	−55°C to +200°C
M (2 for Harris, 54 for TTL)	−55°C to +125°C
I	−25°C to +85°C
C (5 for Harris, 74 for TTL)	0°C to 70°C

Table 2 Permitted temperature range. One of these letters (or numbers in the case of Harris ICs and TTL) will usually appear immediately after the IC number.

Family type	Description	Propagation delay (per gate)	Average Power (per gate)
74 ALS . .	Advanced Low-power Schottky	3-4ns	1-2mW
74 LS . .	Low-power Schottky	10ns	2mW
74 . .	Standard TTL	10ns	10mW
74 S . .	Schottky TTL	3ns	20mW
74 L . .	Low-power TTL	33ns	1mW
74 C or CD	CMOS	50ns	<1μW

Table 4 The letter codes used in the middle of 7400 series TTL type numbers to indicate the technology used.

Manufacturer	Metal can	Plastic DIL			Ceramic DIL			Power plastic	
	TO99 8 pin / TO100 10pin	8 pin	14 pin	16 pin	8 pin	14 pin	16 pin	TO92	TO220
Advanced Micro Devices		P	P	P	D	D	D		
Analog Devices	J								
Fairchild	H	T	P	P	R	D	D	W	U
Intersil	K								
ITT		N	N	N	D,J	D,J	D,J		
Harris (H, HA, HI)	2*	3*	3*	3*	1*	1*	1*		
Motorola	H,G	P	P	P	V	L	L	P	T
National Semiconductor	H,G	N	N	N	J	J	J	Z	T
Precision Monolithics	J	P	P	P	Z	Y	Q		
Raytheon	H	DN	DB	MP	DE	DC	DD	S	U
Signetics	H	N,V,N,E	F,A,N,H	B,NJ	FE	FH	FJ		
Siliconix	A	J	J	J	K	K	K		
Sprague	H	M	A	A	H	H	H	Y	Z
R.C.A	T								
Texas Instruments	H	P	N	N	JG	J	J	LP	KC
	mainly linear ICs	mainly commercial or industrial types			mainly military or industrial types			transistor types	

Table 3 IC package description. One or more letters will usually be placed immediately after the temperature code letter, except in the case of Harris ICs where numbers are used (marked with an asterisk) and placed before the type number.

First letter	Second letter	Third letter (if any)	Number	Final letters
A = germanium B = silicon C = gallium arsenide	A = small signal diode B = varicap or rectifier diode C = small signal transistor D = power transistor E = point contact diode F, G, L = high frequency transistor R = special purpose device S = switching diode or transistor T = thyristor or triac U = high voltage transistor X = same as B Y = power rectifier Z = zener diode	not usually significant	manufacturers catalogue number	lead-out arrangement:- (Pin view) current gain at 1mA:- A = 40 – 120 B = 150 – 460 C = 270 – 800

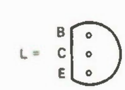


Table 5 The European ProElectron classification system used to identify discrete semiconductors.

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1982	**1983**	**1984**	**1985**	**1986**
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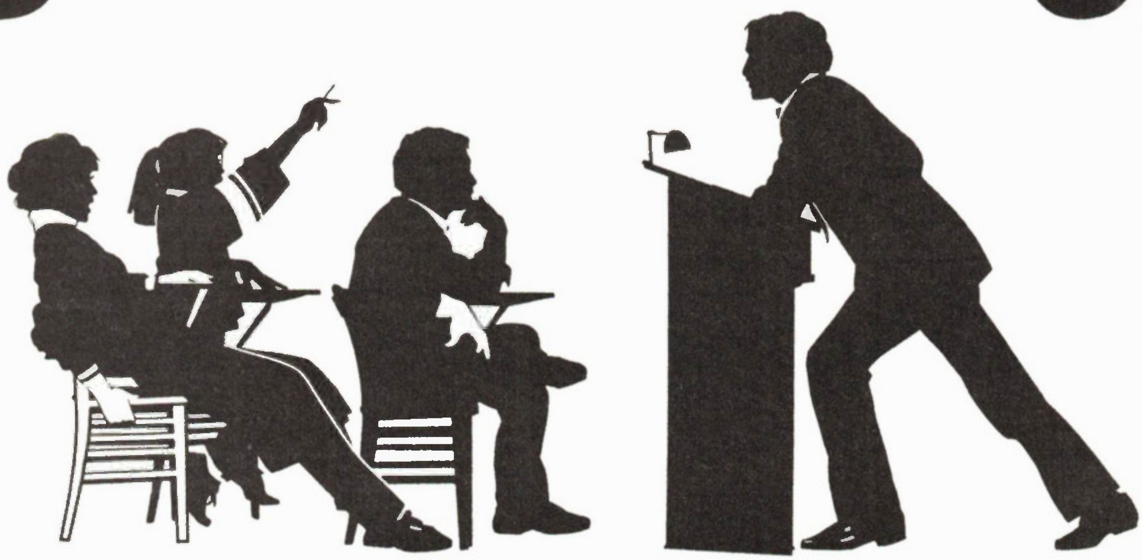


This month, we look at some of the basics of radio, beginning with the Field Effect Transistor.

By Michael Tooley and David Whitfield.

THE field effect transistor operates on a different principle from that used by the conventional junction transistor, the fundamental difference being that the FET is a unipolar device (only one type of charge carrier is involved).

Field effect transistors exist in various forms; the two major subfamilies being Junction Gate (JFET) and Insulated Gate (IGFET) types (see Fig. 1). At this stage we will only consider JFET devices and will go on to use one of these devices in a simple radio receiver.

Fig. 2 shows the simplified internal construction of an n-channel JFET. A thin slice of n-type silicon links the source and drain connections. A narrow p-type region is formed beneath a third electrode called a gate.

With no bias applied to the gate and with a potential difference (of either polarity) applied between the source and drain, electrons will travel within the n-type material in a region called the channel. We have illustrated this in Fig. 3(a) for the normal case in which the drain is made positive with respect to the source.

Now suppose that a negative bias voltage is applied to the gate. The p-n junction formed between the gate and the channel will become reverse biased. The increase in negative charge will repel the electrons away from the p-type region effectively reducing the width of the channel available for conduction, as shown in Fig. 3(b).

Increasing the reverse bias still further will reduce the width of the channel until we eventually reach a condition (known as pinch-off) in which the channel width has been reduced so much that electrons can no longer flow from source to drain. This condition is depicted in Fig. 3(c).

In terms of current flow, when no bias is applied to the gate (i.e. VGS = OV) current flowing into the drain and out of the source (remember that current and electron flows are opposite) will take a maximum value. Note that, since no current flows at the gate, the drain and source currents must be identical in magnitude.

Negative Bias

When negative bias is applied, and depending upon the magnitude of this bias, the source and drain currents will be reduced. Furthermore, no source and drain current will flow at all when the bias exceeds the pinch-off value.

We can illustrate this relationship with the aid of the mutual characteristic curve shown in Fig. 4. This shows drain current (ID) plotted against gate-source voltage (VGS). From Fig. 4, it should be noted that the drain current falls linearly with increasing negative gate-source bias. A typical family of output characteristics for a JFET are shown in Fig. 5. Readers should note that JFETs are not normally operated with the gate-source junction forward biased. (For an n-channel JFET this corresponds to a positive value of gate-source voltage). The danger, of

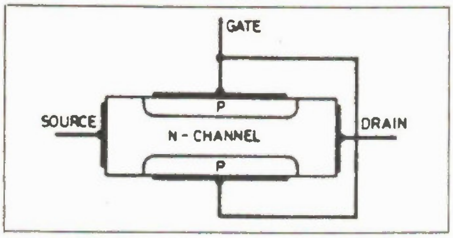


Fig. 1. JFET symbols.

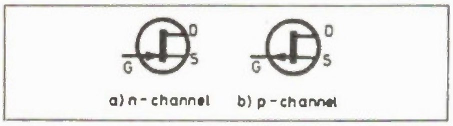


Fig. 2. Simplified internal arrangement of an n-channel JFET.

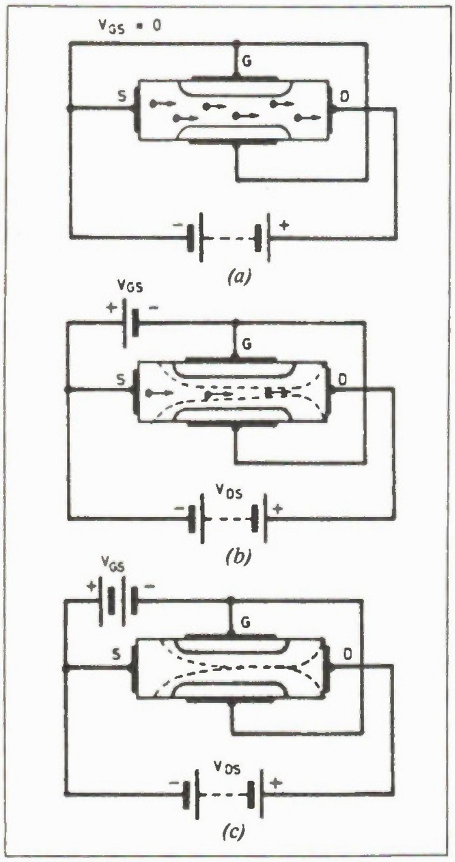


Fig. 3. JFET operation.

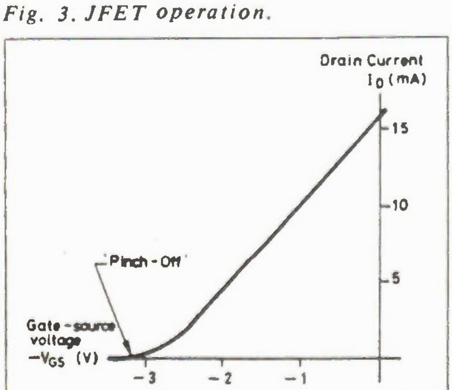


Fig. 4. Mutual characteristic for an n-channel JFET.

course, is that the gate-channel junction will become forward biased and an appreciable value of gate current will be drawn. In this condition the device will no longer operate in a linear manner indeed, an appreciable gate current may destroy the device!

One of the principal advantages of the FET (over conventional bipolar transistors) should now be becoming apparent. Since no current flows into the gate (it is operated by charge rather than current) the resistance looking into the gate of a FET is extremely high (in practice this can be tens of millions of ohms) and thus the device presents very little loading upon the input circuit. A typical JFET amplifier is shown in Fig. 6.

Radio

When a high frequency carrier is radiated into space (as an electromagnetic wave) the system is called radio, the sending and receiving ends being respectively known as a transmitter and receiver.

The modulated high frequency carrier may also be transmitted using a coaxial cable linking the sending and receiving ends of the circuit. By choosing appropriate carrier frequencies, systems of this type can permit a number of signals to be transmitted simultaneously down the same line. This Frequency Domain Muliplexing (FDM) is used in many long distance trunk telecommunication systems.

The Radio Frequency Spectrum

Radio signals occupy a very wide frequency range which itself is part of the complete electromagnetic spectrum, as shown in Fig. 7. The wavelength of a radio signal is simply the distance between corresponding points on consecutive cycles of the electromagnetic wave, as depicted in Fig. 8. In air, or space, such a wave travels at a velocity equal to that of the speed of light (300 million metres per second).

Velocity of propagation, v, wavelength, w, and frequency, f, of a radio wave are related by the following equation:

$v = fw$

Hence, when v = 3E8 m/s (where E8 is ten to the eighth):

$f = v/w = (3E8)/w$

and

$w = v/f = (3E8)/f$

where w is the wavelength expressed in metres and f is the frequency expressed in Hertz.

A radio wave with a frequency of 3MHz, for example, will have a wavelength given by:

$* = (3E8)/(3E6) = 100$ metres

Similarly, a radio wave having a wavelength of 1m will have a frequency given by:

$f = (3E8)/1 = 300$MHz.

The lowest frequencies used for practical radio communication are in the low tens of kHz. Very Low Frequency (VLF) waves travel close to the surface of the ground and rely on good ground conductivity. A typical application of VLF transmissions is, therefore, long distance telegraphic communication with submarines.

At the other end of the spectrum, frequencies of beyond 30GHz (i.e., 30,000,000,000 Hertz) travel only in straight lines over an unobstructed path.

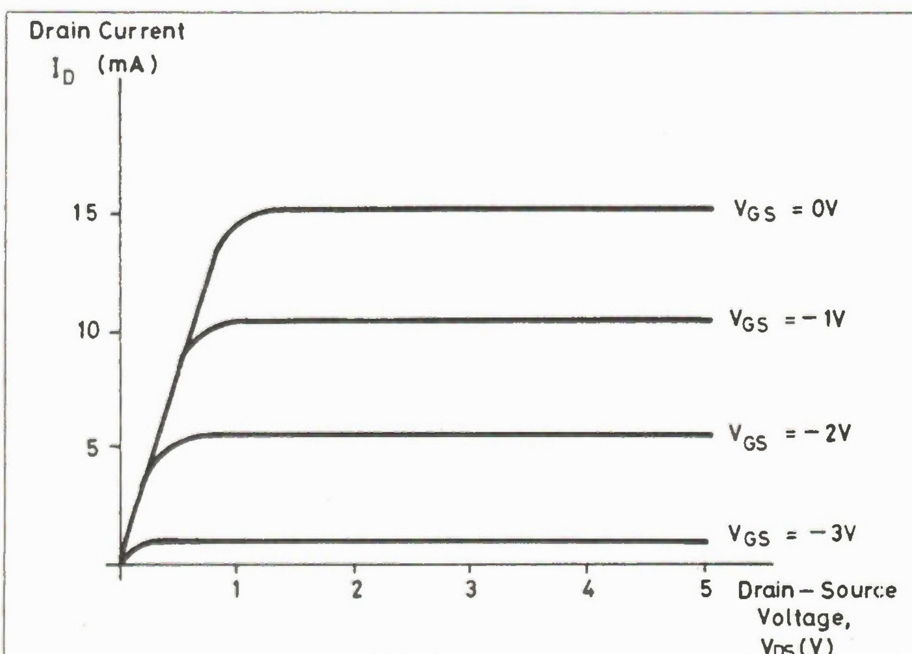


Fig. 5. Output characteristic for an n-channel JFET.

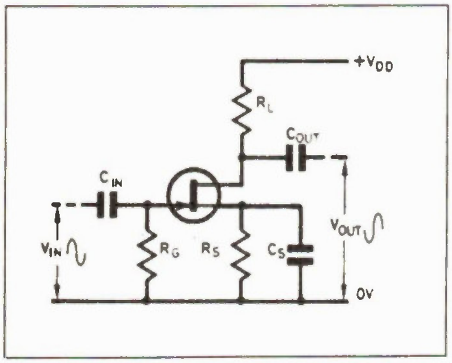


Fig. 6. Typical JUGFET amplifier state.

They are thus used for applications such as short range high resolution radar.

The use to which each frequency range is put depends upon a number of factors, paramount of which is the propagation characteristics within the range. Other factors that need to be taken into account include the efficiency of practical aerial systems in the range concerned and the bandwidth available.

Finally, though it may appear from Fig. 7 that a great deal of the frequency spectrum is unused, it should be stressed that competition for frequency space is fierce. Frequency allocations are, therefore, ratified by international agreement and the various radio services carefully safeguard their own areas of the spectrum.

Modulation

In order to convey information from one end of a radio circuit to another, the signal information must be modulated onto the high frequency carrier. The process of modulation is simply that of changing a particular property of the carrier wave in accordance with the instantaneous voltage (or current) of the signal to be conveyed.

Several methods of modulation are in common use, two of the most common being Amplitude Modulation (AM) and Frequency Modulation (FM). In the former case the carrier amplitude (its peak voltage) varies according to the voltage, at any instant, of the modulating signal. In the latter case the carrier frequency is varied in accordance with the instantaneous modulating signal voltage.

Typical waveforms showing a sinusoidal carrier modulated by a sinusoidal modulating signal are shown in Fig. 6.9. It should be noted that, in a practical case, far more cycles of the RF carrier would occur in the timespan of one cycle of the modulating signal than can actually be shown.

Consider, as an example, the case of a 1MHz carrier modulated by a 1kHz signal. One thousand cycles of RF carrier will occur during the time interval occupied by only one cycle of the modulating signal.

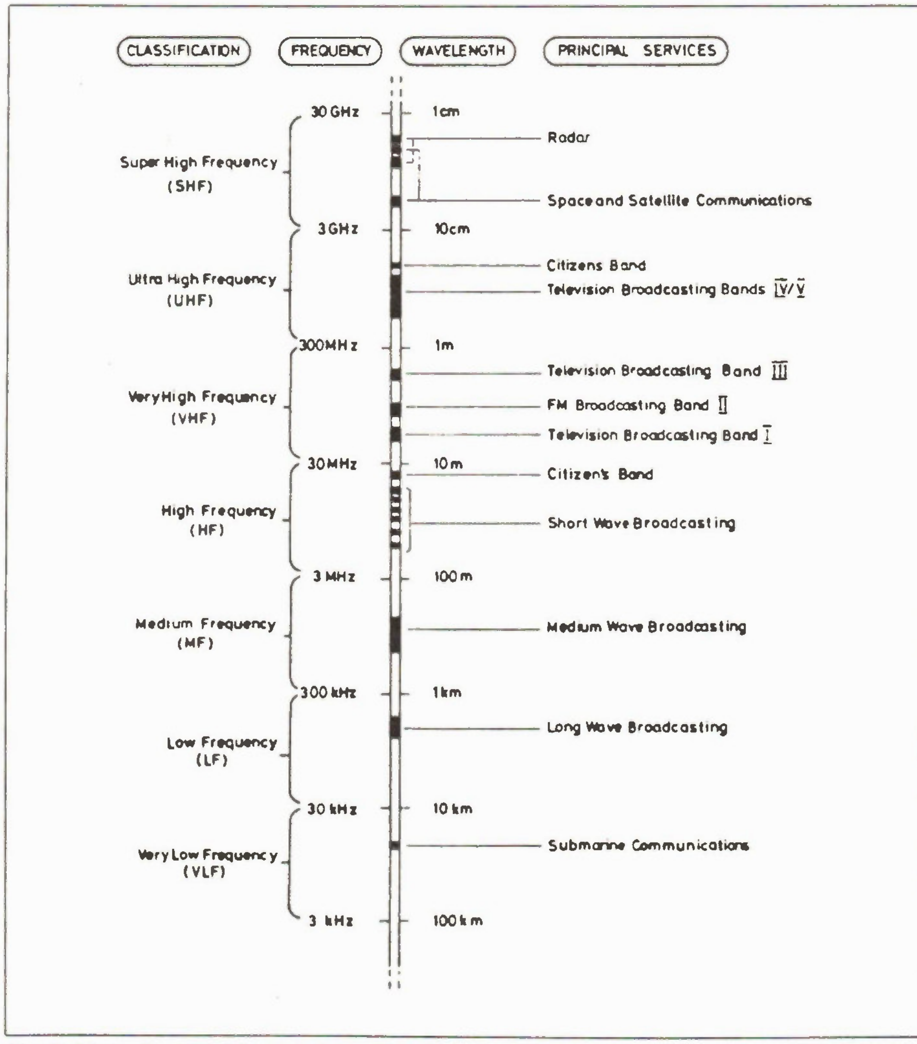


Fig. 7. The radio frequency spectrum.

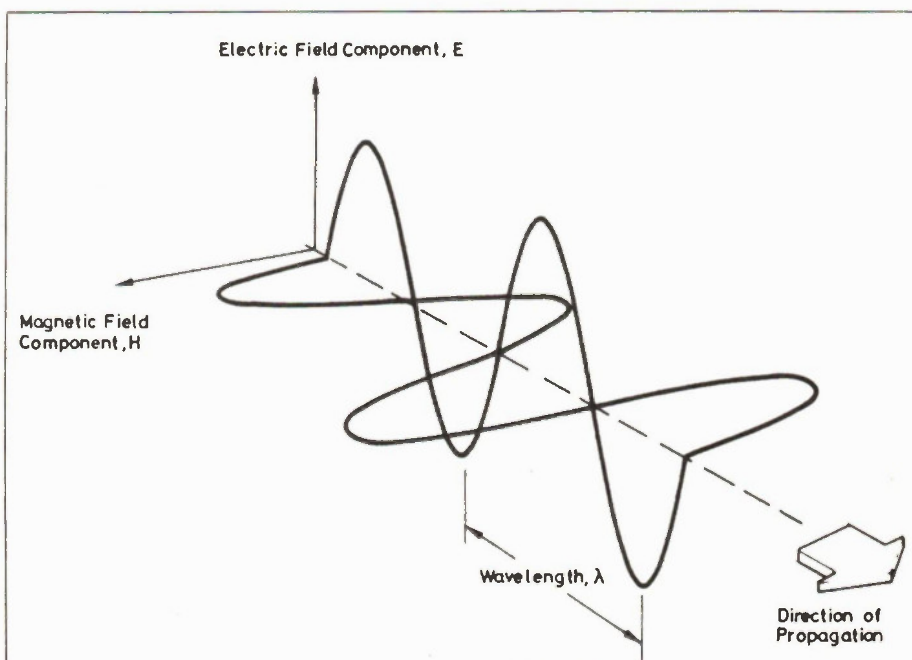


Fig. 8. An electro-magnetic wave.

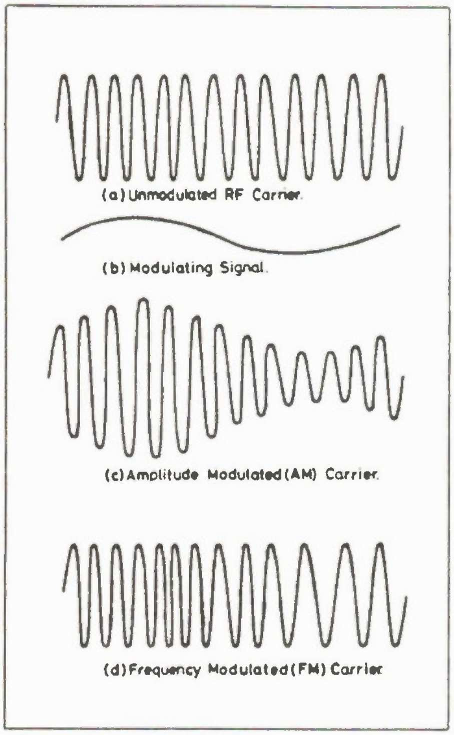


Fig. 9. Amplitude and frequency modulation.

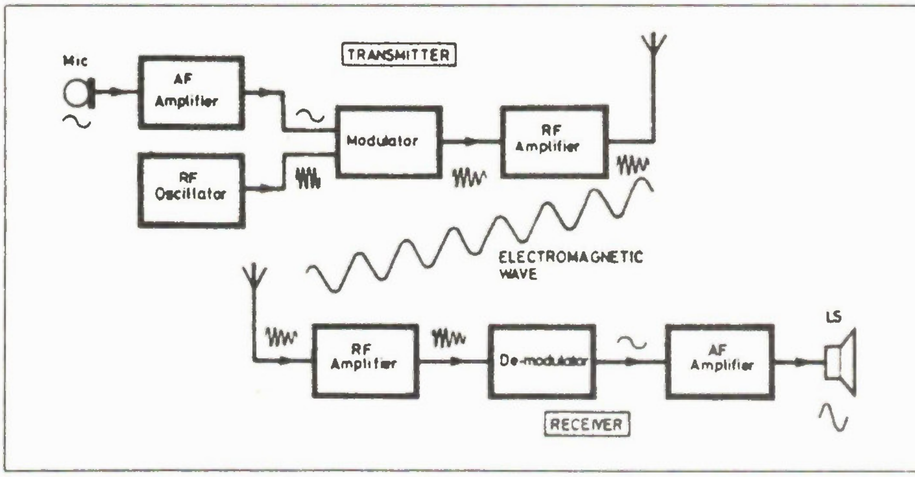


Fig. 10. Block schematic of a radio communication system.

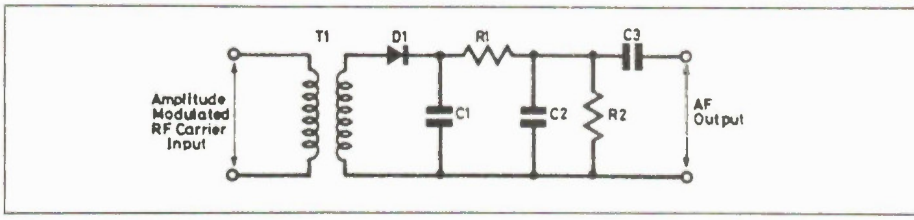


Fig. 11. A diode demodulator for AM signals.

Demodulation

The process of recovering the signal from a modulated carrier is known as demodulation. This process is carried out by a circuit known as a demodulator (sometimes also called a detector).

The block schematic of a complete AM radio system is shown in Fig. 10. The carrier wave (of constant frequency) is generated by means of an RF oscillator. In order to ensure unconditional stability of such an oscillator the frequency determining element is generally a quartz crystal. The output of the modulator (a modulated RF carrier) is amplified before outputting to an aerial system. The output is usually also carefully filtered to remove any spurious signals (harmonics) that may be present.

At the receiver, the signal produced by the receiving aerial is a much weaker copy of the transmitted signal. Also present will be countless other signals at different frequencies. These must be rejected in the receiver's RF tuned circuits if they are not to cause interference at the demodulator.

Besides selectivity, the RF amplifier stage also provides voltage and power gain so that a larger signal is presented to the demodulator. This stage then recovers the modulated information.

The signal recovered by the demodulator normally has quite a small amplitude (500mV, or less) and thus further (audio frequency) amplification is subsequently required to bring the signal to a voltage and power level suitable for connection to a loudspeaker.

Diode Demodulator

A simple diode demodulator is shown in Fig. 11 together with representative voltage waveforms in Fig. 12. The modulated RF carrier is applied (usually via a radio frequency transformer) to the diode which conducts on positive going half cycles of the RF input voltage. The diode used, incidentally, should be a germanium (rather than silicon) type by virtue of the much smaller forward bias voltage required for conduction to take place. This helps to improve the sensitivity and linearity of the detector.

Capacitor, C1, charges to the peak voltage of each RF cycle and maintains a voltage which resembles the shape of the envelope of the amplitude modulated input waveform.

Series resistor, R1, and shunt capacitor, C2, then form a simple low-pass filter which removes any residual carrier frequency components present on the recovered audio frequency output voltage. Finally, R2 completes the DC path (required by the detector) whilst C3 acts as a DC blocking/AC coupling capacitor to pass the signal to the next stage.

Tuned Circuits

We have already mentioned the need for selectivity within the RF amplifier stage. Selectivity is achieved with the aid of a tuned circuit comprising inductance, L, and capacitance, C. Where the frequency of the tuned circuit is to be made adjustable, either of the components may be

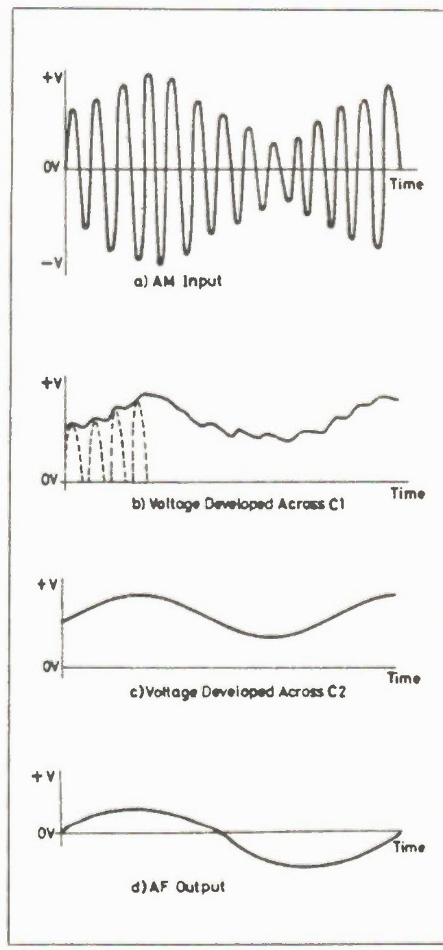


Fig. 12. Waveforms for the circuit of Fig. 11.

made variable. In practice, however, it is usually easier to make use of a variable capacitor rather than a variable inductor.

Two forms of series tuned circuit are possible; series and parallel, as depicted in Fig. 6.13. We have included, in each case, an equivalent loss resistance which accounts for the imperfections of the circuit (i.e. the leakage resistance associated with the capacitor and the winding resistance of the inductor).

Fig. 14 shows the impedance/frequency characteristic of each type of tuned circuit. It should be noted that the series and parallel tuned circuits have opposite characteristics and, furthermore, the series tuned circuit has a minimum impedance of Rs whilst the parallel tuned circuit has a maximum impedance equal to Rp.

The characteristics of the tuned circuit make it ideal for selecting or rejecting a range of frequencies. For this reason the series tuned circuit is often known as an acceptor circuit whilst the parallel tuned circuit is often called a rejector circuit.

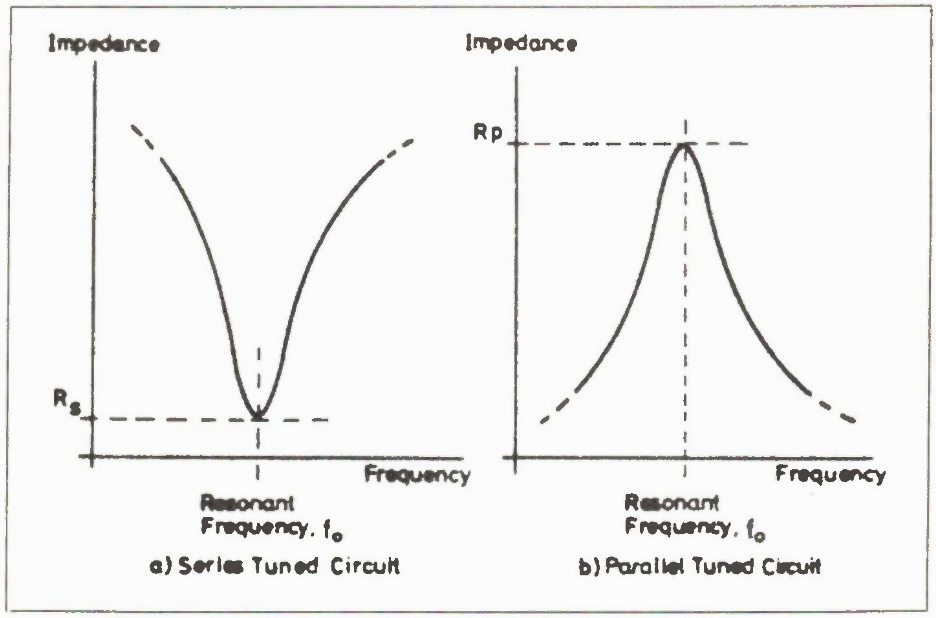


Fig. 14. Impedance frequency characteristics for the tuned circuits of Fig. 13.

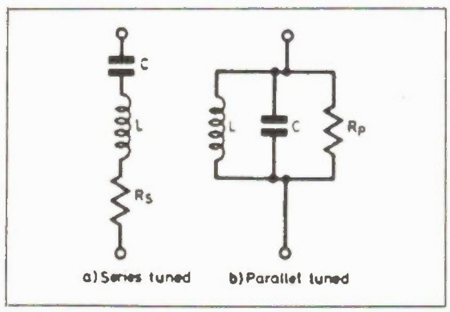


Fig 13. Tuned circuit.

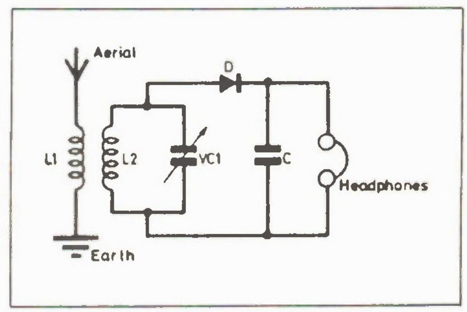


Fig. 15. A simple "crystal set".

A Simple Radio Receiver

A practical radio receiver can be produced by combining a tuned circuit with a diode demodulator, as shown in Fig. 15. The tuned circuit provides a degree of selectivity whilst the diode demodulator recovers the amplitude modulated signal. This arrangement is often called a crystal set since the first generation of such receivers employed a piece of galena crystal and a cat's whisker (a small piece of spring steel with a sharp point) to make a crude form of diode.

Provided that a reasonable efficient aerial and ground system can be realized, out simple radio receiver should be capable of providing acceptable reception of around half a dozen of the strongest broadcasting stations in the medium and long wave bands.

The selectivity and sensitivity of the receiver still leaves a great deal to be desired and thus the simple crystal set must now be considered as something of an antiquity.

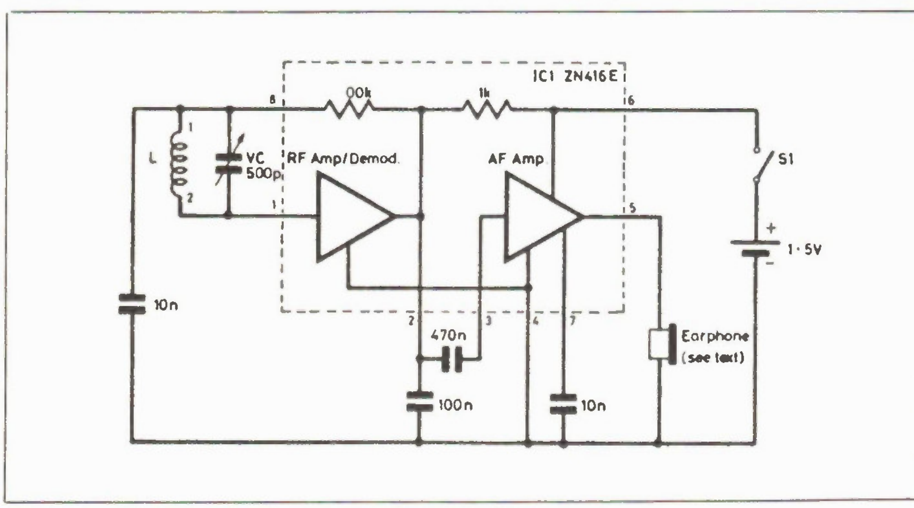


Fig. 16. a modern tuned radio frequency (TRF) receiver.

TRF Receiver

A modern tuned radio frequency receiver using just one tuned circuit is shown in Fig. 16. This receiver uses a ferrite rod (the same as that employed for this month's practical assignment) and does not require any external aerial or ground connection. The integrated circuit provides all the functions of an RF amplifier, demodulator, automatic gain control (AGC) and audio amplifier all contained on the same 8-pin dual-in-line plastic packaged chip.

The circuit requires only six external components (excluding medium/high impedance headphones or small loudspeaker) and is capable of operation over the range 150kHz to 3MHz, depending upon the tuned circuit employed. The IC provides a typical power gain of 72dB and operates from a nominal 1.5V single dry cell.

Despite its simplicity, this little receiver is capable of quite astonishing performance producing reception of more than a dozen medium wave stations at reasonable volume. Hopefully, it should make an interesting constructional project for readers wishing to put the components used in this month's practical assignments to some good use. ■

Coming in the December issue!
Canadian Satellite Downlink

We present a 24-page special section on satellite TV reception. The relay satellites have dozens and dozens of channels, and the new technology gives super quality video

Here are just some of the contents:

An Introduction – what's there to watch, and what you basically need to get it.

Choosing A System – a hands-on approach to the available hardware.

A Commercial Installation – how the pros install it.

A Do-It-Yourself Installation – how to manage it yourself.

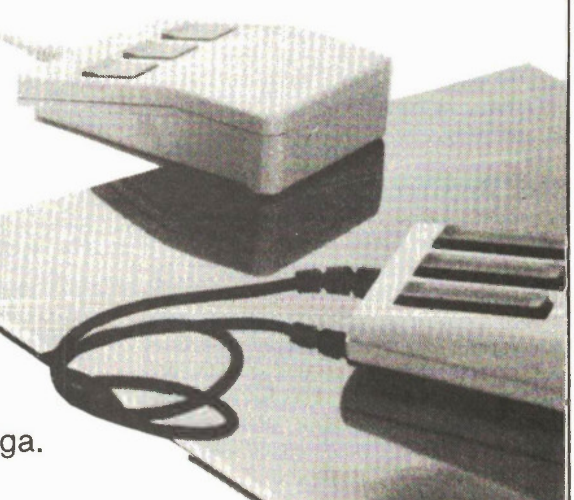
The Truth About Scrambling – what's currently scrambled or about to be, and what's not scrambled and not about to be. How scrambling works.

Alternate Services – there's more than TV on TV. The extra channels carry FM radio, videotex, wire services, interlace data and more. How they work and how you can access them.

All this and more in the December issue of Electronics Today!.

This Month in
Computing Now!

Mouse Review
A tale of two mice: the Logimouse and the SummaMouse are unveiled.



BEST AT Review
CN! takes the **BEST AT** for a test drive. Check out the results.

Build The Sloth
That's what it said. Take a look at what it takes to build your own computing machine.

Amiga Peripheral Survey
Find out about all the neat stuff available for the Amiga.

Low-co$t Transistor Tester

Build this simple, inexpensive gain checker for bipolar transistors.

By Jerry Penner

TRANSISTORS are one of the most basic components of active electronics. Building with them can be easy, but unless you know some basics, designing with them can range from mildly frustrating to completely unthinkable.

Have you ever wanted to match two complementary transistors exactly by gain? How about that digital power interface to control your house? Do the transistors in it have a high enough gain to work? Or do you just want to separate your junkbox into high and low gain transistors for future reference? In any of these cases a gain tester would provide the answer.

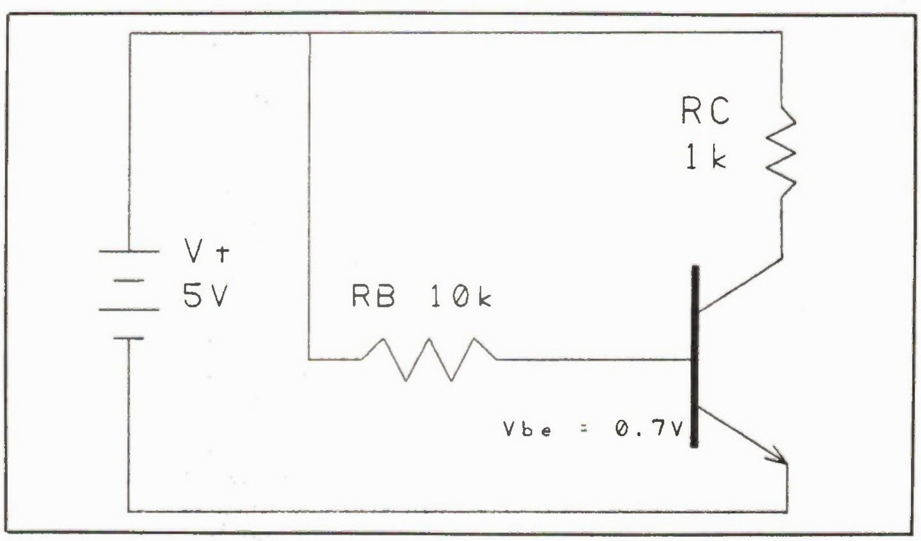


Fig. 1. The basic circuit used to measure Beta (HFE).

Transistor Gain

Transistor gain is equal to the amount of current through the collector divided by the amount of current through the base (Ib/Ic). In Fig. 1 the base resistor Rb is 10k and the voltage supply is 0.7 volts for silicon. The base current is equal to voltage supply minus the base emitter drop, divided by the base resistor value (Ib = (Vt - Vbe)/Rb). In the case of Fig. 1, Ib = (5V - 0.7)/10 kohms = 430uA. If Bdc = 100 and Rc = 1000 ohms, the maximum current through Rc equals Ib x Bdc, which equals 430uA x 100 = 43mA. This demonstrates the effects of transistor gain. Note that the collector current is 100 times greater than the base current. If the base current is changed to 1 microamp, the collector current is equal to the Bdc in milliamps.

If you recall that the amount of voltage across a resistor is direct, voltage across Rc can be used to measure Bdc. Therefore if Ib = 1uA, Rc = 1 kohm, and Bdc =

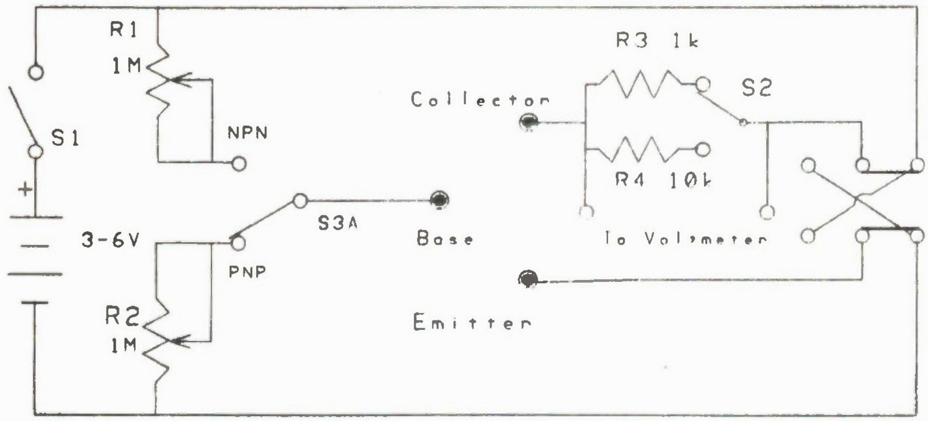


Fig. 2. The schematic of the tester for use with voltmeters with automatic polarity control.

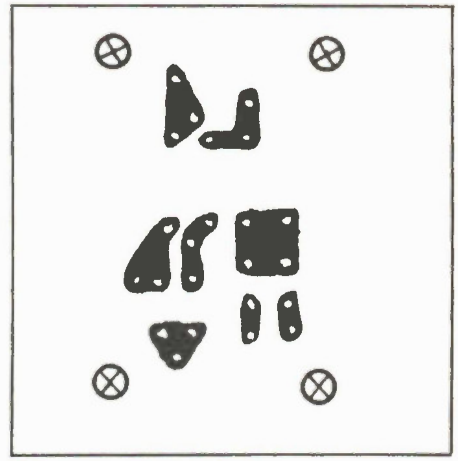


Fig. 4. The PCB for the automatic-polarity-control version.

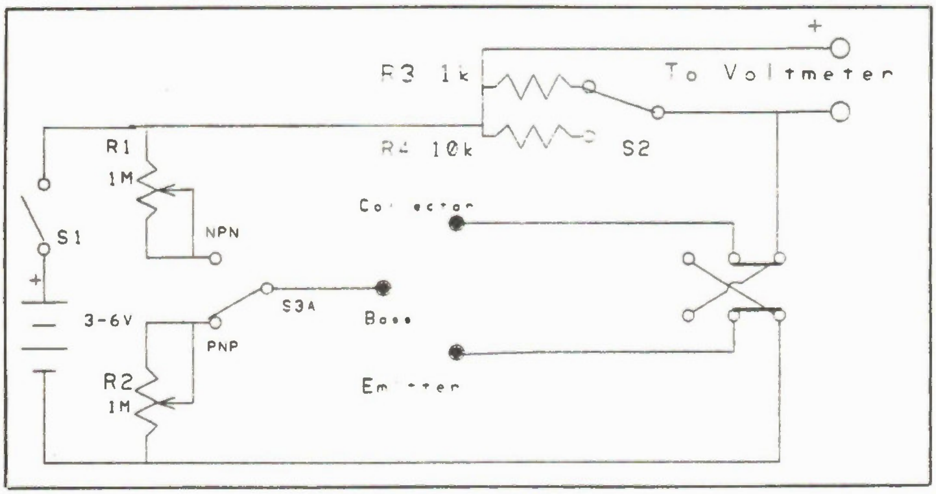


Fig. 3. The schematic of the tester for use with voltmeters which do not have automatic polarity control.

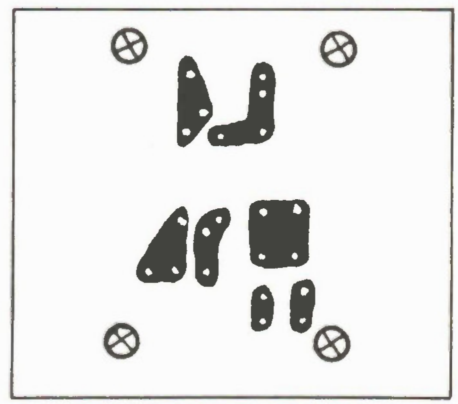


Fig. 5. The PCB for the non-automatic version.

100, then:
Vc = Ib x Bdc x Rc
Vc = 1uA x 100 x 1000ohms
Vc = 100mV.

Since most voltmeters can't read in the millivolt range, Ib must be 10uA to give a measurable Bdc for low gain transistors. This means that a Bdc of 1 would actually read as 10mV.

Fig. 2 is the schematic for the meter itself. One problem exists with this project if you don't have a digital voltmeter. To maintain accuracy, the collector resistor should stay on the collector. However when the type selector is switched from NPN to PNP, the polarity on the collector resistor changes. If you don't have automatic polarity reversal on your meter, you should use Fig. 3. In Fig. 3 the load resistor switches between collector and emitter as the transistor selector is switched. Since the base current on a transistor runs out the emitter, Bdc for PNP will be measured one unit higher than it actually is.

Construction

Construction may be by any method, but Veroboard or PCB are suggested to keep everything compact. Remember to use Fig. 5 if your meter doesn't have automatic polarity control. Resistors R3 and R4 should be as close to their ratings as possible. If they are within 1 percent either way, the tester will give good accuracy.

In order to make the device plug directly onto a meter, the connecting pins must be fastened to the back of the box. Because of this, a nonmetallic box must be used. The particular meter this tester was designed for has banana connectors. To get the exact fit needed, banana plugs were put into the V+ and common terminals and screws tightened into the plugs. Then the plastic box was placed on top of the screws and the screws heated with a soldering iron. The plastic melted enough to mark where holes must be drilled.

Note: When connecting the transistor lead wires, use three different coloured wires to make identification easier. Also identify the NPN and PNP trimpots to make calibration less frustrating.

Calibration

There are two methods of calibration. The easiest is to have an NPN and PNP transistor of known Bdc. Put the NPN transistor under test, connecting emitter, base, and collector correctly. Switch the type selector to NPN and set the LO/HI Bdc switch to LO if the calibration transistor has a Bdc of 20 or less. Adjust trimpot R1 until the known Bdc is indicated on the voltmeter in x 10mV, or x 100mV if the LO/HI Bdc Switch is in the LO position.

The second method is more complex, but Bdc need not be known. First find Vbase by measuring the battery voltage and subtracting the 0.7 volt base-to-emitter drop (Vbe). Divide Vbase by Ibase of 10uA to find the base resistance Rb (Rb = Vt-Vbe/10uA).

Switch your multimeter to the resistance scale. Adjust the NPN trimpot until the calculated resistance is reached. Repeat for PNP.

Now that the unit is calibrated remember what the battery voltage is. Battery voltage can be checked by switching the unit on and shorting the collector and emitter leads together. This tester

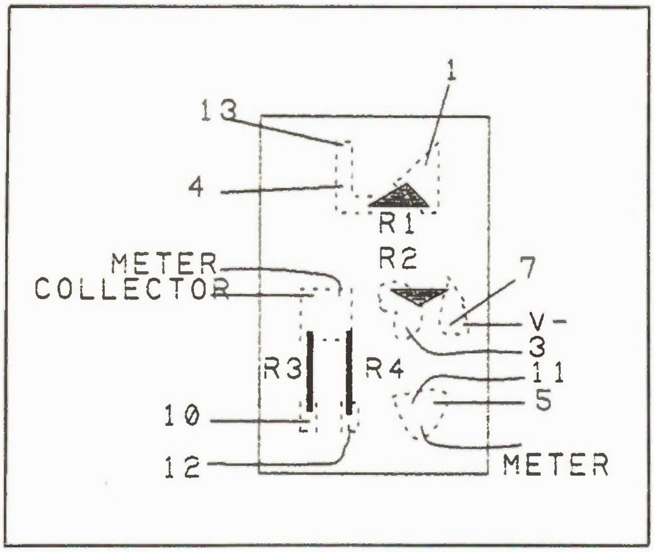


Fig. 6. The wiring of the automatic version PCB.

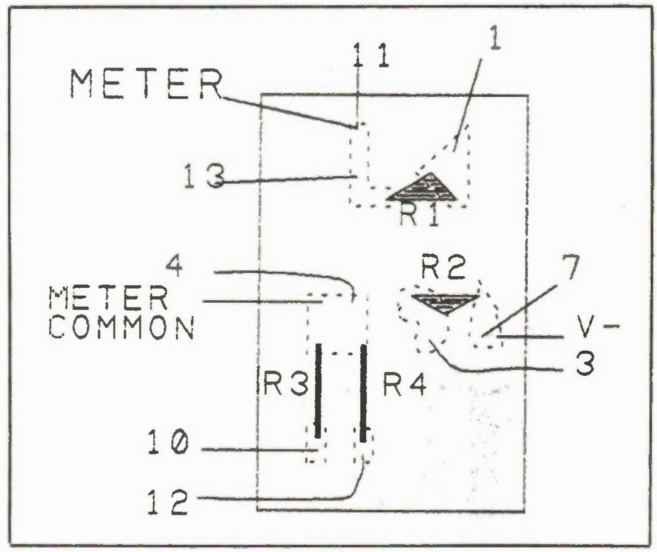


Fig. 7. The wiring of the non-automatic version PCB.

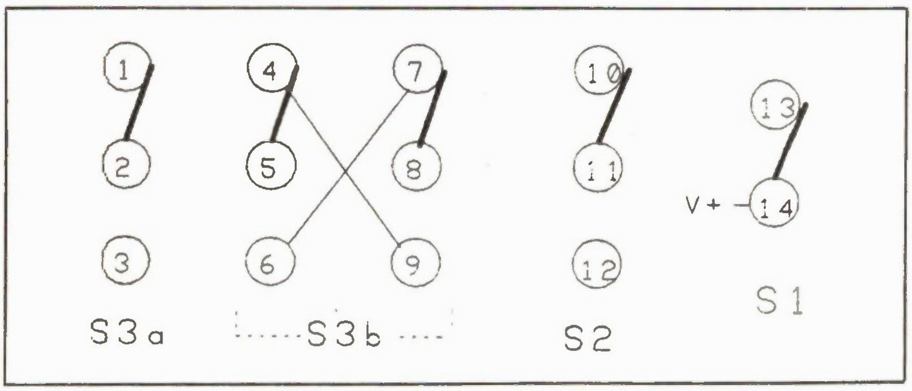


Fig. 8. The switch terminal numbering.

has the added advantage of testing its batteries under load. When the battery voltage drops by 100 mV, measured Bdc drops by five percent. Rechargeable batteries would be a good idea here because they tend to hold their rated voltage during discharge. Ordinary batteries do not. If you are willing to lose portability, a plug-in power supply would be the best idea. No worries about battery voltage.

The Circuit

Resistors R1 and R2 provide the precision resistance to the transistor base. S1 is the type switch. It switches between these two resistors and also reverses the polarity of the emitter and collector leads. The base resistance is adjusted to give a 10uA current into the transistor base. The test transistor amplifies the base current to by amount equal to 10uA x Bdc. Bdc is measured across either R3 or R4 as voltage. Low gain transistors can be measured accurately by switching the Lo-Hi Bdc selector to the Lo position. This places a 10k ohm resistor in series with the transistor under test, allowing currents up to 20mA to pass and Bdc up to 20 to be measured. In the Hi position a 1000 ohm resistor is in series with the transistor, allowing Bdc up to 200 to be measured.

Current is converted to voltage potential across R3 or R4 and the Bdc measurement taken as voltage across one of these resistors. Higher Bdc may be measured if a higher battery voltage is used and the trimpots adjusted, or by substituting R3 or R4 with a lower resistance. Be careful that no transistor parameters are exceeded. This will cause the transistor to break down.

Conclusion

Now that you have a Bdc tester of your very own, that growing mound of used transistors in the corner may not look so menacing. They say that necessity is the Mother of invention. Currently, my desk is crawling with millions of homeless three-legged amplifiers. I think of this project as my latest weapon in the war of useable workspace. ■

MARKET PLACE

Continued from page 33

Precision Power Supply

Parts List

Resistors

R1	1.2K
R2	7.5K
R3	15K
R4	160R
R5	0.22R 5W
R6	0.22R 5W
R7	10K 1W
R8	180K
R9	330K 1W
RV1	5K
RV2	5K
RV3	500R
RV4	100K
Pot 1	50K ten turn
Pot 2	500R

Capacitors

C1	2200uF 100V electolytic
C2	2200uF 100V electrolytic
C3	220uF 50V electrolytic
C4	0.1uF ceramic
C5	10pF ceramic
C6	240pF ceramic
C7	0.1uF ceramic
C8	100uF 100v electrolytic

Semiconductors

D1, 2, 3, 4, 5, 6, 7, 8	1N4007
Br$_1$	6 amp 200V Bridge
B$_2$	1 amp 50V Bridge
Q1	TIP 31C
Q2	2N6385
IC$_1$	MC1466

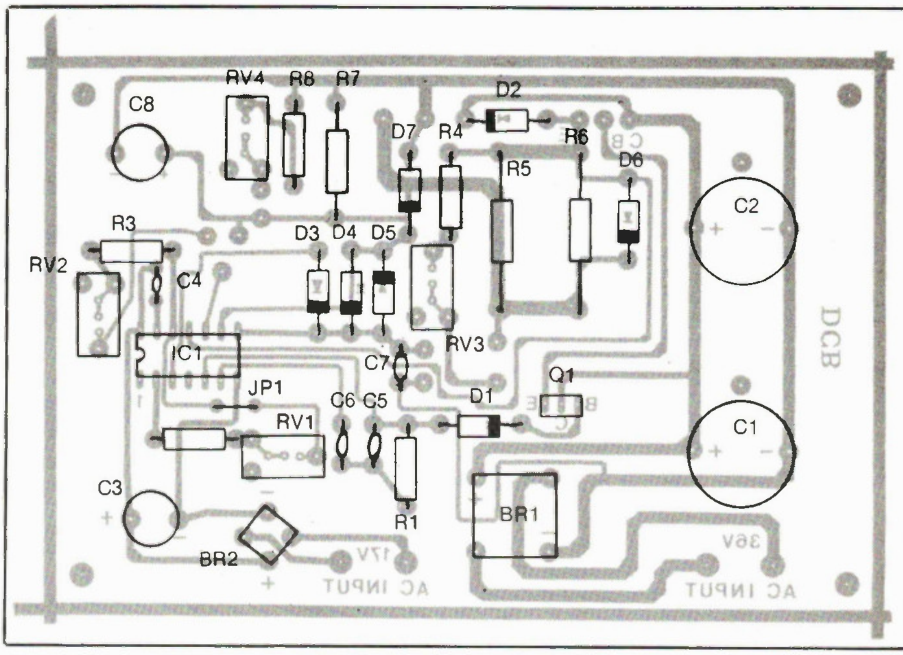
Other:

17 VAC	300 ma
36 VAC	3A

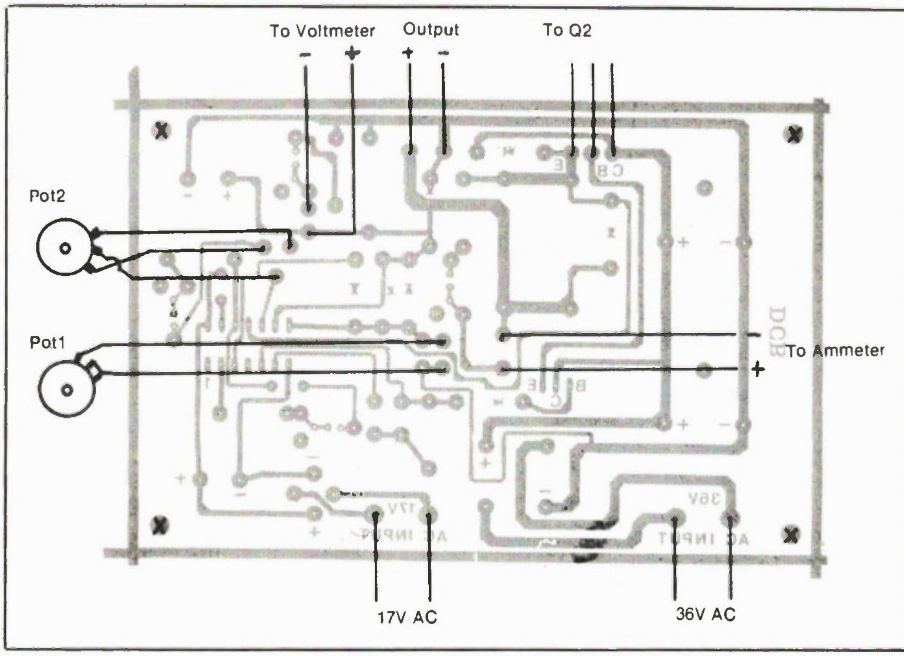
Power Switch
Led
Heatsink
Cabinet (Hammond 1458 series)
3 binding posts
2 knobs

Meters

2	250 uA meters



Parts overlay (top) and the wiring detail for the P.S.U.



Continued from page 8

For Your Information

If you need to check the quality of the grounding on live 110VAC circuits, the Metrohm Ground Loop Impedance Tester generates a 25 ampere pulse for 40 milliseconds in the ground line loop. The resultant reading is displayed as total input resistance. Two neon lights indicate improper connections, and a plug-in test probe can be used to check the grounds of conduit, boxes, tools, etc. Contact Duncan Instruments, 121 Milvan Drive, Toronto, Ontario M9L 1Z8, (416) 742-4448.

Circle No. 23

One-day seminars on Microcomputers and Microprocessors will be held by the Ontario Centre for Microelectronics in Toronto, November 12, and Ottawa, December 10. It's a technical overview for managers, engineering personnel and general staff who work with microprocessors. For more information contact the Training Coordinator at OCM at 1-800-2267-8727, or in Ottawa call 596-6690. Ontario Centre for Microelectronics, Suite 400, 1150 Morrison Dr., Ottawa, Ontario K2H 9B8.

Circle No. 38

The Motorola Microprocessor Products Group announces a 25MHz version of the MC68020 32-bit microprocessor, along with a 20MHz version of the MC68881 Floating Point Coprocessor. The CPU now operates in the burst mode at 12.5 million instructions per second with a sustained throughput of 5MIPS. It's also available in versions that run at 12.5MHz, 16.67MHz and 20MHz. Contact local Motorola dealers, or the Products Group at PO Box 3600, Austin, Texas 78764, (512) 440-2839.

Circle No. 39

Yet another change: Lenbrook Electronics will henceforth be using their corporate name: Birde Marketing Inc. The address and telephone remain the same: 111 Esna Park Drive, Unit 1, Markham, Ontario L3R 1H2, (416) 477-7722.

The Hitachi Corporation will now be a second source for Fairchild's FACT line of CMOS digital logic circuits. The FACT line features power consumption levels as low as 0.1mw per gate and internal gate delays of 1ns.

Circle No. 40

Digital Controlled Solder Dispenser

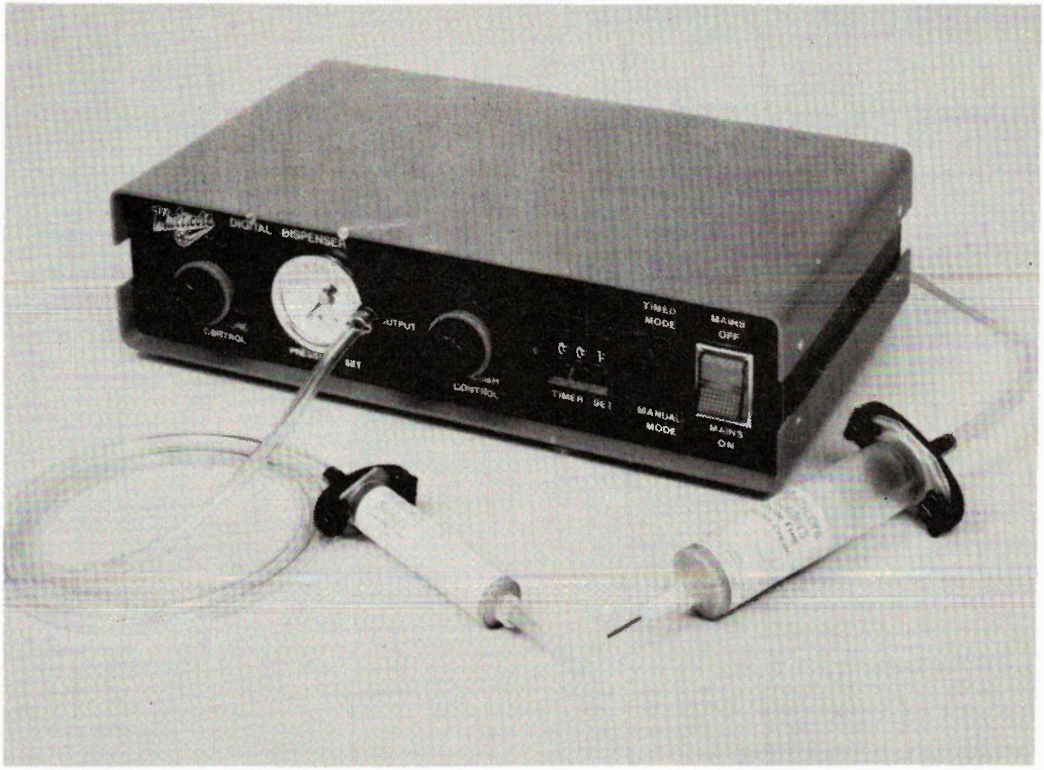
Looking for a clean and efficient way to solder? Check out this digital controlled dispenser from Ersin Multicore Canada.

The unit is ideal for accurate and repeatable shot time application of solder creams, solder masks and SMD adhesives on a printed circuit board. Accuracy on all settings is better than 1% from 0.01 to 9.99 seconds. Dispensing pressure is fully adjustable and a manual override control and automatic foot lever operation are standard.

The system includes a unique vacuum pull back, before and after dispensing for precise cut-off and to eliminate dripping. It also includes a vacuum pick-up pen for SMD devices, dual outlets for simultaneous paste deposition and vacuum pick/place. Facilities required are a filtered air supply and standard 115V power. A selection of adapters, cartridges, and dispensing tips are available.

Ersin Multicore Canada, 3525 Robert Chevalier, P.A.T. Montreal, Quebec H1A 3R7. (514) 642-4095.

Circle No. 24 on Reader Service Card



Circle No. 19 on Reader Service Card

Special VCR Tools

Philips ECG, of Waltham MA, have introduced a set of eight specially designed wrenches for use in the repair and maintenance of Video Cassette Recorders.

Part of a complete ECG line of Audio/Video repair and maintenance equipment, these wrenches are made to match the configuration of the recesses that adjust tape feed, tape tension, and various other functions within VCRs. Tools are offered for both VHS and Beta units.

To locate the nearest distributor, consult the 'Electronic Parts and Supplies' section in the Yellow Pages or contact: Philips ECG, 100 First Avenue, Waltham MA 02254. (617) 890-6107.

Circle No. 28 on Reader Service Card

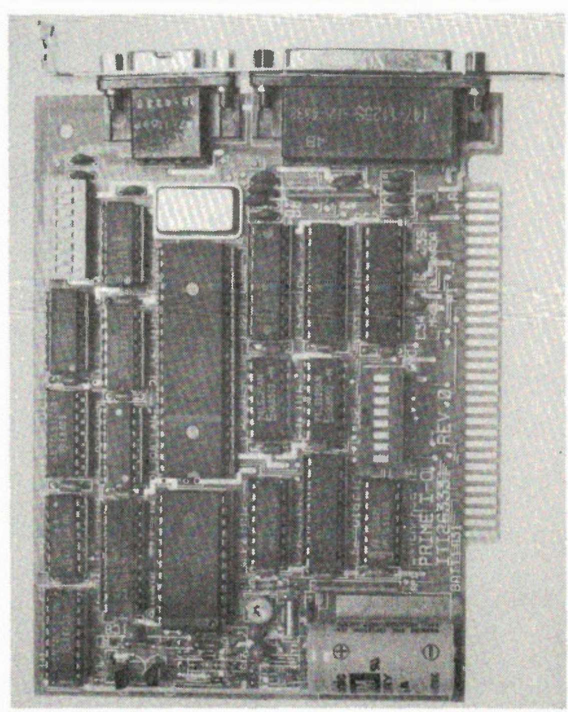
Two New PC Add-Ons

Interface Technologies Inc. has introduced two new peripheral cards for the IBM PC/XT and compatibles - Command Performance and Prime Time I/O.

Command Performance is a high-resolution enhanced graphics adaptor (EGA) card combining the functions of the IBM-enhanced graphics adaptor, IBM color graphics adaptor and the IBM monochrome graphics adaptor with smooth scrolling, panning, and windowing. Resolution in the various graphics modes are: 640 x 350 in the EGA with 16 colors, 640 x 200 one color, 320 x 200 four color, and 640 x 350 in monochrome with 4 shades.

Prime Time I/O is a half-size, three function card featuring a serial port, parallel port, and real time clock with a four year calendar. Software is included for full function set-up.

Ron Wyvill, Interface Technologies Inc., 25-4 Connell Court, Toronto, Ontario M8Z 1E8. (416) 255-5551. 1-800-387-7313 Can., 1-800-387-7208 USA.



Circle No. 29 on Reader Service Card

Computers in EDUCATION 86

Computers and Software for Educators

Hands-on Show and Conference

October 23, 24 and 25, 1986.

Arts Crafts Hobbies Building
Exhibition Place, Toronto
Thursday and Friday 10:00-9:00
Saturday 10:00-5:00

1	**"Hands-on" Involvement**	Unlike most shows, which are appendages to lecture series, this Conference will bring educators together with software, hardware and peripheral product suppliers for the first time on a large scale, permitting teachers to test their products in an unpressured, untimed environment, and thereby personally determine what's good, what isn't and where it fits in the curriculum.
2	**125+ Machine Computer Lab**	In the computer lab teachers will be able to test software at their leisure on the types of machines with which they are currently familiar, as well as on the newer machines.
3	**Software Passport**	Conference delegates will receive a Software Passport allowing them to borrow software from among the estimated 2,000 + packages available for individual testing in the computer laboratory.
4	**Latest Hardware**	Those teaching computer studies will be able to see and test educational electronics packages designed with secondary school courses in mind. To help teachers understand the full strength of the software packages available, the latest hardware and where it all fits into the curriculum, there will be demonstrations to individuals or small groups of teachers at their request.
5	**Full Program of Educational Computing Seminars**	To be opened by the Ontario Minister of Education, The Honourable Sean Conway, the Conference Seminars will only include subject areas of practical use to teachers in the classroom. A partial list of titles includes: Copy Not, Want Not • Work Related Software, • The Educational Context for Computers in Education • Avoiding the Proprietary Software Trap • The Need for Large Courseware on CD ROM • Using Logo within the Existing Mathematics Curriculum • Towards Quality Courseware Development • The Classroom of the Future • Designing Exemplary Software for the Georgraphy Curriculum • Selecting Appropriate Software - The Ins and Outs • ECONET • The UNIX and DOS Connection - Tapping Larger Software Sources for Classroom Use • Use of the Word Processor in Generating Examinations • Designing Computer Lessonware • Courseware and Authoring • Special Education Software • Using the York Educational Software Database • Using the Amiga in the Music Classroom • Using the Amiga in the Art Classroom • The Amiga in the Classroom.

Registration Information

Conference delegates who pay the $25 registration fee by October 15, 1986 will be eligible for the special drawing for an ATARI 1040ST colour system to take place October 24. Your cancelled cheque will confirm your registration and eligibility for the draw. An official receipt will be attached to your conference passport, to be picked up on arrival at the Show. Visitors who pre-register but who are unable to attend can receive a full refund if written notice is provided on or before October 21, 1986. To register, complete the registration card included in the September or October issues of Computers in Education, or send a cheque directly to Moorshead Publications, or telephone (416) 445-5600 and charge it against your Visa, Master Card or American Express Card.

Computers in Education '86
Moorshead Publications
1300 Don Mills Road
Don Mills, Ontario
M3B 3M8

ATARI Registration prize computer donated by ATARI Canada ATARI

For Toronto accommodation information, contact Merrylee Greenan at the above address or at (416) 445-5600.

In co-operation with the Ontario Principals' Association.

Circle No. 30 on Reader Service Card

Reliability in Numbers

Full Line DMM's Protected by Triplett's 3-Year Warranty.

Dependable Digital Multimeters

Triplett announces the three-year warranty on its complete line of high-tech digital multimeters. These accurate, reliable digital testers, with their exclusive warranty, reinforce Triplett's position as the world leader in the design and manufacture of test equipment and panel instrumentation.

Adaptable. Triplett's complete line of digital testers offers the convenience of an easy-to-read liquid crystal display housed in an impact-resistant, ergonomically designed case. All models feature overload protection, auto polarity, solid-state electronics and low battery indicators. They come complete with batteries, test leads and instruction manuals.

Cost-effective. Model-for-model, feature-to-feature, Triplett's digital testers are competitively priced with any other testers in today's market.

Quality. State-of-the-art technology identifies the entire line of Triplett digital testers. Assurance of quality allows Triplett to offer this unique 3-year warranty.
*Model 2030: 1-Year Warranty

When you are looking for the finest in high-tech digital multimeters, look to Triplett, the Company America has trusted for more than 80 years.

In Canada, Complete Sales and Service Available Through...

Circle No. 31 on Reader Service Card.

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Downsview, Ontario,
M3J 2S2
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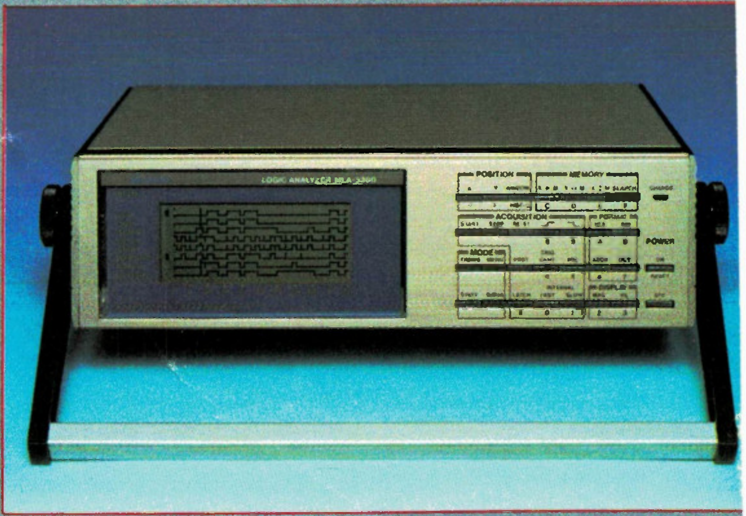
TELEX 065-28169
Mon-Fri 8-5 pm, Sat 10 am-1 pm.

MEGURO/RCC - MORE FOR YOUR INSTRUMENT DOLLAR

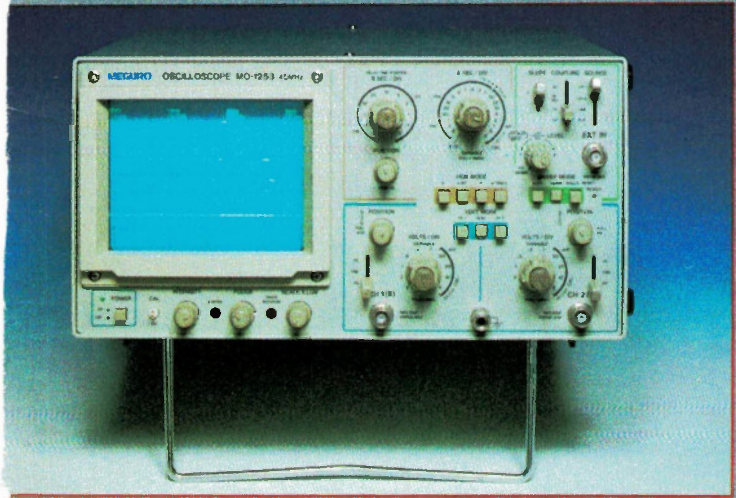
'SCOPE for 100 MHz

The MO-1255 100 MHz 'scope features 3-channels and 8 traces. Has alternate sweep, 6-inch rectangular high luminance internally calibrated CRT, wide dynamic range and 2-channel X-Y operation. Control logistics make this unit exceptionally easy to operate. Has TV sync, separator circuit and 20 MHz bandwidth limiter.



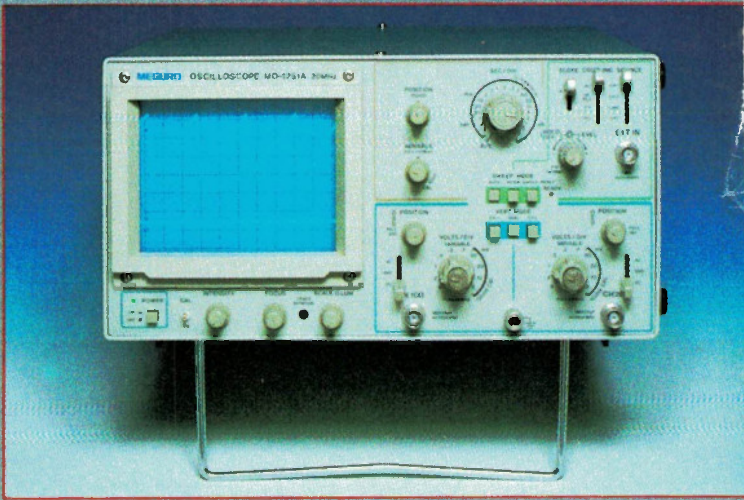
LOGIC ANALYZER - 16 channel

The MLA-3300 combines timing analyzer, state analyzer and signature analyzer in one. Has 16-channel input and 100 ns resolution at 10 MHz. Portable, battery or AC operation, low power LCD display. Comparative acquisitions are easy with 256 bit/channel acquisition and reference memories. Menu operated.



DUAL-TRACE OSCILLOSCOPE — 20 MHz

The MO-1251A dual trace 20MHz oscilloscope features sensitivity of 1 mV div. and speed of 20 ns/div., high luminance cathode ray tube, measurement to 400 Vp-p and a stabilized power supply for accurate measurements.



DUAL-TRACE OSCILLOSCOPE — 40 MHz

The MO-1253 has a delay time sweep function used to enhance the accuracy of fine measurements. It has an acceleration voltage of 12kV and a six inch high luminance cathode ray tube with beam intensity and scale illumination controls. This provides for more accurate and readable measurements needed in the fields of research and development, production lines and maintenance/servicing sections.

meguro

RCC ELECTRONICS

310 JUDSON ROAD, UNIT 19, TORONTO M8Z 5T6 (416) 252-5094
Moncton: P.O. Box 921, Moncton, N.B., E1C 8N8, Telephone: Toll Free 1-800-361-2909
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