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August 1986

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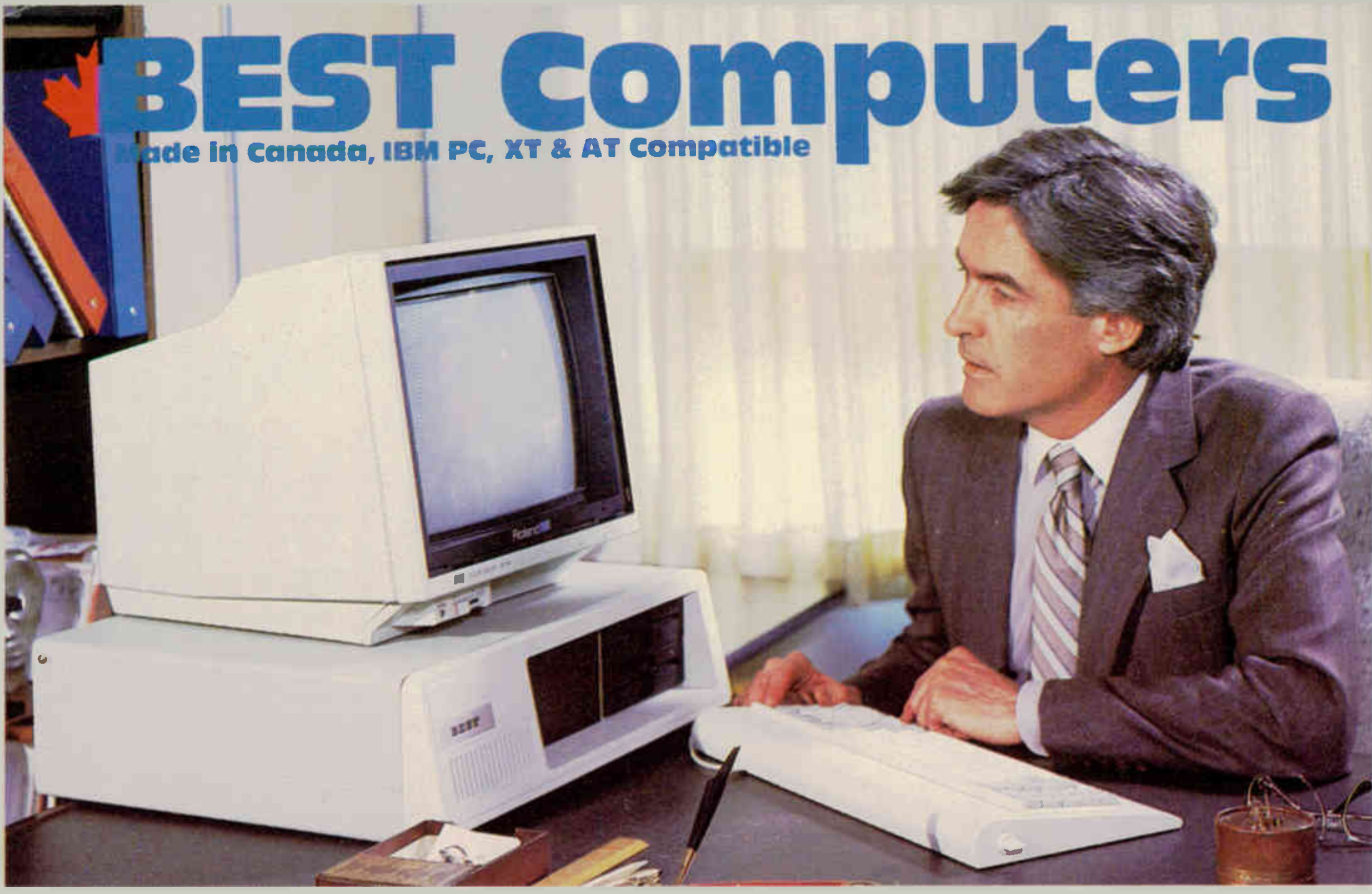

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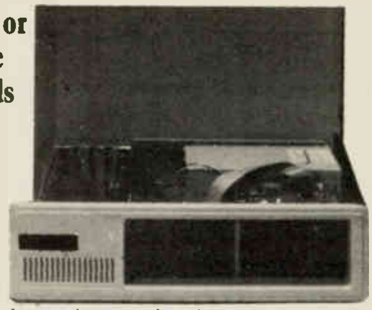

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Electronics Today

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Our Cover

It's a house, see, made from a Laser computer with 8" floppy disks as the roof. It illustrates our Home Computer Control article, page 28, and was concocted and photographed by Bill Markwick and Ed Zapletal.

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For Your Information

The Editor's Corner

By Bill Markwick

Hello again. Welcome to a new column, an idea that just sort of happened as a result of all the little bits and pieces of musings and ramblings that I put in the For Your Information section. I decided to get them all together and give them their own space because they didn't fit too well anywhere else. It gives me a chance to comment on all sorts of irrelevant things and gives the reader the chance to ignore them all at once.

Take MS-DOS compatibles, for instance. Why are they so expensive? A famous-name two-drive unit with 256K and a monitor can cost you $4500, and an AT work-alike may be in the neighbourhood of $8000. For what? They aren't upgrades of the original, rather cumbersome IBM design; they aren't much faster or better.

Compare these units with what you could get for the price of an XT compatible: a good used car (or a new car at AT prices), a roomful of elegant furniture or a houseful of reasonable stuff, or five or six colour TVs. Are you into woodworking? For the price of a PC or XT, you could get yourself a fine quality tablesaw, an 8-inch Swiss jointer, a bandsaw, a drill press, every portable power tool you've ever wanted, plus enough left over to buy some rare woods to get you going.

For the price of an AT or compatible you could build a concrete block garage to put it all in.

If you think I'm being unfair to the corporations, consider the IBM-compatible computers built in Canada by the smaller companies. At the moment you can get a two-drive 256K with a monitor *and* printer for $1895. And yes, they do work; after all, everybody uses the same Intel-based system anyway.

I suppose it's all because people have become used to paying exorbitant prices for computers, just as they're conditioned to mufflers that fall off every two years.

Next gripe: the dreadful quality of Canadian electrical wiring equipment sold to the homeowner for new installations or rewiring. Not even the shoddiest of third-world importers use the sort of junk you're forced to buy from hardware stores and electrical supplies.

Those outlet boxes! What fool designed them? And the approved wiring methods make me wonder why every second house doesn't burn down: uninsulated ground wires, rinky-dink outlets and switches with terminals a hair's-breadth from the box, and mounting tabs that make it virtually impossible to mount the box solidly to wood or wallboard.

My 100-amp service panel accepts 24 circuits, but there isn't provision for 24 ground wires. There are no wire guides or clamps, something you need because the neutral connections are to a common buss at the bottom. What a mess. Why have a service panel at all? Borrow the idea of the ring main, where a high-current cable loops through the house and each outlet box has its own fuse or breaker. Much more sensible.

I'll bet that if we really knew the exact cause of electrical fires, those twist-on wire nuts would be involved to a great extent. Would you accept a computer or stereo that had wire nuts inside? What ever happened to terminal blocks?

The authorities insist on a system with a safety ground, and rightly so. Yet you can still buy any number of 2-wire extension cords, and now they come with one pin larger than the other for polarizing. What a mish mash. We seem to be at the mercy of an arbitrary system that changes at random. And why are some kitchen appliances grounded while others are not? Toasters and kettles are not double-insulated, but rarely have a ground pin.

I can hear the electrical distributors screaming already: the equipment is very inexpensive and does the job if installed properly. And so it does. But installing it properly would try the patience of a saint, and there are no options anywhere at any price. If you imported a sensible system such as the British type, or designed one yourself using the best of the components available to electronics people, you couldn't get it approved by the authorities because it isn't in the books.

Those doing domestic power wiring should have some higher-quality equipment available to them as an alternative.

Mini-review: The Portasol Butane Soldering Iron

The incredibly talented hands in the photograph belong to the editor, who has just soldered three 16-gauge wires together using the Portasol Portable Soldering Iron. It's completely cordless, being powered by butane gas, the same stuff you use for lighters. In the cap (foreground) is a flint wheel lighter which ignites the gas after you thumb the on-off valve forward; the flame goes out in seconds, leaving a catalytic element to heat the tip flamelessly. The black band at the rear of the unit is a flow valve which will adjust the tip heat over a range equivalent to 10-60 watts. This means an adjustment range suitable for any soldering from delicate PCBs to big hairy power wires.

The unit started instantly, every time, and even better is the fact that the catalytic element will restart if it's still hot; this means that you can shut off the gas flow between solder joints and it will come on again without the flint. The operating time is up to one hour, depending on how high you set the flow. The lowest settings seemed fine for most electronic work. The supplied tip is a general-purpose nickel type; other sizes are available.

Besides the convenience of complete portability, other advantages include the elimination of leakage currents and magnetic effects; no grounding is necessary. Minor drawbacks: the list price is a wee bit high at $49.95, and the gas flow is a bit erratic at low settings, particularly when the fuel is getting low.

This unit is the best thing to happen to soldering since they invented flux. They'll have a hard time getting the review model away from us. From Varah's Direct, with locations in Vancouver, Edmonton, Calgary, Winnipeg and Nepean, or contact them at 504 Iroquois Shore Rd., Oakville, Ontario L6H 3K4, (416) 842-8833.

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Circle No. 61 on Reader Service Card

 Continued on page 34

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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.

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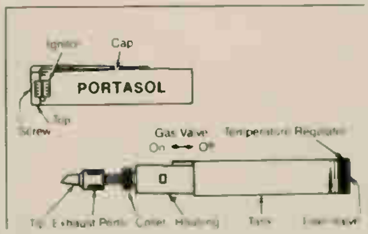

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Laser 128 Computer

Put the features of a IIe into a IIc case, add some ports and stir.

By Bill Markwick

THE LASER 128 consists of the functional equivalent of an Apple IIe inside a case that's obviously been designed by taking a IIc package and adding a numeric keypad. The single included disk drive is a slot on the right hand side. The power supply lives in a small external box; it has adequate output to power the computer plus options such as another added drive.

The Laser is certainly comprehensive; aside from the 128K of memory, BASIC in ROM, and IIe cursor and function keys, it has a back panel that will be the envy of every Apple owner because it holds a mouse port, a parallel printer output, RGB/composite video outputs, an external drive connector, a port for an external modem, a serial printer port and one expansion slot. To add ports with an Apple II or compatible, you had to move half your desk, pry it open, and add a printed circuit card that had to have a suitable cable connector on it. With the Laser it's all there on the back for you.

Hackers may object to the single expansion slot, but after a II was outfitted with what you'd consider standard equipment, it usually only had one slot left over. Besides, Laser makes an expansion box with two advantages: you get two external slots and your PCB doesn't hang out in space unprotected.

The tiny disk space available on the Apple system (about 140K with DOS, about 125K with CP/M) means that you'll want a second drive for sure. The optional second drive ($207) is in a half-height plastic box, and it plugs into the back panel via its included cable, no muss, no fuss.

Other interesting features include a volume control (and earphone jack) for the internal squeaker (bless 'em!), a switch to convert the keyboard to the Dvorak format and a built-in 80-column card with a front panel switch. The volume control was worth its weight in gold, but there was no keyboard overlay mentioned for the Dvorak switch. I suppose you could always scramble the keys and fool your friends, for a while anyway. The 40/80 column switch seemed a bit pointless; DOS boots in 40, CP/M boots in 80 and the switch didn't do much. You could convert DOS to 80 by typing PR3, just like on the real thing.

The ten function keys were preprogrammed with control keys, like CRTL-C, and if there was a way to reprogram them to something more useful, I couldn't find it. There were some handy functions available from the keys on either side of the space bar, though, such as being able to do a warm boot without typing PR6, or calling up the port configuration tables from ROM (a neat feature).

The computer arrived with two disks. On one of them was a DOS demonstration disk, one of those dig-these-graphics types (and the double-res graphics are very good indeed), and I suppose you could use its HELLO to copy DOS to other disks. The manual is quiet when it comes to DOS functions, probably for copyright reasons. The other disk contained a flavor of CP/M from Applied Engineering, called CP/AM. It seemed to be functionally identical to the Digital Research original, at least as far as syntax. The supplied version was a 44K type, and contained a COM file which allowed you to make a 60K type.

The CP/M was a bit problematical. While the Applied Engineering type booted every time and did what it said it would, it had a fair amount of trouble with programs which had run successfully on an Apple II compatible with a Z80 card. WordStar in particular. It refused to load via CP/AM, and insisted on having the Digital Research CP/M version loaded first. This created another problem: on powering up with 'real' CP/M,the disk would run and then stop, with no video happening. Nudging CRTL-RESET would then bring up the sign-on. Although WordStar would then run, it refused to exit nicely, hanging the computer every time on quitting.

To be fair about the CP/M problem: some of our programs were patched to run properly on our compatibles, so there's a gray area when it comes to saying anything definite about the Laser's Z80 capabilities. Most of our small CP/M disk utilities ran without a glitch. Still, greenhorn users will be utterly baffled, especially since the included documentation for CP/M just ain't there at all, except for a short 'readme' file.

The manual is written in a silly have-a-nice-day style that gets in the way of information, what little there is. Typical example, reproduced exactly: 'When you trun on your computer, for the first split second the microprocessor is completely confused!' Uh-huh. I trunned it on and it sure got the Z80 confused.

To sum up: the Laser is loaded, jam-packed with features and ports. You won't have to go on a hunt for auxiliary printed circuit cards and connectors. It's probably the most comprehensive Apple-compatible going.

On the down side is the fact that it costs $789.95. With two drives (essential), the price is now $1000. Since the sun has set on Apple DOS and CP/M, you'll have to be a real fan to invest in a compatible these days: IBM PC compatibles are turning up at the same price, with 256K and a vastly better disk operating system. Users will also have to know their stuff, or else be willing to spend some time on the phone finding out matters of syntax and so forth.

The Laser 128 is available from:
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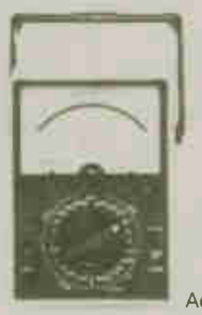

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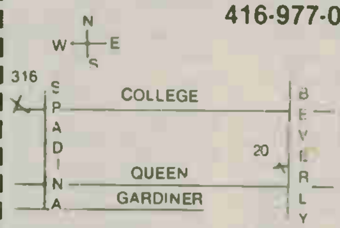

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Audio Signal Tracer

As an inexpensive alternative to the scope, this unit makes the troubleshooting of audio circuits a little less tedious.

By Michael Tooley and David Whitfield

THE AUDIO SIGNAL tracer described here is a self-contained variable gain audio amplifier which provides sufficient amplification to allow even the lowest level signals to be traced. It can be operated from any convenient DC supply in the 9V to 20V range, and it features its own monitor speaker.

Circuit Description

The signal tracer is designed around a fixed gain integrated circuit audio amplifier: the LM380. It's an audio power amp featuring short circuit protection and internal thermal limiting. The gain of the amplifier is fixed at 34dB over a bandwidth of 100kHz, i.e. the gain never falls below 25 at any frequency up to 100kHz. The LM380 operates over a wide range of supply voltages, automatically setting the quiescent output voltage to half of the supply voltage. The input resistance of 150k minimizes the need for any input buffer stages, and an output power of up to 2.5W RMS is available into an 8 ohm load when operated with suitable heatsink and power supply.

The internal circuit for the LM380 is shown in **Fig. 1**. The three centre pins on either side should be connected to ground; this is intended to allow copper heatsink fins to be soldered to these pins for high power operation. The heatsinking can alternatively be provided by a suitable printed circuit layout with a minimum of 40 square centimeters of 2 ounce copper foil area connected to these pins.

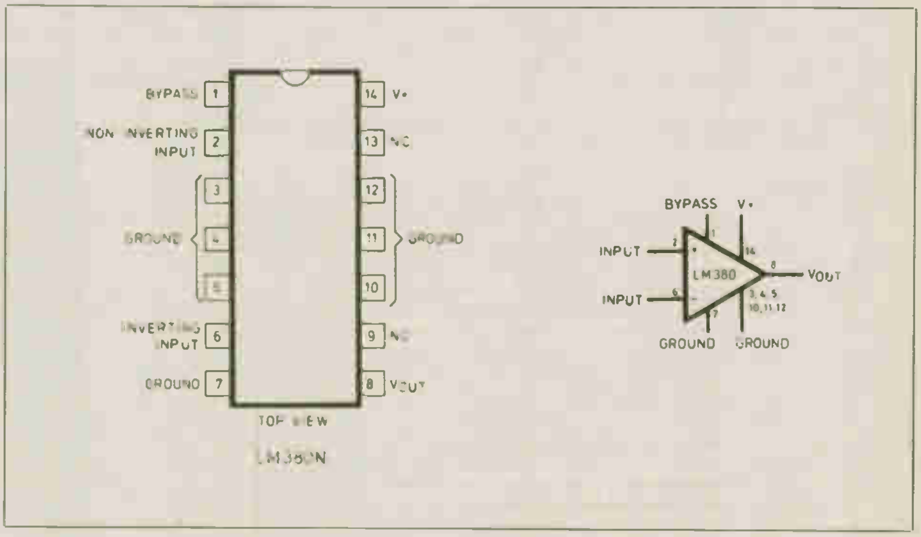

Fig. 1 The LM380N pin connections.

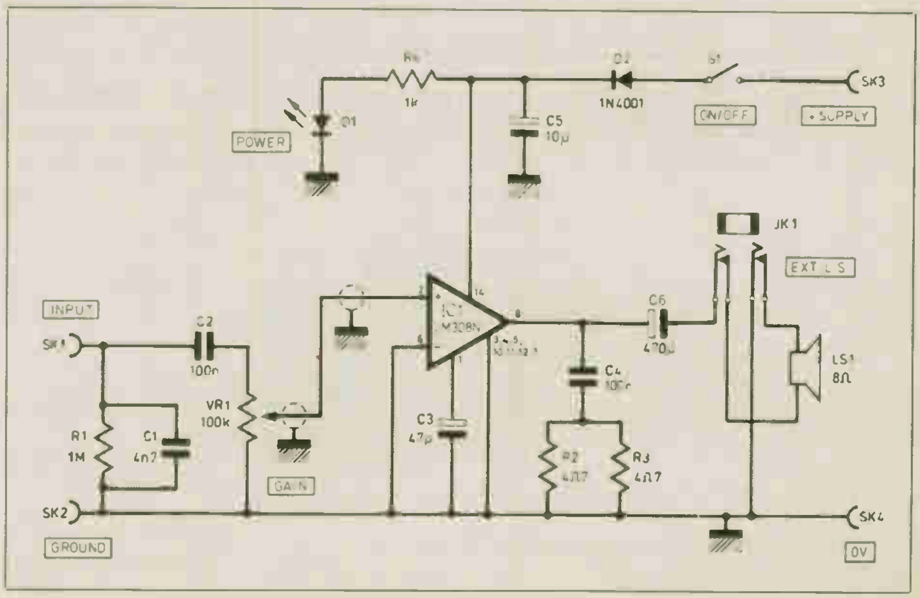

Fig. 2 The circuit diagram of the Audio Signal Tracer.

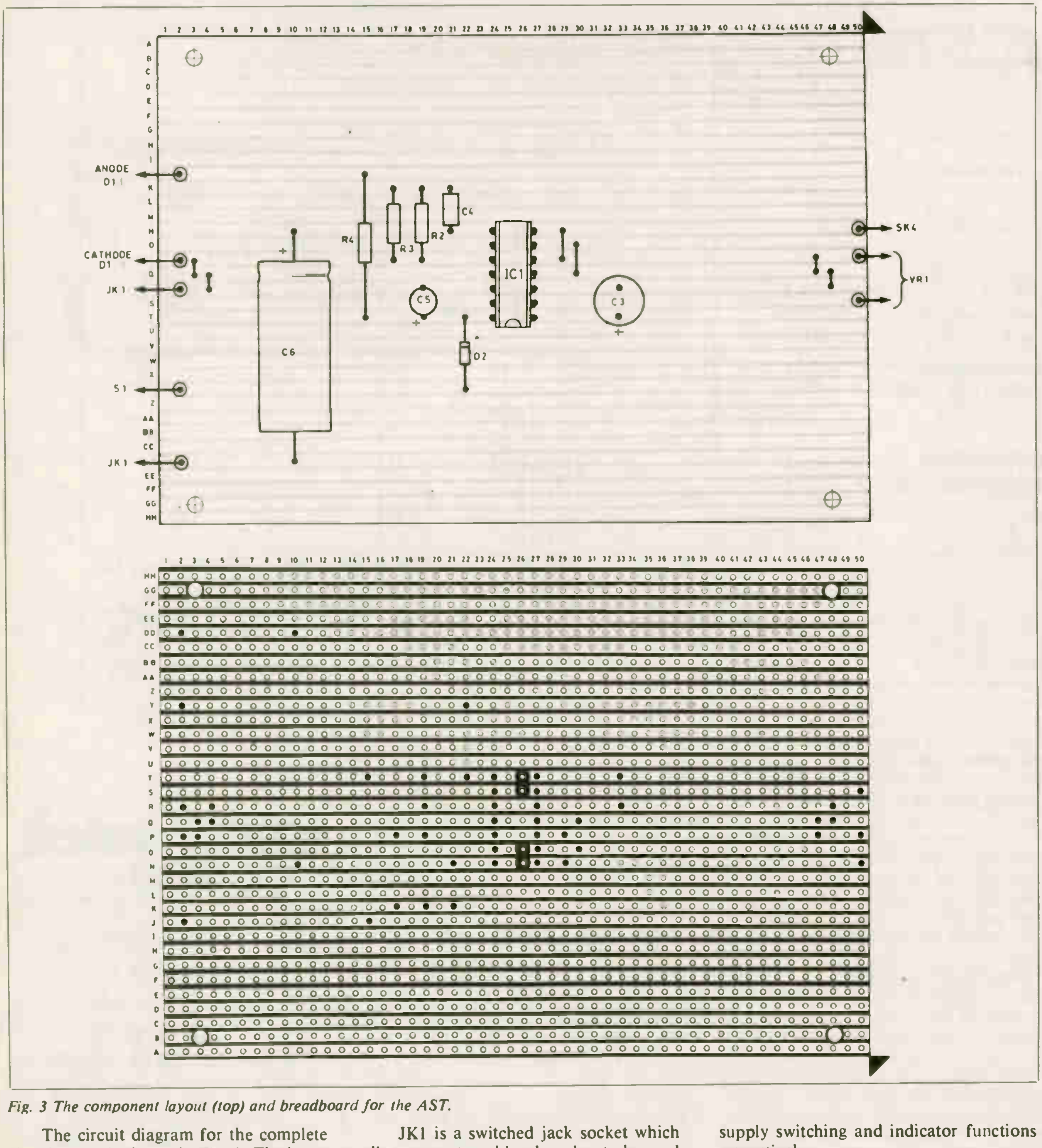

Fig. 3 The component layout (top) and breadboard for the AST.

The circuit diagram for the complete signal tracer is shown in **Fig. 2**. The input signal from SK1 is AC coupled to the non-inverting input of IC1 via C2. The gain of the tracer is set by VR1, and C3 provides the necessary bypass. The output from IC1 is coupled to the loudspeaker via C6. AC coupling is necessary because the no-signal output of the amplifier is automatically set to half of the supply voltage.

JK1 is a switched jack socket which allows an external loudspeaker to be used in place of the integral monitor, LS1. This is fairly useful if the tracer is being used simply as an audio amplifier, rather than a tracer. The series network formed by C4 and R2/R3 prevents oscillation of the amplifier, which may otherwise occur under some load conditions. The unit is protected against incorrect supply polarity by D2, while S1 and D1 provide power supply switching and indicator functions respectively.

Construction

Any suitable case which is capable of comfortably housing the perfboard and speaker can be used.

No special sequence is necessary in mounting the components; just take care in making sure that polarized components are oriented properly. The IC should be

Parts List

Resistors
All 0.25W 5%

R1	1M
R2,3	4R7
R4	1k

Potentiometer

VR1	100k linear pot.

Capacitors

C1	4n7 polyester 250V
C2	100n polyester 250V
C3	47u 25V electro.
C4	100n polyester
C5	10u 25V electro.
C6	470u 25V electro.

Semiconductors

D1	0.2"LED and panel holder
D2	1N4001
IC1	LM380N

Miscellaneous

LS1	2.5" 8 ohm speaker
SK1	4mm terminal (red)
SK2	4mm terminal (black)
SK3	4mm socket (red)
SK4	4mm socket (black)
JK1	switched standard jack socket
S1	SPST toggle switch

Knob with pointer; case; 0.1" breadboard, 5" x 3.75" and mounting hardware; 8 terminal pins.

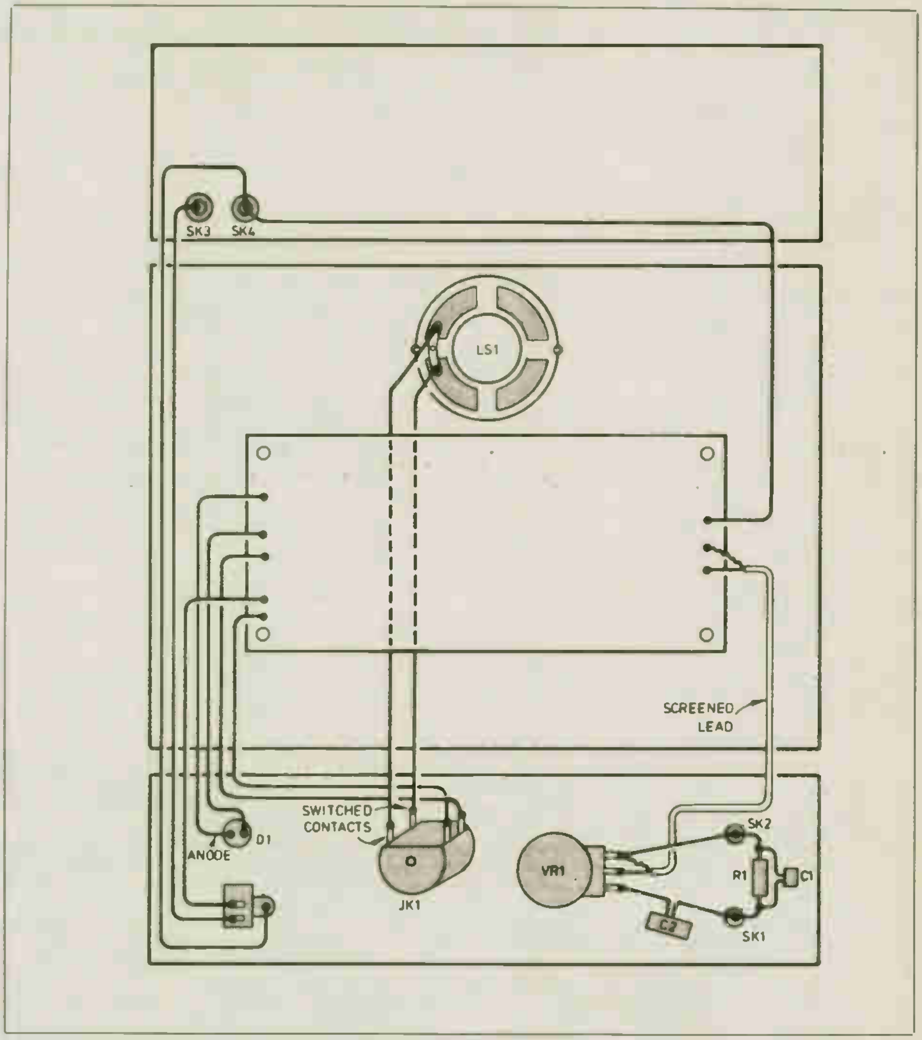

Fig. 4 Overall wiring diagram of the tracer.

mounted with a heatsink only if prolonged operation at high power levels is expected, and no heatsink is required if you're only using the small internal speaker.

The main circuit board should be mounted giving adequate clearance to both LS1 and the front panel mounting components. The remaining components (SK3 and SK4) should be mounted on the rear panel in any convenient position.

Using The Tracer

The first check on the completed tester is to measure the supply current when the unit is connected to a DC supply of between 9V and 20V. With the gain setting at the minimum position, the current should be between 20mA and 50mA, and D1 should be illuminated. If there is no current, check the polarity of D2, and the power supply wiring. Any significantly higher current should be investigated before proceeding.

As the gain is increased, a low hum may become audible, particularly if a finger is placed on SK1. This indicates that all is well, and the tester is ready for use. The maximum output power available in use will depend on the impedance of the speaker, and on the power supply voltage.

To use the tester, a screened test lead with a 4mm plug at one end and insulated crocodile clip at the other will be required. The unit should produce a clearly audible output from signals as small as 1mV RMS.

To troubleshoot a circuit, a suitable audio signal is required, usually from a tuner, tapedeck or signal generator. The tracer can be used to follow the signal from the source (where the signal may be very low) through the various stages to the output. The change in setting of the gain control to keep the output approximately the same will give some idea of the gain of the various stages under test. This should allow the location of any change of signal, loss of gain, gain or distortion to be identified.

It must be stressed that the audio signal tracer is intended for use on transistorized equipment. *Under no circumstances should it be connected to full 120V AC potential.* ■

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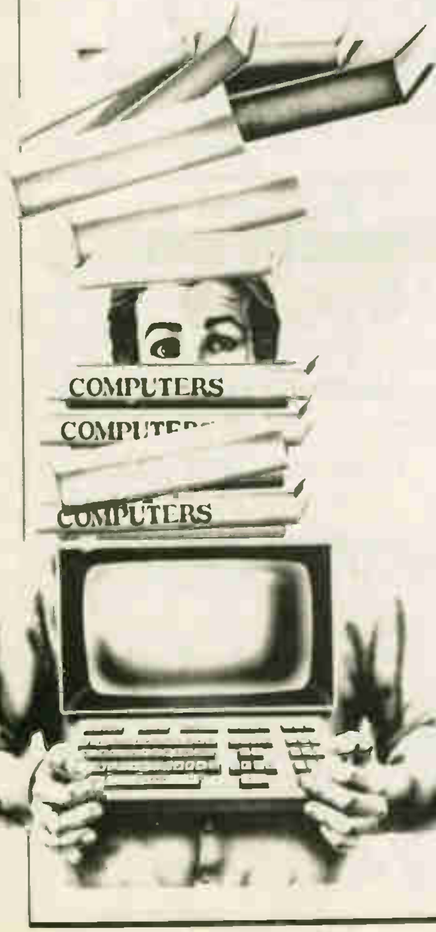
The popular 6502 microprocessor is used in many home computers, this is a guide to beginning assembly language.

BP150: AN INTRO. TO PROGRAMMING THE SINCLAIR QL — $7.75
Helps the reader make the best use of the Sinclair QL's almost unlimited range of features. Complements the manufacturer's handbook.

BP225: A PRACTICAL INTRODUCTION TO DIGITAL ICs — $6.65
This book deals mainly with TTL type chips such as the 7400 series. Simple projects and a complete practical construction of a Logic Test Circuit Set are included as well as details for a more complicated Digital Counter Timer project.

BP130: MICRO INTERFACING CIRUITS - BOOK 1 — $8.55
Aimed at those who have some previous knowledge of electronics, but not necessarily an extensive one, the basis of the book is to help the individual understand the principles of interfacing circuits to microprocessor equipment.



BP131: MICRO INTERFACING CIRCUITS - BOOK 2 — $8.55
Intended to carry on from Book 1, this book deals with practical applications beyond the parallel and serial interface. "Real world" interfacing such as sound and speech generators, temperature and optical sensors, and motor controls are discussed using practical circuit descriptions.

BP111: AUDIO — $13.25
This one is ideal for readers who want to really get into sound. A wide range of material is covered from analysis of the sound wave, mechanisms of hearing, room acoustics, microphones and loudspeakers, amplifiers, and magnetic disc recording.

BP141: LINEAR IC EQUIVALENTS AND PIN CONNECTIONS
ADRIAN MICHAELS — $21.95
Find equivalents and cross-references for both popular and unusual integrated circuits. Shows details of functions, manufacturer, country of origin, pinouts, etc., includes National, Motorola, Fairchild, Harris, Motorola, Intersil, Philips, ADC, AMD, SGS, Teledyne, and many other European, American, and Japanese brands.

BP156: AN INTRODUCTION TO QL MACHINE CODE — $7.75
The powerful Sinclair QL microcomputer has some outstanding capabilities in terms of its internal structure. With a 32-bit architecture, the QL has a large address range, advanced instructions which include multiplication and division. These features give the budding machine code programmer a good start at advanced programming methods. This book assumes no previous knowledge of either the 68008 or machine code programming.

BP47: MOBILE DISCOTHEQUE HANDBOOK — $5.25
Divided into six parts, this book covers such areas of mobile "disco" as Basic Electricity, Audio, Ancillary Equipment, Cables and Plugs, Loudspeakers, and Lighting. All the information has been considerably sub-divided for quick and easy reference.

BP59: SECOND BOOK OF CMOS IC PROJECTS — $7.75
This book carries on from its predecessor and provides a further selection of useful circuits, mainly of a simple nature, the book will be well within the capabilities of the beginner and more advanced constructor.

BP32: HOW TO BUILD YOUR OWN METAL & TREASURE LOCATORS — $7.75
Several fascinating applications with complete electronic and practical details on the simple, and inexpensive construction of Heterodyne Metal Locators.

ELECTRONIC THEORY

ELEMENTS OF ELECTRONICS — AN ON-GOING SERIES
F.A. WILSON, C.G.I.A., C.Eng.

BP62: BOOK 1. The Simple Electronic Circuit and Components	$11.70
BP63: BOOK 2. Alternating Current Theory	$8.55
BP64: BOOK 3. Semiconductor Technology	$18.55
BP77: BOOK 4. Microprocessing Systems And Circuits	$11.70
BP89: BOOK 5. Communication	$11.70

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

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

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

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

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

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

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

BOOK 5. A book covering the whole communication scene.

PROJECTS

BP48: ELECTRONIC PROJECTS FOR BEGINNERS — $7.75
F.G. RAYER, T.Eng.(CEI), Assoc.IERE
Another book written by the very experienced author — Mr F.G. Rayer — and in it the newcomer to electronics will find a wide range of easily made projects. Also, there are a considerable number of actual component and wiring layouts to aid the beginner.

Furthermore, a number of projects have been arranged so that they can be constructed without any need for soldering and, thus, avoid the need for a soldering iron.

Also, many of the later projects can be built along the lines as those in the 'No Soldering' section so this may considerably increase the scope of projects which the newcomer can build and use.

BP37: 50 PROJECTS USING RELAYS, SCR's & TRIACS — $7.75
F.G.RAYER, T.Eng.(CEI),Assoc.IERE
Relays, silicon controlled rectifiers (SCR's) and bi-directional triodes (TRIACs) have a wide range of applications in electronics today. This book gives tried and practical working circuits which should present the minimum of difficulty for the enthusiast to construct. In most of the circuits there is a wide latitude in component values and types, allowing easy modification of circuits or ready adaptation of them to individual needs.

BP221: 28 TESTED TRANSISTOR PROJECTS
R.TORRENS — $5.00
Mr Richard Torrens is a well experienced electronics development engineer and has designed, developed, built and tested the many useful and interesting circuits included in this book. The projects themselves can be split down into simpler building blocks which are shown separated by boxes in the circuits for ease of description, and also to enable any reader who wishes to combine boxes from different projects to realise ideas of his own.

BP71: ELECTRONIC HOUSEHOLD PROJECTS — $7.20
R. A. PENFOLD
Some of the most useful and popular electronic construction projects are those that can be used in or around the home. The circuits range from such things as 2 Tone Door Buzzer, Intercom, through Smoke or Gas Detectors to Baby and Freezer Alarms.

BP73: REMOTE CONTROL PROJECTS — $8.10
OWEN BISHOP
This book is aimed primarily at the electronics enthusiast who wishes to experiment with remote control. Full explanations have been given so that the reader can fully understand how the circuits work and can more easily see how to modify them for other purposes, depending on personal requirements. Not only are radio control systems considered but also infra-red, visible light and ultrasonic systems as are the use of Logic ICs and Pulse position modulation etc.

BP90: AUDIO PROJECTS — $7.60
F.G. RAYER
Covers in detail the construction of a wide range of audio projects. The text has been divided into preamplifiers and mixers, power amplifiers, tone controls, and matching and miscellaneous projects.

BP 174: MORE ADVANCED ELECTRONIC MUSIC PROJECTS — $19.95
Complementing Book BP74, "Electronic Music Projects", BP174 provides more advanced projects, such as a flanger, a phaser, mini-chorus and ring modulators, percussion synths, etc. Each project has an introduction, circuit diagram and constructional notes.

BP74: ELECTRONIC MUSIC PROJECTS — $7.20
R.A. PENFOLD
Although one of the more recent branches of amateur electronics, electronic music has now become extremely popular and there are many projects which fall into this category. The purpose of this book is to provide the constructor with a number of practical circuits for the less complex items of electronic music equipment, including such things as a Fuzz Box, Waa-Waa Pedal, Sustain Unit, Reverberation and Phaser Units, Tremelo Generator etc.

BP44: IC 555 PROJECTS — $7.75
E.A. PARR, B.Sc.,C.Eng., M.I.E.E.
Every so often a device appears that is so useful that one wonders how life went on before without it. The 555 timer is such a device. Included in this book are Basic and General Circuits, Motor Car and Model Railway Circuits, Alarms and Noise Makers as well as a section on the 556, 558 and 559 timers.

BP82: ELECTRONIC PROJECTS USING SOLAR CELLS — $7.75
A collection of simple circuits which have applications in and around the home using the energy of the sun to power them. The book deals with practical solar power supplies including voltage doubler and tripler circuits, as well as a number of projects.

See order form in this issue.

BABANI BOOKS

BP49: POPULAR ELECTRONIC PROJECTS $7.75
R.A. PENFOLD
Includes a collection of the most popular types of circuits and projects which we feel sure will provide a number of designs to interest most electronics constructors. The projects selected cover a very wide range and are divided into four basic types: Radio Projects, Audio Projects, Household Projects and Test Equipment.

BP94: ELECTRONIC PROJECTS FOR CARS AND BOATS
R.A. PENFOLD $7.60
Projects, fifteen in all, which use a 12V supply are the basis of this book. Included are projects on Windscreen Wiper Control, Courtesy Light Delay, Battery Monitor, Cassette Power Supply, Lights Timer, Vehicle Immobiliser, Gas and Smoke Alarm, Depth Warning and Shaver Inverter.

BP95: MODEL RAILWAY PROJECTS $7.60
Electronic projects for model railways are fairly recent and have made possible an amazing degree of realism. The projects covered include controllers, signals and sound effects; stripboard layouts are provided for each project.

BP93: ELECTRONIC TIMER PROJECTS $7.60
F.G. RAYER
Windscreen wiper delay, darkroom timer and metronome projects are included. Some of the more complex circuits are made up from simpler sub circuits which are dealt with individually.

BP113: 30 Solderless Breadboard Projects-Book 2
R.A. Penfold $8.85
A companion to BP107. Describes a variety of projects that can be built on plug-in breadboards using CMOS logic IC's. Each project contains a schematic, parts list and operational notes.

BP104: Electronic Science Projects
Owen Bishop $8.85
Contains 12 electronic projects with a strong scientific flavour. Includes Simole Colour Temperature Meter, Infra Red Laser, Electronic clock regulated by a resonating spring, a 'Scope with a solid state display, pH meter and electrocardiograph.

BP110: HOW TO GET YOUR ELECTRONIC PROJECTS WORKING $7.60
R.A. PENFOLD
We have all built circuits from magazines and books only to find that they did not work correctly, or at all, when first switched on. The aim of this book is to help the reader overcome just these problems by indicating how and where to start looking for many of the common faults that can occur when building up projects.

BP84: DIGITAL IC PROJECTS $7.60
F.G. RAYER, T.Eng.(CEI),Assoc.IERE
This book contains both simple and more advanced projects and it is hoped that these will be found of help to the reader developing a knowledge of the workings of digital circuits. To help the newcomer to the hobby the author has included a number of board layouts and wiring diagrams. Also the more ambitious projects can be built and tested section by section and this should help avoid or correct faults that could otherwise be troublesome. An ideal book for both beginner and more advanced enthusiast alike.

BP67: COUNTER DRIVER AND NUMERAL DISPLAY PROJECTS $7.05
F.G. RAYER, T.Eng.(CEI), Assoc. IERE
Numeral indicating devices have come very much to the forefront in recent years and will undoubtedly find increasing applications in all sorts of equipment. With present day integrated circuits, it is easy to count, divide and display numerically the electrical pulses obtained from a great range of driver circuits.
In this book many applications and projects using various types of numeral displays, popular counter and driver IC's etc. are considered.

BP99: MINI—MATRIX BOARD PROJECTS $7.60
R.A. PENFOLD
Twenty useful projects which can all be built on a 24 x 10 hole matrix board with copper strips. Includes Doorbuzzer, Low-voltage Alarm, AM Radio, Signal Generator, Projector Timer, Guitar Headphone Amp, Transistor Checker and more.

BP103: MULTI-CIRCUIT BOARD PROJECTS $7.60
R.A. PENFOLD
This book allows the reader to build 21 fairly simple electronic projects, all of which may be constructed on the same printed circuit board. Wherever possible, the same components have been used in each design so that with a relatively small number of components and hence low cost, it is possible to make any one of the projects or by re-using the components and P.C.B. all of the projects.

BP107: 30 SOLDERLESS BREADBOARD PROJECTS — BOOK 1 $8.85
R.A. PENFOLD
A "Solderless Breadboard" is simply a special board on which electronic circuits can be built and tested. The components used are just plugged in and unplugged as desired. The 30 projects featured in this book have been specially designed to be built on a "Verobloc" breadboard. Wherever possible the components used are common to several projects, hence with only a modest number of reasonably inexpensive components it is possible to build, in turn, every project shown.

BP106: MODERN OP-AMP PROJECTS $7.60
R.A. PENFOLD
Features a wide range of constructional projects which make use of op amps including low noise, low distortion, ultra high input impedance, high slew rate and high output current types.

CIRCUITS

How to Design Electronic Projects
BP127 $8.95
Although information on standard circuit blocks is available, there is less information on combing these circuit parts together. This title does just that. Practical examples are used and each is analysed to show what each does and how to apply this to other designs.

Audio Amplifier Construction
BP122 $8.95
A wide circuits is given, from low noise microphone and tape head preamps to a 100W MOSFET type. There is also the circuit for 12V bridge amp giving 18W. Circuit board or stripboard layout are included. Most of the circuits are well within the capabilities for even those with limited experience.

BP80: POPULAR ELECTRONIC CIRCUITS — BOOK 1 $7.75
R.A. PENFOLD
Another book by the very popular author, Mr. R.A. Penfold, who has designed and developed a large number of various circuits. These are grouped under the following general headings: Audio Circuits, Radio Circuits, Test Gear Circuits, Music Project Circuits, Household Project Circuits and Miscellaneous Circuits.

BP98: POPULAR ELECTRONIC CIRCUITS, BOOK 2 $8.85
R.A. PENFOLD
70 plus circuits based on modern components aimed at those with some experience.

BP39: 50 (FET) FIELD EFFECT TRANSISTOR PROJECTS $6.75
F.G. RAYER, T.Eng.(CEI),Assoc.IERE
Field effect transistors (FETs) find application in a wide variety of circuits. The projects described here include radio frequency amplifiers and converters, test equipment and receiver aids, tuners, receivers, mixers and tone controls, as well as various miscellaneous devices which are useful in the home.
This book contains something of particular interest for every class of enthusiast — short wave listener, radio amateur, experimenter or audio devotee.

BP162: COUNTING ON QL ABACUS
This book is designed to introduce the beginner to the use of spreadsheets in general and Abacus on the Sinclair QL in particular. It assumes no previous experience in computing or spreadsheets. Practical examples show the calculations for domestic, small business and technical applications.

BP87: SIMPLE L.E.D. CIRCUITS $5.40
R.N. SOAR
Since it first appeared in 1977, Mr. R.N. Soar's book has proved very popular. The author has developed a further range of circuits and these are included in Book 2. Projects include a Transistor Tester, Various Voltage Regulators, Testers and so on.

BP24: 50 PROJECTS USING IC 741 $6.75
A unique book con[illegible] projects that can be simply constru[illegible] op amp and a few components. Origin[illegible]ished in Germany, this book will be an valuable asset to any hobbyist.

SOLD OUT

BP88: HOW TO USE OP AMPS $8.85
E.A. PARR
A designer's guide covering several op amps, serving as a source book of circuits and a reference book for design calculations. The approach has been made as non mathematical as possible.

BP65: SINGLE IC PROJECTS $6.05
R.A.PENFOLD
There is now a vast range of IC's available to the amateur market, the majority of which are not necessarily designed for use in a single application and can offer unlimited possibilities. All the projects contained in this book are simple to construct and are based on a single IC. A few projects employ one or two transistors in addition to an IC but in most cases the IC is the only active device used.

223: 50 PROJECTS USING IC CA3130 $5.00
R.A.PENFOLD
In this book, the author has designed and developed a number of interesting and useful projects which are divided into five general categories: I — Audio Projects, II — R.F. Projects, III — Test Equipment, IV — Household Projects, V — Miscellaneous Projects.

BP117: PRACTICAL ELECTRONIC BUILDING BLOCKS BOOK 1 $7.60
Virtually any electronic circuit will be found to consist of a number of distinct stages when analysed. Some circuits inevitably have unusual stages using specialised circuitry, but in most cases circuits are built up from building blocks of standard types.
This book is designed to aid electronics enthusiasts who like to experiment with circuits and produce their own projects rather than simply follow published project designs.
The circuits for a number of useful building blocks are included in this book. Where relevant, details of how to change the parameters of each circuit are given so that they can easily be modified to suit individual requirements.

BP102: THE 6809 COMPANION $7.60
Written for machine language programmers who want to expand their knowledge of microprocessors. Outlines history, architecture, addressing modes, and the instruction set of the 6809 microprocessor. The book also covers such topics as converting programs from the 6800, program style, and specifics of 6809 hardware and software availability.

BP118: PRACTICAL ELECTRONIC BUILDING BLOCKS - Book 2
R.A. PENFOLD $7.60
This sequel to BP117 is written to help the reader create and experiment with his own circuits by combining standard type circuit building blocks. Circuits concerned with generating signals were covered in Book 1, this one deals with processing signals. Amplifiers and filters account for most of the book but comparators, Schmitt triggers and other circuits are covered.

BP24: 50 PROJECTS USING IC741 $6.75
RUDI & UWE REDMER
This book, originally published in Germany by TOPP, has achieved phenomenal sales on the Continent and Babani decided, in view of the fact that the integrated circuit used in this book is inexpensive to buy, to make this unique book available to the English speaking reader. Translated from the original German with copious notes, data and circuitry, a "must" for everyone whatever their interest in electronics.

BP83: VMOS PROJECTS $7.70
R.A. PENFOLD
Although modern bipolar power transistors give excellent results in a wide range of applications, they are not without their drawbacks or limitations. This book will primarily be concerned with VMOS power FETs although power MOSFETs will be dealt with in the chapter on audio circuits. A number of varied and interesting projects are covered under the main headings of: Audio Circuits, Sound Generator Circuits, DC Control Circuits and Signal Control Circuits.

RADIO AND COMMUNICATIONS

BP96: CB PROJECTS $7.60
R.A. PENFOLD
Projects include speech processor, aerial booster, cordless mike, aerial and harmonic filters, field strength meter, power supply, CB receiver and more.

BP222: SOLID STATE SHORT WAVE RECEIVER FOR BEGINNERS $47.60
R.A. PENFOLD
In this book, R.A. Penfold has designed and developed several modern solid state short wave receiver circuits that will give a fairly high level of performance, despite the fact that they use only relatively few and inexpensive components.

BP117: AN INTRODUCTION TO COMPUTER COMMUNICATIONS.
Connecting up an ordinary home computer to the telephone system via a modem opens up a new world of possibilities: talking to other computers, databases, networks, radio links, etc. An explanation of basic principles and practicalities in simple terms.

BP91: AN INTRODUCTION TO RADIO DXing $7.60
This book is divided into two main sections, one to amateur band reception, the other to broadcast bands. Advice is given to suitable equipment and techniques. A number of related constructional projects are described.

BP105: AERIAL PROJECTS $7.60
R.A. PENFOLD
The subject of aerials is vast but in this book the author has considered practical designs including active, loop and ferrite aerials which give good performances and are reasonably simple and inexpensive to build. The complex theory and math of aerial design are avoided.

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OTHER PUBLISHERS

PH121: HARDWARE INTERFACING WITH THE TRS-80
J. UFFENBECK (1983) $19.45
TRS-80 Model I and Model III o... rs now have a book to help them understand h... eir personal computers to monitor an... interfaces between the computer a... industrial environment. Contains 14 hands on ... riments using BASIC.

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Clearly written, highly practical, concise assembly of all procedures needed for writing, disk filing, and printing programs with an Apple II. Positively ends your searchs through endless manuals to find the routine you need! Should be in the hands of every new Apple user, regardless of experience level. Ideal for Apple classrooms too!

A BEGINNER'S GUIDE TO COMPUTERS AND MICROPROCESSORS — WITH PROJECTS.
TAB No. 1015: $14.45
Here's plain English introduction to the world of microcomputers — it's capabilities, parts and functions ... and how you can use one. Numerous projects demonstrate operating principles and lead to the construction of an actual working computer capable of performing many useful functions.

TAB1370: A MASTER HANDBOOK OF IC CIRCUITS $21.95
A circuit for every occasion. You'll ... all the circuits you're looking for in this 53... The 932 circuits are broken down ... functions and in six categories. It ... ornucopia of ideas, projects and designs that yo... can build now.

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This book gives you needed tips on th... principles of electronics and building techniq... n how to set up a work area, and muc... inds of practical accessories for yo... studio or darkroom with this helpful guide.

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A wealth of information on hardware, software etc. for the Mac. Included are such topics as making your desktop more efficient, improving your productivity with the Mac, getting the most from your mouse, how the 6800 microprocessor works and much, much more.

PH131: ZAP! POW! BOOM!
ARCADE GAMES FOR THE VIC 20
T. HARTNELL & M. RAMSHAW (1983) $17.45
Move through the maze eating dots with MAZEMAN. Sail through space zapping the ASTROIDS. Outshoot the fastest draw in town, GUNFIGHT. Owners of the VIC 20 can now play these games — and more — simply by following the programs outlined in this handy guide.

THE BASIC COOKBOOK.
TAB No. 1055: $10.45
BASIC is a surprisingly powerful language ... if you understand it completely. This book, picks up where most manufactuers documentation gives up. With it, any computer owner can develop programs to make the most out of his or her machine.

HANDBOOK OF MICROPROCESSOR APPLICATIONS
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Highly recommended reading fo... ose who are interested in microprocessors as a ... complishing a specific task. The auth... individual microprocessors, the 1802 and ... now they can be put to use in real world applic... ons.

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An excellent reference or b... building your own microcompute... hardware and software are developed as w... any practical circuits.

SOLD OUT

PH180: 1984 CANADIAN BUSINESS GUIDE TO MICROCOMPUTERS
K. DORRICOTT $11.95
Written by the managing director of Deloitte, Haskins & Sells, a Canadian partnership of public accountants and other professional advisors to management, this book is one of the most complete comprehensive guides to microcomputers available. Starting with a general overview of microcomputers and their business applications, the author helps you assess your computer needs, compares and evaluates computer systems and application packages, and gives you tips on "doing it right". A must for anyone thinking of purchasing a microcomputer for business.

COMPUTER PROGRAMS IN BASIC
AB01 $15.45
A catalogue of over 1,600 fully indexed BASIC computer programs with applications in Business, Math, Games and more. This book lists available software, what it does, where to get it and how to adapt it to your machine.

PH217: BASIC COMPUTER PROGRAMMING FOR KIDS
P. CASSIDY & J. CLOSE $16.45
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SOLD OUT

PHS1: PASCAL FOR THE APPLE
IAIN MacCALLUM $34.20
A step by step introduction to Pascal for Apple II and Apple II Plus users. The package of text and software diskette provides readers with worthwhile and interesting programs which can be run immdiately and the results studied. Includes over 200 exercises with full solutions. Book/Disk Package.

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Contains 10 arcade style games written especially for Apple II including Spider, Piano, Pairs and Poker as well as education, math and designing games. Book/Disk Package.

PHS7: START WITH BASIC FOR THE COMMODORE VIC 20
D. MONRO $33.45
This book/cassette package shows the reader how easy it really is to create programs using the full capacity of the machine. Includes helpful exercises and step by step instructions to put the full power of the VIC 20 at the user's finger tips. Book/Cassette Package.

SB21822: ENHANCING YOUR APPLE® II — VOLUME 1
D. LANCASTER $25.50
Who but Mother Nature or Don Lancaster could successfully enhance an Apple? YOU can, with help from Volume 1 in Don's newest series for Sams. Among other things, you'll learn (1) to mix text, LORES, and HIRES together anywhere on the screen in any combination, (2) how to make a new wire modification that will open up whole new worlds of 4D graphics and other special effects, plus (3) a fast and easy way to tear apart and understand somebody else's machine language program. Other goodies abound!

PH106: PROGRAMMING TIPS AND TECHNIQUES FOR THE APPLE II
J. CAMPBELL (1983) $23.45
An advanced exploration of the intricacies of structures programming. Further develops the skills necessary to solve programming problems. Special chapter on sound and graphics which discusses both high and low resolution graphics for the Apple II.

HB131: THE BEGINNER'S GUIDE TO BUYING A PERSONAL COMPUTER $6.45
Written for the potentially interested computer buyer in non-technical language, this affordable book explains the terminology of personal computers, the problems and variables to be discussed and discovered while making that initial buying decision. The book does not make recommendations but does present a great deal of information about the range of hardware avaialble from the largest personal computing manufacturers. Readers discover the meaning and impact of screen displays, tape cassette storage and disk storage, graphics and resolution and much more. Comparison charts clearly define standard and optional features of all the current mass market personal computers.

DESIGNING MICROCOMPUTER SYSTEMS
HB18: $18.95
POOCH AND CHATTERGY
This book provides both hobbyists and electronic engineers with the background information necessary to build microcomputer systems. It discusses the hardware aspects of microcomputer systems. Timing devices are provided to explain sequences of operations in detail. Then the book goes on to describe three of the most popular microcomputer families: the Intel 8080, Zilog Z-80 and Motorola 6800. Also covered are designs of interfaces for peripheral devices and information of building microcomputer systems from kits.

S100 BUS HANDBOOK
HB19: $26.00
BURSKY
Here is a comprehensive book that exclusively discusses S-100 bus computer systems and how they are organized. The book covers computer fundamentals, basic electronics, and the parts of the computer. Individual chapters discuss the CPU, memory, input/output, bulk memory devices and specialized peripheral controllers. It explains all the operating details of commonly available S-100 systems. Schematic drawings.

110 THYRISTOR PROJECTS USING SCRs AND TRIACS
MARSTON
HB22 $13.45
A grab bag of challenging and useful semiconductor projects for the hobbyist, experimenter, and student. The project range from simple burglar, fire, and water level alarms to sophisticated power control devices for electric tools and trains. Integrated circuits are incorporated wherever their use reduces project costs.

PH104: ACCOUNTANT'S BASIC PROGRAMMING FOR THE APPLE II
A PARKER & J. STEWART (1983) $20.45
Shows the reader how to program the Apple II to perform a variety of accounting functions such as payroll, accounts payable, accounts receivable, tax, inventory, customer statements and more.

HOW TO PROFIT FROM YOUR PERSONAL COMPUTER: PROFESSIONAL, BUSINESS, AND HOME APPLICATIONS
LEWIS
HB01 $18.95
Describes the uses of personal computers in common business applications such as accounting, managing inventory, sorting mailing lists, and many others. The discussion includes terms, notations, and techniques commonly used by programmers. A full glossary of terms.

AN INTRODUCTION TO MICROPROCESSORS EXPERIMENTS IN DIGITAL TECHNOLOGY
HB07 $18.95
SMITH
A "learn by doing" guide to the use of integrated circuits provides a foundation for the underlying hardware actions of programming statements. Emphasis is placed on how digital circuits compares with analog circuitry. Begins with the simplest gates and timers, then introduces the fundamental parts of ICs, detailing the benefits and pitfalls of major IC families, and continues with coverage of the ultimate in integrated complexity — the microprocessor.

MICROCOMPUTERS AND THE 3 R'S
DOERR
HB09 $16.45
This book educates educators on the various ways computers, especially microcomputers, can be used in the classroom. It describes microcomputers, how to organize a computer based program, the five instructional application types (with examples from subjects such as the hard sciences, life sciences, English, history, and government), and resources, listings of today's products. The book includes preprogrammed examples to start up a microcomputer program, while chapters on resources and products direct the reader to useful additional information. All programs are written in the BASIC language.

HB107: GRAPHICS COOKBOOK FOR THE APPLE
WADSWORTH
HB107 $15.95
Learn how to use your Apple II to "paint" shapes, objects, and letters in low resolution graphics. The author provides a library of microcomputer graphics including such multicoloured illustrations as robots and flying saucers, trees, sailboats, and colourful picture backgrounds. Contains complete annotated Applesoft BASIC programs to draw all the pictures described in the book as well as suggestions for improving programming techniques.

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Versatile PSU

A regulated variable voltage supply with constant current for charging Ni-cads or powering your projects.

By M.P. Horsey

THE HIGH COST of any power supply unit is due mainly to the transformer and the need for protection from high AC voltages in the form of fuses, switches, neon indicators, and a substantial case. It is helpful, therefore, to make any power unit as versatile as possible. The unit to be described provides a regulated variable voltage output from 1.2V to 15V and a constant current output, suitable for charging a wide range of nickel-cadmium cells.

Control

The voltage is controlled with a variable resistor linked with an integrated circuit, and regulation is sufficiently accurate to allow a scale to be marked, without the need for a built-in voltmeter.

The constant current required is set via a rotary switch. The settings are as follows:

Setting 1. Regulated voltage output.
Setting 2. Constant current 8mA (for charging 9V batteries & AAA cells).
Setting 3. Constant current 45mA (for charging AA cells).
Setting 4. Constant current 80mA
Setting 5. Constant current 150mA (for charging C cells).
Setting 6. Constant current 320mA (for charging D cells).

Automatic Voltage Regulation

Regulator circuits can be designed which automatically compensate for a changing current, and therefore provide a true regulated voltage. Such circuits can now be obtained in the form of miniature integrated circuits, such as the chip which forms the heart of this project, the LM317T.

This IC provides a possible regulated voltage range from 1.2V to 37V, at up to 1.2A. It is fully protected from short circuits, and includes thermal shutdown which automatically reduces the current if the IC becomes too hot. The basic regulated voltage circuit is shown in Fig. 1.

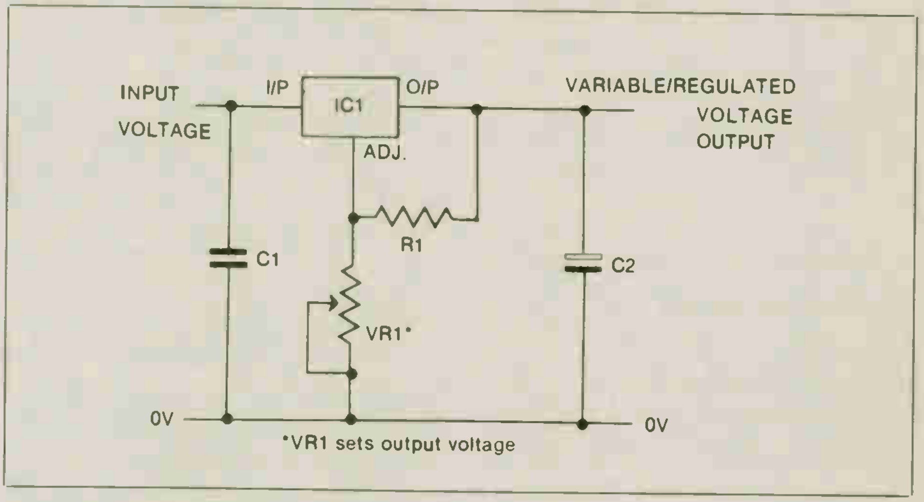

Fig. 1 Basic regulated voltage circuit.

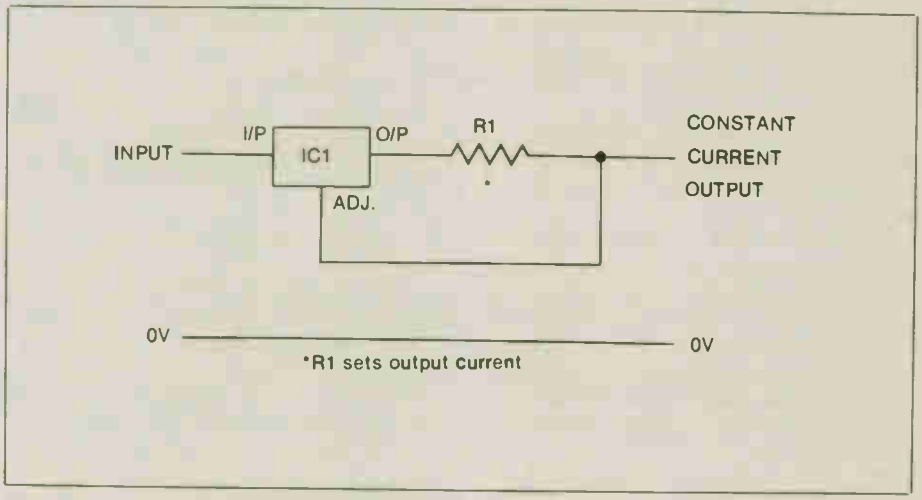

Fig. 2 Constant current regulation is determined by R1.

Automatic Current Regulation

The same IC may also be wired to produce a constant current which is determined by a single resistor. The following formula may be used to calculate the size of the resistor required:

Output current = 1.25/R
(where R is the value of the resistor)

Thus, if a current of 45mA is required, the resistor needed will have a value of 27 ohms as shown in Fig. 2.

The figures quoted for voltage and current regulation assume ideal conditions but actual values will depend on the type of heat sink used, and the voltage drop across the IC.

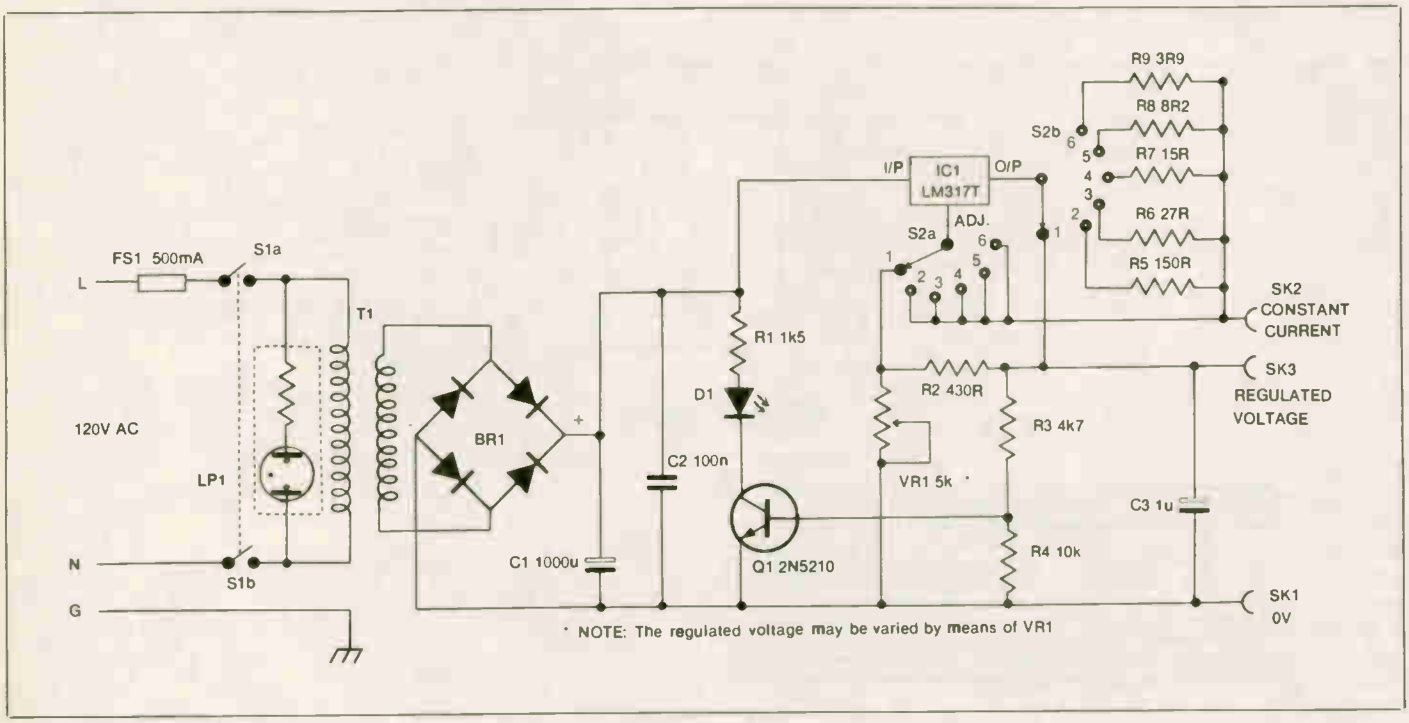

Fig. 3 Complete circuit diagram for the unit.

Circuit Description

In this project a conventional transformer circuit is employed, with transformer T1 stepping down the 120V ACto 12V AC. Four silicon diodes (contained in a bridge rectifier), are used to rectify the AC into DC, and capacitors C1 and C2 provide smoothing of the supply. The positive supply is fed into the IC, the output of which is fed via switch S2, either into one of the current control resistors, or to the regulated voltage output. This allows VR1 to control the voltage when S2 is in position 1.

Voltage regulation is sufficiently accurate to allow calibration of VR1, which removes the need for a built-in voltmeter. However, without a voltmeter, there is no indication if a short circuit is connected across the output. An LED indicator is therefore included, with components R3, R4, Q1 and R1.

Under normal conditions, enough current will flow into the base of transistor Q1 to turn it on, and the LED will light as current flows through limiting resistor R1 to ground via the transistor. If a short circuit occurs the voltage at the junction between R3 and R4 will fall, causing the LED to switch off.

Such a short circuit will not harm the IC, or any other part of the power unit. However, it is essential to be aware of this condition, in case damage is caused to whatever is connected to the power unit. Note that the LED does not function when the unit is set to constant current, since a virtual short circuit is normal in this application.

If switch S2 is set to position 2, the adjust pin is connected directly to the constant current output. The IC output is also connected to the constant current output, but via resistor R5. Thus a circuit similar to that shown in Fig. 2 is created, the 150 ohm value of R5 fixing the output current to 8.3 mA.

The other positions of switch S2 work in a similar manner providing a variety of output current options.

Construction

The majority of components are housed on a piece of stripboard measuring 70mm by 40mm. This is large enough to allow four holes to be drilled for mounting purposes.

Begin by marking out the stripboard, shown in Fig. 4, including the positions of the breaks. Strictly speaking, only one break is necessary on track F. It was considered necessary, however, to isolate the AC supply as much as possible; hence the other break. If the stripboard is to be mounted with metal screws, make additional breaks to isolate them from the circuit.

The regulator IC (IC1) is positioned in order to allow a heatsink to be fitted. The prototype used a strip of aluminium measuring 19cm by 5cm, and shaped in order to avoid other components. Alternatively, IC1 may be bolted to the case, if it's made of metal. Note, however, that the metal tag on the IC is connected internally to the output pin. It is essential to electrically isolate the tag, if it is bolted to the case.

The LED is connected via flexible wires. Be sure to use wires capable of carrying up to 2A for the AC input. The wires linking the rotary switch with the stripboard must have the lowest possible resistance, if good load regulation is to be achieved. Therefore, keep the wires as short as possible, and reasonably thick.

Resistors R5 and R9 are soldered to the rotary switch contacts. A piece of flexible wire is used to join their opposite ends together with the other tags of the switch as shown. The constant current output is also taken from this connection. Finally, link variable resistor VR1 with the stripboard, and solder in the regulated voltage output, and zero output wires. Check the stripboard for bridged tracks, dry joints, etc. Check also that the AC supply is fully isolated from the DC side of the circuit.

It may be easier to test the circuit before the stripboard is mounted in the case. (See 'Testing').

Almost any sturdy case may be used. Ensure that there is sufficient space for the transformer, and allow enough clearance for the potentiometer, switches, etc. The prototype unit was housed in a case with sloping front.

If ventilation holes are not provided, begin by drilling some, especially near the heatsink. However, ensure that small children are not able to make contact with AC connections inside. Any metal parts of the case must be properly grounded(i.e. connected to the AC ground), as must the transformer.

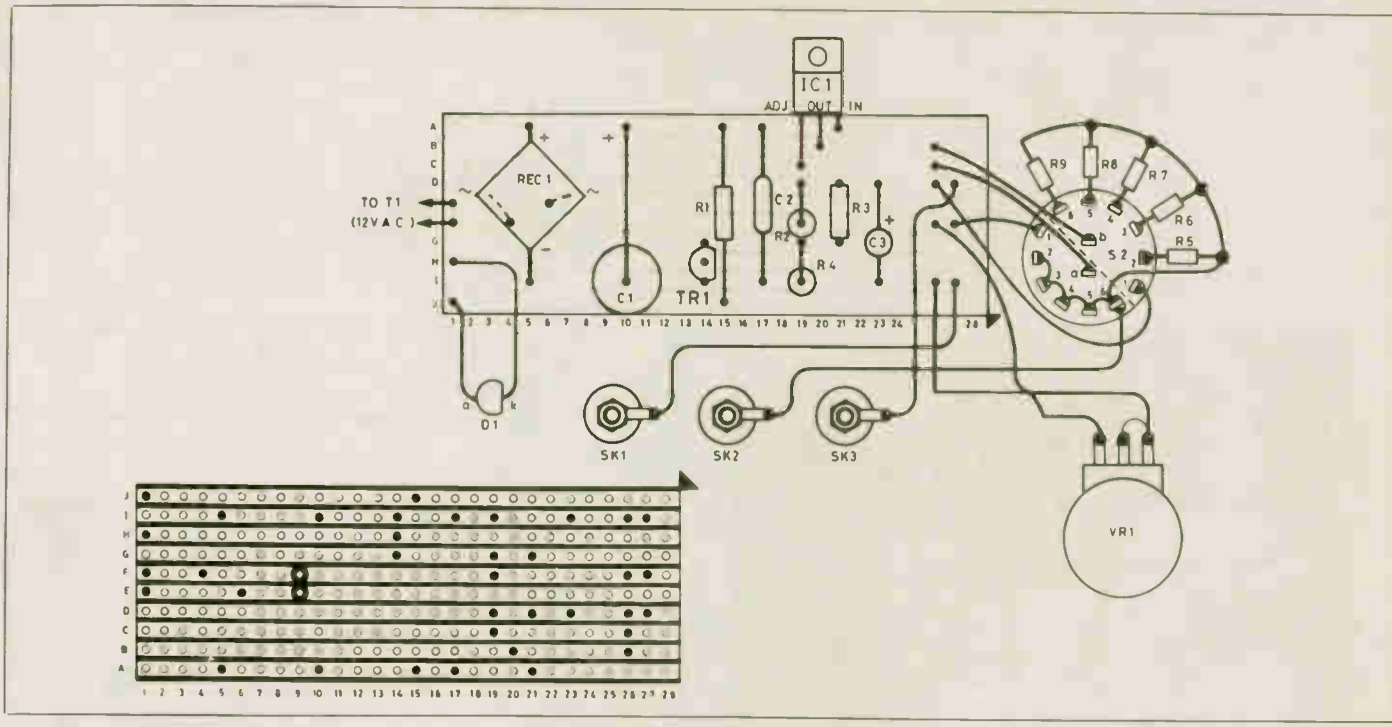

Fig. 4 Component layout.

Parts List

Resistors
(All resistors 5% 1/4W unless noted otherwise)

R1 ....1k5
R2 ....430R
R3 ....4k7
R4 ....10k
R5 ....150R
R6 ....27R
R7 ....15R
R8 ....8.2R (1/2W)
R9 ....3.9R (1/2W)

Potentiometers
VR1 ....k linear

Capacitors
C1 ....1000uF 25V elect.
C2 ....100n polyester
C3 ....1uF 50V elect.

Semiconductors
BR1 ....2A, 50V bridge rectifier
Q1 ....2N5210 (npn)
IC1 ....LM317T variable regulator IC
D1 ....0.2" LED

Miscellaneous
LP1 - AC neon indicator with integral resistor; T1 - 20VA, 12VAC power transformer, 1.6A output; S1 - DPST toggle switch; S2 - 2 pole, 6-way rotary; fuse holder and 500mA fuse; knobs (2); terminals (2 red, 1 black); case to suit; heatsink; 13A plug; stripboard (40mm x 70mm); AC cable; screws etc.

Testing

The circuit may be tested at this stage if a suitable AC or DC supply is available (a 9V battery will suffice). Alternatively, testing may be carried out when the transformer and associated circuitry is installed and working.

Connect the AC (on the stripboard) to the supply. Set the rotary switch S2 to position 1 (fully counter-clockwise — if wired correctly).

The LED should light. If it does not, use a voltmeter to find out if there is a voltage across it. If a reading of several volts is obtained, the LED is probably connected the wrong way around.

Use the voltmeter to test the regulated output voltage. It should be possible to vary this voltage, using VR1, from 1.2V to a little less than the input voltage. If no reading is obtained, connect the voltmeter across tracks A and I, and establish that the rectifier is working properly. Check the voltage on the output (centre) pin of IC1. If this is satisfactory, there may be a wiring fault at switch S2. Note that for a regulated voltage output, the rotary switch should connect track B to track D, and track C to track F.

Final Checks

WARNING: These checks will quickly run down a battery, if in use as a temporary power supply.

If all is well, short circuit the regulated voltage output. The LED should go out. The short circuit current should range from 2A to 3A, quickly falling to about 1A. This may be tested if an ammeter with an FSD of about 5A is available.

Finally, connect an ammeter set to 1A FSD to the constant current output. Turn the rotary switch to position 2. The LED should turn off, and the ammeter should show a small reading, which when set to a smaller scale, indicates about 8mA. Check that the other positions of S2 produce the correct current readings.

Calibration

Calibration of VR1 must be accomplished with the aid of a voltmeter. The scale must be marked by hand, at 1V or 5V intervals. Switch S2 may be marked with the current options outlined earlier, not forgetting that setting 1 is reserved for regulated voltage operation. ■

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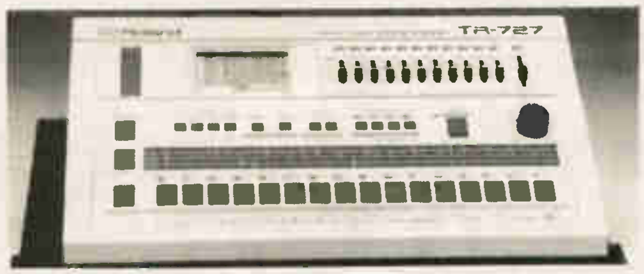

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Designer's Notebook

Programmable Logic Controllers

The programmable controller is a miniature computer for industrial control; a look at the basics of how they work.

By Peter Ihnat and Lew Pogson

SINCE the successful development of the digital computer there has been a steady increase in the application of digital principles and devices in industrial electronics. The reason for this is that digital implementation is efficient, reliable, flexible and, in many cases, cheaper than existing analogue equipment. Couple this with the ability to interconnect digital equipment in the plant with the central computer back at the office and you have a factory which is efficient and economical to run; all stages of production can be easily monitored, and new orders or changes to existing orders can be rapidly passed on to the plant.

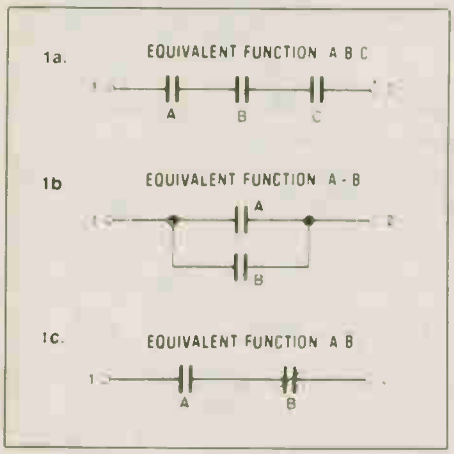

Fig. 1. Equivalent logic functions for some simple relay contact connections.

Industrial Control

Most industrial processes require several operations to produce the required output. Some or all of the following could be involved: manufacturing, machining, assembling, packaging, finishing and transporting. But on closer examination it becomes obvious that each of these operations is composed of other operations.

For example, to machine a particular metal piece may involve loading it into a lathe, machining into shape, drilling appropriate holes and then putting it onto a conveyor to travel to the anodizing area. This is where the industrial control system comes into the picture; it must provide precise coordination of the individual tasks for the overall system to function.

Controllers can be divided into two general categories: sequential and combinatorial. Sequential controllers are for processes which require that certain operations be performed in a specific order. Combinatorial controllers, on the other hand, perform operations without regard to the order. The machining of a metal piece as described above is an example of a sequential process needing sequential control, a bit like filling a bottle and then putting the cap on: it has to be done in that order.

An example of a combinatorial process is the placing of labels on the front and back of a cardboard carton; it doesn't matter in which order this is done. In industry, the majority of control problems are sequential but in practice all processes, whether inherently sequential or not, are performed sequentially. This generally reduces setup costs and results in a well-ordered system.

Early controllers used multicontact relays which were interconnected to perform various functions. Control switches such as start, stop, override, etc. operated the relay coils. The contacts they switched operated indicator lamps, motors, solenoids and other relay coils. With the introduction of digital logic to industry, design and implementation of these controllers were greatly simplified. Let's examine some simple ideas in the development of digital controllers.

A closed relay contact represents the TRUE or logic 1 state and the open contact FALSE or logic 0. Fig. 1 shows some basic relay contact connections and their equivalent logic functions.

Fig. 1a shows the AND function: there will be continuity between points 1

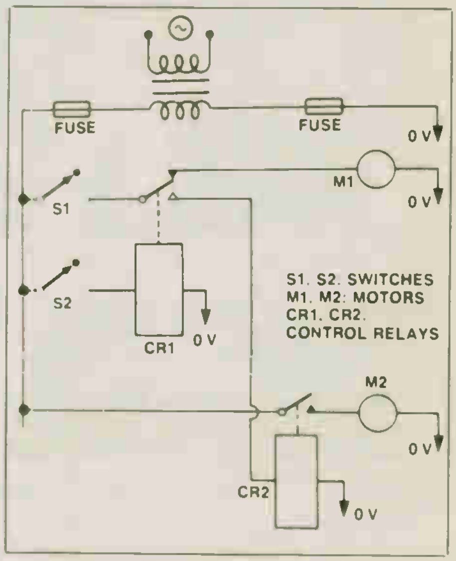

Fig. 2a. Example of a simple controller.

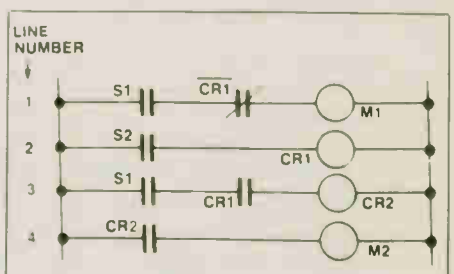

Fig. 2b. Relay ladder diagram for Figure 2a.

Electronics Today would like to indulge in an experiment. This article was typeset from a manuscript using a word processor, typesetting software and a laser printer. It should be interesting to see how the digitally created characters fare against the usual phototypesetting.

and 2 only if contacts A AND B AND C are closed. This will occur if the coils which operate contacts A, B and C are all energized.

The OR function is shown in **Fig. 1b** and results in continuity if contact A OR B (OR both) are closed. Once again this implies that any of the coils which operates contacts A or B is energized (or both are).

Fig. 1c is basically the same as 1b except that continuity is realized if contact A's coil is energized and B's coil is not (in other words, B is a normally closed contact which opens when its coil is energized).

To give a more practical example, refer to **Fig. 2**. Figure 2a shows two motors, M1 and M2, connected to switches S1, S2 and control relays CR1 and CR2. Operation is as follows: Motor M1 is energized if S1 is ON and S2 is OFF. Motor M2 is energized via relays CR1 and CR2 only if S1 AND S2 are both ON.

Figure 2b shows the equivalent "circuit diagram" which is more commonly known as the RELAY LADDER DIAGRAM. The supply transformer usually has fuses in each secondary lead which then extend vertically to form boundary lines for the diagram. The following conventions are used:

* the supply transformer and its fuses are usually not shown

* switches, relay contacts and other input devices are placed on the left of the diagram.

* relay coils, lights, motors and other output devices are placed on the right of the diagram.

* output devices are shown in the order they are energized during normal sequence of operations. This enables the operation sequence to be easily listed by traversing the ladder diagram line by line.

The actual controller is hard wired by interconnecting banks of relays in accordance with the ladder diagram and then connecting switches, motors, lamps, etc, to it.

There are several techniques for designing the sequential controller, given a request in the form of word statements, specifications or manufacturing statements. Most are rather involved and require state diagrams, transition tables and minimization techniques and, as mentioned previously, are outside the scope of this article. For very simple cases the "common sense" approach usually works and basically is a way of producing a relay ladder diagram line by line as one goes through a machine cycle. This is the method we'll use later when showing examples of P.C. programming.

Application of Solid-state Logic

Originally, the relay ladder diagrams were implemented as implied: racks of relays hard wired to each other, to switches, indicator lights, motors and whatever else needed controlling. You can probably see the major disadvantage of such a system. Any changes required to the control system meant physically changing relays and rewiring the new section, a costly and time-consuming operation.

So it seems quite logical ('scuse the pun) that the next step in the evolution of controllers was to use solid-state digital logic to replace many conventional relay panels. The advantages were higher reliability, lower cost, smaller size, higher speed, increased flexibility and compatibility with computers.

The transition to digital logic was straightforward since, as we saw in Figure 1, the various lines in a ladder diagram can be written as Boolean equations. The design process involves converting the control requirements to Boolean form, performing any simplifications, choosing the components to perform the logic decision-making and selecting the proper interfacing devices to match the circuitry to the outside world.

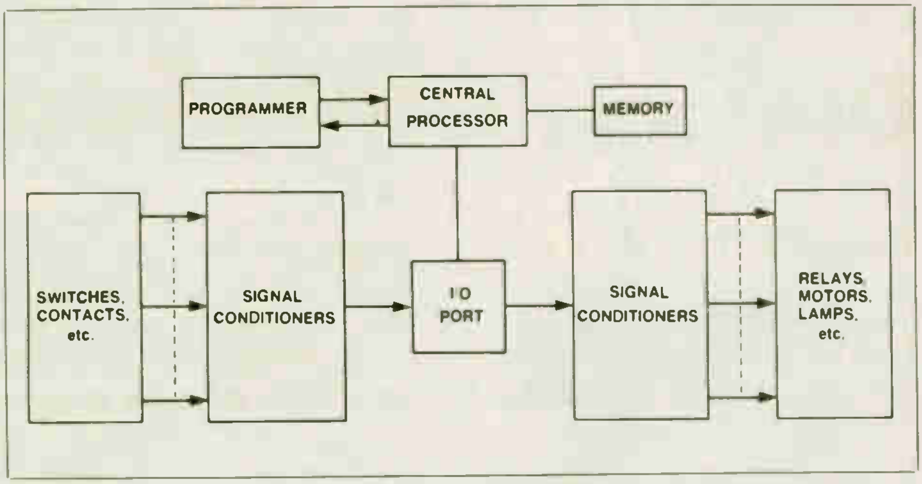

Fig. 3a. Block diagram of a programmable controller setup.

Solid-state logic components are classified into four categories: input interfacing, logic gates, output interfacing and accessory components. Each component is a transistorized, plug-in module able to perform one function. Groups of these plug into a base which allows interconnections to be made between the modules. Diagrammatically, the relay ladder diagram is replaced by a logic diagram which uses appropriate logic symbols for the different functions.

Programmable Controllers

Even though solid-state logic controllers were simpler to construct than an equivalent relay panel, they were still designed and built for a specific operation or process. The cost of making changes to the circuit was still quite high. In the late 1960s a new type of controller emerged from the automotive industry's need for more flexible control on the factory floor. The programmable con-

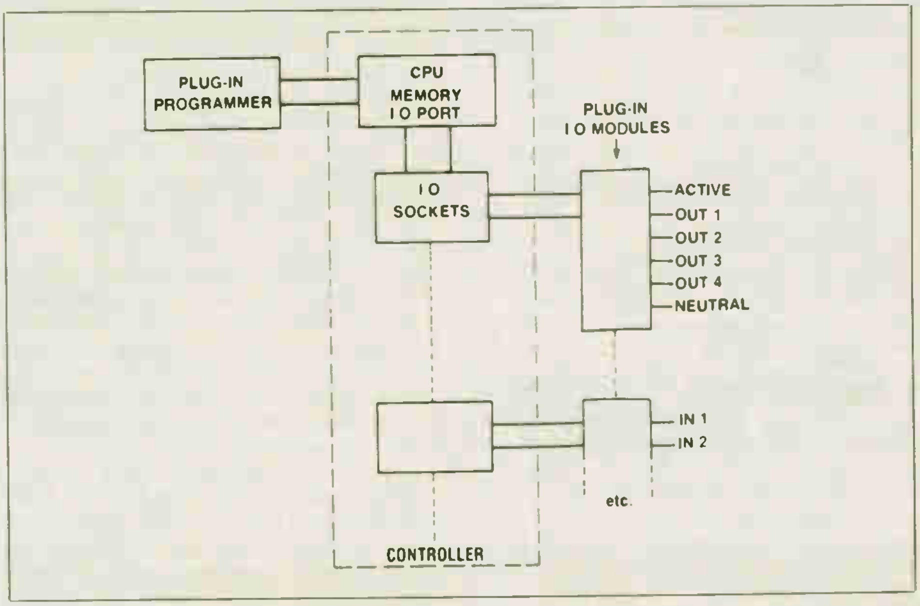

Fig. 3b. A typical P.C. used in practice.

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troller revolutionized industrial control by being able to have its operation specified by a program.

The transition to using the new controllers was aided by using a programming language already understood by the plant electrician and engineer (relay ladder diagrams).

These days, controllers can replace everything from simple relay circuits to sophisticated process control equipment and, in addition, have new capabilities such as being able to accept analogue inputs, provide analogue outputs and carry out closed loop control. Other invaluable features include the ability to communicate with other P.C.s and with computers over long distances and under adverse conditions with or without separate intelligent data handling equipment.

It's probably not hard to guess that the introduction of P.C.s had something to do with the microprocessor revolution. Basic ally, a P.C. is a robust microprocessor-based unit which uses memory to store instructions specified in a simple ladder logic programming language. When running, it monitors the conditions of its inputs to provide outputs by implementing logic, sequencing, timing, counting and arithmetic functions.

Architecture

Fig. 3a shows the block diagram of a typical P.C. The important sections are the CPU/memory, the programmer and the I/O modules (signal conditioners). These may all be contained in the one unit or, for added flexibility, may be available as separate units. In the latter case, the CPU/memory unit usually includes panels of sockets for the I/O modules to be plugged in. This allows any combination of inputs and outputs to be set up (only limited by maximum number possible for that particular P.C.). Let's look at each section in turn to better appreciate the operation of a P.C.

1)CPU

The CPU is actually the "brains" behind the controller. In many P.C.s it is a standard microprocessor such as the Z80A, 6502 or 6800 (some manufacturers, though, use chips specially designed for logic decision making). With only a few exceptions, all the CPUs are either 8- or 16-bit devices.

The CPU, memory and I/O port form the heart of the unit. THE programmer and signal conditioners are usually external units which are simply plugged in as required. Figure 3b shows the arrangement of a typical unit used in practice. The programmer and I/O modules are discussed in the next two sections.

The controller has two modes of operation: PROGRAM and RUN, usually selected by a slide switch or, in some cases, a key-operated switch, making the unit tamper-proof. Programs are entered whilst in PROGRAM mode, which also offers a complete range of editing facilities (we all make mistakes). These include inserting and deleting entries, finding a particular entry, changing parameters of timers and counters etc. Once programmed, it's possible to test the operation by plugging in a test panel made up of switches and indicator lights and going through all input combinations.

Alternatively, most P.C.s implement the "force" function. THis allows the operator to force inputs and outputs ON and OFF under software control whether or not there are any inputs or outputs actually connected. Its main use, though, is to aid in troubleshooting.

Once programmed and checked, the unit is simply left in RUN mode to control the equipment it becomes part of. Obviously, there will be times when power failures will occur and, as every computer buff knows, static RAM loses all its information if this happens.

The problem is overcome in P.C.s by three methods. Firstly, internal static RAM always has battery backup. This, however, is not usually a permanent arrangement. It is used when the program is first loaded and de-bugged. If all is well, the program is then copied into EPROMs, which plug into the CPU unit. This provides the permanency required by the controller. If any changes are required, these are made in RAM and copied into the EPROMs after erasing the original program.

The third and latest development is to use EEPROMs (Electrically Erasable PROMs) to hold the program. These don't need a UV source for erasing old information and allow changes to be made relatively quickly.

In RUN mode, the CPU performs a number of functions. Firstly, it scans the inputs and loads their status (1 for ON, 0 for OFF) into a temporary store. Also in this store are the outputs: the results of the Boolean, arithmetic and other operations. These are output to their appropriate output modules. Next, the CPU traverses the stored program line by line and logically or arithmetically combines inputs and outputs as specified by the program to produce new outputs, which are placed in the temporary store. The cycle then repeats.

Other functions which the P.C. implements are timers, counters, master control relays, drum controllers, etc. These are all implemented in software and, as mentioned before, will not be treated here in any depth.

2) The programmer

There are basically two types of programmers available with P.C.s: handheld programmers and video programmers. The cheapest is the handheld programmer and is most often used with small P.C.s. Its appearance is similar to that of a calculator and has a display (LED or more recently, LCD) and a sealed keyboard to stand harsh industrial conditions (see Fig. 4a). It is plugged into the controller either directly (that is, it physically mounts into a recessed area on the controller) or via a cable of some sort.

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Some controllers have built-in programmers but in many cases this is not required. The reason is that once the controller is programmed and fitted beside the equipment it controls, the programmer is of no further direct use. It can, however, be carried by the plant engineer and plugged into a controller to modify the program, monitor inputs, outputs, internal timers, counters or even change variables or conditions of inputs and outputs while the controller is running.

Note that if numerous controllers are used on the plant and if all are identical, then only two or three programmers need be purchased. This reduces the overall cost of the system since not all controllers will require programmers simultaneously once commissioned.

The most sophisticated method of programming and fault-finding is by use of a video programming unit. These may be standard intelligent VDUs or may be a small VDU built into a small unit which has special keys in place of the regular keyboard (see Figure 4b). This type of programmer draws ladder diagrams on the screen as the controller is programmed and if a hard copy is required, a printer can be connected to the system.

When troubleshooting or placed in RUN mode, controller operation can easily be monitored since paths and coils which are energized are shown by thicker lines (intensification of light on a VDU or double lines in printouts). Figure 4c gives an example of a typical printout. Of course, this type of programmer is much more expensive than the other.

c) I/O modules

These modules provide the link between the controller and the outside world. The equipment connected to a P.C. will almost certainly require different operating voltages. In fact in practice, most outputs will need to control much higher voltages and currents than the controller will supply. Inputs may also be high voltage ac an/or dc signals. In all cases, isolation from the controller circuitry is required. This is achieved easily by means of opto-couplers, but sometimes in the case of outputs relays are used. **Fig. 5a** gives some examples of I/O modules.

Smaller P.C.s have a small number of inputs and outputs which come built-in. These are isolated internally and can operate devices rated up to 240VAC. Extra terminals are provided on the I/O strip (similar to a terminal strip) to which an external power supply can be connected for powering each particular device (see Figure 5b).

The outputs and inputs are usually grouped in pairs or fours so that different voltages can be applied to each group. Larger P.C.s simply provide panels of sockets into which input and output modules are plugged. Each module provides four inputs or outputs, each with an individual indicator lamp, fuse and opto-isolator. This provides the greatest flexibility since:

* only the number of I/O modules actually required need be purchased (plus spares).

* a blown module can be easily swapped without switching off the entire system.

* number of I/Os can be increased up to the limit of the machine by using expansion modules which hold extra I/O modules.

Typical inputs to a P.C. include pushbuttons, limit switches, sensors, flow switches, controllers, thumbwheels, LDRs and other optical devices, vacuum switches. Some outputs are solenoid coils, motor starter coils, indicator lights, alarm circuits, etc.

Overall Advantages

1. Size: A P.C. can be housed in an enclosure which is substantially smaller than that required for its relay counterpart.

2. Reliability: The P.C. has no moving mechanical parts to wear out and fail. With

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electronic systems, most failures occur during manufacture and testing.

3. Flexibility: The P.C. is ideally suited for control systems whose control schemes may be revised later. Changing a hand-wired relay system often requires long downtimes and high labour costs. By contrast, changing the control system in a P.C. most often only requires the changes to be entered with the programmer.

4. Ease of installation: With a P.C. minimal panel wiring is required for installation in the plant.

5. Simple programming: Most P.C.s are designed to be programmed in ladder logic, a language normally understood by the users.

6. Faultfinding: Faultfinding is relatively easy with the use of ladder diagrams and input/output module indicators.

7. Hostile environment: P.C.s are specifically designed to operate in industrial environments; e.g., a typical operating temperature range could be 0-60 degrees C.

8. Cost: Overall costs of P.C. schemes are less than relay schemes.

9. Range of P.C.s available: Nearly 40 manufacturers in the USA alone produce P.C.s. They vary in size from eight I/Os to 4096!

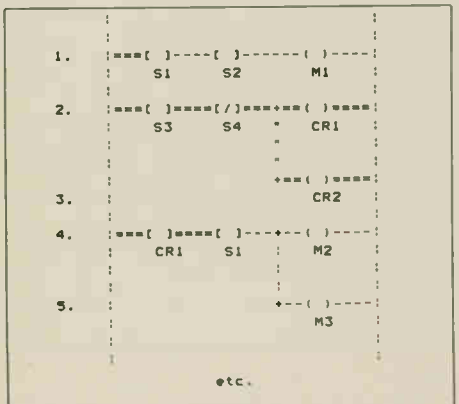


Fig. 4c. Example of a P.C. printout.

Normally open contacts (NO)	[]
Normally closed contacts (NC)	[/]
outputs	()
active path	=====
inactive path	-------

Programming Example

Just to complete the discussion of P.C.s, let's look at some very, very simple programming examples.

Example 1: Refer to the example given in Figures 2a and 2b. Since the relay ladder diagram is already given, the controller can be programmed without further simplification. Using a typical programming language we obtain:

START X1
AND NOT CR1
OUT Y1
START X2
OUT CR1
START X1
AND CR1
OUT CR2
START CR2
OUT Y2
END.

Note that START begins each new line of the program. Inputs and outputs can be represented by X and Y and control relays by CR.

When switches S1, S2 and motors M1 and M2 are connected to the P.C. they connect to I/O terminals X1, X2, Y1 and Y2, respectively. Finally, an ENTER button is usually pressed after each line of programming. Simple! Saves interconnecting relays.

Example 2: Refer to Fig. 4c.

START X1
AND X2
OUT Y1
START X3
AND NOT X4
OUT CR1
OUT CR2
START CR1
AND X1
OUT Y2
OUT Y3
END.

Example 3: Assume we have a room with two doors and one light in the middle of the ceiling. Each door has a switch which operates as follows: the light can be switched ON and OFF by either switch. For example, the light can be switched ON when you enter door 1 and switched OFF as you leave door 2. The same applied if you reenter via door 1 or door 2.

Those of you into logic will recognize this as the EXCLUSIVE-OR function. If we start with both switches in the UP position, the light will be OFF. If the room is entered via either door and the switch operated, the light will come ON.

In this condition, one switch will be in the UP position and the other DOWN. When leaving, to put the light OFF, either both switches will be in the DOWN position or both will be UP (depending on which door is used). To put this into digital form, let's call the switches X1 and X2 and the light Y1.

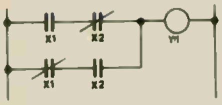
If a switch is put in the UP position then it is represented by barX1 (or barX2). If in the down position, then it becomes X1 (or X2, depending on which switch we're talking about).

For the light to come on, we can deduce from the previous paragraph that one switch must be DOWN and the other UP. If both are UP or DOWN then the light will be OFF. In other words:

light ON = X1.X2 + X1.X2.

This is read as "the light will be ON if X1 is DOWN AND X2 is UP OR X1 is UP AND X2 is DOWN". The ladder diagram and program are:

START X1
AND NOT X2
START NOT X1
AND X2
OR MEMORY
OUT Y1
END.



Note how two lines are started to give the two parallel paths. When the second path is started, the first is stored in memory (like a stack) since it wasn't completed. The OR MEMORY instruction ORs the current line with the stored line. ■

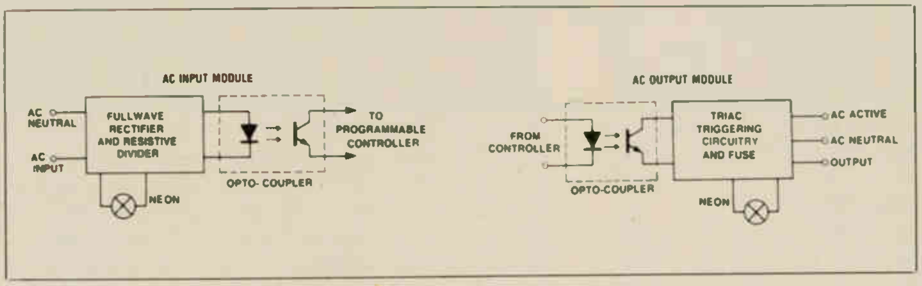


Fig. 5a. Block diagrams of typical I/O modules.

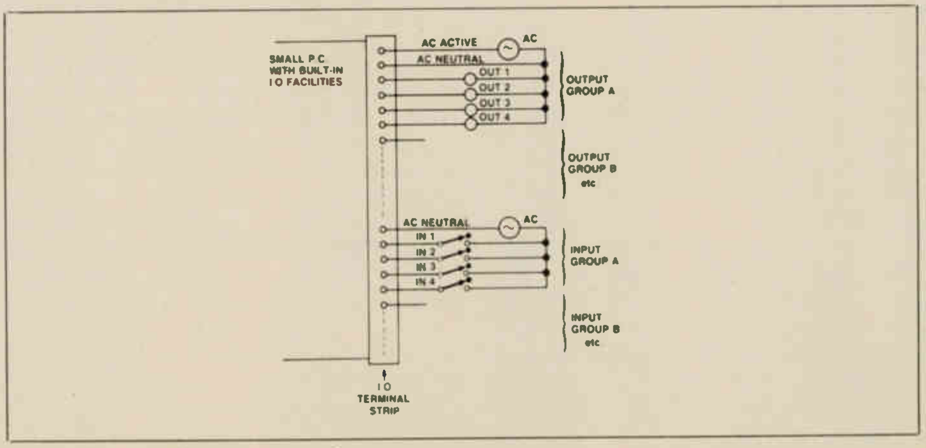


Fig. 5b. Example of I/O connections for a small P.C.

Home Computer Control

Controlling the home with the computer, that is. Dust off the micro and put it to work.

By Bill Markwick

ONCE you get bored with the video games, or if you think a few hours a week with a word processor lets the computer go to waste, you can always get more out of your micro by adapting it to home control. The micro is a natural for this; it can monitor the state of its ports with the appropriate software and then activate other ports via an interface. It can wake you up, turn on the light, start the coffee, keep an eye out for burglars, run the heating system and take the dog out for its morning walk. Well, perhaps I exaggerate a bit...

The Micro

Any micro with inputs and outputs will do, of course, if you want to build a system from scratch, but in that case you either need a large reference work or you don't need me at all. In most cases, the best route to follow is to look into the available commercial interface units; this saves you from reinventing the wheel. After all, the majority of electronics involved is simply mating I/O ports to sensors or relays. Mind you, this might be fun, and there's an idea for a future ET project. Hmmm.

The reason that most commercial suppliers specify particular computers is not that they work better, but that the equipment can be standardized for the I/O connections and the software can be made compatible. For this reason you'll generally find that home control systems are designed for popular micros such as the Apple, C64, Mac or IBM.

The job of the micro in all this is straightforward enough. Under control of the supplied software, the computer, timed by its own clock, sends out signals at predetermined intervals to start or stop some particular household function. In the more elaborate systems, feedback is used so that the computer has some idea what's going on and doesn't just blindly start up the power saw when you're sitting on it (not a good example, I know).

Transmission

There are two basic types of transmission, one-way and two-way. The two-way may also be known as a feedback or full-duplex system. The two methods are further divided by the method of getting the signal in or out; the two most popular systems are hard-wiring and RF remote control via power lines.

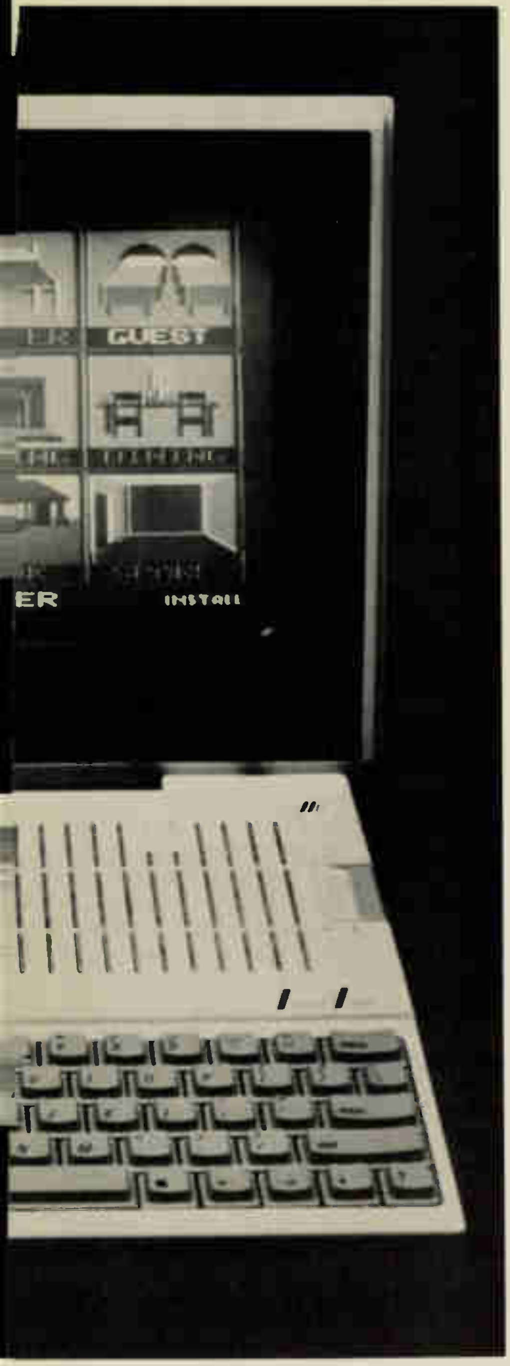
The one-way system is appealing because of its simplicity and low cost. The computer counts down to a specific time like a smart alarm clock, and then makes a particular port line go high or low. The interface translates this into an on or off code which is picked up by an appliance controller, either by direct dedicated wiring or by decoding a digital signal sent over a common carrier. The disadvantage to the one-way system is that the computer is largely in the dark as to the state of the loads connected to it; it never finds out whether the furnace actually did bring the temperature up or not.

The two-way system is a bit more involved, but it begins to bring a bit of intelligence into things. The user can now install more sophisticated sensors, letting the computer know whether some desired function has actually happened or not. In some cases, only a simple yes/no is required, and in others a wide-range analog signal may have to be sampled and converted to a digital value which the computer can read, initiating action or not under control of the software.

A One-Way System

X-10 Home Controls was formerly known as BSR X-10, and claims to be the leading manufacturer of home control units. Besides the X-10 systems which they market, they also make equipment for other companies such as the Radio Shack 'Plug 'n Power' and Sears; the private-label units are compatible with the X-10.

X-10 makes a computer interface called



the 'Powerhouse', consisting of a small panel with eight switches, an interface cable, and software on a disk. At present the system is available for the Commodore 64 and the Apple IIc/e computers; by the fall of this year they'll have systems for the Macintosh and the IBM PC. The appeal of the Powerhouse system is the simplicity of installation; no special wiring of the house is required. The switch unit consists of a microprocessor (an 80C48) with the necessary ROM and RAM and a 100-hour battery backup. Information from the software is read out of the computer via the RS232C port, processed, and converted to a high frequency signal which can be impressed on the power wiring. Although they didn't give exact figures on the frequency, most RF remote system use a signal between 100kHz and 200kHz.

The low power used (in the milliwatt range) means that the signal is unlikely to cause any interference with domestic electronic equipment, and the signal is unlikely to survive outside the house wiring, though it's theoretically possible that some interaction could happen if your next-door neighbour has an X-10.

At each location where you'd like to control an AC appliance, you install an X-10 module. For simple on-off or dimming functions, this consists of a box that plugs in between the outlet and the appliance. The RF signal is decoded by a demultiplexer, and the box performs its function whenever it sees its preset code. The modules can run incandescent lamps, small motors and so on.

If you want a small, self-contained system, the control centre of the Radio Shack version has 16 pushbuttons to control 16 modules, and presently lists at $49.95 plus $29.95 for each module. If you'd prefer computer control, allowing you to add more complex timing and graphic displays, the Powerhouse can control up to 256 modules and display their state on a graphic representation of the house which appears on your computer monitor. There are also eight pushbuttons for instant manual control. The control unit, software and interface cable is under $200 in Canada.

Aside from the convenience of having the lights come on and the coffee perking in the morning, the units are ideal for timing all the lights in the house if you're away. Imagine a computer glitch that makes all the lights in the house go on and off at random every two seconds - that should confuse burglars.

In the works is a setback thermostat that can be controlled by the X-10, and a telephone responder which will allow you to phone home and issue commands to the computer. If a burglar is in the house while you're in Tasmania, you can at least get the coffee perking for him.

Going The Other Way

The X-10's function is to send signals to a module to control some function. If you'd like a simple system that works the other way, the PCI Sentry from Precision Controls Inc. is a receiver unit which can monitor up to 99 remote sensors. The remote sensors apply their RF signal to the power line in much the same way as the X-10 (but in the opposite direction).

Each transmitter in the system has a two-wire connection to detect the closure of any type of sensing switch, DIP switches to set the desired code, and a standard wall plug (similar to an AC adapter plugpack). When the sensing contacts close, the preset code is detected by the receiver which flashes the number of the transmitter on its front panel display. A relay is also provided on the receiver for activating various bells and whistles.

Two models are available: the Model 100 accepts up to 99 transmitters, and the Model 10 accepts up to nine. In addition, Call Buttons are available for paging the central receiver.

The company also supplies a range of 400 types of switches for monitoring pressure, immersion, air and liquid flow, voltage, noise, etc. The manufacturer claims that their 'random phase digital circuitry' is not affected by noise on the power lines and will not interfere with other equipment.

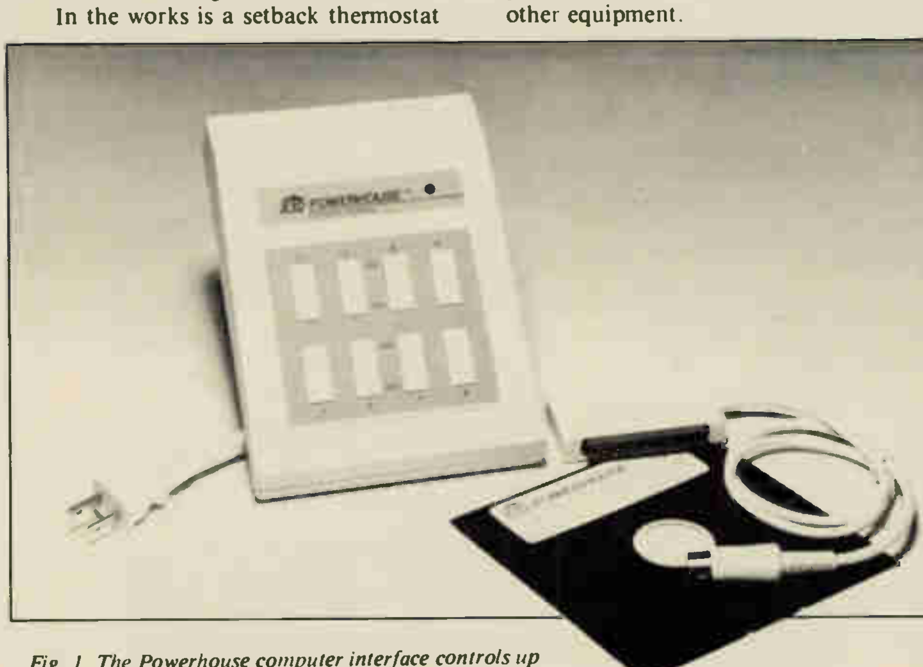


Fig. 1. The Powerhouse computer interface controls up to 256 appliance modules with a signal sent over the power wires.

Sensors

If you're concocting your own computer monitoring system, either for the home or industrial applications, much of the work of designing the interface is already done for you by the Sensatrol system. It consists of a small control box with eight differential-input voltage-monitoring inputs and eight control outputs.

Connection to the computer is made via an RS232C port, and the controller responds to commands in BASIC, making it compatible with any micro. When BASIC sends it a PRINT statement, an input line is selected, read at two samples per second, and the result transmitted back. The manufacturers claim that it has the resolution of '4 1/2 digits' or '40,000 sample points'. This is slightly better than the resolution you'd get from a 15-bit A/D converter (which uses 32,768 sample points per measurement), and should be more than adequate for the majority of uses. The resolution for measuring AC or DC sensor signals is 100uV, and accuracy is 0.01 percent for DC and 0.1 percent for AC. Audio signals, for instance, can be sampled over a 66dB range.

When the software decides that something should be done, one or more of the seven outputs can be activated, controlling just about anything via 3-amp relays or optoisolated 3-amp DC power controls. Sensors are available for measuring just about everything: temperature, pressure, light, noise, humidity, flow rates, electrical signals of all types, etc.

Although the Sensatrol requires special wiring, it has the advantage that only an RS232 link is needed between the unit amd the computer, and multiple control units can be connected to the same wire. Each control responds only to its own presettable code. This allows you to place the control units in locations that will minimize the amount of sensor wiring required.

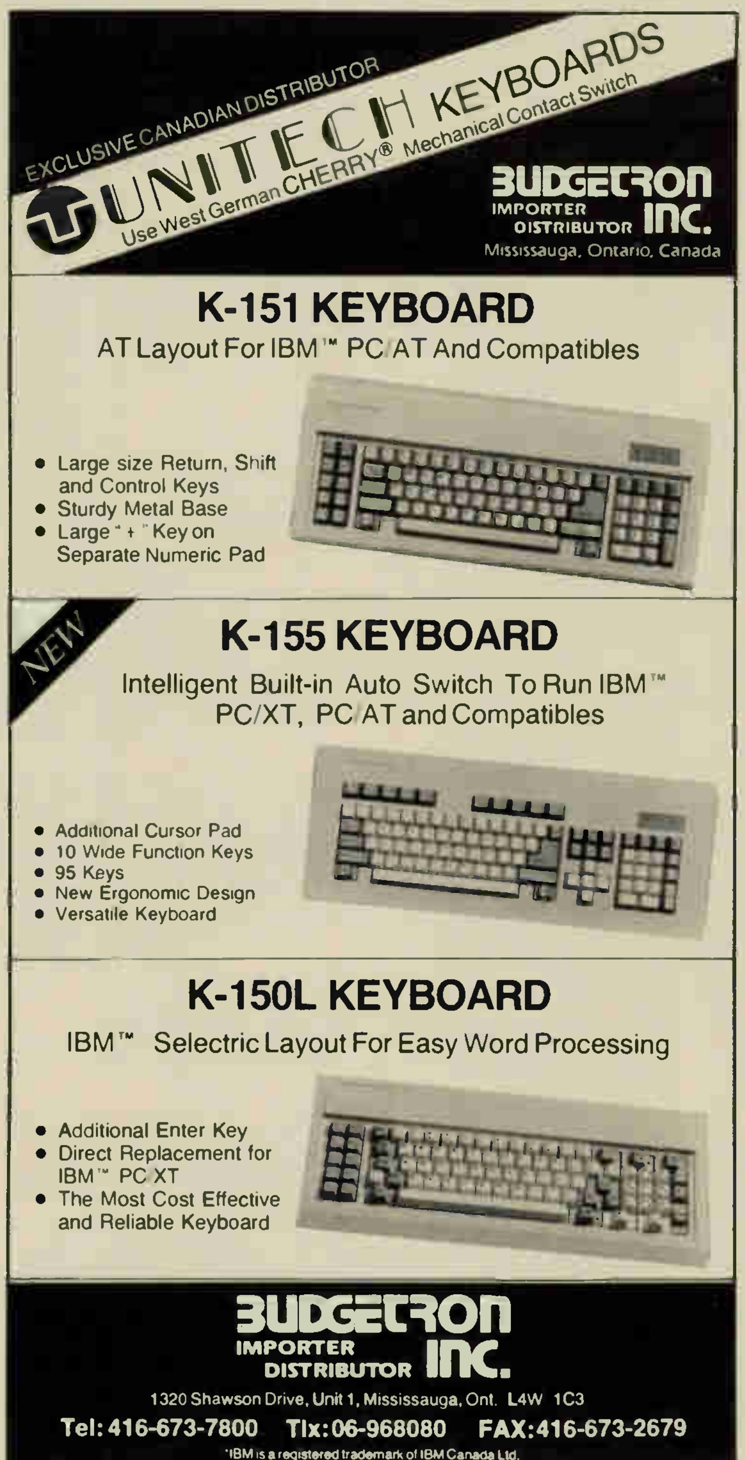
In Fig. 4, traffic noise has been monitored with a microphone preamp and a Sensatrol. A Radio Shack Model 100 portable computer recorded the readings under control of custom-written software. As you can see, the vertical axis has been converted to logarithmic form (decibels) by the software. Other measurements which were recorded with the same system included inside/outside temperature, humidity, light levels, windspeed, etc.

Butler In a Box

For those of you who are irritated by synthesized voices coming from less-than-useful gadgets, Simon the Electronic Butler at least has a purpose. It can store up to 15 numbers; a voice-recognition circuit will then make it control a particular light or appliance when it hears a number, and it can also recognize up to four different voices. It can also speak short phrases, such as a request for identification, and best of all: the voice is a real prerecorded one rather than synthetic.

Simon consists of a 64K computer with most of the processing done by software rather than expensive dedicated chips. It can be voice-activated as described, controlled by switches on a concealed front panel, or programmed with an automatic timer. Other features include an infrared intrusion alarm (which can be turned off when it hears the right identification) and a telephone speaker-phone function. The Canadian price tag is $2195.

Although Simon might appear to be an expensive frivolous toy, but the usefulness for the handicapped shouldn't be underestimated. Monsanto Canada presented one to the Ontario March of Dimes, whose director said that Simon 'could help a disabled person lead a more nearly normal life'.



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Grappler	$ 49.00	128K(128K)	$149.00
Cable above	$ 19.95	Drive Cont.	$ 49.95
		Z-80	$ 45.00

Circle No. 10 on Reader Service Card

Fig. 2. The PCI Sentry is a receiver that monitors up to 99 remote transmitters for monitoring levels, flow, pressure, etc.

Fig. 3. The Sensatrol can accept up to eight analog inputs and outputs for sophisticated monitoring of sensors.

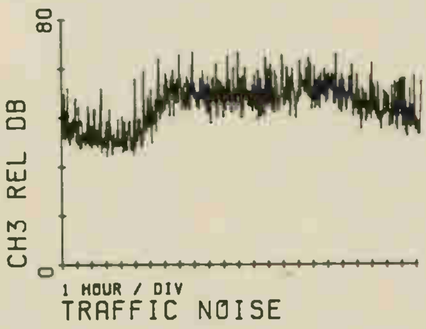

Fig. 4. Traffic noise was monitored with a mike preamp, a Sensatrol and a portable computer.

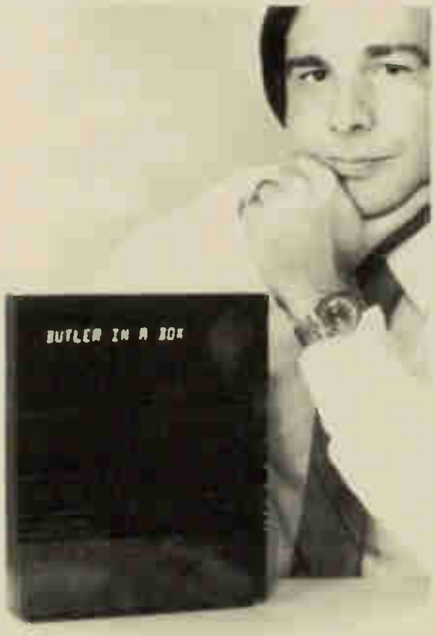

Fig. 5. Simon, the Electronic Butler with its creator, Gus Searcy.

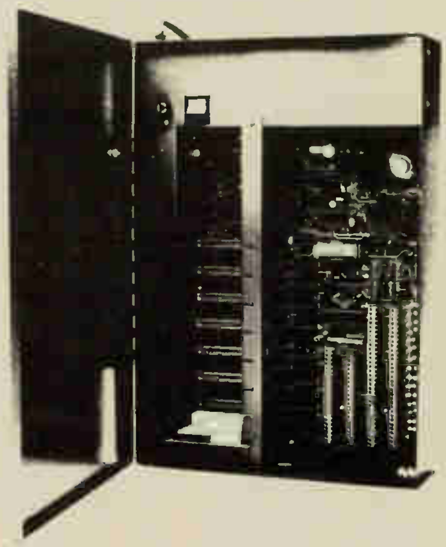

Fig. 6. The TomorrowHouse PCB in its mounting case.

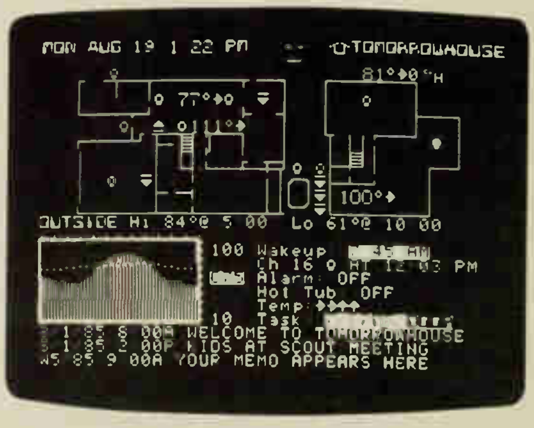

Fig. 7. A graphic display from the TomorrowHouse on a home computer.

HVAC

Heating, ventilating and air conditioning is a natural area for computer control, particularly with home systems, whose simple thermostats don't do an awful lot for energy conservation. The Hitek 3000 is a computer-controlled energy management for residential and commercial use. It uses a microprocessor for optimizing temperature, duty cycle and setback functions. The unit replaces the existing thermostat.

An EEPROM retains the heating/cooling program indefinitely in case of a power failure. The manufacturer claims savings of up to 25 percent on residential installations.

TomorrowHouse

The TomorrowHouse system consists of a printed circuit board in a box which can mount anywhere in the house. It communicates with your micro via an RS232C link, and will display a graphic representation of the floor plan along with a readout of the state of the various things it's controlling. These include eight zones of HVAC, various dampers and registers, a theft-fire-smoke security system, exit lighting, up to 256 individual lights and appliances, the sprinkler system and more.

The unit has voice synthesis and can do wake-up calls, memos, etc. The programmable microprocessor board has a capacity of 128 SPDT relays, 22 digital channels (expandable), 29 analog inputs (also expandable), a realtime clock, battery backup and even an X-10 controller.

While the unit may run in the $2000 area, it's said that the energy management functions will make the unit pay for itself (that's a lot of energy). Lights can come on and off when you're away, and the unit can phone for help should unforeseen things go wrong.

Not a bad gadget to have, and particularly appealing to those of us too lazy to go upstairs to turn out the closet light.

The drawback to any of the home controllers is the number of sensors you have to install, even if a lot of them can use the power lines. The TomorrowHouse, for instance, is not supposed to turn on the sprinklers during or just after a rain because it monitors soil moisture. This means a widget buried in the lawn with wires coming back to the controller. In fact, a *lot* of wires have to come back to the controller.

There's yet another drawback to a machine that runs everything in and around the house for you. If it decides that the sprinklers should come on because the soil is too dry, say, it removes a small chore from your life that really wasn't unpleasant. In fact, if something *really* unpleasant has to be done, standing around the back yard sweeping the hose back and forth is good for hours of very enjoyable goofing off.

And you should learn to turn off lights when you're done with them. All these systems remove something from life that shouldn't be removed...

But enough philosophy. Think how much fun one of these electronic servants could be! ■

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1200 Aerowood Drive, Unit 20,
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PCI Sentry:
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Sources:

Sensatrol:
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Simon:
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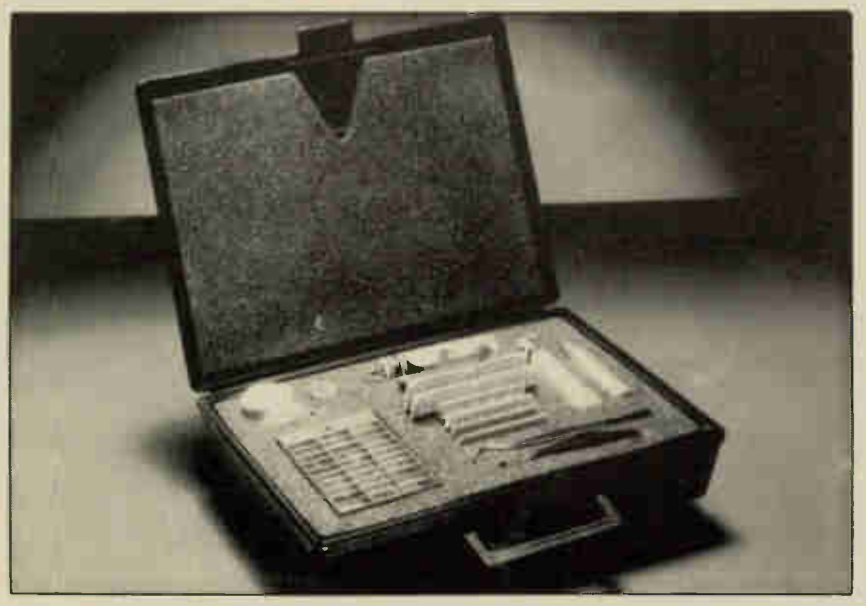
Continued from page 6

SMT Training Kit



Design engineers and electronics technicians take note: a Surface Mount Technology training kit is now available for those who wish to keep up with the latest in component mounting technology.

The SMT2000 kit from the Vector Electronic Company of California will get you off to a good hands-on start in SMT. Included in the kit is: over 575 SMT devices, various prototyping boards, component attachment and interconnection materials, and a comprehensive 50-page manual containing the names and telephone numbers of manufacturers and suppliers of SMT products. The Canadian price of the kit is $591.60

For more information on availability contact: Electro Sonic Inc., 1100 Gordon Baker Rd., Willowdale Ontario M2H 3B3. (416) 494-1555.

Circle No. 54 on Reader Service Card

The Institute of Electrical and Electronic Engineers have announced that Electronicom 87, the Canadian high-tech exhibition, will be held at the Metro Toronto Convention Centre September 28-30, 1987. The 1986 exhibition, originally scheduled for December, 1986, has been cancelled. For more information, contact the show manager at the Canadian Region, IEEE, 1450 Don Mills Rd., Don Mills, Ontario M3B 2X7, (416) 445-6641.

The Canadian government has removed the import duty from computer parts, parts of computer peripherals or accessories, hybrid transistors, linear audio amplifiers rated at less than 20 milliwatts and some other semiconductors. We have to wonder about that 20mW figure; even a 741 op amp can manage 50mW.

Cantel Inc. has introduced a data service that will allow cellular telephone customers to send or receive computer data using a mobile or transportable telephone. Data communication while travelling is made possible by automatic correction techniques to eliminate transmission errors due to radio noise or radio signal hand-off between cells. Transmission rate is initially 300 baud, with a 1200-baud service to be introduced in late 1986.

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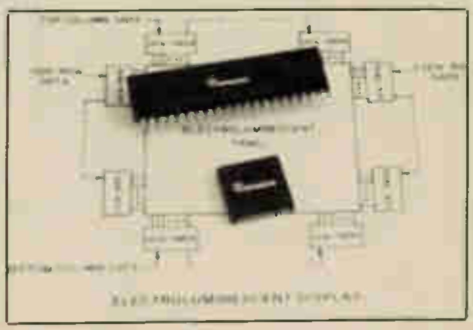

The UCN-5851A/EP and UCN-5852A/EP display row drivers from Sprague Electric combine a 32-bit shift register with 225V, 120mA DMOS sink drivers. These high voltage, thin-film electroluminescent (TFEL) drivers make it possible to economically replace bulky, heavy, and expensive CRTs with flat-panel displays such as plasma, vacuum flourescent, and electroluminescent types.

A logic supply voltage range of 4.5V to 15V is possible, and in addition, these TFELs are suitable for use with piezoelectric elements, PGD, and other high voltage applications.

For more detailed information contact Sprague's Technical Literature Service at 41 Hampden Rd., P.O. Box 9102, Mansfield, MA 02048-9102.

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Circle No. 26 on Reader Service Card

Continued on page 40

Digital Frequency Doubler

Digital Frequency Doubler

Easily double your clock frequencies or have a TTL signal and its double without dividing down.

By N. Hancock

DOUBLING A CLOCK frequency can be very convenient in digital circuits when synchronizing two parts or two system components particularly when its not feasible to divide the clock down. Simply doubling the frequency of your clock can save the hassle of redesigning. For applications where a high clock frequency or multiples of a frequency are required, this project is ideal.

A maximum output frequency of 10MHz is possible when the input is a 5MHz TTL level signal with a 50% duty cycle. To achieve this frequency range, high speed comparators (TL710s) are triggered by the rising and falling edges of the input waveform, when they pass the threshold levels.

The level of the thresholds not only determines the mark-to-space ratio of the output waveform as in **Fig. 1**, but also ensures even spacing of the pulses. Therefore, if the incoming signal does not comply to TTL constraints (approx. 0V-5V) the waveform will not pass the threshold levels at points for which they were set. The resulting output pulses will have irregular width and spacing.

At high frequencies the frequency doubler can actually improve the quality of TTL pulses by virtue of the resistor and capacitor combination on the input. This combination not only slews the leading and trailing edges of the incoming signal, but also filters out any spikes and ringing on it. Therefore the comparators cannot be inadvertently triggered by those glitches.

The output from the comparators is fed directly into a TTL gate and providing that there is no mismatch with the load, the output pulses from the TTL gate will be clean of ringing and spikes.

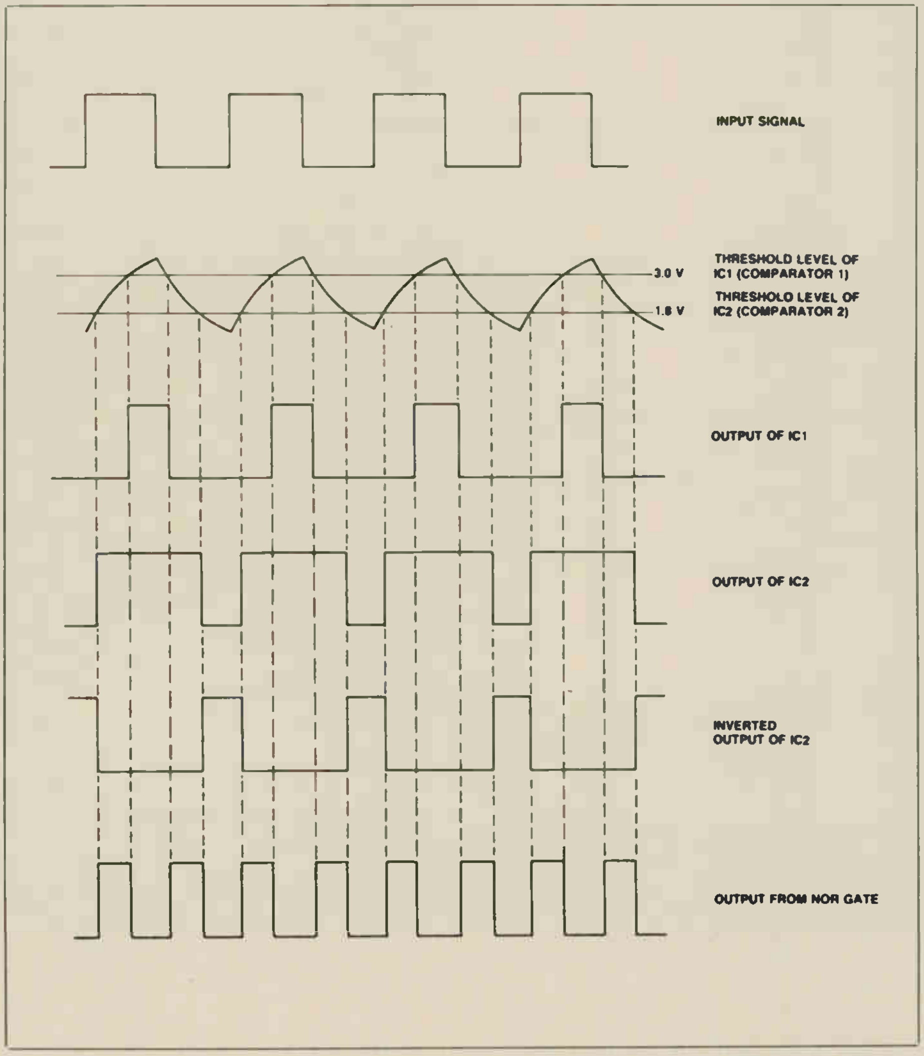

Fig. 1 The progression of the input signal through the circuit, showing how its double is derived.

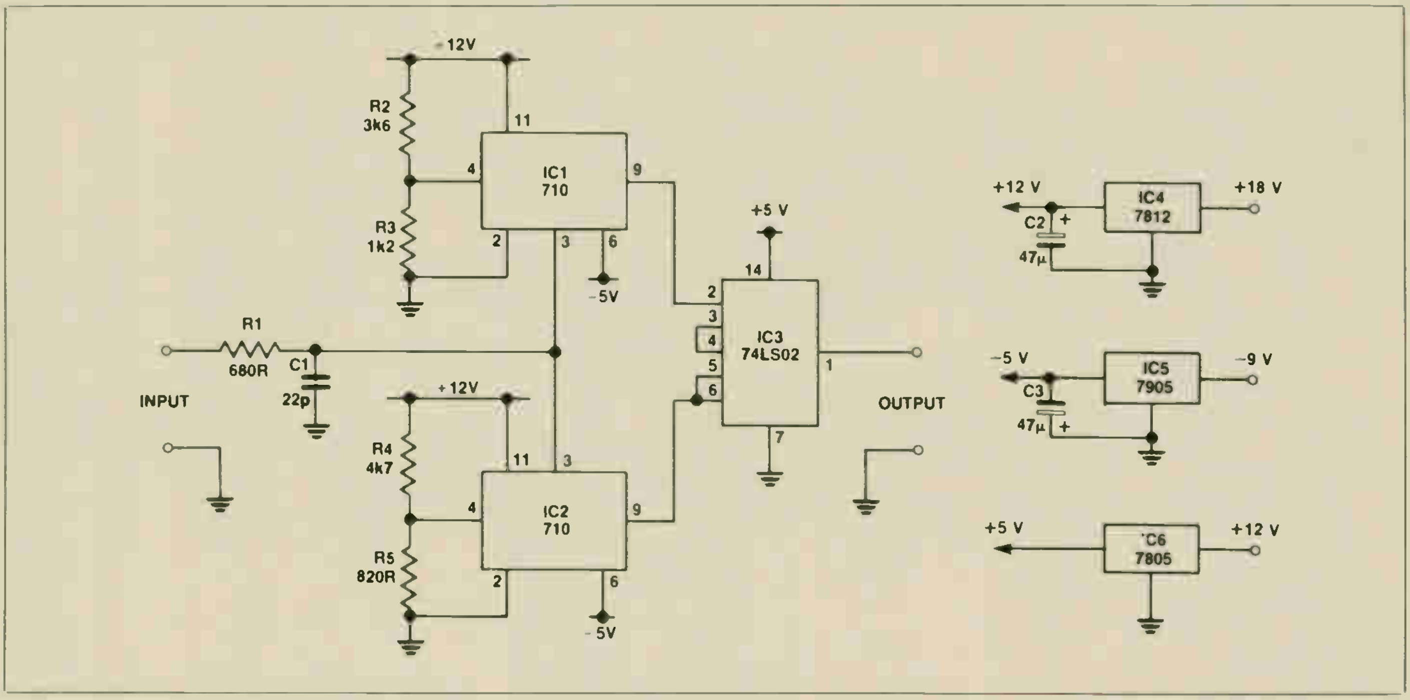

Fig. 2 The circuit diagram of the unit.

Construction

Start by soldering in the wire link which is located near the middle of the board. Next, solder in the capacitors and resistors, and watch for the polarity of the electrolytics. Also, avoid excessive heating of R2, R3, R4, and R5 as this may cause their values to drift.

The voltage regulators can now be soldered in; check their orientation with the parts overlay. The rest of the ICs can be inserted at this stage taking the same precautions as before.

Begin the wiring connections with the battery clips. The black lead which connects the single 9V battery is soldered to one of the middle poles of the switch. The end pole is connected to the -9V input on the PCB. The red lead is soldered into the ground point next to R5. Take the remaining two battery clips and solder the red lead from one to the black lead of the other. Be sure to insulate the joint connecting the two wires or there'll be trouble. The unconnected red lead is then soldered on to the other middle pole of the switch, and the end pole to the 18V input of the PCB. The black lead from this pair of clips is connected to the ground point next to IC3.

The wires connecting the RCA sockets to the PCB can now be soldered in. First connect the input socket and the signal ground lead to their respective pads on the PCB, making these leads as short as possible. These wires should also be twisted together to reduce the chance of undesirable effects at high frequencies such as losses and crosstalk. The output RCA socket has its central terminal connected to the output pad on the PCB with a short length of wire. The ground terminal of the output socket is connected to the ground terminal of the input socket by a short length of wire.

Testing

First check the circuit board for dry joints and solder bridges. If it looks satisfactory, connect the three 9V batteries and switch it on. Before connecting up, check that the output from the voltage regulators IC4, IC5, and IC6 are within 100mV of their rated values which are 12, -5, and 5 volts respectively. If they are not, double check for shorts in the vicinity of the voltage rails.

If you do not get a satisfactory waveform out of the doubler check that the voltage level on pin 4 of IC1 is close to 3V. Also, check that pin 4 of IC2 has a voltage level close to 1.8V. These levels are critical because they set the threshold level of the comparators. The comparator limits can also be affected by DC offset of the incoming signal, so check that the incoming signal is pure AC.

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How It Works

The combination of R1 and C1 is used to slew the leading and trailing edge of the incoming square wave, making the rise and fall times longer. The resulting waveform goes to the non-inverting inputs of the differential comparators IC1 and IC2. R2 and R3 are connected to the inverting input of IC1 and set the upper threshold. The lower threshold is set by the combination of R4 and R5 connected to the inverting input of IC2. The outputfrom IC2 is then inverted to make the mark-to-space ratio compatible with the output of IC1. Fig. 1 shows the relationship between the threshold settings and the resulting output waveforms from the comparators.

To combine the outputs from the two comparators, the waveforms are put through IC3 which is a quad NOR gate, thus giving twice the input frequency. The upper input frequency gives a mark-to-space ratio of close to 1:1. As the input frequency decreases, so too does the mark-to-space ratio. This is because the pulse width is set by the risetime of the waveform going into the comparators. Since the risetime is dependent on the value of C1, the mark-to-space ratio at lower frequencies can be increased by increasing the value of C1. However, this will limit the bandwidth of the doubler as high frequencies will be filtered out.

IC4 and IC5 are the 12V and -5V regulators respectively. These regulators provide accurate voltage levels, which are critical for setting the comparator thresholds. Capacitors C2 and C3 are used to decouple the voltage supply lines and thus remove any noise on the waveforms. IC6 is a 5V regulator and provides the voltage supply to IC3

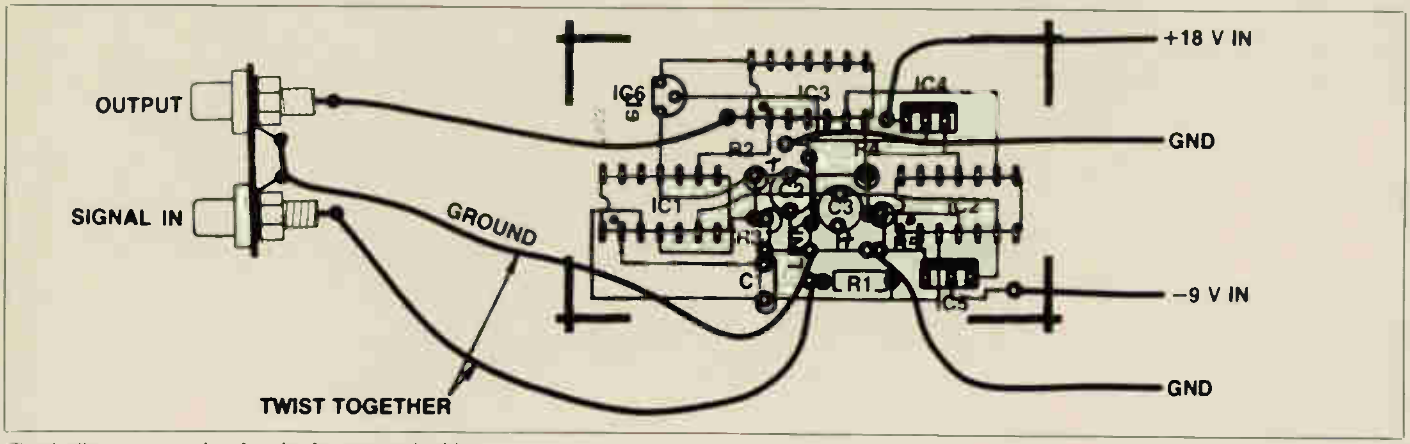

Fig. 3 The parts overlay for the frequency doubler.

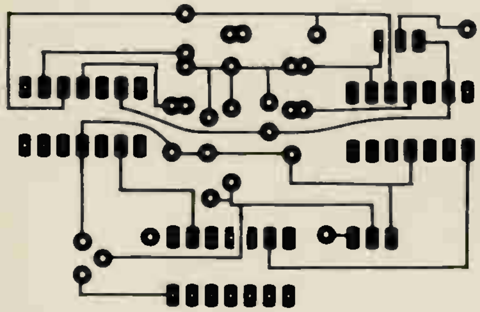
Fig. 4 The frequency doubler printed circuit artwork.

Parts List

Resistors
All 1/4W metal film, 1%

R1	680R
R2	3k6
R3	1k2
R4	4k7
R5	820R

Capacitors

C1	22p ceramic
C2,3	47u 16V electro.

Semiconductors

IC1,2	710 comparator
IC3	74LS02 hex NOR gate
IC4	7812
IC5	7905
IC6	7805 100mA

Miscellaneous
PC board; 3 x 9V batteries and clips; hookup wire; case to suit; 2 x RCA sockets; DPDT switch.

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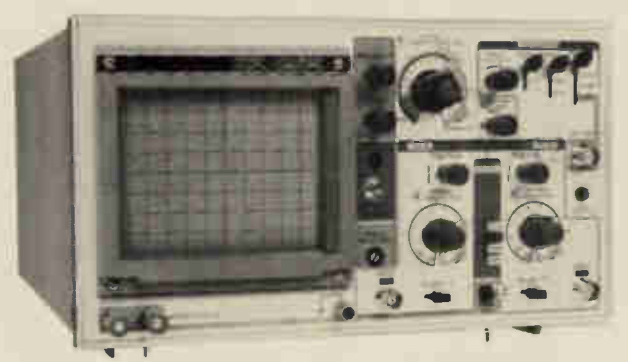

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Circle No. 14 on Reader Service Card

Multi-Channel Electronic Signal Switching.

By A. Armstrong & L. Buzzard.

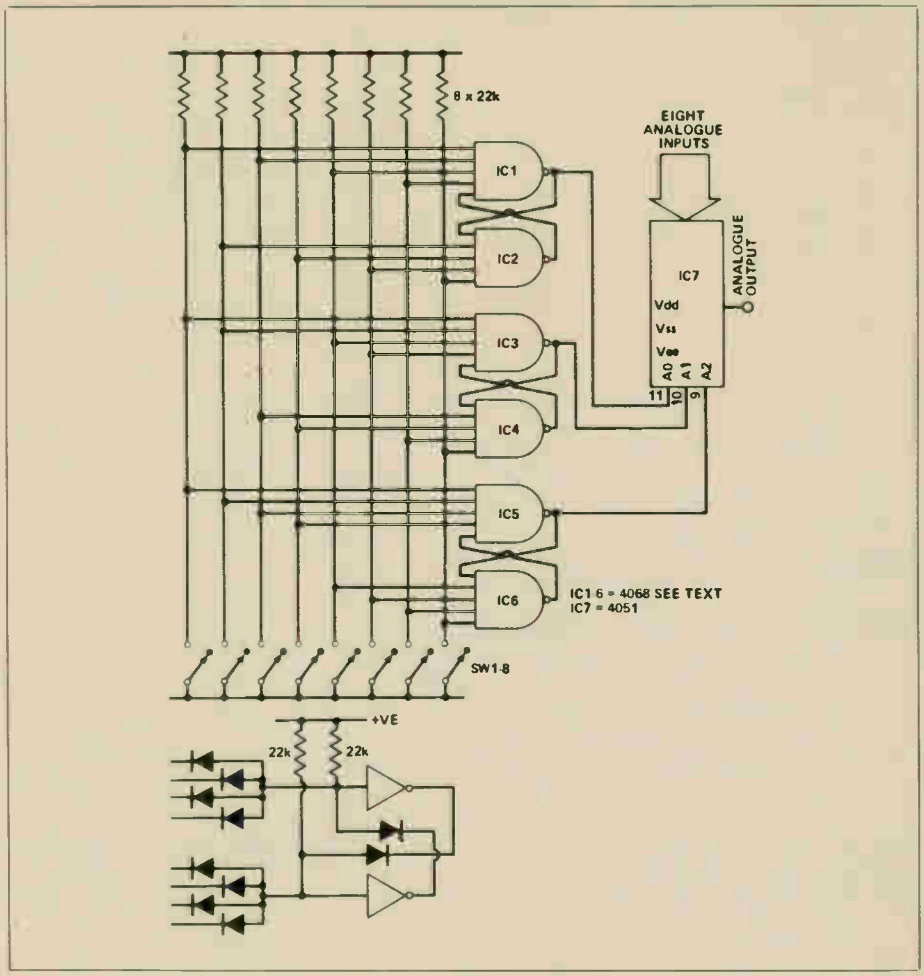
THIS CIRCUIT demonstrates the use of electronically latched switching of up to 8 signals. It is intended for use in home audio systems. Unlike many electronically latched systems, it can be made to remember which position it was in when last used. Indicator driving is no problem either.

The NAND gates shown in the first figure are arranged so that, as any switch is pressed, the outputs of the latches take up the binary number corresponding to the switch pressed. Five-input NAND gates are needed for eight way switching, so one can either use 4068s and connect the extra inputs to logic 1, or five-input gates can be constructed from inverters and diodes as shown in the lower figure. In this case, the only pull-up resistors required will be the ones directly connected to the gates, a total of six instead of eight.

This scheme can be carried out using one hex inverter rather than six 4068s, but it is untidy with all those diodes hanging on the board. If you only want four way switching, two triple, three-input gates can be used, leaving two gates spare. A 4052 would then be used to switch both channels of the stereo source.

Only one 4051 is shown in the diagram here, but in practice three would be used, with the address lines in parallel. Two of them would switch the signal and the third the indicator LEDs. It is quite safe to put 5mA through this type of device, so the common input/output pin is connected to +7.5V via about 1k2 and the LEDs are connected to the switched terminals. Then one LED will illuminate at a time, corresponding with the channel selected.

Battery backup can easily be added. The positive connections to all the CMOS gates and pullup resistors should be connected to the battery supply, but nothing else should be. The only thing to remember is that it is possible to change the state of the latch while only the battery supply is present.

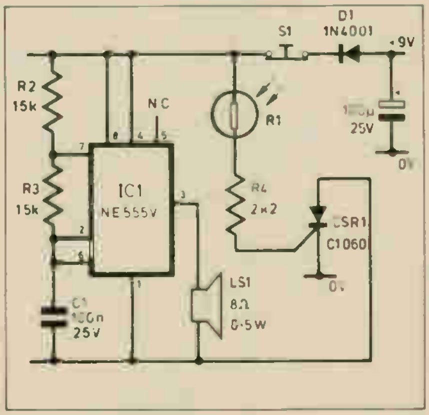


Light Operated Oscillator

By J. Short

THE FIRST half of the circuit is a light operated latch comprising the light dependant resistor, R1 and the thyristor, CSR1. R1 has a resistance of approximately 100M until it is exposed to light when the resistance will fall to about 100R. When this occurs CSR1 will fire and provide current to the second half of the circuit.

When CSR1 fires, a low pitch noise is emitted from LS1 which is driven from the 555 timer, IC1. Once the tone is activated, it will continue until the circuit is reset via S1.



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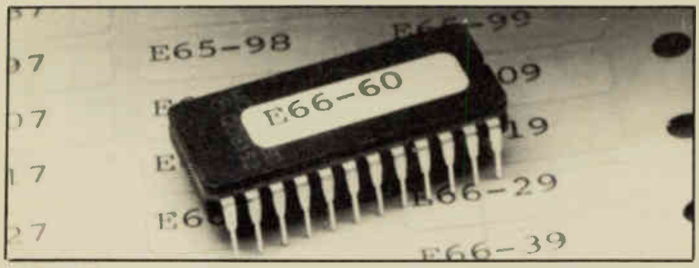


A line of five new computer-printable EPROM labels are available from W.H. Brady Inc.

Two sizes are available in B-652 polyimide material, designed to withstand virtually all processes that PC boards are subjected to including heat, soldering, and solvents.

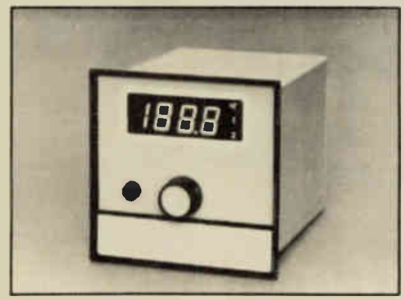
In addition, two other sizes are available in B-637 polyvinylflouride material which is smear-resistant, and self-extinguishing.

The fifth new EPROM configuration is made from B-619 polyester, making it resistant to solvents and smudging while offering high resolution and temperature performance (22°C to 172°C).

For further information contact: Peter Kaminski, W.H. Brady Inc., 10 Marmac Dr., Rexdale Ontario M9W 1E6. (416) 675-2112.

Circle No. 59 on Reader Service Card

Canadian Temperature/ Process Controller



The model TC1 temperature/ process controller is a Canadian designed and manufactured unit from Marcland Instrument Services.

The TC1 has an accuracy of ± 0.25% and is easily modified to on-off, time proportional, high limit, low limit, and Fahrenheit or Celsius operation. A second set-point can be changed from tracking to process, to high limit or low limit by jumpers.

A unique feature is the front panel 'range change' whereby any new range can be chosen from 0-100% of span while still keeping the ± 0.25% accuracy.

For more information contact Bob Crooks or Brian McGee at Marcland Instrument Services Inc., 156 St. Denis, St. Lambert, Quebec, J4P 2G2. (514) 866-4607.

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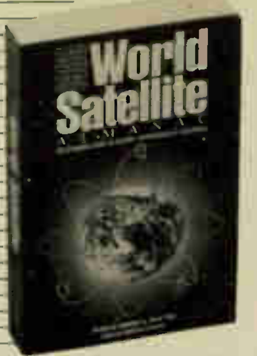

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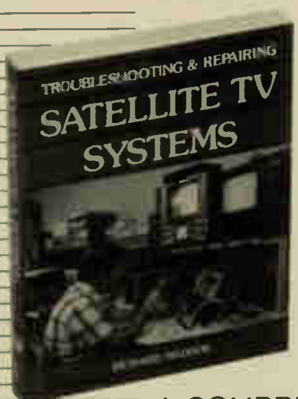

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Continued from page 34

For Your Information

Tool Source

What should you be looking for in good quality tools for electronics applications? According to Hi-Tech Tools of Canada Ltd., the following is a good guideline.

In cutters, the steel is everything, but this is often difficult to determine, however, the following features are more easily identified:

- a box-joint or precision screw joint
- soft, well cushioned handle for comfort
- jaws which meet first at the tip, then close completely as pressure is applied
- a mat, dull or black finish to eliminate glare
- an internal spring or leaf spring

Gripping pliers are designed primarily around the joint. These tools are often subjected to twisting and flexing, and only a well made box-joint is going to hold the gripping tips in alignment for a long service life and precision work. Also look for the following:

- soft, well cushioned handle
- mat, dull or black finish
- an internal or leaf spring

In tweezers, the range of qualities is much greater: ranging from low carbon steel, nickel plated models for a couple of dollars, to very high precision exotic alloy types costing anywhere from $50 to $80. Most users, however, would be well served by Stainless Steel, anti-magnetic, anti-acid types in the $10 to $20 range.

If you're interested in what's available from Hi-Tech Tools, you can contact: R. Kirkwood, Hi-Tech Tools Canada Ltd., 2175 Dunwin Dr., Unit 6, Mississauga, Ontario L5L 1X2. (416) 828-0068

Circle No. 53 on Reader Service Card

Continued on page 43

Pacific Bell is testing a system in Danville, California, that will enable users to transmit five data and two voice channels simultaneously over standard telephone twisted-pair wiring. Called Project Victoria, the service uses an encoder on the subscriber's premises and a decoder at the central office; the decoder separates the signals and routes them to the proper circuits. One of the five channels offers data transmission at 9600 bps, while the other four operate at up to 1200 bps. The service is expected to be in commercial operation by 1987.

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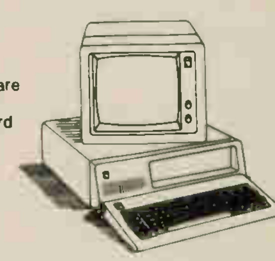

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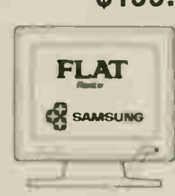

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Circle No. 23 on Reader Service Card

Circle No. 24 on Reader Service Card

The Multimeter

The VOM has not been outmoded- it's a basic, versatile meter for the testbench.

By James W. Essex

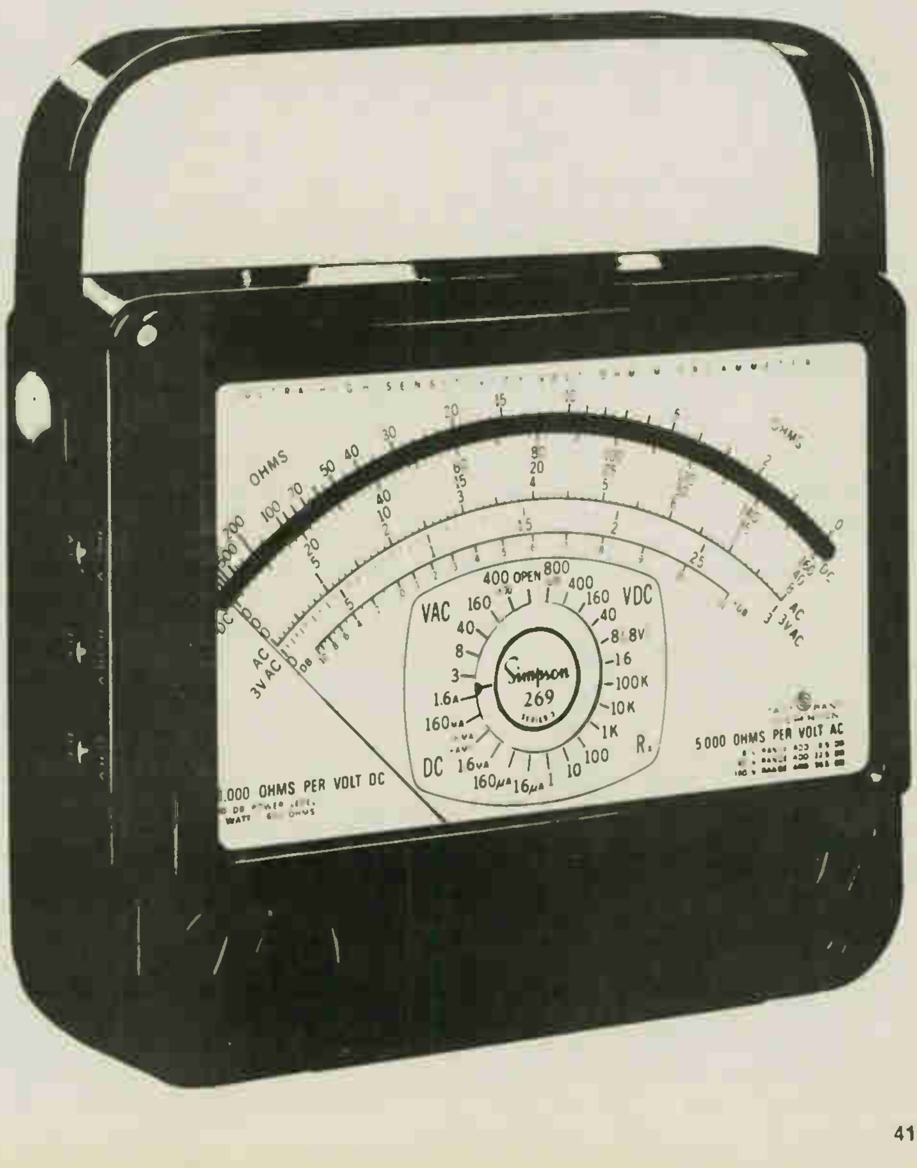
IN MY early days of radio, I met an engineer who was enraptured with a multimeter he'd just bought because it had a '20,000 ohms per volt' movement. This was well before vacuum-tube-voltmeters were common. I'd just learned about capacitance, inductance and transformers in those early days. The 'ohms-per-volt' posed a great mystery. What were they? By the expression on his face, I could tell that the expression was important to him. Several VOMs and many years later, my appreciation for this figure of merit of a multimeter has grown, and like that broadcast engineer of long ago, I've learned to appreciate it more.

Consider your own experience. No doubt you have thought, like most, that you needed a VTVM to read the Automatic Gain Control or Automatic Volume Control circuits, and may have been surprised to learn that a good volt-ohmmeter can exceed the input impedance of a VTVM, at least on the higher ranges. Yet, there's some feeling today that the ascendancy of the VTVM (or its solid-state equivalent) has tended to outmode the universal VOM by the accompanying glitzed-up advertising and flashing digital readouts. Not so. I learned that the old-fashioned VOM is still the best, despite those who argue that the sweep-needle with inherent parallax leaves much to be desired, or that they don't understand what ohms-per-volt means as a figure of merit. There's still much to recommend the regular VOM over the VTVM, and it's not all because of price or portability.

Portability

On portability, and nothing could be more portable than the VOM with its built-in battery, it's perhaps significant that a line of VTVMs features a battery pack, perhaps an admission that the necessity to plug in the early VTVMs left something to be desired. In any case, especially if you're just entering electronics, buying a piece of test equipment would be much easier if the demands on it weren't so great. Unlike some trades like 'water divining', where all you need is a willow branch, an electrical tester requires reliability and utility, every time. It's not enough, as with a water search, to note the bending of a tree branch (experts generally agree that you'll find water underground most anyplace anyway).

With the low impedance found in today's transistor circuits, the concern for a high impedance instrument has all but



disappeared. This makes the VOM a coveted tester. And neither do you have to go to the more expensive meters to get high sensitivity with accuracy. Like the water underground, there are volts and amps everywhere to be found, and there's a multitude of electronic equipment to suit every style and price. But how well you can interpret observed results is important, and there are many pitfalls.

Commercial VOMs

Generally, the VOMs available today have particular merits to meet buyer's requirements, and your own demands will determine which one to buy. Basically, there are features common to each: portability, easy-to-read scales, and a minimum price for a reasonable degree of accuracy.

It's interesting to note that the sensitivity of the VOM is equal to or better than the VTVM on the higher ranges, according to the manufacturer of the Model 269, Bach-Simpson. Further, the current sensitivity is extremely good; the 269, for example, allows evaluation of DC current as small as a fraction of one microampere. As far as I'm aware, no other portable has approached this current sensitivity, even in high-priced non-portable lab meters.

Even the mini 'cheap' versions of the VOM now appear regularly in the most unusual situations. I'm constantly surprised to find equipment in the over-$40,000 category being serviced with the aid of one of those minis pulled surreptitiously from a pocket or briefcase. Perhaps the moral here is that for all their complications, circuits reduce to volts, amps and ohms, and a good basic multimeter can do the job of testing.

Looking Inside

Inside the Bach-Simpson 269, for example, we find a simplified DC meter movement with a full-scale-deflection of 10uA. This is considerably more sensitive than the inexpensive variety, but it will serve to illustrate. In series with the meter coil is a string of resistors; the input switch can connect the input to any point in the resistor chain, allowing the sensitivity to be varied. In this case, the resistors are chosen to allow full-scale-deflection on the following DC voltage ranges: 1.6, 8, 40, 160, 400 and 1600 volts. Another resistor in an external probe allows measuring to 4kV.

The input resistance of the meter consists of the resistance of the meter coil (20k) plus any series resistors in the chain. On the lowest, most sensitive range, this consists of 20k plus the 140k, a resistance of 160k for an input of 1.6V.

To allow larger voltages to be measured, we introduce another resistor into the chain; the 8V range adds a 640k to the 160k for a total of 800k.

You can see that the internal resistance is 100k ohms for every volt on the range switch: 800k for 8V, 4M for 40V, etc. This is what the manufacturer means by a sensitivity rating of '100,000 ohms/volt'. The ohms-per-volt does not refer to the input voltage, but to the voltage on the range switch.

For measuring AC, the meter is now in a rectifier bridge configuration. The added two-diode bridge and its calibration resistors reduces the basic sensitivity to 5k ohms/volt. Basically, the meter circuit is the same as for DC. The input resistance of the unit is found by multiplying 5,000 times the number of volts that will give FSD: 40,000k for 8V, 4M for 800V, etc.

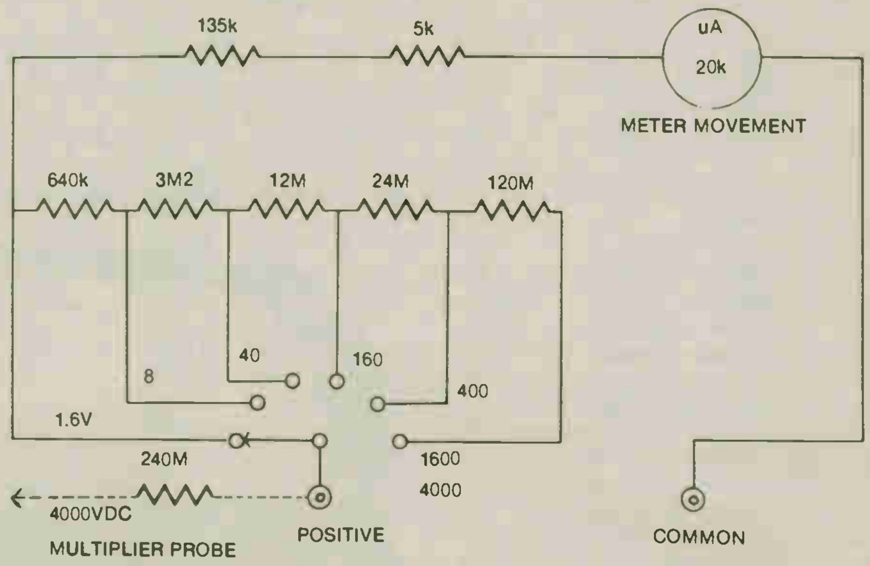


Fig. 1. A simplified DC voltmeter circuit.

Loading

Since the VOM is a *passive* device (its movement is powered by the circuit under test), we have to take into account the current that it draws, and whether or not this will cause erroneous readings.

An important fact becomes obvious: the unusually high resistance presented by a VOM on its higher ranges means the loading effect will probably be negligible. On the 40VDC range, for instance, the Model 269 has an input resistance of 4M, and 16M on the 160V range. This latter figure is as high as the best of VTVMs, which usually have a 10M input resistance. The disadvantage is that we lose sensitivity as we increase the input resistance. Still, many measurements can be made on the 40V scale, which has an acceptably high resistance of 4M.

A good rule of thumb for general testing is that the load should be at least ten times higher than the source. The 4M figure means that we can measure circuits up to 400k in resistance without causing unacceptable errors. Of course, if you want lab-quality accuracy, the load will have to be 100 times the source or even more.

Isolation

Another advantage to the VOM over the line-powered VTVM is the absence of grounding problems. If both the test circuit and the meter have their common leads connected to ground, it's possible to create a short circuit: you can blow fuses if the test circuit is powered up, or you can have resistors read zero ohms if the ground circuit gets in the way. The self-contained VOM skirts this problem.

The natural isolation of the VOM also means that the ungrounded common lead isn't likely to short out any delicate transistor stages, blowing out components and causing additional trouble.

Ohms

To implement an ohms range, a battery is inserted in series with the meter. When the test probes are placed across a resistor, current flows and deflects the meter; the internal resistors and the meter scale are calibrated to read out the value of the unknown resistor.

In checking transistors, the ohmmeter of your VOM is indispensable, for it readily indicates shorts, opens and even polarity in doubtful areas. This may sound archaic, but according to one of the largest manufacturers of solid state equipment, this is exactly how they troubleshoot on their assembly lines.

By placing the appropriate test probe of your ohmmeter onto the matching polarity of a transistor under test and reading the resistance, you can easily tell which is the P and which is the N of a base, besides testing for obvious opens or shorts. With an NPN, the positive terminal of your VOM connected to the base gives a

Continued from page 40

Disturbance Recorder

No, this doesn't keep track of barking dogs or screaming children, but it does keep watch over your precious power supply lines.

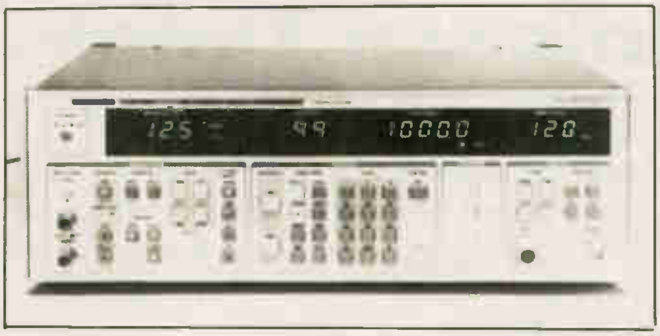
The AP-904 from Kuwano Electrical Instruments is a diagnostic tool which monitors and records various disturbances on AC and DC power lines by measuring each item per 10 millisecond or half wave cycle interval.

In addition, the unit incorporates an 8-channel event recorder capable of measuring a pulse width of 1 microsecond to 1000 microseconds. In the event that a change in input voltage is detected, the AP-904 prints out the channel number and status of event, together with the time of occurrence.

Mr. Henry Taub, RCC Electronics Ltd., 310 Judson St, Unit 6, Toronto, Ontario M8Z 5T6. (416) 252-5094.

Circle No. 50 on Reader Service Card

AM Stereo Signal Generator



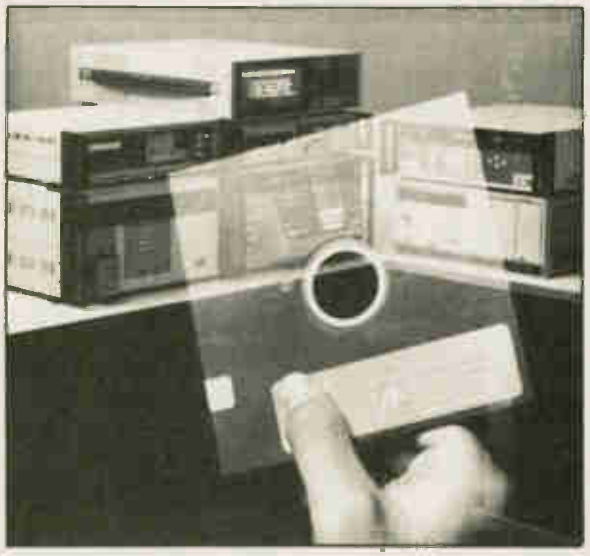
The LSG 245 AM Stereo Signal Generator from Leader Instruments provides a wide variety of modulation and output conditions, and is an ideal source for sensitivity, separation, selectivity, distortion and other tests on Motorola C-QUAM-type AM Stereo systems.

All parameters are entered by front panel pushbuttons and are verified by LED displays. In addition, up to 100 sets of user defined test conditions can be stored and recalled enabling measurements to be made rapidly and without error. For those who have fully automated production facilities, QA and service environments, a rear panel connector allows remote control of all front panel functions (except on/off). An optional GPIB interface is also available.

Omnitronix Ltd., 2410 Dunwin Dr., Unit 4, Mississauga, Ontario L5L 1J9. (416) 828-6221.

Circle No. 52 on Reader Service Card

Automated Calibration Software



The versatile 7411A 'Calibration-at-a-Keystroke' software package from Fluke permits a modular approach to automating calibration and management functions of major electronic instrumentation equipment.

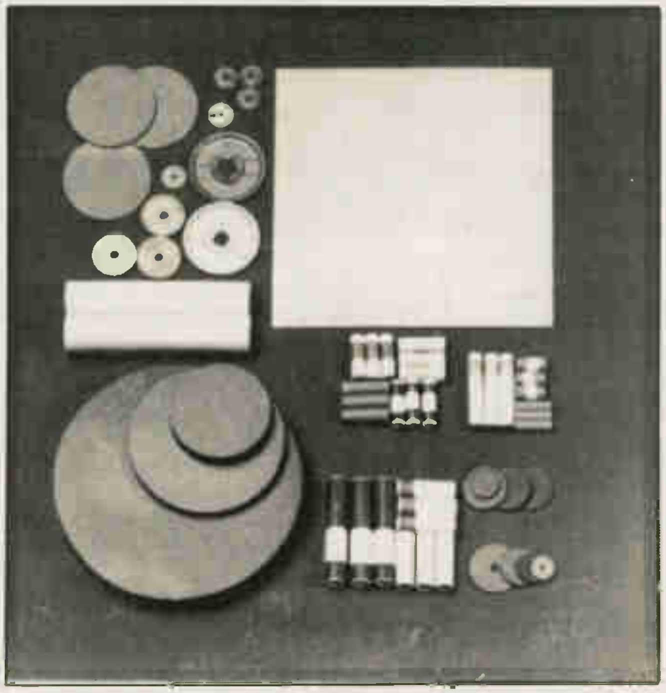
It can be used with a wide variety of calibration instruments, such as the Fluke 1722A instrument controller, in several system configurations. The complete calibration procedure can be automatically controlled using IEEE-488 based meters and scopes.

The 7411A software automates data management and report requirements, saving time and eliminating errors. It also reduces cost per calibration and increases throughput to improve productivity. A Calibration History Management feature manages your data base and generates reports, such as instrument recalls, in addition to listing procedures and test results. The 7411A package is available in Canada for under $2000.

For more information contact: Mrs. Rose Monk; Allan Crawford Associates Ltd., Test and Measurement Division, 5835 Coopers Ave., Mississauga, Ontario L4Z 1Y2. (416) 890-2010

Circle No. 51 on Reader Service Card

Technical Ceramic Dialectrics



A source for technical ceramic dialectrics is Tusonix Inc., manufacturers of fixed, variable ceramic capacitors, and EMI filters.

The dialectrics are available in a variety of shapes, sizes, and formulations, including extruded, pressed, and cast. Ceramic formulations developed over a 50 year period are available in more than 100,000 variations in capacitance values up to 1 mFd, and up to 40 kV voltage ratings.

Tusonix Inc., P.O. Box 37144, Tucson, AZ 85740-7144. (602) 744-0400

Circle No. 56 on Reader Service Card

Interval Timer

An inexpensive timer with many useful applications featuring intervals from 30 seconds to 15 minutes.

By C.J. Bowes

THERE ARE NUMEROUS occasions when it's useful to have some sort of timer which emits a signal at regular intervals. The circuit described here has been designed to fulfil this function in a versatile way, by providing a range of switched time intervals between 30 seconds and 15 minutes. The duration of the output tone can be varied so that a range of signals between a short burst and long tone can be obtained.

Circuit Description

The circuit diagram of the unit is shown in **Fig. 1**. The heart of the circuit is a 555 timer (IC1) which is connected as an astable multivibrator.

In this configuration the output of the IC swings from V+ to ground for a period T2 after a time interval T1, as shown in **Fig. 2**. The duration of both T1 and T2 are determined by the values of the resistors RA and RB (**Fig. 3**).

T1 is calculated using the formula:

$$T1 = 0.7 \times (RA + RB) \times C$$

(Where T = time in seconds, RA, RB = values in ohms, and C = value of the capacitor in Farads). T2 is obtained in a similar manner from the formula:

$$T2 = 0.7 \times RB \times C$$

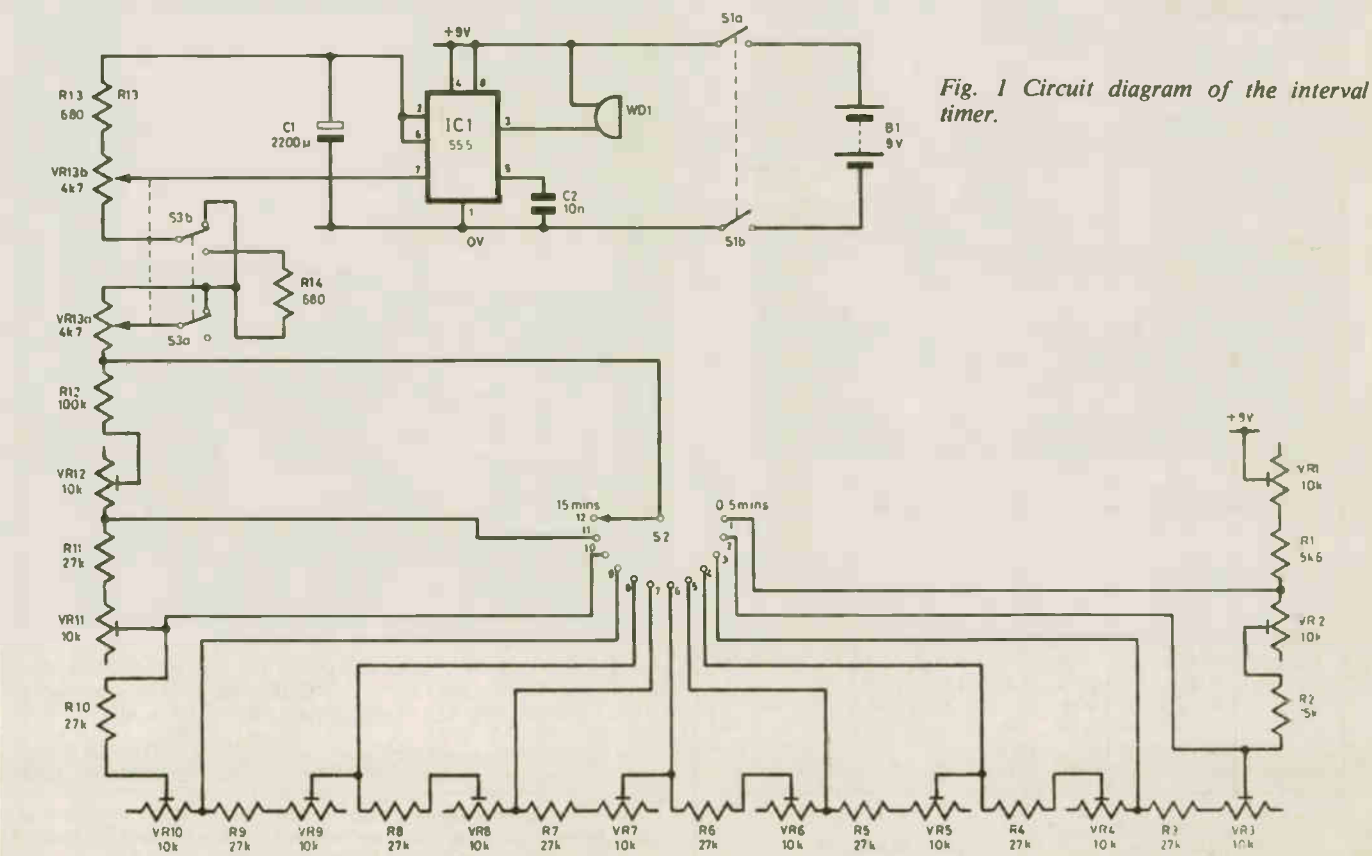


Fig. 1 Circuit diagram of the interval timer.

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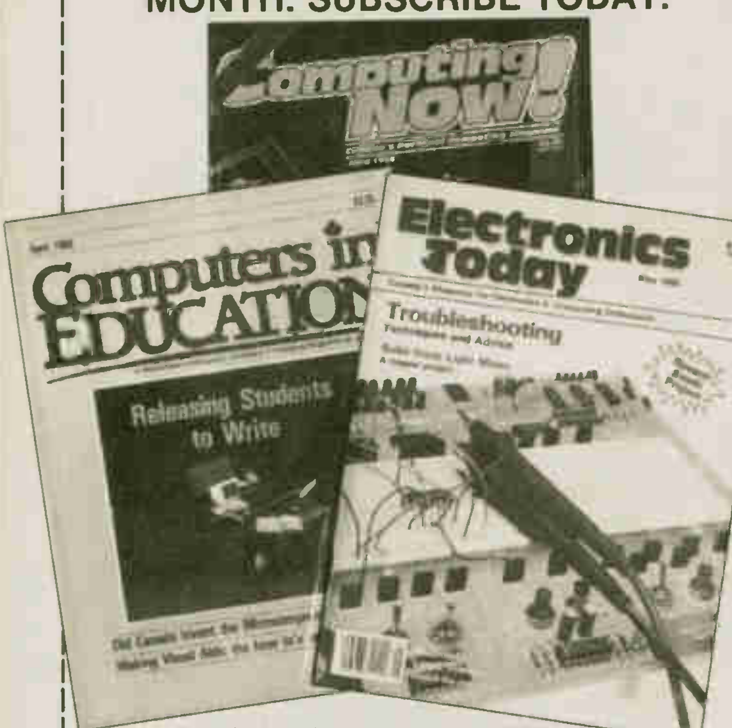

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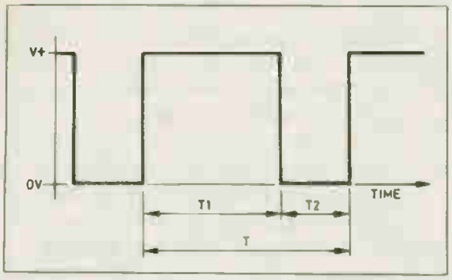

Fig. 2 Timing diagram for the circuit.

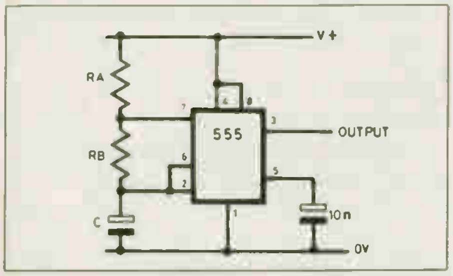

Fig. 3 The basis of the Timer circuit.

By splitting the value of RA into several smaller values it is possible to produce a circuit in which a single switch can be used to select a series of different values for T1. This has been exploited in this circuit, so that RA is in fact made up of a series of fixed and variable resistors (VR1-VR12 and R1-R12) which are wired as a chain.

The proportion of the chain used as RA is selected by the position of the wiper of the time selector switch, S2. This determines T1, which is the interval between the output tones. The length of the tone corresponds to T2 and is calculated from the second formula given above. This is set by the total resistance of VR13 and R13. R13 is chosen to give a minimum tone duration of about one second.

If the two timing formulae are combined we see that the total time for the sequence (T in Fig. 2) is found from the formula:

$$T = 0.7 \times (RA + (2 \times RB)) \times C$$

RB is the value which is adjusted to increase or decrease the duration of the tone. It is therefore necessary to alter the value of RA by twice the alteration in the value of RB if adjustment of the duration of tone burst is not to alter the duration between tones.

This is achieved by making VR13 a dual gang 'stereo' potentiometer, connected so that its wiper forms the junction of RA and RB and is connected to pin 7 of IC1.

The second half of the stereo control is connected in series with the resistor string (RA) to double the changes in value of RB. Switch S3 is included so that the duration of the tone can be either included in or excluded from the time between tone bursts.

In the inclusive position the interval set by S2 runs from the start of one burst of tone until the beginning of the next. In the exclusive position the interval selected by S2 runs from the end of one burst until the start of the next. The longer time period is achieved by placing the whole 5k of VR13a and R14 in series with the resistor chain.

Construction

Construction of the unit is reasonably straightforward as the great majority of the components are mounted on the PCB as shown in **Fig. 4**. The remainder of the components are mounted on the removable lid of the case, with the exception of the buzzer. The one used in the prototype is rather large in comparison with the depth of the case, so it is mounted inside the box and protrudes through the lid **(Fig. 5)**.

The PCB pattern shown in **Fig. 4** should be transferred to a suitable board, etched and drilled in the normal way. The components should then be inserted in the appropriate positions and soldered, starting with the smallest components. After the soldering has been completed, trim off any excess wire.

Switch Wiring

The wires required for making connections between the PCB and the other components can be soldered into place. It is advisable to use ribbon cable for the connections between S2 and the PCB. The board should then be thoroughly inspected for solder bridges between tracks.

Once the PCB has been completed and checked it should be inserted into the case and a suitable position found for the piezo element you selected. This component is mounted in the case and may protrude through the lid if necessary.

When a suitable position has been found, the position of the component should be marked on the case lid and an appropritely sized hole cut out, preferably with a hole-cutter. The postions of the remaining components can be marked on the case lid and suitable holes cut or drilled.

Rub-on lettering should be applied to the exterior of the case. The only component requiring careful positioning of the lettering is S2, which is the interval time selector switch. A convenient method to locate the lettering for S2 is to mount the switch temporarily in its correct position and rotate the spindle to its farthest anticlockwise position.

The knob is then fitted with its pointer in the appropriate position. A fine pencil spot should be marked on the case directly below the pointer. This marks the location of the first legend.

The switch is then rotated to its next position and the process repeated until all twelve positions have been marked. A small rub-on spot can then be applied to cover the pencil spot and the appropriate

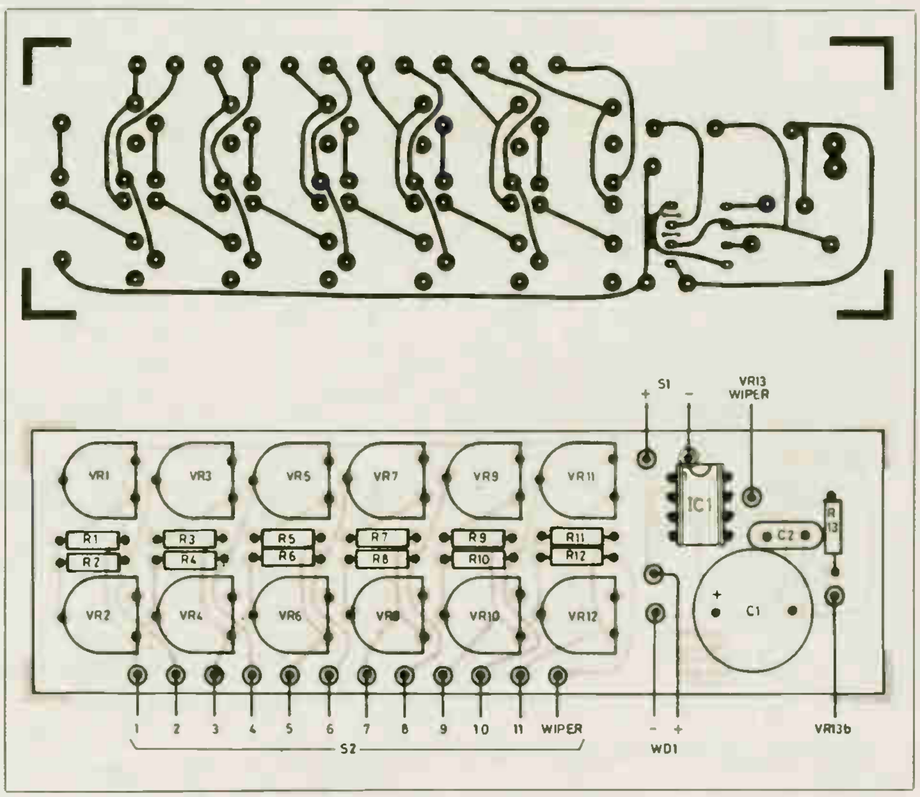

Fig. 4 The PCB (top), and the parts overlay, shown actual size.

lettering applied to complete the legend. With the components specified, the intervals will be as shown in Table 1:

Table 1: Timing intervals.

Switch Position	Interval
1	30 sec
2	1 min
3	2 min
4	3 min
5	4 min
6	5 min
7	6 min
8	7 min
9	8 min
10	9 min
11	10 min
12	15 min

Once applied, the lettering should be protected by several layers of spray-on clear lacquer.

When the case is dry, the components can be mounted onto the lid, cutting down the spindles of the rotary components as required. Both S1 and VR1 should be rotated to their fully anticlockwise position so that the knobs can be placed in position and correctly lined up before tightening the securing screws.

The wiring between the panel-mounted components and the PCB should be completed, as should the connection between the battery connector and S1. All solder joints should then be thoroughly inspected before connecting the battery and testing the circuit.

Testing and Calibration

To test the unit the controls should be set as follows:

S1 On
S2 Position 1 (Fully Anti-clock.)
S3 Inclusive
VR1 Minimum (Fully Anti-clock.)

After a short stabilizing period, the circuit should start emitting a short tone burst at about 30 second intervals. The intervals between the output tones should be indentical but will not necessarily be accurate since the system will not have been calibrated.

VR13 should then be rotated to check that the duration of the tone is increased but that the interval between the start of one tone and the start of the next remains the same, irrespective of the setting of VR13. When S3 is placed in the exclusive position the interval between the end of one tone and the start of the next should remain constant irrespective of the setting of VR13.

Calibration of the unit is, unfortunately, a little tedious but, if done carefully and methodically, worth the effort involved. The unit should be switched on with S2 at position 1, S3 at the inclusive setting and VR13 set to give minimum tone duration. A stop-watch should be used to time the interval from the end of one tone to the end of the next. VR1 is then adjusted until this interval is correct.

Once the first time interval is correctly set, S2 can be rotated to the next position and VR2 adjusted until the correct interval is obtained. This process is repeated until all the presets have been correctly adjusted. If the correct time interval cannot be obtained by adjusting the appropriate preset, then the associated fixed-value resistor should be substituted by one with a different value.

To increase the time period, the value of the fixed resistor should be increased, and to decrease the time period the value should be decreased. Once the unit has been calibrated, the buzzer can be mounted in position, the PCB placed in the correct location and the lid attached. Care should be taken to ensure that the preset potentiometers are not disturbed during this process.

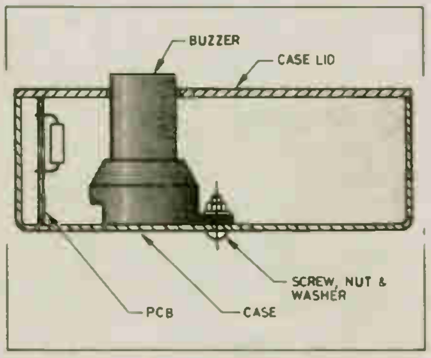

Fig. 5 Buzzer and PCB mounting details.

In Use

Operation of the unit is simple and straightforward but it must be remembered that there will be a longer delay than that selected between switching on the unit and the production of the first tone.

This is caused by the need for the circuit to settle down and can be overcome by switching to the lowest time interval and waiting for the first tone to be produced before commencing to use the timer as part of an activity. ■

Parts List

Resistors

R1 ... 5k6
R2 ... 15k
R3 to R11 ... 27k
R12 ... 100k
R13, R14 ... 680R
All 1/4W 5%

Potentiometers

VR1 to VR12 ... 10k skeleton preset, horiz. mnt
VR13 ... Dual ganged 4k7 linear rotary

Capacitors

C1 ... 2200u, 16V electro. radial
C2 ... 10n ceramic disc

Semiconductors

IC1 ... 555 Timer

Miscellaneous

B1 ... 9V battery
S1 ... DPST min. rocker
S2 . single-pole, 12-way rotary wafer switch
S3 ... DPDT min. rocker
WD1 . Piezoelectric transducer, single tone.

case, 115mm x 95mm x 37mm internal dimensions.

■

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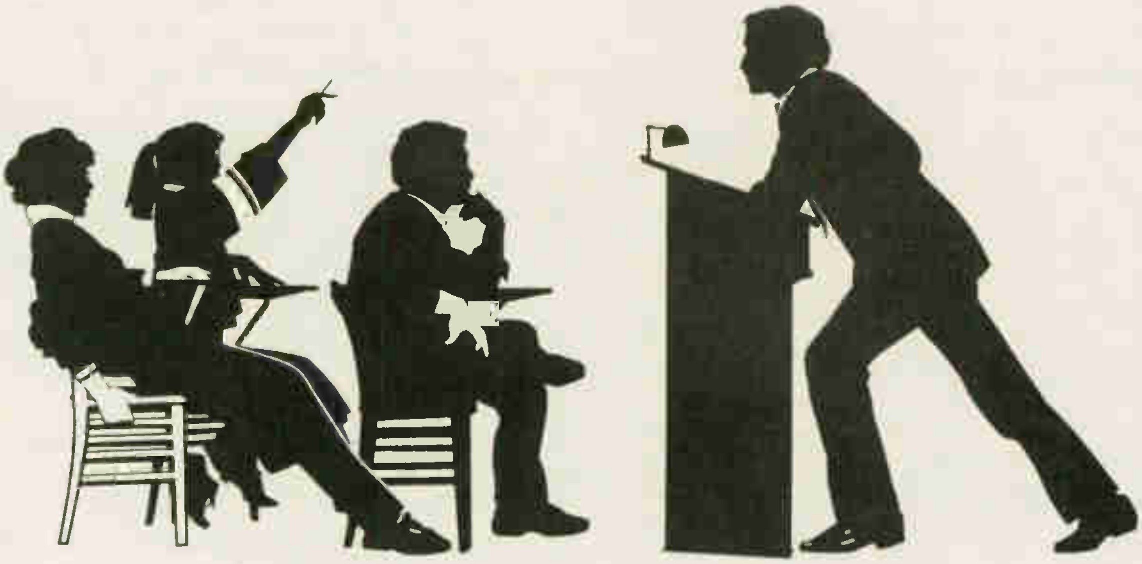


An introduction to the hardware involved in processing basic digital logic.

By Michael Tooley and David Whitfield

DIGITAL signals are very different from their analog counterparts. A digital signal does not change its signal slowly, nor does it vary freely over a range of levels. When the voltage level of a digital signal is not rapidly changing, it remains steady at one of only two possible levels or states. Any transition between these states occurs very rapidly (typically a fraction of a microsecond).

The two possible states for digital signals are commonly referred to as low/high, off/on, false/true or 0/1. Conventionally, these binary states are defined so that high/on/true/1 refers to a higher (more positive) voltage level while low/off/false/0 refers to a a lower voltage level. This is known as *positive logic*. In *negative logic* the two states are simply reversed. To keep things as simple as possible, we will just refer to 0 and 1 to describe the binary logic states. Further, all our circuits will be positive logic.

The majority of circuits are designed so that 0 is represented by a voltage level near zero and 1 is represented by a voltage near the power supply level. In **Fig. 3**, the output remains near zero until the input circuit voltage exceeds a certain threshold voltage, at which point the output rapidly changes state from 0 to 1. This characteristic is in marked contrast with that associated with a conventional linear device shown in **Fig. 4**.

Digital Advantages

Digital circuits offer a number of important advantages over their analog counterparts. In an analog system changes in component values due to the effects of ageing and temperature can have a marked effect on circuit performance and considerable care must be taken to ensure that such changes are compensated for. Applications requiring high precision are particularly troublesome in this respect. Digital systems, on the other hand, use straightforward switching techniques and are very much less susceptible to individual component changes.

Another significant advantage of digital circuits is their inherent immunity to noise and interfering signals. With analog circuitry this is a particular nuisance when signals are very small and are thus easily contaminated by noise. Digital signals, however, have a very large amplitude and thus ca be made relatively impervious to noise. The voltage levels used to denote the 0 and 1 states are separated by a 'forbidden region' in which no valid signal can exist.

Logic Families

As part of the development of digital integrated circuits, a number of standard logic families have emerged. The importance of the concept of standard logic families cannot be over-stated. The basic

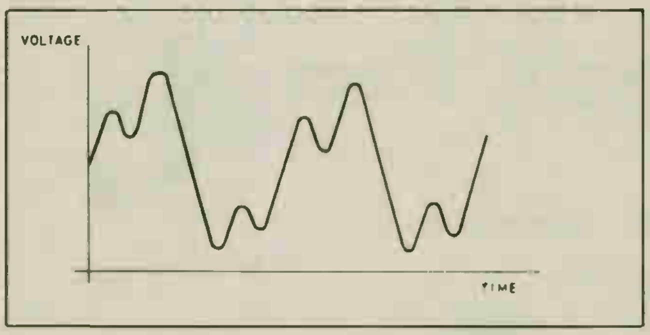


Fig. 1. Representative analog signal waveform.

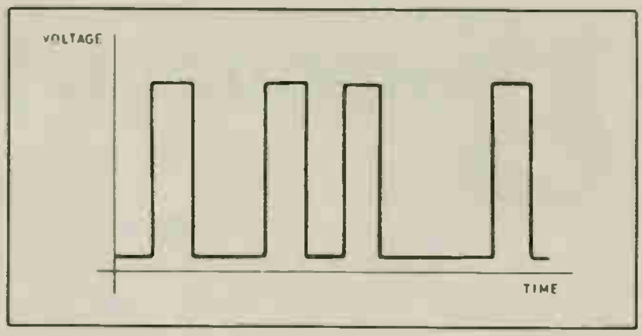


Fig. 2. Representative digital signal waveform.

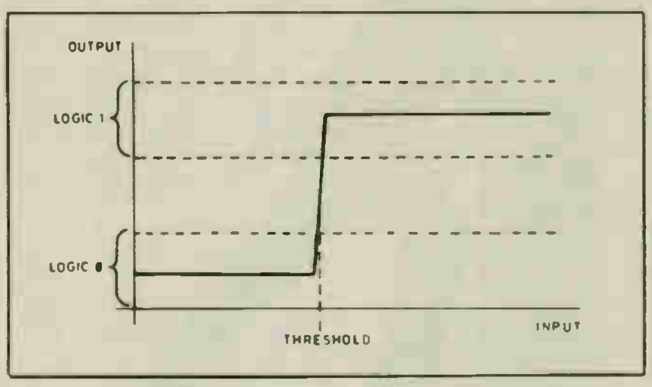


Fig. 3 Transfer characteristic for a typical logic device.

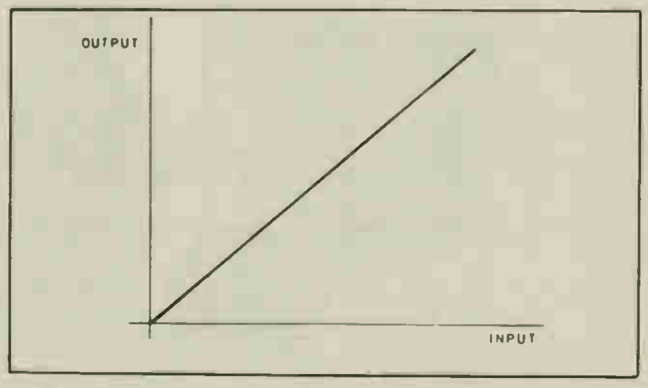


Fig. 4. Transfer characteristic for a conventional linear device.

gate in each range gives the name to the complete family of devices and determines the operational characteristics of the complete family. In this way, the designer is freed from the problem of checking that the logic levels between gates are compatible; the logic levels, power supply requirements, and general rules for dealing with such points as unused inputs are common to all devices in a particular logic family. This then allows the designer to concentrate on the functional design of his circuit and, once the basic rules are understood, greatly simplifies his overall task.

Over the years a number of different logic families have become available, but in the light of developments in technology many have become obsolete and have virtually dropped out of use. The main logic families to have emerged are listed below:

Diode transistor logic (DTL)
Transistor resistor logic (TRL)
Resistor transistor logic (RTL)
Direct coupled transistor logic (DCTL)
Transistor transistor logic (TTL)
Emitter Coupled logic (ECL)
Complementary metal oxide semiconductor logic (CMOS)
N-channel metal oxide semiconductor (NMOS)
P-channel metal oxide semiconductor (PMOS)

Each of the logic families listed has its own special characteristics which may make it appropriate for particular applications. ECL, for instance, is extremely fast but consumes considerable power. In current practice, the two most commonly used logic families are TTL and CMOS.

At this point it is worthwhile stressing that the theory of digital logic is the same for all logic families. The difference between the various families is confined to the practical aspects of implementing circuits: power supply voltages, logic levels, power consumption, etc. A clear understanding of the theory of logic circuits is an essential prerequisite to the successful design of real digital circuitry, regardless of the logic family employed.

The 7400 Family

Of all the families to emerge, TTL has earned by far the greatest popularity among designers of general purpose digital circuitry. The family is very commonly available at reasonable cost and in a variety of sub-families which offer significant advantages over the original standard family.

The internal circuit of a basic TTL gate is shown in **Fig. 5**. Readers should note the distinctive multi-emitter transistor which is associated with the input stage of TTL gates.

Standard TTL devices require a single-rail power supply which provides a well regulated voltage of plus 5V. A typical TTL power supply using a monolithic three-terminal regulator is shown in **Fig. 6**.

The commonest TTL family is known as the 7400 series. Each IC in the series has a four or five digit number starting with 74. Examples are 7407, 74107, and 74207. These three devices are quite different from each other; the 7407 is an 'open collector hex buffer', the 74107 is a 'dual J-K bistable', and the 74207 is a '1k-bit RAM'.

Manufacturers add various prefix and suffix letters to indicate the origin and packaging of devices. The SN7407N, for example, is a 7407 gate manufactured by Texas Instruments and packaged in a 14-pin dual-inline-package (DIP). Readers should note that ICs of the same number will always have the same function regardless of the suffix or prefix.

The basic voltage characteristic for a TTL gate is shown in **Fig. 7**. As can be seen, there is a range of input voltages for which the output will be indeterminate. This simply means that any output produced by an input in this region cannot be predicted in terms of logic levels (0 or 1). Although possibly surprising, this is quite common in digital circuits and does not contradict the theory. A logic 0 is defined as a level of less than 0.8V while a logic 1

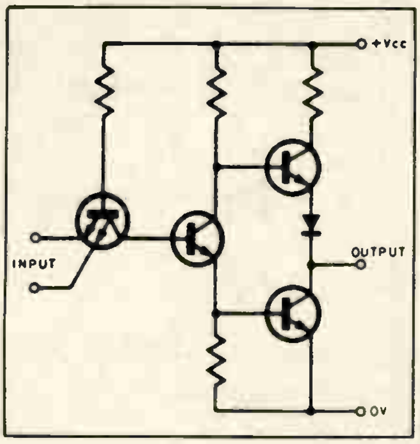


Fig. 5. Internal circuitry of a basic TIL gate.

is defined as a level greater than 2.4V (i..e., between 2.4V and the 5V power supply rail).

standardizing the signals, in terms of logic levels, which are presented to or derived from logic circuits.

When drawing logic circuits, the symbol used to prevent a buffer is shown in **Fig. 8**. In logic diagrams it is normal to show the input on the left hand side and the output on the right. Thus, in most logic circuits the progress of a signal is left to right across the page. It is worth illustrating two of the rules which must be obeyed when connecting logic elements together (see **Fig. 9**). Whereas a single output can drive a number of inputs, a single input cannot be connected to more than one output. To put this more simply, circuits cannot be expected to behave properly if several outputs are directly linked together.

The 7407 is a typical example of a TTL buffer. This device actually comprises six separate inverters contained within the same 14-pin DIP package. The pin connections for the 7407 hex buffer are

output. This circle indicates inversion; the gate complements the input signal. Inverters share the same electrical properties as buffers with regard to current drain and thus can also be used in similar applications. If two inverters are connected together as shown in **Fig. 13**, called series, tandem or cascade connecting, the result will be the same thing as a non-inverting buffer.

The 7404 is a typical example of a TTL inverting buffer. This device is actually six buffers in one package.

Truth Tables

The logical function of any given gate arrangement can be accurately defined using a 'truth table'. Such a table consists simply of lines representing all possible input states together with a column representing the logical state of the output. **Fig. 15** and **Fig. 16** show the truth tables for a buffer and an inverter. For both of these gates, there is only one input which can exist in

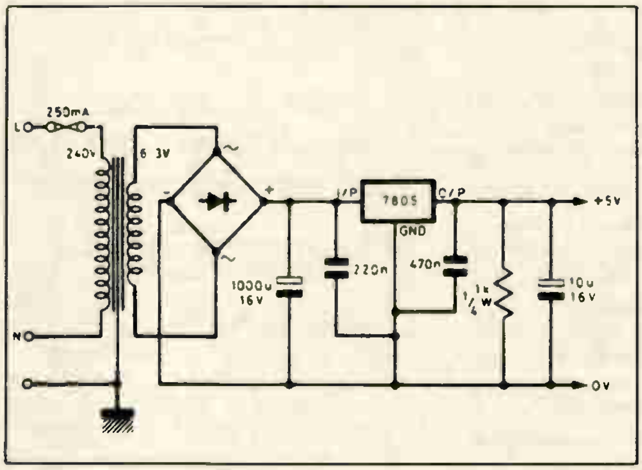


Fig. 6. A typical TTL power supply.

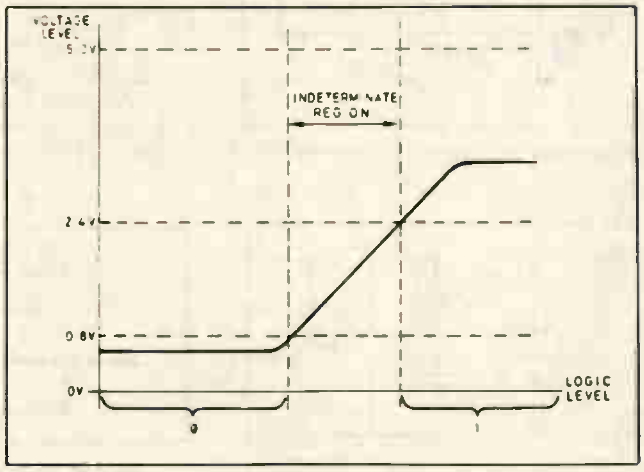


Fig. 7. Voltage characteristic for a TTL gate.

Buffers

The simplest of all active devices is the buffer. This device has only one input and one output, and its logical output is the same as its logical input. Readers can be excused for wondering what the purpose of such an apparently redundant device might be.

Buffers are in fact quite useful and there are a number of situations in which they can be invaluable. The point to note is that although the input and output voltages of the buffer might be identical, the currents present can be very different. The output current can be greater than the input ('current gain'). In this way, buffers can be used to interface logic circuits to circuitry that requires so much current that the normal logic levels cannot be maintained by standard logic devices. Another less obvious application of buffers is concerned with regularizing and

shown in **Fig. 10**. For a 14-pin DIP, the conventional supply connections are ground (0V) on pin 7 and 5V on pin 14.

Inverters

An inverter, or inverting buffer, has only one input and output. Inverters are used to generate the logical opposite or 'complement' of a logic signal. The inverse of a 0 is 1 and vice versa.

The action of an inverter can be illustrated used the simple relay circuit shown in **Fig. 11**. When the logic input is at a 0 level, no current flows in the relay coil and the contacts remain in the state shown, producing an output of 1. When the logical input is 1, the relay contacts change over and the output becomes 0.

The symbol for an inverter is shown in **Fig. 12**. Note that it is almost identical to that shown earlier for a buffer with the addition of a small circle shown on the

one of two possible states. Thus the truth table consists of simply two columns: input (X) and output (Y).

Fan-in and Fan-out

As mentioned earlier, the output of a TTL gate may be connected to the inputs of several other logic gates. The drive

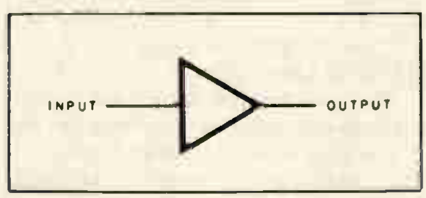


Fig. 8. Symbol for a buffer.

capability of a gate is known as its fan-out, and is usually expressed as the number of standard input loads which can be driven by the gate. For most TTL gates

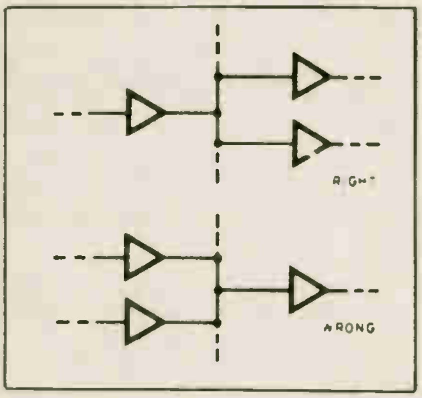


Fig. 9. Rules for connecting logic circuits.

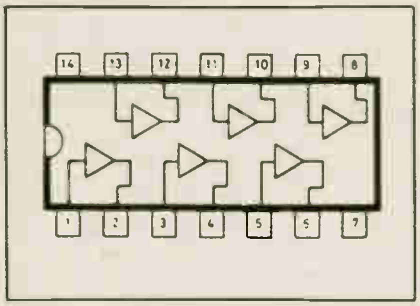


Fig. 10. Pin connector for a 7407 'hex' buffer.

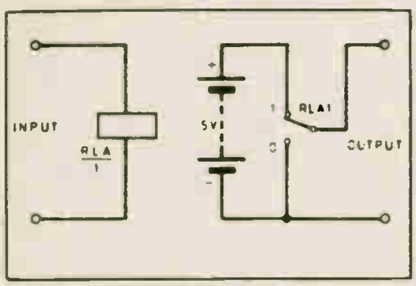


Fig. 11. Relay analogy for an inverter.

the fan-out is ten; one output can drive up to ten inputs.

The fan-in of a gate indicates its loading effect on a gate output, and is normally expressed as the number of standard inputs (loads) that it represents. The fan-in for most logic gates is therefore simply one for each available input.

TTL I/O Currents

The limits on fan-out are caused by the currents which must flow to hold the input of a gate at logic 0 and at logic 1. In TTL, the logic 0 currents usually predominate in determining fan-out. A standard gate input requires 1.6mA to flow between the input and common (0V). Thus, to support a fan-out of 10, the gate must be capable of 'sinking' a total current of 16mA. In the logic 1 state, the current flow is in the opposite direction and is considerably smaller. Standard TTL outputs are typically able to source 400uA while each input typically requires 40uA in the logic 1 state.

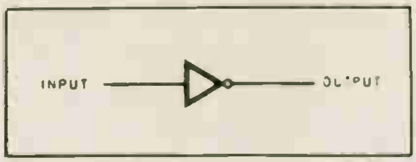


Fig. 12. Symbol for an inverter.

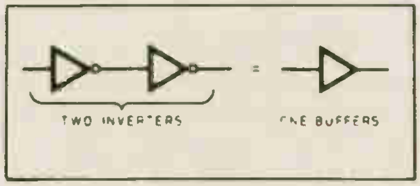


Fig. 13. Inverters connected in tandem.

Driving LEDs

Light-emitting-diodes (LEDs) are commonly used as indicators in digital circuits. A typical LED requires about 10mA in order to provide a reasonably bright display. There are several methods of driving an LED directly from a TTL inverter or buffer. The actual method chosen depends on whether the diode is to be illuminated for a gate output of 0 or 1 and whether the gate is required to drive any other logic gates in addition to the diode. The various techniques are shown in **Fig. 17** together with the logic input/output states required to illuminate the LED and the fan-out remaining to drive other gates.

INPUT X	OUTPUT Y
0	0
1	1

Fig. 14. Truth table for a buffer.

INPUT X	OUTPUT Y
0	1
1	0

Fig. 15. Truth table for an inverter.

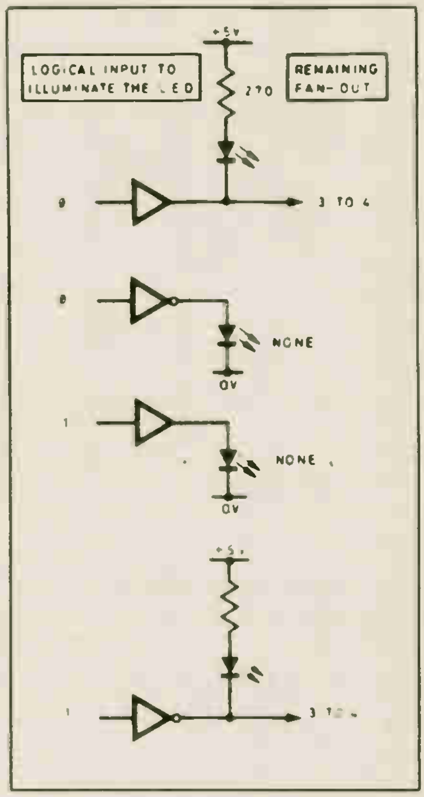


Fig. 16. Techniques for driving an LED.

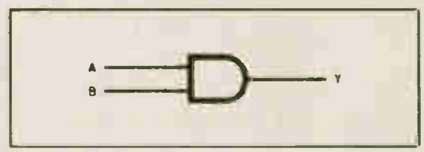


Fig. 17. Symbol for a two-input AND.

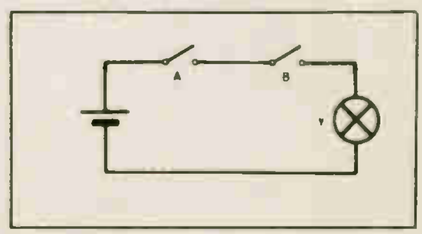


Fig. 18. Switch equivalent for a two-input AND gate.

A	B	Y
0	0	0
0	1	0
1	0	0
1	1	1

Fig. 19. Truth table for a two-input AND gate.

Two-Input AND

The symbol for a two-input AND gate is shown in **Fig. 18**. In order to obtain a logic 1 output from this gate both inputs must be at a logic 1. Any other input combination will produce a logic 0 output. The operation of the gate can best be understood by drawing a simple 'switch equivalent' circuit like that shown in **Fig. 19**. In this circuit, a closed switch represents a logic 1 while an open switch represents a logic 0. In order for the lamp Y to light, both switch A and switch B must be closed. Thus a logic 1 is only obtained when both inputs are at a logic 1.

The truth table for a two-input AND gate is shown in **Fig. 20**. Note that, since there are two inputs and each input can exist in one of two possible states, there are four possible input combinations. To keep things neat we have arranged these in ascending order following a binary counting sequence where A is considered to be the most significant binary digit (bit).

The 7408 is a typical example of a two-input TTL AND gate. The device comprises four gates (a 'quad' gate) housed in the same DIP package.

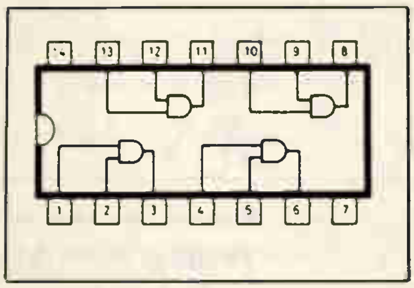


Fig. 20. Pin connections for a 7408 'quad' two-input AND gate.

Two-input OR

The symbol for a two-input OR gate is shown in **22**. In order to obtain a logic I output from this gate, any one, or more, of its inputs must be at a logic 1. Putting

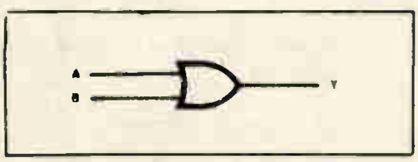


Fig. 21. Symbol for a two-input OR gate.

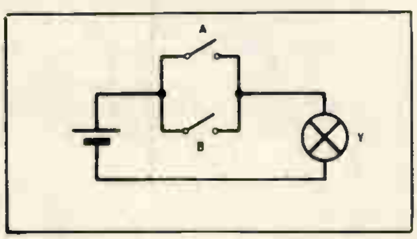


Fig. 22. Switch equivalent for a two input OR gate.

A	B	Y
0	0	0
0	1	1
1	0	1
1	1	1

Fig. 23. Truth table for a two-input OR gate.

this another way, a logic 0 will only be obtained if both inputs are at logic 0. The 'switch equivalent' of the two-input oR gate is shown in **Fig. 23**. The lamp will light when either switch A or switch B (or both) are closed. The truth table is shown in **Fig. 24**. Again, since there are two inputs, there are four possible input connections.

Two-input NAND

The symbol for a two-input NAND is shown in **Fig. 26**. The output of this device is a logical complement to that produced by the two-input AND gate. The

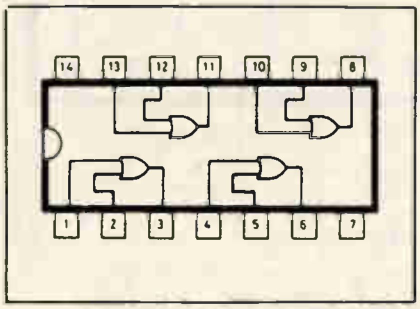


Fig. 24. Pin connections for a 7432 'quad' two-input OR gate.

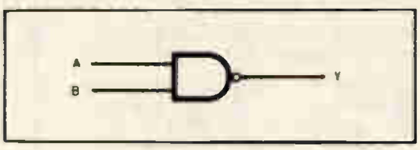


Fig. 25. Symbol for a twopinput NAND gate.

A	B	Y
0	0	1
0	1	1
1	0	1
1	1	0

Fig. 26. Truth table for a two-input NAND gate.

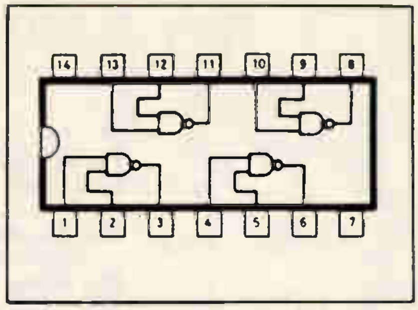


Fig. 27. Pin connectors for a 7400 'quad' two-input NAND gate.

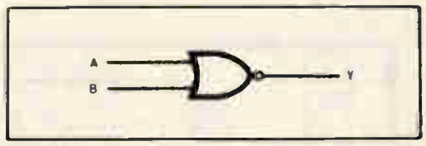


Fig. 28. Symbol for atwo-input NOR gate.

A	B	Y
0	0	1
0	1	0
1	0	0
1	1	0

Fig. 29. Truth table for a two-input NOR gate.

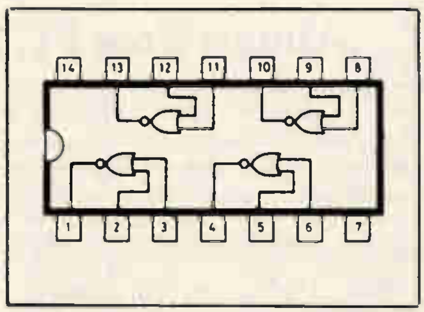


Fig. 30. Pin connections for a 7402 'quad' two-input NOR gate.

name stands for NOT-AND (and inverted AND). The truth table is shown in **Fig. 27**. Readers should compare this with that shown for the two-input AND.

Two-input NOR

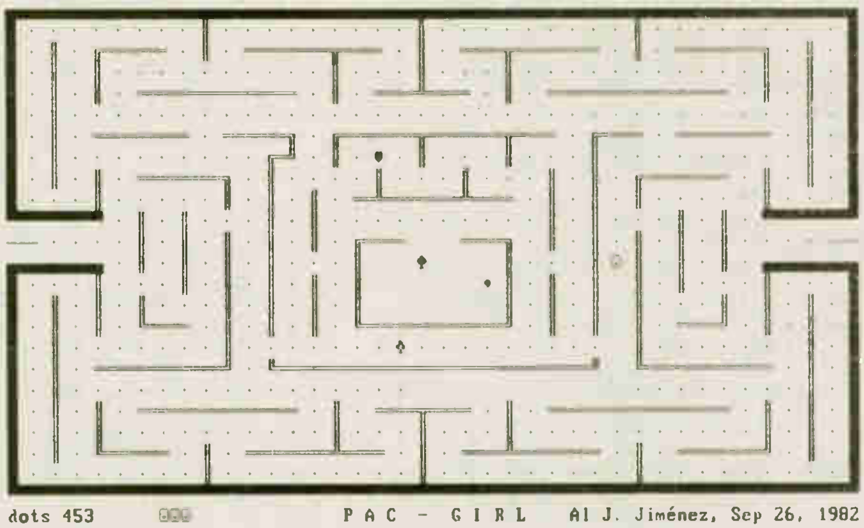
The symbol for a two-input NOR gate is shown in **Fig. 29**. The output is the complement of the two-input OR gate; the name stands for NOT-OR (an inverted OR). The truth table is shown in **Fig. 30**. ■

Three Almost Fr

for the IBM PC and

This month we really smoked the modem, listening to the wail of carriers long into the night to download the software for these three... count 'em... almost free software disks. There are two here for the IBM PC and one for the Apple Macintosh. All of them are crammed with the cream of the public domain. There are games, utilities, serious things... there was almost a computerized horoscope generator, but it got bumped by the helicopter game.

If you've encountered almost free software before, you may notice that there are fewer titles on these disks than there were on some of our earlier volumes. There is just as much software here... all the disks are within a few kilobytes



Almost Free PC Software Volume 11

Pac Girl is, predictably, a variation on the almost mythical Pacman game. This one moves like a greased cat on a skating rink, with all the speed and generally strange behaviour of the arcade version.

Menu allows one to set up a menu driver, tree structured operating environment that's a great deal friendlier and more manageable than is DOS. It's ideal for creating interactive systems for non-technical users.

Z80MU is one of the most brilliant bits of software we've ever encountered... free or not. It actually emulates a Z80 based computer running CP/M on the PC with no additional hardware... you don't even need a V20. It will run almost all CP/M software, including the old favourites like WordStar and dBase. However, it has features that CP/M never had... and even MS-DOS lacks.

SERIO is the assembler file from the July edition of Computing Now! that implements an interrupt driven terminal in higher level languages, such as C. It's also suitable for use with compiled BASIC. MASM is required to use this code.

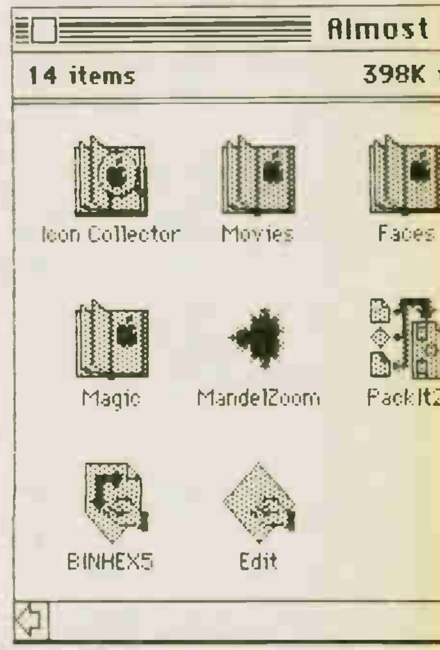
Breakdown is a very peculiar program... it takes meaningful text, analyses it and generates meaningless... but very profound sounding... prose from it. It's fabulous in offices for creating reports if you're wondering if anyone really bothers to read your stuff.

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

GRABIT is the screen grab program from the July Computing Now! It will make a useable text file from the contents of one's screen at the touch of a key. This code requires MASM.

Available for only

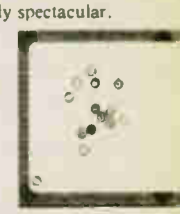
$19.95



Almost Free Macintos

Icon Collector is a peculiar little program that allows yo
and use them in other things. It's a surprising amount

Billiard Parlor is worth the cost of the disk all by itsel
play most of the usual variations of pool and billia
unspeakable realism. It's wholly spectacular.



MandelZoom is the nicest Macintosh fractal generator
thing considering the nature of the Mac's floating poi

Red Ryder. This is the latest version of this program... c
dant rumours of bugs. This one runs perfectly, imp
facilities, macros and enough toggles and menus to ke

PackIt2...not to be confused with regular PackIt...
downloaded from bulletin boards. It's pretty well esse

BINHEX5 is a file manipulation utility which allows M
Red Ryder.

Edit is the most sophisticated text editor available for t
to edit documents in multiple windows. It produces c
things.

Available

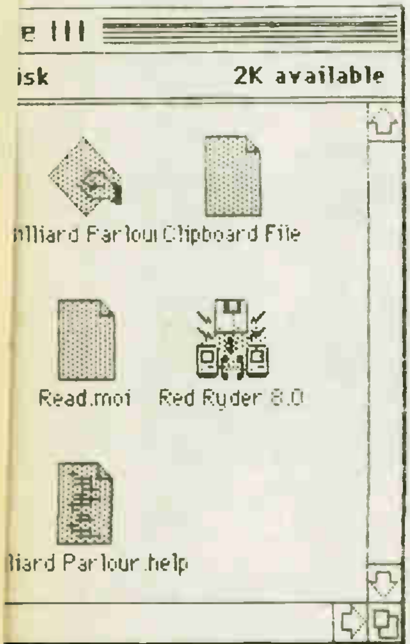
$23.

e Software Disks

:he Apple Macintosh

of being full. However, these applications are more sophisticated than some of the earlier programs, and, as such, are bigger.

We've had quite a few requests to put the source files from some of the programs we've run in Computing Now! on these disks and, as such, these volumes contain several C and assembler programs. In actual terms, these take up only a few K of code, but they'll save you a lot of typing if you want to play with them.



Software Volume IV

o locate icons in applications, swipe 'em, store 'em f fun considering how pointless it sounds.

It's a glorious simulation of a billiard table. It will), and simulates the movement of the balls with

e've come across. It's extremely fast... a remarkable library.

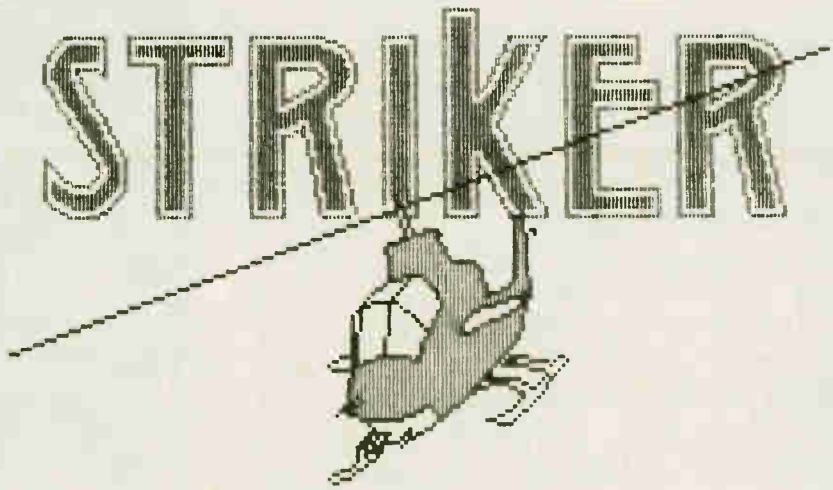
, at least, the latest one to be released without attenementing a sophisticated terminal with download p your modem in stitches for a month.

will compress and uncompress P2T libraries... as tial if you're into telecommunications.

: files to be sent over a modem... another adjunct to

: Mac. Operating similar to MacWrite, it allows one ar text files for use with a compiler, among other

for only
95



Almost Free PC Software Volume 12

CV is a small utility to change the volume names on disks. Most humans never think to specify this when creating disks and, thereafter, it's usually unalterable. This is about six hundred bytes of salvation.

Breakout Box is an assembly language program that hides in memory and shows you what your serial ports are doing. It's the most invaluable thing going to solve your serial printer or modem glitches.

Icon Maker allows you to generate sophisticated bit mapped images with relative painlessness. It's easy to use and extremely colourful, producing data that can be incorporated into other programs.

Shell is another DOS menu program. This one is very fast, free of snow, and offers one access to virtually all the DOS features that one might want.

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

Ramset is a RAM expansion program from the July edition of Computing Now!. It allows one to have memory beyond the six hundred and forty kilobyte limit of the PC and to get around the long memory check time associated with lots of RAM.

TRAP is the high resolution Gemini patch program from the May edition of Computing Now!. It makes the Gemini 10x suitable for use with Personal Composer, but is easily modified to fix most bit mapped printing problems. This code requires MASM.

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Moorshead Publications
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Fine print: All of this software was either written by ourselves or collected from public access bulletin boards, and is believed to be in the public domain. All of it has been tested and appears to be functional. However, we cannot assist you in modifying it to suit your individual applications.

We warrant that your disks will be readable. The post office, however, doesn't even warrant that they'll reach you without claw marks. If you are unable to read your disks, please contact us for a prompt free replacement.

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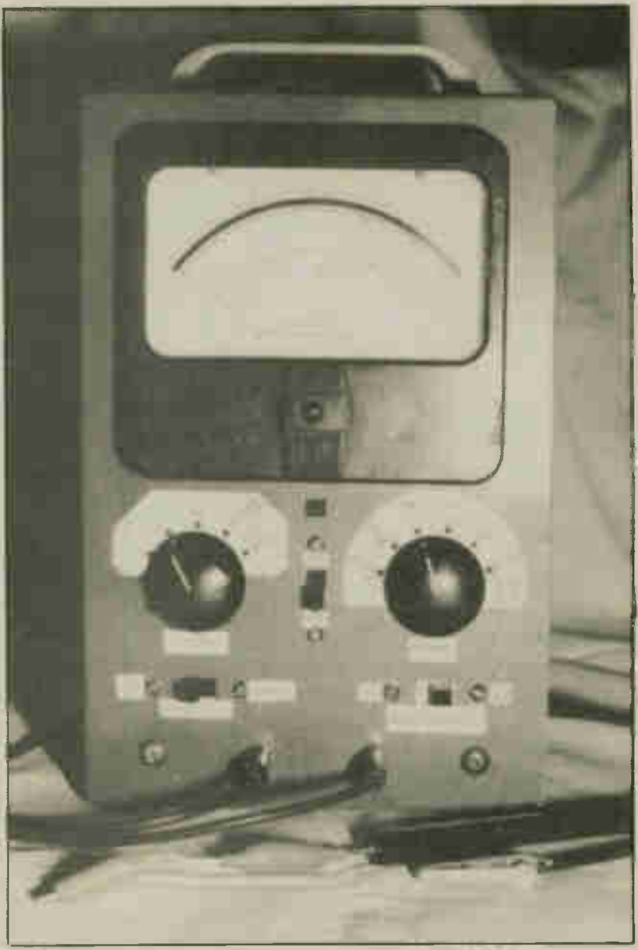

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Radio Shadows

Radio's shadow voices, practising an art dating back to WWII, but as contemporary as today's headlines.

By Gerry L. Dexter

THEY speak of violence. They demand change. They call for revolution. They are quite unlike anything you can hear on an ordinary AM or FM dial. They are radio's shadow voices from secret stations.

Wherever there is a sore spot or an open wound on the world globe, there is usually at least one clandestine radio station doing its best to add fuel to the flames. These secret voices take several forms, some of which are more secret than others. The classic clandestine broadcaster is one which is run by a rebel group and operates in or near the territory of the government which it seeks to overthrow. The broadcasts are usually made from facilities which can be quickly knocked down and moved to another hidden location in the event government soldiers get too close. In other situations anti-government stations may be operated from more distant but still secret locations and be backed by groups not directly involved in the revolution. Often as not, no in-progress revolution is underway; the broadcasts may simply be seeking to stir up a population and help create conditions conducive to revolution.

Sometimes unfriendly neighboring governments get involved, either by providing aid to an existing opposition group, or working through a 'front' group the government has created for this purpose. In still other cases, the opposing government may simply run the stations on the sly and make no announcements about a backing organization, even denying any knowledge of the broadcasts.

Other opposition groups don't actually operate their own secret radio stations. Instead, they produce programs which are then carried by stations in countries which are sympathetic to that group's aims.

Black Clandestines

Although the technique was much used in World War II and the Vietnam War, the so-called 'black' clandestine is a rarity today. A black clandestine is operated by the government it speaks out against. But the tone of those broadcasts is less anti-government, and the object is to spread misinformation and to pull listeners away from the more strident opposition voice.

There are probably more clandestine broadcasters of all types on the air today than at anytime in the past decade, each pitching its own version of the truth. Most of these stations operate on shortwave frequencies and many of them can be picked up by listeners in North America, assuming ownership of a quality receiver and some patience. Others are difficult if not impossible to hear, since they are on the air for local and regional audiences at times and on frequencies which are not propagationally effective for a North American audience.

Here is an overview of the current clandestine broadcasting picture, worldwide.

Africa

Clandestine broadcasters dot the African continent from the shores of the Mediterranean south to South Africa. In Libya, Colonel Khadaffi has had a hand in several thinly veiled broadcast efforts, opposing at various times the governments of the Sudan, Lebanon and Egypt. He is believed to have been behind the brief appearance in the spring of 1985 of 'The Voice of Vengeance', which called on Arabs living in the Maghreb area to kill their Jewish neighbours and confiscate their property. At the moment, Libya continues to operate 'Radio Chad', (formerly Radio Bardai) which opposes the current government of Chad. In the winter months, this station can be heard to sign off at 3:30PM EST on 6,009kHz.

The Eritrean Popular Liberation Front, which seeks independence for the Ethiopian state of Eritrea and is backed in that effort by Somalia, operates the 'Voice of the Broad Masses of Eritrea'. It makes only rare appearances here, at 11PM to 12:30AM EST on a widely varying frequency between 9,930 and 9,985 kHz. The station operates from rebel-held territory and also broadcasts the programs of the group seeking independence from the Ethiopian state of Tigre ('Voice of the Tigre Revolution'). Somalia adds its two cents worth by turning over transmitter time on the government-owned Radio Mogadishu to the 'Voice of the Eritrean Popular Revolution'.

Ethiopia returns Somalia's fire with 'Radio Halgan', supposedly operated by the United Voices of the Somali Opposition, carried over official Ethiopian government transmitters. This airs at noon on 9,595 kHz.

The current ruler of the Sudan are the target of broadcasts by 'Radio SPLA' operated by the Sudan People's Liberation Army and Sudan People's Liberation Organization. The broadcasts, originally hosted by Libya until a coup brought in a government more to Khadaffi's liking, originally sought independence for the southern Sudan. The current broadcasts, believed to be coming from Egypt, now call for a total change in the Sudan.

Jonas Savimbi's UNITA opposition force in Angola runs 'La Voz de la Resistencia do Galo Negro' (Voice of the Resistance of the Black Cockerel), heard occasionally in Portuguese from 11:30PM on 4,972. Another Angolan opposition voice is 'La Voz de Verdade' (the Voice of Truth). Long thought to be a second UNITA station, that theory was recently denied by a US representative of UNITA. The station can often be heard signing on at 10PM on 4,950kHz. A third station, 'Cubanos en Africa' broadcasts on a sporadic basis to Cuban troops stationed in Africa, usually from midnight EST on 6,045. All three stations are believed to broadcast from the Transvaal area of South Africa, probably with the knowledge and support of that government.

Zimbabwe is the target of another South African-based clandestine, 'Radio

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