Electronics Today

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March 1986

Canada's Magazine for Electronics & Computing Enthusiasts

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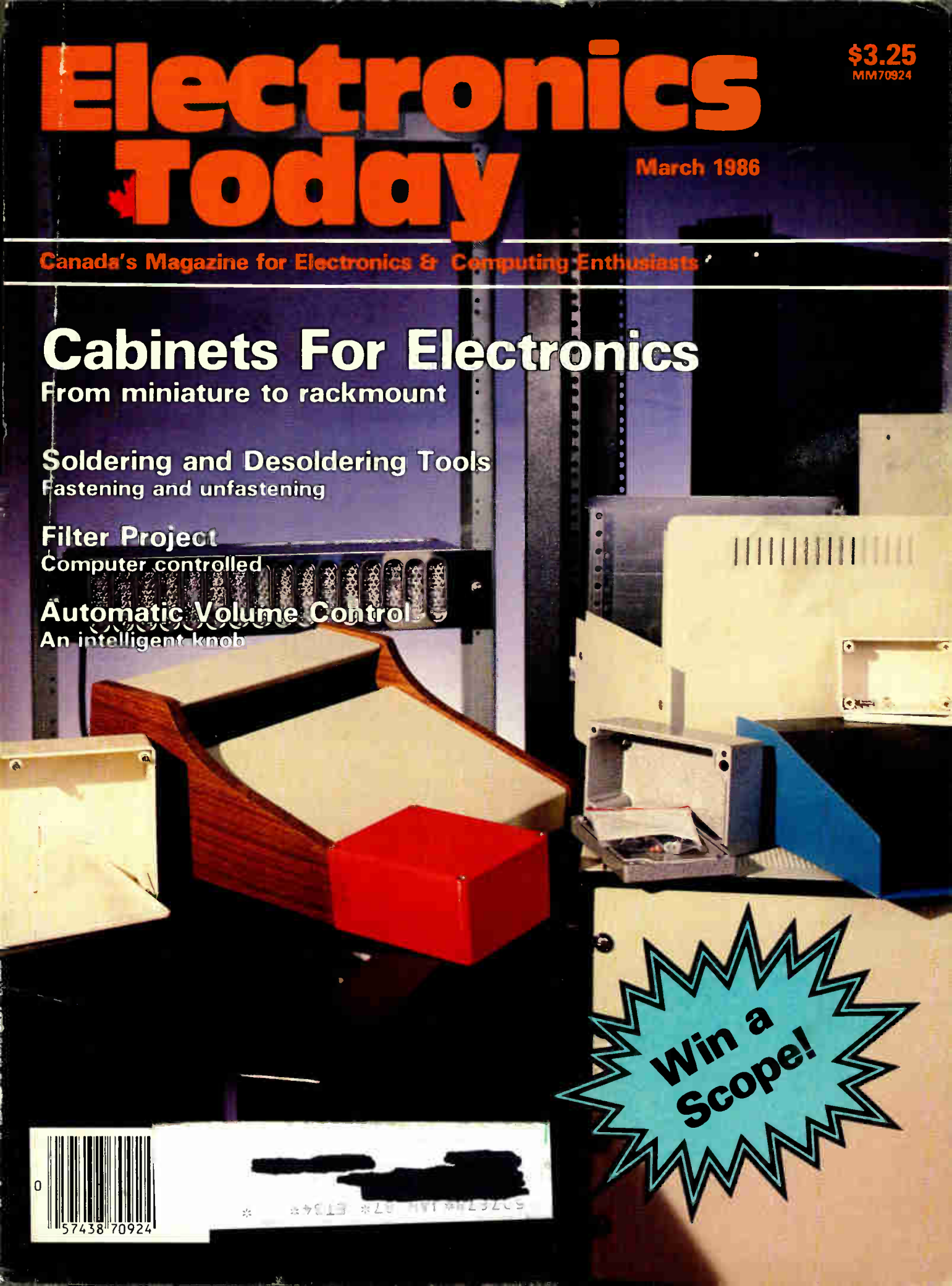
Fastening and unfastening

Filter Project
Computer controlled

Automatic Volume Control
An intelligent knob



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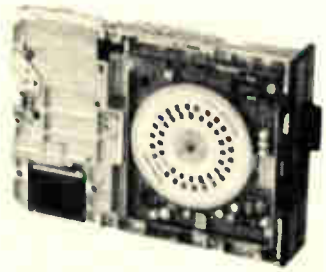

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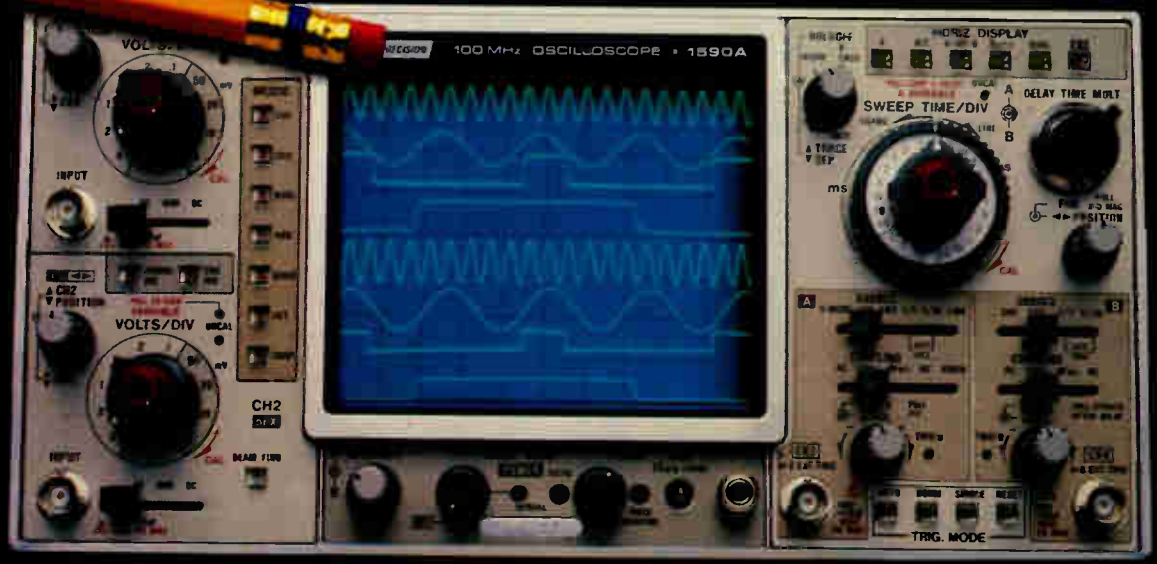

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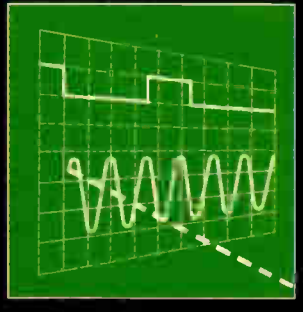

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Reader Service Card

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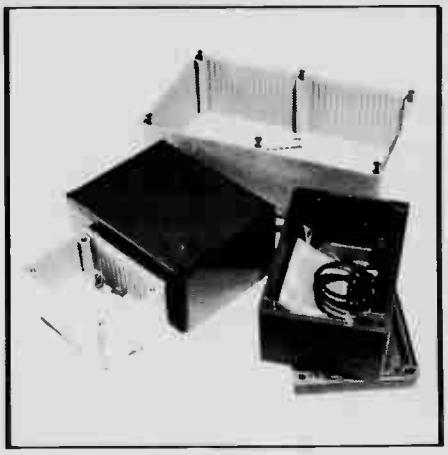

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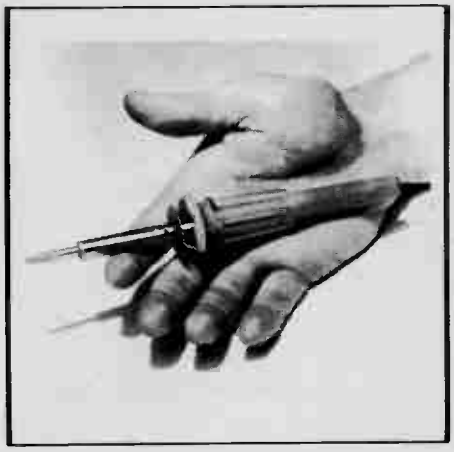

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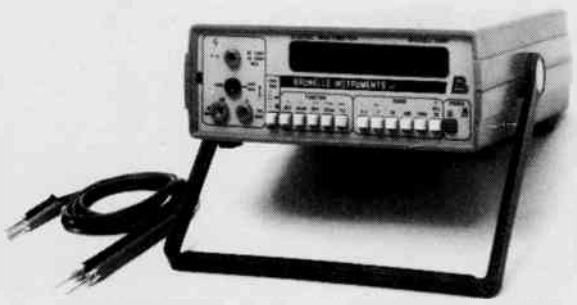
For Your Information

Digital Multimeter



The Brunelle Model 5060 Digital Multimeter features six functions: AC/DC voltage, AC/DC current, resistance and a diode test. The 4 1/2 digit LED display has a DC voltage range of 1200 volts with accuracies of 0.03 percent plus four digits. Automatic zero and overload protection on all ranges. Contact Brunelle Instruments Inc., 73-6th Range South, St-Elie d'Orford, Quebec J0B 2S0, (819) 563-9096.

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Component Notation and Units
We normally specify components using an international standard. Many readers will be unfamiliar with this but it's simple, less likely to lead to error and will be widely used everywhere sooner or later. Electronics Today has opted for sooner!

Firstly decimal points are dropped and substituted with the multiplier: thus 4.7uF is written 4u7. Capacitors also use the multiplier nano (one nanofarad is 1000pF). Thus 0.1 uF is 100nF, 5600pF is 5n6. Other examples are 5.6pF = 5p6 and 0.5pF = 0p5.

Resistors are treated similarly: 1.8Mohms is 1M8, 56kohms is the same, 4.7kohms is 4k7, 100ohms is 100R and 5.60hms is 5R6.

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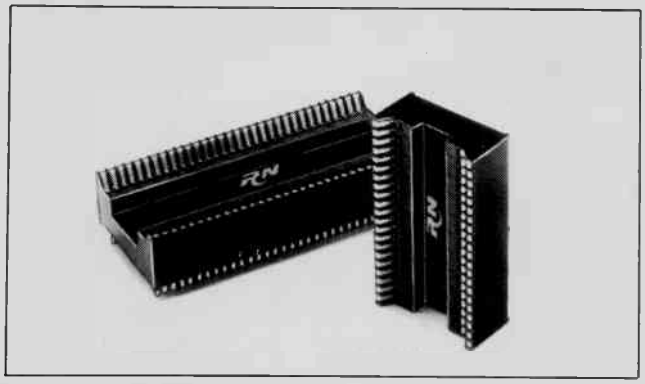
Shrink Sockets



The Robinson Nugent TSS Series burn-in sockets are designed to accept the shrink DIP ICs with lead pitch at .070. Available in 28, 42 and 64 pin counts, the sockets feature a centre channel to guide IC removal and adapt to automatic handling equipment. DGW Electronics Corporation, 85 Spy Court, Markham, Ontario L3R 4Z4, (416) 475-8500.

Circle No. 8 on Reader Service Card

Aptron, the folks who bring you the Bugbuster machine code debugging system for the Apple, have a similar system for the IBM PC and compatibles. It consists of a card for an expansion slot, a manual trigger switch, software and a manual. The unit monitors the machine level operations and stores a real time trace of 2048 cycles around a trigger point. Full screen setup menus allow the user to define two levels of triggering on any program condition for quickly debugging any machine language or compiled program running under PC-DOS or MS-DOS. The system sells for $999; a software demo package is available for $19. Aptron Design Ltd., PO Box 13193, Kanata, Ontario K2X 1X4, (613) 831-0163.

Circle No. 42 on Reader Service Card.

The new CRAY-2 supercomputer is guaranteed to outrun your ZX81, even with a disk drive. It consists of four independent background processors, each more powerful than a CRAY-1; they can operate together or independently on scalar or vector processing (see *Supercomputers*, ET June, 1985). A common memory is accessible from any of the processors or data channels and consists of 256 million 64-bit words. The clock cycle time is 4.1 nanoseconds; the dense multi-layer circuit boards are cooled with a fluorocarbon liquid. The operating system is based on Unix V. The cost, obviously, is in the millions. You could put one in your basement and have the fastest WordStar in town.

Continued on page 28

Auto-Volume Control

A clever automatic volume control for your PA System.

By C. Capel and P. Green

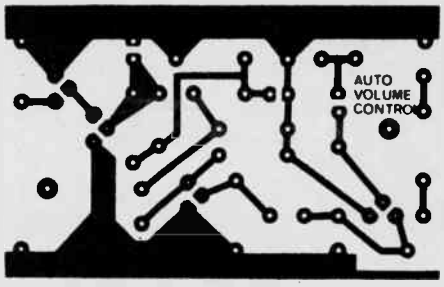
AUTOMATIC VOLUME control has been used for years in broadcast radio receivers, at least it has been termed automatic volume control although it was actually automatic gain control. AGC responded not to changes in the audio frequency output, but fluctuations in the level of the RF carrier. Part of the carrier appearing at the last IF stage was rectified, applied to a circuit having a time constant sufficient to remove audio modulations, then fed as a DC control potential to the grid circuit of the first IF stage. Thus fading was reduced and strong local carriers did not produce overloading of later stages. This illustrates the rather confused manner in which the term is used.

Expanding On Compression

Another confusing idea often encountered is between automatic volume control and volume compression. Although both are concerned with audio levels and their control, there is an important difference that dictates which feature should be used in a particular application.

With volume compression, the dynamic range is reduced and the gain of the circuit varies according to the amplitude of the signal. This reduction may take place over the whole range of signal levels, or it may start at some predetermined threshold below which the circuit behaves normally with linear gain. Above it, the signal produces an output which is proportionally less as the amplitude increases.

Volume compression is used where the dynamic range (the range between the loudest and softest signals) is too great for the equipment of system to safely handle. Either the loud signals would overload the circuit, over modulate the carrier, or introduce unacceptable distortion, or the soft signals would approach the noise level so that a poor signal-to-noise ratio would result. Broadcast radio transmissions are an example of the use of compression, and the compressed result is generally considered satisfactory for domestic listening.



The PCB artwork for the Auto-Volume Control.

Orchestral Manoeuvres

It may be worth mentioning at this point that there is often a considerable 'overkill' in the range stipulated in hi-fi circles. Some quote figures around 70 dB as the range between the quietest and loudest sounds produced by a symphony orchestra. Measurements of sound levels made by the author at public symphony concerts failed to produce anything like this. The difference between the quietest passages (whispering strings) and full-blooded climaxes with percussion, brass and everything else playing flat out was little more than 45 dBA.

The opportunity has not arisen for measurements during large scale choral and orchestral works in which a somewhat wider span could be anticipated, but from theoretical calculation it would not be a lot more. For example if a choir and orchestra each generated 45 dB, together the combined sound level would be only 48 dB.

Levelling Off

Automatic volume control does not reduce dynamic range by lessening the amplitude of loud signals more than that of quiet ones. it reduces the overall level (so that both loud and quiet sounds are affected equally) when the level is high, and increases it when the overall level is low. The operation is the same as that of a manual volume control, except it is automatically actuated by the signal.

One common use is the automatic recording level control that is incorporated in most portable cassette recorders. This permits recordings to be made without

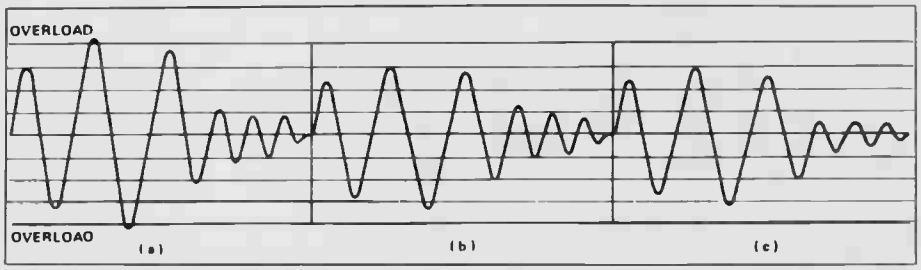


Fig. 1 A signal comprising successive loud and soft tones. The tone exceeds the overload level of the equipment (a). With volume compression, the loud tone is reduced more than the soft one, reducing dynamic range (b). With automatic volume control, all the signals are equally reduced (c).

trial runs and careful watching of the recording level meter. Though very useful for spontaneous recordings it does have its drawbacks in being too inflexible in the form usually used. Fades, either up or down, cannot be executed as there is normally no recording level manual control. The effect is also less than satisfactory when recording music which has sudden changes of volume. The manual override which accompanied the first automatic level circuits in recorders now seems to have disappeared completely.

PA Problems

Public address systems are another application for which auto level control is ideal. Many platform orators are notoriously bad microphone users; they turn away and often step away from the rostrum, while at other times some lean forward and shout into the microphone to emphasize a point. As the level varies according to the square of the distance between the lips of the speaker and the microphone, some pretty hefty volume changes take place. With interviews or forums there may be a variety of participants, some soft-spoken and some loud. Any of these may shift his position during the programme and wind up nearer or further from the microphone. The poor PA operator struggles manfully to compensate by rapid adjustment of the sliders, sometimes the wrong ones, and in the wrong direction. No wonder they sometimes emerge from a session as nervous wrecks!

It was for the purpose of PA control that our unit was designed, and it has proved very useful. However, there are no doubt other applications for which readers may find it practical. Being comparatively small it could be built into most existing amplifiers or mixers, drawing only a small amount of current from the power supply. However, if desired it could be mounted in a separate box with a battery supply.

Alternative Technology

Several methods were tried (and rejected) in order to achieve satisfactory auto-control. The simplest method (which has been frequently used for cassette recorder ALC circuits) is to rectify part of the output and apply it as negative bias to an early NPN transistor (or positive bias to a PNP device). This way the forward bias is reduced, reducing the collector current and also the gain of the circuit (Fig. 2).

There are several snags with this arrangement. One is that with the reduction of base current on which the signal current is superimposed, the capability of the circuit to handle large signals is also reduced. Now this occurs precisely at the time when large signals are present at the base, which are not affected by the gain of the following circuit. Therefore there is a strong possibility of overloading and distortion, the stronger the signals are, the smaller the base current becomes.

Overloading is less likely in a cassette recorder when the internal microphone is being used, as close-talking is not usual under these circumstances. But it could occur if a high sensitivity external microphone or auxiliary input were being recorded. It could certainly occur when used as a general automatic volume control for PA or other purposes.

The other drawback is that noise in a transistor is dependent on the current in the base and collector circuits; the larger the current, the greater the noise. As the current varies with the operation of the automatic control, noise will also vary. However, the current, and hence the noise, is greatest in the absence of a signal, and least when the signal is at a maximum. This of course is the opposite to what it should be, as noise is relatively unimportant in the presence of large signals which mask it.

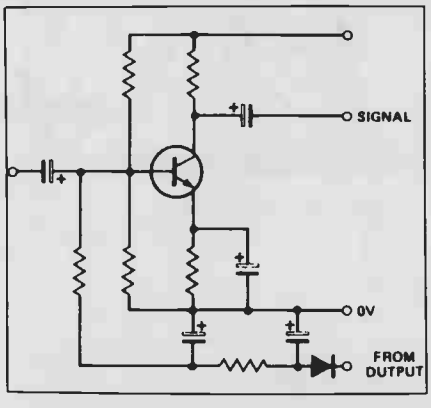


Fig. 2 A simple AVC circuit as used in some cassette recorders for recording level control. It can be overloaded as the forward bias is reduced by a strong signal.

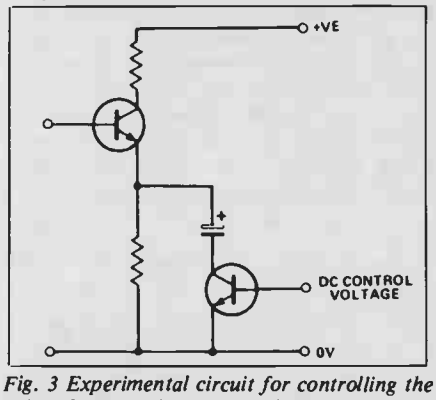


Fig. 3 Experimental circuit for controlling the gain of a stage by varying the negative feedback.

Variable Variation

Another circuit which at first seemed promising (Fig. 3) consisted of a transistor used as a variable resistor. This was controlled by a rectified voltage derived from the output, which was connected in series with an emitter bypass capacitor. The signal developed over the emitter resistor by the collector current is in opposition to the applied signal between base and emitter, thereby providing a form of negative feedback. When bypassed with a capacitor having a low reactance compared to the emitter resistor, the feedback disappears.

Continued on page 38

How It Works

The signal is sampled from the output of the mixer or some other convenient high-level point, and is applied to the potentiometer PR. This permits the amount of AVC to be preset. SW1 shorts the preset wiper to ground, which allows the circuit to be switched out without disturbing the control setting.

Q1 amplifies the control signal and the output is applied to Q2; this is an emitter follower with a low impedance output and high current sourcing. The purpose of this is to ensure that the capacitors C4 and C5 charge rapidly at the onset of a sudden loud sound and so achieve a quick reaction. The capacitance of these components has been limited for the same reason.

After rectification by D1, the DC control signal charges C5 through D2 which offers a low impedance path. However, the capacitor cannot discharge back through D2 because of reverse polarity, but does so through R8 and R7. Thus the discharge is considerably slower than the charge, so the control signal doesn't fluctuate with every change in amplitude of the original signal (which would result in volume compression). Instead it maintains a level which corresponds with the average level of the incoming signal; thus if a quiet signal follows immediately after a loud one, the same dynamic range is maintained and the gain drifts back only slowly to the previous level. Small changes in signal amplitude as in normal speech have little effect.

The rapid initial response greatly reduces the devastating effect of the explosive consonants P and B when spoken too close to the microphone. But because the general overall level is governed by the average input signal, the circuit evens out longer variations which arise when a speaker turns his head away from the microphone to address one section of his audience.

Transistor Q3 drives the control transistor Q4, which behaves as a variable resistor and is connected as the bottom leg of a potentiometer across the signal source. The upper leg is a fixed resistor, and the tap between them is the variable point for feeding the following amplifier. A shunt resistor is connected across Q4 to maintain the load on the source when the transistor is cut off.

When a large signal is received, Q4 is made conductive and the resistance of the bottom leg reduced, changing the ratio between it and the top leg. When the signal is small the opposite happens and Q4 becomes less conductive, increasing the lower leg resistance. Thus the circuit operates in the same manner as a manual volume control, by reducing the signal applied to the controlled stage rather than changing the gain of the stage itself. Therefore it can't be overloaded and self-generated noise remains the same. Noise from earlier stages is reduced along with the signal, so the drawbacks of other control circuits are eliminated.

Designer's Notebook: GaAs Devices

Gallium arsenide technology offers a considerable increase in the operating speed of semiconductors.

By Stuart Smith

TO appreciate how Gallium Arsenide (GaAs) devices work, and why they are superior in many respects to silicon-based devices, it is necessary to understand some of the fundamental physical properties of semiconductors. At the risk of repeating already well-known information, the next few sections will cover some of this ground.

Energy Bonds

It's a fact of life that electrons in an atom can have only certain energies. When the atoms are bonded together to make a crystal, the electrons can have energies within certain allowed bands, which may overlap. The 'band structure' (**Fig. 1**) of solids determines whether they are conductors, semiconductors or insulators.

Electrons with energies within the valence band are attached to particular atoms in the crystal. They cannot move through the crystal and contribute to conduction. Electrons in the conduction band have sufficient energy to escape the attraction of the nucleus and can move through the crystal under the influence of an applied electric field.

Band Gap

The basic difference between insulators, semiconductors and conductors is the size of the energy gap between the valence and conduction bands, because this governs how easy it is for an electron to enter the conduction band. In metals the bands overlap - there are always conduction band electrons available, so metals are good conductors.

In insulators the gap is so wide (over 3 or 4eV) that virtually no electrons enter the conduction band at reasonable temperatures.

In a semiconductor the band gap is about 1eV, which leads to a resistivity midway between insulator and conductor.

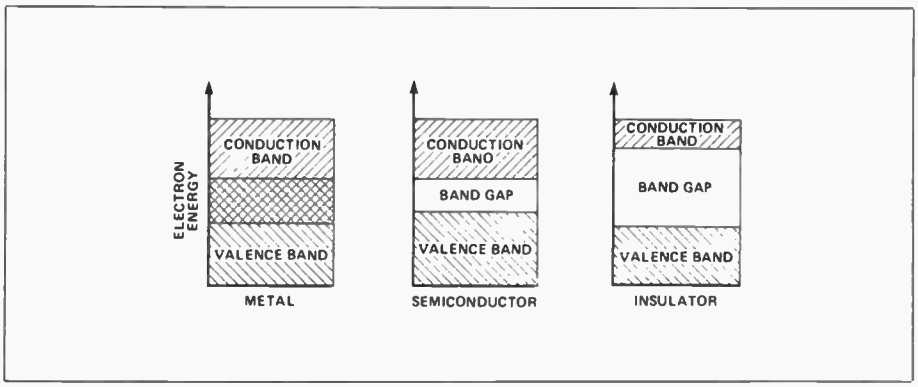


Fig. 1 Energy band diagrams.

At absolute zero temperature (-273 deg. C) the valence band is completely filled and the conduction band empty. At higher temperatures some electrons gain sufficient energy from the thermal vibrations of the crystal to leave the valence band and jump into the conduction band. The number of conduction band electrons is exponentially related to temperature.

There are several elements and alloys with band gaps in the 1eV region but for various reasons not all of them are suitable for electronic devices. Table 1 shows the important electronic properties of Germanium (Ge), Silicon (Si) and GaAs. Some of these properties are discussed below.

Excitation and Recombination

It's possible to raise the energy of an electron in a crystal by several methods: heating it, shining a light on it or applying an electric field to it. When an electron is excited from valence to conduction band it leaves behind a vacant energy level (or state) called a hole. The hole behaves like a positive charge.

Electrons do not stay in the conduction band for ever: they naturally 'fall back' into the valence band, but they must fall into a hole. This process is called recombination, and it releases energy, the energy the electron originally gained to enter the conduction band. The energy may be released as heat, light or both, depending on the type of material.

Doping

To make useful electronic devices, it's usually necessary to control the conductivity of the materials by altering the number of holes and electrons in the material which are available for conduction. This can be done by adding small quantities of other materials called 'dopants' to the pure (intrinsic) semiconductor. If the dopant adds electrons, it is a donor and the resulting semiconductor is called n-type. If it adds holes it is an acceptor and the semiconductor is p-type.

Temperature

The relatively high bandgap of GaAs means that at normal temperatures (-20 C to 100 C or so) the amount of free carriers (electrons or holes) is minimal compared with those introduced by doping. this is still true at high temperatures. Some

GaAs devices are usable at up to 400 C and most will work at temperatures between -200 C and 200 C. The range is much wider than for silicon devices.

Mobility

When subjected to an electric field, electrons accelerate towards the most positive point. In a crystal this does not continue forever, as the electrons eventually collide with the crystal atoms. Collisions may even cause the electrons to reverse direction. Overall the electrons can be said to reach a mean or drift velocity which is constant and proportional to the applied field. The ratio of electron speed to applied field is called the electron mobility, and it is much higher in GaAs than in silicon. Electron mobility governs the switching speed of transistors and GaAs devices are therefore much faster than their silicon counterparts. There is a limit to the drift velocity attained as the applied field is increased, but this limit is higher in GaAs than in silicon.

Photoconduction and Photoemission

A quantum of light energy (a photon) can, if it has the right frequency, transfer all its energy to an electron and cause it to jump into the conduction band. the relationship between photon frequency and energy is:

E = hv, where
E is energy in Joules (J) (1eV = 1. $6x10^{-19}$J),
h is Planck's constant, $6.63x10^{-34}$Js,
v is light frequency in Hertz.

Below a threshold frequency, Vth = Egap/h, the electrons cannot gain sufficient energy to across the band gap and will not be excited. At a frequency greater than Vth the light will cause excitation and generate electron-hole pairs, so the conductivity of the material will increase with light level. Cadmium Sulphide (CdS) has a band gap of 2.42eV which gives it a response to light similar to that of the human eye. Other semiconductors respond well to infrared or lower frequency electromagnetic radiation.

Light Emitting Diodes

As we have seen, electrons eventually recombine with holes, giving up their energy as heat or light. Recombination in Si produces mostly heat. In GaAs, recombination gives off light in the infrared. By adding phosphorus (P) to the GaAs the band gap is increased and the emission moves towards the blue end of the spectrum. GaP LED's emit green light.

An LED is a junction between p and n type GaAs (or GaAsP, or GaP). In the bulk of the diode, away from the junction, there are a lot of free carriers (**Fig. 2a**). Application of a forward bias voltage (**Fig. 2b**) makes it easy for electrons to leave the n region, cross the junction and enter the region. Here there are many holes, which recombine with the electrons. The holes are continually replaced by fresh ones at the diode anode so the current flow, recombination and light emission continue as long as the forward bias is applied.

Semiconductor Lasers

The semiconductor laser is a device of great importance in modern communications. Fiber-optic data transmission using a semiconductor laser as the lightsource allows the transfer of huge quantities of information over large distances at great speed.

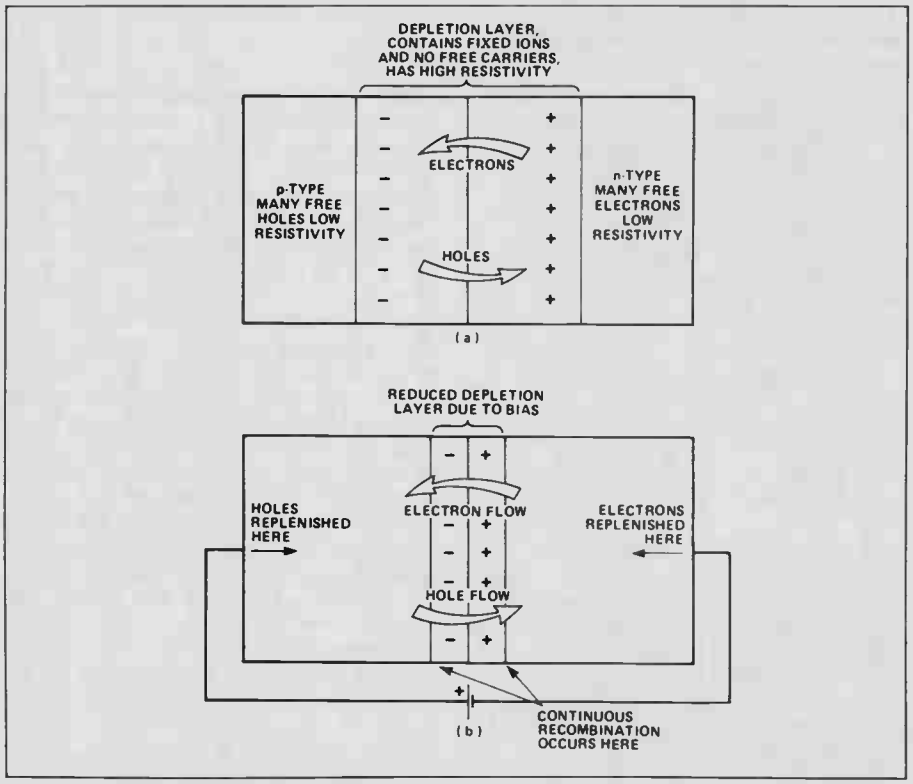


Fig. 2 PN junction with no bias applied (a) and with forward bias (b).

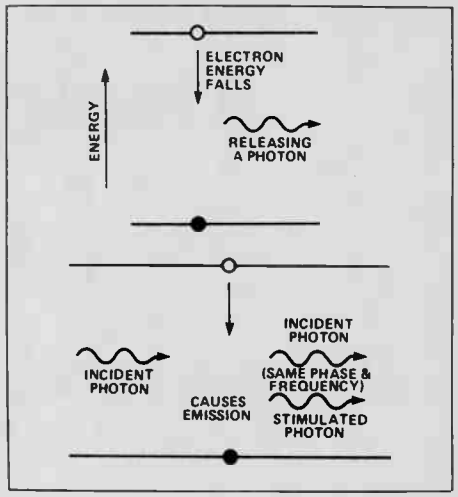


Fig. 3 Spontaneous and stimulated emission of radiation.

To use an optical fiber at high speed over an appreciable distance (say several kilometers), a number of conditions must be satisfied:

1. The laser light must be capable of being modulated at a high rate;
2. The light must be of a single frequency to avoid spreading of pulse edges;
3. The light must be very intense to allow large spacings between repeaters (which pick up weak signals, amplify and retransmit them);
4. The light source must be very efficient, for low cost and power consumption.

Semiconductor lasers fulfil all these requirements.

The basic principle of the laser is quite simple. We have already seen that electron-hole recombination releases energy. In most cases recombination occurs randomly and spontaneously. Any photons given off in the process are in random phase with one another. The light so produced is said to be incoherent.

The presence of photons of the wavelength corresponding to the band gap energy can cause recombination, accompanied by emission of light. This 'stimulated emission' is in phase with the photon which caused the emission. The light amplitudes add in phase and the resulting light is very intense and coherent (**Fig. 3**).

We also know that photons can be absorbed by the material, causing the electrons within it to be excited into the conduction band. In order for there to be a continuous output of coherent light, two conditions must prevail.

1. There must be a high density of photons in the material, so that more stimulated than random emission occurs;
2. There has to be an electron 'population inversion', a greater number of electrons in a high-energy state than a low-energy state. This ensures that more emission than absorption takes place.

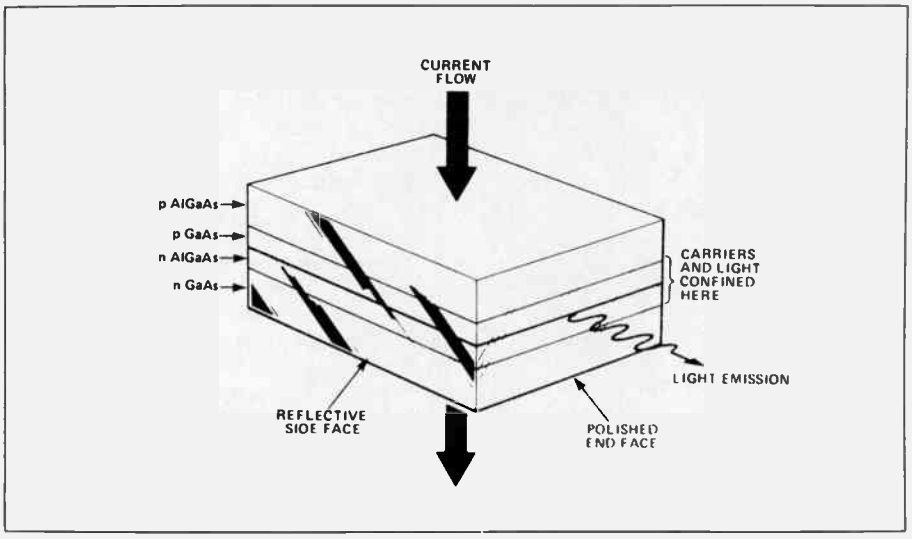


Fig. 4. Simplified diagram of GaAs/GaAlAs diode laser.

The first requirement is met by creating an optical resonant cavity, simply a bar of material with mirrored faces so that the light intensity builds up within the cavity by repeated flections.

Population inversion occurs in the semiconductor junction's depletion layer. It is called the depletion layer because it usually lacks carriers (holes or electrons). At high currents, however, it is far from depleted. There is a continual stream of high-energy carriers being injected into the junction and swept away. Over a short distance in the junction there can be more conduction than valence band electrons.

The basic structure of a GaAs/GaAlAs injection diode laser is shown in **Fig. 4**. The laser action takes place at the junction between the p-GaAs and the n-GaAlAs (gallium aluminium arsenide). The regions immediately adjacent to these perform two functions.

1. They confine the light to a narrow region because thy have different refractive indices to the junction materials;
2. They keep the volume within which population inversion takes place small, so reducing the threshold current at which laser action begins. The effect occurs because the band structure of the materials forces the carriers to recombine in the narrow region near the junction.

For optical fiber communications the GaAs/GaAlAs laser is being replaced by a GaInAsp (Gallium-indium-arsenic-phosphide) diode on an InP substrate. By adjusting the relative quantities of Ga, In, As and P in the diode it is possible to adjust the band gap so that the emitted light has the wavelength at which the fiber is most transparent. By the same means the lattice constant (the distance by which atoms are separated) can be adjusted independently of the band gap. This allows the growth of diodes directly matched to the InP substrate.

The present aim is for systems using 1.5 to 1.65um radiation modulated at 2 gigabits/sec. With the latest optical fibers signals may be sent up to 100km without repeaters.

The Gunn Diode

The Gunn diode is a two-terminal device used in microwave oscillator circuits. It has a variety of different modes of operation, but its basic principles can be understood with reference to resonant circuits.

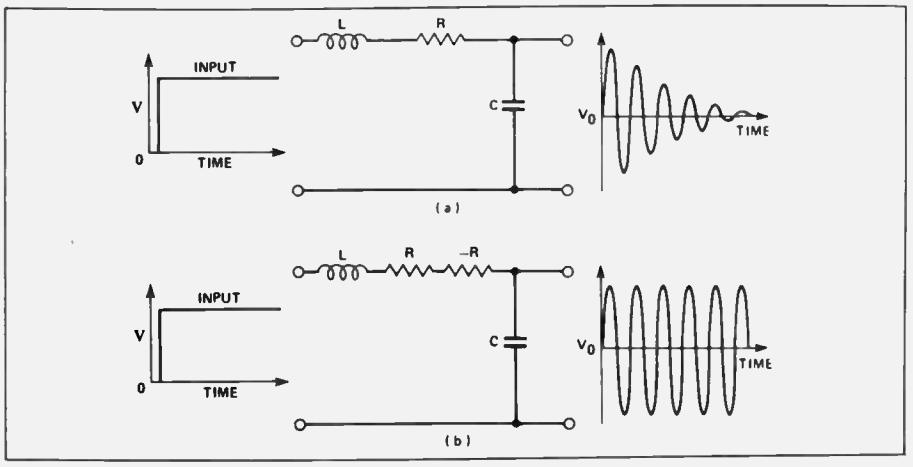


Fig. 5 LC oscillator with damping (a) and with negative resistance applied (b).

A common LC circuit, when stimulated by step input voltage, will oscillate at a frequency:

$$f = 1/(2\pi\sqrt{LC})$$

The oscillations will die away exponentially, however, because of resistive losses (damping) in the circuit (**Fig. 5a**).

In most oscillators, these resistive losses are compensated for by feeding back an amplified version of the output to the input in such a way as to sustain the oscillation. Another approach is to use a device which exhibits negative resistance over part of its I-V characteristic (**Fig. 5b**).

A real negative resistance would be very valuable! In practice, we find some devices for which a small increase in applied voltage causes a small decrease in current flow (**Fig. 6**). Strictly speaking, they have negative differential resistance and a suitable doped piece of GaAs exhibits this property due to its band structures.

Electrons in GaAs can be excited into the conduction band by an applied field. Up to a certain threshold field (about 3kV/cm) the electron drift velocity increases with field strength, since the mobility is constant. Above the threshold field the electrons gain sufficient energy to reach part of the conduction band where their mobility is much smaller because of the increased probability of collisions. The conductivity of the GaAs drops. Small increases in field cause more electrons to enter the low-mobility region and the current falls; this is the negaive-resistance region. This property is utilized in Gunn diodes and makes the devices useful for circuits of the form shown in Fig.5.

The Gunn diode (named after J.B. Gunn who discovered the principle of producing microwaves by the application of a steady voltage in 1963) is formed from a single section of n-type GaAs. The GaAs is unevenly doped so that, with the application of a suitable voltage, both high and low mobility electrons are liberated. The crystal becomes partitioned into areas of different intensity electric field. In the negative-resistance region of operation, the existence of a highest-intensity area, in which electron density is greatest, will cause an increase in current flowing into the area and a decrease flowing out of it. The domain of high-intensity charge builds-up and is eventually attracted to the anode end of the GaAs crystal. It travels through the crystal, a packet of charge not altogether unlike a spark bridging two electrodes in the air, producing a spike of current at the anode. The process repeats itself, generating a microwave output which has reached 65mw at 2GHz continuous and up to 200w pulsed.

Transistors and ICs

Although GaAs transistors for microwave applications have been available for some

More on Transformers

Transformers are for more than just power supplies; here are some of the special applications.

By Bill Markwick

LAST October, we looked at the usual transformer/rectifier/filter found in most power supplies, plus a hurried look at audio applications. What with one thing and another, this sequel didn't quite make it into the following month, or the next, or the next...

But I've been taking vitamins, and here's a rundown on the special-purpose types you may find in circuitry.

The Autotransformer

One of the great advantages to transformers as power supply components is the resulting isolation; the output of the secondary coil acts like a power source on its own, eliminating ground path shock hazards and allowing considerable DC offset. The heater filament of a scope CRT is a good example of the latter; it might have only a few volts across it, but operates at kilovolts above the chassis potential.

If you don't need this isolation and only want to change voltage levels, the transformer can be simplified by letting both primary and secondary share a common coil, called an autotransformer. The schematic is shown in **Fig. 1.**. It can function either as a step-up or step-down, depending on which way around you put the source and load.

The voltage ratio is the same as the turns ratio, as in normal transformers. If you're using it as a step-up, the entire number of turns is taken as the secondary and the primary will be the number of turns from the tap to the common. For step-downs, take the entire number of turns as the primary, and the number of turns from the tap to common as the secondary.

Autotransformers are most often used to adjust power line voltages. For instance, Hammond's model 168B autotransformer has a 115VAC input, and taps at every 5V from 85 to 125. It can supply about 200 watts and weighs 2kg. Another popular use is in the variac. In this unit a slider wipes across contacts on the entire secondary wire itself, giving a smooth control of output voltages from zero to slightly higher than the input. Great for lab supplies, RFI-free lamp dimmers and motor controllers (costly, though: expect $50–300 for small ones).

You can make your own autotransformer from any standard power type. Connect one primary wire to one of the secondary wires; this connection becomes the tap. For instance, suppose you needed to step up the 10VAC output of an oscillator to about 50V. A small power transformer such as a 115VAC-to-25VAC would be ideal. It has a turns ratio of 115:25, or 1:4.6 (we can ignore the actual number of physical turns; we're only interested in ratios). As a step-up autotrans, we use the former primary side as our new secondary. Since it's on top of the former secondary, the total turns ratio is now 4.6 + 1 = 5.6. See **Fig. 2.**

The voltage step-up is now 5.6, for a total of 56 volts out. The available current at the input is divided by 5.6 at the output.

There are limitations here. Don't be tempted to use the homemade autotransformer to get really high voltages, because the secondary may not be insulated adequately, and the original transformer was not designed to run at frequencies too far from 60Hz, though you might be able to push it to a few hundred Hertz with some losses. This quickie method is best suited to very low power requirements such as bias supplies.

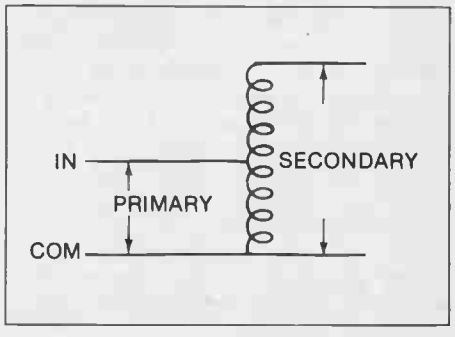


Fig. 1. The schematic of a step-up autotransformer. The secondary and primary connections can be interchanged to form a step-down type.

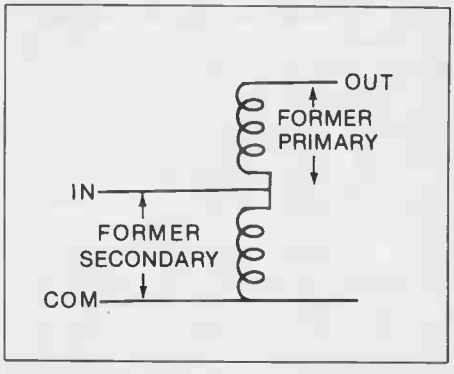


Fig. 2. An autotransformer for special applications, made from an ordinary small power transformer.

Switching

The reason power transformers are so big and heavy is that it takes a lot of iron to operate at 50 or 60Hz, values chosen by

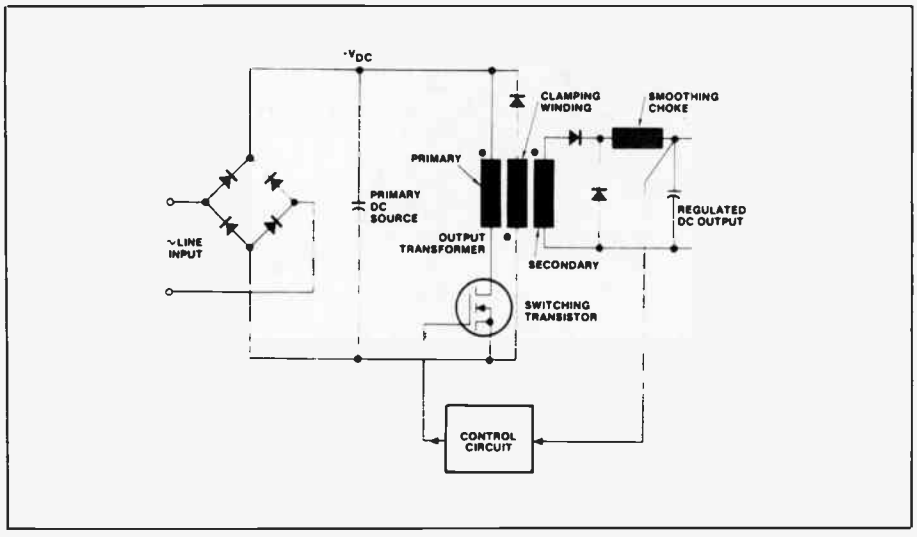


Fig. 3. The basic diagram of a 100kHz switching regulator, courtesy of International Rectifier.

the world's utility companies to minimize transmission and distribution losses due to high-frequency effects, not to mention the annoyance of hearing your toaster sing at some audible high frequency.

If the operating frequency can be stepped up, however, the size of transformers goes down remarkably. The transformers in the switching power supply of an Apple or IBM computer are hardly larger than an ice cube, and they supply 100 to 150 watts.

Fig. 3 shows a 100kHz switching power supply designed by International Rectifier to showcase their HEXFET power transistors. The transformer is custom wound on a ferrite core: only 20 turns in the primary and 3 turns of copper strip in the secondary.

Aside from the diminished size of the magnetics, switching supplies have another big advantage. The switching transformer/transistor is off until the output capacitor needs a squirt of current to keep it topped up, and then the transistor switches on full. This minimizes power dissipation in the transistor, allowing input voltages to vary from as low as 85VAC to as high as 265VAC with no adjustment or tap-changing required.

In the circuit of Fig. 3, the AC line voltage is rectified and filtered by a standard bridge/capacitor arrangement. The control circuit turns the transistor switch on, causing a current pulse through the primary. This pulse transfers through the secondary to the output smoothing circuit, and when the capacitor is charged, the control circuitry shuts off the transistor switch. The clamping winding then returns the magnetizing current in the transformer back to the primary DC source, resetting the flux in the core prior to the next cycle.

If you'd like complete details on the construction of this supply, which can deliver 20A at 5VDC with 0.5% regulation, it's covered in International Rectifier application note AN-939A, *A Universal 100kHz Power Supply*, contained in their HEXFET Databook HDB-3 and available from IR dealers.

Class A

The Class A power transformer has faded from the scene, but at one time it was the favorite for small vacuum tube power amplifiers. It can still be found occasionally in professional audio applications, such as high-quality balanced output amplifiers.

In this type of amplifier, collector current flows at a preset level all the time, whether a signal is present or not. When the signal appears, it modulates the collector current to produce the output power. Obviously, the power dissipation is very high at all times; this inefficiency is the price paid for the absence of Class B biasing problems.

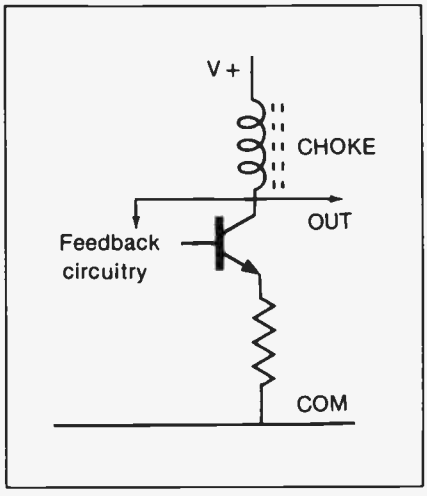


Fig. 4. Using a choke to increase the signal swing of a common emitter amplifier.

The transformers used in this application must be specially made for the purpose because the constant flow of collector current magnetizes the core. It isn't too likely that you'll have your heart set on one anyway; the transformer is unnecessary in Class A amplifiers for the highest of fi.

On the other hand, suppose you need a very high voltage swing from a Class A small-signal amplifier. A typical application would be the mixing stage of an audio console; the sudden arrival of a dozen audio feeds at once may require a very large signal swing from the mixing amp to avoid overload distortion. The circuit in **Fig. 4** shows a good solution to the problem of getting more output voltage without raising the supply voltage. A large inductor is used in place of the usual collector resistor. Any large choke (1H or more) will do, but linearizing feedback should be incorporated in the circuit to offset distortion from core magnetization. The choke will double the output voltage because of the energy storage in its core.

Stay Tuned

Tuned transformers are a mainstay in high frequency design. Before delving into them, it's worth recapping the phenomenon of resonance.

If we put a coil in series with a capacitor, we get a *series-resonant* circuit. If a low-frequency signal is applied, the capacitor dominates and its reactance (resistance to AC flow, in ohms) goes down with increasing frequency. As the frequency continues to rise, the inductive reactance begins to increase. At some point determined by the circuit values, the inductive and capacitive reactances will be equal; this is the *resonant frequency*. Since they're also out of phase, they cancel, leaving only the circuit resistance.

If we put a coil across a capacitor, we get a *parallel-resonant* circuit. Its circuit action is much the same as a series-resonant, except that at resonance the coil and capacitor tune each other out, giving the equivalent of an open circuit.

Since transformers have inductance and capacitance, and additional capacitance can be added externally, we can make them into a resonant circuit. Sometimes only the secondary is tuned, and sometimes both coils are tuned (a *double-tuned* transformer).

The advantage is that we now have a bandpass filter. The secondary of a single-tuned transformer is really the series-resonant filter discussed above, and at resonance the secondary circuit appears to be resistive. **Fig. 5** shows the current in the secondary versus frequency for a single-tuned transformer. The three different curves are for high, medium and low *Q*, which defines the narrowness of the bandpass response and is the ratio of

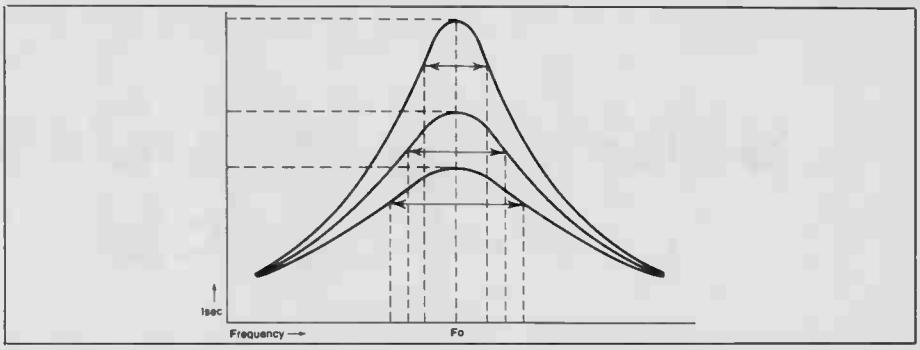
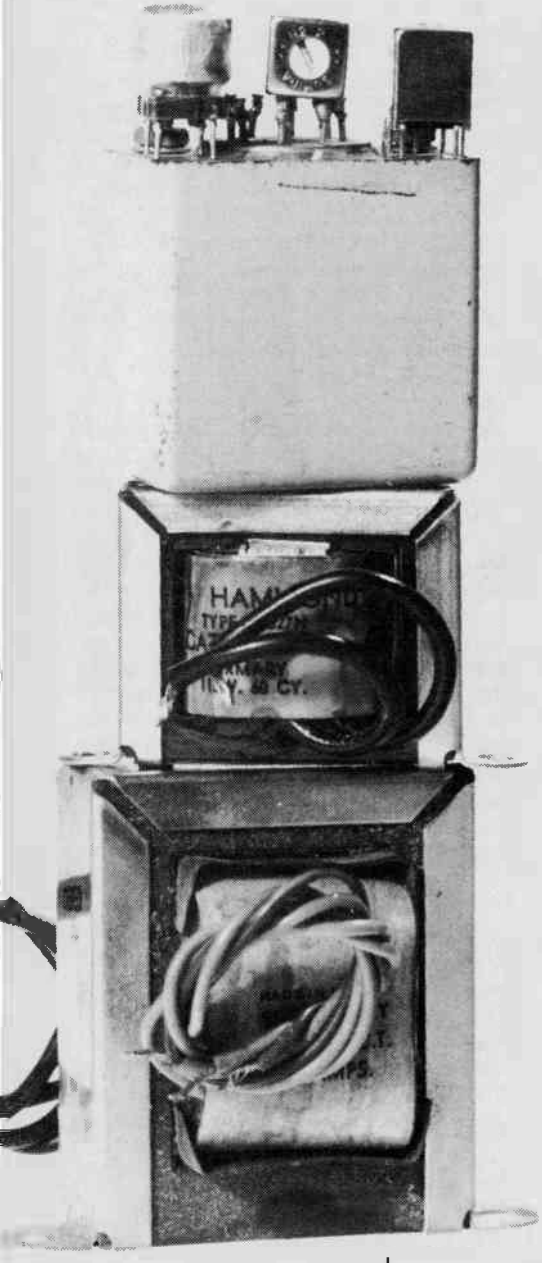


Fig. 5. The frequency response of a single-tuned resonant transformer. The three curves show high, medium and low Q.



the circuit inductance to the circuit resistance.

The response of the double-tuned transformer is almost identical except that two curves are produced. If they're tuned a distance apart along the frequency axis, then we have a bandpass with very rapid rise, a wide reasonably flat peak, and a very rapid falloff. Tuning the coil resonances together produces a filter with an extremely sharp response curve.

If you look in almost any radio receiver, you'll see the resonant transformers, usually mounted in small rectangular metal cans for shielding. These transformers are usually tuned with a variable capacitor; the familiar egg-slicer for station-tuning, or a small PCB variable for trimming. For calibrating the circuitry, a ferrite core is used to change the inductance of the transformers by moving it in or out of the coils with a top-mounted adjusting screw ("Dear Sirs, I bought one of your radios and due to your poor quality control, all the little screws on top of the transformers were loose. I tightened these down and now nothing works...").

Pulsing

Pulse transformers are rarely encountered, and very straightforward when they are. Their most popular use would be in the triggering of photographic flashtubes (see *Electronics In Photography* in the December, 1985 issue). Next most popular would probably be in isolating the trigger circuits of SCRs and triacs, though optoelectronic couplers have generally taken over this application.

Pulse transformers are always very small in size, since they don't pass much power. The turns ratios are generally 1:1 or 2:1. If the transformer is to be used for isolating a line-operated device, check for adequate insulation for the voltages in use, as well as some assurance that the unit can withstand short-lived high-voltage transients for at least a fraction of a second.

Sound Distribution

When you go to install 20 or 30 speakers in the ceiling of an installation, you immediately have impedance-matching problems. It's possible to get the whole works to come out to 4 or 8 ohms by juggling series-parallel hookups, but the resulting wiring would be impossibly complicated.

The usual method is to step up the amplifier's output voltage level with an audio power transformer. This gives you a high-voltage, low-current, high-impedance line running through the ceiling. Any place you want a speaker, you install a speaker transformer to convert the distribution line level back to the low-voltage, higher-current signal so enjoyed by loudspeakers. Most speaker transformers have a number of taps to allow presetting the maximum volume. For instance, the Hammond 117 J4 will couple a 3.2 ohm speaker to a 25V line with taps at 4, 2, 1, 1/2 and 1/4 watts output.

And what exactly is this 25 or 70 volt business? It's simply the voltage which will be present on the distribution line when the amplifier is producing full power. Suppose you have a solid state power amplifier which will produce 25 watts into 8 ohms and you'd like to match it into a distribution line. Using the power equation (power equals voltage squared over resistance) to solve for voltage gives 14 volts. Since we'd like 70 down the line, the turns ratio should be 70/14 = 5. Or, you can just look in a catalog; the Hammond 119 Y30 will match a 30W, 8 ohm amp to either 25 or 70V lines. Nothing to it.

It's of interest to work backwards from the speaker to look at the impedance changing that takes place. If a speaker transformer transfers one watt from a 70V line to an 8 ohm speaker, the voltage on the speaker solves to 2.8. This is a turns ratio of 24.75, and squaring this gives an impedance ratio of 612 times. Thus the 8 ohm speaker appears to the distribution line as 8 x 612 = 4896 ohms. To double-check: squaring the 70V maximum line voltage gives 4900, or one watt across the speaker's reflected impedance. ■

Soldering and Desoldering Tools

No other operation is as critical to the reliability of electronic circuits. A look at the tools available.

By Bill Markwick

SHOULD you find the soldering operation to be a tense, painful thing and desoldering to be even worse, you may not be using the right tools or the right procedures. Or, maybe you are using them and you just got stuck with wiring a 100-pair cable into a 1-inch diameter connector. In any case, here's a look at some of the tools to make soldering a breeze instead of a teeth-clencher.

But First, This Word

Which will bore the old pros, but it can't be repeated often enough if you've just put one toe in the electronic water, so to speak.

Rule Number One: the surfaces to be soldered must be clean. If components have been sitting in the junkbox oxidizing away, shine them up with a small wire brush or very fine sandpaper.

Rule Number Two: Heat the work, not the solder. It is absolutely *verboten* to melt the solder onto the iron and carry it to the work.

Good solder joints look smooth and shiny, and the edges of the solder seem to flow into the surface of the work. Bad solder joints sit up on the surface; joints that have been moved before they solidify look dull or frosty.

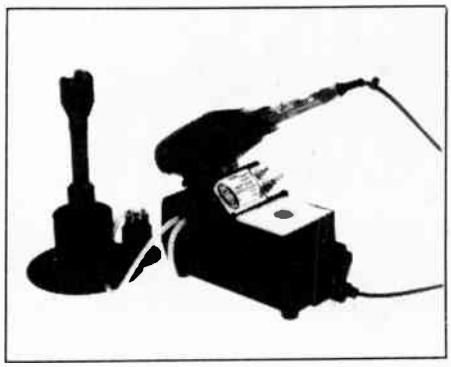
I like to place the iron's tip on the surfaces to be soldered, and then melt a bit of solder between the tip and the surfaces to aid heat conduction. Within a split second, the surfaces should be hot enough to accept a further bit of solder, and it should flow nicely around the joint by itself.

If it won't flow, it isn't clean enough and it isn't hot enough.

An Edsyn soldering station, typical of small workbench types.

Controlled Irons

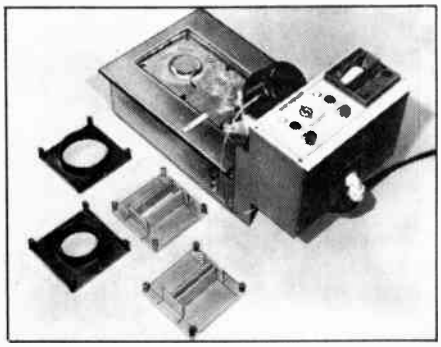
Further to the problem of getting it hot enough, here's the rub: small irons (pencil types) don't have enough power, and large irons with lots of power are cumbersome to work with and burn out their tips quickly. The cure is to use a controlled-temperature iron; this is a pencil type with lots of power and some sort of thermostat arrangement to keep it at a reasonable temperature.



The Edsyn Model 1036 hot-air soldering station, which will solder or desolder and is said to be ideal for the new surface-mount devices.

There's just nothing like having a good soldering station. Work that used to put you into depression just thinking about it now becomes rapid and even pleasant.

On my particular station, the manufacturers use a 24V, 2A supply to the heating element near the tip. The electrical contacts are held shut magnetically, and controlled by a phenomenon called the Curie effect. When the tip reaches a certain temperature (determined by the tip model itself; I use 700-degree tips), the magnet loses its magnetism and the contacts open. On cooling, the magnetism returns and they close again.



A solder bath typical of those used for small printed circuit boards.

One of the disadvantages to the Curie method is the burst of RFI which may be generated when the contacts open; this can find its way into adjacent test equipment. I find it a bit annoying if I'm testing high-gain, low-level circuits, but I can live with it. Irons that use thermistors or

similar are usually free of RFI.

Another advantage to the soldering station is that it's heavy and stays where it's put instead of skating around the bench as you insert and remove the iron. Yet another is that there's usually room on the top for a wet wiping sponge for keeping the tip clean, an important task.

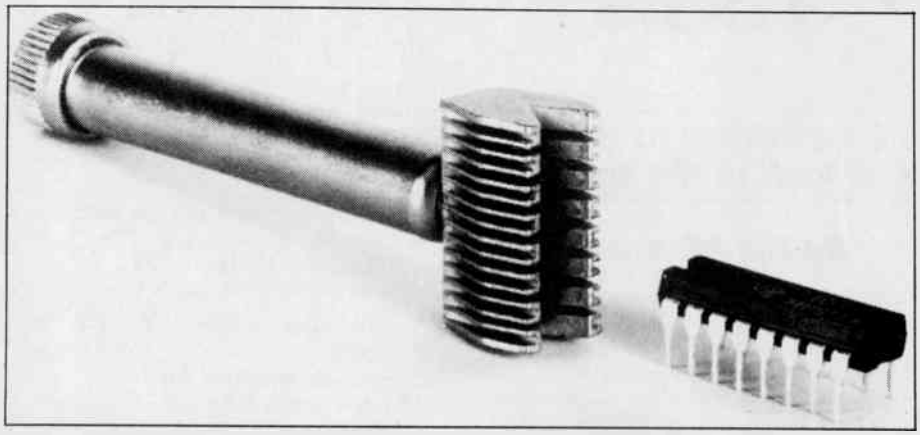
Soldering irons are generally grounded through the power cord third pin. This is mandatory if you're assembling anything with MOS circuitry, and a good idea in general. There are isolated irons available if you have the need for one.

All this is not to say that the small self-contained soldering pencils are no good. They have their uses, particularly for PCB work or field service, but they're very limited in scope. They take a long time to heat up and are useless on heavier work.

A good soldering station may change your whole attitude towards electronics. They're not inexpensive, starting at about $100 and heading upward rapidly, but you'll never regret getting one.

There are also portable irons with rechargeable batteries, said to give you over 100 solder joints from one charge. An example is the Wahl 7500.

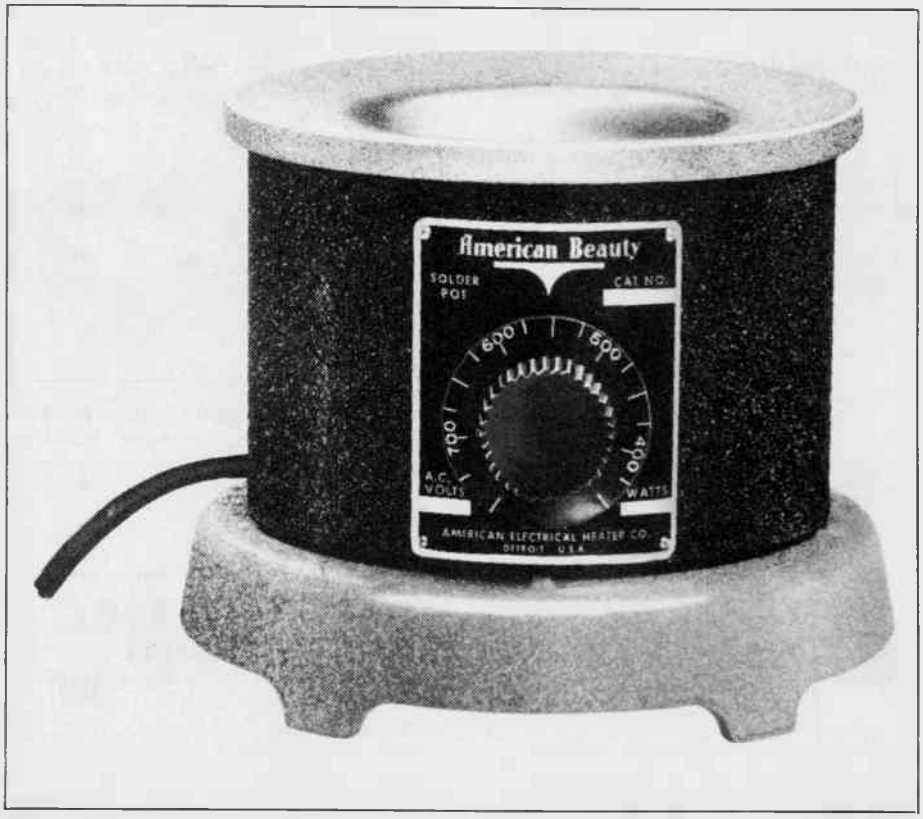
By the way, you aren't soldering with one of those hardware store pistol-grip things, are you? Shame on you.



A desoldering tip for integrated circuit removal.

Look for names like Weller, Ungar, Wahl, OK or American Beauty. Why you would pick a name like American Beauty for a soldering iron, I have no idea.

There are lots of different tips available for soldering stations. I prefer a fine cone-shape for PCB work and a chisel tip for heavier point-to-point wiring. An 800-degree tip comes in handy for soldering large-diameter wires or soldering to the chassis.



A small solder pot for dip-soldering of leads.

Facts About Solder

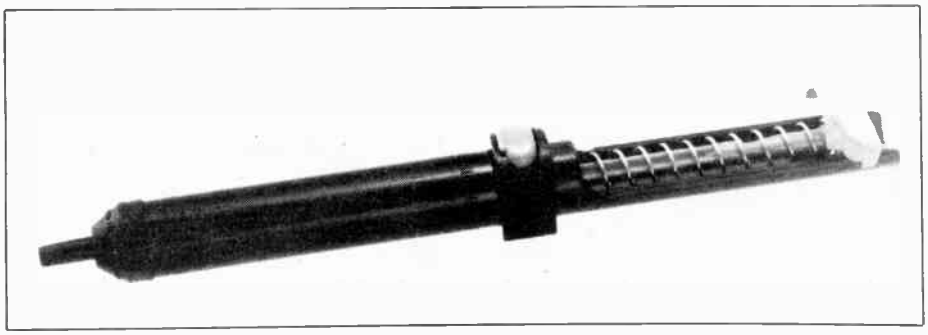
1. Solder has only about 10% of the conductivity of copper. The amount of solder and the small size of a solder joint makes the extra resistance negligible for electronic applications.
2. The tin in the solder promotes wetting of the surfaces and a good flow of solder via capillary action. The lead is used for filler.
3. The quality of a solder joint can be judged by the angle that the sides of the solder ball make with the surface. 90 degrees indicates that no wetting or bonding has taken place, 20 degrees indicates good wetting, and the best joints approach zero degrees.
4. Electronic solder should never be relied on for mechanical strength; first secure the components, then solder.
5. The ratio of tin to lead determines the melting point of the alloy; a 2/98 tin/lead ratio has a melting point of about 600 degrees F and is used for seams in cans; a 63/37 solder melts at about 360 degrees F and is used in heat-sensitive electronic work.
6. Soldering flux is mildly corrosive and may also cause conductive paths during high humidity. It should be removed with commercial flux solvents.

Accessories

There's the OK SH-1 solder spool holder, a good idea since solder spools have a built-in navigational system that guides them under things where they can't be seen. There's Ungar's 8001 Anti-Seize, a lubricant for threaded tips so you can get them back out again. It smells sort of pleasant when it's hot. There are various solders of various alloy mixes, though I find that the thinner diameter 60/40 type is just fine for everything electronic (by the way, don't use any solder or chemical that you even *think* might contain acid). There are silver solders and solders for aluminum, though I've never had much luck with these; maybe I'm doing something wrong.

There are all sorts of probes and hooks that look like dentist's tools, available with sharp ends, or brushes, or mirrors or what have you; these are useful for probing the quality of joints, moving wires or components around, or doing root canals on the side. There's a dull-tipped probe called the *spudger* and I've never known what it was for.

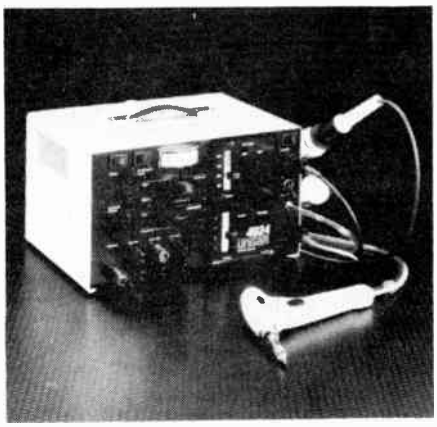
There are various chemicals available for PC work. If the boards have been sitting around oxidizing, the surfaces can be renewed with something like Kester's Copper-Nu Formula 5520. If they have to sit around some more, Kester's Protecto Formula 5612 is a protective coating that comes off with any flux remover. There are various solvents and sprays for cleaning off flux and other residues. The big-



A spring-loaded plunger for removing molten solder.

gies in soldering chemicals would be Kester, Chemtronics and GC.

If you solder a whole lot of small PCBs at once, a solder pot may be the answer to speeding things up. The American Beauty type 600, for instance,



A solder service centre from Ungar, for soldering or desoldering.

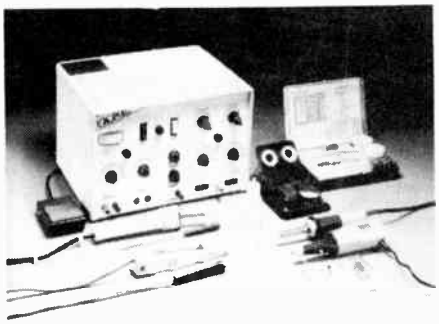
has a 3 1/2 inch diameter crucible for dip-soldering of connections and costs about $200. There are other models with rectangular crucibles that will accept entire PC boards. The board is dipped in flux and then into the solder bath, doing the whole job in seconds.

Desoldering

Now that you have it all soldered up, you can get all sorts of gadgets to take it apart again. The reasons you'd want to desolder, aside from having a weird hobby, would be servicing and reclaiming components from scrap boards.

The most common desoldering aids for the small workbench are drywick and the desoldering bulb. Drywick comes under various tradenames, and consists of a metallic braid covered in flux. It's placed on the joint and heated; it sucks all the solder right up, leaving a joint completely clear of solder. It's the only way to remove ICs without damage if you don't have special IC desoldering tips for your iron. Incidentally, you can make your own drywick out of cable shield braid by dipping it in flux if you have any. The air-bulb type has a tip made of Teflon or other heatproof material, and it sucks up a ball of molten solder with one released squeeze. Later you can pry out the tip and discard all the little solder blobs.

Some of the iron manufacturers, such as Weller, will sell you an iron with a desoldering bulb attached directly to the tip. Another way to do it is with tools such as the Edsyn Soldapullt or similar models made by most of the soldering equipment people. This is like a hypodermic syringe in reverse; a spring-loaded piston is compressed into the barrel and latched; pressing a button zips the piston out again and draws the molten solder up into the barrel.



A service centre from Automated Production Equipment, containing everything necessary for installation and repair.

If you'd like complete control over soldering and desoldering, companies such as Automated Production Equipment or Ungar will sell you complete systems for the workbench, including one or more temperature-controlled irons, a desoldering probe and a built-in vacuum pump. ■

Distributors of soldering and desoldering equipment are listed below; they can direct you to retail outlets.

Ungar:
Eldon Industries of Canada Inc.,
500 Esna Park Drive, Unit 13,
Markham, Ontario L3R 1H5,
(416) 475-9407.

OK, American Beauty, Edsyn:
Len Finkler and Company,
80 Alexdon Rd.,
Downsview, Ontario M3J 2B4,
(416) 630-9103.

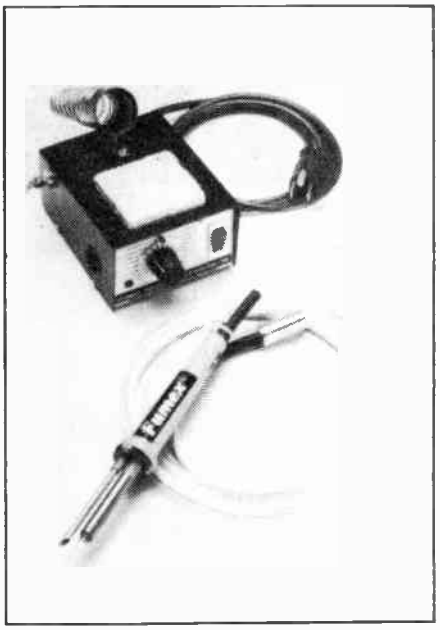
Weller:
Cooper Tool Group.
164 Innisfil St.,
Barrie, Ontario L4N 3E7,
(705) 728-5564.

Chemtronics:
Paco Electronics,
20 Steelcase Rd. W., Unit 10,
Markham, Ontario L3R 1B2,
(416) 475-0740.

Kester Solder,
1 Prince Charles Rd.,
Brantford, Ontario,
(416) 368-3777.

Automated Production Equipment,
142 Peconic Avenue,
Medford, NY 11763,
(516) 654-1197.

Fumex:
Cygnus Air Industries Inc.,
3550 Wolfedale Rd.,
Mississauga, Ontario L5C 2V6
(416) 848-7780



The Fumex 101 soldering station features an air intake over the tip to remove soldering fumes.

Electronics from the Start

by Keith Brindley

— Part 9

A continued look into diodes and some practical applications.

LAST MONTH we took a detailed look at diodes and their characteristics. This month we're going to take this one stage further and consider how we use the characteristic curve to define how the diode will operate in any particular circuit.

The components you'll need for the circuits this month are:

1 x 10k resistor
2 x 15k resistors
2 x 100k resistors
1 x 10u 10V electrolytic capacitor
1 x 220u 10V electrolytic capacitor
1 x 1N4001 diode
1 x LED
1 x 555 integrated circuit

Figure 1 shows the forward biased section of a typical diode characteristic curve. It has a transition voltage of about 0V7, so you should know that it's the characteristic curve of a silicon diode.

Diodes aren't the only electronic components for which characteristic curves may be drawn; most components can be studied in this way. After all, the curve is merely a graph of the voltage across the component compared to the current through it. So, it's equally possible that we draw a characteristic curve of, say, a resistor. To do this we could perform the same experiment we did last month with the diodes: measuring the voltage and current at a number of points, then sketching the curve.

But there's no need to do this in the case of a resistor, because we know that resistors follow Ohm's law which is a linear relationship. If however we were to plot the curve of the resistor characteristics, we would see that they are straight lines (ohmic) because of that linear relationship. We know that:

$$R = V/I$$

where R is the resistance, V is the voltage across the resistor, and I is the current through it. So, for any value of resistor, we can choose a value for the voltage across it, and calculate the current through it.

Diode characteristic curves are necessary because these components are non-ohmic (non-linear). To see what current passes through the device with any particular voltage across it, it's useful to see its characteristic curve.

Load Lines

It's important to remember that although a diode characteristic curve is non-linear and non-ohmic (i.e. it doesn't abide by Ohm's law throughout its entire length), it does follow Ohm's law at any particular point on the curve. For example, if the voltage across the diode whose characteristic curve is shown in **Fig. 1** is 0V8, the current through it is about 80mA. Therefore, the diode resistance is:

$$R = V/1 = 0.8/80 \times 10E{-}3 = 10R$$

as defined by Ohm's law. Any change in voltage and current, however, results in a different resistance.

Generally, diodes don't exist in a circuit merely by themselves. Other components, eg. resistors, capacitors, and other members of the semiconductor family, are combined with them. It is when designing such circuits and calculating the operating voltages and currents in the circuits that the use of diode characteristic curves really come in handy. **Fig. 2** shows as an example, a simple circuit consisting of a diode, a resistor and a battery. By looking at the circuit we can see that a current will flow. But what is this current? If we knew the voltage across the resistor we could calculate (from Ohm's law) the current through it, which is of course the circuit current. Similarly, if we knew the voltage across the diode we could determine (from the characteristic curve) the circuit current. Unfortunately

we know neither voltage!

We do know, however, that the voltages across both the components must add up to the battery voltage, ie:

VB = VD + VR

(It's a straightforward voltage divider) This means that we can calculate each voltage as being a function of the battery voltage, given by:

VD = VB - VR

and

VR = VB - VD

We know that the voltage across the diode can only vary between about 0V and 0V8 (given by the characteristic curve), but there's nothing to stop us hypothesizing about larger voltages than this, and drawing up a table of voltages which would thus occur across the resistor. Table 1 is such a table, but it takes the process one stage further by calculating the hypothetical current through the resistor at these hypothetical voltages.

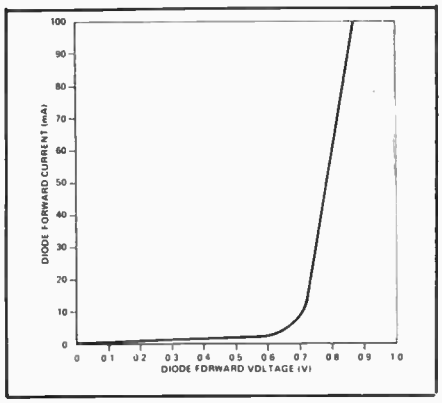


Fig. 1 The forward biased section of the characteristic curve of a silicon diode.

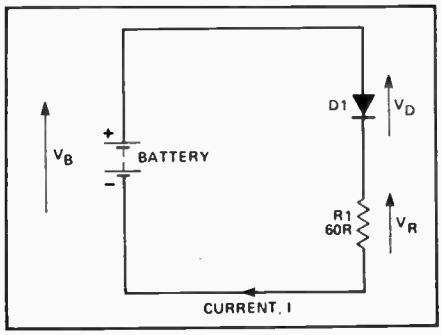


Fig. 2 A simple diode circuit.

From Table 1 we can now plot a second curve on the diode characteristic curve, of diode voltage against resistor current. **Fig. 3** shows the completed characteristic curve. The second curve is a straight line; all we've done is plot a voltage and a current for a resistor, and resistors are ohmic and linear. In a circuit such as that of **Fig. 2**, the resistor is known as a load, i.e. it absorbs electrical power, and the line on the characteristic curve representing diode voltage and resistor current is called the load line.

Table I

Diode voltage (VD)	Resistor voltage (VB - VD)	Resistor current (I)
3	0	0
2.5	0.5	8.3mA
2.0	1.0	16.7mA
1.5	1.5	25 mA
1.0	2·0	33.3mA
0.5	2.5	41.7mA
0	3.0	50mA

Where the load line and the characteristic curve cross is the operating point. As its name implies, this is the point representing the current through and voltage across the components in the circuit. In this example the diode voltage is thus 1V and the diode current is 33mA at the operating point.

If you think carefully about what we've just seen, you should see that the load line is a sort of resistor characteristic curve (in reverse, i.e. the slope is opposite to that of a resistor characteristic line).

The slope of the load line and the exact position of the circuit operating point depends on the value of the resistor. Let's change the value of the resistor in **Fig. 2** to 200R. What is the new operating point? Draw the new load line corresponding to a resistor of value 200R on **Fig. 3** to find out. You don't need to draw up a new table as in Table 1; we know it's a straight line so we can draw it if we have only two points on the line. These two points can be when the diode voltage is 0V (thus the resistor voltage:

VR = VB - VD

equals the battery voltage), and when the diode voltage equals the battery voltage and so the resistor current is zero.

Fig. 4 shows how your results should appear. The new operating point corresponds to a diode voltage of 0V8 and current of about 11mA.

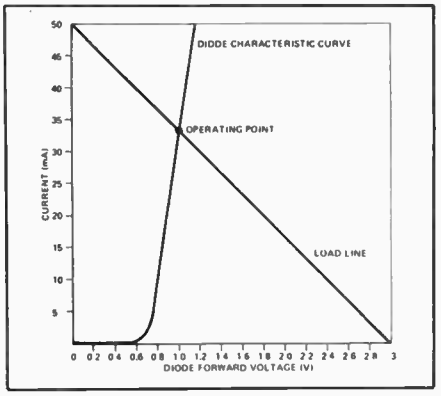


Fig. 3 A diode characteristic curve and the load line crossing to give the operating point of the diode.

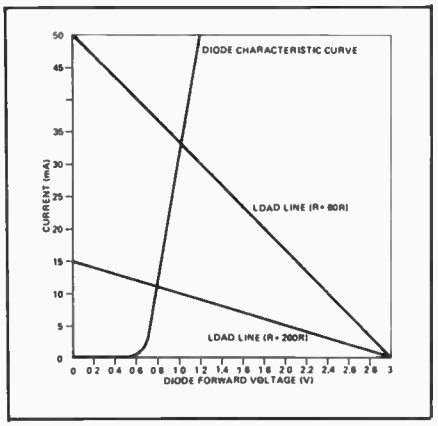


Fig. 4 The load line plotted on Figure 3 for a resistor of 200R.

Diode Circuits

We're now going to look at some ways in which diodes may be used in circuits for practical purposes. We already know that diodes allow current flow in only one direction (ignoring saturation reverse current and zener current for the time being) and this is one of their main uses: to rectify alternating current (AC) voltages into direct current (DC) voltages. The most typical source of AC voltage we can think of is the 120V power supply to every home. Most electronic circuits require DC power so we can understand that rectification is one of the most important uses of diodes. The part of any electronic equipment (TVs, radios, hifis, or computers etc) which rectifies AC voltages into low DC voltages is known as the power supply (sometimes abbreviated to PSU - for power supply unit).

Generally, we wouldn't want to tamper with voltages as high as 120V AC, so we would use a transformer to reduce the 120V AC supply voltage to about 12V AC.

The simplest way of rectifying the AC output of a transformer is shown in **Fig. 5**. Here a diode simply allows current to flow in one direction (to the load resistor, RL) but not in the other direction (from the load resistor). The AC voltage from the transformer and the resultant voltage across the load resistor are shown in **Fig. 6**. The resistor voltage, although in

only one direction, is hardly the fixed voltage we would like, but nevertheless is technically a DC voltage. You'll see that of each wave or cycle of AC voltage from the transformer, only the positive half gets through the diode to the resistor. For this reason, the type of rectification shown by the circuit in **Fig. 5** is known as half wave rectification.

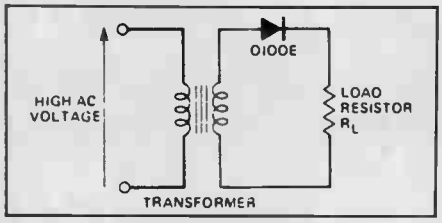


Fig. 5 A simple output rectifier circuit using a diode.

It would obviously give a much steadier DC voltage is both half waves of the AC voltage could pass to the load. We can do this in two ways. First by using a modified transformer, with a centre-tap to the output or secondary coil and two diodes as in **Fig. 7**. The centre-tap of the transformer gives a reference voltage to the load, about which one of the two ends of the coil must always have a positive voltage (i.e. if one end is positive the other is negative, if one end is negative the other must be positive) so each half wave of the AC voltage is rectified and passed to the load. The resultant DC voltage across the load is shown.

Second, an ordinary transformer may be used with four diodes as shown in **Fig. 8**. The group of four diodes is often called a bridge rectifier and may consist of four discrete diodes or can be a single device which contains four diodes in its body.

Both of these methods give a load voltage where each half wave of the AC voltage is present and so they are known as full-wave rectification.

Filter Tips

Although we've managed to obtain a full-wave rectified DC load voltage we still have the problem that this voltage is not too steady (ideally we would like a fixed DC voltage which doesn't vary at all). We can reduce the up-and-down variability of the waves by adding a capacitor to the circuit output. If you remember, a capacitor stores charges so we can use it to 'average out' the variation in level of the full wave rectified DC voltage. **Fig. 9** shows the idea and a possible resultant waveform. This process is referred to as smoothing or filtering and a capacitor used to this effect is a smoothing capacitor.

You should remember that the rate at which a capacitor discharges is dependent on the value of the capacitor. To make sure the stored voltage doesn't fall too far in the time between the peaks of the half cycles, the capacitor should be large enough (typically of value of thousands of microfarads) to store enough charge to prevent this happening. Nevertheless a variation in voltage will always occur, and the extent of this variation is known as the ripple voltage, shown in **Fig. 10.** Ripple voltages of the order of a volt or so are common, superimposed on the required DC voltage, for this type of circuit.

Stability Built In

The power supplies we've seen so far are simple but they do have the drawback that output voltage is never exact; ripple voltage and to a large extent, load current requirements mean that a variation in voltage will always occur. In many practical applications such supplies are adequate, but some applications require a much more stable power supply voltage.

We've already seen a device capable of stabilizing or regulating power sup-

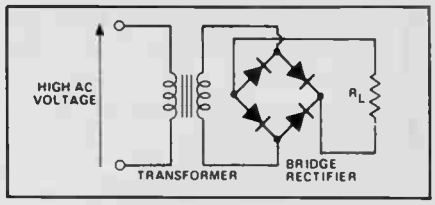


Fig. 8 A very familiar rectifier arrangement: four diodes as a bridge rectifier.

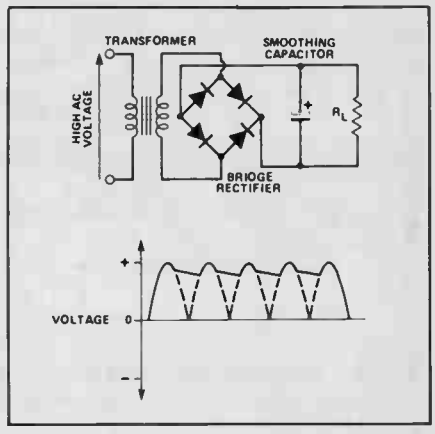


Fig. 9 Levelling the rectified DC with the help of a capacitor: the process is known as smoothing.

plies: the zener diode. **Fig. 11** shows the simple zener circuit we first saw last month. You'll remember that the zener diode is reverse biased and maintains a more or less constant voltage across it,

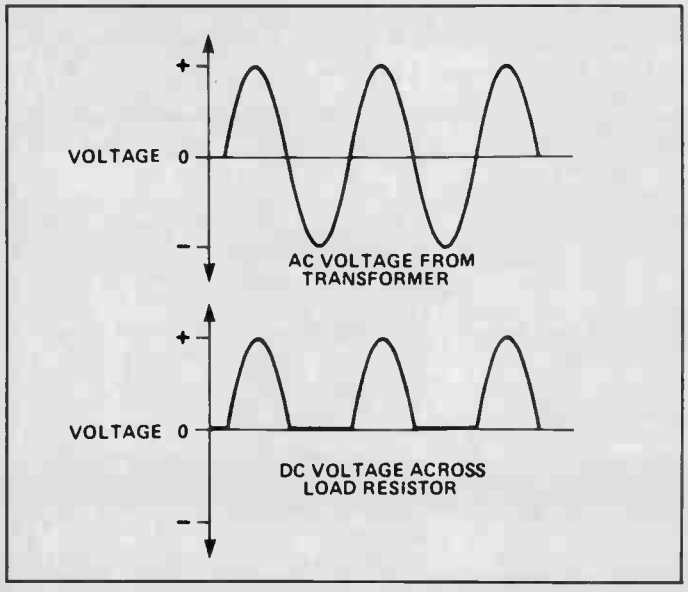


Fig. 6 Waveforms showing the output from the transformers, and the rectified DC voltage across the load resistor.

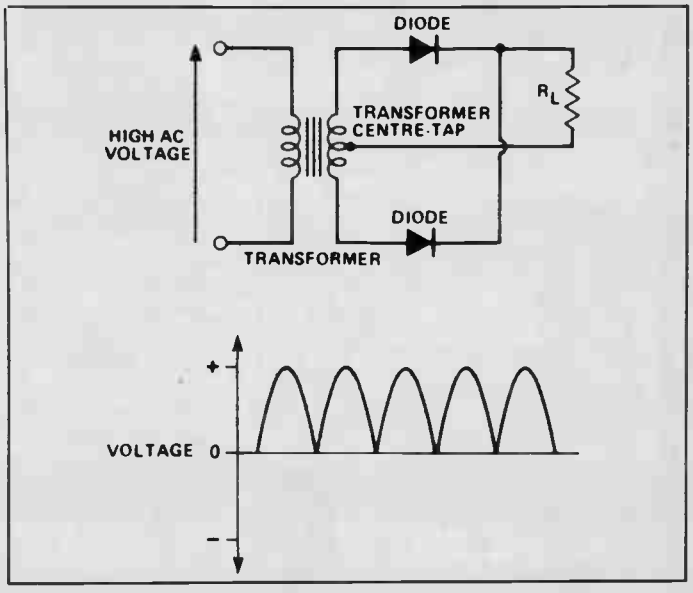


Fig. 7 A more sophisticated rectifier arrangement using two diodes and a transformer centre tap.

This Kit's A Hit!

The response to last December's drive kit ad was so overwhelming that we sold out! We're pleased to announce that a shipment of brand new Tandons has recently arrived. These terrific expanded capacity drive kits come in an all-inclusive do-it-yourself package.

And at great sale prices!

A screwdriver and one of these complete drive kits from Tandon instantly gives you up to 40MB of extra storage capacity. *Direct to you* from the world's #1 disk-drive manufacturer ... with controller card, cables, and all accessories for guaranteed do-it-yourself installation!

- Fully pretested and formatted.
- Easy to follow instructions.
- Complete 90-day warranty.
- Simply plug in, boot up and go!

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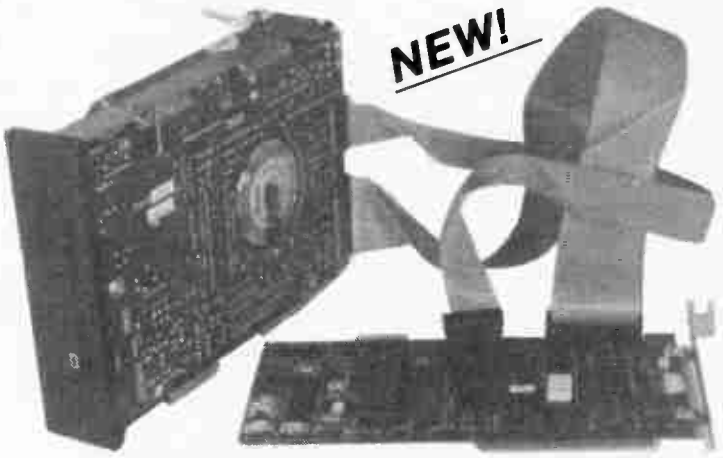

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even as the input voltage V changes. If such a zener circuit is used at the output of a smoothed power supply (say, that of Fig. 6) then the resultant stabilized power supply will have an output voltage which is much more stable, with a much reduced ripple voltage.

zener stabilizing circuits are suitable when currents of no more than about 50mA or so are required from the power supply. Above this it's more usual to build power supplies using stabilizing integrated

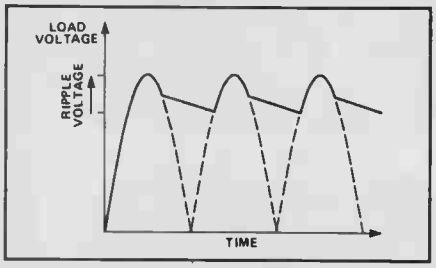

Fig. 10 The extent to which the DC is not exactly linear is known as the ripple voltage.

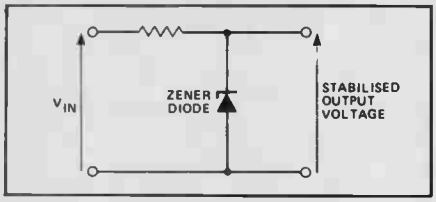

Fig. 11 A simple zener circuit which can be used with a smoothing circuit to give a greatly reduced ripple voltage.

circuits (ICs), specially made for the purpose. Such ICs, commonly called voltage regulators, have diodes and other semiconductors within their bodies which provide the stabilizing stage of the power supply. Voltage regulators give an accurate and constant output voltage with extremely small ripple voltages, even with large variations in load current and input voltage. ICs are produced which can provide load current up to about 5A.

In summary, the power supply principle is summarized in **Fig. 12** in block diagram form. From a 120V AC input voltage, a stabilized DC output voltage is produced. This is efficiently done only with the use of diodes in the rectification and stabilization stages.

Practically There

Fig. 13 shows a circuit we've already seen and built before: a 555-based astable multivibrator. We're going to use it to demonstrate the actions of some of the principles we've seen so far. Although the output of the astable multivibrator is a

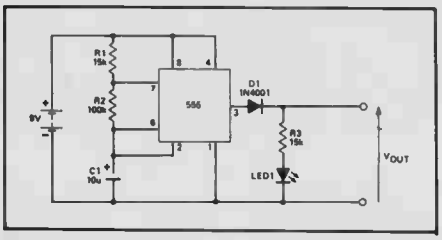

Fig. 13 An astable multivibrator circuit. This can be used to demonstrate some of the principles under discussion.

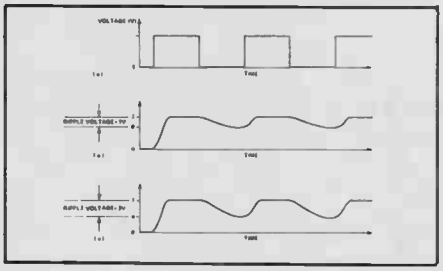

Fig. 14 The squarewave output from the circuit in Figure 13 experimentally modified by a 100k resistor (b) and a 10k resistor (c).

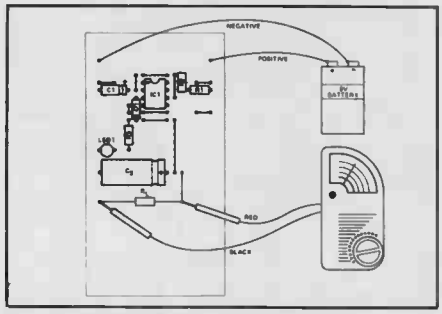

Fig. 15 The breadboard layout of the circuit in Figure 16.

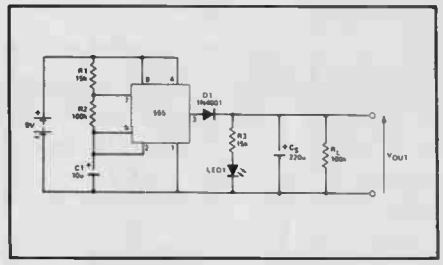

Fig. 16 A modification of Figure 13 to include a smoothing capacitor.

square wave, we're going to imagine that it is a sine wave such as that from a 120V AC powered transformer. **Fig. 14a** shows the square wave output, and if you stretch your imagination a bit, rounding off the tops and bottoms of the waveform, you can approximate it to an alternating sine wave.

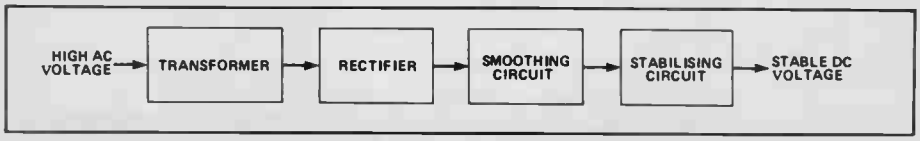

Fig. 12 A block diagram of a power supply using the circuit stages we have described.

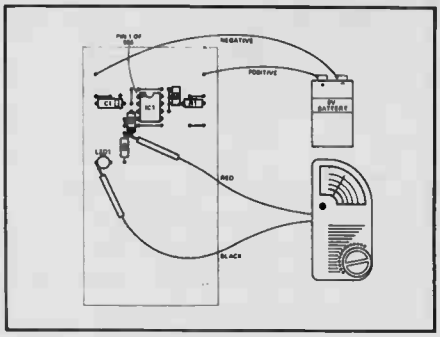

Fig. 17 The breadboard layout for the circuit in Figure 13.

Build the circuit, as shown in the breadboard layout of **Fig. 17**, and measure the output voltage. It should switch between 0V and about 8V.

Now let's add a smoothing capacitor, Cs and load resistor RL to the output of our imaginary rectified power supply as in **Fig. 16**. The output voltage of the smoothing stage is now fairly steady at about 6V5 indicating that smoothing has occurred. Although you can't see it, the voltage waveform would look something like that in **Fig. 14b** with a ripple voltage of about 1V. The breadboard layout for the circuit is shown in **Fig. 15**.

We can show you what happens when the load current increases by putting a lower value load resistor in circuit; take out the 100k resistor and put a 10k resistor in its place. The ripple voltage now increases causing greater changes in the DC output level, and the whole waveform is shown as **Fig. 14c.** ■

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Computer Controlled Filter

There are various ways of controlling the filter frequency of a musical effect. This one uses a Commodore 64.

By R.A. Penfold

NORMAL FILTER type musical effects units (phase and waa-waa units for example) use a low frequency oscillator to provide automatic sweeping of the filter frequency. Another approach is to use the envelope of the input signal or the control voltage from an envelope shaper (as in a synthesizer) to provide the sweeping. A third method is to simply use a foot pedal to control the effect. This novel effects unit uses yet another approach, and this is to have a computer to control the filter frequency. Although only a relatively crude method of control is possible, this enables a useful range of effects to be obtained, and the versatility is increased by having two filters. Notch, bandpass, and lowpass filtering are available, with each filter having a Q or resonance control. This enables simple phasing plus two forms of waa-waa effect to be produced.

While perhaps not being ideal as a guitar effects unit, this project is useful to anyone interested in sound synthesis, particularly in stereo set-ups. For stereo operation the main way of using the unit is to feed one signal to both filter inputs, and then take a pseudo stereo output from the two filter outputs. This would be pointless if the filters were to be swept up and down in frequency in unison, but some interesting effects can be obtained if the filters are operated in antiphase, with the frequency of one being swept downwards while the other is swept upwards. The effective sweep waveform can be altered under software control, and can be triangular, sawtooth (of either type), squarewave, or even a random modulation of the filters can be used if desired. The two filters do not need to be set for the same type of filtering, and interesting results can be produced using bandpass filtering in one channel and notch filtering in the other. Each filter has a separate input, and the unit can be fed from a stereo source if desired. Obviously there are numerous ways in which the unit can be used, and it is ideal for the more adventurous electronic music enthusiast.

The unit is primarily intended for use with the Commodore 64 computer, but it will work in a more basic manner with the VIC-20 or any computer which has a user port provided by port B of a 6526 or 6522 device. With machine code software it should be possible to drive it from any computer that can provide one or two digital outputs, but this goes beyond the scope of this article.

Operating Principle

One approach to a computer controlled filter would be to have an ordinary voltage controlled filter driven from the computer via a digital to analogue converter. A more simple alternative, and the one adopted for this design, is to use a switched capacitor filter with the computer providing the clock signal. Switched capacitor filters may be unfamiliar to many readers, and while not being a particularly new concept, have received relatively little use.

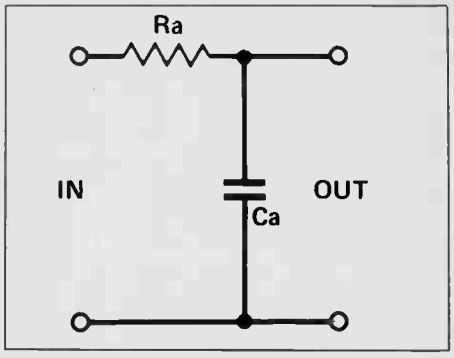

Fig. 1a A simple low pass filter circuit.

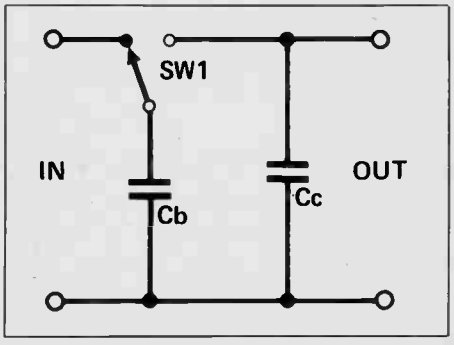

Fig. 1b The circuit for a switched capacitor filter.

An ordinary single stage lowpass filter just consists of a resistor and a capacitor connected as shown in **Fig. 1(a)**. Ra and Ca form a potential divider circuit, but the degree of attenuation through the circuit is not fixed, and depends on the impedance of Ca. This decreases as the input frequency is increased, giving losses that rise as the input frequency is increased. The losses are minimal at first, but once the 6dB point has been reached (the output potential is half the input voltage) the attenuation rate is 6dB per octave (doubling the input frequency halves the circuit gain).

A switched capacitor filter operates in a similar fashion, but the resistor is replaced with a low value capacitor and an electronic (SPDT) switch, as in **Fig. 1(b)**. Cb and SW1 are the capacitor and the switch, while Cc is the normal filter capacitor. A clock oscillator controls the rate at which the electronic switch alternates between the position where it takes a charge from the input, and is discharged into Cc. A change in the potential at the input of the circuit is obviously transferred to the output of the circuit by the

charge/discharge action of Cb and SW1, but changes in potential are not instantly transferred. The time taken for the output of the circuit to respond to changes at the input depends on the relative size of Cb and Cc, and on the rate at which SW1 is clocked. It is this last point which is of importance, since raising the clock frequency provides a faster transfer, and boots the cutoff frequency of the filter. In other words, the filter's cutoff frequency is proportional to the clock frequency.

In a practical switched capacitor filter there are usually two filters wired in series, and some other circuits are included so that the basic lowpass filter action can be modified to give any other form of filtering. The switched capacitor device used in this project is the National Semiconductor MF10CN which can operate in any filter mode, has adjustable Q, and two 12dB per octave filters. The filter frequency can be either 1/50th or 1/100th of the clock frequency but it must be the same for both filters.

Circuit Operation

The block diagram of Figure 2 shows the make-up of one channel of the unit (the other channel is identical). A passive lowpass filter is used ahead of the switched capacitor filter, and this is needed to prevent strong signals close to the clock frequency from entering the switched capacitor filter and producing heterodyne 'whistles'. The switched-capacitor filter operates in a mode which gives notch, bandpass, and lowpass filtering, and a switch is used to select the desired mode. Clock glitches only appear at the output of the filter at a relatively low level, but an active filter here gives further attenuation and a clean output signal. This stage also provides output buffering.

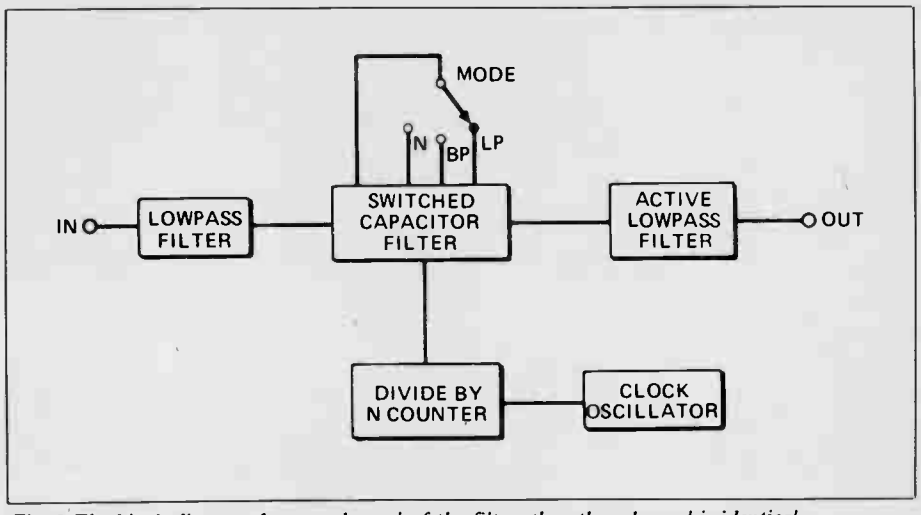

Fig. 2 The block diagram for one channel of the filter; the other channel is identical.

The clock signal is provided by the system clock of the computer, and is at a frequency of about 1MHz, but the precise frequency depends on the particular computer used (980kHz in the case of the Commodore 64). It is connected to the filter via a divide by N counter, but this is also part of the computer and not included in this project. The divider can be pro-

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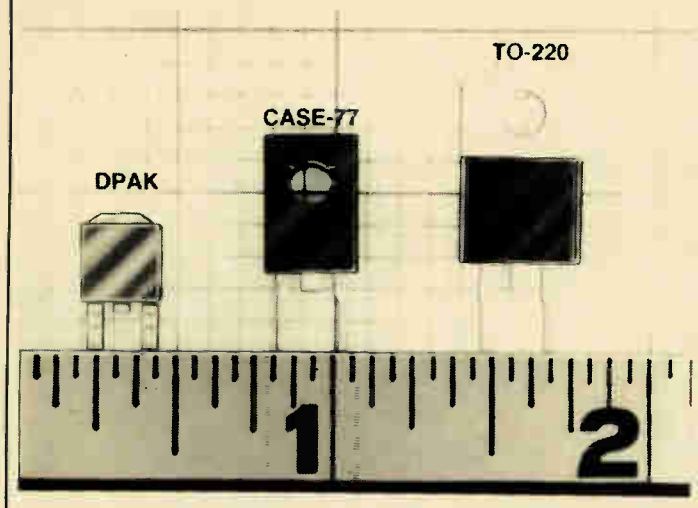
Continued from page 8

Surface Mounts



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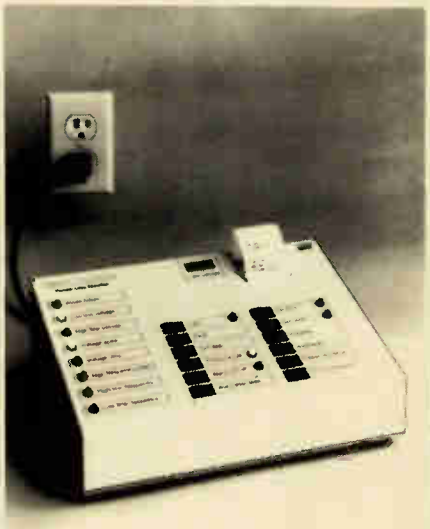

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Continued on page 40

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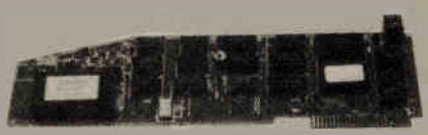

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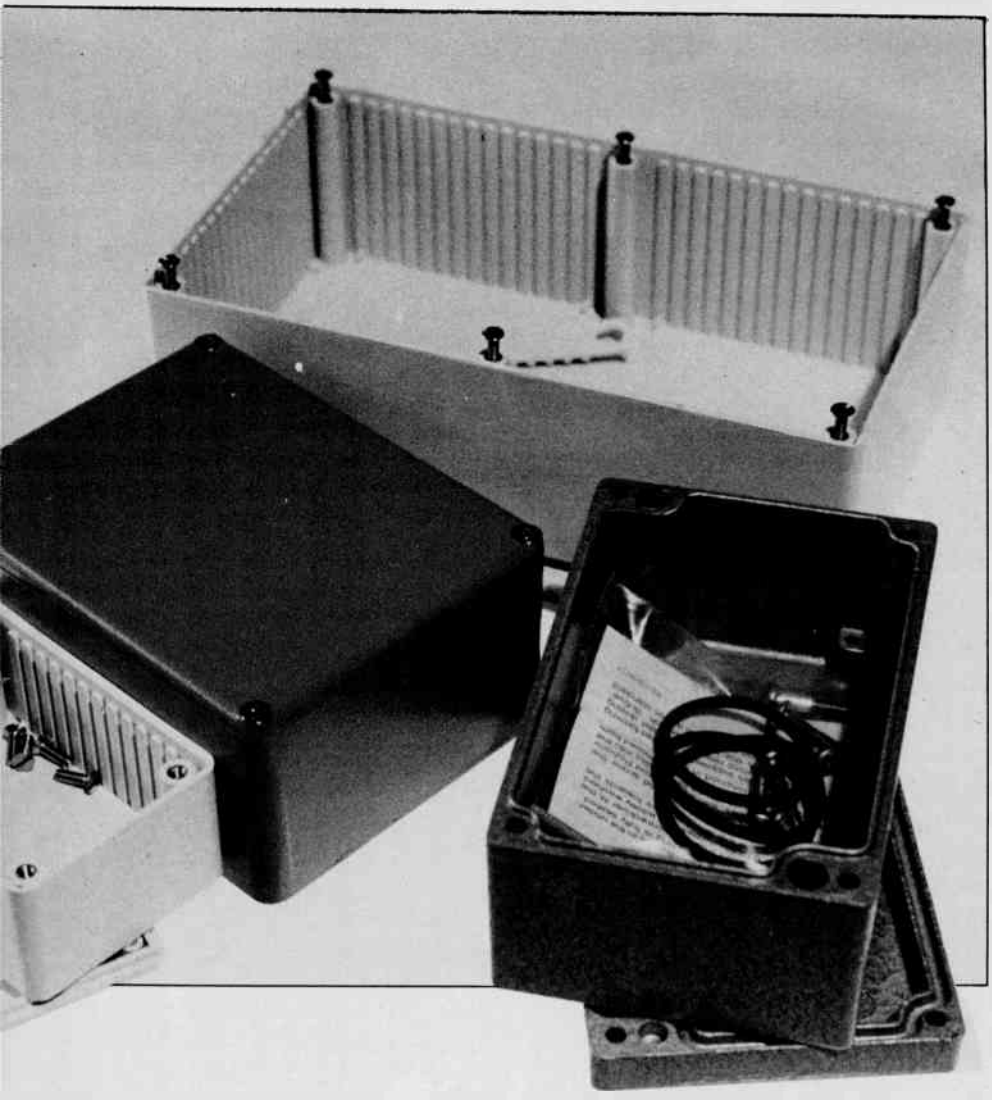


Dressing up your elegant projects in an elegant box.

By Bill Markwick

AFTER the solder fumes clear from the breadboard and the little LEDs all come on properly and the LCD display says what it should and the speaker plays *76 Trombones*, you're justified in thumping yourself heartily on the back for being so clever. Rush upstairs with your breadboard and show it to your wife, husband, *amorata*, butler, chauffeur, the dog, whoever. They will feign delight and say "That's really nice, really it is, but what are all those parts doing sticking up in the air and what are the paperclips for?"

Sigh. It's time to think about putting it in a box. But take heart, oh ye of little machine shop experience, it doesn't have to look like something out of a WWII submarine. You can get really nice stuff these days, and working your creation into it doesn't require a 50-ton press or a four-foot shear.

Of course, I *have* a 50-ton press and a four-foot shear in my basement, but the neighbours won't let me use them.

Planning

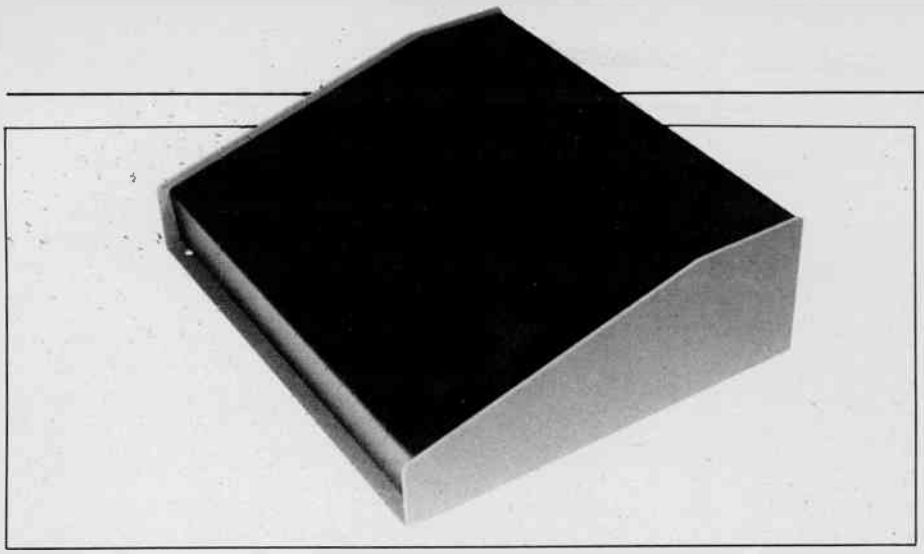
Planning helps no end. If you get the box first, and then design the circuit card around it, you've saved all that uncertainty at the parts counter with a catalog and a tape measure.

For instance, Radio Shack sells a box and matching perfboard, the 270-291, for $4.49. If your circuit will fit on a 2 by 3 inch perfboard, you're away. Otherwise, you'll have to either buy a box on speculation or build the circuit and go looking. The choices for small projects that don't have to look too distinguished would be the plastic handy cases, available from most component stores, or the all-metal types that consist of two channels, one for the top and one from the bottom. I really like the plastic boxes because drilling holes is so easy. I hate drilling holes. All the passages from the interior of the box to the outside world will be automatically insulated too, unlike the metal boxes which require bushings or tape.

If your perfboard or PCB can mount vertically as opposed to being in the bottom of the box, you can get plastic utility boxes with grooves cast into the sides for holding your board. These are wonderful for modifying and debugging; the whole works lifts out so you can find out where the burnt smell is coming from.

Mini-Consoles

If you're making a device that will be used often by an operator (as opposed to a box that fastens under the desk), you can get very attractive looking mini-consoles. Examples are the Radio Shack 270-282 slope-front or the Hammond 1456 series; some of them even have walnut sides). The disadvantage to these is that the sloping part separates from a flat bottom, leaving you with the puzzle of how to mount the components. If you fasten a large motherboard to the bottom, it means a thick wiring harness up to the controls. I prefer to make mini-PC



The Hammond 1456 series, a standard for miniature consoles.

boards with the pots and switches on them; these are fastened to the sloping top with the pot shafts. The board on the bottom of the case contains the power supply and output amplifiers. The disadvantage to this method is the number of PCBs you have to paint and etch.

Another disadvantage that you may not think of is the problem of wiring harnesses or components squashing things when you close the case halves. It's particularly a problem when you have movable things like trim pots; extra care is needed to route any wiring into a vacant area so everything coexists peacefully. Otherwise you can do a beautiful job on the top and on the bottom, and when you fasten them together and turn it on, things go *bzzzzt*.

The real cream of the cream (*creme de la creme*) of mini-consoles is the Hammond SC series. The SCED 251126 is on our cover, clad in walnut. This model is available in widths up to 17 inches, and also with the rear part 9.5 inches deep, allowing more room for output circuitry. The extra-deep version also comes in 20 inch widths. Aside from great looks, the series SC series offers easy access to the interior because all panels come off easily.

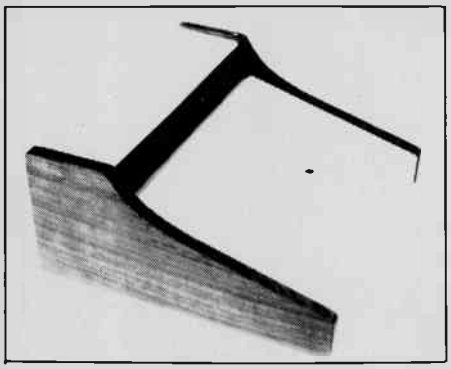
For a real deep-dish version, the SCEH series adds a 3.5 inch high hinged lid to the large SCED models. This gives you plenty of room for meters, more interior circuits, etc., and also gives excellent serviceability. When the audience is waiting for you to find out why they can't hear the performers, you can raise the hood and rummage away knowledgeably.

All the above models can have the display panel replaced by a red, green or gray filter for illuminated displays. The filter height is only 2 inches, so you can't use it for a vertical LED level meter, but it's ideal for status lights. I got status, man, dig the lights.

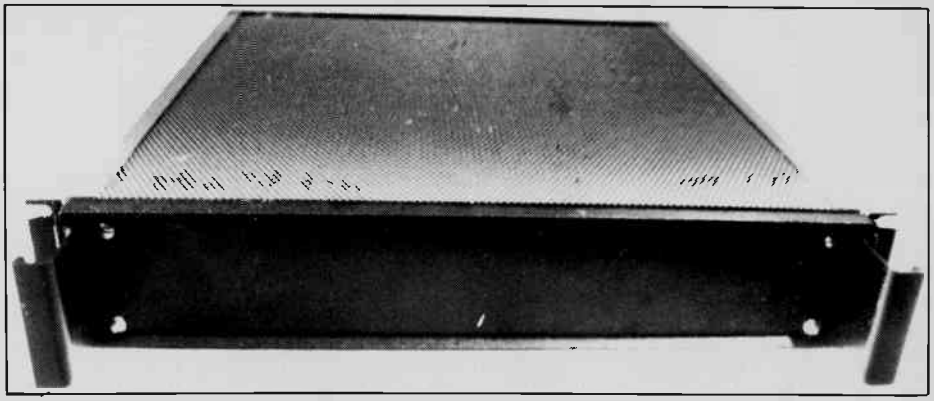
The SC series isn't cheap, starting at about $60, but then if you do a good job screening on the lettering, you'll have a finished project as good or better than the pro stuff. I have an urge to fasten the sides of a 20 incher and a 10 incher together and make a 12-channel 30-inch wide PA mixer. There's lots of room in the SCEH series for recording outputs (musicians always want to take home a cassette of the gig).

Specials

If you're making your own test equipment, there are some good looking instrument cases available, such as Hammond's 1452, 1458 or 1426 series. Meter cases,



The SCED series from Hammond has a fancier look than the 1456 series.



Rackmount cases come in every shape and size and aren't a bad idea, even for small testbenches.

such as the 1412 series, come with the large hole already punched for you.

When making something to go under the hood of your car, it improves reliability to use a sealed case. The 1590 series is a waterproof diecast box with a neoprene sealing ring; circuits inside it will continue functioning long after you've driven off the end of a dock. How you seal the wire entry and exit points is up to you. Silicone caulking, maybe.

Another nifty gadget is the Polycase, Hammond's answer to the plugpack. The case itself is available in 2 or 3 inch heights, and the base can be a variety of things: 2 or 3 pin AC plugs, octal plugs, 11-pin plugs, plain, etc. There are also grooves inside the case for holding perfboard or PCB.

Rackmount

Why not? Everybody with a testbench usually has various bits of equipment in 19 inch rack boxes, and they also usually have a clutter all over the bench. If you mount as much as possible in a rack beside the bench, you free up lots of room on the work surface so you can fill it up again with components and tools and bits of wire and the lamp you said you were going to fix last year. You don't have to buy expensive rackmount cabinetry; you can get relay racks, which are just a skeleton frame, or you can go for used or surplus racks.

Rackmounting is particularly good for portable equipment; a rack cabinet on casters can hold stacks of power amplifiers and still be reasonably easy to maneuver. You can also add power ventilation painlessly. The rackmount gadget with the silver slotted front on our cover is a 150 cubic foot per minute centrifugal blower, the RAVB 15 003 from Hammond.

Then there's the approach of mounting each piece of gear in a tiny module that slips into a main mounting rack. This gets very expensive and means a whole lot of work, not the sort of thing you'd spend your Saturdays on, but good for prototypes or small runs.

Tooling Up

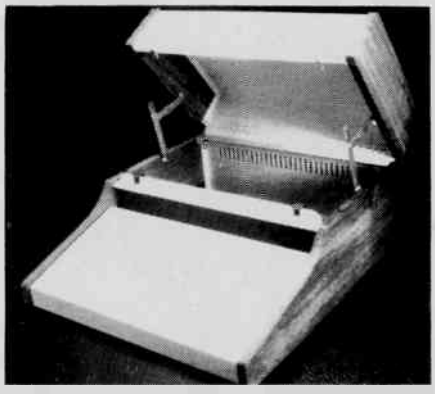
Maybe I should have started off with this section. Metalworking is what puts everybody right off doing proper packaging of their projects. It doesn't have to be that way if you have the right tools, which doesn't mean you have to spend a fortune equipping yourself with a sheet metal shop.

Holes are the first hurdle. There are lots of different holes in any project, and the more different ones you have to contend with, the more likely you'll be to forget the whole packaging thing and just tape your PCB to the side of the workbench.

The first and most obvious way to make a hole is to put a twist drill bit in a power drill and have at it. This works within limits: the hole size shouldn't be much more than 6mm (1/4 inch) and you should really centre-punch all the hole positions, even if a variable-speed drill isn't supposed to need that. If the size exceeds 1/4 inch, drill small pilot holes first. I know, it means doing it all twice, but it beats having the drill skate down the panel and leave a shiny spiral through your nice new black crackle finish. Furthermore, the actual time spent is less because large twist drill bits don't like to start their own holes, at least not with a handheld drill. If you don't have a centre punch, a concrete nail will do in a pinch.

The next most obvious way to alleviate the drilling pain is to use a drill press. If you have a proper machine shop type, you're away and probably don't need much help anyway. If you have one of those little ones that hold a 3/8 power drill, you're still ahead. One problem with the little drill presses is that it's difficult to control the drill speed; turn it down and there isn't enough torque, turn it up and it's too fast for large bits. You sort of have to compromise by setting the speed a bit high and hoping it comes down to the right speed under load. Incidentally, cutting oil (which has some sort of stuff in it; I think it's sulphur) makes a big difference in the speed and pressure of drilling, particularly on steel panels. You can get it from a hardware store, or use light general-purpose oil. Bits will stay sharper longer, too. One other problem in drilling large holes with twist bits is their tendency to bite into the metal and grab it solidly, twirling the work around and around, knocking off bits of knuckle until you can calm the thing down. Use sharp bits, use oil, use clamps. Stand well back, preferably in another room. Get someone else to do it.

Or, you can get a set of conical cutters. Mine came from Canadian Tire. These are born and bred to cut holes in sheet metal. They cut so fast, in fact, that you have to be careful to observe a depth mark of some kind, such as a piece of masking tape on the bit. If the hole is larger than 1/2 inch or so, I'd highly recommend the Greenlee chassis punches. Though expensive, about $20 each, they make a perfect hole with minimum effort. A pilot hole is drilled for the bolt, the



The top-of-the-line in miniature consoles, Hammond's SCEH series.

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For many, Public Domain software is one of the most exciting and rewarding aspects of microcomputing. Each year, thousands of programs are created by private individuals and distributed through computer bulletin boards systems. Magazines such as Computing Now!, Computers In Education and Electronics Today, have also contributed to the body of public domain software by publishing program source code listings.

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Xerox 820 II (SSDD)

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Almost Free PC Software

Moorshead Publications

Volume I.

PC-Write While not quite WordStar for nothing, this package comes extremely close to equalling the power of commercial word processors costing several hundred dollars. With full screen editing, sophisticated cursor movement, PC-Write also boasts features such as user-definable help screens and a 'printer ruler file' which can be customized to work with virtually any printer.

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

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

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

PC-TALK Telecommunications packages for the IBM PC are typically intricate, powerful and huge. This one is no exception. It has menus for everything and allows full control of all parameters, even the really silly ones. It does file transfers in both ASCII dump and MODEM7/X-MODEM protocols. And, it comes with a comprehensive documentation file which uses 119424 bytes of disk space.

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

FORTH This is a small FORTH, written in Microsoft BASIC. It's good if you want to get used to the ideas and concepts of FORTH. You can build on the primitives integral with the language.

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

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

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

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

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

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

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Volume II.

Almost Free PC Software

SWEEP is a disk utility which virtually replaces the DOS COPY command. It allows one to do mass copying, deletions, renaming and other disk operations in menu-driven comfort.

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

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

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

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

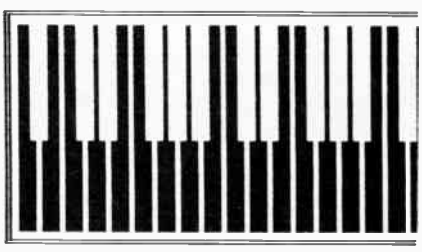
FOS is a well designed personal finance manager which will do much to help you tame your cheque books.

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

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

```
        POPULAR                    M
A -- Downtown              E -- Cabi
B -- Garota de Ipanema     F -- Impr
C -- Satisfaction          G -- Retr
D -- Sounds of Silence     H -- Sunr

===> SELECTION:  D <===
```



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

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

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

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

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Almost Free PC Software

Volume III.

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

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

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

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

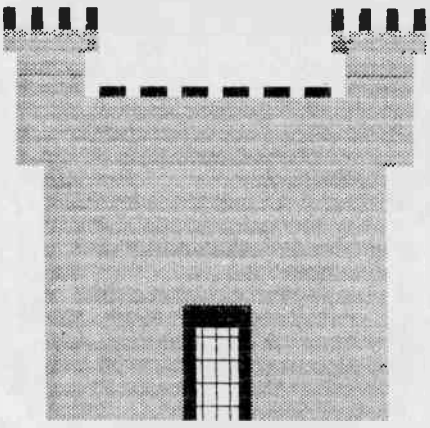
CGCLOCK is a simple little program which displays the running time in the upper right hand corner of your screen. In addition, the program has lots of display options and works with the colour graphics card.

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

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

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

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



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

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

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

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

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

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Volume IV.

Almost Free PC Software

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

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

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

CLOCK is a useful tutorial in writing character oriented device drivers for the PC. In addition, the program is an improved replacement CLOCK.SYS file which works with many real time clocks. The ASM file is included.

CRYPTO is a BASIC program which unscrambles cryptograms. It's an interesting study for puzzle enthusiasts.

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

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

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

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

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

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

LIST is an improved version of the DOS TYPE command which shows you the contents of a file page by page.

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

MONOCLOK is a screen clock display program, designed specifically to work with monochrome displays.

MOVE is a disk utility which moves and optionally erases disk files. Using wild cards, the user can ensure that specific types of files are not MOVED by the program.

NEWBELL is a tiny program which performs the lowly task of changing the sound of the PC's control G beep.

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

PARCHK is a trap which prevents the system from 'freezing' when a "parity error" is encountered. It gives you the option of finding out what caused the error and recovering from it.

PURGEDUP is an intelligent little program which cleans up obsolete backup files. Very useful on a hard drive.

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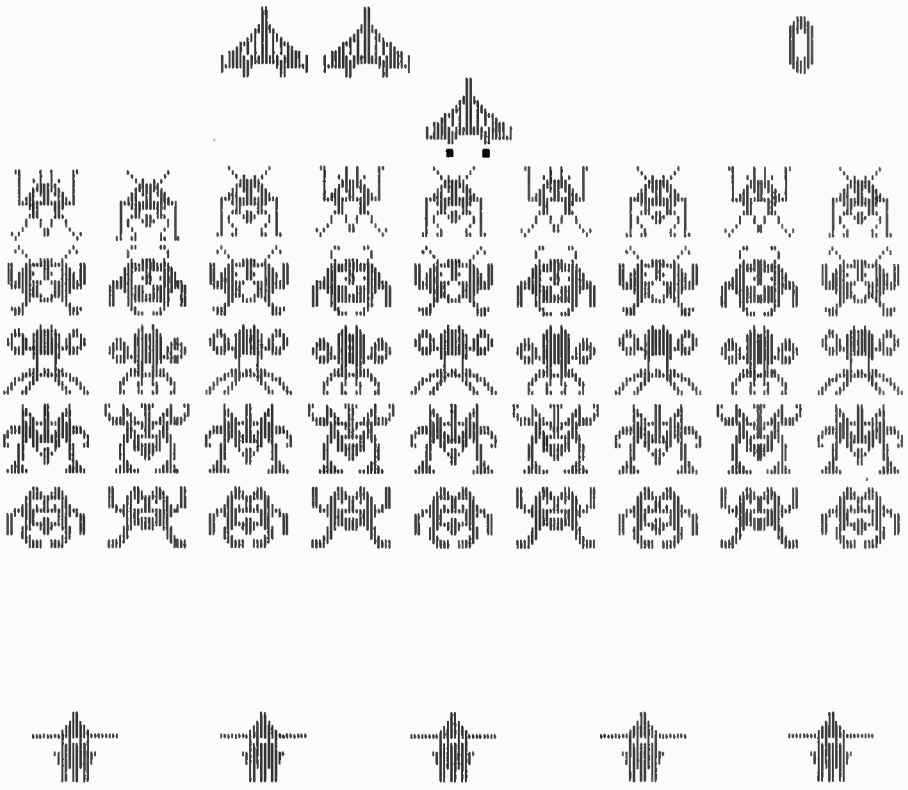


SPACE INVADERS A fast variation of this popular arcade game. the graphics are superb.

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

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

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

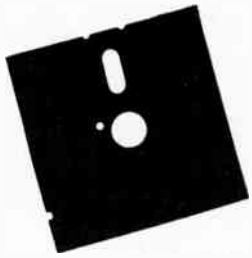
PX is a cross reference generator for assembler programs. It helps you keep track of where you put procedures in large files.

QS is a DOS patch which eliminates some of the wait encountered when DOS is booted while it performs a number of system checks. The program is not compatible with all software, but is still handy to have.

SDIR is an improved sorted directory program.

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

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



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Volume V. — *Almost Free PC Software*

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

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

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

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

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

MORTGAGE generates amortization charts.

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

MAIL1 is a mailing label utility written in BASIC.

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

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

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

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

WHEREIS finds files in a complex hard disk system.

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

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Almost Free PC Software

Volume VI.

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

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

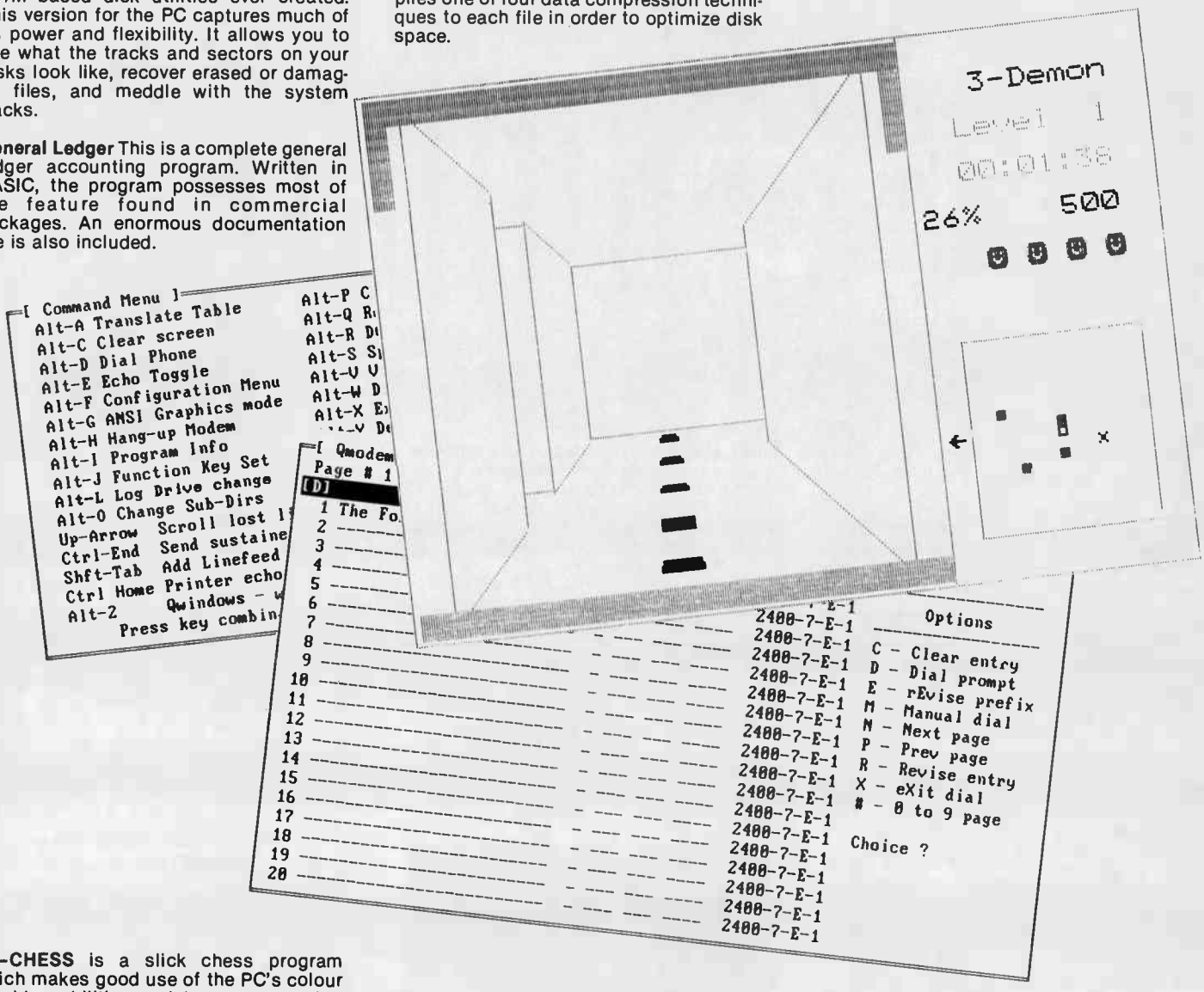
General Ledger This is a complete general ledger accounting program. Written in BASIC, the program possesses most of the feature found in commercial packages. An enormous documentation file is also included.

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

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

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

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



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

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

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

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

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

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

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

Two Disk Set

Only $24.95

Order as AFPC#6

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

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

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

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

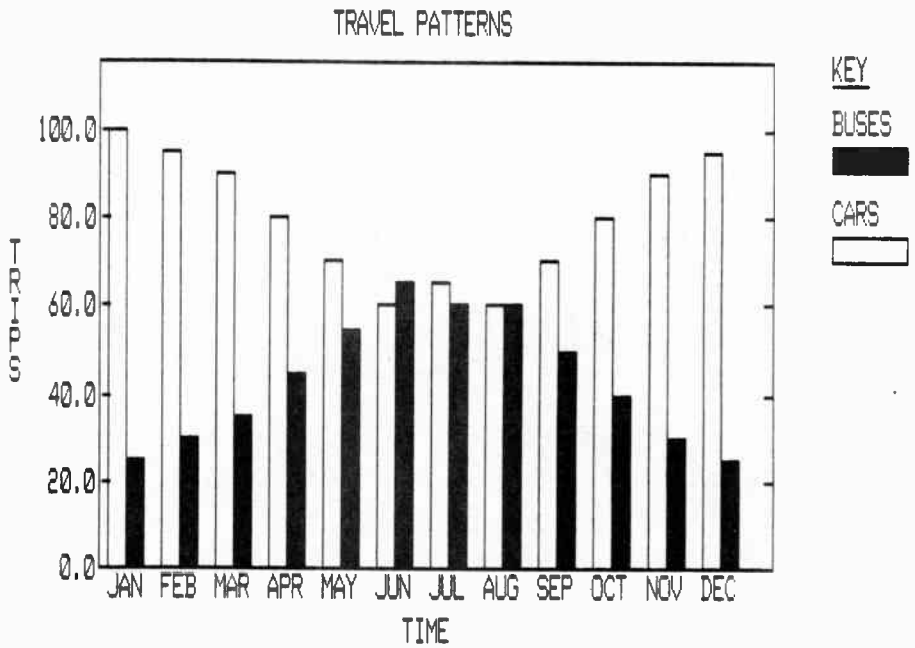
FXMASTER is a printer program for the popular Epson FX Series and compatible printers. It uses a full screen menu to enable you to easily change printer settings and modes.

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

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

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

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



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

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

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

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

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

Only $19.95

or $22.95 for two single sided disks.

Order as AFPC#7

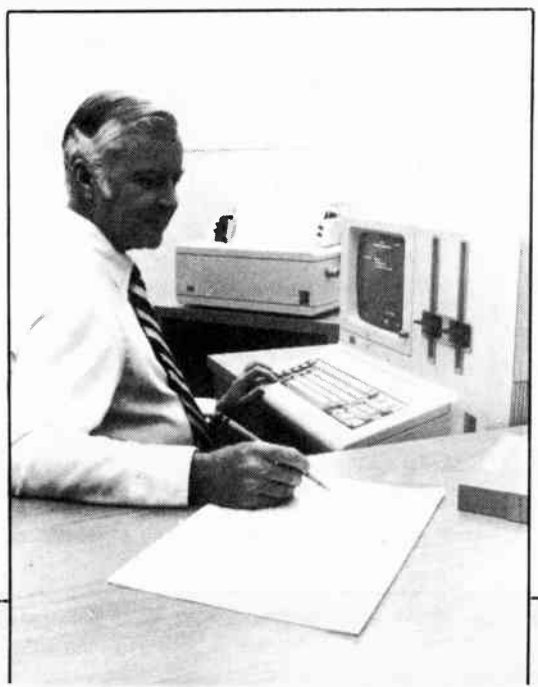
Stockboy Inventory

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

Stockboy can:

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

Stockboy is written in Microsoft BASIC and is designed to be easily altered to suit your needs. It can be compiled using BASCOM if desired and is designed to be used by nontechnical operators. Available for MS DOS/ PC DOS and many CP/M systems. See order form for a list of available formats.



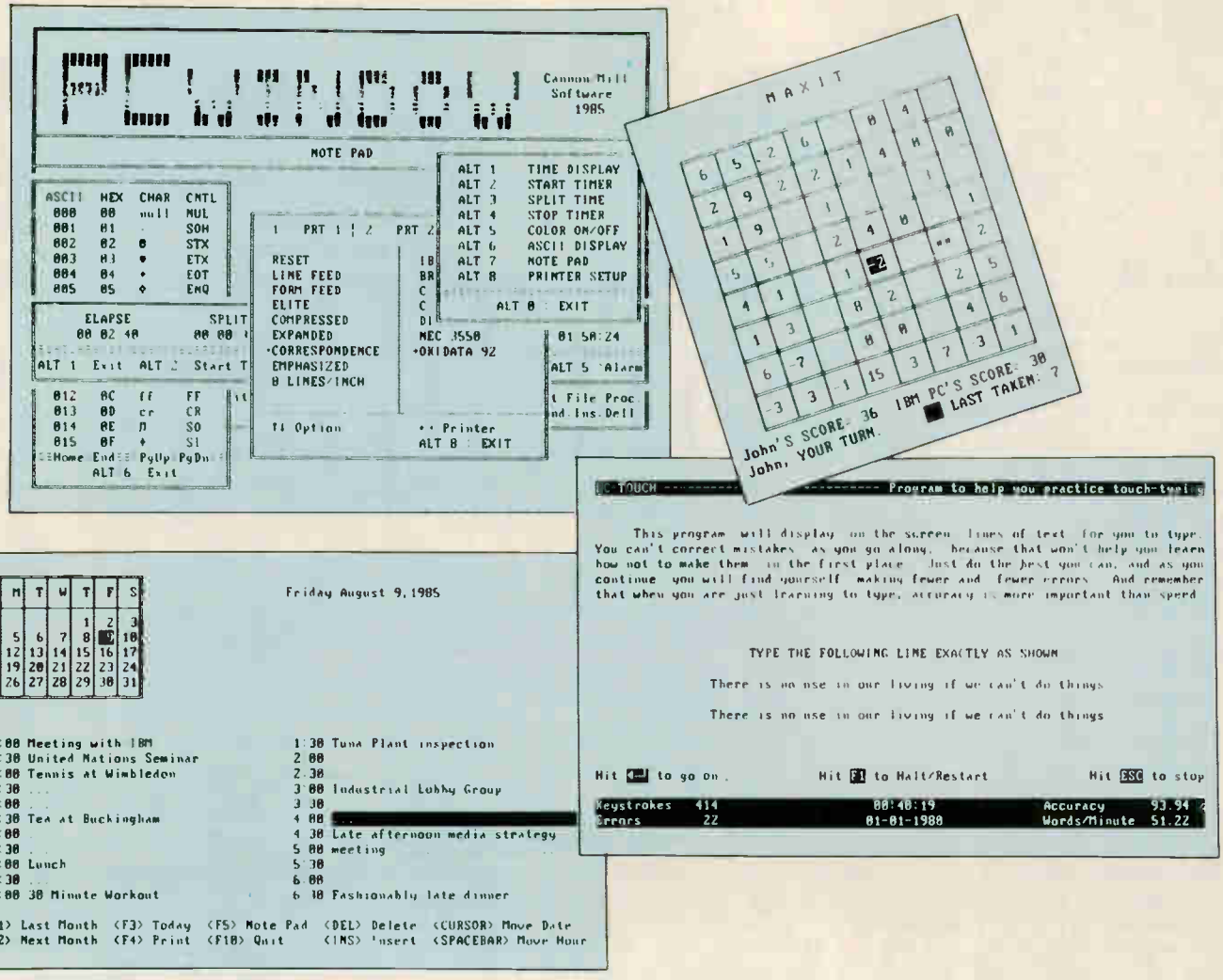
Also available for CP/M Systems.

See Order form for available formats.

Only $29.95

Order as Stockboy

Almost Free Business Software



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

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

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

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

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

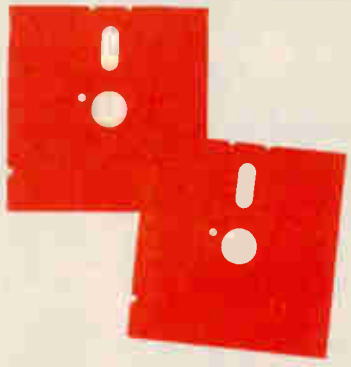
PCWNDW22 A "Sidekick"-like co-resident window utility. Pop-up window functions include ASCII table, stopwatch, alarm, printer setup utility and notepad. The entire program takes up less than 30K of space on your disk.

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

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

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

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



Only $19.95

or $22.95 for two single sided disks.

Order as AFBUS

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

Almost Free CP/M Software

Moorshead Publications

Volume I.

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

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

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

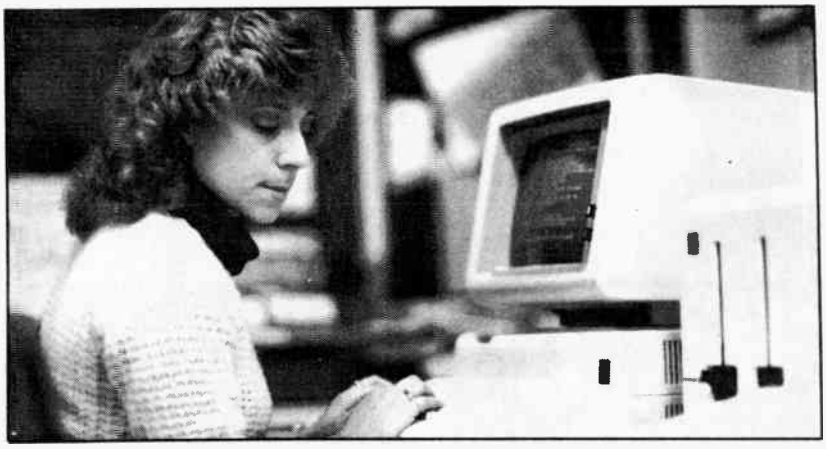
DUU The ultimate disk utility, DUU lets you recover accidentally erased files, fix corrupted files, and modify the system.

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

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

FINANCE A fairly sophisticated financial package written in easily understandable and modifiable Microsoft BASIC.

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



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

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

STOCKS A complete stock management program written in BASIC.

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

Only $19.95

or, $22.95 for 8" formats or two single density disks.
See order form for available formats.
Order as AFS#1

Almost Free CP/M Software — Volume II.

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

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

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

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

RACQUEL

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

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

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

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

Only $19.95

or, $22.95 for 8" formats or two single density disks.
See order form for available formats.
Order as AFS#2

Almost Free CP/M Software

Volume III

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

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

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

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

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

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

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

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

Only $19.95

or, $22.95 for 8" formats or two single density disks.
See order form for available formats.
Order as AFS#3

Gemini WordStar Press

With all its many strengths, WordStar's printing function is very slow. It can also be difficult to get page numbers and headers to appear the way you want them... and where you want them.

PRESS is a utility which handles the formatted printing of all sorts of text files such as manuscripts, drafts, program listings... anything that you'd normally want printed in page form. PRESS installs the header of your choice at the top of the page and prints the page number beside it.

It also provides a running count of characters and pages printed. You can print with a variety of type size and style permutations, depending on the capabilities of your printer.

Most important, PRESS will send formatted text to your printer as fast your printer can accept it.

PRESS comes configured for Gemini 10x and 15x printers, but will work with most Epson compatible dot-matrix printers. A version is also available for daisy wheel printers. PRESS is easy to use and very fast.

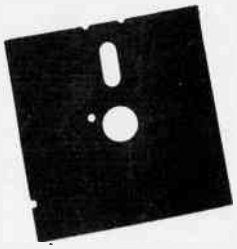
Only $19.95

Order as PRESS

Steve's Wunderdisk

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

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



Only $19.95

See Order Form for available formats.
Order as WUNDER

Apple WordStar Fixer

Apple compatibles and WordStar are not entirely friendly. Apple compatible systems equipped with Videx type eighty column cards do a number of unpleasant things to this popular word processor. While there are simple cures for this... they all involve some delicate code hacking.

The FIXER solves this problem. Place it on the same disk as your copy of WS.COM, type FIXER and after a suitable amount of disk noise, you'll have APWS.COM on there too. This patch version releases the control K's, translates the left arrow to a delete character and patches Unitron keyboards.

In addition, the FIXER lets you change certain default settings which are not alterable with MicroPro's INSTALL program. All features are menu-driven for easy operation.
Will run in either 44K or 56K CP/M

Only $19.95

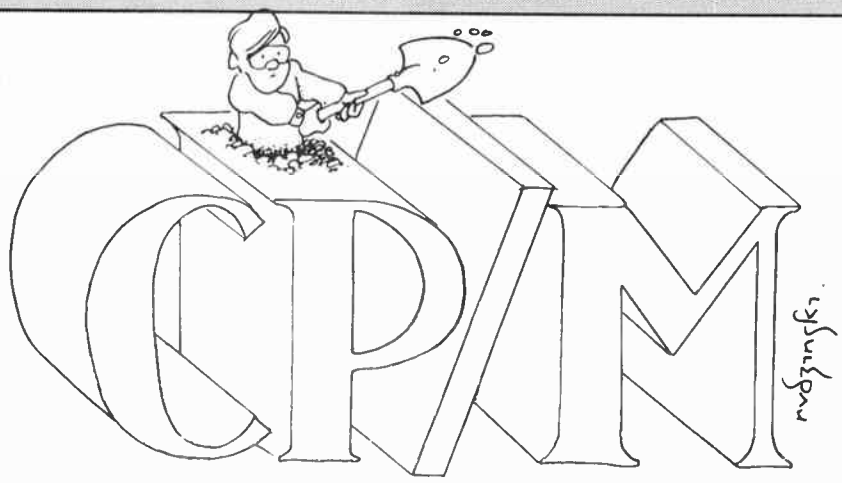
Available for Apple II series with CP/M.
Order as FIXER

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

Almost Free CP/M Software

Moorshead Publications

Almost Free CP/M Hacker Software



SUPERZAP is a disk utility similar to the DU programs. It lets you modify your disks at the track and sector level, patching code and fixing BDOS errors. But, unlike DU, its all menu driven with a full screen editor.

MEMDSK32 is the best memory disk program we've ever seen for CP/M systems. It runs on any 64K system to create a 32K RAM disk labeled drive D. The source is included, in case you'd like to alter its parameters.

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 won't give you lines of question marks when you're trying to patch your BIOS or other commercial software.

ZESOURCE and REZ are two of the most powerful disassemblers ever created. They'll create salvageable assembler code from any .COM file. With perseverance you can recreate the source code for most existing software in order to learn its secrets or patch it for your own applications. Especially useful for patching CP/M. Both are supplied to allow you to use simple assemblers or M80 and L80.

COPY is a handy way of copying an entire disk, files and system tracks, onto another floppy. Includes source code.

PROBE digs through your version of CP/M and tells you everything there is to know about it, including the locations of its various components, where things *jump* to, how the disk allocation is set up, etc. A splendid tool for low level programming.

DU-V88 The latest version of this tried and trusted disk utility. This one also includes the long sought after DU.DOC file.

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

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

Only $22.95

See Order Form for available formats.
Order as HACKER

MDM730 for Apple CP/M

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

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

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

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

The Computing Now! MDM730 package is available for:

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

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

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

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

Only $29.95

Available for Apple II series and compatibles with CP/M

Order as MDM730
and specify modem type

Almost Free Apple DOS Software

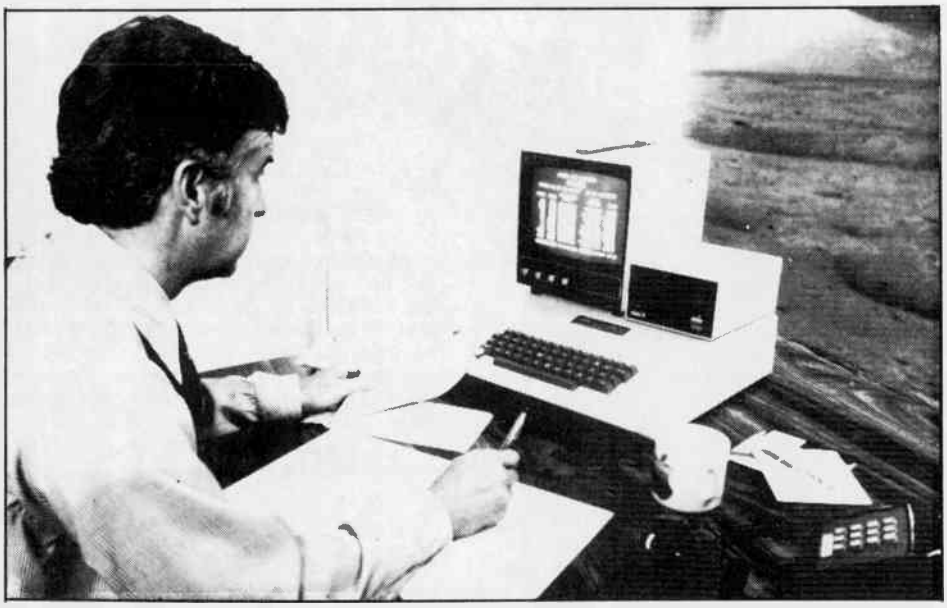
Volume I

DATABOX is a small, but useful database program written in BASIC. Sample files are included to get you started.

NULLSPACE INVADERS is a fast BASIC HiRes game which tests coordination and judgement as you manipulate a monolith through mysterious gates.

DNA TUTORIAL Written in Integer BASIC, this is an interactive low resolution graphics tutorial which uncovers the mysteries of DNA.

TOAD is an Applesoft BASIC implementation of 'Frogger' that can be played with either a joystick or the keyboard. User's high scores are saved to disk.



FUNCTION PLOTTER is a sophisticated Applesoft BASIC program that takes any inputted function and plots it on the HiRes screen.

DATA DISK FORMATTER is a binary program which formats a disk without putting DOS on system tracks, freeing up more room for data on multiple drive systems.

BASIC TRACE is a utility for the advanced Applesoft programmer which displays the hexadecimal locations of each Applesoft line number currently in memory.

GEMINI UTILITY is a word processor pre-boot utility for Gemini printer users which initializes the printer's font or pitch before you boot your word processor.

PAYMENTS This basic program enables you to keep track of payments and credits to and from up to 100 accounts on a single disk. A sample account is included.

PICTURE CODER Standard Apple II high resolution graphics pictures are require an inefficient 36 sectors of disk space. This utility creates graphics text files, squeezing out the zero bytes that can later be EXEC'd into memory. These text files often take up less space on disk than regular graphics files.

Only $19.95

Order as AFAD#1

Volume II.

Almost Free Apple DOS Software

AMORT is a monthly amortization program that calculates monthly payments, principle and interest on every balance and prints the resulting chart.

VOICEPRINT An unusual program that uses the HiRes screen to sample sounds inputted through the Apple's cassette jack. Sampling rate and other variables can be controlled, and two sounds may be compared side-by-side.

CALC NOW! Written in BASIC, this spreadsheet program is not as fast as VisiCalc, but it still offers the power you expect from a spreadsheet. With sample files.

CAVERN CRUSADER A mix of BASIC and binary programming, winning this game is difficult, to say the least. For every wave of aliens shot in the cavern, there's always a meaner bunch waiting in the wings.

NEWCOUT This binary program replaces the I/O hooks in the Apple with its own so you can operate your Apple through the HiRes screen. Includes a sample character set and program source code.

CHARSET EDITOR A utility for creating graphics character sets to use with NEWCOUT.

CALENDAR A BASIC program for finding a particular day of any inputted month and year. A calendar for any year can also be print.

LCLODR2 With source code, this binary utility BLOAD's any given file into the 16K language card space at $D000. The source listing is useful in showing how to use DOS commands in assembly language.

CRISTO REY is an animated HiRes BASIC program which displays Cristo Rey by moonlight. For apartment-bound romantics.

ATOT An acronym for 'Applesoft to Text'. EXEC this textfile to produce a textfile of your program.

APPLESOFT DEFLATOR This program takes textfiles created with ATOT and squeezes them replacing PRINT statements with '?' and removing unnecessary spaces form the listing.

Only $19.95

Order as AFAD#2

Almost Free Apple DOS Software — Volume III

GENERAL LEDGER is an extensive BASIC general ledger program.

EE-DESIGN A shape and design program written in BASIC. Lets you plot shapes in HiRes graphics and save them to disk or print them out.

QUICKZAP is a disk sector utility that reads a given track and sector into memory and permits you to alter it and write it back to disk.

SOFTGRAPH A complete graphing program written in a combination of Applesoft and Assembly language that enables you to see your data plotted in pie, line or bar charts.

INTELLICALC An intelligent calculator with three memories and a 'paper tape' readout.

POKER! A fast Applesoft BASIC version of this popular card game. Harmless electronic avarice.

POLAR GRAPHICS Similar to Function Plotter, this BASIC program supplies a number of attractive functions in REM statements which can be used to plot on the HiRes screen.

CLOCK AND CLOCK II Two Applesoft digital clocks to help you keep track of those late hours spent at the keyboard. One has an alarm function.

CONVERT UTILITY A BASIC program that converts number between decimal, hexadecimal, binary and disk sectors.

FLOWERS An assembly language program that prints a border of flowers around the high resolution screen. Source code is included as an valuable lesson in handling HiRes shapes in assemble language.

ProDOSfix.TXT Apple clone users who have purchased ProDOS will note that it doesn't work on their machines. This text file explains why, and how to remedy the problem.

Only $19.95

Order as AFAD#3

A Teacher for the Apple

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

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

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

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

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

Only $35.00

Order as TEACHER

Apple DOS Wunderdisk

Over the last few years, Computing Now! has featured many programs for Apple II users. These programs have involved a lot of work and have been thoroughly debugged. Because the tedious job of typing in program listings is not everyone's favourite past time, we've gathered together a collection of our best Apple programs and put them all on a single disk. Enshrined on this disk are some of the classics of the past.

You get DOSdial, the dialing terminal program, Clef Hangar, an Apple music box, Skyhook, a radio teletype converter, Fruit Crate, a small bulletin board system, MuGraph, an experimental sound system, Hashit, a sorting routine, JoyGraph, a graphics program, and of course, the infamous Blort! Ah, the memories!

Only $16.95

Order as Apple DOS Wunderdisk

Almost Free Electronics Design.

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

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

Only $19.95

Order as DESIGN

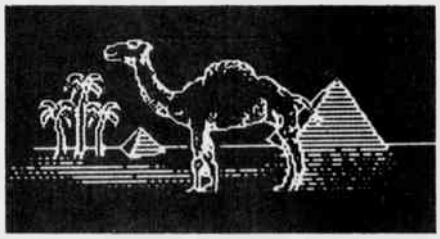
Almost Free Apple DOS

Camel Term for Apple DOS

CP/M and IBM PC system owners who use modems for file transfers and bulletin boards have long had the advantages of the XMODEM/MODEM7 or Christensen file transfer system. Telecommunications programs using XMODEM perform some sophisticated checks to ensure that data received over the phone is identical to the data originally sent. In fact, using XMODEM ensures that all data received is over 99% free of errors caused by telephone line noise.

Now for the first time, Apple users can upload and download files and transfer data with the knowledge that all files will be received error free.

We are pleased to offer CamelTERM for Apple II and compatible systems. It combines the functions of a simple terminal program, a phone number library and automatic dialer with a checksum compatible MODEM7/XMODEM file transfer system.



With CamelTERM you can call remote bulletin boards and download software. You can even call CP/M and MS DOS-based boards to download BASIC and PASCAL files for subsequent conversion to Apple. You can also send files between two Apple systems confident that the data will not be corrupted.

Note that for CamelTERM to work, both ends of the transfer must support it.

CamelTERM will cheerfully move binary files, machine language code and high resolution pictures. It will handle files up to twenty-four kilobytes long and supports multiple baud rates on some serial cards. At present, the following cards are supported:

- PDA 232C with Hayes Smartmodem or equivalent.
- Hayes Micromodem II at 300 baud only.
- SSM Modemcard at 300 baud only.

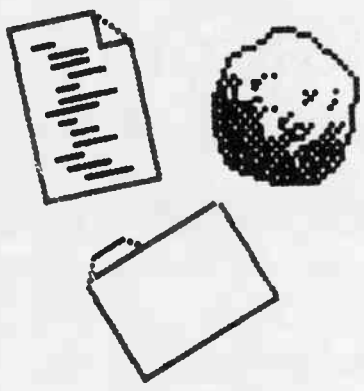
These cards can be in any slot from one to seven. CamelTERM will not work on clones of these cards.

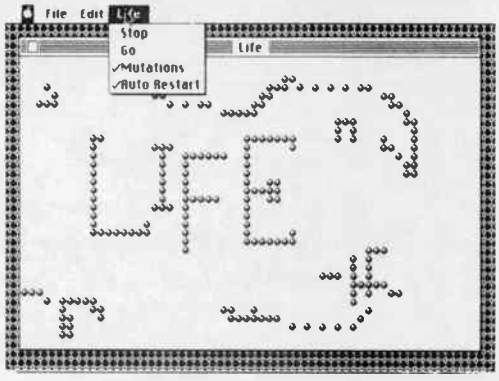
Best of all, CamelTERM is inexpensive.

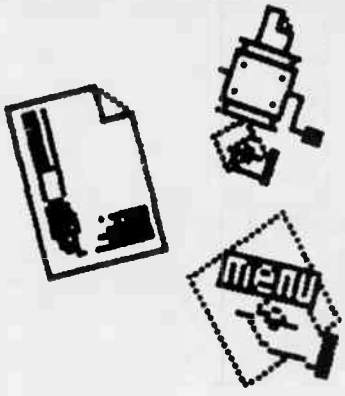
Only $32.95

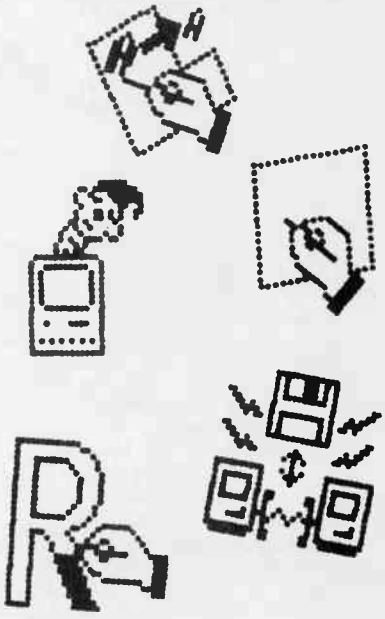
Order as CAMEL and specify modem type

Volume I. Almost Free Macintosh Software









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

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

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

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

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

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

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

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

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

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

Only $29.95

Order as AF-MAC #1

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

Almost Free Macintosh Software — Volume II

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

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

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

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

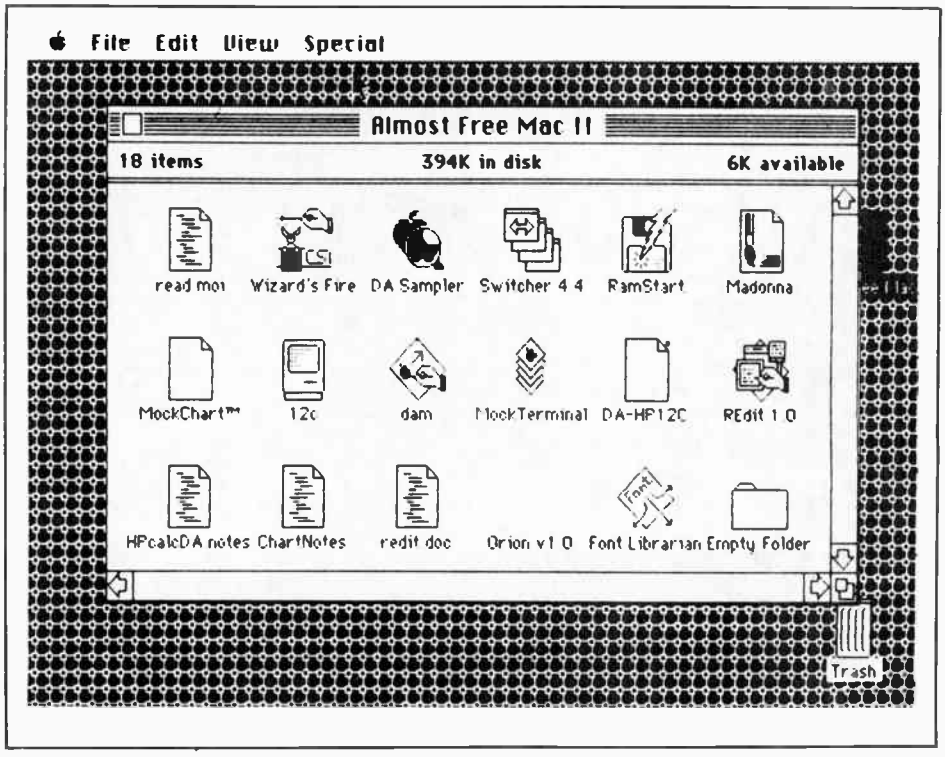
MADONNA A MacPAint picture of the popular pop star.

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

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

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

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



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

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

Only 24.99

Order as AF-MAC #2

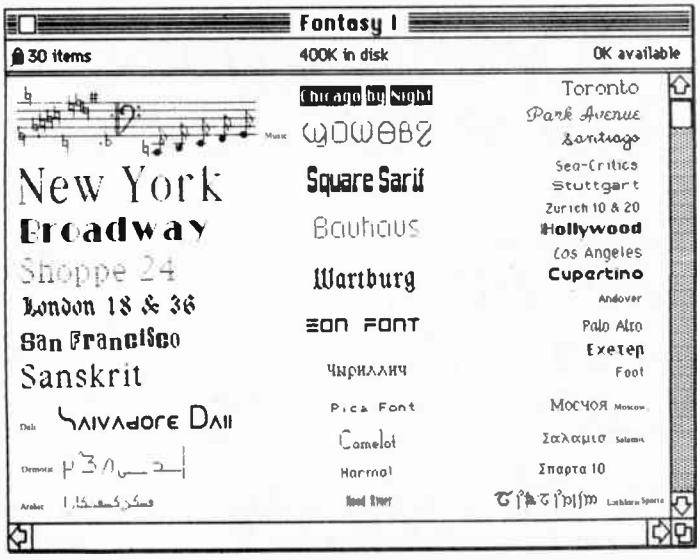
Almost Free Macintosh Software

One of the most interesting aspects of the Macintosh is its amazing typography. Far from being hard wired into its operating system, the Mac allows one to change the fonts available to an application to suit one's needs... or just 'cause one feels weird today.

While there are a number of commercial font collections available for the Mac, we feel that the best things in life are almost free, and have thus created this disk. It is full... right down to a zero K in the upper right hand corner... of font files. There are thirty eight unique fonts on the disk but, as most of them are available in several sizes the actual number of fonts is considerably higher. We've tried to select a variety of body copy and display faces, both fairly normal ones, really bizzare ones and a number of special purpose ones. In most cases, there are also plenty of extra symbols available in these fonts as well.

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

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



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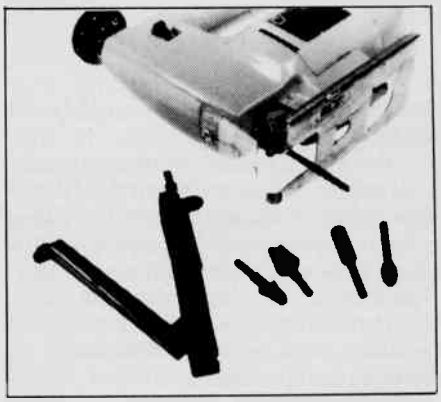
punch and backing plate are put on opposite sides of the metal and the bolt is tightened with a wrench. It's the best way to make holes for things like XLR mike connectors. Keep everything well oiled.

Rectangular holes aren't the drag you'd think. If it's a smallish sort of hole, 1 x 2 or thereabouts, a metal nibbler is the best way. Mine is the Adel nibbling tool, available from component suppliers. It needs a 7/16 inch starting hole, and nibbles a line about 1/8 inch wide. For larger holes, try a power sabre saw fitted with a hacksaw blade. Zip-p-p! Relief at last. The edges may be a bit rough if you're working freehand, though they'll be better than with a metal nibbler. You could always use C-clamps to fasten a wooden strip to the work to guide the saw. That reminds me. When it comes to clamping

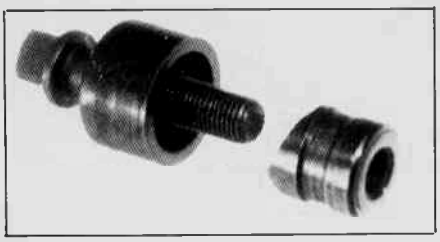


Some metal-working tools to make life easier: the Adel nibbler, a sabre saw, two conical cutters and two rasps that fit power drills.

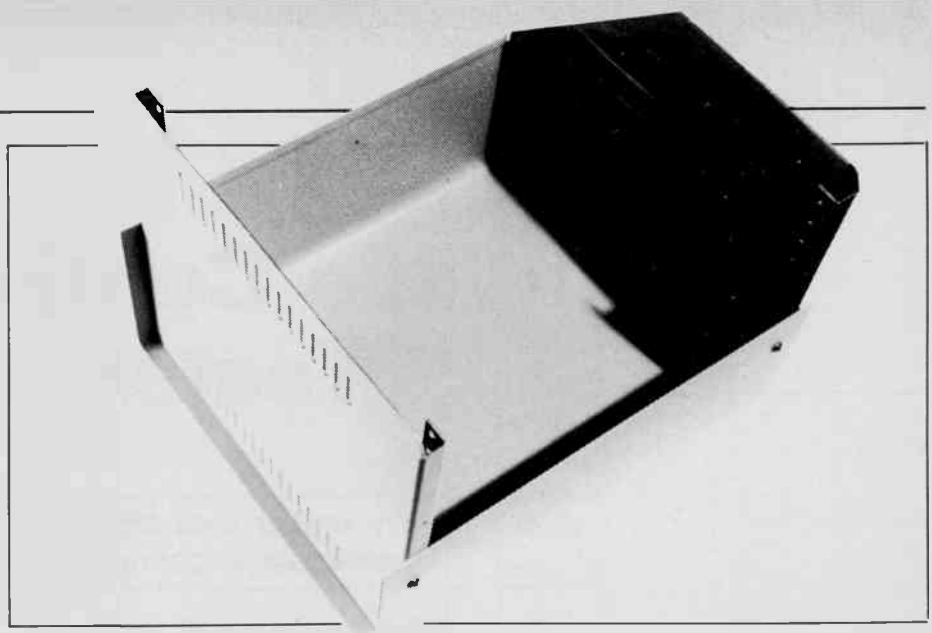
and positioning, there are few things as useful in the workshop as a Workmate or similar worktable. The adjustable clamping jaws have a million uses, and the whole thing folds up if you want to hang it on the wall.

There are also handles into which you can insert a standard hacksaw blade for cutting blind holes. I guess they're better than nothing, but hacksaw blades are meant to be supported at both ends, and they flex a lot when held only at one end.

If you have to bend a piece of sheet metal for shielding or other purposes, try using C-clamps to fasten the sheet to the workbench with the foldline right at the edge. C-clamp plywood on both sides of the bit that's hanging over, allowing a bit of space for the bend. Bend it. Well, it ain't no professional bending brake, but it's better than bashing at it with a hammer. ■



The Greenlee chassis punch, also available in various shapes other than circular holes.



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CLEARANCE, BACK SWITCH CASE $59.95

We also have an IBM 8 Slot/6502 Board dual duty case for making IBM look-a-like 6502 systems $79.95

NICADS 8.4V 7 "D" 4A.H CELLS

A great buy, a pack of 7 brand new GE NICADS giving 8.4v at 4 Amp hours. Each cell is 12v and separates easy. Used as 5V backup through a 7805. Gives 5v 1 Amp for 4 hours. $14.95

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(A) 384K RAM CARD. A ¾ sized card that has 384K of 64K DRAM on board. With OK $79.95

(B) 512K RAM CARD. A full sized card with 512K of 64K DRAM on board. With 64K $119.00

(C) 576K RAM CARD. A very popular card with 576K of 64K and 256K DRAM on board. This is a ¾ sized card for portable use. With OK ..... $ 79.95

(D) KRAM RAM CARD. A clone of the JRAM with up to 2 MBYTE on board using 256K DRAM. 100% compatible, complete with software for using as RAMDISC and RAMSPOLL. With OK $139.00

(E) COLOR GRAPHICS. A clone of the popular PERSYST color card. Has three outputs and one input. A. RGB for IBM color monitor. B Video 1v P to P composite color video. C. Video gray scale 1v P to P for seeing color on green or amber monitor $129.95

(F) MONOCHROME GRAPHICS/PRINTER. A workalike clone 100% IBM compatible for the HERCULES card. Has par printer port and hi-res text and graphics mono output $159.95

(G) 384K HEXPACK. A copy of the AST 6-PACK, 100% compatible with software. Has Clock/calendar/alarm and 384K DRAM and serial and parallel ports and game I/O. With OK $189.00

(H) 640K HEXPACK. Similar to above but with 640K on board using 256K and 64K DRAM. All other features the same. With OK $279.00

(I) DISC CONTROLLER. For 1-4 DS-DD drives. Full IBM standard with cable and instructions. ..... $ 79.95

(J) DISK CONTROLLER + I/O CARD. A very good card that has a clock/calendar/alarm and game I/O and serial and parallel ports and a standard 1-2 drive controller card on a full sized card. Very efficient card $189.95

(K) I/O + 2. A clone of the very popular USA card of the same name. Has clock/calendar/alarm, with game I/O, serial and parallel, ports $129.95

(L) PRINTER CARD. A standard centronics printer port for all parallel printers ..... $ 59.95

(M) SERIAL CARD. A standard ASYNC serial card for modem use etc. ..... $ 49.95

(N) MODEM CARD. A 300/1200 Baud modem using the 8910 WORLD chip. Compatible with many popular software packages. $189.00

(O) 8255 I/O CARD. Uses 2 8255's to give 16 lines of I/O for various uses. Fully locatable $129.95

(P) CLOCK CALENDAR CARD. A small card to add the clock/calendar/alarm battery to system ..... $ 49.94

(Q) GAME PORT CARD. Adds two std game I/O ports to the system ..... $ 39.95

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- High order compatibility due to the DTC bios which is recognized superior to others.
- 8 Slots for plug in cards, just like IBM
- Made right here in Canada
- Socketed for the 8087 Co-processor
- IBM compatible serial keyboard
- Disc controller using 9216 IC, the most advanced, for error free operation.
- Properly made 135W power supply with accessory plugs.

(A) Basic system 256K, 1 DSDD drive, & controller monochrome card, 135W PS and keyboard $949.00

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(1) 640K Motherboard with 640K $110.00
(2) Color graphics card with gray scale ... $ 80.00
(3) Parallel printer port card 59.00
(4) Clock, calendar, alarm, serial, parallel, and game card $110.00
(5) Extra drive, installed and tested $160.00
(6) 10 Meg hard drive, w/controller $699.00
20 Meg hard drive, w/controller $949.00
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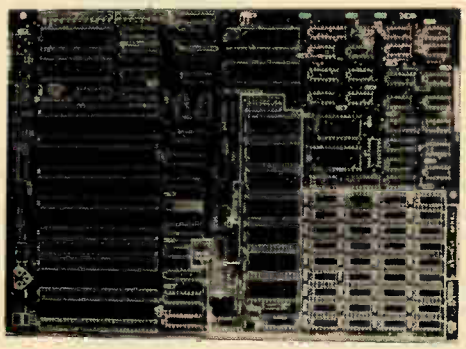
Tape cartridges for above ..... $ 34.95
(8) External hard drive box w/power supply for hard drive or tape B/U option, w/cables and ready to go $249.00

HARD DRIVE BOX

This nicely made box is ideal for externally mounted hard or floppy drives. It has space for one full height or two half height drives and power supply space at rear. This is a well made and rugged units for only $59.95

NEW SME-XT 640K TO 1M BYTE



In response to popular demand we have developed an upgrade of the famous MBE-XT board. The new board is called the SME-XT and has space for up to 1 Mbyte on board. The most popular configuration is 640K which is the IBM max addressable memory. The extra RAM above 640K is normally used for system purposes such as video lookup, ROM sitting, and other uses. However, we can supply proms to allow full use of this overhead space on demand. The 256K RAMS are more highly evolved than 64K RAMS and board using them have far fewer problems with parity errors. We have decided to maintain the low-low price we pioneered with the MBE-XT and sell the new PCB at $39.95 as well. All other attributes stay the same as the original IBM and the MBE-XT.

SME-XT $39.95
Manual and Schematic ..... $ 4.95

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LAZYBOARD. No we are not lazy, it's for YOU!!!. We had a bunch of 640K motherboards expertly wave soldered with all solder-in parts with AMP style IC sockets but no IC's at all. You buy the IC's or use your own stock and you can get a system going really cheaply. We are selling this "LAZY BOARD" for only $135.00

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Set of 941256 ..... $44.00

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IBM Parallel printer cable $14.95
IBM serial printer cable $14.95
IBM 6' Keyboard extension (curly) ..... $ 9.95

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DISC DOUBLER

Just that, it doubles your discs by cutting another write protect notch on the other side of the Apple SSDD diskette so the other side can be used, doubling your storage space. Note, almost all diskettes are good on both sides and the diskette packagers just lable them SS or DS and sell the DS for 25% more. So spend $8.95 and save hundreds later on.

MODULATOR

This modulator was made for the TI 99-4A that is now dead as a doornail. We bought a bunch and are selling em for.. $14.95. They are a very good quality modulator for use on 12 Volts DC and have both sound and video inputs and are for color use on channel 3 or 4. They also have a built in antenna switch. They are a very good unit professionally built. $14.95
Video cable, RCA-RCA 6 feet $1.00

CONNECTORS DB SERIES

DB-25 M solder	$1.95
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2N3906 trans	$ .79
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20 pin female header for disk drive	$ 1.69
20 pin male	$ .89
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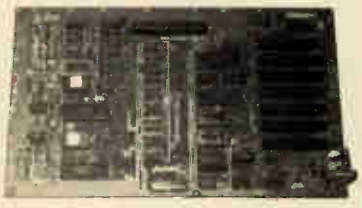
220 ohm trimpot	$ .89/ft.
20 conductor ribbon cable	

MOTHER BOARD



100% IIe* Compatible, for those of you who wish to build a clone of the very popular APPLE IIe*. This board is a reverse engineered copy of the IIe* and is 100% compatible. We have the motherboard and the custom ICs only. All other parts are widely sold. The custom ICs are workalike chips that do not infringe any copyrights. The software for operating the board must be obtained elsewhere as we do not have it for sale. When we say 100% we mean it.
A very good buy at $49.95
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Character generator, U/LC $14.95
48K 6502 Motherboard, same old 100% compatible 2+ clone $29.95

IIe* ABS PLASTIC CASE
$59.95

This case is made to fit the Mother Board listed here for making IIe* clones and it makes a very nice looking copy. There is just enough difference to avoid design infringement. The case also has no brand names or other marks on it.
A good buy at $59.95
ABS numeric case for 48K motherboard. Exact fit $49.95

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2716	$3.49
2732	$3.95
2764	$4.95

GRAY SCALE ADAPTER

As you know the IBM color graphics card does not look very good on a monochrome monitor. This is because often two colors look the same on monochrome so you cannot read red print on a blue background or some such. This little gray scale proportionately scales each color into a different intensity allowing easy viewing on amber, green or white monitors. We sell it as a kit for only (with cable) $19.95
or wired and tested (with cable) $24.95

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As you know AMP makes the best IC sockets. With a double wipe action and a very wide open target for easy insertion, the best.

6, 8, 14, 16, 18, 20, 24, 28, 40
Pin in stock at only
1.5¢ PER PIN

V-20 CHIP

You may have heard of the NEC V-20 chip. It is an upgraded 8088 that can run programs up to 50% faster (depending on code). It also can run Z-80 code, allowing it to be used for Z-80 development. Especially good for Video when using code using it's features. A hot and hard to get CHIP at (5 Mhz) $24.95
Faster version runs at 8 Mhz $44.95
Note this chip is also rebranded and sold as the 88000 by others. be warned

FEEWARE

Feeware??. It is public domain software that we have collected into volumes and are offering out at a fair price considering the gathering effort. You can do what you like with it, set up your own resale operation in your area etc. What we offer is two sets of 4 diskettes with each set covering a general area of interest.

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Continued from page 10

A variable resistor in series with the capacitor enables the gain of the stage to be varied in sympathy with the signal amplitude by changing the total impedance across the emitter resistor and also the amount of negative feedback.

Unfortunately, the circuit proved unsatisfactory in practice because the DC charge in the capacitor changed according to the value of the series resistance.

into existing mixers or amplifiers, the top leg resistor of can be inserted in series with the main volume control at its 'high' end. The transistor is connected across the control which therefore serves as the shunt described in the 'How It Works' section. The value of the top leg resistor should be about a tenth of that of the volume control, so a 25k control would need a 2k2 resistor. This will reduce the gain of the amplifier by an eleventh or less than 1 dB. If the unit is constructed in a separate control box, the shunt resistor can be 47k and the upper one less than a tenth at 3k3.

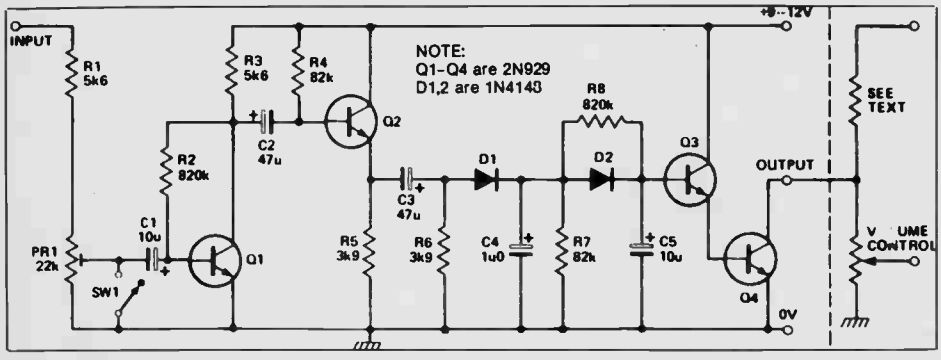


Fig. 4 The circuit of the AVC unit, showing the connections required when it's built into existing equipment.

Design Developed

Finally, the circuit shown in **Fig. 4** was developed, and with some minor modifications over a period of use has proved to be very effective. When the device is built

Parts List

Resistors (all 1/4W, 5%)

R1,3	5k6
R2,8	820k
R4,7	82k
R5,6	3k9
PR1	22k potentiometer

Capacitors

C1,5	10u 16V PCB elect.
C2,3	47u 16V PCB elect.
C4	1u0 16V PCB elect.

Semiconductors

Q1-4	2N929
D1,2	1N4148

Miscellaneous

SW1	SPST or SPDT (see text)

Manual Mode

The AVC control is shown as a preset mounted on the circuit board, but if desired it could be an ordinary manual control fitted either to the control panel of the mixer or on the case of a separate unit.

A manual control is useful as different conditions call for different degrees of control. In the lowest positions, operation of the control automatic circuit is not noticeable to an audience, but the

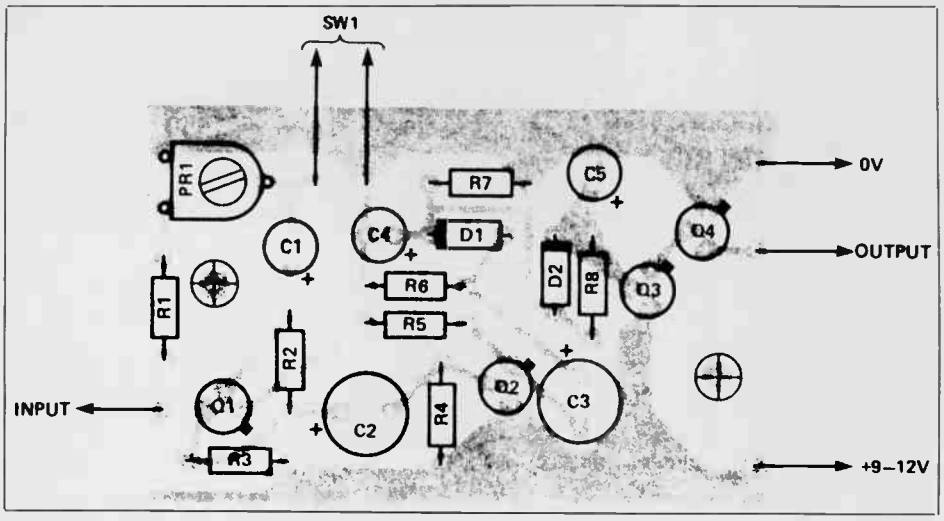


Fig. 5 Component overlay for the AVC unit.

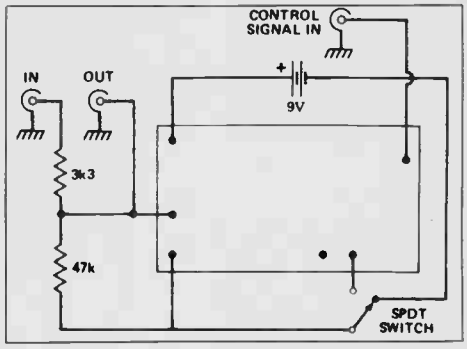


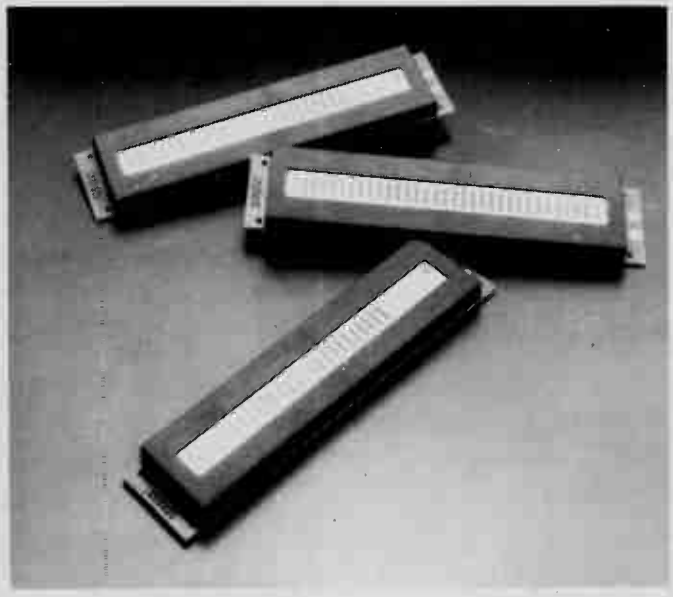
Fig. 6 Board connections to peripheral components when used as a separate control box. PR1 can be replaced by a manual control on the panel if desired.

operator can see form his output meters that the loudest signals are restrained and kept within the range of the equipment. At the other extreme, if turned fully up, the loud sounds come out quieter than the soft ones. This degree of control would obviously never be used, and the setting will be somewhere well below that.

Modifications

A switch can be incorporated, if desired, to short the wiper of the control to ground. The same effect is obtained by turning down the control to zero, but the separate switch enables a particular control setting to be preserved when the circuit is switched out. Another optional feature is that the switch can be a double pole type with the second pole arranged to switch a LED on and off as an indication that the automatic circuit is in operation. ■

LCD Bargraph



PCI Displays announce the PCIM 500 Bar Graph Module. The LCD module has stand-alone capability, containing the necessary decoders and drivers. Features include a full-scale graph of 32 segments, operation from 5V, a selectable alarm level, and an alarm indicator and output. The voltage reference is built-in. From Zentronics, 8 Tilbury Court, Brampton, Ontario L6T 3T4, (416) 451-8445.

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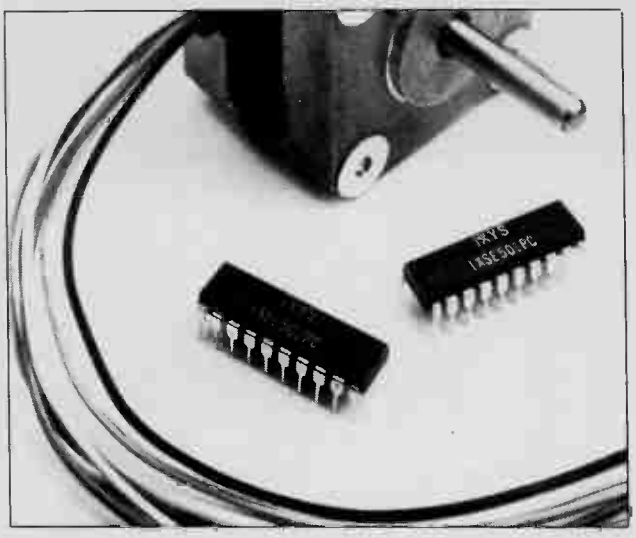

The IXYS Corporation, designers of VLSI circuits for motion control and one of the more unpronounceable names around, announce the IXSE501 Shaft Encoder Peripheral Interface IC, which links position and velocity feedback from motors to microprocessors. It uses incremental optical shaft encoders to provide velocity and direction information, error detection, homing, etc. The 8-bit format allows shaft speeds up to 38,000 RPM, depending on the encoder used. IXYS Corporation, 142 Charcot Ave., San Jose, CA 95131, (408) 435-1900.

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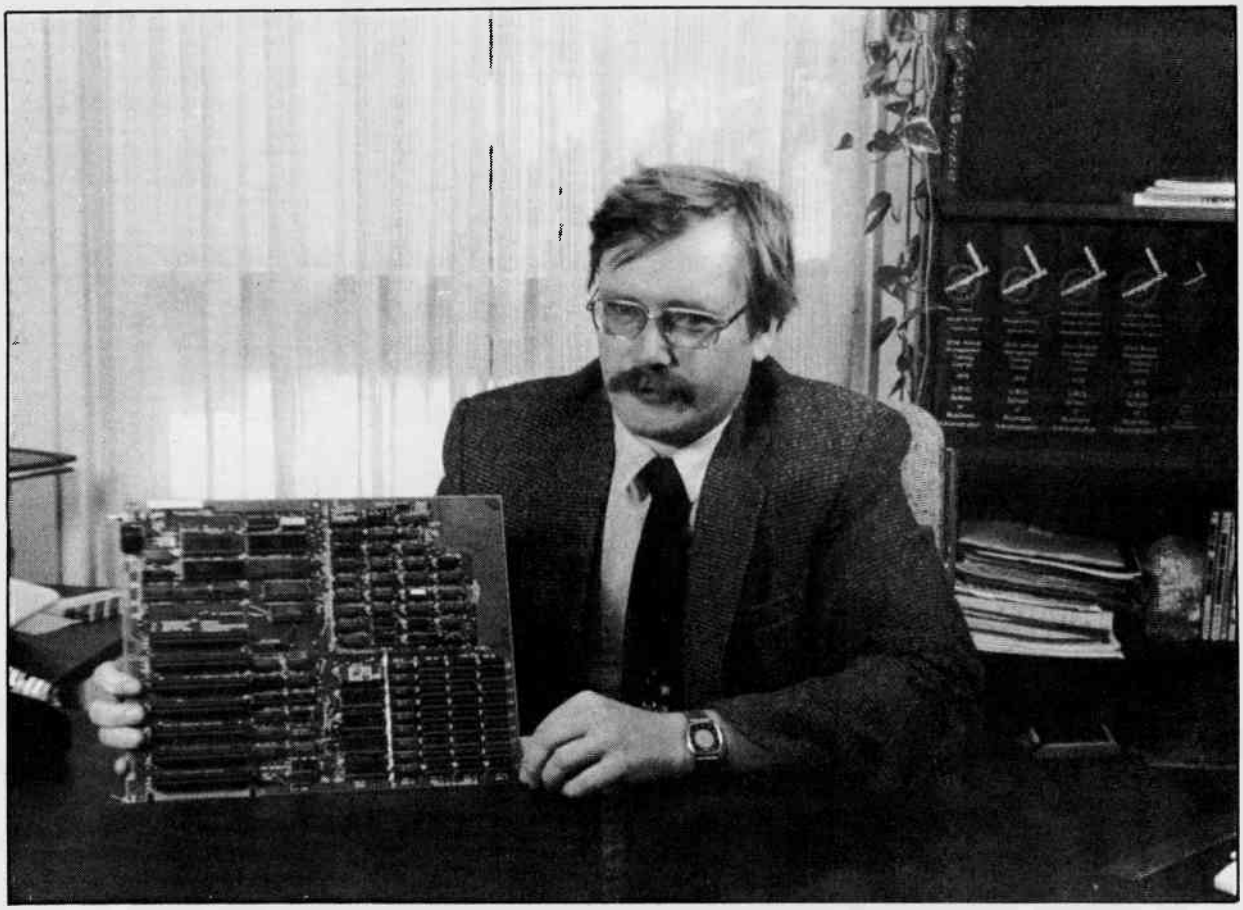
Continued on page 44



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Continued from page 27

grammed to divide by any even integer from 2 to 131070, and a vast range of some 65535 output frequencies is therefore available. However, most of these are unusable in this case as they are within the audio range, and would produce noticeable breakthrough at the output. The available range enables some useful effects to be generated though.

The full circuit diagram of the unit appears in **Fig. 3**. If we take the channel based on IC1a, R1 and C2 are the input filter, while IC2 operates as a standard third order 18dB per octave lowpass filter at the output. SW1a selects the required type of filtering, and on the prototype this is ganged with SW1b in the other channel. However, separate switches should be used here if you wish to use the two channels in different filter modes. RV1 is the 'Q' control. The filters are connected to operate with a 100 to 1 clock/cutoff frequency ratio, which gives an effective sweep range of about 150Hz to 5kHz.

The circuit requires dual balanced 5 volt supplies. The ⁵5 volt supply is available rom the Commodore 64's user port, but the -5 volt supply has to be derived from one of the 9 volt AC outputs using a simple rectifier, smoothing, and regulator circuit based on IC4.

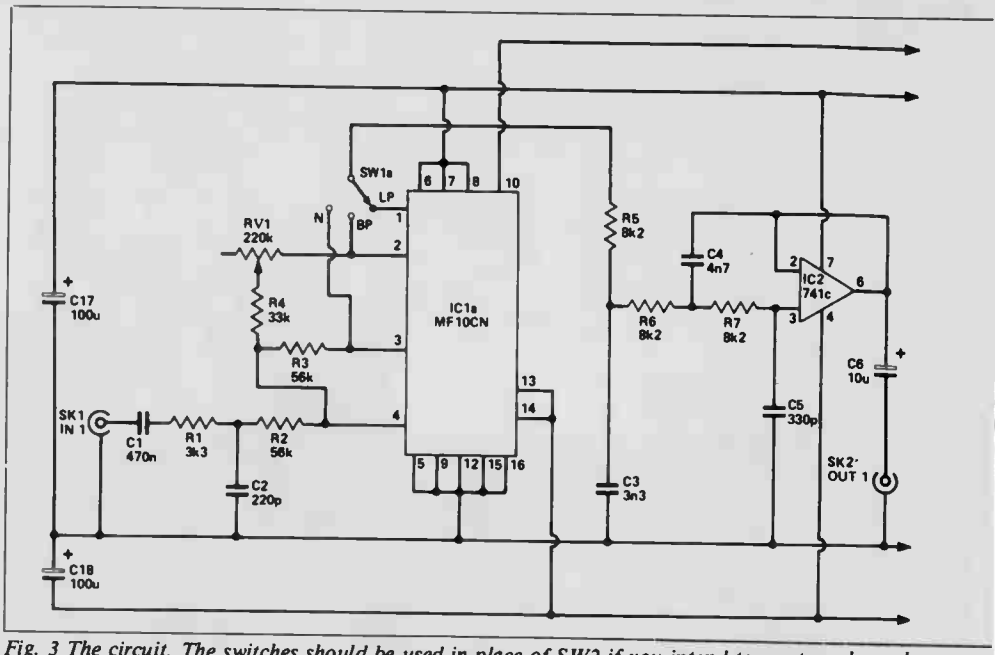


Fig. 3 The circuit. The switches should be used in place of SW2 if you intend to use two channels in different filter modes.

Construction

Details of the printed circuit board and wiring are shown in **Fig. 4**. There is nothing unusual about construction of the board, but note that IC1 is a MOS device and should be mounted in a socket. The other MOS handling precautions should also be observed. The connections to the computer are taken via a 5 way DIN socket fitted on the rear panel of the case. From here the connections are carried to the computer by way of a 5 way ribbon cable up to about a metre long and fitted with a 5 way DIN plug to connect to SK5, and a 2 by 12 way edge connector at the end which connects to the user port of the computer. **Fig. 5** gives wiring details for the edge connector.

The case for the prototype is a plastic Verocase having metal front and rear panels, with approximate outside dimensions of 180 by 120 by 39 millimetres. Any case of roughly the same size should take all the parts without any difficulty though. The controls and input/output sockets are mounted on the front panel. I used a stereo jack socket at the inputs, and another at the outputs, but any type of audio connector that is convenient for your particular setup can be used.

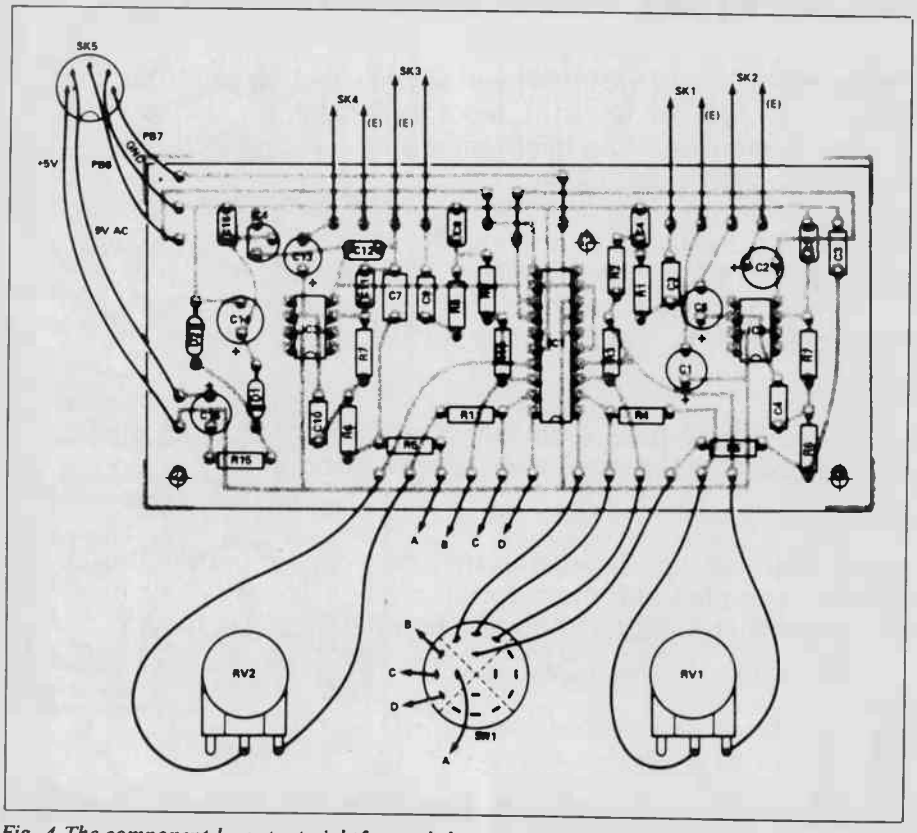
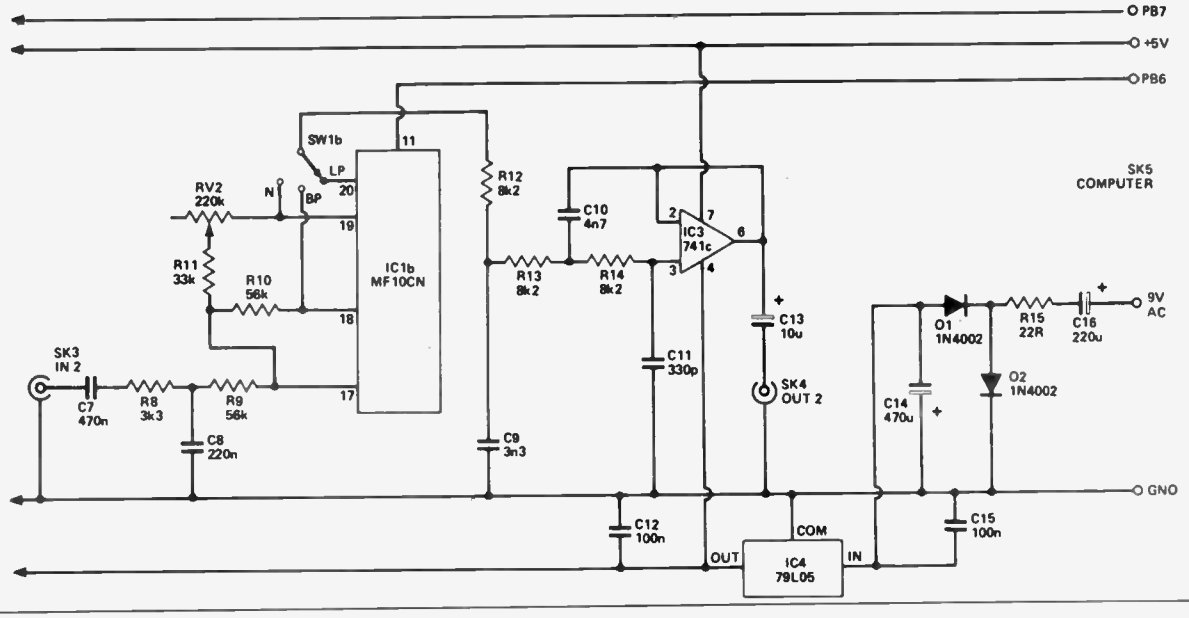


Fig. 4 The component layout: straightforward, but use an IC soket for IC1.

In Use

It is advisable to plug the unit into the computer prior to switching on the latter. The filters have a medium input impedance, low output impedance, and nominally unity voltage gain, and they should therefore fit into most set-ups with no problems. Signals of up to about 2 volts RMS can be handled.

In order to set the timer/counters of the computer's interface chip to the correct operating mode a value of 23 must be written to the two control registers. These are at addresses 56590 and 56591. The high bytes of the two timer/counters are at addresses 56581 and 56583, and in this application these are set to and simply left at zero. The filter frequencies are then controlled by the values written to the low bytes at addresses 56580 and 56582. These control the filters fed from PB6 and PB7 respectively. Values from 1 to about 25 can be used, and although this gives rather crude control of the filter frequency, it nevertheless produces some good effects. This simple program demonstrates the basic way in which the filter is used.



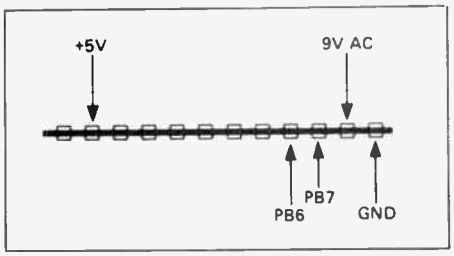


Fig. 5 Wiring details for the edge connector.

Parts List

Resistors (All 1/4W 5%)

R1,8	3k3
R2,3,9,10	56k
R4,11	33k
R5,6,7,12,13,14	8k2
R15	22R
RV1,2	220k linear pot.

Capacitors

C1,7	470nF carbonate
C2,8	220pF ceramic plate
C3,9	3n3 carbonate
C4,10	4n7 carbonate
C5,11	330pF ceramic plate
C6,13	10uF 25V radial elect.
C12,15	100nF ceramic
C14	470uF 16V radial elect.
C15	220uF 16V radial elect.
C17,18	100uF 10V radial elect.

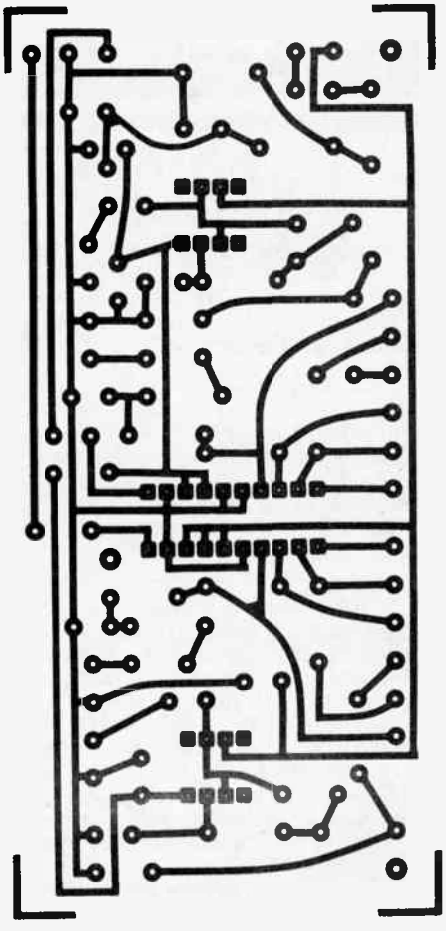
Semiconductors

IC1	MF10CN
IC2,3	741C
IC4	79L05 5V 100mA regulator
D1,2	1N4002

Miscellaneous

SW1	4 pole 3 way rotary
SK1-4	standard or stereo jacks
Sk5	5 way DIN socket (180 degree)

Case about 180 x 120 x 39mm; three control knobs; five-way cable; 5-pin (180 degree) DIN plug, and 2 x 12 way 0.1 inch pitch female edge connector; 20 pin DIL IC socket; wire, etc. *The MF10 switched capacitor device is available from Hobbilt Electronics, 7454 Langelier, St. Leonard P.Q., H1S 3B7, (514) 259-5581.*



```
10 POKE 56590,23
20 POKE 56591,23
30 POKE 56581,0
40 POKE 56583,0
50 R=25
60 FOR L = 1 TO 25
80 R=R-1
90 NEXT
100 FOR L = 25 TO STEP-1
110 POKE 56580,L:POKE 56582,R
120 R=R+1
130 NEXT
140 GO TO 60
```

This program moves the filter frequencies up and down in antiphase, using what is effectively a triangular modulation waveform. You do not really need to be a software genius in order to work out simple routines to vary the filter frequencies in various ways, and timing loops or dummy instructions can be added in order to reduce the modulation frequency. If you are familiar with 6510 machine code programming then it is possible to obtain faster operation if desired.

With the VIC-20 computer both filters must be driven from PB7 of the user port. A value of 192 is written to the control register at address 37147 in order to set the timers to the correct mode, 0 is written to the high byte of the timer/-counter at 37141, and the filter frequency is controlled by writing a value in the range 1 to about 25 or so to the low byte at 37140.

As pointed out earlier, any computer with one or two digital outputs could probably provide suitable clock signals with the aid of a machine code program. ■

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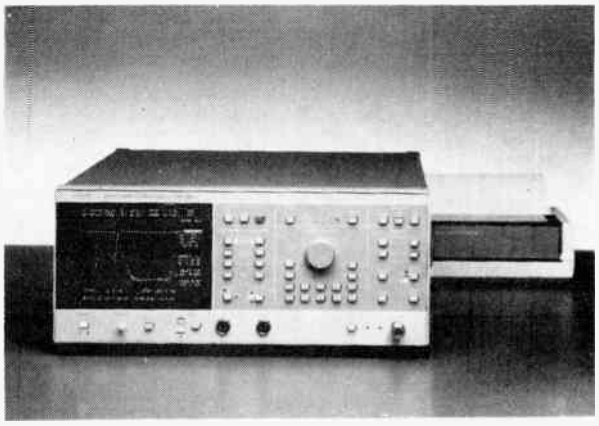

The Wiltron 6407 RF analyzer makes precision transmission, return loss and absolute power measurements over the 1-1000MHz range, with the Model 6409 covering the 10-2000MHz range. The portable microprocessor-controlled units contain a crystal-derived swept signal source, a scalar network analyzer, an external RF detector and an SWR autotester function. The analyzers can store up to nine test setups. For more information, contact Wiltron Instruments Ltd., Unit 102, 215 Stafford Rd., Nepean, Ontario K2H 9C1, (613) 726-8800.

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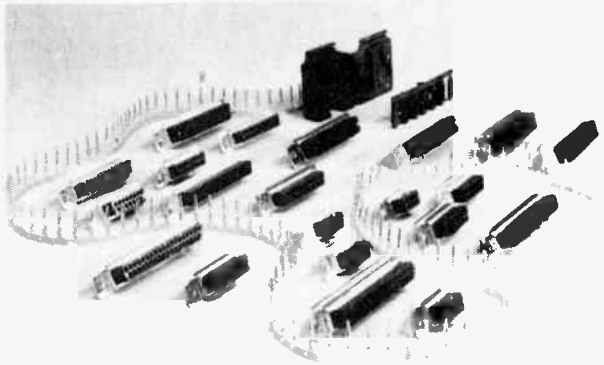
Connectors



ICC Canada is marketing and distributing a complete line of AMP-compatible connectors, including 9, 15, 25, 37 and 50 pin D-subminiatures with crimp snap-in style connectors of 20-24 and 26-28 AWG. Various shell styles are available for interference suppression. ICC Canada, 461-28 Alden Rd., Markham, Ontario L3R 3L4, (416) 477-0566.

Circle No. 26 on Reader Service Card

The Canadian Standards Association has announced the publication of the 1986 Canadian Electrical Code, Part I: Safety Standards for Electrical Installations. The Code is a national standard throughout Canada, although amendments can be made by provinces or municipalities. Major changes are said to have been made on the regulations for circuit loading, grounding, wiring methods, electrical communications systems, etc. The Code is available by mail order or telephone order for $30.00 plus $1.25 postage from the Canadian Standards Association, Sales Group, 178 Rexdale Blvd., Rexdale, Ontario M9W 1R3, (416) 747-4044. For $33.75 plus $1.25 postage, you get the Code plus a summary of the changes, 'What's New In 86'.

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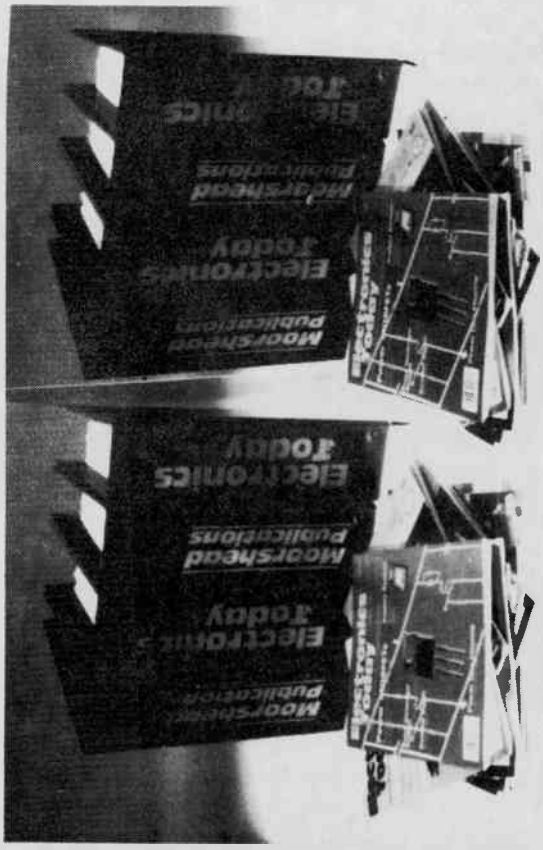

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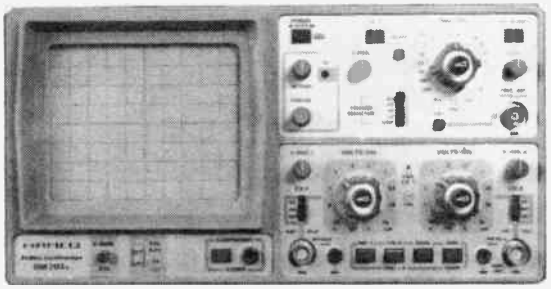

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The Hameg HM203-5 is supplied by the distributor, BCS Electronics Ltd., 980 Alness St., Unit 7, Downsview, Ontario M3J 2S2.

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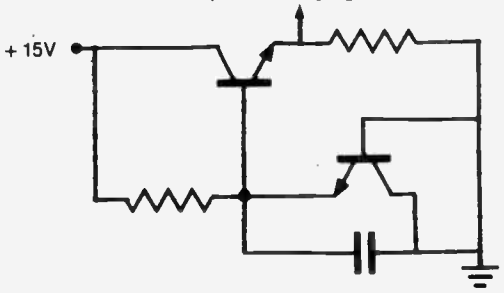

The circuit represents:

A. A relaxation oscillator. **Circle Reader Service Number 97.**

B. A voltage regulator. **Circle Reader Service Number 98.**

C. A temperature-compensated audio amplifier. **Circle Reader Service Number 99.**

D. A non-functioning circuit. **Circle Reader Service Number 100.**

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2. Only one entry per person, please.
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4. The deadline for entries is April 15, 1986. The winner will be notified by mail or telephone within seven days of judging. The winner and correct answers will be published in the May issue.
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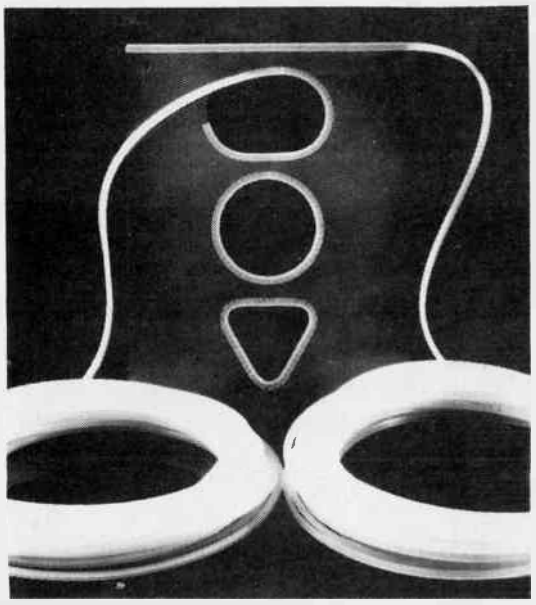
Rolled Grommets



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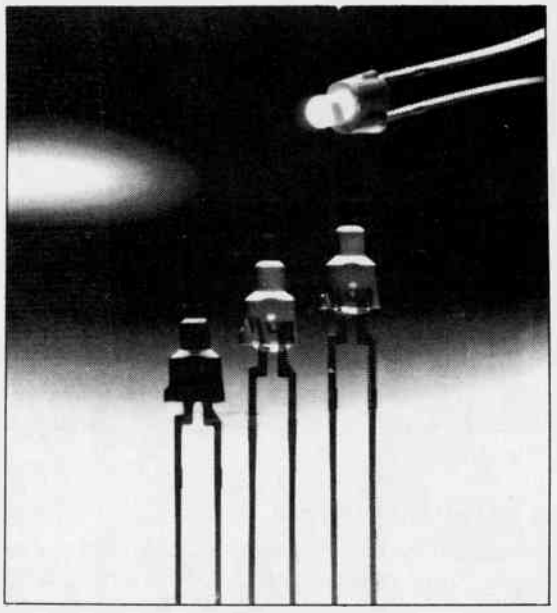
Flat-top LED



Hewlett-Packard's flat-top LEDs combine flush-panel mounting with a wide viewing angle and uniform light output. The product selection includes standard-brightness, high-brightness, and integrated-resistor types; also available are low-current devices in high-efficiency red or yellow. Contact the Inquiries Manager, Hewlett-Packard Canada Ltd., 6877 Goreway Drive, Mississauga, Ontario L4V 1M8, (416) 678-9430.

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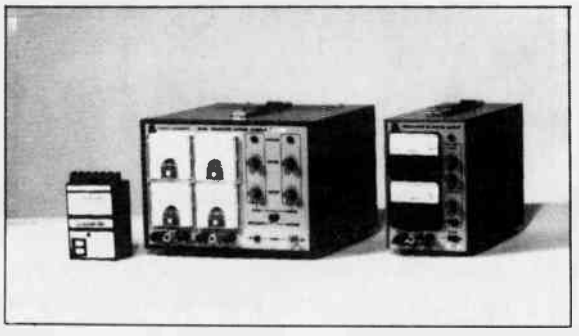
Power Supplies



A new line of bench power supplies is available in the Brunelle Commander series. 20 models are available in eight voltage ranges, including six dual tracking models from 0-18VDC to 0-150VDC, with current levels from 1 to 20A. All units feature short circuit protection, automatic constant current and constant voltage outputs, and excellent regulation. Brunelle Instruments, 73 6th Range S. (Industrial Park), St. Elie d'Orford, Quebec J0B 2S0, (819) 569-1408.

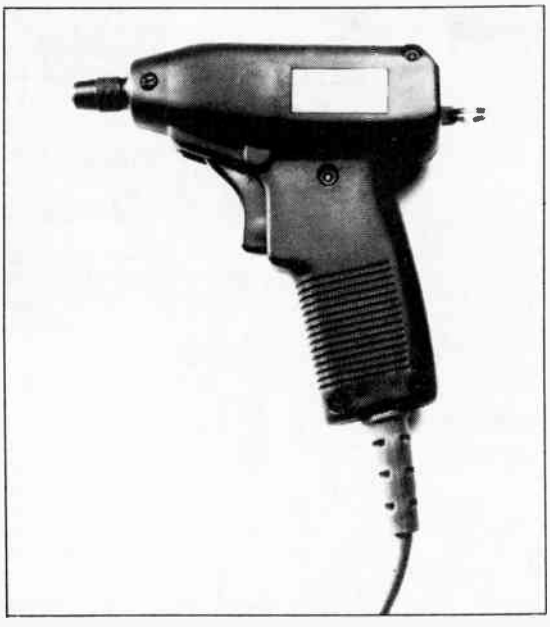
Circle No. 30 on Reader Service Card

A computer now can perform in 15 minutes a procedure that often takes physicians two to four hours, and the use of dyes, x-rays and five to six catheters. Radionuclide angiography provides for an easier, more accurate diagnosis of many heart disorders, says Thomas Bashore, assistance professor of medicine and radiology at Ohio State University, Columbus, Ohio. Cardiologists hope that the added information this procedure gives about the heart will aid physicians in determining a patient's risk of sudden death.

The uniqueness of the procedure is the computer's ability to recognize and record the location of the heart's "skip beats." These irregularities, called premature ventricular contractions or PVCs, indicate a misfiring within the heart's normal rhythm of contractions. While much remains to be learned about the significance of PVCs, Bashore says that "certainly, PVCs can be harbingers of sudden death. Most sudden death is thought to be initiated by a series of PVCs called ventricular tachycardia," says Bashore. "Most, but not all, sudden death victims have exhibited PVCs."

But until now, heart catheterization has been the only method of correctly determining the location of a PVC, he says. Catheters threaded through blood vessels into the heart record electrical activity at various sites in order to pinpoint the PVC. While the procedure is highly accurate, the use of the catheter can present both discomfort and risk for the cardiac patient, he says. As an alternative, patient monitoring with an electrocardiogram, or

Wirewrap Tool



The OK Industries OK-11 wirewrap tool is ideal for all applications from R&D to high-volume production. The tool uses 22-34 gauge wire, incorporates positive gear drive for long life and low maintainence, and has circuitry fro RFI suppression. From Len Finkler and Company, 80 Alexdon Rd., Downsview, Ontario M3J 2B4, (416) 630-9103.

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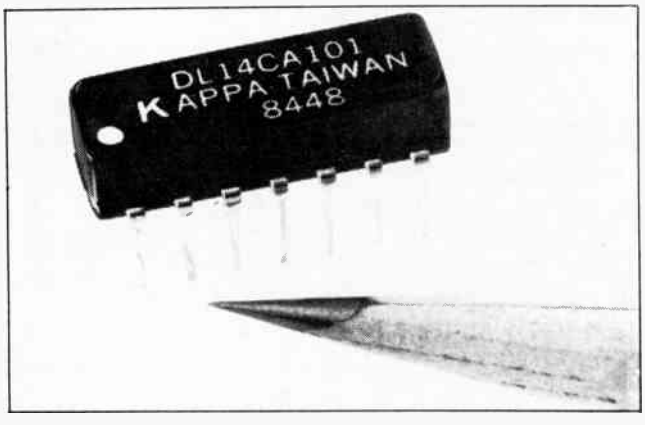
Delay Lines



Lower height, auto-insertable delay lines for logic circuitry allow delays of 25ns to 250ns in 10 standard delays; five equally-spaced taps per IC are available. Output rise time is 4ns, with drive capabilities of 10 STTL loads with logic 0 or 20 STTL loads with logic 1. Kappa Networks Inc., 1443 Pinewood St., Rahway, NJ 07065, (201) 541-1600.

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AC Current Sensor

Now why does it say 'ZH 09' in the photo? Anyway, if you need to monitor AC current flow with complete isolation, the Coilcraft G6517-A 60Hz current sensor functions as the secondary of a current transformer while the current-carrying lead passes through it and acts as a one-turn primary. Output is 12mV at 1 amp to 90mV at 10 amps. The centre hole is 1/8 inch in diameter. While the company deals mainly with the OEM market, they'll no doubt have a list of distributors. Coilcraft, 1102 Silver Lake Rd., Cary, Illinois 60013, (312) 639-6400.

Circle No. 33 on Reader Service Card.

ECG, is used to locate the PVC origin. The procedure is less threatening to the patient, but also less accurate in certain situations. "When determining skip beats in the right ventricle, we've found that the ECG is accurate about 90 percent of the time. On the left ventricle, it's accurate only 17 percent of the time," says Bashore.

The ECG often mistakes damaged heart tissue as sites of PVCs, he believes. Because damage to the left ventricle is much more common than damage to the right, the margin of error is much greater in that portion of the heart, he says. In more than 50 comparisons at University Hospitals, Bashore pitted his computer technique against catheterization and ECG readings.

"We took the 'gold standard,' the catheter, and tried to see if we could learn the same thing non-invasively," he said. The results, says Bashore, were "very impressive. We didn't miss any PVC sites," he says.

In addition, the computer images provided the information on chronic heart disease, evidence of heart damage, blocked blood vessels and the percentage of blood pumped. Data could be collected on a patient who was at rest or on a stationary bicycle. A patient about to undergo radionuclide angiography will be injected with a small amount of radioactive material, allowing for about the same radiation as a chest X-ray, Bashore says. Catheterization also involves the use of some radioactive material. Since the radioactive substances adhere to red blood cells, nuclear gamma ray cameras can record images of blood "pooling" inside the heart. The normal heart "beat" is really a wave of contractions which spread from the upper to lower heart chambers and out into the ventricles.

Recording blood pool images of heart contractions is not difficult, said Bashore. Each series of heart contractions presents a faint, but separate, image for the computer to record. Stacking the images, the computer can assemble a multi-coloured picture of the beating heart. But to stack the faint images of PVCs, the computer must be able to differentiate between the electrical misfirings, or PVCs, and normal heart contractions.

Now that radionuclide angiography could offer the same results as catheterization, Bashore said he would like to try to go a step further and use the procedure to determine how sudden death relates to PVC sites.

"The extent of coronary heart disease, the amount of damage to the left ventricle and the presence of PVCs are the three things which tell the most as to who's susceptible to sudden death," he says.

Using radionuclide angiography, Bashore can record each ot these three factors. If some relationship is established between the PVC site and the tachycardia which can signal sudden death, cardiologists may be able to determine a method of lowering risk. "Previous studies using just the ECG suggest that PVCs in the right ventricle may be benign while those in the left ventricle often may be more dangerous. But because of the problems of interpreting the origin of PVCs with the ECG, the new computer methods may be able to clarify whether the difference exists," Bashore says.

- David Dempster

Continued on page 57

Electronics Today

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1977

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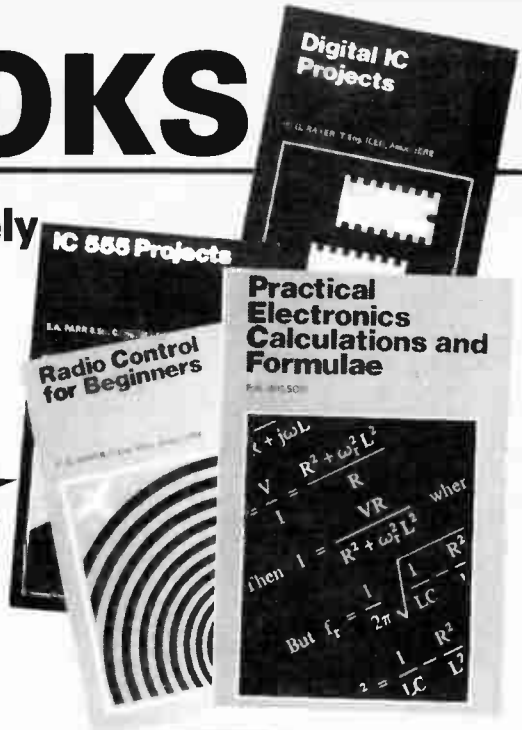

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R.A.PENFOLD
In this book, the author has designed and developed a number of interesting and useful projects which are divided into five general categories: I — Audio Projects II — R F Projects III — Test Equipment IV — Household Projects V — Miscellaneous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

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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.

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RUDI & UWE REDMER
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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

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R.A. PENFOLD
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Continued from page 13

Designer's Notebook: GaAs Devices

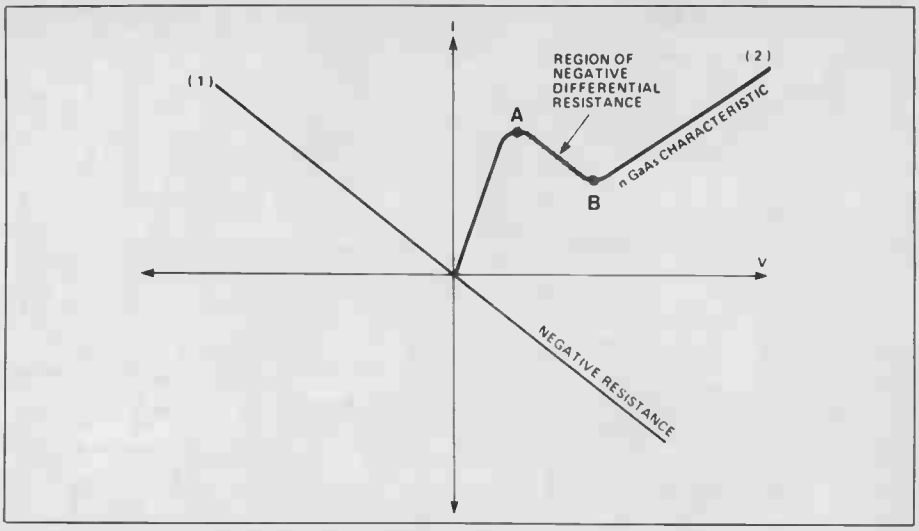

Fig. 6 Negative resistance characteristic of doped GaAs.

time, the development and production of integrated circuits is still in its infancy; commercial ICs have only been on the market since early 1984.

GaAs integrated circuits are difficult to make: the raw material cost is high, defect-free wafers (circular slices of single-crystal semiconductor) are hard to obtain and the processing of them is difficult (**Fig. 7**). To take full advantage of the speed of GaAs, the devices need to be very small, stretching the limits of current technology. In addition, the wafers are brittle and have to be handled more carefully than silicon.

On the other and, GaAs devices promise higher speed than silicon at lower power levels, which should allow higher levels of integration before heat dissipation becomes a problem. As yet only MSI devices have been produced in commercial quantities.

Most of the work currently being done on GaAs integrated circuits concentrates on ultra-high speed digital circuitry. Results so far indicate that GaAs devices may rival superconductor Josephson junction devices for speed, and more importantly, they are available now and developing quickly. Current commercially available logic circuits feature gate delays of around 300ps and maximum counter clock rates of around 2 to 3GHz.

It is useful to look at what makes an ideal transistor switch for digital integrated circuits. It should be small, so that large circuits can be fabricated in a small space. This reduces the likelihood of encountering a wafer defect and so increases the yield. It should consume very little power, so that heat dissipation at high circuit densities does not become a problem. It should require very little voltage change between the on and off condition. This reduces the switching time as less charge has to be put on to or removed from internal capacitances during switching. Finally, its control input should have low capacitance, again to reduce switching time.

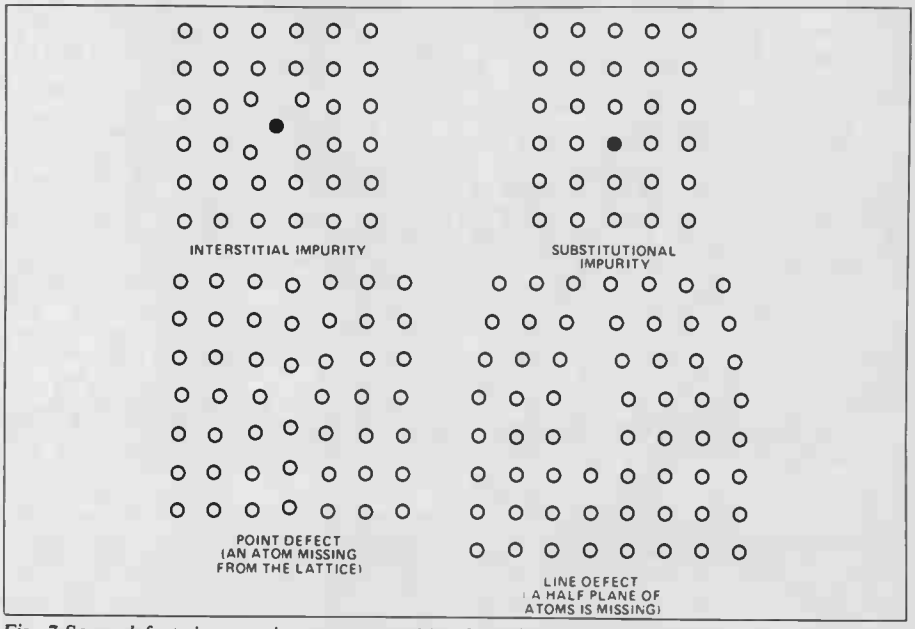

Fig. 7 Some defects in crystal structure capable of causing device deterioration.

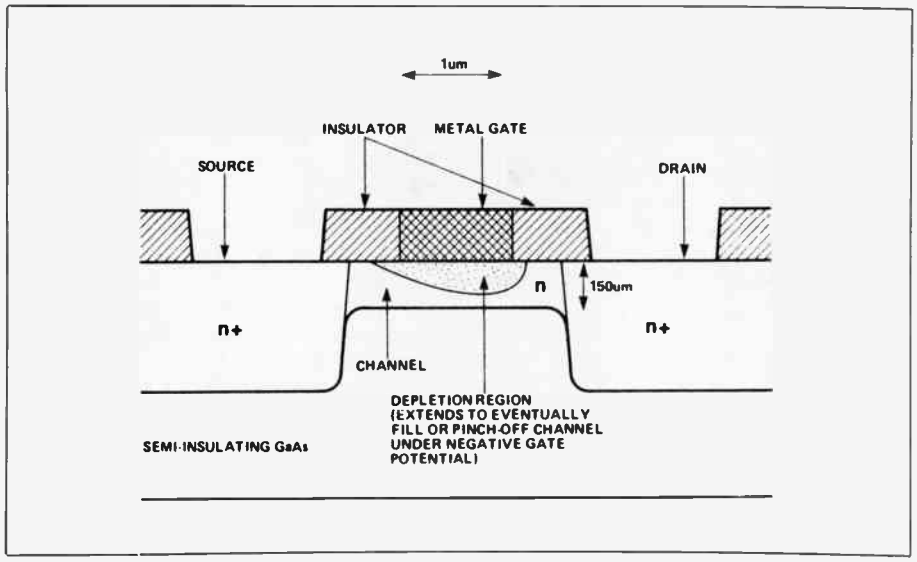

Fig. 8 Cross-section of D-MESFET (not to scale).

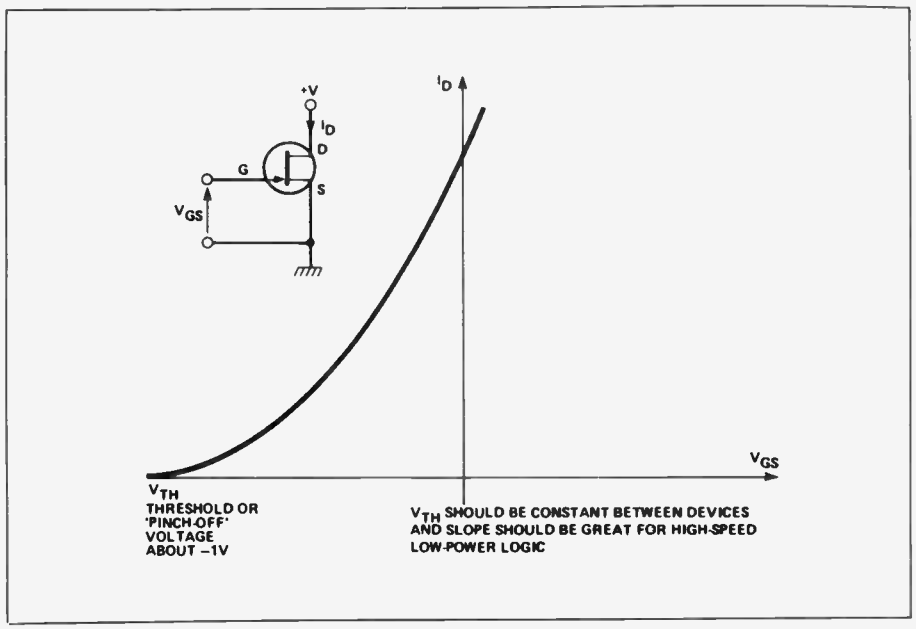

Fig. 9 Id against Vgs for a D-Mesfet

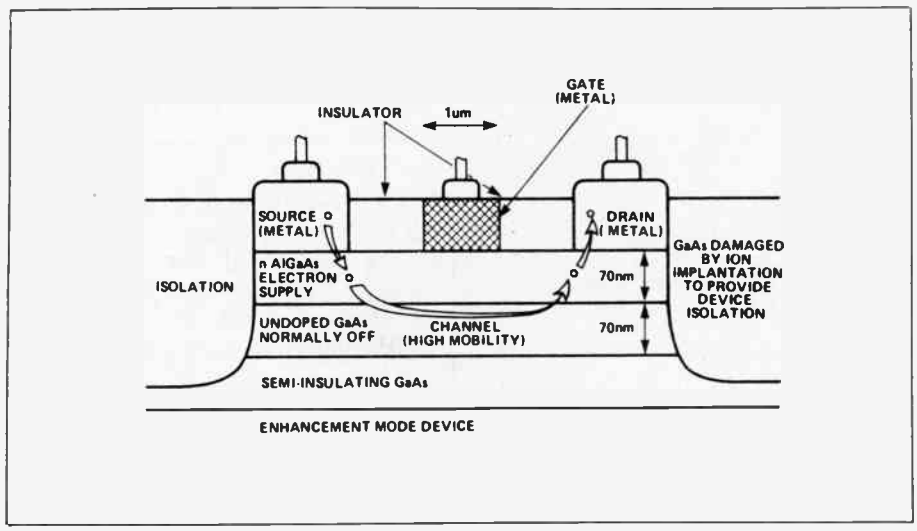

Fig. 10 Cross section of High Electron Mobility Transistor (not to scale).

Most current GaAs integrated circuits use depletion-mode metal-semiconductor field effect transistors (D-MESFETS), as these are the easiest devices to produce (**Fig. 8**). Unfortunately a negative gate voltage is required to turn these devices off, while the output is positive (**Fig. 9**). They require two power supplied (plus ground) and level shifting circuitry between circuits (**Figs. 11, 12 and 13**).

Enhancement-mode FETs (E-MESFETs) have been produced, but they are not yet at the mass production stage. Their construction is similar to that of the D-MESFET but the channel is very shallow and lightly doped so that the built-in potential of the metal-semiconductor junction keeps the channel pinched off with no external gate bias. Thus the E-MESFET is normally off. It requires only about 0.1V gate potential to turn on. This is a definite advantage for high speed and low power circuits, but requires very tight control over processing in order to keep the threshold voltages within a very narrow range, or else the devices become overly susceptible to noise. E-MESFETs are also difficult to fabricate as the channel is very lightly doped and surface defects can easily pinch off the channel; various structures and geometrics are being tried to avoid this.

Other devices under development include the high-electron mobility transistor (HEMT) (**Fig. 10**) and the heterojunction bipolar transistor (HJBT). Up till now I have only mentioned field effect (unipolar) transistors. An NPN sandwich made entirely from GaAs does not work well as a transistor, partly because holes, which are the dominant carriers between base contact and active base region, travel rather slowly in GaAs. A much better transistor can be made with an n-GaAs emitter and a p-GaAs base. Work on the HJBT is not as far advanced as on the various FETs, but it could be the best device for very high speed VLSI. Single-transistor switching speeds of 1ps and logic swings of 250mV have been predicted.

The current dominant technology is the D-MESFET. Several logic structures are in use, just as silicon bipolar circuits are available in TTL, LSTTL, 12L and ECL. Buffered FET Logic, Schottky-Diode FET Logic and Capacitor-Diode FET logic gates are illustrated in Figs. 11,12 and 13.

Even after a GaAs circuit has been produced, the problems are not yet over. To preserve reasonable pulse-shapes at, say, 1GHz, circuits have to deal with frequency components up to 3GHz. The digital designer will have to utilize microwave design techniques such as impedance matching of chips to interconnections to avoid pulse reflections. Supply decoupling becomes vastly important, and the capacitors used have to behave properly at GHz frequencies. Testing is likely to become anther large (and expensive) headache.

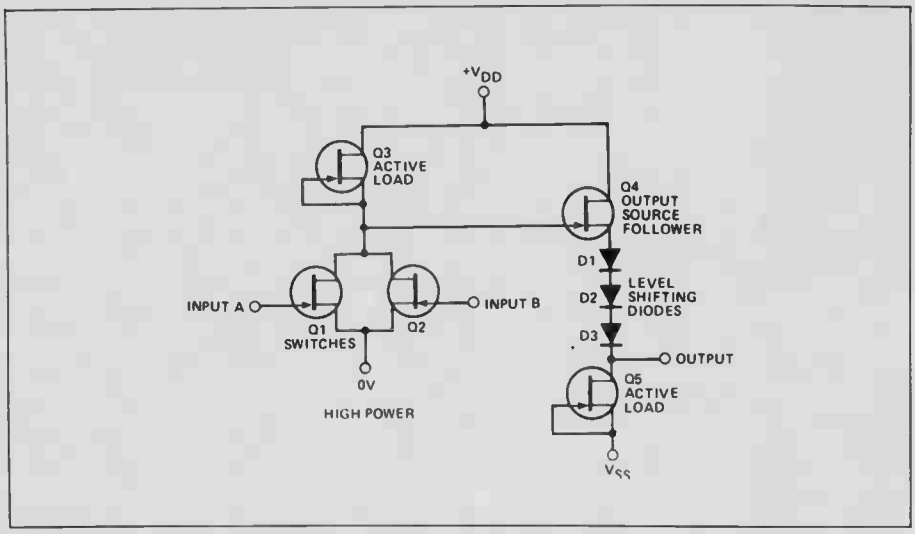

Fig. 11 Buffered FET logic (BFL) NOR gate.

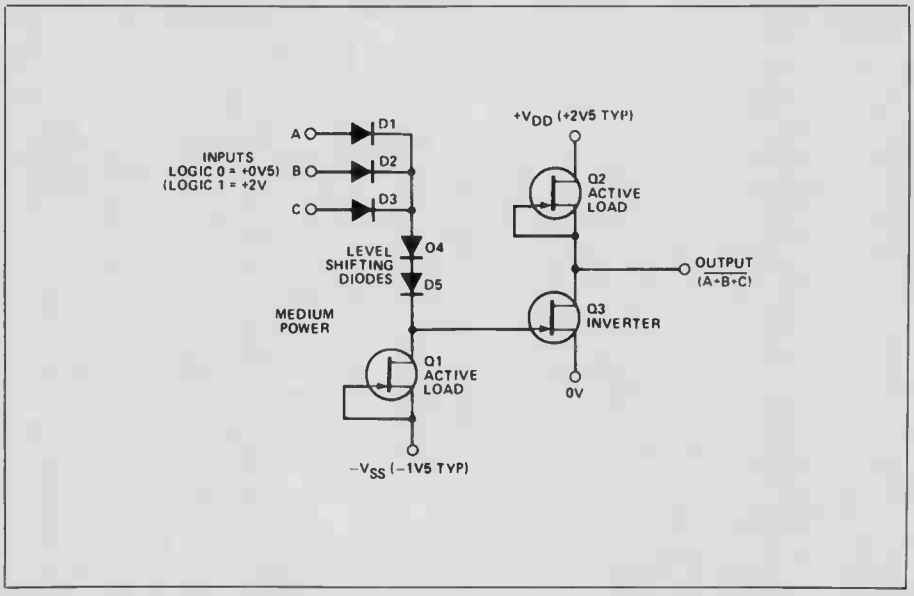

Fig. 12 Schottky-Diode FET logic (SDFL) NOR gate.

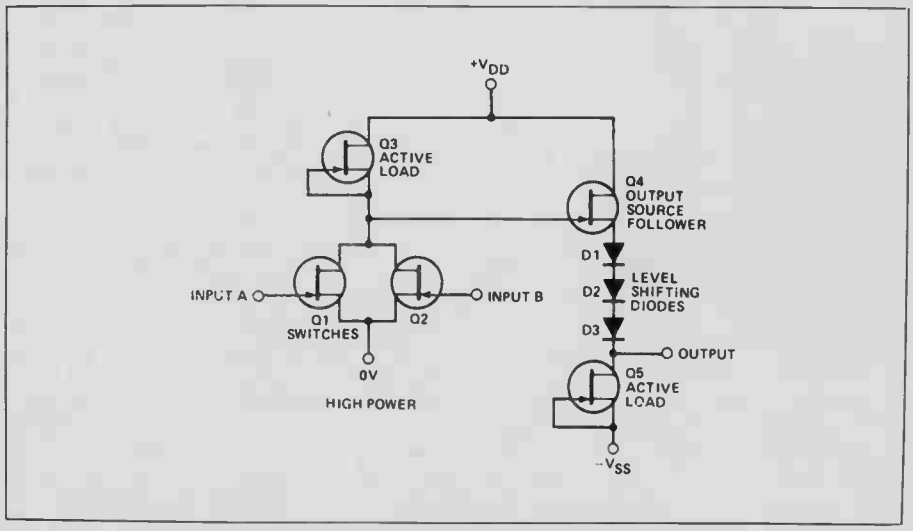

Fig. 13 Capacitor Diode FET logic (CDFL) NOR gate.

The Market

The major semiconductor manufacturers have, on the whole, stood back and waited to see where GaAs is going; after all, the market for high speed bipolar and MOS devices is not going to go away just yet. Also, there is a world shortage of engineers qualified to develop GaAs devices. This is probably a good reason for not spreading them too thin on the ground.

The two major UK suppliers of GaAs logic circuits are Harris Semiconductors and Gigabit Logic. Both have a range of small scale integrated circuits (NOR gates, D-types, dividers and, for example, shift registers), which work at around 1 to 4GHz clock rates. Harris also market a range of discrete GaAs FETs for use at up to about 18GHz. They have also released preliminary data on a 170-gate array. Both companies sell an evaluation kit for their ICs.

The Future

Future markets for GaAs integrated circuits include the Direct Broadcast by Satellite system, very high speed computers, optical communication and phased array radar. As for the future of the technology itself, researchers at Glasgow University have produced tiny MESFETs with only 75nm wide gates, while Sheffield University has demonstrated an all-optical switch in GaAs/GaAlAs which holds promise for all-optical logic (which may be very fast, indeed). Inevitably GaAs development will be largely determined by the military value attached to high-speed temperature and radiation resilient devices. The rest of us will have to wait to savour the benefits of this remarkable material. ■

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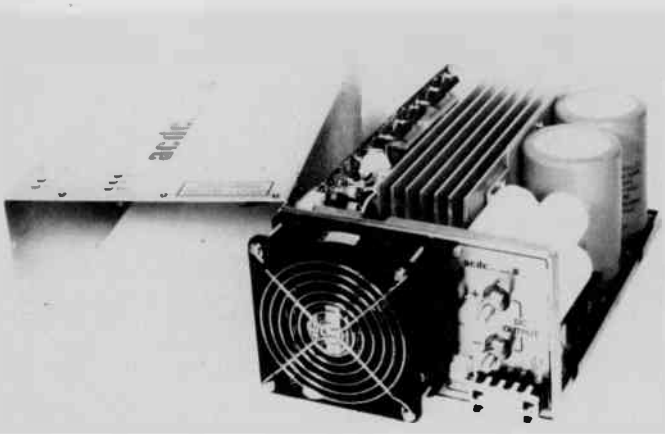
Switching PSU



The ACDC Electronics JF-series switching power supplies are available in 750, 1000 and 1500 watt versions using sub-modular wireless construction and complete protection from overcurrent, overtemperature, overload, reverse voltage and short circuits. Fast transient response holds voltage excursions to less than 10mV following 50% or 100A load step. From Webster Instruments, 176 Main St. North, Markham, Ontario L3P 1Y3, (416) 294-5711.

Circle No. 34 on Reader Service Card.

A mouse for the IBM PC and compatibles is available from Basonje Systems. The ZNIX mouse is said to be compatible with the Microsoft mouse system, Lotus, WordStar, dBase II, AutoCAD, GEM, PC Paint and PC Brush. For $169, the system includes the mouse, circuit card, connector and software. Basonje Systems, 138 Huron St., Toronto, Ontario M5T 2B2, (416) 598-7992.

Circle No. 44 on Reader Service Card.

Last month we reviewed the remarkable MC300 capacitance meter from Daetron. This month we'd like to pass on the information that the meter is also being distributed by Varah's Direct, with locations in Vancouver, Edmonton, Calgary, Winnipeg, Oakville and Nepean, or contact Varah's Direct, 504 Iroquois Shore Rd., Oakville, Ontario L6H 3K4 (416) 842-8833.

In a press release that looks more like something written by the National Lampoon, an American research firm says that the use of hi-tech security and verification systems such as fingerprint, retinal pattern and speech detectors has suddenly become a rapid-growth market due to terrorists and "the increasing numbers of AIDS-infected people". Soothe your paranoia with a retinal pattern scanner.

VIZ Test Equipment announces the release of their new 19-page catalogue, detailing power supplies, isolated AC sources, frequency counters, analog meters, generators, testers, digital meters and wattmeters. For a copy and a Canadian price list, contact H.W. Cowan Canada Ltd., PO Box 268, Richmond Hill, Ontario L4C 4Y2, (416) 773-4331.

Circle No. 45 on Reader Service Card.

Xerox Canada has introduced a bilingual computer compatible with the IBM PC. The 6064 has a keyboard with French characters, and software such as Lotus, WordStar, dBase III and Multiplan are also offered in French by Xerox. The 6064 has two floppy disk drives, and the 6065 has one floppy and one hard disk. List price for a basic 6064 is $4485. Xerox Canada Inc., 703 Don Mills Road, Toronto, Ontario M3C 1S2, (416) 429-6750, or in Montreal at (514) 288-9400.

Circle No. 46 on Reader Service Card.

Economical Appliance Controller

Save energy and control your power consumption with this helpful Watt miser.

By Phil Walker

AFTER this winter's snow, frost and electricity bills you're probably looking for ways to save a little money without losing comfort or convenience. This project is designed so that electric heaters or other appliances can be set to turn on a little before they're actually needed.

The device could also be used to control other devices such as tape recorders, radios and so on where the precise timing isn't too critical.

Operation

The device operates by dividing the AC frequency (60 Hz) by 180,224 to get a signal with a period of about 1 hour. The actual division required was 180,000 but the 180,224 was more easily achieved and the error involved was less than 60 seconds in the maximum period of 9 hours delay.

This 1 cycle per hour signal advances a divide-by-10 counter which has 10 separate outputs. Each output is active for 1 hour and only one is active at a time. One of the outputs is selected to drive the AC power switching triac giving an 'on' period of 1 hour after a selectable off period. It's also possible (if SW4 is on) to have the output come on permanently after its set delay (this is always the case on the 9 hour delay setting).

To use the device, set the number of hours of delay with SW3, select whether '1 hour only' or 'permanently on' operation is required with SW4 and press SW2 to start the device working.

Installation

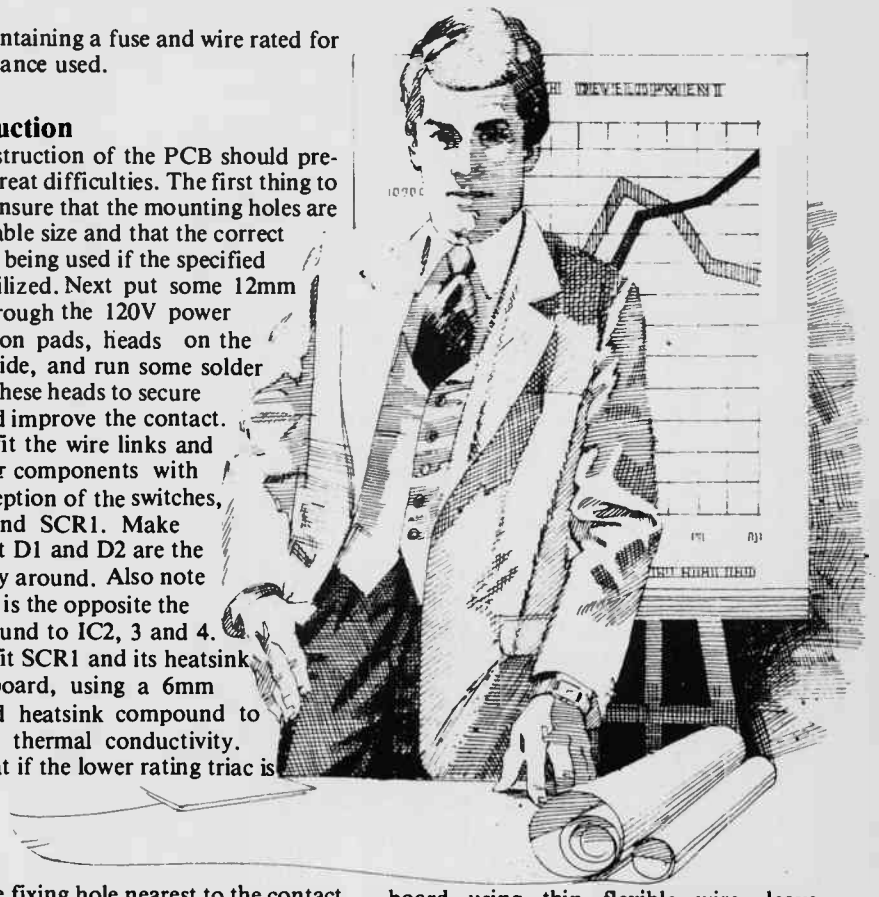
When using the device, the AC supply must be fed from a plug or switched fuse outlet containing a fuse and wire rated for the appliance used.

Construction

The construction of the PCB should present no great difficulties. The first thing to do is to ensure that the mounting holes are of a suitable size and that the correct ones are being used if the specified box is utilized. Next put some 12mm bolts through the 120V power connection pads, heads on the copper side, and run some solder around these heads to secure them and improve the contact.

Now fit the wire links and the other components with the exception of the switches, LED1 and SCR1. Make sure that D1 and D2 are the right way around. Also note that IC1 is the opposite the way around to IC2, 3 and 4.

Next fit SCR1 and its heatsink to the board, using a 6mm bolt and heatsink compound to improve thermal conductivity. Note that if the lower rating triac is used, the fixing hole nearest to the contact pads should be used and vice versa. Connect SW3, if the contacts are on a 22mm diameter circle they may be connected straight to the board, otherwise short lengths of stiff wire should be used. If all else fails you could attach the switch to the cover of the box and connect it to the board using thin flexible wire, leave enough to remove the lid when fitted.



Attach some lengths of flex (6") to the PCB at the remaining switch positions (SW2 and SW4), LED1 position and transformer connections. Fit the transformer into the corner of the box and then the cable glands, neon, AC switch

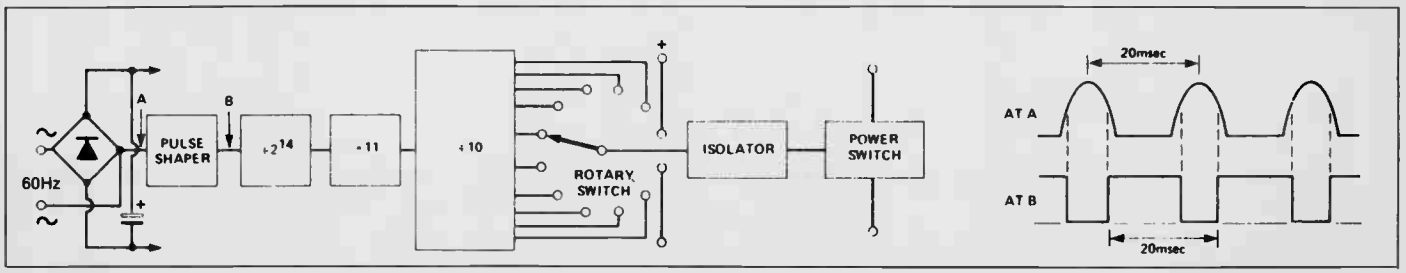


Fig. 1 Block diagram of the unit.

Fig.2 Pulse shaper action.

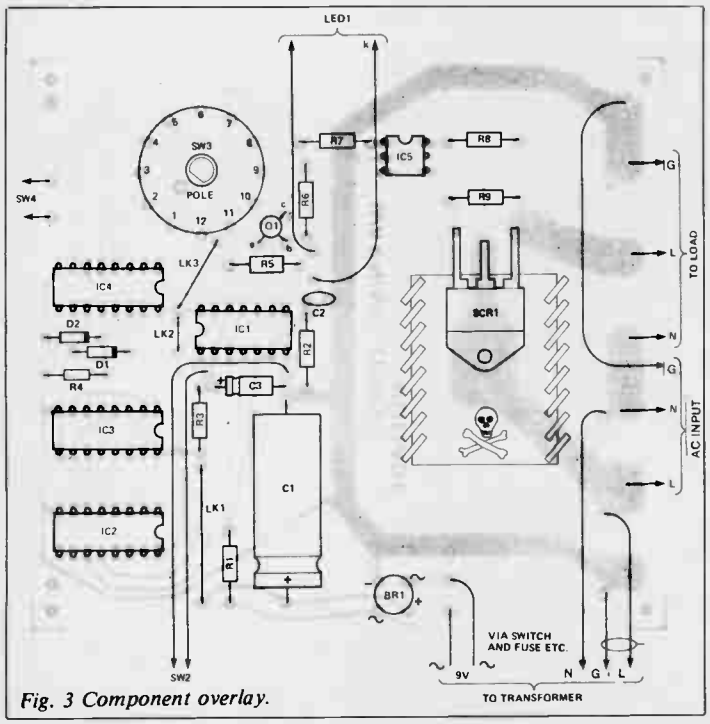
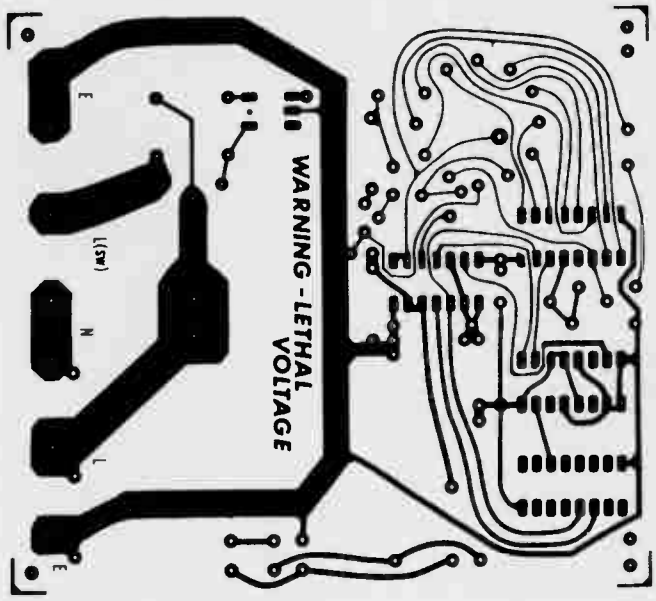


Fig. 3 Component overlay.



The PCB for the Appliance Controller.

and fuseholder into the end-plate.

Finally fit SW2, SW4 and LED1 to the lid of the box and cut a hole through to take the SW3 spindle.

It is advisable to solder eyelets to the 120V leads to fit on to the PCB bolts; alternatively the ends of the wires should be soldered to stiffen them.

NOTE: As a 120V are present, care must be taken that no ungrounded metal parts are accessible from the outside and that clearances between live and grounded parts are maintained under all circumstances.

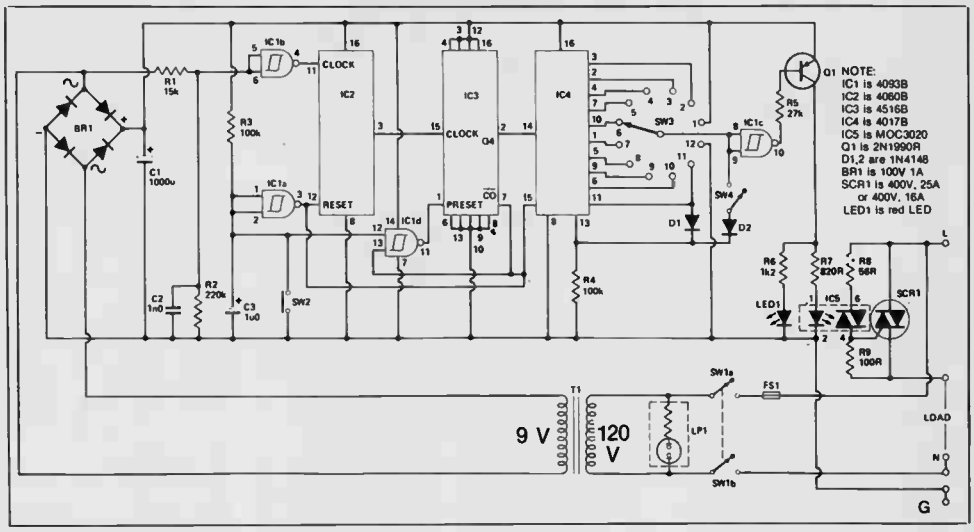


Fig. 4 Circuit diagram of the appliance controller.

Parts List

Resistors (all 1/4W, 5%)

R1	15k
R2	220k
R3,4	100k
R5	27k
R6	1k2
R7	820R
R8	56R
R9	100R

Capacitors

C1	1000u 40V axial elect.
C2	1n0 ceramic
C3	1u0 63V axial elect.

Semiconductors

IC1	4093
IC2	4060
IC3	4516
IC4	4017
IC5	MOC3020
Q1	2N1990R (TO18 package)
D1,2	1N4148
BR1	100V, 1A bridge rectifier
SCR1	400V, 25A or 400V, 16A
LED1	3mm red LED

Miscellaneous

SW1	DPDT AC on/off miniature rocker
SW2	1 pole push-to-make, momentary action
SW3	1 pole, 12 way rotary wafer switch, contacts on 22mm diameter circle
SW4	SPST toggle switch
FS1	1A anti-surge fuse and panel fuse holder (20mm)
LP1	120V panel mounting neon indicator with internal resistor
T1	6VA transformer (9V secondary, 120V primary)

PCB; case to suit; 2 cable strain reliefs; 3 16-pin and 1 14-pin IC sockets; TO-220 heatsink; knob; nuts, bolts, spacers etc.

How It Works

IC1a takes the raw AC 60 Hz signal applied to the bridge rectifier and converts it to a train of pulses at the same frequency. This is divided by 16,384 by IC2. Further division is done by IC3 which is connected with IC1c to divide by 11.

This is accomplished by loading 1011 binary into IC3 each time it counts down to 0000 binary. At the Q(4) output of IC3 there is a signal which has a period of 20 mS x 16,384 x 11 = 3,604,480 mS = 3,604.48 seconds. This signal is applied to the clock input of IC4, a divide-by-10 device with 10 decoded outputs. The output of IC4 selected will change every 3,604.48 seconds (about 1 hour) until the '9' output (pin 11) is high. At this time further clocking of IC4 is prevented by a signal at pin 13 via D1.

SW3 selects which output of IC4 drives the output power switch. This varies from permanently on (position 1), through zero delay (position 2), up to 9 hours delay (position 11), to permanently off (position 12).

If SW4 is open then in the 0 to 8 hour delay positions the output will be on for 1 hour after the set delay only, whereas if SW4 is closed or a 9 hour delay is selected the output will stay permanently on after the delay period.

IC1c takes the output signal from SW3 and drives Q1 and thus IC5. IC5 is an optically isolated triac which enables us to have the logic circuitry safely at ground while switching the AC power with SCR1.

The last part of the circuit is that around IC1a and IC1d. This is the reset circuitry which ensures that the time period will be consistent and start when SW2 is released. IC2 and IC4 are reset to 0 by IC1a, while IC3 is set to 1011 (decimal 11) by IC1d.

■

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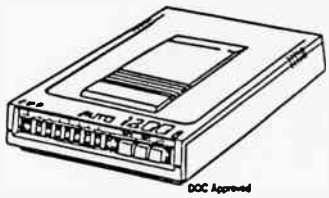

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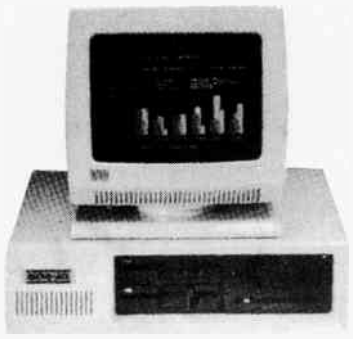

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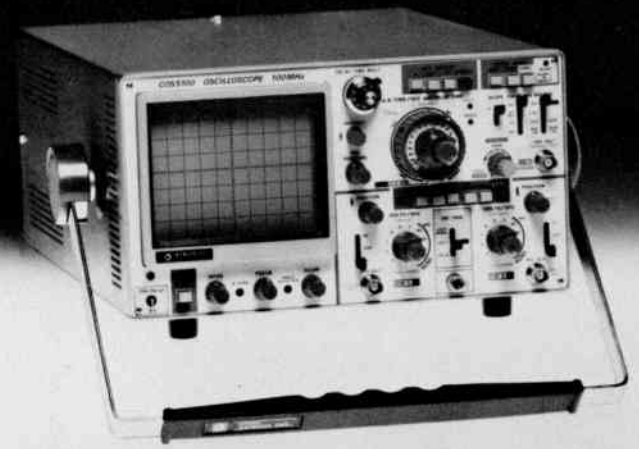

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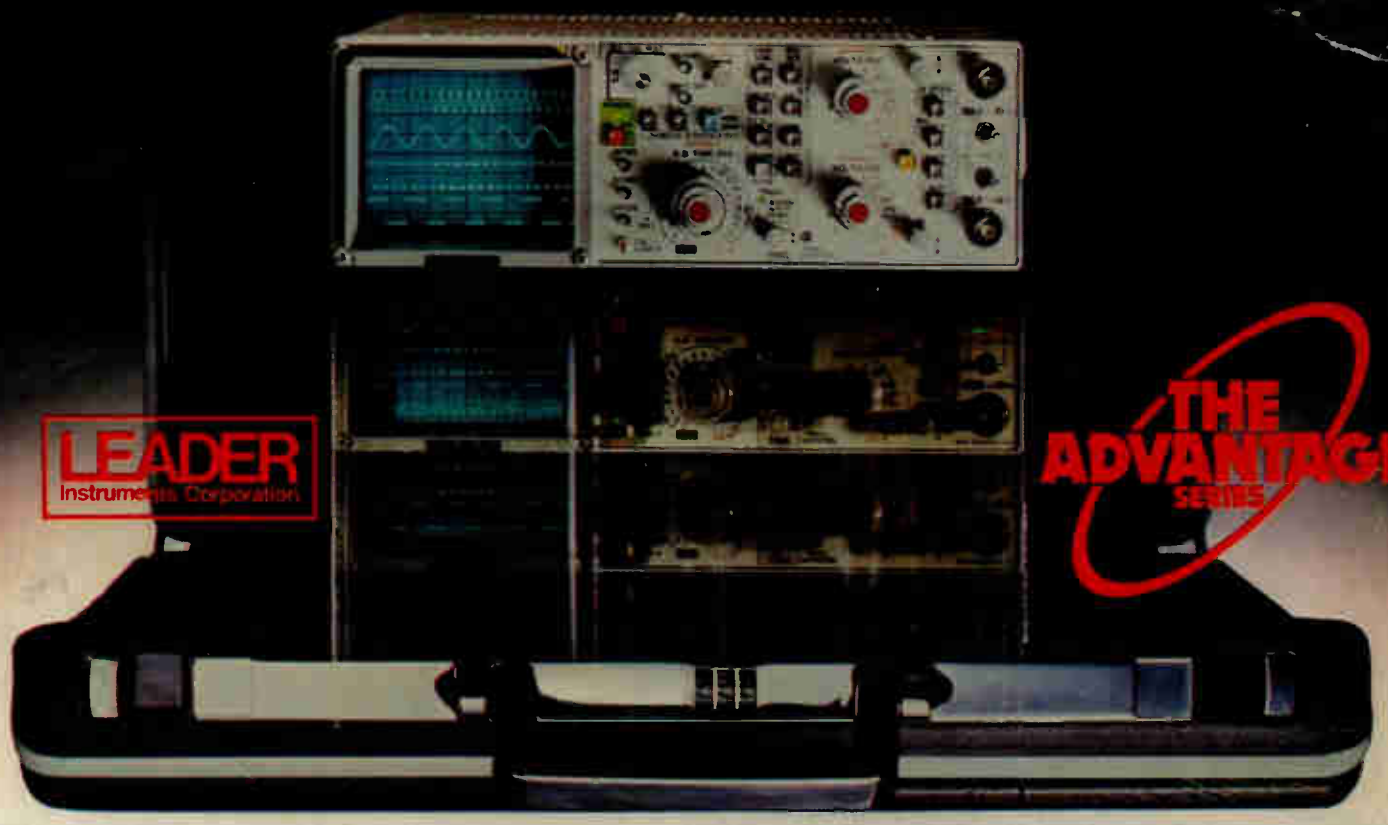

Omnitronix Announces An On-Site Diagnostics Breakthrough.

The new Leader *Advantage Series* gives you brief-case portability with lab-grade features. Finally there is a family of oscilloscopes that breaks the barrier between true portability and multi-feature functionality. Leader's new *Advantage Series* from Omnitronix. Their sturdy die-cast aluminum frames are just 230 x 290mm by 75mm high. And they weigh a mere 4kg!

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