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For Your Information

The Editor's Corner

By Bill Markwick

A POTPOURRI, a commentary, a grab bag of musings: one night last week I noticed that my clothes dryer had been running for an unusual length of time. I checked it and found that the timer had jammed and really cooked the old socks.

I took the timer apart and discovered that the gears appeared to have been stamped out of a tin can, like the motors in flywheel-drive toys before they got crazy into batteries. The thin, tiny gears had stripped the teeth off the pinion gear on the timer motor after ten years of use.

Now, if I had phoned the manufacturers and complained, I'm sure they would have said "Ten years? You're complaining after *ten years* of use?"

Well, yes, I'm complaining after ten years of use. After all, I'm still using some appliances that belonged to my parents and were purchased in the 50s, back when makers weren't just concerned about getting the product past the warranty date. I have woodworking and metalworking tools from my father and grandfather. For heaven's sake, I own and use planes and chisels from the nineteenth century.

This present attitude of throwaway products and it's-good-enough manufacturing is a crying shame. The manufacturers tell us that cost factors and production rates prevent building things the old way, and the advertising agencies convince us that hi-tech and computer control is giving us the very best of everything. Don't believe it. Our grandparents got by, and they had some fine possessions to leave us.

I'm not saying that there weren't some turkeys from the past; it's just that we're ignoring too much of the good stuff.

Did you ever send in a Reader Service Card and get no reply from some companies? Occasionally I write to various large corporations to see if their product would be suitable for a project in *ET*, and nothing happens. You can only blame so much on the mail, and I think that some outfits forget about us because we're not huge multinationals ready to order a million units.

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Of course, in all fairness, some companies have gone to no end of trouble just to get us a five-cent part.

Software: the desktop micro is now a standard feature in offices, common enough that you'd expect software writers to have got the hang of it by now. Yet there are still programs with cumbersome structures and far too much typing. I've never quite come to terms with DBase II or DBase III, the popular database. Its commands seem to be trying to emulate some sort of conversational style: "Set Default to B:", for instance, instead of plain old "B:".

Micros aren't big enough or intelligent enough to emulate a conversational tone, as you've probably discovered if you've played those adventure games where you answer questions:

"What do you want me to do?"
"Go out the door."
"I don't understand."
"Go to the left."
"You can't go that way."
"What way can I go?"

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Circle No. 5 on Reader Service Card

Oops! The circuit diagram of the Precision Power Supply from our October 1986 issue (page 34) neglects to show the values and locations of R3 and RV2. They are as follows:

R3 is located just to the right of R2 and has a value of 15k ohms. RV2 is located directly below R3 and has a value of 5k ohms.

Our sincere apologies for any inconvenience this may have caused.

Continued on page 60

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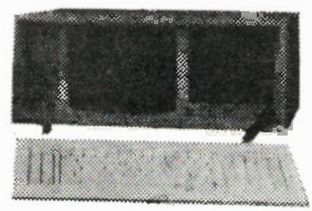

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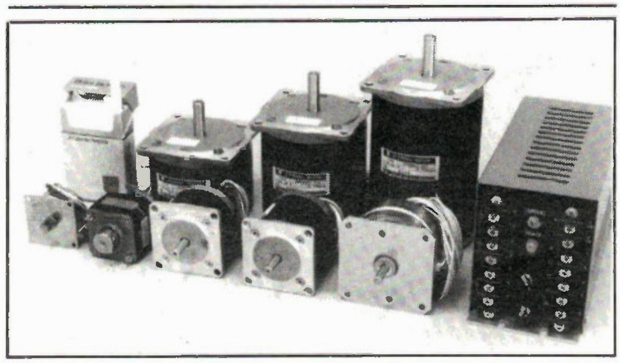

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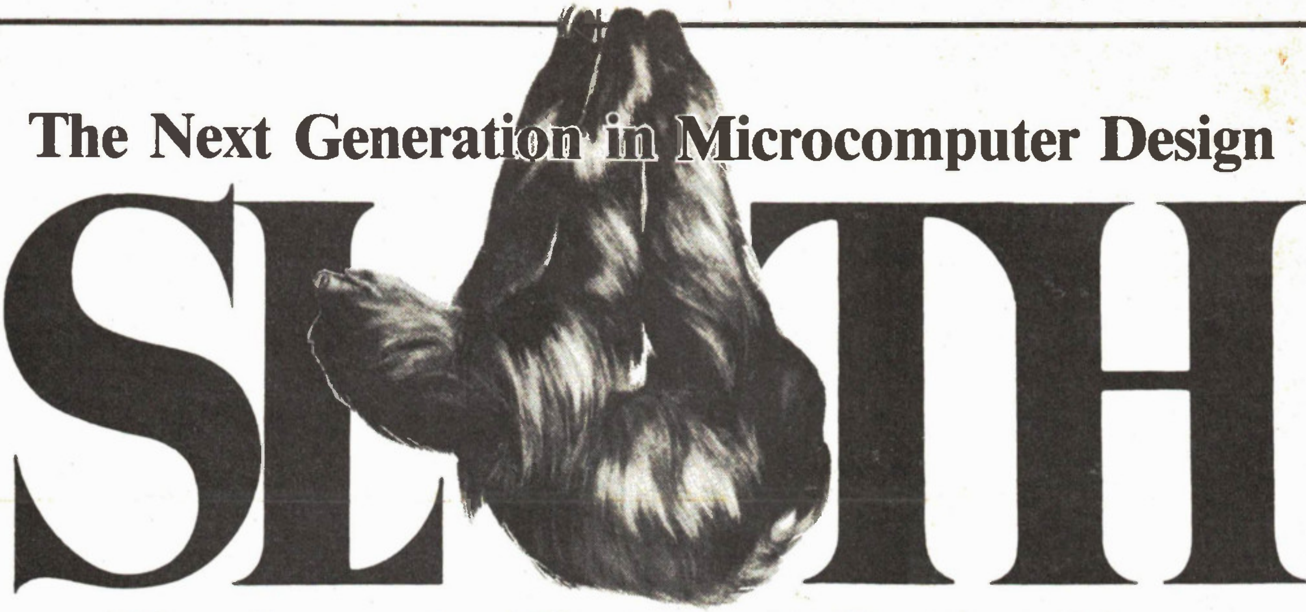
Circle No. 10 on Reader Service Card

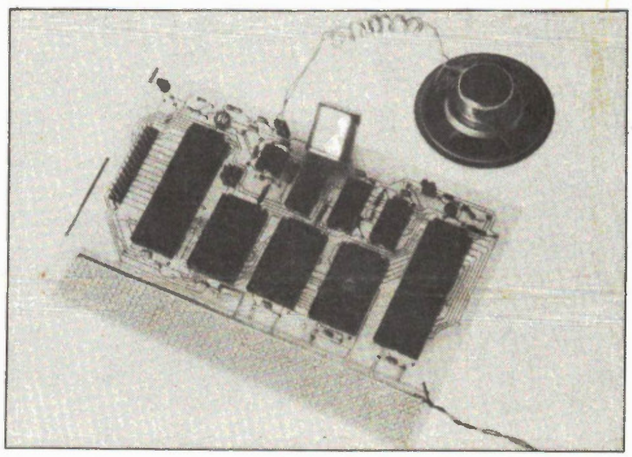
The Next Generation in Microcomputer Design



The Computer That Can't Do Anything

Computers can do a lot more than just manage data bases and play video games. Specialized microprocessor boards can be used as programmable frequency counters, intelligent temperature controllers, timers, monitors... dedicated microcomputers are at the heart of most of the sophisticated high tech toys that make our lives exciting and our bank balances so easily managed with just a few fingers.

Unfortunately, most individual humans don't get to work with small, board level micros. These things usually have to be custom designed, which is generally beyond the abilities and the means of most of us. This is unfortunate, as working with computer hardware at this level is fascinating... and can give one the power to create unspeakably sophisticated projects.



This is why we created the Sloth. The Sloth is a small Z80 based computer which is designed to be turned into things. It has no screen, keyboard, floppy disks or printer port... but it's easy to get parts for, quick to assemble and painless to program. It has powerful I/O facilities to allow you to interface it to anything you want to make it work with, from the remote control of a video recorder to the ignition of your car.

The Sloth isn't a trainer... it's designed to be built up into working projects. It's programmed with inexpensive 2716 EPROMs. It has twenty-four lines of I/O and three programmable counter timers to talk to the rest of the world with. Included on the main Sloth board are a speaker driver, two kilobytes of static RAM, a pulse source and jumpers to allow you to configure the system to do what you want it to do.

The basic Sloth also comes with a peripheral board to let one's program control a six digit LED display.

If you have a rudimentary knowledge of assembly language programming, a working soldering iron and a burning desire to get into the fast lane of computer technology, you should try the Sloth. The October 1986 edition of Computing Now! features an extensive look at the construction of the Sloth board and a sample program for it. Future issues will carry some basic Sloth applications... timers, controllers and other things that can be made with the Sloth. However, the low cost and flexibility of the Sloth will unquestionably give you countless ideas for projects of your own.

The Sloth package available from us includes a bare Sloth board... both the main processor board and the LED display board... a parts list, a complete schematic and parts overlay, a source listing for an exercise program and a set of article reprints to explain the system in painstaking detail. In addition to this you'll need the parts to stuff the board... which are widely available... and a computer capable of running an 8080 or Z80 assembler and burning the resultant code into 2716 EPROMs. We recommend an Apple compatible system running CP/M with a Multiflex PROM burner or a PC running Z80MU and a PC compatible EPROM programmer. Z80MU, a CP/M emulator for the PC, is available separately from our Almost Free Software service for $19.95.

The Sloth can be whatever you want it to be... it's the most interesting electronics project on the planet. The complete Sloth package is available for

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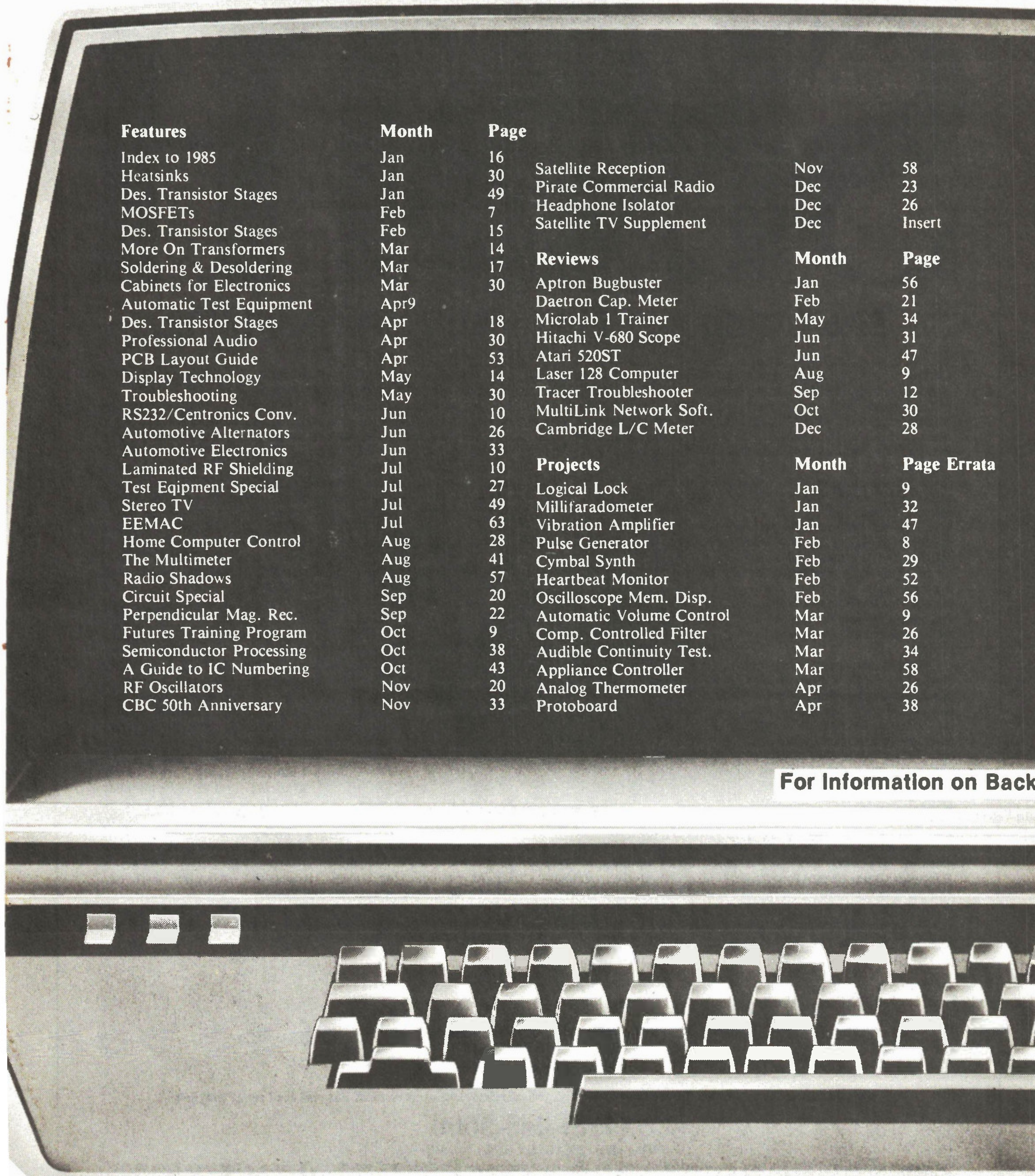

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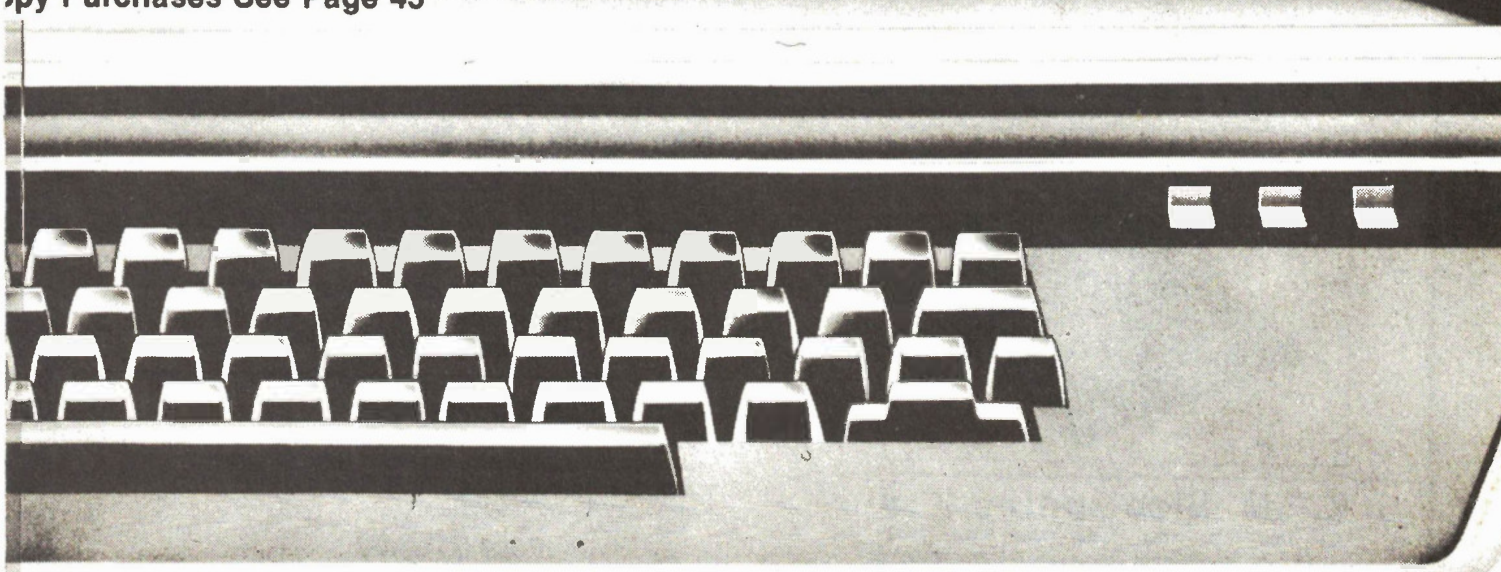

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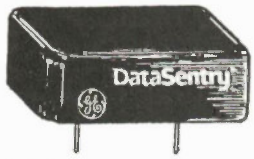

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MARKET PLACE

The Differential Amplifier

By Joe Pritchard

THE DIFFERENTIAL AMPLIFIER, the name is very descriptive; it is an amplifier that amplifies the difference in the voltage applied to its two inputs as shown in **Fig. 1**.

The circuit is therefore useful for detecting small changes in voltage that may be superimposed on a larger voltage that is common to both input terminals. Well, what's in this black box? In the past, it would have been a fairly messy arrangement involving several transistors. But today, with operational amplifiers, we can put a difference amplifier together with one chip and four resistors. **Fig. 2** shows the basic configuration for a differential amplifier.

The output voltage would ideally be related to the two input voltages by the relationship:

$$V_{out} = \frac{-R3}{R1} * (V_1 - V_2)$$

(where R1 = R2 and R3 = R4).

Note that I said ideally. However, reality takes over and there is a further parameter that describes the behaviour of a differential amplifier. This is called the common mode rejection ratio, or CMRR for short.

CMRR

From the above equation, it follows that V1 = 0V and V2 = 0.001, and V1 = 10.0V and V2 = 10.001V should both give the same output voltage. After all, the differences between each pair of voltages are the same, 0.001V. In a real amplifier, this isn't so. The two "common mode" voltages, 0V and 10V, are never totally ignored in difference amplifiers. The common mode voltage affects the output by different amounts for different amplifiers. This is partly caused by mismatches in the values of R1 and R2, and R3 and R4, but other causes include the manufacturing tolerances of the amplifier.

The better the amplifier, of course, the less effect the common mode voltages will have on the output. A measure of this is the CMRR, which measures how much the circuit "ignores" the common mode voltages. This is quoted in dB, the higher the figure the better the CMRR. CMRR varies with both the size of the common mode voltage and its frequency.

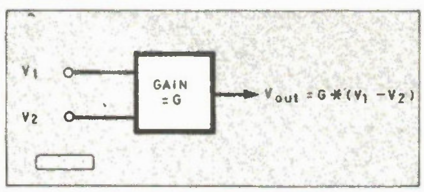


Fig. 1 Basis of the differential amplifier.

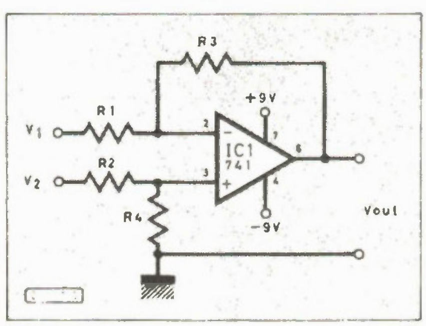


Fig. 2 Basic configuration.

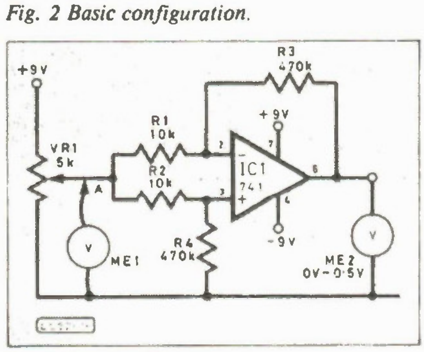


Fig. 3 Practical circuit.

Practical Demonstration

For a practical demonstration, try the circuit in **Fig. 3**. This allows us to measure the output voltage from a difference amplifier whose input terminals are at the same voltage. You will see that the effect on the output voltage is not very high, but it can be annoying in some situations. The gain of the circuit shown is 47. I measured output voltages of between 0.2 and 0.4 for different 741 op-amps in the same circuit.

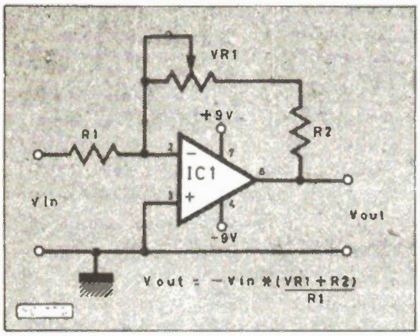


Fig. 4 Inverting amplifier with variable gain.

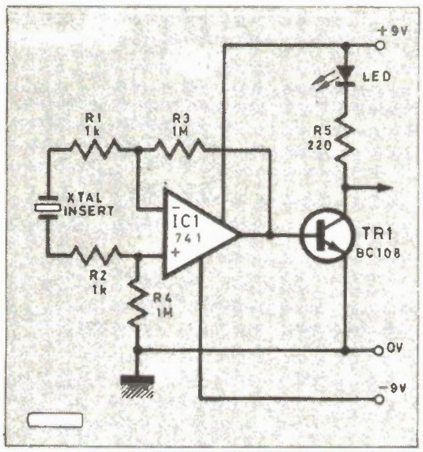


Fig. 5 Simple sound operated switch.

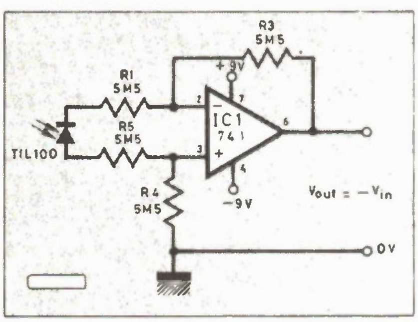


Fig. 6 Measuring photodiode voltage.

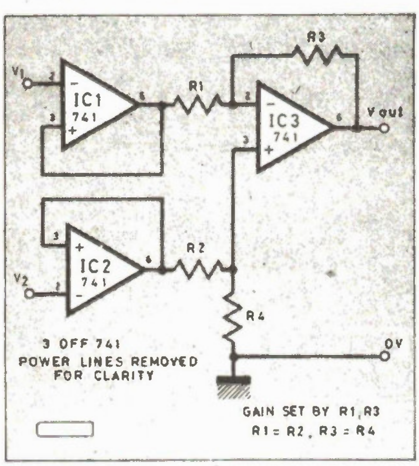


Fig. 7(a) Instrumentation amplifier.

The output voltage also increased with increasing input voltage.

A circuit such as this is useful in that it allows you to choose values of R1, R2, R3, and R4 that are accurately matched. The experiments that I carried out were done with five per cent tolerance resistors; for accurate work, 0.1 per cent devices are often used. The aim, of course, is for as low an output voltage as possible.

In some circuits, R4 often has a trimmer in series with it so that a fine adjustment of the CMRR of the amplifier as a whole can be made. The fact that good CMRR from such a circuit relies on R4 and R3 being closely matched in value means that the usual method of varying the gain of the op-amp based amplifier, altering the value of the feedback resistor between inverting input and output, cannot be used here. If it were, varying the gain would vary the CMRR of the circuit unless we also varied the value of R4. Not exactly convenient, so the usual trick is to make the differential amplifier with a fixed gain, and follow it with a conventional inverting amplifier with variable gain.

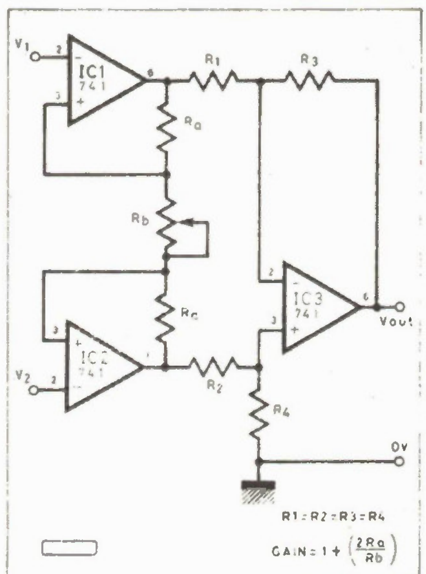


Fig. 7(b) Instrumentation amplifier with variable gain.

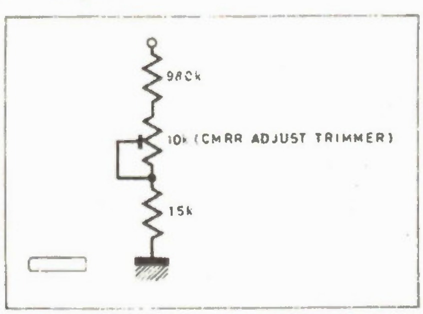


Fig. 8 Arrangement to replace R4 in Figs. 7(a) and (b).

Such a circuit is shown in **Fig. 4**. Here, the following relationship exists between input and output voltages.

$$V_{out} = -V_{in} * \frac{(VR1 + R2)}{R1}$$

In fact, in some situations, where a high CMRR is more important than gain, the differential amplifier is made with four resistors of the same value. This gives a gain of one, but is easier to match all the resistors from a single large batch. In this situation, an amplifier such as that in Fig. 4 might well provide all the gain.

As for actually selecting values for the resistors, select R1 and R2 so that they are higher than the impedance of the voltage sources providing the inputs. Once this has been done, R3 can be selected to set the gain, and R4 = R3. Having said that, though, R1 and R2 can be chosen to be as high as possible so as to provide a high input impedance for the amplifier. If you do this, then the chances are that the gain of the differential amplifier will not be all that high, as you will then have to find a correspondingly large pair of resistors for R3 and R4. However, further gain can be easily provided, as we've already seen.

As for a choice of operational amplifier, the 741 is as good as any for starting your experiments. One reason for this is that it's "well behaved"; high gain amplifiers of any type will occasionally "take off" into spontaneous oscillation. This is still possible with the 741 but less likely. If I get this problem, I often limit the gain of that particular amplifier to a level at which stability can be maintained. If you want to try other op-amps, the TL072 and the LM324 will do the job quite nicely.

Sound Operated Switch

A simple sound operated switch circuit is shown in **Fig. 5**. This will respond to claps, telephone ringing, etc. It is especially sensitive in the range of 3 - 4 kHz. The input device is a piezoelectric insert from Radio Shack, 273-069, which was originally intended to be an output "bleeper" driven by a 3 - 4 kHz square wave. However, when sound impinges on it a voltage is developed across its terminals, which we can then amplify. The input voltage is fairly large, so I haven't bothered with accurately matching the input impedance of the amplifier to that of the insert. Any sound will cause the LED to flicker, and the addition of a Schmitt Trigger device will allow a logic signal suitable for TTL or CMOS logic circuitry to be obtained.

The insert could be mounted at the end of a long run of cable, any AC hum being rejected by the CMRR of the amplifier.

One subtle point to note here is that the voltage must be identical in both input leads for it to be rejected. If you run the leads to the insert by different routes, then each lead will be subject to different amounts of AC interference which will cause different amounts of voltage to be induced in each lead. This will lead to some AC interference getting through. Therefore, the cables to the insert should follow the same route.

Photodiode Amplifier

There are a variety of devices, such as the photodiode, that are capable of producing a very small current. **Fig. 6** shows a circuit with a gain of 1 that allows the voltage produced by the photodiode to be measured on a meter. The voltage output depends upon the incident light, but will be in the 0 to 0.25V range.

Instrumentation Amplifier

We've already said that the input impedance of the differential amplifier should be higher than the impedance of the voltage source that is driving the inputs. So, if we want a general purpose differential amplifier, we should try and get as high an input impedance as possible. Such a circuit is often used in scientific instruments, and is often referred to as an instrumentation amplifier. **Fig.** 7 shows two possible arrangements of this circuit.

Of these two circuits, 7(b) is the best, offering variable gain and requiring no great matching of Ra and Rb. In these circuits, the CMRR of the amplifier is provided by IC1 and IC2. These two amplifiers also provide a very high input impedance, making the circuit useful with a variety of voltage sources. In each of these circuits, R4 can be replaced with an arrangement like that in **Fig. 8**. Assume that R4 is to be a 1M resistor. The trimmer allows the value of R4 to be varied between 995k and 1005k, thus allowing adjustment of the CMRR of the circuit.

The measurements made with instrumentation amplifiers are often in the low frequency part of the spectrum. For this reason, capacitors are often use to provide what is called "high frequency roll-off", which is a reduction in the gain of an amplifier with increasing frequency. **Fig. 9** shows a typical arrangement of capacitors to limit the high frequency response of the circuit. The values of C1, C2, C3 and C4 are chosen to suit the maximum frequency that the amplifier is designed to be used with. The value of these capacitors are especially valuable in limiting the response of instrumentation amplifiers to low frequency radio signals.

If you want an instrumentation amplifier with a very high input impedance, then FET operational amplifiers such as the TL072 can be used.

AC Differential Amplifier

It's possible that the signal of interest might be superimposed on a fixed difference of 100mV on top of which there is a 2 - 3mV AC signal that we're interested in. The simple way around this is to "block" the DC signal with capacitors; the circuit is given in **Fig. 10**.

The gain of such a circuit is now dependant upon the values of the input capacitor, input resistor and feedback resistor R3. At a given frequency, the input capacitor will have a certain impedance, or "AC resistance". Therefore the output of the circuit is related to the input voltage by the expression:

$$V_{out} = -V_{in} * \frac{R3}{R1 + (1/2*\pi*f*C1)}$$

where f is the frequency of operation. The gain of the amplifier will thus fluctuate with frequency, and the input capacitors can also be used to limit the frequency response of the amplifier.

If you experiment with these circuits, whether differential amplifiers or instrumentation amplifiers, then the following points may be useful to you.

Pointers

1. Choose a "well behaved" amplifier, such as the 741 when you start experimenting.
2. For accurate work, matched resistors are needed.
3. For high gain amplifiers, clean circuit boards are next to godliness! Don't leave soldering flux, pencil lines or finger prints around the wiring side of the PCB or Veroboard. Also, ensure good soldered connections. Any of these problems could lead to radical alterations in the gain of the amplifier.
4. There is no point in introducing hum into the circuit via the power lines if you've gone to the trouble of producing a circuit that has low CMRR. Batteries are thus preferable in situations with noisy AC supplies.
5. If batteries are used, take care when they run down. Low batteries can lead to rather mysterious problems, such as violent oscillation.
6. For AC differential amplifiers, the input capacitors should have matched values of capacitance, but remember that the tolerance of capacitors is often quite large.
7. **Fig. 11** shows the pinouts of some suitable op-amps for experimenting.

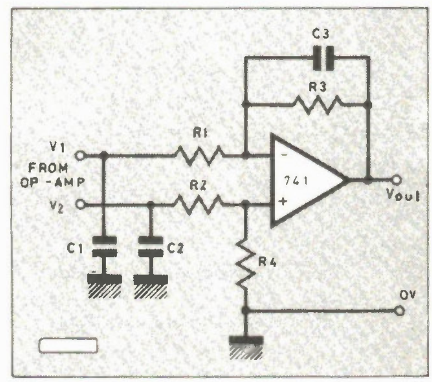


Fig. 9 Circuit with high frequency roll off.

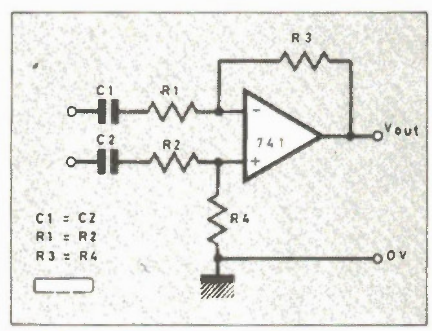


Fig. 10 D.C. blocking circuit.

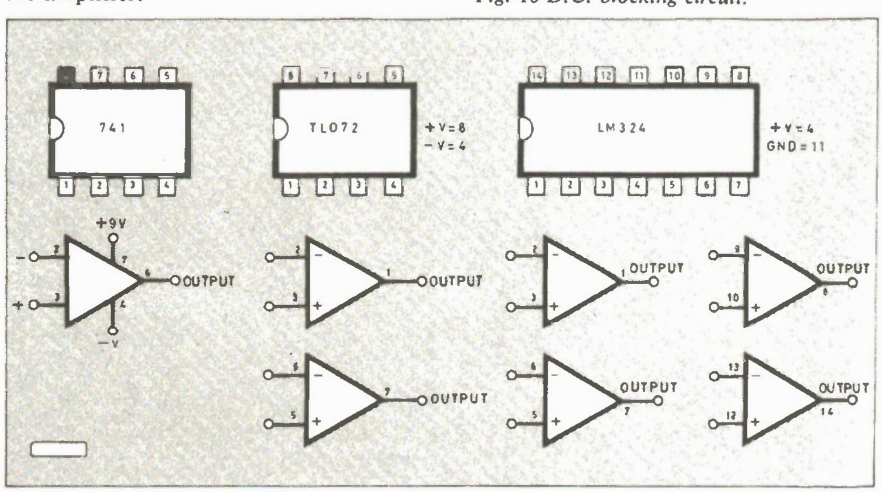


Fig. 11 Pin outs of some amplifiers suitable for experimenting.

Micro Tracer Unit

A useful piece of test gear for the constructor with a computer.

By John Becker

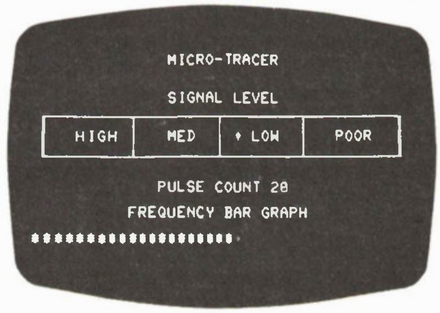
THE MICRO TRACER shows an interesting way in which a computer and two integrated circuits can be used as a signal injector and tracer. The software has been written for the C64 and PET series of computers.

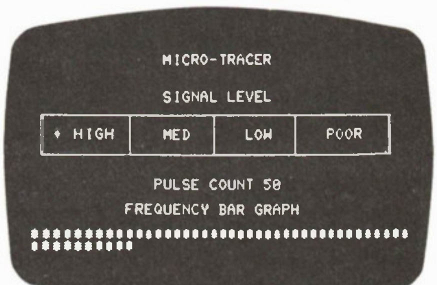
It has been designed for the constructor who occasionally assembles a project, but does not have access to an oscilloscope for tracing the course of signals through it if it malfunctions. From the block diagram **(Fig. 1)** it will be seen that in addition to the computer there are four very simple stages. The first allows the computer to send an audio tone out to the unit under test. The second amplifies the probed signal from the circuit under examination, to a level suitable for sending the to the computer. The third controls the amplifier gain and is under computer control. Simple analytical data about the probed circuit is displayed on the screen.

The computer also puts out a second audio signal which can be fed to an ordinary amplifier. This signal consists of a series of bleeps, the frequency and rate of which depend on the strength of the probed signal. Rudimentary information on the frequency probed is also shown on the screen as a bar graph.

Injection Signal

The computers mentioned above have internal timers that can produce a program controlled frequency output as a 5V peak to peak square wave. Here this is set for approximately 440Hz, though the value can be changed if preferred. It is put out onto one of the handshake lines of the output port. Since this line is often used for calling the attention of external equipment, it is referred to here as the ATN **(Fig. 2)** or attention line. In the unit C7 gives AC coupling, and VR2 enables the desired signal strength to be set, to suit the circuit under test. Switch S1 then selects for AC or DC coupling of the injection output.





Photographs of the screen display of two tests using the Micro Tracer.

By means of a probe, the signal can be sent to any part of the circuit under test. This can be at the usual audio input, or somewhere along the rest of the circuit signal path. If preferred an alternative signal source can be used instead. Switch S2 enables the injection signal to be switched back to the computer as a self-check facility.

Tracer

With the second probe (Test In), the passage of the injection signal can be followed. The signal is brought back into the Tracer input at C1 via VR3. The next stage is a voltage controlled amplifier around IC1 and IC1b. The amplification of this stage can be adjusted by the computer in accordance with the strength of the traced signal.

The computer adjusts the gain until the output is sufficiently high for the computer to detect it. The screen readout then displays the detected signal strength as falling into one of four categories, Poor, Low, Medium or High. These represent ranges commencing at about 50mV, 150mV, 400mV and 1V respectively. If no signal is detected, this condition is displayed instead. All the time that the computer is acquiring data, an asterisk flashes at the sampling rate.

Amplification Control

The characteristics of the VCA around IC1a and IC1b, allow the gain to be adjusted by the amount of current flowing into its control node. This can be set by a resistor in series with the node. Four gain ranges are controllable through resistors R13 to R16 as selected by the multiplexer IC2. The multiplexer is a gate that will allow a voltage through to a particular output. This is routed by a binary code applied via data lines DA0 and DA1 to its control inputs at pins 9 and 10. Since there are two control inputs, there are four binary codes that can be used.

With a low level expressed as "0" and a high level as "1", the codes are 00, 01, 10, 11. Any of these codes will open the respective gate to one of the resistors. The gate is connected so that a +5V level goes to the selected resistor, while the others remain in a high impedance state. The resulting current through the resistor then sets the VCA gain.

Initially the software program opens the gate to the highest resistor value so that minimum gain is given. The output of IC1b is returned to the computer via the data line DA2. The computer examines the state of this line to see if it is going up and down, as it will if a sufficiently high signal is present from the test probe. If within a preset time, no signal is detected, the computer switches to the next lowest resistor, so increasing the gain. Once more DA2 is examined.

If necessary the computer will continue to select increasing gain factors. If a signal is still not detected, this condition will be displayed on the screen as a series of asterisks in the relevant areas, and the computer will continue to search indefinitely until a response is found.

When a signal has been detected, from the knowledge of the gain factor used, the screen displays the range into which the signal strength falls. This is indicated by an asterisk in the relevant screen box. Having done so it again examines the state of DA2. Since it is necessary to know the minimum amount of gain required to bring the probed signal up to strength, the computer selects the previous higher resistance range each time round the sampling loop. Then, as before, it will continue to increase the gain until a signal is acquired, or the time out factor reached.

Pulse Count

When signals are present on the DA2 line, they are squarewave pulses, and so can be counted, irrespective of the injection source. Indeed in some instances it may be an internal clock signal that is under examination. Once a signal has been detected on DA2, the computer counts the number of times the line goes up and down within a set period. The count is then displayed both as a number, and as a bar graph.

This is not a true frequency conversion, but can be used as a rough guide. For example on the PET, a count of two pulses represents a frequency of about 150Hz, 100 pulses about 9kHz, and 255 pulses about 16kHz. For the software though, this is about the maximum rate at which it can distinguish individual pulses. It will be aware of frequencies above this rate, but

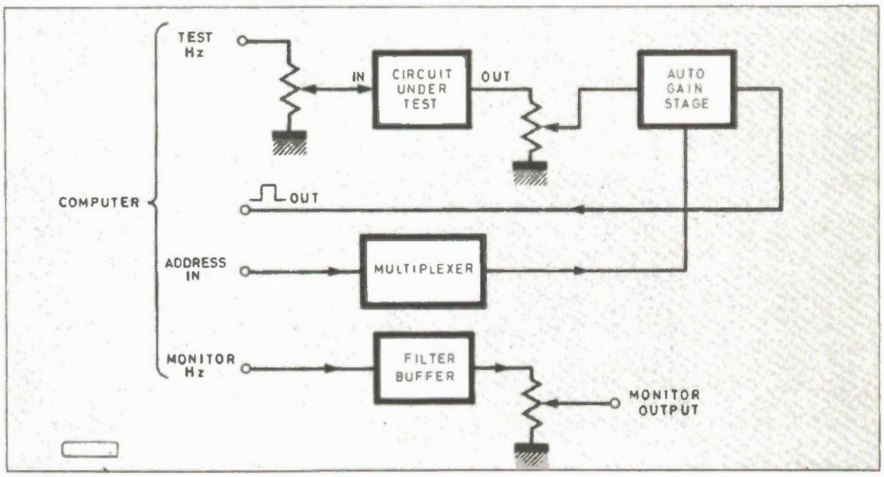


Fig. 1 Block diagram of the Micro Tracer Unit.

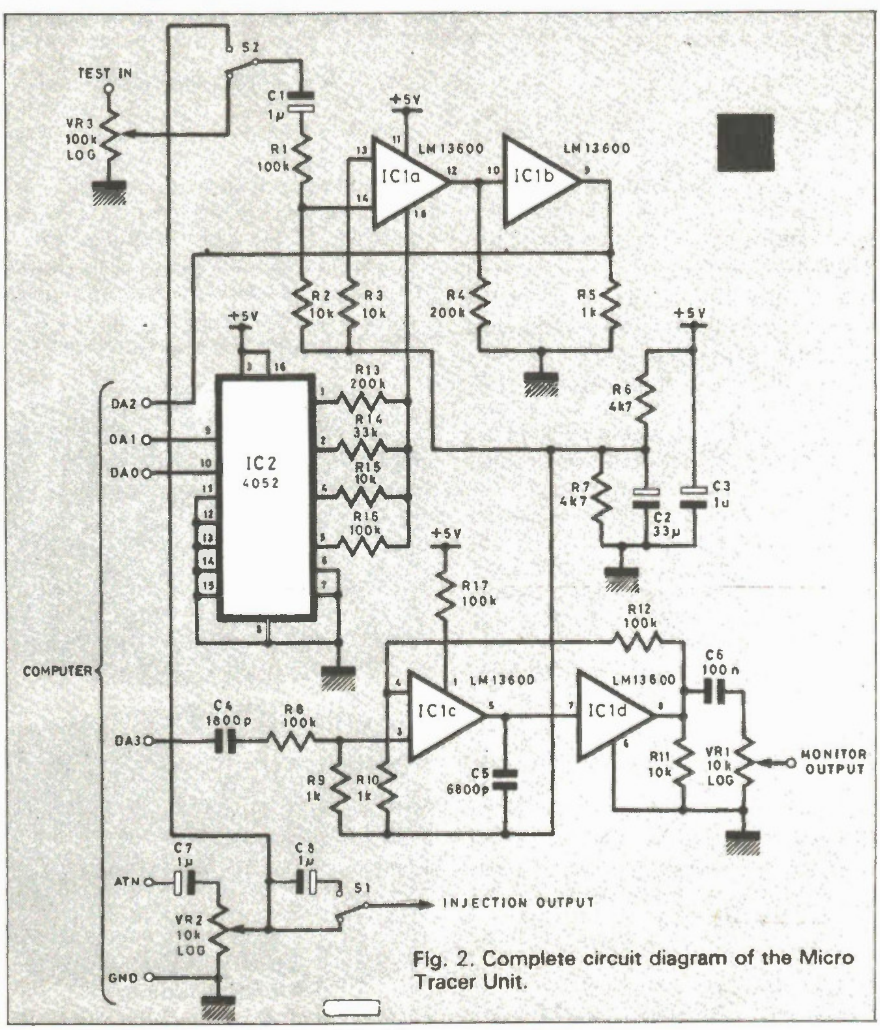


Fig. 2. Complete circuit diagram of the Micro Tracer Unit.

Fig. 2 Complete circuit diagram of the Micro Tracer.

several pulses may pass while it is processing just one of them. So the pulse count will effectively represent the subharmonics of high frequency signals, and intelligent interpretation to the bar graph must be given. The VCA will in fact allow frequencies of at least 1MHz to be detected.

Audio Monitoring

In addition to monitoring the screen for data on the probe condition, audio monitoring is also available. After each batch of pulses has been counted, the computer sends a pulsed squarewave frequency onto data line DA3. This frequency, and its duration, is varied in accordance with the gain range detected. Thus a series of bleeps varying in pitch and spacing is generated. If a signal is not detected the bleeps cease. DA3 feeds them to the low pass filter stage IC1c and IC1d. This smooths off the edges of the pulses, which in themselves are a bit harsh to listen to. The somewhat smoother output can be fed to an audio amplifier via the level control VR1. The amplitude is around 1V peak to peak at maximum.

Power Supply

The circuit requires a 5V power supply, and draws only about 3mA. This can be readily supplied by the computer. The BBC has up to 100mA available on its user port, whilst the PET and C64 have cassette ports that can deliver up to 250mA and 100mA respectively. Alternatively a 5V p.s.u. can be used.

Assembly

The unit is housed in a box 15cm x 13cm x 4.5cm. The potentiometers are mounted 21mm above the base, 30mm apart starting in the centre. Switches are at the same height, 20mm from the sides. The computer socket and its wiring can be selected to suit the computer lead used. The wiring shown for this socket should be regarded

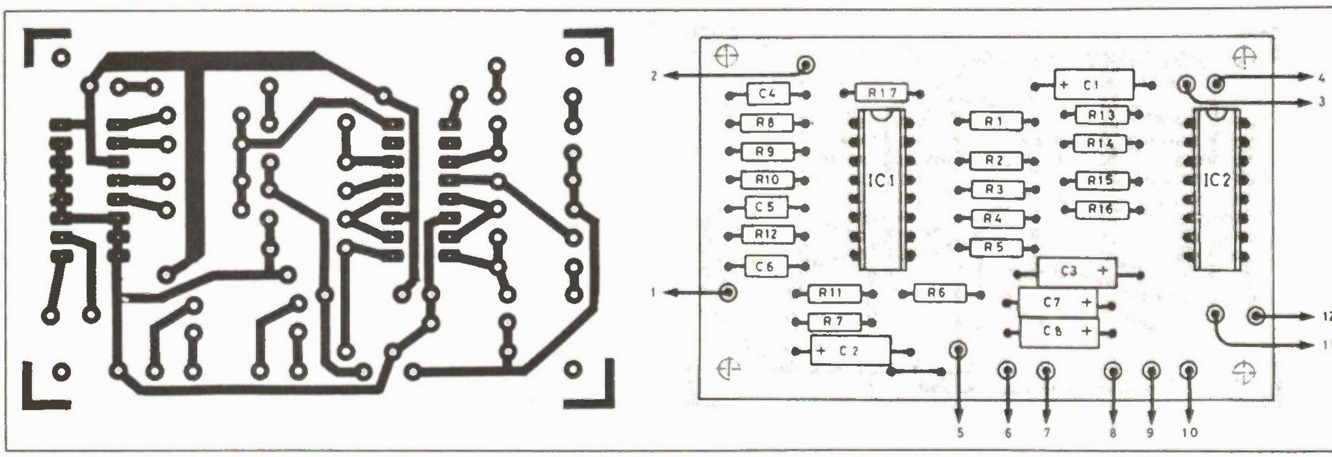
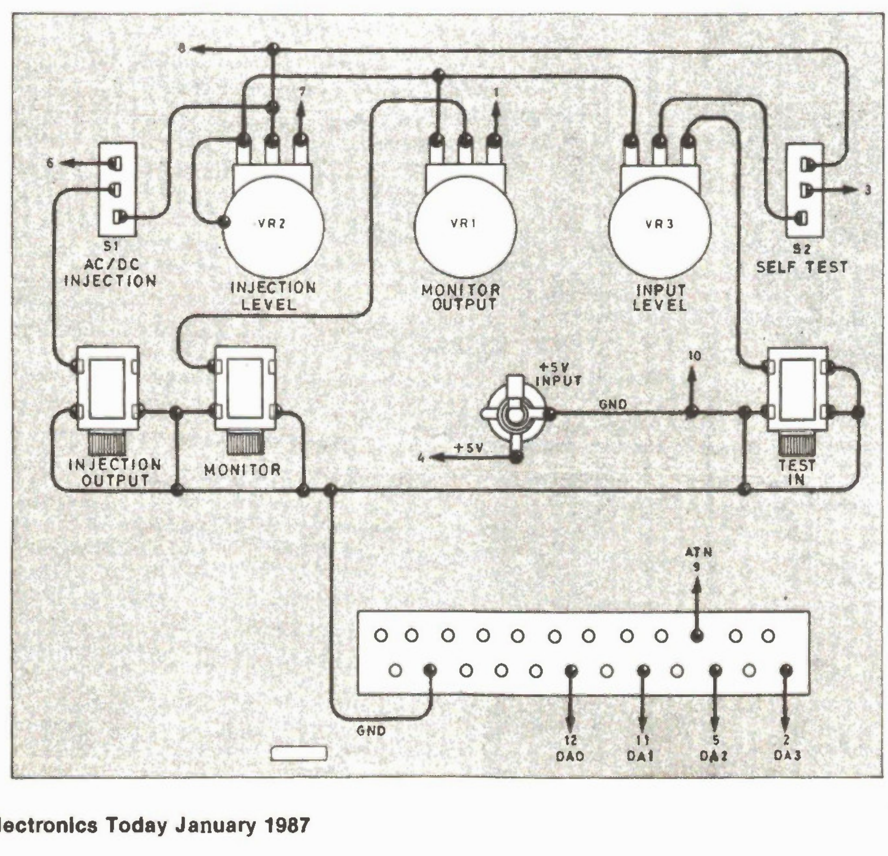
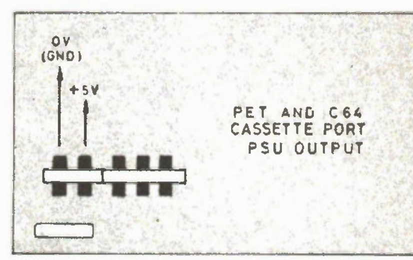


Fig. 3 PCB layout and wiring.





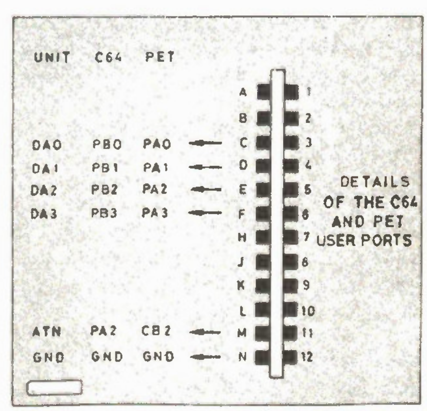


Fig. 4 Layout and wiring of the components mounted on the case

just as a guide. **Fig. 3** shows the PCB layout and wiring and **Fig. 4** shows the interconnection of all other components. Connection details for the two types of computers are shown in **Fig. 5**.

Software Program

The C64 and PET all have BASIC and machine code monitors that are practically identical. The program has been written in PET BASIC, and the machine code is compatible with the 6502 and 6510 microprocessors. The main differences between the three machines are essentially only variations in memory locations and cursor control codes. The software listing gives all the information needed for entering the program into any of these computers.

Other computers can control the unit if they have normal 8-bit parallel data sockets with an ATN handshake line. User Ports and IEEE 488 ports are suitable. The BASIC should be straightforward to translate for other machines. An assembly language code dump can be supplied if required, so experienced programmers can translate the machine code for other processors. The program requires just over 3K of memory. The machine code subroutine will automatically place itself at the highest memory location available.

Use

The unit will be of assistance in the checking of audio or digital circuits, and for frequencies between about 50Hz and at least 1MHz. Normally VR3 should be at maximum input level for signals below 5V. For signals greater than this, it should be reduced accordingly. The test probes and sockets used are a matter of personal choice. For average signal strength examination, the leads of a multimeter will be adequate. For low level signals though, the probe lead should be screened to avoid mains hum pick up. Oscilloscope probes are ideal, and can be purchased separately from many suppliers. The probes are well screened and available with interchangeable clip or probe tips.

The tracer can be used for checking equipment that has ceased to function after previously working satisfactorily. It can also be used for trouble shooting on a newly assembled project. However, the need to use a trouble tracer can be minimized if the assembly has been carried out correctly and checked carefully in the first place.

Parts List

Resistors (All 1/4W ± %)

R1,8,12,16,17	100k
R2,3,11,15	10k
R4,13	200k
R5,9,10	1k
R6,7	4k7
R14	33k

Capacitors

C1,3,7,8	1uF 63V elect.
C2	33uF 6V elect.
C4	1n8 polystyrene
C5	6n8 polystyrene
C6	100n polyester

Potentiometers

VR1,2	10k log. mono rotary
VR3	100k log. mono rotary

Semiconductors

IC1	LM13600
IC2	4052

Switches

S1,2	miniature SPDT

Miscellaneous

PCB and mounting clips; knobs(3); 16-pin IC sockets(2); 3.5mm jack socket; mono jack socket(3); interconnection lead and plug to suit computer.

MICRO TRACER SOFTWARE

```
100 REM EE MICRO-TRACER PROG261 05AUG86. THIS PROG CAN BE USED WITH THE
110 REM BBC, C64 AND PET COMPUTERS. BBC USERS SEE END NOTES BEFORE TYPING IN.
120 REM C64 AND PET USERS TYPE IN AS PER THIS LISTING.
130 DATA1-PET USER:REM SUBSTITUTE RIGHT NO & NAME IN THIS LINE = 2-C64, 3-BBC
140 GOTO260
150 FORA=1TO6:D$=D$+CHR$(CD):NEXT:V$=CHR$(CH)+D$+D$+CHR$(CD):D$=CHR$(CH)+D$
160 PRINTD$;TAB(13);"SIGNAL LEVEL"
170 PRINT" ________________________________________ "
180 PRINT" |          |          |          |         "
190 PRINT" |   HIGH   |   MED    |   LOW    |  POOR   "
200 PRINT" |          |          |          |         "
210 PRINT" ________________________________________ "
220 PRINTTAB(52);"PULSE COUNT":PRINTTAB(49);"FREQUENCY BAR GRAPH"
230 POKEDRT,251:POKEZ(0),0
240 SYS(SY):PRINTY$;TAB(23);PEEK(Z(1));CHR$(CL);"   ":GOTO240
250 STOP
260 READA$:A=VAL(A$):ONAGOSUB490,530,570
270 PRINTCHR$(CC);TAB(133)"MICRO-TRACER":PRINTTAB(95);"LOADING"
280 IFA<3THENSY=PEEK(MM)*256+PEEK(ML):GOTO300
290 SY=HIMEM
300 A$="":FORC=0TO4:A$=A$+CHR$(PEEK(SY+C)):NEXT:IFA$="TRACE"THEN340
310 B=SY-210:IFA<3THENHI=INT(B/256):LO=B-(HI*256):POKEML,LO:POKEMM,HI:GOTO330
320 HIMEM=B
330 A$="TRACE":FORC=0TO4:POKE(B+C),ASC(MID$(A$,C+1,1)):NEXT:CLR
340 DIMZ(3):RESTORE:READA$:A=VAL(A$):ONAGOSUB490,530,570
350 IFA<3THENSY=PEEK(MM)*256+PEEK(ML)+5:A=SY-1:GOTO370
360 SY=HIMEM+5:A=SY-1
370 READB$:IFB$="*"THEN150
380 A=A+1:IFB$<"A"THENPOKEA,VAL(B$):GOTO370
390 IFB$="OUT"THENB=OUT:GOTO470
400 IFB$="IN"THENB=IN:GOTO470
410 IFB$="DRT"THENB=DRT:GOTO470
420 IFB$="SCR1"THENB=SCR+679:GOTO470
430 IFB$="SCR2"THENB=SCR+362:GOTO470
440 IFLEFT$(B$,1)="Z"THENB=VAL(MID$(B$,2)):POKEA,Z(B):GOTO370
450 IFB$="SBL"THENPOKEA,SBL:GOTO370
460 STOP
470 HI=INT(B/256):LO=B-(HI*256):POKEA,LO:A=A+1:POKEA,HI:GOTO370
480 REM PET USER
490 CD=17:CL=157:CC=147:CH=19:Z(0)=0:Z(1)=1:Z(2)=2:Z(3)=3:ML=52:MM=53
500 DRT=59459:IN=59457:OUT=59471:DAV=59469:CTL=59467:OSC=59464:SRL=59466
510 SBL=42:SCR=32768:Q=140
520 POKECTL,PEEK(CTL)AND227OR16:POKEOSC,Q:POKESRL,15:RETURN
530 REM C64 USER
540 CD=17:CL=157:CC=147:CH=19:Z(0)=251:Z(1)=252:Z(2)=253:Z(3)=254:ML=55:MM=56
550 DRT=56579:IN=56577:OUT=56577:DAV=56589:CTL=56591:OSC=56582:SRL=56583
560 SBL=42:SCR=1024:Q=95:POKECTL,7:POKEOSC,Q:POKESRL,4:RETURN
570 REM BBC USER
580 CD=10:CL=8:CC=12:CH=30:Z(0)=112:Z(1)=113:Z(2)=114:Z(3)=115:Q=140:SBL=42
590 DRT=&FE62:IN=&FE60:OUT=&FE60:DAV=&FE6D:CTL=&FE6B:OSC=&FE68:SRL=&FE6A
600 SCR=&7C00:POKECTL,PEEK(CTL)AND227OR16:POKEOSC,Q:POKESRL,15:RETURN
610 DATA120,162,0,134,Z1,134,Z2,164,Z0,140,OUT,173,IN,41,4,133,Z0,173,IN,41,4
620 DATA197,Z0,208,16,133,Z0,232,208,242,200,192,4,144,227,160,0,132,Z0,88,96
630 DATA132,Z2,160,0
640 DATA162,1,173,IN,41,4,197,Z0,240,8,133,Z0,200,169,SBL,153,SCR1,232,208,236
650 DATA132,Z1,169,32,200,240,5,153,SCR1,208,248,164,Z2,132,Z0,160,0,228,Z0
660 DATA208,6,169,SBL,132,Z2,208,2,169,32,153,SCR2,152,24,105,9,168,232,224,4
670 DATA208,231,169,32,166,Z0,240,4,10,202,208,252,133,Z3,164,Z2,169,32,153
680 DATASCR2,169,251,141,DRT,162,192,164,Z3,165,Z0,141,OUT,136,208,253,9,8,141
690 DATAOUT,164,Z3,136,208,253,164,Z3,200,208,253,232,208,228,164,Z2,169,SBL
700 DATA153,SCR2,165,Z0,141,OUT,240,2,198,Z0,169,243,141,DRT,88,96,0,*
710 REM BBC USER NOTES
720 REM THE  BBC USES '?' INSTEAD OF 'PEEK' AND 'POKE', THUS 'POKEDRT,251'
730 REM BECOMES '?DRT=251'. FOR 'PEEK' THE '?' CAN BE SUBSTITUTED DIRECTLY,
740 REM THUS 'PEEK(Z(1))' BECOMES '?(Z(1))'. 'SYS(SY)' BECOMES 'CALL(SY)'.
750 REM 'CLR' BECOMES 'CLEAR'. WHEN TYPING IN THE NORMAL BBC REQUIREMENTS FOR
760 A SPACE BETWEEN SOME STATEMENTS SHOULD BE OBSERVED. IF NECESSARY SPLITTING
770 LINES INTO TWO PARTS, GIVING THE 2ND PART A LINE NUMBER INCREMENTED BY 5.
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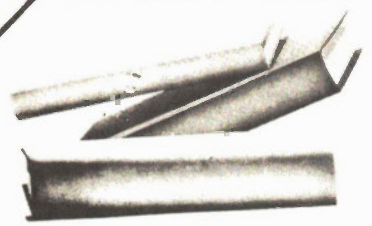

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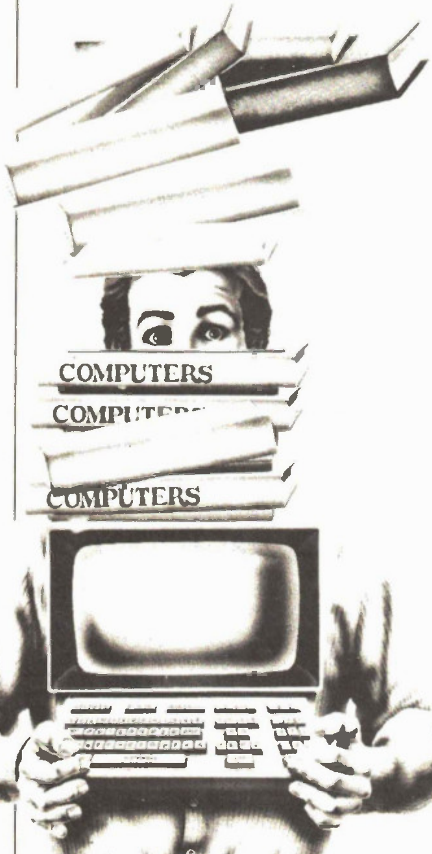

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PROJECTS

BP48: ELECTRONIC PROJECTS FOR BEGINNERS $7.80
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Furthermore, a number of projects have been arranged so that they can be constructed without any need for soldering and, thus, avoid the need for a soldering iron.

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

BP37: 50 PROJECTS USING RELAYS, SCR's & TRIACS $7.80
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Relays, silicon controlled rectifiers (SCR's) and bi-directional triodes (TRIACs) have a wide range of applications in electronics today. This book gives tried and practical working circuits which should present the minimum of difficulty for the enthusiast to construct. In most of the circuits there is a wide latitude in component values and types, allowing easy modification of circuits or ready adaptation of them to individual needs.

BP221: 28 TESTED TRANSISTOR PROJECTS $11.80
R.TORRENS
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This book is aimed primarily at the electronics enthusiast who wishes to experiment with remote control. Full explanations have been given so that the reader can fully understand how the circuits work and can more easily see how to modify them for other purposes, depending on personal requirements. Not only are radio control systems considered but also infra-red, visible light and ultrasonic systems as are the use of Logic ICs and Pulse position modulation etc.

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

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Complementing Book BP74, "Electronic Music Projects", BP174 provides more advanced projects, such as a flanger, a phaser, mini-chorus and ring modulators, percussion synths, etc. Each project has an introduction, circuit diagram and constructional notes.

BP74: ELECTRONIC MUSIC PROJECTS $10.00
R.A. PENFOLD
Although one of the more recent branches of amateur electronics, electronic music has now become extremely popular and there are many projects which fall into this category. The purpose of this book is to provide the constructor with a number of practical circuits for the less complex items of electronic music equipment, including such things as a Fuzz Box, Waa-Waa Pedal, Sustain Unit, Reverberation and Phaser-Units, Tremelo Generator etc.

BP44: IC 555 PROJECTS $10.00
E.A. PARR, B.Sc.,C.Eng., M.I.E.E.
Every so often a device appears that is so useful that one wonders how life went on before without it. The 555 timer is such a device. Included in this book are Basic and General Circuits, Motor Car and Model Railway Circuits, Alarms and Noise Makers as well as a section on the 556, 558 and 559 timers.

BP82: ELECTRONIC PROJECTS USING SOLAR CELLS $7.80
A collection of simple circuits which have applications in and around the home using the energy of the sun to power them. The book deals with practical solar power supplies including voltage doubler and tripler circuits, as well as a number of projects.

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BABANI BOOKS

BP49: POPULAR ELECTRONIC PROJECTS $10.00
R.A. PENFOLD
Includes a collection of the most popular types of circuits and projects which, we feel sure, will provide a number of designs to interest most electronics constructors. The projects selected cover a very wide range and are divided into four basic types: Radio Projects, Audio Projects, Household Projects and Test Equipment.

BP94: ELECTRONIC PROJECTS FOR CARS AND BOATS
R.A. PENFOLD $7.80
Projects, fifteen in all, which use a 12V supply are the basis of this book. Included are projects on Windscreen Wiper Control, Courtesy Light Delay, Battery Monitor, Cassette Power Supply, Lights Timer, Vehicle Immobiliser, Gas and Smoke Alarm, Depth Warning and Shaver Inverter.

BP95: MODEL RAILWAY PROJECTS $7.80
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BP93: ELECTRONIC TIMER PROJECTS $7.80
F.G. RAYER
Windscreen wiper delay, darkroom timer and metronome projects are included. Some of the more complex circuits are made up from simpler sub-circuits which are dealt with individually.

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R.A. Penfold $9.00
A companion to BP107. Describes a variety of projects that can be built on plug-in breadboards using CMOS logic IC's. Each project contains a schematic, parts list and operational notes.

BP104: Electronic Science Projects
Owen Bishop $9.00
Contains 12 electronic projects with a strong scientific flavour. Includes Simple Colour Temperature Meter, Infra-Red Laser, Electronic clock regulated by a resonating spring, a 'Scope with a solid state display, pH meter and electrocardiograph.

BP110: HOW TO GET YOUR ELECTRONIC PROJECTS WORKING $7.80
R.A. PENFOLD
We have all built circuits from magazines and books only to find that they did not work correctly, or at all, when first switched on. The aim of this book is to help the reader overcome just these problems by indicating how and where to start looking for many of the common faults that can occur when building up projects.

BP84: DIGITAL IC PROJECTS $7.80
F.G. RAYER, T.Eng.(CEI),Assoc.IERE
This book contains both simple and more advanced projects and it is hoped that these will be found of help to the reader developing a knowledge of the workings of digital circuits. To help the newcomer to the hobby the author has included a number of board layouts and wiring diagrams. Also the more ambitious projects can be built and tested section by section and this should help avoid or correct faults that could otherwise be troublesome. An ideal book for both beginner and more advanced enthusiast alike.

BP67: COUNTER DRIVER AND NUMERAL DISPLAY PROJECTS $11.80
F.G. RAYER, T.Eng.(CEI), Assoc. IERE
Temporarily out of print
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In this book many applications and projects using various types of numeral displays, popular counter and driver IC's etc. are considered.

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BP103: MULTI-CIRCUIT BOARD PROJECTS $7.80
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This book allows the reader to build 21 fairly simple electronic projects, all of which may be constructed on the same printed circuit board. Wherever possible, the same components have been used in each design so that with a relatively small number of components and hence low cost, it is possible to make any one of the projects or by re-using the components and P.C.B. all of the projects.

BP107: 30 SOLDERLESS BREADBOARD PROJECTS — BOOK 1 $9.00
R.A. PENFOLD
A "Solderless Breadboard" is simply a special board on which electronic circuits can be built and tested. The components used are just plugged in and unplugged as desired. The 30 projects featured in this book have been specially designed to be built on a "Verobloc" breadboard. Wherever possible the components used are common to several projects, hence with only a modest number of reasonably inexpensive components it is possible to build, in turn, every project shown.

BP106: MODERN OP-AMP PROJECTS $7.80
R.A. PENFOLD
Features a wide range of constructional projects which make use of op-amps including low-noise, low distortion, ultra-high input impedance, high slew-rate and high output current types.

CIRCUITS

How to Design Electronic Projects
BP127 $9.00
Although information on standard circuit blocks is available, there is less information on combing these circuit parts together. This title does just that. Practical examples are used and each is analysed to show what each does and how to apply this to other designs.

Audio Amplifier Construction
BP122 $2.25
A wide circuits is given, from low noise microphone and tape head preamps to a 100W MOSFET type. There is also the circuit for 12V bridge amp giving 18W. Circuit board or stripboard layout are included. Most of the circuits are well within the capabilities for even those with limited experience.

BP80: POPULAR ELECTRONIC CIRCUITS — BOOK 1 $11.80
R.A. PENFOLD
Another book by the very popular author, Mr. R.A. Penfold, who has designed and developed a large number of various circuits. These are grouped under the following general headings; Audio Circuits, Radio Circuits, Test Gear Circuits, Music Project Circuits, Household Project Circuits and Miscellaneous Circuits.

BP98: POPULAR ELECTRONIC CIRCUITS, BOOK 2 $9.00
R.A. PENFOLD
70 plus circuits based on modern components aimed at those with some experience.

BP39: 50 (FET) FIELD EFFECT TRANSISTOR PROJECTS $7.00
F.G. RAYER, T.Eng.(CEI),Assoc.IERE
Field effect transistors (FETs), find application in a wide variety of circuits. The projects described here include radio frequency amplifiers and converters, test equipment and receiver aids, tuners, receivers, mixers and tone controls, as well as various miscellaneous devices which are useful in the home.
This book contains something of particular interest for every class of enthusiast — short wave listener, radio amateur, experimenter or audio devotee.

BP162: COUNTING ON QL ABACUS $10.00
This book is designed to introduce the beginner to the use of spreadsheets in general and Abacus on the Sinclair QL in particular. It assumes no previous experience in computing or spreadsheets. Practical examples show the calculations for domestic, small business and technical applications.

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

BP88: HOW TO USE OP AMPS $11.80
E.A. PARR
A designer's guide covering several op amps, serving as a source book of circuits and a reference book for design calculations. The approach has been made as non-mathematical as possible.

BP65: SINGLE IC PROJECTS $6.00
R.A.PENFOLD
There is now a vast range of ICs available to the amateur market, the majority of which are not necessarily designed for use in a single application and can offer unlimited possibilities. All the projects contained in this book are simple to construct and are based on a single IC. A few projects employ one or two transistors in addition to an IC but in most cases the IC is the only active device used.

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

BP117: PRACTICAL ELECTRONIC BUILDING BLOCKS BOOK 1 $7.80
Virtually any electronic circuit will be found to consist of a number of distinct stages when analysed. Some circuits inevitably have unusual stages using specialised circuitry, but in most cases circuits are built up from building blocks of standard types.
This book is designed to aid electronics enthusiasts who like to experiment with circuits and produce their own projects rather than simply follow published project designs.
The circuits for a number of useful building blocks are included in this book. Where relevant, details of how to change the parameters of each circuit are given so that they can easily be modified to suit individual requirements.

BP102: THE 6809 COMPANION $7.80
Written for machine language programmers who want to expand their knowledge of microprocessors. Outlines history, architecture, addressing modes, and the instruction set of the 6809 microprocessor. The book also covers such topics as converting programs from the 6800, program style, and specifics of 6809 hardware and software availability.

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

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

BP83: VMOS PROJECTS $7.80
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Although modern bipolar power transistors give excellent results in a wide range of applications, they are not without their drawbacks or limitations. This book will primarily be concerned with VMOS power FETs although power MOSFETs will be dealt with in the chapter on audio circuits. A number of varied and interesting projects are covered under the main headings of: Audio Circuits, Sound Generator Circuits, DC Control Circuits and Signal Control Circuits.

RADIO AND COMMUNICATIONS

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

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This book is divided into two main sections one to amateur band reception, the other to broadcast bands. Advice is given to suitable equipment and techniques. A number of related constructional projects are described.

BP105: AERIAL PROJECTS $7.80
R.A. PENFOLD
The subject of aerials is vast but in this book the author has considered practical designs including active, loop and ferrite aerials, which give good performances and are reasonably simple and inexpensive to build. The complex theory and math of aerial design are avoided.

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Computerized Circuit Analysis

Designing amplifier circuits? This article shows how to design programs to take the sweat and guesswork out of the operation.

By Lance Wilson and Jon Fairall

SOONER OR LATER you'll find yourself in a position where you have to design basic amplifier circuits. This need not be a tedious and time-consuming task if you develop some of the ideas presented in this article. We have included a demonstration program for the sake of interest, but the object of this exercise is to show you how to go about the problem of designing with a computer. You can write your own program to suit your own computer and your own design.

The fundamental circuit for a Class A amplifier is given in Figure 1. The first step in analysing a transistor circuit is to establish the biasing, since it is this that sets up the effective gain of the amplifier. For the circuit in Figure 1 the first step is to establish the base voltage, Vb. A standard but simplified equation which allows a quick solution is:

$$Vb = \frac{Rb2 \times Vcc}{Rb1 + Rb2}$$

From this we can determine Ve very quickly if we assume that there will be a drop of about 0.6V across the base-emitter junction of the transistor:

$$Ve = Vb - 0.6$$

We now have access to the current flowing

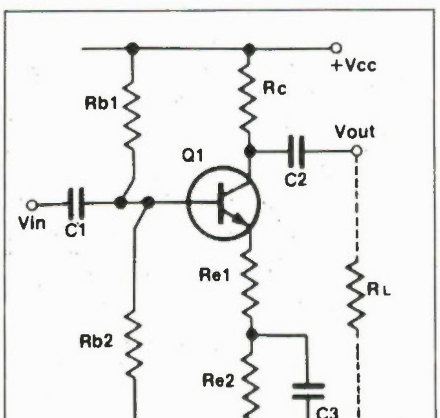

Fig. 1 General form of the Class A voltage amplifier.

in the emitter resistor from Ohm's law, since we know the voltage across the resistor and its value:

$$Ie = \frac{Ve}{Re}$$

where Re = Re1+Re2.

Since we also know that the emitter current must be more or less the same as the collector current we can also work out the collector voltage:

$$Vc = Vcc - RcIc$$

AC response

With this series of simple steps we have worked out all the voltages around the transistor plus the current flowing between the collector and the emitter. We are now in a position to begin an examination of the circuit's response to an input signal, ie: its AC response.

The gain of an amplifier is given by:

$$Av = \frac{\text{collector load}}{\text{emitter load}}$$

Bear in mind that these values apply to AC conditions only. The collector load includes all the resistances that tie the collector to either the ground or supply rails. (Supply is ac-shorted to ground through the power supply). It includes at least the collector resistor Rc, the load resistance Rl and the collector-emitter leakage resistance. This latter is usually so high that it can be ignored in low frequency, small signal applications.

The emitter load, likewise, includes all the resistances between the emitter of the transistor and either rail. In practice this will mean the unbypassed, emitter resistor Re1, but not Re2. Remember we are talking about AC and assuming that all the capacitors are short circuits, so Re2 is effectively shorted. It also includes the base-emitter resistance, re, which is given by 30/Ic.

The result of this is that we can establish a gain equation for the circuit of **Fig. 1**:

$$Av = \frac{Rc}{r_e + Re1}$$

Obviously, different configurations will have different equations, but the principle remains the same, so you can work out the relevant equation for your particular application.

So far, we have sufficient information to generate a program that will predict certain elements of the performance of an amplifier given the circuit. If you input the values of the resistors the program should come back at you with the gain. If you go to a textbook you should be able to extract equations to give you input and output resistance as well.

The question not answered, and the one we would like to know, is whether the combination of resistors we have chosen is an optimum. The classic method of doing this is with the load line.

Load Lines

Load line analysis involves drawing a pair of straight lines corresponding to the AC and DC loads on the transistor. It is actually a graph of Ic and against Vce. The load line is therefore all the possible combinations of Ic and Vce that can exist at the collector of the particular amplifier under consideration.

We can determine the DC line quite easily (see **Fig. 2**). When no current flows i.e: Ic = 0, then Vce = Vcc. This defines the bottom point of the line: ie: the intersection with the horizontal axis. At the other end of the line, when Vce is at a minimum, Ic is determined by the value of the resistors through which it flows (Vce is assumed to be zero). The DC load line is

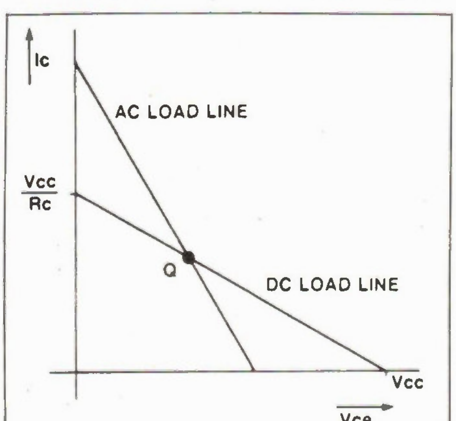

Fig. 2 Plotting the AC and DC load lines.

```
10 REM**********************************
11 REM* THIS PROGRAM PLOTS A SET OF    *
12 REM*TRANSISTOR CHARACTERISTICS WHEN*
13 REM*CERTAIN PARAMETERS ARE ENTERED.*
14 REM*THEN LOAD LINES ARE PLOTTED FOR*
15 REM*VARIOUS VALUES OF COMPONENTS.  *
16 REM**********************************
35 PAPER 1: INK 7
38 PRINT "****************************"
39 PRINT "*                          *"
40 PRINT "* *  *  *  **  *  * * * ***"
41 PRINT "* * * * * * * * *  * *** * *"
42 PRINT "* * * * *** * * *  * *** ***"
43 PRINT "* * * * * * * * *  * *** * *"
44 PRINT "* ** *  * * **  ** * * * ***"
45 PRINT "*                          *"
46 PRINT "*    LANCE WILSON, 1984    *"
47 PRINT "*                          *"
48 PRINT "****************************"
49 PAUSE 2000
50 CLS
55 REM**WRITTEN FOR THE MEMOTECH*****
56 REM**        MTX500          *****
57 REM**GRAPHICS DUMP FOR CP80 PRINTER*
58 REM~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
65 REM*THESE LINES SET VIRTUAL SCREENS,
66 REM*1ST FOR TEXT, THEN GRAPHICS.
70 CRVS 2,0,3,0,36,5,40
75 VS 2: CLS : PAPER 6: INK 7
80 CSR 4,0: INPUT "COMPLEX:Y/N?";A$
81 LET PMAX=200
82 LET VSF=2: LET ICMAX=20
83 LET BVCEO=30: LET HFE=100
84 IF A$="N" THEN  GOTO 100
85 CLS : CSR 4,0: INPUT "HFE:?";HFE
86 CSR 4,1: INPUT "MAX PC:?";PMAX
88 CSR 4,2: INPUT "ICmax:?mA";ICMAX
90 CSR 4,3: INPUT "BVCEO:?";BVCEO
92 LET VSF=INT(ICMAX/10)
100 CLS
102 CSR 4,0: INPUT "    ENTER STEP";STP
104 CLS : CSR 4,0: INPUT " ENTER Vcc";VCC
105 CSR 4,0: INPUT " EMITTER&COLLECTOR R";RE,RC
106 CSR 4,3: INPUT "RB1,RB2= ?";RB1,RB2
107 LET ID=VCC/(RB1+RB2)
108 VS 4: CLS : COLOUR 2,11: COLOUR 3,4
109 COLOUR 0,1: COLOUR 1,15: COLOUR 4,6
110 REM**SETS UP AXES AND SCALES*******
111 LINE 20,12,255,12: LINE 20,12,20,190
112 CSR 5,22: PRINT "05  10  15  20  25  30  35"
113 CSR 22,21: PRINT "volts Vce"
114 FOR I=0 TO 11 STEP 1
115 CSR 0,(11-I)*2: PRINT I*VSF
117 NEXT I
118 REM**DRAWS CHAR. CURVES     *******
119 LET X=20: LET Y=10
120 LET NEWX=X+STP/10: LET NEWY=Y+STP
122 LINE X,Y,NEWX,NEWY
123 LINE NEWX,NEWY,250-.8*Y,NEWY*1.11
125 CSR 30-Y/12,21-Y/7: PRINT Y+10
126 LET X=NEWX: LET Y=NEWY
127 IF Y>150 THEN  GOTO 130
128 GOTO 120
129 REM*AFTER TOP CURVE, PLOT PCMAX
130 FOR I=1 TO 230
135 LET YP=PMAX*100/(VSF*I)
140 IF YP>175 THEN  GOTO 150
142 COLOUR 3,6
145 PLOT 20+I,YP+12
150 NEXT I
151 CSR 16,10: PRINT "Pc=";PMAX
153 REM******UPPER IC & VCE LIMITS*****
154 LET ILIM=ICMAX*16/VSF+12: IF ILIM>190 THEN  GOTO 990
155 LINE 20,ILIM,80,ILIM
156 CSR 10,22-ILIM/9: PRINT "Imax=";ICMAX
157 LET VLIM=BVCEO*6.2+20: IF VLIM>250 THEN  GOTO 990
158 LINE VLIM,12,VLIM,80: CSR VLIM/9-4,18: PRINT "BVceo=";BVCEO
159 REM****NEXT CALCS. FOR QPT. AND****
160 REM****** DC LOAD LINE ************
161 LET ICQ=((RB2*VCC)/(RB1+RB2)-.6)/RE
```

Continued on page 53

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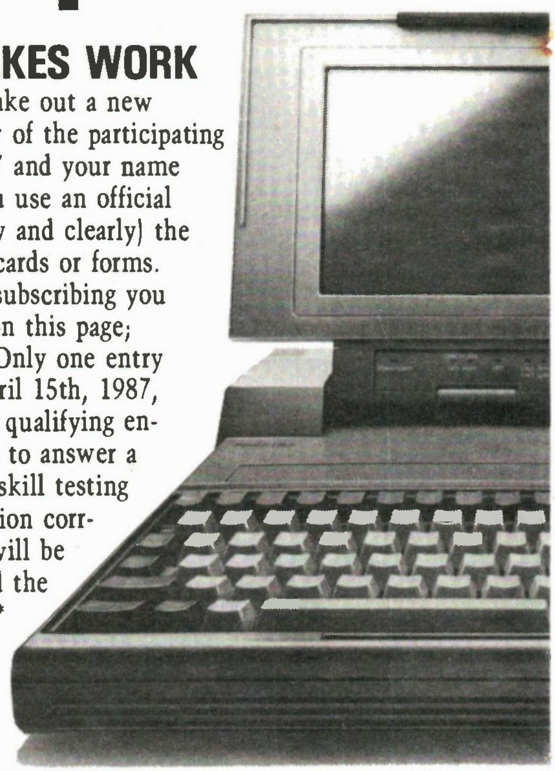

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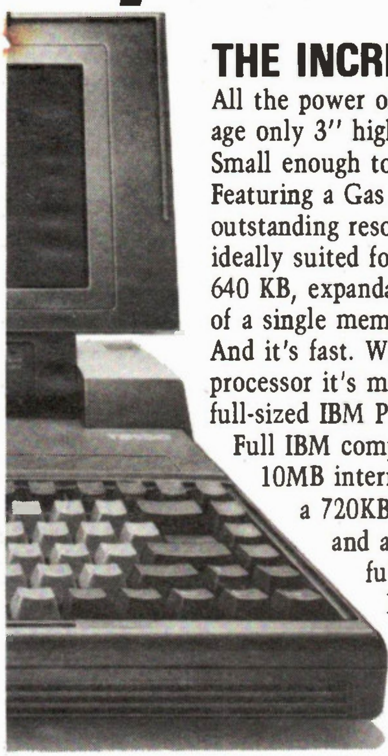

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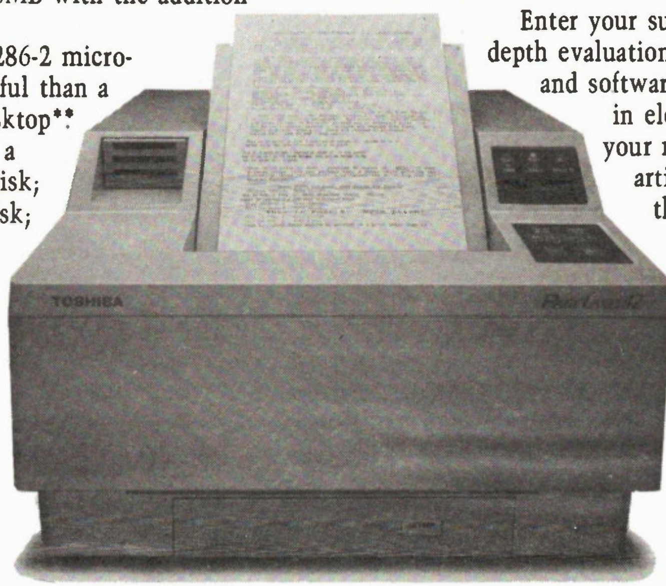

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Computer Aided Drafting

Schematics and illustrations are a snap with the various CAD programs for the PC.

By Bill Markwick and Frank Lenk

CAD programs have made enormous changes to the way we do electronic design from the breadboard to the final product. Because the field of design software is so wide, this article will have to be limited to computer-aided *drafting*. The many circuit and PCB design and analysis programs will be covered in a future issue. Because there are so many programs available, this is far from a comprehensive listing; we just chose the programs with which we are most familiar.

It's also important to note that the software and techniques described are relatively inexpensive versions for desktop microcomputers. While they can't match the giant mainframe versions of CAD/CAM, the increasing power of the micro makes them tremendously flexible for anyone doing technical drafting or illustrations.

Basic Types

The software falls into two groups, each with its own advantages and limitations. The first is the pixel-oriented type, unfairly known as the "paintbox" program (they've come a long way recently). With this method, the pattern drawn on the screen is captured by the computer by recording each screen pixel as a bit. Eight pixels make up a byte, and another byte may be assigned for controlling colour, brightness, etc.

The pixel-oriented type has the advantage that it's very easy to edit. If you set the cursor to the Erase mode, for instance, you can then cut a swath through your drawing, blanking pixels wherever you want, or even changing them to another colour. If you want to make very tiny corrections, most programs have a "fat bit" edit mode in which a small area is magnified on the screen and individual pixels erased or added.

One disadvantage is the difficulty in changing size, or *scaling*. While it can be done, the software can only make a good guess at how to enlarge a drawing, and fills the space between the gaps the best it can. This is no problem with rectangles, but may cause circles to become polygons and angled lines to become staircases. Another problem is that printouts tend to be no better than the screen resolution; thus the "jaggies", a series of steps as the screen or printer attempts to construct an angled line or curve.

The second type is the object-oriented program. With this system, each line, circle, box, etc., is considered an integral object. For instance, a line may be specified in terms of the coordinates for the beginning and end, plus a short piece of code to tell the program what sort of object is referred to. When the program draws a screen from a disk file, for instance, it will take the two coordinates and the code and look up its line-drawing facility.

The great advantages of the object system are the ease in manipulating the image size and angles and the higher quality of the printout. Drawings can be scaled or distorted to your heart's content, and since the objects are not concerned with the screen resolution, smoothing routines are employed to permit printouts limited in resolution only by the quality of the printhead or plotter.

A serious disadvantage is the lack of a simple eraser. If you should make a line a little too long, you have to delete the entire line and redraw it unless the program has the capability of "splitting", which will make two objects out of one. Another drawback is that the Paint or (Fill) function takes a very long time to complete; redrawing the screen many times with lots of painting can put you right to sleep unless you have fast hardware.

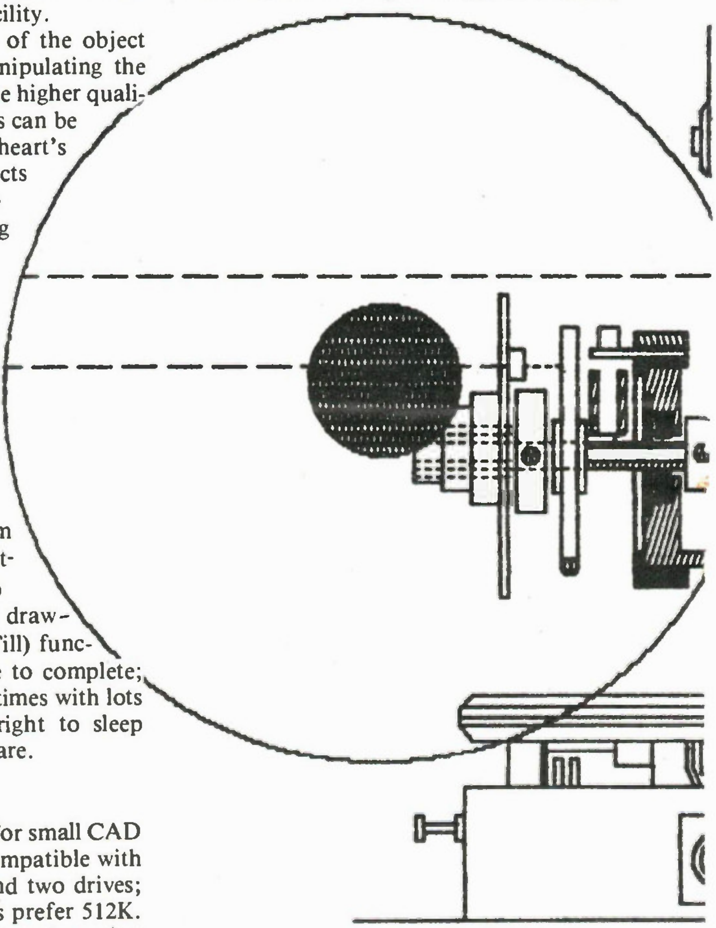
Hardware

The minimum requirement for small CAD systems is an IBM PC or compatible with at least 256K of memory and two drives; most of the larger programs prefer 512K. This will get you going, but you're going to be rather frustrated. Cursor keys are a cumbersome way to do complex drawings, and the regular 4.7MHz PC is a bit slow for anything but the most straightforward artwork.

If you're going shopping, put a mouse on your list for sure. All the software tested would support most popular brands of mice (mouses? meeses?), and most of

ASSEMBLY

*A mechanical drawing done with In*a*Vision.*



the lesser known mouse-clones include software that emulates their famous cousins like the MicroSoft mouse or Summa mouse. These *device drivers* must be run before running your CAD software; a batch file or Autoexec file will do this for you. You'll also need a serial port for connecting the mouse, and you might even need two if you use a serial-input plotting device. There are also graphics tablets and digitizers available if you need better resolution than a mouse can give you.

One last word on mouses: there are two basic types, the trackball and the photocell/pad types. The trackball mouse can run on any surface, but tends to be a bit jumpy and is seriously affected by dust accumulation. The other type uses LEDs and photocells to track a grid below it for very good precision, but it must run on the supplied pad, which takes up more desk space.

On the problem of slowness: each time you do a full-screen function like zooming, the computer completely redraws everything. If it's a complex piece with lots of painting, you can spend more time waiting than drawing. There are a number of cures. One is to buy a computer with an 8MHz clock, speeding everything up by 60 percent or so. If you already have a 4.7MHz computer, the Turbo facility can be plugged in via a PC board in one of the card slots (if your dealer can't find such a thing, there's the Turboswitch 9MHz accelerator from Hi-Line Sales and Service, 546 Heritage Road North, Box 206, Barnwell, Alberta T0K 0B0, (403) 223-6628).

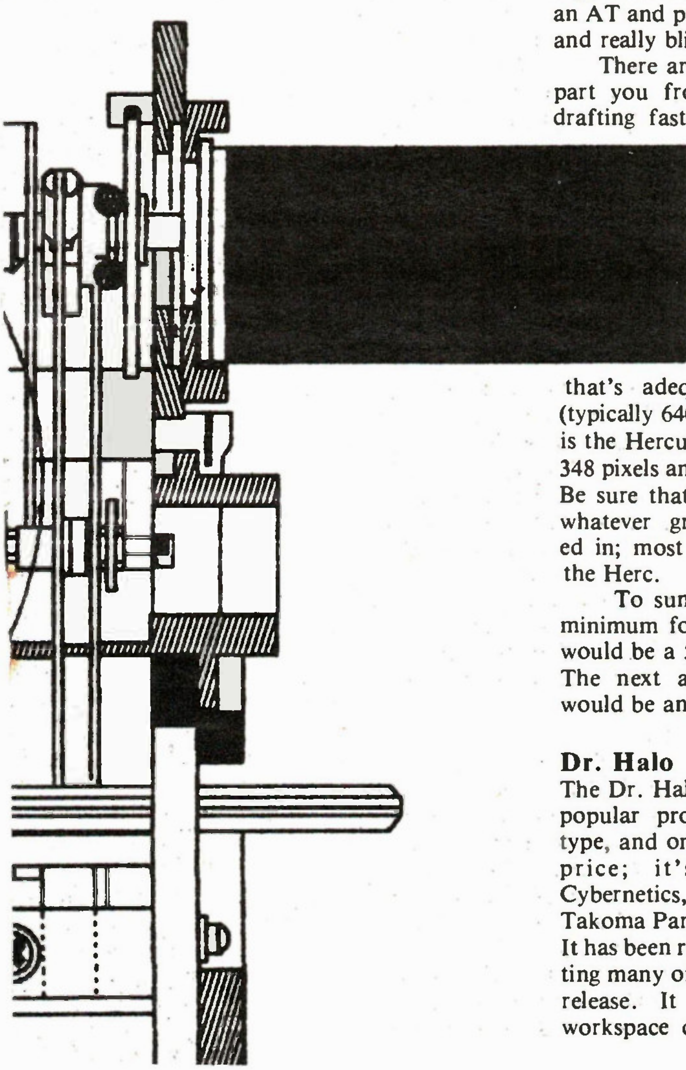
Another accelerator gadget is the 8087 numeric co-processor, a sort of extra CPU which plugs into the provided socket beside the regular 8088 and takes care of the number-crunching. They're available in either 4.7MHz or 8MHz versions, both of them expensive (typically $200 to $500). Also, be sure to check that your software can make use of the 8087; if it isn't activated by the software, an 8087 won't do you any good.

Another add-on for speed would be one of the plug-in accelerator cards which adds an 80286 processor, effectively turning your PC into an AT. Or, you could get an AT and put an accelerator card in *that* and really blister the bytes.

There are lots and lots of gadgets to part you from your money and make drafting faster and easier, so we'll just have to refer you to your friendly neighborhood CAD dealer. One last recommendation: if you do a lot of CAD, your eyes will thank you if you get a video controller and monitor capable of higher resolution than the one that's adequate for word processing (typically 640 by 200 pixels). An example is the Hercules card, capable of 720 by 348 pixels and requiring a TTL monitor. Be sure that your software supports whatever graphics card you're interested in; most of them have drivers for the Herc.

To sum up the hardware: the bare minimum for satisfactory but slow CAD would be a 512K computer and a mouse. The next and most desirable step up would be an accelerator of some sort.

CROSS SECTION



Dr. Halo

The Dr. Halo graphics software is a very popular program. It's a pixel-oriented type, and one of the most versatile at the price; it's published by Media Cybernetics, Inc., 7050 Carroll Avenue, Takoma Park, MD 20912, (301) 270-0240. It has been reissued as Dr. Halo II, correcting many of the deficiencies in the earlier release. It now has a much larger workspace called a virtual screen; what you see on your monitor is only a window into a much larger area. There's also a much-needed Undo function that can erase such booboos as painting the entire screen when you only wanted a square inch. The quality of the printouts seem to be much improved over the past versions, which tended to suffer from the jaggies something fierce.

The version we have is the latest one, called the Desktop Publishing Version (DPE). While it isn't suitable for typeset-quality desktop publishing, it's probably the best you can get without spending a lot of money. The only major difference between this and Halo II seems to be the improved virtual-page handling; you can call up a miniaturized version of the whole page onto the screen and then use almost all the functions to draw, paint, letter, etc. With Halo II these functions had to be done one window at a time. You still have to change screens by moving the cursor to an icon of the page instead of just cursoring around as you can do with ProDesign.

Programs like Dr. Halo are not really CAD programs, but they're wonderful for illustrations. If you do artwork for manuals or newsletters as well as your drafting, it's highly recommended.

On booting it up, you'll notice that everything is displayed in icon form; not a word or control code appears. In fact, if you're using a mouse, the keyboard is disabled for anything but entering text for lettering. This, I find, is a disadvantage; the mouse is unmatched for speedy cursoring, but the cursor keys are handy to have when you need precision. You'll also notice that the screen is set to white, oddly, meaning a bit of fiddling to reset everything to white-on-black.

If you put the cursor on any icon and click the right button, a submenu pops up with even more choices. The number of choices really is amazing. You can even click onto the full virtual screen, inhale a word-processor file, convert it to one of Halo's two dozen fonts and move it around on the page until you get the size and location you like. Impressive. The printout of text is far from typeset, but it's adequate for most purposes.

Once you get the hang of the icon system, and they're very well thought out, Halo plus a mouse allows for very rapid drawing indeed. Text entry is a delight; the letters can be ballooned to any size you want, and after each Return, the cursor drops down to the beginning of the next "line", giving you a very neat-appearing block of text, something tricky to do with most CAD systems. Schematics are possible but not recommended; it's just too difficult to store and recall symbols and have them join up with any precision.

Other features include a comprehensive paint palette, curve fitting to a set of points, easy moving and duplicating facilities and an airbrush function for which you can create your own patterns. There's also an included program called Grab. This is a tiny (2K) utility which hides away in memory; you can then run any other type of graphics program, and when you see a screen you like, a press of Alt-PrtSc will store the contents of screen RAM as a Halo file. The you can load Halo, call up the newly-made file, enhance or change it, and print it out. This feature allows compatibility of sorts between Halo and any other CAD files.

When it comes to printing, a disappointment is that the entire virtual screen is printed, even if you've only used one tiny corner of it. This makes it difficult to fill a page without going back and forth between screens. The quality of the print, however, seems a lot better than in previous versions.

Because we do lots of illustrations, memos, page planning and what have you, I couldn't be without my Dr. Halo. It's probably the most comprehensive package you can get at the price, and it only takes up a bit less than one disk.

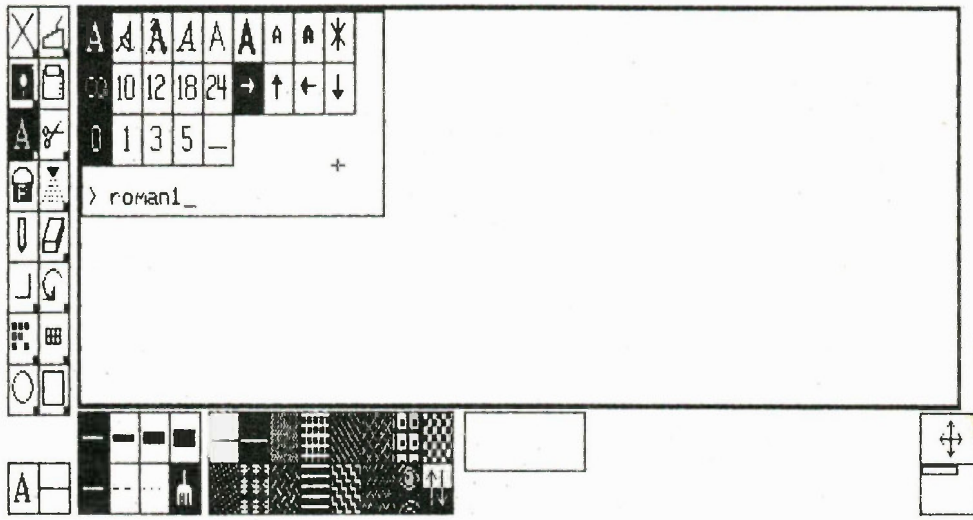


Fig. 1. The Dr. Halo II screen showing the main icons, text submenu and the virtual page icon (at lower right).

ProDesign II

ProDesign II is from American Small Business Computers, 118 South Mill St., Pryor, OK 74361, (918) 825-4844, and is one of the new generation of low-cost ($299US), comprehensive one-disk CAD systems. It's object-oriented, packed with features and easy to learn and use. Mind you, not everyone takes immediately to the object-oriented system of placing points and then activating a command. For instance, if you want to draw a line, you set the beginning, the end and then press V (for Vector). The line will then appear, unless you've selected the Rubber Band feature; this draws the line as you go. It gets trickier with more complex objects; circles are drawn by specifying the centre and the radius, and ellipses require three points. These points are not easy to find if you want precise alignment with other lines on the drawing. The object system also makes it more difficult to move things around as you can with Halo; you have to specify a new location and the symbol moves to it in one jump; if you don't like it, you have to keep trying until it looks right.

It's all the other features of ProDesign that make up for the awkward features of the object-oriented method. You can have three different kinds of cursor, three choices of grids, a snap feature that moves the cursor on a visible or invisible grid to speed up precise alignment, rotation, infinite text sizing, zooming, and an overlay function for recalling another drawing non-destructively on top of yours.

Marking, storing and recalling symbols from a disk is a breeze, but you'll have to do a bit of planning if you're making a library of electronic symbols. The trick is to be able to recall symbols such as transistors and have all the leads line up with existing lines. I couldn't find any facility included for this as there is in AutoCAD, so I worked out a library of commonly used electronic symbols, printed them out, and labelled the printout with how many cursor strokes it takes to align the leads to a specific point (ProDesign allows both cursor keys and the mouse).

Another handy feature is the ability to redraw or recall drawings with any size or angularity. Four points are specified and the drawing will appear within this shape. If you put the points down in the wrong order, ProDesign will literally turn your drawing inside out. Aside from accurate scaling, the feature is great for perspective

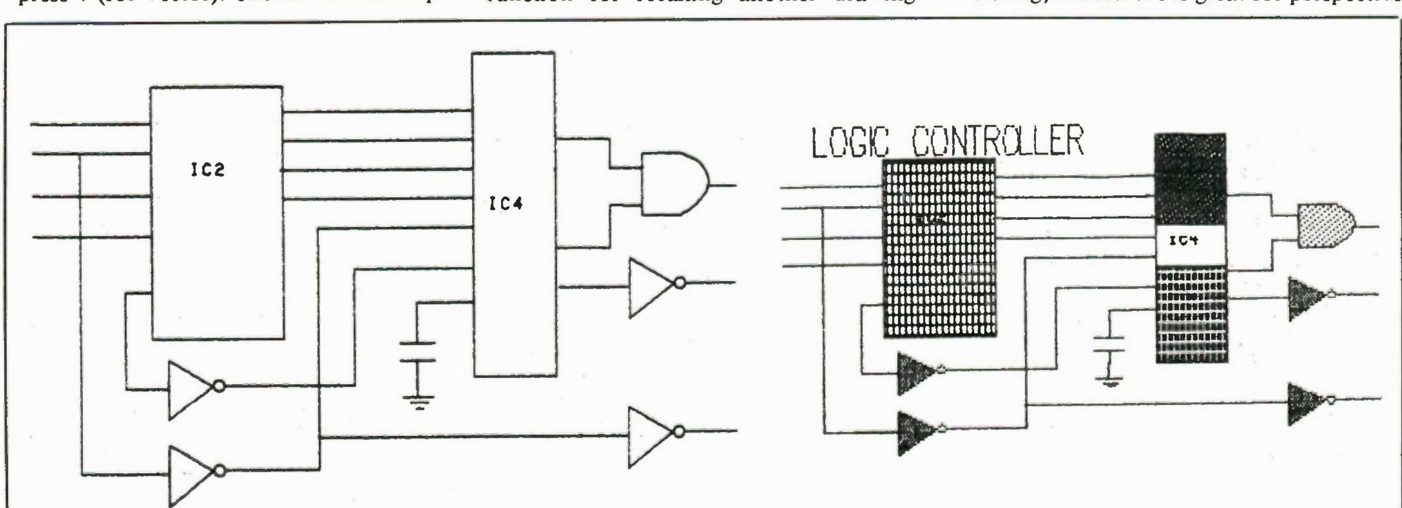


Fig. 2. Dr. Halo can enhance drawings done with other CAD programs. The logic circuit was done with ProDesign as shown on the left and enhanced, right, with some loss of definition.

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AILTECH

MODEL NUMBER	PRODUCT DESCRIPTION	LIST PRICE	SALE PRICE	QTY IN STOCK
	AILTECH			
AIL/187	PLUG-IN	9,748	5,472	1
AIL/7511C	NOISE METER	10,742	1,318	1
AIL/7618	NOISE GENERATOR	2,195	855	1
AIL/7618E	NOISE GENERATOR	2,233	1,448	2
	ANDERSON-JACOBSEN			
AJ/1212-AD2	MODEM	1,040	388	3
AJ/1233	TRIPLE COUPLER	1,147	385	14
AJ/1234	COUPLER	1,121	123	1
AJ/1255RTA	MODEM/DATAPHONE	1,175	129	1
AJ/1259	TRIPLE MODEM	1,070	384	3
	ANRITSU			
ANR/ML93A	OPTICAL PWR METER	7,438	4,496	3
	APPLIED MICROSYSTEMS			
AMC/EM-189	EMULATOR	4,805	3,117	2
AMC/EP-6809	PROBE ASSY.	2,310	1,140	1
AMC/EP-6809E	PROBE ASSY.	2,310	990	1
	BEEHIVE			
BEE/ATL-004	TERMINAL	1,532	606	5
BEE/ATL-008	CRT TERMINAL	2,302	678	1
BEE/ATL-083	TERMINAL	1,994	880	1
BEE/CC76	CONTROLLER	4,897	1,923	1
	BELL, F.W.			
BEL/HAB4-2502	AXIAL PROBE	354	38	1
BEL/HAB4-2508	AXIAL PROBE	377	250	1
BEL/HAG4-2508	AXIAL PROBE	462	50	1
	BERKELEY INST			
BER/3021	LINE NOISE GENERATOR	4,920	1,069	1
	BIDDLE			
BID/63241	EARTH TESTER	1,450	794	1
	BIOMATION/GOULD			
BIO/K105-D	LOGIC ANALYZER	33,698	17,245	3
BIO/RTE-8085A	8085A PROBE	1,199	816	1
	BIZ			
BIZ/1031-03	INTELLIGENT MOD	419	52	4
	BRADLEY			
BRA/2A/2B	IMPAIRMENT GEN	9,856	2,478	1

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	BRUEL AND KJAER			
B&K/1526A	STRAIN INDICATOR	7,686	949	1
B&K/1621	B/P FILTER	4,371	795	1
B&K/1625	FILTER SET	3,166	2,218	1
B&K/2218	SOUND LEVEL MTR	6,223	1,147	1
B&K/2230	SOUND LEVEL MTR	4,637	3,048	1
B&K/2503	BUMP RECORDER	13,686	1,505	1
B&K/2635	CHARGE AMP	3,051	1,521	3
B&K/2808	POWER SUPPLY	602	192	1
B&K/4135	MICROPHONE	1,107	340	2
B&K/4291	CALIBRATOR	4,349	525	1
B&K/4425	METER	1,522	226	2
B&K/507	ACCESSORY KIT	385	42	1
B&K/509	SLM KIT	385	42	1
B&K/7003	TAPE RECORDER	17,641	4,227	1
B&K/AO0116	COAXIAL CABLE	49	10	3
B&K/AQ0148	CONTROL CABLE	105	11	1
B&K/UA0393	RAIN COVER	748	103	1
B&K/ZM0053	FM CHANNEL	1,523	872	1
	BRUSH/GOULD			
BRU/13-4615-30	DC BRIDGE AMPLIFIER	1,371	150	2
BRU/13-4618-20	FREQ.-VOLT CONV	1,579	948	1
BRU/222	2 CHANNEL RECORDER	7,546	1,101	1
	CYBERNEX			
CYB/APL-100	CRT TERMINAL	2,841	437	1
CYB/MDL-110	TERMINAL	1,968	358	1
CYB/XL-84	TERMINAL	1,475	228	8
	DATA I/O			
DIO/121A	PROM PROGRAMER	15,092	7,038	1
DIO/1310A	VERIFIER	3,072	1,453	1
DIO/29A	PROM PROGRAMMER	7,277	2,730	6
DIO/29B	PROM PROGRAMMER	7,731	4,108	3
DIO/303A-101	DESIGN ADAPTER	609	246	1
DIO/GANGPAK	UNIV. GANGPAK	3,812	1,506	2
DIO/UNIPAK	UNIPAK	3,234	957	2
DIO/UNIPAK II	UNIPAK II	3,962	1,964	4
	DATA SOUTH			
DS/180	RO PRINTER	2,148	587	13
DS/220	PRINTER	2,610	948	5
	DATUM			
DAT/9100-210	TIME CODE GENERATOR	2,079	228	1
DAT/9300	TIME CODE GENERATOR	4,574	804	1

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	DIABLO			
DAB/1650/2	TRACTOR	334	36	1
DAB/320781-01	INTERFACE CABLE	108	21	2
DAB/320837-01	CABLE	51	13	1
DAB/F32	SHEET FEEDER	2,695	805	1
	DIEGO SYSTEMS			
DIE/101	SIG CONDITIONER	1,147	126	1
	DIGITAL COMM ASSOC.			
DCA/IRMA CARD	INTERFACE CARD	1,840	716	1
	DIGITAL EQUIPMENT CORP			
DEC/BCC05	CABLE	46	17	16
DEC/LA100KSR	PRINTER	3,534	1,190	1
DEC/LA34	KSR PRINTER	1,734	190	1
DEC/LA34-KL	KSR PRINTER	1,803	248	1
DEC/LA36	KSR PRINTER	2,775	305	1
DEC/LAX34-AL	TRACTOR OPTION	222	25	1
DEC/VT102	TERMINAL	2,633	718	8
DEC/VT1XX-AA	CURRENT LOOP OPTION	185	80	1
DEC/VT1XX-AB	ADVANCED VIDEO	416	87	18
DEC/VT1XX-AC	PRINTER PORT OPTION	593	65	4
DEC/VT220-A	TERMINAL	1,687	898	23
DEC/VT220-B	TERMINAL	1,687	830	1
DEC/VT240	CRT TERMINAL	3,380	1,177	2
DEC/VT240-B	CRT TERMINAL	3,380	1,487	1
	DORIC			
DOR/235A	DATALOGGER	10,926	3,839	2
DOR/235A-0024	FEM REMOTE	530	85	6
DOR/235A/FEM	FEM	1,906	881	5
	DRANETZ			
DRA/626PA6902C	PLUG-IN	1,271	335	4
DRA/626PA6003	PLUG-IN	2,772	1,674	1
DRA/626PA6006	PLUG-IN	1,271	139	1
DRA/626PA6009	PLUG-IN	3,072	1,525	1
DRA/626PA600R1	PLUG-IN	2,618	1,476	3
DRA/626PA600R2	PLUG-IN	2,618	1,303	1
	DYNATECH			
DYN/1500	MONITOR	12,104	3,287	2
DYN/2000	MONITOR/SIMULATOR	21,036	2,313	1
	EATON/SINGER			
ETN/DM105 KIT	FCC ANTENNA KIT	5,500	3,139	1

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ELGAR

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	ELGAR			
ELG/1751	AC POWER AMPLIFIER	7,877	3,871	2
ELG/2 UNIT CAB	INTERCONNECT CABLE	116	12	2
ELG/3 UNIT CAB	INTERCONNECT CA	116	12	1
ELG/3006B	AC LINE CONDITIONER	8,609	6,026	1
ELG/400B	BLANK PLUG IN	116	12	1
ELG/400BT	BLANK PLUG IN	100	10	1
ELG/TG704A-3D	TRANSIENT GENER	7,739	4,522	1
	EPSON			
EPS/FX80	PRINTER	853	499	1
	ESTERLINE-ANGUS			
EA/804D918	CURRENT TRANSFORMER	1,525	1,074	2
EA/S21019-1	AC AMMETER/VOLT	5,727	629	1
	FLUKE MFG., JOHN			
FLU/2180A	THERMOMETER	2,365	1,500	1
FLU/2280A	DATALOGGER	21,138	12,092	2
FLU/2280A/171	INPUT ASSY	320	204	1
FLU/2280A/176	INPUT ASSY	154	98	1
FLU/2280A/179	DIG CONNECTOR	154	101	2
FLU/5200A	AC CALIBRATOR	18,172	11,286	1
FLU/7220A	COUNTER	5,075	1,545	1
FLU/7261A	COUNTER/TIMER	3,442	1,280	1
FLU/8030A	DIG MULTIMETER	676	413	3
FLU/80K-40	HI VOLTAGE PROBE	114	70	5
FLU/8810A	DIGITAL MULTIMETER	2,609	1,193	2
FLU/9010A/6800	INTERFACE POD	1,595	425	1
FLU/9010A/6809	INTERFACE POD	1,994	792	1
FLU/9010A/8085	8085 I/F POD	1,667	483	1
FLU/9010A/Z80	INTERFACE POD	1,667	808	1
FLU/9010A68000	INTERFACE POD	3,425	1,919	1
FLU/Y2001	MULTIPOINT SELECTOR	939	123	1
	FUTURENET			
FUN/DASH-2/AT	CAD 'ADD-ON' PKG	6,780	5,040	2
	GENRAD			
GR/1433H	DECADE RESISTOR	2,998	2,012	1
GR/1658	RLC DIGIBRIDGE	5,159	2,654	3
GR/1863	MEGOHMMETER	2,723	1,222	1
GR/1982-9720	SND ANALYS SYST	6,072	4,216	1
	GRID COMPUTERS			
GRD/1121	GRID 1121	9,260	5,036	1
GRD/2102	DISK DRIVE	1,840	574	1
GRD/21040	SOFTWARE	231	25	1

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GRID COMPUTERS

MODEL NUMBER	PRODUCT DESCRIPTION	LIST PRICE	SALE PRICE	QTY IN STOCK
GRD/23010	SOFTWARE	762	83	1
GRD/6100	CABLE	100	32	1
	HEKIMIAN LABS			
HLI/3901	COMM. TEST SYS	11,473	7,765	1
HLI/3934	SIGNALING MODULE	4,800	1,927	1
	HEWLETT PACKARD			
HP/10269A/070	68000 INTERFACE	2,556	1,455	1
HP/10276A	Q-BUS INTERFACE	785	130	1
HP/10352B	GRAFLOK BACK	539	94	1
HP/10369A	CAMERA ADAPTER	169	18	1
HP/10631B	INTERCONNECT CA	123	13	2
HP/10833B	HP-IB CABLE	139	49	16
HP/1121A	AC PROBE KIT	1,355	984	1
HP/11687A	50-75 OHM ADAPT	270	74	1
HP/11852A	MIN LOSS PAD	316	185	2
HP/11975A	POWER AMPLIFIER	6,314	4,024	1
HP/13222N	HP CABLE	122	23	42
HP/13296A	HP-IB INTERFACE	1,132	124	3
HP/15508B	CONVERTER	316	204	3
HP/1611A	LOGIC STATE ANALYZER	8,470	931	1
HP/1611A/A85	PERSONALITY MOD	2,618	561	1
HP/1611A/Z80	PERSON. MODULE	2,618	1,560	1
HP/1630D	LOGIC ANALYZER	19,348	10,789	6
HP/1640A	SERIAL DATA ANALYZER	9,394	1,346	2
HP/1640B	SERIAL DATA ANALYZER	12,151	3,397	2
HP/17255	CABLE	69	13	5
HP/17501A	INPUT MODULE	1,155	127	1
HP/18135A	INTERFACE	1,690	1,165	1
HP/18137A	INTERFACE	1,463	1,031	1
HP/197B	SCOPE CAMERA	2,302	1,304	1
HP/2382A-202	CRT TERMINAL	2,772	335	1
HP/2622A	CRT TERMINAL	2,663	1,227	12
HP/2622A-202	CRT TERMINAL	2,774	305	1
HP/2623A/050	GRAPHICS CRT	7,999	1,321	2
HP/2623A/050-2	GRAPHICS CRT	7,390	1,653	1
HP/2624B	CRT TERMINAL	4,790	1,123	12
HP/2624B/050	TERMINAL	6,537	1,670	2
HP/2631B	RO PRINTER	4,706	527	1
HP/2647A	CRT TERMINAL	16,277	1,790	1
HP/2671G	GRAPHICS PRINTER	2,526	968	5
HP/2673A	PRINTER	3,450	1,441	1
HP/3311A	GENERATOR	770	402	1
HP/3312A	GENERATOR	2,233	1,095	1
HP/3325A	SYNTHESIZER	9,239	4,800	2
HP/334A	ANALYZER	4,235	2,061	2
HP/339A	ANALYZER	4,345	2,700	1
HP/3403C	VOLTMETER	6,160	687	1

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HP/3421A	DATA ACQ/CON	2,695	1,528	1
HP/3421A/020	10-CH MULTIPLEX	508	277	5
HP/3421A/541	CONTROL PACK	923	554	1
HP/3421A/561	CASSETTE DRIVE	693	434	1
HP/3421A/562	PRINTER/PLOTTER	693	434	1
HP/3438A	MULTIMETER	1,848	608	1
HP/3467A	VOLTMETER	5,259	1,987	2
HP/346B	NOISE SOURCE	2,195	1,194	3
HP/3488A	SWITCH/CONTROL	2,002	1,291	1
HP/3488A/011	GP RELAY MUX	539	355	2
HP/3488A/012	VHF SWITCH	847	542	2
HP/3488A/013	MATRIX SWITCH	693	447	1
HP/3495A/004	ASSEMBLY	1,324	528	2
HP/3497A	CONTROL UNIT	7,161	3,743	5
HP/3497A/010	ASSEMBLY	924	644	1
HP/3497A/050	ASSEMBLY	847	364	1
HP/3497A/110	ASSEMBLY	1,155	452	3
HP/355C	ATTENUATOR	539	164	2
HP/3561A	SIGNAL ANALYZER	19,058	6,879	2
HP/3575A	NETWORK ANALYZER	8,362	5,019	2
HP/3581A	WAVE ANALYZER	8,316	4,724	1
HP/3581C	SELECTIVE VOLTMETER	8,740	3,879	1
HP/3730B	DOWN CONVERTER	8,416	6,308	1
HP/3738B	R.F. MODULE	11,550	4,508	1
HP/3762A	DATA GENERATOR	14,850	7,903	1
HP/3763A	ERROR DETECTOR	13,296	6,883	1
HP/3780A	PATTERN GENERAT	11,904	4,450	2
HP/3785B	JITTER GEN/REC.	23,865	12,385	2
HP/423B	CRYSTAL DETECTOR	416	284	1
HP/4262A	LCR METER	5,829	2,533	1
HP/4271B	LCR METER	12,381	4,666	1
HP/4274A	LCR METER	14,322	5,506	1
HP/4276A	LCZ METER	6,822	4,935	1
HP/4328A	MILLIOHMMETER	2,264	1,493	1
HP/436A	POWER METER	5,236	3,787	1
HP/4436A	STEP ATTENUATOR	1,863	1,205	1
HP/4935A	TIMS	5,736	4,211	4
HP/4940A	TIMS	30,753	13,438	1
HP/4955A	ANALYZER	32,240	22,684	2
HP/5315A	UNIVERSAL COUNTER	2,387	1,572	1
HP/5335A	COUNTER	10,164	6,127	1
HP/5363B	PROBES	5,852	3,655	1
HP/59306A	RELAY ACTUATOR	1,694	186	1
HP/59313A	CONVERTER	3,542	1,756	1
HP/59501B	PROGRAMMER	1,170	643	2
HP/6002A	POWER SUPPLY	3,865	2,628	1
HP/6113A	POWER SUPPLY	1,925	211	1
HP/6205B	POWER SUPPLY	847	342	1
HP/6205C	POWER SUPPLY	1,001	690	2

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HP/6206B	POWER SUPPLY	924	561	4
HP/6209B	POWER SUPPLY	1,186	194	1
HP/6236B	POWER SUPPLY	1,095	666	2
HP/6237B	POWER SUPPLY	1,078	361	1
HP/6269B	POWER SUPPLY	3,080	2,238	2
HP/6274B	POWER SUPPLY	2,814	1,510	1
HP/64100A	MDS STATION	25,349	11,867	4
HP/64110A	MDS STATION	19,327	11,194	1
HP/64242S	68000 EMULATOR	8,470	3,862	3
HP/64252S	Z80A EMULATOR	5,606	3,118	1
HP/64262S	8048 EMULATOR	6,853	3,990	1
HP/64271A	EMUL. CONTROL	1,956	884	1
HP/64812AF	COMPILER	3,111	1,876	1
HP/69351B	OUTPUT CARD	308	33	1
HP/6940B	MULTIPROGRAMMER	3,850	1,816	2
HP/69422A	INPUT CARD	1,086	391	2
HP/69602A	TIMER/PACER	624	360	1
HP/8011A	PULSE GENERATOR	2,249	670	1
HP/8012B	PULSE GENERATOR	2,695	1,979	1
HP/8082A	PULSE GENERATOR	8,350	6,132	1
HP/8111A	PULSE/FUNC GEN	3,596	2,162	1
HP/8116A	PULSE/FUN GEN	6,132	4,505	1
HP/82905A	PRINTER	1,224	350	2
HP/82906A	PRINTER	1,224	763	2
HP/82908A	64K RAM	685	286	2
HP/82909A	128K RAM	916	448	1
HP/82936A	ROM DRAWER	69	38	1
HP/82939A	SERIAL INTERFACE	702	327	1
HP/8350B	SWEEPER MAINFRAME	7,115	4,504	1
HP/83540A	RF PLUG-IN	16,763	6,881	4
HP/8410C	NETWORK ANALYZER	12,900	7,708	1
HP/8411A	CONVERTER	9,348	6,169	2
HP/8414B	CRT DISPLAY	5,952	2,844	1
HP/8443A	TRACKING GENERATOR	10,749	5,714	1
HP/8444A	TRACKING GENERATOR	7,330	4,725	2
HP/8478B	THERMISTOR MOUNT	816	307	1
HP/8482B	POWER SENSOR	2,082	1,388	1
HP/8483A	POWER SENSOR	893	598	2
HP/8484A	POWER SENSOR	1,355	323	1
HP/8495B	ATTENUATOR	1,009	451	3
HP/85020A	RF BRIDGE	1,463	998	1
HP/85021A	RF BRIDGE	3,850	2,481	1
HP/8502B	TRANS/REFL SET	5,251	3,540	1
HP/8556A	ANALYZER	5,228	3,254	1
HP/8557A	ANALYZER	11,548	6,623	1
HP/85650A	QUASI-PEAK ADAPTER	7,669	4,464	2
HP/8565A	ANALYZER	44,006	27,941	2
HP/85F	COMPUTER	5,954	1,614	4
HP/86230B	SWEEPER PLUG-IN	5,929	809	1

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MODEL NUMBER	PRODUCT DESCRIPTION	LIST PRICE	SALE PRICE	QTY IN STOCK
HP/86250D	SWEEPER PLUG-IN	8,124	4,749	1
HP/8640B	GENERATOR	17,724	10,923	4
HP/8656A	GENERATOR	12,503	8,600	4
HP/86603A	RF SECTION	14,630	8,810	1
HP/86632B	PLUG-IN	4,620	3,131	1
HP/8663A	SYNTHESIZER	91,160	48,187	1
HP/8684B	SIGNAL GENERATR	26,649	15,008	2
HP/8901A	ANALYZER	17,234	10,781	3
HP/8903A	ANALYZER	11,832	7,256	4
HP/9133D	DISK DRIVE	5,151	3,006	1
HP/98036A	INTERFACE	1,140	462	2
HP/98046B	INTERFACE	1,555	171	1
HP/98217A	ROM	798	87	2
HP/98254A	ADD-ON MEMORY	1,540	337	1
HP/98256A	256K RAM	1,278	553	13
HP/98261A/004	LANG ROM	2,179	290	2
HP/98261A/011	LANGUAGE ROM	2,179	397	2
HP/98261A/715	LANGUAGE SYS.	2,333	870	1
HP/9826A	CALCULATOR	14,684	5,806	3
HP/9836A	COMPUTER	19,204	7,964	2
HP/98413A	ROM	809	88	1
HP/9845T	CALCULATOR	43,713	4,808	1
HP/98601A/655	LANGUAGE SYS.	2,179	1,091	2
HP/98615A/655	LANGUAGE SYS.	2,333	1,042	1
HP/98627A	INTERFACE	1,555	646	2
HP/9872C	DIGITAL PLOTTER	8,932	3,038	1
HP/9885M	DISK DRIVE	5,390	592	1
HP/9895A	DISK DRIVE	9,101	1,423	3
	HITACHI DENSHI			
HIT/V-1100A	100MHZ SCOPE-DISTRIB	4,535	2,467	1
HIT/V-209	SCOPE-DISTRIBUTOR	1,155	689	1
	HONEYWELL			
HON/122-RACK	AMPLIFIER RACK	1,363	149	1
HON/1858	VISICORDER	17,495	10,719	2
HON/1882LGD	AMPLIFIER	1,571	172	2
HON/1883MPD	AMPLIFIER	631	294	20
HON/1885SGC	MODULE	1,579	173	4
HON/1887TCD	DIFF AMP MODULE	1,609	571	4
HON/612	HYGROMETER	935	505	15
	HUGHES			
HUG/1177H02	TWT AMPLIFIER	12,590	2,014	2
	I.B.M.			
IBM/DOS 2.0	SOFTWARE	92	10	2
IBM/DOS 2.1	OPERATING SYS	100	10	15
IBM/DOS 3.0	SOFTWARE	100	10	5

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I.B.M.

MODEL NUMBER	PRODUCT DESCRIPTION	LIST PRICE	SALE PRICE	QTY IN STOCK
IBM/PC	MICROCOMPUTER	2,695	1,903	9
	IFR			
IFR/1100S	COMM. MONITOR	16,409	9,938	1
IFR/FM/AM-500	SERVICE MONITOR	8,490	5,372	2
	INTEL			
INT/ICE-49	EMULATOR	6,930	762	1
INT/ICE-85B	MCS-85 EMULATOR	8,470	5,010	1
INT/III 520	INTERFACE	2,772	1,813	1
INT/MDS-201	XPANDER CHASSIS	3,427	1,706	1
INT/MDS-225	MDS SYSTEM	25,410	2,795	1
INT/MDS-286A	DEV. SYSTEM	36,806	14,328	1
	KEITHLEY INSTRUMENTS			
KEI/616	ELECTROMETER	4,458	1,873	2
	KROHN-HITE			
KRO/3342	FILTER	4,458	490	1
	LEAR-SIEGLER			
LSI/ADM-11	TERMINAL	1,070	399	5
LSI/ADM-31	CRT TERMINAL	2,387	262	1
LSI/ADM-31-1	CRT TERMINAL	3,850	423	1
LSI/ADM-36	CRT TERMINAL	1,840	476	1
LSI/ADM-42A	CRT TERMINAL	2,002	243	1
LSI/ADM-5 GP	DUMB TERMINAL	882	188	1
	MARCONI			
MAR/TF2091B	NOISE GENERATOR	7,238	796	1
MAR/TF2092B	RECEIVER	7,238	796	1
MAR/TK2095/3	FILTER	886	486	1
MAR/TK2096	FILTER	886	97	1
	MILLENNIUM			
MIL/9508S	MDS EMULATOR	8,008	4,759	1
MIL/XE6801	EMULATOR	4,574	2,258	1
	MOTOROLA			
MOT/MEX6832-22	32K MEMORY	1,194	613	1
	NEC - NIPPON ELECTRIC			
NC/3550	PRINTER	2,218	980	8
NC/35XX-7	5	1,532	484	1
NC/35XX-8	PRINTER ACC.	347	107	1
NC/35XX-9	PAPER GUIDE	139	76	4
NC/7710	PRINTER	3,773	1,133	2
NC/77XX-6	TRACTOR	539	244	1

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NICOLET

MODEL NUMBER	PRODUCT DESCRIPTION	LIST PRICE	SALE PRICE	QTY IN STOCK
	NICOLET			
NIC/4094-2	OSCILLOSCOPE	25,102	15,856	2
NIC/XF-44/2	DISK DRIVE	5,544	3,356	2
	NORTHEAST ELECTRONICS			
NEC/4002	TEST SET	6,160	802	1
NEC/TTS41-3A	ANALYZER	17,325	9,557	2
	OKIDATA			
OKI/82A-SS	PRINTER	468	191	1
OKI/83	RO PRINTER	1,153	126	1
OKI/83-SS	RO PRINTER	1,338	147	1
OKI/83A	PRINTER	1,153	345	6
OKI/84P	PRINTER	1,384	641	4
	P-CAD			
PCD/PCB-2	CAD PCD & SCH DESIGN	22,287	9,608	2
	POWER DESIGNS			
PD/6050C	DC LAB POWER SUPPLY	960	684	6
	PROLOG			
PRO/GC-3	CONFIGURATOR	231	28	2
PRO/GC-4	CONFIGURATOR	231	98	1
PRO/GC-5	CONFIGURATOR	231	25	1
PRO/GC-6	GANG CONFIG	231	25	1
PRO/M980	PROGRAMMER	3,827	884	2
PRO/PA16-1	ADAPTER	185	20	1
PRO/PA24-10	ADAPTER	185	69	1
PRO/PM9047	MODULE	755	83	1
PRO/PM9074	MODULE	847	286	2
PRO/PM9075A	PERSONALITY MOD	1,848	239	3
	QUADRAM			
QAD/QUADMEG-AT	QUADRAM AM0128	895	500	2
	RAYTEK			
RAY/R2-LT	THERMOMETER	3,072	1,743	3
	RIXON			
RIX/905-6611-0	PERSMISSIVE CBL	108	44	6
RIX/905-6675-0	CABLE	100	65	1
RIX/LDM710-L1/	MODEM LMTD DIST	460	108	9
RIX/PC212A	MODEM	768	311	4
RIX/R212 EXEC	MODEM	922	394	36
RIX/R212A	MODEM	768	199	1
RIX/T209A	MODEM	6,152	1,265	2
RIX/TA201C	MODEM	1,538	526	3

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MODEL NUMBER	PRODUCT DESCRIPTION	LIST PRICE	SALE PRICE	QTY IN STOCK
	RIXON			
RIX/TA208A/B	MODEM	2,957	1,093	7
	ROD-L ELECTRONICS			
RLE/M100BV	TESTER	4,466	2,848	2
	TEC-COM			
TCM/3001	COUPLER	229	26	6
	TEK-TRAN			
TKN/822	DUAL DATA CASSE	2,723	299	1
	TEKTRONIX			
TEK/016-0249-0	ADAPTER	100	10	2
TEK/016-0342-0	CAMERA ADAPTER	354	116	1
TEK/016-0357-0	ADAPTER	31	20	1
TEK/12RM02	8085 PROBE	924	577	2
TEK/12RM41	Z80 PROBE	924	652	2
TEK/1405	ANALYZER	8,901	3,826	2
TEK/1410R	GENERATOR	42,244	8,168	2
TEK/147A	GENERATOR	15,015	5,442	1
TEK/1485R	MONITOR	10,164	5,994	3
TEK/149A	GENERATOR	15,015	9,366	2
TEK/1502/4	PLUG-IN	1,705	1,014	1
TEK/1503	TDR	8,500	4,446	1
TEK/177	FIXTURE	2,017	1,036	1
TEK/214	SCOPE	4,004	2,544	2
TEK/318	LOGIC ANALYZER	10,010	6,357	1
TEK/338	LOGIC ANALYZER	10,780	7,001	1
TEK/434	SCOPE	8,239	4,469	1
TEK/466/DM44	SCOPE	12,197	6,545	1
TEK/520A	VECTORSCOPE	13,129	4,575	2
TEK/577D1	CURVE TRACER	9,818	6,067	1
TEK/655HR-1	MONITOR	11,920	5,460	2
TEK/7603	MAINFRAME SCOPE	4,551	2,113	2
TEK/7613	MAINFRAME SCOPE	8,725	3,066	1
TEK/7834	MAINFRAME SCOPE	20,105	2,378	1
TEK/7844	MAINFRAME SCOPE	23,592	13,020	1
TEK/7A26	PLUG-IN	3,319	2,304	2
TEK/7B80	PLUG-IN	2,356	1,723	2
TEK/7B92A	PLUG-IN	5,506	3,363	1
TEK/7D02	PLUG-IN	13,740	9,397	1
TEK/7L14	ANALYZER	27,812	17,676	1
TEK/7L5	ANALYZER	19,450	11,440	1
TEK/8002/49	MEMORY	2,387	262	4
TEK/8300E15	EMULATOR CARD	9,394	4,443	1
TEK/8300E40	80186 EMULATOR	7,905	3,672	1
TEK/8300P18	8088/87 PROBE	4,620	2,476	1
TEK/832	TESTER	3,072	337	1
TEK/833	DATACOM TESTER	4,235	2,638	2

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MODEL NUMBER	PRODUCT DESCRIPTION	LIST PRICE	SALE PRICE	QTY IN STOCK
	TEKTRONIX			
TEK/834R03	LINK TEST ROM	570	356	2
TEK/8540	DEVLPMT SYSTEM	50,710	21,278	1
TEK/8550F03	TRACE ANALYZER	6,006	4,422	1
TEK/9109	D.A.S. MAINFRAME	14,322	6,684	2
TEK/91A08	DATA MODULE	6,137	3,664	4
TEK/91A32	DATA MODULE	7,685	4,841	3
TEK/91P16	P.G. MODULE	6,145	3,384	4
TEK/C30B	CAMERA	2,225	1,398	2
TEK/C59P	CAMERA	2,025	774	3
TEK/CT-5	CURRENT PROBE	1,771	535	1
TEK/J16	PHOTOMETER	2,104	1,000	3
TEK/J6503	PROBE	901	596	5
TEK/J6505	PROBE	901	651	2
TEK/J6523	PROBE	2,625	1,779	1
TEK/L3	PLUG-IN	2,433	1,563	2
TEK/P6046	PROBE	2,695	1,804	1
TEK/P6063B	PROBE	331	121	6
TEK/P6202	PROBE	1,040	480	2
TEK/P6462	PROBE	524	370	4
TEK/SG502	OSCILLATOR	1,324	405	1
TEK/TM506	MAINFRAME	1,019	571	1
TEK/TR502	GENERATOR	10,195	3,420	1
	TELECOMMUNICATIONS TECH			
TTC/2000/392	RS-232 ASYNCH I/F	1,329	146	1
	TELEVIDEO			
TVI/914	CRT TERMINAL	1,076	306	1
TVI/924	CRT TERMINAL	1,384	419	15
TVI/950	CRT TERMINAL	1,840	500	5
TVI/970	CRT TERMINAL	2,302	646	3
TVI/TP750	PRINTER	1,840	776	4
TVI/TPC2	MICROCOMPUTER	3,688	1,427	1
TVI/TS1605	MICROCOMPUTER	3,996	1,447	2
	TEXAS INSTRUMENTS			
TI/743-2	KSR TERMINAL	1,802	257	2
TI/745-239	KSR TERMINAL	3,996	439	1
TI/820-613-PKG	KSR PRINTER	5,513	606	1
	TEXSCAN			
TEX/AFS-1	ANTENNA	216	37	2
	VELONEX			
VEL/510	GENERATOR	9,625	5,377	3
VEL/587	TRANSIENT GEN.	26,335	13,087	1
VEL/V-2269	ISOLATION NETWK	1,771	1,085	3
VEL/V-2734	ISOLATION NET.	10,811	6,616	1

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VENTEL

MODEL NUMBER	PRODUCT DESCRIPTION	LIST PRICE	SALE PRICE	QTY IN STOCK
	VENTEL			
VEN/502-1	TELEPHONE	185	20	1
VEN/MD212-1-00	MODEM	926	103	1
VEN/MD212-3	MODEM	906	270	11
	WANDEL & GOLTERMANN			
WG/PJM-1	METER	8,393	1,804	1
	WANG LABORATORIES			
WANG/WOA-20/55	COMPUTER	7,846	4,533	1
	WAVETEK			
WAV/148	GENERATOR	3,100	1,800	1
WAV/171	GENERATOR	2,302	891	1
WAV/178	SYNTHESISER	8,462	4,805	1
WAV/180	GENERATOR	1,532	168	1
WAV/1801B	GENERATOR	5,044	2,619	2
WAV/2001	SWEEPER	5,692	2,320	1
WAV/2002A	SWEEPER	9,879	6,919	1
WAV/3002	GENERATOR	8,462	4,929	2
WAV/3006	GENERATOR	7,700	5,005	2
	WESTERN GRAPHTEC			
WAT/4301	X-Y RECORDER	3,819	2,632	1
WAT/WTA8101-J	THERMOCOUPLE PREAMP	275	30	3
	WILCOM			
WLC/T207	TEST SET	5,395	1,035	1
	WILTRON			
WIL/9361B	TEST SET	7,623	4,045	3
	Z - ODDS AND ENDS			
EIA/RS232-25	CABLE	75	15	8
MIC/MICE8086-8	MICE 8086-88 POD	5,999	4,175	2
MIC/PWR SPLY	MICE POWER SUPPLY	395	261	2

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views.

The virtual screen in ProDesign is the best I've seen. The page is four times the size of the screen and is divided into overlapping windows; a tiny icon at the top shows you what section you're in. To change window locations you just cursor over to the edge and pop into a new screen.

Disadvantages include: only one paint function and not a very good one at that, and only two fonts. I discovered that the file deletion section could cause a reboot if you used the extension "PD1" on the filename. Since ProDesign puts the extension on automatically, I guess it didn't know what to do when it saw the extension already there. It's the only fatal error I've ever come across with ProDesign; it's actually very well designed and user-friendly.

The printout feature is when you'll see ProDesign really shine. Using only an Epson Homewriter dot matrix printer, I can turn out drawings worthy of a plotter, with perfect curves and no jaggies. When you select the third and highest of the three available print resolutions, ProDesign employs smoothing routines that use the maximum possibilities of the dot matrix printhead. It's a bit slow, of course, because of multiple passes and the necessary calculating time, but the quality is second to none. You can also specify any page size you like and the drawing will be scaled to suit. Also, it prints out only the area you've actually drawn in, unlike Halo, which prints the entire virtual page, empty or not.

Because it's compact, fast and inexpensive, ProDesign II is my favourite drafting program, and since getting it I've retired the Letraset and technical pens.

Compatibility

Since Dr. Halo stores its files as binary and ProDesign uses ASCII coordinates, it would appear that the two systems are utterly incompatible. Actually, there's a way around this: the Grab file utility that comes with Halo. In the accompanying illustration, I've used the Grab memory-resident program to store a ProDesign schematic as a Halo file. I then called this file into Halo and embellished it a bit with painting and different text. A drawback to this convenience is that you lose the ProDesign high-res smoothing routines when the file is printed back out again with Halo. You can't have everything.

The Cover

This month's cover was done with Dr. Halo, ProDesign and some studio trickery. The schematics were drawn normally using ProDesign, stored on the disk and recalled using the four-point method to get the extreme perspective. Then the starburst and stars were drawn with Halo, using the airbrush icon. After printing out, the drawings were contact-printed onto 8 by 10 sheets of Kodalith high-contrast film. Colored gels were taped behind the schematic negatives and the three placed on a light box and photographed onto 4 x 5 Ektachrome five stops above the meter reading (Zone 10 to fanatics). The schematics were replaced with the starburst and double exposures made.

It's interesting to note that drafting programs have trouble with circles when they try adjusting the perspective. Note the weird ellipse on the leftmost of the two inverter gates at the bottom right of the cover. That ellipse used to be a tiny circle before I twisted things around. I assume the distortion of the ellipse has to do with where you specify the two required points; if they're off-centre it skews the ellipse on the wrong axis.

Cruise Control

Here's a nifty RAM-resident program we came across by way of a review copy. It was originally designed to prevent cursor overshoot in software like word processors and spreadsheets, and turns out to be just the ticket for drafting programs. ProDesign in particular suffers from an over-enthusiastic cursor; if you hold down the auto-repeat too long, the cursor hits one of the margins and the display just sits there redrawing itself over and over until the buffer empties. Cruise Control shuts off the auto-repeat the instant your finger leaves the key. In addition, you get an timer that dims the screen if the keyboard is unused for a preselected number of minutes. Even the large programs that demand 512K usually leave you enough room to load small RAM programs like Cruise or mouse drivers. Originally released at $29.95US, Cruise Control is from Revolution Software Inc., 715 Route 10 East, Randolph, NJ 07869, (201) 366-4445.

AutoCAD

If you're doing complicated drafting and you need every possible facility in one program, AutoCAD is for you. It's the most comprehensive program going; it's certainly the largest and most expensive. You'll need 512K and two drives, and from the number of disk accesses the program makes, a hard drive will eliminate a lot of disk swaps.

The program consists of four disks: the main file, the overlays, the shape tables and the driver files. Unless you have a hard disk, the overlays remain in B drive and the disk for storing your files goes in A. Occasionally the program will want to look something up from one of the other disks and a swap is necessary. The drivers are used only when configuring the system, and the disk contains device drivers for almost all popular mice, digitizers, plotters, graphics cards, etc.

The latest version, 2.5, also has device drivers for dot-matrix printers as well as plotters, though only four are listed (Datacopy 90, Epson, HP Laserjet and Okidata). The dot-matrix method isn't up to the quality of a plotter with a felt-tip pen, but it's just fine for most uses. It's also cheaper and more convenient than fiddling with pens.

The number of functions in AutoCAD boggles the cortex, as you'd expect from a program with a 247K EXE file and two disks worth of overlays. Fortunately, the menus and directories are first rate, giving you the ability to cursor from one menu to the next with a click of the mouse, plus comprehensive Help files that pop up an explanation of any command if you type a question mark.

It's the most time-consuming to learn, as you'd expect with so many available functions, but it's all worth it when you need to do a complex drawing with lots of features. The cursoring (mousing?) is fast and accurate; it's helped no end by a feature that assists the crosshairs in locking onto the nearest point - you don't have to jiggle the mouse hither and yon to join one line to another. Another nice touch, and an unusual one for an object-oriented system, is the ability to "drag" an object around the screen until its location suits you.

Another function that's ideal for schematics is the ability to specify how a recalled symbol will be attached to existing lines, eliminating the need to calculate the number of cursor keystrokes and so on.

The paint function ("Hatch") has to be seen to be believed. There are *pages* of different textures, most of them corresponding to ANSI architectural standards. Here's where you'll really want an accelerated computer; the Hatch takes forever on a regular PC, especially if the screen redraws itself much.

The new version has also increased the operating speed of the Pan and Zoom functions over the previous editions, and colour and line type can be attached to individual entities rather than whole layers.

Another great advantage of AutoCAD is the support offered by the publishers and by third-party companies. All sorts of utilities, expansions, interfaces and hardware is available. AutoCAD 2.5 is published for $2750US by Autodesk Inc., 2320 Marinship Way, Sausalito, CA (415) 332-2344, with a network of local distributors and dealers worldwide.

Bill Markwick

GENERIC CADD

On first sight, Generic CADD from Generic Software, represented in Canada by Saraguay Software Distributors, P.O. Box 117, Station P, Toronto, Ontario M5S 2S6, (416) 924-7218, looks like *the* bargain buy in CAD packages. For a very moderate price, only about a hundred dollars, US, you get something that looks and acts like the megabuck design systems.

Upon closer examination a few serious flaws do appear, marring this idealized view. Nevertheless, Generic CADD is a potent choice among drafting packages, and well worth a serious look.

One thing's for sure: Generic CADD is the clear winner in the AutoCAD lookalike contest. As you might expect, this borrowed user interface brings a certain sophistication to the system. The screen layout certainly looks familiar: a vertical menu down the right side, coordinate display tucked into the upper left corner, and prompt lines appearing along the bottom.

Despite their illustrious antecedents, Generic CADD menus end up being structured much the same as your average pull-down system -- they just happen to run vertically rather than horizontally. However, the main, or "root", menu contains an relatively large number of options. These include: draw, components, text, zooms, edit, windows, layers, drawing, controls, grids, display, units, utility and measure. The mildly experienced CAD user will realize that these headings summarize a fairly powerful set of features. Selecting an option from the root menu places the user in a subsidiary menu that contains the actual drawing functions.

As with more expensive systems the Generic CADD user is not restricted to merely picking options off of a menu. All functions are fundamentally represented by mnemonic two-key commands. For instance, *qu* means "quit", and *ds* means "drawing save". Each of the menus tends to group commands with a common first letter, much the way WordStar commands are grouped into five menus according to the first of their two control key codes. In CADD, drawing commands start with D, component library commands with C, and window commands with W. Some of the other groups are less coherent, but it's amazing how quickly you can pick up a basic vocabulary.

The program is always ready to seize your first two letter keystrokes, and attempt to execute them as a command.If you enter numbers rather than letters, preferably in two groups, separated by a comma, they will be used to reposition the cursor to an absolute coordinate location. As an added convenience, Generic CADD even allows you to assign your own favorite commands to the function keys.

This command driven structure permits Generic CADD to implement two more advanced features -- batch programming and custom menus. As in DOS,

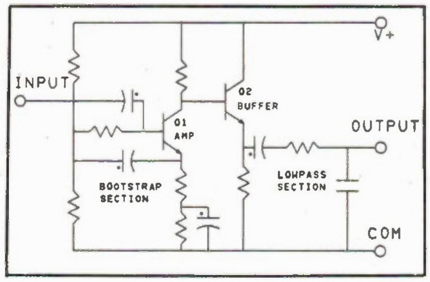


Fig. 3. Part of the cover schematics done with ProDesign, without computer-aided perspective and with added labelling.

CADD batch files are simply ASCII text files containing a string of valid commands. The software has an option that allows any drawing to be saved in this format, as a long string of commands that will recreate the image. Menu files are similar, each line of the file giving a menu word followed by the commands to be executed should that word be selected by the user.

While it sports this sort of advanced bells and whistles, Generic CADD does not forget to include all the fundamental drawing operations that one could imagine. You can create circles, rectangles, arcs, spline curves or lines. You can edit the drawing using either specific object references, or use the "window" commands to select objects for editing using the familiar "rubber band" box method. You can erase, copy, move, stretch, rotate or re-scale objects.

The CADD virtual working surface is laid out as a Cartesian coordinate map, dimensioned in either metric or British units. You start out at zero zero, and move freely off into the distance. The constant onscreen coordinate display normally shows your position in the chosen units. You can also reset it to display arbitrary absolute distances, or relative distances from your last plotted point.

Zooming and panning are both tied to this coordinate system. You can shift the viewing window either by specifying a new center point, or by pointing with the cursor. The handy "zoom all" and "zoom limits" commands can be used to either fill the screen with your drawing or give you a bird's eye view of the entire drawing surface.

Images in Generic CADD are both object oriented and layered. The layering is extremely flexible. Up to two hundred and fifty-six layers may be defined, and each layer can be either displayed or hidden at any time. Editing is always restricted to the "current" layer. Objects can be moved from one layer to another. Entire layers can be erased at one swoop. Also, the properties of a layer -- color, line type and layer number -- can all be reset.

Object libraries can easily be created using CADD, although none are available as prefab accessories. To create a "component", one simply draws the component, defines a reference point and then saves using a special command.

When recalling components, one has the option of scaling, rotating, and stretching them. Once positioned, a component is treated as a single drawing object, unless it is specifically "exploded" for more detailed editing. The "component list" command presents a list of all components available in the current drawing, and lets the user pick any of them just as he would a stock drawing primitive like a circle or rectangle. Furthermore, the "component dump" command allows one to save all available components *en masse* -- handy for creating a comprehensive collection of all the components used in a particular design.

For output, Generic CADD supports various plotters. If you want to use your dot matrix printer, you'll have to spring for the accessory module, DotPlot. This lets you dump any CADD file to your

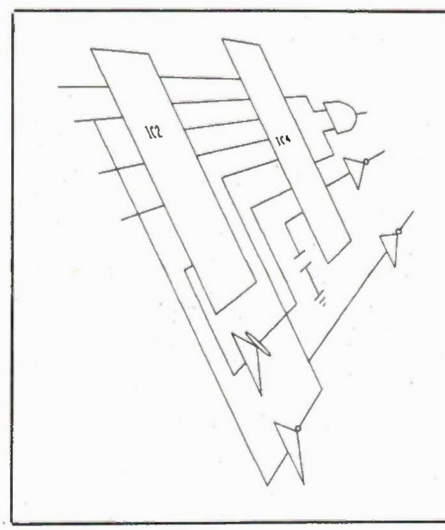


Fig. 4. The schematic of Fig. 4 after perspective distortion was added with ProDesign.

printer, at low, medium or high resolution. The process is time consuming; it took almost twenty minutes to get a relatively simple drawing at low resolution. However, if you want to avoid the expense of plotting equipment, DotPlot is a bargain. It even offers a preview of the

Continued on page 43

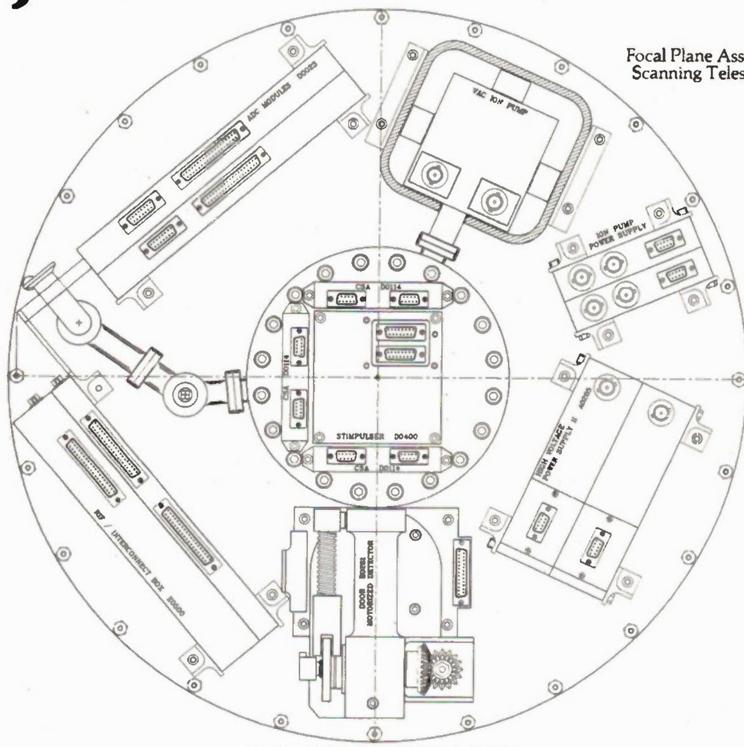
Two schools of thought on the subject of AutoCAD™

The sky is the limit.

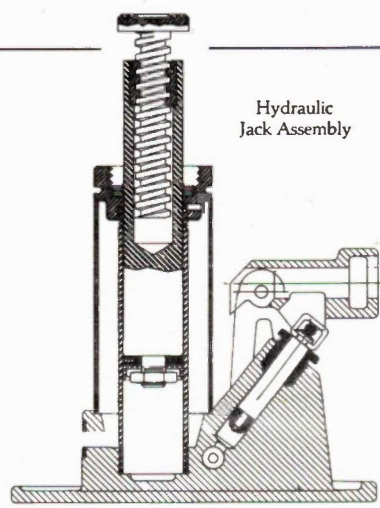
When professors at the UC-Berkeley Space Science Laboratory had a satellite-bound telescope to design, a budget to meet, and a variety of options available, they chose AutoCAD. The results are evident, the reasons are many. AutoCAD offered the flexibility, features, and accuracy that a project of this magnitude required.

Power to the pupil.

To students at the University of Nebraska-Lincoln, dodging the draft means minimizing the tedium of repetitious design tasks, while maximizing the time available to master the future tools of their trade. Their answer is straight-forward, easy-to-learn, PC-based CAD software called AutoCAD. Their question, why have we waited so long?



Courtesy of University of California-Berkeley Space Science Laboratory



Courtesy of University of Nebraska-Lincoln

Whatever the school of thought, educators agree that the simplicity of teaching AutoCAD to future engineers, designers, architects, and technical illustrators will help to ensure a workforce that is ready for whatever challenge and change technology brings.

Educators also appreciate the fact that the role of AutoCAD does not stop in the classroom. Autodesk, Inc., the developers of AutoCAD, work closely with educational administrators to evaluate specific CAD curriculum needs, provide training and assist in implementation.

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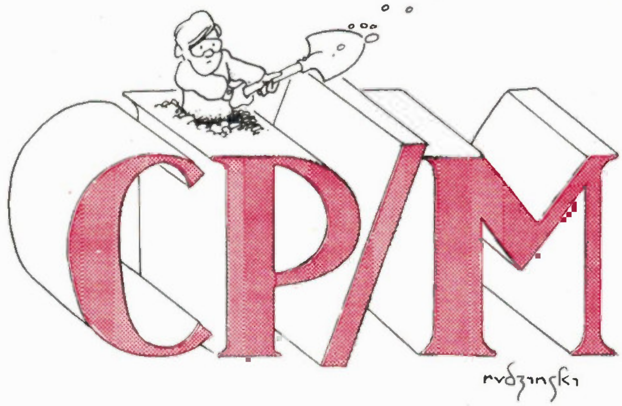
Almost Free CP/M Hacker Software

CP/M is anything but a dead language . . . if you are into hacking code on this powerful operating system you'll know that it's one of the most flexible environments there is to develop software in. Beyond all this, of course, it's enormous fun.

We haven't lost touch with CP/M. Because there is still so much interest in developing assembly language programs for it we have brought together a collection of the latest releases of CP/M based programmer's tools from the public domain. Included here are debuggers, disk utilities and a number of other extremely powerful programs which have evolved into packages which far excel commercial programs in many cases.

Included on this disk are:



SUPERZAP This is a disk utility similar to the DU programs . . . the latest one of these is also included. Superzap lets to modify your disks at the track and sector level, patching code and fixing BDOS errors. However, unlike DU it's all menu driven, with a full screen editor.

DU-V88 The DU programs have been the universally accepted disk utilities for CP/M since prehistoric times. While not overly friendly they offer every conceivable feature. Included here too is the long sought DU DOC file.

MEMDSK32 is the best memory disk program we've ever seen for CP/M. Far from needing a week of hacking to get it going, it runs on any 64K system without patches or parameters to create a 32K RAM disk labeled drive D. The source is included should you want to alter its parameters. This makes things like ASM and MAC work like they had wings on their feet.

ZDEBUG is a Z80 debugger. Its function is analogous to that of DDT, but it works in Zilog mnemonics rather than those of the Intel 8080. As such, it'll handle Z80 code and not give you lines of question marks when you're trying to patch your BIOS or other commercial software.

COPY is a handy program for users of systems that don't have a way to copy entire disks. This will take everything . . . files and system tracks . . . and pop'em over to another floppy. The source file is provided.

PROBE digs through your version of CP/M and tells you everything there is to know about it, including things like the locations of its various components, where things jump to, how the disk allocation is set up and so forth. It's a splendid asset to low level programming.

ZESOURCE and REZ are the most fiendish disassemblers in creation. They will allow you to create pretty good assembler code from a COM file . . . with a bit of ingenuity you'll be able to recreate most existing software to enable you to learn its secrets and patch it for your own applications. It's especially useful for patching CP/M. Both are supplied to allow you to use either simple assemblers or M80 and L80.

ASM65 is a 6502 cross assembler. It runs under CP/M but it assembles 6502 source code. It's extremely useful for developing sophisticated Apple software, of course, and for doing EPROMs for 6502 based systems. In fact, it supports the entire range of 6500 series processors.

MLOAD24 is a replacement for the LOAD command . . . with considerably more power behind it. It is ideal for doing loads that call for merging in overlays, multiple hex files and so on.

All of the above software is supplied with appropriate documentation in the form of DOC files. It is the software we use to create and modify CP/M programs. All of it is in the public domain.

This collection is available for

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(this is two single sided disks or one double sided disk, as needed. It is available for Apple CP/M, eight inch SSSD format and all of the five and a quarter inch formats listed in the Almost Free software section elsewhere in this magazine.)

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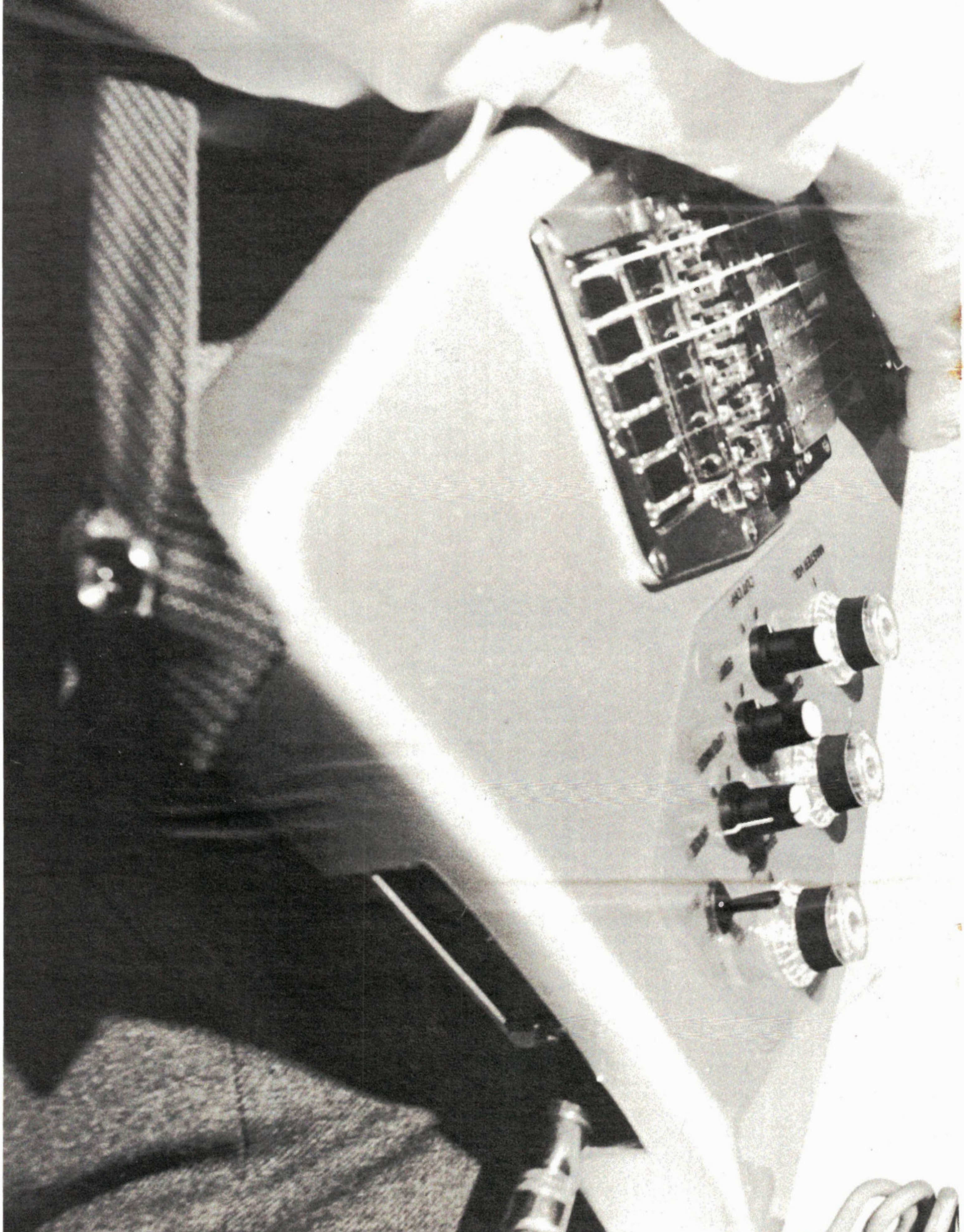
Fine Print: All of this software was obtained from public bulletin boards and is believed to be in the public domain. Our charge defers the cost of collecting, testing and assembling this collection, plus the cost of the media and its shipping and handling. We are not charging for the software itself.

We have done our best to ascertain that this software does what it says it does. We are not, however, able to assist you in adapting it for your application.



The DI Connection

Optimize your stage or studio sound with a Direct Input.

By Bill Markwick

IF you play on stage or in studios with a fair amount of equipment, or if you're the recording engineer, you'll have met the DI. The Direct Input, or Direct Insertion, or Direct Injection, is one of several number of methods of sending an instrument's signal straight to a mixing console via input cables. In some cases, such as electronic keyboards, it can't be avoided. In others, such as instrument amps or acoustic instruments, it's a way of avoiding microphones with their attendant problems of level, feedback, etc. Here's a rundown of the various ways the DI is used, plus a few operating hints.

Keyboards

The electronic keyboard is very popular these days, what with its light weight and enormous versatility. While the musician might like to have a small instrument amplifier near the keyboard for checking on the sound, miking these amps introduces problems for the sound people: placing the mike properly, using up another stand, getting feedback howl and so forth.

On the back of the keyboard there will be one or more output connectors. The most popular type and the most inexpensive is the unbalanced line. This is a single conductor with a shield, and generally terminates in a 1/4" phone plug and jack system. It's sometimes incorrectly called "single-phase" - all sound lines are single-phase; they're either balanced (two wires plus shield) or unbalanced (single wire plus shield).

The output impedance of the unbalanced line might be just about anything, but the majority of equipment these days uses an emitter-follower or an opamp, giving a very low impedance that suits any load at the other end.

Most mixing consoles designed for stage use have a 1/4"jack for an unbalanced input in addition to the usual 3-pin microphone inputs. They may be marked "high impedance", which just means that the console won't load down the keyboard's amp. It's safe to drive a high-impedance input from any source.

The DI couldn't be simpler here. Just run a shielded cable with suitable connectors over to the PA console. There's one disadvantage: the unbalanced line has no noise rejection as does the balanced type, meaning that it's susceptible to hum pickup from crossing power cables or RF interference. If this happens, try relocating the cable away from other wires (if that's even possible on today's hitech stage) or try replacing the cable. Various brands of cable have varying effectiveness when it comes to shielding; try different makes if you can.

If the keyboard has a 3-pin XLR output labelled "mic level" or similar, it's even easier. One of the regularmicrophone cables can be plugged into this. It's likely that the mixing console has a gain control on the microphone input, allowing it to adapt to whatever level comes out of the keyboard (probably 10mV to 500mV). In the unlikely event that the output signal is too high for the console to handle, I've drawn a handy attenuator in **Fig. 1**. It gives a choice of -6dB for mild overload, -10dB for medium and -20dB for curing heavy-duty distortion problems. I've assumed that the console input impedance is somewhere between 600 and 1200 ohms (typical values); the input impedance of the attenuator is a bit low at about 1000 ohms, but shouldn't bother most solid-state equipment. The

Continued on page 41

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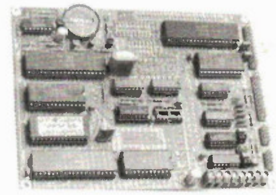

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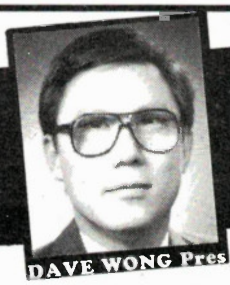

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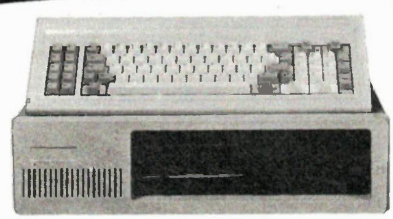

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Continued on page 39

into an XLR. By the way, label it with something durable or you'll puzzle some poor soul later if they think it's a regular mike cord. If you're not into soldering at all, the Shure company makes a similar gadget with XLR terminations that fits into any mike cable. Ask a Shure microphone dealer for information on the A15 series of attenuators.

Unbalanced to Balanced

Suppose the keyboard or other instrument amp has only an unbalanced output jack, putting out a large signal (line level, about 1/2 to 2 or 3 volts), and you need to feed this into a console which has no unbalanced line inputs, as is possible with lots of studio consoles. Fear not. This part is easy, if expensive.

In **Fig. 2** I've shown a Hammond professional audio transformer wired to (a) reduce the signal from line level to a voltage suitable for a console microphone input and (b) convert the unbalanced output to an isolated, balanced line. The microphone should be mounted in a utility case ("handy box") to protect the wiring. I'm sorry to have to break the news that the Hammond pro audio transformers will set you back about $30 to $50 each depending on the model. On the other hand, they're beautifully made and probably have better specs than the equipment they're used with. If you have severe hum problems, try opening the wiring at the dotted line to break the ground loop.

This business of isolation is a great thing from the point of view of safety. I'm not saying you should run out and isolate all your line feeds, but the following story makes the point of keep your equipment in good shape:

A bass player I knew popped the ground pin off the power plug of his amp so it wasn't such a hassle plugging into 2-pin outlets. One night during a gig the mixing console literally exploded, with a cloud of smoke pouring out of the input section. It turned out that sloppy assembly of the bass amp chassis had allowed a mounting screw to eventually poke its way through the line cord insulation, electrifying the chassis. The power line current went down the unisolated cable shield and into the console; cable shielding is for noise suppression, not for safety grounding, and things began erupting.

They brought the console to me for repairs. The first six inches of the bass input channel were blackened and completely stripped of copper PC tracks. In addition, the majority of the opamps in the board had failed from the transient voltages.

An isolation transformer would have prevented this damage. Now, I'm not saying that you have to isolate everything, but you remove ground pins at your own risk. If they had been playing outdoors in the damp, there might be a few less musicians around today.

Guitars

Acoustic, electric and bass guitars can all benefit from the DI, though there are other problems introduced. You can't have everything, as I'm fond of saying.

With bass and electric guitars, the DI gets you away from microphone problems, but eliminates the amp's speaker as an effect. The sound of an electric guitar is very much dependent on the response of the speaker, particularly with basses where the player may like the percussive effect of overloading (or "bottoming") the speaker cone.

Nonetheless, the DI is widely used in this application. If the amp has outputs similar to those described under "Keyboards", follow the same methods. But what if the amp has no outputs (and they often don't)? In that case, you can tap offthe signal conveniently right at the speaker terminals; most amps have open backs with accessible speakers. The problems are (a) the speaker level is very high, perhaps 25 volts or more, and (b) isolation is a good idea. **Fig. 3** shows a combination attenuator and balancing transformer that will convert the speaker signal to a balanced mike level signal ready to go straight into a console mike input. The leads to the speaker can be terminated in alligator clips; polarity is not important. Again, a utility box should be used to protect the wiring. The unit gives 35dB of attenuation; if this isn't enough you can get another 6dB by wiring the console side of the transformer to 150 ohms instead of 600.

Another widely used method is bridging the guitar's output. With this method, the amplifier is eliminated entirely. This is acceptable for bass guitars played in a studio, where the musician can hear the output through headphones, but may not be very satisfactory on stage. A common way of implementing this method is to use a ready-made high-impedance to low-impedance adapter such as the Shure A95 adapter. This looks like a long XLR mike connector and has an internal transformer for impedance conversion. Electric guitars can produce several volts of output, and the matching transformer generally divides this by about ten (-20dB) to suit the console mike input. The low impedance of the console input, generally 150 to 1200 ohms, is boosted by a factor of 100 (as seen by the guitar). Incidentally, magnetic pickups don't like to see much less than 50k ohms. Lower than this and you can hear the treble frequencies tapering off, just as if you'd turned down a tone control.

But what if the musician insists on having an amp nearby as a reference sound? You can still get the best of both with the circuit of **Fig. 4.** This circuit bridges across the guitar's output, sending a low-

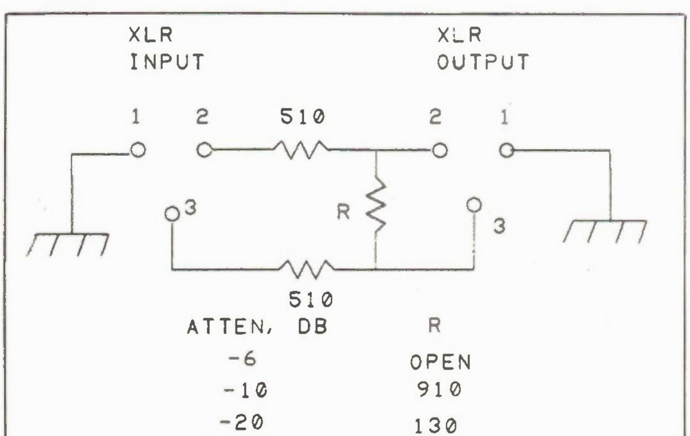

Fig. 1. An low-impedance attenuator cable for reducing the output of microphones or other sources. Quarter-watt resistors will fit in an XLR connector.

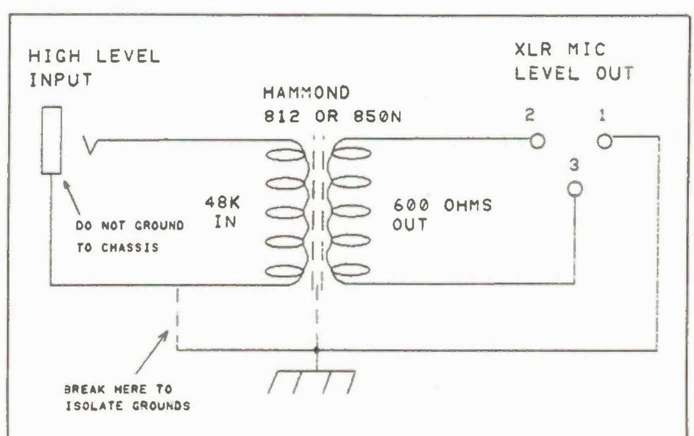

Fig. 2. A Hammond 812 or 850N used to convert a high-level unbalanced source to a low-level balanced microphone line. Transformer circuits shown should be in a metal utility box.

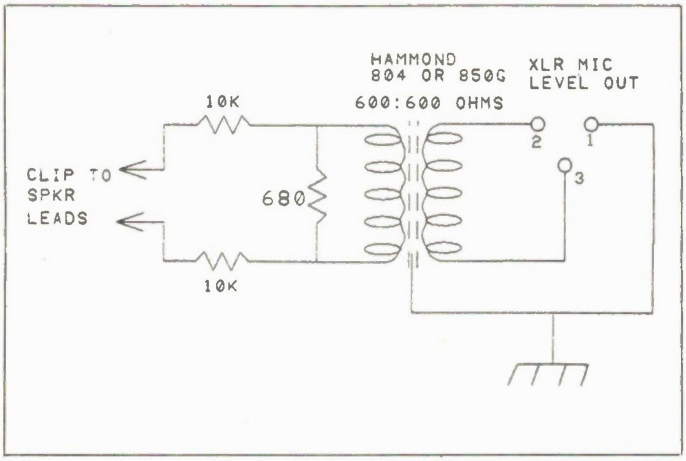

Fig. 3. A Hammond 804 or 850G used to convert speaker level signals to a balanced microphone line. The attenuation is 56 (-35dB) and will handle power amps up to about 150 watts.

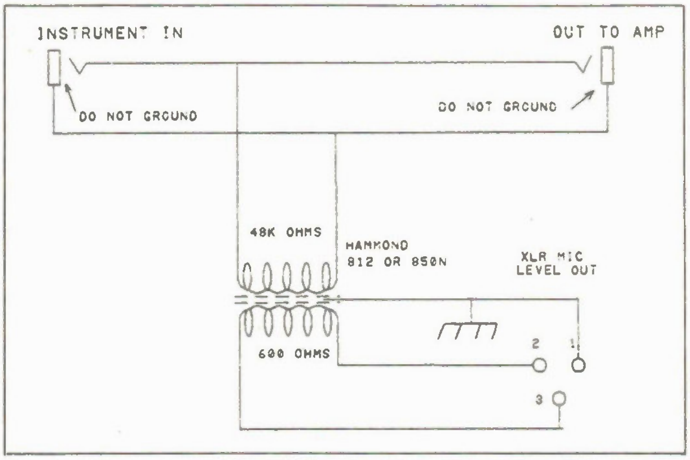

Fig. 4. A Hammond 812 or 850N used as a bridging unit, allowing use of both amp and balanced microphone input. The attenuation is about 10 (-20dB) and the ground circuits are isolated.

impedance balanced signal to the console input and an unbalanced output to the instrument amp. The term "bridging", incidentally, means that the load (the transformer) is much higher in impedance than the source (the guitar's pickups) and doesn't cause any loss of signal. With the Hammond 844, a 600-ohm console input will be transformed to a 48k load on the guitar, just high enough to avoid treble loss. The guitar's output voltage is divided by about 10 (-20dB) if you include a 1dB loss in the transformer.

This bridging transformer can be used for a multitude of purposes; it's a very flexible and useful gadget to have around a sound system. Note that the ground line for the 1/4" jacks is isolated from the box; grounding of the instrument comes from the amp, keeping everything separate to prevent ground loops.

Acoustic Guitars, etc.

Few instruments cause as much trouble as acoustic guitars. The sound output isn't very high, and guitarists tend to be very fussy ("Can you give me that Doc Watson flatpick sound?" "Oh, sure, we have a control just for that."). Also, the box of the guitar makes a great collector for room noise when you use a microphone, complicating the problem of feedback.

Now, on one hand you're going to get a more faithful sound by taking the trouble to use a guitar microphone. On the other, you may not want the above-mentioned hassles.

One answer is a magnetic pickup mounted in the soundhole; follow the advice in the electric guitar section above. These pickups sound terrible, unless you're trying to imitate old danceband records.

A good compromise is the piezoelectric pickup (Barcus-Berry, Ibanez, etc.). These are tiny crystal or ceramic elements that are fastened to the bridge or internal bridge plate (or violin bridges). Their output is closer to a natural acoustic sound, though they're very bright and have excessive midrange. A good recording engineer can work wonders with the console equalizer. My favorite EQ for these pickups is to put a wide notch in the mids at about 2 to 3kHz and tweak up the bass and treble. One-note bass can be calmed down if you have a tunable bass control.

Disadvantages of these pickups include a high impedance and a low output voltage. I've seen setups where a Barcus-Berry has been run straight into a high-impedance unbalanced PA console input, but the input channel had to be run at full gain and the sound was dull and lifeless, requiring excessive EQ to make it cut above the other instruments. Piezo pickups like to see a megohm or more as a load; a 100k line input muffles them too much.

The cure is to use one of the multitude of little battery-powered boxes that are available to clutter the stage underfoot. You can get boxes with straight gain, boxes with phasers, boxes with compressors, and lots of other effects. These usually have unbalanced outputs, making them suitable for either direct input to a console or for the transformer methods described above. I know that more equipment is just one more bother and expense, but they sure do improve the sound. One caution: not all of these little boxes are well-designed. Some of them are a real Niagara Falls of noise. It's worth spending some time with a tryout at your friendly neighborhood music store making sure you're not getting a turkey.

I haven't had much experience fitting these pickups to anything but guitars or violins, but there's no reason you can't fit them onto anything that makes noise. Experimentation seems to be the key; tiny changes in location or mounting method will have a great effect on the sound.

Troubleshooting

The DI is fairly straightforward, although I know that not everyone is comfortable with the bugaboo of impedance matching. If there's no sound at all, the problem will always be improper wiring. Check for shorts or opens or miswired terminals.

If the problem is inadequate level, you may have a matching transformer turned around. Remember that low-to-high impedance conversion steps up the signal voltage, and high-to-low steps it down. Both electric and piezoelectric pickups are high-impedance devices and don't like being loaded down.

Hum is just part of the general scheme of things. It's everywhere. Try moving or swapping cables, and make sure everything possible is shielded. If you've used the Hammond professional transformers, make sure the interwinding shield pin (usually the pin in the centre) is grounded and that they're in a grounded metal box.

Radio pickup is another real problem, though most modern equipment is equipped with very good RF suppression. Good shielding is essential. I've found that some electric instruments make great radio antennas and there's nothing you can do about it except use something else. Ground loops will often accentuate RF problems; if the console and the instrument amps are all grounded via their power cord third pin, you've created a huge network that can pick up large RF signals and feed them into everything. One cure is to use the isolation transformers as described above, breaking the continuity of the ground circuit without compromising safety. ■

Editor's note: some sound-system people who read drafts of this article wanted to see more on the problems of safely and quietly grounding pro audio systems. So, an article is in the works.

final page layout, which saves both time and paper.

Another accessory program, Auto-Convert, lets you exchange files with AutoCAD.

Generic CADD claims to support various pointing devices, but steadfastly refused to recognize my own Mouse Systems compatible SummaMouse. It did work, briefly, with another Mouse Systems compatible, the Z-Nix mouse --but made up for this concession by crashing completely after only a few minutes operation. I'm not sure what the problem is here, but potential buyers should make sure their dealer can do something to smooth out this kind of trouble. The keyboard works well enough, although you'll have to fritz around with the grid snap feature a bit in order to stop your cursor skipping over lines in the menu.

I did get CADD to crash on at least one other occasion, by using *control break* in a vain attempt to escape some long and unwanted operation. On yet another occasion I got the cryptic and unsettling message "Null pointer assignment" upon quitting the CADD system. I never did discover what this was all about.

Learning to use CADD is mostly a matter of trial and error. There are no tutorials, printed or otherwise, no online help, and no sample drawings. On the plus side, the menus are quite clear to anyone who has the barest CAD experience.

The manual is a lucid affair, in a convenient foldback coil binding. All the information is organized in reference fashion, conforming in sequence to the CADD menu system. Tutorial information... such as it is... is embedded in the various command entries. Amazingly, there are no diagrams to illustrate command operation. On the other hand, the index and table of contents are top notch.

As with most CAD systems, speed is a major hangup in Generic CADD. If you really can't get by on a pixel oriented drawing program, you should probably include the cost of a math coprocessor chip in the price of your CAD software. Screen redraws in Generic took several minutes at a time, and that was for a more or less trivial test drawing. Unfortunately, there's no way to interrupt any of the many time-consuming operations in Generic CADD. Frequently I found myself locked into a five minute wait while the program performed a redraw I didn't really want.

Two facts emerge from this examination. Generic CADD is clearly a powerful system. Equally clearly, it is a young product, still in a state of flux. As it now stands, Generic CADD is a bargain for the "amateur" user, who can afford to risk the program's foibles in order to take advantage of its many professional features. If reliability is cleaned up a bit, Generic CADD could readily go head to head with the big guns.

Autosketch

If you happen to be hunting around for a quick and easy drafting system, chances are that your expectations have been influenced by exposure to, or glowing reports of, a program called AutoCAD, from Autodesk (reviewed elsewhere in this issue). You might, therefore, be excited to learn that Autodesk has come up with a low-cost, entry-level product, called AutoSketch, introduced for $79.95US.

Before you get *too* excited, however, you should realize that AutoSketch is really a very distinct creation, with a whole new set of virtues and vices of its own. The best approach is to forget all about any other products, and view AutoSketch purely for what it is -- an attractive, if somewhat quirky package, that combines a large number of powerful CAD features with low price and an attractive user interface.

AutoSketch is specifically intended to be a painless introduction to CAD for the novice. Although all the usual CAD functions are available, they are shrouded within an unusually friendly interface. The AutoSketch display looks much like what you'd see in a paintbox program such as MacPaint. The screen is lit up to display black text and lines on a black background -- unless, of course, you happen to be blessed with an EGA card, in which case you can have your choice of colors.

Drawing functions are accessed using a series of pull-down menus, arranged across the top of the screen. The headings include: draw, change, view, assist, settings, measure and file. Note the use of "user friendly" terminology, such as "change" instead of "edit". The menu structure is quite logical, and you'll be able to work most of it out with no recourse to the manual.

When you do bog down, by the way, you'll find that the AutoSketch manual is extremely well designed. A thin, paper-bound booklet, it includes tutorial and reference sections, plus very complete table of contents and index.

Installing AutoSketch is no problem. Just *copy* *.* to wherever you wish. The program fits on a single floppy disk, although there's no room left over for accessories... like *command.com*, which you'll need later on, when departing the AutoSketch environment.

On your first boot up, you'll automatically be asked to specify your choice of pointing device, display and printer or plotter. You can get by with just cursor keys and a drab old graphics adapter, but AutoSketch is quite capable of supporting fancy hardware -- up to and including PostScript compatible printers, such as Apple's formidable LaserWriter. To reconfigure later on, just delete the *cfg* file

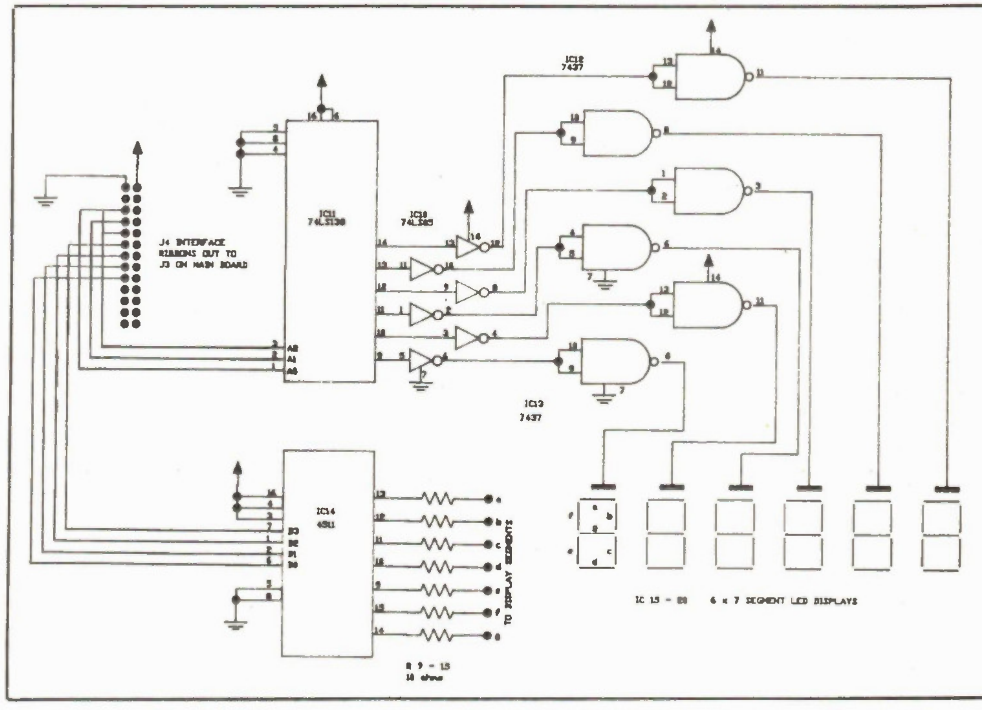

Fig. 5. A logic circuit drawn with AutoCAD and produced with an HP plotter (courtesy of Steve Rimmer).

from your disk, or start AutoSketch using the /R command line option.

All the normal CAD type drawing functions are available in AutoSketch. You can draw points, lines, rectangles, circles, arcs, spline curves and polygons. You can erase, move, copy, stretch, scale, mirror, or rotate screen objects. As with all CAD systems, each drawing element... from the lowliest point, to the fanciest polygon... is considered an object, or collection of vectors.

Many operations can also be invoked by function key, although the key choices are not subject to change, and are not easy to remember at first.

When editing your drawing, objects are selected by pulling a "rubber band" box over them with the mouse. Selecting one corner and then pulling this box to the right will affect only objects entirely surrounded by the box. Stretching the selector box to the left will catch objects that are even partially enclosed. The *group* function -- on the "change" menu -- lets you collect groups of screen objects together, so that editing operations can be performed on all of them at once.

AutoSketch includes the usual drawing aids... grid display, point snap, coordinate display and so on. Coordinate usage is particularly nice. You can enter points simply be specifying their coordinates, rather than by mousing. Continuous coordinate display can be accessed using a selection from the *measure* pulldown menu.

Naturally, AutoSketch lets you zoom and pan around a large virtual page. There are several zoom options, including the elegant *zoom box*, that lets you fill the screen with any specified portion of the picture.

From the circuit design point of view, several AutoSketch features should prove particularly useful. For instance, there's the *ortho*, or orthogonal, mode -- selected from the *assist* menu. This limits drawing entirely to horizontal and vertical lines -- perfect for laying out schematics or PCB traces.

AutoSketch also includes a simplified equivalent of the true CAD "part library". Any AutoSketch drawing file can be merged into your current work, simply by selecting the *part* function from the *draw* menu. The saved drawing will be inserted with its "base" point at the cursor. This base can be specified for any drawing before it is saved, using an option on the *settings* menu. The part functions would allow a user to accumulate a library of stock symbols -- for instance, electronic components -- that could be easily pasted together into complex designs. However, unlike AutoCAD, AutoSketch at this point lacks the availability of vast libraries of predefined symbols, so you'd have to start building your own library from scratch.

A powerful CAD feature that is well supported in AutoSketch is the concept of drawing "layers". An obvious use for layering might be to represent the various layers in a printed circuit. However, layering need not be restricted to such literal interpretation. One could place all components on one layer, traces on a second, text annotations on a third. Each layer can then be manipulated individually, hidden from view, or plotted in a distinct color. AutoSketch allows up to ten layers, quite a respectable number for any CAD system.

The dimensioning powers of AutoSketch, although less relevant in electronics applications, are one of the program's nicest features. The *measure* menu lets you simply pick any two screen points, then specify the line to be used for displaying the standard two headed dimension arrow. AutoSketch instantly calculates the measurement, draws in the arrow and types the value in the appropriate position. Dimensions can be taken horizontally, vertically, and aligned to any arbitrary angle.

The AutoSketch *undo* and *redo* options utilize an established CAD trick... a command summary, stored in a special disk file. Using this file, the entire drawing process can be torn down or reconstructed, one move at a time. This gives the user virtually infinite undo control.

Text is handled quite well in AutoSketch. Although there's only one basic font, it can be scaled, italicized, underlined or overlined.

AutoSketch does not directly support the AutoCAD file format. However, files can be saved to *dxf* format using a separate option on the file menu, so the connection is there if you need it.

However, AutoSketch is not without its drawbacks. To begin with, AutoSketch positively demands advanced hardware --at least a matching coprocessor, and preferably an AT type computer as well. Although it purports to be an easy-to-use, entry-level system, AutoSketch seemed more hardware hungry than the other low priced CAD systems. Part of the problem is that the program interface does not let you work around its processing demands. For instance, there's no way to interrupt a redraw. Thus, if you pan incorrectly you have to wait while the program recreates the entire screen before you can try again. Even a simple drawing will take several minutes to redraw, a long time to wait.

The other major drawback I found in AutoSketch is both serious and inexplicable. I could not get it to print. Although I triple checked all the procedures, installation, and hardware, I simply could not get any output at all on my Panasonic dot matrix printer. I suppose that there is some simple solution, but I never did find it.

Even had the process worked, I believe the AutoSketch printing functions to be rather complicated for what is intended as a beginner's system. The extra help included in a "read me" file on the program disk is both confusing and unenlightening.

Overall, I liked AutoSketch well enough, and would have felt even more warmly toward it had I had sufficiently powerful hardware at my command. The printing problem is not necessarily a fatal flaw, provided that it does have some sort of solution. If you make sure you have a proper guarantee when you buy the software, I think AutoSketch should prove to be quite a workable drafting tool.

In*a*Vision

Probably the most unusual product we looked at, and certainly not the least powerful, was In*a*Vision, from Micrografx, available from Alton Computerware of Thornhill, Ontario, for $495US. Rivalling any of the other, more traditional CAD systems on features, In*a*Vision nevertheless manages to present an extra dimension of slickness, and quite a bit more speed as well.

How is it done? Well, on the user interface side, the answer was to crib. All of the interfacing is handled using Microsoft Windows protocols and drivers. In*a*Vision does work independently of Windows. In this mode, it benefits from the elegant Microsoft display layout and efficient device handling. Under a Windows-based system, however, In*a*Vision would certainly take on an entirely new dimension. For instance, it could coexist in an onscreen window alongside any other Windows compatible applications. Even without full Windows system support, In*a*Vision is capable of running multiple windows,with full cut and paste available among them.

The In*a*Vision/Windows screen resembles the well-established Macintosh layout. Using the mouse one pulls down menus, points to objects or paints freehand. The only novelty is that the second mouse button is left for the user to define. Also, unlike the usual Mac type programs, In*a*Vision allows you to reset the screen colors, so you are free to work in white on black. Beware printing from this vantage, however, since the black will really come out black -- rendering your printer ribbon a smoking ruin.

All the usual CAD features are present. You can draw shapes, lines or whatever. Unlike most other products,

Continued on page 49

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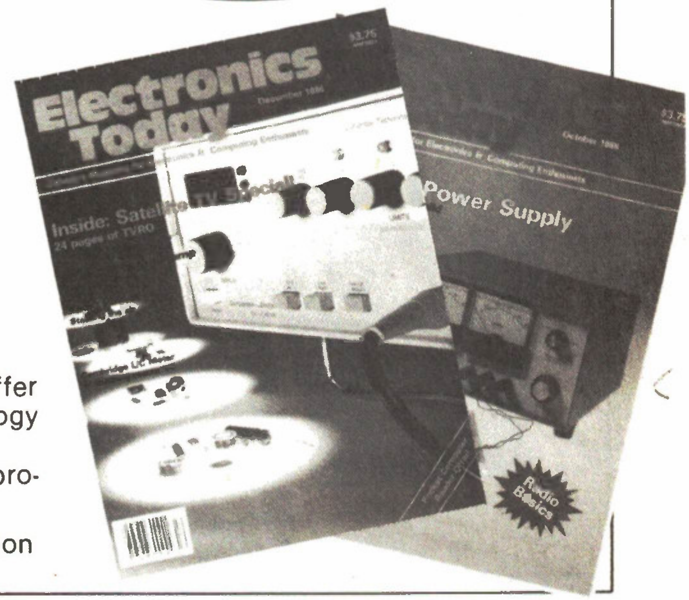

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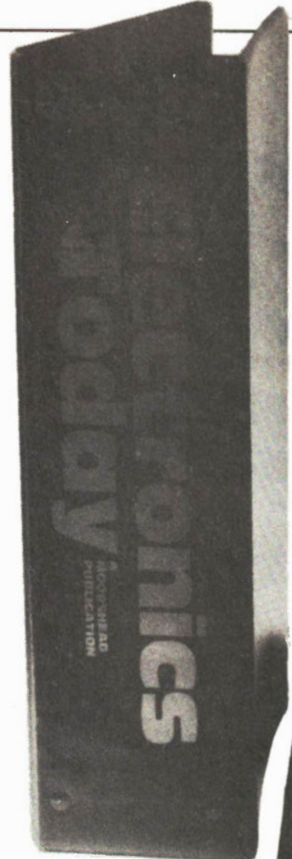

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We always appreciate getting suggestions from readers about their likes and dislikes, and we received a well-thought-out letter from Mr. Rob Ivanowich listing what he prefers to see in the magazine and what he feels should be modified to make it more suitable. But then, after he had written a page of very useful ideas, he suddenly broke into capitals and said: **"I HATE BINDER ADS!"**

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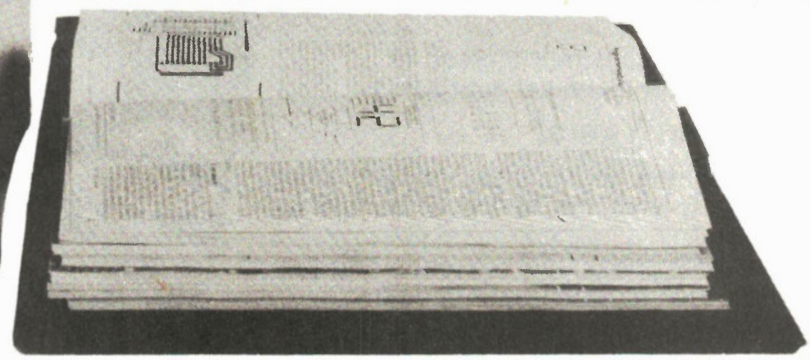

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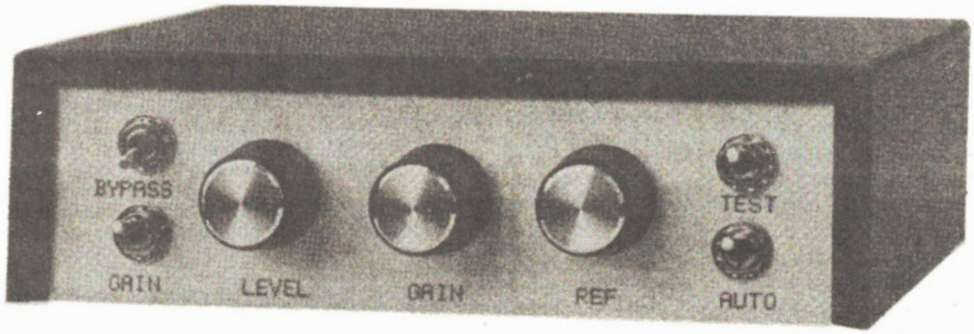
Micro Mini Tuner



A computerized aid for musical instrument tuning.

By John Becker

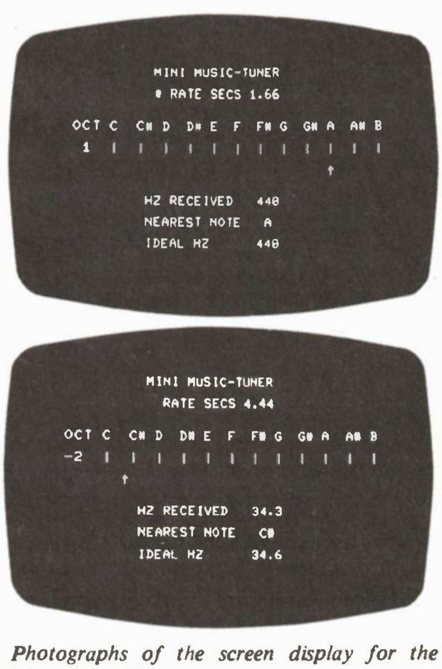
THIS IS a simple little tuning aid for the average solo instrumentalist. Both electronic and acoustic instruments can be used with it. It has been designed for control by the C64 or PET series of computers, but can readily be used with other computers having an 8-bit parallel socket such as a User Port or IEEE 488 port, with only minor modifications to the program. The computer performs most of the controlling analysis, and gives a screen readout showing the frequency received, the nearest note to it, and the ideal frequency for the note. A scale shows the deviation from the ideal.

Tuning Precision

Instrument tuning is not the precision science that some may believe it to be, and strangely instruments tuned to exact mathematical frequencies do not always sound correct to the ear. The main criteria can be summed by saying that a note which sounds right is right!

The making of music is a very subjective activity and throughout history different racial groups have had different ideas about the ideal notes to be played. Despite this, the basic relationships of notes played in succession have certain common factors. Essentially these result in frequency relationships of one to two and two to three producing the most satisfying sounds. From these ratios, other frequency ratios can be established to produce a scale within an octave.

By definition of course, an octave implies eight notes to the scale, the first and last notes having the frequency ratio of two to one. The ideal frequency of these eight notes depends on the starting point. Starting with one note, the next seven can be tuned so that when played consecutively they will sound correct. But if the starting note is one of the other notes just played, it is quite probable that when playing the rest of the notes the tuning will sound incorrect. Some of the notes may sound right, but others need to have a different pitch.



Photographs of the screen display for the Micro Mini Tuner

Well Pitched

In 1885, a Mr. Helmholtz remarked on an extreme instrument designed to produce all possible pitch variations in true scales. This resulted in 53 notes to each octave! Insanity must have been the end product for any musician attempting to play such a monster. More realistically, if instruments are tuned close to the standard one to two and two to three ratios, a range of 18 notes to the octave can be accepted as an ideal. For many stringed and wind instruments this ideal is not hard to achieve, but for keyboard instruments a requirement of 18 notes is a problem for the designer, the tuner, and the player. Fortunately some of these notes are so close in frequency that we have now adopted the less than ideal standard of 12 notes to an octave, resulting in some sharps and flats being treated as interchangeable.

Also by way of standardization, a convention in 1939 pronounced that note A in the treble clef should have a precise frequency of 440Hz. Literature shows that prior to 1939 the frequency of treble A had varied amongst instruments in different countries between 373Hz and 567

Hz. The table shown later gives the calculated note frequencies for the modern tempered scale.

Uniformity

However, scientific definition of a note does not ensure ideal uniformity. A note correctly produced under laboratory conditions may sound totally wrong under concert conditions. Indeed if all instruments were identically tuned to precise frequencies the music produced could sound extremely dull and uninteresting. The fullness of an orchestral sound is partly due to instruments not playing at precisely the same frequency and degree of synchronization. In fact professional musicians will often vary the frequency of a particular note by introducing vibrato. This generally can vary the frequency to either side of the ideal by as much as half a tone, and at a rate of about 6.5 times per second. The exact deviation and rate of modulation is highly personalized and will vary from musician to musician, and in regard to the mood of the music.

In electronic music production, frequency modulation is often introduced by using chorus or vibrato units inserted between the instrument and the amplifier. They can add considerable richness to a sound when used in moderation.

Stability

Stability of a tuned note is also a common problem for musicians. Any instrument player will be aware that a note produced at the start of a session will probably have changed in pitch a short time later. One of the reasons for this is changes in temperature. As a concert hall becomes warmer, so the instruments will be subjected to expansion, whether they are metal, wood, stringed or membraned.

Electronic instruments suffer from a similar problem due to the characteristics of resistors, capacitors, and semiconductors, etc. changing slightly the warmer they get. Expansion with a rise in temperature is a fundamental fact of nature, and although sophisticated design techniques can counteract this to a certain extent, the tendency to drift still remains.

Pitch Perception

Atmospheric temperature and moisture content also play a significant role in pitch determination. A frequency counter can be used when setting an instrument to an exact frequency, yet the ear may not regard this as correct, even though the meter says it is. Again, it is another factor of nature, this time related to the speed of sound. The speed of sound is not a constant, and should be expressed in relation to the conditions of the medium through which it travels. The density of the medium is a fundamental controlling factor. This will change with temperature, pressure and in the case of air, with the moisture content.

The usual speed of sound is taken to be 1120 feet per second at 0 degrees C at sea level. Through fresh water at 20 degrees C the figure is 4756 feet per second, five times as fast. Although concert halls are not usually flooded, just the addition of

```
110 GOTO520
120 L$=CHR$(CL)+"     ":U$=CHR$(CU)+" "
130 T=64:CL$="                                   ":A=SY-1:TI$="000000"
140 READB$:IFB$="*"THEN240
150 A=A+1:IFB$<"A"THENPOKEA,VAL(B$):GOTO140
160 IFB$="UU"THENPOKEA,UU:GOTO140
170 IFB$="DD"THENPOKEA,DD:GOTO140
180 IFB$="OUT"THENB=OUT:GOTO230
190 IFB$="IN"THENB=IN:GOTO230
200 IFLEFT$(B$,1)="Z"THENB=VAL(MID$(B$,2)):POKEA,Z(B):GOTO140
210 IFB$="REG"THENREG=A:POKEA,2:GOTO140
220 STOP
230 HI=INT(B/256):LO=B-(HI*256):POKEA,LO:A=A+1:POKEA,HI:GOTO140
240 V=36/LOG(2):Y=LOG(2)/12:FORA=1TO20:IFEXP(Y*A)<1.71875THENNEXTA
250 X=LOG(1.71875)-(Y*(A-1)):POKERE,2:D=1:R=INT(6400/Z)/100:S$="**":Z$="*****"
260 PRINTTAB(80);"OCT ";:FORB=1TO11:READN$(B):PRINTN$(B)" ";:NEXT:READN$(12)
270 PRINTN$(12):PRINTTAB(44);:FORB=1TO11:PRINT"   ";:NEXT:PRINT" ":FORB=1TO5
280 D$=D$+CHR$(CD):NEXT:V$=CHR$(CH)+D$+D$:PRINTV$;D$;TAB(8);"HZ RECEIVED"
290 PRINTTAB(48);"NEAREST NOTE":PRINTTAB(48);"IDEAL HZ":POKEDRT,128
300 D$=CHR$(CH)+D$
310 PRINTD$;TAB(9)"*";TAB(20);R+(INT(TIME/6)/10);L$:TI$="000000"
320 SYS(SY):N=PEEK(Z(1))*256+PEEK(Z(0)):F=(N*Z/T)/D:PRINTTAB(9);U$
330 IFF>19THEN360
340 D=1:POKEREG,2:R=INT(6400/Z)/100
350 PRINTV$;S$;TAB(83);CL$:PRINTTAB(101);Z$;TAB(103);S$;TAB(101);Z$:GOTO310
360 L=LOG(F)*V:H=INT(L/36):P=LOG(F)/Y:K=INT(P/12)*12:F=INT(F*10)/10
370 M=INT(P-K):IFM-INT(M)>0.5THENM=M+1
380 M=INT(M):W=(K+M)*Y+X:S=INT(EXP(W)*10)/10:IFF>100THENF=INT(F):S=INT(S)
390 J=INT(L-(H*36)):IFJ-INT(J)>=.5THENJ=J+1
400 IFJ<1THENJ=1
410 IFPEEK(DAV)ANDSETHENG=11:GOTO 440
420 G=H:IFG<7THENG=6
430 IFG>11THENG=11
440 G=11-G:D=2↑G:E=D*2:POKEREG,E:R=INT(6400*D/Z)/100
450 PRINTV$;H-7:PRINTTAB(44);LEFT$(CL$,J-1);"↑";LEFT$(CL$,35-J)
460 PRINTTAB(101);F;L$;TAB(103);N$(M+1);TAB(101);S;L$:GOTO310
470 DATA120,162,0,134,Z0,134,Z1,134,Z2,169,UU,141,OUT
480 DATA169,DD,141,OUT,173,IN,168,41
490 DATAREG,240,1,96,152,41,1,197,Z2,240,240,133,Z2,24,101,Z0,133,Z0,165,Z1
500 DATA105,0,133,Z1,240,225,208,223,0,0,*
510 DATAC ,C#,D ,D#,E ,F ,F#,G ,G#,A ,A#,B ,*
520 READA$:A=VAL(A$):ONAGOSUB640,680
530 PRINTCHR$(CC),TAB(129)"MINI MUSIC-TUNER":PRINTTAB(51)"RATE SECS"
540 IFA<3THENSY=PEEK(MM)*256+PEEK(ML):GOTO560
550 SY=HIMEM
560 A$="":FORC=0TO4:A$=A$+CHR$(PEEK(SY+C)):NEXT:IFA$="TUNER"THEN600
570 B=SY-65:IFA<3THENHI=INT(B/256):LO=B-(HI*256):POKEML,LO:POKEMM,HI:GOTO590
580 HIMEM=B
590 A$="TUNER":FORC=0TO4:POKE(B+C),ASC(MID$(A$,C+1,1)):NEXT:CLR
600 DIMN$(13):RESTORE:READA$:A=VAL(A$):ONAGOSUB640,680
610 IFA<3THENSY=PEEK(MM)*256+PEEK(ML)+5:GOTO120
620 SY=HIMEM+5:GOTO120
630 REM PET USER PORT
640 CU=145:CD=17:CL=157:CC=147:CH=19:Z(0)=0:Z(1)=1:Z(2)=2:ML=52:MM=53
650 DRT=59459:IN=59457:OUT=59471:DAV=59469:CTL=59467:OSC=59464:SRL=59466
660 Z=440:Q=140:UU=128:DD=0:SE=2
670 POKECTL,PEEK(CTL)AND227OR16:POKEOSC,Q:POKESRL,15:RETURN
680 REM C64 USER PORT
690 CU=145:CD=17:CL=157:CC=147:CH=19:Z(0)=251:Z(1)=252:Z(2)=253:ML=55:MM=56
700 DRT=56579:IN=56577:OUT=56576:DAV=56589:CTL=56591:OSC=56582:SRL=56583
710 Z=440:Q=95:UU=199:DD=251:SE=16:POKECTL,7:POKEOSC,Q:POKESRL,4:RETURN
720 REM *** CORRECTION FOR C64 USE - SWAP OVER WIRES TO PCB PINS 13 & 14 ***
```

water molecules breathed out by the audience can alter the speed of sound to an extent. This means that the perceived pitch of an instrument may be different from the frequency shown on a meter alongside the player.

Increased intensity of a sound can also raise the perceived pitch. This is especially true of instruments producing purer tones that are close to sine shaped. Complex tones though, may appear to be more stable with amplitude variations. This is probably due to complex tones containing harmonics less likely to cause perceived pitch changes.

Objectives

From the above, the uninitiated may well query the need to tune at all, since it is all so variable. Initially musical satisfaction can only come from playing notes that sound right. Precise frequency control, though, is less important than consistency. If a whole group decide to tune for A at 435Hz instead of 440Hz, it really makes little difference since it is expected that everyone will still be playing subsequent notes that are harmonically related. If they do not have their notes equivalently tuned the sound can be appalling.

So in tuning the objective is to take a standard starting point, and tune other notes so that they are harmonically related to the first. This is where the problem arises for those who are not fortunate enough to have perfect pitch perception.

Tuning Aids

Amongst any group of musicians there will usually be at least one who can establish the starting note from which the others can tune their instruments. The amateur soloist though, sitting alone in a room somewhere, may have to rely on a tuning aid of some sort. There are several types available, ranging from tuning forks, pitch pipes, frequency meters, to electronic frequency comparators. All have their advantages and disadvantages.

Tuning Forks

The tuning fork is arguably the simplest to use for setting the initial note. The commonest one is probably the one tuned to 440Hz, as this is the international frequency standard for treble A. If a tuning fork is hit on a hard surface and held to the ear at the same time as an instrument note is played, the two frequencies produced will interact, resulting in a third or beat frequency. The closer the first two frequencies are to each other, the slower will be the beat frequency. By adjusting the instrument note until the beat is no longer apparent, precise tuning can be achieved. It is very easy, and perfect pitch perception is not necessary.

Having set the first note, subsequent notes can be tuned in a series of rising and descending steps, usually in octaves and musical fourths or fifths. The notes are adjusted until a certain number of beats can be counted and related to predetermined beat tables, enabling precise matching to be achieved.

Experience is needed though, since if each note is tuned just fractionally out, the errors can accumulate across the full range, and inharmonious discords result. This is especially true with a keyboard instrument like a piano. Guitars are perhaps more easily tuned against a fork since the fretting enables the same string to produce different notes. So, for example, if E is tuned on one string, A can be readily tuned on another by fretting the first string at a point where it should produce note A, in this instance the fifth fret. By playing both strings simultaneously the tension of the second string can be adjusted until the beat frequency disappears. Other notes

Continued from page 44

Computer Aided Drafting

In*a*Vision boasts pattern fill functions rivalling those of many pixel paint programs. Text options are similarly bountiful, resembling those to be found on the Macintosh in terms of both the number of fonts and the special effects that can be applied to them. Any fonts available for the Windows system can be used.

Editing functions are totally standard: just grab a block with the mouse, then delete, move, copy, mirror, rotate or whatever you like.

Drawing aids such as grids and layering are available as well. Dimensioning is available, although auto-dimensioning --such as the marvellous function built into AutoSketch -- is not present. seem to "Overlay" layers can be enabled or disabled, and individual objects can be shuffled between layers. Coordinates can be displayed, and are measured on a grid from that extends 32,767 units horizontally and vertically. Screen units translate at the rate of 480 to the printed inch, giving a totally unprintable maximum resolution of two thousandths of an inch.

The drawing area is subdivided into "pages", which correspond to standard fanfold printer pages. You can view your entire drawing surface with page boundaries laid out gridwise across it, or zero in on any individual page. Of course, you can also zoom in until each coordinate unit corresponds to a single pixel on the screen. The "view actual size" option can show you how big things are going to turn out on paper, while "view used pages" will nicely frame your current drawing on the screen.

The Windows interface includes an ideal solution to the problem of panning the image: Macintosh type scroll bars. Just grab the little scroll box and drag it over to where you want to be.

Unlike the other CAD systems I tried, which wouldn't allow me to interrupt a redraw or print no matter how hard I tried, In*a*Vision actually multitasks, or at least time-shares, these tedious operations. Thus you can freely cursor around the screen even while a redraw is in progress. If you select a menu option, the redraw politely takes a back seat. Ditto for printing out. Ah, heaven!

Templates are roughly equivalent to the "part libraries" found in most CAD systems. In*a*Vision is unusual in that it can pull up a separate template window, on which you can display available templates or even create new ones without leaving your drawing in progress.

In*a*Vision supports a large variety of output devices. Print quality on my dot matrix was excellent, more like what might come out of GEM Draw than from the average CAD package. Printing speed is not exactly blinding, although a spooler program is included in the package.

Unfortunately, In*a*Vision was the last of the reviewed packages to arrive, so we had less time with it than with the others. Even so, the potential of the program seemed quite remarkable.

There is, of course, a price. Although In*a*Vision is amazingly fast, it is also strikingly bulky. Running the program from floppy disks is a bit of an ordeal, as one is forced to not only juggle four or more floppy disks, but also move critical overlay files among them in order to ensure that files are available when called for. Running In*a*Vision under Windows would simply be impossible without a hard disk.

Pending a more intensive experience with the package, I'd have to rate In*a*Vision very highly indeed. Unless there's some sort of hidden bug in there somewhere, this one might well be the champion in its class.

Frank Lenk ■

can be tuned in a like fashion, providing of course the player is sufficiently experienced to know which fretting should produce which note.

Pitch Pipes

Pitch pipes take the tuning fork principle a little further since they normally have six notes of E, A, D, G, B, E octave. Oddly they only appear to be available with A at 220Hz rather than 440Hz. Using pitch pipes, tuning can again be done while listening for beat frequencies. There is the danger though that if they are blown too hard, a false pitch somewhat higher than the ideal is produced.

Pipes are also rather harsh and inexperienced ears may have difficulty in recognizing the difference between a note and one of its harmonics since the tonal qualities of the pipe and the instrument are likely to be different. It is also very easy to become out of breath while using them!

Electronic frequency comparators extend the pitch pipe principle to a much wider range of musical notes, often to a full eight octaves, covering 96 notes. For several years special tone generator chips usable in this way were produced, but they appear to have vanished from semiconductor catalogues.

Frequency Counters

Frequency Counters can be used as tuning aids, though in this case the frequency needs to be related to a chart giving the equivalent musical notes and octaves. Frequency determination can be either by measuring the duration of one cycle, or by counting the number of cycles or pulses received during a predetermined time. The unit presented here employs the latter method, using the computer to set the sampling rate and translate the pulse count into notes and octaves.

With a frequency counter of this nature, the timing period across which the pulses are counted will depend upon the degree of accuracy required. For musical purposes, the accuracy of the pulse count will be relative to the octave in question. For example, note A of the 3rd octave has a frequency of 1760 Hz. Since A' is 1864Hz and G' is 1661Hz, a deviation of several cycles in the count can be tolerated. It is unlikely that the ear will readily detect the difference between 1760Hz and say 1750Hz. However, for A at 220Hz a difference of 10Hz in the count is the equivalent of a semitone, which the ear will certainly notice.

The length of time for which a stringed note will vibrate will depend on the string length and tension. Higher notes cannot be sustained for as long as lower ones. Consequently timing ranges must be changed for different octaves. This could be done manually, but since the computer is being used to calculate notes from frequency, it is just as easy to also make it automatically control the sampling rate in accordance with the frequency that it detects. Which leads us to the block diagram.

Block Diagram

Most of the work is carried out by the computer, and so the electronics of this project is extremely simple. It consists basically of a preamplifier and a sample period gating stage, **Fig. 1**. A reference frequency output stage is also included, not as an essential part of the unit but as an extra facility that can be plugged into an audio amplifier.

Input Stage

Acoustic instruments can be coupled in via a microphone, preferably of the high output type. This should be placed as close as possible to the sound output. Electronic instruments or signal generators can be plugged straight in. Those producing a 5V squarewave output can be switched directly to the computer via S2 (**Fig. 2**). Other signal sources need

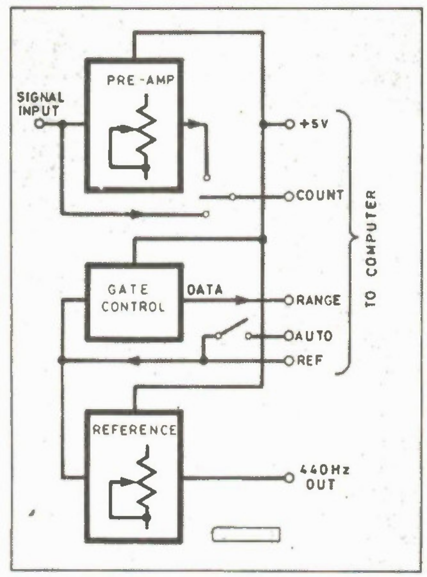


Fig. 1 Block diagram of the Micro Mini Tuner.

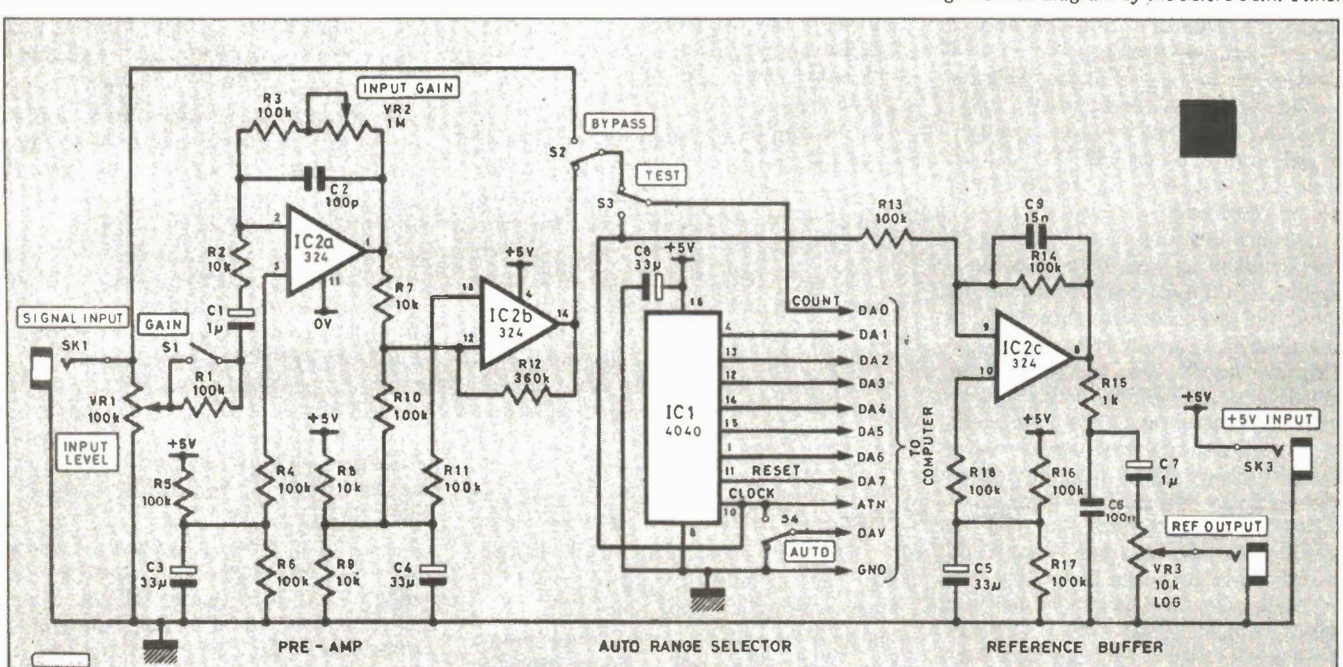


Fig. 2 Complete circuit diagram of the Mini Tuner.

to be pre-amplified and shaped so that the voltage swing can be detected by the computer.

Potentiometer VR1 sets the initial input level, and enables signals greater than 5V to be processed. The gain of the pre-amp IC2a is set by both VR2 and S1. With S1 open, VR2 can vary the gain from around unity to x10. With S1 closed, VR2 varies the range between about x10 and x100. The precise amount of gain is determined by the ratio of the input resistance of R1 plus R2, to the total feedback resistance of R3 plus VR2.

IC2a is coupled to the comparator stage IC2b. The reference level here is 2.5V as set by R8 and R9. R7, R10 and R12 set the comparator trip point. In the absence of an input signal, the output of the comparator will be static. As the input signal level increases, the output of IC2a will swing in sympathy by an amount dependent upon the gain set. When the output rises above the reference level, so the output of IC2b will change from low to high.

Once the waveform falls below the threshold the comparator will again change state. As it is being tripped by opposing cycles of the signal waveform, irrespective of its shape, so the output will be a squarewave of the same frequency. This is switched via S2 and S3 to the first data line DA0 of the computer. The software program for the computer is written so that the number of times the squarewave goes high and low can be counted.

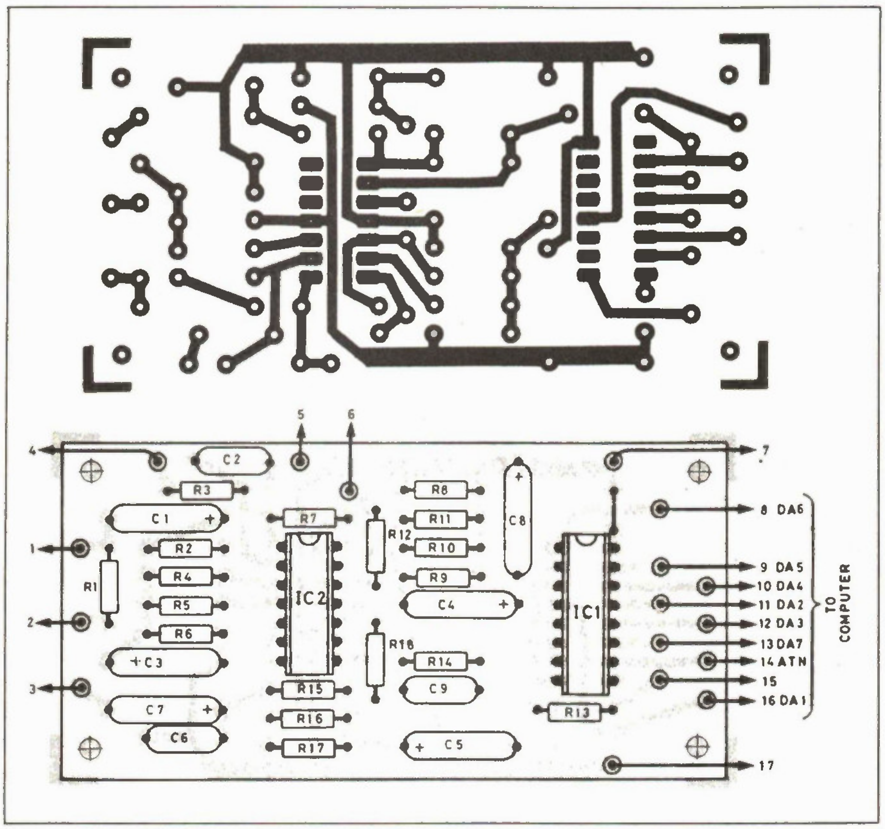


Fig. 3 Layout and wiring of the PCB.

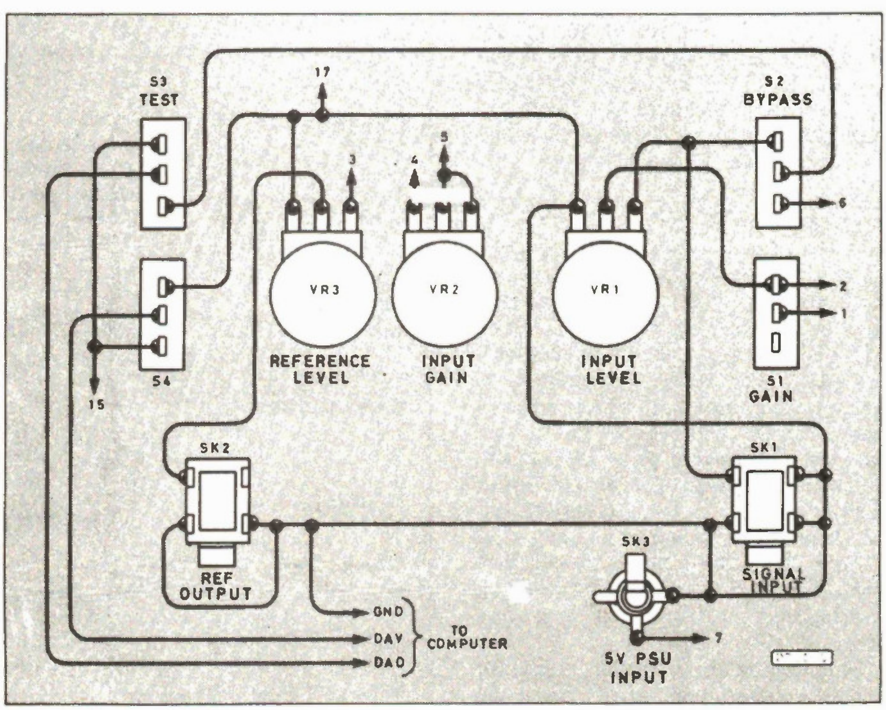


Fig. 4 Interwiring of the controls and connec-

Computer Control

One of the handshake lines of the computer can be used for calling the attention of external equipment. For this reason it is referred to here as the ATN (attention) line. The computer has an internal timer that can be program controlled to cause the ATN line to put out a constant frequency. Here the program sets this output as close as possible to 440Hz, and it is used as the clock input to the counter IC1. This is a 12-stage binary counter, each output of which divides the frequency by two.

Output one, therefore, is half the input frequency, output two is one quarter, output three is one eighth, etc. Since each output is at half the rate of the previous one, the rates are, in musical terms, one octave apart. The computer data lines DA1 to DA6 are connected to IC1 outputs seven to 12 respectively.

The program detects which of these lines is high at any particular moment.

UNIT	C64	PET		
			A	1
DAV	FLAG 2	CA1	B	2
DAD	PB0	PA0	C	3
DA1	PB1	PA1	D	4
DA2	PB2	PA2	E	5
DA3	PB3	PA3	F	6
DA4	PB4	PA4	H	7
DA5	PB5	PA5	J	8
DA6	PB6	PA6	K	9
DA7	PB7	PA7	L	10
ATN	PA2	CB2	M	11
GND	GND	GND	N	12

Fig. 5 Connection details for the PET and C64.

When a selected line goes high, the computer stores the pulse count so far received, calculates the equivalent frequency, finds its note and octave values, and displays them on the screen. It then checks the figures against an internal table, and decides whether the counting period should be changed. In this case, on the next counting round it chooses a different data input as its trigger line.

After processing the count, the computer sends data line DA7 up and down, which resets IC1 back to zero. The count restarts and once more the computer counts the signal input pulses until the relevant trigger line goes high. In this way the optimum sampling period for particular octave ranges is constantly updated.

Since there are six lines available, six octaves of input frequency can be assessed with their relative sampling rates standardized. Taking the treble clef octave containing A-440Hz as octave 1, octaves between -1 and +4 have standardized counting periods. Octaves above and below these points can be sampled, though the relative accuracy will deteriorate. The duration of each sampling count is thus controlled between 0-11Hz and 3-5Hz.

The number of times that samples are made in a given number of seconds is also displayed on the screen. It is calculated by adding the sampling rate to the length of time that the computer takes to process each answer. This range varies from 0-64Hz for octave 4 to 5-15 seconds for octave -1. Do not be confused by sampling rates and sampling periods. The sampling period is the time during which the count is collected. The sampling rate is the total of the sampling period plus the time taken to process the answer.

Override

If only an approximate idea of frequency is needed, sampling consistency can be dispensed with. Consequently switch S4 is included to tell the computer to sample at the highest rate irrespective of the musical octave. In this mode the computer's second handshake line is used. This is termed here as the DAV, or Data Valid Line. It is connected in the computer to a register that detects the arrival of a leading or trailing edge of an input pulse. The state of the register can be read and appropriate action taken.

In this unit, S4 can switch the constant stream of 440Hz pulses onto the DAV line, so that the register can be kept constantly set by the leading edges of the ATN signal. If the DAV register is found to be set, the computer will only respond to the setting on the first trigger line from IC1, line DA1. It will then perform all its sampling at the highest rate. As less processing work is required, the sampling rate goes up to 0.24Hz.

440Hz Reference

As the computer is putting out a known frequency on the ATN line, this can be used as an audio reference signal. It is fed to IC2c, which acts as a buffer stage, and also gives a bit of filtering due to C6 and C9 in order to smooth off the edges of the squarewave signal. Squarewaves are a bit harsh to listen to for any length of time. Smoother ones are less tiring to the ear. VR3 controls the output level. The signal may be fed to any normal amplifier system and at a maximum is about 1.5V peak to peak. As a self check facility, the 440Hz reference can be switched direct back to the computer by S3.

Power Supply

The unit requires a power supply of 5V at about 1mA. This can be supplied direct by the computer or from a separate PSU. The PET can deliver 250mA from its cassette port. The C64 cassette port can deliver 100mA, and the cartridge port 450mA.

Assembly

Assembly of the unit is straightforward and needs no special comment. Just ensure that all joins are checked and the wiring is kept neat. **Fig. 3** shows the PCB layout and **Fig. 4** interwiring of the controls and connectors. The computer socket and its connections can be varied to suit the lead available. The case used in the prototype measures 15cm x 11.3cm x 4.5cm. Holes for the potentiometers are drilled 21mm above the base, 30mm apart starting 45mm from the left. Switch holes are 20mm from the sides, at 15mm and 30mm above the base. Connections to the PET and C64 are shown in **Fig. 5**.

Program

The pulse counting of audio frequencies must be performed as efficiently as possible. Consequently the sampling part of the program is carried out by a machine code routine. The rest of the processing is in BASIC. The screen presentation is shown in the photograph. The program is written for the Commodore PET, with additional information given for use with the C64. The differences between these machines are very minor, and largely consist of memory location and cursor control code variations. Notes in the software listing give all the necessary information for using the unit with any of these computers.

The program can be readily altered for use with other computers possessing similar facilities. The requirements are that an eight-bit parallel data socket with two handshake lines is available. This can be of the User Port or IEEE 488 variety. Most computers have a BASIC that is only a dialect variation on Microsoft BASIC, and translations should be quite simple. The machine code, though, is for computers having 6502 and 6510 microprocessors, often found in conjunction with a Microsoft interpreter. Manuals should be consulted if it is intended to use the unit with other processors. The program requires a little over 3K of memory.

Use

It should be remembered that the signal being sent to the unit should be as free from noise and extra harmonics as is possible. If either are present, the tuning interpretation may erroneously also calculate on the unwanted input portions.

As stated earlier, tuning is in many ways a matter of personal interpretation. Any tuning unit should therefore be used with discretion and treated as a guiding source rather than a definitive analyzer. Professional tuning, through centuries old practise of setting relative fourths, fifths and octaves, is still superior if you have the ear and the patience. Nonetheless, for the average musician, this tuning aid should remove the question marks from the tuning of many instruments by guesswork and bring about a little more harmony. ■

Parts List

Resistors (All 1/4W ±*FN55•*)

R1,3-6,10,11,13,14,16-18	100k
R2,7-9	10k
R12	360k
R15	1k

Capacitors

C1,7	1uF 63V elect.
C2	100pF polystyrene
C3-5,8	33uF 6V elect.
C6	100n polyester
C9	15n polyester

Potentiometers

VR1	100k log. mono rotary
VR2	1M mono rotary
VR3	10k log. mono rotary

Semiconductors

IC1	4040
IC2	324

Switches

S1 to S4	mini SPDT

Miscellaneous

SK1, SK2, SK3 mono jack sockets; knobs(3); 14-pin IC socket; 16-pin IC socket; PCB; ribbon cable and suitable multiway socket for connection to computer; connecting wire; case.

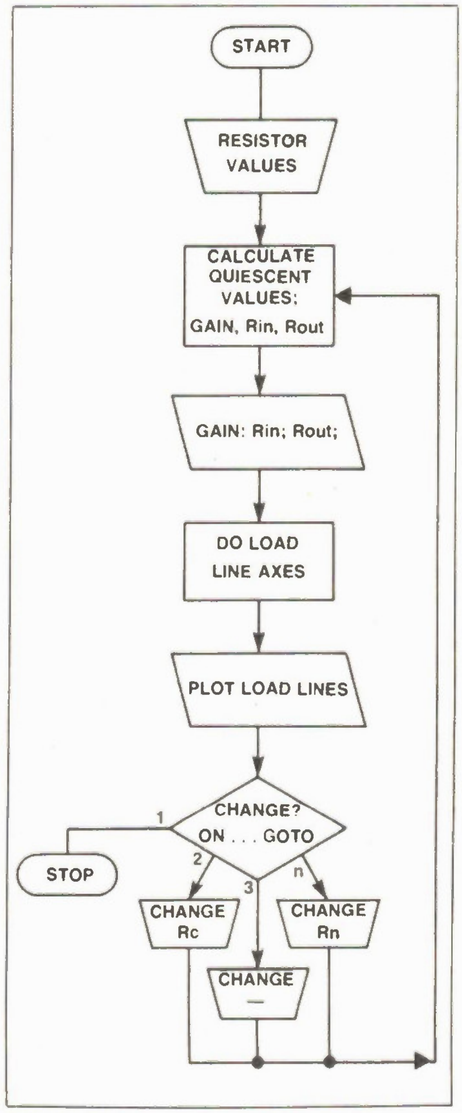
Continued from page 27


```
162 LET IBQ=ICQ/HFE
163 IF IBQ*6>ID THEN  GOTO 300
165 LET VCEQ=VCC-ICQ*(RC+RE)
170 LET IQX=ICQ*16/VSF+12
175 LET VQX=VCEQ*6.2+20
177 IF VQX>250 OR IQX>190 THEN  GOTO 850
179 IF VCEQ<0 THEN  GOTO 2000
180 CIRCLE VQX,IQX,2
185 CSR .8*VCEQ+1,22-1.65*ICQ/VSF: PRINT "Q"
190 CSR 22,0: PRINT "ICQ ";INT(ICQ*10)/10
191 CSR 22,1: PRINT "VCEQ ";INT(10*VCEQ)/10
192 CSR 24,2: PRINT "RE ";RE
193 CSR 24,3: PRINT "RC ";RC
194 CSR 4,0: PRINT "RB1&2";RB1;RB2
199 GOTO 800
300 REM**
305 VS 2: CLS
308 LET S=ID/IBQ
310 CSR 6,10: PRINT "Id/Ib Ratio is ";S
311 CSR 8,12: PRINT ":rather low!"
315 PAUSE 8888
320 GOTO 106
400 REM****** AC LOAD LINE ************
405 VS 2: CLS
410 INPUT "RE BYPASSED?";A$
420 INPUT "RL=? ";RL
425 LET RAC=(RC*RL)/(RC+RL)
430 LET VPK=ICQ*RAC
435 LET VPX=(VCEQ+VPK)*6.2+20
440 VS 4
443 CSR 24,4: PRINT "RL ";RL
445 LINE VPX,12,VQX,IQX
450 LET IPK=ICQ+VCEQ/VPK*ICQ
455 LET IPX=IPK*16/VSF+12
457 IF IPX>192 THEN  GOTO 480
460 LINE VQX,IQX,20,IPX
470 PAUSE 7777
475 GOTO 1000
479 REM***** LIMIT CONDITIONS *********
480 LET IPX=190: LET IPK=(IPX-12)*VSF/16
482 LET VA=VCEQ-RAC*(IPK-ICQ)
483 LET VAX=VA*6.2+20
484 LINE VQX,IQX,VAX,IPX
488 PAUSE 7777
489 GOTO 1000
800 REM
810 LET IX=VCC/(RE+RC)*16/VSF+12
812 LET VX=VCC*6.2+20: REM SCALEUNITS
814 IF IX>190 THEN  GOTO 900
815 LINE 20,IX,VX,12
820 PAUSE 8888
830 GOTO 400
850 REM*********************************
855 CSR 15,10: PRINT "QPT OFF SCREEN"
860 GOTO 190
900 REM*TO COVER OFF-SCALE LOADLINE
905 LET IC=ICMAX
906 LET IX=IC*16/VSF+12
910 LET VX=(VCC-IC*(RC+RE))*6.2+20
916 PAUSE 9000
920 LINE VCC*6.2+20,12,VX,IX
930 GOTO 930
990 CSR 5,2: PRINT "ICMAX OFF SCREEN"
998 STOP
999 REM*********GRAPHICS DUMP**********
1000 LPRINT CHR$(27);"A";CHR$(8);
1010 FOR J=191 TO 0 STEP -8
1020 LPRINT CHR$(13);CHR$(10);
1030 LPRINT CHR$(27);"K";CHR$(254);CHR$(1);
1040 FOR I=1 TO 255
1050 LET R$=GR$(I,J,8)
1060 LPRINT R$;: LPRINT R$;
1070 NEXT I
1080 NEXT J
1099 STOP : REM************************
2000 VS 2: CLS
2001 PRINT "NEGATIVE COLLECTOR VOLTAGE"
2002 PRINT "NOT ALLOWED"
2004 PAUSE 7777
2005 GOTO 104
```

just a straight line between these two points.

The operating point, Q, at which the amplifier is biased, must lie somewhere on this line. The AC line intersects the DC line at this point. It is drawn with slope equal to the inverse of the AC collector load. For an unloaded amplifier this will just be Rx, with the result that the AC slope will be the same as the DC slope. However, when the amplifier is loaded the slope of the line will tend to increase as the total collector resistance decreases.

As with the DC load line, the AC line determines the combination of values of Ic and Vce that can exist in the amplifier with a specific load. We are now in a position to ask the question about the amplifier we have designed, namely: what is the maximum output voltage I can get from this amplifier without distortion? In most applications the aim of the exercise, after all, is to magnify the input as much



Flow Chart

as possible while distorting it as little as possible.

Non-linearities

Non-linearities will occur whenever the output gets close to either end of the load line. Clipping will occur if you try to push the output past it. The idea then is to arrange your gain for a given input such that it can drive the output close to, and not right to, the end of the line. You also want to arrange things such that both positive and negative voltage excursions begin to slip at the same time. There is no point building something that will leave the positive side of the wave unclipped while distorting the negative wave badly. This state of affairs will come about when the Q point, ie: the quiescent voltage of the transistor collector is midway between the maximum voltage excursions.

Departures

To get this far in the analysis we have made certain assumptions about the circuit which are not strictly true. Whether they are significant or not depends on the individual case. It is important to realize they are there, however, so that if you start getting results that are not as predicted you know where to look.

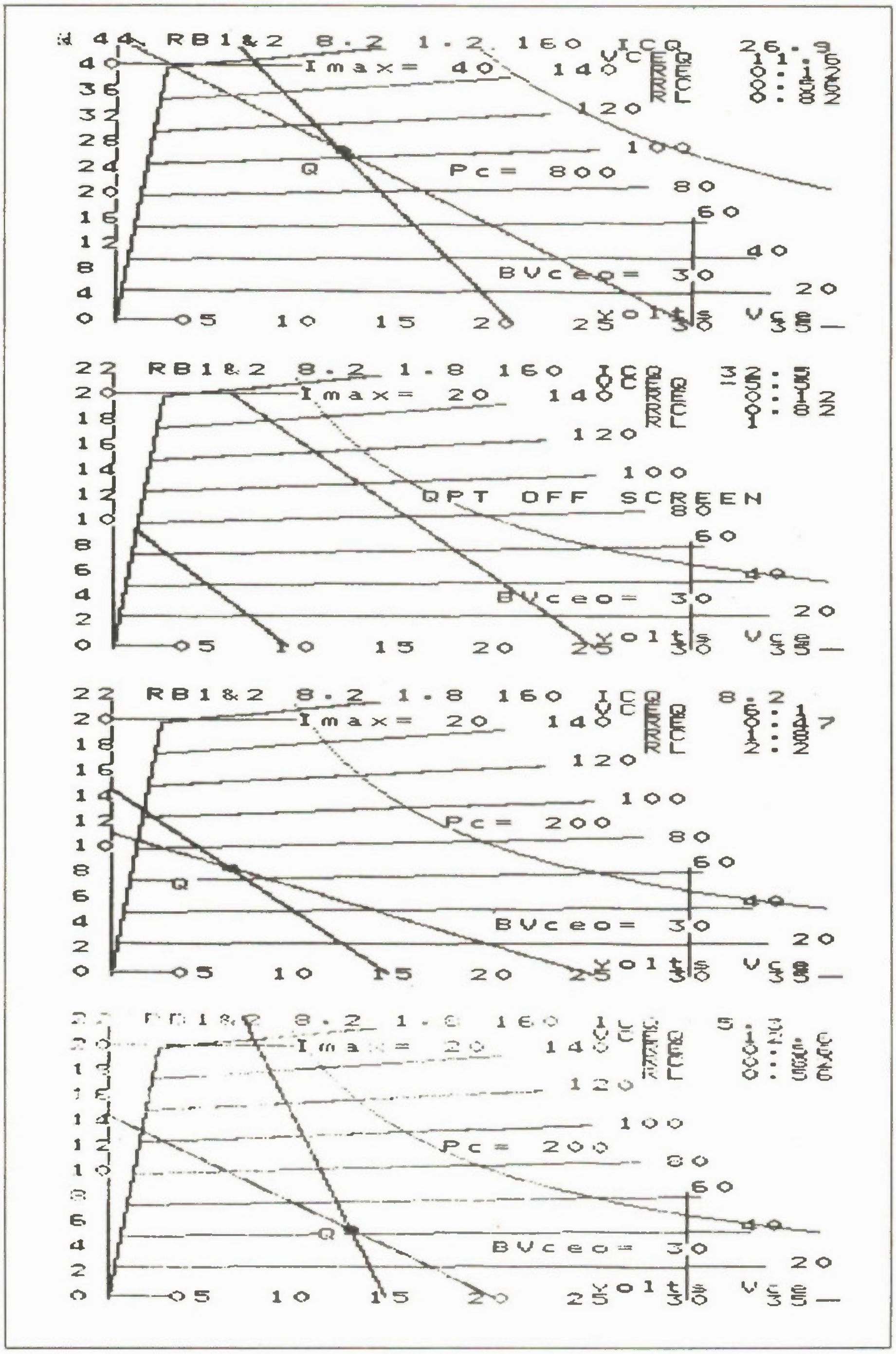
The first problem is that the transistor has a saturation voltage that depends primarily on the current. Saturation voltage is drawn on a load line diagram as part of the transistor collector characteristics. Usually these are drawn as a family of curves indicating the relationship between collector current and voltage for a given base current. These curves will be more or less flat in the linear operating region of the transistor, falling off on the left-hand side as the transistor goes into saturation.

In order to achieve a really accurate determination of the transistor characteristic you ideally need to make a plot for each individual transistor. Failing that, manufacturers' data is a good source for typical figures. However, for our purposes it is probably just as useful if you think of the transistor characteristic as a line passing through the origin. The slope is set by at least one typical combination of current and voltage supplied from manufacturers data. If you don't have access to this information then a value of 0.3V at 2mA is typical for small signal transistors.

A second source of errors is likely to be the assumption that all the capacitors are short circuits and that stray capacitances around the circuit are negligible. As frequency goes up this will become more and more of a problem.

So far, we have thought through this problem as a simple linear process, a not very difficult programming exercise involving a few calculations and the ability to draw some lines. This doesn't really explore the potential of the computer in this regard, though. Its biggest advantage is the fact that you can very quickly see what happens to a host of different parameters of the amplifier if you change values of any of the biasing resistors, or indeed if you change resistor configurations.

We have included a flow chart that should give you some idea of how to go about writing the program. It includes a menu for making individual changes to resistors and then re-running to see the effect. We have also included a listing of a BASIC program that draws a load line diagram complete with transistor characteristics and both load lines. This is written for the Memotech computer and so will need to be rewritten by anyone using a different type of machine, but close study of how it works will be instructive. ■



The plot thickens. Screen dumps of load lines plotted by the program given in the listing. The beauty of the technique is its ability to show the results of any variation quite quickly.

8088 Programming, Part 3: Macros

One of assembly language's less attractive features is code repetition. Save lots of typing with macros.

By Ellery Henn

PROGRAMMERS have long been offering plaudits to macro assembler authors. For good reason, too. Macro assemblers can save the most methodical programmer scads of time in getting his program finished. Macros make source code listings shorter, though the working code produced will be longer. Macros make debugging source code listings easier as well. A large macro library can make writing assembly programs as easy as writing in a high-level language, without the attendant dearth of program speed high-level languages offer. There's one catch to all this, though ... it takes time to produce a macro library that'll be the envy of your assembly programming peers.

Before I get too carried away, I should explain just what a macro *is*.

Macro Polo

Most PC owners either have purchased or have a general idea of what keyboard macro programs do. A string of whatever characters the user defines is assigned to a key, and, when the appropriate key sequence is struck, the requested characters fly to the screen, usually accomplishing things in other programs that would otherwise wear your fingers down to nubbins.

A macro assembler operates in a relatively similar fashion. The programmer first defines a section of code as being a macro, then gives that section a name. Whenever the assembler chances upon a macro name in its journey down your source code, it will insert the defined code into the macro name's place. For example, the code to push the four 16-bit registers normally goes like this:

```
PUSH AX
PUSH BX
PUSH CX
PUSH DX
```

If your program does a lot of register-bashing, you'll be typing those four instructions a number of times in the average program. Hopefully you'll also be POPping the registers back off the stack when necessary.

Code defined as a macro is preceded by a *header*, which includes the name you've given the macro (we'll use SHOVE here, as PUSH is an actual op-code), the word

MACRO for the assembler to chew on, and optional parameters which we'll get into shortly. After the code, the macro-to-be is completed with a *terminator* (no funny movie jokes, please). The above code would look like this when defined as a macro:

```
FPUSH  MACRO
       PUSH AX
       PUSH BX
       PUSH CX
       PUSH DX
       ENDM
```

The header "MACRO" and the terminator "ENDM" are pseudo-operation codes which have no basis in 8088 assembler, but are recognized as macro terms by MASM. Other, more universal pseudo-ops include EQU (equate) and DB (define byte). MASM supports 59 pseudo-ops, which is why 8088 aficionados do double-takes when first reading MASM source code.

Macros are usually inserted at the very beginning of your source code. MASM then sets them up in memory, then begins assembling your regular code. When MASM comes upon a label in your code previously defined as a macro, the code within that macro is inserted into the spot where the macro label was typed. To illustrate, SHOVE is now a four instruction macro. This means anytime you need to PUSH all four 16-bit registers, all you have to type is SHOVE, as below:

```
       ...
       MOV DL,0E4H
       MOV AH,2
       INT 21H
       SHOVE
       JMP SOMEWHER
```

In the above source code, the first three instructions print the greek letter sigma, the registers are PUSHed, then the code jumps to a routine called SOMEWHER. When MASM assembles this code, it will, after checking its internal library of pseudo-ops, check to see if SHOVE was temporarily defined as a macro. If it was, the four instructions from SHOVE will be inserted at that location into the .OBJ file resulting from the assembly.

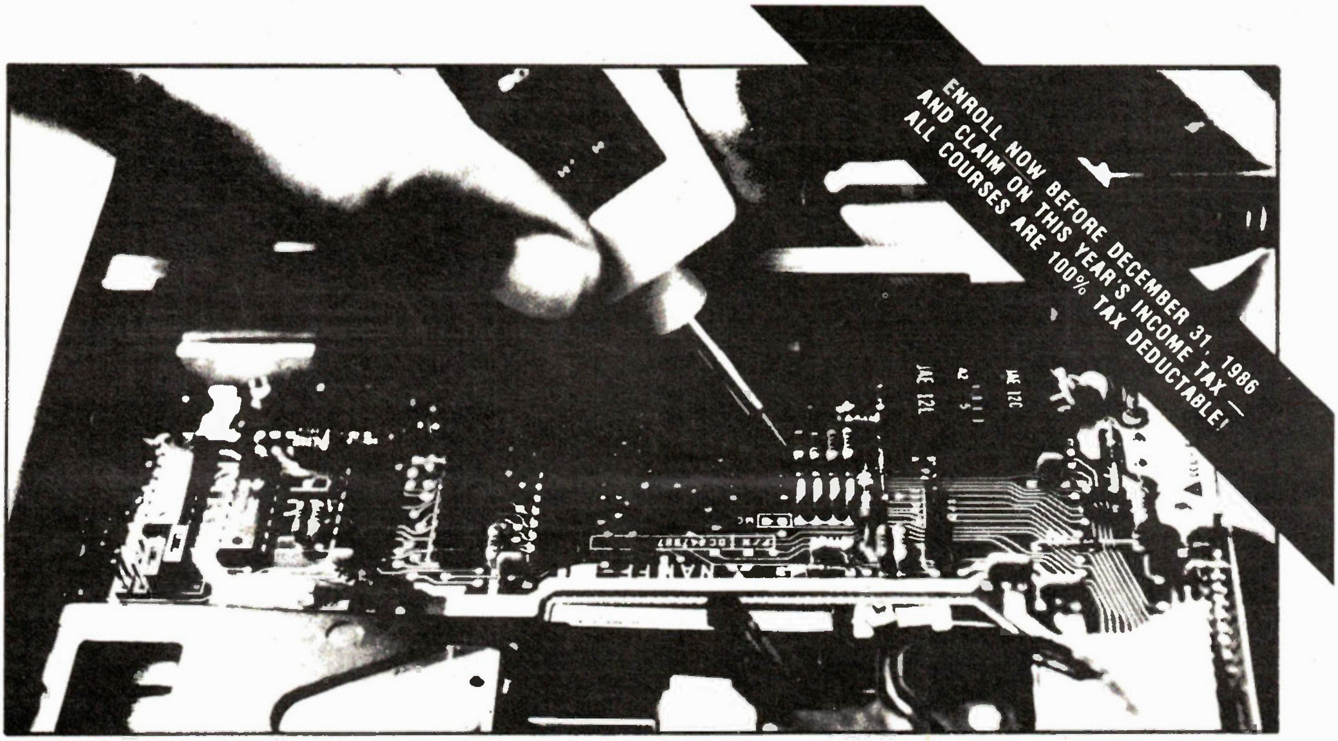
If you still enjoy BASIC as a programming language, you can make your assemblies resemble BASIC by defining macros to do what various BASIC instructions do. For instance, if these macros were defined at the beginning of your assembly program ...

```
GOTO   MACRO  LABEL
       JMP    LABEL
       ENDM
```

```
;
; MACRO library
;
PRINT    MACRO  STRING                   ;Print string
         MOV    DX,OFFSET STRING         ;onto screen
         MOV    AH,9
         INT    21H
         ENDM
;
INPUT    MACRO  LOCATION
         MOV    DX,OFFSET LOCATION       ;Input string
         MOV    AH,0AH                   ;to buffer named
         INT    21H                      ;by variable
         ENDM                            ;LOCATION
;
CLS      MACRO
         MOV    AH,6                     ;Clear the screen
         MOV    AL,0
         SUB    CX,CX
         MOV    DH,24
         MOV    DL,79
         MOV    BH,0FH
         INT    10H
         MOV    AH,2
         MOV    BH,0
         SUB    DX,DX                    ;BH = 0 is high intensity
         INT    10H
         ENDM
;
OPEN     MACRO  FIL2OPEN
         MOV    DX,OFFSET FIL2OPEN       ;Open an existing file
         MOV    AH,15
         INT    21H
         ENDM
;
CREATE   MACRO  FIL2CREA
         MOV    DX,OFFSET FIL2CREA       ;Create and open a new file
         MOV    AH,16H                   ;for WRITING to. DON'T
         INT    21H                      ;create an existing file,
         ENDM                            ;or its contents will be
;                                        ;erased!
DOSBUFF  MACRO  BUFFER
         MOV    DX,OFFSET BUFFER         ;Where DOS will put records
         MOV    AH,1AH                   ;or take them from
         INT    21H
         ENDM
;
COORD    MACRO  ROW,COLUMN,PAGE
         MOV    DH,ROW                   ;Set the on-screen
         MOV    DL,COLUMN                ;cursor location.
         MOV    BH,PAGE                  ;Note that THREE
         MOV    AH,2                     ;variables are
         INT    10H                      ;required here.
         ENDM                            ;This is followed by a
;                                        ;RDLOC or WRLOC.
RDLOC    MACRO
         MOV    BH,0                     ;Read cursor
         MOV    AH,8                     ;location. The
         INT    10H                      ;character on-screen
         ENDM                            ;will be in AL register.
;
WRLOC    MACRO  CHR
         MOV    AL,CHR                   ;Write a character
         MOV    BH,0                     ;(CHR) at the cursor
         MOV    CX,1                     ;location, which is
         MOV    AH,10                    ;set first by the
         INT    10H                      ;macro COORD
         ENDM
```

Listing 1: The Macro library. Repeated functions can be executed with a single command using these utilities.

Continued on page 58



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Continued from page 56

```
;
BEEP     MACRO                 ;BIOS bell-beep
         MOV      AL,7         ;routine. Useful when
         MOV      AH,14        ;you don't want the bell
         MOV      BH,1         ;'printed' on-screen.
         INT      10H
         ENDM
;
SHOVE    MACRO                 ;PUSH registers
         PUSH     AX
         PUSH     BX
         PUSH     CX
         PUSH     DX
         ENDM
;
YANK     MACRO                 ;POP registers
         POP      DX
         POP      CX
         POP      BX
         POP      AX
         ENDM
```

```
;
GOSUB  MACRO  SUBRT
    CALL  SUBRT
    ENDM
```

... then this code would be accepted by MASM:

```
...
PUSH   DI
GOSUB  CHKDSK
GOTO   DOCLEAR
```

... where, after the DI register is PUSHed, the routine CHKDSK is CALLed, and then the program JuMPs to an area of the program signified by the label DOCLEAR.

Variations

Both GOTO and GOSUB introduced us to macro *variables*, which give macros their greatest appeal. Often a choice code routine could be referenced to over and over by the program if that routine didn't have specific values within it.

Consider this routine to place the cursor at the upper left corner of the screen:

```
MOV   DH,0
MOV   DL,0
MOV   BH,0
MOV   AH,2
INT   10H
```

Register DH holds the row, DL the column and BL the page number you want the cursor to be placed. If you're doing screen animation, though, you'll need to type those five instructions (with different values in the registers) every time you want to place the cursor before printing a character on the screen. If the thought doesn't make you shudder, you're made of stronger stuff than you may think. A macro allowing you to specify a row, column and page number would be in order:

```
COORD             MACRO
ROW,COLUMN,PAGE
    MOV   DH,ROW
    MOV   DL,COLUMN
    MOV   BH,PAGE
    MOV   AH,2
    INT   10H
    ENDM
```

When this macro is defined, MASM will take the following instruction in your source code ...

```
COORD 12,39,0
```

... and place the value 12 into DH, 39 into DL and 0 into BH when it inserts the five instructions your program's object code. The code itself just places the cursor in the middle of an 80 column screen.

Macros are defined either by your typing them into an assembly source before the program itself, or by INCLUDEing a macro library from disk into your source. This is accomplished by inserting the line

INCLUDE MACRO.LIB [or whatever the filename is]

into your source after your title and before the code starts. MASM will haul the entire library file into memory, but only use those macros which you specify throughout your code. As you may not have a macro library at present, a modest offering is supplied in listing one. Type it up with an editor or word processor (in ASCII text mode) and save it as MACRO.LIB. Add your own macros to it as it becomes convenient. As a macro library isn't a program, I'd feel bad not leaving you with something more substantial to type in. Listing two, SKULL.ASM, becomes a 330-byte .COM file when assembled. It's a short program; the only macro in it is PRINT. We'll dust off John Rudzinski next month to lay on the macros with a trowel in a PC-DOS textfile encryption/decryption program.

SKULL.ASM does little but print a skull onto your HiRes screen. If you have an IBM or Hercules monochrome card, spare your fingers. Only colour graphics cards need apply. Give the code a peer ... the entire deed is accomplished in six subroutines and one macro.

Macros aren't the perfect solution to your assembly problems, but they can certainly save you a lot of typing and debugging time. Where they're least welcomed is in programs where available memory is a factor, or if a critical, die-hard hacker is likely to be browsing through your code. While your source code will be compact, your .COM or .EXE file will be somewhat meatier than a macroless offering.

Skinny code looks horrible in bathing suits, y'know.

```
;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
;
;                   SKULL.ASM
;                 by Ellery Henn
;                 1986  HennSoft
;
; A wholesome part of this nutritious breakfast
;
PRINT     MACRO   STRING               ;Print string on tube
          MOV     DX,OFFSET STRING
          MOV     AH,9
          INT     21H
          ENDM

CODEX     SEGMENT PARA PUBLIC 'CODE'
          ASSUME CS:CODEX,DS:CODEX,SS:CODEX,ES:CODEX

          ORG     100H
BEGIN:    JMP     START

ONELINE   DW      640                  ;First offset
TWOLINE   DW      8832                 ;Second offset
COUNT     DW      0
;
MSG1      DB      'And now, a skull in 640 x 200 graphics...'
          DB      0DH,0AH,0AH,0AH,0AH,0AH,0AH,0AH
          DB      'Hit any key... $'
;
ONEADDR   DB      00000001B,11111111B,10000000B
TWOADDR   DB      00000011B,11111111B,11000000B
OA2       DB      00000111B,10111111B,11100000B
TA2       DB      00011111B,11111111B,11110000B
OA3       DB      00111111B,01111111B,11110000B
TA3       DB      00111111B,11111111B,01111000B
OA4       DB      01111111B,11111111B,11111100B
TA4       DB      01110111B,11111111B,11011110B
OA5       DB      01101111B,11111111B,11111110B
TA5       DB      01101110B,00011100B,00110110B
OA6       DB      01101100B,01001000B,10010110B
TA6       DB      01101000B,00001000B,00010110B
OA7       DB      01101000B,00011100B,00010110B
TA7       DB      01001000B,00110110B,00010100B
OA8       DB      01111100B,00100010B,00111100B
TA8       DB      01111110B,11100011B,11101110B
OA9       DB      00111111B,11100011B,11111110B
TA9       DB      00010001B,11010101B,11001100B
OA10      DB      00001101B,11111111B,10111000B
TA10      DB      00001110B,11110111B,11110000B
OA11      DB      00001111B,11110101B,10110000B
TA11      DB      00001111B,01010101B,01110000B
OA12      DB      00000111B,00000100B,01110000B
TA12      DB      00000111B,11010001B,11110000B
OA13      DB      00000111B,11110111B,11100000B
TA13      DB      00000011B,11111110B,11000000B
OA14      DB      00000001B,11111111B,11000000B
TA14      DB      00000000B,01111111B,10000000B
OA15      DB      00000000B,00110110B,00000000B
;
START     PROC    NEAR
          CALL    INIT                 ;Initialise 640x200
          CALL    CLS                  ;Clear HiRes screen
          CALL    HOME                 ;Remember ET?
          PRINT   MSG1                 ;Print 'hit key' message
          CALL    ?SKULL               ;Print skull on tube
          CALL    GET                  ;Wait for keypress
          CALL    RESET                ;Reset screen to 80x25
          RET                          ;Say g'night, Gracie.
;
START     ENDP
;
INIT      PROC    NEAR
          MOV     AH,0                 ;Set mode of
          MOV     AL,6                 ;640x200 graphics and
          INT     10H                  ;let BIOS know about it
```

```
          RET
INIT      ENDP                         ;Enough of that.
;
CLS       PROC
          MOV     AX,0B800H            ;CGA card address
          MOV     ES,AX                ;Put it into extra segment
          SUB     DI,DI                ;Clear DI and
          SUB     AX,AX                ;AX registers
          MOV     CX,8000              ;This pokes 8000 zeroes
          CLD                          ;into the HiRes page,
          REP     STOSW                ;clearing it.
          RET
CLS       ENDP
;
HOME      PROC
          MOV     AH,2                 ;Set cursor position to
          SUB     DH,DH
          SUB     DL,DL                ;0,0 (Home)
          SUB     BH,BH                ;0=Graphics mode
          INT     10H
          RET
HOME      ENDP
;
?SKULL    PROC
          MOV     CX,3                 ;Going to poke 3 bytes
          MOV     BX,OFFSET ONEADDR    ;Point BX to ONEADDR
          MOV     DI,ONELINE           ;Point DI to offset
          MOV     COUNT,0              ;Clear COUNT
THREE:    MOV     AX,[BX]              ;Contents of BX to AX
          MOV     ES:[DI],AL           ;Poke AL into HiRes screen
          INC     BX                   ;Bump pointers up one to
          INC     DI                   ;get next byte to poke.
          LOOP    THREE
          INC     COUNT                ;Increment line count
          CMP     COUNT,14             ;First 15 lines printed?
          JG      MORE                 ;Yep. Do last 14
          ADD     DI,77                ;Move one line down
          ADD     BX,3                 ;Skip three data bytes down
          MOV     CX,3                 ;Reset CX
          JMP     THREE
MORE:     MOV     CX,3                 ;Poking three bytes ...
          MOV     BX,OFFSET TWOADDR    ;Ready last 14 lines
          MOV     DI,TWOLINE           ;Get second offset
          MOV     COUNT,0              ;Clear COUNT
STUFF:    MOV     AX,[BX]              ;Take byte from BX
          MOV     ES:[DI],AL           ;and poke it on-screen
          INC     BX                   ;Increment both BX and DI
          INC     DI                   ;pointers to poke more
          LOOP    STUFF                ;bytes.
          INC     COUNT                ;Make ready for next line
          CMP     COUNT,13             ;Last 14 lines poked?
          JG      ENDGRAP              ;Yep, wait for keypress
          ADD     DI,77                ;No. Move one line down
          ADD     BX,3                 ;Skip 3 data bytes down
          MOV     CX,3                 ;Gonna grab three bytes
          JMP     STUFF
ENDGRAP:  RET
;
?SKULL    ENDP
;
GET       PROC
          MOV     AH,0CH               ;Clear keyboard buffer
          MOV     AL,7                 ;and wait for keypress
          INT     21H
          RET
GET       ENDP
;
RESET     PROC
          MOV     AH,0                 ;Return screen to
          MOV     AL,2                 ;80x25 B/W
          INT     10H
          RET
RESET     ENDP
;
CODEX     ENDS
          END     BEGIN
```

Listing 2:
The skull program mables use of macros

Continued from page 7

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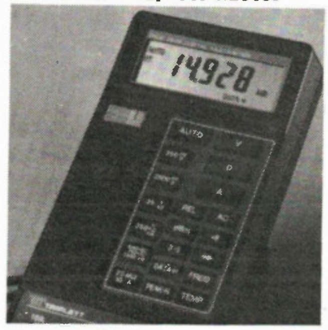

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"Stay right there. I'm coming to pick you up."

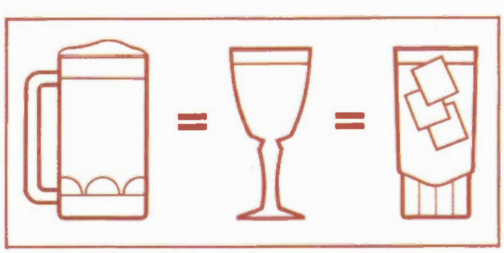
"Thanks, Dad. Oh, and something else."

"Shoot."

"Are you angry with me?"

"Angry? No, Sandy. Not on your life."

Seagram



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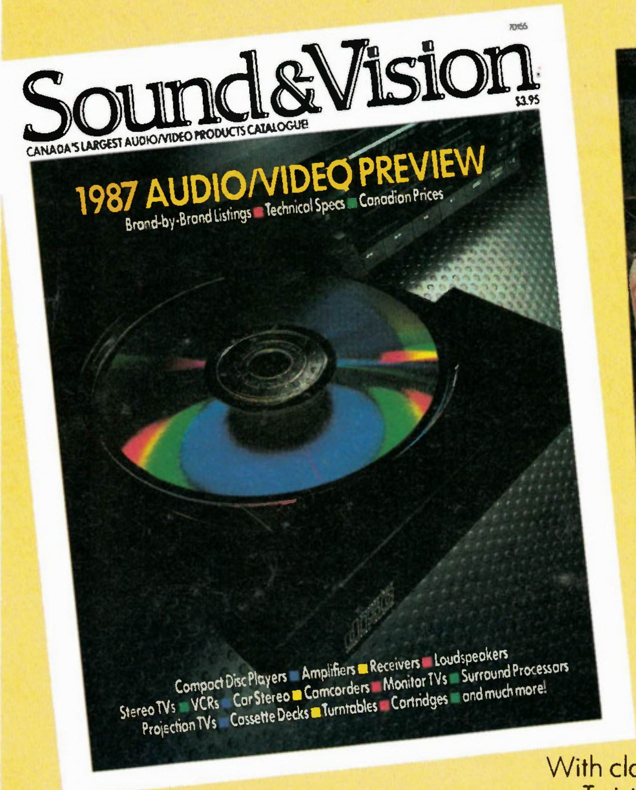

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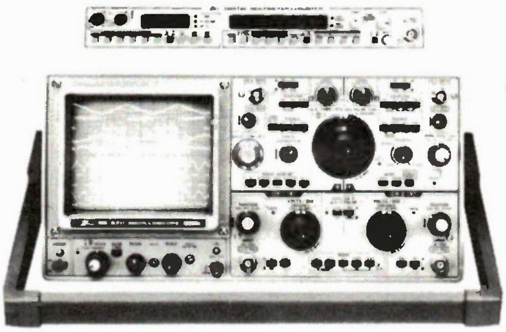

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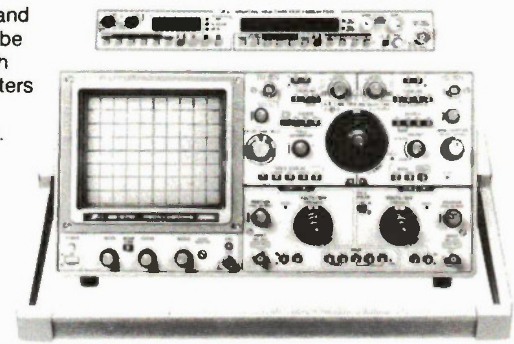

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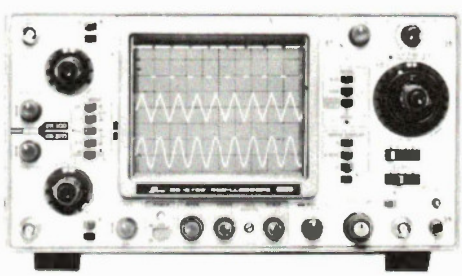

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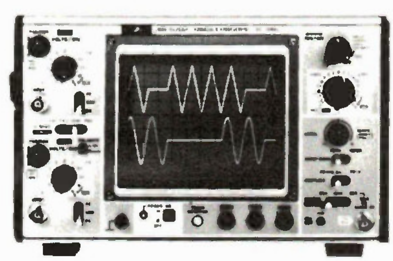

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