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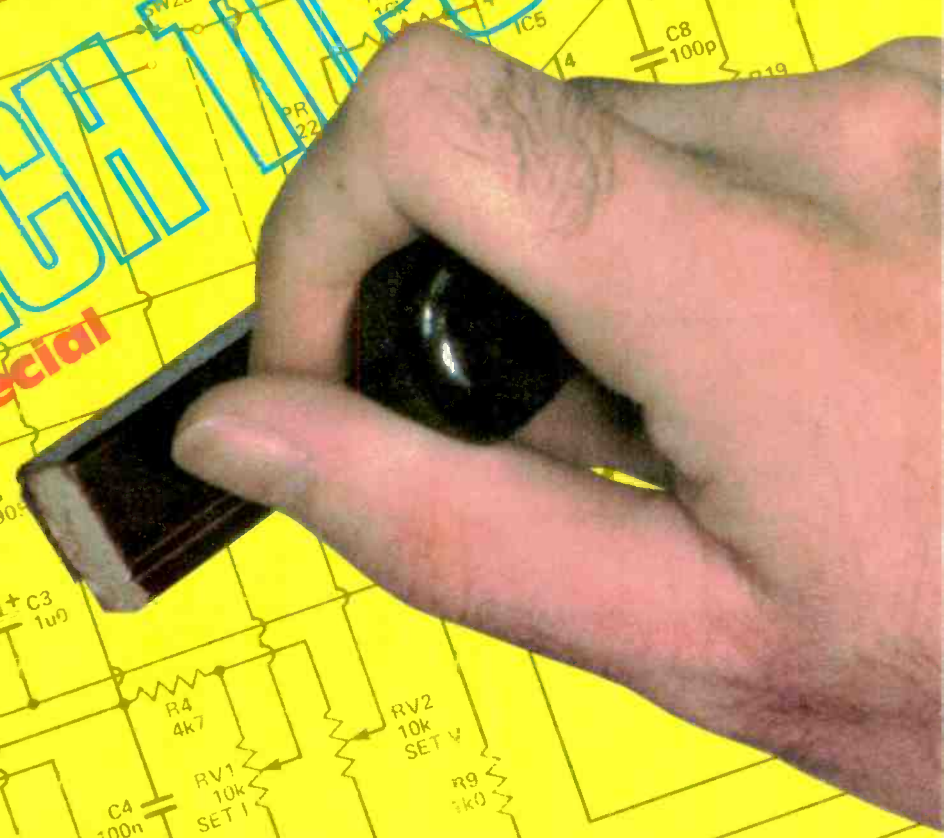

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The Magazine for Electronics & Computing Enthusiasts

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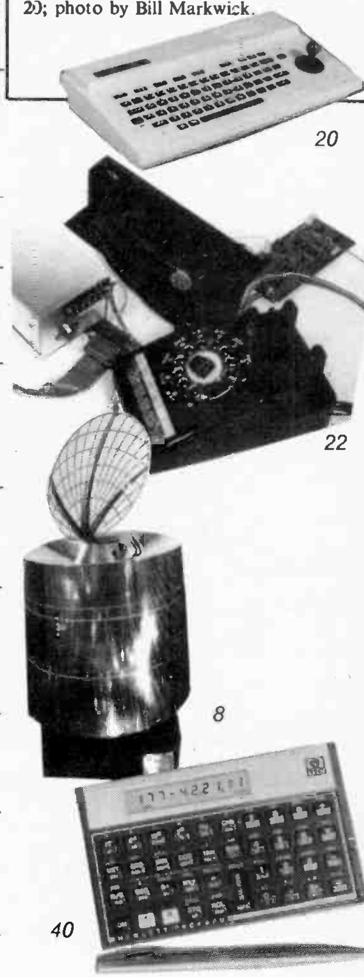
Features

Projects

Columns, News and Information

Our Cover

Pages of circuits sent in by readers appear on page 28. CANDU reactors are described by R. Moorshead on page 36; photo courtesy of Ontario Hydro. The Spectravideo SV318 gets a workout on page 20; photo by Bill Markwick.



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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. ETI has opted for sooner!
Firstly decimal points are dropped and substituted with the multiplier: thus 4.7uF is written 4u7. Capacitors also use the multiplier nano (one nanofarad is 1000pF). Thus 0.1uF is 100nF, 5600pF is 5n6. Other examples are 5.6pF = 5p6 and 0.5pF = 0p5.
Resistors are treated similarly: 1.8Mohms is 1M8, 56kohms is the same, 4.7kohms is 4k7, 100ohms is 100R and 5.6ohms is 5R6.

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

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

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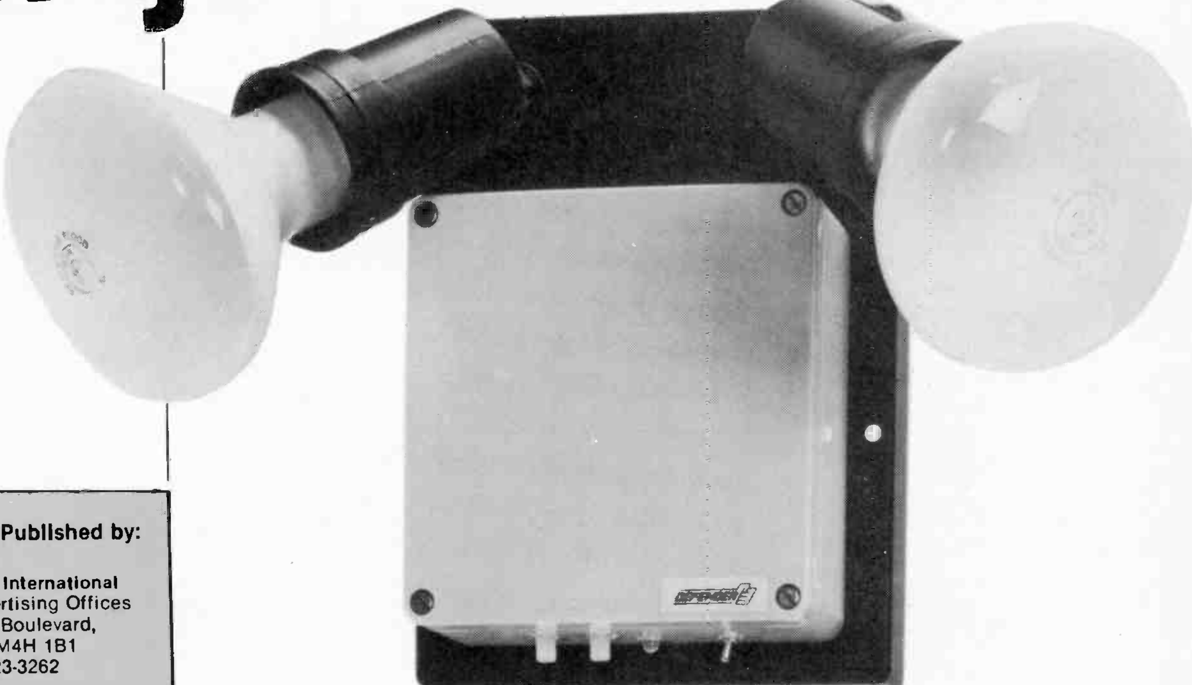

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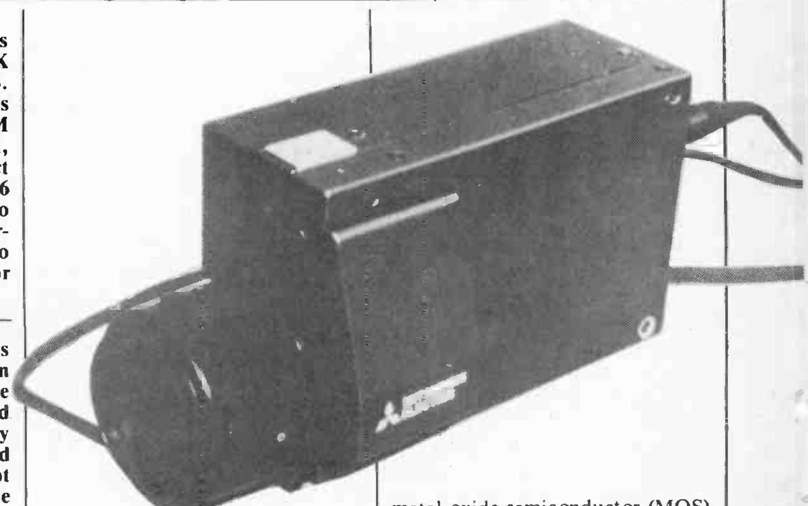
The D12 or D12L is suited for activation of porch or garage lights, helps ward off intruders and saves money by turning off lights not in use. The device automatically switches loads up to 1,000 Watts at 120 VAC and can easily be used in energy management applications.

For complete information, write: Entrex International Limited, P.O. Box 248, Brampton, Ontario. L6V 2L1 (416) 459-2196.

Correction

In our September issue, the prices listed in the Timex/Sinclair 64K RAM news release were in U.S. funds. The correct Canadian prices are $159.95 for the 64K RAM pack, and $59.95 for the ZX-81, now on special. Please contact Gladstone Electronics, 1736 Avenue Road, Toronto, Ontario M5M 3Y7 (416) 787-1448 for further information. Our apologies to Gladstone and their customers for any inconveniences caused.

CP Air is having a great success with portable video games on overseas flights, according to the Toronto Globe and Mail. Good responses on domestic flights may mean permanent installations, and other airlines are interested, except for Air Canada, who passed on the whole thing.



Infrared Imaging

Mitsubishi Electric Corporation of Tokyo has developed a near-infrared ray imaging system that can monitor objects in darkness by using an invisible near-infrared ray. The system consists of a high-efficiency near-infrared illuminator using rare-gas discharge lamp technology developed by Mitsubishi Electric, a compact, lightweight and long-life, solid-state near-infrared ray camera and a monitor screen. Like an ordinary fluorescent lamp, the illuminator is inexpensive and has a simple structure, high efficiency and a long life. The camera, which has a metal oxide semiconductor (MOS) image element, also features low power consumption, long intervals between maintenance and improved image characteristics. When the system is used in a room measuring 3 meters by 3 meters with a ceiling height of 3 meters with a near-infrared ray illuminator having two 25 W lamps, it produces a clear image of an object in darkness of 0.1 lux or lower.

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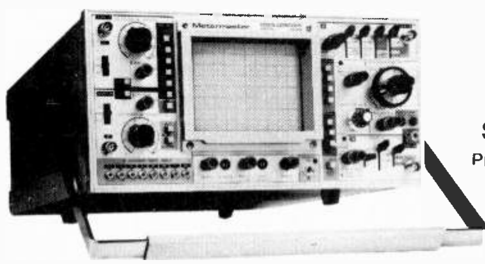

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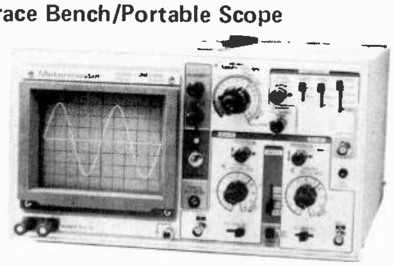

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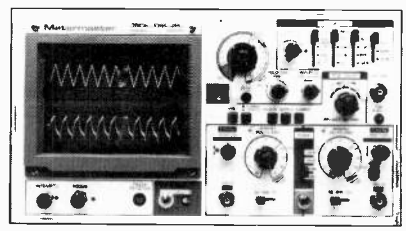

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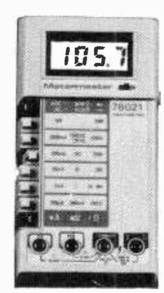

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Anik C Satellites

The space shuttle's Canadarm may have eclipsed the fact that the Anik series has made Canada a world leader in satellite technology.

by Eric McMillan

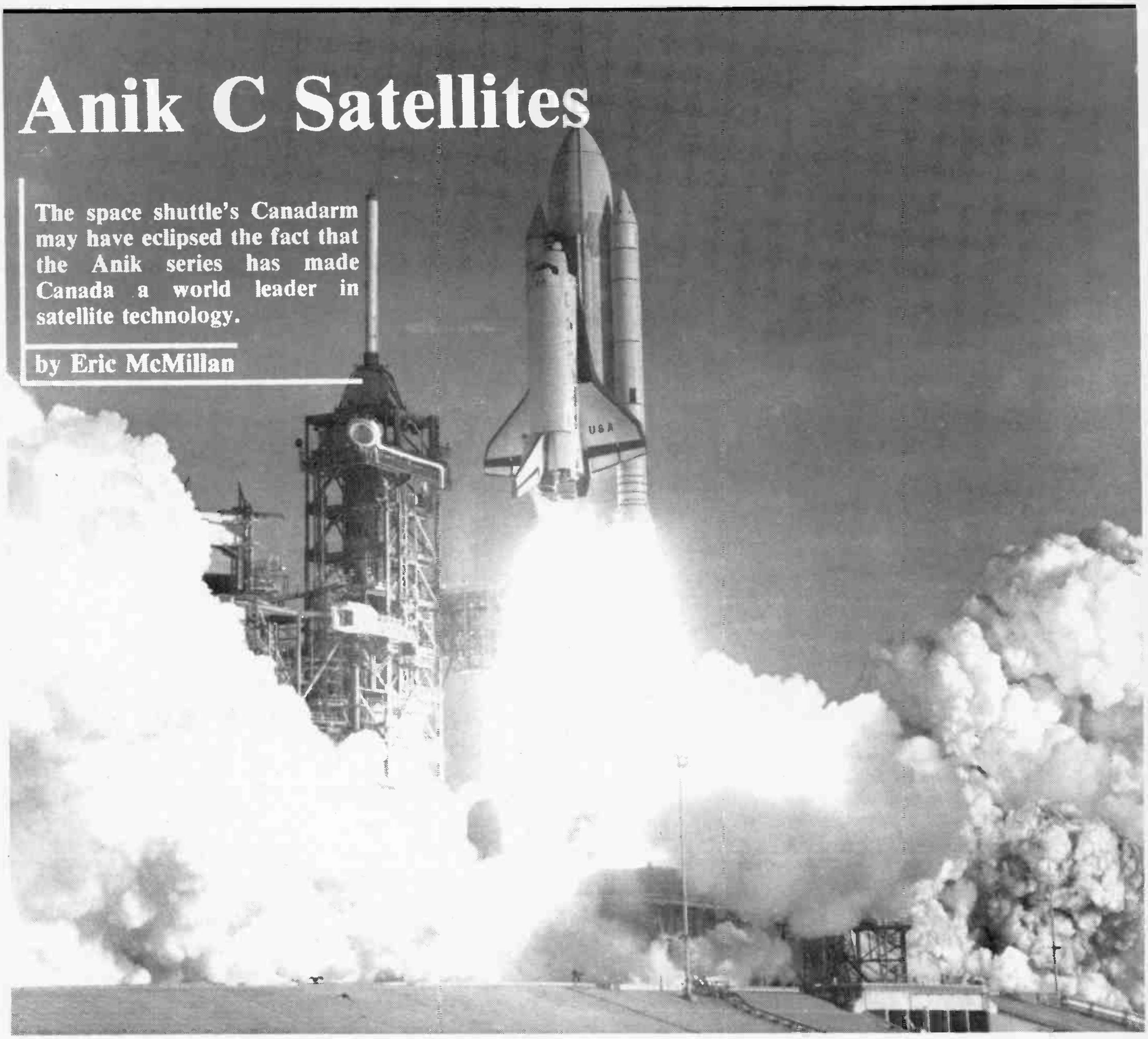


Photo Courtesy of NASA

SINCE FEBRUARY 1st of this year, Canadians have come to think of Pay TV as a service available from their local cable companies. But the programs are transmitted more than 70 thousand kilometres through space before the local distributors receive them to pass on to us.

The reason for the television signal's long journey lies in a drum-shaped gadget floating 35,800 km from earth. From its position over the Pacific Ocean off the western hump of South America, the Anik C 3 satellite relays Pay TV programs from their originators to distributors in any, or all, of four regions in Canada which include almost the entire population. The national and regional Pay channels are wholly dependent upon the Anik C 3.

But that's not all the Anik C 3 can do.

Direct broadcasting to rooftop antennae, two-way teleconferences and a host of other communications services have been made possible by what has been called the world's most powerful communications satellite.

If someone had asked you which country has the most powerful satellite in space, you might have guessed the United States or Soviet Union. You'd likely have been right if the question had included military satellites (in which case, "powerful" has more ominous connotations), but if you're talking about TV satellites, the answer is the Canadian Anik C 3, though built mainly by Hughes Aircraft in California and launched by NASA from the American Shuttlecraft Columbia. The Anik C series, of which the C3 is the first to be put into orbit, has a number of features which earns them the title of "most powerful."

The satellite has 16 transponders which receive signals from earth, amplify them and send them back on a different frequency. Each transponder can carry up to 1,344 one-way voice channels or two colour TV programs, making a total of 21,504 voice channels or 32 TV channels per satellite. Most U.S. satellites can carry only 24 channels.

Anik C's frequencies of 14 and 12 Gigahertz are also higher than other satellites and much higher than the frequencies used by most earth-based systems. This prevents the sort of interference which has forced receiving stations in the past to locate themselves away from crowded areas such as cities.

These factors, and a signal strength of 15 watts, allow Anik C to deliver high-quality TV pictures to private homes equipped with receiving dishes as small as 1.2 metres across. Anik C is ideal as part of a Direct Broadcast Satellite (DBS) system in which the originators of programs can beam them directly to consumers, bypassing local distributors. Proponents of DBS see a day when every rooftop will have a dish antenna.

Although Anik C is not officially designated for direct broadcasting, it can be used for interim DBS until new American satellite capacity is available. Anik's operator, Telesat Canada, already has lined up a Connecticut company to use the Anik C to provide direct-to-home Pay TV services in the United States.

The satellite itself is not impressive-looking. At 21 feet in height and 1160 kg in weight, it may be impressive if it landed in your front yard, but in the vastness of space, the Anik C is dull, even old-fashioned in appearance — a cylindrical trash can with lid up. The "lid" is actually an antenna. The lower section of the "can" consists of concentric solar panels which soak up enough sunlight to produce the 1100 watts of DC power to run the satellite.

So far, Telesat has sent seven Anik satellites into orbit. Oddly, the satellites are not launched in order of their letter and number designations. The Aniks A1, A2, A3 and B blasted off sequentially between 1972 and 1978. The next to go up was the Anik D1 in August 1982. The first of the third generation launched was the C3 in November 1982, to be followed by the C2 and lastly the C1 sheduled for April 1984.

Designed to last 10 years, the satellites are expected to be in use for eight or nine years. The Anik A1 was retired from active service only in July 1982.

Meet Me In St. Louis . . .

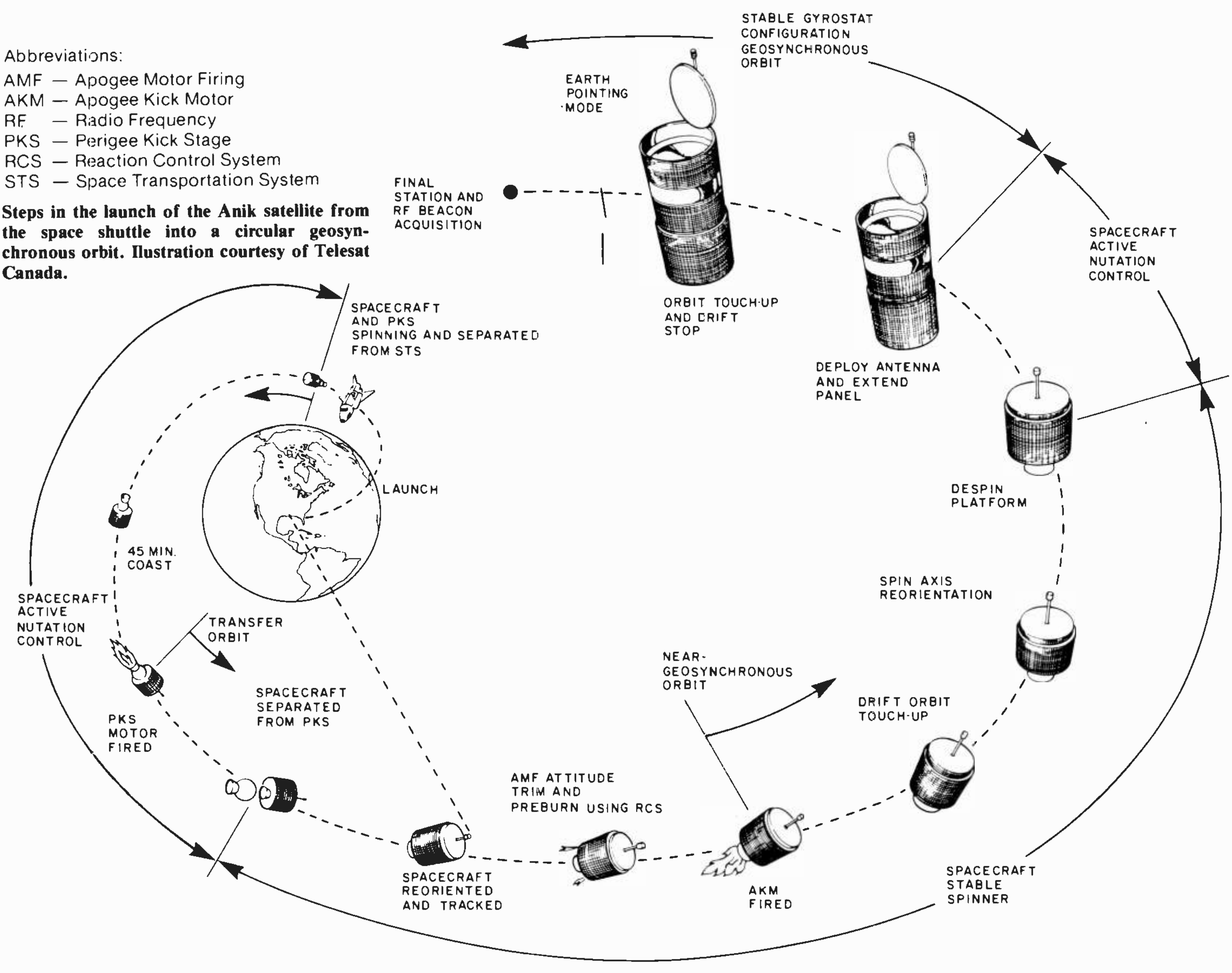
Although it may be hard for the average TV viewer to appreciate the functioning of a satellite thousands of kilometres away, such is not the case with participants in teleconferences.

Teleconferencing has become almost a buzzword in certain circles. At its simplest, it just means holding a discussion among people in various locations by means of some telecommunications device, such as a phone. Telephone companies offer a variety of arrangements for audio-only conferences, one of the most popular being the "Meet-Me" type whereby participants call a special number to check in at the agreed-upon time.

. . . and Halifax . . .

It has been demonstrated that 40 percent of business meetings can be handled effectively by audio teleconferencing. How-

Abbreviations:
AMF — Apogee Motor Firing
AKM — Apogee Kick Motor
RF — Radio Frequency
PKS — Perigee Kick Stage
RCS — Reaction Control System
STS — Space Transportation System



Steps in the launch of the Anik satellite from the space shuttle into a circular geosynchronous orbit. Illustration courtesy of Telesat Canada.

ever, a major demand of businesses considering long-distance conferences, market surveys have discovered, is that they want to create as accurately as possible the conditions of an in-person meeting around a table. More than just a desire for a "you-are-there" feeling, this is a recognition that physical gestures, facial responses and visual data are important. Business people don't want to waste the time saved by a teleconference on trying to sort out who is addressing whom, what the figures look like on a graph and who is falling asleep with boredom. Perhaps people in executive training will have to include acting lessons.

. . . and Calgary, and . . .

Satellite and video technology can add immediacy to a teleconference. By bouncing live images off a satellite, a business can approximate the feel and content of a meeting held in one room, although the participants may be scattered across the continent or even around the globe.

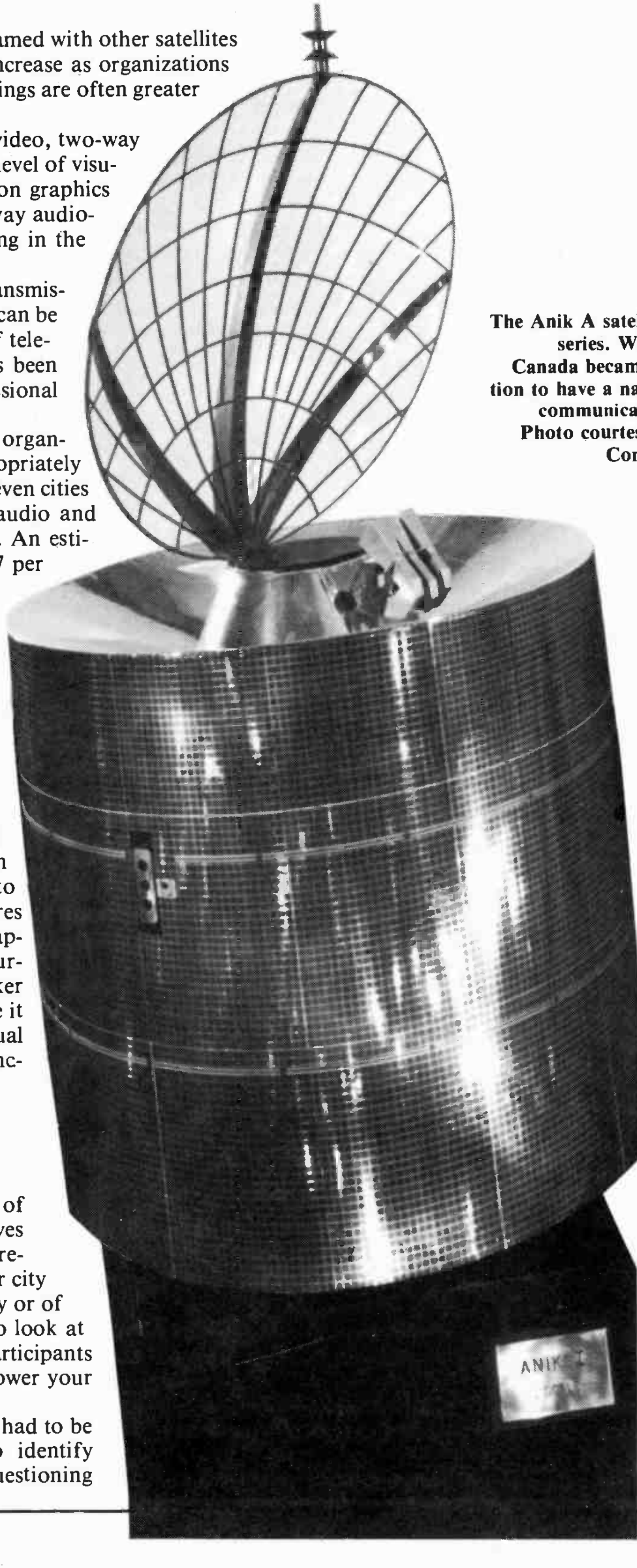
The Anik satellites have been used on their own or teamed with other satellites for videoconferences, and Telesat expects the trend to increase as organizations catch on to the fact that travel costs involved in large meetings are often greater than the costs of transmitting by satellite.

A videoconference can be held with two-way audio/video, two-way audio plus one-way video, or two-way audio plus a lower level of visual transmission such as freeze-frame (still images), Telidon graphics and telecopier link-ups. The most expensive type is two-way audio-video which usually originates in fixed-site studios costing in the hundreds of thousands of dollars.

The second kind, with audio interaction but video transmission from one site only, is more popular; it is cheaper and can be held anywhere the equipment can be set up. This type of teleconference is not limited to wealthy institutions and has been used for press conferences, medical services and professional conventions.

In April, the Canadian Science Writers Association organized the first teleconference employing the Anik C3. Appropriately the subject of the conference was . . . teleconferencing. Seven cities from Halifax to Vancouver were linked with two-way audio and with video beamed from the convention site in Toronto. An estimated 700 people took part for a cost of $40,000, or $57 per person. The cost in this case was borne by the companies who donated rent and services. This compared favourably with the hypothetical expense of that many people coming to Toronto from all parts of the country.

Participants could not help noticing that the use of satellite communications changed the nature of the conference to some degree. On the way into the Toronto studio, set up in the basement of the Planetarium, we skirted the large dish, camera, truck and cables in front of the building. Inside we found ourselves in a setting similar to that of a TV game show. We had been asked to be in our seats half an hour before the conference began and the time was taken up with instructions about how to behave and repeated roll calls to have the other centres across Canada check in. Anticipation mounted as we approached "air time." At zero hour a minor calamity occurred when someone in the truck outside threw a breaker switch and the conference was delayed five minutes. Once it began, however, it went fairly smoothly with only the usual conference delays such as the slide projector malfunctioning.



The Anik A satellite, first of a series. With its launch, Canada became the first nation to have a national civilian communications satellite. Photo courtesy of Dept. of Communications.

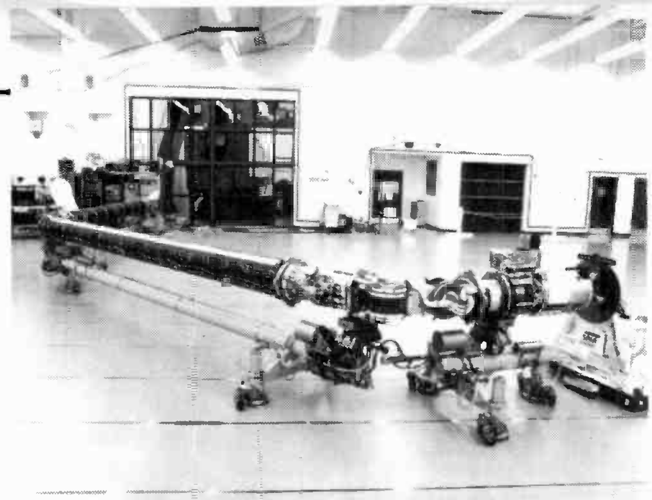
Let's Make a Deal?

Three cameras in the Toronto studio provided a variety of shots of speakers and audience who could watch themselves on a 50-inch TV screen. Audiences in the other six cities received the same images. Whenever someone from another city spoke, a Toronto camera focused on a picture of that city or of the speaker, presumably to provide us with something to look at while we listened. A floor director gave the Toronto participants visual cues such as "speed up your speech," "raise or lower your voice" and "applaud."

In order to coordinate discussion, a certain protocol had to be learned by the participants. Speakers were asked to identify themselves, where they were located, whom they were questioning and when their question was finished. A one-second lag between transmission and reception made it impossible to interrupt a speaker. Comments and questions were taken in order across the country, one per site, creating the possibility that some locations might have made up remarks so as not to lose their allotted time, and some might have been sitting on remarks that they didn't have time to make.

The advantages of teleconferencing were also apparent. Speakers were well aware of time limits and made a discernible effort to be concise. A member of the panel, Larry Steinman, president of Canadian Teleconference Network, pointed out that about half the Toronto audience was watching the TV screen rather than the speakers in the flesh because television made the proceedings more dramatic. His own face, for example, could be watched in close-up on the screen as he spoke, rather than being seen indistinctly from the back of the room.

Not everyone was unabashedly enthusiastic, though. Sociologist Michael Gurstein, president of the consulting firm Socioscope, noted that going to conferences is one of the perks of business and that many people look forward to traveling as a break from routine. Face-to-face meetings are necessary for certain purposes such as negotiating and getting to know one another. An educator in Halifax asked whether using satellite communications for conferences wasn't employing "Cadillac technology for a Volkswagen economy?"



The Canadarm remote manipulator, built by Spar Aerospace in Canada, and used by the space shuttle to place the Anik satellite into position for its orbital burn.

The consensus seems to be that costs are still quite high for many applications, but that they are coming down while travel expenses are skyrocketing. The two curves, one climbing, one falling, meet at the point where it becomes feasible for a moderately sized organization to consider beaming their meetings by satellite. The financial benefits improve as the number of participants per meeting and the number of meetings per year increase.

The Shrinking Global Village

The same holds true for international satellite communication. Teleglobe Canada, which operates the Canadian portion of the global communications system, expects teleconferencing costs to drop drastically as the new technology develops. Marketing vice-president Atherton Wallace told the science writers' conference that a teleconference between Toronto and London, England, which cost $9,000 an hour in 1981, is now priced at $4,000 and will likely fall to $2,000 in the near future.

This points up another use of Anik: forming a link in communications around the world. A transmission from western Canada to Europe, for example, might involve the combination of Anik to send it across North America, microwave or cable systems to carry it to another transmitter and an INTELSAT satellite to beam it over the Atlantic Ocean.

International communications, teleconferences, direct-to-home broadcasting, Pay TV; even as the most powerful satellites of their type, the Anik Cs have their work cut out for them. ETI

for your information

PC Board Connector

A new two-piece printed-circuit board connector system from TRW Cinch Electronics eliminates gold from non-functioning surfaces for significant cost savings without sacrificing performance. Primarily used in computers and sophisticated instrumentation where long life and high reliability are required, TRW's system was designed to replace traditional mother/daughter edge card connectors.

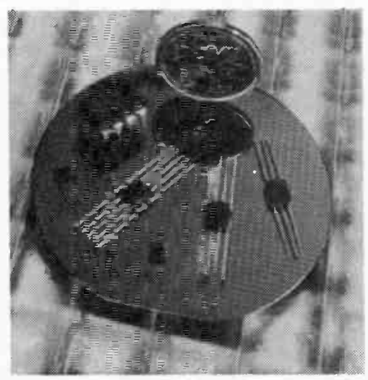
The new connector system, which was introduced last fall, is said to be at least 50% more reliable than conventional systems because the quality of the gold in the connector is controlled by the manufacturer, guaranteeing electrical contact. For further information contact TRW Electronic Components Group, 1501 Morse Avenue, Elk Grove Village, Illinois, 60007.

The Federal government has announced a three-day symposium called Canada Tomorrow to be held Nov. 6 to 9, 1983 at the Capital Congress Centre in Ottawa. 750 representatives from labour, academia and private companies will discuss such topics as productivity and job opportunity, the government role in technology and the changes technology is bringing to society. Further information is available from the office of the Minister for Science and Technology, 99 Bank St., Ottawa K1P 6B9.

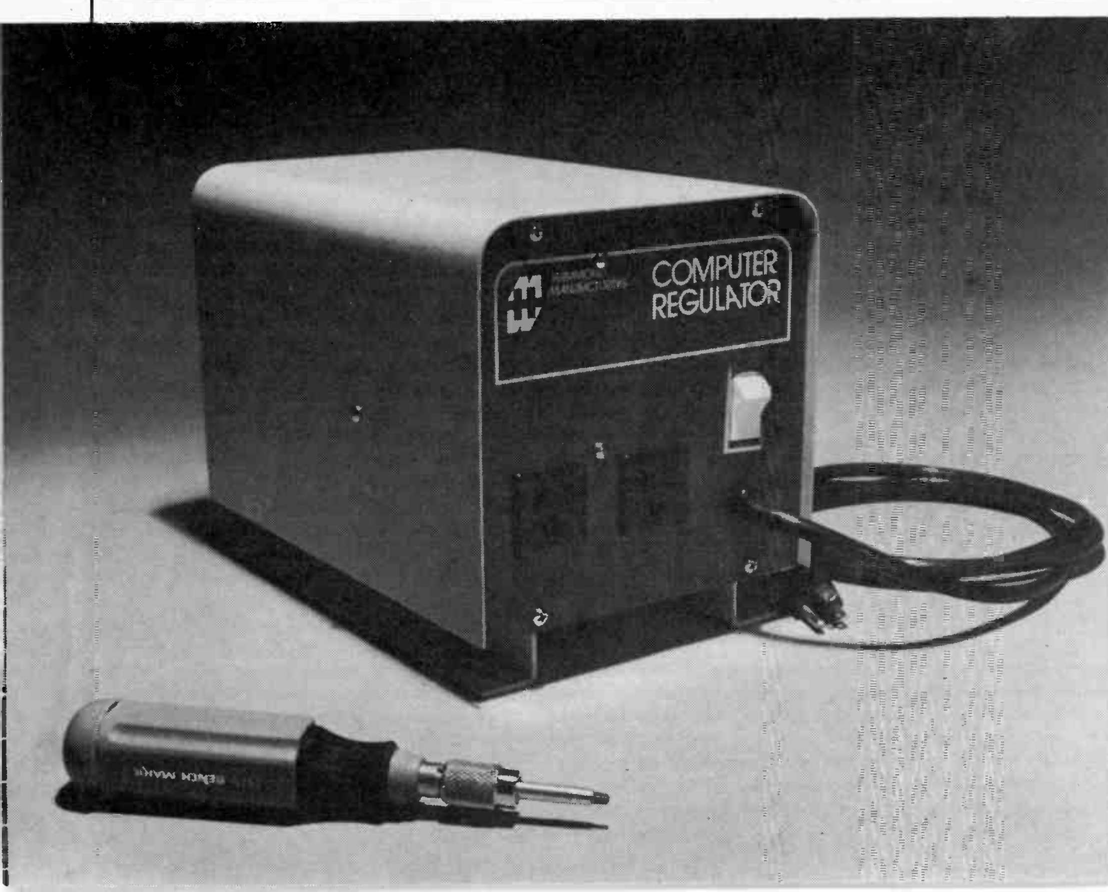
Monolithic Amplifier

Linear Technology Inc. introduces a low voltage monolithic linear wideband amplifier, the LE507. The LE507 is a three stage, Class A amplifier designed to operate with a single polarity supply from 0.9 V to 1.6 V. Other features include, bandwidth of DC to 25 MHz and gain of 30 dB (R_L = 1K), low power consumption, minimum external parts count and application flexibility.

Independent access to all three transistor collectors permits frequency shaping and control of the gain bandwidth product. The second stage emitter is pinned out separately from the first and third stages allowing the use of emitter resistors for negative feedback. A bias network is included on the chip for DC biasing of the input stage.



For more information, contact: Bob Gibbons, Linear Technology Inc. P.O. Box 489, Station "A", Burlington, Ontario. L7R 3Y3 (416) 623-2996.



Computer Regulator

Voltage fluctuations and line noise can adversely effect sensitive electronic equipment such as: CRT terminals, cash registers, word processors and micro processors. The Hammond Computer Regulator instantly regulates line voltage fluctuations and, at the same time, provides isolation from both transverse and common mode noise. The regulator maintains common mode noise rejection in excess of 120 db and transverse noise rejection of better than 60 db. ±15% voltage fluctuations are instantly regulated to an output deviation of ±3% maximum. Input voltages as low as 65% are maintained within NEMA standard output voltage specifications. Hammond Computer Regulators can be ordered through any authorized Hammond Distributor.

Gladstone Electronic Distributors, Inc., distributors of software and hardware, announce a change of name to: EDG Electronic Distributors, Inc. The address remains the same at 3950 Chesswood Drive, Downsview, Ont. M3J 2W6.

The change does not apply to the Avenue Road retail store.

IC Design Aid

Linear Technology Inc., Burlington, Ontario, has just introduced a complete package of design aids for customers to use when designing functions on the company's new semicustom linear array chips. The design package contains a step by step manual that instructs designers in how to design proprietary custom IC's on Linear's LA200 series of uncommitted circuits. Also included are twenty-five kit parts (active and passive components individually bonded out and packaged in D.I.P.), and large sized (x250) sheets of the chip layout to facilitate the task of interconnecting circuit components. The company plans to augment these design tools with complete applications and design engineering assistance for users of the arrays as well as providing training to those customers who need it. The complete design package sells for $79.00 and is available now from L.T.I.'s Marketing Department in Burlington. For more information contact: Bob Gibbons, Linear Technology Inc., P.O. Box 489, Station "A", Burlington, Ontario, L7R 3Y3. (416) 632-2996.

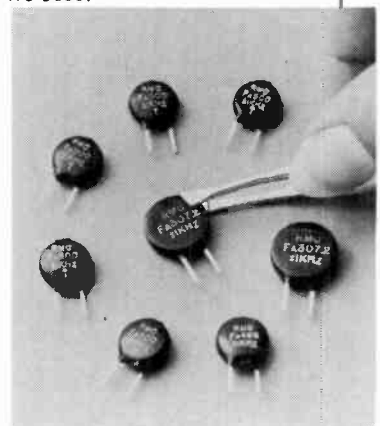
Looking for a painless way to learn about computers? CLASS Associates, Inc., P.O. Box 492, Wilton, CT 06897, have come up with a great one: a seven-day computer course will be held on a Mississippi riverboat departing from New Orleans and visiting various historic ports on the way. Three cruises will leave this winter, and both the cruise and the computer course appear to be first-class. So is the price, at up to $1895 per person, but then, it's tax deductible.

According to International Resource Development, Inc., whose press releases are always a good read, the influx of computer technology into the home will result in more paperwork instead of less. "We are living in a age of increasing uniformity, mechanization, and depersonalization . . . It stirs in people a longing for the unique, the human, the personal. Electronic mail, for example, takes the humanity out of a communication." Sounds like a good point; who'd want to get a love letter on a disk?

SAFT Batteries of Scarborough, Ont. has been awarded a $1.5 million contract to supply emergency back-up batteries for the 825 railway cars to be built for the New York City Transit Authority by Bombardier of Quebec. SAFT also manufactures chargers and monitors for heavy-duty industrial applications.

Ceramic Resonator

A new ceramic resonator, Model CR-35, is a "flat pack" or "discoidal" package design that offers improved volumetric efficiency and mechanical ruggedness has been introduced by Radio Materials Corporation (RMC), Chicago. The new CR-35 extends the frequency range available in a "flat pack" design downward from the minimum of 455 kHz with the CR-40 case to 295 kHz with the CR-35 case. This range allows OEMs to engineer the popular FA 307.2 component (used primarily in clock circuits) in an improved package. For further information on the new CR-35 ceramic resonator, contact: Radio Materials Corporation, 4242 W. Bryn Mawr Avenue, Chicago, Illinois 60646. Telephone (312) 478-3600.



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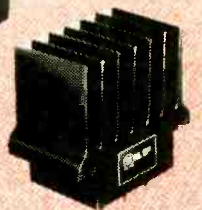

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MOSFET MODULES

Module Number	Output Power Watts rms	Load Impedance Ω	DISTORTION T.H.D. Typ at 1KHz	I.M.D. 60Hz 7KHz 4:1	Supply Voltage Typ	Size mm	WT gms	Price $
MOS 128	60	4-8	0.005%	0.006%	± 45	120 x 78 x 40	420	89.95
MOS 248	120	4-8	0.005%	0.006%	± 55	120 x 78 x 80	850	154.95
MOS 364	180	4	0.005%	0.006%	± 55	120 x 78 x 100	1025	229.95

Protection: Able to cope with complex loads without the need for very special protection circuitry (fuses will suffice).
Slew rate: 20v/ps. Rise time 3ps. S/N ratio 100db.
Frequency response (-3dB): 15Hz — 100KHz. Input sensitivity 500mV rms.
Imput impedance: 100K. Damping factor: 100Hz: 400.

BIPOLAR MODULES

Module Number	Output Power Watts rms	Load Impedance Ω	DISTORTION T.H.D. Typ at 1KHz	I.M.D. 60Hz/7KHz 4:1	Supply Voltage Typ	Size mm	WT gms	Price $
HY30	15	4-8	0.015%	0.006%	± 18	76 x 68 x 40	240	31.95
HY60	30	4-8	0.015%	0.006%	± 25	76 x 68 x 40	240	34.95
HY6060	30 + 30	4-8	0.015%	0.006%	± 25	120 x 78 x 40	420	59.95
HY124	60	4	0.01%	0.006%	± 26	120 x 78 x 40	410	59.95
HY128	60	8	0.01%	0.006%	± 35	120 x 78 x 40	410	59.95
HY244	120	4	0.01%	0.006%	± 35	120 x 78 x 50	520	79.95
HY248	120	8	0.01%	0.006%	± 50	120 x 78 x 50	520	79.95
HY364	180	4	0.01%	0.006%	± 45	120 x 78 x 100	1030	119.95
HY368	180	8	0.01%	0.006%	± 60	120 x 78 x 100	1030	119.95

* Complete circuitry is encapsulated in compact module!

* All Connections are made via edge connector (supplied)!

Compact modules — not much larger than a matchbox — that give you the very best reproduction possible! All ILP modules are fully compatible with each other so you can create almost any audio system! Fully shortproof. Complete with full connection data and 5 year warranty.

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PRE-AMP SYSTEMS

Module Number	Module	Functions	Current Required	Price $
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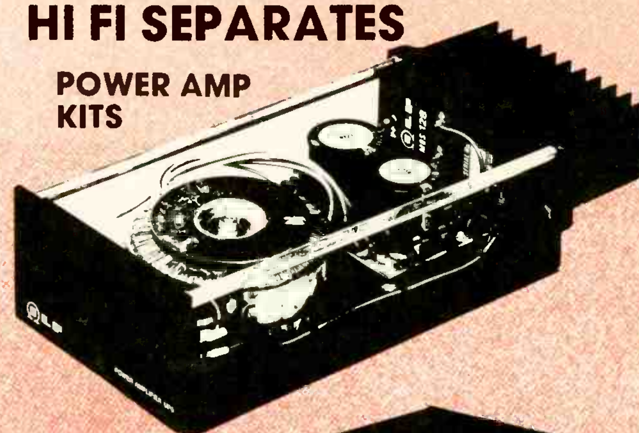
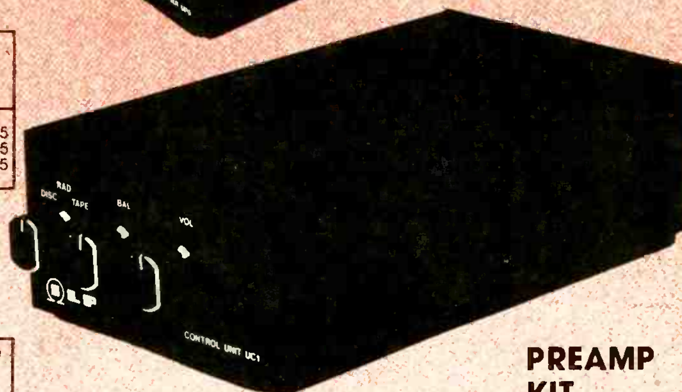
HY66	Stereo pre-amp	Mic/Mag. Cartridge/Tuner/Tape/ Aux + Vol./Bass/Treble/Balance	20mA	54.95
HY73	Guitar pre-amp	Two Guitar (Bass Lead) and Mi + separate Volume Bass Treble + Mix	20mA	54.95
HY78	Stereo pre-amp	As HY66 less tone controls	20mA	49.95

HI FI SEPARATES

POWER AMP KITS





PREAMP KIT

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POWER AMPS: The UP series feature a clean line front panel incorporating on/off switch and concealed indicator. They are designed to compliment the style of the UC1 pre-amp. Performance for each unit which includes the appropriate power supply, is as specified.

Each Unicase kit contains all the hardware required to build a complete unit without the need for any special tools. Because of ILP's modular approach, "open plan" construction is used and final assembly of the unit parts forms a compact aesthetic unit. By this method construction can be achieved in under two hours with little experience of electronic wiring and mechanical assembly.

UNICASES

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UC1	Preamp				99.95
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UP4X	120W/4 Ω	Bipolar	Mono	HiFi	259.97
UP5X	120W/8 Ω	Bipolar	Mono	HiFi	259.95
UP6X	60W/4-8 Ω	MOS	Mono	HiFi	229.95
UP7X	120W/4-8 Ω	MOS	Mono	HiFi	299.95

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Spectracolumn

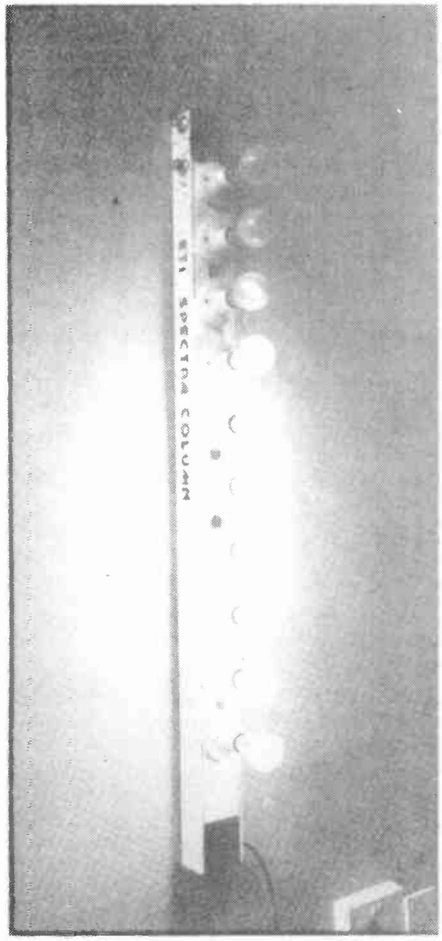
With this project we throw some light on the problem of how to jazz up your disco or party. This cost-effective, crammed-with-everything light column can be used singly or in groups to dazzle the dancefloor. Design by Roray Holmes.

THE ETI SPECTRACOLUMN is an up-market sound-to-light system; by this we mean its lighting effect is a cut above the average 'three bulb' system, although its cost is not. Ten 15 to 100 W bulbs, arranged in a column, respond to the intensity of music (or any sound signal) within a pre-selected frequency range. It works like a giant bargraph voltmeter; the more energy in the chosen frequency band, the more bulbs will illuminate, forming a column of light that rises up from the floor and follows the rhythm of the music. The display system is very versatile; it can be built with any type of bulb in any configuration, and may be expanded for large parties or discos. Multiple columns can be set to adjacent frequency bands to build into a giant spectrum analyser and display system. Imagine — a kilowatt light column devoted to each octave across the whole audio spectrum!

In designing the band-pass filter system, we have made use of the latest switched capacitor filter IC, the MF10. This device contains two second order filters whose cut-off frequencies are directly controlled by a square-wave clock input. Clock frequency control removes the constraint of having to use high tolerance filter network components and the associated difficulty of altering the filter frequency. The clock, and thus the filter frequency, can be set from a logic divider chain to provide any frequnecy in octave increments. We have configured the MF10 as a low-pass filter in cascade with a high-pass filter to allow complete control of the filter band. The upper and lower frequency limits may be set independently under logic control using rotary switches. There is no setting up or filter tuning required and the entire range of octaves is implemented with very few components.

On The Circuit

With the price of modern triacs and some economical design work from ETI, what seems to be a complex system in fact turns out to have only about $50 worth of parts (less the PCB and lightbulbs). Since the triacs don't need heatsinking, we adopted the 'let's get it all on one board' philosophy, and did exactly that. Even the small crystal mike that picks up the audio signal is mounted on the PCB to provide complete isolation between the sound equipment and the power line. Mounting a single board directly with all the bulbs in the column housing also removes the inconvenient cables that often make the dancefloor a dangerous place to negoti-



Ten white light-bulbs, hanging on a wall . . .

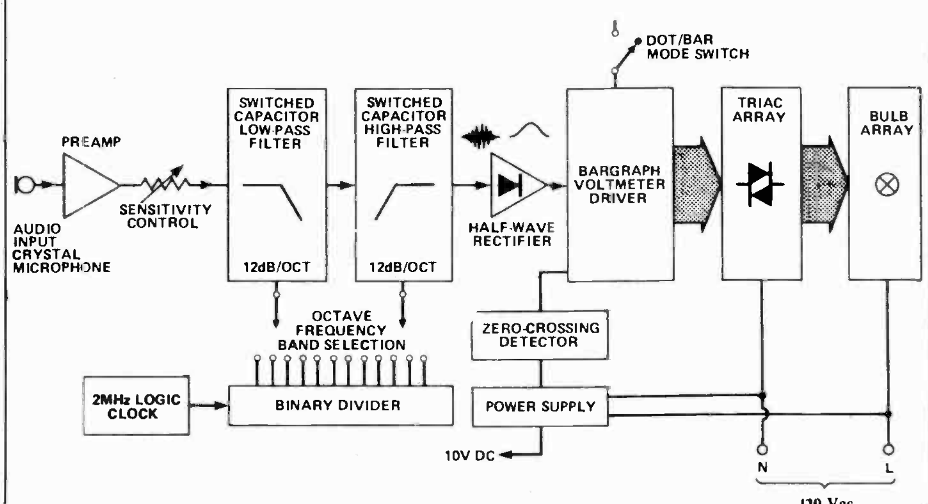


Fig. 1 Block diagram of the Spectracolumn.

FEATURES

- Drive 10 100 W bulbs in bargraph or dot display
- Zero-crossing switching give RFI elimination
- Logarithmically proportional display to correspond with music volume
- Independent high-pass and low-pass filters, 12 dB per octave
- Digitally-controlled switched capacitor filters eliminate setting up
- Pass band switchable in octave increments over 10 octaves anywhere in the audio spectrum
- Internal crystal mike gives complete isolation from sound equipment
- All parts on one PCB powered directly from the line

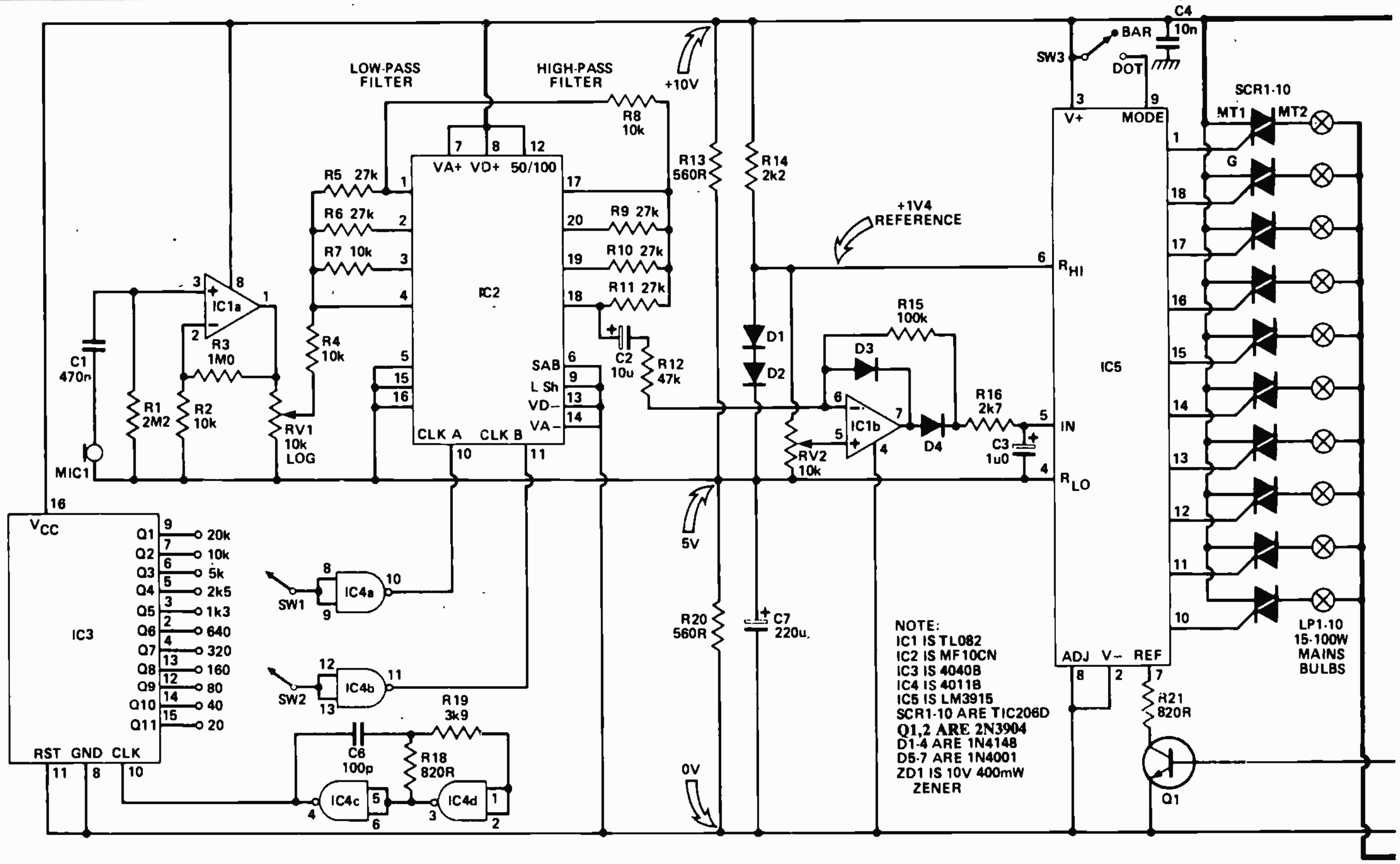


Fig. 2 Circuit diagram for the complete Spectracolumn.

TABLE 1

DIVIDER OUTPUTS	DIVIDED CLOCK	RESULTING FILTER Fc	STANDARD CENTRE
	FREQUENCY (Hz)		
Q1(÷2)	1M	20k	
Q2(÷4)	500k	10k	16k
Q3(÷8)	250k	5k	8k
Q4(÷16)	125k	2k5	4k
Q5(÷32)	62k5	1k25	2k
Q6(÷64)	31k2	625	1k
Q7(÷128)	15k6	312	500
Q8(÷256)	7k8	156	250
Q9(÷512)	3k9	78	128
Q10(÷1024)	1k9	39	64
Q11(÷2048)	980	20	32

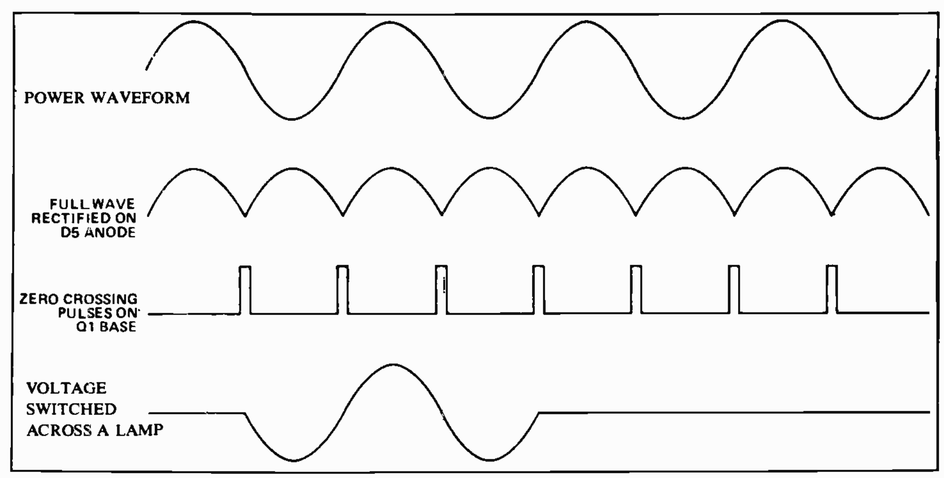


Fig. 3 Triac zero-crossing switching waveforms.

ate. Finally, the design features zero-crossing triac control, so your sound equipment won't be plagued with RFI.

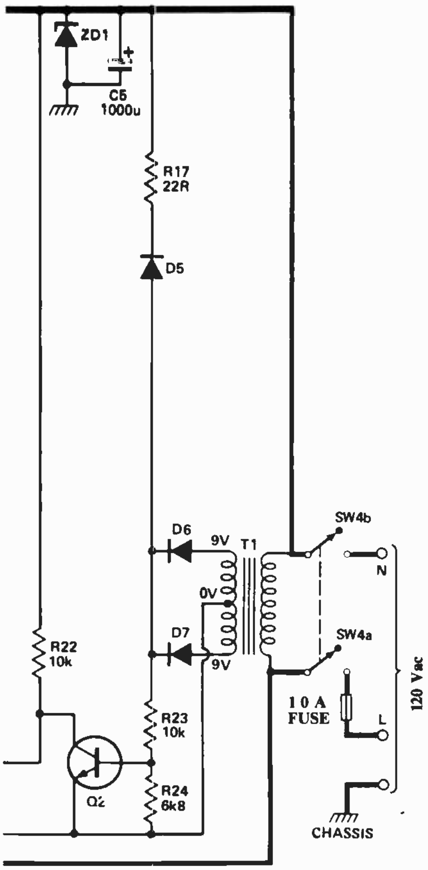
Using the system couldn't be easier; just plug it into the power and switch on! No other connections are needed, because the internal mike picks up the music signal. The sensitivity control is turned up as required for the sound level, and a 'background' control is available which moves the illumination 'baseline' up or down the column, so increasing or decreasing the amount of light. With no sound it acts as a giant dimmer control.

The display could be hung on the wall, as we did for our photograph, or stood vertically on the floor. Large sheets of acetate (available from most good art shops) may be wrapped around the entire column to provide a coloured tube, which also tones down the display. But keep the plastic well away from the light bulbs!

The alternative is to use coloured bulbs. A three column system, using red, green, and blue for the bass, middle, and treble ranges would be an ideal starting system for most disco light shows. The filters could, for example, be set at 20 Hz to 312 Hz, 312 Hz to 2.5 kHz, and 2.5 kHz to 20 kHz. As more Spectracolumns are added into the system the filter ranges can be instantly amended according to taste; but watch out for the current rating of your power sockets!

Construction

All the components except the controls are mounted on our PCB. The triacs, the transformer, and even the microphone are mounted on board, as the overlay diagram of Fig. 4 illustrates. Assembly should begin first with the links, then resistors, followed by ICs and so on. IC sockets should be used as a good precaution, but note that IC5 is an 18-pin device



and IC2 is a 20-pin DIL! Follow the overlay diagram for the orientation of all the components and solder in everything except the PCB-mounting transformer, the triacs, and the crystal mike.

The metal heatsink tab of the triacs has been used to form a screw terminal for the lamp connections (it's connected internally to the central leadout wire MT2). Hence the middle terminal lead of all the triacs must be completely cut off, which immensely simplifies board design too. The remaining two leads are inserted into the board and a nut and bolt are used to clamp the metal tab to the PCB. The bolt protrudes above the component side and a further washer and nut can be added to create a screw terminal. When all the triacs are bolted in place their leadout wires should be soldered and cropped as normal. The lamp wires will be retained on the screw terminals using solder tags.

The PCB-mounting transformer has been used simply for convenience and should be soldered in as a normal component. Other types could also be used provided they are connected to the PCB pads as per the circuit diagram. Bolts should also be fitted, in the same manner as the triacs, to make screw terminals on the pads marked for the mains connections. The photographs of our completed PCB show these terminal connections.

Our crystal microphone insert was 23 mm in diameter; it should be mounted last. The metal shielding case of the insert

How it Works

The block diagram of Fig. 1 illustrates the different parts of the system. Sound from a microphone is amplified and fed through both low-pass and high-pass filters (digitally controlled); the resulting audio signal is then rectified to produce a voltage envelope proportional to the sound intensity within the pre-defined frequency band. This envelope is displayed using a bargraph voltmeter IC to drive triac-switched power bulbs which light up in a column according to the instantaneous sound level. A simple power supply provides both the 10 V DC rail and the 120 Hz signal for zero-crossing triac control.

Figure 2 shows the complete circuit diagram for the Spectracolumn. The audio signal provided by the music or other sound is picked up by the microphone insert MIC1 and amplified by IC1a, which is configured as a straightforward non-inverting amplifier with a gain of 100. The high input impedance required by the crystal mike is set by R1 to be about 2M0.

The audio input from this gain stage is taken via the sensitivity control. RV1 (acting as a potential divider) to the input of the filter system at R4. The audio filter system is built out of an MF10 monolithic switched capacitor filter. This IC contains two identical second order (12 dB per octave) filter systems which can be configured in a number of different modes, with the filter corner frequency being determined by a single square wave clock input.

We have used the MF10 to construct both a low-pass and a high-pass filter, which are wired in cascade. The resistor values shown have been chosen to give a pass band gain of 3 and a Q of 1. The cut-off frequencies are set to be 1/50th of the applied clock signals, which can be independently varied for each filter. Using high and low-pass filters in cascade results in a band-pass type of response, where the bandwidth can be very effectively controlled using the two input clocks, and positioned in any part of the spectrum. The clock on pin 10 of the MF10 controls the low-pass filter determining the upper frequency limit, and the clock input on pin 11 determines the high-pass filter's corner frequency, thus setting the lowest frequency that will be passed.

The clock signals are generated and selected using a separate block of CMOS logic circuitry. IC4c and d are configured as a standard CMOS astable to provide the master clock of 2 MHz. This clock is fed directly to the counter divider chip IC3 (a 4040). The Q outputs progressively divide the clock frequency by two to give those frequencies shown in Table 1. As music lovers will know, dividing the frequency thus will give us equal octave increments; the entire audio bandwidth is thus catered for using the 11 outputs of the 4040. The two remaining gates of IC4 take their inputs from the common pole of each 10-way rotary switch, SW1 and SW2, buffering the outputs from the divider chip and providing selectable clock frequencies to program the high and low-pass filters.

The band-pass filtered audio signal is coupled via C2 to a precision half-wave rectifier, built around IC1b. A positive-going audio envelope thus appears across C3. R16 determines the attack time constant and R15 the decay time constant. Potential divider RV2 supplies an offset voltage derived from the 1V4 reference to the non-inverting input terminal of the op amp IC1b. This allows a 'background' voltage level to be superimposed on the envelope voltage, giving an independent control of the light column's illumination. The 1V4 reference is created by the forward voltage drop across D1 and D2 which are biased by resistor R14; this reference is also used to feed the internal resistor chain of the LM 3915 at pin 6 of IC5. The LM3915 converts the envelope voltage applied at the pin 5 signal input to an array of 10 switched outputs. Pin 4 is the ground reference for the signal and resistor chain voltages; it is tied to the 5 V 'pseudo ground' rail. This half supply-volts rail is derived from the low-impedance potential divider R13,20.

Direct drive from IC5 to the triacs is achieved by connecting the neutral to the positive rail on IC5 and the common MT1 terminals of all the triacs. The switched outputs of IC5, which provide constant current, are taken directly to the gates of the triacs and the bulbs are placed in series with the triacs in the returning live lead. Now, resistor R21 is normally used for setting the output drive current of the LM3915, going from the pin 7 reference to ground.

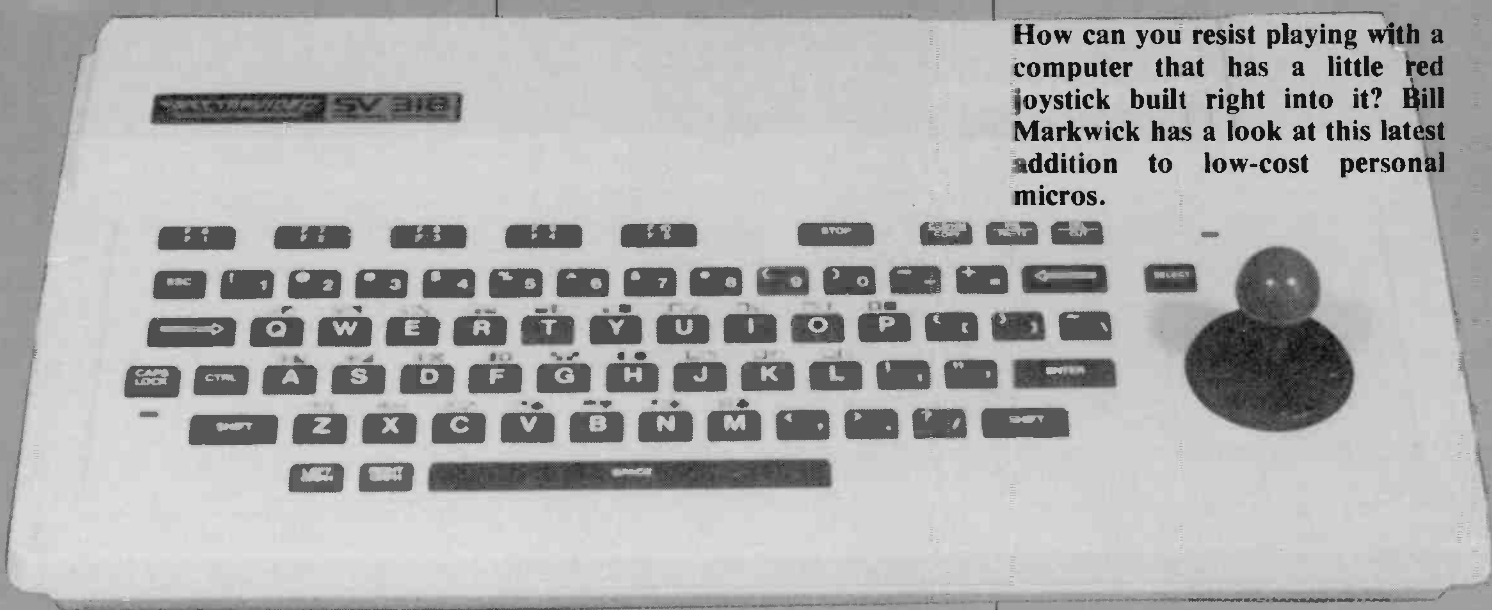
In our arrangement, however, it is switched to ground using Q1. Thus when Q1 is off, the constant current sources that drive the gates of triacs SCR1 to 10 will all be disabled, and the triacs cannot turn on. Q1 is driven by brief pulses derived from the zero-crossings of the power cycle; in other words, when the AC cycle reaches 0 V (which occurs 120 times per second), transistor Q1 turns on and allows the triacs to be triggered on only at this moment. The triacs automatically turn off again as the line current falls away to zero, assuming there is no further drive signal. For the triac to turn on then, the corresponding output from IC5 must be 'active' due to the sound level, and at the same time as a zero-crossing pulse occurs. By turning on the triacs and thus the lamp current flow only when the line voltage is close to zero, the problems of radio frequency interference are effectively avoided.

The circuitry is powered from a 10 V supply rail, regulated by the 10 V zener diode ZD1, and decoupled by C5. The centre-tapped 9-0-9 V transformer is full-wave rectified by D6 and D7; Q2 is driven by the 120 Hz signal at the junction of D6 and 7 to detect the zero crossing points. As the voltage cycle falls down to zero the voltage on the base of Q2 also falls. When it goes below 0V6, Q2 will turn off (the zero crossing point), thus allowing Q1 to turn on. D5 and R17 isolate the full wave rectified DC from the 10 V power rail.

Continued on page 58

Spectravideo SV319
Colour Computer

How can you resist playing with a computer that has a little red joystick built right into it? Bill Markwick has a look at this latest addition to low-cost personal micros.



THE SECOND thing you'll notice after the red joystick is that the keys are made of erasers, just like the VZ200 reviewed in a past issue. On firing it up, though, you'll find quite a difference: the VZ had a touchy keyboard that spewed out reams of letters when you didn't want them, and the SV318 has a very reluctant one that occasionally has to be punched firmly to get the key to register.

Once you get the hang of the wiggly keys, though, there's lots to look at hidden in the innards of this little machine. The rear panel sports a 5-pin DIN plug for audio and video outputs, so if you insist on using a TV set with the accompanying fuzz and wavey lines, you'll need the included modulator, a small box which resides in the middle of its connecting cord. The power supply is a separate unit, too; it gets to be quite a collection of boxes and wires.

Should you want to use a monitor with its attendant better quality, you'll have to go digging for the DIN plug pinout; it isn't listed in the Contents, but it's in there somewhere. More on this manual later.

Microsoft Touch

Having hooked all this up, the first thing to greet you is "Spectravideo" in three different colours, sort of like those old Cinemascope titles, and then the announcement that the BASIC used is SV-BASIC by Microsoft. There won't be any surprises here.

Well, there's one, and it's a good one. The SV318 has a decent editing system! It's almost as good as CBM's; just cursor up, make a change, and a RETURN enters it. And what cursoring! The little joystick serves as a cursor control when it isn't blasting aliens; pushing it to intermediate positions sends the cursor off at a 45 degree angle, and you can even go in circles, all with auto-repeat, of course. When I become King of Canada, all computers will be required to have this sort of feature.

32K RAM?

So says the box it came in. However, the screen credits say 12,815 bytes to begin with. Some digging through the manual (more on this manual later) tells you that 16K gets conscripted to aid the video generator, and the rest is sacrificed to the BASIC operating system. 13K is a hefty chunk of memory, but should you feel the need for more, you can expand it up to 144K by adding, you guessed it, more boxes to the outside.

Automatic Writing

Across the top of the computer live five function keys, ten if you use the shift key. These can be programmed by the user to pop out your sweetie's phone number and so on, but in their pristine state they supply you with single-keystroke words such as "run", "list", and best of all, "Auto". The Auto feature will supply BASIC line numbers in multiples of ten, each time you hit RETURN. Wonderful! Of course, unless you know how to unhook this feature when you're done, it will continue line-numbering forever, like the Sorcerer's Apprentice. I pawed through the manual in vain (more on this manual later), and eventually tried good old Control C; this worked, and popped me back to the real world. Oddly, you're supposed to use Control-Stop, which writes Control-C on the screen anyway.

Expanding

Bored with it already? No problem. One of Spectravideo's big selling points is expandability, and then some. There are ROM packs that plug into the top of the computer, adapters for Coleco games, modems, RS-232 adapters, 80-column cartridges, RAM packs, a disk controller, a disk drive, joysticks, a matrix printer, and more. They have more options than your GM dealer; hook them all up and you'll have to find another place for your model railroad.

Micro Music

Any computer worth its RAM now includes a music synth of some sort; the best part of the SV318's is that, wait for it, you specify notes instead of numbers! Notes! And not only that, you can generate three notes at once. Here's a C major triad:

Play "C","E","G".

If you specify only the note name, all the other possible parameters are set by default, the other parameters being Tempo, Length, and Volume. There is also the familiar "Sound" command which allows much greater control of tone, noise, and envelope shape. And the quality of sound? Pretty much like a kazoo, but then, all computers tend to sound that way.

Graphics

If you've followed the various discussions we've published on graphics in ETI and Computing Now!, you'll be familiar with sprites. If you haven't (shame!), a sprite is a small block of pixels, or picture elements, that lives on a dimensional plane of existence parallel to the screen. Other sprites live on other planes or layers, the whole idea being that they can move around and over each other without colliding. Usually, the pixels are turned on or off by much PEEKing and POKEing, but the SV318 uses READ and DATA statements; this is much more convenient. There isn't very much in the manual on the sprites (more on this manual later), but I typed in a sample program to see what would unfold. What unfolded was a persistent, nagging error message. An impassioned plea went down the hall to Steve Rimmer, who pushed and pulled and muttered magic spells and incantations, but all to no avail, and we had to shut him down because he was overheating. We never did find out much about the sprites except that they seem to be about eight by ten pixels.

More On the Manual

Some manuals are hard to use, and others don't quite tell you exactly what you want, and then there are manuals that are so dumb, you stuff them in the back of a drawer along with a set of almost-useable sparkplugs and a tri-lite bulb with one filament gone. The SV318's manual belongs in the latter class. You might well ask yourself, "Why would a manufacturer make such a powerful machine and then cripple it with such a manual?" You also might hazard a guess that the extensive software and game-playing ability of this box will keep sales up nicely, and the users who'll be wringing out the advanced BASIC can take a back seat for now.

The first thing you'll notice about the manual is cardboard dividers that make it impossible to thumb through. Then you realize that there isn't much point in thumbing through anyway, because (a) you can't find it, and (b) it isn't explained properly anyway. It's shot through with errors in both typesetting and program listings; for instance, there's an error in the explanation of the PAINT function, and this was caught by somebody somewhere and a photocopied Errata included. Unfortunately, they made another mistake in the Errata, and you won't get the PAINT to paint without bunches of experimenting. Mind you, once it works, it works beautifully to fill in areas bounded by a border of a different colour.

I suppose they could print another Errata, but to avoid snowing us under with photocopies, would somebody please write a decent manual for the person who's looking for information (as opposed to just trying out bits and pieces from front to back), and this time, write an Index, would you?

At the time of writing, this little pail of bytes was going for $399.95, but since computer prices change with the weather, check with dealers. Interestingly, the Commodore 64 is being discounted to just about this price range. The SV318 has a lot of the 64's features, such as sprites, music synth, good editing, good graphics, plenty of expansion and lots of memory (though less than the 64); it should give it a run for its money, especially if the price drops at all on the SV318. On the negative side is that detestable manual, which is about as good as no manual at all, and that elastic keyboard with the reluctant contacts. The 64 wins in these areas. To sum up: if you spring for this one, are you going to get stuck with a turkey? Not in the least. It's a powerful little wedge whose advantages far outweigh the bad points. Maybe they're at work on the keyboard and manual right now.

Quick Reference

SV318 Colour Computer
Mfg: Spectravideo, Hong Kong
Cost: $399.95
ROM: 32K
RAM: 32K
User RAM: 13K
Screen: 40 x 24 tex, 256 x 192 graphics
Language: SV BASIC by Microsoft
Connectors: Audio/video, cassette, expansion, joystick, ROM pack
Other Features: Includes RF Modulator, block graphics, 10 user-definable keys, hi-res graphics, sound synth., built-in joystick for cursor control and games, auto-repeat on all keys.

ETI

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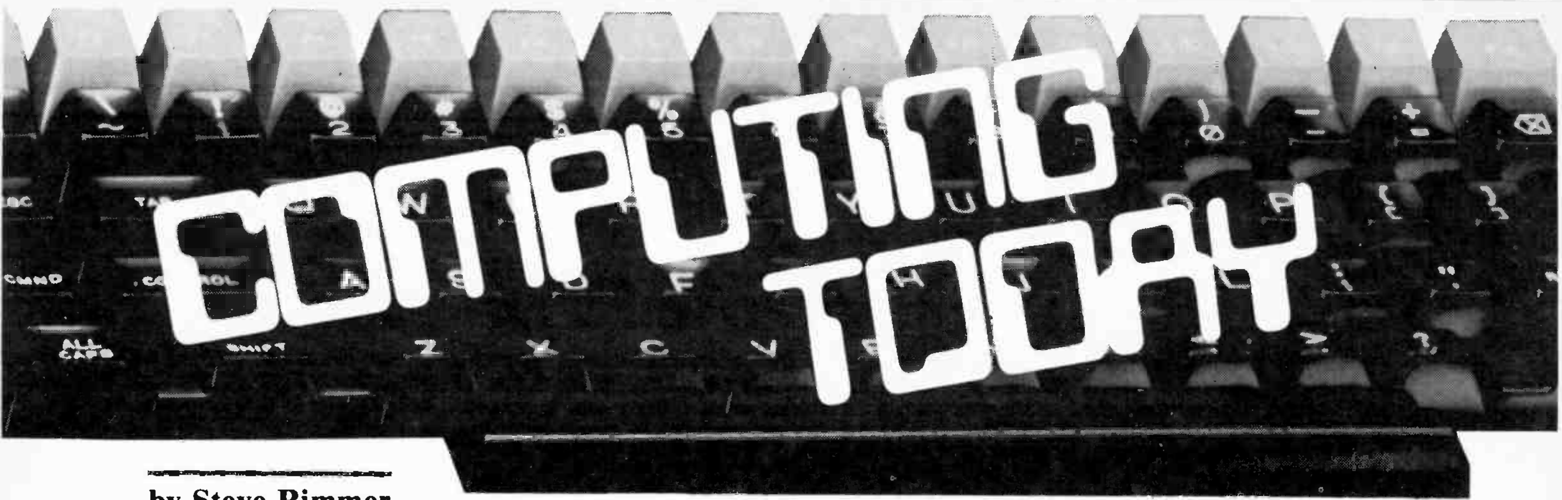


by Steve Rimmer

BULLETIN BOARDS ARE everywhere. A few years ago setting up an on line computer system was a heavy trip even if you had a fair idea of what the bits and bytes did . . . and the hardware was something only fit for contemplation if you owned stock in IBM. All of it. The systems that date back to the early days of BBS's are usually well rooted in sweat.

Things have definitely changed. At the moment, there are bulletin board system packages available for almost all the popular computers. Many of these are free, and most are pretty neat. If you have a micro, an auto-answer modem and at least one disk drive, you can probably become a sysop with very little additional investment.

How you explain the whine in your phone to the rest of the family is, of course, your problem.

What's Up

Getting going from a standing start in setting up a BBS is often a difficult undertaking because, while the hardware is usually all available off-the-shelf, coming up with a suitable software package to drive the whole mess can be tricky. Most often, bulletin board software turns out to have been written by really obscure parties.

Finding dealers who'll sell you BBS software is often hard enough. However, you may very well find that the package you want is completely free . . . a denizen of the public domain. This latter group of trolls is, if anything, more difficult still to locate.

This month we're going to look at what's available. Unfortunately, finding local sources for much of it is still up to the individual. However, it helps to know what you're looking for . . . and what it will do when you find it.

The following are certainly not all the BBS systems available, but they're probably among the best and the easiest to locate.

Commodore There is a really super BBS package available, for most of the professional series CBM computers, with availability for the Commodore 64 expected shortly. It's written by Steve Punter, the author of the Wordpro word processing package. It features automatic message reformatting, which makes entering messages a real slice. It's written in a combination of BASIC and machine code, making it customizable if you have a decent command of BASIC.

Apple There are a number of packages available for the Apple. The most often encountered is ABBS, which sprouts from some Apple dealers. It has a number of fairly handy features, including the capacity for **conferencing** . . . that is, a caller can request access to any of several completely different groups of messages.

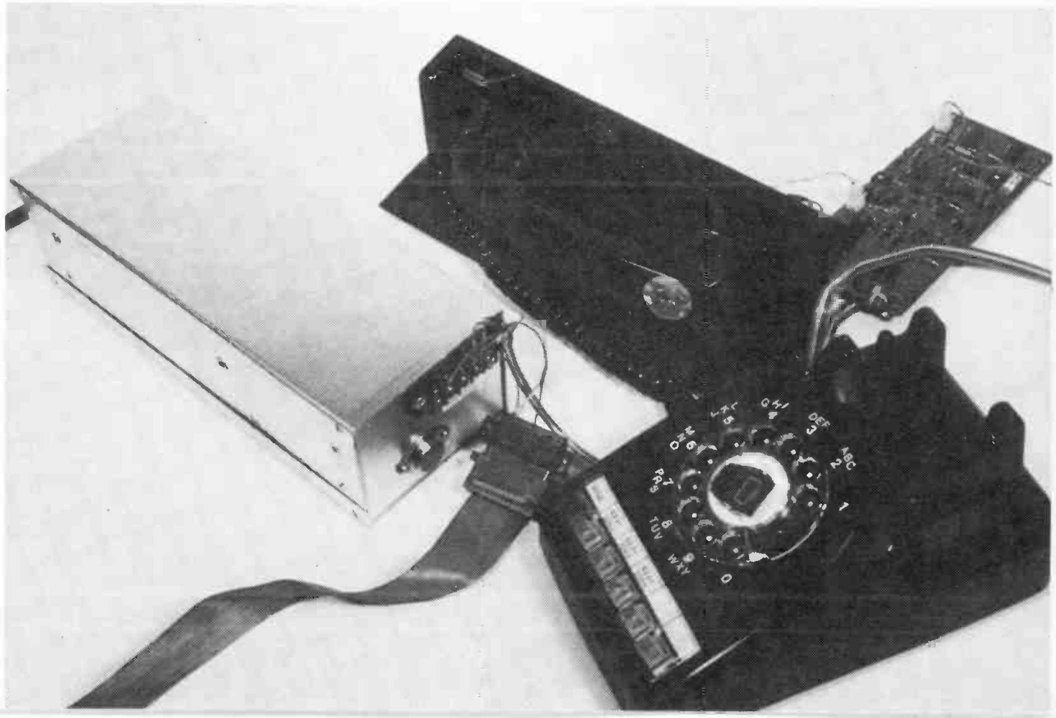
The unfortunate part about virtually all Apple based BBS packages is that they entail the installation of a relatively expensive D.C. Hayes **Micromodem** in the computer . . . if you are thinking about setting up a system on an Apple II clone, you may find that the modem costs as much as the computer. To this end, we've developed a system called the Fruit Crate, which is designed to interface with the real world over a low cost Pure Data PDA232C interface card. It will be outlined in the next issue of Computer Now! magazine if everything goes as planned.

You can also get a BBS up on an Apple by plugging a Z-80 card into it and running a CP/M based board. See the CP/M section below. This will entail the use of a program called BYE to interface the BBS to the real world. BYE is available in two forms for the Apple, APBYE and BYEII with a DC Hayes configuration block. The latter will run without any bus right out of the can. It took some heavy duty fighting to get the former going.

If you are thinking about this latter approach, read the caveats below.

TRS-80 There is a bulletin board package for the TRS-80 Models I and III . . . which should also run on the Model IV . . . called Connection 80. It is a pretty straight-forward package, with one decidedly nice feature which allows callers to scan through messages, marking the ones they want to peer at, and then have the system display all the marked messages.

There is no immediately useful package for the TRS-80 Model II running under TRS-DOS. If you get CP/M for the



Model II you can use the BYE program, but it is a very serious trip to make it run even moderately well. Our own bulletin boards use this approach, but the results are far from ideal.

CP/M In order to get a BBS package up under CP/M one normally needs both a BBS package . . . the thing that logs you on, handles the messages, and so on, and a host program to mediate between the computer and the outside world. This latter work is called BYE.

BYE is a public domain program which comes as an 8080 machine code assembler file. Unless you have one of the few systems which BYE is easily configured for, you will probably have to patch it, probably severely. If you can't deal with 8080 code . . . or can't find some really gullible fool who'll do the deed for you . . . you are probably sunk before you start.

For a more complete explanation of just what BYE is, and why it is so unspeakably complex, see the July issue of Computing Now!.

If you do get BYE going, you'll have a choice of several BBS packages. The easiest to come by is RBBS, a fairly large system written in MBASIC. It is meant to be compiled using BASCOM prior to actually putting it on line, although you can use it with MBASIC if you don't mind a slight reduction in speed. However, RBBS is quite huge . . . it's actually split into two modules to allow it to fit into the available RAM. It's also an abominable hack.

There is a much smaller board called PVT which is very similar to RBBS, but is a lot easier to work with.

Note that any system using a RBBS-like board requires an additional program called RBBSUTL to maintain the message files.

There is a very large set of programs which, when gotten up and running produce a replacement log-on module for RBBS-like boards called SIGNON. Signon is obscenely complicated, and really only worth the effort if you need the features it provides.

There is a really funky little BBS package called REDSTICK which is a lot tighter than either RBBS or PVT. However, it is written in CB80, a structured BASIC compiler language. You will not be able to compile the source code without this . . . rather extensive . . . compiler.

There is a BBS which is all written in Z-80 assembler. It's extremely fast, but a bit primitive. Called CBBS it is, unlike the other CP/M software we've looked at, not in the public domain, but must be purchased for real actual hard cash.

There are two CP/M based systems that don't need BYE. Both are written in the C language, requiring a BDSC compiler to get going. The simplest is called CNODE . . . it supports CP/M file exchanges, but, at last look did not have a true message function. The *Citadel* board is a very intricate tree structure system . . I've never been able to get all the files needed to make it work, so I can't say what it's like. It's written by a programmer who signs himself only as CrT. As such, it is also impossible to contact the author to get assistance with implementing Citadel.

Both of these systems require some really heavy duty patching in some cases, as they both do all their own communicating with the real world. You may find that getting one up is no easier than patching BYE.

Getting a bulletin board running is usually not simply a matter of plugging in all the right cables and letting it rip. One rarely winds up using a package in exactly the way the author intended. This entails making modifications to the software . . . prior to getting deeply enmeshed in a BBS project, you should make sure you are up to the programming aspect of it.

And then there's that phone problem.

ETI

Precision Pulse Generator

Fed up with boring, ordinary 1:1 mark/space ratio square waves? Here's a digital pulse generator that lets you stretch 'em or shrink 'em with finger-tip control. Design by Andy Elam.

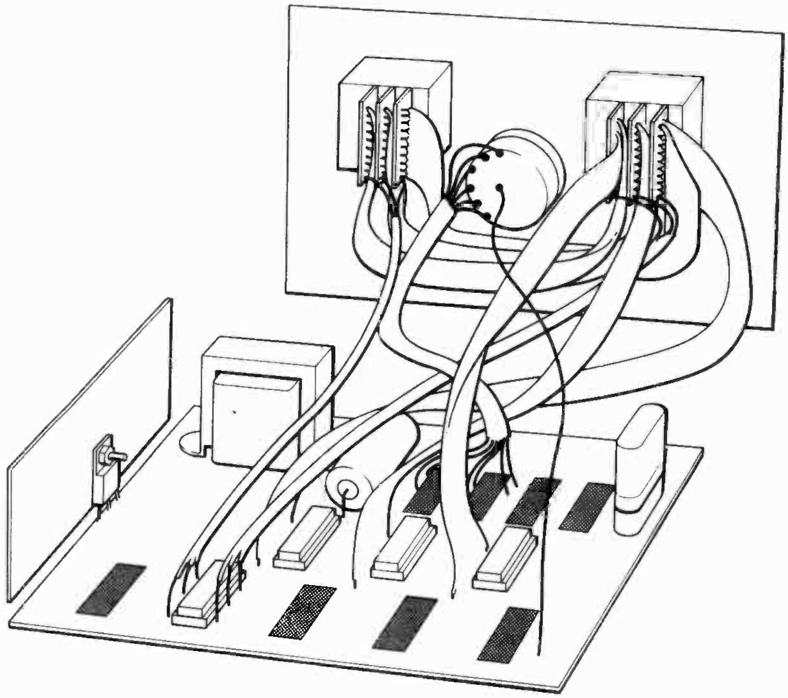


Fig. 1 Wiring diagram of board to thumbwheel and range switches.

THE PULSE GENERATOR described here is a piece of laboratory test equipment that can be built for a price that is modest when compared with equivalent commercial gear. It is a very accurate unit and has many applications.

Mark/space ratios from 1:999 to 999:1 and a wide range of frequencies can be set from the front panel. The unit delivers a clean TTL-compatible DC coupled signal, accurate to a very small fraction of a percent.

For convenience, thumb-wheel switches are used; these should be of the decade type. However, these are quite expensive, and you may possibly find these switches on sale in a surplus store.

Construction

The PCB should be assembled first. We recommend using IC sockets throughout to avoid damaging the ICs when connecting up the wires for the thumb-wheel switches, etc. Using Vero pins for the off-board connections will make life easier anyway. The voltage regulator needs a heatsink bolted on to it or it could be mounted directly on to a metal case (note that the metal tab is connected to the 0V line). Leave mounting the ICs and crystal until after the wiring is complete.

What sort of box you use to house the unit is up to you; it must, of course, be large enough for the board and all the other components. We used a die-cast aluminum box, and metal boxes such as this should be grounded. The most troublesome part of preparing the box will probably be the cutting of the holes to take the thumb-wheel switches. However, this must be done very carefully, because otherwise the switches won't stay put. Probably the best method is to use drilling and sawing to get an under-size hole, then carefully finish off using a flat file.

Wiring up the thumb-wheel switches should present few problems if colour-coded ribbon cable is used. The resistor colour code can be handy for sorting out what all the wires are — eg, use black for 0, brown for 1, etc.

Connect the crystal and insert the ICs, and, after a careful check to ensure that all the components and connections (particularly the power connections, the electrolytic capacitor and ICs) are where they should be and the right way around, you should be ready to switch on and go! If any problems develop, the first point to check is that the master oscillator is running, and after that the divide-by-10 counters in the clock generator are running (though this does assume that you have checked the fuse).

Continued on page 45

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TECH TIPS

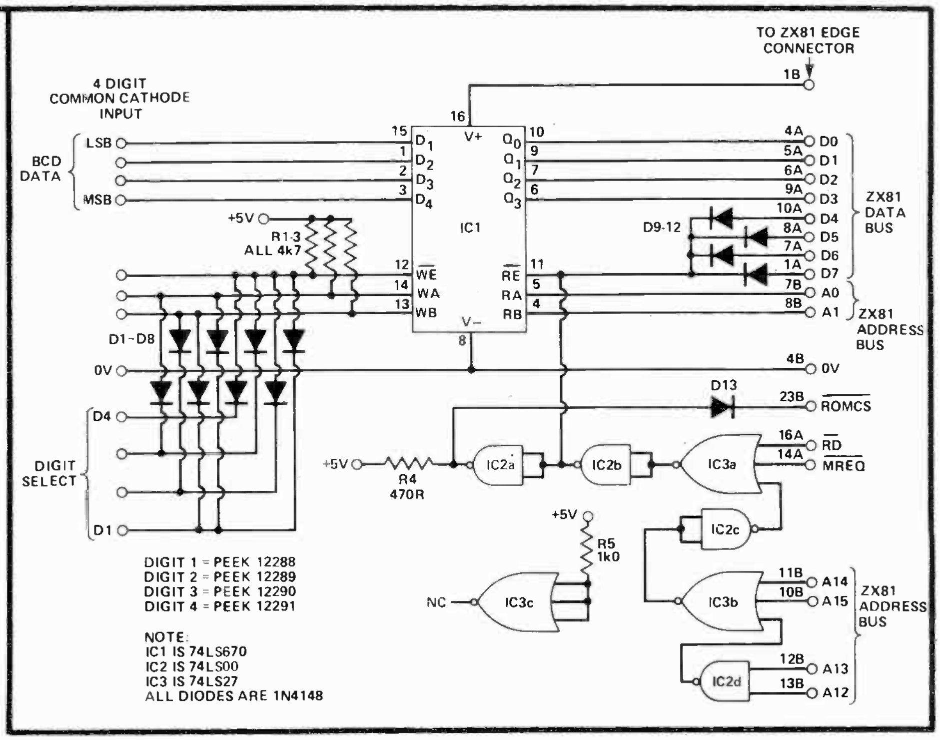
Four-digit Multiplexed BCD to ZX81 Adaptor
W.K. Todd

This device interfaces a four-digit common-cathode multiplexed BCD output device, such as the 7217 counter IC, with a ZX81. The circuit is based around IC1, a 74LS670 4x4 register file. The digit select inputs address the Write Address pins, WA and WB, via diodes D1-4. The Write Enable pin, $\overline{WE}$, is pulled low by diodes P5-8 when any digit is selected.

The ZX81 address decoding is performed by IC3a, b and IC2d. When an address between 12288 and 16383 is PEEKed, the output of IC2b goes low and enables the outputs of IC1 via the $\overline{RE}$ pin: the data is output onto the data bus on lines D0-3. Data lines D4-7 are pulled low via the diodes D9-12, allowing the computer to read the data bus directly.

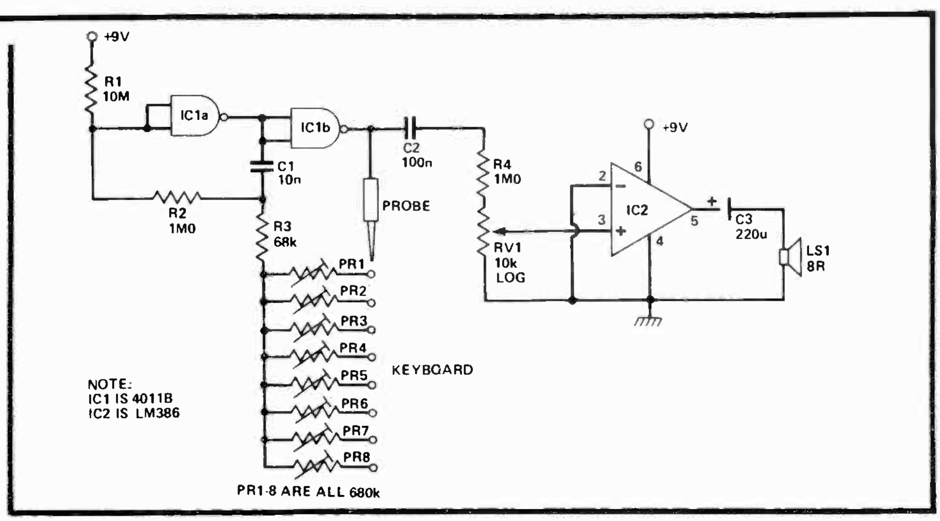
The Read Address of the register file is driven directly by the address lines A0 and A1. IC2a disables the internal ROM via D13 when the device is being PEEKed.

Common anode devices could be used with this circuit if the digit select lines were driven by transistor inverters.

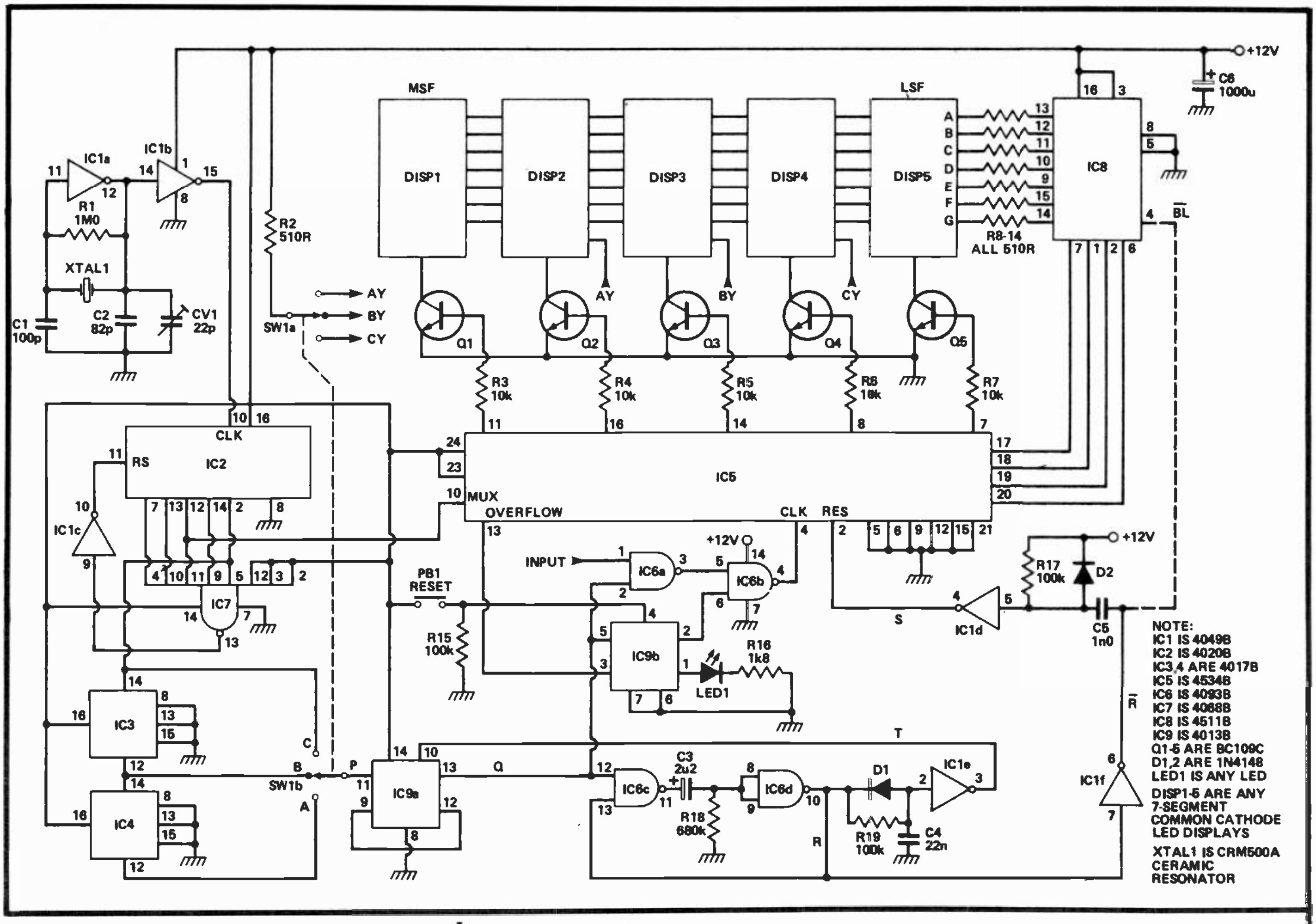


Simple Organ
J.P. Macaulay

With the financial climate being what it is, the following circuit may be of interest to harassed parents whose children want a stylophone. A simple oscillator is formed with two CMOS NAND gates (half a 4011B). Under quiescent conditions no sound is emitted. When the stylus is placed on the keyboard, the circuit is made through the selected preset and the oscillator produces a square wave which is coupled to the output stage, an LM386. This IC is ideally suited to this application since its maximum output is limited to 200 mW and its quiescent current consumption is 3 mA. This, together with the fact that both ICs will work with battery voltages as low as 4 V, means that a fairly long battery life can be expected.



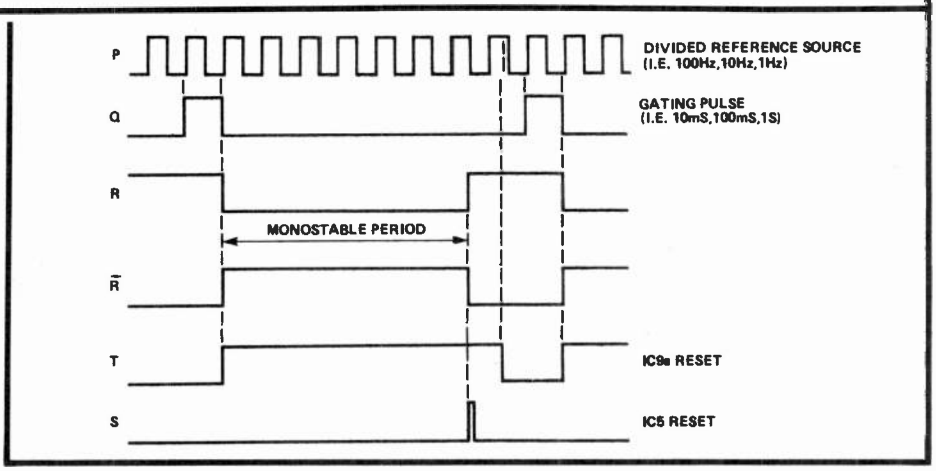
The organ will obviously require some form of keyboard. A simple one can be made from a piece of 0.15" matrix Veroboard with alternate tracks removed. Tuning is most easily done with the aid of a digital frequncy meter; if all else fails, the instrument can be tuned by ear against a piano.



Digital Frequency Meter
William Leung

The design shown is an alternative to those projects for DFMS that utilize one of those new-fangled all-in-one DFM chips. As you can see from the circuit diagram, the only additional circuitry required is an input preamplifier and a suitable regulated 12 V power supply.

IC5 is a real-time five-decade counter incorporating a multiplexed BCD output. With the aid of IC8 (a BCD-to-seven-segment decoder) and transistors Q1-5, the counter and display section of the DFM is formed. The BLANK pin on IC8 is used to extinguish the displays while IC5 is counting, otherwise pin 4 of IC8 should be connected to the positive rail. The frequency reference oscillator is somewhat unique in that a 500 kHz ceramic resonator is used. In practice it offers reasonable accuracy; however, the circuit can be easily modified to use a 1 MHz quartz crystal. In this case, the connections between IC2 and IC7 of the frequency divider section will require the inputs of IC7 to be connected to pins 3, 5, 12, 14 and 15 of IC2. Pin 14 of IC3 should also be connected to IC2 pin 2, and a suitable multiplexing frequency of around 1 kHz should be fed to pin 10 of IC5.



Depending on the position of SW1b, either 1Hz, 10 Hz or 100 Hz will appear at IC9 pin 11 (see Fig. 2, point P), where IC9a is a D-type flip-flop configured to divide by two. Should IC9a be continuously enabled, the output of IC9a will, in fact, be a square wave of half the applied frequency with a mark/space ratio of 1:1. This means that for a 1Hz applied frequency, 0.5 Hz will appear at IC9a pin 13 and the time for which the cycle will be high is, in fact, one second. This is then fed to the gate IC6a. However, only one such gating pulse is produced, after a certain time period set by C3 and R18. The monostable formed round IC6c,d is used to give the reading period of the display, when triggered, by enabling IC8 and disabling IC9a. At the end of the monostable period, a short pulse is produced at S which resets the counter. IC1e is there to ensure that IC9a is not enabled before the reset pulse to the counter is produced (see T), otherwise all hell will break out!

Finally, the D-type flip-flop that remains is used as the basis of the overflow indicator; on the transition of the counter from 99999 to 00000, a pulse is produced at IC5 pin 15 which latches IC9b pin 1 high, thus lighting up the LED. Pressing PB1 resets the whole system.

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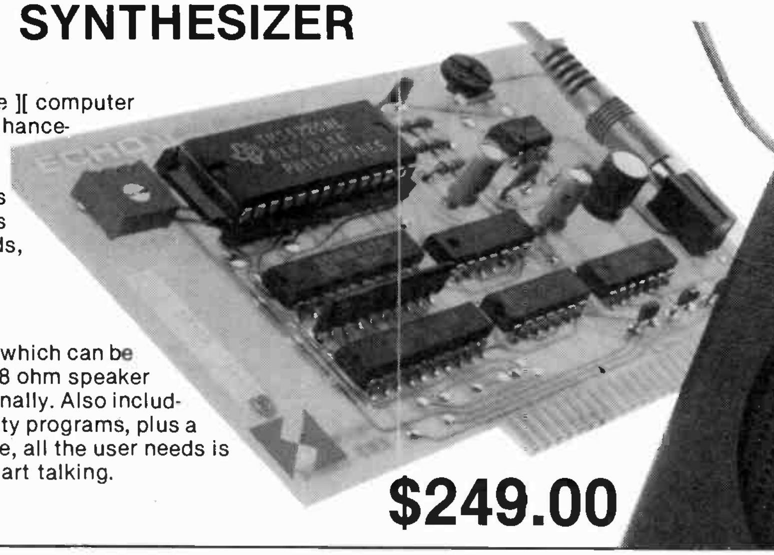

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Tech Tips Special

Keyboard Alpha-numeric Lock Switch
G. Franklin

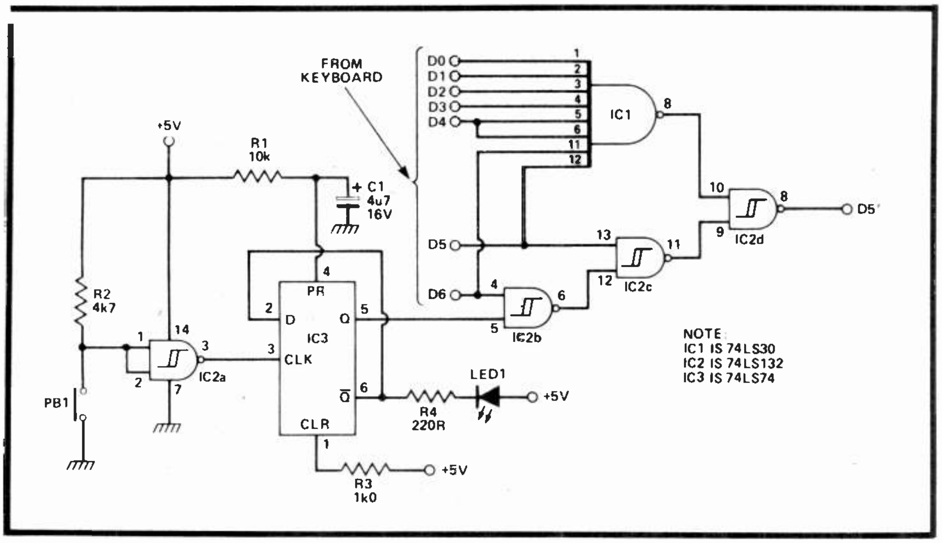
If your ASCII keyboard is like mine, then you too will have become tired of having to press 'SHIFT' for capital letters. SHIFT lock is useless because you have to 'unlock' to use the numbers. This circuit does away with this problem by providing you with yet another key to press. This is the 'ALPHA LOCK' switch.

If you study the ASCII codes, you will find that to change 'a' into 'A' requires only the removal of the logic '1' on the data bit 5 line (of the 8 bit bus from the keyboard to your computer).

e.g.:	a	A
ASCII code	a	A
in binary:	01100001	01000001

We require to alter the complete alphabet, this stretches from a ($61) to z ($7A). The circuit cheats slightly, by altering codes $60 to $7F inclusive, the only problem with this is that $7F is the ASCII code for 'DELETE'. IC1 deals with this, by detecting the $7F code and making sure D5 stays at a logic 1 via the NAND gate at the end of the circuit.

One quarter of the 74LS132 is used to give a degree of switch bounce to S1. Every time S1 is pressed, the Q output of the latch (IC3) will change, R1 and C1 ensure that on power-up the output is at a logic 1. This, along with data bit 6 being 'HIGH' will make D5' a 'Low', thus shifting a $60 code down to $40 (unless of course it was the 'DELETE' key that was pressed). The LED will come on to show when the ALPHA mode is selected. To insert this circuit into your keyboard, it is only necessary for D5 to come via this circuit, D5' then continuing in its place to the computer, the other data lines just reconnect to the circuit. The only other requirement is that you insert a switch somewhere.

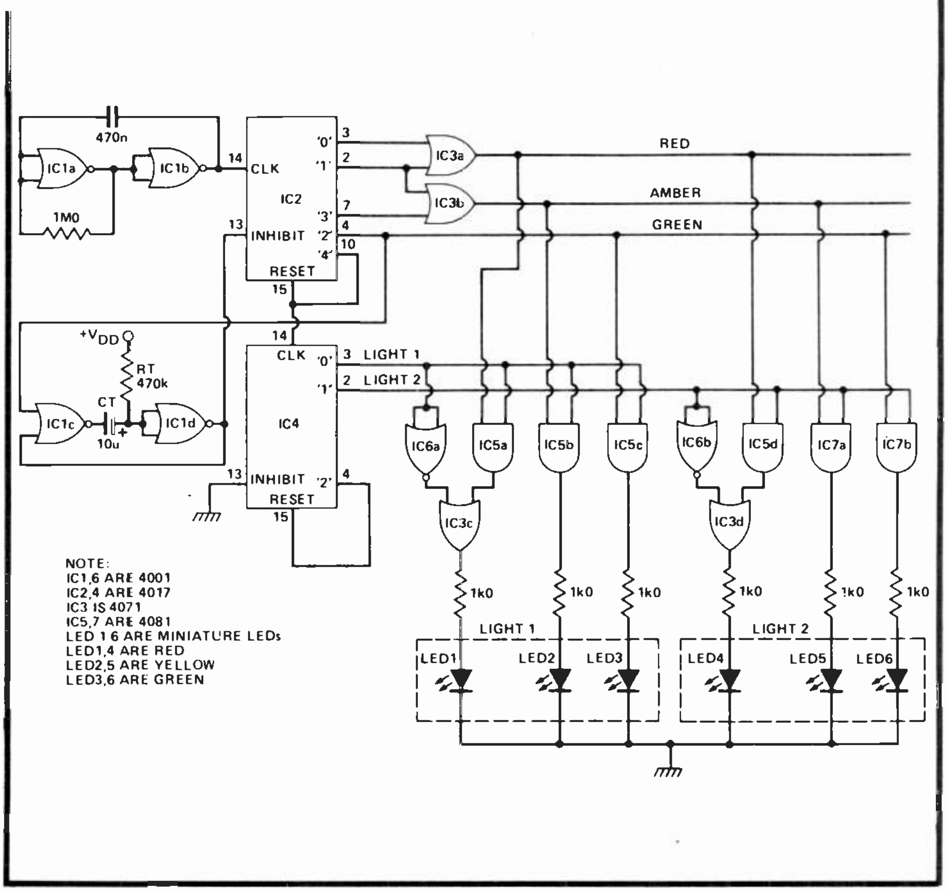


Controller For Model Traffic Lights
P. Pailey

The circuit shown was devised to control LED traffic lights at a road junction in a model railway layout, for added realism. IC2, a decade counter, together with IC3a and IC3b, generates the normal traffic light sequence continuously at a rate determined by the oscillator formed around IC1a and IC1b. A monostable formed by IC1c and IC1d is triggered by a '1' on the 'GREEN' output, and inhibits IC2 for a period set by C_T and R_T, thus causing the green light to be on for a longer period than the others.

IC4 selects either LIGHT 1 or LIGHT 2 to display the sequence, these being selected alternately. When one light is changing or at green, the other is held at red.

The controller is easily expanded to operate more than two lights by using further outputs from IC4, but if this is not required, IC4 could be replaced with a single flip-flop stage (eg. da 4013), set to toggle, LIGHT 1 and Light 2 being connected to the Q and $\overline{Q}$ outputs respectively. With a little ingenuity, realistic-looking traffic lights can be constructed from miniature LEDs and empty pen refill tubes.



Tech Tips Special

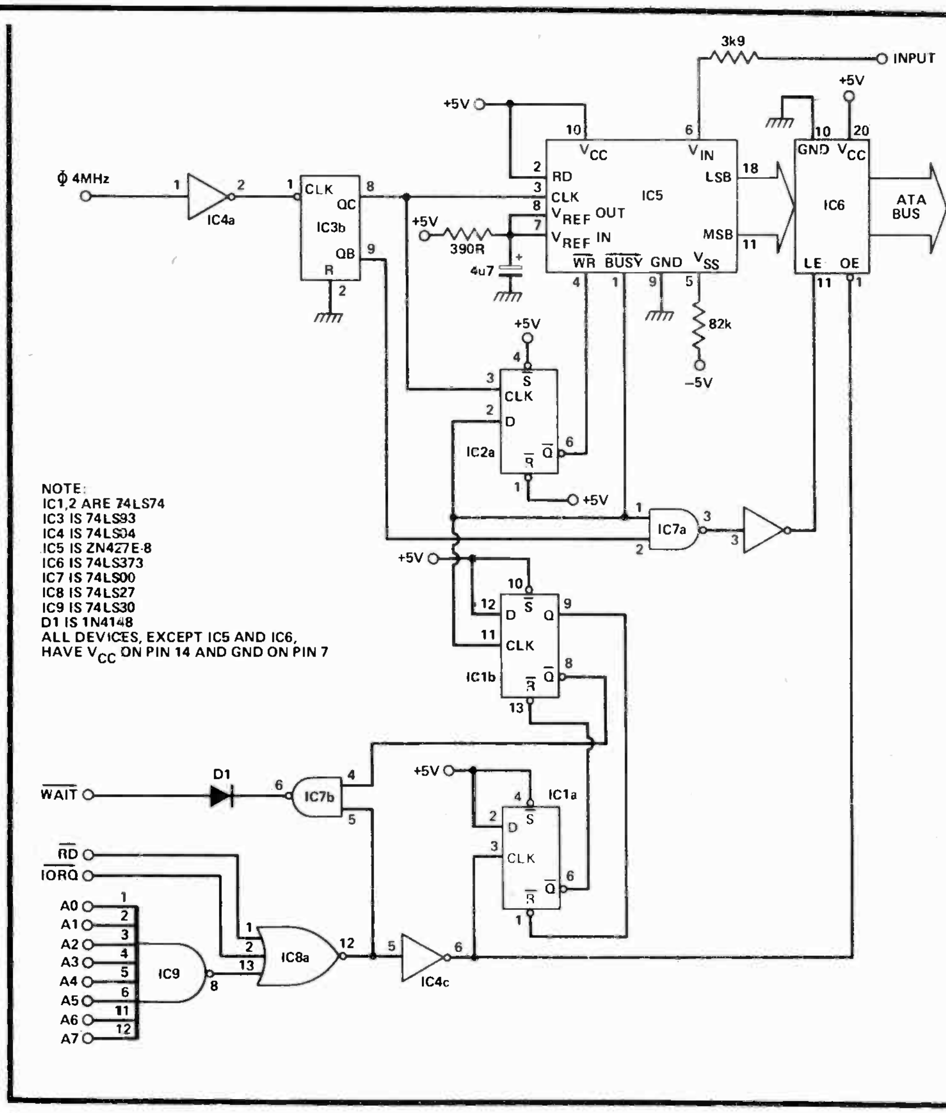
High Speed Eight-Bit A-to-D Converter

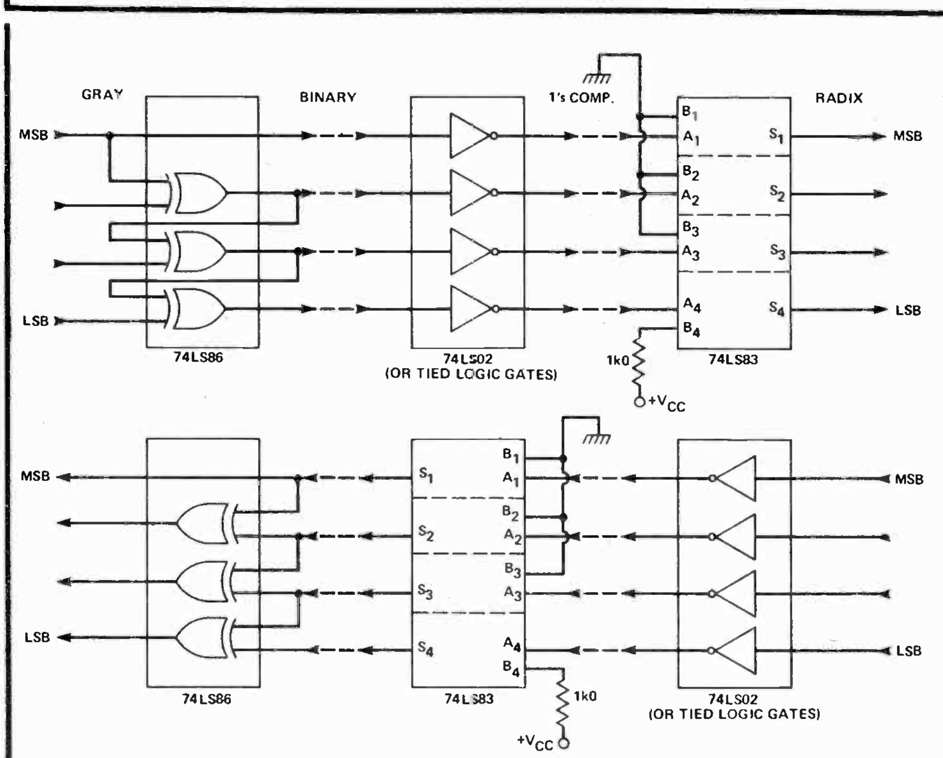
Michael Jones

An analogue-to-digital converter is a useful device for any computer system. The circuit shown operates at up to 100,000 conversions per second — making it ideal for use with the full range of audio frequencies. As shown, the circuit has just one channel; more may be added by using more converter ICs (for maximum speed) or using an analogue multiplexer, such as the CD4051, which has eight channel inputs selectable under software with a three bit output port. If it is to be used at full speed, machine code programming is essential.

The given circuit will work on any Z80A system running at 4 MHz without automatic I/O cycle wait state insertion. It will work with slower clock frequencies with corresponding increase in conversion time. Decoding occurs on port 0FFH only; this may be changed by placing inverters on the appropriate input to IC9. There is no need for a status port since the circuit is constantly converting and latching the result in IC6. It returns the result of the most recent conversion when read, unless it has already been read, in which case it inserts wait states until the current conversion is complete. In this way continuous reading will guarantee one result per 10 microseconds. It is not possible, because of time constraints, to use polling software. In addition, this arrangement permits a DMA device to carry out the transfer in the background. By adjusting the clock reduction circuit around IC3 it should be possible to cater for frequencies of 2 MHz or less, but still having 100,000 conversions per second.

Circuit operation is fairly simple. ICs 8 and 9 decode the input port, so enabling the tri-state latch (IC6), the WAIT gate (IC7b) and the wait latch (IC1). The latter ensures that WAIT is only issued when there is no new data. IC2a restarts the conversion as soon as possible after the end of the previous conversion. IC7a and IC4b latch the data into IC6 after it has settled. The actual converter (IC5) accepts an input in the range 0-2V55 in 10 mV steps, continually outputting its best estimate on pins 18 through 11 using successive approximation (binary search). Care should be taken that the input doesn't exceed 3V5 or become negative.





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Optical Memory Systems

Improvements in the technology of optical disks may mean that they'll be giving the magnetic media a run for their money.

By Roger Allan.

Matsushita's Panasonic Optical Memory Disc Recorder, claimed to be the only disc recorder in the world which can record and erase up to one million times.

MOST READERS will be familiar with optical recording discs as being those rather pricey items in the better record shops which presume to give extraordinarily high quality playback with no audible deterioration over time. Few readers, in fact, will have ever used such a disk system due to their currently outrageous prices: $25-35 for a disc, $1,500 plus for the system with $15,000 plus as a minimum set-up cost for a business quality system. But nonetheless, with volume production, it is believed in the record and computer industries that as a memory system they are very much the wave of the future, with good potential cost-wise, volume of data capable of being stored and retrieval times. More specifically, after some ten years of research, primarily in Japan but also in the U.S. at RCA, Shugart and others, optical recording systems have been found to provide a number of major advantages: very high information densities of 10^{10} to 10^{11} bits per disc, very high data rate of up to 50 Mbits/sec in a single channel recorder, rapid random access to the data, a cost projection of 5×10^{-8} cents/bit, and the potential for archival storage capabilities (more than 10 years without deterioration).

Reading and Writing

The process of reading and recording on such a system is superficially simple. Essentially, for recording, the output of a laser is directed through a modulator that varies the intensity of the light in response to an input electrical signal. This laser beam is enlarged by the recording optics such that it will fill the aperture of the focussing lens. This lens focuses the laser beam into a small area on the recording medium so that the intensity of the beam results in the information being stored as a series of 'spots' along a track in the surface of the recording medium.

Readout is essentially the reverse process. However, the laser beam is unmodulated and less intense. The laser beam is reflected from the recorded 'spots' and passes back through the focussing lens and a quarter-wave plate. The light is therefore rotated through 90 degrees in polarization by the two passes through the quarter-wave plate. It is then passed through a polarisation beam splitter, detected by a photodetector and converted into an electrical impulse.

The radial position of the laser's spot on the disc is determined by the position of the motor driven translation stage and the track mirror. The control system can move the translation state so that either spiral or concentric circular tracks can be recorded. During the readout (translation) stage, it is used to determine the approximate track location, while the track mirror provides the fine tracking control to lock on the read the desired information.

The primary factors that determine the bit density along a disc are the number of tracks (revolutions), the number of bits per recorded area (modulation-encoding scheme), and the minimum recorded area size per bit. Further, the spacing between tracks is pivotal in preventing cross-talk.

Lasers

There are a variety of lasers in such in such optical memory systems. The Helium-cadmium (HeCd) laser produces the shortest wavelength beam and thus produces the smallest recording element. This provides for the highest disc-data capacity and the highest single-channel recording rate. The Argon (Ar+) laser has a much higher output power and can therefore have its beam split into a number of sub beams (up to nine). These can be independently modulated and used to simultaneously record data on different tracks. To date the most commercially acceptable laser has been the Helium-neon (HeNe) due to its proven lifetime characteristics.

As part of the fallout from studies in integrated optics (see Light Memory, ETI, Aug 1982) semi-conductor lasers are beginning to be used. Unlike the gas lasers mentioned above, semi-conductor lasers have permitted the design of extremely compact systems with significant reductions in the size and cost of the system. Since the output power of the diode laser, such as the aluminum-gallium-arsenide variety (AlGaAs) is capable of being directly modulated by the input signal, the external light modulator common to all gas laser optical recording systems can be eliminated, ultimately permitting extremely high data rates measured in the Mbit/sec range. Further, the diode laser is potentially more reliable than its gas brother and uses less power.

For example, the CDH-LOG (constricted double-hetero junctional large optical cavity laser) laser diode provides for high power, up to 100 mW, and a good lifetime (10,000 hours).

A diode-laser optical recording system has some differences from a gas laser system. It begins with a microscope objective of sufficient numerical aperture to collect most of the laser light, customarily having a NA of 0.35. Due to the asymmetric beam spreading in the lateral and transverse planes, further beam conditioning is required. This is accomplished by a combination of two simple plano-convex cylindrical lenses that function as a beam expander in one dimension. When the optical system is aligned, an approximately symmetrical beam just fills the focussing objective lens (NA of 0.83) producing a spot size of 0.6 um in both the lateral and transverse directions. Following this are the standard readout paths such as the tracking mirror, quarter-wave plane, polarising beam splitter and photodetector.

A separate laser can be built in, operating at a lower power than the writing laser, so that a read-after-write (RAW) system can be used to verify that the data has been recorded without errors. This is due to the data being written in real time.

There are essentially three ways that this data can physically be recorded on the optical disc: pit forming, bubble forming and a reversible mode.

The Pits

The basic and most widely used method involves the formation of pits. The highly focussed laser beam serves as an intense and extremely localized source of heat. A thin film is locally heated by the focussed laser beam, and surface tension opens a hole or pit in the melted area. The simplest ablative recording medium that has been used for optical recording is a single 30 to 50 nm vacuum deposited layer of metal. This type of optical recording structure reflects about 40 percent of the incident light and also absorbs about 40 percent, the rest being transmitted. It is essentially of trilayer construction. A substrate is first coated with a reflective layer of aluminum, followed by a layer of transparent dielectric material and finally with a very thin layer of the metallic recording medium. By choosing the thickness of the dielectric and thin metal layer appropriately, it is possible to create an anti-reflection condition for light of the recording wavelength. This results in a very high fraction of the incident beam being absorbed by the thin metallic layer. The optical coupling of the trilayer structure can thus be up to twice that which can be achieved by use of a single layer of the recording material due to the losses by reflection and partial transmission through the single layer.

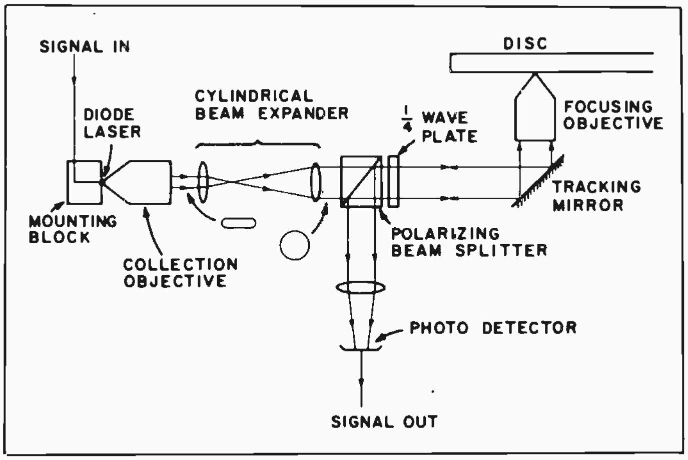

Fig. 1 The optical components of a diode-laser optical recording and playback system. The cylindrical beam expander and objective lens are the major items. Illustration courtesy of RCA.

Of a large variety of low melting point metals used, tellurium (Te) has been found to provide the highest playback signal-to-noise ratio.

The thermal efficiency of the process depends not only on the thermal properties of the recording medium and material in contact with this layer, but also on the duration of the pit-forming process. This in turn is dependent on system-related factors such as recorded signal bandwidth, laser-output cycle, turntable speed and laser spot size.

The presence of the aluminum-reflector layer in the trilayer structure represents a potential heat sink that may reduce the thermal efficiency of the recording process. The heat generated in the tellurium layer by the absorption of the incident recording beam will diffuse through the dielectric layer, and after some characteristic time, dictated by the thickness and the thermal properties of the dielectric layer will reach the aluminum-reflector layer. Since aluminum is a good thermal conductor, once this layer is thermally coupled into the process of pit formation, the thermal efficiency of the recording can be substantially reduced, leading to corresponding reduction in the recording sensitivity.

Essentially, in order to eliminate the deleterious effects of the heat losses to the aluminum layer, the parameters of the dielectric layer must be specified such that the thermal time constant for heat to diffuse from the layer of the recording medium to the aluminum layer exceeds the duration of the pit forming process.

Bubble Machine

The second process involves the formation of bubbles. In this mode, the absorbing layer is a high-melting point metal such as titanium instead of a low melting point metal such as tellurium, and the dielectric layer material is chosen to have a vaporisation temperature well below the melting point of the absorbing layer. Upon exposure to the highly focussed laser beam, bubbles are formed as the top layer bulges due to the gas pressure from the vaporised dielectric layer underneath. The readout process is similar to that of the pit forming mode, eg. high-reflectivity recording regions and a low-reflectivity unrecorded region.

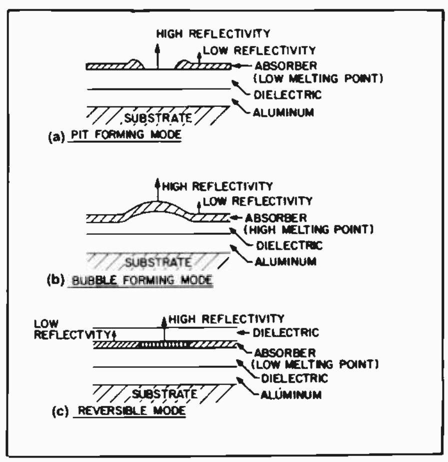

Fig. 2 The three different recording modes of the layered optical disc structure. Illustration courtesy of RCA.

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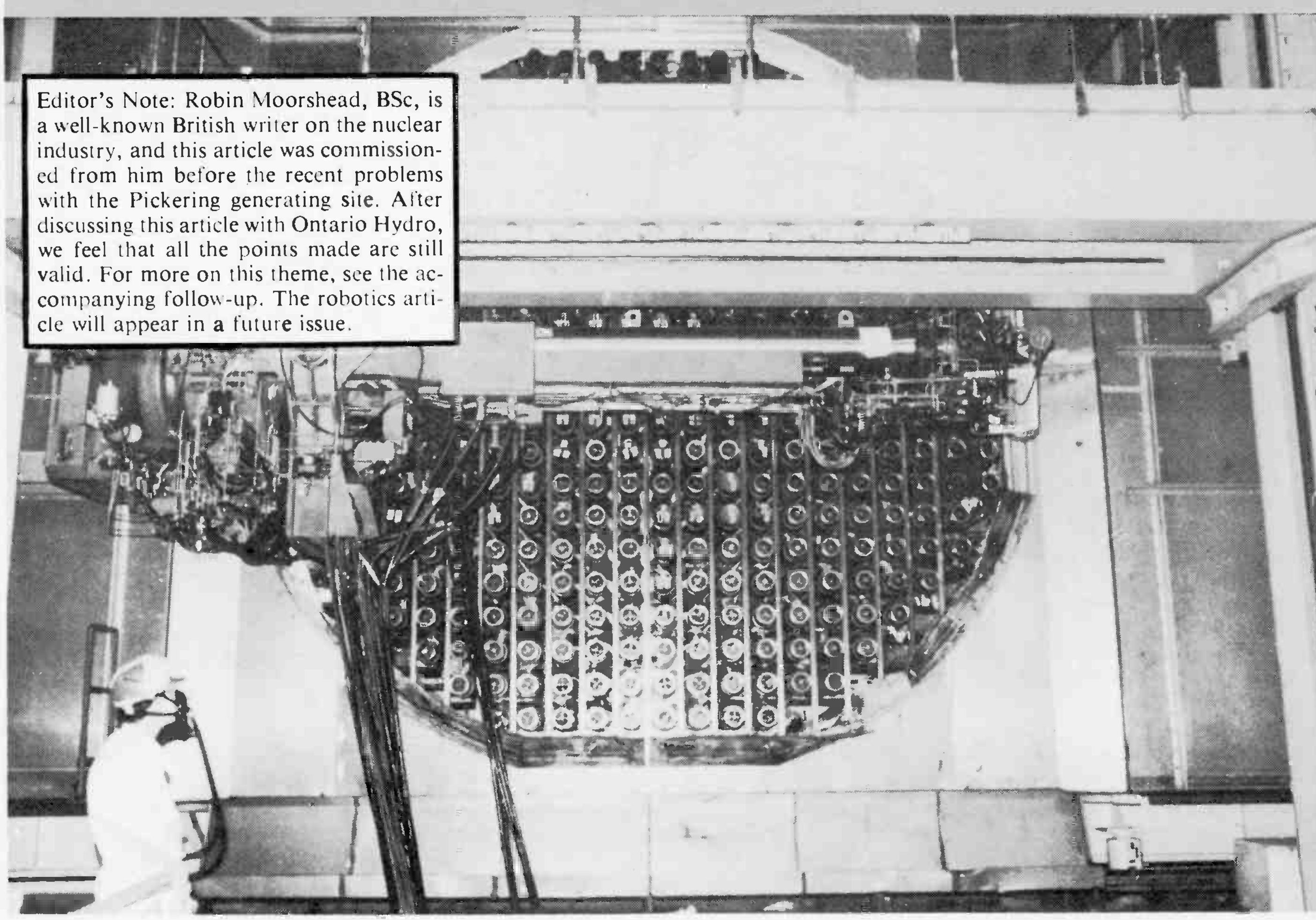
CANDU Reactors



Editor's Note: Robin Moorshead, BSc, is a well-known British writer on the nuclear industry, and this article was commissioned from him before the recent problems with the Pickering generating site. After discussing this article with Ontario Hydro, we feel that all the points made are still valid. For more on this theme, see the accompanying follow-up. The robotics article will appear in a future issue.

THE "MANHATTAN PROJECT" to create the atomic bombs that were dropped on Japan in 1945 was the combined effort of American, Canadian and British scientists. However, almost all the facilities constructed for the project, such as experimental reactors, were in the U.S.A. As soon as the war was over, the U.S. government passed the McMahon Act making it illegal for Americans to give any information on nuclear energy to foreigners. The rationale behind the act was to avoid proliferation by restricting knowledge of the bomb to as few people as possible. As you well know, the effort was futile. The net effect was twofold; firstly, the most powerful group of nuclear physicists ever assembled was disbanded for ever as the non-American scientists were called home by their respective Governments. Secondly, each country set up its own nuclear research facility and embarked on its own programme.

The American efforts were concentrated in two directions: to build bigger bombs, and to develop a small reactor capable of powering a submarine. The British concentrated on making their own bomb, and indeed had one within five years. They did, however, pull off a magnificent coup by being the first country in the world to produce electricity from a nuclear reactor. This was hailed at the time as "swords to plowshares", and the advent of "free electricity for the nation". The fact is that this first reactor at Calder Hall produced a mere 25 megawatts of electricity, far too small to be commercially viable. It was in reality a plutonium factory. The Canadians, on the other hand, did not want a bomb, nor did they have any urgent need for more electricity. As a result they concentrated their efforts into research on commercial reactors.

This historical perspective explains why three countries who had initially cooperated on the development of nuclear power finished up with such astonishingly different types of reactors. The British managed to develop their plutonium-producing "Magnox", and the later "advanced gas cooled reactors" (AGC), into reasonably efficient, but somewhat unreliable power producers. The Americans, put out by the British publicity coup with Calder Hall, stitched a submarine reactor to a turbine and the now infamous "Pressurized Water Reactor" (PWR) was born. The Canadians, not beholden to military pressure, nor in desperate need for alternative energy sources, took a full 25 years to develop a safe, reliable and efficient commercial reactor, the CANDU.

To understand the differences between the three types of reactors, here are the principles on which the reactor works.

Reactor BASICs

There is just one naturally occurring nucleus that will fission easily, that of Uranium 235 (the 235 refers to a particular isotope of uranium; the more common non-fissile form is Uranium 238). Occasionally such a uranium nucleus will split of its own accord. It will do it reliably if struck by a suitable missile; such a missile is a neutron, itself one of the building blocks of the nucleus. Very conveniently, a uranium nucleus splitting releases two or three neutrons. If these neutrons are then encouraged to cause other fissions, a "chain reaction" can be established. If this is allowed to happen in a big lump of pure Uranium 235, all the uranium will be burned up in a few millionths of a second, and you have a bomb. On the other hand, if you use Uranium 235 diluted with non-fissile Uranium 238, and ensure that on average one fission leads to only one new fission, a stable, continous output of heat is established. Such a condition is known as "critical" and is the basis of a nuclear reactor. It would appear to be impossible to keep a reactor in critical condition if one fission leads to more than one neutron, since the activity should multiply. However, control is quite simple.

Reaction Control

1. Some neutrons are absorbed by the non-fissile Uranium 238. This has the double advantage of helping to control the reactor activity and converts the otherwise useless Uranium 238 into another fissile material, Plutonium 239, which then becomes part of the fission process, contributing as much as 30% of the total energy output.
2. Some neutrons escape from the system and are absorbed by the reactor vessel or the concrete shield surrounding it.
3. The smaller nuclei left after fission known as "fission products" act as neutron absorbers.
4. Precise control of the neutron flux can be achieved by raising or lowering rods of a neutron-absorbing material such as boron, cadmium or steel into the reactor core, or by introducing some other neutron-absorbing material. In the event of a problem, these absorbers can be inserted into the core, stopping the reaction immediately. This is known as a SCRAM. Commercial reactors use separate banks of rods, one for normal reactivity control, and one for fast shutdown.

Somewhat surprisingly, fissile nuclei absorb slow moving neutrons better than they do fast ones. Since neutrons produced by fission are very fast, they have to be slowed down. This is done by placing amongst the fuel a "moderator". The moderator is usually ordinary ("light") water, heavy water, or graphite (carbon).

Fuel Burn-up

Fuel rods don't last forever. Apart from distortion caused by changes in the rods, the fuel runs out. There is an astonishing difference in the use different reactors can make of their fuel. This is expressed as the fuel burn-up in megawatt days per ton, i.e., how much power for how many days you will get from one ton of fuel.

The CANDU and MAGNOX reactors both use natural (0.7%) Uranium 235; however, CANDU achieves a burn-up of 7,000 megawatt days per ton, while the MAGNOX achieves only 3,800.

As a result, the CANDU fuel rods are not worth reprocessing, while the MAGNOX have to be, which is costly and dangerous. The PWR and AGC reactors achieve high burn-up figures, but they use enriched fuel, and consequently produce proportionately poorer figures. Their fuel is reprocessed.

Moderator

By far the best moderator is heavy water, which is used in the CANDU reactor. It slows neutrons down much better than either light water or graphite. Also, being a liquid as used in the CANDU format, it can be drained from the reactor very quickly to stop the reaction in an emergency (although some CANDU reactors use a "poison" injection system). Heavy water is very expensive (about $60 a pound), and this is a disadvantage in cost, but has been responsible for much greater care in design to avoid loss. It has been suggested that this aspect of design philosophy has been a major contribution to CANDU's reliability.

"No other topic can generate emotion outbursts quite like nuclear power . . . anti-nuclear arguments often have a curious lack of fact."

Another separate advantage of the heavy water moderator is that CANDU reactors can uniquely be modified to use another isotope, Thorium 232 in place of the Uranium 238.

The Thorium 232 absorbs a neutron and becomes Unranium 233, which is fissile and becomes part of the energy producing process. There is at least three times as much Thorium 232 available as Uranium 235. Using only Uranium 235, we have about 50 years energy supply; if thorium 232 were included in the cycle, we could have many centuries of power.

The PWR, by using the cooling water as a moderator, cannot dump the moderator in an emergency, as there would be no way of removing residual heat in the reactor core.

Cooling

Water cooling offers the advantage that there is a large body of design knowledge about high-pressure liquid cooling systems, and water is an extremely efficient heat-transfer medium.

A disadvantage is that water boils at 380° C regardless of the pressure applied to it, and the resulting steam is a poor transfer medium. The upper temperature of a water-cooled reactor is thus limited, and hence so is the thermal efficiency.

Gas cooling, on the other hand, does not call for high pressures, but does require large mass flows. Theoretically, much higher temperatures are possible, but experience shows that this can give rise to materials problems in both fuel and reactor structure. For instance, the magnesium fuel cans used in the MAGNOX reactors could actually catch fire from overheating; the carbon dioxide coolant is separated into its constituents, and the fuel cans then oxidize, adding more heat to an already overheated core.

A similar effect can occur with the fuel bundles in water-cooled reactors; this destroyed the core at the Three Mile Island site. Obviously, the emergency cooling system for the core is critically important.

Power Density

The original design objective of the PWR was to make it small enough to fit in a submarine, and as a result it has a great deal of energy stored per unit volume (100 kilowatts per litre). In the event of a problem, action must be taken very fast to dispose of the concentrated heat. This again was a contributing factor to the Three Mile Island accident. The other three have substantially lower power densities with proportionately more time to sort out problems if they arise.

Overall Safety

There are two separate parts to safety: firstly, the design philosophy of the reactor and its safeguards, and secondly, the attitude of the operators. Ontario Hydro have clearly laid out their philosophy in respect of system design and operation:

1. **Redundancy.** For example, instead of having just one pump, two are connected in parallel. Thus if one fails the other can take over.
2. **Diversity.** There must be more than one way of doing a job, e.g., as well as having a SCRAM mechanism, a "poison" such as gadolinium nitrate can be injected into the core. This will stop fission just as effectively as the primary mechanism.
3. **Separation.** The components of different safety systems are separate from one another, so a catastrophe in one location will not affect system components in the other plant locations.
4. **Independence.** Safety systems are independent of each other. For example, each safety system must run from its own power supply.
5. **Failsafe.** When a component fails, it triggers that component or system to move to a safe condition. For example,

Scram rods are held up by electromagnetic clutches; an electrical failure automatically drops them into the core, stopping the reactor. An important factor contributing to the Three Mile Island accident was that valves to the "auxiliary feedwater pumps" had been left closed after maintenance. It should not have been possible to start up and operate the reactor in this condition.

Except for the recent pressure tube problem (see accompanying box), there have been no accidents in the twelve years of commercial operation of CANDU reactors. This is testimony to the *attitude* of operation as well as the safety of design. The majority of accidents are at least in part caused by operator error.

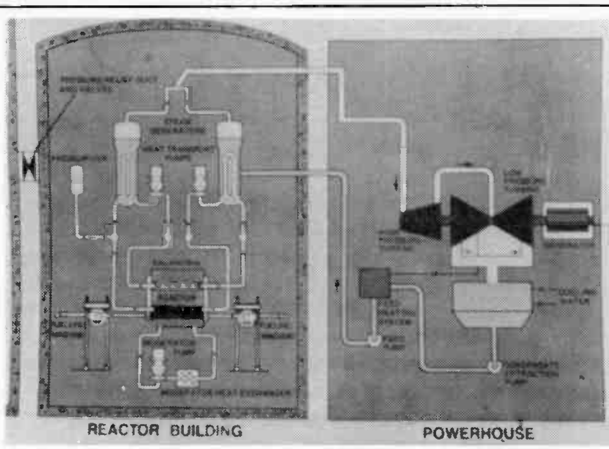
There have, however, been two accidents in the development of CANDU:

1. 12th December 1952, at the NRX reactor at Chalk River, when a combination of operator error and system failure caused the demolition of the calandria of the first prototype CANDU reactor. Nobod was hurt, but it took 14 months to repair the damage.
2. 25th May 1958, at the NRU reactor, a fuel rod caught fire in a refuelling machine; this caused a considerable contamination problem, but again nobody was hurt.

The ultimate test of whether any type of reactor is a success is if it can produce electricity economically and reliably. In terms of reliability, CANDU reactors have had fewer breakdowns than the turbines they run. This is astonishing, considering that turbines have been around for 100 years! Testimony to their reliability is the league table of world power reactor performance.

It is very difficult to produce an objective set of figures covering the relative cost of electricity from Canadian, British and American reactors due to different accounting procedures. Some include development and decommissioning costs, others do not. Figures for the British gas graphite reactors vary widely. At present, it appears the costs are about the same for coal and nuclear power, which is four times the cost of power from Ontario Hydro. Figures comparing the cost of power from a coal fired station in Ontario (Lambton), and a CANDU reactor (Pickering), using the same accounting procedures for both, put the cost of electricity from CANDU at less than half that from coal. No figures are available from America, but the cost of contracts cancelled following Three Mile Island, and due to cost overruns, is staggering.

It is a great pity that national pride stands in the way of other countries. CANDU reactors are the best in the world. Using them with Thorium 232, the world could have safe, reliable economic electricity for many centuries. It is also ironic that they were first conceived by an Englishman, Sir John Cockcroft, and brought to fruition by another, Dr. W.B. Lewis.



The CANDU reactor vessel consists of a barrel 7 metres diameter by 6 metres long lying on its side, called the calandria. Placed horizontally in this are pressure tubes. Pickering B, for instance, has 380 tubes. In the pressure tubes are placed the fuel bundles of uranium oxide. There are twelve fuel bundles per tube, making 4,560 in all. The heavy water moderator fills the body of the calandria. Separate heavy water coolant is pumped through the pressure tubes; this boils water in the heat exchanger, which in turn drives the turbines. To change fuel bundles any pressure tube can be isolated, a new fuel bundle can then be pushed in at one end by the refuelling machine, and the spent one accepted at the other side. The fueling and accepting machines work remotely due to the extreme radiation hazard of spent fuel bundles.

There are a variety of safety mechanisms incorporated in case of an accident.

There is a huge tank of water standing by to make up for primary coolant lost in the event of a pipe fracture, the "emergency core cooling system".

On some versions of the CANDU, the heavy water moderator can be dumped into a tank below the calandria; this immediately stops the reactor. To add further safeguard, there is a tank of gadolinium nitrate (a neutron absorber) available to fill the calandria in place of the heavy water; the "poison injection system".

The control rods can be dropped into the core, once again stopping the reaction (a SCRAM).

The whole reactor is surrounded by a "biological shield" of several metres of concrete to absorb any radioactivity that might leak out of the reactor.

Beside each reactor is a "vacuum building". The air in this space is kept under reduced pressure; in the event of a break in a coolant pipe, the released steam will be sucked into this space where it is doused with cold water to condense it.

FOLLOW-UP

NO OTHER topic can generate emotional outbursts quite like nuclear power. It is seen to be an evil, insidious con-game perpetrated on us by power- and money-hungry officials who are toying with the public safety for their own ends. Anti-nuclear people are willing to argue vehemently and violently, and often with a curious lack of facts.

Some of this misinformation is understandable. The intricacies of the technology are difficult to explain to the public, and the media are naturally tempted to feed the public's paranoia to increase circulation. It's interesting to note that a survey published in Scientific American shows that the majority of people polled placed the nuclear power industry in the five most dangerous occupations. In fact, it is one of the safest available. There is no valid evidence, for instance, to show that CANDU reactors are a threat to the community; they've been operational at Pickering since 1971, and by now there should be some hard evidence concerning radiation exposures. Nuclear power is claimed to cost about 40% of the price of fossil fuel generation, including capital costs; the $1 billion repair bill for the recent tubing failure includes standby power from fossil fuels, as well as a complete overhauling of the reactors, which would have been done in the future anyway.

On the negative side, there is a disturbing amount of nuclear waste generated. At the moment, it is kept on-site, but eventually a permanent disposal method will be necessary, and this will involve transporting the waste. Secondly, the claims by the industry that any spills are below "safe levels" brings in the problem of defining "safe"; there is little agreement here among biologists. Thirdly, reactors may be a stepping-stone to the production of nuclear weapons, and the CANDU's market includes politically unstable countries. Lastly, the high capital costs of reactors may divert funding from research into other power sources.

In summary, the excellent safety and reliability record of the CANDU means that it will be around for some time; it bridges the gap between dwindling fossil fuels and the far-distant fusion reactor or its equivalent. The negative points mean that the fission method should only be considered a temporary measure; we're still looking for the ideal power source.

The sad truth is that society allows people to die to keep processes economical. Airplanes, cars, highways, and coal mines are all less safe than they could be because a certain number of deaths is cheaper than safety measures. On this basis, nuclear generation is one of our best power sources; it deserves constructive criticism instead of hysteria.

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As everyone knows Big Blue has some nice machinery out there and everyone is wondering whether or not "CLONES" will emerge for that market. The answer is yes and no. The software used by the IBM PC is freely available on the legal market and several clones have appeared that run most of the PC software. The Columbia, Eagle, Corona and Garcia's board to name a few. These all are 95% compatible with the PC but are very expensive, nearly as much as the real thing. So I thought long and hard and came up with what I consider an excellent idea. Namely to redesign the PC main board and put all of it's functionality on two standard sized IBM PC plug in cards. Now these two cards would be plugged into the IBM bus (like S-100, but with 62 pins and off board regulation) connected to a power supply, keyboard and would run just like a PC with 100% software compatibility and be fully legal in that no proprietary software would be used that could not be legally acquired. The project has now been fully debugged and will be available for sale at the end of September 1983. The items that will be available are;

(A) Mother board with 3, 6 or 9 slots
(B) Edge Connectors for above.
(C) Power supply
(D) Nice looking cabinet good for 2 drives, closely resembling the real thing.
(E) Keyboard, 4 wire serial, in nice box with curly cord.
(F) Main board, Has CPU, IO, DISC Ctrl, Serial, Parallel ports, Math chip.
(G) Memory/Video board, has 256K and monochrome video

The pricing for all these items will be available at the end of September as will much more extensive literature.
The main advantage this system has is it can be very cheap compared to the real thing yet just as capable. Look for an article in this magazine soon.

IBM PROTOTYPING BOARDS

(A) Wire wrap board for general use. Has 100% of area full of holes on 0.1" spacing with a DB-25 and a DB-9 footprinted at the outboard end for IO $34.95
(B) Memory/Prototype board. A unique board that has a 256K, 4 bank memory fully roughed in with all common traces bussed but with all parity, bank select, 64/256 K chip select brought out to WW pins so that up to 1M can be quickly wrapped. This is all down at the inboard end and takes up 40% of the board. The other 60% is fully covered with holes on 0.1" spacing for WW use. This board also has a DB-25 and a DB-9 footprint.
(C) Bench motherboard, a 6 slot motherboard with proper power traces for setting up an IBM system on the bench. Has connector that takes the 6502 board power supply (even though it is not powerful enough for a full IBM system it is good enough for a 2 board system without hard disc, like ours). Bare PCB $29.95
Edge connectors for the above 6 needed ea. $4.50

MODEM

The attractive EMP modem, a 300 baud direct connect modem that is Bell 103 compatible. Full CSA approved complete with manual and modular phone plug for quick connection. Just the thing for our new dial-in catalog. Operates as either answer or originate end and full duplex data flow. Has carrier detect light for easy monitoring. Many of these have been sold at $199.00
Parts Galore Special Price **$99.00**

Parts ELECTRONIC COMPUTER Galore

316 College St., Toronto. M5T 1S3
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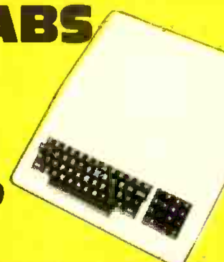
OUR 6502 BOARD
Now only $24.95, still with all the versatility of the original and a full 8 slots.

SOLID ABS CASE

NUMERIC $49.95
STANDARD $39.95



ASCII KEYBOARDS

Our ASCII keyboards are by ALPS, a famous Japanese switchmaker and feature high quality debounced switches. Full upper and lower case capability. Direct plug in compatible with all 6502 boards and 'SURF' board. Available in numeric and std style.
(a) Standard KB **$89.00**
(b) Numeric KB **$99.00**

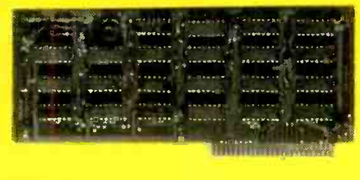
POWER SUPPLY

Our Famous "BLACK BEAUTY" power supply, now reduced in price but not in quality. Our ratings are 5V-5A; 12V-2.5A; -5A-½A; -12V-½A for real. Make sure that any other power supply that lays claim to this rating actually does so. Labels are cheap and we have seen many of the old silver power supplies unchanged except for the label. Easily beats all the rest $99.95

SYSTEM SAVIOUR

Hot and getting hotter??? Got an older power supply??? Then you need a SYSTEM SAVIOUR. This is not a religious object, it is a nicely packaged 3½" muffin fan in a molded plastic housing that fits against the slots on the side of our 6502 computer case and draws out the hot air. Widely used by all major political parties, especially the NDP, now at a new low-low price. Complete with 2 grounded 3 wire switched sockets, pilot light, surge protector and on-off switch to turn off your system and two plugged in items. **$55.95**

PERIPHERAL CARDS



New low prices.
A) Z-80, A versatile card that uses an onboard Z-80 CPU to run the vast array of programs written for the 8080 and Z-80 under the CP/M™ operating system, on your Apple™ or compatible 6502 machine. Sold as a bare PCB with assembly data . $15.00. or wired and tested . $69.95
B) 80 Character, fully compatible with Videx™ card, a direct copy fully compatible with all common word processing programs and accounting programs. Sold as bare PCB with assembly data ...... $15.00. or wired and tested $89.95
C) 16K, commonly called a language card, has a jumper to get precise timing signals from the mother board so that CPM will run to perfection. Sold as a bare PCB with assembly data . . . $15.00. or wired and tested . . . $59.95
D) Floppy Disc card, allows one to control up to two 5¼" flexible disc drives from one 6502 machine. Sold as bare PCB with assembly data .... $15.00 or wired and tested $59.95
E) Shamrock 13/16 Sector autoselect controller card. Allows use of the older Apple™ program base with automatic selection of DOS for 13 or 16 sector. Sold only as a wired and tested card for $79.95
F) Apple™ Prototype card; a standard sized card that has been optimized for wire wrapping. There are no power runs around the board so that a maximum density board can be wrapped.
G) Tamecard; Our copy of the "WILDCARD"™ that allows user to make a copy of a program while it is running using hold states so that back-up copies can be made by the buyer of copy-protected software. Sold as a bare PCB with assembly data for . . $20.00 or wired and tested . . $79.95 Disc for above with program copy hints . . $8.95
H) 128K card, a copy of the Saturn card allows use of 128K memory with your 6502 machine. Sold as a bare PCB with assembly data for . . . $25.00, Wave soldered with no IC's . . . $69.95. or wired and tested with 64K . . . $149.95 128K $239.95

Remember, any bare PCB is $15.00 and the following wholesale discount applies, so get together in a group. 10 PCB @ $10.00 ea., 25 PCB @ $9.00 ea., 50 PCB @ $8.50 ea., 100 PCB @ $8.00 ea., and 500 PCB at $7.50 ea. You can order any combination of PCB that reaches the discount number but they must all go to the same address.
The summer of 83, a summer of very low prices on the peripheral cards and 74LSTTL is over. There is now a severe shortage of 4116, 4164, all 74LSTTL and as of this issue we can no longer honour the previous deep discount price structure. Maybe next depression.

GREAT DEAL

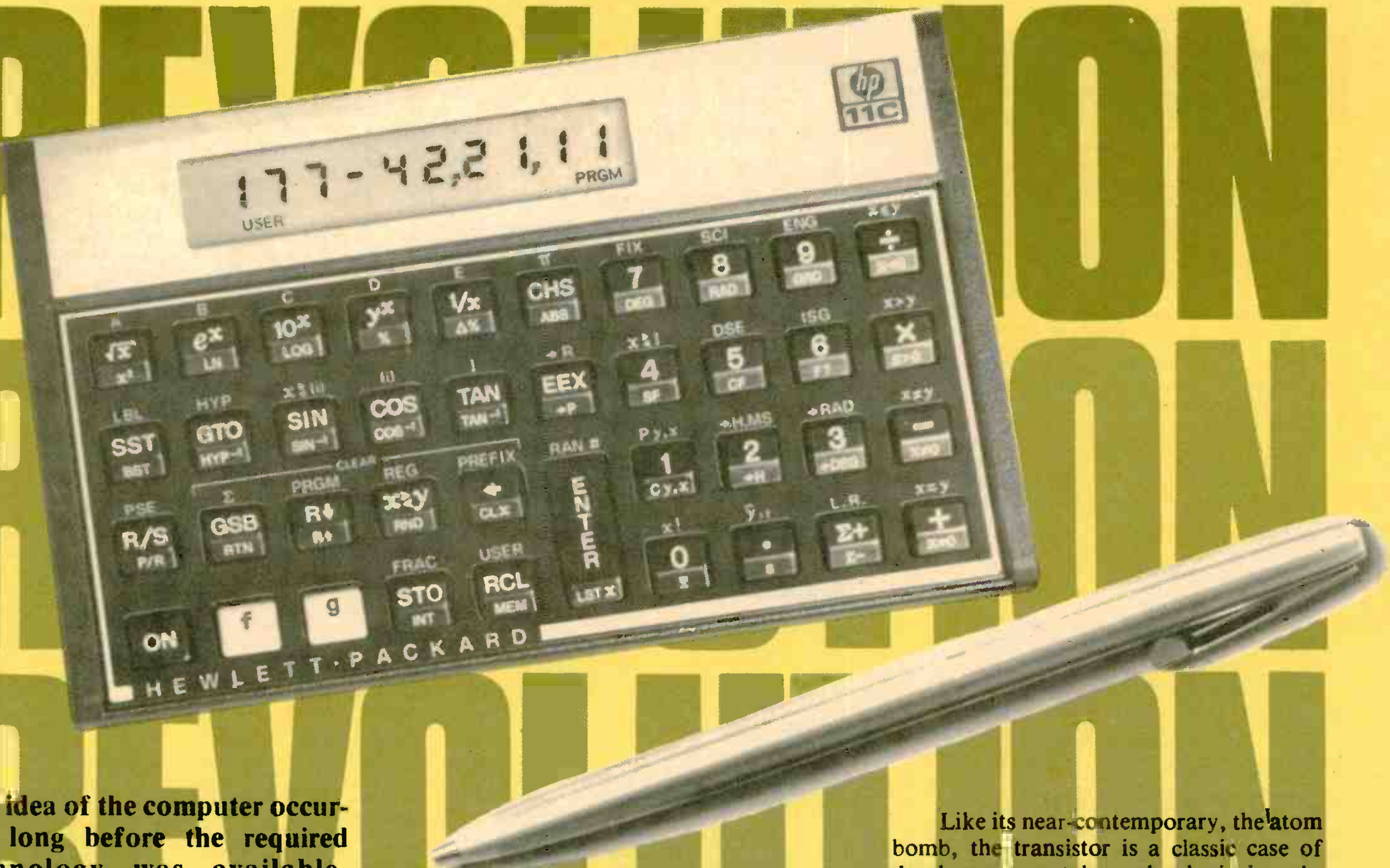
THE GREAT DEAL
CARRIES ON FOREVER AND GETS BETTER
We made an even better buy on over 1000 sets of power supply, 6502 board, numeric keyboard and numeric ABS case (solid coloured ABS All the way through, not just painted plastic) and can now offer the great deal with numeric case and keyboard for the amazing price of **$275.00**
along with any 4 of the peripherals listed above as a bare pcb with parts layout. The price is the same for numeric or non-numeric styles of KB and case for this great deal. Please specify numeric or non-numeric when you order.

AN EVEN GREATER DEAL $800.00

WHAT ABOUT THOSE OF YOU WHO WANT AN EVEN GREATER DEAL? WHERE DO WE GO FROM THE GREAT DEAL? HERE'S WHERE. WE OFFER THE FOLLOWING:
1. A wired and tested 6502 board.
2. Numeric case.
3. Numeric keyboard.
4. Heavy duty (BLACK BEAUTY) power supply.
5. Any 3 wired and tested peripheral boards from the ones listed in this ad, less cable, except megabit RAM.
6. All the other bare peripheral boards that you don't have in the above 3 wired and tested. The mega-bit and tame bare cards are not included.
ALL FOR THE AMAZING PRICE OF $800.00

Circle No. 15 on Reader Service Card.

The Electronic REVOLUTION



The idea of the computer occurred long before the required technology was available. Here's a brief history of how that technology developed.

IT IS VERY rarely indeed that the birth of a new era can be located exactly on a particular day. The explosion of the first atomic bomb on 16th July, 1945 at Alamogordo, New Mexico is the twentieth century's most obvious candidate for the title of a day which changed the world for ever. But there have been a few others, and the events of 23rd December 1947 at the Bell Laboratories certainly give that date a strong claim to be one of history's great turning points. On that day the world's first transistor was made to work.

Some inventions creep up upon the world rather than burst upon it. Faraday's magnetic induction demonstration in August 1831 took a good half-century to turn into even the beginnings of an electric power industry while radio dawned so gradually that we cannot even say with any certainty who transmitted the first signal. Some inventions, like television, were eagerly awaited for decades before anyone could produce a workable system, while others like radio-telephony lay around for years before anybody realised what could be done with them.

But the transistor fell into none of these categories. Its birth that day represented the pinnacle of nearly thirty years' concentrated research by some of the most talented physicists in the world, all labouring with the conscious aim of constructing a solid-state analogue of the radio tube. And over the previous three years, Bell Labs alone had invested several million dollars and some of its best researchers in the project. Nor were the implications of the event lost on those present. No one had much idea of the sort of world that the transistor would have produced thirty-five years later, but all those who were there seem to have been conscious that something out of the ordinary had happened and that things would never be the same again. In the event it took a decade for the transistor to be perfected and built into electronic technology, but when this happened it pushed the science of electronics into an age of exponential growth which has done more to change the world in the last generation than steam did in the two centuries before that.

Like its near-contemporary, the atom bomb, the transistor is a classic case of development not by technological push, but by demand-pull. The state wanted the bomb and the corporations wanted the transistor for their own purposes, and both were prepared, whether the project turned out to be feasible or not, to invest any amount of money and time and research talent towards achieving it.

The idea of solid-state transducer was almost as old as radio itself. In fact, radio wave detection began with a primitive semi-conductor, the coherer, and continued for many years afterwards with another form of the semi-conductor in the shape of the crystal detector. Looking back, you might almost see the half century of thermionic tube development following Fleming's diode of 1904 as a blind alley in electronics history. Tubes came in largely to make up for the deficiencies of the crystal detector: its fragility, its need for constant delicate adjustment and above all it puny current output. Tube manufacture began by having access to all the resources and experience of the light-bulb industry out of which it had accidentally sprung, and the tube's versatility as oscillator, detector or amplifier led to it dominating radio from about 1919 onwards.

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Whatever your needs.... Test Equipment, Home & Business Computers, Software, Books, Peripherals, Audio equipment, Speakers and more....WE HAVE IT ALL!
1983-84 Product Catalogue
GLADSTONE ELECTRONICS

Gladstone 64K RAM

Expand your TS1000 to its maximum!

G64

$159.95

SALE

That's right: **64K RAM** for your Timex Sinclair for a great low cost! Increased production allows lower price on this American made quality RAM pack. 64K expands the capacity of the TS1000 to its maximum, enabling longer programs and greater databases. Completely reliable and warranted for 6 months. Precision tooling of the case with a close cosmetic match to the finish of the Timex Sinclair computer. Gladstone's 64K RAM adds programming power to the already powerful Timex Sinclair TS1000.

Professional Keyboard with metal case

K71 **$129.95**

A full sized professional key board for TS1000/ZX81. Features 47 keys and a full-sized space bar. Connects to the TS1000/ZX81 with no soldering required, via a plug-in flexible connector. Expansion devices (i.e. RAM etc.) connect to the TS1000/ZX81 edge-connector which extends from the rear of the cabinet.

- American made
- keycap legends will NOT wear out
- Keys with life rated at 20 MILLION cycles.

Gladstone's BASICARE Micro System ZX81 TS1000 TS1500

A totally unique series of modules to upgrade the ZX81 and T/S1000 computers. Expand the address space up to 1 megabyte!

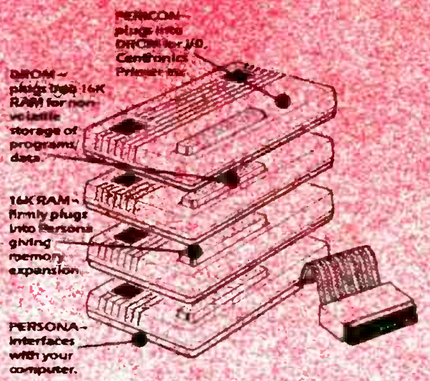
Gladstone's BASICare Micro System modules are an advanced series of add-ons to truly expand the capabilities of the ZX81 and T/S1000 computers. Now, you can develop your Timex Sinclair into a sophisticated computing system.

This exciting system is a series of separate modules that perform a whole range of microcomputing functions. They simply (and firmly) stack together. You buy the hardware you want and add to the system. Each module may have a separate function, or may integrate several functions. And when you want more . . . you add more!

In short, you can develop an entire range of hardware options that fit together to form a complete package "Computing" in the real sense of the word.

Apart from its good looks and stability under operating conditions, Gladstone's BASICare Micro System offers a fantastic range of options.

The heart of the system is unique computer interface called the PERSONA. This one unit plugs into the ZX81 or T/S 1000 without modification and acts as the "brains" of the whole operation. Thereafter you choose how you want to expand by simply plugging in more modules.



GLADSTONE'S BASICare Micro System Modules:

Persona - An interface module to enable an ORGANIC MICRO to grow on the ZX81 or T/S 1000. It buffers in all the signals from the expansion port via a ribbon cable. It then talks to other modules via a 64-way Organic Bus configured so that it fits onto the given ZX81 Memory Address Map.
B20 $79.95

MINIMAP - the key module for adding large amounts of memory although a few memory modules can be used without it. Extends the 64K of the address space up to a possible 1 Mbyte. The space is organized into vertical 64K pages. Up to 16 pages can be supported. All this memory can be defined dynamically from within a program . . . allowing (for example) a program in one segment to manipulate the contents of various data segments.
B21 $79.95

RAM 08 — a low cost, low power memory expandable from 2K to 8K by plugging in extra chips in the vacant sockets. Located in a region of address space not used by BASIC programs, is therefore ideal for data or machine coded routines which might be shared by several programs.
B22 $69.95

RAM 16 - 16K Add on memory at remarkably low cost. On-board address decoding permits simultaneous use of many RAM 16 modules in conjunction with Minimap.
B23 $69.95

RAM 64 - a true 64K of memory expansion arranged as four blocks of 16K all of which can be used simultaneously under the control of Minimap.
B24 $199.95

DROM - ultra low power memory backed by rechargeable battery for non-volatile storage of programs and data. An invaluable module, especially for saving programs under development or often used routines or data. It makes tedious cassette saving and loading unnecessary. Individual 2K blocks can be protected against accidental overwriting.
B25 $99.95

TOOLKIT - accepts up to 8K of utility programs in EPROM/ROM. Located in address space after ZX81 on-board ROM, allows for calling of Toolkit-held routines via the USR function.
B26 $59.95

INPUT/OUTPUT MODULES

PERICON a - a general purpose user programmable device with 24 lines of I/O. Up to four can be used simultaneously allowing basic I/O, strobed I/O, and bidirectional 8 bit data transfer with handshakes.
B27 $69.95

PERICON b - is for access and control of the outside world. 24 lines capable of directly operating relays or driving long signal lines. On-board address decoding allows simultaneous use of up to four such modules.
B28 $69.95

PERICON c - a Centronics type parallel interface permitting an 80-column dot matrix printer to be connected.
B29 $99.95

HOW MEMORY IS ORGANIZED IN GLADSTONE'S BASICARE SYSTEM

With Gladstone BASICARE modules, memory is arranged in 64K PAGES. Each page has the structure of figure 1. The starting address of each SEGMENT has been included.

0000	ROM (8K)
2000	TOOL (8K)
4000	FILE A (16K)
8000	DATA (8K)
A000	PATH (4K)
B000	SLOT (4K)
	FILE B (16K)

Write, phone or come in for full specification listings.

ZX81 TS1000 TS1500

Each SEGMENT in the 64K PAGE has a specialized use dictated by the design of the T/S 1000. The TOM area is the T/S 1000 ROM, and contains the BASIC interpreter and operating system. PATH is for future applications. SLOT is used connection with the peripheral modules.

FILE A is the normal residence of BASIC programs. FILE B is used in the best place for your own machine coded routines, and can also be used for data. Can also contain user-created characters (via USERFONT). DATA is extra space for data, and can also be used for BASIC.

With MINIMAP in use, large amounts of memory are available. It is then possible to have many BASIC programs, and several TOOL and DATA SEGMENTS distributed between different pages.

The unique way in which memory is addressed allows for the extreme flexibility and usefulness of the system. BASIC programs in one PAGE can be used to manipulate data in another PAGE. TOOL and DATA segments can be used in a similar fashion. Many BASIC programs can be simultaneously resident in different PAGES. It is possible to instantly switch between them. One might, for example, use the output of a program in one PAGE as the input to a general graphics program resident in another PAGE. MINIMAP will support sixteen PAGES of TOOL and DATA.

HOW CAN GLADSTONE'S BASICARE MODULES BE USED?

A simple system (without MINIMAP) could consist of, for example, a RAM 08 with USERFONT option, in which 2K of RAM was used for programmable characters, and a RAM 16. This system would be good for graphics games, and could use all usual 16K software for ZX81 and T/S 1000. Addition of PERICON modules would enable control of the outside world, including adding a printer if desired.

Adding a DROM would be useful developing programs and saving macine code routines. For the software writer, the combination of RAM 16, DROM, and PERICON e would be perfect.

For machine control applications up to four of each PERICON modules can be used to give a total of 96 high current output lines, 16 I/O lines and four CENTRONICS printer drivers.

Larger systems can be constructed using MINIMAP. Up to 16 BASIC programs can be co-resident sharing the resources of up to sixteen DATA and TOOL segments. This is usually called multi-tasking and is normally only available on very expensive systems.

By using data files in FILE A and FILE B space, manipulated by TOOL-held machine code routines, an enormous fast access data base can be created. A menu driven enquiry system could be developed, for example. For animated graphics games the system is unrivalled, allowing, for example, the multiplexing of complex backgrounds with moving foregrounds on several screens, each possibly controlled by a different program.

ZX99 Automatic Tape Controller

The logical extension to the TS1000 / ZX81 giving data and word processing

D71 **$219.95**

***DATA PROCESSING**

The ZX99 gives you full software control of up to four tape decks (two for loading and two for saving) allowing mixing of data files to update and modify them. This is achieved by using the remote sockets of the tape decks to control their motors as commanded by a program.

***PRINTER INTERFACE**

The ZX99 has a RS232C interface allowing you direct connection with any such serial printer using the industry standard ASCII character code (you can now print on plain paper in upper and lower case and up to 132 characters per line.)

***MANY SPECIAL FEATURES**

AUTOMATIC TAPE TO TAPE COPY: You can copy any data file regardless of your memory capacity (a C90 has approx. 200K bytes on it) as it is loaded through the Sinclair block by block.

TAPE BLOCK SKIP without destroying the contents of memory.

DIAGNOSTIC INFORMATION to assist in achieving the best recording settings.

The ZX99 contains its own 2K ROM which acts as an extension to the firmware already resident in your ZX81'S own ROM. The ZX99's ROM contains the tape operating system, whose functions are accessed via Basic USR function calls. Each function has an entry address which must be quoted after the USR keyword. All of the functions can be used in program statements, or in immediate commands (i.e. both statements with line numbers and commands without them).

DCP Speech

D80

$149.95

Add high quality solid-state speech to your **ZX81** or **TS1000**. Many applications in personal computing, education, and industry. DCP Speech Pack contains all the letters of the alphabet, numbers zero to over a million, and some other general words. Easy to use under **ZX81/TS1000** control using **POKE** commands (fully explained in manual). The DCP Speech Pack connects directly onto the rear of your **ZX81/TS1000**. It can be used in addition to a RAM Pack, Printer or other accessories. Contains its own speaker and volume control, and allows an external extension to be added. Additional Word Pack ROMs are available and simply plug into sockets inside the Speech Pack to extend the vocabulary of the unit.

MEMOTECH

ZX81 TS1000 TS1500

Memopak Range

MEMOPACK 64K MEMORY EXTENSION **A64 $219.95**

The 64K Memopak extends the memory of the ZX81 by 56K, and with the ZX81 gives 64K, which is neither switched nor paged and is directly addressable. The unit is user transparent and accepts commands such as 10 DIM A(9000)
Breakdown of memory areas ... 0-8K-Sinclair ROM. 8-16K. This area can be used to hold machine code for communication between programmes or peripherals. 16-64K-A straight 48K for normal Basic use.

MEMOPAK 32K and 16K MEMORY EXTENSIONS **A32 $139.95 / A16 $49.95**

These two packs extend and complete the Memotech RAM range (for the time being!) A notable feature of the 32K pack is that it will run in tandem with the Sinclair 16K memory extension to give 48K RAM total.

MEMOPACK HIGH RES GRAPHICS PACK **A70 $119.95**

The Memopak HRG gives you the opportunity to program at dot level thus opening up a world of design, geometry, video games and animation to the **TS1000/ZX81** user.
The pack contains a 2K EPROM chip packed full with 30 machine code functions easily called by a BASIC program. These functions offer a fascinating range of graphic effects at dot, line, character, block and page levels. For example, the SKETCH function allows the user to design his own characters, images or patterns. A full screen of 192 x 248 dots or HRG pixels is stored in a video page of memory and the number of video pages stored is limited only by your RAM size (each video page requires 6.2K of memory). Animated effects can be obtained by rapidly rotating the video pages on the screen.

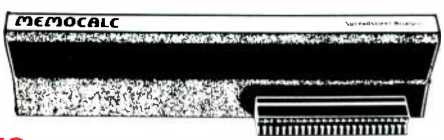
MEMOPAK CENTRONICS TYPE PARALLEL PRINTER INTERFACE **A71 $119.95**

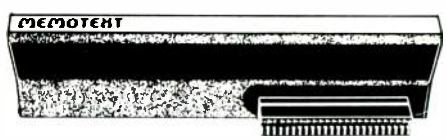
This pack introduces your **TS1000/ZX81** to a range of full-scale professional printers of the Centronics parallel interface type, including dot matrix and daisy wheel, tractor and friction fed printers.
The Interface is fully compatible with the **TS1000/ZX81** code to the standard ASCII code; in addition lowercase characters are generated from the **TS1000/ZX81** inverse character set. The Centronics Interface is compatible with all Memotech products and with a suitable printer will print output from our High Resolution Graphics pack and from the special international character sets. Connecting Cable for I/F A80 $35.00

The Memotech Keyboard comes with a Buffer Pack that simply plugs in behind the TS1000/ZX81. As a result you will NOT have to: • open your TS1000/ZX81; • do any soldering; • recase your TS1000/ZX81; or • risk invalidating your TS1000/ZX81 warranty.

The Buffer Pack comes already connected up with cable to the Keyboard itself, which is free standing, Any Memopak or Sinclair memory pack can be attached behind the Buffer Pack. Of course the product is fully compatible with the rest of the Memotech range as well as the TS1000/ZX81 memory pack, and printer.

Plug-in ROM's





Memotech Software Packs

Memocalc (Spreadsheet)

This is a spreadsheet analysis pack which provides an extensive grid for calculations and projections of a mathematical kind. It is ideal for planning in a financial or engineering environment. The user may enter either raw values or numerous and substantial equations (drawing on the full range of Sinclair maths functions) in a grid of up to 7000 numbers.
The screen window can be scrolled or sent directly to any part of the grid, and the line and column labels are always present. The functions are flexible but simple and the user is closely guided as he progresses.
This software includes a useful decimal option and total, sub-total and repeat functions. Results may be either stored on cassette or put out to a printer (ZX or commercial). The pack comes fully documented so that the user can master the Memocalc rapidly. **A81 $79.95**

Memotext (Word Processor)

The Memotext Word Processor brings commercial standards of text editing to your **TS1000/ZX81** computer. Text is first arranged in 32 character lines for the screen with comprehensive editing facilities. On output the user simply chooses the line length required for printing and the system does the rest. Used with the Memopak Centronics Interface, the Word Processor makes available printout with 80 character lines, upper and lower case and single and double size characters. **A82 $79.95**

Memopak Assembler

The Memotech Z80 Assembler is designed for users who really want to roll up their software sleeves and get down to precisely controlling the power of their **TS1000/ZX81**. It allows you first to code and edit a source program in the Z80 language, and then assemble it into machine code. You can now write flexible and economic programs, tailor-made in every detail to your own needs, and free from the extravagant use of time and space required by BASIC. The Editor mode allows you to code directly in the right format, manipulate individual lines and control the exact placing of source and machine code. Routines may be merged or listed (even to a commerical printer with our Centronics Interface). The assembler mode handles all standard Z80 mnemonics, numbers in hex or decimal, comments and user-selected labels. Become an expert software engineer with this pack and its accompanying documentation. **A83 $79.95**

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ZX81 TS1000 TS1500

Memotech Keyboard

$149.95

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PERMANENT MEMORY! ZX81 TS1000 TS1500

Program Your Own Plug-in ROM's!

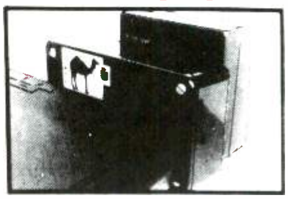
CRAMIC-81

Store 16K even with power switched off!

CRAMIC-81 is a 16K RAM pack using CMOS technology for permanent data retention. Data can be stored almost indefinitely and loaded almost instantly with virtually zero chance of error.

CRAMIC-81 module uses chips made in a special CMOS technology which require only a tiny amount of power to retain data when not actually in operation. Used on its own it behaves like an ordinary Rampack EXCEPT that it can be powered down and removed. Program and data in it is permanently stored when this is done. **C12 $229.95**

MEMIC-81



Faster than a Floppy .... Easier than an Eprom

MEMIC 81.2 is a 4 kilobyte Rampack for the **TS1000/ZX81** which can store programs WITHOUT POWER. A state-of-the-art Lithium battery supplies the tiny power requirement of the Special technology memories used. MEMIC-81.2 resides in the 8-12K area of the memory map but can be moved within the 8-16K area.

MEMIC-81.2 enhances the **TS1000/ZX81** by providing almost instant, error-free availability of stored programs. The doors to imaginative hobby and industrial applications are opened. **C11 $89.95**

C10 2K $79.95

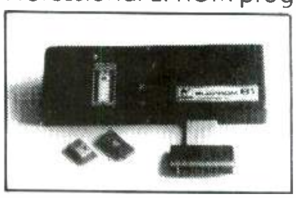
DREAM-81

A 64K RAM PACK with a difference!

DREAM-81 is a memory expansion unit for the **TS1000/ZX81** which gives it the total amount of RAM its processor can address. The processor cannot always use all this RAM since parts of the memory map may be required for other purposes in a system. The 0-16K area has therefore been made de-selectable. A ROM socket is also provided which may contain up to 16K (27128) of EPROM. Permanently stored information in EPROM can quickly be loaded into RAM without errors. **C16 $219.95**

BLOPROM - 81

Professional EPROM programmer



Eproms are a very cheap and convenient method of storing information without fear of its corruption or loss. Eprom programmers have been either expensive (and difficult to use) or cheap and unreliable (and difficult to use). BLOPROM-81 uses a wholly new 'friendly screen' approach to user instruction which makes User Notes almost unnecessary. At the same time it provides professional features which instruments costing 10 times as much can't provide. **C14 $229.95**

ROM - 81

Provides two 24 pin sockets for up to 8K of memory expansion for the ZX81. Two 2716's or 2732's can be mapped in the 8-16K area. EPROMs require programmers such as BLOPROM-81 to write into them, after which they retain data without the need for power. Slow or fast EPROMs may be used. Location and device types are push-on link selectable.

Control or other programs can be permanently kept in these ROMs and moved into RAM with a simple PRINT USR .... command. **C13 $45.95**

PROMER - 81

A low cost **ZX81/TS1000** Eprom programmer for 2516, 2532, 2716, 2732. Its low price should persuade users to put their programs in Eproms. Pricing tables, toolkits, educational and scientific programs, assemblers, text editors etc., can be instantly and reliably called up from ROM readers like ROM-81 and DREAM-81.

All the standard programmer functions of CHECK, SPECIFY, READ, PROGRAMME and VERIFY are provided. The control program contains various safety features e.g. a check on Vpp status before executing a task. User Notes give easily understood guidance on procedure, and the additional routines necessary for blowing Eproms to work with the **ZX81/TS1000**.

Four 9V batteries are required, to provide a regulated programming voltage. The control program is supplied on tape. The menu driven program with on-screen prompts is designed to make it easy for the newcomer. PROMER-81 comes assembled and tested, with an extension connector at the rear. **C15 $59.95**

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ZX81 Best Selling Software TS1000

Fastload

An incredible breakthrough in TS1000 and **ZX81** software development! Enables you to load and save programs up to 6 times faster than normal. You can easily convert your existing programs into new I.P.S. **FASTLOAD** programs. And unlike other systems **NO ADDITIONAL HARDWARE** is required! **FASTLOAD** has won rave reviews from users, and has proven to be exceptionally reliable in test after test. Occupies only 1/2K of memory. Additional features include verification of proper loading, and catalog of programs, names and memory usage. Complete with comprehensive user manual.

Z61 $ 24.95

ZXForth

FORTH is an interactive, compiled language that expands the capabilities of the **TS1000** and **ZX81**. It has the simplicity of BASIC but runs up to ten times faster! **FORTH'S** most distinctive feature is its flexibility. Its unit is the WORD. The programmer can use existing **WORDS** to define new ones. **ZX FORTH** has over 250 commands and occupies only 5K of memory. Works on 16 bit numbers, and also includes some 32 bit arithmetic routines. Comes complete with a comprehensive 80 page user/programmer manual.

Z43 $ 39.95

ZX Bug

Machine Code Monitor and Disassembler

ZXBUG is a powerful tool for machine language programming. It is 4K long and uses memory from 7100 to the top memory. **ZX BUG** works in hexadecimal (base 16) not decimal, so all addresses are a maximum of 4 hex bits long. Provides a total of 28 commands.

Z41 $ 19.95

Toolkit

TOOLKIT adds these 9 new powerful functions to your computer: Renumbering, Memory indicator, Print all string and numerical variables, Find any string up to 255 characters long, Replace any string by any other string, Transfer programs to Ramtop, Join two programs together, Remove all **REM** statements, Delete whole sections at once.

Z42 $ 19.95

Z-Aid

Z-AID is a programmer's tool, adding 5 important functions to **T/S 1000, ZX81** computer. **VERIFY** checks for corrupted program saves; **MSAVE** will copy any continuous block of memory between 0 and 32767; **MLOAD** allows entry to the memory saved using **MSAVE**. **TPTR** allows instant access variables; **CHAIN** links two **BASIC** programs together.

Z98 $ 19.95

ZX Assembler

This Machine Code program occupies 7K of memory and locates itself at the top of memory. The program is a full Editor/Assembler and Monitor. Labels may be used instead of any string. The features include Line Insertion Delete, Insert Characters, Auto Repeat on all keys. The monitor has facilities to inspect memory, registers and run machine code programs.

Z40 $ 19.95

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Household Management Business & Professional

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Contains 2 tapes with a detailed reference/instruction manual to help you gain and maintain control of your personal finances. The programs include: Checkbook balancing; Personal Net Worth; Budget Plan (for home or business); Mortgage Plan.

Z53 $ 39.95

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Contains four programs recorded on 2 tapes, accompanied by a detailed manual. To help you plan, record and control your stock market activities. These programs have been adapted for the **ZX81** and **T/S 1000** from routines used in large scale computers by a leading software house. Programs include: Dow Jones Moving Average; Personal Stock/Bond Transaction Recorder; Portfolio Review; Point and Figure.

Z54 $ 39.95

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The most needed financial analysis routines for many business decisions, plus a detailed guide on how to use them. Five long programs are supplied on 2 cassettes. Invaluable aid for the business man. Break Even Analysis, Cash Flow Analysis, Payback Analysis, Internal Rate of Return, Depreciation Analysis.

Z49 $ 39.95

Business Pac II:

Project Scheduler & Proposal Sheet.

Time is the most valuable commodity for the businessman. **Project Scheduler** helps you keep track of work in progress and billings in progress. **Proposal Sheet** is a tool to help you quickly record work items and hours, billing rates, overheads, material and labor costs, to finalize your proposals.

Z50 $ 19.95

Home Mathematics Tutor *Grades 1 to 6*

Each package contains 32 full 16K programs, plus a 32 page workbook! The most ambitious software project undertaken for the **TS1000** demonstrating the ability of the computer to aid in mathematics instruction. These are self-teaching programs with sufficient fun and feed-back to keep young minds involved. Give your child the **TS1000** learning advantage. Complete with handsome vinyl storage case.

M1 (Grade 1) through M6 (Grade 6) Each

$ 22.95

Exciting New Software

Tiny Logo

Let the world of computers become a comfortable one for your child through the use of this powerful and fun teaching language. In the age of the computer, **Tiny Logo** is the key to helping your child to learn and understand real computer programming. (Tiny Logo is a sub-set of the popular MIT Logo).

Z111 $ 24.95

Home Money Manager

This complete home budgeting system allows you to establish your own budget categories, keep track of monthly bills and income, and do a monthly and year end balance sheet. No bookkeeping knowledge is needed.

Z104 $ 19.95

PIXEL

'TRADER' is an incredible game pack-ed with fully animated illustrations. It is actually 48K long but is loaded in three parts so that it can run in your 16K RAM. The variables are passed between programmes to give con-tinuity. P10 $24.95

'STARQUEST' . . . You search the galaxy for a habitable planet for col-onisation, but discover they are few. You do find a host of planets of great mineral wealth. You can be caught in the gravitational pull of massive black holes or come out of Hyper-drive beside a star about to go super-nova. You run the gauntlet of vast meteorite storms and are attacked by hostile aliens.
If you survive all this, you are reward-ed with a paradise planet. A New Earth. P12 $19.95

'ZOR' . . . In the style of a mediaeval joust, two mighty robots join for bat-tle on a remote and barren planet. Your energy shield is being eaten away by Zor's onslaught; can you think and fire fast enough to save your planet from enslavement?

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'ENCOUNTER' . . . What at first just seems to be another UFO sighting turns into a nightmare. Your curiosity and some unknown force draw you into a waiting spacecraft. Somewhere, lightyears away from Earth, you are probed and examined to determine your intelligence.
If you fail, you are jettisoned with the garbage. If you pass, you are set back on Earth. But if you do extremely well . . . ? Now its the Space Invaders turn to play you! P14 $19.95

"SUBSPACE STRIKER" - You are the com-mander of the Subspace Striker, "Sword-fish", the most feared class of attack craft in the galaxy.
Your mission is to disrupt the Federation space lanes, to sever their vital supplies of fuel and arms.
You are likely to be attcked if you miss with your torpedoes, but even if you hit you must watch out!
"SUBSPACE STRIKER" - A new dimension in space warfare. A new dimension in microcomputer games. P11 $19.95

Also available for Commodore VIC 20 see page

NEWSFLASH: Timex announces new TS1500 personal computer will run all ZX81 and TS1000 software!

Computerized Diet Program

Z47 $39.95

Gain control over your eating patterns. This is an individually tailored, systematic weight loss program. Uses a personal status assessment. Based on your assessment, the **TS1000/ZX81** becomes your monitor and feedback system, allowing you to discretely track yourself against your optimum model. Complete with a 22 page Guide Book, personal data storage tape, and vinyl storage case.

KRAKIT(TM)

Bored with crosswords? Want a real mental challenge? Try solving **KRAKIT**, the ultimate adventuring and treasure hunt for the personal microcomputer. **KRAKIT** consists of 12 clues that will lead you around the world in search of 12 cities, 12 countries and 12 numbers. And if you are clever enough to be the first to solve these clues, then you can win at least **$20,000** prize money. Each cassette also includes a full sized **KRAKIT** poster at no charge!

Z48 $ 24.95

Chess

Choose from 4 games, for beginner to Master!

Beginner (1K) Chess A single level of play introduces Chess. Z87 $ 12.95

2K Chess (for unexpanded **TS1000**) Better graphics and a vastly improved range of moves. Z55 $ 19.95

Chess 1 (Enhanced) 16K Full graphics display with six levels of play. Choose black or white. Castling and en passant. Save games in progress. Z85 $ 19.95

Chess II Master The ultimate 16K chess for **TS1000**. 7 levels of play. Highest rating by Timex Sinclair User magazine. Z86 $ 29.95

Strategy Games

Run the Country

A strategy game of political and financial management. What would you do if you ran a country? Here you can grapple with problems like inflation, unemployment, foreign currency exhange. It's both fun and educational. Can you do better than the politicians?

Z77 $ 15.95

Around Europe In 80 Hours

You are in your club in London, England where you have just had a blazing row with Sir Roger Partington-Smythe. As a result of this you have accepted a wager of $20,000 against your travelling around western Europe and returning within 80 hours. In each capital city you visit you must obtain a souvenir. Z82 $15.95

Pop Star

A question and answer type game simulating the exciting world of popular music. Will you make it big and become a star, or go broke?

Z84 $12.95

Inheritance

Your Great-Uncle is planning to leave his entire estate to you, but first you must prove your financial acumen. If you succeed in this first challenge, you will then be invited to load part B where greater opportunities for riches await.

Z83 $15.95

Adventure & Fantasy

Alien Space Ship

A long involving wordadventure game for the **TS1000** and **ZX81**. While on space reconnaissance, your ship has been dragged onto an enemy space cruiser. They are intent on taking humanoid life forms as slaves. You must reach their computer room and release your ship. Fast and varied responses arise and there are many different ways to win the game.

Z81 $19.95

Keys to Gondrun

Another involving fantasy word game in which you travel beneath the Enchanted Forest in search of the missing keys of Gondrun the Wizard. Program features real time monster fights at 6 skill levels. There are alternative responses to ensure a different game every time.

Z95 $12.95

Planet of Fear

In this machine code program you find yourself stranded on an alien planet. On this planet you will meet various hazards, including aliens, little green men, some natural - some not. Your aim is to escape this planet by finding your captured and disabled space ship. You really are the commander of your computer. Z79 $19.95

Inca Curse

In this adventure you find yourself in South America in the jungle, near an as yet undisturbed INCA temple. Inside this temple you will find lots of treasure, your aim is to get out with as much treasure as you can. BEWARE, do not let greed be your downfall. Your adventure is complete when you have returned to the jungle clearing with treasure.

As this is a very long program, it has cassette routines with which you can save and load a game at any stage.

Z80 $19.95

Arcade Games

Gobbleman

Arcade action fun for the family. A superb realization of this exciting classic game, showing the true capability of the **TS1000** and **ZX81** computer. Written in machine code, this one is fast, fun and challenging. Z70 $19.95

Galaxy Invaders

Another arcade classic, masterfully translated to the **TS1000** and **ZX81**. Protect your seven lives against fleets of hostile invaders. Fast, exciting and unpredictable. Z91 $19.95

ZX Galaxia

ZX-Galaxians is a good adaption to the ZX81 of the popular arcade game of the same name. You are being attacked in deep space by formations of hostile Galaxians, and it is your mission to prevent them from attacking Earth by zapping them with your laser gun as they break out of formation and hurtle towards you. . . . Z72 $19.95

Invasion Force

The huge Mother ship hovers above your base raining missiles and bombs down onto you. Blast through its force field and destroy it before you are disintegrated . . . but don't hit the reconstruction zones or all the damage you did to the Mother ship is instantly rebuilt! Fast paced machine code action. The ultimate space game! Z60 $19.95

Sword of Peace

Free yourself from a dungeon to prove yourself worthy of becoming the Monarch of Oz.

Zombies

Stranded on an island, your only hope to avoid the Zombies is to lure them into potholes. Z74 $19.95

ZX Scramble

Pilot your spacecraft through a fast moving, complex space maze. Watch out for missiles being fired from all directions. You can shoot back or evade them. Written in machine code for fast paced excitement. Z90 $19.95

Marine Rescue

Your ZX81 becomes the command console as a diver descends to the sunken submarine Nautilus to rescue as many of the stranded crew as possible. It's a race against time as your oxygen supply must be replenished. It's also a constant battle against marauding sharks which you can attempt to blast with your laser.

Z96 $12.95

Invaders

Fast-moving, machine code version of the famous arcade game, for the 16K ZX81. Shields are provided to help protect you from the bombs of the marching aliens. Ten levels of play, from easy to suicidal. On screen scoring. Why settle for a lesser program when you can have "Invaders"?

Z62 $19.95

Family Games

Battleship

The classic confrontation of two naval forces. Position your battleships, cruisers, destroyers and subs, then search out your opponents' fleet. Keep your forces hidden while trying to sink the enemies.

Z56 $12.95

Shell Game/Number Maze

Consists of 2 amazing games on one cassette.

Shell Game: Watch the "Hustler" move the shells! Try to keep track of the "pea". Which shell is it under? Bet and guess! Can you beat the game?

Number Maze: The computer version of the popular pocket puzzle. Move the number squares one space at a time until they are in order. A new and different challenge every time.

Z59 $12.95

3D Monster Maze

Exceptional graphics! Can you find your way through the maze? The exit is there somewhere . . . but so is a T.REX. Written in machine code, the 3D Monster Maze has been rated among the finest ZX81 and T/S 1000 games available. 16K B78 $19.95

Catacombs

A multi-level graphics adventure. Each level can contain up to 9 rooms, 8 passages, 7 monsters, food, gold, traps, phantoms, an exit (to the next level) . . . and there's an unlimited number of levels. Exceptional and exciting. 16K.

B77 $19.95

Family Games

(cont'd)

1K GAMES PACK
A selection of 11 exciting games for the unexpanded ZX81 or T/S1000 computer. Games include: Slot Machine, Etch and Sketch, Slalom Ski, Catch Me If You Can, Space Pirate, Spacefire (2 Versions), Car Crash, Man-Eating Budgies, Maze and the Wall. **Z52 $12.95**

Hangman
TWO exciting games. Can you discover the MOVIE title or the film star's name before the hangman gets you? Over 100 titles and names — three categories to choose from. How well do you or your kids know famous SUPERHEROS? Guess their names and the names of their arch-enemies before your arch-enemy, the HANGMAN, wins. **Z78 $12.95**

Concentration/Word Challenge/ Number Challenge
Consists of 3 games on one cassette. Concentration: There are three ways to play this game. Match numbers, shapes or patterns with a friend or challenge your computer.
Word Challenge: This exciting game is modelled after the famous word game Boggle. Have fun with up to six players!
Number Challenge: How many numbers can you recall . . . backwards? Up to six players are challenged by the computer.
Three different ways to play. **Z58 $19.95**

Espionage Island
The latest of our devious and tormenting adventures to amuse and entertain you. You have to survive an engine failure while flying over an apparently uninhabited island in the South Atlantic. Learn to treat the natives with respect, avoid capture and have the enemy and return with the island secret. Cassette routines are available to save and reload at any stage of the game. **Z99 $19.95**

Program of Days
A Historical databank. Organized to provide insight and information regarding historical events. You can access the program to find out what famous persons were born and what noteworthy event happened on your birthday! **Z45 $15.95**

Solar System File
A databank of information on the cosmos! Interesting facts, interrelationships of the planets, their moons, the Sun, artificial satellites, and the constellations. Now you can have fingertip computerized access to amazing facts about the Universe. **Z44 $15.95**

Biorhythms
Helps you "track" your up and down cycles for intellectual, emotional, and physical factors. Lets you know what phase of your personal biorhythm cycle you are experiencing on any specific day. The program is supplied with a detailed booklet explaining the theory and application of biorhythms. **Z46 $15.95**

Flashcard
Memory aid and testing device. This program simulates a set of flashcards. You can put questions on side one of the flashcard and the answers on side two. Then give yourself, your children or your friends a random test or a non-repeating test. Set up math quizzes, trivia, games, memory tests, etc. You define what is places on each card. The program is menu driven. You can set up, edit, and save cards for later review. **Z51 $15.95**

Gunfighter
An excellent graphic representation of an old time wild west shootout. For one player against the ZX81, or two. Six levels of skill.

3D TIC-TAC-TOE. A much more challenging and interesting version of the popular game.
LIFE. Simulates the birth, growth, and death of a cell colony. The human player sets up the ground rules and then watches the results of his decisions. **Z76 $15.95**

Blackjack
Blackjack at its best. Blackjack as it played in the casinos of Nevada. Up to five players can play against a dealer with a fifty-two card deck. Split pairs, double down, and even buy insurance. The deck is reshuffled only when needed — allows for a continuous game. Your winnings and losings are displayed after each hand. **Z88 $12.95**

Slots
Here is your chance to beat the 'one-arm bandits'. Slots lets you choose 5¢, 10¢, 25¢, 50¢ and even $1 machine. Each machine has six sets of different graphics and pay according to the number of coins you played. Excellent, striking graphics, and lots of fun and excitment! **Z89 $12.95**

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Commodore VIC 20

Software / Books

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Timex Sinclair 1000: Programs, Games, Graphics
Robin Jones and Ian Stewart team up to give you what you've been waiting for — a professional comprehensive book of programs for the T/S 1000. Over 50 ready-to-run games and applications, as well as tips on debugging and graphic programming. ZX80 and ZX81 owners will not be left out in the cold either.
B60 $14.95

TIMEX SINCLAIR 1000 Users Guide (Vol. 1)
An excellent alternative to the manual accompanying your T/S 1000. The User's Guide is written in plain English and takes the guess work out of learning BASIC. You'll be writing programs in no time at all, so you can get the most for your money with the T/S 1000.
Q20 $14.95

The BASIC Handbook
The most complete collection of BASIC words anywhere! Makes program conversion simple: provides valuable tips on how to translate a program with "foreign" BASIC to run on your computer. Now you can make use of programs which appear in magazines not specifically written for your computer. This is one of the few books we carry not specifically devoted to the T/S 1000 and ZX81 because it is of great value to all users of BASIC.
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Learning Timex Sinclair BASIC
A uniquely uncomplicated way to learning BASIC. A step by step guide by a proven teacher (Dr. David Lien, author of the Basic Handbook). This guide is ideal for elementary level computer users. Also excellent for class situations, seminars and training programs. 350 pages.
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Getting Acquainted with your ZX81/TS1000
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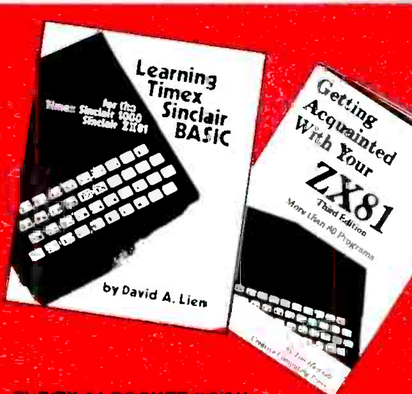

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Games Pack 6

DODGEMS — Survive colliding with the computer controlled car. Game gets faster every time you win!
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AMOEBA — Try and create the shapes devised by the computer.

Games Pack 7

GREENTHINGS — Find a way to destroy the green aliens that have invaded your spacecraft.
BALLISTICS — See if you can hit your opponent hiding on the other side of the hill.
SNAKE — Guide your snake towards digits which it eats, but don't let it eat the walls or itself!

Games Pack 8

STARGATE — Protect your missile base against aliens invading at high speeds.
GOMOKU — Play against the computer to get five counters in a row.
ROBOTS — Lure the robots into potholes, before they turn you into scrap metal.

Games Pack 9

SNAPPER — Find a cross and eat it to become invulnerable; then avoid the creatures in the maze while eating more dots. Different mazes and faster creatures follow.
MINOTAUR (3D) — Move the five gold bars from their treasure chests to safe before the Minotaur eats you!
BABIES — Rescue falling babies by bouncing them off a trampoline to the right hand side of the screen.

Games Pack 10 (8K & 2K)

BREAKOUT — Knock bricks from a wall and beat the high score.
HECTIC — Catch the blocks falling from the sky before they block your way.
MASTERMIND — Guess the computer's code in less than 10 attempts.
SKI-RUN — Ski down a mountain while avoiding the trees.
SNAKE — Guide your snake to the food, but don't bump the edge!
TRACK — Avoid the oncoming traffic on a fast paced race track.
SIMON — Test your memory with a series of letters provided by the computer.
SQUASH — Keep 15 balls in play in the squash court.
MOON — Land your module controlling thrust and with readouts of height, velocity and acceleration.
BOMBS AWAY — Destroy the bunker on the other side of the mountain by choosing the angle and speed of the bombs.

Games Pack 11

MISSILE BASE — Defend your cities with missiles from 3 ground bases.
SNOOKER — Control the angle and speed of your shot in this fast real-time game.
DOMINOS — Play this traditional game against the computer and try to win.

SoftVDU

This replaces the normal ATOM VDU. 128 characters including upper and lower case letters and mathematical symbols can be mixed with high res graphics. The DESIGN program allows new characters such as foreign letters, to be designed and added to the character set.

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PLOT — A versatile graph-plotting package for use in research, accounting, schools and mathematics, or simply for fun!
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Utility Pack 1

DISASSEMBLER — A versatile disassembler which can list machine code in standard ATOM assembler form or store the assembler text into memory.
FAST COS — Speeds up program saving by modifying the ATOM's standard cassette interface routines to operate at 1200 baud, or 4 times the standard speed.
RENUMBER — A fast renumber for BASIC or assembler programs, which gives a display of the line numbers for labelled lines.

Atom Adventures

DUNGEON — Find the treasure in a maze of caverns, tunnels, and caves inhabited by friendly and unfriendly creatures.
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INTERGALACTIC — As an intergalactic traveller, you must survive battles against the inhabitants of alien planets and return home with treasure.

ATOM SYNTHESIZER (3 songs included) — Turns the Atom into a programmable musical synthesizer.

LIFE — A fast paced game of LIFE using high resolution graphics.

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RELATIONS — Select from a list on the screen the phrase to complete related words.
SENTENCES — The pupil must reconstruct a given sentence by selecting the items in the correct order.

Atom Business

Describes eleven business programs covering a wide range of different business applications.

Atom Chess

A complete chess-playing program with up to 127 moves which can be stored and replayed at any point of the game.

Atom LISP (8 & 12K)

Consists of 5½K of machine code interpreter plus 3K of initialised LISP workspace containing LISP utilities and constants, which can be deleted to make space if not required.

Utility Roms

Programmers Tool Box (ROM) $79.95
A packed 4K ROM (fits into utility ROM socket) containing 300 baud cassette operating system, ALSO a total of 27 other BASIC commands like READ, DATA, TRACE, etc.

ATOMcalc (ROM) $99.95
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Edit / Debug (Rom) $79.95

EDIT is a sophisticated program text editor, similar to editors available on more expensive machines than the Acorn Atom, which allows the user to make major alterations painlessly. DEBUG is primarily an aid to debugging machine code programs and includes a disassembler.

Atom Business Book	$24.95
Atom Magic Book	$19.95
39 Tested Programs	$19.95
Make Up Your Atom	$16.95
Practical Programs for BBC & Atom	$19.95

Getting Acquainted with your Acorn Atom $19.95

The ATOM is a powerful computer, but because of its non-standard BASIC, it can take a while to get to grips with it. This book will take you from the first stages of programming in ATOM BASIC right through to mastering the graphics and using assembler.
Explanations cover such things as PEEK and POKE, arrays and string functions. More than 25 programs are included, which cover the field from personal utility, through education, to games such as DRAUGHTS, SPACE STATION, THE FOREVER WAR and DODGEM.

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Expansions:
Internally mounted expansions for ACORN ATOM including MP100 (DC/DC Converter)
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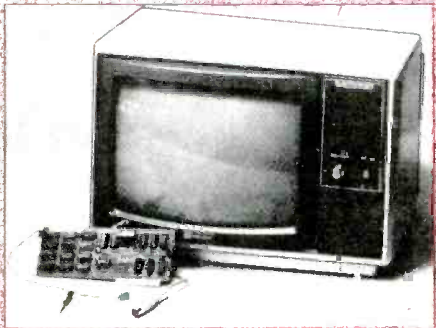

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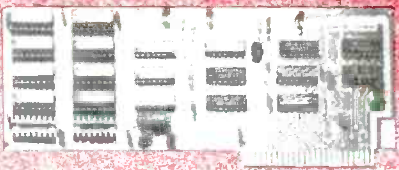

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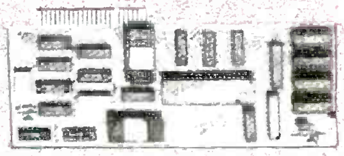

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- Up to 1100 transactions per month
- Maintains transaction [illegible]
- Provides Hi-Res bar graphs for [illegible] of budget [illegible] expenses [illegible] output to screen and printer

[illegible] user's guide with step by step [illegible] Micro 48 and Apple [illegible] Workalikes [illegible] Requirements: 48K, 3.3, 2 disk drives, printer optional.

The Word Handler $229.95

A truly professional word processing system with features found in processors selling at 5 to 10 times the price. Allows documents larger than memory, simplicity of operation, upper and lower case, underlining, superscript, bold, justification and unlimited TAB functions — to the screen as well as the printer.

Displays a full 80 columns on the screen, with no additional cards or boards needed. What you see is what you get.

Merge files from different disks for processing — great for form letters when used with the List Handler. Complete with step by step instruction manual and backup disk. The Word Handler, from Silicon Valley, only.

The List Handler $116.95

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Can hold up to 3000 records per drive, manage 1 to 8 drives, allowing up to 24,000 records. Great for "inventory" "product lists" "form letters" mailing lists "personnel directories" "invoices" labels.

The list handler can be used as a database system, or can interface with Word Handler for the most efficient processing available — ideal for preparing personalized letters. Compatable with all Apple II and similar computers.

Junior Education Package

Toddlers Tutor - Number, Letter and Word recognition $38.95

Makes best use of the Micro 48's (and other Apple compatible) colour and graphic capabilities, to draw screen sized letters and numbers for your child to identify. Also provides full illustrations they can identify with each letter and count with each number, to re-enforce recognition skills. (Our main researcher, four year old Michael Gladstone prefers Toddlers Tutor to Space Invaders). Screen can run for up to 20 minutes without repeating. Both colourful graphics — make learning fun.

EZ Learner $49.50

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0835912035, $118.95/Software

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0835987906, $45.95/Software

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0135278392, $39.00/Book & Disk
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BRAIN TICKLERS Apple II Edition: Recreational Problem Solving with the Microcomputer

A software package containing 196 recreational puzzles, pastimes, and projects specifically designed for the Apple II [illegible] beginners or advanced users [illegible] with a [illegible] explanation of each project. Equipment needed: Apple II [illegible] Apple DOS 3.3 format. All programs are written in [illegible]

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[illegible] how to [illegible] makes [illegible] CP/M commands [illegible] For users of the Apple II [illegible]

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After [illegible] exercises [illegible] creation of [illegible] Apple II Plus, Apple Pascal [illegible]

013652[illegible], $4[illegible].95 Software

FANCY PROGRAMMING IN APPLESOFT

Users who want to go a step beyond simple programming will learn • how to renumber a program • how to INPUT data without stopping a program • how to save an Applesoft program as a binary file • and more. 0835918584, $19.95

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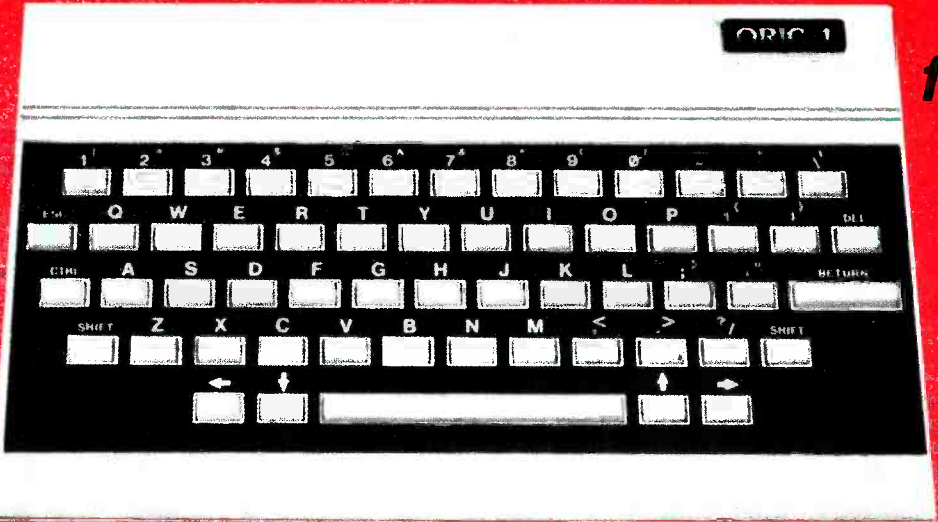

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COLOUR COMPUTER
- 16K and 48K RAM versions
- Microsoft BASIC
- 16 colours: 8 foreground & 8 background
- 6 Octave Sound Synthesizer
- Easy to use keyboard with 57 moving keys
- 28 rows x 40 characters high resolution
- Centronics printer interface
- Built-in cassette interface
- A fully expandable system for real computing!
- 200 page user guide and programming manual

48K only $399.95

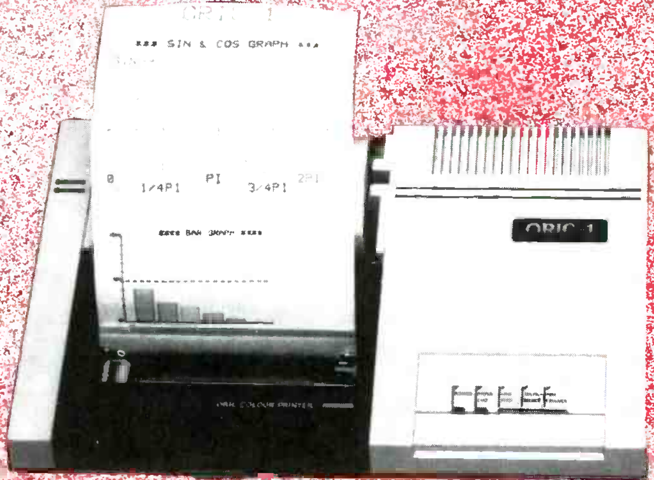
16K only $329.95

Oric-one is the newest and most powerful small computers from the United Kingdom. The standard 6502 processor comes complete with 48K RAM and a wide range of ergonomically designed peripherals. A 16K version is also available.
For those who want to create new programs, you can use the ROM based Microsoft BASIC. An extensive 200 page users guide is provided which includes a complete programmers manual.

High resolution graphics are standard, with 240 by 200 pixel resolution. The 16 colors allows you 8 foreground, 8 background and a mixture of text and graphics. With the 6 octave sound synthesizer you have your choice of ZAPPING, EXPLODING, SHOOTING or PINGING those space creatures. You can choose to use a standard household television set or a separate colour monitor.
The full sized key-pad accents the futuristic approach taken by Oric. You can select between upper or lower case and each of the 57 keys is provided with auto repeat in a familiar QWERTY layout.
You can easily expand your system through the Centronics parallel interface to the Oric 4 color printer. The built-in cassette interface immediately opens you to a world of software or you can upgrade into the Oric 3" Micro Floppy Drive system for a total storage capacity in excess of 1 Megabyte. Oric even allows you option to choose French software from our expanding selection!
The Oric is truly a fully expandable SYSTEM with real computing power.

Specifications

CPU Memory:	6502 A Microprocessor with the operating system and BASIC interpreter in 16K ROM. 16K byte or 48K byte models available.
Keyboard:	57 moving auto repeat keys with full upper and lower case in a QWERTY layout.
Display:	Standard T.V. output on channel 36 (UHF). RGB for color monitor output.
Screen:	28 lines by 40 characters - Text mode 200 lines by 40 graphic cells - Hi resolution 16 colors, 8 foreground and 8 background.
Cassette Interface:	Selectable 300 or 2400 Baud rates for the storage of data, memory blocks or screen displays.
Expansion Ports:	Serial/modem, Network interface, Disk Pack, Micro Drives and RAM, ROM expansions.
Printer Port:	Centronics Parallel.
Sound:	7 Octave range of 15Hz to 62kHz for Ping, Shoot, Explode or Zap sounds.



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The Oric Colour Printer is quality engineered to provide 4 colour hard copy on plain paper, with superb graphics and text capability, printing either 40 columns or 80 columns. It prints in red, green, black and blue, onto a 4 ½" width standard paper roll. With a print speed of 12 characters a second, the MCP 40 comes with its own power supply and all necessary leads to connect straight into your Oric or to any standard Centronics interface.
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Coming Soon

Assembler
Machine Code Monitor / Disassembler
ORIC - CALC - Spreadsheet

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By Ian Sinclair - THE ORIC - 1 and How To Get the Most From It

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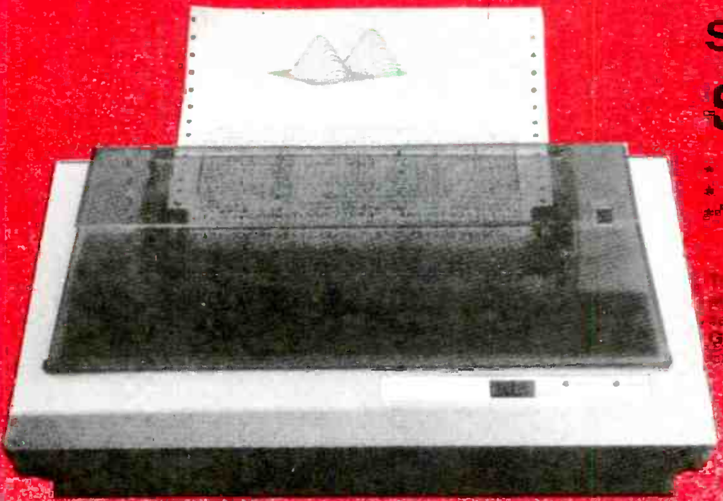

SEIKOSHA GP-100

$488.00

* The Perfect Addition to your ZX-81/TS1000, Acorn, or Micro 48
* Full Graphics Capability
* Single or Double Width Characters

This low priced 80 column graphics printer comes with a centronics parallel interface, adjustable pin feed paper widths from 4.5 to 10 inches, and accepts tractor fee. Prints at 30 characters per second. Both commodore and Atari have chosen Seikosha, make it your choice.

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Extra Ribbon (one is supplied) $9.95

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* Centronics Parallel interface

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Replacement Ribbon Cassette

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Model TP-1

* Daisy Wheel

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Print Wheels $ 8.50

Available print wheels include pivva 10 (pitch), Regency 10, Judicial 10, Tempo 10, Corporate 10, Elite 12, Presidential 12, and Tempo 12. (sample print styles available on request)

Printer Compatibility Chart

All printers require a printer interface and cable to connect to computer. Here's what you need to connect the printers on this page.

	ZX-81 TS 1000	Acorn Atom	Micro 48
Siekosha GP-100	Memotech C.1 $119.95 Memo. Printer cable $35.00	Acorn Printer Interface $35.00 Acorn Printer cable #1 $35.00 (both for $59.95)	Pro printer card $89.95 Pic printer cable $35.00
Epson MX-80	Same as above	Same as above	Same as above
Smith Corona TP-1	not applicable	same as above	same as above

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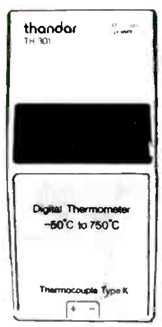

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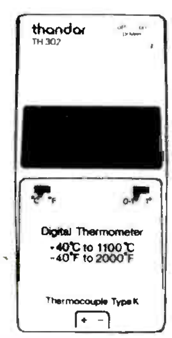

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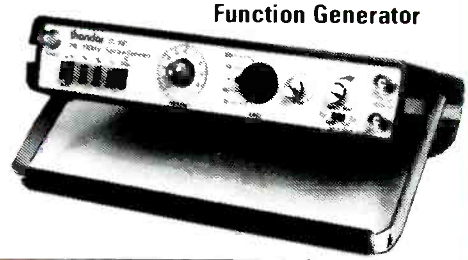
TG 100

$281.00



Frequency Range	1Hz to 100kHz
Functions	Sine, Square, Triangle and DC from variable 600Ω output. External sweep input permits ≈300:1 linear sweep below range maximum, i.e. below 0.1Hz on 10Hz range.
Outputs	1mV to 10V from variable 600Ω output; variable DC offset to ±5V. TTL output.
Power Requirements	120V or 240V AC (nominal) 50/60Hz
Size & Weight	255 × 150 × 50mm : 1200gms

★ 0.2Hz to 2MHz Function Generator

TG 102

$510.00

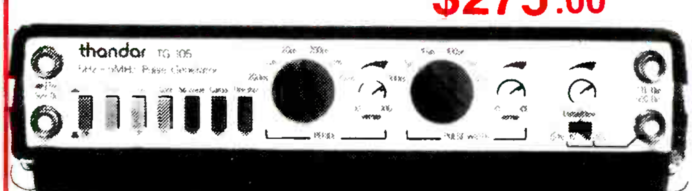
* 0.2 Hz to 2MHz in 6 RANGES
* FINE Adjustment by calibrated VERNIER
* EXTERNAL SWEEP MODE

* SINEWAVE, TRIANGLE, SQUARE WAVE & DC OPERATING MODES
* VARIABLE 50 and TTL output
* MAXIMUM INPUT ± 10V
* 0.2Hx to 2MHz Function Generator
* Sine, Square Triangle Waveforms
* Variable DC offset
* Variable 50 output TTL output
* External Sweep Mode

★ 5Hz to 5MHz Pulse Generator

TG 105

$275.00



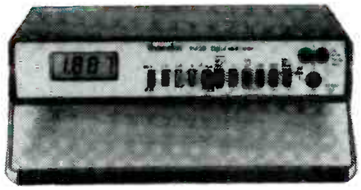
★ 5Hz to 5MHz Pulse Generator
★ Free-Run, Gated or Triggered Modes
★ Squarewave, Complement
★ Variable 50Ω output
★ TTL output
★ Sync output

cont'd.

thandar

MULTIMETERS

TM 351



★ Bench/Portable
★ 3½-digit 0·5″ LCD
★ 0·1% basic accuracy
★ 29 ranges
★ Battery life typically >2000 hours
★ Complete with batteries and test leads

$309.00

TM 353

$264.00

★ 26 ranges
★ Battery life typically >3000 hours
★ Complete with batteries and test leads
★ Bench/Portable
★ 3½-digit 0·5″ LCD
★ 0·25% basic accuracy

TM 355

$264.00

★ Bench/Portable
★ 3½-digit 0·5″ LED
★ 0·25% basic accuracy
★ 29 ranges
★ Battery or mains (AC adaptor) operation
★ Supplied with test leads

TM 354

$121.00

Measurement capability:

DC volts	:	1mV to 1000V
AC volts	:	1V to 500V AC rms
DC current	:	1µA to 2A
Resistance	:	1Ω to 2MΩ

★ Pocket size
★ 3½ digit 0·5″ LCD
★ 0·75% basic accuracy
★ 14 ranges
★ Battery life >2000 hours

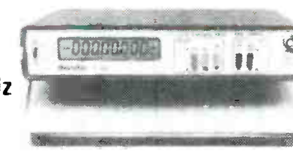
COUNTERS

TF 200 10Hz to 200MHz

★ Bench/portable
★ 8-digit Liquid Crystal Display
★ Frequency range 10Hz – 200MHz
★ Resolution better than 1ppm
★ Sensitivity typically 10mV rms
★ Timebase accuracy 0.3ppm
★ Battery life 200 hours
★ Frequency, time average period, totalize & reset; 2 ranges, 5 gate times; external clock facility
★ Complete with batteries

$485.00

TF 040 10Hz to 40MHz



★ Bench/portable
★ 8-digit Liquid Crystal Display
★ Frequency range 10Hz – 40MHz
★ Resolution 1Hz
★ Sensitivity 40mV rms
★ Timebase accuracy 0·5ppm
★ Battery life 80 hours
★ Frequency, totalize & reset; 2 gate times
★ Complete with batteries

$385.00

PFM 200A

$210.00

★ Pocket Size
★ 8-digit L.E.D. Display
★ Frequency range 20Hz – 200MHz
★ Resolution 0·1Hz
★ Sensitivity typically 10mV rms

★ Timebase accuracy 2ppm
★ Battery life 10 hours
★ Frequency; 2 ranges, 4 gate times
★ BNC Input Sockets

TF-600

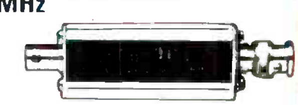
$139.00

★ Frequency range 40MHz – 600 MHz
★ Sensitivity 10mV rms
★ Powered direct by TF200 or TF040 (lead supplied)

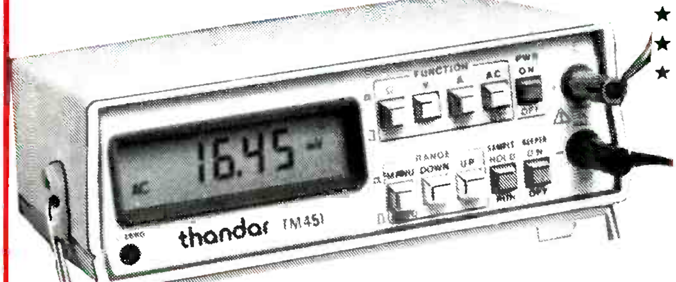
IP-1000

$225.00

★ Frequency range 100MHz – 1000MHz
★ Sensitivity better than 25mV rms
★ Will extend TF200 and PFM200A capability beyond 1GHz



MULTIMETERS TM451



★ Bench/Portable
★ 4½ digit 0·4″ LCD,
★ 0·03% basic accuracy
★ Full auto-ranging or manual
★ Sample hold
★ Audible continuity test
★ Complete with battery and test leads

$495.00

Accuracy	Basic Accuracy ± (.01% of reading)
Battery Life	70 hours from 9v Battery
Size	155 x 120 x 57mm
Weight	585 g (including Battery)
DC and AC Volts	200mV to 1000V
DC and AC Currents	200mA to 1A
Resistance	1 to 20M

Write, phone or come in for full specification listings.

LEADER TEST INSTRUMENTS

*Wide Bandwidth

*High Sensitivity

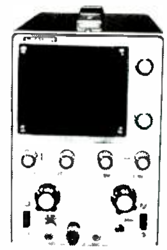
*High Accuracy

OSCILLOSCOPES (RECURRENT SWEEP), 5" CRT, DUAL TRACE

LBO-510B **$529.00** *NEW*

LBO-310A **$349.00**

4MHz



LBO-514A **$919.00** *NEW*

15MHz · 1mV

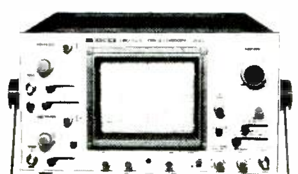
MODEL	LBO-510B	LBO-310A
Sensitivity	20mV/p-p/div or better	20mV/div or better
Bandwidth	DC (2Hz) ~ 4MHz	DC (2Hz) ~ 4MHz
Sweep Speeds	10Hz ~ 100kHz, 4 steps	10Hz ~ 100kHz, 4 steps
Synchronization	Internal, External, Line	Internal
CRT	130mm, 8 x 10 div (1 div = 1 cm)	75mm, 8 x 10 div (1 div = 6 mm)
Size (W.H.D)	250 x 175 x 375mm	125 x 180 x 300mm
Weight	6kg	4.5 kg

LBO-514A

Sensitivity	5mV/div (1mV: GAIN×5)
Bandwidth	DC (2Hz) ~ 15MHz
Vertical Mode	CH-1, CH-2, CHOP, ALT, X-Y.
Sweep Speeds	0.5µs/div ~ 200ms/div
Sweep Magnification	X5 ±5%
Synchronization	Automatic, Normal
CRT	130mm, 8 x 10div (1div = 1cm)
Size (W.H.D)	290 x 160 x 375mm
Weight	7.5kg

6" P.D.A. CRT, DUAL TRACE,

LBO-523 **$1449.00** *NEW*



35MHz · 500µV

Sensitivity	5mV/div (500µV: MAG×10)
Bandwidth	DC (10Hz) ~ 35MHz
Vertical Mode	CH-1, CH-2, CHOP, ALT, ADD, CH-2 Invert
Sweep Speeds	0.2µs/div ~ 0.2s/div
Functions	ALT trigger, Hold-off, X-Y, Remote X-Y, TV-V/H
CRT (PDA 7kV)	150mm, 8 x 10 div (1div = 1cm)
Size (W.H.D)	290 x 160 x 375mm
Weight	8.5kg

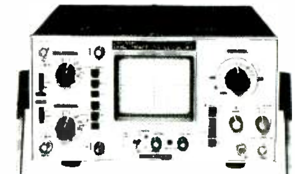
STEREO SCOPE

LBO-552C **$1049.00** *NEW*

Sensitivity	20mVp-p/div or better
Bandwidth	DC (2Hz) ~ 10MHz
Waveform Switching	Left and right at respective sides on a common base line
Sweep Speeds	10Hz ~ 100kHz, 4 steps
X-Y Operation	20mVp-p/div or better DC (2Hz) ~ 1MHz
CRT	130mm, 8 x 10div (1div=1cm)
Size (W.H.D)	175 x 250 x 375mm
Weight	7.2kg

3.5" CRT, DUAL TRACE,

Battery Operated **$1395.00**



20MHz · 2mV

Sensitivity	2mV/div ~ 10V/div
Bandwidth	DC (2Hz) ~ 20MHz
Vertical Mode	CH-1, CH-2, CHOP, ALT, ADD, X-Y
Sweep Speeds	0.5µs/div ~ 200ms/div
CRT(Rectangular)	95mm, 8 x 10div (1div = 6.35mm)
Power Supply	AC (100 ~ 240V), Battery (+12V rechargeable pack), EXT. DC
Size (W.H.D)	235 x 120 x 320mm
Weight	5.8kg

SIGNAL GENERATORS,

LAG-27 **$264.00** *NEW*

MODEL	LAG-27
Frequency Range	10Hz ~ 1MHz, 5 Ranges
Amplitude Control	HIGH/LOW
Sine Wave	Level: 5Vrms (no load) Distortion: 200Hz ~ 100kHz, 0.5%
Square Wave	5Vp-p, Rise time 200ns
Burst Output	————
Size (W.H.D)	238 x 150 x 130mm
Weight	2.5kg

R.F. SIGNAL GENERATOR

LSG-17 **$214.00** *NEW*

Freq. Range	100kHz ~ 150MHz (up to 450MHz on harmonics)
Output Voltage	0.1Vrms (no load)
Output Control	HIGH/LOW selected
Modulation	Intenal: 1kHz Ext.: 50Hz~20kHz
Audio Output	1kHz, 1V or more
Size (W·H·D)	238x150x130mm
Weight	2.5kg.

TRANSISTOR CHECKER

LTC-906A **$319.00**

LTC-906A
DC Parameter Mode
Measurement Range:
VD, VBE ... 0 ~ 3VDC
ICEO .... 0 ~ 10000µA
HFE .... 0 ~ 10000

*Automatically Identifies Leads
*Tests Good Bad—In or out of Circuit!

Write, phone or come in for full specification listings.

Thurlby 1503 and 1504

high resolution digital multimeters

1503 **$470.00**

1504 **$545.00**

* 4¾ digits (±32,768 counts)
* 10 uV, 10m , 1 nA resolution
* 0.03% basic dcV accuracy (1503-HA)
* True RMS ac functions (1504)
* LCD, fully field portable
* Current measurement to 25 amps
* 7 functions including frequency
* Outstanding price/performance ratio

Accuracy	12 months 19-25°C ±(% reading + % full scale)		Tempco - <0 1 of applicable accuracy per °C
DC Voltage	**1504**	**1503**	**1503-HA**
±320 00mV	0 09%r +02%fs	0 1%r+ 02%fs	0 08%r+ 015%fs
±3200 0mV	0 05%r + 005%fs	0 05%r+ 005%fs	0 03%r+ 005%fs
±32 000V	0 07%r+ 005%fs	0 08%r+ 005%fs	0 03%r+ 005%fs
±320 00V	0 09%r+ 005%fs	0 1%r+ 005%fs	0 05%r+ 005%fs
±1200.0V	0 1%r+ 01%fs	0 1%r+ 01%fs	0 05%r+ 01%fs
Resistance	**1504/1503**		**1503-HA**
320 00Ω	0 15%r+ 05%fs		0 15%r+ 05%fs
3200 0Ω	0 1%r+ 01%fs		0 1%r+ 01%fs
32 000k	0 1%r+ 005%fs		0 08%r+ 005%fs
320 00k	0 1%r+ 005%fs		0 08%r+ 005%fs
3200 0k	0 2%r+ 005%fs		0 15%r+ 005%fs
32 000M	0 6%r+ 01%fs		0 5%r+ 01%fs
AC Voltage	**1504 (True RMS)**	**1503/1503-HA**	**(Average Sense)**
3200 0mV	0 3%r + 05%fs	1600 0mV	0 2%r+ 02%fs
32 000V	0 35%r+ 05%fs	16 000V	0 25%r+ 02%fs
320 00V	0 35%r+ 05%fs	160 00V	0 25%r+ 02%fs
750 0V	0 35%r+ 2%fs	750 0V	0 25%r+ 04%fs
DC Current	**1504/1503**		**1503-HA**
±80 00μA	0 2%r+ 05%fs		0 15%r+ 04%fs
±800 0μA	0 15%r+ 02%fs		0 1%r+ 015%fs
±8 000mA	0 15%r+ 02%fs		0 1%r+ 015%fs
±80 00mA	0 15%r+ 02%fs		0 1%r+ 015%fs
±800 0mA	0 3%r+ 02%fs		0 25%r+ 02%fs
±10 00A	2 0%r+ 1%fs		1 5%r+ 1%fs
AC Current	**1504 (True RMS)**	**1503/1503-HA**	**(Average Sense)**
800 0μA	0 4%r+ 2%fs	0 3%r+ 04%fs	
8 000mA	0 4%r+ 2%fs	0 3%r+ 04%fs	
80 00mA	0 4%r+ 2%fs	0 3%r+ 04%fs	
800 00mA	0 6%r+ 2%fs	0 5%r+ 04%fs	
10 00A	2 5%r+ 1%fs	2 5%r+ 3%fs	
Diode Test	**1504/1503/1503-HA**		**Excitation Current**
3200 0mV	0 05%r+ 005%fs		1mA
Frequency	**1504/1503/1503-HA**		**Sensitivity typical**
4000 0kHz	0 005%r+ 0025%fs		1V pk pk

Thurlby 1503 Higher Performance at a Lower Cost

The 1503 provides more resolution, more effective accuracy, and more versatility than any other meter in its price category. High stability components, low power dissipation and maximum emphasis on quality ensure a longer calibration cycle and a minimum cost of ownership.

Greater Sensitivity with Greater Versatility

With a maximum resolution of 10μV and 10mΩ, the 1503 is ten times more sensitive than the best 3½ digit meters. Ultra-wide current handling copes with currents up to 10 amps ac or dc (25 amps short term) whilst providing resolution down to 1nA for measurement of capacitor leakage, etc.

An important feature often omitted is high impedance voltage. Up to ±3.2 volts, the input impedance can be chosen as 10MΩ or >1000MΩ, eliminating error when measuring high impedance circuitry.

Frequency Measurement with crystal control

The Thurlby 1503 provides direct measurement of frequency up to 4MHz with resolution of 0 1kHz (up to 7MHz with display overflow). A crystal timebase provides high accuracy and also defines precise integration periods, ensuring high stability and rejection of 50Hz related interference in multimeter mode.

A 4¾ digit scale length for greater resolution and accuracy

The Thurlby 1503 has a scale length of 15 bits (32,768 counts) on dc voltage resistance, 14 bits (16,384 counts) on ac voltage, and 13 bits (8,192 counts) on current. This longer scale length gives the 1503 much greater resolution and higher accuracy than competitive instruments.

The Thurly 1504 has True RMS ac functions in place of average sensing ac, for application involving power related measurements on non-sinusoidal signals.

SPECIFICATIONS

Reading Rate	- 3 125/sec	**Input Impedance**	- 10MΩ//40 PF (>1000 MΩ available on 3200mV range)
Polarity	- automatic	**Voltage burden on** Current ranges	- 100μV/count
Zero	- automatic	**DC NMR**	- >60dB at 50Hz
Display	- 9mm LCD	**1kΩ CMR**	>100dB AC line essentially infinite on batteries
Overrange	- display flashes	**Temp range**	- 0-40°C
Low battery	- LW symbol	**Nett weight**	- 1 2kg
Max. Inputs		**Dimensions**	- 230 x 230 x 60mm
Voltage	1200Vpk (320, 3200mV - 370Vpk)	**Battery**	- 6 x C cells
Current	1A fused (10A range - 25A 10 secs)		
Resistance, Diode Test, Freq	- 370 Vpk		

Frequency Function– requires fast rise-time signal (0 5V/μsec) Sinewaves below 50kHz must be converted to pulse waveform

AC Functions – True RMS (1504). Average sensing RMS-calibrated for sinewave (1503/1503HA) AC coupled.

Quoted accuracy 45-1kHz current, 45-65Hz voltage

Additional errors	65Hz - 400Hz	400Hz - 5kHz	5kHz - 10kHz	10kHz - 20kHz
1600mV/3200mV	0.1%	0 2%	0 3%	0 6% (1504)
16V/32V	0 3%	2%	5%	
160V/320V	0 3%	5%		
750V	2%			

Thurlby 1905a

5½ digit intelligent multimeter

with keyboard programmable computing and datalogging capabilities

1905a **$990.00**

* ±210,00 count scale length
* uV, 1m , 1 nA sensitivity
* AC functions included as standard
* 0.015% basic 1 yr. accuracy, 5ppm resolution
* Wide range of computing functions
  Ax+b, Hi-Lo-Pass, % Deviation, Min-Max, Running average
* dBV, dBrel, dBm at any impedance
* Single key null and relative functions
* Intelligent digital filter with adaptable characteristics
* Automatic data-logging with programmable interval timing

Specifications 1 year 18°C 28°C

r = of reading
s = of scale
* indicates use of null key

Reading rate	- 3 per second
Polarity	- Automatic
Zero	- Automatic
Display	- 13mm LED 8 digits
Scale length	- 4½ 5½ or 6½ digits
Overrange	- Displays ORR
Tempco	- <0 1 of applicable accuracy per °C
Input Current	- <100pA
DC NMR	- >60db at 50 60Hz
1kΩ CMR	- >120db at DC 50 60Hz
AC response	- Mean sensing rms calibrated for sine wave. Accuracies apply above 1000 counts
Additional Errors	- 65Hz - 400Hz - 5kHz - 20kHz
210/2100mV	0 1% 2%
21V	3% 2% ½db
210V	3% ½db
750V	2%
Single key functions	- null hold store
Computing functions	- Ax+b %deviation Limits AvLoHi Dec pt Filter
Data-logging	- 80 readings period 33 to 9 999 secs
Temp Range	- -20 to +60°C storage 0 to 40°C operating
Weight	- 1 9kg
Dimensions	- 230 x 230 x 90 mm
Supply	- 200-264V or 94 125V 40 440Hz

DC Voltage	Accuracy	Input Impedance	Max Input
±210 000mV	±(025%r+ 0015%s+2dgt)*	10MΩ or >1000MΩ	1100V pk 15 secs
±2100 00mV	±(015%r+ 001%s +1dgt)		400V DC or RMS cont
±21 0000V	±(02%r + 001%s +1dgt)		
±210 000V	±(025%r+ 001%s +1dgt)	10MΩ	1100V DC or AC pk
±1100 00V			
Resistance	**Accuracy**	**Excitation Current**	**Max Input**
210 000Ω	±(05%r+ 003%s+2dgt)*	1mA	
2100 00Ω			
21 0000kΩ	±(04%r - 001%s+2dgt)	100μA	400V DC or RMS cont
210 000kΩ		10μA	
2100 00kΩ	±(08%r - 002%s+2dgt)	1μA	
21 000MΩ	±(25%r + 003%s+2dgt)	1μA	
DC Current	**Accuracy**	**Voltage Burden**	**Max Input**
±210 000μA			
±2100 00μA	±(1%r+ 0015%s+2dgt)*	250mV max	1A 300V fuse protected
±21 0000mA			
±210 000mA			
±2100 00mA	±(25%r - 0015%s+2dgt)*	500mV max	5A 300V
±5 0000A	±(45%r - 00 5%s+2dgt)*	1V max	fuse protected
AC Voltage	**Accuracy 45-65Hz**	**Input Impedance**	**Max Input**
210 00mV	±(2%r+ 05%s+10dgt)		1100V pk 15 secs
2100 0mV			400V rms cont
21 000V		10MΩ 40pF	
210 00V	±(2%r+ 02%s+4dgt)		750V rms cont
750 0V			
AC Current	**Accuracy 45Hz 1kHz**	**Voltage Burden**	**Max Input**
210 00μA			
2100 0μA	+(3%r+ 05%s+10dgt)	250mV max	1A 300V fuse protected
21 000mA			
210 00mA			
2100 0mA	±(45%r+ 05%s+10dgt)	500mV max	5A 300V
5 000A	±(65%r - 05%s+10dgt)	1V max	fuse protected
Diode Test	**Accuracy**	**Excitation Current**	**Max Input**
2100 00mV	5%r	1mA	400V

Computing power to solve your problems

The 1905a has a set of computing functions waiting to transform its capabilities. Voltages can be expressed in dBV, related to any 0dB reference or expressed in dBm for a chosen impedance. Transducer outputs can be scaled, offset and displayed in the required engineering units. Tests can be made against present limits, percentage deviations from a preset nominal displayed, running averages taken and maximum and minimum values recorded.

A simple and consistent entry sequence combined with clear display prompts and a logical keyboard arrangement makes programming quick and simple, and the various computing functions can be operated simultaneously.

Automatic data-logging saves time and effort

The 1905a can store readings for recall later at any required time interval from ⅓ second to 2¾ hours. Up to 80 readings can be stored. Tedious time related measurement sequences can be handled automatically without disrupting your work.

You can also capture rapidly changing measurements and read them out at a convenient speed.

Thurlby 1905a – Extra performance without extra cost

The 1905a is a high performance 5½ digit multimeter incorporating dc and ac voltage, dc and ac current, resistance and diode test ranges as standard. It has all the functions and capabilities of a conventional bench multimeter combined with longer scale length, greater sensitivity, higher effective accuracy, and very powerful computing and data-logging capabilities. Yet it costs much the same as a conventional 4½ digit meter.

Thurlby

Professional test and measurement instruments

GLADSTONE SPEAKERKITS

SPEAKERS, CABINET KITS & INSTRUCTIONS
YOU SAVE 50% COMPARED TO BUILT SYSTEMS!

PHILIPS

Gladstone's complete Speakerkits are the money-saving way to better sound. The 5 systems shown on this page use Philips Deforest speaker components for the best in performance at economical prices. You save (typically) 50% or more of the price compared to factory-finished enclosures.

- **TRANSMISSION LINE SPEAKERS ELIMINATE BASS BOOM.**
- **SEE DETAILS ON OPOSITE PAGE.**

100 WATT "DOUBLE 12" 3-WAY KIT

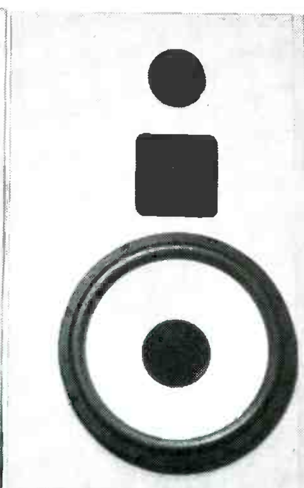
$214.75 EACH

Double up on your low frequency output without doubling your cost! The addition of the Philip's Passive Radiator boosts the bass frequency response while maintaining a remarkably smooth output throughout the audio spectrum.

SYSTEMS 5

1 AD01600 T8	19.95
1 AD02160 SQ8	39.95
1 AD12250 W8	79.95
1-AD1201	39.95
1 AD3WXSP	34.95
Price without cab.	214.95
Cab. kit	37.00
Price with cab.	228.80

125 WATT 15" WOOFER 3-WAY KIT



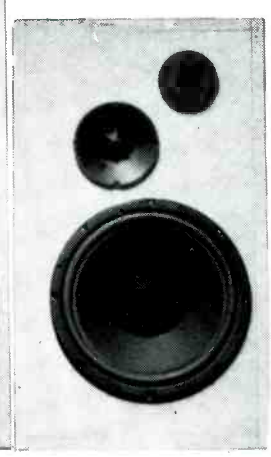
$164.80 EACH

15" SUPER SYSTEM handles 125 watts with thunderous bass, smooth mids, and sizzling top end! Woofer (AD15240/W8) is combined with new high power "exposed" dome midrange (AD2160/SQ8), dome tweeter, plus superior quality air-core coil based crossover AD3WXSP. Floor standing at 32" x 19¼" x 14"D. Response is 18 Hz — 20 KHz.

SYSTEM 4

1 AD01600 T8	19.95
1 AD02160 SQ8	39.95
1 AD15240 W8	69.95
1 AD3WXSP	34.95
Price without cab. kit	164.80
Cab. kit	37.00
Price with cab. kit	201.80

100 WATT 12" WOOFER 3-WAY KIT



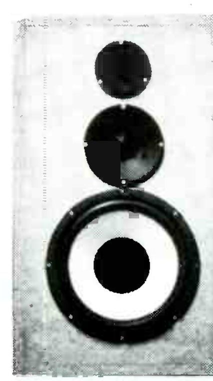
$145.35 EACH

12" SYSTEM handles 100 watts RMS with ease! Heavy-duty woofer, AD12240W/8, is combined with AD0211/SQ8 midrange, with air-core crossover AD3WXSP Response is 23-20,000 Hz. Cabinet size is 26½" x 15½" x 12"D.

SYSTEM 3

1 AD01600 T8	19.95
1 AD02110 SQ8	30.50
1 AD12240 W8	59.95
1 AD3WXSP	34.95
Price without cab. kit	145.35
Cab. kit	32.00
Price with cab. kit	177.35

80 WATT 10" WOOFER 3-WAY KIT



$120.40 EACH

Our 10" SUPER SYSTEM handles up to 80 watts RMS easily! Includes heavy-duty woofer, dome midrange, dome tweeter, and AD3WXA crossover network. Response is 25-20 KHz. Cabinet size 24" x 14" x 10"D.

SYSTEM 2. 10" 3 way

1 AD01600T15	19.95
1 AD02110SQ8	30.50
1 AD10240 W8	56.00
1 AD3 WXA	13.95
Price without cab. kit	120.40
Cab. kit	24.00
Price with cab. kit	144.40

50 WATT 80" WOOFER 2-WAY KIT

$54.40 EACH

Our upgraded "Budget" system, handles 60 watts RMS in compact cabinet (19" x 11½" x 8"D). Consists of Philips 8" woofer, dome tweeter, ADF1600/8 2-way crossover. Response 40-20,000 Hz. Compares with factory built "name" systems at $150-$200.00 ea!

SYSTEM 1. 8" 2 way

1 AD0163T15	13.95
1 AD80671	29.95
1 ADF3000/8	10.50
Price without cab.	54.40
Cab. kit	18.00
Price with cab.	72.40

SPEAKERS, CABINET KITS & INSTRUCTIONS INCLUDED!

SAVE 50% COMPARED TO BUILT SYSTEMS!

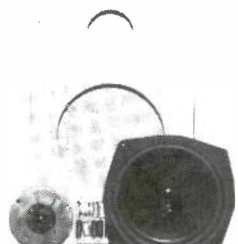
KEF

KEF-based speaker systems are considered the ultimate in quality for the home constructor. Gladstone's offers 5 kits including cabinets suitable for use with the highest quality home audio components, backed by our ten-year warranty on KEF products!

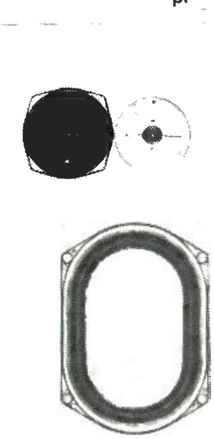
ALL CABINET KITS PRECUT TO SIZE FOR EASY ASSEMBLY. SEE DETAILS BELOW.

AS1 $320 00 pr

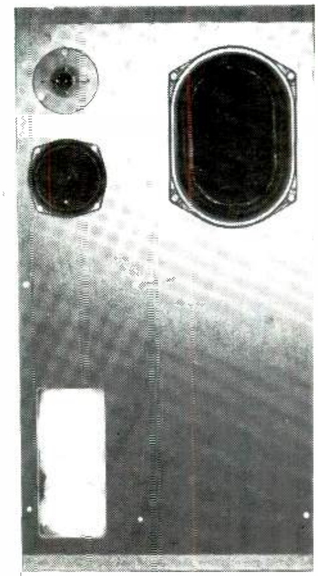
AS2 $280 00 pr



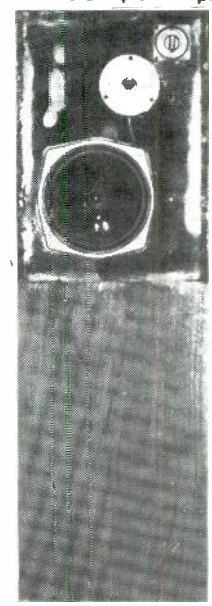
AS3 $585 00 pr



TL-90 $678 00 pr



TL-30 $310 00 pr



MINI-SIZE HIGH PERFORMANCE 2-WAY KIT

A mini-speaker that no one can believe! The **LS3/5A** system is world-famous as the best small speaker available — and our kit price is less than 50% the price of the factory-built equivalent. Consists of KEF B110 Woofer, Midrange T27 Dome tweeter, and Falcon #23 Crossover network. Meaures only 12 x 7½ x 9"D, yet packs an incredible bass wallop combined with superior imaging and stereo dispersion.

KIT AS1 INCLUDES (LS - 35A Cab.)

2 T27A	**90.00**
2 B 110A	**110.00**
2 Falcon 23	**120.00**
	320.00 pair
Price with Cab. Kit	**380.00** pair

50 WATT 8" WOOFER 2-WAY KIT

Popular bookshelf sized system with consistent KEF quality and performance. Handles 50 watts RMS with tight bass and clean midrange from B200 woofer, and excellent highs (from T27 tweeter). KEF DN13 crossover network. Box is 19 x 11½ x 8"D. Response 25-30,000 Hz.

KIT AS2 INCLUDES

2 T27	**90.00**
2 B200A	**125.00**
2 DN13 (Sp1106)	**65.00**
	280.00
Price with cab. kit	**316.00**

100 WATT DYNAMIC 3-WAY SYSTEM

Dynamic full-range system for up to 100 watts RMS. Ideal for powerful music from rock to classic to jazz. Consists of all KEF components: B139 woofer, B110 midrange, T27 tweeter and DN12 crossover. The box measures 26½ x 15½ x 12"D and comes with a sub-enclosure for the midrange speaker. Response is 20-20,000Hz.

Kit #AS3 INCLUDES

2 T27	**90.00**
2 B110A	**110.00**
2 B139B	**300.00**
2 DN12 (SP1004)	**85.00**
without cab. kit	**585.00**
with cab kit	**649.40**

FAMOUS TL.90 TRANSMISSION-LINE KIT

The TL.90 is the closest approach to concert hall realism without attending! Our most famous kit offers incredible performance. Response from 17 to 40,000 Hz, power handling up to 200 watts (25 minimum). Consists of KEF B139 woofer, B110 mid, T27 tweeter, and Falcon #5 crossover (specially designed and built for this system). The cabinet consists of extra-heavy 1-⅛" particle board for resonance-free super-deep accurate bass. Cabinet size 37 x 19½ x 15¼"D.

TL-90 INCLUDES

2 T27	**90.00**
2 B110A	**100.00**
2 B139B	**300.00**
2 **Falcon** 6C	**118.00**
•6 lbs wool	**60.00**
without cab. kit	**678.00**
with cab. kit	**810.00**

FAMOUS TL.30 TRANSMISSION-LINE KIT

Extended bass response due to the "labyrinth" design of the enclosure, with no bass boom! The TL.30 two-way system is an outstanding value in terms of price/performance balance. It is ideal for amplifiers from 25 to 75 watts per channel, and has a virtually flat response from 30 to 40,000 Hz. Consists of KEF B200, T27, DN13 crossover network. Cabinet kit has all parts precut to size, including the internal dividers, and can be constructed in a short time. Includes wool for internally lining the box, and instructions. Size: 42 x 13½ x 13½"D.

TL30 INCLUDES

2 T27	**90.00**
2 B200A	**125.00**
2 DN13 (SP1106)	**65.00**
3 LBS wool	**30.00**
without Cab. Kit	**310.00**
with cab. kit.	**442.00**

Gladstone's "Knock Down" Cabinet Kits.

Consisting of 3/4" particle board, accurately cut to size, ready to assemble! Price includes pre-cut front-panels!

CAB-8-KD	For 8-inch woofer and 4" tweeter. 19 x 11½ x 8" D. **$18.00 each**
CAB-10-KD	For 10" woofer, 5" midrange, 4" tweeter 24 x 14 x 10" D. **$24.00 each**
CAB-12-KD	For 12" woofer, 5" midrange, 4" tweeter 26½ x 15 ½ x 12" D. **$32.00**
CAB-15-KD	For 15" woofer, 5" midrange, 4" tweeter 32 x 19¼ x 14" D. **$39.00 each**

Why Transmission Line Speakers?

The transmission line design offers several acoustic advantages over sealed or reflex type enclosures: lower cabinet resonance with no "boominess", (meaning deeper and more accurate bass response); decreased driver cone excursion (resulting in better transient response); midrange and tweeter speakers at "ear level" for better imaging.

Incredible savings!

Before Gladstone's Transmission Line Kits were available, the cost of comparable factory-built systems was prohibitive to most consumers. For example, an imported system similar to our TL.90 retails in Toronto at close to $3,000.00 per pair — more than FOUR TIMES our kit cost!

Facts About Our Transmission Line Kits!

Our cabinets use 1-1/8" extra-high density particle board (as compared to 3/4" typically used in most speaker boxes). This ensures a strong resonance-free enclosure. All internal dividers are pre-cut with angled edges; assembly is straight-forward. We provide all necessary hardware. You provide drill, screwdriver and white-glue, and make your own grille frame.

• Transmission line speaker cabinets are lined with long-fibre wool, which is INCLUDED in the price of the complete kit and kit minus cabinet.

Optional level controls.

To "balance" the sound of the TL.30 and TL.90 we recommend that controls be added for midrange and tweeter level.

ML-1 Midrange control.
HL-1 Tweeter control.
Each **$4.95**

If you're serious about sound . . . we recommend KEF quality speakers backed by a year warranty!

2 KEF 200 mm Woofers

B200A

BEXTRENE $125.00 pr

200 mm
(8½") WOOFER - outperforms most 12" units. Best in its class! 8 ohms, nominally rated at 50 watts RMS. 1 inch voice coil, recommended enclosure is 20.4 litres (2-way infinite baffle system) but used successfully in air suspension, reflex or transmission line enclosures. 25-3,500 Hz. Resonance: 25 Hz. 1-year guarantee!

New B200G 200mm $175.00 pr

Heavy Duty 8" Woofer Finally Released! Low/mid range unit with visco-elastic damped Bextrene diaphram and high temperature coil assemble, suitable for use where low distortion and high power handling are required. As originally used on the KEF 104. 100 Watts Continuous Power, 25-3,500 Hz.

Famous KEF B139 Woofer

$300.00 pr

9" x 13" WOOFER - with unique plastic cone! Rated by experts as one of the world's best!. 8 ohms, rated at 100 W. Voice coil diameter 2". Recommended enclosure size 62.0 litres (3-way reflex system) out may be used in other types. Frequency response: 20-1,000 Hz. Resonance: 23 Hz!

New BD139B Passive — Radiator $125.00 pr

The B139 now available without voice coil and magnet, for use as passive radiator.

KEF's Best Woofer $400.00 pr

B300 Woofer first used in the Kef 105s, this 12" Bextrene 200 Watt woofer has now been made available to the constructor. Suitable for use where low distortion and high power are required. Responds from 25 - 2,000 Hz, with a 2" voice coil. Free air res. is 23 Hz.

KEF 110 mm Midrange Woofer

B110A

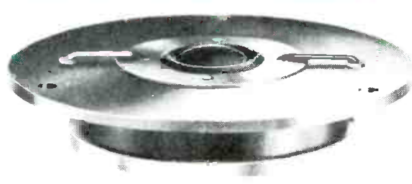
BEXTRENE $110.00 pr

110 mm
(5½") WOOFER-MIDRANGE covers bass, midrange, or both! May be used in compact system (7.26 litres, 13 x 9 x 6") with power handling of 20-30 watts. Response: 55-3,500 Hz. Or, may be used as a midrange with B139, covering frequencies above 4000 Hz, and requiring separate sub-enclosure. Resonance: 30Hz.

New B110B $130.00 pr

B110B Same specs as above, for matches with different drivers. See listing on constructor series.

3 KEF Dome Tweeters



T27 $90.00 pr

DOME TWEETER NEW DESIGN IS AN INDUSTRY STANDARD! Remarkable 1" dome tweeter with reponse from 3,500 to 40,000Hz. Can be used in systems rated at 40 watts 9 ohms. Like all other KEF units, the T27 is backed by a 1-year Warranty.

New T 33 $100.00 pr

T33 A high frequency unit with extended response and wide dispersion. Operates 3K to 20 Khz, at 100 Watts program power.

T 52 $200.00 pr

T52 A melinex dome tweeter with extended high end natural response, and ultra wide dispersion. Responds from 800 to 20,000 Hz, and can be used up to 200 Watts program power. As originally used on the Kef Cantata, and others, available for the first time to the home builder.

Better materials . . .

KEF believe that speaker performance can be more consistent and dependable, free from the distorting 'coloration' introduced by conventional diaphragm materials. Coloration will result if a cone continues vibrating **after** an input signal ceases. So KEF technology evolved specially formulated moulded plastic diaphragms, with laminated damping layers that absorb unwanted energy . . . instead of radiating it. This is why a KEF diaphragm sounds purer, cleaner.

Constant tests . . .

To be totally sure every product will always perform to specification, KEF test and test again. All incoming components are checked and graded, then further checked at every assembly stage. No KEF driver or crossover goes on to speaker assembly until it has passed rigorous tests

Greater care . . .

Through stage after stage, where the final result depends on careful workmanship, specially developed processes and unique jig designs keep up KEF standards of consistency.

KEF CROSS-OVER NETWORKS

"ECONOMY SERIES"

SP1004 (B139/B110A/T27)	$ 85.00
SP1106 (B200A/T27)	65.00
SP1017 (B110A/T27)	60.00

"CONSTRUCTOR SERIES" *Suggested Enclosure

DN-23 (B110B/T-27)	CS1	$100
DN-24 (B110A/T-27)	CS1A	$100
DN-25 (B200G/T33)	CS3	$100
DN-25 (B200G/T33/BD139)	CS5	$100
DN-26 (B139/B110B/T33)	CS7	$200

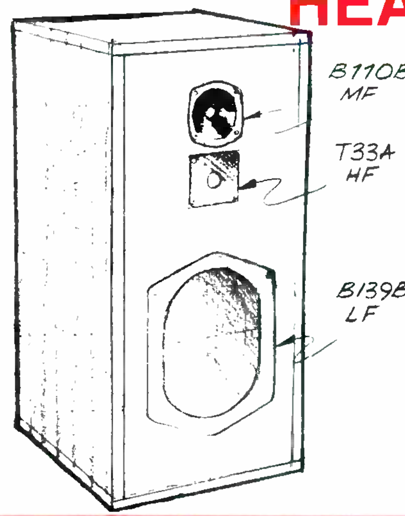
KEF

KEF CONSTRUCTOR SERIES

MODEL CS7

HEAY DUTY 3 WAY

* 150 WATT



This is a full three-way loudspeaker system employing the KEF B139 which is the world's most famous bass driver fitted with a flat diaphragm originally developed by KEF over twenty years ago. The mid-range unit features a Bextrene cone diaphragm and PVC roll surround. High frequencies are handled by a 25mm dome radiator. This remarkable system has an extended bass response and excellent power handling capacity. The computer designed crossover network gives a very smooth frequency response characteristic and ensures finely detailed reproduction of critical mid-range information.

$730.00 PR

SPEAKERS INCLUDE

CS7	
2 T33	**$100.00**
2 B110B	**$130.00**
2 B139B	**$300.00**
2 DN-26	**$200.00**

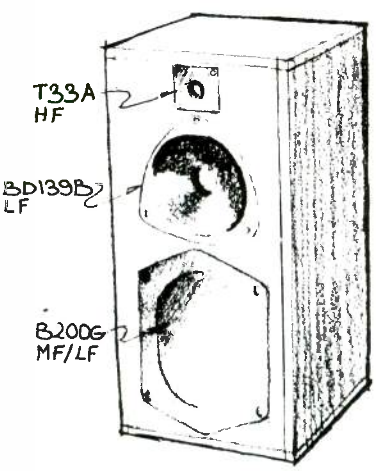
MODEL CS5

8" system with famous KEF

9" x 13" Passive Radiator

*100 Watts

$525.00 PR



This floor-standing loudspeaker has an extended low-frquency performance and provides remarkably sharp stereo imaging. It features a 200mm diameter Bestrene cone LF drive unit with a passive bass radiator. Model CS5 will reproduce the full frequency range available from the best modern recording s with outstanding clarity and low distortion.

KEF CONSTUCTOR SERIES KITS

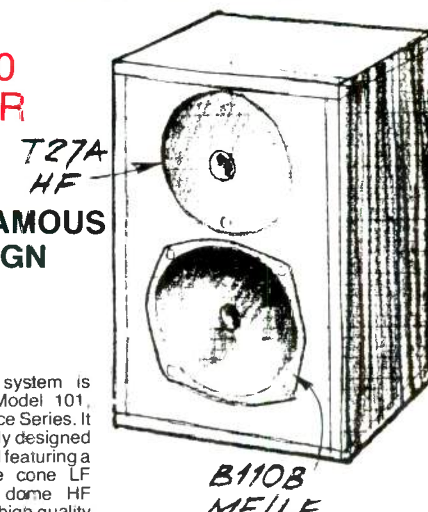
speakers include

CS5	
1 T33	**$100.00**
2 B200G	**$175.00**
2 BD139B	**$150.00**
2 DN-25	$100.00

MODEL CS1

BIG SOUND FROM A SMALL BOX.

$380.00 PR



- **BASED ON FAMOUS**
- **KEF 101 DESIGN**
- **50 WATTS.**

This miniature bookshelf system is based on the renowned Model 101, smallest of the KEF Reference Series. It is a two-way system specially designed for the home constructor and featuring a 110mm diameter Bextrene cone LF drive unit and a 19mm dome HF radiator. It can provide very high quality reproduction where small physical size is essential and high efficiency is not of prime importance. Wide bandwidth is achieved from a small enclosure of only 8 litres with a characteristic sensitivity of 81 dB/m/W Amplifiers giving continuous power output of 50 watts per channel are recommended for use with this design

CS1	
2 T27	**$ 90.00**
2 B110B	**$130.00**
2 DN-23	$100.00
Price without cab.kit	$320.00
Price with cab.kit	$380.00 **PAIR**

Model CS3

* Based on Famous KEF 103.2

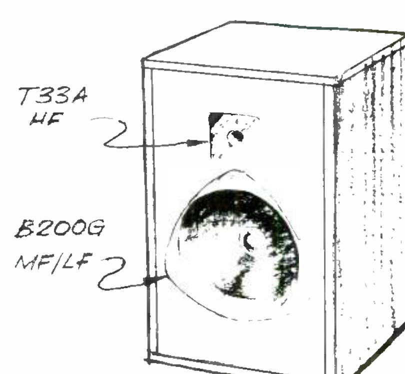
*75 WATTS

$375.00 PR

This very high quality bookshelf loudspeaker is based on the **KEF MODEL** 103.2, utilising the same drive units. It is a two-way system specially designed for the home constructor. The drive unit compliment comprises a 200mm Bextrene cone LF unit and a 25mm HF dome radiator. Model CS3 is capable of very high quality performance and can out-perform some of the best loudspeakers available.

(with cabinet **$411.00** PR)

CS3	
2 T33A	**$100.00**
2 B200G	**$175.00**
2 DN-25	$100.00



Write, phone or come in for full specification listings.

Easy to Build Kits Featuring ILP Modules

PROFESSIONAL SERIES

These feature the same performance specifications as the UP series, but the larger 19" x 5" professional cabinet enables the highest power ILP modules to be incorporated, in a stereo configuration.

BIPOLAR SERIES

	Power	Impedance		price
RB20	60W + 60W	4 ohms	Stereo	$285
RB30	60W + 60W	8 ohms	Stereo	$285
RB44	120W + 120W	4 ohms	Stereo	$345
RB48	120W 120W	4 8 ohms	Stereo	$345
RB54	180W + 180W	4 ohms	Stereo	$515
RB58	180W + 180W	8 ohms	Stereo	$515

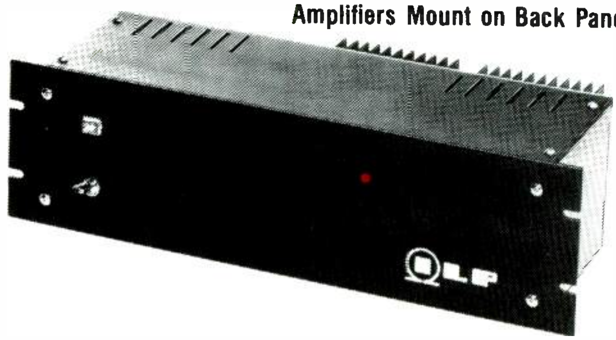
MOSFET SERIES

RM60	60W + 60W	4-8 ohms	Stereo	$355
RM70	120W + 120W	4-8 ohms	Stereo	$505
RM80	180W + 180W	4 ohms	Stereo	$755

Complete and detailled specifications on the modules that comprise the ILP amplifier series are available.

ILP Rack Mount Cabinet Available separately Complete with precut panels (specify modules) and Complete assembly hardware.
L1905A/B - (for bipolars) - $84.50
L1905A/M - (for MOSFETS) - $89.50
L1905A (no hardware) - $59.90

Amplifiers Mount on Back Panel



ILP AMPLIFIER KITS ARE EASY TO BUILD!

ILP power amplifier kits are designed to be assembled by anyone without prior experience. The ILP Modular Concept makes these the simplest and quickest kits available.

Here's how simple it is:
The power amplifiers modules are fully assembled and encapsulated. They mount on the back panel of the chassis with the supplied hardware.

The power supply components (transformer and printed circuit board) are fully assembled & tested. These mount internally in the chassis.

After they are mounted, the components are interconnected following the simple instructions. It's a quick and easy procedure. Each amplifier requires only 5 connections. They are not sensitive to overheating when being soldered (as are many other audio kits not using modular construction).

In less than two hours (typical) any ILP kit can be fully completed, and ready for use!

ILP POWER BOOSTER AMPLIFIER

The C15 and C1515 are power booster amplifiers (mono and stereo respectively). They are designed to increase the output of your existing car radio or cassette player to a nominal 15W rms from the C15 and 15 + 15W rms from the C1515, giving the advantages of being able to overcome road and engine noise without introducing annoying distortion. The amplifiers are encapsulated to an integral heatsink giving them the compact, robust modular form which is characteristic of all ILP audio products. Their many easy-to-use features include:-

Automatic supply switch-on activated when the ON switch of your radio or cassette player is operated

Selectable input level facility so that you can drive them from either low signal levels from the pre-amp of your radio or cassette player or straight from your existing unit's speaker leads

Output protection They are short circuit and thermally protected in order to ensure that the units do not become overheated.

Screw Terminal Connector Block Makes the attachment of the wiring quick and easy, no soldering required.

Two hole fixing allows them to be mounted anywhere in your car, in the boot or under the dashboard etc. No need for extra brackets.

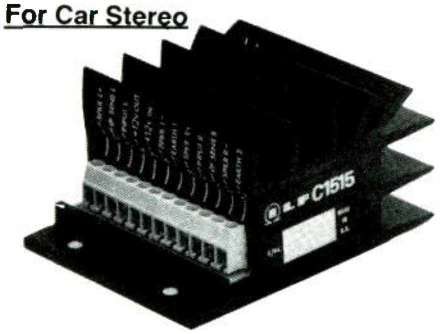
Technical Specifications

MODULES	C15	C1515
Output power maximum	30W peak into 4Ω	30 + 30W peak into 4Ω
Output power continuous (typical)	15W rms into 4Ω	15 + 15W rms into 4Ω
Frequency Response (3dB)	15Hz to 30KHz	15Hz to 30KHz
Total Harmonic Distortion (typical)	0.1% at 10W, 1KHz	0.1% at 10W, 1KHz
Signal to noise ratio (DIN AUDIO) Typical	80dB	80dB
Crosstalk – at 1KHz	– N/A –	60dB
Input sensitivity and impedance (Selectable)	700mV rms into 15KΩ 3V rms into 8Ω	700mV rms into 15KΩ 3V rms into 8Ω
Load Impedance	3Ω – ∞	3Ω – ∞
Supply Volts	8V to 18V dc	8V to 18V dc
Size	95 x 48 x 50	95 x 48 x 70
Weight (grams)	256	371

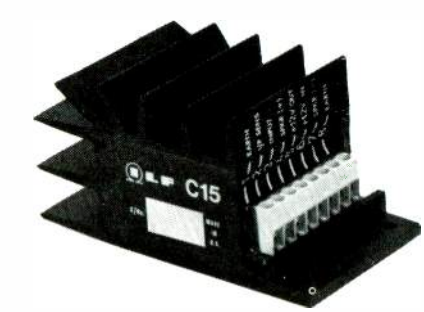
IMPORTANT NOTES:

1 Do not ground either speaker lead of the C15 or C1515 to earth pins or chassis
2 For use with negative earth wiring systems only
3 The user should be aware that the heatsink temperature of the C15 and C1515, under some load conditions, can be in excess of 60°C.
4 The speakers used with the units must be adequately rated to handle the power increase.
5 When utilizing the automatic switch on facility the output of pin 5 of the C15 or pin 4 of the C1515 now becomes the 12V supply rail for your radio or cassette player. There should be no other 12V connection to your existing equipment. With this connection arrangement, the C15 will not function until load current of your radio/cassette player passes through it from pin 6 to pin 5 and with the C1515 from pins 5 to 4
6 Standard suppression techniques, recommended for your car should be observed to ensure minimum interference.
7 The inputs to the left and right channel of the C1515 may be connected together to give a total of 60W peak in mono. (See back page for 60 Watts peak stereo application)

For Car Stereo



C1515 $69.95
Stereo Booster



C15 $39.95
Mono Booster

HIGH FIDELITY PRODUCTS

Easy to Build Kits Featuring ILP Modules

$99.95

UCI STEREO PREAMP:

A compact, high performance stereo control unit; elegant and sleek in appearance, with all the most desired features in a state-of-the-art preamp.

Has inputs for magnetic cartridge, tuner and tape/monitor facilities. This unit provides the heart of the ILP hi fi system and can be used in conjunction with any of the ILP series of power amps.

No tone controls for cleanest possible performance. Rather than risk the possibility of any tonal coloration through the use of bass or treble potentiometers, the UCI has only a stereo balance control and volume.

Separate power supply for total hum rejection. The UC1 draws its power from the power amp unit (connection is provided).

The UC1 preamp features the ILP HY78 module, which uses two stages of amplification: the first is dedicated to providing RIAA equalization for magnetic cartridge; the second stage introduces a partially logarithmic characteristic to the action of the volume control, and gives additional amplification to achieve the final output level. The circuit includes a 100 KHz filter designed to reduce transient intermodulation distortion in subsequent stages.

UC1 Specifications

Power Source: Connects directly to any UP series power amplifier. In other applications, requires unregulated dc supply voltages of between ± 15 v and ± 30 v, at 20 mA current consumption.

Phono Input

RIAA equalisation accuracy	+ / - 1 db from 30 Hz to 20 kHz
Overload	38 db
Distortion	0.005%
Sensitivity	3mV rms for a nominal 100 mV rms output

Overall performance

Frequency response	DC to 100 kHz (+ 0. -3dB)
Signal to noise Ratio	90db
Output level	500 mV (for 100 mV rms input)
Output protection	Fully shortproof

ILP POWER AMPLIFIERS

* **Feature use of preassembled, tested audio power modules**
* **Toroidal power transformer produces lower noise, weighs far less**

ILP power amplifiers represent an excellent choice for the tops in performance, low price, compact size and ease of assembly. All ILP power amplifiers feature ILP audio power modules, factory assembled and pretested to ensure long term trouble — free operation. In addition, ILP toroidal transformers reduce noise within the amplifier to insignificant levels, while reducing the weight to half that of comparable systems.

BIPOLAR POWER AMPS

	Power	Impedance		price
UP10	30W + 30W	4 -8 ohm	Stereo	$199.95
UP20	60W	4 ohms	Mono	$199.95
UP30	60W	8 ohms	Mono	$199.95
UP40	120W	4 ohms	Mono	$259.97
UP50	120W	8 ohms	Mono	$259.95

Specifications

Frequency response	(-3 db) 15 Hz - 50 kHz
Total harmonic distortion	0.01% (typical at 1 kHz)
Intermodulation distortion	0.006% (7 kHz 4:1)
Signal / noise ratio	100db
Slew rate	15 v / uS
Rise time	5 uS
Input impedance	100 K ohm
Input sensitivity	500 mv
Damping factor (at 100 Hz)	400

MOSFET POWER AMPS

	Power	Impedance		price
UP60	60W	4 - 8 ohms	Mono	$229.95
UP70	120W	4 - 8 ohms	Mono	$299.95

Specifications

Frequency response	(-3db) 15Hz - 100 kHz
Total harmonic distortion	0.005% (typical at 1 kHz)
Total intermodulation distortion	0.006% (7K kHz 4:1)
Signal / noise ratio	100db
Slew rate	20 v / uS
Rise time	3 uS
Input impedance	100 k Ohm
Input sensitivity	500 mV rms
Damping factor (at 100 Hz)	400
Protection	Able to cope with complex loads without the need for any special protection circuitry

Power Slave

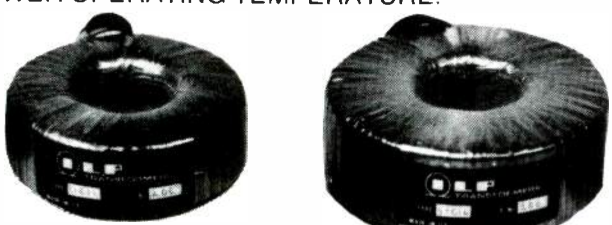
In addition to the hi fi amplifiers, there are 4 "power slave" amplifiers for professional sound applications. They share the same specifications as the **BIPOLAR** and **MOSFET** models shown above. Additional features include front panel input jack, level control and carrying handle.

US10	60W	4 ohm	Bipolar	Mono	$299.95
US20	120W	4 ohm	Bipolar	Mono	$299.95
US30	60W	4-8 ohms	MOS	Mono	$249.95
US40	120W	4-8 ohms	MOS	Mono	$309.95

THE TOROIDAL POWER TRANSFORMER

Offers the following advantages:—

* SMALLER SIZE AND WEIGHT TO MEET MODERN "SLIMLINE" REQUIREMENTS.
* LOW ELECTRICALLY INDUCED NOISE DEMANDED BY COMPACT EQUIPMENT.
* HIGH EFFICIENCY ENABLING CONSERVATIVE RATING WHILE MAINTAINING SIZE ADVANTAGES.
* LOWER OPERATING TEMPERATURE.



15VA — $23.00

TYPE	RMS VOLTS	RMS CURRENT
00010	6 + 6	1.25
00011	9 + 9	0.83
00012	12 + 12	0.63
00013	15 + 15	0.50
00014	18 + 18	0.42
00014	22 + 22	0.34
00016	25 + 25	0.30
00017	30 + 30	0.25

Size 2.44 x 1.33 (62mm x 34 mm)
Weight 0.77lb (0.35 kgs)

30 VA — $24.95

TYPE	RMS VOLTS	RMS CURRENT
10010	6 + 6	2.50
10011	9 + 9	1.66
10012	12 + 12	1.25
10013	15 + 15	1.00
10014	18 + 18	0.83
10015	22 + 22	0.68
10016	25 + 25	0.60
10017	30 + 30	0.50

Size: 2.76 Dia x 1.18" (70 mm Dia x 30 mm)
Weight: 1 lb (0.45 Kg)

50VA — $28.00

TYPE	RMS VOLTS	RMS CURRENT
20010	6 + 6	4.16
20011	9 + 9	2.77
20012	12 + 12	2.08
20013	15 + 15	1.66
20014	18 + 18	1.38
20015	22 + 22	1.13
20016	25 + 25	1.00
20017	30 + 30	0.83

Size: 3.12" Dia x 1.37" (80 mm Dia x 35 mm)
Weight. 2 lbs (0.9 Kg)

80VA — $30.95

TYPE	RMS VOLTS	RMS CURRENT
30010	6 + 6	6.64
30011	9 + 9	4.44
30012	12 + 12	3.33
30013	15 + 15	2.66
30014	18 + 18	2.22
30015	22 + 22	1.81
30016	25 + 25	1.60
30017	30 + 30	1.33

Size 3.5" Dia x 1.17" (90 mm Dia x 30 mm)
Weight. 2.2 lbs (1 Kg)

120VA — $34.00

TYPE	RMS VOLTS	RMS CURRENT
40011	9 + 9	6.66
40012	12 + 12	5.00
40013	15 + 15	4.00
40014	18 + 18	3.33
40015	22 + 22	2.72
40016	25 + 25	2.40
40017	30 + 30	2.00

Size: 3.5" Dia x 1.56" (90 mm Dia x 40 mm)
Weight: 2.6 lbs (1.2 Kg)

160VA — $39.95

TYPE	RMS VOLTS	RMS CURRENT
50012	12 + 12	6.66
50013	15 + 15	5.33
50014	18 + 18	4.44
50015	22 + 22	3.63
50016	25 + 25	3.20
50017	30 + 30	2.66
50018	35 + 35	2.28

Size: 4.3" Dia x 1.56" (110 mm Dia x 40 mm)
Weight: 4 lbs (1.8 Kg)

225VA — $44.95

TYPE	RMS VOLTS	RMS CURRENT
60014	18 + 18	6.25
60015	22 + 22	5.11
60016	25 + 25	4.50
60017	30 + 30	3.75
60018	35 + 35	3.21
60026	40 + 40	2.81

Size: 4.3" Dia x 1.76" (110 mm Dia x 45 mm)
Weight. 4.85 lbs (2.2 Kg)

300VA — $49.95

TYPE	RMS VOLTS	RMS CURRENT
70016	25 + 25	6.00
70017	30 + 30	5.00
70018	35 + 35	4.28
70026	40 + 40	3.75
70025	45 + 45	3.33

Size 4.3" Dia x 1.95" (110 mm Dia x 50 mm)
Weight 5.72 lbs (2.6 Kg)

500VA — $65.95

TYPE	RMS VOLTS	RMS CURRENT
80017	30 + 30	8.33
80018	35 + 35	7.14
80026	40 + 40	6.25
80025	45 + 45	5.55
80033	50 + 50	5.00

Size 5.5" Dia x 2.35" (140 mm Dia x 60 mm)
Weight 8.8 lbs (4.0 Kg)

625VA — $78.95

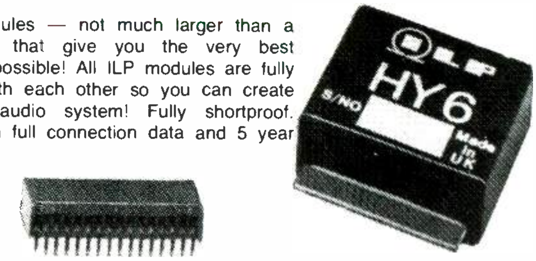
TYPE	RMS VOLTS	RMS CURRENT
90017	30 + 30	10.41
90018	35 + 35	8.92
90026	40 + 40	7.81
90025	45 + 45	6.94
90033	50 + 50	6.25
90042	55 + 55	5.68

Size: 140 x 75 mm
Weight: 5.0 Kg
Regulation 4%

ALL VOLTAGES ARE QUOTED FULL LOAD. Please add regulation figure to secondary voltage to obtain off load voltage.

PREAMPLIFIER AND MIXER SERIES

Compact modules — not much larger than a matchbox — that give you the very best reproduction possible! All ILP modules are fully compatible with each other so you can create almost any audio system! Fully shortproof. Complete with full connection data and 5 year warranty.



PRE-AMPS

Model No	Module	What it does	Current required	price $
HY 6	Mono pre-amp	Provides inputs for mic/mag cartridge/tuner/tape/auxiliary with volume/bass/treble controls	10 mA	$29 95
HY 9	Stereo pre amp	Two channels mag cartridge mic + volume control	10 mA	$29 95
HY 12	Mono pre-amp	Mixes two signals into one with bass/mid-range/treble controls	10 mA	$29 95
HY 66	Stereo pre-amp	Two channels with inputs for mic/mag cartridge/tape/tuner/auxiliary with volume/bass/treble/balance	20 mA	$54 95
HY 69	Mono pre-amp	Two input channels mag cartridge mic with mixing and volume/treble/bass controls	20 mA	$44 95
HY 71	Dual stereo pre amp	Provides four channels for mag cartridge/mic with volume control	20 mA	$49 95
HY 73	Guitar pre-amp	Provides for two guitars (bass + lead) and mic with separate volume/bass/treble and mixing	20 mA	$54.95
HY 75	Stereo pre amp	Two channels each mixing two signals into one with bass/mid-range/treble controls	20 mA	$49 95
HY 78	Stereo pre amp	Similar to HY66 minus tone controls Inputs for phono tuner, aux, plus tape monitor	20 mA	$49 95

MIXERS

Model No	Module	What it does	Current required	price $
HY 7	Mono mixer	Mixes eight signals into one	10 mA	$24 95
HY 8	Stereo mixer	Two channels each mixing five signals into one	10 mA	$29 95
HY 11	Mono mixer	Mixes five signals into one — with base/treble controls	10 mA	$29 95
HY 68	Stereo mixer	Two channels each mixing ten signals into one	20 mA	$34 95
HY 74	Stereo mixer	Two channels each mixing five signals into one — with treble and bass controls	20 mA	$49 95

AND OTHER EXCITING NEW MODULES

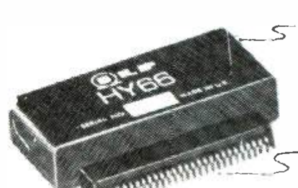
Model No	Module	What it does	Current required	price $
HY 13	Mono VU meter	Programmable gain/LED overload driver	10 mA	$29 95
HY 67*	Stereo head phone driver	Will drive stereo headphones in the 4 ohm 2K ohm range	80 mA	$54 95
HY 72	Voice operated stereo fader	Provides depth/delay effects	20 mA	$59 95
HY 73	Guitar pre amp	Handles two guitars (bass and lead) and mic with separate volume/bass/treble and mix	20 mA	$54 95
HY 76	Stereo switch matrix	Provides two channels each switching one of four signals into one	20 mA	$64 95
HY 77	Stereo VU meter driver	Programmable gain/LED overload driver	20 mA	$39 95

For easy mounting we recommend
B 6 mounting board for modules HY6 -HY13 $ 3.95
B 66 mounting board for modules HY66-HY77 $ 5.25

*All modules are encapsulated and include clip-on edge connectors All operate from ±15v minimum to ±30V maximum needing dropper resistors for higher voltages HY67 can be used only with the PSU 30 power supply unit Modules HY6 to HY13 measure 45 × 20 × 40mm HY66 to HY77 measure 90 × 20 × 40mm

FP 480 BRIDGING UNIT FOR DOUBLING POWER

Designed specially by ILP for use with any two power amplifiers of the same type to double the power output obtained and will function with any ILP power supply In totally sealed case, size 45 × 50 × 20mm with edge connector It thus becomes possible to obtain 480 watts rms (single channel) into 8Ω Contributory distortion less than 0 005%



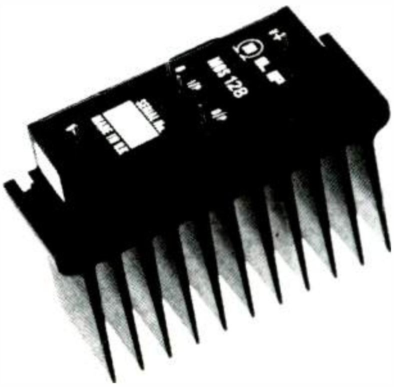
*Complete circuitry is encapsulated in compact module!

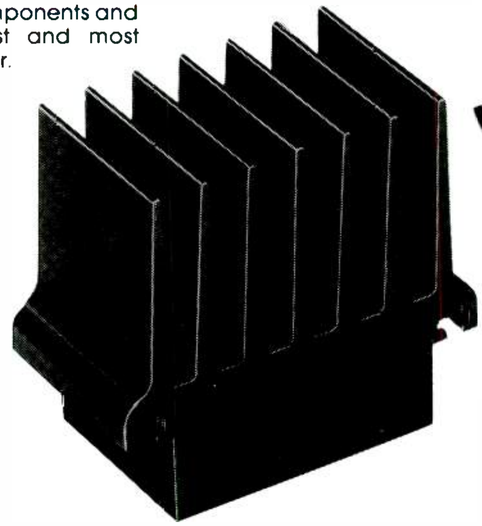
*All Connections are made via edge connector (supplied)!

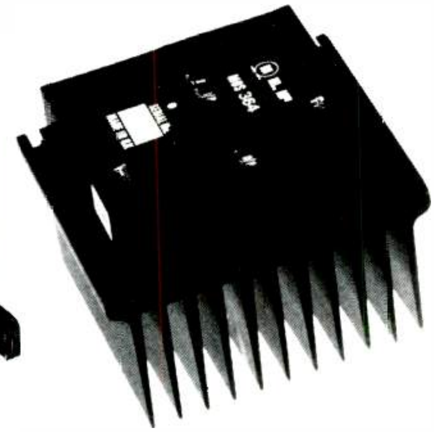
Write, phone or come in for full specification listings.

POWER AMPLIFIER MODULES

Due to continous improvements in components and design ILP now launch the largest and most advanced generation of modules ever.







* Built in Heatsinks
* Only five connections
* Five-year warranty!

MOSFET SERIES.

These high quality power amplifiers utilize the very latest technological development in the audio field — the MOSFET. Superior performance characteristics can be achieved by using these devices in the output stage of the amplifiers, a comparison to which can only be demonstrated by the most sophisticated and expensive designs using bipolar devices.
They provide faster slew rate and complete absence of crossover distortion. Their inherent positive temperature coefficient makes them immune to thermal runaway, hence eliminating the need for complicated protection ciruitry which often contributes to distortion. Also they have the ability to operate into complex loads without difficulty, therefore making them suitable for many audio applications.
The amplifiers are encapsulated to fully adequate heatsinks and connections are made via five easily soldered terminations.

MOSFET MODULES

Module Number	Output Power Watts rms	Load Impedance Ω	DISTORTION T.H.D. Typ at 1KHz	DISTORTION I.M.D. 60Hz/7KHz 4:1	Supply Voltage Typ	Size mm	WT gms	Price $
MOS 128	60	4-8	0.005%	0.006%	± 45	120 x 78 x 40	420	89.95
MOS 248	120	4-8	0.005%	0.006%	± 55	120 x 78 x 80	850	154.95
MOS 364	180	4	0.005%	0.005%	± 55	120 x 78 x 100	1025	229.95

Protection: Able to cope with complex loads without the need for very special protection circuitry (fuses will suffice).
Slew rate: 20v/ps. Rise time 3ps. S/N ratio 100db
Frequency response (-3dB): 15Hz — 100KHz. Input sensitivity 500mV rms
Imput impedance: 100K Damping factor: 100Hz › 400.

BIPOLAR SERIES.

These modular hybrid amplifiers have been designed to provide the utmost in high fidelity performance. Encapsulation to an integral heatsink, together with internal safeguards to ensure full protection, make them both mechanically and electrically extremely rugged and therefore suitable for all audio applications. Connections are made simply and quickly by only five soldered terminations: input, output, positive supply, negative supply and earth.

BIPOLAR MODULES

Module Number	Output Power Watts rms	Load Impedance Ω	DISTORTION T.H.D. Typ at 1KHz	DISTORTION I.M.D. 60Hz/7KHz 4:1	Supply Voltage Typ	Size mm	WT gms	Price $
HY30	15	4-8	0.015%	0.006%	± 18	76 x 68 x 40	240	31 95
HY60	30	4-8	0.015%	0.006%	± 25	76 x 68 x 40	240	34.95
HY6060	30 + 30	4-8	0.015%	0.006%	± 25	120 x 78 x 40	420	59 95
HY124	60	4	0.01%	0.006%	± 26	120 x 78 x 40	410	59.95
HY128	60	8	0.01%	0.006%	± 35	120 x 78 x 40	410	59.95
HY244	120	4	0.01%	0.006%	± 35	120 x 78 x 50	520	79.95
HY248	120	8	0.01%	0.006%	± 50	120 x 78 x 50	520	79.95
HY364	180	4	0.01%	0.006%	± 45	120 x 78 x 100	1030	119.95
HY368	180	8	0.01%	0.006%	± 60	120 x 78 x 100	1030	119.95

Protection: Full load line. Slew Rate: 15V/ps. Risetime: 5ps. S/N ratio: 100db. Frequency response (-3dB) 15 Hz — 50KHz. Input sensitivity: 500mV rms. Input Impedance: 100K . Damping factor. 100Hz › 400.

ILP POWER SUPPLIES
all with toroidal transformers

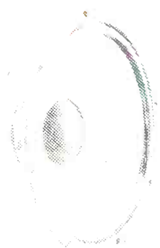
	STANDARD LAMINATED TRANSFORMERS FOR ILP	PRICE EACH
G36V4	Use With 1 or 2 HY60 1 HY6060	33.95
G50V4	1 or 2 HY124 1 or 2 HY128	39.95
G64V4	1 HY244 1 HY 248 1 HY364 1 HY368 1 or 2 MOS128*	42.95
G64V8	1 or 2 HY244 1 or 2 HY248 1 or 2 HY364 1 or 2 HY368 1 or 2 MOSS248*	66.95

Please Note:
Each Power Supply Unit (PSU) stocked and sold as two separate components, namely the Transformer (TR) and the Printed Circuit Board (PCB). If you are ordering a complete power supply, be sure to order one of each, by part number.

ILP PART No.	FOR USE WITH	Code - Part#	Price each
PSU210	1 or 2 HY30	PCB 210	14.95
PSU410	1 or 2 HY60, 1 x HY6060,	TR 40027 PCB 410	34.00 14.95
PSU420	1 x HY128	TR 40040 PCB 420	34.00 29.95
PSU430	1 x MOS128	TR 40041 PCB 430	34.00 33.95
PSU510	2 x HY128, 1 x HY244	TR 50020 PCB 510	39.95 29.95
PSU520	2 x HY124	TR 50027 PCB 520	39.95 29.95
PSU530	2 x MOS128	TR 50034 PCB 530	39.95 33.95
PSU540	1 x HY248	TR 50019 PCB 540	39.95 33.95
PSU550	1 x MOS248	TR 50035 PCB 550	39.95 41.95
PSU710	2 x HY244	TR 70047 PCB 710	49.95 35.95
PSU720	2 x HY248	TR 70019 PCB 720	49.95 39.95
PSU730	1 x HY364	TR 70017 PCB 730	49.95 39.95
PSU740	1 x HY368	TR T.B.A PCB 740	49.95 46.95
PSU750	2 x MOS248, 1 x MOS368	TR 70036 PCB 750	49.95 46.95
PSU30	FOR HY 6 and HY66 preamp series		34.95

Philips Speakers + Gladstone's Special Prices = Sound Value

15" Woofer



$69.95

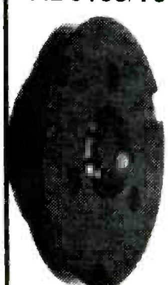
*100 Watts RMS
*2" Voice Coil
*40 oz. Magnet
AD1524O/W8

Reproduces frequencies from 18 to 1000 Hz. Rigid paper cone with high flexibility, for thundering bass!

Philips Dome Tweeters

AD0163/T8

*40 Watts RMS
*4" Round



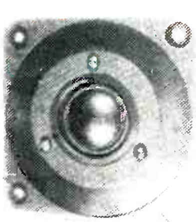
$13.95

*Textile dome for smooth sound and side dispersion
*Use in multiples for higher power
*Specify 4, 8, or 15 ohm version

Square dome Tweeter

AD1600/T8

$16.95



Same as above, except enhanced appearance, in 4" square

Philips Crossovers:

Matches all of the speakers on this page, and most general purpose replacement loudspeakers.

A:ADF3000
B:ADF500/4500
C:AD3wxSP
D:SUB1-W

A.	2 way, 3000 Hz, 30 Watts	$13.95
B.	3 way, 500 and 4500 Hz., 65 Watts	$13.95
C.	Heavy duty 3 way, 150 Watts, all air core inductors for low distortion	$34.95
D.	Subwoofer crossover, at 125 Hz.	$34.00

12" WOOFERS

Philips Best Woofer! AD12250/W8

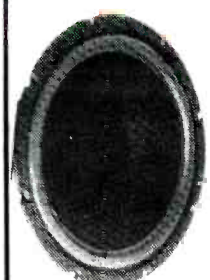
*2" Voice Coil
*25 Hz res. freq.

$79.95

Features regged paper cone and rubber surround for low distortion and clean bass. Use in systems up 150 W RMS.

70 WATTS

AD12240/W8



$59.95

*Our Most Popular Woofer
*40 oz. Magnet
*2" Voice Coil
Uses foad surround for bass you can feel. Rated for amps 15 to 120 Watts Channel.

60 Watts - Rubber Surround

$49.95

Type Number
AD12650/W

Excellent defined bass response. Use with amps 15 to 100 Watts per Channel.

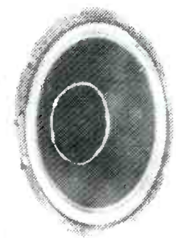
PASSIVE RADIATORS

Will enhance the bass performance of any sealed speaker, giving sound similar to bass reflex enclosures. Use a passive radiator of the same size or larger than your woofer.

AD8000	8" Rubber Surround	$13.50
AD8002	8" Foam Surround	$14.95
AD12000	12" Foam Surround	$29.95
AD1201	12" Rubber Surround	$39.95

10" 70 WATT WOOFER

*2" Voice Coil *40 oz. Magnet

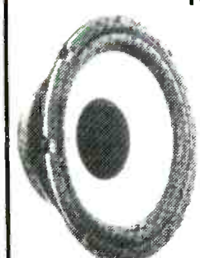


$56.00

Based on the design of the AD12240/W8 in a 10" format. Surround is of rugged foam roll, and usable power is 15 to 120 Watts RMS.

8" WOOFERS

100 Watt AD80671/W8



$29.95

*30 Hz. Res. Freq.
*16 oz. Magnet
*Rubber Surround
Philips' highest power 8" driver - useful in two and three way systems.

40 WATT $39.95

AD80100/W8

*40 oz. magnet
*based after the AD12240/W8
Foam rim paper cone for powerfull bass, great for two and three way systems.

DOME MIDRANGE

AD0211

2 MODELS

Each is housed in its own optimum size enclosure for isolation from the woofer. Cloth domes are used for extra smooth reproduction, and ultra wide dispersion.

AD02110/SQ8
50 Watt version of above square frame

AD02160/SQ8 Highest quality deluxe, High power (60 Watt), 10 oz. magnet, specify 4 or 8 ohms. Use several for higher power. $39.95

About Philips Speakers

All Philips speakers come complete with cabinet plans and full assembly instructions. Specs given are for sealed cabinets. Typical sizes are: 8" - 1 cu. ft., 10" - 2 cu. ft., 12" - 3 cu. ft., 15" - 4 cu. ft (Sizes are approximate). Philips speakers carry a full one year replacement warranty for defects of manufacturer.

MAXCOM-7

Porta-Mobile 27 MHz CB

40 Channel C.B.

complete with antenna

- Can be used in car, or as a portable
- Antenna attaches quickly to car via magnet, or quickly detaches for portable use

The Maxcon-7 is a practical and versatile communications system designed to go where it is needed. It comes complete with a durable vinyl case for storage under seat or trunk, and cigarette lighter DC plug for quick mobile power. RF output is a full 4 Watts, for a range of 3 to 5 miles, and operation is 40 channel. Controls include power, volume, rotary squelch, and large channel selector.
Model Maxcom 7

Each **$124.95**

Price includes all accessories shown in picture

Stereo Mixer

Super quiet deluxe stereo mixer has inputs for 2 mics (adjustable hi or low impedance), 3 phono inputs (2 magnetic, 1 ceramic), tuner, tape and selectable monitor through headphones. It features mono/stereo switch and fully long throw slide controls. Frequency response is a full 20-20,000 Hz, outputs 3V and distortion is kept to a low .5%.

Mx-800 Price each $99.95

Easy Talker Hands Free Wireless Communication

Two For $199.90

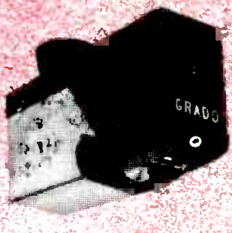
Additional Units $89.98 ea.

The easy talker's headphones are lightweight and fully adjustable. The are equipped with an electret condenser mic for maximum performance. Operation is on the FM band for extra quiet and clear reception. No license is required to operate the easy talker, and they are fully approved.
Model 49S
Two units are required for communication.
Two for $199.90
Additional Units $89.98 each

MODEL 49B
SAME AS ABOVE, BUT INCLUDES BATTERY CHARGER AND VINYL CASE
Two for $239.50
Add'l units $109.95ea

- Light Weight
- Portable go anywhere two way radio system
- Voice activated switching from transmit to receive
- Up to ¼ mile range
- Use any number of units for multiway communications
- Great for film crews, business, construction sites, warehouse, surveying and numerous other applications.

GRADO The most complete line of Stereo Phono Pick-Ups in the World.



SIGNATURE PROFESSIONAL

Signature VIII	$250.00
Signature IX	$425.00
Signature X	$725.00

GTE + 1	$35.00
GCE + 1	$55.00
GF3E +	$67.50
GCE +	$75.00
GF2 +	$85.00
GF1 +	$100.00
G +	$135.00
G1 +	$175.00
G2 + (Twin tip)	300.00

NEW "PLUG-INS"

Many of the modern turntables require a plug-in phono cartridge. e.g. B + 0; Sony. Simply order your plug-in by adding a "P" to the part number eg. PG+ $18.00. All pricing as standard series.

CLEAROUTS

Reduced to Clear

Sansui AX-7 Studio Quality Mixer

Featuring master volume, 3 tape in/out puts, 6 recording modes, 4 adptor modes, 5 mixing selections, balance control for source/tape to mic/guitar/line, 4 mode reverb, 4 input with volume and balance controls for line/guitar/mic $529.95
Clearance: $250.00

HARMON KARDON HK-770

Ultra wide band DC 65 watts per channel amp. .006% Harmonic distortion with exceptionally wide response (1 Hz to 250 K Hz) with led power meters $699.95
Clearance: $465.00

HK-750

Deluxe int.amp. features slim line, 2 tape in and outputs, 2 phono inputs 1 tuner input, 1 aux. input, 1 subsonic and 1 high filters. $529.95
Clearance: $365.00

HK-775

Deluxe mono amps (sold only in pairs) 130 watts each. Reg. 2 for $1,399.00
Clearance: $925.00

HK-2500

Front load tape deck features 3 position dolby, 3 position bias, 3 position bias trim, 3 position equalization, plus memory rewind. $549.95
Clearance: $365.00

HK-503

Intergrated amp. featuring 40 watts per channel RMS Bass/tremble controls, high sub filters. tone defeat, loudness switch, 2 tape in/out puts plus phono/tuner/anux. inputs $449.95
Clearance: $300.00

HK 350i

Stereo am/fm receiver with 20 watts RMS per channel. Equipped with tape in/output, aux, phono, loudness, bass/treble controls, and stereo/mono blend. $429.95
Clearance: $$229.95

HK460i

Stereo am/fm receiver with 30 watts RMS per channel. Equipped with 2 tape in/outputs, 1 phono, 1 aux, bass/treble controls, loudness, filters, and stereo/mono blend. $529.95
Clearance: $365.00

PHILIPS 22EN8365 Automotive Speakers:

Featuring 2 way bass relex system with 40 watts RMS power handling, and a freq. range of 80 Hz to 20,000 Hz $169.95
Clearance: $125.00 pair

PHILIPS EN8320 Automotive Speakers

Car tune up speakers with level controls and freq. response of 1,200 to 20,000 $49.95
Clearance: $35.00

L91 JBL

Horn/lens an exponential horn having optmum crossover freq. of 500 Hz and a 10" slant plate acoustic lens. $123.00
Clearance: $89.00

HL87 JBL

Horn/lens. cast aluminum horn lens for 60 degree dispersion $123.00
Clearance: $89.00

H89 JBL

Horn for high performance dispersion $440.00
Clearance: $250.00

LE14 JBL

14" Woofer 200 watts power handling and freq. response of 35 Hz to 2000 Hz. can be used in cabinets as small as 1.5 cu. ft. $440.00
Clearance: $250.00

PAIA Kits

4740 Envelope Generator: Attack, decay, sustain and release $61.95
Clearance: $37.20 requires + 18v supply

4730 V.C.F.

Multi filter features simultaneous, low pass, highpass and band pass outputs with variable Q requires ± 9, 18 volts supplies. $81.95
Clearance: $49.20

3730 Wind Kit

Wind kit creates synthesized wind sounds, plugs into any stereo. $30.95
Clearance: $16.95

3731 Wind Chimes

Wind chimes kit creates a synthesized brass chimes or bamboo percussion rod sound. $30.95
Clearance: $18.60

4782 Road keyboard

36 Key A.G.O. keyboard and case includes power supply and glide control. $339.95
Clearance: $200.00

1550 Strings and Things

Features strings, cello, and piano sounds with split keyboard between cello and strings, plus many other features. $745.00
Clearance: $447.00

2720-5 Control Oscillator

Has a Frequency range if 1 to 25 Hz with an out put volume control requires 18 v supply $40.00
Clearance: $24.00

CJ Chatter Jammer

Generates pink noise to cover up office noise or any other annoying noises from the outside world. $16.95
Clearance: $10.20

6780 Organtua

Creates a very thick organ sound which can be tuned to wider intervals such as 4ths or 5ths plus many other features. $745.00
Clearance: $447.00

PYGMY PORTABLE battery operated guitar amp. (Assembled)

Lightweight guitar amp. with a 5 inch acoustic suspension loud speaker out put wattage is 1.2 RMS (8 watts peak) runs on eight penlight batteries. $89.00
Clearance: $54.00

2720 Mono Synth Kit

Comes with a 36 key keyboard, V.C.O. function generator, control OSC./noise source, V.C.A. band pass filter, low pass filter, ENV. follower and an inverter buffer. $585.00
Clearance: $351.00

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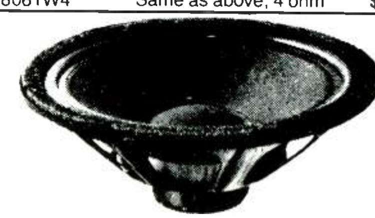

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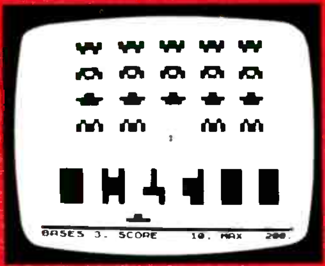

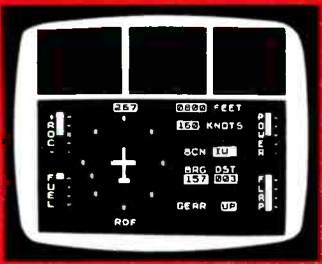

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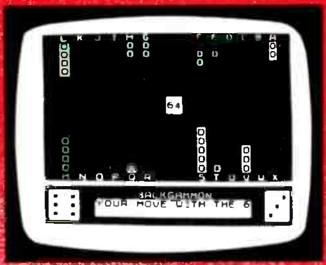

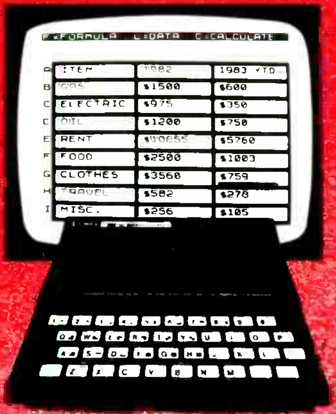

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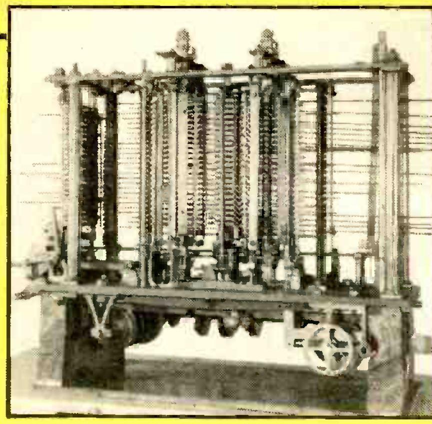
Down The Tubes

Tube design became remarkably sophisticated between the Wars in the hands of specialists like Philips of Eindhoven, and the Second World War produced great advances in miniaturization. But even in the 1930s it was beginning to be apparent that the law of diminishing returns applied to tube development as to everything else. Research and development could reduce some of the tube's many drawbacks, but could never abolish them: its size, its fragility, the expense of its manufacture, its large power requirement, its need for cooling (40 gallons of water per minute for some of the giant transmitter tubes of the mid-1920s) and its highly unpredictable life-span. For these reasons interest in semi-conductors never died away, despite the apparent death of the crystal receiver some time after 1930. For one thing, pure undirected speculative research went its own sweet way during the 1920s and 1930s. Physicists like Pohl at Gottingen University carried on a long pre-1914 tradition of research into the electrical properties of crystals, though this was sometimes more by accident than by design, as in Pohl's case, where Germany's ruined economy in the years after 1918 prevented him from getting hold of liquid oxygen to study gas conductivity and obliged him to look at solids instead.

Most of this research was quite innocent of any immediate practical application but, at the back of it, the idea of a solid-state analogue to the tube was never far away. One Lilienfeld patented a crystal amplifier in Germany in 1925, though none was ever built and argument goes on to this day as to whether the thing would ever have worked if it had been. All experimenters had to grapple with serious problems in getting crystals pure enough to experiment with, but gradually some substances began to emerge as front-runners. Copper oxide was in common use as a rectifier during the early 1930s, and in 1935 Oskar Heil attempted to build a field-effect amplifier by passing a current through a slab of the stuff forming one side of a capacitor: an idea which was to be taken up again by Bell after 1945, but which was eventually beaten by electron retention at the slab's surface. Embedding an electrode in a crystal to modulate the current passing through it was the obvious next step, and in 1938 Pohl and Hilsch in Germany announced that they were confident of soon being able to use this technique with a potassium bromide crystal to produce the long-sought successor to the triode tube.



Babbage's "Analytical Engine" was perhaps the earliest computer — a machine designed specifically for performing mathematical calculations.

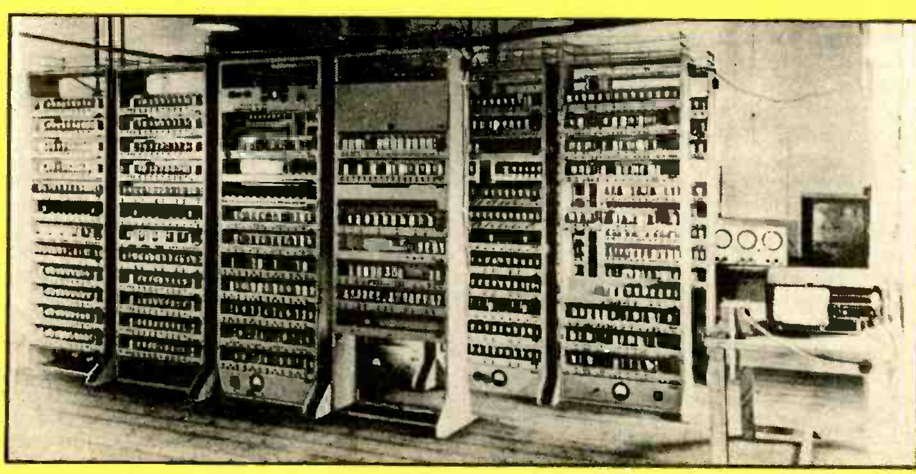
Enter Germanium . . .

The war which broke out the following year brought most German research to a halt. But in the end it was the war's demands which forced development of the transistor ahead once more, and in particular the development by the Allies, circa 1942, of centimetric radar. Ordinary radio tubes had too high a capacitance to detect the returning signal, so the crystal detector was brought out of retirement — this time in the form of a silicon crystal touched by a tungsten cat's whisker. It worked, but not very well, so germanium was investigated as a substitute. The Massachusetts Institute of Technology and about forty other US research institutions got to work on the problem, and by late 1943 germanium detectors were available which could handle up to 150 volts.

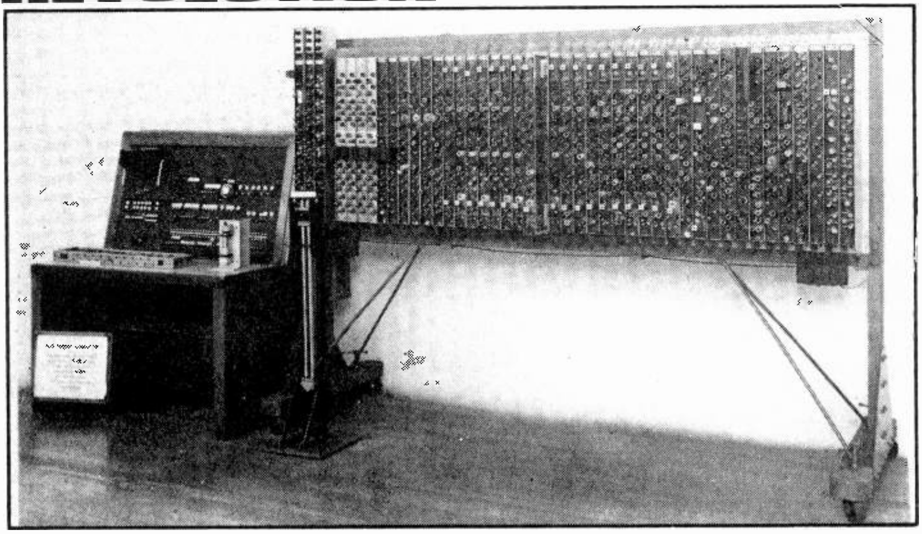
When the war ended, the research team at Bell Labs, Brattain, Bardeen and Shockley, were tinkering once more with the field-effect transistor, though this time as part of a vast programme aimed at producing reliable solid-state equivalents of the tube. The field-effect approach was eventually defeated by the surface retention which had beaten Heil a decade earlier. But point-contacts with a germanium crystal turned out to be far more promising. It was a semi-conductor of this type, soon to be christened the transistor, which was successfully tested at Bell Labs two days before Christmas, 1947. The more familiar junction transistor followed soon afterwards and the first public demonstration was given at the end of June, 1948.

Contrary to later legend, Bell was anxious from the very first to get the transistor as widely used as possible as soon as possible. To this end it was prepared to grant manufacturing rights at very favourable terms. For the first few years, though, there were few takers. Up until the spring of 1953, in fact, the main optant was the hearing-aid manufacturer Raytheon which was not too concerned about sound quality so long as it could get miniature, low-power amplifiers. Radio, television, the telephone manufacturers and (strangely enough) the military showed very little interest at first. True, apart from its size and its low power requirement, the transistor offered few immediate advantages over tubes. The first generation were noisy, expensive (about eight times the price of an equivalent tube in 1950), limited in the voltages they could tolerate and limited in their frequency response. Manufacturing methods were often astonishingly haphazard by the standards of a generation later, not so much designing a batch of transistors to fit a desired range of characteristics, but rather making the batch and then sifting out those transistors which measured up to the requirements. And there was always the problem of minute traces of impurity left in the crystals, known collectively as 'sudden-deathnium', and the reason for the failure of many early semi-conductors. But above all these difficulties there was the attitude of the industry itself. Though interested in solid-state devices, the engineers of the great American and European electronics firms were men who had grown up with tubes from their earliest youth. For this reason they tended to regard the transistor as a mere tube-substitute until well into the 1950s, by which time it was establishing itself as a technology in its own right and developing the sub-technology of small-scale integrat-

More than a hundred years after Babbage, the ESDAC I computer was built in Cambridge. It was no smaller, but a lot faster!



The Electronic REVOLUTION REVOLUTION REVOLUTION



The ACE computer, built in 1950, still used tubes, though less of them than its predecessor ESDAC.

ed circuitry which was to lead to the micro-chip in the early 1970s. This conservatism may have had a great deal to do with the electronics industry's great migration to the Far East from the late 1950s onwards.

The thing that really made the transistor's fortunes, though, was the providential development, at about the same time, of the digital computer. But unlike the transistor, the computer was not propelled into an eagerly waiting world by a massive research program. Instead it crept up on an almost unaware human race.

The idea of calculating by machine was scarcely a new one in the late 1940s when the electronic computer began to dawn upon the public consciousness. The abacus, Napier's bones, the slide rule (remember the slide rule?), Pascal's calculator and the Burroughs comptometer were all attempts — more or less unsatisfactory — to rid calculation of some of that mind-numbing drudgery involved in projects like the one, about 1840, which had an entire company of Prussian army engineers scribbling away for six months to calculate the curvature of a single lens. In 1833, the mathematician Charles Babbage had designed (but not built) his Analytical Engine — the world's first project for an analogue computer with input, ouput and some sort of memory. At the very end of the nineteenth century, the increasing demands of each successive US census had produced a number of increasingly elaborate card-processing machines to deal with the returns. But true computers required an accuracy far beyond the reach of even early twentieth century precision engineering, and in the mid-1930s, the tube began to be built into electronic analogue calculating machines at Harvard University and Bell Labs.

As with the transistor, the demands of the Second World War pushed development forward and began the transition from calculator to true computer. Not only the Manhattan atomic bomb project but also ballistics trials required calcuations of an unheard-of complexity, far beyond the capacity of human beings working unaided. And in this area, the Harvard Mark 1 electronic calculator was able to score a notable triumph in 1942 when it predicted — correctly, as it turned out — that the German army would never get anywhere with the electrically powered long-range gun which it was trying to build. Meanwhile, across the Atlantic, the Enigma code-breaking operation required the building of a succession of increasingly powerful electronic cipher-machines at Bletchley Park. On a more mundane level, the vast complexity of modern armed forces led to the development of electronic personnel selectors in an effort to sort out the right man for the job from among the millions available. Evelyn Waugh's novel *Sword of Honour* mentions one of these latter contraptions installed in a War Department office in London circa 1943. And beyond the strictly technical considerations of electronic systems design, the war led to the first concentrated, systematic study of operational logic, information flow and decision-making — all areas essential to the creation of artificial intelligence after the war was over.

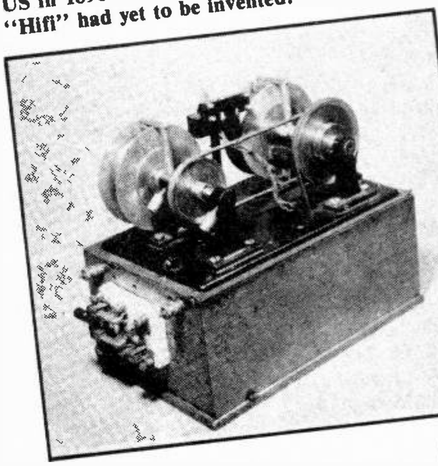
. . . And The Computer

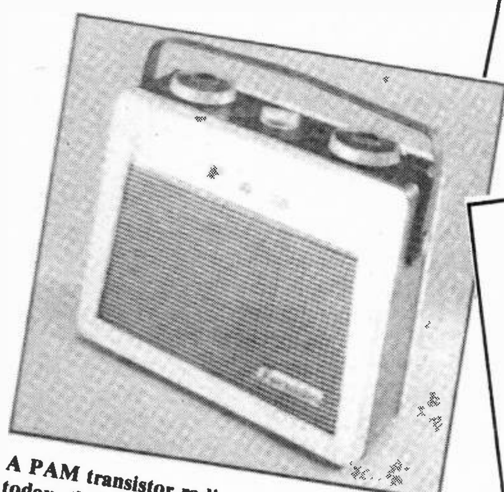
The value of electronic calculation was so evident by the time the war ended that the US Government was keen to sponsor the building of the first true electronic analogue computer ENIAC at the University of Pennsylvania in 1946. The previous year John von Neumann had suggested the use of the binary system for electronic calculation, and after Cambridge University's EDSAC in 1947, all computers went over to digital operation. Meanwhile, Pennsylvania University was building ENIAC's successor EDVAC with the first magnetic core memory, and computers were moving outside the field of strictly scientific calculation with the US Air Force's Whirlwind flight-simulator. Likewise, the universities and government departments lost their monopoly of computer ownership in 1952 when GEC acquired its Univac I, the first computer in the world to be owned by a private firm.

The trouble with these early computers was their sheer size and unreliability. Bell's Model V in 1944 contained over 9,000 tube relays and fifty pieces of teletype equipment. It weighed ten tons and took up over a thousand square feet of floor space. Heat dispersal from these forests of tubes was a major problem and power requirements were vast. ENIAC used 130kW and is said to have dimmed lights over half of Philadelphia when it was switched on. Above all, down-time was huge, given the number of tubes, their unreliability and the difficulty of getting at them to replace them. When it arrived on the scene at the end of the 1940s, the transistor was the answer to the computer builder's prayers, with its miniscule size, cool operation, low power requirement and — post 1953 or thereabouts — long life. From about 1955 onwards, the tube began to be ousted by the transistor in computer construction, and as the transistor took over, the computer began to move out into the world.

At the end of the 1940s the experts had confidently predicted that a country like Britain would never need more than two or three computers to serve all its needs, while the USA itself would only require a hundred at most. But as is the way with these things, the increase in supply created its own demand. As the computer became smaller and cheaper, it was found that more and more previously manual administration jobs could be handed over to the machine — not just censuses and scientific calculation, but banking and payrolls and stock control and police records. From then on it began to affect the lives of every one of us. Computer and transistor were the twin foundations of the post-1945 electronic age, and neither could really have existed without the other.

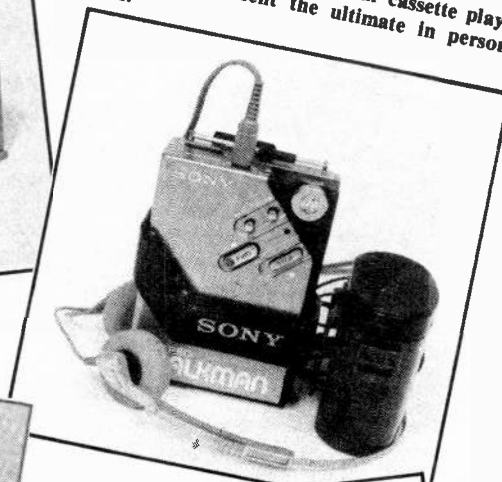
Poulsen's "Telegraphone" was patented in the US in 1898 and used mainly as a dictaphone. "Hifi" had yet to be invented!

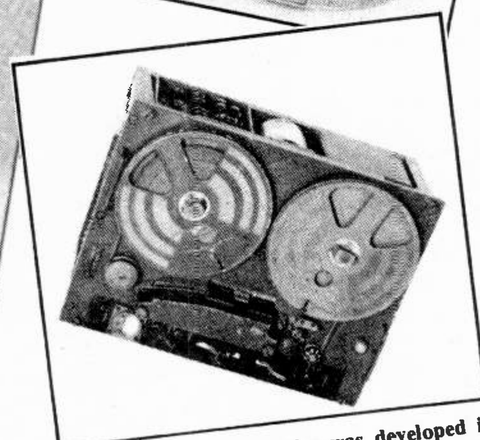




A PAM transistor radio dating from 1956. As today, the physical size was determined by the need for a relatively large loudspeaker.

The "Walkman" and similar cassette players probably represent the ultimate in personal hifi.





The modern tape recorder was developed in Germany during World War II, when it was used to replay and broadcast speeches by the Nazi leaders.

The miniaturization of electronics made possible by the semi-conductors, and the durability and low power consumption which they brought with them, caused another great leap forward (or upward) in the second half of the 1950s. After all, where would space exploration be if it relied upon tubes? The nasty blow dealt to American prestige by the launching of the Sputnik in October, 1957 led directly to the race to the moon. But so far as this century is concerned, its most important consequence may turn out to have been the birth of space communications. As early as 1928 the German rocket pioneer Hans Oberth had suggested space relay stations in geosynchronous orbit 22,300 miles above the Earth, though in this case he proposed beaming messages up and down by heliograph because of the limited power available from the transmitters of the day. And this idea was taken up again by Arthur C. Clarke in 1945. But it was not until the late 1950s that the idea came anywhere near realization when the United States launched its first Echo communications relay satellites.

These were passive reflectors — mere balloons of metallized PVC which were supposed to act as mirrors for microwave signals. They were not particularly successful, and it was not until July, 1962 that the first active relay satellite, Telstar I, was put into orbit, powered by solar cells and capable of redirecting TV signals for the part of the day when it was above the horizon. Geosynchronous orbit followed with the Syncom series of satellites launched from February 1963 onwards. By 1980, upwards of fifty communications satellites were in orbit with a further fifty planned. The tariffs demanded by the international Intelsat corporation were too high at first for more than a minimal amount of direct TV broadcasting via satellite, but from the mid-1970s onwards, US television networks and Third World governments alike began to see the advantages of a satellite-based TV system. And not only the advantages of satellite TV but also the benefits of secure telephone communications and computer data links of a hitherto unimaginable speed and purity. Again, once the transistor made it possible, people began to think of needs they had never considered before.

Getting Taped

This kind of self-sustaining growth, with new developments creating demand and demand calling forth new developments, has been particularly noticeable in the world of home entertainment over the past eight-odd years. Radio and television we all know about, of course. But what about recorded music? After all, one of radio's first and greatest conquests in the late 1920s was its absorption, for a time at any rate, of the gramophone — previously a scratchy, faint-sounding, clockwork instrument, but transformed by the tube, the loudspeaker and electric drive into a robust, reliable means of entertainment. The great success story of the age, however, was the tape recorder. The idea of recording sound on magnetic steel wire had been suggested as far back as 1888. But it was ten years before the Danish inventor Valdemar Poulsen took out a US patent on his Telegraphone. This operated by means of clockwork-driven spools passing wire through a magnetizing/demagnetizing coil at a rate of 7 feet per second. It was hailed as a major new discovery when it appeared on the market and Poulsen set up the American Telegraphone Company to sell it, but in the end the idea came to nothing. The machine's frequency response was too poor for use as anything except an office dictaphone and the wire suffered from an incurable tendency to twist and stretch — as well as occasionally snapping and

"At the end of the 40s, experts predicted that the USA would only require one hundred computers at most."

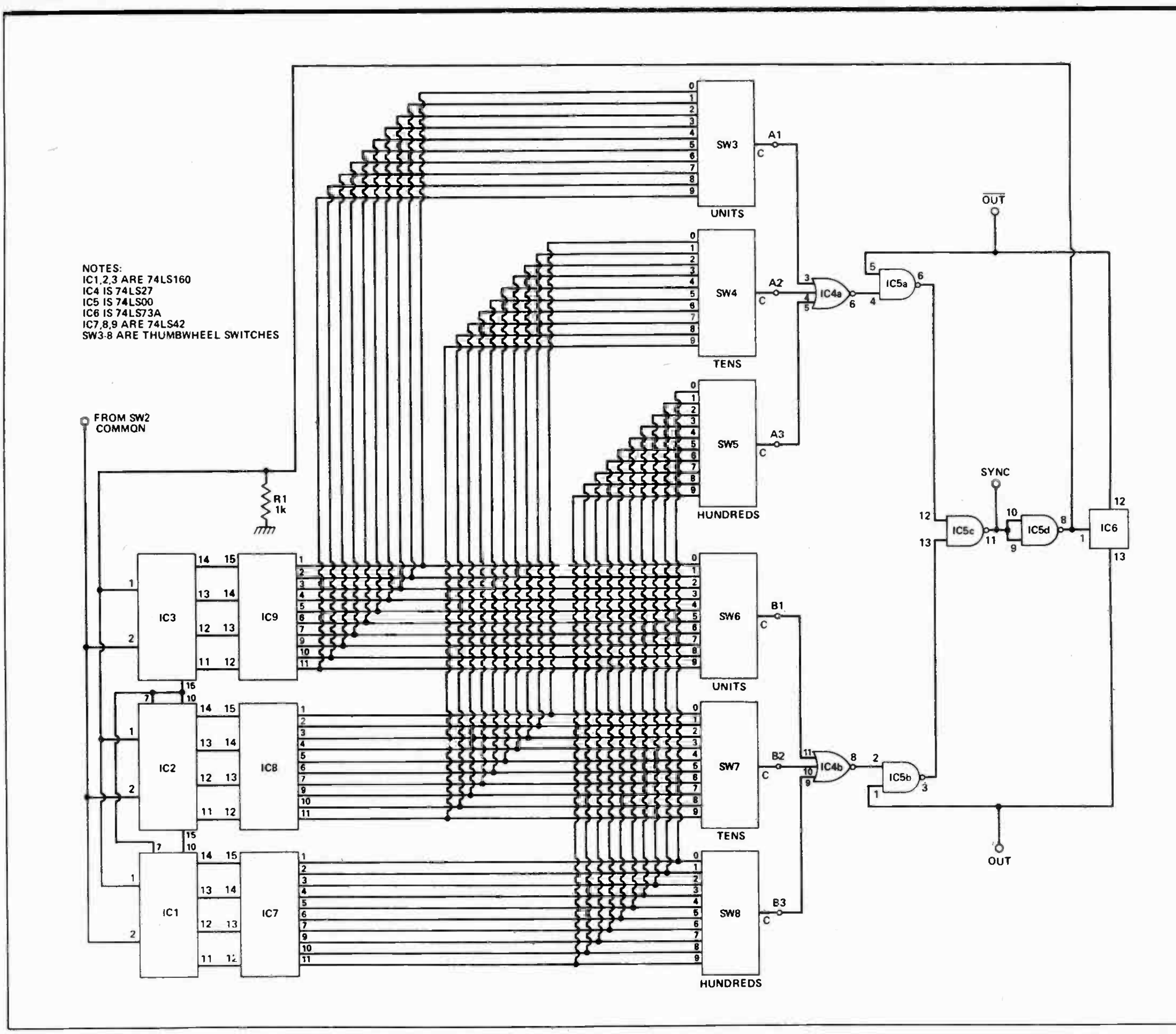


Fig. 4 Circuit diagram of counter section.

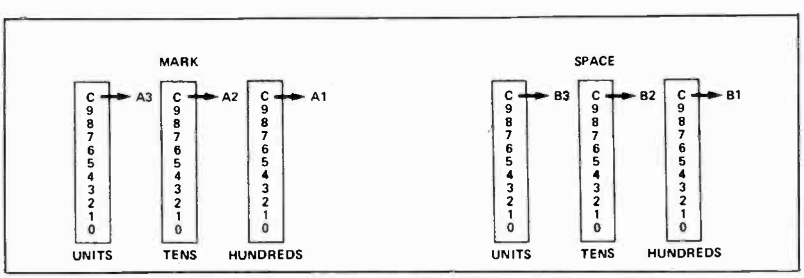


Fig. 5 Details of connections and mounting of thumb-wheel switches.

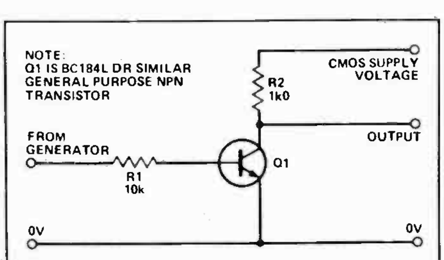


Fig. 6 A simple level shifter circuit that can be used to drive CMOS or similar operating at 12 V or 15 V; note that this circuit inverts the signal, so use $\overline{OUT}$ rather than OUT or vice versa.

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Continued on page 70

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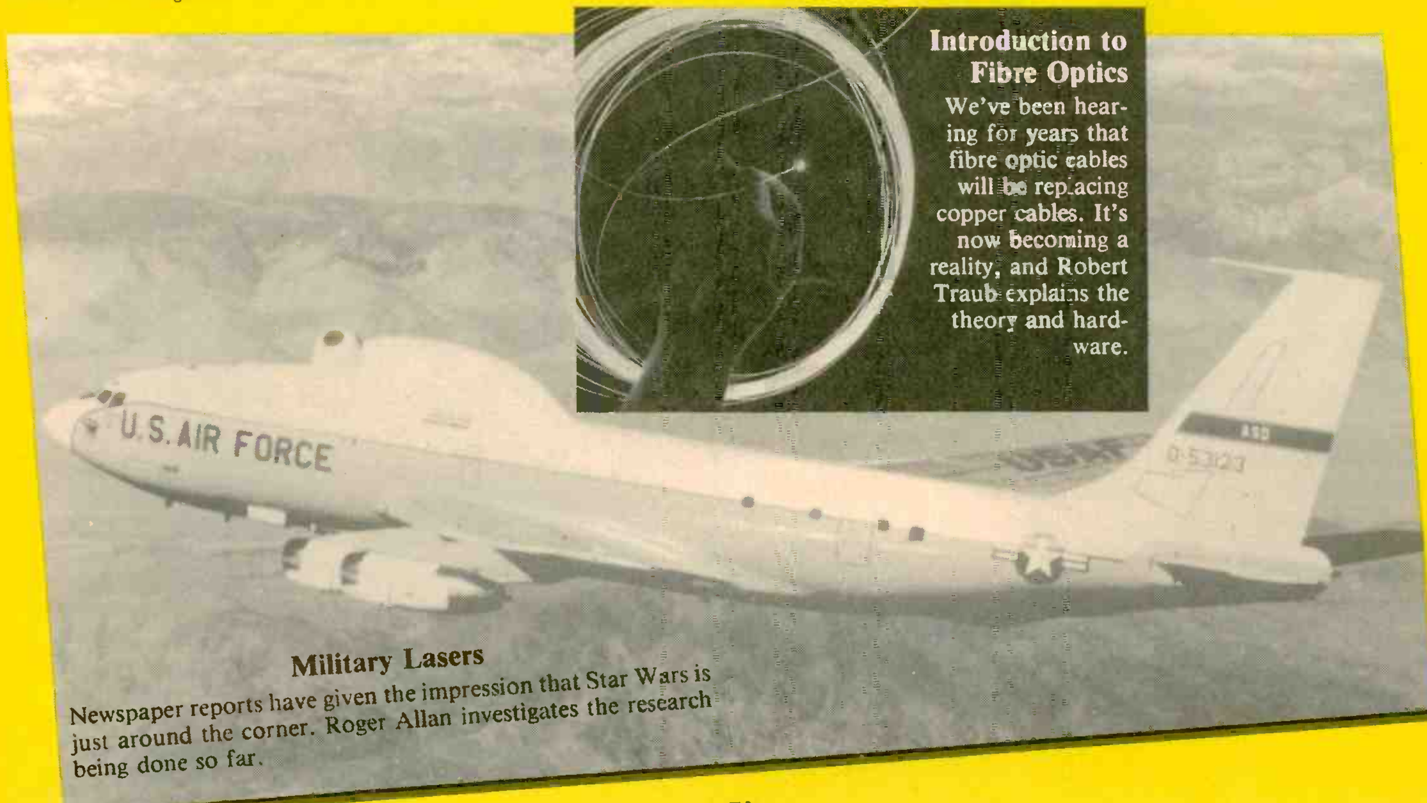

Introduction to Fibre Optics

We've been hearing for years that fibre optic cables will be replacing copper cables. It's now becoming a reality, and Robert Traub explains the theory and hardware.

Military Lasers

Newspaper reports have given the impression that Star Wars is just around the corner. Roger Allan investigates the research being done so far.

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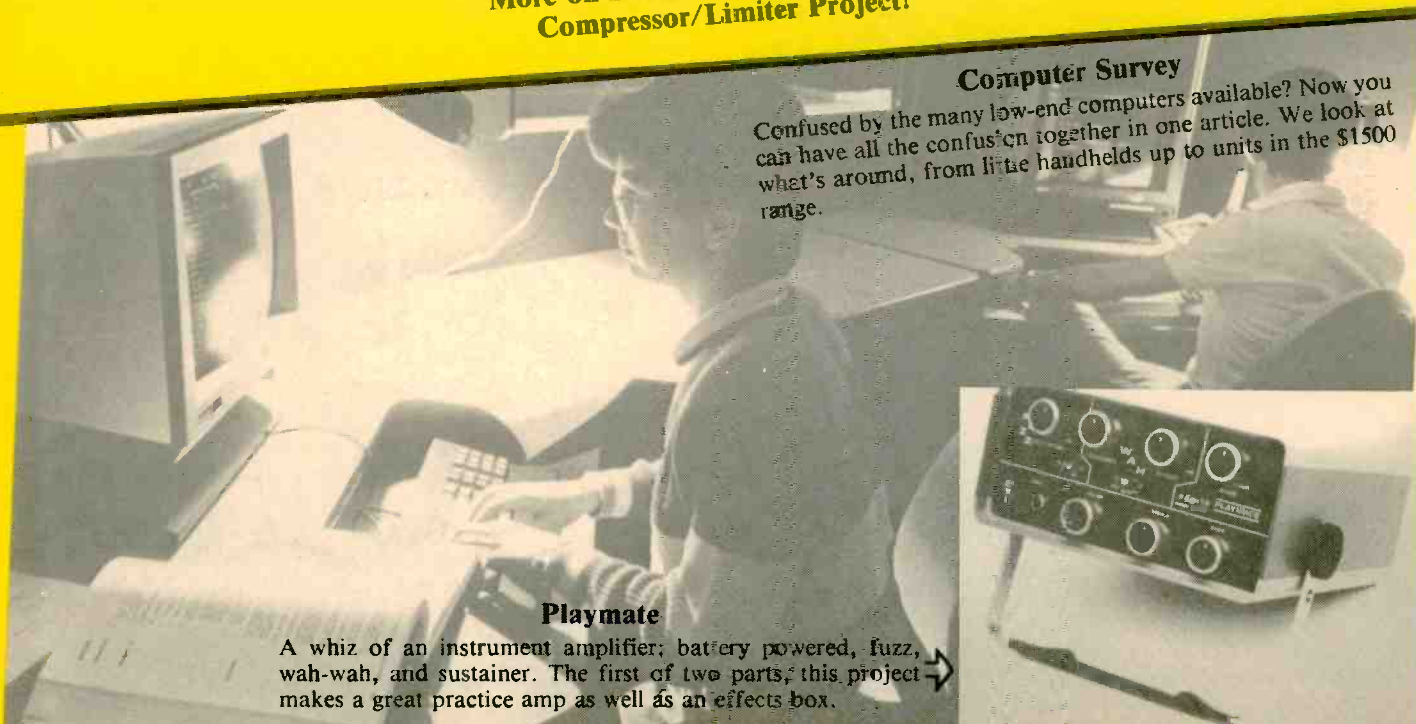


Computer Survey

Confused by the many low-end computers available? Now you can have all the confusion together in one article. We look at what's around, from little handhelds up to units in the $1500 range.

Playmate

A whiz of an instrument amplifier; battery powered, fuzz, wah-wah, and sustainer. The first of two parts, this project makes a great practice amp as well as an effects box.

Designer's Notebook
Switched Capacitor Filters

Switched capacitor filters might appear to be unsuitable devices for anyone who isn't an expert. In Part One, Tim Orr looks at them and finds that they are really much easier to use than conventional filters.

MOST COMPLEX FILTER designs require a large number of precision resistors, inductors and capacitors. Resistors and capacitors are relatively easy to integrate, and inductors can be synthesized using an op amp plus capacitors and resistors. Thus it would seem possible to produce a monolithic active filter, but there is one major problem. The accuracy of monolithic capacitor values is typically fairly low, and constructing multi-pole filters requires good matching between stages: a sixth order low-pass filter would typically require a component tolerance of 1 or 2%. Additionally, monolithic capacitors and resistors are limited to fairly low values, though this could be designed around.

Switched capacitor techniques get over these problems by using a capacitance to synthesize a resistance; see Fig. 1. The resistance is synthesized by switching charge into and out of the capacitor C_R, as the MOSFET switches open and close in antiphase; the average current passing from the input to the op amp (and hence the apparent resistance) depends on the switching frequency. This helps because the *ratio* of the values of two monolithic capacitors on the same IC can be accurately controlled (to 1% or better). In the simple example of a low-pass filter shown in Fig. 1, the break frequency is proportional to the switching frequency and the ratio of the capacitor values. Switched capacitor filters are normally designed this way (even the very complicated ones). The switching frequency is usually arranged to be around either 50 or 100 times the break frequency of the filter, and therefore only very simple anti-aliasing and recovery filtering are required.

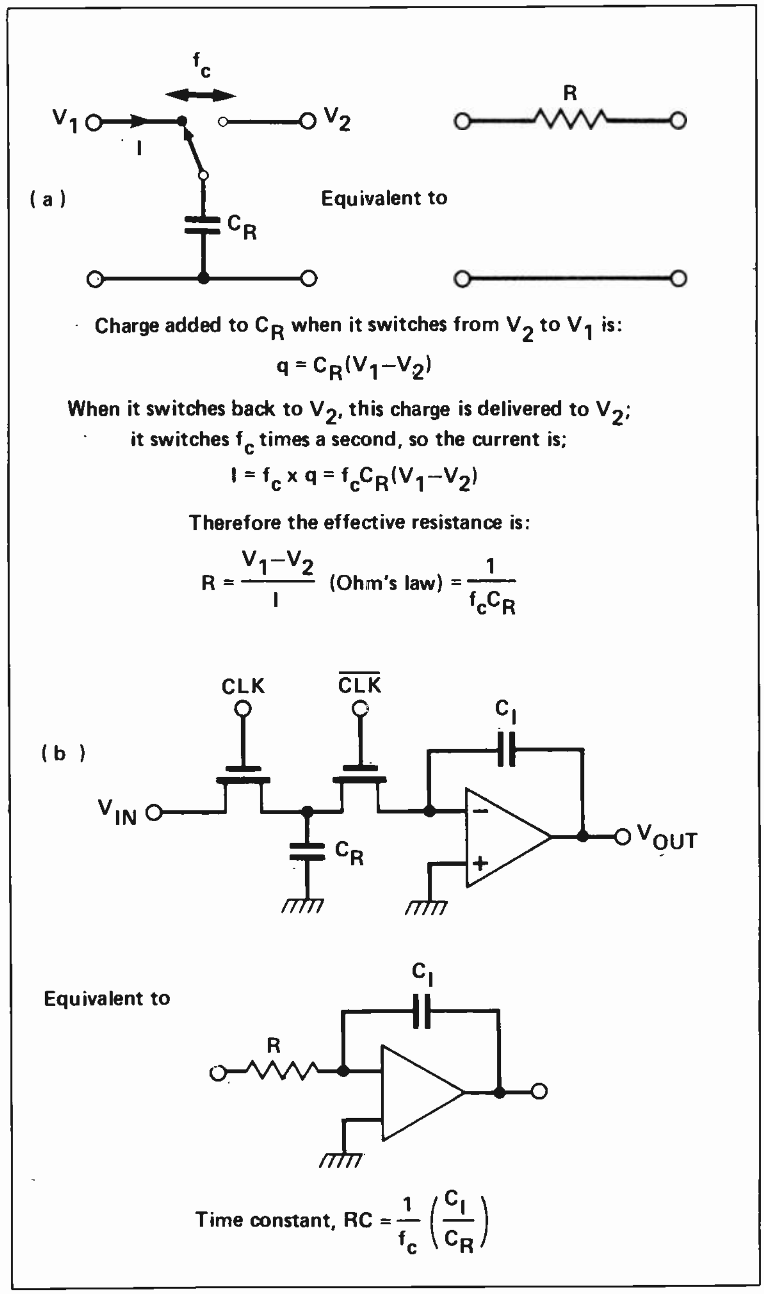


Fig. 1 Basics of switched capacitor filters. Synthesising a resistance (a); a simple low-pass filter using a synthesised resistance (b).

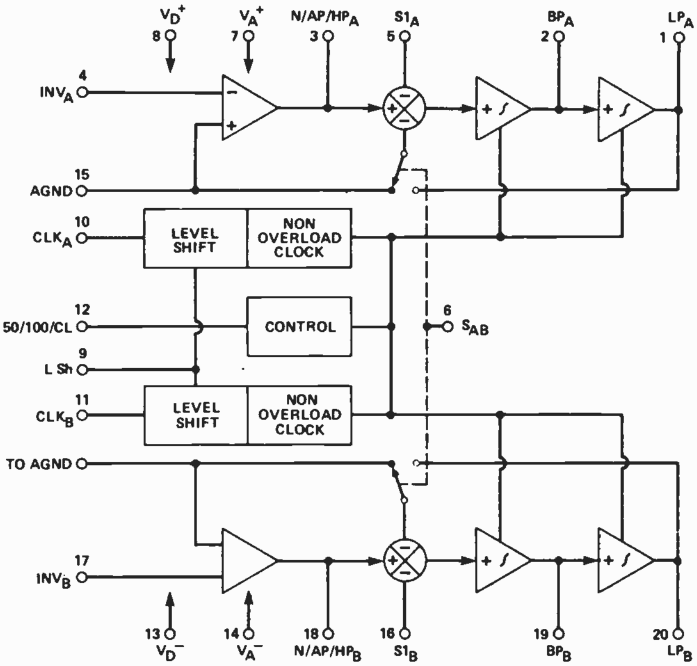
Several manufacturers produce switched capacitor filter ICs and all the classic filter structures are available. These devices offer several advantages over conventional passive and active filters:

- filters can be made very compact
- very few external components are needed
- the filters are tunable by adjusting the externally generated sampling frequency — so no re-alignment is necessary when break-frequencies are changed
- circuit calculations are made very easy

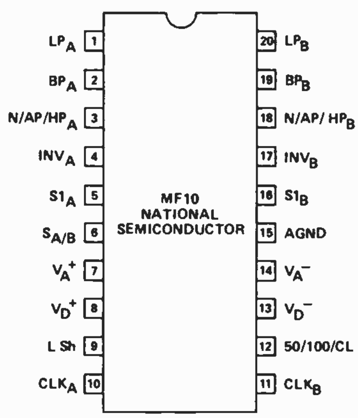
The following section is a review of some of the currently available devices. Next month, we'll look at a few examples of practical filter circuits using switched capacitor ICs.

MF10 — National Semiconductor

The MF10 is a dual independent active filter building block. Virtually any classic filter structure can be fabricated with this device.



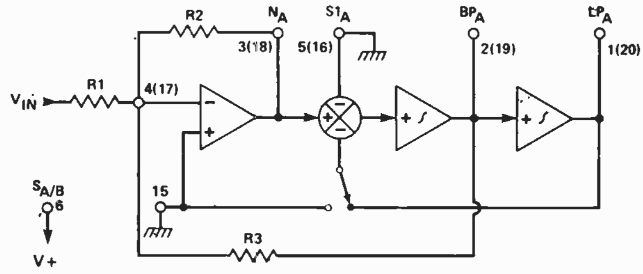
DUAL-IN-LINE PACKAGE



TOP VIEW

SUPPLY VOLTAGE ± 5V

LP, BP, N/AP/HP	low-pass, band-pass, notch, all-pass and high-pass outputs respectively. All can sink 1 mA and source 3 mA; N/AP/HP can sink 1.5 mA	L Sh	level shift for clock inputs. For TTL input, tie to 0 V; for CMOS operated from 10 V, tie to negative supply rail
		CLK A or B	clock inputs for each filter unit
V_A+, V_D+	positive analogue and digital supply rails. These are linked internally, and so must have the same supply voltage applied to them, normally +5 V	50/100/CL	defines relationship between clock frequency and filter centre frequency; tie to positive supply for 50:1 ratio, tie to 0 V for 100:1
V_A-, V_D-	negative supply rails, also internally connected; normally −5 V	$S_{A/B}$	activates internal switches, see section on use; note that there is only one $S_{A/B}$ for both filters
AGND	analogue ground, which should be at 0 V, ie mid way between positive and negative supply rails		



MODE 1

MODE 1: Notch 1, Band-pass, Low-pass outputs: $f_{notch} = f_o$

f_o = centre frequency of the complex pole pair

$$= \frac{f_{CLK}}{100} \text{ or } \frac{f_{CLK}}{50}$$

f_{notch} = centre frequency of the imaginary zero pair = f_o

H_{OLP} = Low-pass gain (as $f \to 0$) = $\frac{R2}{R1}$

H_{OBP} = Band-pass gain (at $f = f_o$) = $-\frac{R3}{R1}$

H_{ON} = Notch output gain as $\left\{ \begin{array}{l} f \to 0 \\ f \to f_{CLK}/2 \end{array} \right\} - \frac{R2}{R1}$

$Q = \frac{f_o}{BW} = \frac{R3}{R2}$

= quality factor of the complex pole pair.

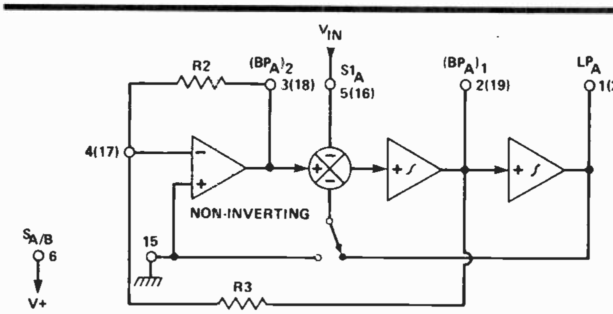
BW = the −3dB bandwidth of the band-pass output.

Circuit dynamics:

$H_{OLP} = \frac{H_{OBP}}{Q}$ or $H_{OBP} = H_{OLP} \times Q = H_{ON} \times Q$.

$H_{OLP(peak)} = Q \times H_{OLP}$ (for high Q's)

The above expressions are important. They determine the swing at each output funtion of the desired Q of the 2nd order funtion.



MODE 1a

MODE 1a: Non-inverting BP, LP.

$$f_o = \frac{f_{CLK}}{100} \text{ or } \frac{f_{CLK}}{50}$$

$$Q = \frac{R3}{R2}$$

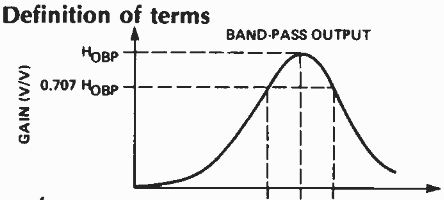
$H_{OLP} = 1$; $H_{OLP(peak)} \cong Q \times H_{OLP}$ (for high Q's)

$H_{OBP_1} = -\frac{R3}{R2}$

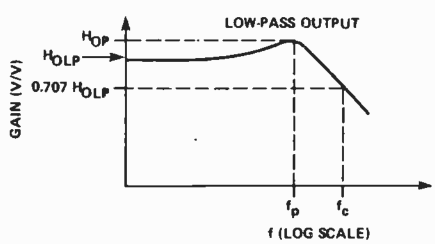
$H_{OBP_2} = 1$ (non-inverting)

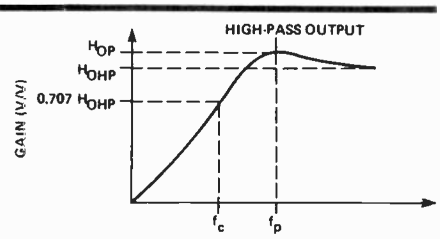
Circuit dynamics: $H_{OBP_1} = Q$

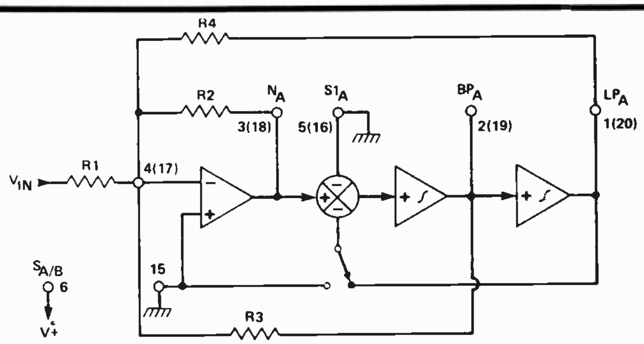
Definition of terms



$Q = \frac{f_o}{f_H - f_L}$; $f_o = \sqrt{f_L f_H}$







MODE 2

MODE 2: Notch 2, Band-pass, Low-pass: $f_{notch} < f_o$

f_o = centre frequency

$$= \frac{f_{CLK}}{100}\sqrt{\frac{R2}{R4}+1} \text{ or } \frac{f_{CLK}}{50}\sqrt{\frac{R2}{R4}+1}$$

$$f_{notch} = \frac{f_{CLK}}{100} \text{ or } \frac{f_{CLK}}{50}$$

Q = quality factor of the complex pole pair

$$= \frac{\sqrt{R2/R4+1}}{R2/R3}$$

H_{OLP} = Low-pass output gain (as $f \to 0$)

$$= -\frac{R2/R1}{R2/R4+1}$$

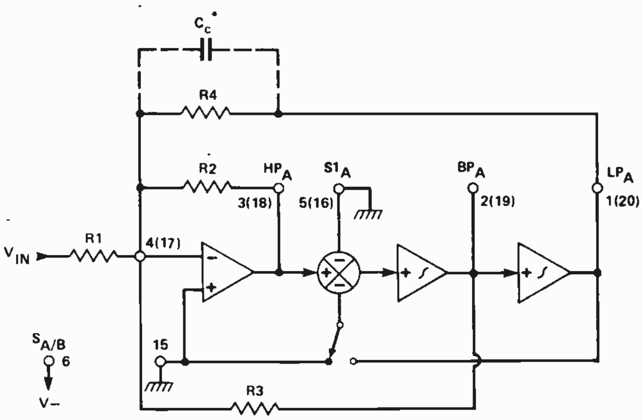
H_{OBP} = Band-pass output gain (at $f = f_o$) = $-R3/R1$

H_{ON_1} = Notch ouput gain (as $f \to 0$)

$$= -\frac{R2/R1}{R2/R4+1}$$

H_{ON_2} = Notch output gain $\left(\text{as } f \to \frac{f_{CLK}}{2}\right) = -R2/R1$

Filter dynamics: $H_{OBP} = Q\sqrt{H_{OLP}H_{ON_2}} = Q\sqrt{H_{ON_1}H_{ON_2}}$



MODE 3

* In Mode 3, the feedback loop is closed around the input summing amplifier; the finite GBW product of this op amp causes a slight Q enhancement. If this is a problem, connect a small capacitor (10pF-100pF) across R4 to provide some lead.

MODE 3: High-pass, Band-pass, Low-pass outputs

$$f_o = \frac{f_{CLK}}{100} \times \sqrt{\frac{R2}{R4}} \text{ or } \frac{f_{CLK}}{50} \times \sqrt{\frac{R2}{R4}}$$

Q = quality factor of the complex pole pair

$$= \sqrt{\frac{R2}{R4}} \times \frac{R3}{R2}$$

H_{OHP} = High-pass gain $\left(\text{as } f \to \frac{f_{CLK}}{2}\right) = -\frac{R2}{R1}$

H_{OBP} = Band-pass gain (at $f = f_o$) = $-\frac{R3}{R1}$

H_{OLP} = Low-pass gain (as $f \to 0$) = $-\frac{R4}{R1}$

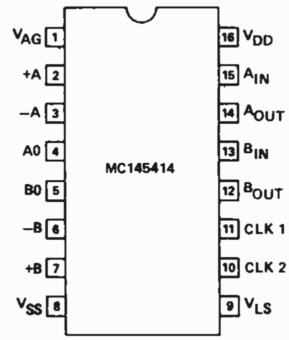
Circuit dynamics: $\frac{R2}{R4} = \frac{H_{OHP}}{H_{OLP}}$; $H_{OBP} = \sqrt{H_{OHP} \times H_{OLP}} \times Q$

$H_{OLP(peak)} = Q \times H_{OLP}$ (for high Q's)

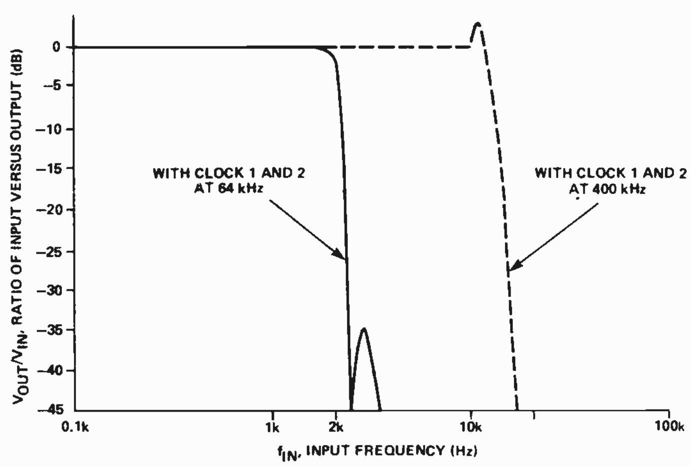
$H_{OHP(peak)} = Q \times H_{OHP}$ (for high Q's)

MC145414 — Motorola

This is a dual low-pass filter which can operate with a break frequency between 1.25 and 10 kHz. It also contains two completely uncommitted op amps in the same package. Filters are fifth-order elliptic, and have a clock-to-break-frequency ratio of approximately 36:1 (clock frequency must be between 50 and 400 kHz). Filter A has 18 dB gain in the pass band, while filter B has unity gain. The clock input voltage may be selected to be 5 V or 12 V, or the whole IC may be powered down by the application of suitable supply voltages.



V_{AG}	analogue ground; all analogue signals are referred to this level, and it should normally be around mid-way between positive and negative supply rails. If taken to within 1 V of positive rail, IC will power down	V_{LS}	logic shift voltage; for TTL clock input, take to mid-way between supply rails; for CMOS operating on to 12 V, take to negative supply rail. To power down IC, take to positive supply rail
+A, −A, AO	non-inverting, inverting inputs, and output of op-amp A	CLOCK 1, 2	clock inputs — should always be tied together
+B, −B, BO	as above for op-amp B	A_{IN}, B_{IN}	inputs to filters A, B
V_{DD}, V_{SS}	positive and negative supply rails. V_{SS} is also ground for digital inputs	A_{OUT}, B_{OUT}	outputs from filters A, B



R5620 — Reticon (not illustrated)

This device is a switched capacitor universal active filter, with digital setting of both the Q-factor and the filter centre frequency. It is a second-order filter capable of high-pass, low-pass, band-pass, notch and all-pass. The filter frequency is determined by the clock frequency and a five-bit binary input that moves the frequency over a two-octave spread in 32 logarithmically spaced intervals. This enables direct digital control of the centre frequency. The Q-factor is similarly controlled with a five-bit code. The Q range is from 0.57 to 150, and the break frequency range is 0.5 Hz to 25 kHz.

R5604, R5605, R5607 — Reticon

These are octave filters. All contain six-pole Chebyshev filters; however, they contain different numbers of filters with different pass band widths. The R5604 contains three ⅓ octave ANSI Class III filters that together cover an entire octave; the R5605 contains two ½ octave filters that together cover an octave, and the R5607 contains one full-octave ANSI Class II filter. The centre frequency of all the filters is controlled by the single clock input — see the response curves for details. The dynamic range is better than 80 dB and distortion is less than 0.1%. The filters can handle input signals greater than 10 V peak-to-peak and have an insertion loss of less than 0.2 dB in the pass band.

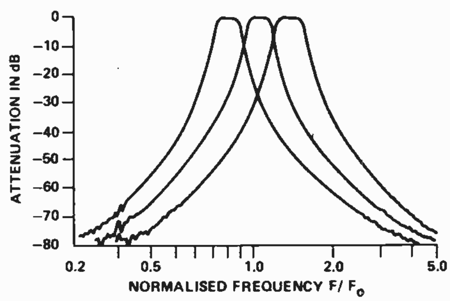
PIN	R5604 FUNCTION	R5605 FUNCTION	R5606 FUNCTION
1	V−	V−	V−
2	N/C	N/C	N/C
3	IN 2	IN 1	N/C
4	IN 1	N/C	N/C
5	V+	V+	V+
6	N/C	N/C	N/C
7	TRIG IN	TRIG IN	TRIG IN
8	N/C	N/C	IN 1
9	IN 3	IN 2	V−
10	V−	V−	N/C
11	N/C	N/C	N/C
12	V+	V+	V+
13	COM	COM	COM
14	OUT 3	OUT 2	N/C
15	OUT 2	N/C	N/C
16	OUT 1	OUT 1	OUT 1

(a) R5604

R5604 3-1/3 OCTAVE BAND-PASS FILTERS

f_{SAMPLE} = 55 kHz

F_o = 1 kHz

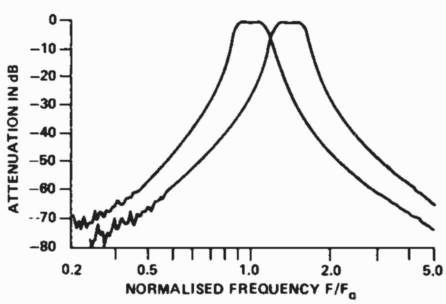


(b) R5605

R5605 2-½ OCTAVE BAND-PASS FILTERS

f_{SAMPLE} = 55 kHz

F_o = 1 kHz

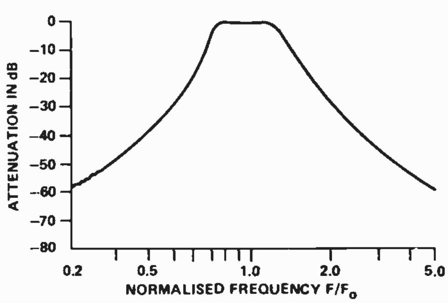


(c) R5606

R5606 1 FULL OCTAVE BAND-PASS FILTERS

f_{SAMPLE} = 55 kHz

F_o = 1 kHz



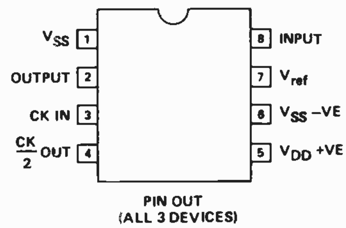
R5609, R5611, R5612 — Reticon

The R5609 is a seven-pole, six-zero elliptic low-pass filter with over 75 dB out-of-band rejection and less than 0.2 dB of pass band ripple.

The R5611 is a five-pole Chebyshev high-pass filter with 30 dB per octave rolloff and less than 0.6 dB of pass band ripple.

The R5612 is a four-pole notch filter with over 50 dB of rejection at the notch frequency.

The corner/center frequencies of these switched capacitor filters is tuneable by the input trigger frequency over a wide frequency range from 0.1 Hz up to 25 kHz. The dynamic range is better than 75 dB and distortion is less than 0.3%. Signal handling capability is over 12 V peak-to-peak, and typical insertion loss is 0 dB. Supply voltages may be ±4 V to ±11 V maximum.



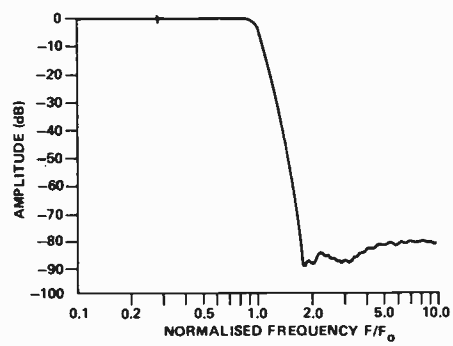
PIN OUT (ALL 3 DEVICES)

SUPPLY VOLTAGE ± 4V TO ± 11V MAX.

(a) R5609

FREQUENCY RESPONSE OF R5609 LOW-PASS FILTER

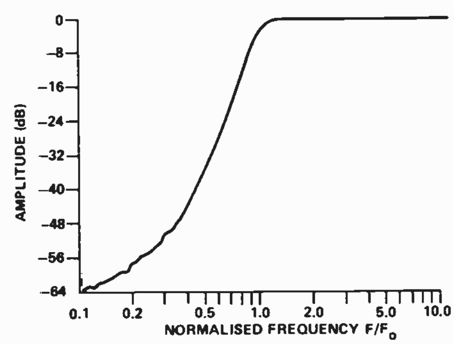
NOTE: f_c/F_o = 100 (typical)



(b) R5611

FREQUENCY RESPONSE OF R5611 HIGH-PASS FILTER

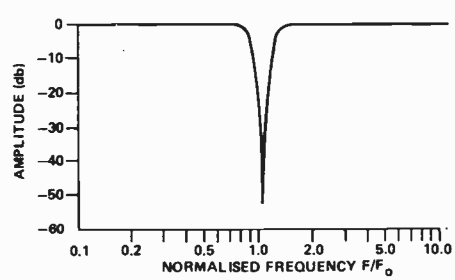
NOTE: f_c/F_o = 500 (typical)



(c) R5612

FREQUENCY RESPONSE OF R5612 NOTCH FILTER

NOTE: f_c/F_o = 930 (typical)



ETI

Rebel Radio Stations

The use of radio to broadcast propaganda may be dissonant to our democratic principles, but it is widely practiced in the Americas. A brief summary by C.M. Stanbury II.

UNDOUBTEDLY the hottest spots in international broadcasting these days, because of their political instability, are the islands of the Caribbean and those tiny but strategic republics of Central America. And Canadians have a ring side seat from whch to monitor the action on shortware and, probably soon, the standard AM band as well. This is an unparalleled opportunity to build up a collection of historic tape recordings. Listed below are some of the insurgent radio stations and the wavelengths that they transmit on.

RADIO VENCEREMOS ("We shall overcome"): the main Salvadorian rebel station operates two transmitters at 0700, 1900 and 2200 EST (i.e. 1200, 0000 and 0300 UTC) on approximately 6210 kHz -often jammed by a counter-broadcast playing non-stop music - and a second channel between 6500 and 7000 kHz. A white noise jammer sometimes follows the latter as it moves, every few minutes, up and down this band.

RADIO 15 DE SEPTIEMBRE: the oldest of the presently operating clandestine stations hostile to the Sandinista government of Nicaragua. It is located in northern Honduras and has a heavily jammed transmitter on 5565 kHz nightly at 2200 EST, and sometimes at midnight as wwll. A second unit operates sporadically between 6200 and 7000 kHz. Broadcasts often use English to attract Miskito Indians listeners.

LA VOZ DE SANDINO: despite its name, this is an anti-communist station as is their sister station, **LA VOZ DE NICARAGUA LIBRE.** Both are associated with Alienza Revolucionaria Democratica (Arde) and may be situated in Costa Rica. La Voz de Sandino is the older of these two clandestine operations, dating back to the summer of 1982. When La Voz de Nicaragua Libre first appeared in February, 1983, both stations were on the air simultaneously but more recently they have been sharing a single transmitter. On 6220 or a channel varying widely above and below 5800 kHz. broadcasts (which also include some English) are at 0500, 1900 and 2200 hours EST.

LA VOZ DEL CID: operated by the Venezuelan-based "Cuba Independente y Democratica", this station can be heard throughout the afternoon hours on 11700 kHz. La Voz Del Cid leases a transmitter from Radio Clarin in the Dominican Republic. They are approximately 7350 in the early evening, then still later on a varying frequency around 7405 kHz. Locations of these two transmitters are unknown.

RADIO MARTI might be considered the ghost of Radio Swan (the Bay of Pigs station), which after that ill-fated 1961 invasion became Radio Americas and operated until 1968. According to the latest plan, Radio Marti will share the Voice of America's mediumwave transmitter site at Marathon Key, Florida. If this plan passes Congress it would be ironic, because there is evidence suggesting that during the 1962 Cuban missile crisis VOA Marathon switched, for security reasons, IDs and frequencies with Radio Americas: the latter was definitely involved in such ID/frequency interchanges on shortwave. It is not yet known whether Radio Marti will share VOA's 1180 kHz channel or set up its own transmitter on the Marathon site. Canadians may or may not have difficulty receiving Radio Marti's broadcasts but we'll certainly hear the Cuban jamming directed against Radio Marti.

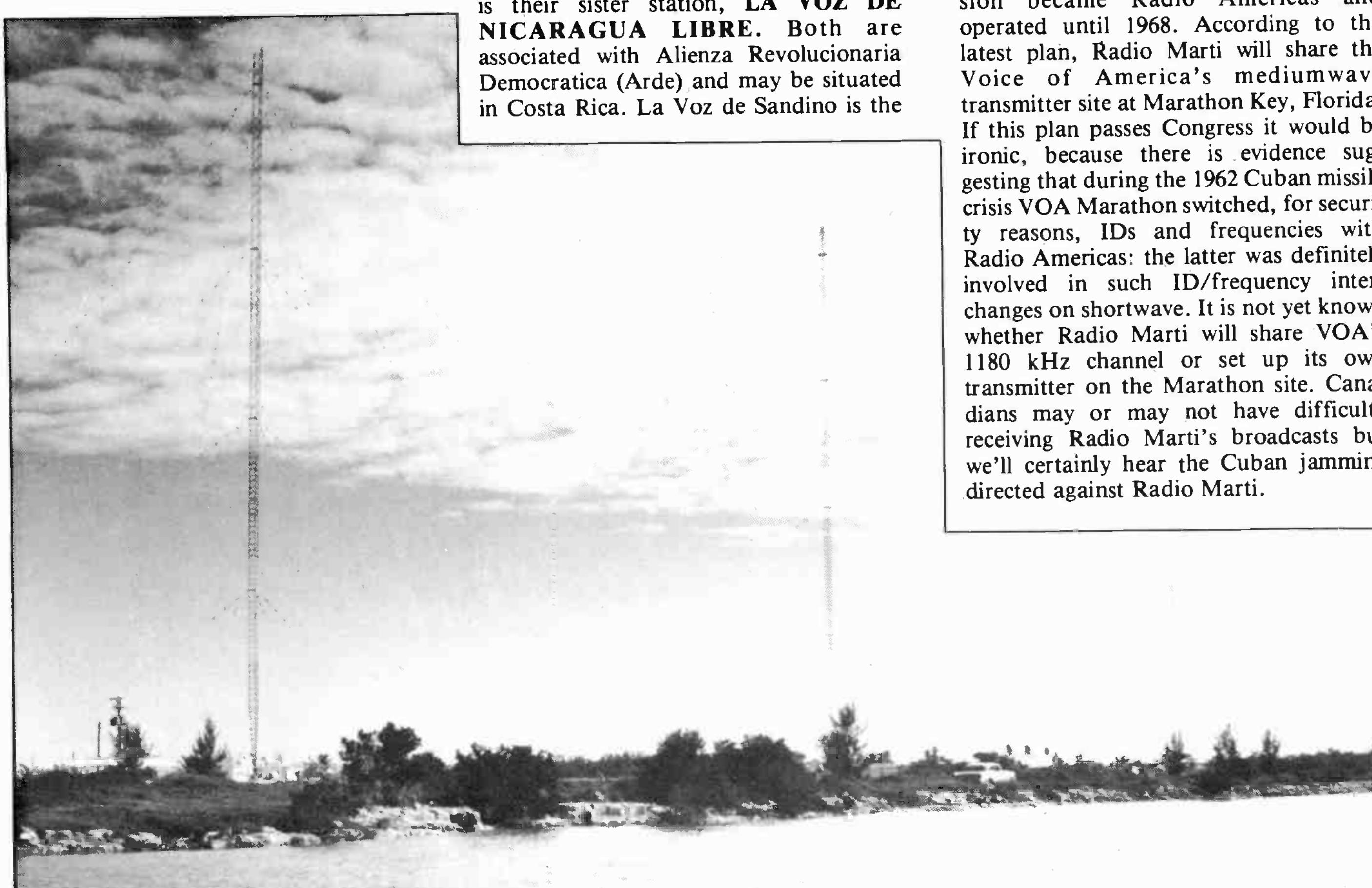


Figure 1. Voice of America transmitter site on Marathon Key, Florida, which, if all goes as planned, will soon be shared with Radio Marti. ETI

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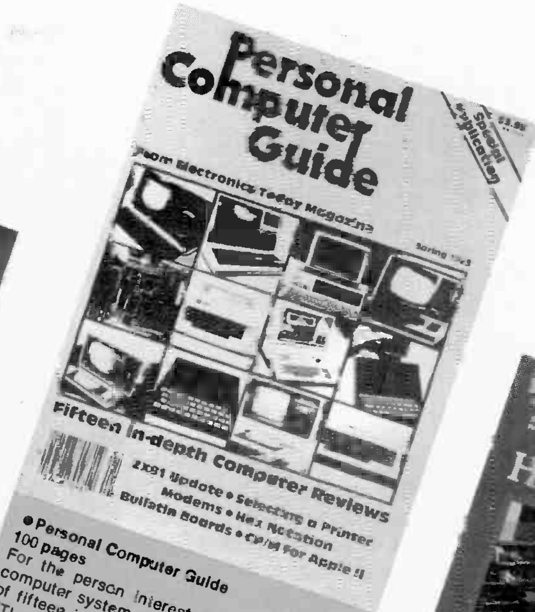

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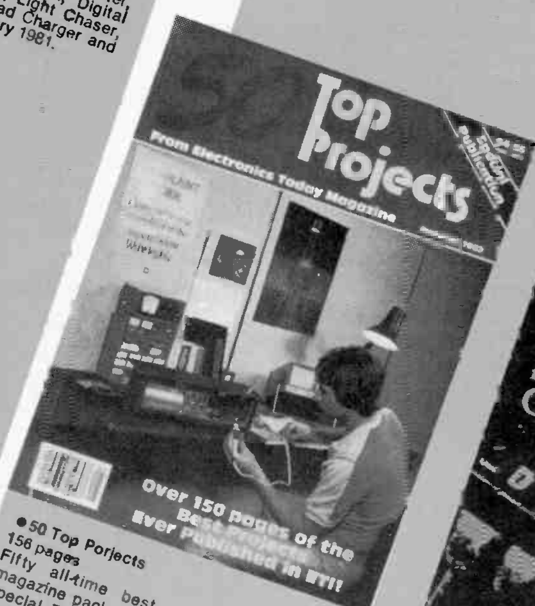

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Continued from page 19

is connected internally to one of its terminals. This shield terminal should be identified (use an ohm-meter) and wired to the mid-rail reference as shown on the overlay; ensure that the wire used is very thin and flexible. A piece of sponge foam about the size of the mike should be stuck to the PCB and the mike may then be glued on top of this to provide a resilient mounting, free from direct vibration pickup.

An electret condensor type of mike insert could also be used and would probably give better quality sound pickup. They usually come with their own internal FET preamplifier, which requires a 1V5 power supply. Luckily, the 1V4 reference terminal indicated on the overlay is ideal for this job, and may be wired directly to the insert.

When the board is completely assembled, the two control pots and the mode switch can then be wired up as indicate Veropins should be inserted as terminals at the appropriate points. The two rotary switches for the frequency selection should also be wired up using ribbon cable as shown in the diagram. Note that the rotary switches are both set to select one out of 10 corner frequency outputs from the PCB and the rotary switches are offset by one frequency band relative to each other i.e., the upper limit switch ranges from 40 Hz to 20 kHz while the lower limit ranges from 20 Hz to 10 kHz.

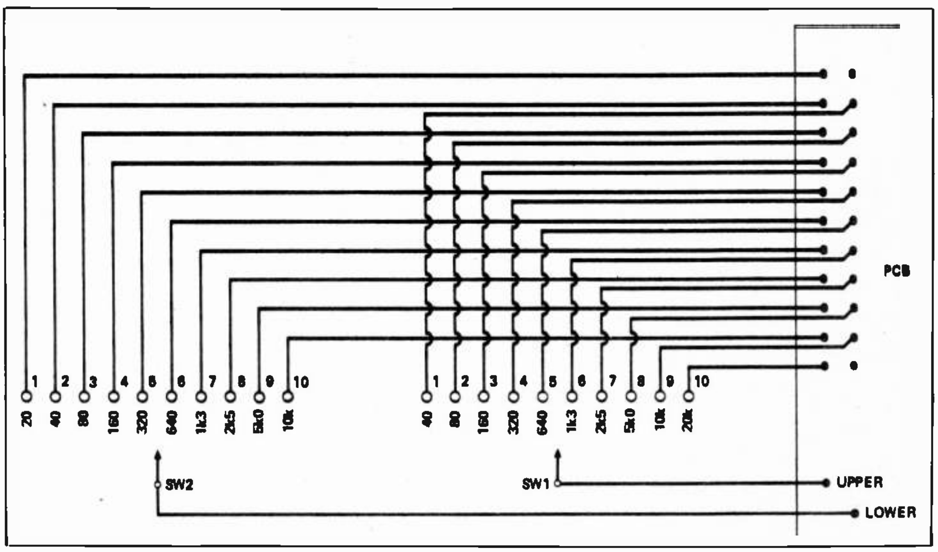


Fig. 4 This diagram shows how to wire up SW1 and SW2.

Testing And Setting Up

After wiring up the controls, some initial tests can be made before completing the assembly. Initially, do not connect any light bulbs and do not plug in any ICs; but do remember that all parts of the circuit are effectively live. Connect the power as shown via a double pole toggle switch and a 10 amp fuse, and then switch on. Using a voltmeter check that there is about 10 V across C5 and 5 V across C7. 10 V should also appear across pins 8 and 4 of IC1, pins 8 and 13 of IC2, pins 16 and 8 of IC3, and pins 14 and 7 of IC4 and pins 3 and 2 of IC5. If all is well, unplug from the power and insert all the ICs. One light bulb can now be wired onto the SCR5 terminal, its other lead returning to the line. Set the upper limit switch to 5 kHz, and the lower limit to 640 Hz; this gives a fairly broad frequency band for vocal testing. The unit should be turned on again with SW3 set in bar mode. Altering the background control RV2 should cause the bulb to switch on and off at some point. As the bulb switches off continue to turn RV2 in the same direction to the end of its travel. The background illumination control is then at its zero setting. Now, depending on the sensitivity setting, a loud noise should re-illuminate the bulb. Increasing the sensitivity control should eventually allow the bulb to come on with normal speech volume. If this test works satisfactorily, then all the bulbs can be wired up to their corresponding terminal posts and the entire display can be tested.

Turning the background control up should result in the successive illumination of bulbs; now turn it down to zero, when all the bulbs should be off. Increasing the sensitivity control will now allow sound to illuminate all the bulbs. Having established a good sensitivity setting, different types of music from a record deck or radio can be used to check the different frequency bands available on the rotary switches. The display can be switched to dot mode at any time, which provides an interesting effect with constant light level.

A Case In Point

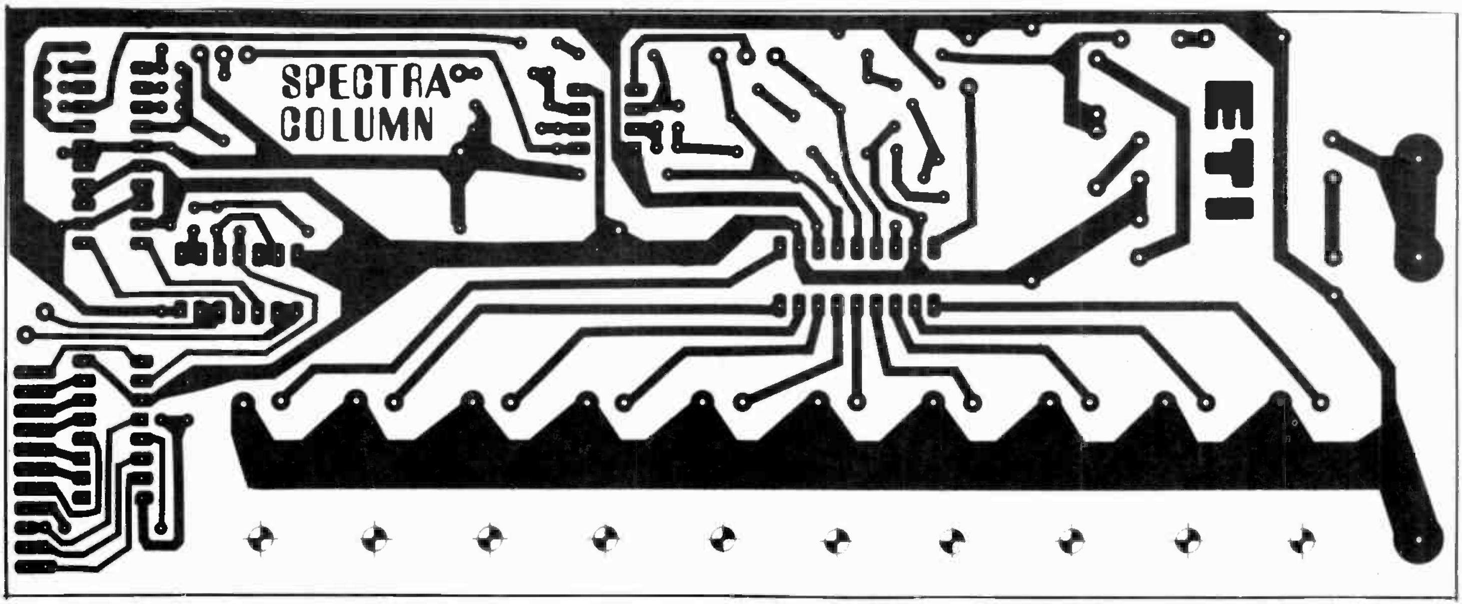
The actual hardware construction of the light bulb arrangement is very much a matter of personal choice. We used large white plastic bulb holders, and mounted the entire column and PCB in a fluorescent light case that was at hand. The case was grounded and provided a nice self-contained unit. Batten-mounting bulb holders could equally well be screwed down to a long strip of wood and the electronics mounted in a spearate diecast box. The photographs illustrate the construction method we used.

A number of important points should be noted with the final assembly. Owing to the circuitry used, the positive rail is directly connected to the neutral; therefore all parts of the circuit should be treated as being effectively *live* since somebody could easily swap the line and neutral leads by accident at the plug end. Consequently we suggest:

- The PCB should be mounted in a metal case on insulating pillars or blocks.
- The case should be grounded, but there should be no other connection between the PCB and the case.
- The mode switch and on-off switch should both be power rated and have a current rating sufficient for the total of the bulbs used.
- The pots and rotary switches should all have plastic spindles and plastic knobs. Ideally the metal pot cases should be insulated from the chassis, or they could be soldered directly to the PCB terminals such that only the plastic spindles pass through the chassis.
- For the reasons of isolation, the microphone must stay inside the case; and on no account try to connect up the mike input to a direct audio signal from your sound equipment (this could be done *only* with an audio isolating transformer).

Notes On Modifications

For those with the urge to experiment, here are some notes on modifying circuit values: R3 decreases the mike preamplifier gain; decreasing R4 and R8 increases the filter gain; increasing R6 and R10 will increase the Q of the filters; R18 alters the frequency of the master clock, currently set at 2 MHz; R21 determines the drive current to the triacs; increase C3 or R16 to increase the attack/decay display time constant; R16 could be a 22k variable pot.



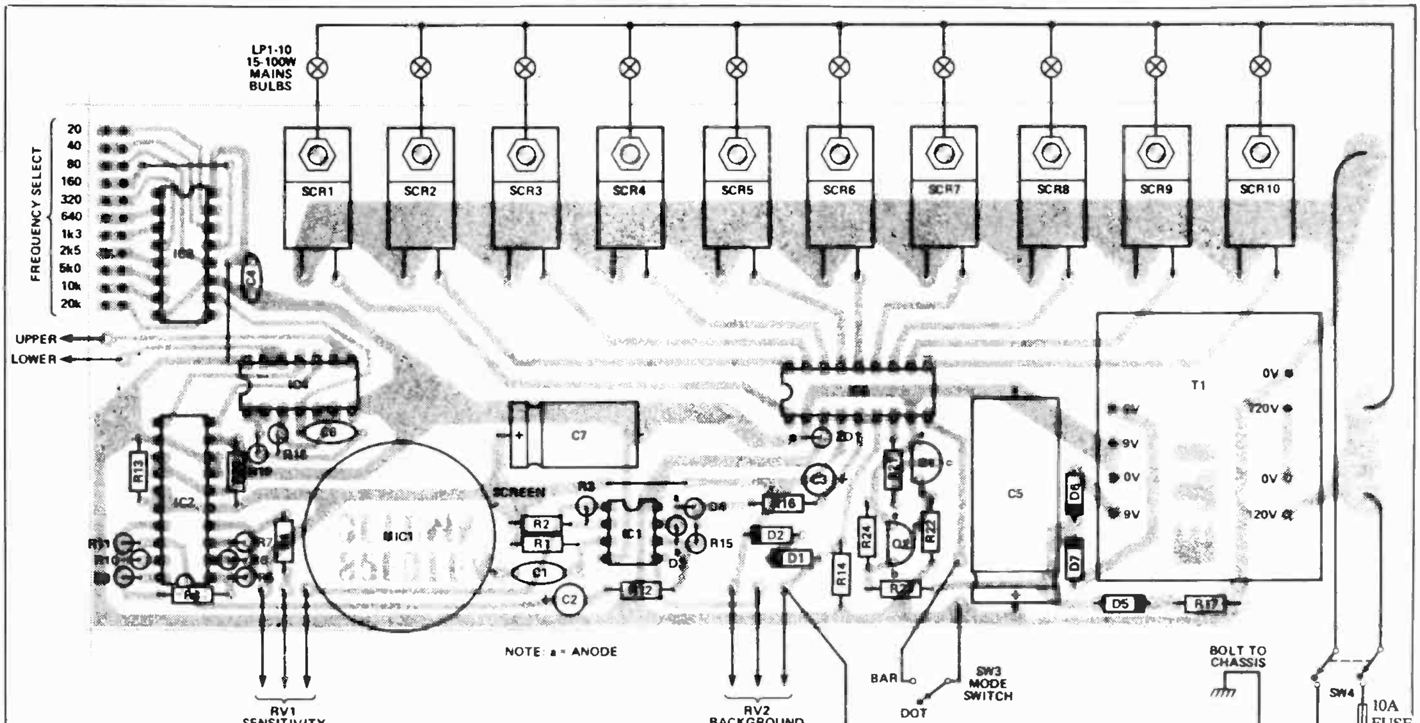


Fig. 5 Component overlay for the Spectracolumn. Use spade connectors for the triac and the line connections.

Parts List

Resistors (all ¼W, 5%)		**Capacitors**		Q1,2	2N3904
R1	2M2	C1	270n polycarbonate	SCR1-10	TIC206D
R2,4,8,22,23	10k	C2	10u 16 V tantalum	D1-4	1N4148
R3	1M0	C3	1u0 35 V tantalum	D5-7	1N4001
R5-7,9-11	27k	C4	10n ceramic	ZD1	10 V 400 mW zener
R12	47k	C5	1000u 25 V axial electrolytic	**Miscellaneous**	
R13,20	560R			SW1,2	1-pole 12-way rotary switch
R14	2k2	C6	100p polystyrene		
R15	100k	C7	220u 16 V axial electrolytic	SW3	SPST toggle switch
R16	2k7			SW4	DPST power switch
R17	22R	**Semiconductors**		MIC1	crystal mike insert
R18,21	820R	IC1	TL082	T1	9-0-9 3 VA transformer
R19	3k9	IC2	MF10CN	FS1	10 A fuse and fuseholder
R24	6k8	IC3	4040B	PCB; 10 bulbs, 15-100 W, and holders; fluorescent lamp fitting or other suitable case.	
Potentiometers		IC4	4011B		
RV1,2	10k log or linear	IC5	LM3915		

Bob Bartolini of RCA Laboratories holding an experimental erasable optical disc. Photo courtesy of RCA Laboratories.

Continued from page 35

Erasure

But perhaps the most interesting recording mode was introduced last April by the Matsushita Electric Industrial Co., for it is the only erasable optical system currently available. In this reversible mode, no topographical (eg. pit or bubble forming) disruption of the trilayer structure occurs during recording. Instead the optical properties of the recorded region are changed when the material switches between the crystalline and amorphous phases. The pit forming mode in this case is inhibited by the use of a dielectric capping layer. The recorded region can be erased by continuing the high power readout. The areas can then be re-recorded and erased up to 50 times.

While this system permits the overcoming of one of optical memory storage system's problems, erasability, it is probably not as useful as it might first appear. While Matsushita claims it to be a major breakthrough, which it is, the application of such a system are limited. While it would permit editing, it, by virtue of being erasable, would not permit the establishment of audit trails required by govenment regulations and laws for business and tax purposes. Further, as with all optical systems, there is a question of reliability which as yet has not permitted optical memory storage systems to compete successfully with computer tape or disc memories. In computers there must theoretically be no error rate greater than one in a trillion bits of information. Imaging systems, such as home videodiscs, are prone to a much higher error rate. This hasn't mattered in visual data recording since the errors just show up as glitches on the screen which the eye forgives. However, when doing mathematical calculations, such an error would result in the wrong answer being determined.

Reliability

There are three major sources of errors in optical memory systems. One source is due to intrinsic surface defects present in the substrate disc. Even the most carefully polished glass substrate will have a finite density of cavities and microscratches on its surface. The surface defects intrinsic to the substrate can be hidden relatively easily by pre-coating from a solution. Such a layer is applied by spin coating and as it dries, surface tension causes the uppermost surface to harden and form an almost defect-free surface for coating with the recording structures.

A second source of defects depends on the intrinsic quality of the evaporated coatings that form the recording structures. These coating must be free of pinholes to a very high degree and this necessitates the most rigorous standards for cleanliness during the evaporation steps.

But the prime source of defects is that of precipitated dust particles which accumulate on the surface of the recording medium. These particles may obscure a number of recorded pits or even prevent their formation if the particle is present during the recording step. A relatively thick transparent overcoat or encapsulation layer will protect against signal degradation due to dust particles by placing them out of focus.

All in all, optical memory systems have come a long way very rapidly since Phillips introduced the first commercial video disc in the late 1970's. So much so that International Resource Development Inc., a Norwall Connecticut market researcher in the field, believes that a $2.3 billion dollar annual business will be developed by 1987, with potentially a $10 billion a year business by 1990.

ETI

Circle No. 11 on Reader Service Card.

Circle No. 3 on Reader Service Card.

Circle No. 9 on Reader Service Card.

Designing Micro Systems Part 2

Bemused by those funny-looking groups of hexadecimal numbers that microprocessors use for a language? From voltages to binary, binary to hex, and hex to English — Owen Bishop does the translating.

IN DESCRIBING THE many and complex circuits which go to make up the CPU and its peripheral devices we often refer to *information* being transferred from one to the other. Last month, it was explained that such information consists of either *instructions* or *data*. In order to understand how the several parts of a computer interact to form an operating system, we need to go into more detail about these instructions and the data. In this month's instalment we pause from considering electronic aspects in order to discuss the nature of the information and the form in which it is transferred.

Information Technology?

The MPU and other integrated circuits composing the micro respond to only one kind of information. This is an electrical signal, a voltage level present on one of its input lines. To the input circuit of the IC, this level is either 0V (or so close to 0V that it counts as 0V), or +5 (or high enough to count as +5V). An instruction given to a Z80 MPU is received as a set of such voltages on each of the eight lines of the data bus. For example, the Z80 might receive a set of signals as set out in Table 1. When (and only when) these signals are present, internal logic within the Z80 is set and causes every flip-flop of the accumulator register to change state. Every 'set' flip-flop is reset, every 'reset' flip-flop is set.

The description above is in purely electronic terms, which is reasonable enough, for a Z80 MPU is a purely electronic device. When we use it in a computer and communicate with it through the agency of a keyboard, using a high-level language such as BASIC, we tend to forget that it is only a rather complicated electronic circuit. In order to make it do anything at all, we have to communicate with it by sending it information (ie, what we want it to do) in terms of electrical signals.

Coding For Clarity

Having looked at this from the MPU's point of view, let us look at it from ours. We are somewhat cleverer than CPUs and can take advantage of this to make things simpler for ourselves. For example, it is a cumbersome procedure to state; "To make each 'set' flip-flop become reset, and each 'reset' flip-flop become set, place +5V on line D0, +5V on line D1, . . ., and 0V on line D8." We need a way of symbolizing the signal levels to be applied to the data bus. In short, we need *codes* which will relate our requirements to the electronic activities of the computer. Mathematics provides us with ways of coding operations performed on the accumulator or other registers. The information sent on the data bus is coded in another way, known as *machine code*. These codes make it much easier for us to follow the workings of the computer, to tell it what to do and to discover what it has done. They make it easier for us to discuss computer activities among ourselves. But keep in mind that these codes are used for **our** convenience to symbolize events which are essentially electronic.

TABLE 1

DATA LINE	VOLTAGE LEVEL
D0	+5 V
D1	+5 V
D2	+5 V
D3	+5 V
D4	0 V
D5	+5 V
D6	0 V
D7	0 V

Bits And Bytes

As mentioned last month, the actions of the electronic circuits of a computer are binary in nature. Voltage levels are 0V or +5V; intermediate voltages are not recognized. Flip-flops are either set or reset; there are no other stable states. Consequently, the simplest way of symbolizing voltage levels is to represent them in binary form.

Conventionally, 0V is represented by the numeral '0', while +5V is represented by '1'. Using this convention, we only have to write out a row of eight such binary digits to represent the eight voltage levels on the data bus. In doing this we use another convention, that the digits refer to lines D0 to D7, in numerical order, written from right to left. We usually split the eight binary digits (or *bits*, a shortened form of the words *'BInary digiT'*) into two groups of four bits each. A group of eight bits is referred to as a *byte*. We can write out the voltage levels of Table 1 as a single byte:

0010 1111

A set of bits representing a set of voltage levels which are interpreted by the MPU as an instruction is called an *op code*.

The action of flip-flops is binary too — we can represent the state of the flip-flops of the accumulator or other registers as a set of bits. The accumulator of the commonly-used MPUs has eight flip-flops, so its contents may be represented by a byte. The Z80 and 6502 are of this type. If the contents of the accumulator are, say, '0101 1100', the op code 0010 1111 instructs the Z80 to change every '0' into a '1' and every '1' into a '0', so that the contents become '1010 0011'.

Such an operation has a mathematical name; we call it *complementing*. If we symbolize the accumulator contents as A, and the inverse of its contents as $\overline{A}$, the whole operation can be represented by the equation:

$$A \leftarrow \overline{A}$$

(A is replaced by $\overline{A}$).
We can now state what happens in much simpler (to us!) terms: Op code 0010 1111 causes operation $A \leftarrow \overline{A}$

To the Z80, it is still a set of voltages causing a change of flip-flops.

Helpful Hexadecimal

Putting op codes into binary form is certainly simpler than referring to voltages in terms of their actual values, but it still has features which are inconvenient. For instance, writing out strings of 1s and 0s is tedious, and readily subject to error. It is not easy to notice the difference between 1001 1101 and 1001 1001, and the situation becomes worse when we are dealing with 16-bit codes. Although many of the early systems used switches to feed in a series of bits to the data lines, we prefer not to have to key in each bit separately. There is a simpler way of doing this.

The hexadecimal code is a short-hand way of representing the binary code. More than this, it is a number scale in its own right. Whereas the binary scale is based on powers of two, and has only two kinds of figure (0 and 1), the hexadecimal scale is based on powers of 16 and has 16 kinds of figure. We already have 10 kinds of figure (0 to 9) available in our common decimal scale and, rather than invent six new symbols, we have adopted the first six letters of the alphabet for use as figures. Table 2 shows how this is done.

By using hexadecimal coding we are able to save time and confusion in writing out lists of instructions for the computer (programs). We are also able to make use of a 16-key keyboard for entering these instructions quickly. Against these advantages there is the disadvantage that we begin to lose sight of the binary nature of the operation of the computer. The individual 0s and 1s no longer appear in our reckoning and we are one stage further removed from the working procedures of the MPU.

One source of confusion in using several number scales is that we must be careful to state which scale we are using. For example, the digits "11" may represent 'three', if they are in the binary scale, 'eleven' if they are in the decimal scale, or 'seventeen' if they are in the hexadecimal scale. In this article we will write all binary numbers in blocks of four bits, and begin them with at least one zero. All hexadecimal numbers will be followed by the letter H. Thus '0011' represents 'three', '11' represents 'eleven', while '11H' represents 'seventeen'.

Giving Instructions

A byte can represent any number from zero (0000) up to 255 (0000 1111 1111). It is therefore possible to specify up to 256 different instructions for the MPU, using just one byte. Such a set of op codes is called the *instruction set*. Examples of the instruction set of the Z80 are listed in Table 3. The Z80 can respond to more op codes than listed there; in fact, its instruction set contains over 500 different instructions. This is more than 256, so some of these are coded by using two bytes. Such a large instruction set makes it a very powerful MPU.

On the other hand, the 6502 has a relatively restricted set, consisting of only 148 instructions, yet remains a popular MPU in spite of this. There is no doubt that the limited set makes it easier for a programmer to get to know how to use the capabilities of the 6502 to the full. Needless to say, the op codes used by different types of MPU do not mean the same thing. When a Z80 receives the op code 25H it subtracts 1 from the contents of its H register; in other words, it decrements H. If you present this same op code to a 6502, it performs the logical AND operation on all bits in the accumulator.

TABLE 2

Binary	Hexadecimal	Decimal
0	0	0
1	1	1
10	2	2
11	3	3
100	4	4
101	5	5
110	6	6
111	7	7
1000	8	8
1001	9	9
1010	A	10
1011	B	11
1100	C	12
1101	D	13
1110	E	14
1111	F	15

Taking Several Bytes

The previous example raises the next point to be considered. An operation such as 'complement' or 'decrement' involves only the register concerned. When we ask the 6502 to AND its accumulator, the MPU must be given something to AND it with. The same applies to instructions such as 'add'. If something is to be added to the accumulator, we must tell the MPU what to add.

The instructions which have been mentioned earlier have consisted of a single op code. Most instructions require the op code to be followed by one or more bytes to supply the data upon which the MPU is to operate.

As an example, consider the op code 25H, which tells the 6502 to AND its accumulator with something. When the 6502 has received this instruction, the next byte fed to its data bus inputs must be a byte which specifies what to AND the accumulator with. The 25H op code is what is known as a *zero-page* op code in that the single byte which follows is to be taken as an address located in page zero of memory. Since the address bus has 16 bits, it requires a double-byte to specify any given address. Zero-page addresses in a 6502 system are those which begin with 00H, for example, the address 00 32H. With zero-page addressing we do not need to send the MPU the first byte (00H) for it already knows from the op code that a zero-page address is forthcoming. We need only send the second byte (32H). Thus the full instruction is '25 32', consisting of op code (25H) followed by a single *operand* (32H). On receiving the second byte, the 6502 fetches the contents of address 00 32H from RAM, and ANDs it with the contents of the accumulator, leaving the result of this logical operation in the accumulator.

TABLE 3

Z80 Op Code	Interpretation
00	Do nothing
04	Increment register B
05	Decrement register B
25	Decrement register H
2F	Complement accumulator
5A	Load register E with contents of register D
5E	Load register E with the contents of a memory register, the address of which is stored in registers H and L
76	Halt
FB	Enable interrupts

Using The Code

Zero-page addressing is a feature of the 6502 which allows a certain range of addresses to be passed to the MPU in an economical way. As a second example, suppose that the value to be ANDed with the accumulator was stored not in page zero (00 32H), but at an address higher in memory, for example, 2D 32H. This address needs **two** bytes to specify it, so after the MPU has received the ANDing op code, it must wait for the next two bytes before proceeding to carry out the instruction. The op code for this procedure is now 2DH (0010 1101) instead of 25H (0010 0101) as before. Looking at the binary code (which is what the MPU is looking at), we see that data line 3 is at +5 now instead of at 0V, as before. The effect of this is to make the MPU wait for two bytes and put them together to make up the full 16-bit address. Then it addresses that unit of memory, fetches the value stored there and ANDs it with the value present in the accumulator.

This second example is a triple-byte instruction, and would be written out as '2D 2D 32'. The first byte (2DH) is interpreted by the MPU as an op code. The next, though it has the same hexadecimal value, is not taken as an op code but as the first byte of a double-byte address. The MPU is able to distinguish between instructions (op codes) and data (eg, addresses) by their context. It is rather like our ability to distinguish between the meanings of the word 'lead' in these two sentences:

1) He fixed the lead pipe from the kitchen sink.
2) He played the lead guitar in the local pop group.

We know which way to interpret the word 'lead' by its context, by its relation to the other words which occur with it in the same sentence. Similarly, the op code 2DH and the partial address 2DH give rise to precisely the same set of voltages on the data bus, but they are interpreted differently by the MPU according to what has gone before. Information on the data bus can therefore be an instruction (op code) or data (eg, an address).

For Immediate Attention

An address is one kind of data, but this is not the only kind. We have mentioned that the MPU fetches a value from a location in memory in order to AND it with the accumulator. This value is transferred from that location to the MPU as a byte on the data bus. Data can include values of this kind, to be used in arithmetical or logical operations, or it might be a value which is part of an instruction. For example, the op code 29H is yet another instruction to perform the AND operation, but this one ANDs the accumulator with the next value to appear on the data bus. This is often called the *intermediate mode.* Thus the instruction '29 16' tells the MPU to AND the accumulator with the value 16H. The MPU knows that 16H is a value, not part of an address, because of its context; it follows the op code 29H.

The op code D0H causes the value which follows it to be added to the value held in the program counter register. The effect of this is to make the MPU jump from one part of its program to another. This op code is only obeyed if a given condition holds true. If the result of the most recent operation has left 00H in the accumulator, the jump is effected. If not, the instruction is ignored.

Talking To The Chips . . .

Ultimately, the only way of sending information to the MPU is by means of voltages on the data lines. The only way that the MPU can send information to other parts of the micro, and to the world outside (including us) is the same. In the simpler micro systems, including most of those specialized systems used in control applications (eg, automatic washing machines and other robots), all communication is at this level.

If the system has a keyboard, it is often a 16-key hexadecimal one with perhaps a few additional function keys. Readers may remember the Sinclair MK-14, the popular but primitive forerunner of the ZX80 and ZX81. This had a 16-key keypad and a reset button. Visual output was by means of an eight-digit seven-segment LED display, which displayed the figures 0 to 9 and the letters A to F. Unless you were using the tape-recorder input, one had to load a program by laboriously keying in machine code. To write one's own programs it was essential to master the machine code of its MPU, the National SC/MP 8060.

. . . In Machine Code . . .

Nowadays such systems are mainly used for industrial control applications and for development of programs to run on other such systems. Most people prefer to be able to instruct the MPU by using a higher level language, such as BASIC, and to receive its output in graphical form on a monitor screen.

At the input and output to the MPU, only machine code can be used. Since it is directly understandable by the MPU, a machine code program runs faster than one in a higher level language; it also takes up less storage space in memory. The monitor program stored in ROM (see next month's article) is in machine code. It is common for complex and lengthy software to be in code, simply to make it possible to cram it in RAM. An example is the SCRIPSIT word-processing program which is being used in preparing this article.

As an example of the MPU as a general purpose logic chip, we'll consider one operation. The logical operation called AND can be summarized like this:

INPUTS A	INPUTS B	OUTPUT Z
0	0	0
0	1	0
1	0	0
1	1	1

Output Z is 1 if (and only if) both input A *and* input B are 1, otherwise Z is 0. Many readers will be familiar with the TTL or CMOS logic gates which perform this operation for two (or more) inputs. The 74LS08 has four two-input AND gates; the CD4081 is its CMOS equivalent. When the Z80 CPU receives the instruction 29H, its logic circuits in the arithmetic logic unit (ALU, see last month) are configured as eight two-input AND gates. Each gate deals with one bit. The eight bits and ANDed simultaneously; if the accumulator holds

0010 1101

And the next byte on the data bus is

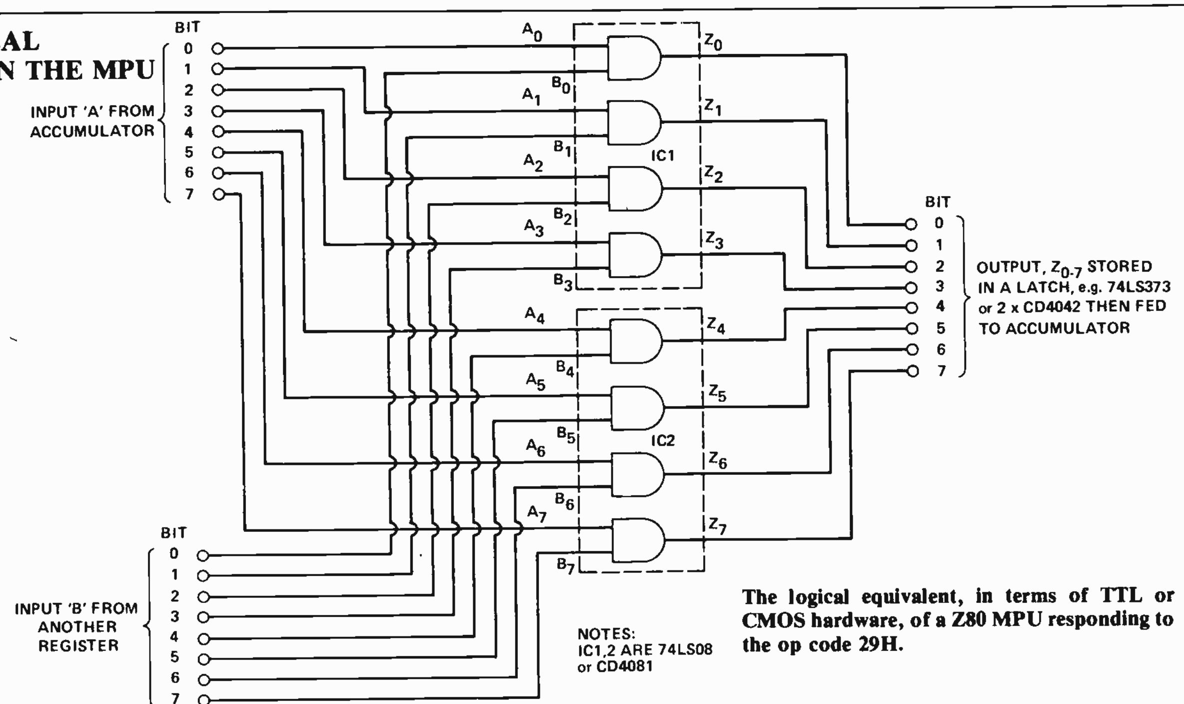
1011 0100

then the result of ANDing the corresponding bits is

0010 0100

This result then replaces the value previously held in the accumulator.

LOGICAL OPERATIONS IN THE MPU



The logical equivalent, in terms of TTL or CMOS hardware, of a Z80 MPU responding to the op code 29H.

Continued on page 70

Digital Dice

A type of random number generator which duplicates the idea of tossing dice. Well, a die, really, but you can build two of them.

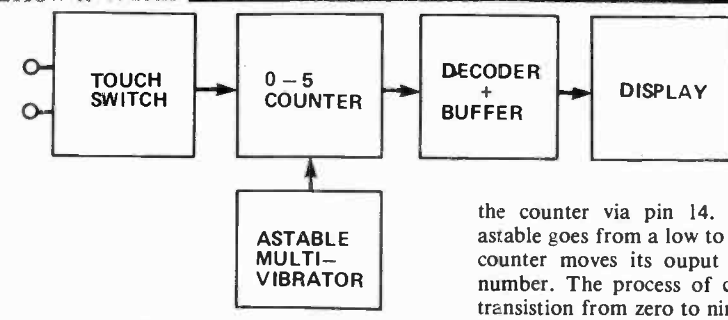
THE DIGITAL DICE project is, as its title suggests, an electronic replacement for those spotted cube-shaped things. However, instead of being thrown around, ours is operated by touching two screws mounted on the top about 3mm apart. The resulting display of red dots show a number from one to six with an equal chance of any number 'turning up' — or, in this case, of turning on!

Construction

The Dice is designed for ease of construction and reliability. The PCB contains only three ICs, all of which are CMOS and must be handled with care (if at all!). Use sockets and an insertion tool to mount them, or, failing this, make sure you never touch the pins with your fingers.

All the off-board connections are made using PCB pins, following the overlay (Fig. 2) very closely (note that IC2 is placed upside-down in relation to the others), and remember to check the polarity of the diodes. A nice touch is to mount the resistors with the tolerance

How it Works



Like nearly all electronic circuits, this one may be understood if it is broken down into small blocks. This is called 'partitioning' and it is a technique used, for example, by engineers to test circuits bit by bit. From the block diagram it can be seen that there are five distinct blocks in the Digital Dice project.

The touch switch tells the counter when to count. It consists of only three parts; a resistor and two gates that are part of IC1, the inverter IC. One gate is kept at nine volts (high) by R1 and therefore its output is at zero volts (low) — it has been inverted. Placing a finger on the touch contacts causes the inverter to switch over because the resistance of 2 or 3 mm of skin is on average, much lower than R1 (10M). Therefore, IC1a input is taken low and its output goes high. The second inverter flips the signal back over; to allow the counter to be switched on — it needs zero volts at its 'enable' input (pin 13) to begin counting.

The astable multivibrator, IC1c, d, supplies a very fast switching waveform to the counter via pin 14. Every time the astable goes from a low to a high state, the counter moves its ouput on to the next number. The process of changing on the transistion from zero to nine volts is called 'positive going edge triggering'. The gates of the astable are connected in series via R2 and C1 — the timing components. The time taken for one complete cycle is given by the product of the timing components, which is around 10 uS and corresponds to a clock frequency of about 100 kHz, ensuring the numbers change too quickly to be predictable.

IC2 has the job of counting sequentially from zero to five, which is the same as counting from one to six. At each positive going edge from the astable, one of the counter outputs goes high. Once the fifth output has been triggered, the count instantly returns to zero due to output six (pin 5) being connected to the reset input, pin 15.

The decoder and buffer circuit, on the outputs of IC2, ensure the correct LED's are lit. Buffers precede each of the six outputs to prevent loading effects on the counter by the LEDs. The decoding circuit can be understood with the aid of a 'truth table' (Fig. 4).

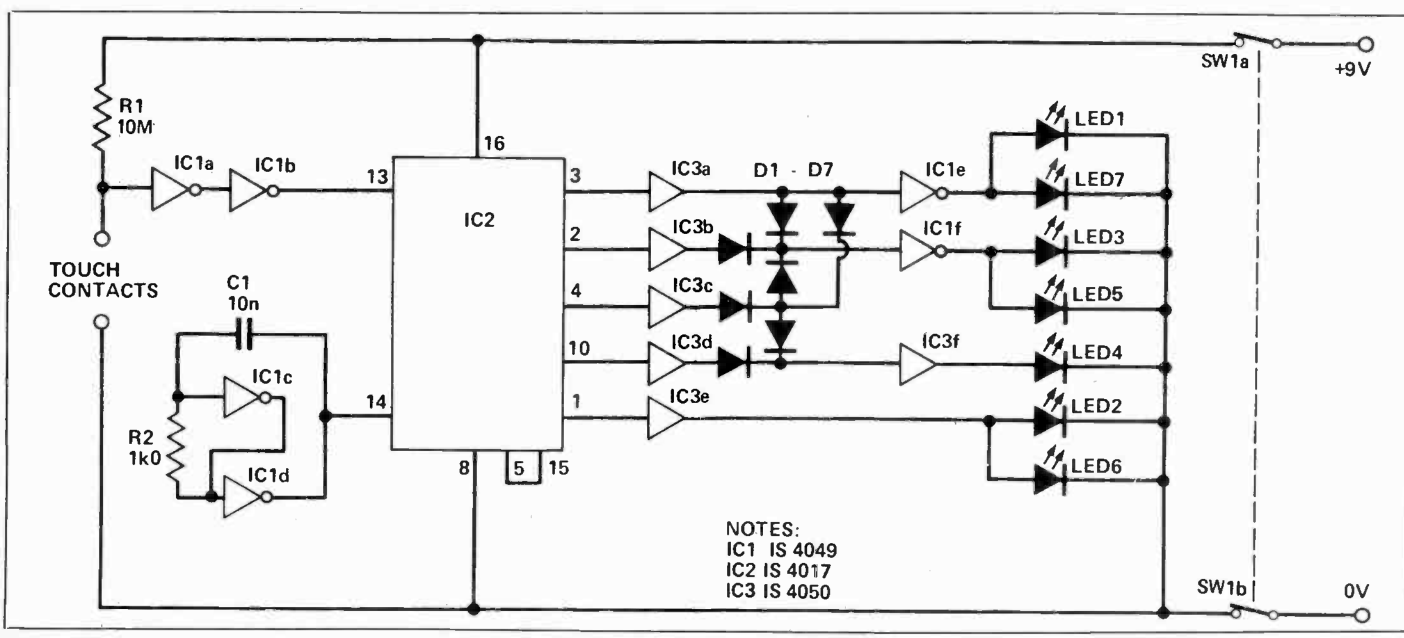


Fig. 1 The circuit uses only thre ICs.

band (gold, 5%; silver, 10%) at the bottom end; this looks neat and makes the values easier to read. The PCB slots neatly into the recommended box, eliminating the need for fixing bolts.

The box should be drilled and assembled before soldering any wires to the board. Fit the LEDs to the lid first, following the layout in Fig. 3. A tip for locating the holes is to use a piece of stripboard as a guide through which a pin is inserted to mark their positions. The holes can then be drilled using a 3 mm drill and the LEDs glued into place with epoxy. The leads from the LEDs should be cropped to a reasonable length for soldering and wired up as shown in Fig. 3. Links on the PCB must be made using insulated wire, to avoid any chance of short circuits occurring. Our prototype used a special square switch, but any small slide switch may be substituted.

When all the wiring has been checked, the battery can be connected and the unit switched on . . . and you're ready for a tumble!

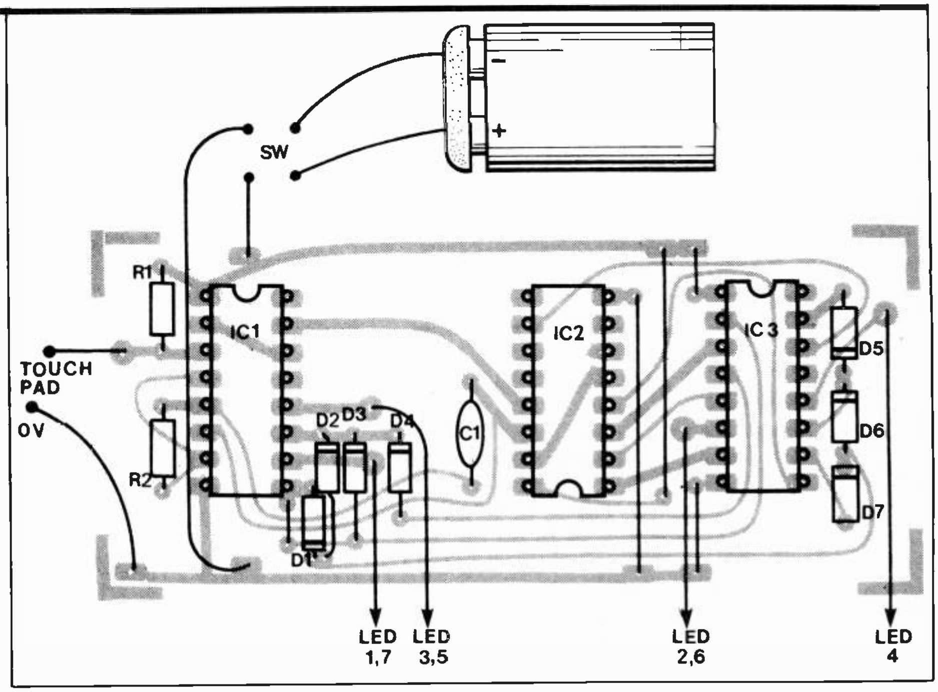


Fig. 2 The component overlay; note that IC2 is reversed, relative to IC's 1 and 3.

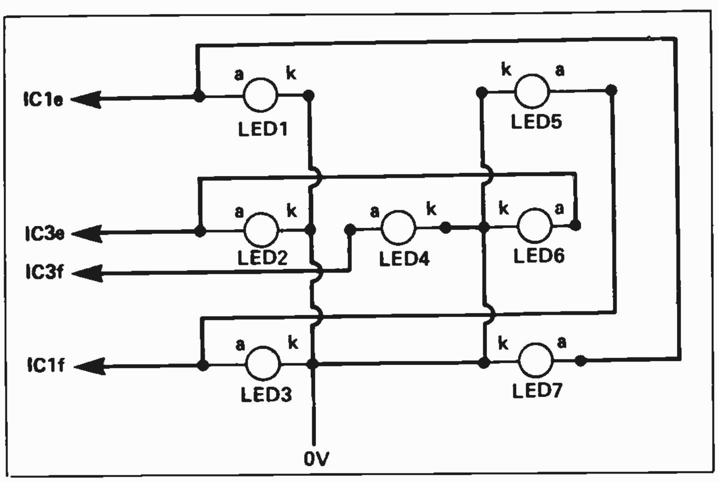
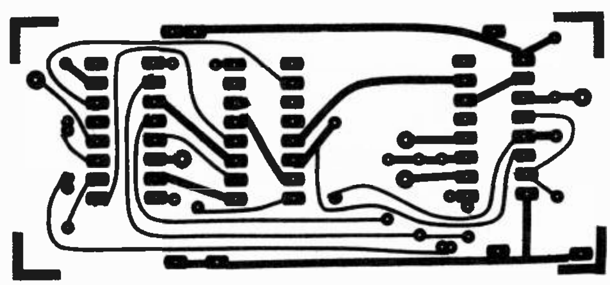


Fig. 3 Connection diagram for the LED's



COUNT	IC2 OUTPUTS PIN 3 "0"	PIN 2 "1"	PIN 4 "2"	PIN 10 "4"	PIN 1 "5"	LEDs 1,7	2,6	3,5	4	DISPLAY
0	+9V	0	0	0	0	–	–	–	ON	
1	0	+9V	0	0	0	ON	–	–	–	
2	0	0	+9V	0	0	ON	–	–	ON	
3	0	0	0	0	0	ON	–	ON	–	
4	0	0	0	+9V	0	ON	–	ON	ON	
5	0	0	0	0	+9V	ON	ON	ON	–	

Fig. 4 Truth table showing how the counter outputs are decoded. For example, if Pin 3, "0", is high (+9V) then all other outputs will be low (0V). Therefore: IC3a output is high, IC1e out is low and LEDs 1 and 7 are off; Pin 2 is low so IC3b output is low and its diode does not conduct — but the high on IC3a output is coupled via a diode to the input of IC1f, therefore IC1f out is low and the LEDs 3,5 are off; Pin 4 is low so IC3c out is low and its diode if off (there is high on the cathode of the diode but this only reinforces the high on IC1f input); Pin 10 is low, IC3d out is low and its diode is off, but there is a high on IC3f input coupled, via the diodes, from IC3a, therefore IC3f output is high and LED 4 is turned ON; finally, Pin 1 is low, IC3d is low, LEDs 2 and 6 are off. Any other count can be decoded in a similar fashion.

Parts List

Resistors (all ¼ W, 10%)
R1 10M
R2 1k

Capacitors
C1 10n polyester

Semiconductors
D1-7 1N4148 or 1N914
IC1 CD4049B
IC2 CD4017B
IC3 CD4050B

Miscellaneous
SW1 DPDT slide switch
Case, 9V battery and clips, nuts, bolts, etc.

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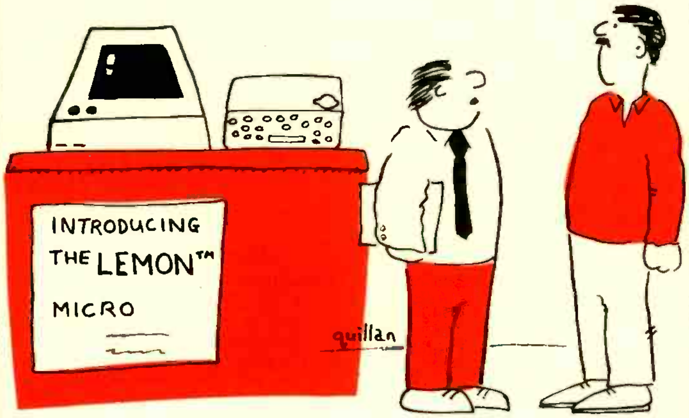

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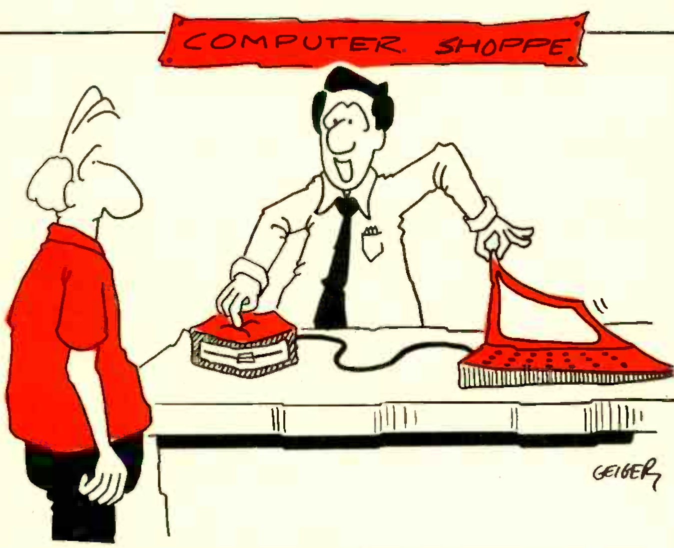

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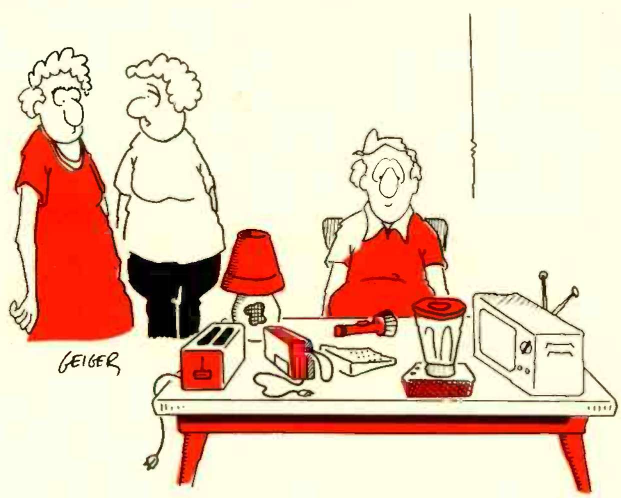

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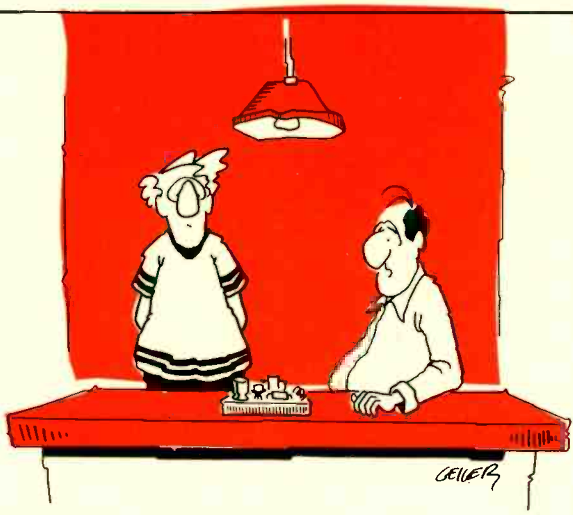

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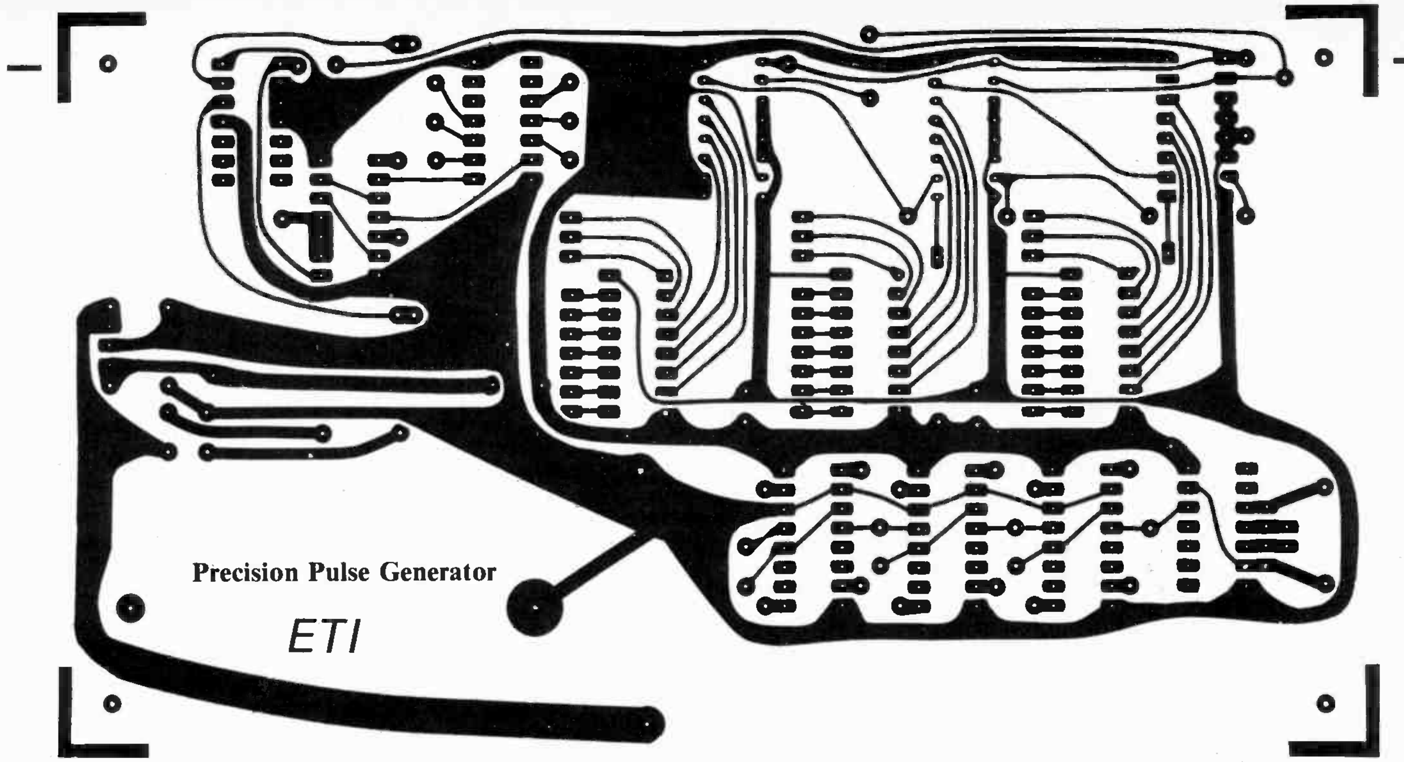

Designing Micros *Continued from page 64*

Many games programs such as adventure games and the several versions of chess are in code. Great complexity can be packed into a reasonable amount of memory and they do not take long to respond to the player's commands. Many utility programs (eg, renumbering programs) are written in code, because although they are short and simple, they must be made as compact as possible in order to leave plenty of vacant space in memory for programs on which they are to operate.

. . . With An Interpreter . . .

One factor in the rise in popularity of the microcomputer is the ease with which people unskilled in (or even totally ignorant of!) machine code are nevertheless able to program the MPU and make it do their bidding. This involves the use of a high-level language, the most popular of which is BASIC. When a BASIC program line is typed in, it is stored in memory. To save space, the words are usually coded so that each word or variable requires only one byte; the handbook usually lists the system of coding used. This gives yet another possible interpretation of a byte on the data line. For example, in the ZX81, the code FBH may be interpreted as:

- An op code — enable interrupts
- A value — equivalent to 251 in decimal
- A code for the BASIC command 'CLS' (clear screen)

The code is interpreted according to context, which includes the mode in which the computer is operating at that time.

Once a BASIC program has been loaded and the RUN command given, the MPU reads the program from memory one byte at a time. It cannot operate directly on the bytes as it reads them. If the byte is FBH, for example, there is no way in which the MPU can directly clear the screen. At this stage the MPU is under the control of a special program called a BASIC *interpreter*. The interpreter contains the complete set of machine code instructions for the operation of clearing the screen. When FBH has been read, the MPU goes back to the interpreter program to find out what to do and how to do it.

Although the MPU is working just as fast as ever, it has to go back to the interpreter program at every step in order to find out what to do. This is why a program takes so much longer to run when it is written using a BASIC interpreter. The interpreting is done line by line and, moreover, has to be repeated every time the program is run.

. . . Or By More Basic Means

A faster method is to use a BASIC *compiler* program. Once the program has been written, the compiler goes through it and converts it into machine code. This is done once and for all, after which only the machine code program is used. The difficulty with this approach is that the program must be recompiled if even a small change is to be made. For this reason most people prefer to put up with the slowness of an interpreter.

Many microcomputers have the BASIC interpreter already stored in ROM, so that it is available as soon as the micro is switched on. Other micros have no resident language program. If you want to use a high level language, you have to load the interpreter or compiler program into RAM before you are able to enter your own programs in the high level language.

Those who prefer, or are forced for various reasons, to program in machine code can make use of yet another type of program called an *assembler*. Instructions to the MPU are typed out in a symbolic form, consisting mainly of abbreviations of the operations which are to be performed. These abbreviations are generally known as *mnemonics*, which means 'to help the memory'. For example, 'decrement register H' is written as 'DEC H'. When the assembler is run, the op code 25H is assembled into the machine code program. The assembler can convert decimal numbers to hexadecimal, removing a constant source of headaches for the programmer, and can calculate the hexadecimal values required in jumping from one part of memory to another. Provided it is well written, an assembler can be of great assistance, yet it is not too far removed from machine code. The programmer is dealing with particular registers within the MPU and specifying each step of operation of the MPU. If it is not well written (and some assemblers are not), then one might just as well learn the commonly-used op codes, have a table of op codes handy, and work out the hexadecimal values on a scrap of paper. Once you have gained a little insight into its peculiarities, there is really nothing quite as satisfying as talking directly to your MPU in its own language! ETI

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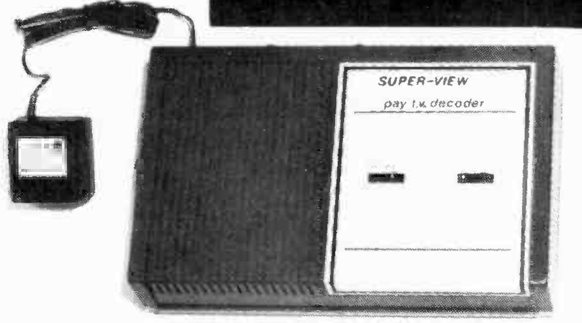

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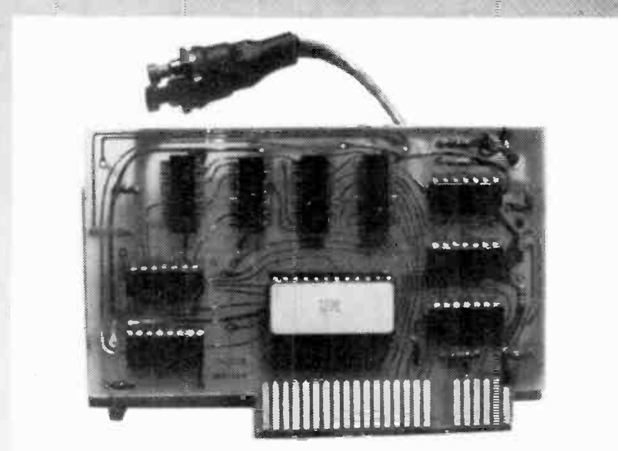

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Tech Tips Special

Continued from page 32

Digital Audio Switch

J.W. Harris

The circuit uses a CMOS 555 which oscillates at a frequency determined by the equation:

$$F = \frac{1.46}{C1(R1 + R2)}$$

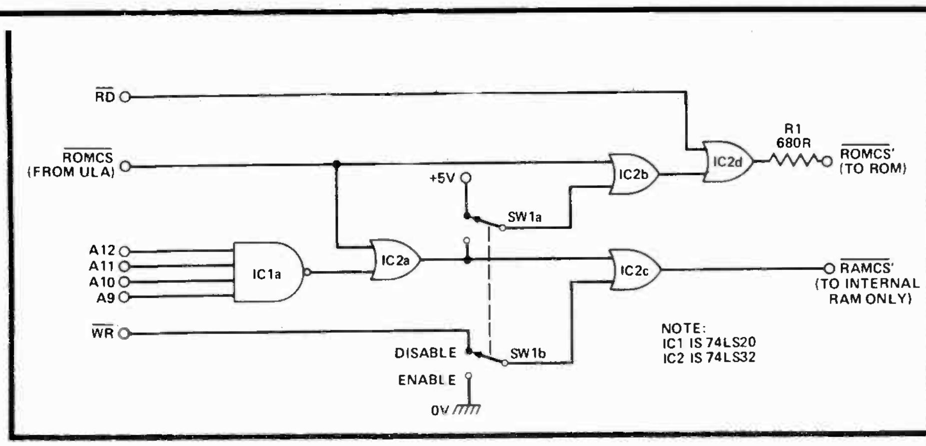
The output from IC1 is decoded by IC2, a decade counter divider, which is activated by PB1. When PB1 is pressed, IC2 produces a positive voltage at one of its four outputs, each of which controls two of the eight switches in ICs 3 and 4, and an LED circuit.

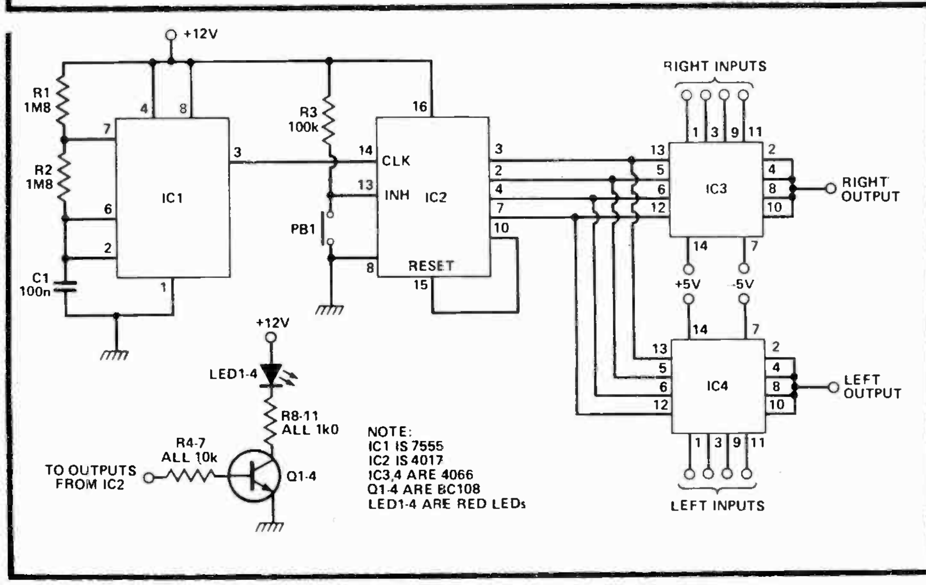
When a switch control goes high, the corresponding audio input is selected and an LED lights to indicate which input has been selected.

Output 5 on IC2 is connected to RESET so when pin 10 of IC2 goes high, the decoder resets and the next pulse from IC1 selects input A.

The chosen values for R1, R2, and C1 produce a frequency of 4 Hz, so IC2 selects each audio input and then resets in 1 second. If PB1 is kept pressed, the input will change every quarter of a second.

ICs 1 and 2 are powered from +12 V, and ICs 3 and 4 are powered from +5 V and -5 V.



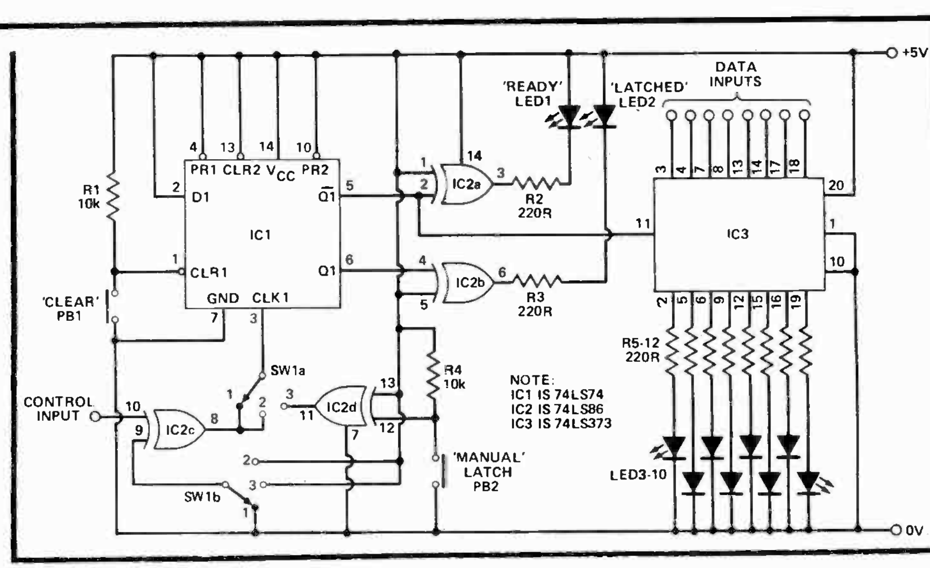


Logic State Analyser

L.V. Barker

When testing a logic circuit it is sometimes necessary to know the simultaneous state of several nodes. A logic probe or oscilloscope will not easily tell this and the best solution is usually a logic analyser. These are, unfortunately, rather expensive; a solution presented here is a logic state analyser. This is an eight bit latch controlled by an input from the circuit under test and easily expandable to more input lines.

The heart of the circuit is the 74LS373, IC3: an eight bit latch. It is controlled by pin 11; when this pin is high (logic 1), the output data is equal to the input data; but when it is taken low, the device latches the data then on the input pins, thereby remembering it. In this application, the input pins are connected to the circuit under test and the outputs drive light emitting diodes LED3-10.



IC1 is a D-type flip flop used to control IC3. In its reset state, achieved by pressing PB1, $\overline{Q1}$ is at logic 1 as is IC3 pin 11. The LEDs now follow the input data. When a rising edge appears on IC1 pine 3, $\overline{Q1}$ goes to logic 0 causing the data on the input pins to be latched. It stays in this condition until PB1 is pressed. LED1 and LED2 give readouts on the state of IC1.

IC2 is a quad exclusive-OR gate; IC2c is used as either a buffer or as an inverter depending on the position of SW1. Three triggering modes exist. These are:

1) SW1 in position 1: latch on rising edge on control input

2) SW1 in position 2: latch on falling edge on control input

3) SW1 in position 3: latch when PB2 is pressed

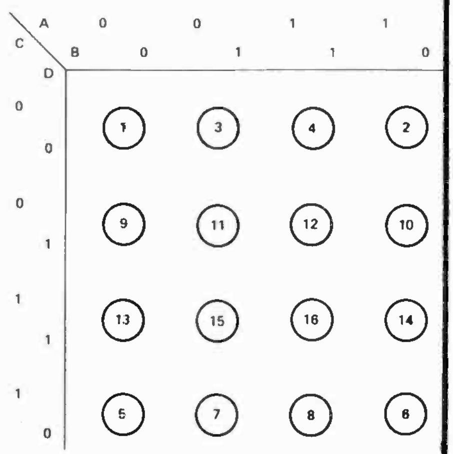
To increase the number of channels, more 74LS373 devices can be connected, with the pin 11 of each connected to pin 6 of IC1. The prototype used five devices giving 40 channels of input.

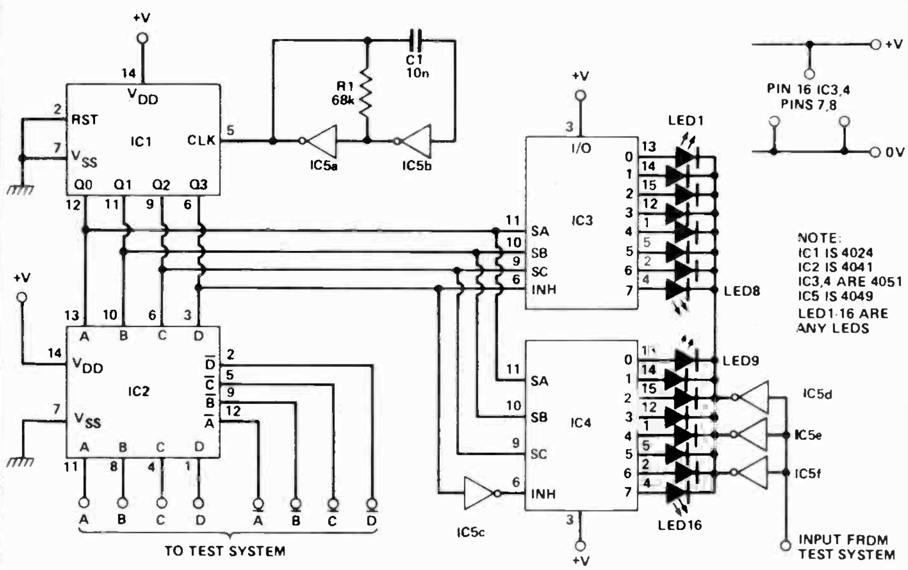
Tech Tips Special

Karnaugh Map Display
K.J. Beeden

The Karnaugh map is a common way of representing the function of a four-input logic system. It is often taught in schools and colleges, when students are given a logic system and have to draw the Karnaugh map for it. This device allows the student to go away and test their map with the actual map generated by this device and a wired-up system on a breadboard.

IC5a and b form an astable, which clocks the 4-bit binary counter IC1. The outputs of this are fed into the quad true/complements buffer, IC2, providing buffered true and inverted outputs to the system under test. The counter outputs





are also used to decode the display — the three LSBs are used as select lines for the eight-way analogue switches, IC3 and 4, and the MSB is used to select the chip by connecting the true value to INH IC3 and the inverted (by IC5c) value into INH IC4.

The output of the system is connected to the input of IC5d,e,f. Thus if the output of the system is high for a given 4-bit number, then the output of IC5d, etc., will be low, and so current will flow from the +ve supply, via the selected analogue switch (resistance of which is conveniently about 160R) through the appropriate LED. If the output of the system is low, then the output of IC5d, etc., will be high, and so no current will flow.

This means that an illuminated LED represents a "1" from the system, and an unlit LED a "0".

Figure 2 shows the arrangements of LED's 1-16 required to obtain the desired Karnaugh map display.

Improving Crossover Performance (Zobel network)
J.P. Macauley

When designing crossover networks, problems are encountered due to the reactive nature of the speakers. This problem can cause ringing, and more importantly the roll-offs will not occur at the frequency that the normal design calculations would indicate. It is pointless to design a crossover on the assumption that the impedance remains at a constant value throughout the operating range.

In fact a moving coil speaker looks like an inductance and a resistance in series. Because of the inductance the impedance of the speaker increases with frequency. It is not unusual to find that the impedance presented by a nominally 8 ohm speaker is nearer 15 ohms at 3 kHz.

This problem can be overcome by shunting the speakers in the proposed system with a series resistor-capacitor combination. If the values of these components are correctly chosen, the speaker will look like a nearly pure resistive load to the crossover. Obviously this ensures that the latter rolls the response of the speakers on and off at the calculated frequencies without problems.

The circuit is shown in Fig. 1, and the component values are determined as follows. Feed the speakers with a sine wave at the desired crossover frequency via a 100R resistor (see Fig. 2). Measure the output voltage at the output of the generator (V_1) and the voltage across the speaker terminals (V_2). The impedance of the speaker Z can now be determined by the equation: $Z = \frac{100 \times V_2}{V_1 - V_2}$

The DC resistance is now measured across the speaker terminals and R is made equal to this. C can now be determined from the equation: $C = \frac{Z - R}{2\pi f R^2}$ where f is the crossover frequency in Hertz and C is given in Farads. The speaker and network now present a resistive load equal to R and the crossover can safely be calculated on this assumption.

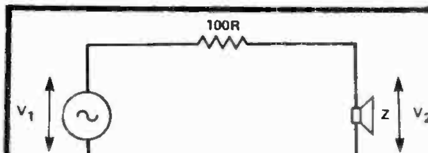


Fig. 1.

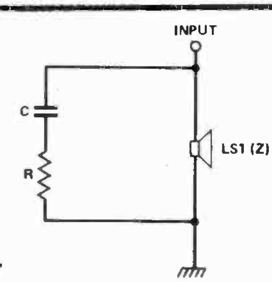
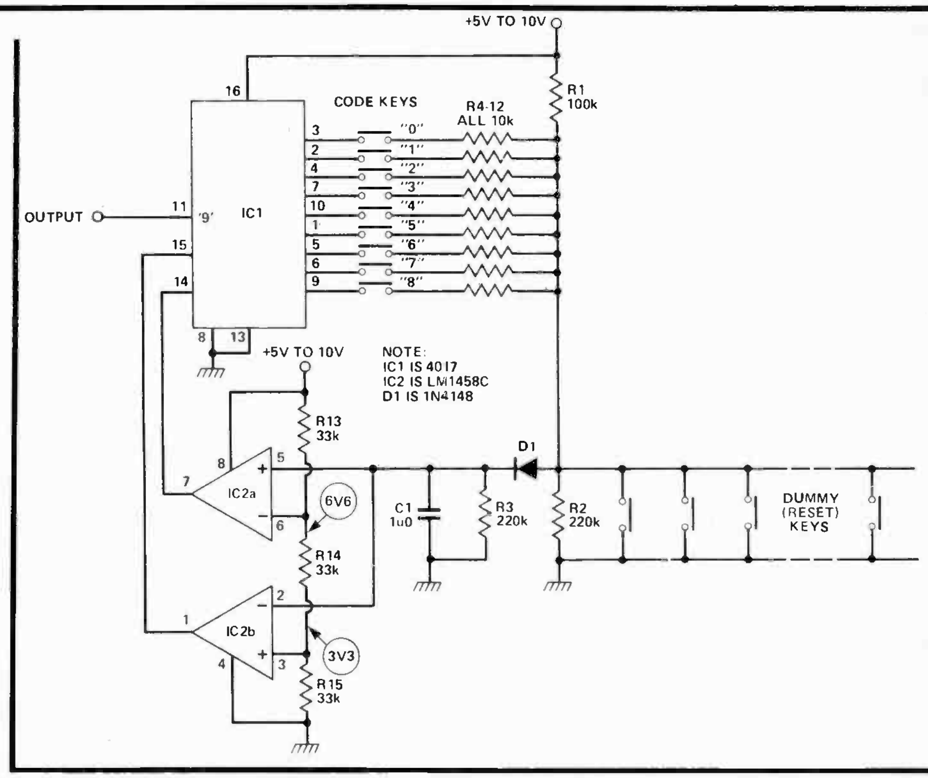


Fig. 2.

Tech Tips Special



Foolproof Combination Lock

Ben S. Meyer

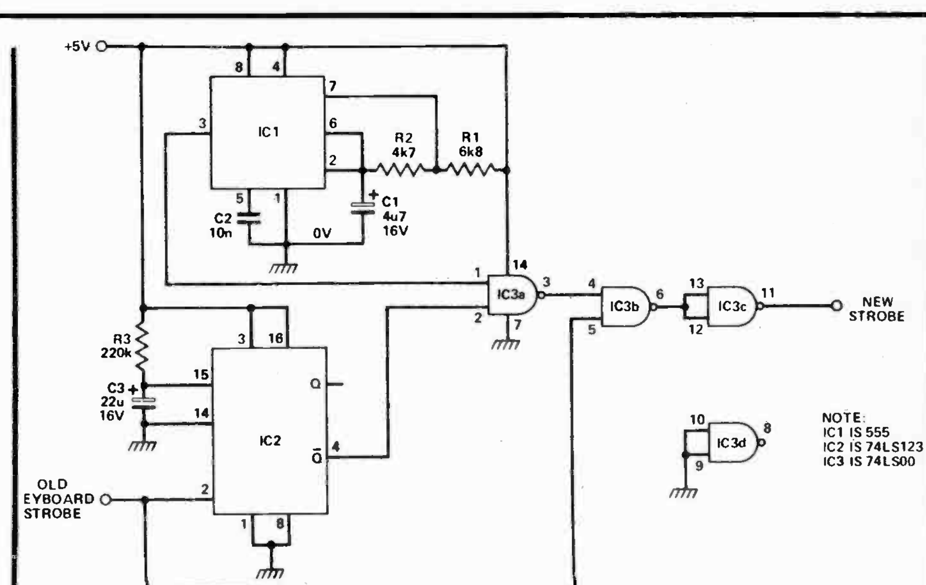
This lock really is foolproof, as all the keys except the correct one will cause a reset. The problem with other types of locks is that only the dummy keys will cause a reset. All voltages given are for a 10 V supply.

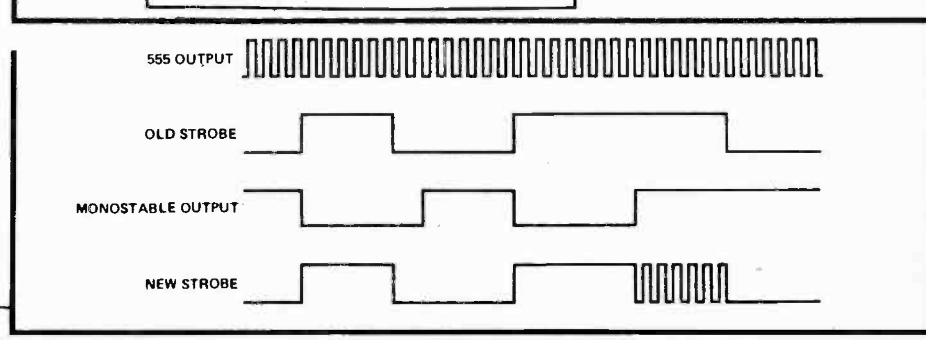
A power-on reset is provided by C1. When reset, pin 3 of IC1 is at 10 V. When code key '0' is pressed, the voltage across C1 rises to above 8 V. This triggers IC2a whose output clocks IC1. This causes pin 3 to return to 0 V, and pin 2 goes high. Pressing the other keys repeats this action until pin 11 goes high.

Pressing a dummy key will cause the voltage across R2 to fall to zero, while pressing a code key out of order will cause a drop to 1 V. C1 discharges via R3 and as soon as the voltage pin 2 falls below the 3V3 reference, IC1 is reset by a high at pin 15.

All the output pins except the one currently switched high by the count are held at ground by IC1. This causes a problem, as it would be impossible to advance the counter since the respective switch would be grounded before it could be released and so reset the count to zero. C1 holds the charge on it during clocking, long enough for the key to be released. The diode prevents any discharge through R2. R3 discharges C1 and provides a bias path for the diode. The value of the capacitor can be altered to suit your needs, but R3 is a part of the voltage divider R1,2,3 and its value cannot be changed.

R4-12 are current limiters which prevent damage to IC1 if more than one key is pressed. To reset the system after the output has been enabled, just press any key.





Keyboard Auto-Repeat Circuit

G. Franklin

This circuit is intended for use with keyboards that do not have a 'repeat' facility. It is not only simple to install, but gives the user the repeat facility on every key on the keyboard.

Basically, the strobe line from the keyboard activates the monostable (IC2); this disables the output of the 555 and prevents its pulses reading the new strobe line. After approximately 3 seconds, the output of IC2 changes state and the signal from the 555 is passed on to the new strobe line. If the key is released before the monostable finished its timing period, only one character will be sent. For a key press of longer than 3 seconds, approximately 10 characters per second will be entered (the frequency being set by 555, used in its astable mode). The circuit is shown for use with a positive-going strobe signal: for a negative strobe, simply move the last NAND gate (used as an inverter) to the input strobe line.

Connecting the circuit into your computer requires the removal of the current strobe line from your keyboard and rerouting it through the circuit.

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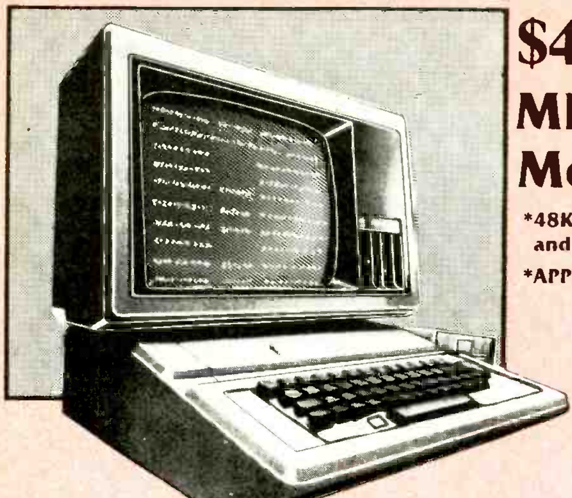

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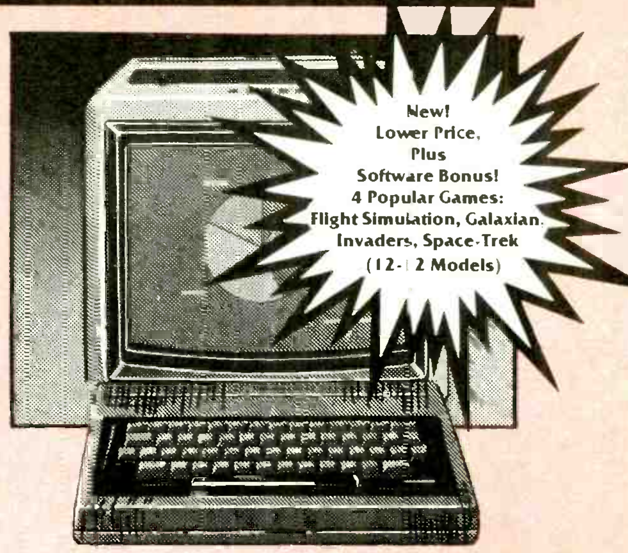

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