

Electronics Today

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November 1986

Canada's Magazine for Electronics & Computing Enthusiasts

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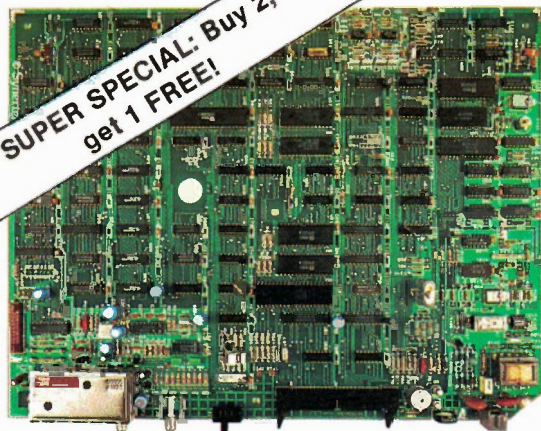
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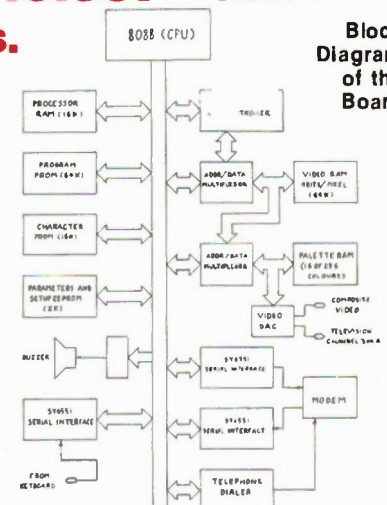
Use your imagination, software and hardware to make this board into many interesting projects. The board is capable of colour graphics and was originally designed as a terminal for home-ordering system and has many of the facilities similar to the Telidon terminals in use in shopping malls, hotels etc.

This magnificent board features an 8088 CPU, 6545 CRT Controller, 150/1200 Baud auto-dial, direct-connect modem, serial ports, RF Modulator (Ch.3) for 40 characters, EPROMs, 64K Video RAM, 16K RAM and 64K of EPROM for the processor.

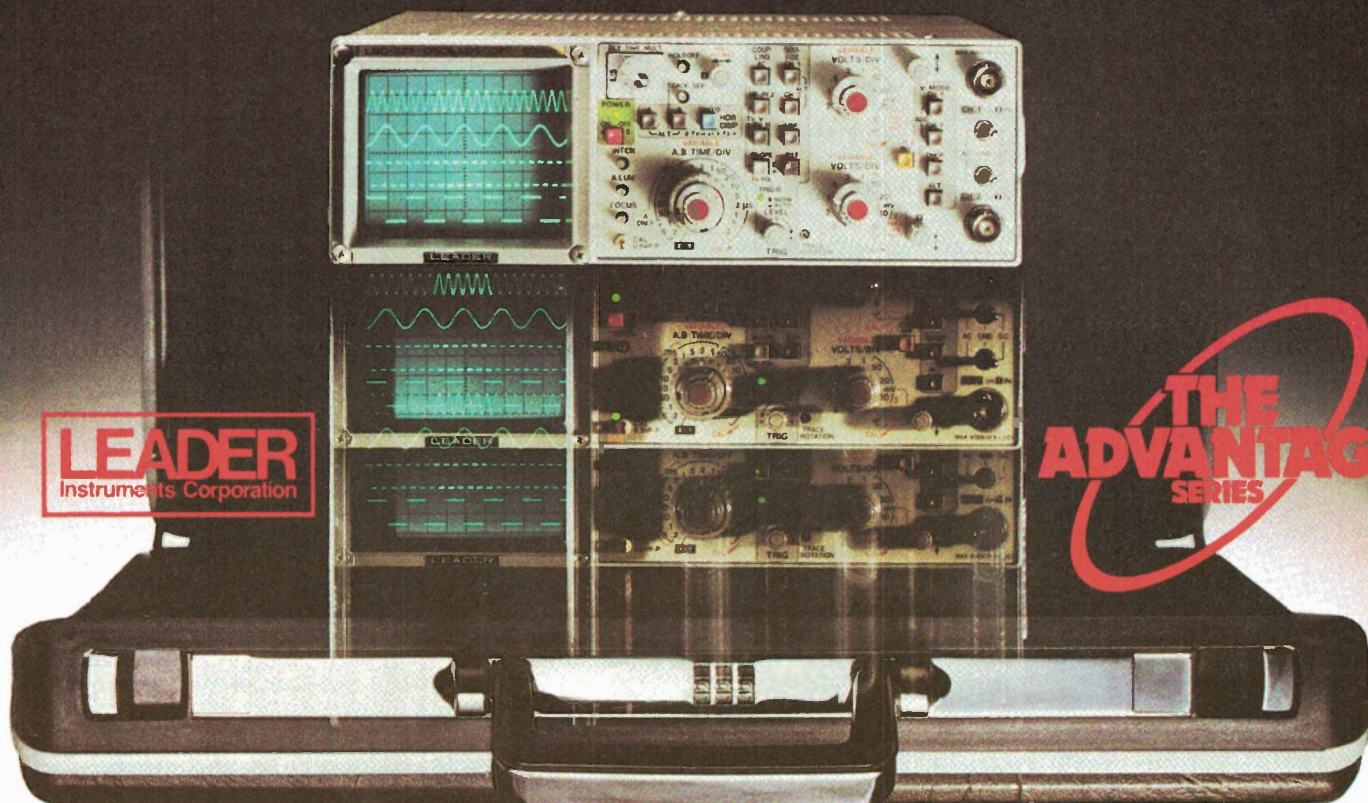
All you need is power supply with 5V at 2A, plus/minus 12V at 0.05A. The current value of the parts alone on this board is in excess of \$300!

- A. The Board itself with the original software, schematics, memory map and block diagram: \$49.95
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Block Diagram of the Board



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Our Cover



A vacuum power tube poses in the limelight for a bit of nostalgia beside a modern transistor which does much the same thing. Yes, they're Krazy-Glued to glass. Photo by Bill Markwick.

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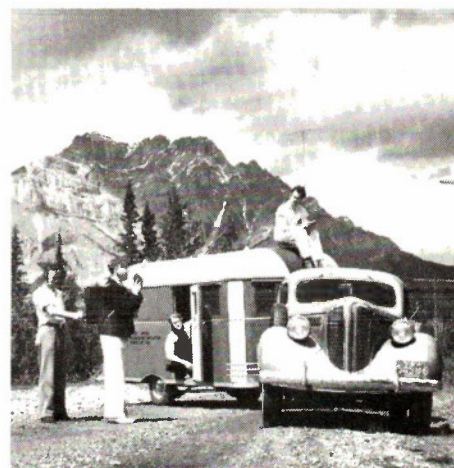
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Component Notation and Units

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

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

Resistors are treated similarly: 1.8Mohms is 1M8, 56kohms is the same, 4.7kohms is 4k7, 100ohms is 100R and 5.6ohms is 5R6.

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For Your Information

The Editor's Corner

By Bill Markwick

IN an upcoming issue we'll feature CAD systems for electronics, a roundup of computer-assisted design and drafting programs for the technologist. There'll be a hands-on (mouse-on?) look at all the systems that we can obtain for review. In the meantime, I thought I'd write a few comments on the various systems that we've tried out here at Electronics Today.

Our immediate need is schematic diagrams, with a secondary need for dimensioned outlines and article illustrations. This is in fact a very tall order for any CAD system, since schematics, drawings and graphic artwork each form a class by themselves, each with its own particular requirements.

We tried a number of systems; the few we tried are only a small sampling of the many available, and we'll have a longer list for the future article. AutoCAD, the Big Daddy of micro drawing systems, is certainly comprehensive. One of its most important features for drawing schematics is the ability to recall symbols from the disk and attach them to the drawing in the proper orientation. Thus transistors can be called up from your library and the leads made to fit. The drawback is the huge size: at

least two 360K disks for the various overlays. This means a fair amount of disk swapping. At the moment, we're using it with an HP plotter. It's supposed to work with a dot matrix printer, but the Epson FX-80 is the only familiar one listed in the device driver files, and we don't have one of those at the moment.

A good compromise is Pro-Design II. This fits on one disk and prints out nicely on most dot matrix printers. Both AutoCAD and ProDesign use high-density vectored printing, which means that your final drawing is reasonably free from the "jaggies", the series of corners and angles on supposedly straight lines that plague low-res displays. ProDesign hasn't much of a Fill (or Paint) function, which makes it limited for artwork.

For artwork, we're trying Dr. Halo. It has an amazingly comprehensive menu composed entirely of icons and pop-up submenus. Drawing with it is a whiz; artwork was never so easy. Unfortunately, it's bit-mapped, and the resulting resolution isn't adequate for quality printouts.

So far, it certainly looks as if you can't have everything in one

package. The bit-mapped programs are incredible fun, with the mouse zipping around moving and changing things as fast as you can click. The vectored systems are slow and cumbersome; you have to change whole parts of the drawing ("objects") just to make a tiny correction, but the resulting drawing is far better in appearance than the "screen-dump" programs.

As far as hardware goes, the bare minimum for CAD would be a PC with 512K, a mouse and associated driver and some sort of printer or plotter. Since the vectored software spends a lot of time calculating, they're very slow unless you have the 8087 math coprocessor, or a higher-speed computer like the AT or the 8MHz turbo types.

But: drawing has never been so much fun. We'll keep you posted.

As I mentioned in a past issue, we'd like to start a series of articles on programming small utilities in MS-DOS. We won't turn you into a programmer ready to unleash the next version of Lotus, but understanding the basic functions of 8088 code will let you enhance your computer no end.

Satellite Automobile Navigation

With satellites being all the rage and automobile dashboards looking more and more like video arcades, it had to happen sooner or later.

The word is out from Mitsubishi Electric that by 1989 satellite navigation for the automobile will be commercially available. The new navigation system will show the driver automatically and precisely where he or she is, eliminating the fear of getting lost even in strange cities.

The highly accurate system is a combination of a global positioning system (GPS) and a stand-alone navigation system which consists of a GPS receiver, geomagnetic sensor, speed sensor, flat antenna, control unit, map generator and CRT display unit that shows the car's position on a map.

According to Mitsubishi, the GPS can pinpoint a car's location accurately to within 100 meters by receiving information simultaneously from three or four satellites.



The combination of the GPS with the stand-alone navigation system (information obtained from the geomagnetic and speed sensors) allows pinpointing a car's position even in a tunnel or between high-rise buildings where satellite reception is poor or impossible.

Given the reliability of computers, and the harsh environment of the automobile, what happens if the electronic map packs it in? Gee Myrtle, can yez get the map out o' the glove box? Sorry Pa, the computer's hung and it won't unlock it. Sigh.

Here we are with our new Project Book Number 3 hot off the press, and due to an editorial error, the cover reads "57 Projects". In fact, the editorial list was pruned to size and the cover copy wasn't changed, leaving you with only 37 projects. The editor grovels humbly, and assures you that it was a honest if stupid mistake, and we weren't trying to scam you out of those 20 projects.

Continued on page 10

Electronics Today November 1986

8088 Programming: A Sample Program

A new series begins with a typical MS-DOS program and will feature programming of basic utilities.

By Ellery Henn

THE Password program is obviously not for beginners, but it demonstrates the basic structure of MS-DOS assembly language programming; MS-DOS is known as PC-DOS if you have a genuine IBM computer, but it's the same thing for programming purposes. And, of course, the program is useful on its own as a security device: when run, it asks for a password (in this case, the word FROG in upper case). After two tries, the operation of the computer is suspended until you reboot. The program can be appended to others, or run in an AUTOEXEC program, or what have you.

The 8088 CPU was designed by Intel to be able to read from and write to one full megabyte of memory. However, the

memory address lines are 16 in number, giving a maximum memory of 64K. To get around this, the 8088 uses *segments* of 64K each. Segments can be any size and lie anywhere in memory, even overlapping each other.

In the IBM PC and its compatibles, a fair chunk of memory is reserved for the necessities of the video display card and the various operating system instructions in ROM (the BIOS, or Basic In-Out Operating System). The video space and the BIOS addresses mean that only 640K is available to the user, and you lose even more of that at the bottom of memory for MS-DOS operating instructions.

This segmenting of memory accounts for the two basic types of executable pro-

grams you'll see in DOS: the COM file and the EXE file. The COM type lives entirely within one segment of memory, and does not send or receive any information from other segments. This obviously limits the maximum size of a COM file to 64K.

The EXE file can spread itself around all over the place, meaning that its size is limited only by physical memory space. It also means that each EXE program will have to have a standard introduction to set up the various segments so DOS knows where everything is supposed to be.

In the listing for PASSWORD.EXE, which is an assembler file known as PASSWORD.ASM, the labels for each instruction appear in the left margin. The

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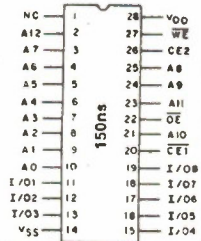
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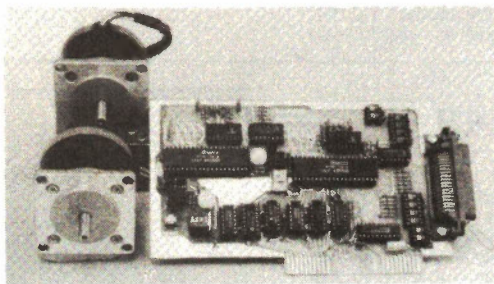
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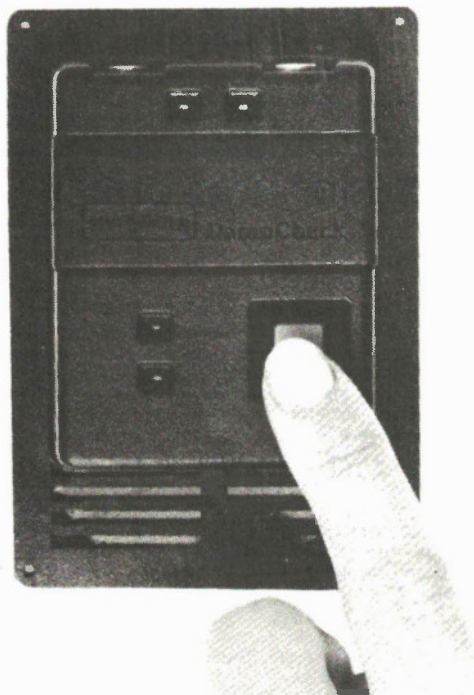
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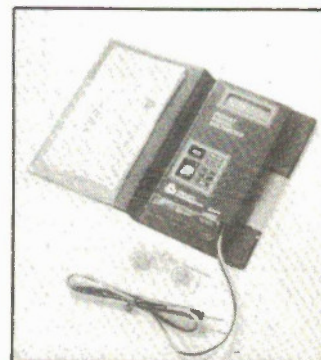
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Marine Security Alarm, Part 2



Constructing water, smoke and blower sensors for the Marine Security Alarm from our September issue.

By Harold Wright

FROM many safety viewpoints, a boat is not unlike an automobile. The automobile has a similar engine, but does not have a vapor-tight hull underneath that can trap explosive vapors. The evaporative gases such as gasoline and propane have an explosive vapor heavier than air. In automobiles this is whisked away by the slipstream as you cruise along the highway. In a boat, these gases can collect in the bilge to form a bomb waiting to go off when the first spark touches it. That spark is usually from the starter commutator or other DC brush-commutator motors. Boat operators still gas up with windows and hatches wide open, allowing fumes to flow like water through the openings and doors and down into the bilge, "But" you say, "They have bilge blowers to remove the fumes, don't they?"

Yes, they do, but are they sure the blowers are actually removing air and fumes from the bilge area? "The switch was on," they say from their hospital beds. Many boat explosions and the ensuing fires occur shortly after gassing, just as the boat is leaving the dock. This kind of deadly accident can be prevented, and that's what this article is all about.

While engine failures may not seem as

serious as the fumes problem, they can be dangerous or costly due to loss of control or engine seizing. Einstein is reputed to have said "A thing must be made as simple as possible, but no simpler". In Part 2 an attempt is made to have circuits as simple as possible.

Water Sensors

Water sensors can be related to safety (when a hull is leaking) or to convenience (when the sewage tank overflows). Fig. 1 shows a cross-section of a Delaval simple float type sensor that will warn of water in the bilge or a full sewage tank. It consists of a reed switch actuated by a pair of magnets moved by a flotation ring that surrounds the switch. It is just about foolproof. Fig. 2 shows the electrical circuitry together with an automatic bilge pump turn-on circuit that is enclosed by the dotted lines.

If you prefer to go the electronic route, use the circuit of Fig. 3. Transistor Q1 has a dual probe connected between base and V+. When the probe tips are bridged with water, the base current through R1 and R2 is sufficient to turn on Q1. The emitter then goes high and this can be applied to the CCU to sound the alarm. With the values shown, and using ordinary tap

water, the high will be about 5 to 6 volts. We're told that most of our lakes now have a high sulphuric acid content, so the high might be greater for bilge water.

Fig. 4 shows how a cheap probe can be constructed from some plastic plumbing pipe or a coupling. A small disk is cut from a piece of stiff plastic to fit the hole at one end of the pipe. This is drilled to take two long brass 6-32 bolts; they are bolted to the plastic disk. R1 and R2 are now soldered to the bolt heads and to a twisted pair as shown. A short section of the twisted pair, the two resistors and the heads of the bolts are then covered with 5-minute epoxy. The twisted pair should be long enough to reach the CCU without splicing. A small air vent hole should be drilled in the side of the pipe near the disk end. This will avoid air pockets when the remaining space is squeezed full of clear silicone rubber. It is important that the probe tips are the only part of the circuit that is exposed to dampness. The twisted pair needs to be insulated with a material well suited to the marine environment.

A small modification of the circuit in Figure 3 will permit its use to warn of low fluid levels. The same basic circuit is used, but an inverter is needed between the output and the CCU as shown in Fig. 5.

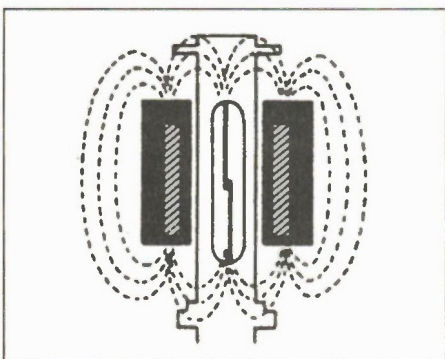


Figure 1. Interior construction of Delaval float type water sensor.

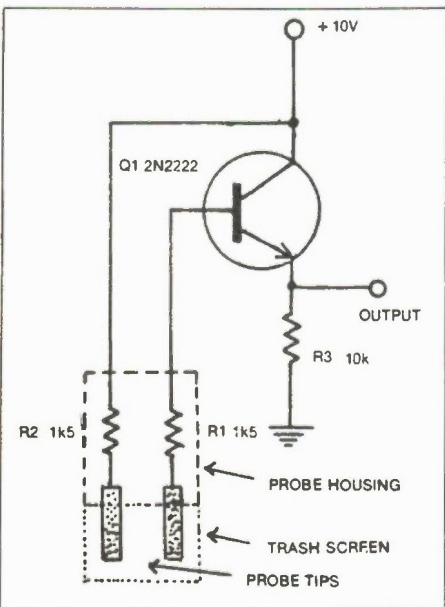


Figure 3. Electronic high water sensor circuit.

When the probe is covered, Q1 is conducting, the emitter is high and the inverter output is low. If the liquid level drops below the probe tips, Q1 turns off, the emitter goes low and the inverter output goes high. This circuit can be used to warn that the fresh water tank is running dry. The probe would have to be installed near the bottom of the tank and all materials chosen so that they would not pollute the fresh water supply. It could also be used to monitor the coolant level if a closed-system radiator is used, though it may not work properly because glycol antifreeze is a very poor conductor of electricity.

Smoke Alarms

Smoke alarms are a desirable feature in a boat's galley, main cabin and engine room. Building a reliable smoke alarm is not a job for hobbyists, but adapting a commercial smoke detector to work with this project's CCU is fairly easy. I have a Simpson-Sears smoke detector that has functioned flawlessly for seven years. I found that the output driving the sounder as measured across the sounder terminals

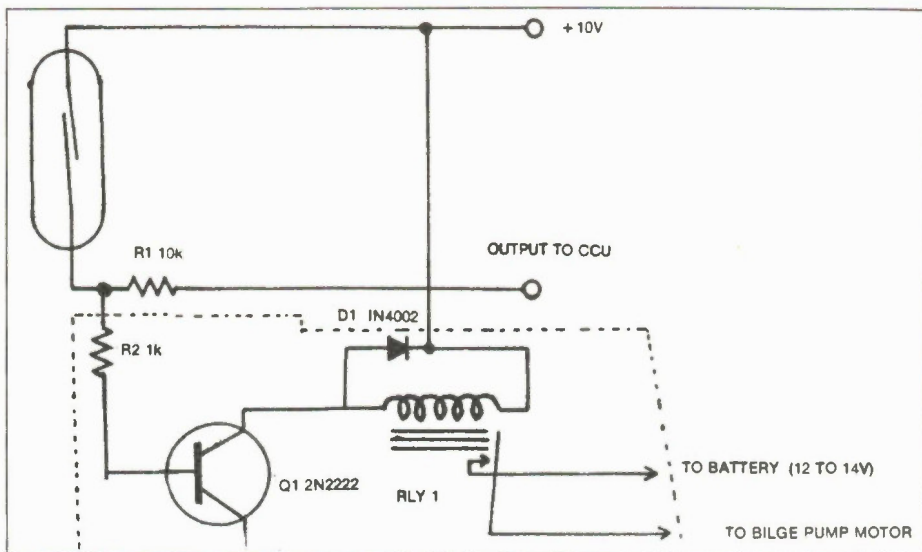


Figure 2. Simple electrical circuit for use with Delaval water sensor. Enclosed in the dotted frame is an optional bilge pump starting circuit.

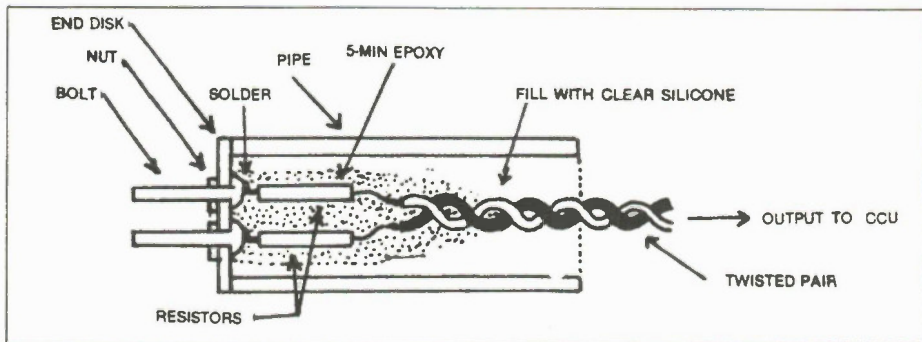


Figure 4. Water sensor probe construction detail.

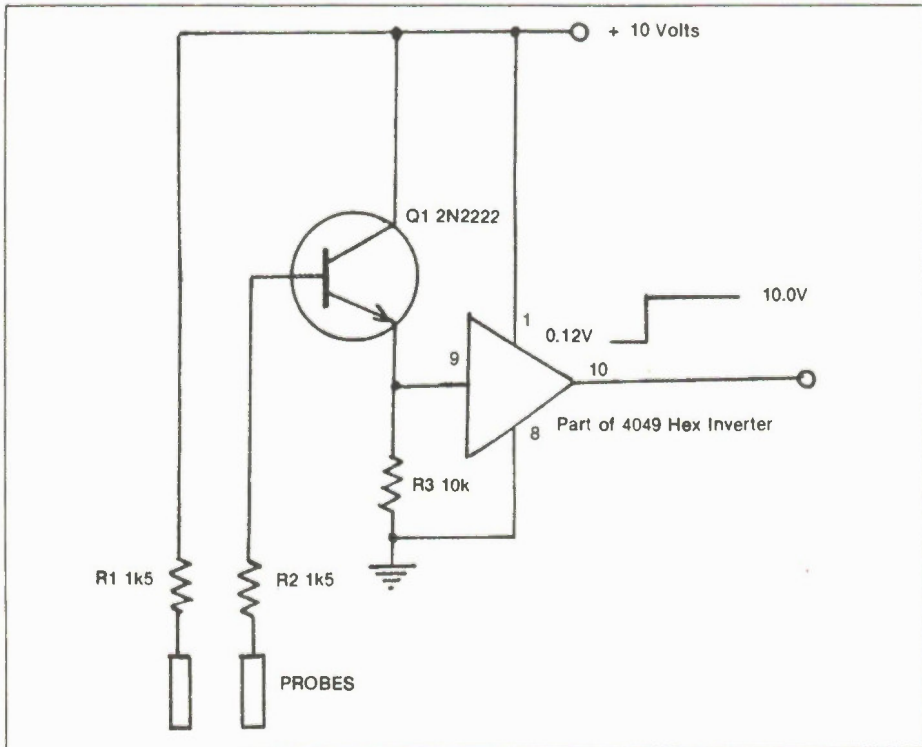


Figure 5. Circuit for low water detection.

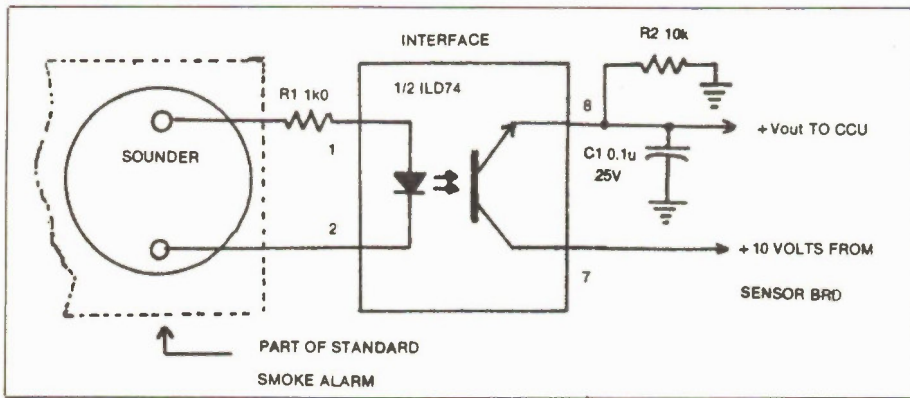


Figure 6. Interface for a commercial smoke alarm.

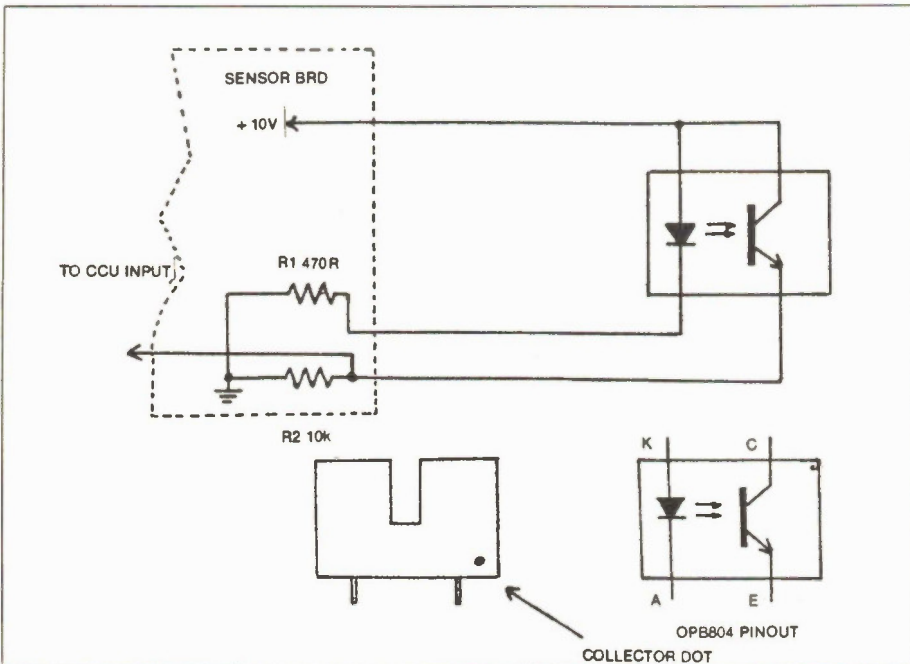


Figure 7. Electronic circuit for blower sensor.

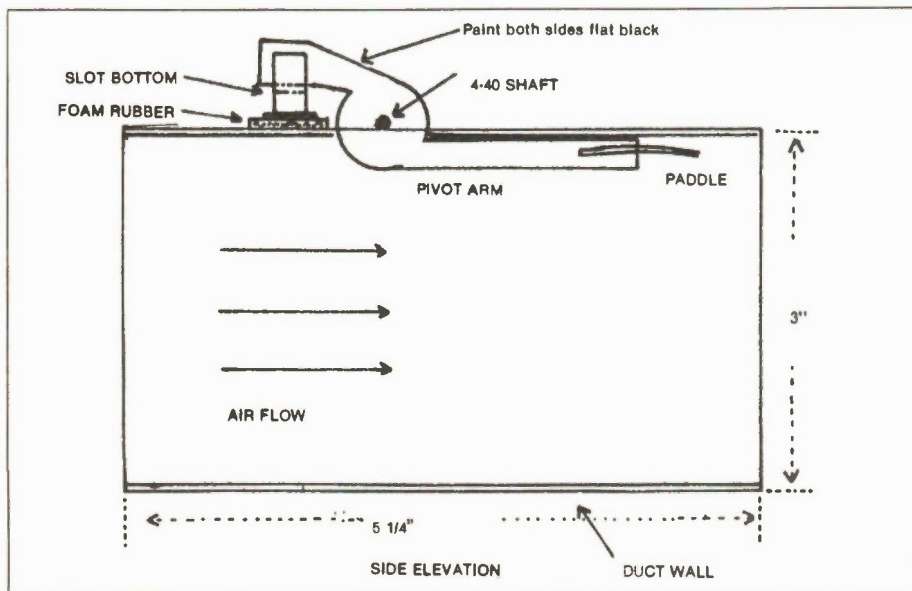


Figure 8. Blower sensor construction (side elevation).

was a 700Hz spikey waveform that resembled the positive-going half of a heavily differentiated square wave. An optocoupler seemed like a good solution to the problem of interfacing without affecting the normal operation of the alarm. Fig. 6 shows the circuit. The LED part of the circuit was paralleled with the sounder through a current-limiting resistor. The phototransistor is wired to provide a high whenever the local sounder is activated; C1 filters the 700Hz output to provide a steady high for the CCU input.

If you have a smoke detector of some other make, take off the cover and access the sounder terminals with an AC/DC voltmeter. If you get an AC response, use the circuit of Figure 6. If the alarm uses a solid-state sounder driven by a DC signal, you're home free. Just run a positive lead and a ground return to the CCU. Just make sure that what you do will not reduce the effectiveness of the local sounder; it shouldn't, because the circuit drain at the CCU is very small.

Blower Alarm

As noted earlier, blowers can be turned on without running, or may run but not blow any air. If the operator is on a flying bridge and the blowers buried deep in the hull, he may not be able to hear them. The only real assurance of operation is that provided by a sensor indicating the actual movement of air in the hose.

Blower hoses are usually 3 inches in diameter and flexible. For this system, a short length of aluminum dryer pipe is reduced to 3 inches by overlapping the material and cutting off the excess, except for a short piece. Use a few *very short* 4-40 screws to secure this narrow overlap to the main body of the duct. A slot is cut in the top of the pipe to accommodate a blade that swings on a small shaft between two angle brackets. A small paddle is then secured to the bottom end of the blade and at right angles to it. When no air is moving, the paddle hangs vertically across the pipe. The blade extends outside and above the pipe. The upper section swings down into the slot of an optical switch, shutting off the infrared beam and inhibiting the alarm. That part of the paddle entering the slot should be painted flat black on both sides to avoid ambient light reflections.

Fig. 7 is the electronic circuitry required and Fig. 8 shows the mechanical construction. The optical switch is mounted on a small piece of perf board that extends slightly from the base of the switch in the direction of the slot. A jacketed 3-wire cable should be used to connect the switch to the sensor board. Remove all solder flux and spread a coating of epoxy cement over all the pins. When this is dry, spread a second coat and lay the assembly

on a 1/4-inch thick rectangle of foam rubber, preferably the closed-cell type similar to that used for winter gaskets. When cured, spread the exposed surface of the foam with epoxy cement and press it in place on top of the pipe, making certain that the blade will enter the slot freely. When cured, attach the board to the pipe with very short 4-40 bolts. With the combination of bolts and glue there should be little chance of the switch coming loose. Even if the switch falls off or the paddle drops from the blade, the alarm would sound.

The whole finished assembly should be mounted horizontally, fairly low in the hull and secured with a clamp. The switch should be at the top. The existing air hose, if it is long enough, can be cut and the two ends attached to the aluminum pipe with pipe clamps. Note that the paddle is slightly curved in the upward direction. This produces a slight suction on the upper side when it is in the horizontal position and lined up with the air stream.

Other Circuits

Fig. 9 shows a circuit that will trip the alarm if the engine speed exceeds a value set by the owner. The signal is picked off at the breaker point side of the ignition coil. Some engines may have breakerless electronic ignition; there is usually a pickoff point for a tachometer. The input frequency will vary with RPM and the number of cylinders. With the circuit shown and a 6-cylinder engine, the output voltage for various speeds was 1V for 2000RPM, 2.5V for 3000RPM and 3V for 4000RPM.

Fig. 10 shows an engine coolant heat sensor. The thermistor used is a Canadian Tire replacement for a Chrysler part number SW 144 heat sender, CTC part 20-5922-8. It has a resistance at 20 degrees C of about 240 ohms, dropping to 20 ohms at 100 degrees C. The Chrysler replacement part may have slightly higher resistance readings.

Connect the ground line for the thermistor to the engine block, as close as possible to the sender. To calibrate the unit, immerse the sender in boiling water (not a full, rolling boil), and set the comparator to just turn on as the water comes to a boil. If you wish to retain the original gauge on your engine, it will be necessary to drill and tap the block for a second sensor.

Fig. 11 shows a low-battery warning indicator. R2 is adjusted so that the comparator trips when the main battery voltage falls to about 12V.

Fig. 12 shows how to add new or existing door or hatch switches to the CCU. If any switch is opened, the output of the series string will jump to 10V, triggering the CCU alarm.

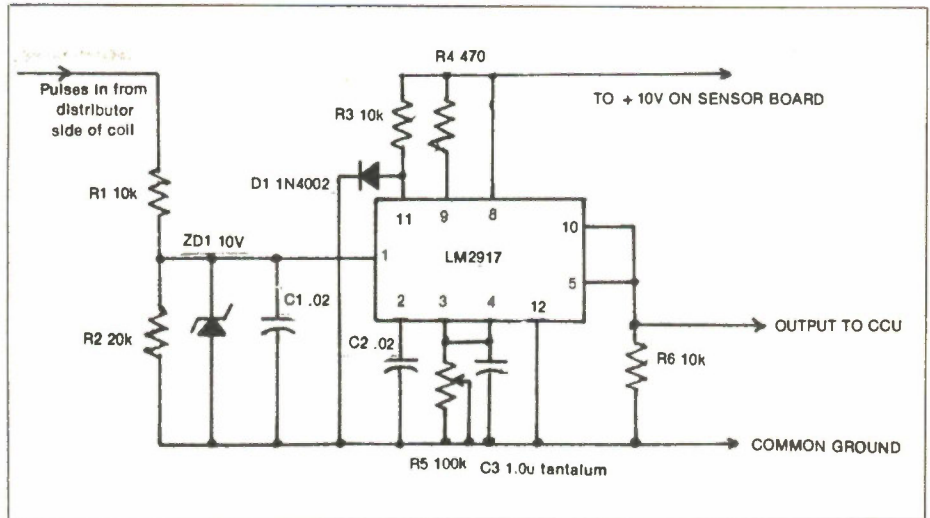


Figure 9. Electronic circuit to sense over RPM safe limit for engine.

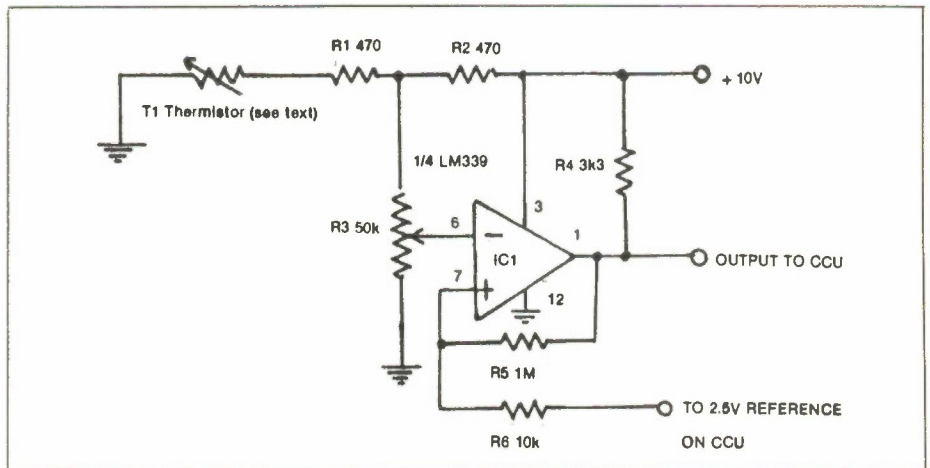


Figure 10. Engine coolant heat sensor circuit.

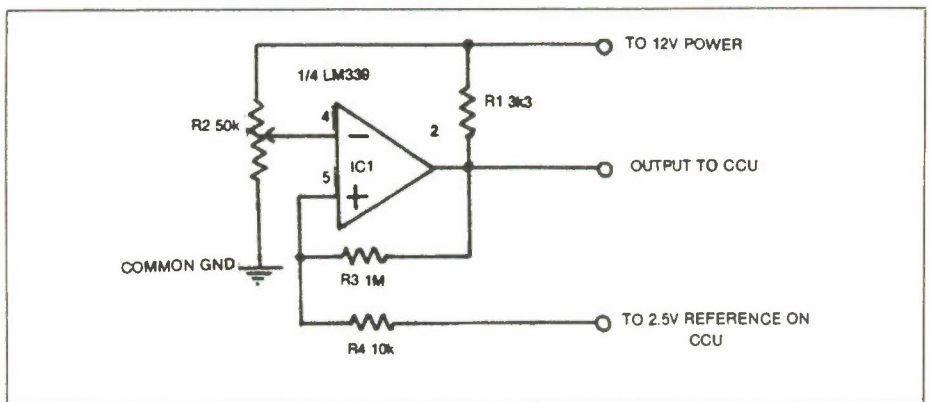


Figure 11. Low main battery warning sensor.

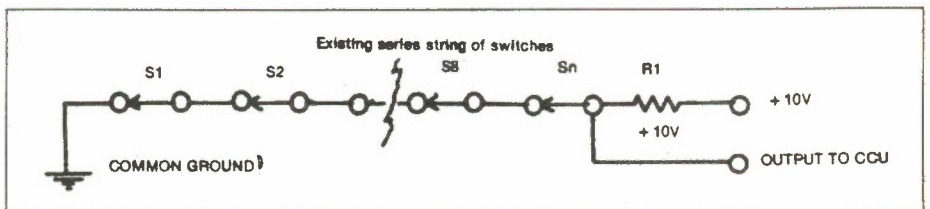
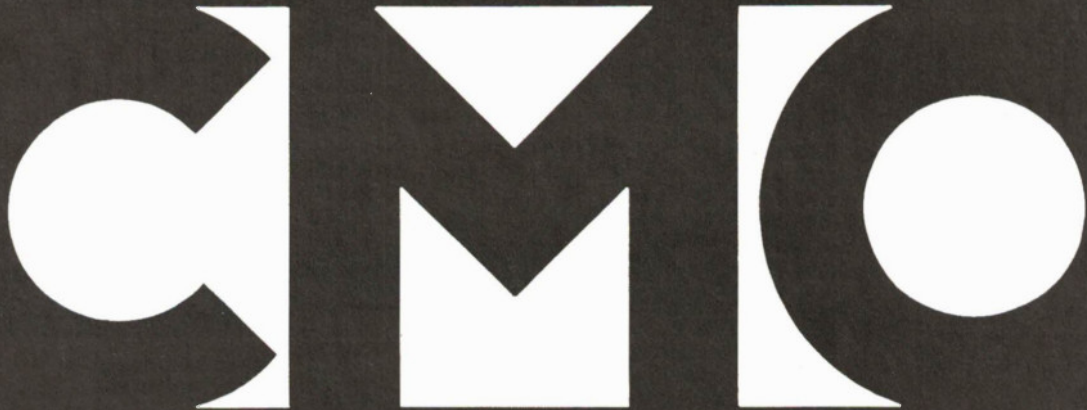


Figure 12. Series door switches sensor circuit.

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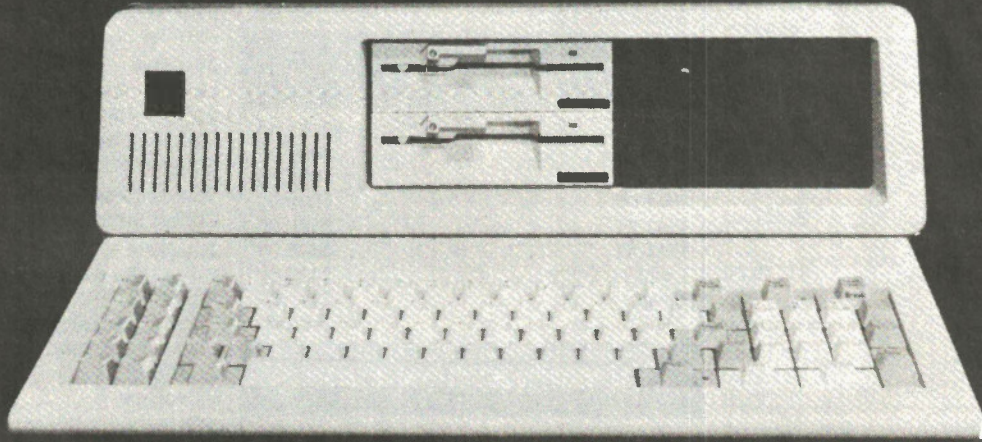
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Circle No. 41 on Reader Service Card.

Designer's Notebook: Pushing CROs

Scope manufacturers are pushing analog with digital technologies, as well as some finer points, for all they're worth.

By Jon Fairall

THE CATHODE RAY oscilloscope is one of the most venerated electronic instruments. Learning how to use it successfully is one of the most important tasks for the would-be designer or troubleshooter. But the CRO isn't perfect. It has limitations imposed by the circuit under test, the way it's built and nature itself. Modern CRO makers are pushing back these limits continuously.

The problem with oscilloscopes is essentially one of bandwidth. We would always like to be able to see events in a circuit more clearly, and by and large that means having more bandwidth. It's possible to get quite exceptional performance with modern day CROs, but only with some fairly exotic techniques. Another partially related problem is that we would like to exploit the advantages of digital circuitry, but this imposes extra bandwidth constraints on the design. Finally, we would like to make it all cheaper.

Bandwidth

Bandwidth in a CRO, as elsewhere, is taken at the 3 dB point, ie, at the point where the amplitude of the displayed waveform has dropped to half in nominal voltage. Some of the less expensive scopes on the market have bandwidths around 6.5 MHz, which is quite adequate for audio work.

Oscilloscopes for serious work start at about 15 MHz, which is good enough for most TV troubleshooting, although most TV techs would probably be a lot happier with 35 MHz, a typical figure for general purpose work. Digital and RF work requires much wider bandwidths, 100 MHz at a minimum, and there is a growing market for high end equipment running at 350 MHz or so.

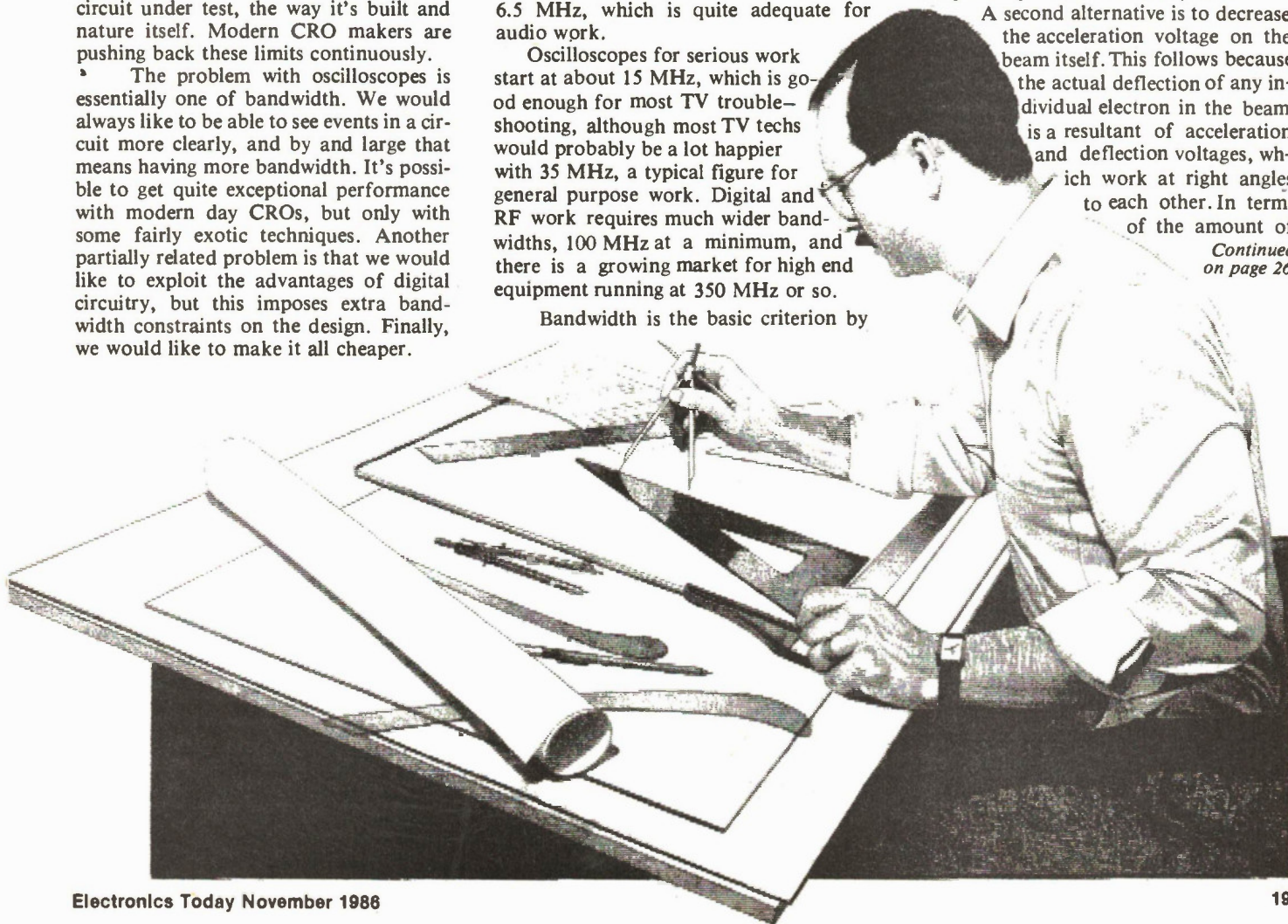
Bandwidth is the basic criterion by

which oscilloscopes are judged. As a general rule, it's related to price more closely than any other parameter. This is not surprising, since the amount of design effort required multiplies in direct proportion to the speed things are to run. The limiting factor is most often the display tube. Essentially, the problem is that the higher the frequency required, the faster the trace must move from side to side, and the faster it must respond to up and down movements of the vertical amplifier.

The speed at which the trace will move depends on a number of factors. Most immediately, it depends on the gradient of the electrostatic field between the plates, ie, increase the voltage on the deflection plates and the trace will move faster. This works fine up to certain limits but it imposes all kinds of power supply and heat dissipation problems on the system.

A second alternative is to decrease the acceleration voltage on the beam itself. This follows because the actual deflection of any individual electron in the beam is a resultant of acceleration and deflection voltages, which work at right angles to each other. In terms of the amount of

*Continued
on page 26*



RF Oscillators

All you'll ever need to know about sine wave oscillators operating at radio frequencies.

By Joe Pritchard

SINUSOIDAL AMPLIFIERS are simply amplifiers which contain enough positive feedback for oscillation to be maintained. The frequency of these oscillations is set by the presence in the feedback path, or in another part of the amplifier, of a filter which is usually a piezoelectric crystal or a tuned circuit made up of inductors and a capacitor. The latter is more commonly referred to as an LC circuit. These are the three fundamental parts of a sinusoidal RF oscillator: the amplifier, the feedback loop and the tuned circuit.

The Amplifier

Simple RF oscillators are usually based around a single stage amplifier like those shown in Fig. 1. Bipolar or FET devices can be used, and should be operated as simple linear amplifiers. The majority of components in most simple RF oscillators are therefore for biasing. With bipolar transistors as the active component, the aim of the biasing is to get a quiescent (no input signal) voltage across the collector and emitter (Vce) which is about half the supply voltage.

This enables the output voltage from the amplifier to swing between 0V and Vcc for an input that fluctuates around 0V, without distorting the waveform. The virtues of class A amplification are simplicity and low component count. Indeed, almost any single-transistor amplifier could be used as the basis of an RF amplifier, with the following considerations:

- It should have voltage or current gain of more than unity where voltage or current feedback is to be used;
- It should be able to operate at the appropriate frequency;
- Any phase change between input and output should be kept in mind.

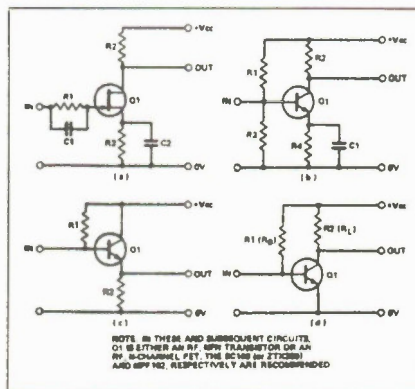


Fig. 1 Oscillators used with various amplifier configurations.

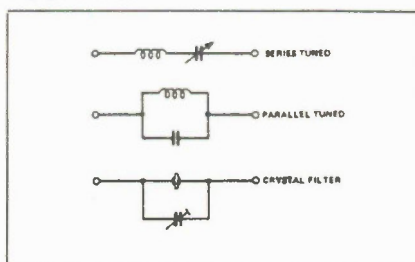


Fig. 2 Basic filter networks.

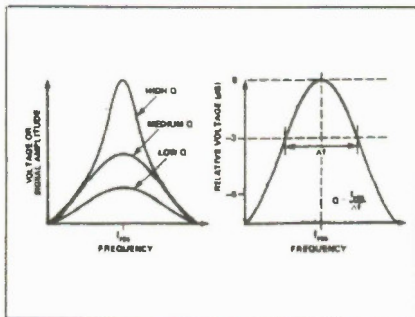


Fig. 3 Q is independent of resonance.

The Filter

All filters serve the same purpose: to discriminate between signals of different frequencies. Inductors and crystals are commonly used in RF circuits because at high frequencies they are compact and efficient. For AF oscillators they would be too bulky.

Fig. 2 shows some basic filter networks. Resonant frequency, the frequency at which the network impedance is lowest, is determined by the dimensions of the inductors, capacitors and crystals used. For an LC circuit, it is given by:

$$f_{\text{req}} = \frac{1}{2\pi} \sqrt{\frac{1}{LC}}$$

In a perfect world, no other frequencies would get through the filter. A good quality real filter will pass very few additional frequencies and a measure of quality is the Q of the filter (Fig. 3). A high Q is desirable in any tuned circuit where signals of mainly one frequency are required. Although Q depends on component values, it can be modified by the way in which the filter is connected, or coupled, to the rest of a circuit.

For example, connecting the network across a relatively low impedance increases Q. In bipolar circuits, especially for LC filters, the coupling between filter and amplifier input is often more complicated. For example, taps on the coil are sometimes used to reduce the loading of the filter by the amplifier.

Leaving circuit configuration aside for the time being, the Q of a tuned circuit using coils and capacitors is limited by the losses in the tuned circuit. Most of these

losses arise due to the resistance of the coil, and the Q of a coil can be approximated by:

$$Q_{\text{coil}} = 2\pi fL/R$$

where R is the DC resistance of the coil.

The Q of a coil can vary from one to a few hundred, that of a capacitor from 100 to 10,000. The Q of a crystal can be as high as 40,000. The Q of a filter or element of a filter is the ratio of its reactance at a particular frequency to its resistance. Due to the very high resistance of good capacitors, most of our losses in Q will be due to the coil. The high Q of a crystal allows us to be a little less particular about coupling it to an amplifier - even component values display wide tolerance.

Fig. 4D shows one possible coupling arrangement of filter and amplifier. On switch-on, small noise voltages in the circuit will be amplified and will appear at the output. Due to the tuned circuit, noise within the resonant band of frequencies will be preferentially amplified. Feedback is a means of sustaining this amplification and building on it.

The Feedback Loop

Part of the output signal must be fed back to the input in such a way as to reinforce the signal. As well as being of the correct frequency, the feedback must be in phase with the input signal. In the Fig. 4 circuit, the feedback path must introduce a phase change; the amplifier itself making good any losses that occur in the circuit.

Two types of feedback loop are shown in Fig. 5. In Fig. 5a, LP provides feedback. Providing the appropriate phase change is simply a matter of which way the coils are wound and connected. The distance between L1 and LF determines the amount of feedback introduced in the circuit. This should be the minimum required for steady oscillation, but it will vary with the frequency of operation. Fig. 5b is the same basic circuit but with the variable capacitor, CV1, providing control over the amount of feedback.

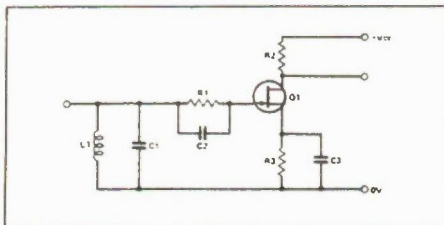


Fig. 4 Filter in an amplifier input.

This circuit is virtually a regenerative radio receiver; an amplifier brought just below the threshold of oscillation, the point at which it gives maximum gain.

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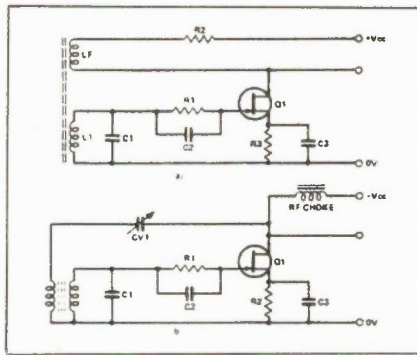


Fig. 5 Positive feedback requires a loop and a phase change.

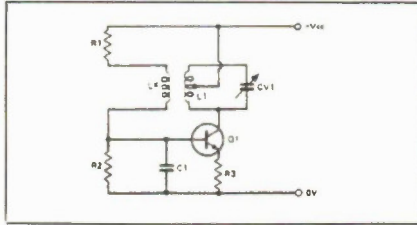


Fig. 6 A version of the Hartley oscillator.

A feedback loop can be purely capacitive, which means that the amount of feedback could be adjusted with a variable capacitor allowing for different transistor characteristics. Variability is also required if the circuit is to be operated over a wide range of frequencies, as the amount of feedback required to sustain oscillation in some circuits is frequency dependent. Some RF circuits don't appear to have a feedback path at all. In these, feedback is often provided via the internal capacitances of the transistor used in the amplifier.

Oscillators

A healthy circuit should produce at its output a signal of the desired frequency which is reasonably stable, has a good waveform and is without other frequencies present. Even a good oscillator may fall down in one of these areas. So, before we go on to look at some actual circuits, let's examine some of the problems to look out for.

Drift: This is a slow variation, up or down, in frequency of oscillation. It can be caused by aging of components in the circuit or, more often, by temperature changes. As the circuit warms up (literally) we can expect some slight variations in frequency. These can be compensated for, but applications requiring high frequency accuracy demand a temperature controlled environment. The aging problem can only really be compensated for by using a high Q filter and good quality parts in the first place.

Pulling: This refers to the slight alteration in operating frequency that can occur if a circuit being driven by the oscillator loads the oscillator and actually changes

operating characteristics. This can be avoided by not taking signals from the feedback path of the oscillator, using loose coupling between driven circuit and the oscillator or using a buffer amplifier.

Frequency Dependence of Output: Some oscillators, such as the version of the Hartley oscillator shown in Fig. 6, suffer from a variation in the output voltage with the frequency of operation. The simple answer to this is not to use such circuits for variable frequency oscillators.

Mechanical Instability: Construction techniques must ensure that there is no variation of frequency or output voltage with mechanical vibration of the type that the circuit is likely to get in use.

High Harmonic Output: The signal generated by the circuit at the frequency set by the filter used is called the fundamental frequency of the oscillator. However, outputs may also be given at frequencies which are exact multiples of the fundamental. These are the harmonics of the signal, and in most cases we want to try and reduce them. The size of these harmonics usually decreases as their order increases. They are usually caused by nonlinearity within the amplifier stage. This may be caused by poor construction. Dry solder joints can act as a semiconductor diode, and the resultant nonlinearity can cause such problems. In some cases, of course (square wave generators, for example) harmonics are desirable.

High Noise: Noisy transistors will introduce noise voltages to the amplifier, and this may widen the band of frequencies generated by the oscillator, effectively decreasing Q. This noise effect is likely to be important only in circuits with very high Q. In general, FET devices have a lower noise than bipolar transistors.

Distortion: Distortion can be reduced by ensuring that the amplifier isn't operated in a nonlinear fashion. One cause of this not dealt with above (High Harmonic Output) is excessive feedback, making the amplifier saturate. Reducing feedback to a level compatible with reliable oscillation is a good idea. High Q circuits and loose coupling of the oscillator to other circuits will also help.

Crystal Oscillators

Crystals provide us with a very stable source of RF signals capable of producing almost any suitable frequency up to about 20MHz. The limit isn't arbitrary, it's just that a crystal whose fundamental frequency is this high is only about 0.1mm thick.

Crystals can produce signals of even higher frequencies. We could, for example, use a circuit to generate harmonics of a lower frequency crystal and then tune following circuitry to select the desired harmonic, or we could use a technique by which the crystal is caused to oscillate at a frequency near one of its odd harmonics.

Special crystals are available which do this in preference to vibrating at the fundamental, called overtone crystals. They allow crystal control at very high frequencies. They are called overtone frequency crystals, not harmonic frequency crystals, because the crystal doesn't vibrate at an exact harmonic frequency.

A crystal is a mechanical device that, when excited by an alternating voltage at close to its resonant frequency, vibrates in sympathy. It can also be viewed as a high Q tuned circuit, as shown in Fig. 7. Crystals have two frequencies at which their electrical characteristics change. At f1, the impedance drops to DC resistance, R. This is called the Series Resonant Frequency. At f2, the crystal acts as a parallel tuned circuit, and the frequency is the Parallel Resonant Frequency. These frequencies are within 1% of each other.

The circuits in Fig. 8 are typical of simple crystal oscillators in Fig. 8a, the crystal provides both feedback and filter. The RF choke provides a load resistance at radio frequencies, and ensures that the crystal is the only path for the RF voltages amplified by the transistor.

Fig. 8b is a useful circuit for marking the lower end of the 80m Amateur band. The coupling between the circuit and the receiver being set up should be kept loose. In many cases the signal can be transferred from oscillator to receiver by wrapping a piece of insulated wire from the output of the oscillator around the aerial input of the receiver.

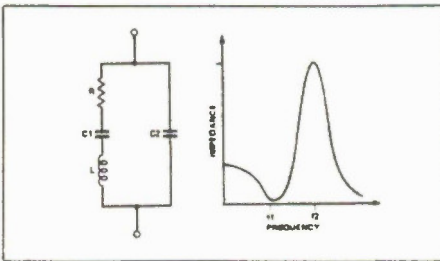


Fig. 7 A high Q tuned circuit.

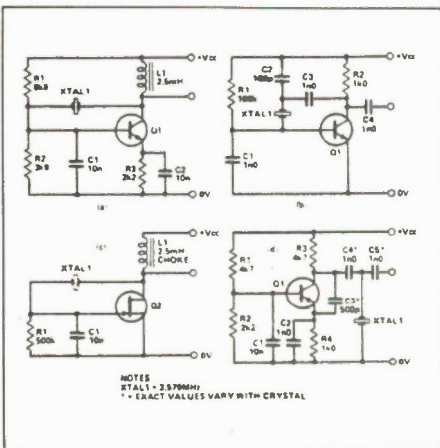


Fig. 8 Simple crystal oscillators

Possible Problems

There aren't many with crystal oscillators, providing that the crystal is reasonably active at the frequency of interest. Although designed to produce a fixed frequency, it's possible to slightly detune a crystal around its designated frequency by putting a trimmer capacitor of 15 to 25pF across it. This is necessary in applications where absolute accuracy of frequency is needed. The trimmer can adjust the crystal oscillator until it is dead on.

Crystals do age, which is one cause of loss of activity. Violent mechanical shock or excess heating can also damage crystals, so be careful with that soldering iron! The frequency of oscillation of a crystal can also vary with ambient temperature, but only by a small amount. The amount of frequency change is measured in terms of parts per million per degree centigrade, or ppm/°C for short. It can be positive, which indicates that an increase in temperature will lead to an increase in frequency, or negative.

The actual drift for a given crystal depends upon the way in which the crystal was cut, or manufactured. The cuts known as AT, BT and GT are best in this respect, having very low or zero drifts. The AT and BT crystals can work at frequencies of up to eight and 20MHz, respectively. GT is limited to frequencies up to 500kHz. The worst drifts that you're liable to meet are from the cuts known as X and Y, which have drifts of around -25ppm/°C and +75ppm/°C, respectively.

Temperature dependency can be increased by the presence of high currents flowing through the crystal at the resonant frequency. Some oscillators are designed to be used in ovens, thermostatically controlled boxes to keep the crystal at a constant temperature.

Fig. 9 shows a circuit in which both crystal and LC filters are used. The biasing arrangement is such that harmonics will be generated. The circuit across the output can be tuned to an harmonic frequency. This is, in fact, a simple form of frequency multiplication.

Fig. 10 shows a circuit that gives a very high harmonic output, and demonstrates a further method of producing an RF signal when the waveform isn't important. Square waves are easily produced by logic or switching circuits, and generate an absolute swarm of harmonics. This circuit is a simple calibrator, generating frequencies at 1MHz and 100kHz which can be used roughly to calibrate short wave receivers. A 10kHz marker could easily be provided by adding a further 7490 (IC2).

Setting up the circuit for accurate 1MHz operation is fairly simple. Select the 100kHz marker, which will generate harmonics at 200kHz longwave. Loosely couple the output from the circuit to the radio; just standing the calibrator next to

the set will often provide a sufficient signal. You'll probably hear a whistle. Now adjust CV1 until the whistle disappears. The calibrator is set. The harmonics from this circuit are audible to well above 30MHz.

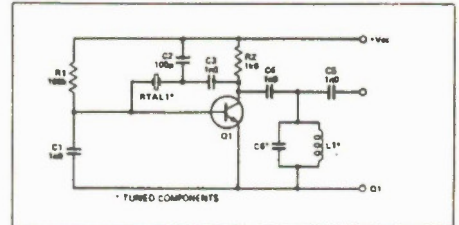


Fig. 9 A circuit designed to produce harmonics.

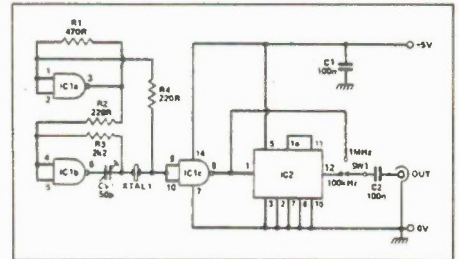


Fig. 10 A circuit which yields a very high harmonic output.

LC Oscillators

The filter in an LC circuit is made from a capacitor and an inductor. If a variable frequency is required, it's most convenient to use a variable capacitor. Again, there are a variety of circuit configurations that an LC oscillator can be based on, and here we'll only discuss the best known types.

No matter how good an LC filter is, it will always be less efficient than crystal filters. They can still be very good, provided that a few pointers are followed.

Most of the losses in a LC filter will come from the coil, so this should be as good as possible. You'll find it convenient to wind your own for many applications, as you can't just buy particular inductance values like you can resistors. An approximate value of the inductance of a coil is given by:

$$L + a^2 N^2 / 4d$$

where N is the number of turns, L is the inductance in microhenries, d is the length of the winding in centimeters and a is the radius of the winding in centimeters. The equation can be rearranged to give the number of turns for a particular inductance. If this approach is used, a wire diameter must be chosen to give a suitable winding length. The equation is useful, but needs a little trial and error in its application. It is meant for single layer coils

only. It also applies to core-less coils. A ferrite core will tend to increase the inductance of a given coil and a brass core will reduce it. A useful approach to coil design is to construct a coil smaller than that required, then bring it to the appropriate value using a core. This can be adjusted until the filter is resonant at the frequency of interest.

The coil should have a low DC resistance. Thicker wire, or Litz wire, which is many stranded wire, are preferred. Both these give low losses. The former on which the coil is wound should be nonmetallic, for similar reasons of low loss. It should also be rigid, so one of the rigid plastics is suitable. For reliable and accurate work, wood is no good and neither are the 'softer' plastics such as PVC. Apart from the construction techniques used in the coil, the inductance can be modified by mechanical vibration causing the turns of the coil to vibrate and move with respect to one another. This is easily dealt with by using something like glue to stick the turns down or by having a former with ridges in to hold the turns rigid. On a similar type of problem, coils wound of thick wire can be self supporting. You can occasionally get slight fluctuations in frequency if the temperature changes as the copper in the coil expands and contracts.

To prevent losses from the coil, it should be positioned on the circuit board at least two coil diameters from other components. This is another good reason for making small coils. You can also screen the coil with a metal can, though this will cause a slight difference in the inductance of the coil.

Finally, if a core is used, ensure that it is a tight fit within the former so that it doesn't wobble. This would have a radical effect on the coil inductance and hence on the frequency of operation. The core, if ferrite, should only be adjusted with a suitable tool. It should be nonmetallic, as this would affect the inductance as well as the act of adjusting the core - not very useful if the coil's inductance changes when you remove the tool. Secondly, ferrite cores are fragile, and it's possible to shatter a core if you are careless in adjusting it.

As to the tuning capacitor, whether fixed or variable, it should be high quality device with a low variation of capacitance with temperature. For fixed capacitors, ceramic or mica components are best. For variable devices, air spaced capacitors are superior to the ones with solid dielectric. They should also be kept scrupulously clean, as grit on the plates of the capacitor can cause variations in capacitance as the capacitor is adjusted in addition to the expected frequency change. These frequency scintillations are random and very annoying.

They should be rigidly mounted, and
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are often equipped with an extension spindle and a slow motion drive, thus allowing very fine adjustments in frequency to be made. Variable capacitors will also have temperature problems, due to the contraction and expansion of the vanes. This can be counteracted by the use of special capacitors.

For example, if a capacitor has a positive temperature coefficient (it's capacity increases with temperature) then a unit with a negative temperature coefficient (capacity decreases with increasing temperature) can be connected in parallel with it. If the compensating capacitor has roughly the same magnitude of capacitance change with temperature as the main capacitor, varying only with direction, then the temperature effects can be almost nulled out.

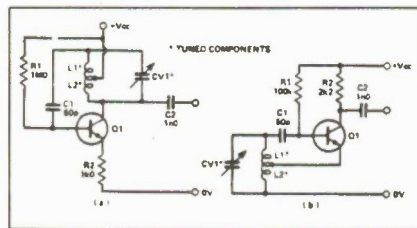


Fig. 11 Two types of practical Hartley oscillators.

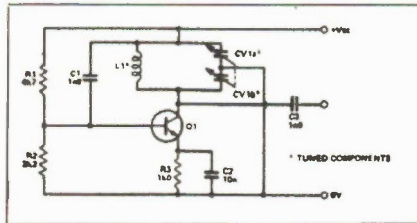


Fig. 12 A practical Colpitts circuit.

Types of LC Oscillator

Fig. 11 shows two alternative arrangements of the Hartley oscillator. The main characteristic of the Hartley Oscillator is that the tuning coil is tapped part way along its length, the ratio of L1 to L2 having an effect on the circuit behaviour. The frequency of oscillation is theoretically set by equation:

$$f = 1/2\pi\sqrt{(L1 + L2) CV1}$$

but the values of resistors used in the biasing arrangements can have some effect on frequency. Generally, R1 should be kept as high as possible.

In both cases, the degree of coupling between filter and amplifier is set by C1, and this should be set as small as possible to give loose coupling. A trimmer can be used here if desired. The value required is frequency dependant to some extent. C2 serves to couple the output of the oscillator to other circuits, and should be as small a value of capacitance as possible so as not to load the oscillator too much.

An alternative method of removing a signal from the oscillator is to wind an additional coil on to the former of L1 and L2. The signal will be available from this winding.

A circuit that is in many ways similar to the Hartley Oscillator is the Colpitts circuit; here the filter is again tapped, but this time the tap is in the capacitive part of the tuned circuit. This is shown in Fig. 12. Here, R1, R2, R3 and C3 form the biasing arrangement of the circuit. C3 provides the feedback path and so should be reasonably small to provide, as in the Hartley circuit, the minimum amount of feedback needed to sustain oscillation. The frequency of oscillation is given by:

$$F = 1/(2\pi\sqrt{(L/C1) + (L/C2)})$$

Both the Colpitts and the Hartley configurations are good, general purpose circuits, providing reasonable stability, good output level and a reasonable span of frequency change for a given coil/variable capacitor combination. Possible points to consider when you're trying to decide which to use are as follows. The Colpitts circuit is better for applications where plug in coils are used to produce a wide ranging VFO; the coils only need two connections, not three. However, the Colpitts oscillator may need a two gang tuning capacitor if the full range possible for a given coil is to be tuned. A third popular LC oscillator is the Clapp circuit, in which the modifications serve to reduce the loading of the tuned circuit by the amplifier. Another feature of the circuit is that for a given variable capacitor/coil configuration, the range of frequencies tuned is not as wide as with the Hartley or Colpitts circuits.

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execution on to the next instruction. Any time you see an operand beginning with the letter J, you know that the subroutine has to make some sort of decision (Jump If Equal, etc.) and then jump to another

label.

Assembly

To turn this listing into a real executable EXE file, you'll need a word processor

```

MOV     ANSR[DI],AL           ;otherwise, put character typed
                                ;into ANSR + DI.
MOV     DL,58H               ;58H is 'X'
MOV     AH,2                 ;AH=2 and INT 21 will display
                                ;the character in DX on-screen.
INT     21H                 ;Display 'X' at cursor position.
INC     DI                   ;Add 1 to DI register
INC     CHRCNT              ;Add 1 to memory location CHRCNT.
CMP     CHRCNT,5            ;Have 6 keys been hit?
JB      GET                 ;Jump if Below (less than) to
                                ;the label GET:

FORCE:  MOV     AH,2         ;This prints a
MOV     DL,0DH              ;Return and
INT     21H                 ;
MOV     DL,0AH              ;linefeed onto the screen.
INT     21H                 ;(AH already has 2 in it)

MOV     CX,4                ;We want 4 iterations of the
                                ;LOOP below.
ROTATE: SUB    DI,DI         ;Clear DI register.
CLC                                ;Clear Carry bit.
ROR     PSWD[DI],1          ;Unscramble one byte of password.
INC     DI                   ;DI=DI+1
LOOP    ROTATE              ;Loop back to ROTATE: until CX=0.
                                ;(CX decrements once every LOOP).

CLD                                ;Clear Direction flag. This
                                ;makes SI and DI increment.
LEA     SI,PSWD             ;SI contains PSWD's address and
LEA     DI,ANSR             ;DI contains ANSR's address.
MOV     CX,4                ;4 iterations
REPE    CMPS                ;REPE CMPS Compares Strings
                                ;until CX=0. 4 bytes of PSWD are
                                ;checked with 4 bytes of ANSR.
JNE     LASTCH              ;Jump Not Equal (no match)
                                ;to LASTCH: (last chance ...)
                                ;If they DO match, user is
                                ;legit, so we go back to DOS.

POP     DX                  ;POP PUSHed registers.
POP     CX                  ;NOTE: POP ALL
POP     BX                  ;REGISTERS IN THE REVERSE ORDER
POP     AX                  ;THEY WERE PUSHED!
RET                                ;Return to DOS or calling program

LASTCH: CMP    TRY2,1        ;Is there a '1' in TRY2?
JAE     FRY                 ;Jump Above or Equal to FRY:
MOV     TRY2,1              ;No. Put a '1' in TRY2,
MOV     CHRCNT,0            ;clear the character count,
MOV     PSWD,8CH            ;and re-scramble the
MOV     PSWD+1,0A4H          ;password back to garbage for
MOV     PSWD+2,9EH          ;one last chance to get the
MOV     PSWD+3,8EH          ;password right.
JMP     CLS                 ;JUMP back to CLS:

FRY:    INT     18H          ;Cassette BASIC. If no got,
                                ;computer will hang. Disk
                                ;I/O unavailable from
                                ;cassette BASIC. Heh heh.

START   ENDP                ;End procedure 'Start' and
CODE    ENDS                ;end code segment and
END     START                ;bow out to applause.

```

and the MS-DOS assembler programs MASM.EXE and LINK.EXE. Type in the listing as shown, using the non-document mode if your word processor has one; you can omit the remarks in the right-hand column. The file must end in the extension ASM.

Place the ASM file and the MASM program in your drives and type MASM PASSWORD, adding whatever disk drive labels are necessary (MASM can be on a separate drive). Note that the extension ASM is not typed in; MASM will automatically look for a file called PASSWORD.ASM.

You'll be asked for three filenames (Object Filename, etc.), none of which are necessary to the operation; just press Return for each question. MASM will ponder for a while and then (if you didn't make any typing errors) will say "Warning Errors 0, Severe Errors 0". If you made a typing error that's detected, MASM will print out the offending lines. Correct your ASM file and have another go.

You should now have a file on your disk called PASSWORD.OBJ. This is the program's object code, but it still isn't in a form executable as an EXE program. To set up the code in the proper format readable by DOS, we go through the same thing all over again with LINK. Type LINK PASSWORD, type a Return for the questions asked, and you should end up with a file called PASSWORD.EXE.

By the way, don't be put off by all this manipulating of files just to get your program in executable form. When you get further into assembler, there are Batch files that will take care of all that, plus RAMdisk techniques to speed up assembling considerably.

To run the program, type PASSWORD and you'll see the word "Entry:". Type FROG in upper case and an X will appear for each character typed. If the password is correct, you'll be returned to DOS. If it isn't correct, you get another try. If it's wrong again, the cursor will freeze and you'll have to reboot.

And so...

This obviously didn't teach you any of the finer points of programming, but it should have given you some idea of the basic structure of 8088 programs. The part about segments looks intimidating, but segments are far easier to use than explain. Besides, much of the code at the beginning of the listing is a strict format required by MS-DOS, and it's the same for every program.

In upcoming issues, we back up a bit and have a look at how the 8088 registers work and how to utilize the power of MS-DOS by writing our own small utilities. ■

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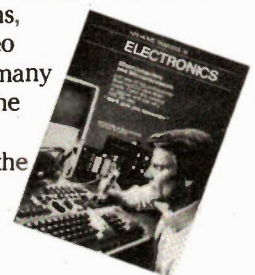
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Continued from page 19

Pushing CROs

deflecting force acting on the electron, increasing one is the same as decreasing the other. The problem with this approach is that the acceleration voltage increases the energy with which beam electrons hit the screen. If you make it too low they won't emit any light when they strike the screen and there will be no visible indication of beam position. Not very useful, you might think.

A third alternative is to increase the aspect ratio of the tube, ie, the ratio of length to breadth. Other things being equal, the longer the tube, the smaller the angle through which the beam needs to be deflected and thus the smaller the deflection voltage needs to be. Of course, the longer the tube, the higher the voltage required on the accelerating plates, and the more difficult it becomes to mount the tube in a practical unit.

Above 200 MHz

In practice, all these alternatives come up against limitations imposed by things outside the tube. There is a limit to how much voltage can be supplied, how quickly it can be supplied, a limit to length, and so on. It appears that by optimizing all these elements, modern oscilloscopes can push back the 100 MHz barrier. To go faster, other methods need to be explored.

One way of doing it, which seems to double the upper frequency limit to about 200 MHz, is post deflection acceleration. The basic principle here is to move the deflection plates backwards in the tube towards the cathode of the gun, and carry out the deflection on the tube while the electrons are moving with rather low energy. Only when they are pointing in the right direction are they accelerated.

The big problem here is one of linearity. The acceleration voltage operates parallel with the axis of the tube, but if the beam has already been deflected, it is travelling at some angle to the axis. The effect of the accelerating voltage is thus to bend the beam inwards, resulting in nonlinearities like pin cushion or barrel distortion (see Figure 1). Curing this results in a complex array of the voltage plates around the top of the tube, but it can be done reasonably successfully.

The death knell of normal electrostatic tubes is sounded when things are happening so fast that the time taken for individual electrons to move through the deflection fields becomes a significant percentage of the time taken to record an event on the screen. Imagine, for instance, if we wanted a single cycle of a very fast sine wave on the screen. If the period of the wave was exactly the same as the transit time of an electron through the field, the net deflection of the electron would be precisely zero.

An obvious way to reduce this problem is to reduce the size of the deflection field,

thus reducing the transit time. This is fine except that it would also reduce the effect of the deflection plates, requiring yet higher voltages between them.

A better solution is to use a transmission line to do the deflecting. The deflection plates are divided into a number of narrow plates down the length of the tube connected to each other by a small inductor. The deflection voltage is passed from one to the other at precisely the same rate as an electron travels down the beam. This means that at every point on its path down the tube, a given electron is subject to precisely the same deflection field. The limit to this technique is set by the frequency response of the LC circuits, formed by the inductors and the plates. It allows one to go up to about 500 MHz.

Other techniques can be used to make a

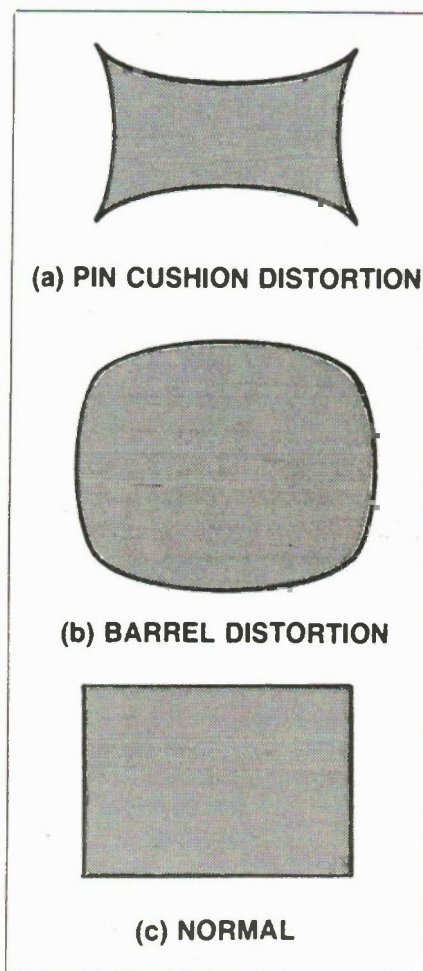
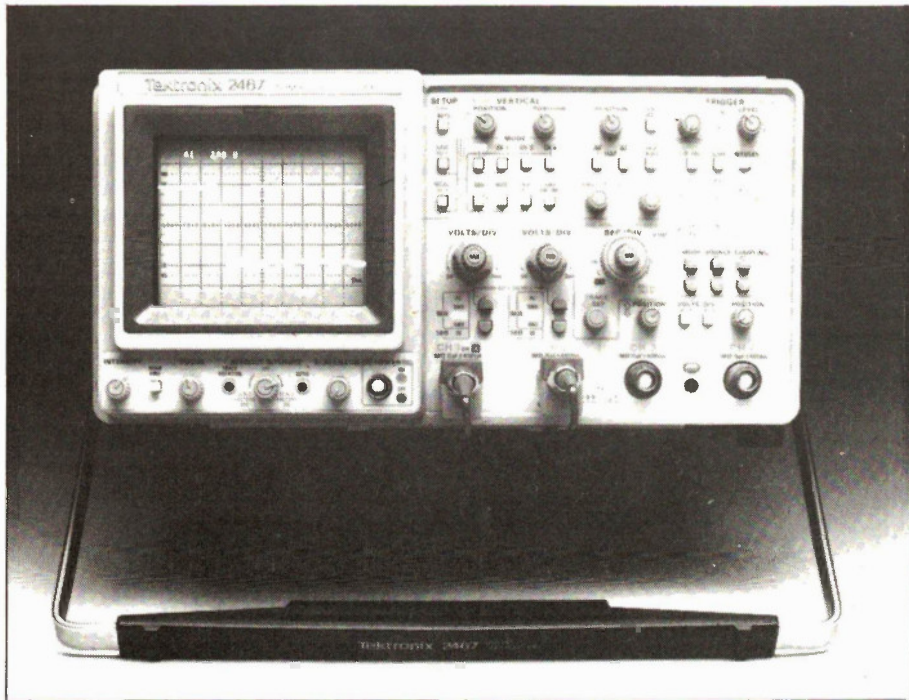


Fig. 1 Patterns of distortion.

CRO run faster than this, although they all have in common a method of matching the speed of the electrons in the beam with the propagation of the deflection information. Typical of these are travelling wave tubes. Using such techniques, it has been possible to push experimental CROs up into the gigahertz region.

The exigencies of practical design problems, things like weight and power sup-

cially available CROs have considerably lower bandwidths. Philips has recently released a 350 MHz CRO with travelling wave tube deflection for instance. There are a few current production CROs that go faster: the Tektronix 7104 and HP 54110D among them.



Decoupling

There is one final method that can be used to extend bandwidth, and that is to attempt to decouple the screen from the input signal. In this method, the write speed of the tube has a variable relationship to the read time of the probe. One method of doing this is to use the profiled peristaltic charged couple device (PPCCD) made by Philips. It loads the input signal into 256 semiconductor capacitors, referred to as wells. Clock pulses cause the wells to first store and then transfer the charge to the next well, clearing the first well for the next input. It is possible to do this very fast, thus information can be read in at speed and read out at leisure. The net effect of putting a signal through a PPCCD is thus to spread it out in time. It means a low frequency tube can be used to capture extremely fast signals.

Another, even more ingenious method, is to think through some of the basic objections to electrostatic tubes again. All of these problems can be alleviated if the tube screen is made very small. Of course, the problem is that you then can't see anything. Unless, of course, you magnify the screen-image in some way. One promising method is to present the output of a minitube to a CCD. The CCD output is then sent to a large screen for final display.

Electronics Today November 1986

An even more radical departure is to question the necessity for a tube at all. The ideal here is that the CCD can be used as the basic sensing unit instead of the tube. Of course, this isn't something restricted to oscilloscopes. Almost everywhere tubes are used, people are trying to replace them with solid state

technology.

The problem is simply one of developing a read and write system with sufficient definition to be practical. Current technology allows manufacturers like Tektronix to build CCD sensors with 1024 x 1024 resolution, and to chase 2048 x 2048. If that could be translated into pixels on an LCD raster it would more than solve any imaging problems and extend bandwidth well into the gigahertz region.

Digital Oscilloscopes

Digital techniques have penetrated the oscilloscope market as everywhere else although it must be conceded, without the usual degree of success. It is still possible to get analogue CROs with incomparably better bandwidth performance than digital CROs at any given price, and there are no immediate signs of this improving. notwithstanding this, modern digital design has resulted in some very fast digital CROs, if you can pay for them.

The problem is fundamental to the digital design. When a signal is read into the front end of a digital oscilloscope, it is first coupled and amplified in the normal fashion, and then fed to an analogue-to-digital converter (ADC). The ADC takes samples of the input waveform at a certain time interval, changes the voltage level of the signal into a digital word (usually 8

bits long) and feeds it out into the rest of the machine where it can be subjected to all the advantages of digital circuitry. It can be stored, manipulated, displayed and so on, easily and cheaply.

The problem, however, is the speed at which the digitizing process is done. This is set by the ADC, these days usually a fully integrated bit of circuitry. Common ADCs available in the shops have conversion speeds from a few milliseconds down to perhaps a few microseconds and prices ranging from a few dollars up to perhaps \$20. In the extreme you can find ADCs with conversion speeds in the 20 ns range that will cost about \$130. To go much faster you need high quality industrial stuff, for which you may pay several hundreds of dollars.

In the extreme, the very best of ADCs will sample every few nanoseconds and cost hundreds of dollars. Now, to see how strong a constraint this is on oscilloscope performance, consider that typically, 40 or so sample positions are required to generate a convincing sine wave shape on the screen. This means a period of perhaps 80 to a hundred nanoseconds if the ADC can sample every 2 ns, or a frequency of 10 MHz.

This way of looking at digital CRO performance can generate a certain amount of confusion, however. Although the bandwidth is only 10 MHz in our example, the ability of the system to respond to transients is very much better than one would assume from this figure. In fact, it will respond to anything larger than the sampling period, say 2 ns or 500 MHz, and is likely to be limited by the amplifier or tube rather than the sampling. Of course, the displayed waveshape will have no necessary relationship to the waveshape on the inputs. All a single sample will allow you to infer is a spike. This all tends to mean that digital CROs are very good at looking at square waves, and indeed, this is where they find their major use.

There are a number of ways to improve the response of digital CROs to continuous waves. One method is to reduce the number of samples and then to interpolate between points so that one generates a smooth wave on the screen. It has the advantage of making the wave look more like the input, hopefully, but at the cost of reducing the ability of the system to track transients.

In fact, some extremely sophisticated algorithms have been developed to allow curve fitting to extend the range of digital CROs. The latest Kikisuis, the 7000 series, use 20 ns ADCs, which should lead to a bandwidth of only 1.25 MHz if we use the 40 sample standard. However, the makers claim to be able to see single shot events up to 20 MHz and repetitive signals up to 100 MHz. The 20 MHz claim is close to

Digital Panel Meter

A 3 1/2 digit panel meter suitable for many applications.

By Paul Chappell

THE PROJECT is based on the ICL7107 panel meter IC, which is essentially a dual slope A-to-D converter with internal decoding and driving circuits for 7-segment LED displays. Dual slope is a relatively slow method of A-to-D conversion; it can take up to 6,000 counts, or 24,000 clock cycles (the clock is internally divided by four to give the count rate) for the 7107 to perform a conversion, as opposed to only about 12 cycles for a successive approximation converter of similar resolution.

The advantage of the technique is that it can produce very accurate results with relatively simple and trouble free circuitry. For a voltage meter, it fits the bill nicely: two or three conversions a second is all that is required, and the 3 1/2 digit (approximately 11-bit) accuracy is all important.

Fig. 1 illustrates the general principle of dual slope conversion. At the beginning of the conversion, SW1, which represents an analogue switch, is set to position 1 for a fixed number of clock cycles. The circuit around the op-amp is an integrator, so C1 will charge up at a rate proportional to the input voltage. At the end of the charge period, SW1 is set to position 2 and C1 discharges at a known rate dependent on the value of $-V_{ref}$. The clock cycles during this phase are fed to a counter; the number that occur during the discharge

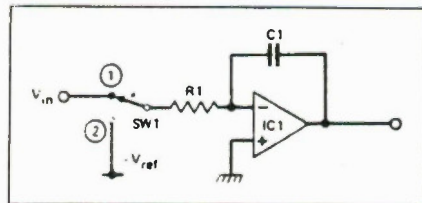


Fig. 1 Integrator used for dual slope conversion.

will be proportional to the voltage on the capacitor at the start of this phase, and therefore to the input voltage.

By careful selection of the timing periods, the output count can be made to indicate the input voltage directly. For instance, suppose that $-V_{ref} = -1$ and the charge period was selected to be 1,000 clock cycles. For an input of 1V, the output count would also be 1,000; for an input of 2V the count would be 2,000, and the counter would indicate the input voltage directly at a scaling of 1 count per mV.

Error Reduction

As long as the sum of the errors in clock frequency, capacitor leakage, resistor temperature drift and so on can be kept to within 0.05% during each conversion cycle, the converter will be accurate enough for a 3 1/2 digit meter.

This is an outrageously demanding specification for long-term drift, but can be met without much trouble for the time of a single conversion cycle. The beauty of the circuit is that long term stability in these factors doesn't matter in the least. If the value of R1 drifts, for instance, C1 may charge to a slightly lower voltage for a given input, but the discharge will be proportionately slower, and the two factors cancel out leaving the count exactly the same.

Unfortunately, there is one source of error that will not cancel: voltage offset in the op-amp. Suppose that the op-amp has an input voltage offset of 1mV. Since the non-inverting input is grounded, the virtual ground point at the inverting input will be at -1mV. This means that an input of 1mV (it will cause current to flow into the virtual ground since R1 will have 1mV across it), an input of 1mV will be seen as zero (since no current will flow in R1) and all readings will similarly be offset by 1mV.

In a practical circuit the input to the integrator would be buffered, the output would go to a comparator, and each would introduce its own time and temperature dependent offset into the circuit, probably adding up to several mV. In the 7107, with a 200mV full-scale, this would have disastrous results: each count on the display represents 100uV, so the last two digits of the display would be totally unreliable.

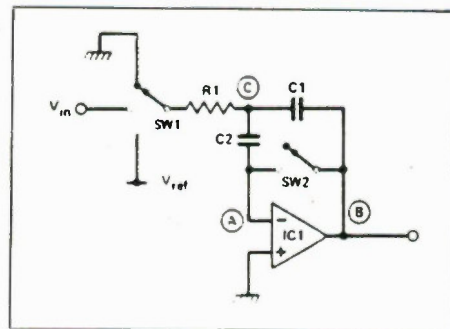


Fig. 2 Modified integrator giving offset cancellation.

Offset errors are cancelled out by the 7107's auto-zero circuit, the principle of which can be seen in Fig. 2. The circuit is the same as Fig. 1 apart from the addition of C2 and some extra switching.

The conversion now has three phases. In the first SW1 disconnects R1 from the input and grounds it. At the same time, SW2 connects the output of the op-amp to its non-inverting input. C2 and C1 have no effect on the op-amp, since they are shorted by SW1, so the circuit stabilizes with points A and B both negative offset voltage, and point C at 0V due to R1. Enough time must be allowed for C1 and C2 to discharge via R1; this 'auto-zero' phase has a period of 1,000 counts in the case of the 7107.

When the circuit enters the charge phase, SW2 is opened and SW1 connects R1 to V_{in} . The op-amp's offset voltage will be held by C2, so point C will still be at 0V. This means that an input of 0V will no longer cause a current in R1, and the offset has been cancelled.

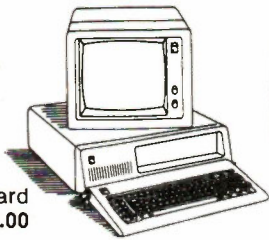
In this simple circuit, the right-hand side of C1 would have to be disconnected from IC1 and grounded during the auto-

Continued on page 53

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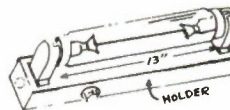
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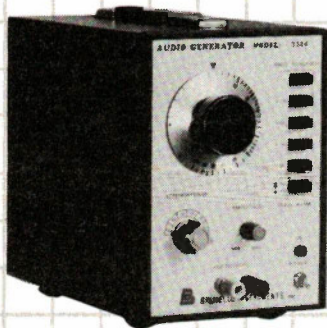
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the Nyquist frequency, and ensures that any voltage excursion will be detected in at least one sample. The 100 MHz limit is the result of continual correlation of the input signal over time; perfectly valid if the input is a sine wave.

The Hewlett Packard HP54201 A/D takes samples continuously at 40 ns and then measures the phase relative to the trigger position. In this way the sample point is displayed at the correct point on the time base. After sufficient repetitions, sufficient points will have been collected to make a sine wave. With this architecture, bandwidth is once again limited by amplifiers and displays, not the digitizing process.

Another method is to increase the number of ADCs. The ADCs are connected in parallel, and made to sample the input one after the other. In theory, the only limitation on this is imposed by the speed of the system clock, and even this can be overcome by running several clocks at different phase angles. The LeCroy 9400 uses this method with 15 ADCs each sampling at 3 ns to give an effective time between samples of only 200 ps, equivalent to 5G samples. In such a situation it is possible to run into much the same sorts of problems that limit analogue CROs. In the case of the LeCroy, the

three dB point is at 125 MHz and determined not by the sampling, but by either the preamplifier or the tube. But notice that in order to get this type of performance it's necessary to go to 15 ADCs, so that the price of the ADC section probably adds considerably to the cost of the unit.

Computers

Another trend in modern digital oscilloscope design is to use the display and computing power of a small computer. In most cases this means developing a plug-in board for an IBM PC, or more likely, an IBM clone. At its simplest level, the board will contain the front end of a standard CRO, the preamps and ADCs, and probably a buffer, and then input this into the bus of the computer for the manipulation required.

There are a number of spurs to this development. The most powerful is the good old bottom line; all things being equal it's cheaper, since half the CRO is already provided in the PC. The second is the wealth of manipulation software that can be provided very easily by the computer. It's no big problem to derive a numerical output giving voltages of various kinds, frequencies and period, spectrum analysis and so on.

It can also be interfaced very easily into the rest of a development system. This might contain all the normal development tools, logic analysers, in-circuit emulators and so on in addition to the oscilloscope, all contained in one box. In fact, many people see this as a logical extension of current technology. It becomes a one stop instrument, capable of making virtually any conceivable measurement.

Composite CROs

The composite oscilloscope adopts the philosophy that while digital treatment of the signal path is difficult, the advantages of computerization do not need to be entirely foregone.

As a general rule, a microprocessor sits between the front panel and the CRO itself, so that controlling the CRO becomes a matter of talking to the micro. This type of architecture leads to some important advantages. Firstly, it matters not whether the operator is in front of the CRO, twiddling knobs on the panel, or half a mile away connected into a telephone line. Typically, this remote control function is implemented over some of the standard test instrument interfaces like GPIB or IEEE.

Secondly, it allows the instrument to be programmed. This is a major advantage

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where the instrument is to be used in a regular test situation. It is quite possible, for instance, to define a test sequence for a particular piece of equipment, and make the CRO set itself appropriately for each measurement.

Many such CROs have the ability to generate text on the screen as well. This gives added advantages with programmable CROs, since all the instructions for a test routine can be displayed on the screen. Another common feature is the provision of cursors for voltage, time and triggering information.

Probably the most important advantage though, is that the processor can be used to intelligently preset the adjustments on the CRO before the operator starts fiddling with the knobs. Thus, when the oscilloscope receives an input, it is possible to have the processor set appropriately on time/div and volts/div so that something is displayed even before the operator touches anything.

Interestingly, many of the operational features of composite CROs are being reintroduced on fully digital machines. The HP54110D reduces all its functions to a keypad and single rotary knob.

ADC and the tube. The storage imposes no special constraints on the design of the CRO, indeed, it follows naturally from its digital architecture to such an extent that digital oscilloscopes without storage facilities are rare, and certainly represent a wasted opportunity.

Analogue storage, on the other hand, is a lot more interesting. Storage is achieved in the tube itself, and depends on special techniques of tube construction. A metal mesh, especially coated with a deposit of highly insulating secondary emission material, is placed immediately behind the screen. During display, the electron beam strikes part of the mesh. These parts emit secondary electrons and so are left positively charged. Thus, forms the pattern of charged particles on the mesh from a replica of the original screen pattern.

To re-display the information the mesh is illuminated by two flood guns. These send a stream of electrons down the tube, spraying all parts of the screen equally. Electrons are accelerated by the positively charged parts of the mesh on to the screen. The negatively charged parts of the mesh form an effective barrier to the flood guns, thus preventing them from



and will generally disappear within an hour or so. Furthermore, it's easy to interface a digital CRO to mass storage of some type so that huge amounts of storage space become available for later display on the CRO or even for display on a computer screen.

As with ordinary CROs the cost of

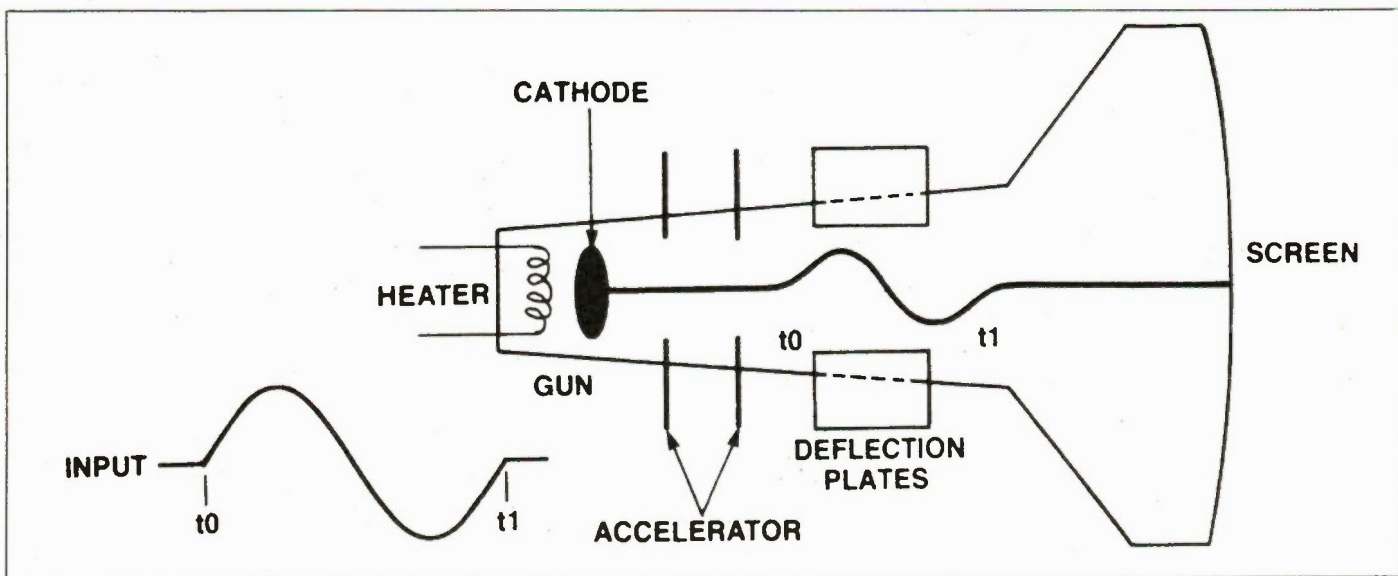


Fig. 2 The path of an electron when its trip time through the deflection field is the same as the period of the input.

Storage

Probably one of the most useful add-ons to the conventional oscilloscope is the ability to store waveforms after they have been received on the input sockets. It comes into its own where signals occur only once, or where they occur so slowly that a meaningful display is impossible to obtain.

The two different types are, as might be expected, analogue and digital. Digital storage CROs develop naturally out of the types of digital techniques we have already discussed. Digital storage is achieved by the addition of some memory between the

getting to the screen.

The advantage of this method as with all analogue oscilloscopes is that it's fast. It also has the ability to capture as many waveforms as can be displayed on the screen. A digital CRO, on the other hand, needs to have special sections of memory defined to store a single waveform; often with a trade off between resolution and the number of waveforms stored.

On the other hand, the advantage of digital storage, and it's often a decisive advantage, is that it will store waveforms indefinitely. The charge on the mesh of an analogue CRO dissipates rather rapidly,

storage oscilloscopes is closely related to speed. At low levels the difference is not significant, and it seems that the extra cost imposed by the special tube of an analogue scope is matched by the extra cost of ADC and memory in a digital one. However, as speed increases, the problems inherent in ADCs start to assert themselves and prices rise far more quickly for digital oscilloscopes than their analogue equivalents.

Special thanks to Philips, Hewlett Packard and Tektronix for information on oscilloscope theory used in preparing this article.

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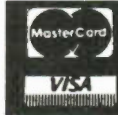
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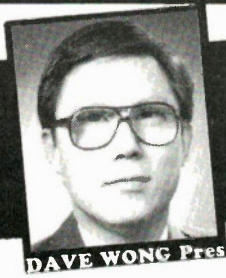
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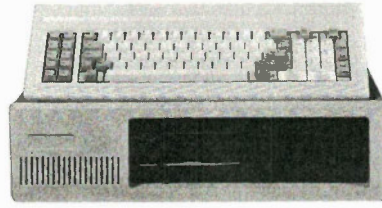
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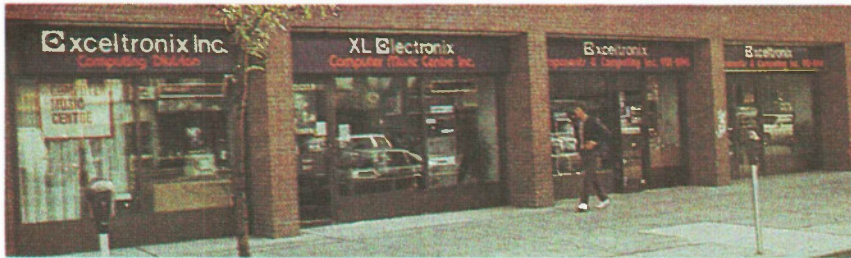
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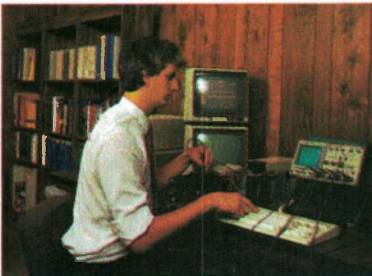
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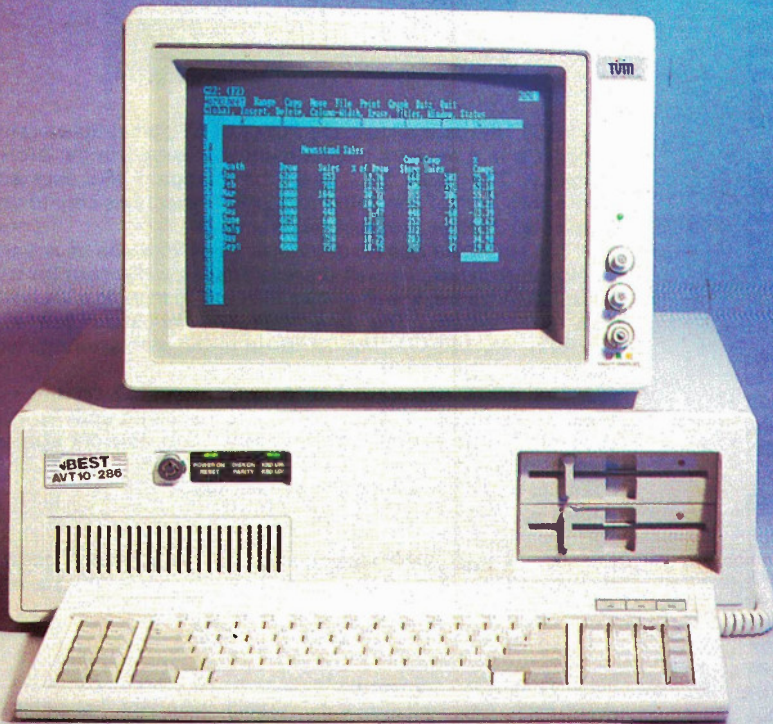
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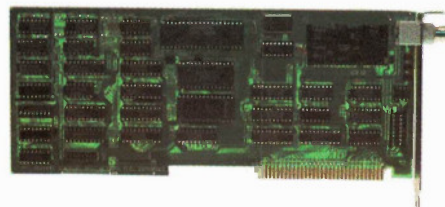
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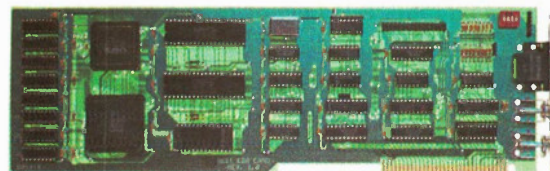
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Four words best describe the **BEST AVT-286** — **Speed, Power, Compatibility and Reliability.**

Speed and Power

The AVT-286 is based on the 80286 microprocessor and supported by the Phoenix IBM AT compatible BIOS, the same software house that supplies the BIOS for all BEST computers as well as many other well known IBM compatibles. Speed is exceptional; the 80286 CPU runs at 8MHz (16MHz clock speed).

The BEST AVT-286 has the power and speed demanded by the software applications used in today's business environment. It is an ideal master unit for multi-tasking and for Local Area Networks (LANs).

On-board RAM is 640K of state-of-the-art memory chips for fast, reliable data processing; this can be expanded up to 16 Megabytes using expansion cards.

Superb Compatibility — with all the Extras!

Software compatibility is exceptional using the Phoenix AT compatible BIOS; programs such as Lotus 1-2-3, DBase III+, Wordstar Professional and Flight Simulator, which are frequently used as a test of compatibility run perfectly. Seven ex-

pansion slots are standard: five support IBM AT signals while the remaining two are compatible with IBM PC or XT peripheral boards.

Two floppy drives come as standard: one has a 1.2 Megabyte capacity, the other has 360K enabling you to read and write to regular double-sided, double density diskettes.

The AVT-286 comes with many features that are extras with other systems: serial and parallel ports, a real time clock/calendar (with battery backup). A heavy duty power supply will take care of not only an added hard disk but a large number of additional peripheral cards.

The keyboard is fully AT compatible; the keyboard lock with a unique security key prevents unauthorized use of the system. The front control status panel provides information on the keyboard lock status, power-on, disk activity and parity errors. Also included is a reset switch, a really useful facility when working with software prone to cause problems which would otherwise need a complete power-down.

The BEST AVT-286 is CSA approved and comes in a durable, attractive flip-top case.

Warranty

We have such confidence in the reliability of the BEST that we offer a full One Year Warranty. This far exceeds the 90 day industry standard. On-site service plan is available across Canada at extra cost through 3M of Canada Ltd.

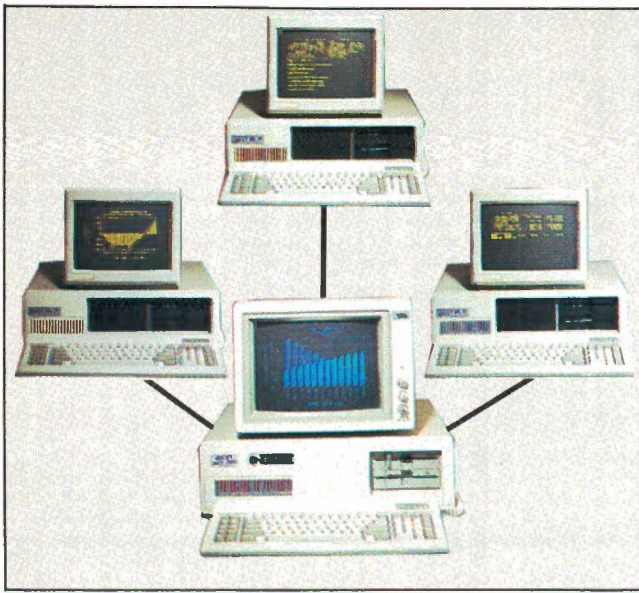
BEST AVT-286: Basic configuration with 640K RAM, two 5.25in. Disk Drives (one 1.2 Megabytes, one 360K), Serial and Parallel Ports, High Quality AT style Keyboard, Keyboard Lock and Status Panel.

\$3495

As Basic Configuration with fast stepping Hard Drives:

20 Meg Hard Drive	\$4,795.00
30 Meg Hard Drive	\$4,995.00
40 Meg Hard Drive	\$5,495.00
80 Meg Hard Drive	\$5,995.00
Built-in Tape Backup Systems from	\$ 799.00
BEST 1200/300 Plug-in Modem	\$ 249.00

Size of basic case approximately 54cm x 44cm x 17cm



The BEST AVT-286 has the power and speed to be the ideal file server for Local Area Networks (LANs) or other multiuser systems. Our own Network Interface Card (NIC) or other multiuser hardware can be installed in the BEST AVT-286 with superb performance characteristics.

The system has proven to be an ideal work-horse in the business environment using such software as Novell, Waterloo Port and LANLink. Networks are becoming more and more popular as they allow existing PCs to share data, input/output devices and software applications. However a network that is under a heavy workload may become so tied up serving the workstations, that the benefits of using a microcomputer are overshadowed by the time delays involved; for example, waiting for a file to be retrieved or a document to be printed. The combination of state-of-the-art data storage devices, Memory chips and the accelerated system clock speed allow the BEST AVT-286 to serve a single workstation on a large network without degrading the performance of the other stations.



The AVT-286 and other BEST computers are extensively used in industry and education. This photograph shows just a few of the over 150 BEST systems in use at Sheridan College. Other major installations of AVT-286 computers include the Governments of Ontario and Alberta.

The speed, power, compatibility and reliability make the AVT-286 an ideal system for most applications at an affordable price.

What People say about the AVT-286

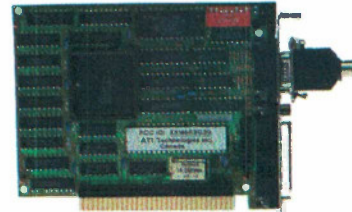
Dan Mersich, a Toronto lawyer whose practice is restricted exclusively to computer law states, "My BEST AVT-286 has acquitted itself with distinction as an outstanding compatible that combines the highest quality with the lowest price".

Uwe Soeder, Director Computer Skills Laboratory, Sheridan College says, "Here in the Computer Skills Centre we have found the BEST AVT-286 matches our needs very well".

Les Palenik, President of Cosmotron Systems Ltd., "I have found BEST computers fully IBM compatible, a good value and with excellent support".

Computing Now!, October 1986, reviewed by Steve Rimmer, Editor, "The AVT-286 is what the PC's really should have been at about the price they should have been sold for. It's the singularly nicest machine I've yet had an extensive play with, and is wholly impressive".

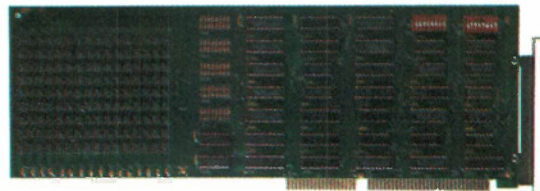
ATI Graphics Solution Card



A solution to practically all IBM and compatible video requirements. Can be used with TTL monochrome, RGB, composite colour or monochrome monitors. Hercules compatible with 720x348 pixel resolution in monochrome, 640x200 in 16 colours, fast flicker free scrolling in all modes, 132 columns in colour or monochrome, runs all colour/graphics software on an IBM monochrome monitor in full screen 16 shades without pre-boot drivers. Half size card, two year manufacturers warranty.

\$395.00

The BEST IBM AT Compatible 4 Meg Memory Card



In order to take advantage of the memory addressing capabilities of the IBM AT or the BEST AVT-286 business computer, we developed a memory card to give the user up to 4 Megabytes of dynamic RAM. The memory card will run at speeds up to 16MHz, which is fast enough to meet the needs of any 80286 microprocessor on the market today. The design uses state-of-the-art (256K x 9) memory arrays, to allow for maximum memory in the smallest physical space. The ninth bit is used as a parity bit to insure the validity of the data. The card is available in memory sizes from 512K to 4 Megabytes in steps of 512K. Boundaries are switch selectable above 1 Meg in blocks of 512K.

With 512K **\$ 695.00**
 With 1 Meg **\$ 895.00**
 With 4 Meg **\$1995.00**

Exceltronix

Toronto Store: 319 College Street, Toronto (416) 921-8941
 Ottawa Store: 217 Bank Street, Ottawa (613) 230-9000
 Mississauga Showroom, Pickup Counter and Mail Orders:
 6315 Kestrel Road, Mississauga, Ont., L5T 1S4
 Long Distance Orders: 1-800-387-8995, Local Orders: (416) 673-5111

BEST Mk IV

Ultra Fast Performance with Superb Graphics at an Affordable Price

- Designed and Made in Canada
- Phoenix BIOS
- Superb IBM PC/XT Compatibility
- Based on the 8086-2 CPU
- True 16-bit Architecture
- Runs at More than Twice the Speed of an IBM PC/XT
- Hardware Switch for 4.77 or 8 MHz Operation
- Standard 640K RAM On-board
- Seven Expansion Slots
- Presocketed for 8087-2 Math Co-Processor
- Two High Quality 360K Floppy Drives
- Real Time Clock/Calendar as Standard
- Parallel Port as Standard
- One Serial Port as Standard (plus a second as an option)
- High Quality AT Style Keyboard
- Hardware Reset Button
- Heavy Duty Power Supply
- Supplied with ATI Hi-Res Colour/Monochrome Card
- Full One Year Warranty



Monitor not included. IBM, IBM PC, IBM XT and IBM AT are registered trade marks of IBM Canada Ltd.

While retaining superb software compatibility with the BEST Mk III and the IBM PC and XT, the **BEST Mk IV** uses the **16-bit facilities of the 8086-2** microprocessor. Although it uses the same clock speed as the BEST Mk III, the 8086-2 has a 16-bit external data bus allowing memory access and main board functions to occur **much faster** than with most compatible computers. However, the basic bus structure is **compatible with the standard IBM 8-bit I/O channel** but still has the benefits of a 16-bit structure.

A hardware switch enables selection of **either 4.77 or 8MHz clock speeds**. The **BEST Mk IV** comes with a range of standard features: Real Time Clock/Calendar (with lithium battery backup), Serial Port, Parallel Port, Reset Switch, Seven Expansion Slots and a heavy duty power supply, more than enough to allow for the addition of a hard drive and a full load of peripheral cards.

The **BEST Mk IV** is fitted with the **ATI Graphics Solution Card as a standard**, this can be used with TTL monochrome,

RGB, composite colour or monochrome monitors. It is Hercules compatible with 720x348 pixel resolution in monochrome, 640x200 in 16 colours. It provides fast flicker free scrolling in all modes and displays 132 columns in colour or monochrome. Runs all colour graphics software on a TTL monochrome monitor in full screen 16 shades without pre-boat drivers (at 4.77 MHz).

One of our difficulties in advertising the **BEST Mk IV** is to impress on customers who have not seen it demonstrated, the **lightening speed** at which it operates. It is more than twice as fast as an IBM PC/XT, runs over 30% faster than other machines which adopt the adjective Turbo and **at two thirds the speed of even the fast 16MHz AT machines** for a true value price. See speed comparison data overleaf.

Used in conjunction with the 8087 math co-processor, you have one of the fastest, most reliable business or engineering aids available in the price range.

Warranty

We have such confidence in the reliability of the **BEST** that we offer a full **One Year Warranty**. This far exceeds the 90 day industry standard. On-site service plan is available across Canada at extra cost through 3M of Canada Ltd.

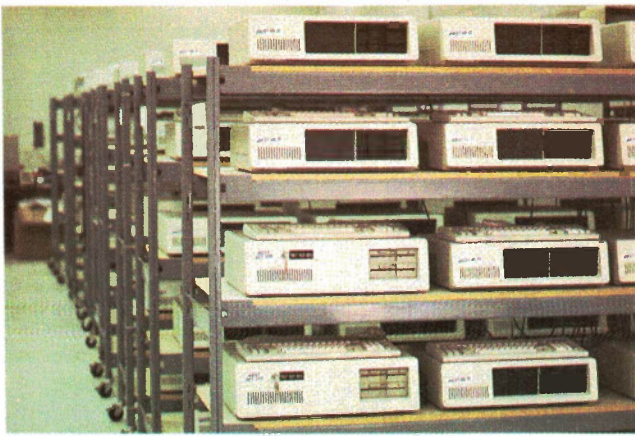
BEST Mk IV: Basic configuration with 640K RAM, two 5.25in. 360K DS-DD Disk Drives, Serial and Parallel Ports, Real Time Clock/Calendar, ATI Graphics Solution Card, High Quality AT style Keyboard.

\$2195

As Basic Configuration with Hard Drives:

20 Meg Hard Drive and One Floppy, 640K	\$2,995.00
40 Meg Hard Drive and One Floppy, 640K	\$3,695.00
80 Meg Hard Drive and One Floppy, 640K	\$4,695.00
Built-in Tape Backup Systems from	\$ 799.00
BEST 1200/300 Plug-in Modem	\$ 249.00

Size of basic case approximately 50cm x 44cm x 14cm



Quality is built into all BEST computers at all stages and our commitment to this is demonstrated by our exceptional One Year Warranty. The quality of a computer does not just lie in the appearance of the case, it depends on quality components, skilled assembly and thorough testing. It begins with the initial design from our own highly qualified engineering staff, continues with Canadian-made boards made to the highest standard with constant quality control through the selection of the highest quality components. These boards are then flow soldered in our own production plant. After quality inspection each system is then subjected to a rigorous 48 hour automatic continuous test (shown in the photograph) simulating an office environment, the equivalent of several months normal usage. Only after a further manual testing of the complete system, is the computer ready for shipping.



The BEST Mk IV makes an excellent business computer. It will run the software you want at a speed that will amaze you; although it costs only slightly more than 4.77/8 MHz systems, it runs at two thirds the speed of even the fast 16 MHz AT systems. Huge spreadsheets recalculate in a flash and it speeds through databases and word processing. This is achieved by using the 16-bit architecture of the 8086-2 microprocessor yet it retains the flexibility of the 8-bit I/O structure allowing for the use of regular boards.

Added to this is the bonus of the ATI Graphics Solution Card as a standard. This can be used with TTL monochrome, RGB, composite colour or monochrome monitors. It is Hercules compatible with 720x348 pixel resolution in monochrome, 640x200 in 16 colours. It provides fast flicker free scrolling in all modes and displays 132 columns in colour or monochrome. Runs all colour graphics software on a TTL monochrome monitor in full screen 16 shades without pre-boot drivers (at 4.77 MHz).

The BEST line

ALL of the BEST personal computers come with standard features that other manufacturers consider expensive options. The excellent reliability proved since we started manufacturing this range enables us to offer warranties far, far better the industry standard.

A complete description of the personal computers manufactured is included in this catalogue. Before you buy your system our computer fluent sales staff can provide you with advice on the hardware and software required to solve your problem. And remember that after you purchase the BEST computer that suits your needs, Exceltronix and its sister companies will be around long after some other retailers have come and gone, to offer you unparalleled service and selection, as we have been for the last seven years.

Special Requirements? We have the in-house experts in both hardware and software to interface a lot of complex equipment to IBM, BEST or compatible computers. We can recommend or customize existing software packages for your business or industrial needs. We have excellent in-store and on-the-road sales staff with computer expertise and a superb team of in-house hardware and software engineers.

We can probably help you with every aspect of your computer needs at reasonable, honest prices. Call us.

APPROXIMATED SPEED COMPARISONS

For the speed comparison test a PL1 programmer was compiled on a 360K RAM disk, namely VDisk supplied on Dos 3.0. The reasons for this instead of a diskette are twofold: 1. The drive characteristics between an AT and a PC are radically different. We wouldn't know if we were comparing speed of the drives or speed of the machines. 2. The 16-bit machines such as the Mark IV and AT cannot utilize their full power while talking to 8-bit devices.

The base was an IBM PC/XT with 640K running at 4.77MHz. The compile was of moderate length: 170 seconds. The table here gives the results of the speed test:

Machine Type	IBM PC/XT 4.77 MHz	Mark III 8.00 MHz	Mark IV 8.00 MHz	IBM PC/AT (12 MHz) (6 MHz CPU)	AVT-286 (16 MHz) (8 MHz CPU)
Seconds	170	105	80	67	53
Relative Speed	1.00	1.62	2.13	2.53	3.2

Looking at the table we see a number of remarkable things. The first is the speed of the AVT-286 over the IBM PC/AT. The AVT-286 is about 25% faster than the IBM AT. The other remarkable thing is that the Mark IV is only 16% slower than the IBM AT! (This is even more remarkable considering the price differential). We also see, as expected, that the 16 bit data path of the 8086 in the Mark IV gives 31% improvement over the Mark III at equivalent processor or clock speeds.

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 6315 Kestrel Road, Mississauga, Ont., L5T 1S4
 Long Distance Orders: 1-800-387-6995, Local Orders: (416) 673-5111

Time Limited Offer
FREE ATI Graphics Solution Card
 (worth \$395) in place of standard video board
 see over page for specifications!

BEST Mk III

A Fully Loaded, Computer with Accelerated Performance (8 and 4.77 MHz)



- Designed and Made in Canada
- Phoenix BIOS
- Superb IBM PC/XT Compatibility
- Based on the 8088-2 CPU
- Hardware Switch for 4.77 or 8 MHz Operation
- Standard 256K RAM On-board, expandable on-board to 640K
- Seven Expansion Slots
- Presocketed for 8087-2 Math Co-Processor
- Two High Quality 360K Floppy Drives
- Real Time Clock/Calendar as Standard
- Parallel Port as Standard
- One Serial Port as Standard (plus a second as an option)
- High Quality AT Style Keyboard
- Hardware Reset Button
- Heavy Duty Power Supply
- Choice of Colour Video or Hi-Res Monochrome Board
- (The ATI Graphics Solution Card described overleaf is available at an extra cost)
- Full One Year Warranty



Monitor not included. IBM, IBM PC, IBM XT and IBM AT are registered trade marks of IBM Canada Ltd.

The **BEST Mk III** was originally introduced as a result of the success of the Mk II but goes one step beyond. It is based on the 8088-2 microprocessor which is capable of running at almost twice the speed of any 8088 system. It includes a hardware switch which allows the user to go from 4.77MHz operation to 8MHz. Any software that uses a lot of memory will run noticeably faster, compilers and spreadsheets will speed through calculations. The facility to revert to 4.77MHz enables a small minority of entertainment software which is clock dependent to be used.

The **Phoenix BIOS** offers superb IBM compatibility to enable practically all MSDOS and PCDOS type software to be run including all the favourites such as Lotus 1-2-3, dBase II

and III and word processing packages.

As with all **BEST** computers, the emphasis is on quality and reliability. Top grade parts, power supplies and disk drives are always selected followed by rigid manufacturing standards and thorough rigorous testing before any unit leaves our premises.

Since the **BEST Mk III** is a serious business microcomputer, it includes a host of standard features rarely found with other comparable systems. This includes two 360K high quality disk drives, a minimum of 256K memory, a real time clock/calendar with battery backup, serial and parallel ports and a heavy duty power supply. The power supply enables you to add a hard drive without having to upgrade.

Warranty

We have such confidence in the reliability of the **BEST** that we offer a full One Year Warranty. This far exceeds the 90 day industry standard. On-site service plan is available across Canada at extra cost through 3M of Canada Ltd.

BEST MkIII: Basic configuration with 256K RAM, 8 and 4.77Mhz operation, two 5.25in. 360K DS-DD Disk Drives, Serial and Parallel Ports, Real Time Clock/Calendar. High Quality Keyboard.

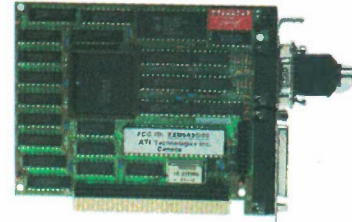
\$1895

With 640K RAM	\$1,995.00
As Basic Configuration with Hard Drives:	
With 20 Meg H.D., One Floppy, 256K	\$2,695.00
With 20 Meg H.D., One Floppy, 640K	\$2,795.00
With 40 Meg H.D., One Floppy, 640K	\$3,495.00
With 80 Meg H.D., One Floppy, 640K	\$4,495.00
Other Hard Drive configurations available.	
Built-in Tape Backup Systems from	\$ 799.00
BEST 1200/300 Plug-in Modem	\$ 249.00
Size of basic case approximately 50cm x 44cm x 14cm	



BEST computers are extensively used in industry and education. This photograph shows just a few of the over 150 BEST systems in use at Sheridan College, just one of several major installations completed in the last year. The BEST Mk III represents exceptional value; even if its basic form it comes fully loaded with two drives, 256K of memory, serial and parallel ports and with a colour or monochrome video board.

ATI Graphics Solution Card



A solution to practically all IBM and compatible video requirements. Can be used with TTL monochrome, RGB, composite colour or monochrome monitors. Hercules compatible with 720x348 pixel resolution in monochrome, IBM compatible colour/graphics 640x200 in 16 colours, fast flicker free scrolling in all modes, 132 columns in colour or monochrome, runs all colour/graphics software on a TTL monochrome monitor in full screen 16 shades without pre-boot drivers. (at 4.77 MHz) Half size card, two year manufacturers warranty.

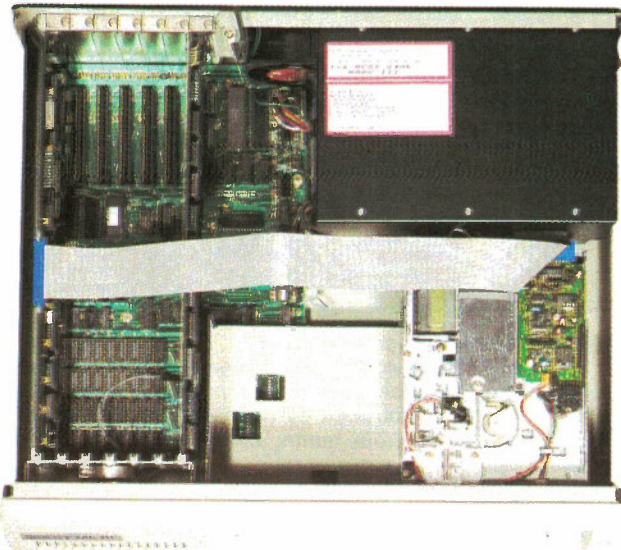
\$395.00

BEST Modem

The BEST Modem is a smart 1200/300 direct connect modem. It can be either a cased stand-alone unit (which requires a small wall adaptor) or plugs directly into one of the slots in the BEST or IBM compatible. When used as a stand alone unit, the modem looks like and behaves like a Hayes 1200 Smart Modem and emulates the same instruction set. When used in an IBM or compatible it looks like an intelligent serial communications port which also supports a super-set of the Hayes instruction set.

The modem supports auto-dial, auto-answer and auto-speed select directly from software control. The modem also has a speaker so that audible monitoring of the call is possible. LED monitors indicate the state of the modem: Modem Ready, Auto-answer Enabled, Carrier Detected, Transmitting, Receiving, Data Set Ready.

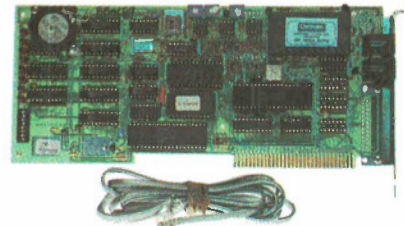
Software packages such as Crosstalk, PC-Talk and Hayes Smartcom II will also run.



The quality of a computer does not just lie in the appearance of the case, it depends on quality components, skilled assembly and thorough testing. It begins with the initial design from our own highly qualified engineering staff, continues with Canadian-made boards made to the highest standards with constant quality control through the selection of the highest quality components. These boards are then flow soldered in our own production plant.

This attention to quality at all stages enables us to offer a full One Year Warranty on all BEST computers, far in excess of the industry standard of 90 days.

All prices and specifications in this catalogue are subject to change without notice.



Plug-in Card Version **\$249.00**



Stand Alone Unit . . . **\$299.00** Serial Port Cables extra

BEST Mk II

All the Features You Need and Remarkable Value

- Designed and Made in Canada
- Phoenix BIOS
- Superb IBM PC/XT Compatibility
- Based on the 8088 CPU
- Standard 256K RAM On-Board
- Seven Expansion Slots
- Presocketed for 8087 math Co-Processor
- Two High Quality 360K Floppy Drives
- Real Time Clock/Calendar as Standard
- Parallel Ports as Standard
- One Serial Port as Standard (plus a second as an option)
- High Quality AT Style Keyboard
- Hardware Reset Button
- Heavy Duty Power Supply
- Choice of Colour Video or Hi-Res Monochrome Board
- Full One Year Warranty



Monitor not included. IBM, IBM PC, IBM XT and IBM AT are registered trade marks of IBM Canada Ltd.

The BEST Mk II includes a host of standard features not usually found on other IBM compatible systems in the same price range. A minimum of 256K RAM is supplied with two 360K double-sided, double density high quality disk drives, a real time clock/calendar with lithium battery backup, serial and parallel ports and a heavy duty power supply. Quality is built in at all stages confirmed by our extended One Year Warranty.

Superb IBM compatibility is supplied by the Phoenix BIOS, the same BIOS used in many other leading IBM compatible computers.

The BEST Mk II offers exceptional value while enabling it to be upgraded by the addition of extra memory, a hard drive or your choice of peripheral cards.

Our Training Centre in Mississauga is now operative, offering comprehensive computer courses at both beginner and advanced levels. Call for course outline.

BEST Mk II Package Deal SAVE \$300! Time Limited Special

- BEST Mk II 256K
- Copal SC1200 Printer
- ZVM 1220A Zenith Monitor
- Printer and Video Cables

A complete system for \$1895

Warranty

We have such confidence in the reliability of the BEST that we offer a full One Year Warranty. This far exceeds the 90 day industry standard. On-site service plan is available across Canada at extra cost through 3M of Canada Ltd.

Basic configuration with 256K RAM, two 5.25in. 360K DS-DD Disk Drives, Serial and Parallel Ports, Real Time Clock/Calendar. High Quality Keyboard.

\$1695

With 640K RAM	\$1,795.00
With 20 Meg H.D., One Floppy, 256K	\$2,495.00
With 20 Meg H.D., One Floppy, 640K	\$2,595.00
BEST 1200/300 Plug-in Modem	\$ 249.00
Size of basic case approximately 50cm x 44cm x 14cm	

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Long Distance Orders: 1-800-387-8895, Local Orders: (416) 673-5111

BEST Colour Video Board

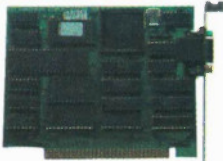


Allows three types of monitor to be connected: composite monochrome, composite colour or direct RGB. Allows use of a light pen. Can display either 80 or 40 column characters selected by software. Can be used in the 40 column mode with a regular TV by adding an RF modulator. Character generator allows all ASCII characters plus block graphics and a set of international characters.

In low resolution mode with colour or monochrome monitors displays 320x200 pixels. In high resolution monochrome graphics can display 640x200 pixels.

\$149.00

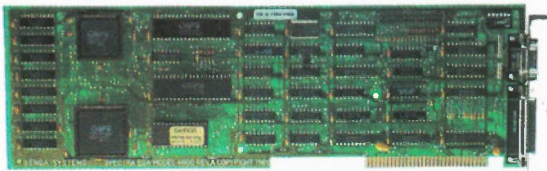
BEST Monochrome Card



An upgraded text display card for high resolution, ideal for word processing or data entry. Characters are made up from 7x9 dots (against regular 5x7). Will work in four modes: normal, intensified, reverse and blinking. The board is half size and will fit into computers with restricted space.

\$149.00

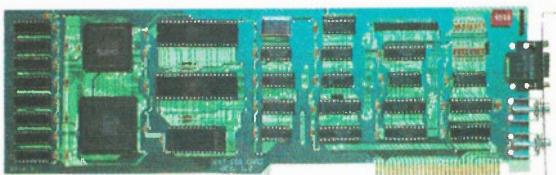
Genoa Systems



Genoa Spectra Enhanced Graphics Card with 256K display memory. 100% IBM compatible, available for the PC XT and AT bus. Monochrome (720x350) pixels and colour graphics (640x350 pixels) capability. Softscroll pan and windows through 1 Meg pixel memory. Includes a parallel port and has a programmable cursor.

\$599.00

The BEST EGA - Enhanced Graphics Adapter



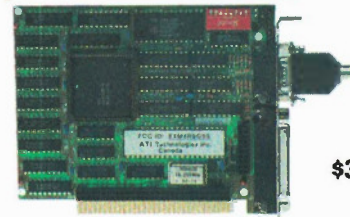
The BEST EGA card has several modes of video operation available on one card. 100% IBM EGA compatible: 640 x 350 pixels in 16 colours on the enhanced colour display.

It supports functions of the IBM Colour graphics video adaptor and IBM monochrome display adaptor; 320 x 200 and 640 x 200 16 colour graphics on the colour graphics monitor; 640 x 350 four shade graphics on the monochrome display (black, normal, intensified and blank); flicker free display; split alphanumeric mode screen display; bit mapped graphics in four planes; up to 512 characters that can be user defined.

The BEST EGA card comes standard with 256K memory for flicker free, text and bit mapped graphics.

\$299.00

ATI Graphics Solution Card



\$395.00

A solution to practically all IBM and compatible video requirements. Can be used with TTL monochrome, RGB, composite colour or monochrome monitors. Hercules compatible with 720x348 pixel resolution in monochrome, IBM compatible colour graphics 640x200 in 16 colours, fast flicker free scrolling in all modes, 132 columns in colour or monochrome, runs all colour/graphics software on an IBM monochrome monitor in full screen 16 shades without pre-boot drivers (at 4.77 MHz). Half size card, two year manufacturers warranty.

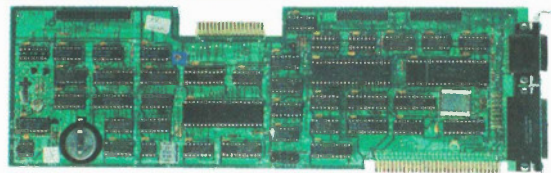
Hercules Graphics Card Plus

Three modes: Text, Graphics and RAMFONT. RAMFONT allows the PC to access up to 3072 custom characters. You can use up to 24 different type fonts. Simplifies displaying international or scientific characters and symbols into a page of standard text. Overcomes the need for both English and French keyboards.

\$429.00 Call for Free Brochure

Exceltronix is an Official Dealer for Hercules Products

BEST Multi-Function Disk Controller



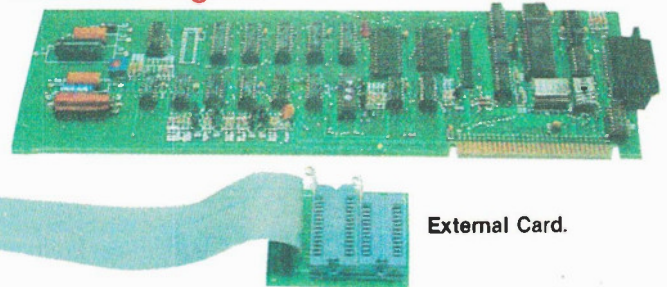
Can handle up to four DS-DD 5.25in 360K Drives. Circuitry can also handle some tape back-up units (such as Irwin) in place of one of the disk drives.

Added Functions:

Two Serial Ports that support standard RS232C signals. Parallel Port can be configured as either primary or secondary printer port.

Real Time Clock/Calendar with lithium battery (includes software). **\$199.00** (Cables extra)

EPROM Programmer



External Card.

Can program any of the following EPROMs: 2716, 2732, 2732A, 2764, 27128. Two sockets are available on the adaptor board for 28 and 24 pin types. ZIF sockets are available as an extra. The software source is supplied to allow users to modify the program to suit their needs.

Optional Extension board is available which attaches to the adaptor via a ribbon cable enabling EPROMs to be programmed without having to open computer cover. A serial port option is also available.

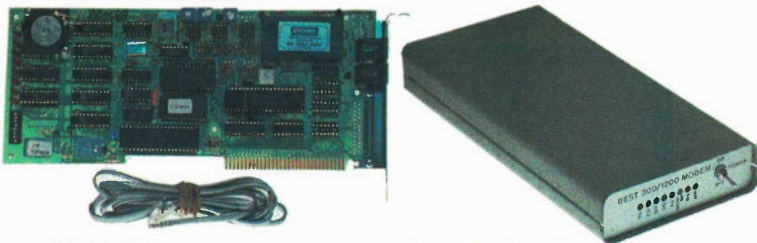
Basic Board with two standard EPROM sockets \$ 99.00

As above but with ZIF sockets \$139.00

External card (includes cable) \$ 69.00

Serial Port Option (cable extra) \$ 29.00

BEST Modem



\$249.00

Stand Alone Unit
\$299.00 Serial Port Cables extra

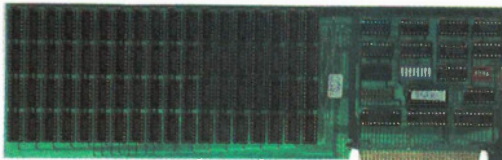
The BEST Modem is a smart 1200/300 direct connect modem. It can be either a stand-alone unit (which requires a small wall adaptor) or plugs directly into one of the slots in the BEST or IBM compatible. When used as a stand alone unit, the modem looks like and behaves like a Hayes 1200 Smart Modem and emulates the same instruction set. When used in an IBM or compatible, it looks like an intelligent serial communications port which also supports a super-set of the Hayes instruction set.

The modem supports auto-dial, auto-answer and speed select directly from software control. The modem also has a speaker so that audible monitoring of the call is possible. LED monitors indicate the Transmitting, Receiving, Data Set Ready and more.

Software packages such as Crosstalk, PC-Talk and Hayes Smartcom II will also run.

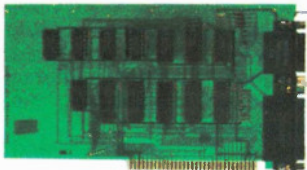
BEST 512K Board

Switch selectable boundaries



Complete with 512K \$299.00
Complete with 64K \$169.00

BEST Parallel/Game Card



Gives you the capacity to add almost any parallel printer or plotter to your system. Game port will handle up to four game paddles or two joysticks.

\$49.00 (Cables extra)

BEST Quanta Board

A Multi-function board with features ideal for upgrading basic IBM and compatible systems.

Two Serial Ports: one or both can be disabled, handles up to 9600 Baud, can be configured to support IBM PC mA current loop.

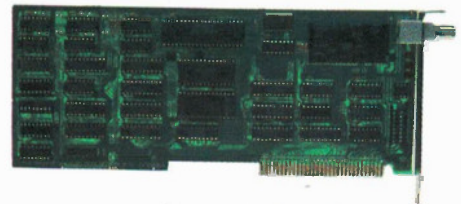
Parallel Printer Port: can be selected to be the primary or secondary port using DIP switches.

Games Port: for up to four paddles or two joy-sticks.

Real Time Clock/Calender: With software to interface to the time/date functions of MSDOS and PCDOS. Lithium battery keeps it operating when system is not powered. Accurate to within seconds a year.

\$149.00 Cables extra.

The BEST NIC Network Interface Card



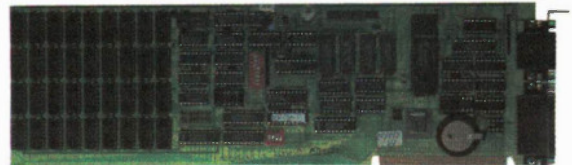
The BEST NIC card allows any PC/XT or AT compatible system to operate in a network environment that supports the ArcNet topology. The BEST NIC uses the Standard Microsystems single chip ArcNet controller and LAN Transceiver chip to conform to all ArcNet protocol requirements.

The NIC Card can be used with many versions of Advanced Novell Network, as well there is space on the card for user installed firmware, which allows the card to work in a Waterloo Port environment. The User installed firmware can also eliminate the need for floppy drives in the workstations, with the use of a Boot Prom.

The BEST NIC card has 3 LEDs mounted on the rear bracket to indicate network, and token passing activity. Also accessible from the rear of the system are network address selection switches, which allows the network address to be changed without opening the system case.

\$299.00

BEST PentaRAM 256K/512K Board



A Multifunction card with almost every option.

RAM Expansion. Up to 256K using 4164s or 512K using 41256s. Switch selectable boundaries. Ideal for older systems not able to hold additional memory on board.

Serial Port. Supports standard RS232C signals

Parallel Port. Supports nearly all parallel printers and plotters, can be configured as either primary or secondary printer port.

Games Port. For up to four game paddles or two joysticks.

Real Time Clock/Calender with lithium battery (includes software).

Cables are extra.

With 256K \$249.00
With 512K \$279.00

BEST Prototyping Board

\$28. 95



Intel ABOVE BOARD

Allows you to use memory above 640K. Comes with 256K standard and expandable to 2 Megabytes.

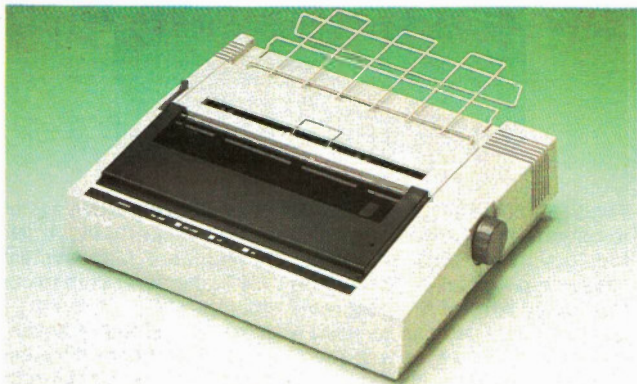
For PC XT \$499.00

At Version starting at 128K, expandable up to 1.6 Megabyte \$699.00

AST RAMPAGE!

For expanding memory above normal 640K limit. Complete with 256K, expandable to 2 Meg.

For PC XT \$509.00



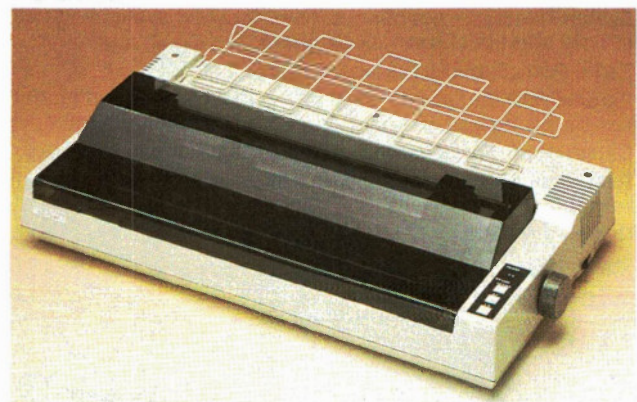
SC-1200

The high cost performance versatile printer for home and office use

Features

- Bi-directional printing at 120 cps
- 80 columns (10 cpi)
- Letter quality print by dual pass
- IBM-PC mode selectable by dipswitch
- Multifunction control available
- Maximum 11" of paper back feeding
- Tractor and friction paper feed (4 — 10")
- The paper can be cut only 1" from the last print position
- Operator replaceable print head without tool

\$329



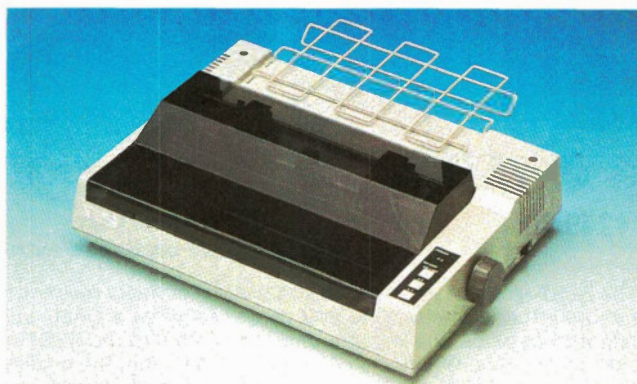
SC-5500

The fastest and the quietest wide column printer for business use

Features

- Fast, 180 cps
- 136 columns for wide paper (10 cpi)
- Letter quality print by dual pass
- Quiet printing (Noise level less than 55dB (A))
- IBM-PC mode available
- Multi function control available
- Download character set (User defined 256 character)
- Buffer capability of 3k Bytes
- Tractor and friction paper feed (4 — 16")

\$699



SC-1500

The fastest and the quietest printer in its class

Features

- Fast, 180 cps
- 80 columns (10 cpi)
- Letter quality print by dual pass
- Quiet printing (Noise level less than 55 dB (A))
- IBM-PC mode available
- Multi function control available
- Download character set (User defined 256 character)
- Buffer capability of 3k Bytes
- Tractor and friction paper feed (4 — 10")

\$499

Copal Company Limited ESTABLISHED 1949

"Quality First with our products; Customer First with our Service" are the two most important concepts that Copal believes in. Since its establishment in 1949, Copal has continued to cultivate its precision production and design of state-of-the-art high level technology. Besides the line of inexpensive high quality printers, Copal is a major manufacturer of Disk drives, electronic components, robotics, medical, office and photography equipment.

The pioneering spirit of reform and challenge is what drives Copal ever forward.

Write Hand 1200 offers Versatility and Economy

This low cost performance printer features 120 cps bidirectional printing, graphic modes, snap-in cassette ribbon, tractor/friction feed, foreign language characters, user replaceable head, and standard parallel interface with near letter quality and serial interface options.

Write Hand 1200 also takes care of checkwriting and short forms with ease. A pushtractor feed mechanism eliminates bothersome form-feeding and wasted paper. And with Write Hand 1200, you can print from the top of your fan-fold paper without wasting the first page. You save time and money!

Write Hand 1500 (80 column) and 5500 (136 column) High Performance Printers for Professional or Office use

Both models boast quiet operation: Less than 55 dB (A) noise level with all the standard features of friction/tractor feed, downloadable character sets, 3K buffer memory, graphic modes (up to 240 dpi), 8 foreign languages marks and symbols, super/subscripts, and replaceable print head as well as near letter quality.

And Write Hand printers interface with most popular computers and are compatible with Epson and IBM.

Write Hand is a trademark of Copal. IBM is a registered trademark of International Business Machines Corporation. Epson is a trademark of Epson Corporation.

*IBM-PC is a registered trade mark of International Business Machines Corp.

Toshiba P321

Impact Wire Dot Matrix, 24-pin overlapping. Letter quality 72 c.p.s.; Draft quality 216 c.p.s. (12 cpi), 180 c.p.s. (10 cpi). With serial and parallel interfaces. Accepts Font Cartridges and downloadable font disks, Qume Sprint 11 emulation, 4" to 11" paper widths, PC compatible and more. **\$1,079.00**

Toshiba P351

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

- Letter quality at 100 cps
- High-speed drafts at 288 cps
- Superb graphics at 360 x 180 and 180 x 180 dots per inch. **\$2,095.00**

Toshiba P351C

\$2,295.00

Printers

Okimate 20 **\$345.00**
80 c.p.s. in draft • 40 c.p.s. in NLQ • 80 column • Black or colour ribbon • With IBM Plug and Print.

Okidata ML192 (IBM) **\$679.00**
• 160 c.p.s. • Parallel (optional Serial) • Correspondance quality • 10"

Okidata ML182 **\$429.00**
120 c.p.s. in draft • 80 column • Enhanced mode • Parallel interface • IBM compatible.

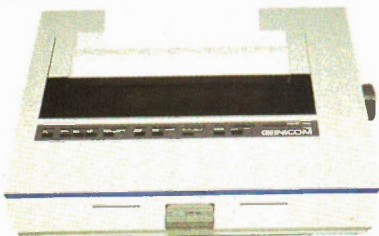
Okidata ML193 (IBM) **\$1069.00**
• 160 c.p.s. • Parallel (optional Serial) • Correspondance quality • 15".

Epson

FX85 **\$750.00**
120 c.p.s., 9-pin print head, NLQ.

FX286 **\$1099.00**
180 c.p.s., 24-pin print head, NLQ.

LQ1000 **\$1595.00**
Daisy wheel



Genicom 1025 . **\$1599.00 with one module**

200 c.p.s. draft, 100 c.p.s. NLQ, 10" paper width, Multiple personality modules, 18-in print head, built in stand.

Star Micronics Star NX 10 **\$529.00**

120 c.p.s., NLQ, parallel only, 10 inch paper.

Toshiba 3100 Portable

The Toshiba brings you the power of the AT in a readily portable, 15lb package. Designed for serious users, the T3100 has the compatibility and capability to run even the most sophisticated software in the IBM PC family.

The T3100 uses the 80286 microprocessor but runs 33% faster than the IBM PC-AT. Standard RAM is 640K, expandable to 1.6Meg. Disk drive is a 3.5in, 720K and a rugged 10Meg Hard Drive. (Options include a 5.25in drive for compatibility).

A state-of-the-art gas plasma screen is easy to read and displays a full 80 characters x 25 lines with a resolution of 640 x 400 pixels. Standard equipment includes RGB colour monitor interface, serial port, parallel port, external drive interface and I/O bus expansion chassis. Size is 12.2 x 3.1 x 14.2 inches.

\$6495.00

Quantity Discounts Available.

Daisy Wheel Printers

Qume LetterPro 20 **\$875.00**
22 c.p.s., 96 character print wheel, 59 DB operation.

Qume LetterPro PLUS **\$1389.00**
45 c.p.s., 96 character print wheel.

Roland 1212 **\$669.00**
180 c.p.s., Font Switch.

TTX 1014 **\$429.00**
14 c.p.s., Daisy wheel, pin and friction feed.

TTX 1114 **\$459.00**
As 1014 same as above with Diablo 630 compatibility.

Laser Printers

Qume Laser 10 **\$5,125.00**
10 pages per minute, 300 x 300 dots per inch, 250 sheet paper tray, 19 fonts per line either down loaded or personality modules, economical to operate, parallel or serial interface, legal, letter, A4, transparencies and envelopes.

Blaser **\$3,900.00**
8 pages per minute, 300 x 300 dots per inch, 8 fonts per line, 128 style per page, landscape mode, legal, letter, A4, B5 and mini (index card), serial and parallel interface, optional 5 computer input.

QMS Kiss Laser Printer **\$3,995.00**
8 pages per minute, parallel printer port, letter size paper tray, 9 resident fonts, emulates Epson, Qume and, Diablo.

Genicom Series 5000 Laser Printer **\$5,400.00**

10 pages per minute, legal, letter and A4, 200 sheet paper tray, 300 x 300 dots per inch, 16 fonts per page, plug in character sets, up to 4 modules can be plugged in simultaneously.

Printer Ribbons

Star Micronics

SG10/15 **\$ 4.50**
Power Type **\$ 9.95**
Radix 10 **\$16.00**
Radix 15/SR15 **\$19.00**

Toshiba

P-1351 **\$15.50**
P-1340 **\$15.50**
P-351 **\$15.50**

Qume

Letter Pro 20 **\$7.95**

Epson
LX80 **\$8.95**
FX80 **\$6.95**
FX100/185/286 **\$9.95**
LQ1500 **\$8.95**

Copal
SC-1200/1500 **\$12.00**
SC-55001 **\$16.00**

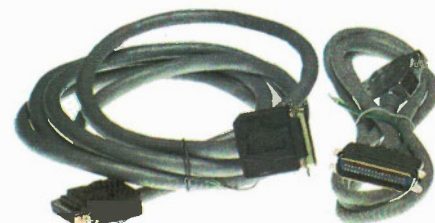
Okidata
ML80/82A/83/92/93 **\$ 4.50**
ML182/183/192 **\$11.95**
Okimate 20 — Black **\$ 8.95**
Okimate 20 — Colour **\$ 9.95**

Serial Switch Box **\$59.00**



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

Cable Assemblies



DB25 Male to DB25 Female **\$18.95**
RS232 Cable (6ft of round conductor) **\$18.95**
RS232 other lengths and connector configurations available on request.

Parallel Cable for IBM interface DB25 through 6ft of ribbon to 36 pin centronics with appropriate connections **\$18.95**

Cable Assemblies for two 5-1/4in drives and controller (e.g. IBM) using three 34 pin connectors and appropriate length of 34 conductor cable. **\$29.95**

Serial Cable: 2 x 13 Female header to DB25 in a bracket **\$29.00**

Y-connector for Hard Drive **\$15.00**



If you liked our MD-3, you'll love our MD-7. And MD-8. And MD-24...

Following the success of our MD-3 high resolution monitor, we at TVM have developed a complete family of high resolution, high performance monitors designed to satisfy any requirements and any budget.

All TVM monitors come with an impressive list of features including non-glare 14" CRT screen, full X-ray shielding, built-in 90-270 volt AC power regulator, and our unique Multi-Display feature, providing customers with built-in amber/green/full color versatility available at the twist of a knob.

Whether sold under our own brand name or as OEM products, our MD-System monitors offer a welcome marketing contrast to the otherwise depressed PC industry.

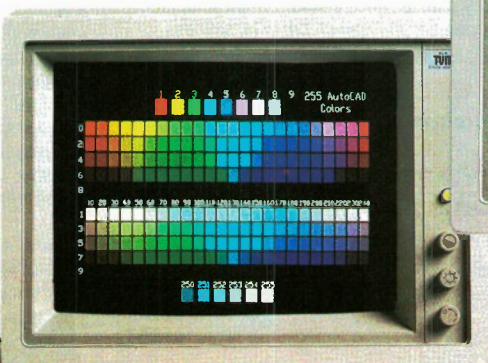


MD-3 Multi-Display Hi-Resolution RGB Monitor

- Compatible with IBM, APPLE and most other PC systems
- Includes green/amber/full color Multi-Display function

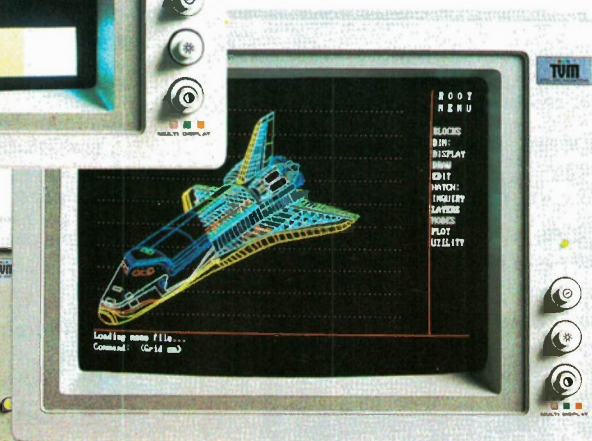
MD-3V Multi-Function RGB Monitor/Receiver

- Multi-purpose "TV-MOUSE" for VTR/TV viewing
- Soft-Touch seven color monochrome selector & white reverse switch



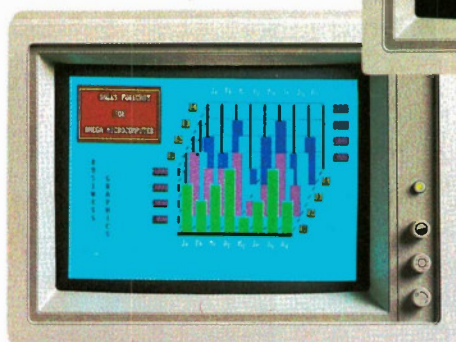
MD-8 Professional Graphics Ultra-High RGB Monitor

- Compatible with IBM Professional Graphics controller
- 720x480 pixel resolution with 4,096 colors capability
- Soft-Touch seven color monochrome selector



MD-7 Multi-Scan Enhanced RGB Monitor

- Compatible with IBM Enhanced Graphics Adapter
- Dual mode 15.75 to 21.85 KHz, 640x200 to 720x350 pixels resolution
- Green/amber/16 to 64 colors



MD-24 BoB Enhanced RGB Monitor

- Compatible with PERSYST "BoB" card or equivalent
- 800x400 pixels resolution (non-interlaced)
- Seven color monochrome selector/16 color text switch

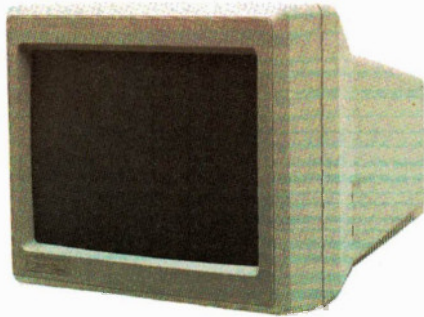
MD-3	\$599.00
MD-3V	\$899.00
MD-7	\$899.00
MD-9	\$929.00
MD-24	\$929.00



Exceltronix is an authorized TVM dealer

Persyst is a registered trademark of Emulex Corporation. IBM is a registered trademark of International Business Machine Corporation. APPLE is a trademark of Apple Computer Inc.

Zenith Data Systems



ZVM-1200A

12" diagonal screen • non-glare amber display • composite input • 25 lines x 40/80 characters.

\$135.00

ZVM-1230A

12" diagonal screen • non-glare green display • composite input • 25 lines x 40/80 characters.

\$135.00

ZVM-1240

12" diagonal screen • non-glare amber display • PC monochrome input (TTL) • 25 lines x 80 characters • 720 x 350 pixels • IBM PC & compatibles.

\$229.00

ZVM-1200 Monitor Stand

Suitable ZVM1220A, 1230A and 1240

\$25.00

ZENITH COLOUR MONITORS

ZVM1330

13" diagonal screen • RGB input • 25 lines x 80 characters • 640 x 240 pixels green screen only switch • 16 colours including PC brown.

\$699.00

CV-2580

25" diagonal screen • RGB/composite input • 25 lines x 80 characters • sound capability • green screen only switch • video "loop thru" feature.

\$1049.00

NEC Multisync 1401

High resolution colour monitor. Ideal for CAD/CAM and graphics. Works with all colour video cards including CGA, EGA and PGA. 800x560 pixels. 7 switchable text colours. Includes cables for all IBM graphics boards 14" screen with tilt and swivel base.

\$1195.00

Amdek Monitors

300A • 12" amber composite • 40-132 character display **\$229.00**

310A • 12" amber TTL • 40-132 character display **\$265.00**

700 Ultra high resolution **\$Call**

Princeton Graphics Monitors

HX-12 12" 15MHz RGB high resolution, horizontal resolution 690 dots, vertical 240 lines (non-interlaced) 480 lines (interlaced) **\$1199.00**

SR-12 12", 30MHz RGB ultra high resolution, horizontal resolution 690 dots, vertical 400-480 lines (non-interlaced) **\$1249.00**

Dynateck Surge Protection

SS-2. Two outlets with 3-stage clamping circuit plus RFI/EMI filtering to withstand and instantly dissipate more than 6000V. CSA approved.

\$99.00

SS-D. As SS-2 plus when power drops below a safe level, Surge Sentry DSF automatically shuts your system off before damage can occur. 4 outlets with reset switch to avoid surge when power comes back on.

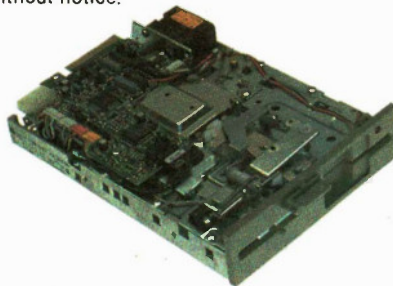
\$199.00

Toshiba Disk Drives

ND-04D 360K DS/DD (black or grey) **\$169.00**

ND-08DE-G 1.2 Mbyte AT Compatible, Grey **\$269.00**

Prices and specifications subject to change without notice.



5.25" Disk Drives

JU455 **\$149.00**

• Shugart/Panasonic 5.25" slimline, double sided, double density disk drive with 360K storage capacity silent stepping. IDEAL FOR IBM COMPUTERS.

JU475 **\$199.00**

• Shugart/Panasonic 5.25", 1.2 Meg, Silent stepping. Ideal for AT and compatible systems.

Seagate AT Compatible Hard Drives

4026, 20 Meg **\$1,295.00**

4038, 30 Meg **\$1,495.00**

4051, 40 Meg **\$1,995.00**

Toshiba AT Compatible

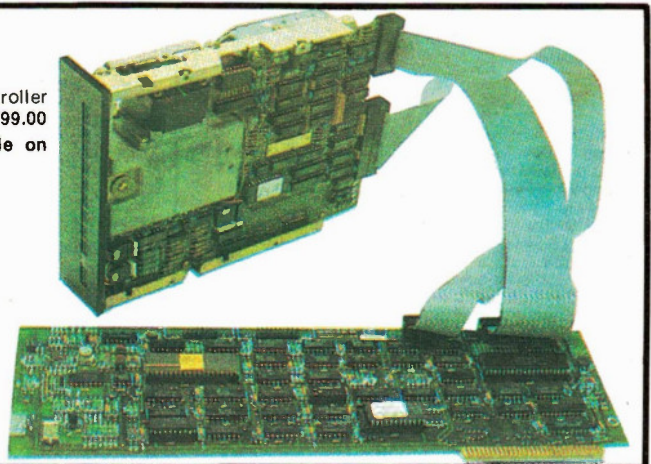
MK56FA, 80 Meg **\$2,495.00**

Quantity Discounts Available.

Hard Disk Drives

Seagate 20 MEG with controller and cables **\$799.00**

Quantity discounts available on two or more.



Diskettes

Prices per box of 10 - 10% discount on 3 or more boxes.

Diskettes

Per Box of 10	
Maxell SS/DD	\$24.95
Maxell DS/DD	\$29.95
Dysan SS/DD	\$27.50
Dysan DS/DD	\$35.95
TDK High Density for AT	\$49.95
Fuji High Density for AT	\$54.95

Disk Boxes

DX50	\$14.95
Disk Mailers (holds 2 disks)	\$ 2.10
Flip 'n File 50	\$39.95

Modems

Hayes	
2400B Stand Alone	\$1095.00
1200B	\$ 599.00
1200	\$ 620.00
300	\$ 265.00
Smartcom II	\$ 188.00
Crosstalk XVI	\$ 175.95
BEST 1200/300	\$ 249.00

Joystick

TAC 10	\$ 54.95
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Hitachi Digitizing Pads

4-button cursor	\$395.00
12-button cursor	\$450.00

Mice

Microsoft	
Serial type	\$229.00
Bus version (parallel)	\$209.00

Mouse Systems

PC Mouse/PC Paint	\$279.00
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Bill Boards

Compuserve's Starter Kit Includes \$25 free access time	\$59.00
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Keyboards

Keytronics 5151 (PC/XT compatible)	\$259.00
Keytronics 5151A (AT compatible)	\$279.00
Maxiswitch (XT/AT switchable)	\$135.00



IBM Compatible Software



BORLAND

	Sug. Retail	Our Price
Turbo Pascal with 8087 Binary	\$150.00	\$ 89.00
Turbo Tutor	\$ 55.00	\$ 39.00
Turbo Toolbox (all types databases, editor, graphics)	\$ 95.00	\$ 55.00
Turbo Gameworlds	\$ 95.00	\$ 69.95
Turbo Prolog	\$150.00	\$ 99.00
Turbo Lightning	\$ 95.00	\$ 69.95
Reflex (the analyst)	\$220.00	\$149.00

MOUSE SYSTEMS

PC Mouse with Paint	\$399.00	\$279.00
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PETER NORTON UTILITIES

Norton Utilities	\$150.00	\$ 99.95
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MICROSOFT

Windows	\$145.00	\$109.95
Word (Version 3.0)	\$675.00	\$499.00
MS Mouse Serial Version	\$320.00	\$229.00
MS Mouse Bus Version	\$285.00	\$209.00
Fortran Compiler	\$510.00	\$399.00
Quick Basic	\$145.00	\$109.00
C Compiler	\$575.00	\$459.00
Multiplan	\$285.00	\$229.00
Flight Simulator	\$ 75.00	\$ 55.95

MSDOS (3.2) & GWBASIC \$ 99.00
 (only as a package deal with any BEST computer).

FIFTH GENERATION

Fastback	\$250.00	\$189.00
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ASHTON-TATE

dBase III + Framework II	\$ 995.00	\$747.00
Multimate	\$1025.00	\$729.00
	\$ 695.00	\$499.00

MICROPRO

Wordstar 2000	\$695.00	\$449.00
Wordstar 2000 +	\$795.00	\$529.00
Wordstar Professional	\$695.00	\$469.00

SATELLITE

Word Perfect	\$469.00	\$399.00
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SUB LOGIC

Jet	\$ 75.00	\$ 55.95
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BOOKS

Using PC Dos	\$32.95
MS Dos Users Guide	\$29.95
Using Word Perfect	\$29.95
dBase III Handbook	\$29.95
Using Microsoft Word	\$29.95
dBase II Advanced Programming	\$35.95
Using 1-2-3	\$29.95
Using 1-2-3 Workbook & Disk	\$44.95
IBM PC AT Users Reference Manual	\$41.95
CP/M Programmers Encyclopedia	\$25.95
Programming in C	\$33.50

If you are looking for a piece of software not listed here, call our Distribution Department for availability and the best price.

For fast service, please have the manufacturer and title of the software before calling (416) 673-5111

USER'S GUIDES

These titles have been chosen for your reading enjoyment and your understanding of popular software.

MS DOS USER'S GUIDE (by Chris DeVoney) \$29.95

For users of computers with Microsoft's popular MS DOS operating system, this book is an essential investment. It explains each of the MS-DOS commands in a clear and concise manner and includes examples of command syntax. Helpful hints on command usage and explanations of the hierarchical directory and I/O redirection will enable you to make the best use of your computer. Whether you're a novice or an expert MS DOS user this guide will prove indispensable.

dBASE III ADVANCED PROGRAMMING (by Joseph-David Carrabis) \$35.95

Experienced dBASE users and other programmers will find this book an excellent guide to tight, fast, and efficient programming. This book is divided into three sections: advanced programming techniques, turnkey systems with dBASE III, and business applications. The book emphasizes how to speed up dBASE programs and how programs written in assembly, BASIC, Pascal, or C language can be adapted to run with dBASE III applications. For those who want to learn and write the best programs, dBASE III Advanced Programming is an excellent choice.

USING 1-2-3 Workbook and Disk \$44.95

New revised version! (by David P. Ewing)
 Designed to accompany Using 1-2-3, this new workbook offers hands-on exercises and step by step instructions that guide you through each stage of building a comprehensive 1-2-3 model. You can use this workbook in group teaching sessions or work through the exercises independently. Either way, this workbook will help you to master quickly the many features of Lotus 1-2-3. Workbook (Includes bound in disk.)

USING 1-2-3 \$29.95

(by Douglas Cobb and Geoffrey LeBlond)
 This award-winning best-seller has shown thousands of 1-2-3 users how to take advantage of the programs full power and flexibility. Special emphasis is given to keyboard macros, the database function, and graphics capability. If 1-2-3 is your first experience with an electronic spreadsheet, Using 1-2-3 offers an introduction to spreadsheeting. Both beginning and experienced users of 1-2-3 will benefit from the detailed, clear explanations and examples this book provides. Using 1-2-3 is being updated to include information on 1-2-3 Release 2.

USING WORDSTAR 2000 \$29.95

(by Eric Sorensen)
 Truly a powerhouse, WordStar 2000 offers a combination of features found in no other wordprocessing software product. This book focuses on the products unique capability to integrate all the document-processing needs of a business. Eric Sorensen's helpful hints and shortcuts for using WordStar 2000's features will get you up to speed quickly. If you want to learn how to use WordStar 2000 to maximize business productivity, you won't find a better resource.

USING MICROSOFT WORD \$24.95

(by Eric Marsha Zager and Claire Chase) \$59.95 Disk
 This popular book has been updated to include information on Microsoft Word, Version 2. This revision also includes a new chapter about spelling and hyphenation. Using Microsoft Word shows you how to take full advantage of the stylesheets that come with the Word program. If you want to modify the stylesheets or create new ones for customized applications this book shows you how. It is a valuable guide for anyone who wants to master both the basics and the finer details of Microsoft Word. A companion disk is available.

CP/M PROGRAMMER ENCYCLOPEDIA (by Bruce A. Bringham) \$25.95

If you are a CP/M user, this book has everything you need to know in a single volume. The author has developed a comprehensive and easy-to-use reference for all commands and syntaxes that are related to the CP/M operating system. Included are all of the syntaxes for the languages that operate under CP/M, such as dBASE II. For serious CP/M users, the CP/M Programmer's Encyclopedia is an excellent investment.

USING WORDPERFECT \$29.95

(by Walton Beacham and Deborah Beacham)
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USING PC DOS VERSION 3 \$32.95

(by Chris DeVoney)
 In the lucid, easy-to-understand style that made him a best-selling author, Chris DeVoney describes both the common and no-so-common operations of PC DOS, Versions 3.0 and 3.1. DeVoney guides users-both novice and intermediate-through basic and advanced DOS commands. A Command Summary defines every DOS command, gives examples, and tells how to handle common problems. Using PC DOS Version 3 is two books in one-a concise tutorial and valuable reference you will refer to over and over again.

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EPROM PROGRAMMER AND EMULATOR



Totally self-contained (has its own display, entry keypad and power supply).

Based on the Z-8 microprocessor.

Can program up to 8 EPROMs simultaneously (anywhere from one to 8 EPROMs at the same time with the information in its own memory or on master EPROM).

Each of the 8 EPROM programming sockets is individually buffered and isolated from one another providing protection in situations when there is a bad EPROM among the eight being programmed. Clearly indicates and singles out any defective or marginal EPROMs prior to or after programming.

After programming the unit does a full VERIFY routine of the EPROM (at a Max Vcc of 5.4V and at a Min Vcc of 4.5V) to ensure high reliability of your EPROMs. Very simple to use.

A standard unit contains 8x16K of on-board memory which is sufficient in most cases, but can be easily optionally be upgraded to 8x64K of on-board memory.

The Gang Programmer can handle a wide selection of EPROMs: 2716, 2732, 2732A, P2732A, 2532, 2564, 2764, 27128, 27128A and optionally upgradeable to handle 27256, 27512, 2758 and 2724.

Gives you option of entering the data which you want to be programmed on the EPROM through a built-in keypad and display into the EPROM programmer's built-in RAM or by downloading the data to be programmed by

RS232 interface (110 to 9600 Baud). The RS232 is standard — not optional!

Data can be checked or modified, since you can examine any memory location of the programmers built-in RAM, this holds true even after you have down-loaded through the RS232 from your computer; you can check or modify the memory before finally programming it on your EPROMs.

Read Master EPROMs; you can plug in a programmed EPROM, dump it into the programmers RAM, check the contents on display by stepping through the memory and, if you wish, you can alter any location before copying to other EPROMs.

EPROM Programmer can also be (optionally) used as an EPROM emulator, saving hours of frustration, reprogramming and waiting.

Using the Emulator option, you can enter via the keyboard or down-load through the RS232 from your computer or development system, the information which you think is right for whatever project you are building. This is the same information which you would normally burn into an EPROM, plug into your new undebugged processor and moments later you realize that you forgot to enter a code or that you must add or delete some codes. This normally would mean waiting 20 minutes for erasing of the EPROM and reprogramming and wasting time.

Using the Emulator option, you simply plug in a 24 or 28 Pin buffered pod into the socket on your board where you would normally fit the

EPROM, the difference being now that you can have all the information in the programmers RAM, connected to the pod by a ribbon cable and you can start your testing. If you wish to change, add, delete any codes, you can modify the contents of the programmers RAM using the keypad and display and continue testing moments later. Keep in mind that the RAM is protected from being accidentally altered.

Complete package with EPROM Emulator, 8 ZIF sockets, Gang Programmer with 16Kx8 of RAM and RS232 **\$995.00**

Gang EPROM Programmer with 8 ZIF sockets, 16Kx8 RAM and RS232, without Emulator **\$695.00**

EPROM Programmer with only one ZIF socket, 16Kx8 RAM and RS232, without Emulator. Able to do all the functions describe but can handle only one EPROM at a time **\$499.00**

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Industrial quality EPROM erasers. Erase time about 15-20 minutes. Starting at **\$129.00**

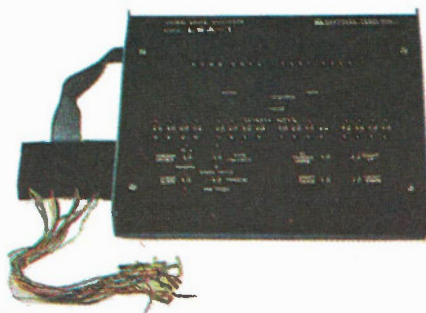
Multiflex Low-Cost Logic State Analyzer

Ideal for Educational Institutions and the Hobbyist.

You've just completed a microprocessor system, and it doesn't work. What next? You can use an oscilloscope to check for clock signals and the like, but if everything appears to be in order you can't go much further without sophisticated equipment. In these situations, professionals turn to their logic state analyzers, each of which cost thousands of dollars. MULTIFLEX has the answer for all those people who don't want to take a mortgage on their house just to get a computer working. The MULTIFLEX Logic State Analyzer has all the essential features of those more expensive units at a fraction of the cost. This is a high-quality piece of test equipment, suitable for industrial or scientific use, but its price is well within the price range of a hobbyist.

Easy to understand and operate, the Logic State Analyzer allows you to monitor 16 points in a digital system (i.e. data and/or address bus, or control lines) which carry continually changing signals. You can select a bit pattern you expect will appear at these points. Once the pattern appears the Analyzer will trigger and record ("freeze") the next 1023 bit patterns so that they can be examined step by step even though data is no longer available in the unit being examined. For software development the Analyzer is invaluable, especially in dedicated systems. If you design a microprocessor system for a specific function, and you have no monitor, assembler or other such software, the best and often only way to debug the system is to use a logic analyzer. It will let you look closely at the data flow as a program is executing, or monitor the address lines to make sure that the instructions are being executed in the proper sequence. The various control lines such as memory read and write, DMA, interrupts, or enable and disable signals can also be examined. You can, of course, monitor any combination of these signals, such as the data bus and half of the address bus, or half of each plus 4 control lines. The combinations are endless.

Complete, assembled and tested **\$369.00**



Note from Industry to Educational Institutions:

At Multiflex we interview many technicians each year, from a variety of Colleges. Only a few applicants know what a Logic State analyzer is and even fewer know how to use one.

Yet in our industry, it is almost as important to know how to operate logic analyzers as it is to use an oscilloscope since the technician will need to use a logic or timing analyzer to trouble-shoot complex equipment.

We have spoken to many other companies and found that they are experiencing the same problems with technicians coming fresh from College. So, we asked educational institutions why they don't teach this aspect of electronic engineering. The teachers are fully aware of the problem but explained that they cannot afford the high cost of logic analyzers; even those institutions which have them can afford only one or two which gives the students little chance to learn them. less expensive than the alternatives.

Here is your chance to prepare technicians for the real world!



EPROM EMULATOR

If you are a computer designer who values your time, you can't afford to be without this!

Did you ever write a piece of code, burn it into an EPROM, plugged it in and it didn't work?

Did you then go through the code (using an analyzer or your brain power) and then discover you left out some crucial Byte which caused the processor to go to the point of no return?

If the above holds true, how many EPROMs have you reprogrammed, erased and damaged? More important how many hours have you wasted?

Put an end to all the above problems and save time, money and frustration: Buy an EPROM Emulator.

It allows you to download over RS232 (at 300 to 9600 Baud) a program from your computer into the Emulator's memory (16Kx8) and then simply plug a 24 or 28 Pin header connected via ribbon cable to the Emulator in place of your EPROM and you have successfully emulated an EPROM.

If you need to change your code, simply change it on your computer, download to the Emulator's memory and you are back in business in seconds.

This stand-alone product emulates the following EPROMs: 2716, 2732, 2764 and 27128. Can be used with any computer with an RS232 Interface.

This product is a must for any hardware development since it allows the user to test and modify EPROM data roughly 20 times faster than conventional methods.

The Emulator normally comes attractively packaged and contains its own power supply. However, to make it more affordable for beginners, we have separated the price into several categories:

1. Complete Emulator with 16Kx8 memory, attractively packaged with power supply. Fully assembled and tested with warranty. **\$189.00**
2. As above but with 8Kx8 of memory **\$159.00**
3. Emulator with 4K RAM, no housing or power supply (requires +5V at 1.5A Max, +/- 12V at 0.03A. Fully assembled and tested. **\$99.00**

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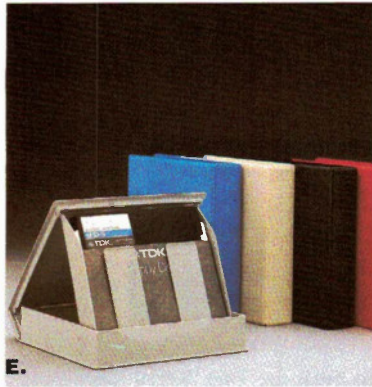
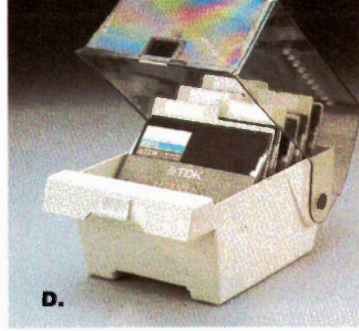
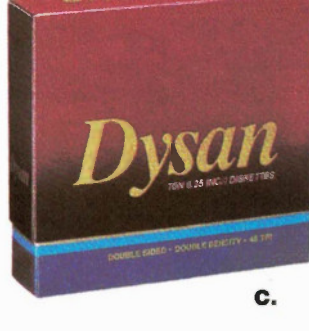
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A. Diskette Storage Box
Holds 50 - 5 1/4" Disks
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PKM-5 \$13.98

E. Disk Transporter
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F. Large Capacity Disk Storage

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J. Computer Security Alarm (IBM PC)
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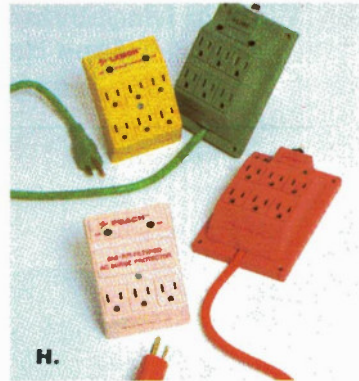
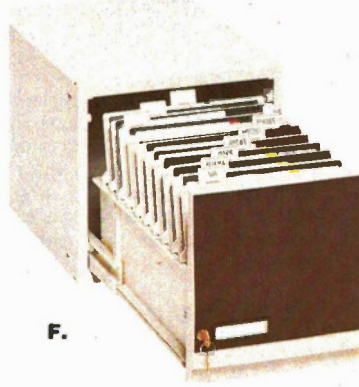
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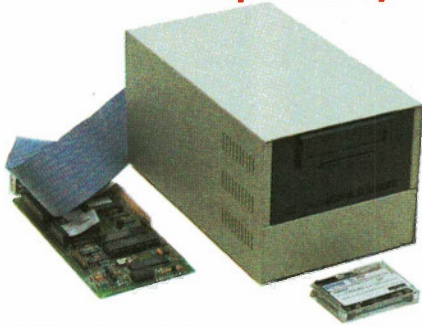
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Multiflex has designed a unit which allows you to physically remove the mass data storage device and lock it in another room without disassembling your entire system. The external hard disk drive and tape backup unit is self contained with its own power supply and connects to back of your system through a ribbon cable. Simply follow normal shut down procedures then unplug the unit and carry it to a safe location.

With Seagate 20 Megabyte Hard drive and Scorpion Tape Backup unit
\$2295.00

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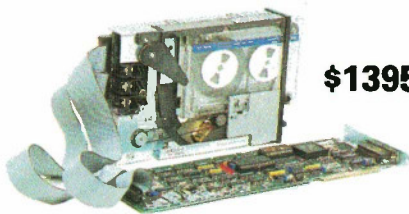
Convert your IBM PC or XT into a Hard Drive System within Minutes
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This unit rapidly converts your system into a Hard Drive unit, and it is compact enough to fit in a brief case. The unit contains its own power supply, fan, a reliable Seagate 20 Megabyte hard drive and a controller card which plugs into your existing system.

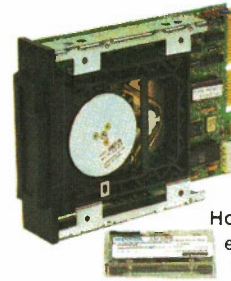
With Seagate 20 Megabyte Hard Drive
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Scorpion 20 Meg Tape Drive Backup and Controller.



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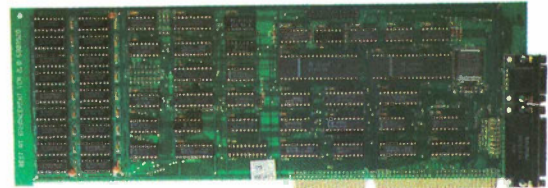
Irwin 20 Meg Tape Drive Backup



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Hooks up to your existing floppy controller.

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BEST AT Compatible Enhancement Card



This card includes the following features: Two Serial Communications Ports, One Parallel Printer Port and Memory starting from 128K to 512K in selectable boundaries. This card will allow IBM AT user with 256K or 512K of on-board memory to expand that AT machine to full 640K capability as well as provide them with two serial ports and one parallel port.

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Watch for our Special Parts Flyer in December Electronics Today

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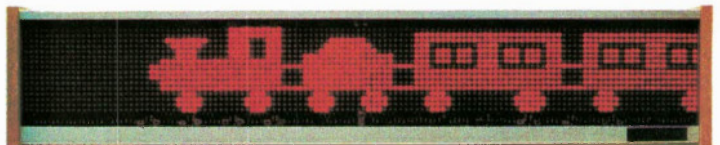
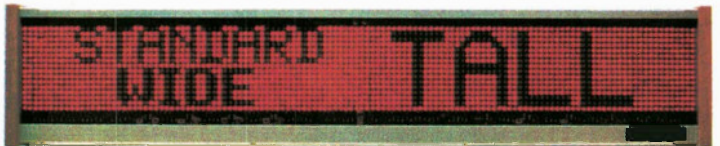
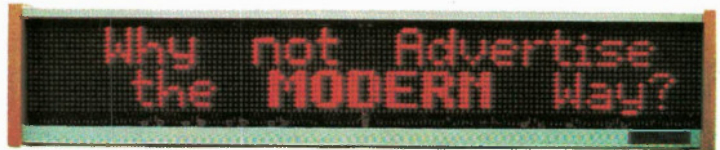
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In this modern market place, you cannot afford to let a superb, competitive advantage such as this to pass you by. The VERSADIGITAL DISPLAY gets results — in increased market awareness, improved market share and most importantly, increased sales.

Manufactured by our sister companies: Multiflex and Versadigital and distributed by Exceltronix.

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50th Anniversary of the CBC

***A fascinating account of 50 years of
Canadian radio and TV broadcasting.***

By Jack Brickenden

THE year CBC was born a tape recorder weighed half a ton, stood seven feet tall, and recorded on two miles of metal tape which wound onto a reel which was two feet in diameter. It was called a Blattner-phone.

At that time a young Toronto Star reporter named Foster Hewitt was already attracting radio audiences for his colorful radio broadcasts describing hockey games. "He shoots; he scores" became a household phrase.

In Canada's smallest province a fledgling musical group was struggling to get going in what ultimately became known as country and western. It was called Don Messer And His Prince Edward Islanders. The year was 1936.

It was not long after that a handsome, debonair young man turned to international radio to share his emotional agony with every man, woman and child in the British Empire. King Edward VIII sat stiffly in front of a set of BBC microphones in London and declared to the entire world that he was giving up his throne "for the woman I love." There wasn't a dry eye in the Empire after that broadcast...and the soap opera was born. Canadians heard the broadcast on the new Canadian Broadcasting Corporation, which had picked it up via short wave from London.

This was the stuff radio was made of in the early days. Broadcasting in North America was a catch-as-catch-can arrangement 50 years ago. Nobody was particularly concerned if more than one station was broadcasting on the same frequency. It didn't seem to matter about program content, at least not at first. Some broadcasters would place a gramophone with a horn speaker in front of a microphone and play scratchy old 78s to fill in the time between patent medicine commercials and bible college messages. Often as not the station owner's children would be assigned to crank the gramophone and change the records.

The handling of commercials on some of those pioneer radio stations was enough to curl your hair. Like the Indian herb man. This man would come on the air and play a few hymns. Then he would advise his listeners that Our Lord had commanded the people of Canada to use a particular Indian herb remedy. His special stationery, which accompanied the elixir when it was mailed out, carried a picture of Jesus in one corner and a picture of himself in Indian costume in the other. This particular program had the distinction of being the first in Canadian broadcasting history to be banned when controls were finally introduced.

Radio was as much a point-of-view as it was a facility. For the benefit of their in-

visible audiences, performers wore evening clothes to take part in classical music programs from the primitive studios. Listeners identified with the radio personalities, and vice versa, in a way that would turn a modern DJ green with envy.

Peter Whittal, who became a public figure as MR. FIXIT when TV came to Canada, started his broadcasting career as a farm commentator. He liked horses. He was doing a farm show out of Winnipeg on one occasion and was also awaiting word from the hospital where his wife was in the process of presenting him with another offspring. While the show was still on the air Whittal was handed a note advising him that his wife had been delivered of a 4 1/2 pound baby girl. He immediately took the folks in the radio audience into his confidence by reading the note on the air. Then, knowing that farm people would understand his sentiments, added: "Four and a half pounds isn't all that much, but I suppose in this dry spell a man's lucky to get his seed back."

Radio and Journalism

Radio wasn't just an accompaniment to other things; it was a vital instant contact with a world that used to be far, far away from the average person. People sat in their living rooms around the radio and became part of the drama and music that wafted its way toward them through the air. And for the first time, they were also part of great news events being described as they happened.

One such event was the Moose Mine disaster. As this drama unfolded for all the world to hear, entire families stayed up all night glued to their radios to be in on the events being described from Moose River Mine.

On Easter Sunday, April 2, 1936, at exactly 11 PM Atlantic Standard Time, one of three men standing at the 141-foot level of a worked-out gold mine in the desolate interior of Nova Scotia pulled a thin signal wire to summon transportation to the surface. The Moose River Mine story had begun.

The mine caved in. Trapped underground were Alfred Scadding, a mining engineer, Herman McGill, a geologist, and David Edwin Robertson, a doctor at the Toronto Sick Children's Hospital. The collapse of the mine sealed them under tons of rubble and there they stayed for 11 days and 11 nights. This was Sunday night. By Tuesday hope had pretty well been abandoned. But on the morning of the fourth day wisps of pale, blue smoke filtered up through the shattered rock formation. There was still life below ground.

The mining men of Nova Scotia rolled up their sleeves and prepared to go to

work. Newspaper men, newsreel cameras, and one lone radio reporter converged on the scene. The only radio man on hand was not even a newsmen. He was J. Frank Willis, who happened to be the public broadcasting official in charge of Halifax. Willis grabbed a technician, Arleigh Canning, a rented touring car, and a heavy silver-plated studio microphone and headed for the scene.

During the long, agonizing days of rescue he broadcast along a second-rate telephone line to all 58 Canadian radio stations, to 650 radio stations in the United States, and by BBC shortwave around the world. Willis broadcast up-to-the-minute reports from the pithead every half hour for 66 consecutive hours until the two survivors were rescued. He scooped every newspaper in the world and altered the face and form of journalism forever.

Suddenly, tempered in the white heat of emergency, radio had come of age.

It was a system that was about halfway between the public radio of Britain and the free-enterprise of the United States.

The First Stations

Canada's first radio station was XWA in Montreal (now CFCF). It was broadcasting out of a small section of the Marconi plant and had begun a schedule of experimental programs in 1919. Probably the best-known photograph relating to early broadcasting in Canada is one taken at XWA showing the famous heavyweight boxer Jack Dempsey being interviewed in front of a horn microphone.

XWA was then followed by commercial stations which sprang up all across the country. The first of these was CJCG which was owned by the Free Press in Winnipeg. It opened May 1, 1922, and closed down a year later.

Phrases like "promise of performance" wouldn't have been understood in those days. With the equipment available to them they were pretty lucky just to stay on the air. The radio stations then were owned by small radio clubs, by large corporations, radio manufacturers, newspapers, church groups, universities, provincial governments and railroads. By 1929, seven years before CBC was born, Canada had about 75 radio stations licensed in both official languages. There were 300,000 known receiving sets in Canada.

The Toronto Star opened radio station CFCF in 1922 and closed it down in 1933.

Both the T. Eaton Company, in Toronto, and Dupuis Freres in Montreal, owned radio stations in 1922 but gave them up because they could see no practical benefit from such investments.

National programming was limited in those days because distribution east and west by land line to Canada's small and scattered population was too expensive. Only half-a-dozen frequencies were exclusively Canadian despite repeated efforts to work out an agreement with the United States and Mexico. It was cheaper and easier to use recorded music and popular American programs. It still is. Canadian stations offered little else.

For this reason there was growing discontent among Canadians with what was happening to Canadian radio. Because of the steadily increasing flow of complaints from the Canadian public the government appointed a Royal Commission to investigate. Its mandate was "to examine into the broadcasting situation in the Dominion of Canada and to make recommendations to the Government as to the future administration, management, control and financing thereof."

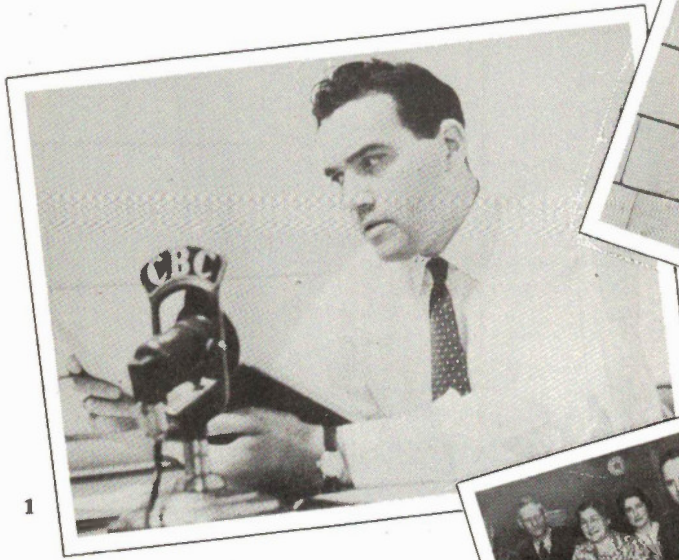
The chairman of this commission was the then president of the Canadian Bank of Commerce, Sir John Aird. His grandson has recently completed a stint of Lieutenant-Governor of Ontario. The study was thorough, covering 25 Canadian centres plus the United States and Britain. The Commission was treated to a considerable variety of opinion about what ought to happen to broadcasting in Canada. However, there was unanimity in one fundamental matter: Canadian listeners wanted Canadian broadcasting.

The Aird report to the House of Commons spoke of the importance of broadcasting in promoting national unity in this enormous country, and of the problem of financing an adequate national service in Canada from commercial revenues alone. In a typical Canadian compromise, the Aird Commission recommended a system that would combine limited commercial revenue with a government grant and a licence fee for each receiving set. There would be both public and private radio stations which would, for the most part, work together to distribute programming nationally in Canada. It was a system that was about halfway between the public radio of Britain and the free-enterprise of the United States.

The CRBC

In 1932 the forerunner of CBC was created. It was called the Canadian Radio Broadcasting Commission. It broke the ground for public broadcasting in Canada and did a lot of good work. CRBC was on the right track but it wasn't structured to handle the complexities and pressures of

Continued on page 39



1

1 *The Voice of Doom.* Long before he became Pa Cartwright on US television, Lorne Green had earned the nickname of Voice of Doom on CBC radio. The combination of his resounding bass voice and the grim war reports he was required to read on the CBC National Radio News during the early years of WWII created the title for him. Among other announcers who read the National with distinction were Charles Jennings, father of Peter Jennings, and Earl Cameron.



2

2 *J. Frank Willis, actor, administrator and son of a piano manufacturer was the only broadcaster on hand at the 1936 Moose River Mine cave-in. He broadcast every half hour for 66 consecutive hours from the pithead as the two survivors were dug out of the debris, scooping every newspaper in the world and altering the face of journalism forever.*



3

3 *When CBC came into being in 1936, there was a little group of musicians in Prince Edward Island who were destined to make their name in Canada, first on radio and then on TV. In those days they were called Don Messer And His Prince Edward Islanders. That's Messer in the plaid shirt and tie and holding the violin, and beside him is the irrepressible (and much thinner) Charlie Chamberlain.*



4

4 *It actually started when Johnny Wayne and Frank Shuster were at university. Then there was the Canadian Army Show (that's Frank, top centre, and Johnny immediately below him with the sheriff's star on his lapel). Then they became a regular CBC Radio Network feature with the Wayne and Shuster Show. Today they are still going strong on CBC-TV.*



5

5 *The CBC News Service came into being early in the Second World War, and such famous war correspondents as Matthew Halton (above), James M. Minifie and Peter Stursberg kept Canadians informed on the progress of the fighting.*



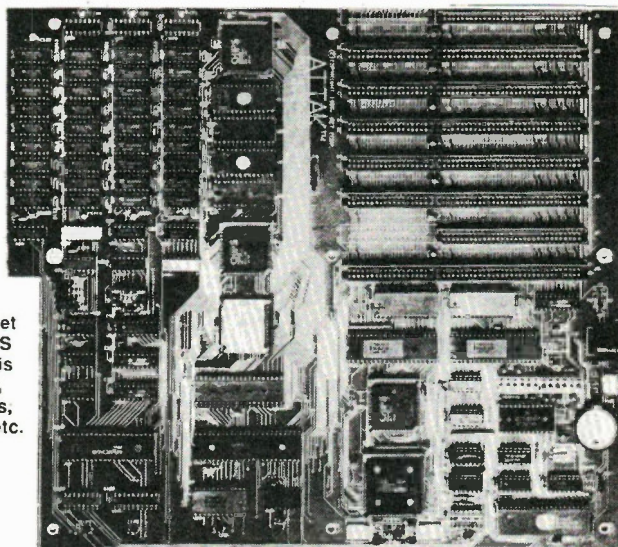
6

6 *Knock-knock-knock. "Who's There?" It was the Happy Gang on CBC radio for many years, bringing their colorful noon-hour musical program to listeners from coast to coast.*

AT SYSTEMS



What a deal, now you can get AT systems based on the US made ATTAK-286 board. This is a robot assembled board, fully tested on a bed of nails, of 4 layer construction etc,etc.



MODEL 1, FOR 8,10,12 MHZ OPERATION

The great new ATTAK-286 board using the CHIPS and TECHNOLOGY 5 chip AT LSI chipset. All the complex TTL functions have been placed on 5 LSI chips. This eliminates all the timing errors that plague the ones still using discrete TTL. This board was worth waiting for, and it is now in stock ready to ship. The board is the same size as the real AT, and has 4 layers for noise free operation. It has all the features of the AT, and some more of it's own, like 1MB on board, 8,10,12 Mhz operation, PHOENIX BIOS, and it runs like a deer.

We got our pictures too late to make this press run of the SHOPPER but if you call up we can send you a set of descriptive literature that will tell more than we could put in this ad.

We are offering the board in several formats to suit almost all buyers. All boards have been pretested for shorts and opens on a bed of nails.

- (A) Fully wired and tested, zero RAM, with all IC's, less the 80287... **\$849.95**
- (B) Socketed board, pretested, but no IC's at all,..... **\$269.95**
- (C) Bare pretested PCB with parts list..... **\$169.95**
- (D) Detailed technical manual with full CHIPS & TECHNOLOGY data and full schematics, with users hints..... **\$39.95**
- (E) PHOENIX BIOS, for B,C above only, very fast BIOS..... **\$99.95**
- (F) Keyboard BIOS, in EPROM/CPU chip..... **\$39.95**
- (G) Power supply, 200 Watt, FCC/UL OK..... **\$229.95**
- (H) HINGED TOP AT CASE, Easy access with this flip top box..... **\$189.95**
- (I) AT Keyboard, see AT/XT keyboards elsewhere on this page.
- (J) CHIPS & TECH 5 Chip set..... **\$169.95**
- (K) OTHER PARTS ARE AVAILABLE, ASK FOR LIST

BASIC SYSTEM

Entry level system with 2 drives, one each 360K, 1.2MB, both are high speed PANASONIC drives, 512K high speed RAM, disc controller for above drives, and video card (choice of monochrome or color graphics), with 200Watt power supply and the 5160 Autoswitch AT/XT keyboard..

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PLEASE SELECT FROM THESE OPTIONS, ADD \$\$

- (A) 2 1.2M drives only..... **\$89.95**
- (B) 1M BYTE high speed RAM..... **\$139.95**
- (C) 20 M HS hard drive with controller... **\$1449.00**
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- (E) 2.5MB Lotus/Intel AT RAM board, 0K... **\$299.00**
- (F) 30-70Mb Hard Drives, ask.....

We have just started with the AT compatibles and will have a lot more products next month.

PANASONIC

THE KING OF DRIVEMAKERS ANNOUNCES 5.25", 1/2 HEIGHT, DS, HD, DISC DRIVES 12M

In the short time these drives have been out they have become the most desirable AT drive of all. Quiet, reliable and fast says it all and they are priced very favourably for you to buy at **\$249.95**

(A) The great new PANASONIC JU-455-5 disc drives, DS, DD, 1/2 height, 150% IBM compatible with new surface mount solid state parts for near Infinite semiconductor reliability. A very nice drive. As you know SHUGART sold their know-how to PANASONIC and now they make drives with the best of Japanese and US technology. A great buy at **\$149.95**

(B) The one and only OUME drives, made for IBM and then the clone explosion cut the number that IBM needed and we got 'em. DS, DD, 1/2 height drives. Even have the IBM logo (but we supply a cover for the logo so no-one need know) A really good deal for **\$129.95**, but their is a limited supply so order now.

(C) The ever popular SEAGATE SA225 hard disc drive. A 25 Meg (20Meg min formatted) drive that has become the standard of the industry. Very reliable, with a 1 year warranty. At only **\$559.00** for the drive. Controllers are separate.

(D) Hard drive controller, runs 1-2 hard drives with up to 40 megabytes on 'em..... **\$179.95**

(E) Cable set for above..... **\$24.95**

TTL MONITOR \$149.95

Limited time special offer on these high quality TTL amber monitors.

These are high quality, Amber phosphor, TTL monitors made for IBM and compatible computers. We usually sell them for \$189.00, but we overbought them and want to sell 'em off at a real good deal. Made by GOLDSTAR **\$149.95**

COLOR MONITORS (RGB)

Another real bargain from PARTS GALORE, these medium resolution RGB monitors were made by HITACHI and are 12"(std size) diagonal with the best resolution in a medium res monitor that we have seen so far. Resolution is 600x240 and gives a very nice clear and sharp picture on all the CAD/CAM packages we have tried..... **\$549.95**

FEEWARE

A collection of IBM compatible free software that we have compiled from many sources for the purpose of saving you both the long distance charges from ma Bell and the time it takes to do the calls, and the time to screen the dumps to keep out the dreaded viruses that are very common on public domain software. Each group consists of 4 disks of software in the area of interest, along with disc based PR files so you can dump 'em and read 'em to find out how to use each package very easily. This is a real plus as many public domain programs are very badly documented. Each pack of 4 comes in a nice plastic diskette box that is good for keeping them in, mailing them, etc.

- (A) COMMUNICATIONS PACKAGE..... **\$19.95**
This package has many many files, among the most useful are: DOS manual, DOS utilities, Communications package com utilities, word processor, games, keyboard macro, pop up desk organizers
- (B) D BASE PACKAGE..... **\$19.95**
A very good diskette set, has a 'C' compiler, spreadsheet, database manager, DOS manual, new DOS utilities, games and many small, useful files
- (C) TURBO + HARD DRIVE PACKAGE..... **\$19.95**
Over 80 files, hard disk organizer, assembler, pascal and turbo utilities, DOS assist program, outline processor TURBO utilities, and many many more
- (D) GREAT DEAL, ALL THE THREE ABOVE PACKAGES IN A NICE PLASTIC DISK BOX FOR THE GREAT PRICE OF..... **\$49.95**

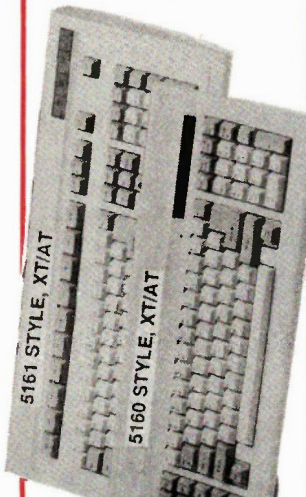
XT* CASE WITH AT* LOOK

- (A) Standard 8 slot hinged case XT* case. Fits side or back power supply (Specify) Has much heavier metal than competitors for stability, takes 1.4 1/2 sized drives and fits very well. **\$79.95**
- (B) Same as above, but the front looks like an AT case, with switch for KB and LEDs on front (picture)..... **\$89.95**
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MAIL ORDERS: We accept VISA, MC, AMEX, credit cards, Money orders, cheques (2 weeks wait) are also OK. Minimum packing and handling fee \$5.00 or 5%, whichever is larger. The only COD we use is via CANPAR (Add \$4.00 COD fee) or motor freight. We do not use postal COD at all. All Ont. res. and 7%. All prices are subject to change without notice. Returns are subject to a 20% restocking charge.

COMPATIBLE KEYBOARDS



- (A) 5150 Style, 83 keys, std IBM layout, uses long lasting CHERRY keyswitches, 100% IBM compatible.....\$39.95
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- (C) 5160 Style, XT/AT Autoswitch, 83 keys, LED status array, CHERRY KSW, 100% XT/AT compatible.....\$149.95
- (D) 5161 Style, XT/AT Autoswitch, 105 keys with numeric and cursor pad, LED status array, 100% XT/AT compatible.....\$179.95
- (E) AES DATA, A surplus ASCII keyboard with serial and parallel output, open frame, with all date and hook-up plans, APPLE CK.....\$24.95
- (F) APPLE IIe, Basic, macro keyboard, for all real and clone APPLES, specify with/not the numeric keypad.....\$69.95
- (G) APPLE IIe Detached keyboard, in standard case for custom uses.....\$149.95
- (H) APPLE IIe(FOX 2001) KB.....\$69.95
- (J) APPLE IIe (FOX2001) Detached KB.....\$99.95

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- (A) 384K RAM WITH OK, BARE PCB & DATA.....\$79.95
- (B) 576K RAM WITH OK, BARE PCB & DATA.....\$149.95
- (C) KRAM CARD, 2 MBYTE, OK, BARE PCB & DATA.....\$179.95
- (D) RAM BANK LOTUS/INTEL 2 MBYTE RAM CARD WITH OK.....\$189.95
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- (F) MONO/COLORES GRAPHICS CARD, THE DEFINITIVE PRINTER/GRAPHICS CARD AT A LOW-LOW PRICE OF.....\$299.95
- (G) 384K MULTIFUNCTION CARD, A COPY OF THE AST SIXPACK.....\$299.95
- (H) DISC CONTROLLER CARD.....\$129.95
- (I) DISC IN-LIKE AN AST SIXPACK WITH NO RAM BUT HAS DISC CONTROLLER.....\$169.95
- (J) IO x2, A VERY GOOD IO CARD.....\$99.00
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- (L) RS232, SERIAL CARD, 1,2 PORTS.....\$89.95
- (M) PARALLEL PRINTER CARD, IBM.....\$129.95
- (N) CLOCK/CAL/NOAR CARD.....\$39.95
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- (P) WW PROTOTYPE, 100% HOLES.....\$24.95
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- (S) BUS TERMINATOR, CLEANS UP NOISE ON THE BUS, GOOD FOR CHEAP CLONES AND MANY PAL LOGIC DESIGNS.....\$19.95
- (T) AT BOARD EXTENDER, 6".....\$38.95

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STANDARD 6850 APPLE I/F
 This interface provides MIDI input and output connections for standard and advanced MIDI modules. It also includes a drum machine, MIDI sequencer software control for Apple II and IIx computers.
BARE PCB AND DATA.....\$16.00
WIRED AND TESTED.....\$69.00

ADVANCED MIDI INTERFACE FOR APPLE WITH DRUM TAPE SYNCHRONIZATION

This card is the advanced version of the above. It is 100% compatible with the software and offers the added features of a drum machine, MIDI sequencer and software control for Apple II and IIx computers.
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WIRED AND TESTED.....\$89.95

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BARE PCB & DATA.....\$16.00
MANUAL & SOFTWARE.....\$19.95
WIRED AND TESTED WITH MANUAL, SOFTWARE.....\$120.00

6850 IBM MIDI INTERFACE
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V-20 NEC 8087

The NEC 8087s have been at it again, they have made a clone of the 8087 that is better than the real thing just like the V-20 beats the 8088. Comes in 5 and 8 MHz styles.
 4.77 Mhz.....\$169.95
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KRAM, The perfect clone of the iRAM, runs all the same software and is cheaper to boot. This book has the full schematic and also has a diskette with RAMDISK software. \$19.95

RAM BANK II

RAM BANK II, A clone of the LOTUS/INTEL 2 MB ram card. Follows the protocol perfectly and runs all the latest software. \$34.95

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A very nice dust cover for your AT/XT system. Stops dust in it's tracks and saves the keyboard and drives. The greatest enemy of both is dust which gets into the mechanism and wears it out too soon. Also helps stop the ARCH enemy of disk drives, cigarette smoke. The fine ash particles that are of micron size, are a fine sand abrasive that soon wears out heads. A study at the CDC found that heads would last 2-3 years after they made the data room non-smoking. Before failures occurred every 6 months. Cheap too at our price of \$12.95

CASE STAND

How nice it is to be able to stand your computer on its side to save space. This stand will adapt to all the XT and AT clones and rest thing on the market. It is a solid heavy steel plate so that your unit will not fall over easily as the center of gravity is kept nice and low. We are able to sell this nice unit at a far lower price than other units of inferior design. Watch out for the plastic ones, they are so light that your unit will fall over all the time, especially on a carpet. \$19.95

UPS-250W 250W INT 150W CONT
UNINTERRUPTIBLE POWER SUPPLY

What is the most annoying thing you can have happen while you are using your XT, MAC or other computer? You guessed it, a power failure or sharp line transient that causes total loss of uncommuted write data in RAM, and that can also cause hard drive head crash, ruining the data or even ruining the drive. A UPS is the answer to this problem. This allows you to quickly back-up your files, and shut down your system in the proper sequence. You can even keep going as if nothing had happened and as long as the line power came back when a reasonable time you would not have any loss at all of operating time or data.

\$489.95

- 1. High efficiency.....85%
- 2. Sinewave (avoid square wave) Sinewave
- 3. Internal no-spill battery Yes
- 4. External battery terminals Yes
- 5. Audible power loss warning Yes
- 6. Fast transfer time, under 5 Mts Yes
- 7. Multiple output sockets 2
- 8. % of line transients filtered 100%

640K MOTHERBOARDS

- FULLY TESTED
- STD 4.77 MHZ, 2LAYER
- SME-XT, WIRED, 8K 3 HR BURN-IN.....\$199.00
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- SME-XTAL, BARE PCB AND ASSY DATA.....\$79.00
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- SME-XT10M WIRED, NO IC'S.....\$149.00
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What a deal, the best price for fully burned in and working XT compatible systems in 4 configurations. All have a legal BIOS and are fully wired and tested to 24 hours of auto-test in our burn in room followed by a hands-on step by step functional test before shipping in our fully cushioned carton. All turbo boards are hard switchable from low to high speed and back without data loss.

- XT 4.77 MHZ STD.....\$869.95
- XT 8.00 MHZ TURBO.....\$949.95
- XT 8.00 MHZ 4 LAYER TURBO.....\$1049.95
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- * 640K MOTHERBOARD, FULLY TESTED
- * 1 DSDD HALF HEIGHT DRIVE
- * DISC CONTROLLER, 1-4 DRIVES
- * KEYBOARD
- * GRAPHICS CARD, COLOR OR MONO
- * FREE SOFTWARE
- * 256K RAM ON BOARD
- * 8 XT SLOTS
- * FLIP TOP CASE
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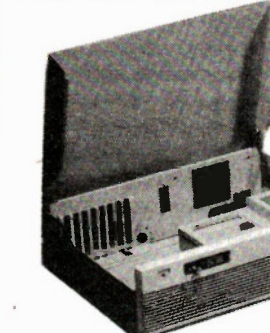
- OPTIONS**
- * CLOCK/CAL/SER/PAR/GAME.....\$125.00
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 - * SERIAL CARD.....\$49.00
 - * EXTRA DRIVE.....\$150.00
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A series of useful switch boxes for controlling several computers and/or printers to save plugging and changing cables all the time. Saves the back panel connectors from wearing out too soon. They come in both serial (25 wires switched) and parallel (36 wires switched) and with a fan out of 2 or 4. They are priced as follows:
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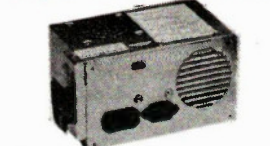
AT CASE
 NEW FLIP TOP TYPE



This nice new case allows you to build an AT compatible and to easily get at the innards. Gone are the days when you get to slide about 80 pounds of scraping iron on and off just to see what you own, and to add/subtract cards, etc. This case fits the real AT board so you can throw away BIG BLUE's steel coffin and use this. It also fits out AT board listed on this page. The case is made for AT power supply, the full set of hard and floppy drives that the AT takes, and has that great flip top. A real buy at \$179.95. Do not forget that there is a lot more to an AT case than to an XT, hence the higher price. Has a nice appearance too, it looks similar to the AT but is not a mirror image so it has individuality.

\$179.95

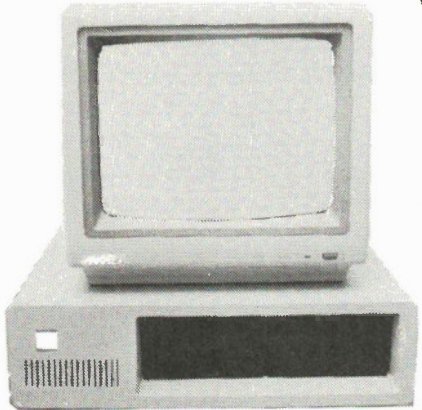
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- (A) 150 Watt XT power supply for all the needs of a fully stuffed XT system. Has +5-15A, +12-5.5A and 1/2A on -5, -12 lines. Pts tell us back or side switch style for your case. \$134.95
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- (C) 200 Watt AT power supply, made for a full AT loaded system it has +5-20A, +12-7.4A and 1/2A on the -5, -12 lines. comes in two styles, one is Hydro approved at \$179.95 and CSA approved at \$229.95
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- (E) OPEN frame NCR power supply, with +5-7A and +12-3A and 1/2A at -5, -12 V. This will run a full XT system with 2 drives, lots of cards, but no hard drives. A good deal \$59.95
- (F) OPEN frame Northern Telecom power supply this unit has all the IBM voltages but not a lot of guts. Has +5-4A, +12-1A, -5-1A, -12-1A. It will run an XT system with 2 drives but very few cards, the drive and color cards is all \$19.95
- (G) POWER CORDS for the above open frame power supplies, 3 wire, for general use with 3 prong connector on it \$4.95

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*XT 8088 4.77 MHz

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775^{xx}

*AT 80286 6-8 MHz Switchable

512K, 1M Motherboard, 1.2 M Drive, Keyboard, Colour Graphics Card and 200W Power Supply

1950^{xx}

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41256-15	\$4.25
1M-12	\$69.00

EPROMS

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2764-250	\$4.85
27128-250	\$5.00
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TTL Monitor	\$139.00
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Diskettes MD2D **99¢** each

*** ONE YEAR WARRANTY**



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100% IBM™ Compatible
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Includes:

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Options: 2nd drive \$149.00
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100% IBM™ Compatible
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640K Memory **\$2250.00**
AT Key Board
Dual Speed

Options: 2nd drive \$175.00
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Auto Modes, 1200 BPS from \$275.00
• Auto Answer • Auto Dial • Full/Half Duplex • RS232C Interface • 8 External Status Indicators • Industry Standard AT Command Set.

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• 1F03 512K RAM VerII-OK	\$ 79.00
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• 1F06 Monochrome	\$119.00
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• 1F13 Game	\$ 29.00
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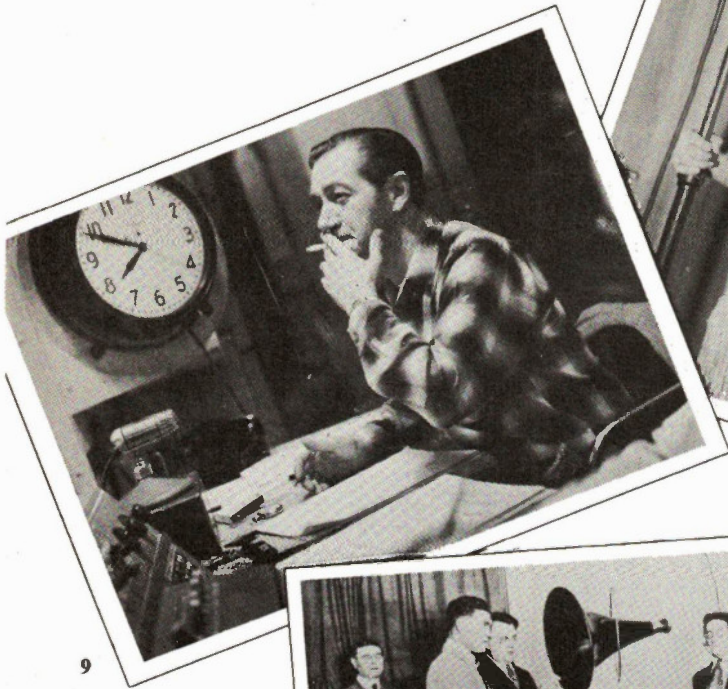
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50th Anniversary of the CBC

Continued from page 35



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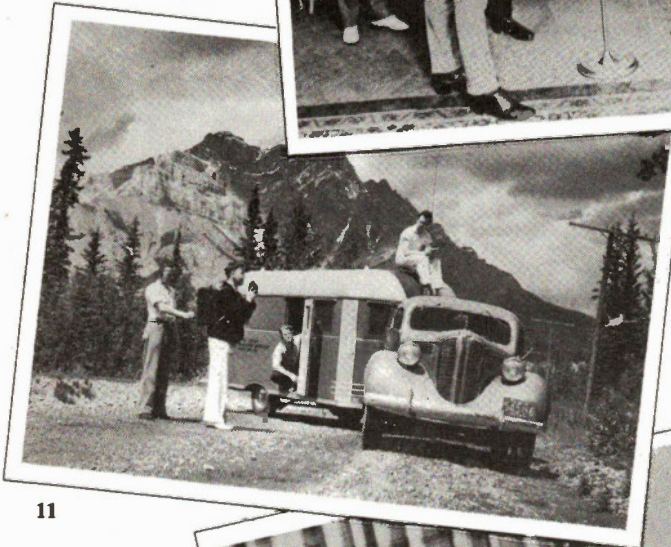
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12

7 This microphone, common to studio broadcasts in the early days of CBC radio, was called an AA4088. The lady all dressed up to sing for an audience that couldn't see her was Marina Toledo. This mike was the one borrowed by Wayne and Shuster for a prop in their man-on-the-street interviews for Ed Sullivan.

8 The first effective tape recorder used in broadcasting was seven feet high, weighed half a ton, and used reels two feet in diameter which wound on two miles of metal tape. Here Margaret Pope, a CBC farm commentator in the early 1970s, poses beside this useful but far from portable machine.

9 One of the most effective drama producers on CBC radio was a fiery Swedish-Canadian named Esse W. Ljungh (pronounced Young). His name is linked with Andrew Allan, Lister Sinclair, Rupert Caplan, Mavor Moore and Tommy Tweed when there is talk about the golden days of radio drama.

10 The tall man in the light grey suit is Jack Dempsey. The big horn is a microphone. The interview is taking place at Canada's first radio station, XWA Montreal, now CFCF. The year is 1919.

11 CBC's first mobile unit was a coupe bearing a 1938 licence and towing a small house trailer.

12 One of the most dramatic broadcasts of all time was in 1938 when King Edward VIII spoke to the Empire on radio and officially gave up the throne of Britain "for the woman I love". CBC carried this broadcast across Canada.

co-ordinating broadcasting in Canada.

So it was that on November 2, 1936, the Canadian Broadcasting Corporation was born, a unique combination of private and public radio that was designed to deliver a broadcasting service to the whole country.

The impact of network radio on Canadians cannot be exaggerated. Names crowd the memories of half a century of radio. Andrew Allan, J. Frank Willis, Esse W. Ljungh, Earl Cameron, Johnny Wayne and Frank Shuster, Harry Boyle, Syd Kennedy, 'Darby' Coates, Blair Fraser, Don Messer and Charlie Chamberlain, Lorne Green, Matthew Halton, Joyce Sullivan, Bob Goulet, Woodhouse and Hawkins, Sir William Muloch, James M. Minifie, Knowlton Nash, Willson Woodside, Lister Sinclair, Kate Aitken, Rene Levesque, the Dionne Quintuplets, Winston Churchill, Trump Davidson, Max Ferguson, Sir Ernest Mac-Millan, Geoffrey Waddington, Joe Lewis, Queen Elizabeth, Rupert Caplan, the Happy Gang, Mavor Moore, Tommy Tweed.

These are only a few of the names associated with music and drama and news reports that dominated the CBC radio network programs from 1936 until the present.

The Happy Gang, with its famous knock-knock-knock, "Who's there?" introduction made a name for itself across the nation with its cheery noon-hour musical show. The group is long gone as a radio show and its members, including such well-known musicians as Bobby Gimby and Robert Farnon, have scattered to the four winds. The program itself was replaced by a radio version of the Tommy Hunter Show.

Music, Drama and News

Music, drama and news. This was the outstanding fare during the heyday of Canadian radio. A major part of CBC's activities from its inception was in the field of music. All programs were produced live, and once a program was under way there was no turning back no matter what happened.

The CBC Symphony in Toronto, for example, originated frequently from an old church on Elizabeth Street. The pews had been removed and the acoustics were exceptionally good. CBC rented the main auditorium of the church and the Banting Institute rented the basement to house its rabbits and chickens and other wildlife used for its experiments. CBC used the upstairs at night after the Banting Institute Staff had gone home at the end of a normal day shift. But there were complications.

When Geoffrey Waddington tapped his baton on the lectern and the CBC orchestra surged into the opening bars of

Beethoven's 5th Symphony it woke up the chickens in the basement. As the radio audience sat back to enjoy one of the finest orchestras in the country, wafting this mighty symphony over the airwaves, clearly in the background could be heard a cacophonous chicken *obbligato* from the basement of the Elizabeth Street Church.

That explosive Canadian-Swede, Esse Ljungh, contributed much to Canadian broadcast drama. He recalled with horror an occasion when he was producing a live drama from CBC's Winnipeg studios. In those days, when you wanted sound effects you figured out some way of producing them first hand. They weren't easily available on recordings as they are today. If you wanted the sound of a cake being mixed you used a real eggbeater. If you wanted the sound of breaking glass you broke a pane of glass. The same with slamming doors and marching feet. Esse Ljungh needed marching feet.

All programs were produced live, and once a program was under way there was no turning back no matter what happened.

So he employed a small group of actors. There wasn't room in the main studio for everybody, so the marchers were located in a small studio down the hall and instructed to begin marching when the red light went on and stop when it went off. The drama progressed as planned, live to air as everything was in those days, and the marchers marched on cue when the red light went on. After sign-off, Ljungh and his associates walked down the street to Child's all-night restaurant for a late coffee and to congratulate themselves on a successful presentation. Suddenly Ljungh leaped to his feet and yelled, "The marchers!" He had forgotten to turn off the red light. He dashed back to the studio and burst in on the little group of actors, still marching gamely an hour after the program was over. The red light glowed accusingly from the console.

Such people provided radio listeners with a vehicle through which they shared flights of glorious fantasy and classic literature. CBC won awards the world over for its radio drama, many of which productions were achieved under conditions that were far from ideal.

For example, in Toronto CBC moved into "temporary" quarters in an old school for girls on Jarvis Street. That was 41 years ago and CBC Radio has been there ever since, still "temporarily". In the early years the bathtubs in what used to be servants quarters on the top floor

were used to store dormant files. Some years later, as the need for additional space became impossible to ignore, two houses of ill repute across the street were rented by CBC, also temporarily. In one of these houses the Corporation, in its wisdom, located a department entitled Women's Interests; in the other, Sports.

Call Letters and Batteries

In radio it was what you heard that counted...a world of images and imagination and glorious sound. The voices of professionals like Earl Cameron, Harry Mannis and Lorne Green couldn't be spoiled by tacky surroundings.

Such programs as News Roundup, which followed the National on CBC Radio, featured the best known news voices in the business at that time. You heard Matthew Halton, James M. Minifie, J.B. McGeachie, Blair Fraser, Knowlton Nash, Rene Levesque, Charles Lynch, Norman DePoe, Michael Maclear, Stanley Burke, Bill Beatty, and about 300 journalists all over the world.

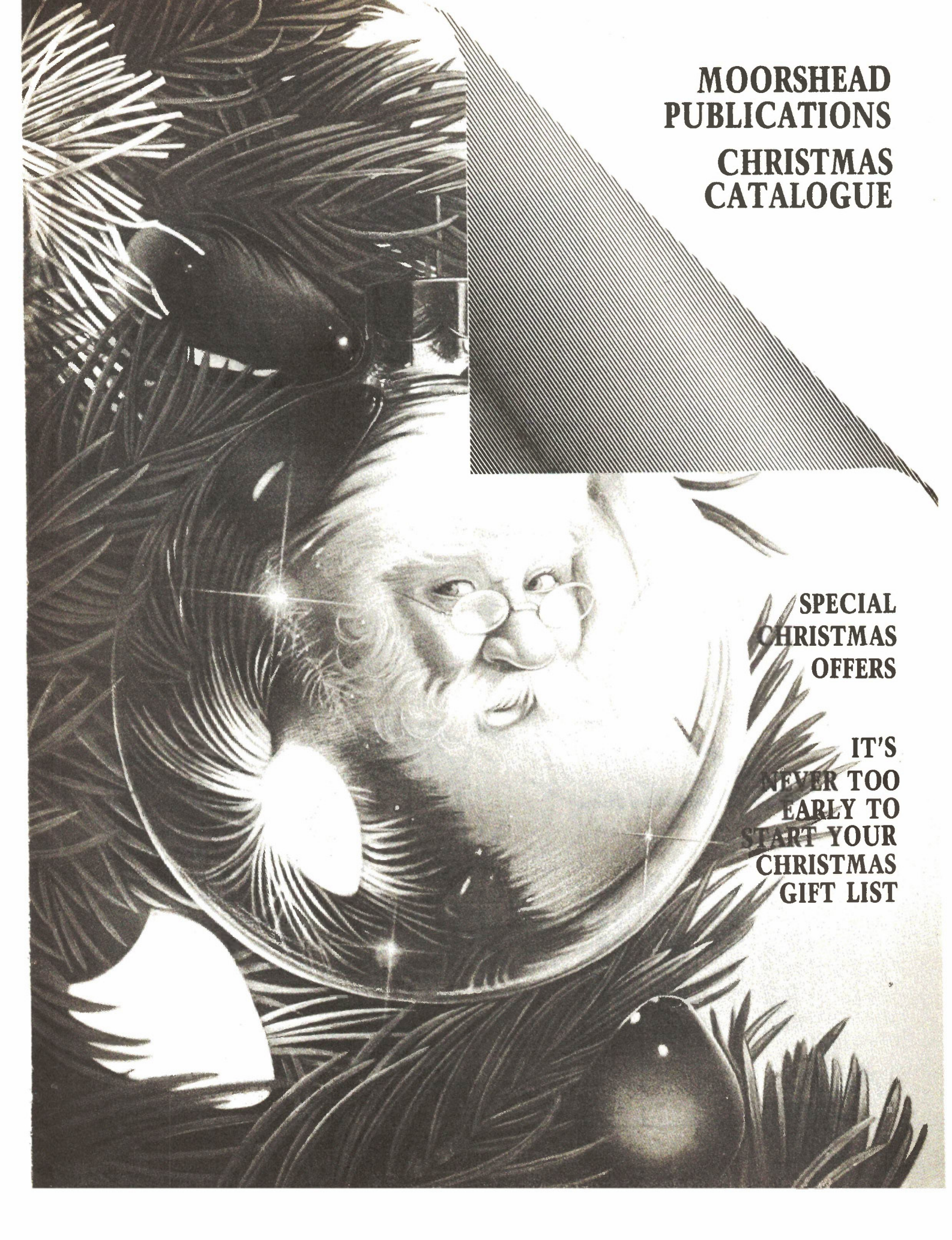
CBC radio stations were, mainly, distinguishable for their three-letter call letters which started with CB, like CBH, Halifax. Most private radio stations have four-letter call signs. With the development of the vacuum tube by Ted Rogers it was no longer necessary to run radio receivers on batteries. Rogers developed what was known as the Rogers Batteryless Radio, which plugged into an A/C outlet. This historic technical development is still represented by the call letters of the Rogers family radio station in Toronto: CFRB for Rogers Batteryless. In CKFH, of course, the FH stands for Foster Hewitt. CFPL stands for Free Press London. CJBC was originally operated by the Jarvis Bible College, although now it is the CBC French Network radio station in Toronto.

In 1936, when CBC took over the modest CRBC facilities and its staff of 132, a coverage survey showed that the national network gave effective AM radio service to less than half the population of Canada. And that was mainly in urban areas. Today, 50 years later, CBC broadcasts reach virtually 100 percent of the population through the CBC's more than 900 owned-and-operated broadcasting stations, transmitters and program production centres across the country. In addition, hundreds of privately owned or community-owned stations and transmitters are associated with CBC as affiliates of its French and English networks.

CBC Radio has adjusted to the changes of time, particularly the colossal influence of television, which has changed the lives of all of us. CBC Radio still delivers the finest in music and information...a service often imitated but never matched.

Happy Birthday CBC. ■

Electronics Today November 1986



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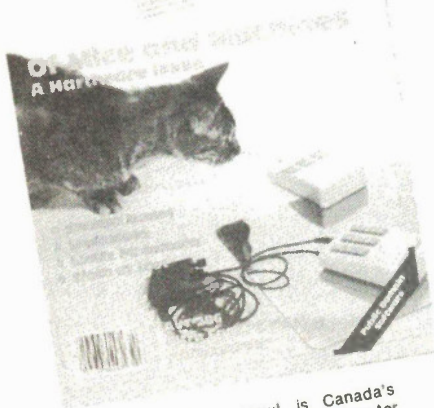
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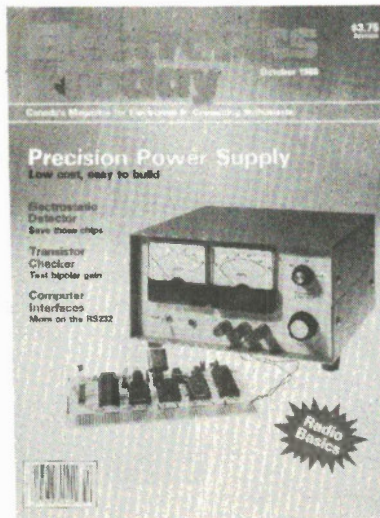
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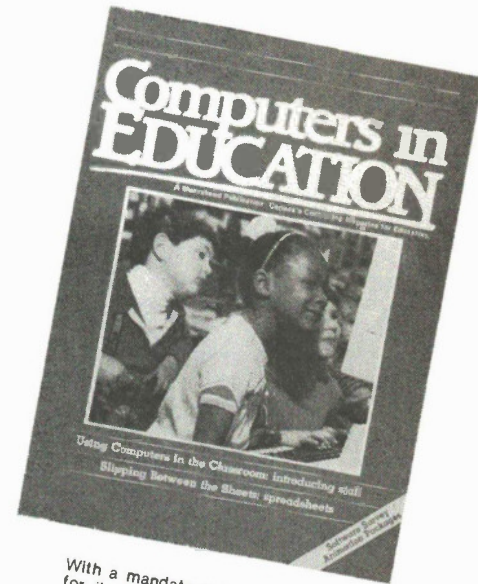
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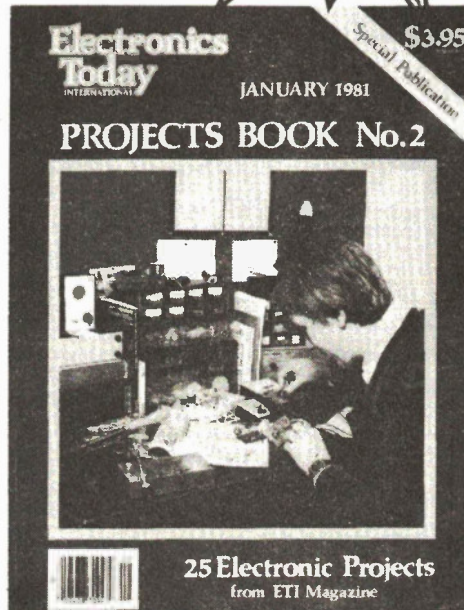
SPECIAL PUBLICATIONS



The Book of Computer Music
104 Pages

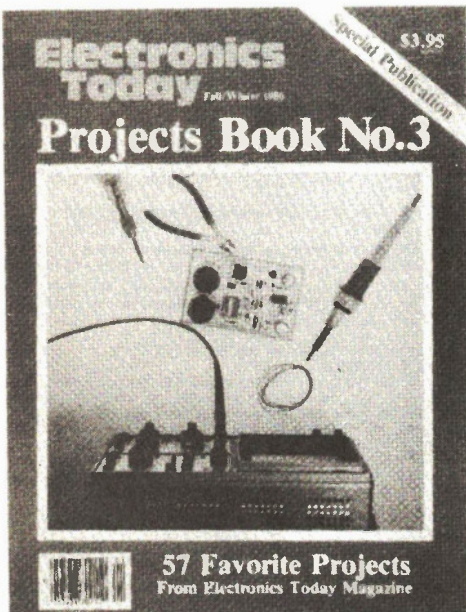
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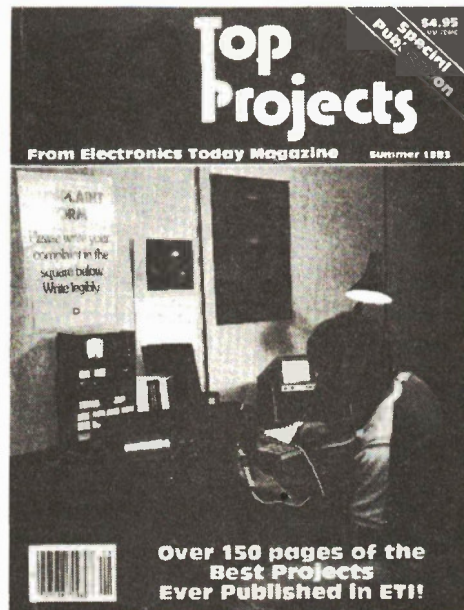
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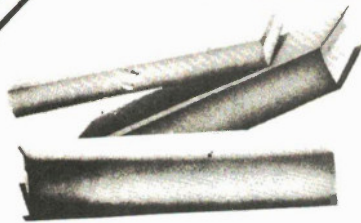
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The powerful Sinclair QL microcomputer has some outstanding capabilities in terms of its internal structure. With a 32-bit architecture, the QL has a large address range, advanced instructions which include multiplication and division. These features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

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

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

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Mr. Richard Torrenes is a well-known electronics development engineer and has tested, developed, built and tested the many of the most interesting circuits included in this book. The circuits themselves can be split down into sub-circuit blocks, which are shown separated by boxes in the circuits for ease of description, and also to enable any reader who wishes to combine boxes from different projects to realise ideas of his own.

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Some of the most useful and popular electronic construction projects are those that can be used in or around the home. The circuits range from such things as '2 Tone Door Buzzer', Intercom, through Smoke or Gas Detectors to Baby and Freezer Alarms.

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

BP90: AUDIO PROJECTS \$7.60 F.G. RAYER

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

BP74: ELECTRONIC MUSIC PROJECTS \$7.20 R.A. PENFOLD

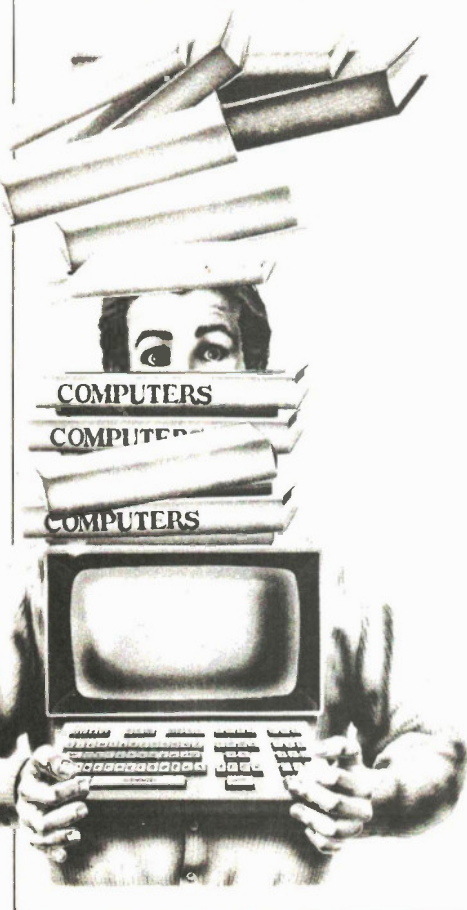
Although one of the more recent branches of amateur electronics, electronic music has now become extremely popular and there are many projects which fall into this category. The purpose of this book is to provide the constructor with a number of practical circuits for the less complex items of electronic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

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Windscreen wiper delay, darkroom timer and metronome projects are included. Some of the more complex circuits are made up from simpler sub-circuits which are dealt with individually.

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

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

BP84: DIGITAL IC PROJECTS \$7.60

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

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F.G. RAYER, T.Eng.(CEI), Assoc. IERE
Numerical indicating devices have come a long way in the forefront in recent years. It is not surprising, therefore, to find increasing applications in a wide range of equipment. With present day integrated circuits, it is easy to count, divide and display numerically the electrical pulses obtained from a great range of driver circuits.

In this book many applications and projects using various types of numeral displays, popular counter and driver IC's etc. are considered.

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

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Features a wide range of constructional projects which make use of op-amps including low-noise, low distortion, ultra-high input impedance, high slew-rate and high output current types.

CIRCUITS

How to Design Electronic Projects

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Although information on standard circuit blocks is available, there is less information on combining these circuit parts together. This title does just that. Practical examples are used and each is analysed to show what each does and how to apply this to other designs.

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

BP80: POPULAR ELECTRONIC CIRCUITS - BOOK 1 \$7.75

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

BP98: POPULAR ELECTRONIC CIRCUITS, BOOK 2 \$8.85

R.A. PENFOLD
70 plus circuits based on modern components aimed at those with some experience.

BP39: 50 (FET) FIELD EFFECT TRANSISTOR PROJECTS \$6.75

F.G. RAYER, T.Eng.(CEI), Assoc.IERE
Field effect transistors (FETs), find application in a wide variety of circuits. The projects described here include radio frequency amplifiers and converters, test equipment and receiver aids, tuners, receivers, mixers and tone controls, as well as various miscellaneous devices which are useful in the home.

This book contains something of particular interest for every class of enthusiast - short wave listener, radio amateur, experimenter or audio devotee.

BP162: COUNTING ON QL ABACUS

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

BP87: SIMPLE I.E.D. CIRCUITS \$5.40

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

BP24: 50 PROJECTS USING IC 741 \$6.75

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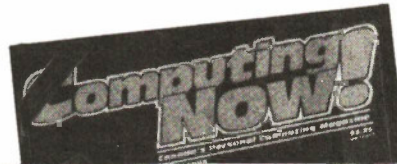
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Electronics Today November 1986

Vacuum Tube Preamplifier

Dust off those 12AT7s and build yourself a RIAA preamp.

By Jeff Macaulay

DESPITE twenty-odd years of solid state audio development there are still many audio enthusiasts who swear that tube equipment is better. At first sight these beliefs may seem a little eccentric; after all, modern semiconductor equipment boasts specifications which, at least on paper, far exceed those obtained with tubes. In addition, tubes require high voltages and a separate supply for the heaters. Another problem is that the parts can be difficult to obtain nowadays.

On the plus side, tubes are approximately ten times more linear than transistors and are simple to design around. Furthermore the large signal swings available make it far easier to obtain high overload margins and low distortion at the same time without overall negative feedback. These features make the tube ideally suited to preamplifier designs.

The design to be described here is a stereo preamplifier which has an RIAA-equalized input for disc and un-equalized or "OQ" flat "CQ" inputs for tuner, tape, compact disc, etc. Three double-triode tubes are used giving a total of six active devices, three in each channel.

Fig. 1 shows the complete circuit diagram of one channel of the preamp. One of the double triodes, V1 is used to provide RIAA equalization. The pickup cartridge is fed directly into the grid of the lower triode which is held at ground potential by R3. This component also defines the input impedance to the required value of 47k.

The triode acts as an input voltage to anode current converter, a transconductance amplifier. The anode is held at a constant DC level of about 100V by the

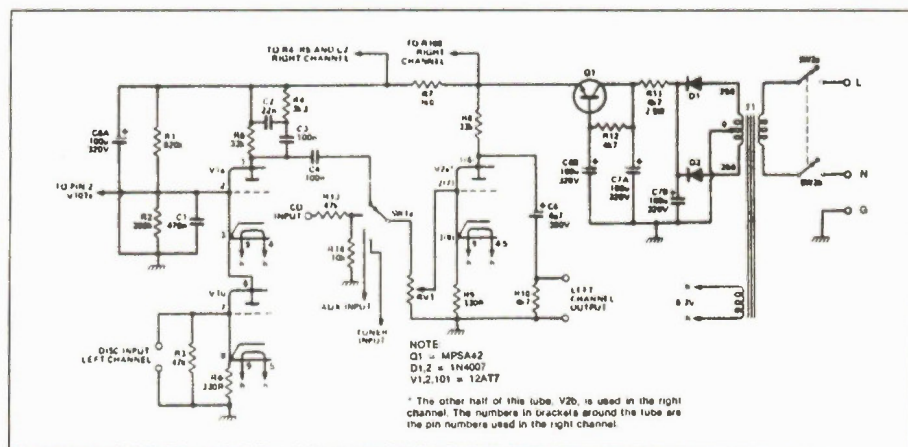


Fig. 1 Circuit diagram of one channel of the tube preamplifier.

cathode of the second triode, V1a, which acts as a capacitance multiplier for C1. R1 and R2 provide grid bias while C1 decouples the grid to ground at AC.

As the second triode is in series with the first it follows that the anode current flows through both tubes. One of the advantages of the cascode configuration is that the output impedance is extremely high, several tens of megohms in fact. As this is so, it follows that the output voltage generated across the load network is directly proportional to the impedance of the network.

In this case the anode load is the network consisting of R4, R5, C2 and C3. At low frequencies, below 50Hz, R5 defines the gain at about 50. Above 50Hz the response rolls off at 6dB per octave until a plateau is reached at about 500Hz. This is due to the shunting effect of the series combination of C3 and R4. From 500Hz

the response is flat until 2160Hz where it is 3dB down due to the impedance of C2. This component ensures that the response continues to fall at 6dB per octave indefinitely, thus producing the standard EQ.

As was mentioned earlier, the output impedance at the anode is very high so the impedance seen by the following stage is equal to the impedance of the network at any given frequency. This never exceeds 33k, so feeding it to a second stage with an input impedance of 1MΩ won't upset the equalization.

Having discussed the EQ stage we can now turn our attention to the second stage of the preamp based around V2. One of the main disadvantages of tubes when compared to their solid-state counterparts is their high output impedance. In order to match the preamp to ancillary equipment a reasonably low impedance drive is

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Vacuum Tube Preamplifier

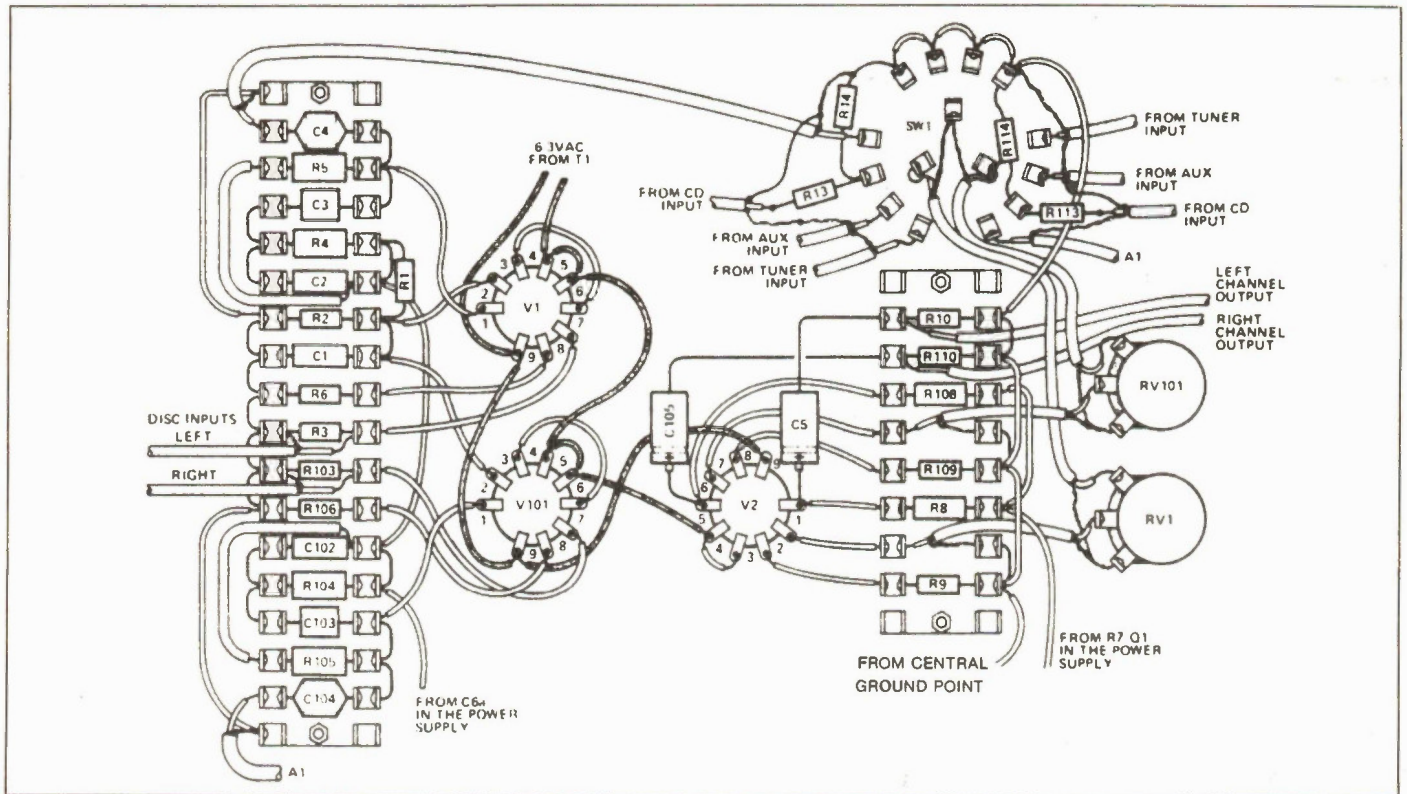


Fig. 2 Wiring of the components beneath the chassis.

required.

The obvious answer is to use a matching transformer but these are expensive and also, unless very carefully designed, are prone to treble loss as well. The solution used here is to 'dump' some of our available gain to provide a lowish output impedance.

Referring again to Fig. 1, V2 is half a double triode, the other half being used for the other channel. The tube is used in standard common cathode mode. Input signals are fed into the grid which is biased to ground by RV1. The value of this component defines the input impedance of this stage. R9 provides cathode bias and a little negative feedback. The output appears across R8.

The gain of the stage is about 40 which is more than is required, so to provide a lower output impedance the signal is fed via C5 to R10. As the tube is capable of providing 10V RMS a 40dB overload ratio is obtained from the disc.

R13 and R14 form an attenuator for high level inputs and the values are chosen with CD players in mind. The other input is designed for use with tuners and the sensitivity here is 50mV for 500mV output.

Power Supply

The main problem associated with HT power supplies for circuits such as this one is the reduction of supply ripple.

Electronics Today November 1986

With solid state audio equipment one can rely on overall feedback to reduce ripple voltages at the output. This is not the case here, so the key to getting a good sound is the quality of the power supply.

It is often said that amplifiers simply act like a kind of magnifying glass enlarging an already present signal. Nothing could be further from the truth! An amplifier, any amplifier, manufactures an enlarged copy of the signal presented at its input. It does this by modulating an external power source, the power supply. No matter how good the signal path may be, if the power supply misbehaves you will have a bad sounding piece of equipment.

In the present case the tubes are operated in class A. That is to say that current consumption doesn't alter with varying input levels. To provide proper operation a low impedance output supply is required. In particular the impedance seen by the circuit between HT and ground must be as small as possible. To this end, the HT winding on T1 is centre-tapped and is full-wave rectified by D1 and D2. The IN4007's do the same job at a fraction of the cost.

Primary smoothing of the raw DC is done with C7B. R11 and C7A smooth the ripple down to a few millivolts. Final smoothing is achieved with a gyrator circuit comprising R12, Q1, and C6B. R12 and C6B provide a very smooth DC voltage to the base of Q1. The latter component acts as an emitter follower pro-

viding a very low output impedance supply for V2.

R7 and C6A provide further smoothing and hefty decoupling for the input stage. Ripple voltages here are miniscule, of the order of a few microvolts.

Construction

Before assembling any part of the preamplifier you will have to decide what sort of case it is to be built in and how the tubes are to be mounted. The traditional approach, of course, is to use a case with a chassis in it and to mount the tubeholders through the chassis. If this is your preferred method, use Figs. 2 and 3D as a guide and cut the holes for the tubeholders with a 3/4" metal punch.

An alternative approach is to bolt the tagstrips and other components through the floor of a case in the usual way and to mount the tubeholders on standoff pillars. If you do this, make sure the pillars are long enough to prevent the tubeholder pins from touching the case metalwork and use either nylon pillars and/or sleeved connections so that there is no risk of a pin shorting to the pillar. Bear in mind that the layouts in Figs. 2 and 3 show the underside of the tubeholders and that the connections will run in reverse order if you are wiring them from above.

When your chosen case or chassis is ready, begin assembly by installing the tubeholders and the tagstrips. The

How It Works

The bulk of the work is performed by the 7107 digital voltmeter IC, which is essentially an A-to-D converter with internal circuitry to drive four 7-segment LED displays. The full scale range of the IC is twice the voltage difference between pins 35 and 36. For a 200mV full scale (a maximum reading of 199.9mV), this voltage is set by R2 to be 100mV. A reference voltage 2.8V below the positive supply voltage is available at pin 32, and this holds the voltage across R2 and RV1 at 2.8V so that the voltage set by RV1 will be stable.

R1 and C1 are the timing components for the internal oscillator. For reasons explained in the text, the oscillator does not need

exceptional long term stability, so there is little point in using a crystal or choosing high stability components for timing. R3 and C3 form a very simple low-pass filter to cut down any noise at the input, and R3 also provides some degree of protection for the IC against accidental connection to excessively high voltages.

C2 holds the reference voltage used during the 'de-integrate' phase of the conversion (see text). The capacitor is charged up to the reference voltage during the first (auto-zero) stage of conversion. A bridge arrangement of switches inside the IC (Fig.4) allows the voltage stored to be used either way around, according to whether

the input voltage to be measured is positive or negative. C4 is the auto-zero capacitor, C5 the integrating capacitor and R4 the integrating resistor. The function of these components is explained in detail in the text.

The sole function of IC2 is to provide a negative supply voltage for the 7107, so that the circuit will run from a single +5V supply. It is a hex inverter IC: one of the inverters is used to present a single gate load to the 7107's clock. This inverter drives the remaining five in parallel, which in turn drive the voltage pump consisting of C6, D1, D2 and C7. This generates about -3.5V, which is fed to pin 26 of the 7107.

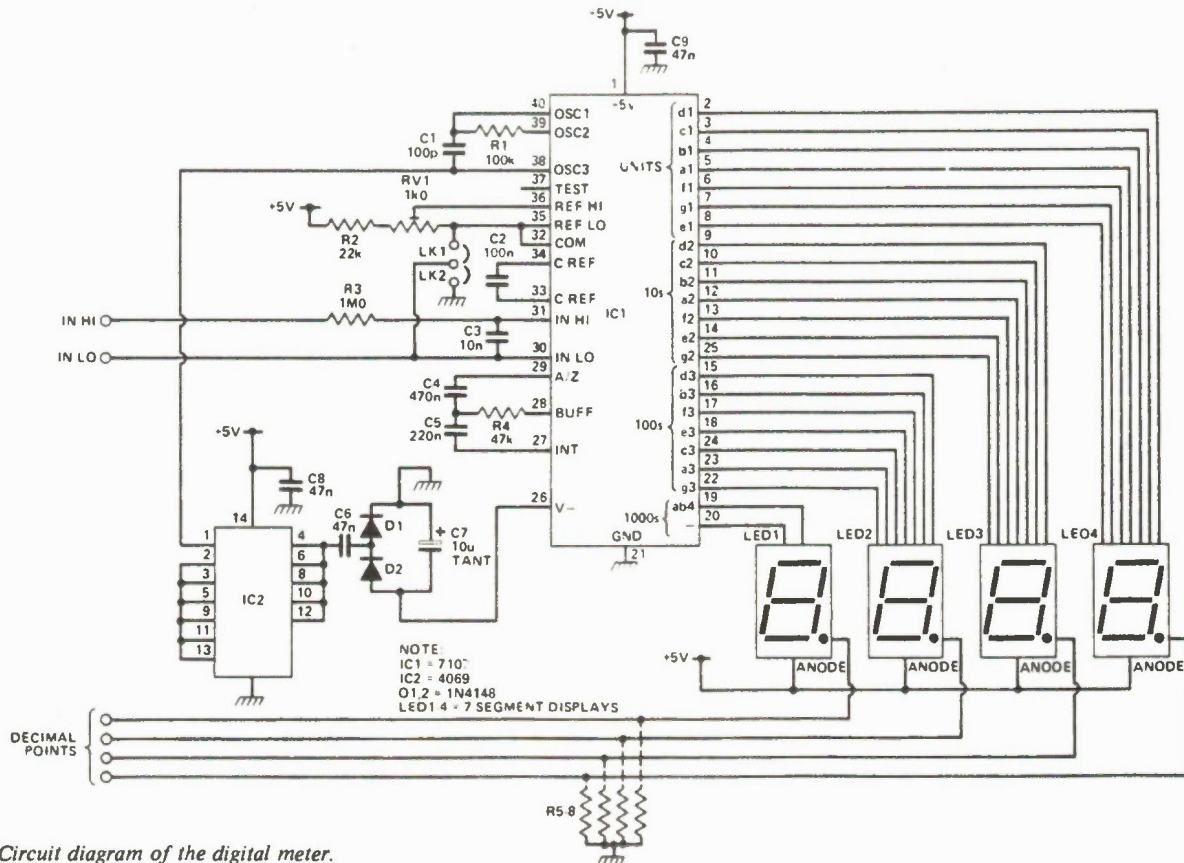


Fig. 3 Circuit diagram of the digital meter.

zero phase. In the 7107, the comparator which follows the integrator is also included in the auto-zero feedback loop, which makes this unnecessary.

Fig. 4 is the analogue section of the 7107, taken directly from the Intersil data book. It isn't as complicated as it looks. The integrator corresponds to our op-amp, Cint to C1, Caz to C2 and Rint to R1. The op-amp feeding R1 buffers the input, and the comparator provides a logic signal to denote the end of the discharge phase of Cint. The circuit around the 6.2V zener is a voltage regulator which establishes a reference voltage 2.8V below the positive supply voltage, available to the internal circuit,

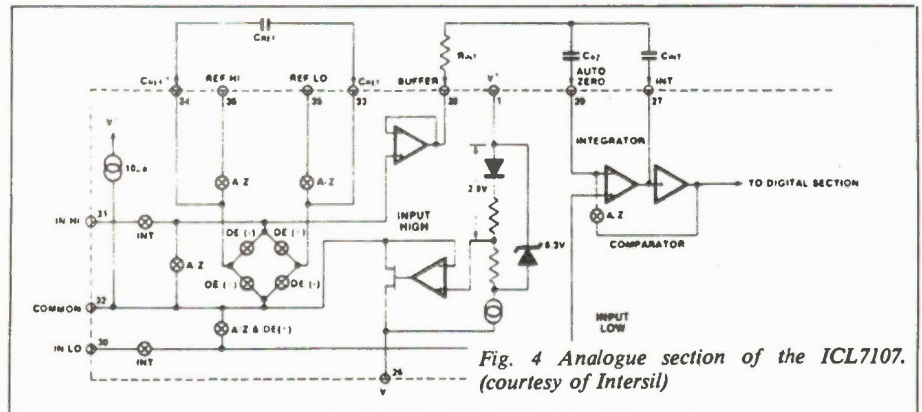
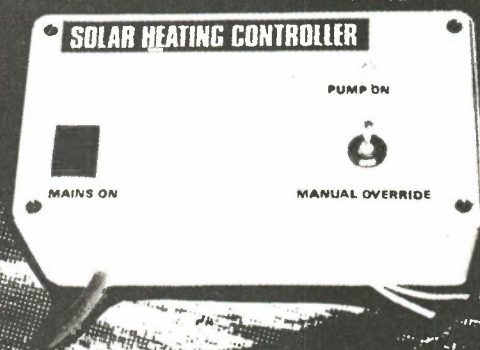


Fig. 4 Analogue section of the ICL7107. (courtesy of Intersil)

Solar Heating Controller

Build this simple control circuit for solar energy applications.

By Barry Wise



ALONG WITH other energy sources, solar energy is greatly under-exploited in North America. We have grown up with the idea that the fossil fuels are going to last forever. But fossil fuel stocks are becoming depleted and more difficult to

extract, and environmental pollution caused by burning them is becoming a major problem. Harnessing solar energy is one way to reduce our dependence on fossil fuels.

The simplest application of solar energy is in providing part of the heat required for domestic hot water. The most common method of doing this is to use a flat

plate collector.

Solar radiation is absorbed by a black sheet and the resulting heat is transferred to the hot water cylinder by water circulating through the sheet or through pipes attached to it. Heat loss from the absorber is minimized by back insulation and a clear plastic or glass cover.

In the simplest systems water is circulated using thermo-syphon principles. However, a pumped arrangement allows greater flexibility of panel position and improves thermal efficiency. The controller described here can be used for most solar heated water systems. It ensures that water is pumped only when there is a useful amount of heat to be gained.

Circuit

The full circuit diagram of the Solar Heating Controller appears in Fig. 2. Diodes D2 and D3 act as sensors mounted on the hot water tank and solar panel. A constant current is passed through each of them via R1 and R2. One property of small signal diodes is that a change of temperature will cause their forward conduction voltage to vary in a repeatable manner. This differential voltage is applied to the inputs of IC1, which is configured to act as a Schmitt trigger with positive feedback introduced by R9. R3 and RV1 are used to balance the schmitt trigger inputs initially so that a differential temperature change within the desired range will be detected.

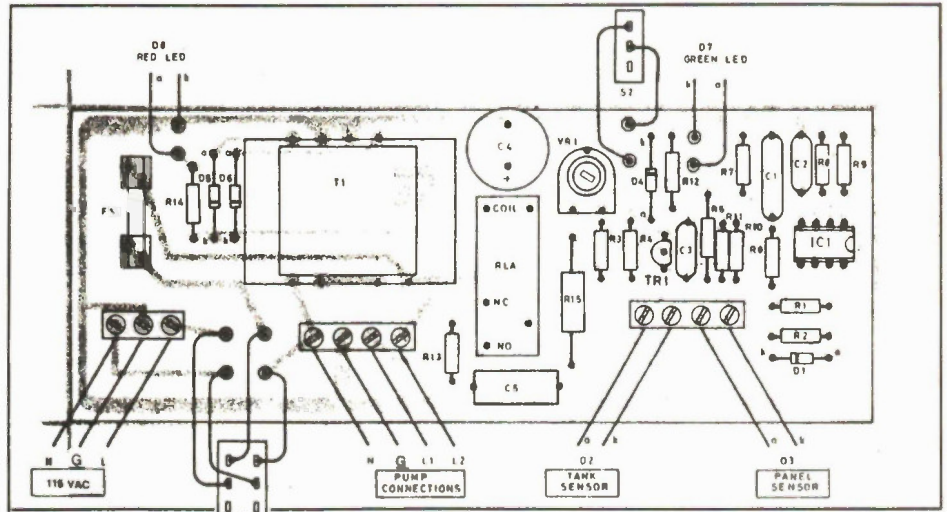


Fig. 1. Parts overlay.

and smoothed 30V nominal. This is then dropped through R15 and clamped by D1 at 8.2V to power the op-amp and provide a stable voltage drop across R1 and R2.

Capacitor C1 has been incorporated to reduce differential input noise. Any common mode noise is filtered by C2. C3 has been provided to reduce the effects of interference on switching Q1.

A manual override facility has been incorporated with S2 switching on the relay. C5 and R13 protect the relay contacts from the arcing that occurs when attempting to switch an inductive load. They also provide electrical interference suppression.

ted to holes in the front of the case and the LEDs and switches are fitted in the lid. Position these lid mounted components so that there is sufficient clearance with the board components when the case is put together.

Complete the interwiring as shown in Fig. 3 paying careful attention to the polarity of the LEDs. It is also worth double checking the wiring of S1 since it will be carrying 120VAC. Lower the board into the case and connect a three-way power cable to the three-way terminal block.

Sensors

Make up two sensor leads, one for the

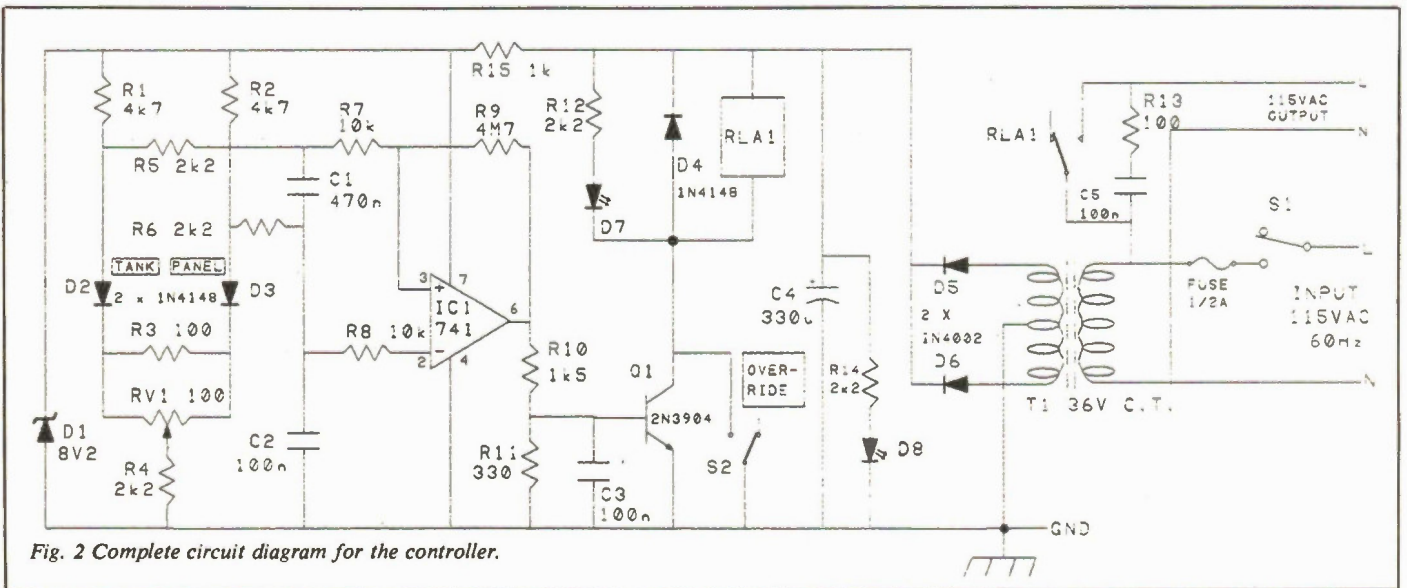


Fig. 2 Complete circuit diagram for the controller.

If the solar panel diode D3 becomes hotter than the tank diode D2, the output voltage of the amplifier will rise. Resistor R9 ensures that the output switches cleanly between the supply rails. This turns on Q1 which activates the relay. The green LED, D7, indicates when this occurs. The power supply for the circuit comprises T1, D5, D6 and C4 giving a full wave rectified

Construction

Most of the components are fitted onto the printed circuit board as detailed in Fig. 3. Ensure that the polarity of diodes and capacitor C4 are correct.

The circuit board was designed to fit inside a plastic case measuring 150mm by 80mm by 50mm although any reasonable size may be used. Three grommets are fit-

solar panel and one for the hot water tank. Twin cable is suitable and the type which has one side marked with the coloured stripe or ribbing is ideal. At this stage each lead can be a couple of metres long. They can easily be extended if necessary with more cable.

A 1N4148 diode is simply soldered to the end of each lead as shown in Fig. 4.

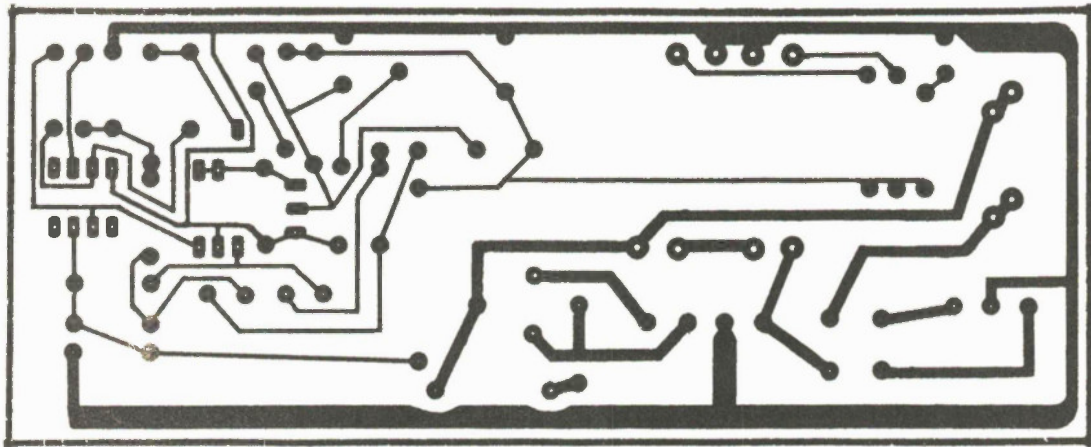


Fig. 3. The PCB for the Solar Heating Controller.

Each sensor can then be potted by moulding epoxy putty around the diode and cable end. Ensure that no bare wires are left exposed. The putty will harden in about 24 hours.

Test Procedure

Thread the two sensor leads through the end grommet and connect into the terminal block as shown in Fig. 3. Plug in the unit and switch S1 on; the red LED should light. Switch S2 to the auto position. Beware, the fuse clips and other components near the three way terminal block are now live! The back of the switch, S1, is also live. Make sure the two sensors are close together and hence at the same temperature. Turning the preset, RV1, should cause the relay and green LED to turn on and off. The correct point at which to set RV1 is found as follows. Turn until the relay is on. Then turn the preset back until it is just past the point at which the relay turns off. Five degrees of rotation past the turn off point is about right.

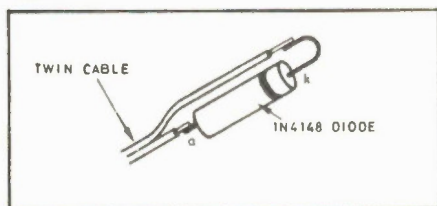


Fig. 4 Sensor construction

Check the operation of the controller by holding a soldering iron against the panel sensor. The relay should turn on after a few seconds. Leave the panel sensor to cool down for a few minutes and the relay should turn off. Disconnect the unit from the power supply and ready it for installation.

Installation

A typical solar heating system is shown diagrammatically in Fig. 5. Solar energy,

collected by the panel, is pumped to the preheat cylinder. The pump is switched by the solar panel controller. This preheated water is then drawn through the existing hot water cylinder.

The pump is normally connected to the terminals marked L1, N and G on the controller's four way terminal block. Note that L2 is live when the green LED is off: this connection being a useful feature on

heating system. The sensor leads should not run next to AC leads. The sensors themselves should be fixed using epoxy putty or silicone sealant and they should be covered with some insulation such as polystyrene. Fig. 6 shows this arrangement.

The tank sensor should be mounted on the pipe which runs from the preheat cylinder to the solar panel. Mount it as

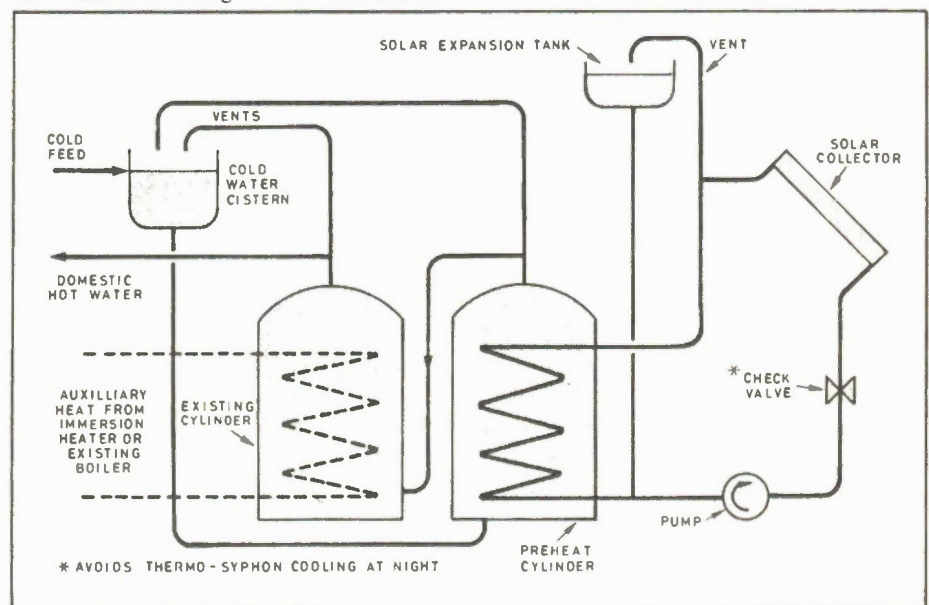


Fig. 5 Typical arrangement for a solar water heating system.

more sophisticated pumping systems. A pump rated at 30 watts or so is quite adequate for most solar installations. A higher powered pump will only cost you more while it is running.

The controller should be located in a visible position so that the switching of the pump can be monitored. The box should be mounted where the temperature is unlikely to vary widely. It should not be mounted in the attic.

The fixing of the sensors is important for good operation of the complete

close as possible to the tank. The actual connection flange is a good place. The panel sensor should go on the black absorber plate of the solar panel, close to the outlet pipe.

Modifying Hysteresis

Hysteresis is the difference between the 'switch on' and 'switch off' points of the controller. The amount of hysteresis is determined by R9, the feedback resistor of the 741 amplifier. The 4M7 resistor specified gives a hysteresis of about seven

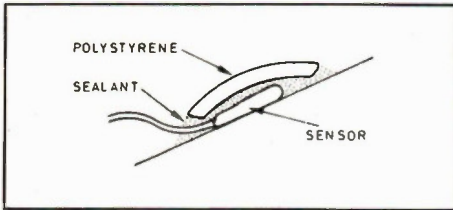


Fig. 6 Method of mounting the sensors.

degrees C which should avoid the possibility of rapid on/off cycling of the pump. If you wish to experiment with the hysteresis of your system, try changing the value of R9. A 3M3 resistor gives a hysteresis of about ten degrees C and a 10M resistor will give about 3-5 degrees C.

Parts List

Resistors

(All 1/4W \pm 5% except where stated)
 R1,2 4k7
 R3,13 100R
 R4,5,6 2k2
 R7,8 10k
 R9 4M7
 R10 1k5
 R11 330R
 R12,14 2k2 1/2W
 R15 1k 1W

Potentiometer

RV1 100 cermet preset

Capacitors

C1 470n polyester 100V
 C2,3 100n polyester 100V
 C4 330u radial electro. 63V
 C5 100n suppression cap 250V

Semiconductors

D18V2 Zener Diode
 D2,3,4 1N4148
 D5,6 1N4002
 D7 green LED (w/mounting clip)
 D8 red LED (w/mounting clip)
 Q1 2N5209
 IC1 741 op-amp

Miscellaneous

RLA1 0A single pole changeover relay, 24V coil.
 T1 .. 3VA 120V primary, 20-0-20 secondary
 S1 DPST 120VAC 4A
 S2 SPST 30VDC 1A

Three-way terminal block; four-way terminal block; (10) PCB terminal pins; 1A fuse and PCB fuse clips; case 150 x 80 x 50mm; epoxy putty; etc.

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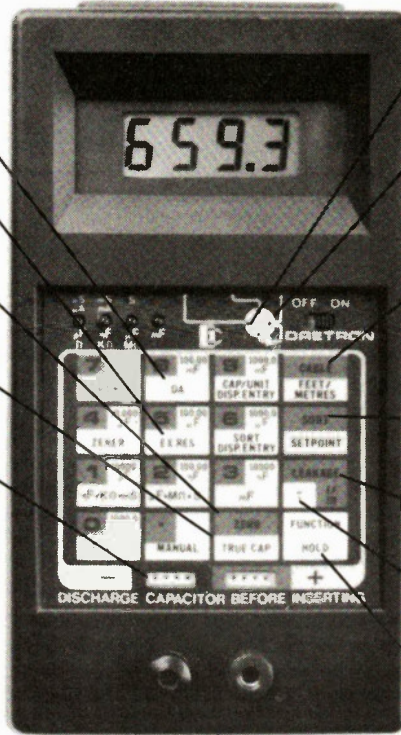
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Satellite Signal Receiving: How It Works

A look at what's involved in getting the signal from a satellite to your TV.

By Mark Windsor

AT A DISTANCE of some 36000km above the equator, along what is known as the Clarke Belt, there are a number of geostationary satellites transmitting signals of various types ranging from high-speed computer data to TV broadcast signals. Approximately 20 or so of these satellites are operating in a 500MHz block of frequencies, called the C-Band, between 3.7 and 4.2GHz. In addition, there are five satellites of a rather hybrid nature which operate in the Ku-Band or 12GHz region.

To be able to accommodate a greater number of channels in the transmission band, North American satellites polarize this transmission energy into vertical and horizontal signals. With 24 transponders on each satellite, 12 are vertically polarized and 12 are horizontally polarized.

The process of getting these signals from the satellite to your TV, however, involves a fair bit of processing by your TVRO system.

Receiving At the Dish

The signals transmitted from the satellite are collected and reflected by the metallic surface of the parabolic-shaped dish, but are extremely weak at this point due to the only five to eight watt strong signal transmitted from the satellite trans-

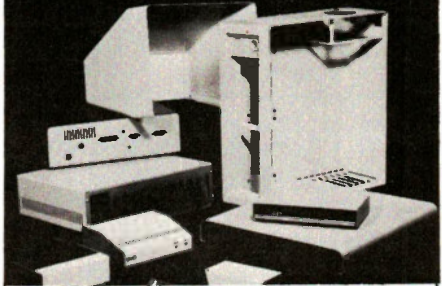
ponder. The received energy at the dish is on the order of -120dBm ; this value is an approximation of the free space signal strength at the aperture of the dish. Because of the focusing action (gain) of the dish, the signal is amplified approximately 41 dB for a three meter reflector.

At the focus of the dish (which depends on the depth of the parabola) is the feed array consisting of the feed rings and the polarization device. The feed collects the reflected energy and conducts it to the centre waveguide where the polarization device allows either the vertical or the horizontal polarized signal to be propagated further.

Block Downconverting

The signal is still very weak and needs to be amplified at the focus of the dish before being passed through any cables. The reason for this is that, at a frequency of 4GHz, attenuation is very high in a normal coaxial cable. Amplification is done by a Low Noise Block Downconverter (LNB) which is bolted to the polarization component. The LNB boosts the 3.7 - 4.2GHz signal another 60dB and then downconverts the block of frequencies to 950 - 1450MHz. Fig. 1 shows a block diagram of a complete TVRO system.

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At this lower frequency block, the signal can now be fed through 200 - 300 feet of low-loss coaxial cable without significant signal level problems. Remember we started with a signal that was at 3.7 - 4.2GHz at a level of -120dBm. We are now at the point where the signal leaves the dish to be carried to the receiver in your home; it is now 950 - 1450MHz at a level of approximately -20dBm.

Receivers

It is the job of the receiver to take the signal passed from the feed and LNB, and recover all the video and audio information that was transmitted. The signal reaching the receiver will have lost strength over the coaxial run to the tune of -9dB/100ft. for an RG-6/u foam cable. This figure is relevant to the highest frequency on the cable (1450MHz). For a 300 foot cable run this loss will be 27dB, giving us a received signal (at the receiver) of -47dBm.

Any good receiver will have what is called a 'dynamic range' of -20 to -60dBm, meaning that any signal between these limits will give an optimum picture whether it is at the high or low end. Therefore, at a level of -47dBm, no signal amplification or attenuation is necessary. Also, most satellite receivers now have synthesized tuning for satellite channels which eliminates drifting of the channel and the need for fine tuning.

Audio

Sophisticated satellite receivers now available to the consumer have programmable digital audio. The frequency modulated satellite signal has audio sub-carriers (A and B) that are transmitted

along with the video on the satellite transponder. The most common audio modes transmitted are: Mono at 6.80MHz and occasionally at 6.20MHz; Discrete Stereo at 5.58 and 5.76MHz; and Matrix Stereo at 5.80 and 6.80MHz.

In the Mono mode, the continuous tuning of subcarrier A demodulates the audio. In most receivers utilizing remodulators for channels 3 and 4, the remodulator derives its audio input from the output of subcarrier A.

For Discrete Stereo, subcarrier A audio appears at the left output and subcarrier B at the right output.

In the case of Matrix Stereo, the audio is derived by subcarrier A plus subcarrier B (A + B) at the left output, and by subcarrier A minus subcarrier B (A-B) at the right output.

The bandwidths of these modes vary typically from 150kHz for narrow audio, to 400kHz for Matrix audio. The satellite receiver employs narrow band filters to demodulate the various audio services which are carried alongside the video on many of the satellite transponders. These filters are in the form of a dynamic noise reduction system (DNR) or a dbx Noise Reduction System both of which give clear stereo reception.

The last stage of the signal processing is comprised of getting the final video and audio signals to your ears and eyes respectively. Most receivers employ video and audio baseband outputs that, when hooked through your stereo and video monitor system, give exceptionally good picture and sound quality. ■

Mark Windsor is Technical Director for Vexus Telecommunications of Mississauga Ontario.

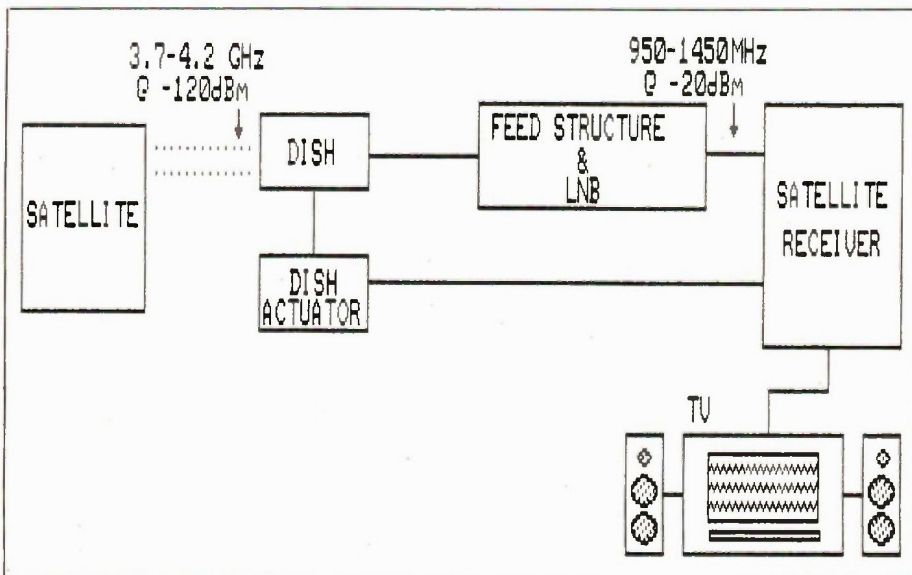


Fig. 1 A block diagram of a complete TVRO system showing signal losses at the various stages.

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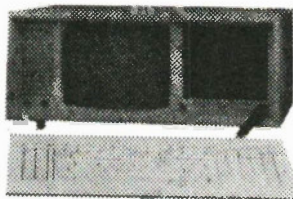
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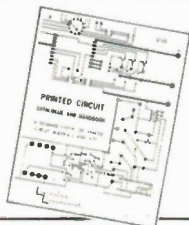
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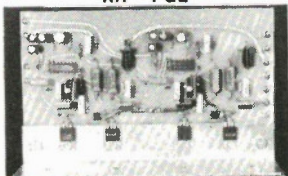
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and also to circuitry outside the IC via pin 32.

The remainder of the circuit deals with analogue switching; more complicated than in Fig. 2 since it allows for negative inputs and a corresponding positive reference voltage. Switches marked AZ are closed during the auto-zero phase, INT during the integrate phase, and DE during the discharge or 'de-integrate' phase.

Two small points: in the 7107, both the inverting and non-inverting inputs of the integrator are connected to the 'common' reference voltage rather than to the ground. All that is required for the auto-zero phase is that they should be at the same voltage.

Secondly, it may seem that the offset introduced by the input buffer will not be cancelled. It will. To see why, just imagine a voltage source equal to this offset voltage between the switch and R1 in Fig. 2. The junction of C2 and C1 would end up at this offset voltage at the end of the auto-zero phase, and a subsequent 0V input, when offset by the buffer, would still result in no current in R1.

Construction and Setting Up

The two PCBs are assembled according to the overlay in Fig. 5. The two boards can be mounted together in a 'sandwich', with the two track sides facing each other. Quarter-inch spacers between the boards will be adequate to prevent any short circuits, and the mounting screws will go through both boards and hold them firmly. The smaller display board can be fixed either at the top or bottom of the driver board, according to which you find most convenient. If the driver board takes up too much space behind the front panel, it can be mounted separately, the two boards being joined by a length of ribbon cable.

The meter requires a supply of 5V DC. In applications where the voltage to be measured is floating with respect to the meter's power supply (as in multi-meter type circuits), link LK1 should be made. If the circuit on which the voltage measurements are made is running from the same power supply, link LK2 can be made to measure voltages with respect to 0V. If differential voltages are to be measured, neither link should be made. In this case, bear in mind that the common mode voltage range will be roughly +4.5V to -2.5V. If either meter input is taken beyond these limits, the readings will not be accurate, and if either input goes outside the range of +5V to -3V, IC1 may be permanently damaged.

Adjusting the Range

The full-scale reading of the meter, with the components shown, is 199.9mV. In

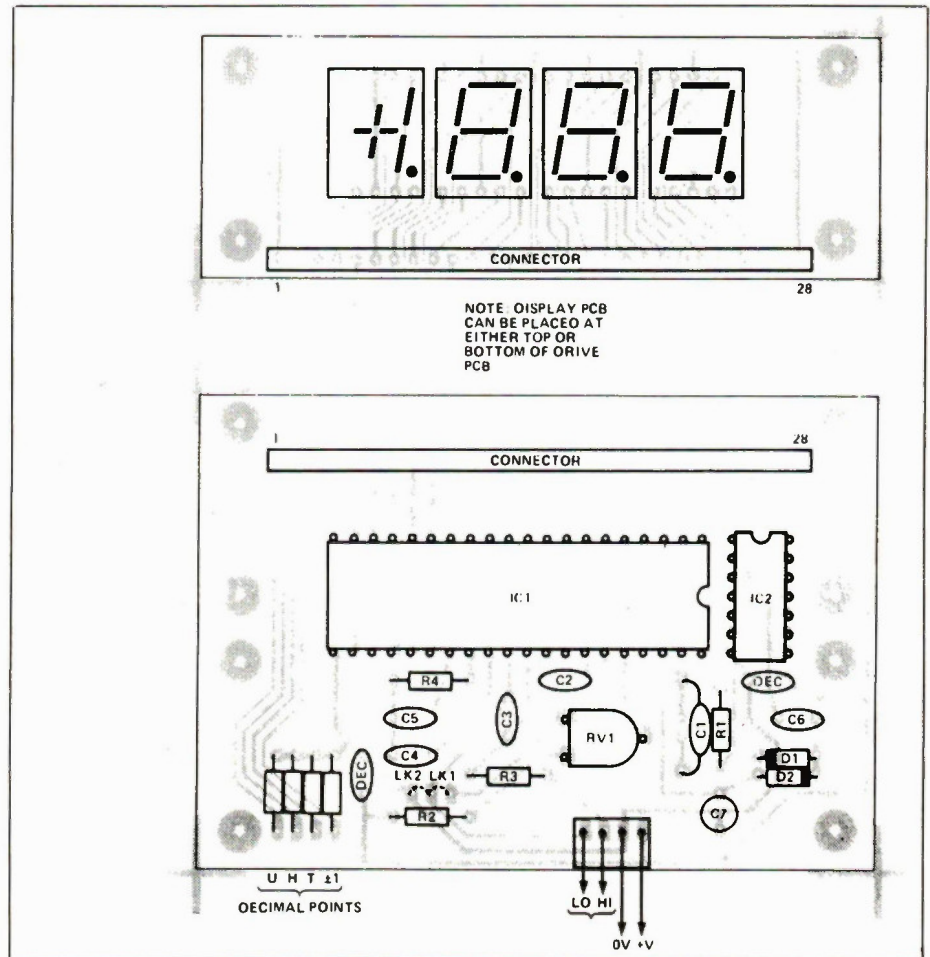


Fig. 5 Components layout for the meter PCBs. The C1 position allows for ceramic or mica capacitors.

some circumstances, you may prefer to choose a different range. Suppose that you decided to use the meter to measure pressure, using (for example) the 136PC15G1 pressure transducer. This device has a range of 0-15 PSI and an output of 6.67mV per PSI. One possibility would be to amplify the output to 10mV per psi, giving a meter display of 100 counts per PSI, so that 15PSI would give a reading of 1500. To avoid using an extra amplifier, the meter range can be adjusted; a full scale voltage of 133.4mV will give the required reading of 100 counts per PSI. Generally speaking, it is not a good idea to increase the meter sensitivity too far beyond 200mV full scale as it becomes more difficult to maintain the full 3 1/2 digit accuracy, but reducing the sensitivity for higher inputs is always preferable to using voltage dividers since, besides keeping down the number of components, it minimizes the noise.

The full scale range of the meter will be twice the voltage appearing between pins 35 and 36. For the 200mV meter of Fig. 5, this voltage is adjusted by RV1 to be 100mV. For small variations of the scale, say up to $\pm 10\%$, it is sufficient simply to adjust RV1. For larger variations, other

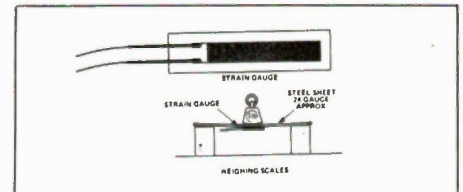


Fig. 6 The structure and use of a typical strain gauge.

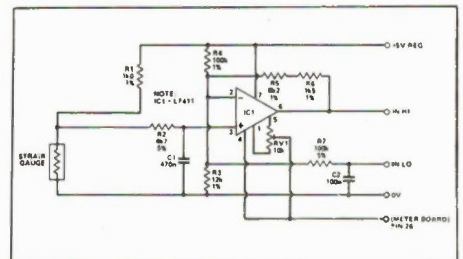
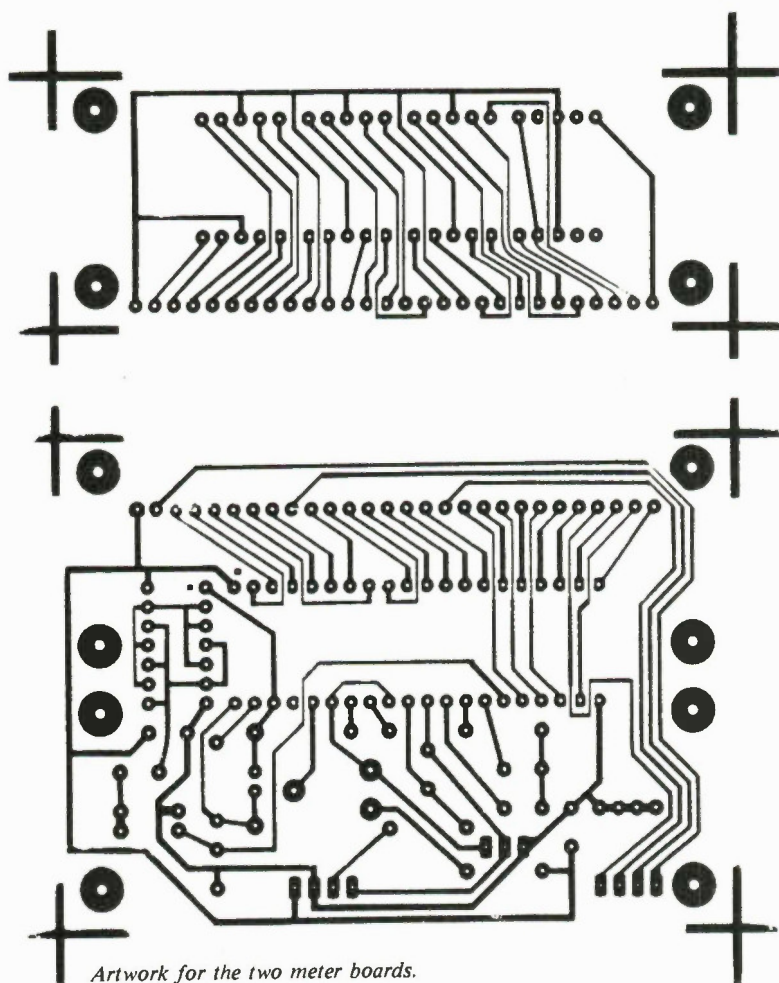


Fig. 7 Circuit of the strain gauge amplifier.

component values must be changed. In general, for a full scale of $n \times 200\text{mV}$, increase the value of R4 by a factor of n and divide the value of C4 by n .

For example, a range of 0 to 2V can be achieved by increasing the voltage between pins 35 and 36 to 1V (you will need



Artwork for the two meter boards.

to substitute a 20k preset for RV1 to allow this), multiplying the value of R4 by 10 to become 470k, and reducing C4 to 47n.

Applications

The capacitance meter circuit for the Multi-Use PCB project in June 1986 can be used with this meter. Current readings can be made by the simple expedient of connecting a resistor across the input - a 1R0 resistor will give a range of 0 to 200mA and a OR1 resistor will give readings up to 1.999 Amps.

For something a little more unusual, the circuit of Fig. 7 will allow the meter to be used with a low cost strain gauge. A strain gauge is a device which changes its resistance in proportion to small changes in its length. Note: you may have to do a fair bit of hunting for a strain gauge. Usually available only to the trades, you may have to con someone into obtaining it for you.

Strain gauges are used in engineering to measure the effects of loading on mechanical structures - bridges, cranes, industrial machinery, and so on. The gauge is bonded to the surface of the part to be tested, and any strain as a result of

the loadings converted to an electrical signal and sent to the measuring apparatus.

In robotics, a strain gauge can be used to give an indication of, say, the strain on a robot arm as a result of a weight that it is trying to pick up. The signal can be used to prevent the arm from attempting to pick up anything too heavy, or as part of a feedback mechanism to allow the robot to judge the weight it is carrying, and perhaps to help it to keep its balance.

A common application of strain gauges is electronic weighing. Transducers for this purpose, which incorporate strain gauges, are called load cells and are usually very expensive (\$200 up). However, the simple arrangement shown in Figs. 6 and 7 can give reasonable results - the strain gauge measures the extension of the lower surface of a sheet of steel, which will be roughly proportional to the weight placed on it over a certain range.

The gauge should be glued with epoxy resin or cyanoacrylate to a metal surface which has been thoroughly cleaned and is free of grease. Avoid touching the surface of the gauge that is to be bonded; it can be picked up and placed in position by means of adhesive tape applied to the top sur-

Parts List

Resistors (all 1/4W 5% carbon film)

R1	.....	100k
R2	.....	22k
R3	.....	1M0
R4	.....	47k
R5,6,7,8	.....	180R (see text)
RV1	.....	1k0

Capacitors

C1	.....	100p ceramic
C2	.....	100n polyester
C3	.....	10n ceramic
C4	.....	470n polyester
C5	.....	220n polypropylene
C6	.....	47n polyester
C7	.....	10u 6V tantalum

(C5 ideally should be polypropylene to prevent errors from dielectric absorptions. If unobtainable, a polyester type can be substituted.)

Semiconductors

IC1	.....	1CL7107 *
IC2	.....	.4069
D1,2	.....	1N4148
LED1,2,3,4	.....	.0.5" common anode, seven segment displays.

Miscellaneous

PCB; 0.1" connectors.

*The 1CL7107 is listed as being available from the Active Components 1986 catalogue, as well as from ElectroSonic.

face. Hold the gauge firmly in place while the glue is curing, and make sure there are no air bubbles underneath.

The components shown in Fig. 6 are for a reading of 100 counts to 1% extension. The only adjustment to be made is to zero the meter reading with RV1 when the metal is unstressed. For weighing purposes, you will probably wish to adjust the gain of IC1 so that the meter scale gives a reading in grams, pounds, or whatever. In this case, R5 and R6 can be replaced with a preset of a suitable value. Don't ask me what value; it depends on the mechanical arrangement of your weighing machine.

RV1 sets the full-scale voltage of the meter, and should be adjusted with a suitable accurate voltage source connected to the meter inputs. Alternatively, the meter can be calibrated against another voltage meter. Resistors R5 to R8 are for the decimal points on the displays. Only one resistor will be required, according to which decimal point you would like to light. The decimal point connections are also available at the edge of the board in case you have ambitions to make an auto-ranging meter etc.

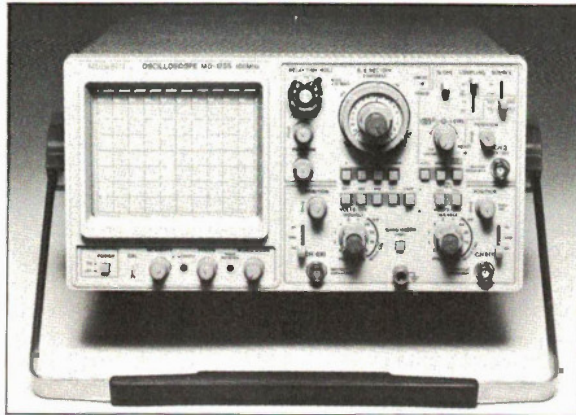
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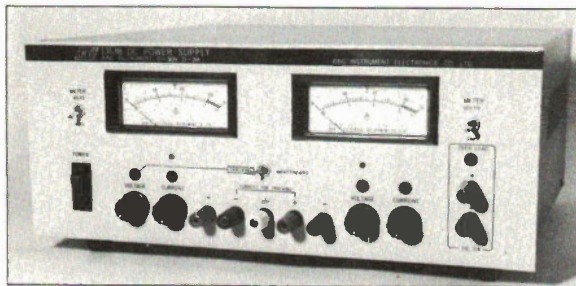
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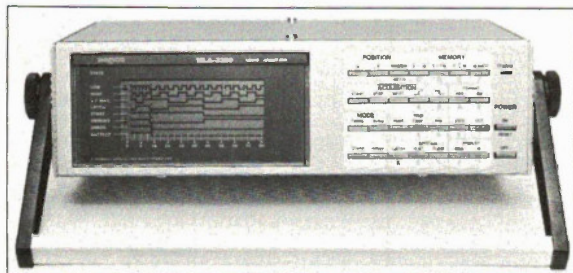
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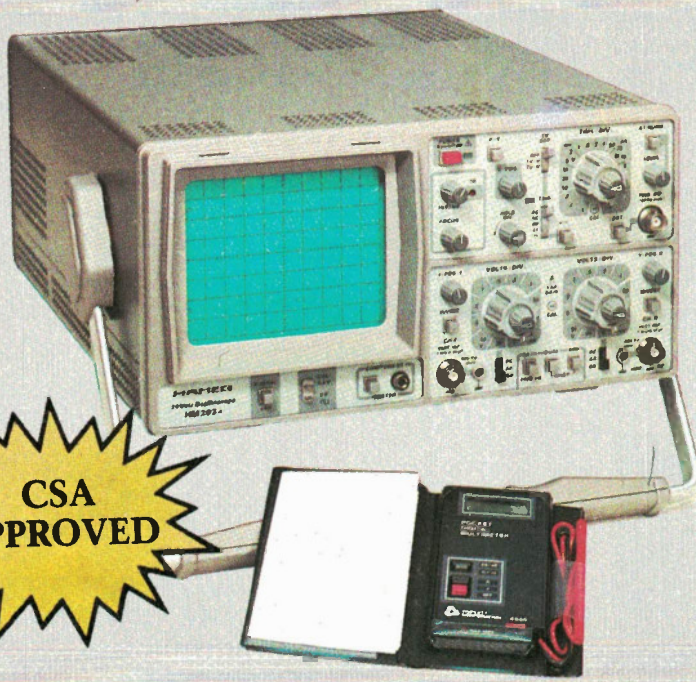
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