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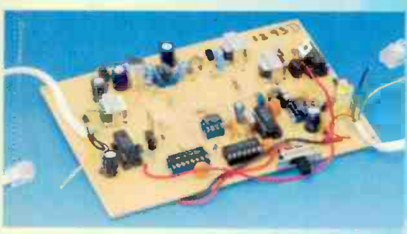

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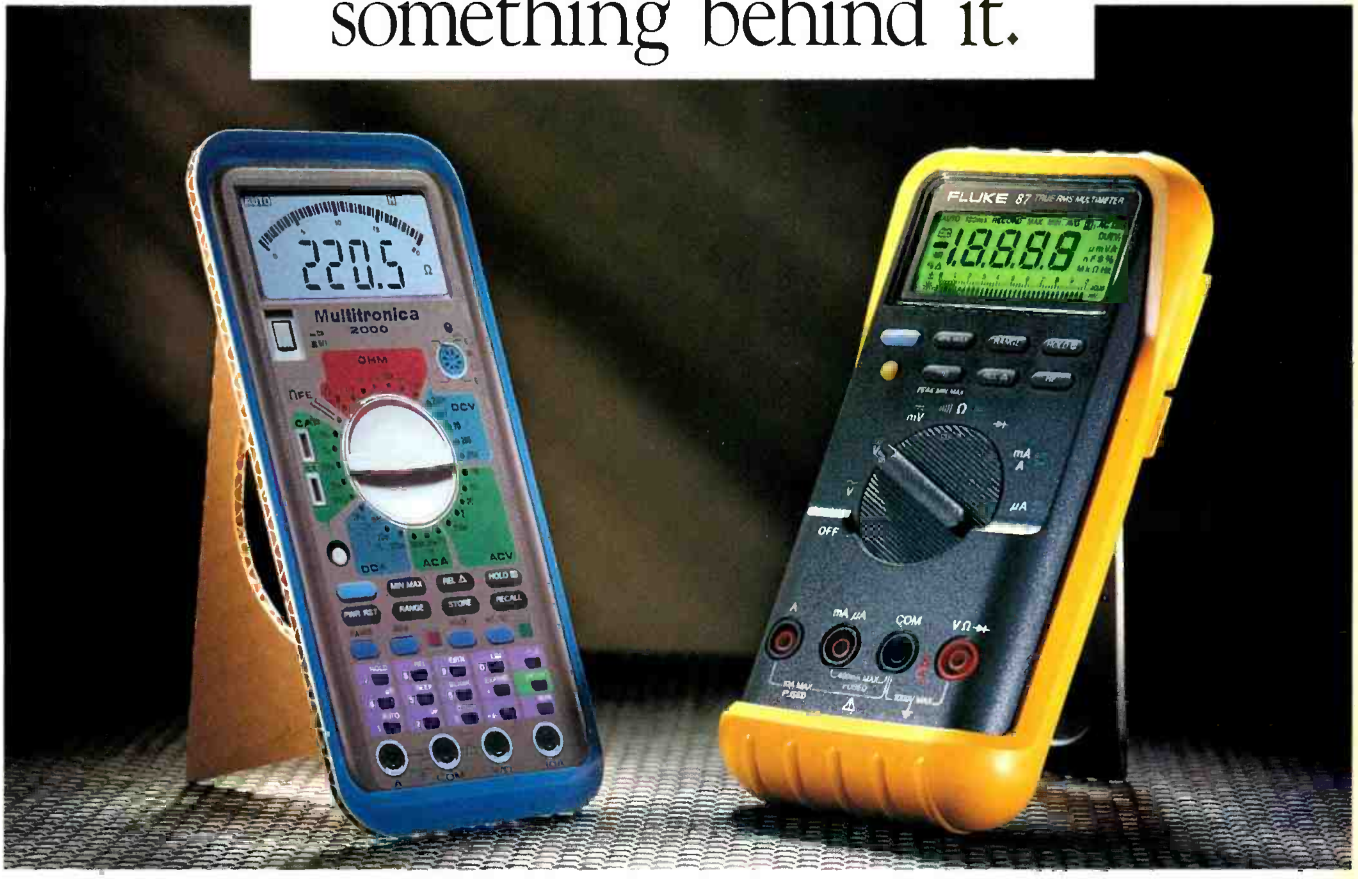

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SEPTEMBER 1994

ON THE COVER

Modem Communications Standards

Serial communications standards have made worldwide computer communications possible. Here's a look at the latest standards.

BUILD THIS

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Quantum-cascade laser developed

A new kind of semiconductor laser diode, called a quantum cascade (QC) laser, has been developed by AT&T Bell Laboratories. Its developers say that it is the first laser diode that can be made to emit at different wavelengths by varying the thickness of its semiconductor material layers rather than the composition of those layers.

The first QC laser developed emitted at a wavelength of 4.25 microns in the mid-infrared region. But its developers say that QC lasers can be made to emit over a range from 2 microns (the near-end of the mid-infrared region) to 100 microns (well into the far-infrared region). The operation of the QC laser diode differs radically from that of the conventional semiconductor laser.

Applications for the QC laser are expected in communications and in scientific instruments for such work as material analysis, spectroscopy, and environmental monitoring.

Conventional semiconductor lasers operate in the near-infrared to visible light regions (about 0.6 to 1.5 microns). Negative and positive charges (electrons and holes) are injected into their active layers where they annihilate each other, releasing energy as photons.

The energy of these photons and their corresponding wavelengths are determined by the bandgap of the laser's active-layer material. The bandgap is the energy difference between a band of energy levels occupied by the injected electrons (conduction band) and a lower band occupied by the injected holes (valence band). The emission wavelength of a semiconductor laser can be altered only by altering the composition of its semiconductor layers because the bandgap is a fundamental material property.

By contrast, the QC laser is a unipolar semiconductor laser; only one type of charge (e.g., electrons) is needed to make it lase. Electrons jump between two well defined energy levels (quantum wells) and the energy of the emitted photons is equal to the differences between those levels.

The photon energy, determined by the wavelength of the emitted light, is controlled by the thickness of the quantum wells and the height of the energy barriers that confine the electrons to those active regions (quantum confinement). Because the wavelength is determined by quantum effects, the laser can be custom made to operate over a wide wavelength region by altering the thickness but not the composition of its semiconductor layers.

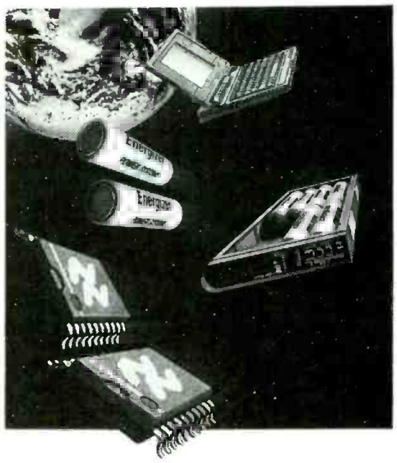
The gain of QC lasers is expected to be much less sensitive to temperature changes than conventional semiconductor lasers. Its emission linewidth is intrinsically narrower, and its frequency response differs from that of other semiconductor lasers.

The development of the QC laser was made possible by recent advances in the understanding of semiconductor band-structures—the relationships between the material's electronic and optical properties—and new material deposition techniques. The laser's layers are formed by molecular beam epitaxy (MBE), a method in which atoms are "spray painted" on a substrate, one layer at a time.

The multilayer material, including its quantum-well active regions, consists of alternate layers of nanometer-thick aluminum-indium arsenide and gallium-indium arsenide grown by MBE on an indium-phosphide substrate.

More smart batteries

Another program to develop "smart" batteries has been announced, this one by Energizer Power Systems, a subsidiary of Eveready Battery Co. and National Semiconductor. The joint effort seeks to simplify the charging of rechargeable batteries and provide means for determining the status of that charge for portable computers.



SMART BATTERIES would be able to determine the proper amount of recharging and the length of battery run-time that remains.

Energizer Power Management brand products will have integrated circuitry within the battery that will monitor battery condition and control battery-charging rate.

By eliminating possible overcharging, which can reduce battery life, Energizer Power Systems says it is possible to increase their charge capacity. The circuitry in the "smart" battery will permit users of the host equipment to determine the status of the charge at any time.

The two companies seek to develop better nickel-metal hydroxide (Ni-MH) and nickel-cadmium (NiCd) batteries. While the initial target is the notebook-computer market, they are planning to apply the concept to mobile communications, power tools, and other battery-powered equipment.

IBM boosts memory capacity

Scientists at IBM's Almaden Research Center in San Jose, Califor-

Continued on page 10

Get a sample of reality.

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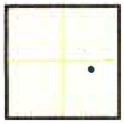
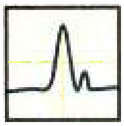
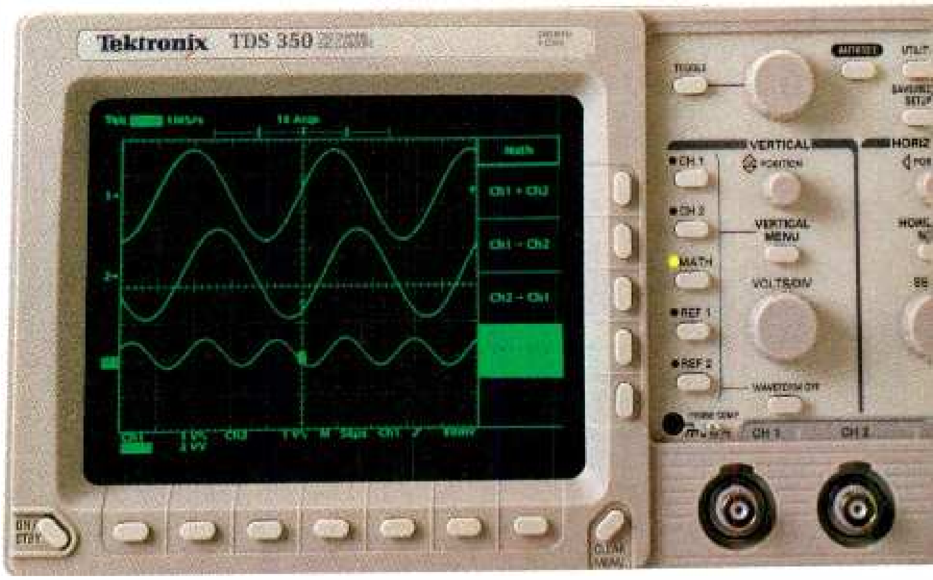


One Point Captured. Single event capture using Equivalent Time Sampling. 20 MS/s 100 MHz DSO.



Real Life Capture. Single event capture using Digital Real Time. 500 MS/s 100 MHz DSO.



Analog look and feel. The TDS 300 family is simple and intuitive; just like your trusty analog scope. Even the digital interface is simplified with on-screen icons. You may never have to crack open the instruction manual!

High-end digital features. Each model features over 20 automatic measurements. Continuous update for hands-free operation. Four acquisition modes and video trigger—perfect for tailoring the display. And a communication option for hardcopy to most printers, or to send/receive waveforms and setups.

There's a TDS 300 Series scope for every application. And every budget.

FEATURES	TDS 310	TDS 320	TDS 350
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Channels	2	2	2
Vertical Sensitivity	2 mV - 10 V	2 mV - 10 V	2 mV - 10 V
Vertical Resolution	8 bits	8 bits	8 bits
Record Length	1K/channel	1K/channel	1K/channel
Standard Advanced Features	TV Line & Field Trigger, Roll Mode, Autoset, 21 Automatic Measurements, Peak Detect		
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Price	$2295.	$2895.	$3995.

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VIDEO NEWS

What's new in the fast-changing video industry.

DAVID LACHENBRUCH

• **Modular TV sets?** General Instrument Corporation, a major manufacturer of cable TV equipment, thinks TV should go the way of audio. It plans to enter the television-set business with modular components, so buyers can choose their features—such as picture-in-picture, type of remote control, screen proportions, and sound system—and build their own custom TVs. GI argues that this will make television sets obsolescence-proof; when one part of the set goes out of date, it's not necessary to discard the whole thing, but just the affected module. Working with Motorola, GI is putting together a package of basic signal-processing components in a box, which it calls "Joey"—after the Australian kangaroo, which carries its young in a modular way, so to speak. Buyers can then plug in the type of display, sound system, or remote control, depending on their wants and needs.

GI and Motorola say they don't want an exclusive on the system, and they are inviting television manufacturers to join in to make and sell compatible components. Joey would be prepared for the future, and it would accommodate a wide variety of inputs, including descramblers for pay cable, decompression devices for digital signals, multimedia modules, and such interactive equipment as printers and keyboards. GI estimates that the first Joeys could go on the market in a year or less at a retail price of $300 to $500.

"Wait a minute," responds the TV industry, visibly unimpressed. TV manufacturers point out that the bucket of dumb components would be selling for the approximate price of a complete 25- to 27-inch set, and it wouldn't even include the two most expensive components— the picture tube and the cabinet. Motorola concedes that prices would have to come down sharply, but TV manufacturers counter that Joey would be impractical at any price, noting that consumers like to buy complete sets they can plug in and play. That, they say, is the most economical way to manufacture and sell TVs. They also note that the public has trouble with plug-ins, asserting that many consumers can't figure out how to connect a VCR to their TV.

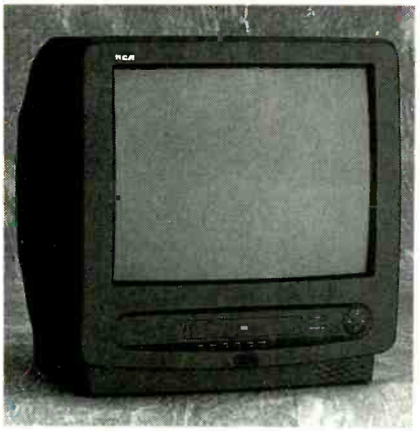


FIG. 1—THE COMBINATION TV/VCR is this year's hottest consumer-electronics product. This might indicate that the U.S. is not ready for modular TV.

TV manufacturers also point out that the trend has been in the opposite direction—the combination TV and VCR is the hottest product of this year. They also point to experience in the past with modular TV. Sony's Profeel was a high-performance TV set whose monitor was sold separately from the tuner and the audio system. It failed in the market because consumers couldn't understand why they should pay more for a set with no tuner and no sound than one with both features—regardless of quality. Joey's fate is still up in the air.

• **Movie on five-inch disc.** Industry interest is intensifying in the concept of a full-length movie on a 5-inch optical disc, spearheaded by Philips. JVC announced that it has developed a system that will record more than 135 minutes of high-quality video on a single disc. It uses the MPEG-2 protocol that provides better than laserdisc quality. JVC said its accomplishment was based on "variable-bit-rate" technology. Existing high-density technology for digital video discs based on conventional red lasers can deliver about four times the capacity of a standard CD, but it would still fall at least 50% short of accommodating a full-length movie, which would require six gigabytes of capacity. JVC said that its variable-bit-rate system provides the six gigabytes by using a "high transmission rate for pictures with a lot of information and low transmission rate for those with little information." JVC pointed out that a fixed transmission rate makes inefficient use of disc capacity because that rate is dictated by the requirements of "pictures with the greatest amount of information."

A high official of Sony Corporation of America said that moves to record a full movie on a five-inch disc are in the "right direction." Sony, which is co-holder of the basic CD patents with Philips, is in discussions with other manufacturers throughout the world on standards for the next generation of high-density video disc, said John Briesch, president of Sony Consumer Products. JVC has also pledged to work toward standardization of a new Digital Video Disc (DVD) format.

• **Electronic game delivery.** It has been predicted so often that it's hard to believe that it actually is being done—or at least tested. Since audio and video cassettes as well as video games are merely electronic impulses recorded on various media, why is it necessary to deliver them to stores by such antiquated methods as mail or

Continued on page 80

Q & A

Write to Q & A, Electronics Now, 500-B Bi-County Blvd., Farmingdale, NY 11735

BATTERY BACKUP

I am building a circuit that stores operating data which configures the circuit in CMOS memory. I'd like to use nickel-cadmium cells to provide power to the memory when the device is turned off. I need some way to charge the batteries when the device is turned on and then power the CMOS memory only when it's turned off. Can you give me a simple circuit that can do this?—N. Herbert, New London, CT

Charging nickel-cadmium batteries isn't complicated. They should be trickle charged because there's no guarantee as to how long the batteries will be kept under charge. A charge rate that is too high will more than likely damage the batteries.

The circuit you're looking for can be small because you don't need a lot of power to maintain the data in memory. Most CMOS static memory is guaranteed to retain data with current drain that's in the microampere range. This means that the batteries you need to do the job should be button cells or some other form that has a rating under 50 milliampere-hours.

The circuit shown in Fig. 1 performs two functions: It provides for both battery charging and directing battery power when the device you've built is turned off. When the device is turned on, power is available to charge the battery, so D2 is reverse biased and current flows into the batteries through current limiter resistor R1.

When you turn the device off, D2 is forward-biased, and battery power is available. Steering diode D1 keeps the battery from powering anything other than the CMOS memory. You can install almost any diode you want for D2 (even a small 1N914) since the power needed to maintain the memory is so low you'll have difficulty measuring it.

Because the battery can be left to charge for an extended period of time, you'll have to choose a value for R1 that will limit the charging current to one tenth of the battery's ampere-hour capacity. This can be calculated by: $R1 = ((V_{CIRCUIT} - (0.6V + V_{BATTERY}))/I_{CHARGE}$

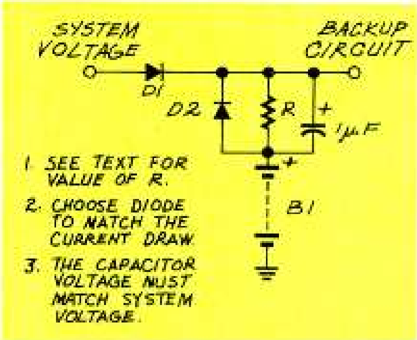


FIG. 1—THIS CIRCUIT CHARGES the battery and controls battery power when the device is turned off.

Note that you have to subtract the 0.6-volt diode drop and battery voltage from the supply voltage. The capacitor in the circuit acts as a sponge to swallow any voltage glitches and also to provide a few seconds of power if you want to change batteries.

MYSTERY IMPEDANCE

I'm trying to measure the impedance of my stereo speakers with no luck. When I put a multimeter across the speaker terminals, I get a reading of less than one ohm. I know there's a difference between impedance and resistance, but I'm not sure what the difference is. Can you explain it to me?—F. Benfish, Scoop, NY

The difference between impedance and resistance is similar to the difference between AC and DC. The resistance exhibited by a particular component remains constant only as long as the materials that determine its resistance remain constant.

The easiest way to understand what this means is to study a capacitor, although it might seem unusual to talk about the resistance of a capacitor. When you apply a DC voltage across the terminals of a capacitor, it initially displays no resistance but, as the field increases, its resistance increases until current flow through the capacitor stops. At that point the capacitor has "infinite" resistance.

The resistance of a circuit element is just the DC component of its impedance. But, as circuit parameters change, the AC component of the impedance will change as well. Those circuit factors include such things as current flow, inductance, and frequency. A speaker's impedance is also affected by environmental factors such as air pressure and temperature, and by the coil that moves the cone in and out of the speaker.

If you want to measure the impedance of your loudspeaker system, put a variable resistor in series with the amplifier and the loudspeaker. By convention, loudspeaker impedance is usually measured at a frequency of 400 hertz, so you'll want an audio function generator or an audio test CD to supply a 400-hertz signal to the amplifier.

Measure the voltage drop separately across both the variable resistor and the speaker, and adjust the resistor until both voltage drops are equal. Then remove the variable resistor from the circuit and measure its value. The value of the resistor will be equal to the speaker's impedance in ohms.

A speaker presents its rated impedance over only a small range of frequencies. You might want to repeat the measurements at different frequencies and chart the results on graph paper.That way you can obtain a graph of how the impedance varies.

VCR HARD-DRIVE BACKUP

I recently exchanged the hard drive on my computer for a new one with a 210-megabyte capacity. I used to back up my old 30-megabyte hard drive with floppy disks, but this is impractical with my new drive. I remember reading about circuit cards that would let me back up a hard drive with my VCR. I've been searching for a system like this but I haven't been able to find one. Can you help?—L. Buxbaum, Boston, MA

Hard drive technology is changing rapidly. In the last few years their quality has gone up and their prices have gone down dramatically. The reliability of modern hard drives has lulled a lot of people into carelessness about backing them up. When hard disk drives crashed all the time, backing them up was a necessity, but today some people regard data backup as an option. Big mistake.

I remember seeing the same ads for VCR-hard drive backup systems, but they disappeared as tape backup became standardized, more available, and more affordable. The problem with all VCR backup systems is that there was never an established standard for writing the data on the videotape. By the time the QIC-40 tape-drive standard became widely accepted, VCR backup technology had all but disappeared.

As things stand now, you can buy a 250-megabyte (with compression) tape backup drive for less than $150. Tape drives cost about half of what they did a few years ago, and they're also significantly less than the cost of those earlier VCR systems you asked about. In addition, standard formats such as QIC-40 and QIC-80 allow tapes to be read on another tape drive in another computer. This not only gives you an easy way to move masses of data from one computer to another but, if your computer goes up in smoke, there will always be a way to restore your data on another machine. This just wouldn't be possible with a non-standard or, worse yet, proprietary backup scheme.

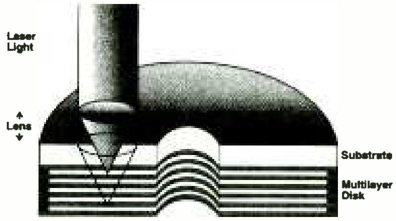
I agree with you that backing up over 200 megabytes to a bunch of floppies is about as inviting as a root canal. If you want to back up the data reliably, consider purchasing a standard tape drive. If it makes you feel any better, you might consider the fact that you can buy both a 200-megabyte hard drive and a tape drive today for about half of what you would have paid for the hard drive alone just a few years ago—now that's progress! Ω

WHAT'S NEWS

continued from page 4

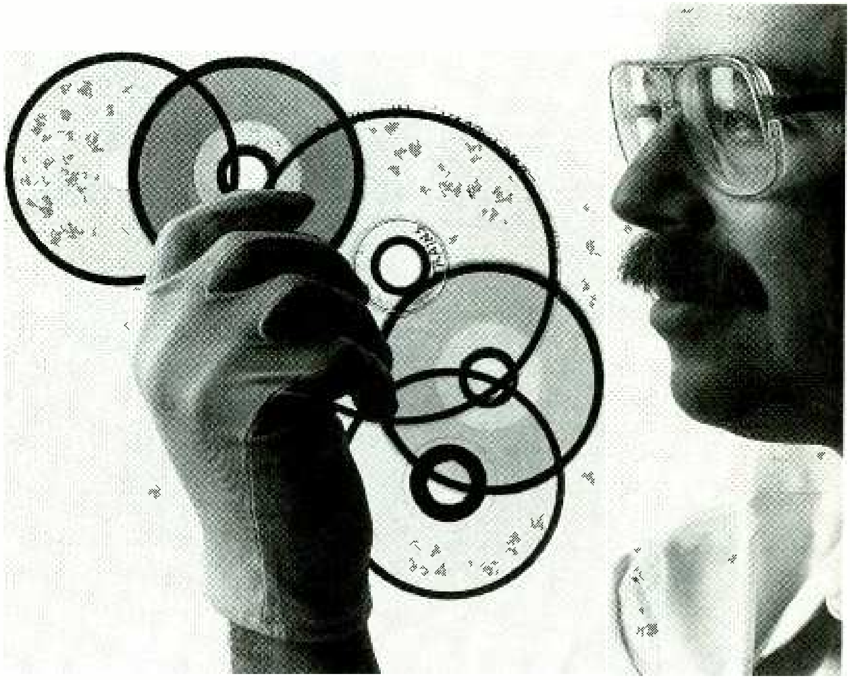
nia, have recently announced advancements that increase the data storage capacity of two different media—conventional magnetic hard-disk drives and CD-ROM drives.

IBM's new hard-disk formatting technique allows it to pack 28% more data into its latest line of magnetic hard-disk drives for laptop computers. IBM's new No-ID sector format is credited with permitting 270 megabytes to be crammed onto each 2.5-inch diameter disk of an 810 megabyte three-disk drive.



Multilayer Optical Storage

IBM'S MULTILAYER OPTICAL DISKS, made by sandwiching together as many as ten partially transparent, partially reflective layers, can hold up to ten times the data of today's optical disks.



SCIENTIST AT IBM'S ALMADEN RESEARCH CENTER holds five disk layers that will be combined in one multilayer optical disk.

The No-ID sector format increases data-storage capacity by removing all of the disk-sector identification (ID) information that normally precedes every block of data on a disk. Their functions are now handled electronically, freeing up about 10 to 15% of the disk area for storing more user data.

When applied to IBM's magnetoresistive (MR) recording head, the No-ID format also permits the data tracks to be positioned closer together, providing additional capacity gain. The new format is said to permit faster and more reliable data-reading and writing.

The Almaden Research Center has also demonstrated a new multilevel optical disk that it says will expand the storage capacity of CDs for playing back audio as well as CD-ROMs for playing back computer audio and video data.

In existing CD storage drives, a fine laser beam is focused on a rotating reflecting disk. All data are stored on the disk as annular rings of tiny pits formed by a powerful "write" laser. The pits cause variations in the brightness of the reflected beam from a "read" laser which are converted into digitally coded strings of 1's and 0's.

In the new IBM system, a stack of transparent but reflective disks replaces a single reflective disk. A

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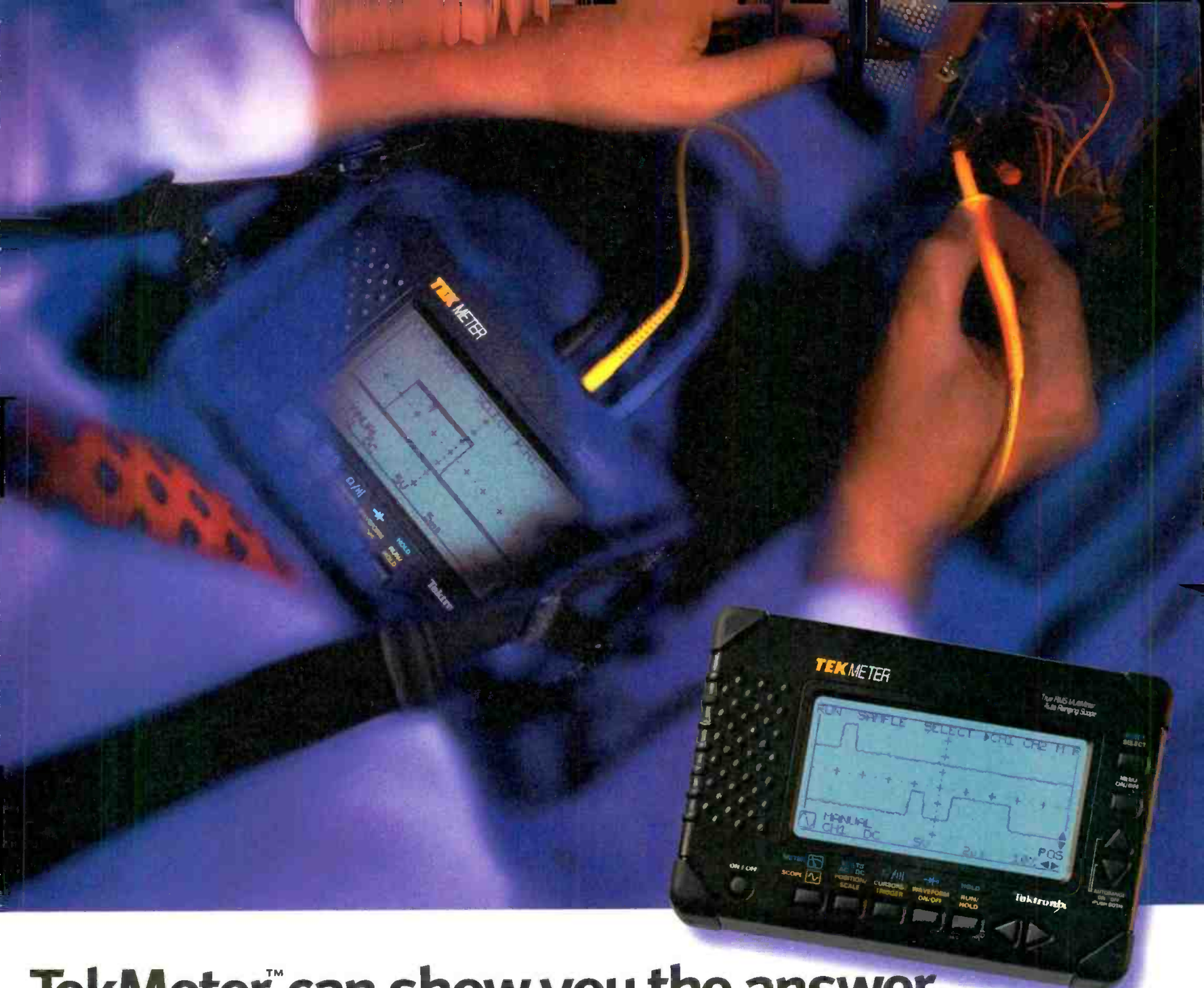

TekMeter™ can show you the answer before you even know the question.

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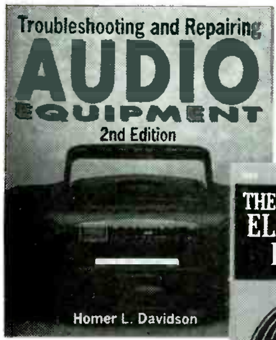

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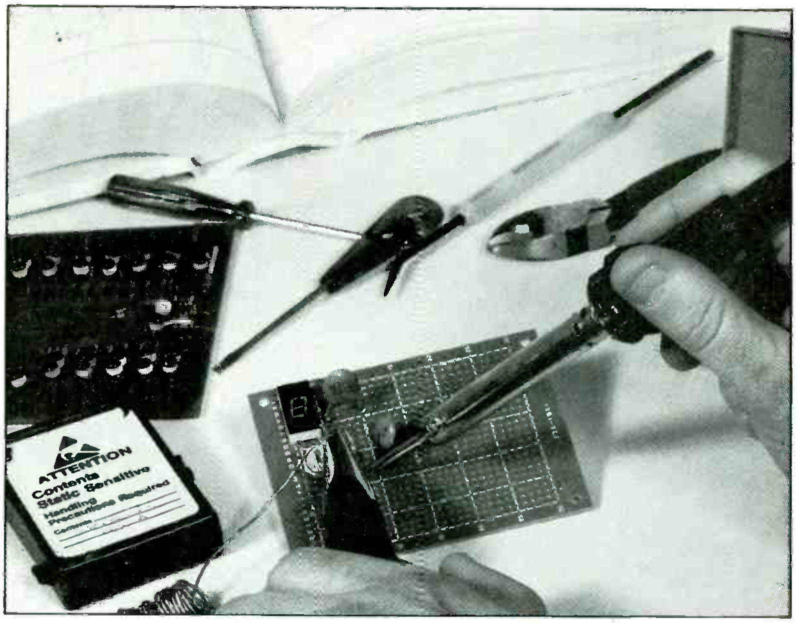

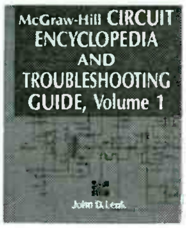

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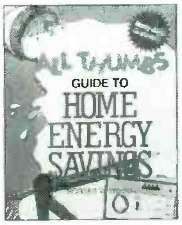

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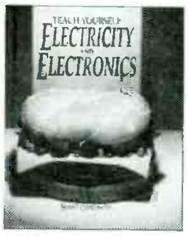

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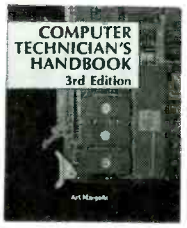

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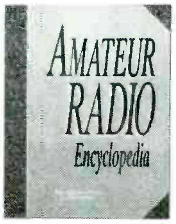

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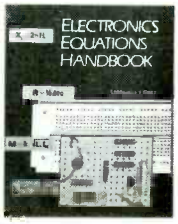

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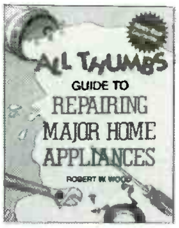

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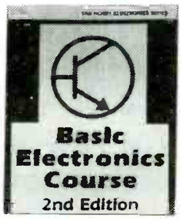

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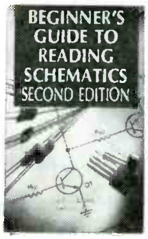

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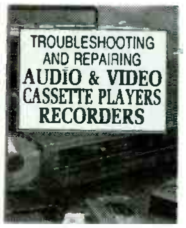

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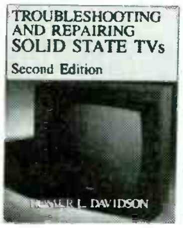

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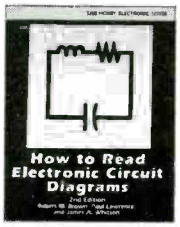

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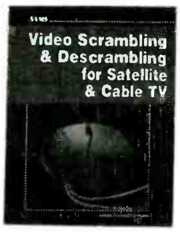

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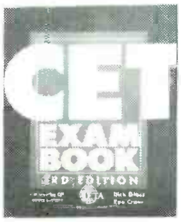

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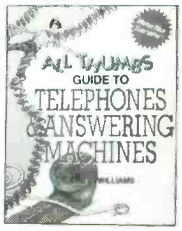

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LETTERS

Write to Letters, Electronics Now, 500-B Bi-County Blvd., Farmingdale, NY 11735

MISSING TABLE

The table referenced in the last paragraph of "Computer Connections" in the July issue of Electronics Now *was inadvertently omitted. We've included it here, and apologize for any inconvenience caused to our readers by its omission.—Editor*

TABLE 1—PRODUCT LINEUPS

	Microsoft	Novell	Lotus	IBM
DOS	MS-DOS	DR-DOS		PC-DOS
GUI	Windows 3.1, NT,Chicago, Cairo			OS/2
Network Operating System	Lan Manager, Windows for Workgroups, NT	NetWare 2.x, 3.x, 4.x		Lan Server
Word Processor	Word	WordPerfect	Ami Pro	
Spreadsheet	Excel	Quattro Pro	1-2-3, Improv	
Database	Access, Foxpro	(Paradox)	Approach	
Email	MS Mail	WordPerfect Office	cc:Mail	
Enterprise Glue	MS Office and Visual Basic for Application	WordPerfect Office	Notes	

ATV CORRECTIONS

There are a few corrections to our ATV story that ran in the July and August 1994 issues of Electronics Now. All corrections pertain to the 5-watt transmitter. To begin with, R24 was missing from the Parts List. It should be included there as a 1K, ⅛-watt resistor.

While it might not have been clear from the parts-placement diagram, reverse-polarity protection diode D4 has only one lead (its cathode) soldered to the PC board. Power is applied to the anode end of the diode, which is not soldered to the board.

In the parts-placement diagram, R30 should be shown as R31. The "real" R30 should be installed between the pad at the base of Q4 (its center lead) and the ground pad to the left.

Also in the parts-placement diagram, R21 shown between potentiometer R18 and Q5 should be shown as C42; R21 is not used in the circuit.—Editor.

REGENERATIVE RECEIVER RESPONSE

I am responding to Mr. Bialkowski's letter (*Electronics Now*, June 1994) expressing his concerns about the use of regenerative receivers.

The demise of regenerative receivers had many causes, but I suspect that the main reason was the availability of low-cost, factory made receivers. As the depression ended,people no longer had to build their own receivers to save money because they were able to buy them. With progress in receiver design, manufacturers chose to make and sell superheterodyne sets, which were easier to tune to the desired stations.

On the subject of radio-frequency interference, my article, "The Lost Art of Regeneration" (*Electronics Now*, March 1994) clearly stated that unbuffered detectors should not be allowed to oscillate. Also, Mr. Bialkowski's comparison of the emissions from old-fashioned, tube-type regenerative receivers that dissipated several watts of power with modern versions powered from a 9-volt battery that dissipate only a few milliwatts is grossly unfair to the older units.

Strictly speaking, *any* receiver with an oscillator will radiate some RF energy. The important point is the level of that emission. Many direct conversion receivers in common use today have free-running local oscillators that are buffered only by the mixer stage (often an NE602). Radiation from that kind of receiver can easily equal or exceed that of a regenerative circuit buffered by an RF stage. Nevertheless, the radiation from both types of receiver is likely to be well below the limits imposed by FCC rules, Part 15.

Finally, the term "Autodyne" commonly referred to a regenerative detector operated in an oscillating condition. The tuning was adjusted to zero beat with AM signals, or slightly off zero, which produced an audible tone for the reception of CW.

CHARLES KITCHIN
Wilmington, MA

RELAY RAVES

I thoroughly enjoyed the article, "All About Relays" (*Electronics Now*, June 1994). Not only was it an excellent refresher course, it also provided valuable general-purpose information in a simple and thorough manner.

I hope you will consider running these "how do they work" articles on a regular basis—perhaps "All About Transformers," "All About Transistors," etc. I am convinced

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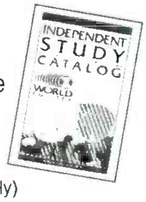

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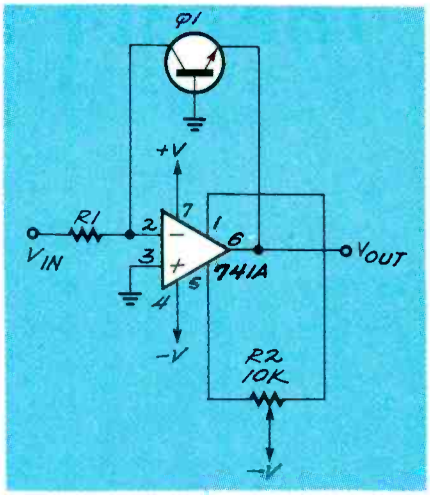

FIG. 1 A LINEAR TO LOG amplifier.

that many of your readers would enjoy this type of article as much as I would. DAVID JENKINS
Austin, TX

Some recent subjects in this series by Ray Marston have included field-effect transistors (March to May, 1993), bipolar transistors (September to November 1993), oscillators (December 1993), audio amplifiers (March 1994), and power amplifiers (April 1993) —Editor

LINEAR-TO-LOG CONVERTER

I am writing to comment on a circuit that was published in the Q&A column (*Electronics Now, June 1994*). A. Blumenthal asked for a simple circuit that would convert linear functions to log functions. However, the circuit shown in Fig. 2 in Q&A will not work as a linear-to-log amplifier because the 741 operational amplifier inputs are reversed.

That configuration of log amplifier shown is known as a *transdiode log converter*. There are other versions that are not true logging circuits, but they closely approximate the function. The logger shown in Fig. 1 has a range of about 5 decades (100 dB). Its basic function is based on its characteristic of V_O that will be V_{BE}. The V_{BE} of a silicon transistor for V_{CE} = 0 volts is as follows:

$V_{BE} = 2.3kT/q \ln (I_c/I_o)$

where

k = Boltzmann's constant (1.38×10^{-23} J/K)

T = absolute temperature (Kelvin)

q = charge on an electron (1.6×10^{-19} coulomb)

I_C = collector current

I_O = reverse saturation current

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(10^{-13} at 27°C)
At 27°C, kT/q is equal to 26 mV, which produces:
$V_{BE} = 60 \text{ mV} \log_{10} (I_c/I_o)$.

Thus, for each decade increase in I_C, V_{BE} will increase 60 millivolts. This circuit is an excellent logger, but its 60-millivolt per decade output is inconvenient for most applications where 1 volt per decade is the standard.

R. JEFFREY PERRYMAN
Rural Hall, NC

SOFTWARE DOCUMENTATION CHECKS

I thoroughly enjoyed Robert Grossblatt's *Drawing Board* column on removing software documentation checks (**Electronics Now**, September 1993). I'm sure you will get some negative feedback regarding that column. Most likely someone will condemn Mr. Grossblatt for encouraging software piracy, or something equally foolish. Anyone who reads the column and runs to their local pirate BBS bragging about his newly learned skill is incredibly lame.

It would have taken me at least twice as long to learn assembly language without the help of a disassembler. Reverse engineering software can also be an incredibly enlightening brain-twister when the software company has seen fit to include an anti-debugger code in its release.

The column was not without its share of inaccuracies, however. Mr. Grossblatt mentions the IRET instructions as "return from subroutine." Actually, IRET means "return from Interrupt Service Routine (ISR)." The complementary instruction to CALL is RET. RETF is also used for returning from far CALLs (those that call code in another 64K segment).

The difference is as follows. When a CALL is executed, it puts the address of the instruction of the next instruction on the stack. That is equivalent to a PUSH IP instruction. When an RET is executed, it restores the word at the top of the stack to the IP register. The effect is to return control to the statement after the CALL. An IRET, however, is for use with the INT instruction. The specifics of ISRs are a book in themselves, so I will not delve into them here. Suffice it to say that the INT instruction pushes both the contents of the FLAGS register *and* the return address onto the stack. The IRET complements those actions. If an IRET was to be used to return from a CALL, whatever word happened to be at the top of the stack would be transferred to the FLAGS register, destroying the state of the register.

Thank you for providing some very interesting reading. I will be interested to see what other readers have to say about the column.

CHRIS McCANN
Gilberts, IL

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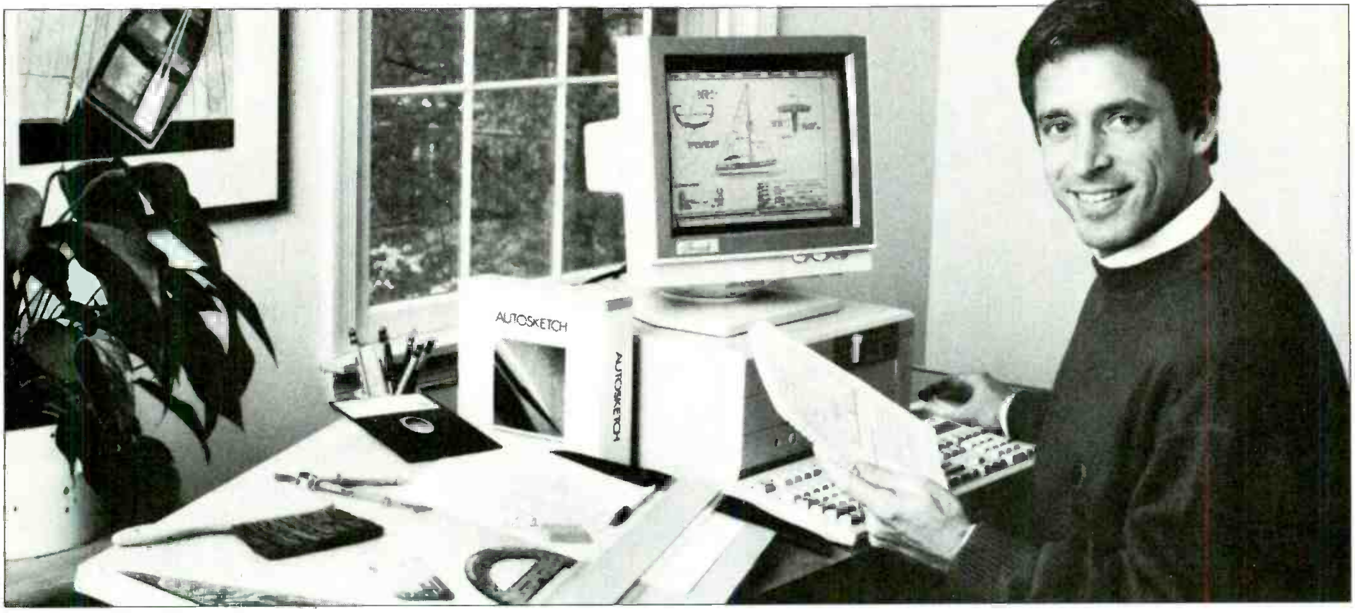

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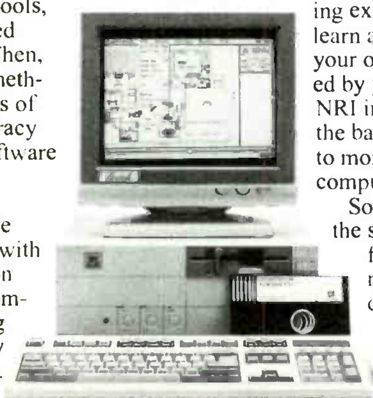

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An experienced electronic technician is known by the quality and capability of the test instruments he keeps. That should not be surprising. After years of trying out different kinds of test equipment, you can expect that he'll end up with the tools that make his job easier, save time, and pay for themselves in as short a time as possible.

Consider the normally odious task of sorting and matching components. This can be very time consuming work if all you have is a basic digital multimeter and you must observe and make a mental note of the value of every part you test. And, of course, you must stay alert enough to reject any parts that don't meet the required tolerances.

Fortunately, a new handheld LCR bridge from B + K Precision (Maxtec International Corporation), 6470 W. Cortland Street, Chicago, IL 60635, 312-889-1448) offers many functions that make sorting and matching components a breeze—it is priced at $275.

The B + K Precision Model 878 LCR bridge measures inductance, capacitance, and resistance with a basic accuracy of 0.7 %. The meter is packaged in a rugged plastic case and weighs less than a pound. There's a built-in stand on the back of the case, as well as two extremely "grippy," ribbed, rubber feet.

The feet are shaped to keep the meter from sliding, whether or not the stand is in use. Believe it or not, simple product details like no-skid feet make a meter a lot more user-friendly. (If you've ever had a test instrument that kept sliding off the test bench whenever you pulled on its test leads, you know what that means.)

Portability is a nice feature, especially when you are out of range of an AC outlet. But a disadvantage of most handheld instruments is that they can be powered only by a battery which periodically must be replaced at extra cost. Out in the field, the Model 878 can be powered by a 9-volt battery, but in the shop you can plug it into the AC line.

Because the meter has features that make bench tasks like sorting easy, it is quite likely that it will be used often on the test bench. That's why B + K thoughtfully added a 9-volt DC adapter that plugs into an AC outlet and a jack on the side of the meter. This eliminates the need to consume battery power whenever an AC outlet is handy.

An automatic power-down feature conserves the batteries in case you forget to turn off the meter. However, that power-down feature can be disabled.

The Model 878 features autoranging, but the ranges can be set manually, if necessary. The four-digit liquid crystal display presents values to 9999 in each range, and a dual-display feature permits the simultaneous display of either inductance and Q or capacitance and the dissipation factor (D).

The display will also indicate when battery voltage is low and when the meter should be calibrated. Calibration, which zeros out test-lead capacitance, inductance, and resistance, is as simple as pressing a CAL button.

The meter can measure capacitance from 0.1 picofarad to 10 millifarads, resistance from 0.001 ohm to 10 megohms, and inductance from 0.1 microhenry to 10,000 henries at either 120 hertz or 1 kilohertz. The 1-kilohertz test signal is normally used to test inductors that will be operating at the higher frequencies found in audio, video, and RF circuits.

The 120-hertz signal is better suited for testing inductors for use in lower-frequency circuits such as power supply filter chokes. A pushbutton on the meter's front panel selects either the 120-hertz or the 1-kilohertz signal.

Inductors are normally tested in the series equivalent mode. The series mode provides the most accurate Q readings for low-Q inductors. For measuring iron-core inductors that operate at higher frequencies, a parallel equivalent mode can be selected.

Two wide slots on the meter's front panel accept the leads of most components, and a pair of short test leads with alligator clips can test any components whose leads don't fit in the slots.

Sorting features

The meter includes a Max/Min/Avg mode that can be selected before testing a new batch of components. Then, as each new component in the batch is tested, the meter recalculates a new average for the batch and records those minimum and maximum readings as

Continued on page 64

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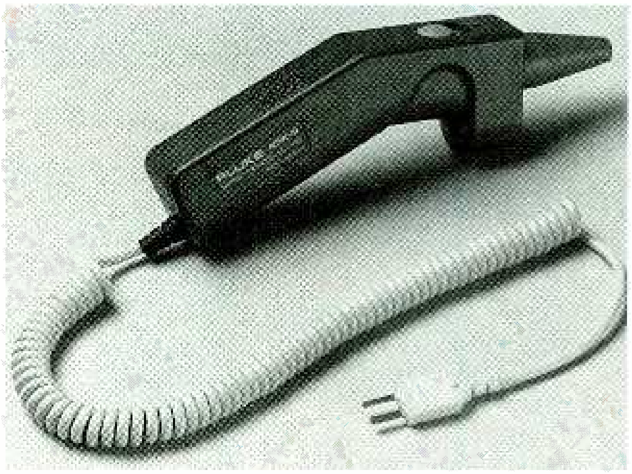
NON-CONTACT TEMPERATURE PROBE. The Fluke 80PK-IR handheld temperature probe is intended for use with Fluke digital thermometers that accept Type-K miniature thermocouples. The probe receives infrared emissions from the source whose temperature is to be measured making it a non-contact instrument. It is suitable for factory maintenance, heating, ventilation and air conditioning installation and repair, and electrical power transmission applications.

Non-contact operation makes the probe suitable for taking temperatures of heat sources that cannot be made by direct contact methods because they are electrically alive, in motion, inaccessible, or will be contaminated by contacts with attached sensors.



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The probe, which connects directly to a digital thermometer, can be held in one hand, leaving the other hand free for adjusting instrument settings. Readings are taken by pointing the probe at the heat source to be measured. The probe has a temperature reading accuracy of 3% and a temperature range of 0° F to 500° F (−18°C to 260° C).

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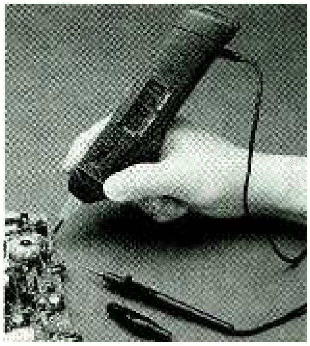
Phone: 800-87-FLUKE
Fax: 206-356-5116

PEN-STYLE MULTIMETER. The SI1000 pen-style digital multimeter from Shoreline Instruments can display 11 measurement ranges including AC and DC volts, AC current, and resistance. It includes a diode tester and an audible continuity checker. Range can be set with a slide switch.

The multimeter, with a 2000-count liquid crystal display, measures 9⅛ × 1¾ × 1 inches and weighs four ounces. It can be held like a pen, or gripped in the palm with the display facing upwards. The DMM has a twist-on alligator clip that attaches to its ground probe to permit the user to connect it to the circuit and make measurements with only one hand.



CIRCLE 21 ON FREE INFORMATION CARD

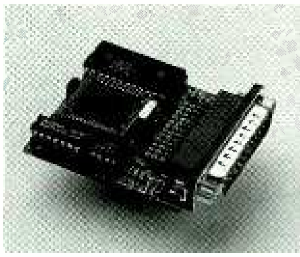
The SI1000 pen-style digital multimeter is priced at $39.95. **Shoreline Electronics, Inc.**

P.O. Box 378
Moffett Field, CA
Phone: 408-987-7733
Fax: 408-987-7735

PERSONAL DIGITAL CONTROLLER BOARD. The Xplor-32 personal digital controller board from Blue Earth Research is intended for embedded control, monitoring limits, and data-logging.

The board, which measures 2.15 × 2.2 inches, includes an Intel 80C32 microcontroller, a Xicor 8-kilobyte EEPROM, a serial port, and a +5-volt regulator. Its EEPROM offers concurrent read/write operation which the device can read while data is being written to it. A BASIC interpreter includes several utilities such as frequency measurement, real time clock/calendar, and hex file loading. The BASIC programs can be interactively edited, and any stored program is automatically executed on power up.

Each of the Xplor-32's 12 digital I/O lines includes a socket that permits solderless connections for external components such as resistors, capacitors, or transistors. All external connections are made through a single 25-pin D-type subminiature I/O connector.



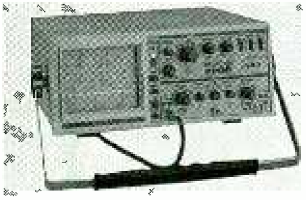
CIRCLE 22 ON FREE INFORMATION CARD

A companion ST-25 interface module accesses Xplor-32 signal lines. Screw-type terminals on all I/O lines include a power-supply jack, a 9-pin D-subminiature connector for PC-compatible serial ports, and an X-10 power-line interface jack.

The Xplor-32 is priced at $59.95. A package including the Xplor-32, ST-25, PC serial interface cable, a 9-volt power supply, an applications disk, and a user's manual sells for $99.95.

Blue Earth Research
165 West Lind Court
Mankato, MN 56001
Phone: 507-387-4001
Fax: 507-387-4008

UPGRADED 100-MHZ SCOPE. The Model 2190A, 100 MHz, three-channel, six-trace oscilloscope from B+K Precision has more user-friendly controls and a lower price than its predecessor. Maximum sensitivity is given as 1 millivolt per division, and accuracy is specified as better than 3%. Rise time is less than 3.5 nanoseconds.



CIRCLE 23 ON FREE INFORMATION CARD

Operating modes are CH1, CH2, ADD, DUAL and TRIPLE. Sweep speed is adjustable from 50 nanoseconds per division to 0.5 seconds per division in 22 calibrated steps with fine adjustment. Trigger modes are AUTO, NORM, TV-V, and TV-H. Trigger coupling can be AC, high-frequency reject, low-frequency reject, or DC. Variable hold-off permits the observation of stabilized complex pulse trains.

The Model 2190A has two timebase generators that allow any part of the waveform to be expanded. The signal-delay line permits viewing the leading edge of high-frequency signals and pulses with short rise times. X and Y inputs are provided for horizontal and vertical deflection, while a Z-axis input allows intensity modulation. The six-inch CRT has an illuminated fluorescent graticule that permits waveforms to show up clearly when they are photographed.

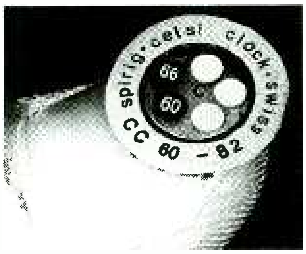
The Model 2190A oscilloscope, complete with instruction manual and probes is priced at $1599.

B+K Precision
6470 West Cortland Street
Chicago, IL 60635
Phone: 312-889-1448

TEMPERATURE-INDICATING LABELS. A CelsiClock temperature indicating label from Solder Absorbing Technology is a small, clock-shaped, stick-on label that accurately and irreversibly indicates the maximum temperature reached by any device to which it is attached.

Each label measures 9/16 inch in diameter and contains five temperature-sensitive circles arranged like the numbers on a clock's face. Yellow digits within each circle indicate that circle's temperature rating. If the temperature rating of any circle is exceeded, that circle turns from clear to black—permanently.

The yellow digits become highly visible when the background turns black. Each of the five circles on the labels has a different temperature rating, accurate to ±1%. The labels are available in eight temperature groups covering 40°C to 260°C (105°F to 500°F).



CIRCLE 24 ON FREE INFORMATION CARD

The manufacturer states that CelsiClocks can be applied to power semiconductor devices and micro-

CIRCLE 89 ON FREE INFORMATION CARD

processors, and are suitable for use on any part or surface where temperature measurement by other means is impractical, dangerous, or expensive.

CelsiClock temperature-indicating labels are priced from $0.95 to $1.35 each in packages of ten or at $0.82 each in a roll of 1000.

Solder Absorbing Technology, Inc.
144 Oakland Street
Springfield, MA 01108
Phone: 800-628-8862
Fax: 413-788-0490

DIGITAL MULTIMETER. The DM28XT handheld, battery-portable digital multimeter from Wavetek can measure and display temperature, capacitance and signal or line frequency in addition to making all of the standard electrical measurements.

It can measures AC voltage to 750 volts, DC voltage to 1000 volts, and both AC and DC current to 10 amperes. It can also measure resistance to 2000 megohms. The DMM includes a diode test circuit and an audible continuity tester.

Temperature can be measured in either Fahrenheit or Centigrade units up to 2000°F (1300°C), and it can measure capacitance up to 2000 microfarads. It can also measure signal or line frequency up to 2 kHz.

The DM28XT includes a liquid-crystal display and a pair of safety test leads. Both current jacks are fused to protect the user and meter from excessive current. Safety features include an audible warning beeper that sounds if a test lead is in the current jack while the meter is set for a voltage measurement.

The *DM28XT* DMM package including a battery, a pair of test leads with insulated probe tips, a spare fuse, a beaded Type-K thermocouple probe, a pair of threaded alligator clips, and an operator's manual is priced at $139.95.

CIRCLE 25 ON FREE INFORMATION CARD

Wavetek Corporation
9145 Balboa Avenue
San Diego, CA 92123
Phone: 619-279-2955

MINIATURE GPS ANTENNA. An AMG Series antenna module for Global Positioning Systems (GPS) from Toko America includes an antenna element, a two-pole bandpass filter, and a low-noise gallium arsenide amplifier and cable.

The antenna is tuned to 1575.42 MHz ±1.023 MHz for GPS receivers, and it operates on 4 to 5.25 volts. Antenna gain is 4 dBi typical at a 90° angle of elevation, and −4 dBi at 0°.

CIRCLE 26 ON FREE INFORMATION CARD

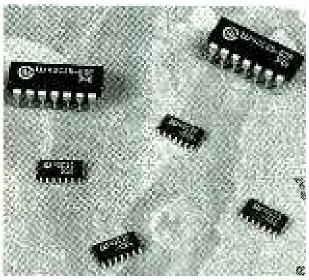
The axial ratio is 3 dB maximum at 90°. Typical power gain of its low-noise amplifier is 26 dB, and it draws a maximum of only 25 milliamperes from a 4 to 5.25-volt supply.

The module is housed in a 38×38×16 mm package. The cable can be customized on request. The module is offered with or without a radome

An AMG Series GPS antenna module is priced at $150.

Toko America, Inc.
1250 Feehanville Drive
Mt. Prospect, IL
60056-6023
Phone: 708-297-0070
708-699-7864

TRIPLE-OUTPUT CLOCK GENERATORS. The W42C25 single-VCO clock generator from IC Works has three simultaneous clock outputs. It is packaged to take up a minimum amout of space on board-level computers with either Intel X86, Pentium, or RISC microprocessors.



CIRCLE 27 ON FREE INFORMATION CARD

An included phase-locked loop is said to reduce phase jitter for reference, and it provides two synthesized frequencies. The reference output provides a fixed frequency that matches the frequency of the input frequency or clock. The two synthesized outputs can vary between 2 and 120 MHz, with as many as eight selectable, preprogrammed frequencies stored in an on-chip ROM.

The generator is available in industry-standard, 14-pin, 150-mil-wide plastic SOIC packages and in a 14-pin, 300-mil-wide plastic DIP packages. It can replace high-speed oscillators in computers or other circuits with X86 microprocessors or those that require multiple clock generators.

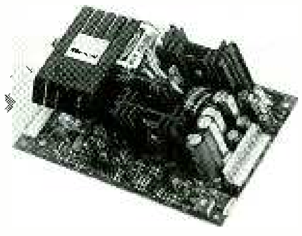
At 5 volts, typical supply current to the W42C25 is 10 milliamperes. The device is packaged in 14-pin SOIC and 14-pin DIP packages.

In quantities of 1000 or more, the W42C25 is priced at $1.80 each.

IC Works Inc.
3725 North First Street
San Jose, CA 95134
Phone: 408-922-0202
Fax: 408-922-0833

SWITCHING MODE DC/DC CONVERTER. The HDB49-C-40 50-watt, switching mode, DC/DC converter from Total Power International has +5.6 and +12-volt as well as −12-volt and −5.2-volt outputs. Rated for a maximum of 50 watts, it is adjustable within ±10%.

The converter's input voltage is from 35 to 60 volts DC, but is typically 48 volts DC. Load and cross regulation is specified at ±1% on all output terminals. Noise and ripple is 1% peak-to-peak. The converter includes overvoltage, overload, and short-circuit protection.



CIRCLE 28 ON FREE INFORMATION CARD

The HDB49-C-40 DC/DC converter is priced at $99 in hundreds.

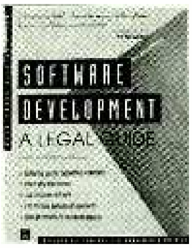
Total Power International, Inc.
418 Bridge Street
Lowell, MA 01850
Phone: 508-453-7272
Fax: 508-453-7395 **R-E**

NEW LITERATURE

Use The Free Information Card for fast response.

Software Development: A Legal Guide; by Stephen Fishman. Nolo Press, 950 Parker Street, Berkeley, CA 94710; Phone: 510-549-1976; Fax: 510-548-5902; $44.95, including diskette.

This book, written by a lawyer, provides the guidance that software developers need to protect their intellectual property and be able to profit from it. In addition to offering candid insights on the effectiveness of software patents and trade-secret law, it



CIRCLE 337 ON FREE INFORMATION CARD

gives the criteria for determining if a certain program is patentable.

Fishman's legal guide explains the strengths and weaknesses of copyrights, trademarks, trade secrets, and patent protection in lay language with a bare minimum of "legalese." It offers advice on the most appropriate protection for intellectual property.

The book also explains how to draft employment, nondisclosure, custom software-publishing, and consulting agreements. Other topics are how to obtain permission to use materials in multimedia projects and how to avoid infringing on the legal rights of others.

How to Digitize Video; by Nels Johnson with Fred Gault and Mark Florence. John Wiley & Sons, Inc., 605 Third Avenue, New York, NY 10158-0012; Phone: 1-800-CALL-WILEY; $39.95 including CD-ROM disc.

This hands-on guide book will inform and guide the reader who wants to learn how to digitize video signals. It will be of value for those with little or no programming or video experience as well as professionals in the field. The text applies to Macintosh as well as IBM or compatible personal computers.

The authors recognize that handling video clips can be tricky because they require special treatment to accommodate their large memory requirements. They want to be sure the reader obtains the best possible playback on screen.

CIRCLE 338 ON FREE INFORMATION CARD

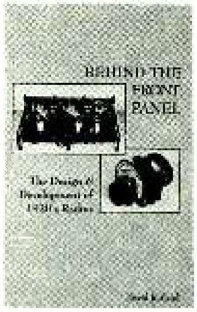
The book explains how to digitize existing videotapes, laserdiscs, and other analog media to create on-screen presentations. It also takes the reader step-by-step from the selection and installation of hardware and software through each phase of video preparation, capture, conversion, storage, editing, and playback. It even explains the conversion of digital movies back to analog videotape.

The enclosed CD-ROM disk contains QuickTime videos that can be played on computers with Windows (version 3.1) and Macintosh (System 7) computers. The disk's sample movies demonstrate how the choice of window dimensions and frame and audio-sampling rates yields differences in video quality. The disk also includes samples of professionally produced desktop videos.

Behind the Front Panel: The Design & Development of 1920's Radios; by David Rutland. Wren Publishers, P. O. Box 1084, Philomath, OR 97370; Phone: 503-929-4498; $18.95.

This book takes the reader back in radio history to discuss the radio pioneers and their crystal and tube circuit designs that were the cutting edge technology of the day. It explains how the early radios were made and how and why they worked.

Rutland describes vacuum-tube sets made in the 1920's. He has gathered historical information on the products of more than 25 radio manufacturers who were active during that time. The book begins with descriptions of simple crystal radio receivers and goes on to discuss various vacuum-tube regenerative detectors and amplifiers. It ends with a discussion of the superheterodyne circuit still in use.



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The operation of each circuit is explained with the help of simple circuit diagrams and many illustrations. Such venerable devices as tubes, variometers, and variocouplers are described. Circuit diagrams come to life when related to the efforts of the many pioneers who saw the future in reliable, effective radio communications.

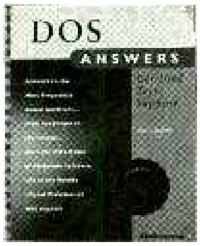
You'll gain insights into the important contributions of such 19th-century scientists as Faraday, Maxwell, and Hertz and see how their work influenced the developments of radio inventors and engineers including Edison, Fleming, DeForest, and Armstrong.

DOS Answers: Certified Tech Support; by Mary Campbell. Osborne McGraw-Hill, 2600 Tenth Street, Berkeley, CA 94710; Phone: 510-549-6600; Fax: 510-549-6603; $16.95.

Readers with personal computers that run the DOS operating system will effectively gain 24-hour technical support if they buy this book. It is based on the answers to the most common questions about computers obtained from

Corporate Software Inc., a computer consulting firm that answers 200,000 similar questions on the subject every month.

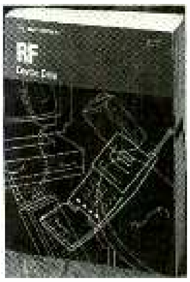
Every aspect of DOS, from hard-disk setup to updating a previous release is covered in this book. It will help readers perform such tasks as troubleshooting memory and solving file and directory problems, and it explains command syntax and error messages. The book advises on techniques for customizing DOS to maximize PC performance. Important topics explained include the DOS Shell, and DoubleSpace batch files.



CIRCLE 340 ON FREE INFORMATION CARD

Opening with a listing of "The Top Ten Tech Errors," the book answers the most common questions on such subjects as setup, file and disk management, utilities, memory, configuration, interoperability, networking, and error messages. An extensive table of contents in question format helps readers find answers in a hurry. Examples are: How can I see if I have any hidden files, and what does the FCBS command in CONFIG. SYS mean?

1994 RF Device Data Book (DL110/D Rev 5). Motorola Inc., Literature Distribution Center, P. O. Box 20924; Phoenix, AZ 85063; Tel: 800-441-2447; Fax: 602-994-6430; free.



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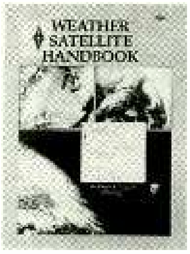
This revised data book presents technical data on Motorola's RF product line. The product families include bipolar, LDMOS, MOSFET RF power, and gallium-arsenide devices packaged in different ceramic and plastic surface-mount cases.

Sufficient information is given on discrete components, hybrid modules, and integrated circuits to permit readers to make the correct selection of Motorola device to meet their specific RF circuit requirements.

Weather Satellite Handbook: 5th Edition; by Dr. Ralph E. Taggart, WB8DQT. The American Radio Relay League, 225 Main Street, Newington, CT 06111; Phone: 203-666-1541; Fax: 203-665-7531; $20.00.

This is the fifth edition of a book on weather satellites that was first published in 1976. It introduces the reader to the hobby of receiving weather satellite transmissions directly or indirectly from U.S.and foreign spacecraft—both polar-orbiting and geostationary. Their transmissions can be viewed on a personal computer screen as cloud photographs, and



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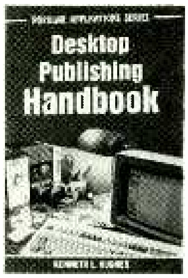
the images can be stored in digital format or reproduced by computer printer or still photography.

This edition has been updated to include information on recent changes and additions to the fleets of satellites that are now operational and whose signals that can be received by amateurs with the proper antenna, receiver, computer, and image reproduction equipment.

The book explains the different kinds of weather satellites now in orbit, how they transmit, their frequencies, and their modes of operation. It also discusses the kinds of images that can be received, and explains how and where to buy or build weather satellite receivers and antennas.

Desktop Publishing Handbook; by Kenneth L. Hughes. Wordware Publishing, Inc., 1506 Capital Avenue, Plano, TX 75074; Phone: 214-423-0090; $12.95.

This book gives an overview of desktop publishing on IBM and compatible personal computers. Well illustrated, it includes a



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detailed coverage of such subjects as page layout and typography. It offers facts and figures on hardware and guidance on the selection of available applications software to help you get results fast.

Chapters in the book cover the history of desktop publishing, the different kinds of publications, applications programs, and different kinds of personal computers. Video subsystems, input devices, printers and printing, and presentation graphics are discussed.

Third-Party Support Reference Guide: Partnering for Success. Microchip Technology Inc., 2355 West Chandler Blvd., Chandler, AZ 85224-6199; Phone: 602-786-7200; Fax: 602-899-9210.

This 90-page handbook identifies and lists suppliers of software development support, compatible products, and design support for Microchip Technology products. The lists include:

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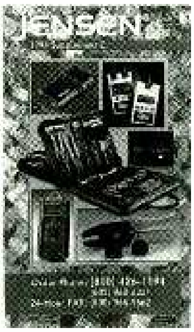
- 37 third-party software development support suppliers for the company's microcontrollers, application-specific standard products, and memory products.
- Companies that offer programmers, emulators, assemblers, simulators, linkers, compilers, and related accessories.

1994 Supplement C. Jensen Tools Inc., 7815 South 46th Street, Phoenix, AZ 85044-5399; Phone: 800-426-1194; Fax: 602-438-1690; free.

This 68-page catalog lists the latest additions to Jensen's line of personal computer and workstation service products, test equipment, and diagnostics products. Their manufacturers include Wavetek, Datatran, Microhouse, Landmark, Fluke, and Tektronix.



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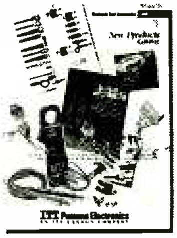
The new listings include Jensen's universal crimp tool and its 13-piece PC repair kit, Fluke's model 650 Cablemeter, and Tektronix diagnostic tools. Other new products offered are wire and cable connectors, LAN connectivity devices, PC reference guides, soldering and desoldering tools, and ESD-control products.

1994 TEST ACCESSORIES CATALOG. ITT Pomona, 1500 East Ninth Street, Pomona, CA 91766-3835; Phone: 909-469-2900; Fax: 909-629-3317; free.

ITT Pomona has introduced more than 100 new products in its 36-page catalog of test-equipment accessories. Products offered include probes meeting the IEC1010 safety standard and those for oscilloscopes, logic-analyzer accessories, multimeter test leads, and test cable assemblies.



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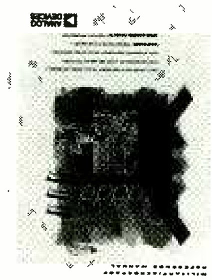
Other new products described include test clips and adapters for the latest Intel and Motorola microprocessors and microcontrollers, and laboratory power supplies.

1994 Military/Aerospace Reference Manual; Analog Devices Literature Center, 70 Shawmut Road, Canton, MA 02021; Phone: 617-937-1428; Fax: 617-821-4273; free.

This 1,408-page catalog from Analog Devices focuses on products for analog, mixed-signal, and digital signal processing circuitry that are qualified to military and aerospace standards and specifications. Data sheets, selection guides, background information and detailed packaging and ordering information are included.



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Divided into 21 sections, the manual is organized by function. Separate sections present information on such subjects as SMD/JAN cross references, RADTEST data service and radiation information, and space-qualification. Ω

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Modem Communications Standards

Serial communications standards have made worldwide computer communications possible. Here's a look at the latest standards.

STEPHEN J. BIGELOW

WE HAVE NOW BECOME AN "INFORmation society." Low-cost, high-speed personal computers—now in almost every office, school, and home—allow just about everyone to tap into a variety of national information networks. National information networks such as CompuServe and America Online are now serving millions of users. The Internet, a worldwide network of computer networks, is growing at a rate of about 15% per month. There are now more than 40,000 small, private computer bulletin board systems (BBS) within the U.S.

Personal computers, for the most part, are not equipped to connect directly to the national and global information networks. Instead, they must be connected through the public telephone system. However, because the U.S. telephone system is an analog system, computers require a modem (modulator/demodulator) to translate (or modulate) their digital output into audible sounds that can be sent by telephone lines to a remote location. Those audio signals must then be converted (or demodulated) back into digital information to be "understood" by another computer. This basic concept is illustrated by Fig. 1.

Modems are certainly not new peripherals. They were used with the earliest personal computers. Like PCs themselves, modems have evolved through continuous advances in electronics so that they now can pass ever greater volumes of data over a telephone system whose characteristics have barely changed in 100 years.

A result of this constant improvement is a long list of modem specifications with such names as V.32 and V.42bis. This article will give you a basic understanding of modems, their specifications, and it will help help you to understand some of the confusing jargon associated with the latest modems.

The serial approach

Computers normally process 16- or 32-bit words of digital information on their internal data buses. Even the computer's parallel printer port offers a data path that is 8 bits wide. However, there is only one transmitting wire in a telephone line. Modems must break down each digital word into a sequence of audio signals, and send each signal in turn along the tele-

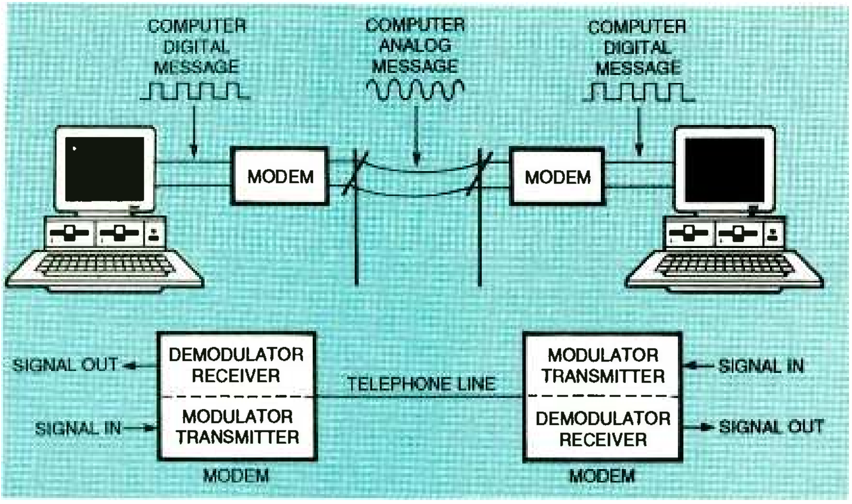


FIG. 1—A MODEM CONVERTS DIGITAL SIGNALS from a computer to analog signals that can be transmitted over telephone lines.

phone wire. An 8-bit data word is sent as eight 1-bit signals.

Most modems for PC communication are *asynchronus* or unsynchronized. (Synchronous modems are more expensive because they require complex circuitry to keep the receiving modem operating in phase with the transmitting modem for the duration of the transmission.) Because two communicating modems are operating asynchronously, the receiving machine must know when a stream of data is being sent, where each stream of data starts and ends, and whether the stream is correct or not. To accomplish this feat, extra bits are added to the data to organize it into a standard sequence known as a *data frame*.

A typical serial data frame consists of four parts as shown in Figure 2: the start bit, the data bits, the parity bit, and the stop bit(s). In its idle state, when no data is being sent, a serial-communications signal normally resides in a logic-1 state. The first logic-0 transition is always interpreted as a start bit. The start bit indicates to the receiving modem when the frame's subsequent bits will arrive. It is essential, however, that both modems be operating at the same transfer speed for the transmitted data to be interpreted correctly.

Data bits follow the start bit. There might be from five to eight data bits in the frame. However, 7- or 8-bit data frames are most common for PC communications. As examples, CompuServe data frames have seven data bits, and most BBS facilities (including the *Electronics Now BBS*) are configured for 8-bit data frames. For successful communications, both modems must be set to expect the same number of data bits.

A parity bit might be added to the frame to aid in error detecting. However, because parity checking is ineffective for detecting more than one incorrect bit in a data word, parity is often deactivated (or set to 'none') through communication software. When activated, parity is either even or odd.

With even parity, the parity bit will be set (made logic 1) if the number of 1's in the data word is even. With odd parity, the parity bit will be set (made logic 1) if the number of 1's in the data word is odd. The receiving modem calculates parity for the data word and compares it with the received parity bit. If a discrepancy occurs, an error is flagged.

One or two stop bits must be added to conclude the data frame. One stop bit is typical for most setups since a second stop bit would be redundant. Stop bits are always logic 1's, which leave the system in the idle state to await the next data frame. Both modems must be set to expect the same number of stop bits.

When you want to connect a computer to a BBS or information service, you must configure your system for the correct data-frame format. The most popular frame format is eight data bits, no parity bit, and one stop bit (commonly written 8,N,1). Another popular format is seven data bits, even parity, and one stop bit (7,E,1).

Port Connections and Signals

The translation from parallel data words to a serial data stream takes place within the computer's serial port circuit in an IC known as a universal asynchronous receiver/transmitter (or UART). Logic 1's and 0's are converted into bipolar signals. Logic 1's are translated to −5 to −15-volt levels (mark), and logic 0's are tralated to +5 to +15-volt levels (space). Those bipolar signals are supplied to the TX (transmit) pin of a standard serial communications port as shown in Fig. 3. Those physical connections are also called RS-232C ports. In Europe, the RS-232C standard is called V.24.

An external modem connected to the serial port modulates the bipolar TX signal into an audio signal which is sent over the telephone line. Audio signals received by the modem and demodulated into bipolar signals are returned to the serial port's RX (receive) pin. An internal modem—that is, a plug-in unit installed inside a

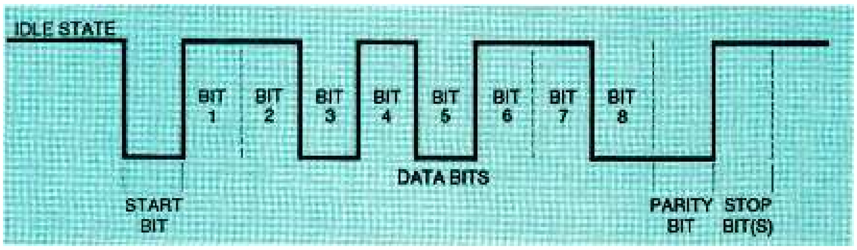


FIGURE 2—A TYPICAL DATA FRAME. This frame is formatted with one start bit, eight data bits, a parity bit, and one stop bit.

computer—contains a serial port on its circuit board. (You might have to disable a serial port in the computer to prevent hardware conflicts with the internal modem's serial port circuit.) For most serial port connections, only TX, RX, and ground wires are needed to establish a working port.

Communications software

Communications software supplies a "front end" for the control of a modem. It helps to remove some of the complexities associated with modem configuration, modem control codes.

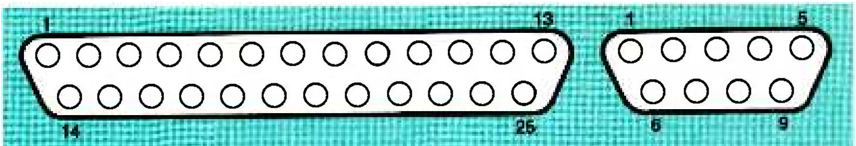
One type of communications software is designed for communications with a specific online service. WinCIM, for example, is the Windows version of the CompuServe Information Manager, which is designed specifically to make it easier to "navigate" the CompuServe information service. Such special-purpose software is outside the scope of this article.

Other communications software is designed for general-purpose communication. Some popular examples include Procomm Plus, Qmodem, and Crosstalk.

All communications software must be able to operate in two distinct modes: the *command mode*, and the *terminal mode*. In the command mode, any commands issued control either the communications software, the host computer, or the modem connected to it. In the terminal mode, any commands issued are sent directly to the modem, or they are sent through the modem and to the remote computer to which it is connected.

Typical instructions that might be issued in the command mode include retrieving a telephone number from a data log, setting the proper communications protocol, dialing a number, and saving any data that is received in a disk file.

In the terminal mode, all keyboard (or disk) input is sent directly to the modem. If the modem is *offline* or not connected to a remote computer,



PIN	NAME
2	TRANSMIT DATA (TX)
3	RECEIVE DATA (RX)
4	REQUEST TO SEND (RTS)
5	CLEAR TO SEND (CTS)
6	DATA SET READY (DSR)
7	SIGNAL GROUND
8	DATA CARRIER DETECT (DCD)
20	DATA TERMINAL READY (DTR)
22	RING INDICATOR (RI)

PIN	NAME
1	DATA CARRIER DETECT (DCD)
2	TRANSMIT DATA (TX)
3	RECEIVE DATA (RX)
4	DATA TERMINAL READY (DTR)
5	SIGNAL GROUND
6	DATA SET READY (DSR)
7	REQUEST TO SEND (RTS)
8	CLEAR TO SEND (CTS)
9	RING INDICATOR (RI)

FIGURE 3 - SERIAL PORT CONNECTORS for both 9-pin and 25-pin standards.

the input is recognized as modem commands. If the modem is *online* and has an active connection to a remote computer, all input is sent through the modem to the remote computer unless certain special control characters precede the data.

The difference between the command mode (in which commands are acted on locally) and terminal mode (in which commands affect the remote computer) is probably the most confusing aspect of modem communications for students and computer beginners.

One common mistake made by newcomers, for example, is to initiate a file transfer in terminal mode without issuing a corresponding command in the command mode. The first command is required to tell the remote computer to send a file. The second is necessary to instruct the host computer to receive it and store it on disk.

Flow control.

To control the flow of data between two modems, software codes (such as XON and XOFF) are passed between them. Communications software interprets such codes and controls modem operation accordingly.

However, the flow of data between a computer and modem is not always controlled by software codes. Instead, additional signal lines in an RS-232 port allow for hardware flow control (or handshaking). The request to send (RTS) line tells a modem to prepare to receive data from the computer. Once the modem is ready to send, it will return a clear to send (CTS) signal to the computer. RTS and CTS signals act together to handle data transfer.

When the computer is ready for operation (but not necessarily ready to send data), it asserts its data terminal ready (DTR) signal. DTR must remain active throughout the entire connection time. The modem sends a data set ready (DSR) signal to the computer after the modem has been activated, and has finished any self-tests or preparation for connection. The DTR and DSR signals establish the connection between modem and computer, but they do not control the flow of data between the two.

If a telephone ring signal is detected at the modem, a ring indicator (RI) signal is sent to the computer. When the modem subsequently picks up the ringing line and detects the presence of carrier, a data carrier detect (DCD) signal is passed to the computer. Ring and carrier detect signals invoke the PC's communication software to receive communication (such as fax messages) from a distant modem.

Modulating the Signals

A modem transmits data by generating a carrier that is then modulated. Several different methods of signal modulation have been developed through the years to improve the efficiency of data transfers. As you might expect, two modems must be capable of the same modulation scheme for successful communications.

Two modems that are communicating with each other must generate different carrier frequencies. Each communication standard defines the transmitting and receiving carrier frequency. For example, for 300-baud communication, one modem must have a carrier center frequency of 1170 Hz, and the second must have a center frequency of 2125 Hz. By convention, the modem initiating the call, or the originate-mode modem, has the lower carrier frequency. The modem receiving the call, or the answer-mode modem, has the higher carrier frequency.

In the early days of modem communication, each transition of the audio carrier signal represented a single bit. Each transition is known as a baud, so the baud rate equaled the transmission rate in bits-per-second or bps. Unlike those early modems, modern modem schemes allow two, three, four, or more bits to be encoded into every audio signal transition (or baud). This means that modem throughput now equals two, three, or four times the baud rate being carried on the telephone line.

For example, a modem operating at 2400 baud (2400 audio signal transitions per second) can carry 4800 bps if two bits are encoded onto every baud. The same 2400 baud modem can carry 9600 bps if 4 bits are encoded onto every baud. Today, the modem's baud rate rarely matches the modem's bit rate in bps. If the modem were operating at 4800 baud with 3-bit encoding, it would be transmitting 14,400 bps (14.4 kbps), and so on.

The concept of encoding is different from data compression: Encoding transfers *all* original data bits from one system to another, while data compression replaces repeating sequences of bits with much shorter bit sequences (known as *symbols* or *tokens*). Encoding schemes and data compression are described in more detail later in this article.

MODEM GLOSSARY

Answer mode—The operating state of a modem that is expecting a call from another computer. (The modem is in its originate mode when calling another computer.) The modem transmits at the defined high frequency of the communications channel, and receives at the defined low frequency.

Asynchronous data transmission—Data transmission between computers in which each data group contains its own start and stop bits to indicate the beginning and end of each character, and there is no control over the time between characters.

AT Command Set—The set of industry-standard commands for the control of a modem. Each command line must start with the two-character attention code AT (or at).

Attention code—A two-character sequence (AT or at) that signals a modem that one or more modem commands are to follow.

Auto answer—A feature that enables a modem to answer the phone automatically after a preset number of rings.

Auto dial—A modem feature that allows it to automatically dial a telephone number.

Auto-reliable mode—A feature that allows two modems to "negotiate" with each other to determine whether they can use error control and data compression during a transmission.

Baud rate—The number of audio transitions transmitted by the modem each second. This usually not the same as the bit rate (or bits-per-second) rate, because a given baud may have more than one bit encoded into it.

Bits-per-second (bps)—The speed at which a modem sends or receives information. For example, a modem that operates at 2400 bits per second can transfer 2400 binary digits each second.

Buffer—In a modem, a storage location in an internal RAM where data is temporarily stored until the modem can process the data.

Carrier—The continuous base signal generated by a modem. The modem modulates this signal (alters its frequency or phase) to encode the data bits to be transmitted.

CCITT—International Telegraph and Telephone Consultative Committee. See ITU.

Clear to Send (CTS)—An RS-232C signal that tells the computer it can start sending information.

Command mode—One of two operating modes for a modem, also called local mode. In its command mode, a modem interprets any information it receives from the local computer as modem commands. It tries to perform the commands sent to it, and it returns result codes indicating the results of the commands.

Communications software—A program that provides an interface for the control of a modem's functions. Examples of communications programs are Smartcom, Procomm, and Crosstalk.

Configuration profile—The present operating characteristics of a modem, stored in the modem's S-registers. Whenever a modem command is issued to change one of the operational characteristics (such as setting the volume control or turning the speaker on or off), the modem changes the values in the S-registers to reflect the changes.

Data Carrier Detect (DCD)—An RS-232C signal that indicates when the modem is receiving a carrier signal from a remote modem.

Data Set Ready (DSR)—An RS-232C signal that tells the computer that the modem is connected to the telephone line.

Data Terminal Ready (DTR)—An RS-232C signal that tells the modem that the local computer is ready for data transmission.

Duplex—See definitions half duplex and full duplex.

Escape sequence—A sequence of three characters (normally +) that switch a modem from the on-line mode to the command mode without breaking the telephone connection.

File transfer protocol—An error-checking protocol for file transfers (such as KERMIT, XMODEM, or YMODEM). The protocol monitors information sent with each block of data. If the received data doesn't match the information used to check the quality of data, the system notifies the sender that an error has occurred and asks for a retransmission.

Flow control—The mechanism that regulates the flow of data between two devices. Modems typically have two methods of flow control: software flow control (XON/XOFF) and hardware flow control (CTS/RTS).

Modulation Schemes

All waveforms have three basic characteristics: amplitude, frequency, and phase. Each of those characteristics can be adjusted to represent a bit.

Frequency-shift keying (FSK) is similar to frequency modulation (FM) where only the frequency of a carrier is changed, and it is one of the oldest modulation schemes still in use. FSK sends a logic 1 as one particular

LAPM (link access procedure for modems)—An error control protocol specified by CCITT V.42. LAPM provides error control when one modem is communicating with another modem that supports LAPM.

Line noise—Random signal disturbances that can occur over telephone lines. Noise can disrupt communications and corrupt the transmitted data.

Loopback test—A diagnostic test in which characters that are sent to the modem are immediately sent back from the modem so the computer can compare the characters sent with the characters received.

MNP (Microcom networking protocol)—Provides error control and data compression when one modem is communicating with another modem that supports MNP. (MNP classes 1 through 4 are specified by CCITT V.42 as a back-up error-control scheme for LAPM.)

Nonvolatile memory (NVRAM)—Solid-state random-access memory that retains the information stored in it even if its power is removed. NVRAM in modems stores configuration information.

On-line mode—One of the two operating modes of the modem, also called data mode. (The other is command mode). In on-line mode, the modem interprets all information sent to it as data, not commands. The only exception is the escape sequence (normally +), which returns the modem to command mode without breaking the connection. The modem is placed in on-line mode when it makes a connection with a remote modem, or when a command is entered to return to a previously established connection.

Originate mode—The state of a modem that is initiating a call to another computer. (The modem is in its answer mode when expecting a call from another computer.) The modem transmits at the defined low frequency of the communications channel, and it receives at the defined high frequency.

Parity—A data-encoding scheme used in computers for checking the validity of transmitted data. This scheme adds an extra bit to each data word, which the transmitting computer selects based on the type of parity the computers agree to use (odd or even). The receiving computer checks each character and flags a parity error if any character has the incorrect number of bits set.

Protocol—A set of rules that governs how data is transmitted. To communicate successfully, two computers must use the same protocol.

Request to Send (RTS)—An RS-232C signal that requests that the modem send data. It initiates all data transmission between the computer (or terminal) and the modem. RTS is answered by a Clear to Send (CTS) signal.

Result codes—The message sent by a modem after it receives a command.

RS-232C—A standardized system for connecting a device to the serial port of a computer or terminal. It is the recommended standard of the Electronic Industries Association (EIA) for exchanging information between data terminal equipment (such as computers) and data communications equipment (such as modems).

S-registers—NVRAM in a modem that stores the current configuration profile (operating characteristics).

Serial port—The circuits and connector that permit a computer to communicate with serial devices such as printers, modems, plotters, and mice. It is also called a COM or communications port.

Start/stop bits—The bits that identify the beginning and end of an data frame in asynchronous data transmission.

Throughput—The total useful information processed or communicated over a specified amount of time. Data compression increases the throughput of a modem by allowing it to send more information in the same number of bits.

Tone dialing—One of two methods for dialing the telephone. With tone dialing, the modem sends standard Touch Tones. Tone dialing is also called dual-tone multi-frequency (DTMF) dialing.

XON/XOFF—A protocol for controlling the flow of data between a modem and its host computer and between two modems (also called software flow control). If the modem receiving data needs time to process the data or perform some other task, it sends an XOFF signal to the sending modem. The sending modem then waits until it receives an XON signal before sending more data. A <CTRL>-S character is usually interpreted as the XOFF command, while XON is usually either a <CTRO>-Q or any character following <CTRL>-S.

frequency (usually 1750 Hz), and a logic 0 is sent as another discrete frequency (often 1080 Hz). Frequencies are typically sent at 300 baud, and each baud can carry one bit, so FSK can send 300 bps. This early technique resulted in the classical "baud equals bps" confusion which still exists today.

Phase-shift keying (PSK) is a close cousin of FSK, but the phase timing of a carrier wave is altered while the carrier's frequency stays the same. A logic 1 or logic 0 is represented by the alteration of the carrier's phase. Because phase can be shifted in several precise increments (for example, 0, 90, 180, and 270 degrees), PSK can encode one, two, three, or more bits bit per baud. A 1200-baud modem using PSK can transmit 2400 bps over an 1800-Hz carrier. PSK in conjunction with FSK can encode even more bits per baud.

In quadrature-amplitude modulation (QAM), both the phase and amplitude of the wave are modulated to encode up to six bits onto every baud, although only four bits are usually reserved for data. Most QAM modems have a 1700-Hz or 1800-Hz carrier and a base rate of 2400 baud, so they can carry up to 9600 bps.

Trellis-coded quadrature-amplitude modulation (TCQAM or TCM) also generates an 1800-Hz carrier at a 2400-baud base rate, but it uses the full 6-bit encoding capability of QAM to provide a rate of 14400 bps. TCM is now the most popular modulation scheme for high-performance modems because data can be checked on-the-fly with high reliability.

Signaling Standards

Most of the present computer communications standards have been developed through international cooperation by the ITU or International Telecommunications Union (formally the CCITT). The ITU sets data communication standards for the world. Its members include the major modem manufacturers, common telecommunication carriers, and government officials.

ITU specifications are characterized by the letter V. The V simply means standard (something like the RS in RS-232). The number following denotes the particular standard. Some standards also add the term "bis" which indicates the second version of a particular standard. You might also see the term "terbo" which is the third

TABLE 1—ITU STANDARDS

V.1—A very early standard that defines binary digits as space/mark line conditions and voltage levels.

V.2—Limits the audio power levels of modems used on phone lines.

V.4—Describes the data frame.

V.5—Describes the standard synchronous signaling rates for dialup lines.

V.6—Describes the standard synchronous signaling rates for leased lines.

V.7—Provides a list of modem terms in English, Spanish, and French.

V.10—Describes unbalanced high-speed electrical interface characteristics (RS-423)

V.11—Describes balanced high-speed electrical characteristics (RS-422)

V.14—Explains the standard procedure for asynchronous to synchronous conversion.

V.15—Describes the requirements and designs for telephone acoustic couplers. This is rarely used today because most telephone equipment is modular and can be plugged into telephone adapters directly rather than be loosely coupled to the telephone handset.

V.17—Describes an application-specific modulation scheme for Group 3 fax which provides two-wire, half-duplex, trellis-coded transmission at 7200, 9600, 12000, and 14400 bps. Despite its low number, this is a recently introduced standard.

V.19—Describes early DTMF modems for low-speed parallel transmission. This standard is essentially obsolete.

V.21—Provides the specifications for 300 bps FSK serial modems (based on BELL103).

V.22—Provides the specifications for 1200 bps (600 baud) PSK modems (based upon BELL212A).

V.22bis—Describes 2400 bps modems operating at 600 baud with QAM.

V.23—Describes the operation of an unusual FM modem operating at 1200/75 bps. The host transmits at 1200 bps and receives at 75 bps, while the remote modem transmits at 75 bps and receives at 1200 bps. In Europe, V.23 supports some videotext applications.

V.24—This is known as EIA RS-232C in the U.S. V.24 defines only the functions of the serial port circuits. EIA-232E (the current version) also defines electrical characteristics and connectors.

V.25—Defines automatic answering equipment and parallel automatic dialing. It also defines the answer tone that modems send.

V.25bis—Defines serial automatic calling and answering, which is the ITU (CCITT) equivalent of AT commands. This is the current ITU standard for modem control by computers via serial interface. The Hayes AT command set is used primarily in the US.

V.26—Defines a 2400-bps, PSK, full-duplex modem operating at 1200 baud.

V.26bis—Defines a 2400-bps, PSK, half-duplex modem operating at 1200 baud.

V.26terbo—Defines a switchable 2400/1200-bps, PSK, full-duplex modem operating at 1200 baud.

V.27— Defines a 4800-bps, PSK modem operating at 1600 baud.

V.27bis—Defines a more advanced 4800/2400-bps, PSK modem operating at 1600/1200 baud.

V.27terbo—Defines a 4800/2400-bps, PSK modem commonly used in half-duplex mode at 1600/1200 baud to handle Group 3 fax rather than computer modems.

V.28—Defines the electrical characteristics and connections for V.24 (RS-232). Where the RS-232 specification defines all necessary parameters, the ITU breaks the specifications down into two separate documents.

V.29—Defines a 9600/7200/4800-bps, PSK/QAM modem operating at 2400 baud. This type of modem often implements Group 3 fax rather than computer communications.

V.32—Defines the first of the truly modern modems as a 9600/4800-bps, QAM, full-duplex modem operating at 2400 baud. This standard also incorporates trellis coding and echo cancellation to produce a stable, reliable, high-speed modem.

V.32bis—A fairly new standard extending the V.32 specification to define a 4800/7200/9600/12000/14400 bps TC-QAM full-duplex modem operating at 2400 baud. Trellis coding, automatic transfer rate negotiation, and echo cancellation make this type of modem one of the most popular and least expensive for general PC communication.

V.32terbo—Continues to extend the V.32 specification by adding advanced techniques to implement a 14400/16800/19200-bps, TCQAM, full-duplex modem operating at 2400 baud. Unlike V.32bis, V.32terbo is not widely popular because of the high cost of compatible components.

V.32fast—The informal name for a standard that the ITU has not yet completed. When finished, a V.32fast modem will probably replace V.32bis with speeds up to 28,800 bps. It is anticipated that this will be the last analog protocol, eventually giving way to all-digital protocols as local telephone systems become entirely digital. It is expected that V.32fast will be renamed V.34 on completion and acceptance.

V.33—Defines a specialized 14400-bps, TCQAM, full-duplex modem operating at 2400 baud.

V.34—The ratified version of V.32fast. It provides for data speeds up to 128 kbps with transmission rates as high as 3429 baud.

V.36—Defines a specialized 48000-bps "group" modem that is rarely used commercially. This type of modem requires several conventional telephone lines.

V.42—Defines a two-stage process of detection and negotiation for LAPM error control.

V.42bis—Extends the V.42 standard to include data compression.

V.50—Sets standard telephony limits for modem transmission quality.

V.51—Outlines required maintenance of international data circuits.

V.52—Describes apparatus for measuring data transmission distortion and error rates.

V.53—Outlines impairment limits for data circuits.

V.54—Describes loop-test devices for modem testing.

V.55—Describes impulse-noise measuring equipment for line testing.

V.56—Outlines the comparative testing of modems.

V.57—Describes the comprehensive test equipment required for high-speed data transmission.

V.100—Describes the interconnection techniques between PDNs (public data networks) and PSTNs (public switched telephone networks).

version of a standard.

The Bell System largely dictated North American telecommunications standards before it was broken up into AT&T and seven regional telephone operating companies in 1984. Before that time, two major standards had been developed that set the stage for future modem development.

BELL103 was the first widely accepted modem standard—simple FSK modulation at 300 baud. This is the *only* standard in which the data rate matches the baud rate. It is interesting to note that many modems today still support BELL103 as the lowest common denominator when all other modulation techniques fail.

BELL212A was a second widely accepted modem standard in North America based on PSK modulation at 600 baud to transmit 1200 bps. Many European countries ignored BELL212A in favor of the similar (but not entirely identical) European standard called V.22.

TABLE 2—MODEM STANDARDS COMPARISON CHART

Standard	Data Rate (bps)	Modulation Technique	Baud Rate (baud)	
Bell 103	300	FSK	300	
Bell 212A	1200	PSK	600	
V.17	7200-14400	QAM	7400	
V.21	300	FSK	300	(Bell 103)
V.22bis	2400	QAM	600	(Bell 212A)
V.23	1200/75	FM	2100/1300 & 450/390	
V.26	2400	PSK (full-duplex_	1200	
V.26bis	2400	PSK (half-duplex)	1200	
V.26terbo	2400/120	PSK (full-duplex)	1200	
V.27	4800	PSK	1600	
V.27bis	PSK	1600/1200		
V.27terbo	4800/2400	PSK	1600/120	(Group 3 fax)
V.29	9600/7200/4800	PSK/QAM	2400	(Group 3 fax)
V.32	9600/4800	QAM	2400	
V.32bis	4800-14400	TCQAM	2400	
V.32terbo	14400-19200	TCQAM	2400	
V.32fast	to 28800	TCQAM	to 3429	
V.33	14400	TCQAM	2400	
V.36	48000	Group-line modem		
V.37	72000	Group-line modem		

ITU Standards

After the Bell System breakup, AT&T no longer wielded enough clout to dictate standards in North America—and certainly not to the international community which had developed serious computing interests. At this time, the ITU gained prominence and acceptance in the U.S. All U.S. modems have been built to ITU standards ever since. Table 1 provides a comprehensive description of ITU standards. Although not all of the listed standards relate specifically to modems, all are related to communications. Table 1 will help you to understand the broad specifications that are required to fully characterize the communications environment.

MNP Standards

The Microcom networking protocol (MNP) is a complete hierarchy of standards developed during the mid 1980s. They were designed to work with other modem technologies to provide error correction and data compression. Originally developed by Microcom, Inc., the protocol is now in the public domain.

MNP provides error control and data compression when one modem is communicating with another modem that supports MNP. MNP class 4 is specified by ITU V.42 as a backup error control scheme for LAPM in the event that V.24 cannot be invoked. Out of nine MNP levels, most modern modems support the first five. Each MNP class has all the features of the previous class plus its own.

MNP class 1 (block mode): Data is sent in one direction at a time. It is about 70% as fast as data transmissions with no error correction. This level is now virtually obsolete.

MNP class 2 (stream mode): Data is sent in both directions at the same time. That results in a speed about 84% as fast as data transmissions with no error correction.

MNP class 3: The sending modem strips the start and stop bits from a data block before sending it. The receiving modem then adds start and stop bits before passing the data to the receiving computer. It is about 8% faster than data transmissions with no error correction.

MNP class 4: A protocol (with some data compression) that checks telephone connection quality and uses *adaptive packet assembly*. On a noise-free line, the modem sends larger blocks of data. If the line is noisy, the modem sends smaller blocks of data so that less data must be resent in the event of an error.

MNP class 5: Provides data compression by detecting redundant data and recoding it to fewer bits, thus increasing effective data throughput. A receiving modem decompresses the data before passing it to the receiving computer. MNP5 can speed data transmissions by as much as a factor of two compared with protocols having no data compression or error correction scheme.

MNP class 6: Universal link negotiation allows modems to obtain maximum performance from a line. The modems start at low speeds, then move to higher speeds until the best speed that both modems can work at is found.

MNP class 7: It offers a more powerful data compression process (Huffman encoding) then MNP5. MNP7 modems can increase the data throughput by as much as a factor of three.

MNP class 8: There is no MNP8 at this time.

MNP class 9: It reduces the data overhead encountered with each data packet. MNP9 also improves error correction performance because only the erroneous data must be re-sent instead of re-sending the entire data packet.

MNP class 10: It includes a set of protocols known as *adverse channel enhancements* to help modems overcome poor telephone connections by adjusting data packet size and transmission speed until the most reliable transmission is established.

Data Compression Standards

Most data sent between modems contains some repetitive or redundant information. If the redundant information is replaced by a small "token" during transmission, the data can be compressed.

Data compression has become an important technique that allows modems to increase their data throughput without increasing the baud or bit rate. Data compression can occur only when the two communicating modems support the same compression protocol.

MNP class 5: This standard includes data-compression algorithms that provide up to 2:1 data compression. In effect, MNP5 can give a 2400-bps modem an effective data throughput of as much as 4800 bps; it can give 9600-bps system as much as 19,200 bps.

MNP class 7: Huffman encoding provides a data-compression ratio of up to 3:1. Although it is more efficient than MNP5, not all modems are compatible with it. MNP7 is still generally slower than the ITU's V.42bis.

V.42bis: This standad is a Lempel-Ziv-based data compression scheme for use in conjunction with V.42 LAPM (error correction). V.42bis can compress data by as much as 4:1 (depending on the file sent). Thus, a 9600-baud modem can transmit data at up to 38,400 bps using V.42bis. A 14.4 kbps modem can transmit up to a startling 57,600 bps.

Error Control/Correction Standards

Modem error correction is the ability of some modems to detect data errors that might have occurred in transit between modems, then automatically resend the faulty data until a correct copy is received. As with modulation standards, both modems must be using the same error correction standard to operate together. However, there are few error correction standards, and most modem manufacturers adhere closely to the few that are available.

MNP class 4 is a Microcom error correction protocol (with some data compression) that checks the quality of the telephone connection and adjusts information in the headers of data blocks using a technique called *adaptive packet-assembly*. If the telephone line is relatively noise-free, the modem sends larger blocks of data to increase throughput. If the telephone line is noisy, the modem sends smaller blocks of data so that less data will have to be resent. This means more successful transmissions on the first try. Because it is about 20% faster than data transmissions using no error correction at all, most modems are now MNP4 compatible.

V.42 is the only ITU error correcting procedure for modems that includes the V.22, V.22bis, V.26ter, V.32, and V.32bis protocols. The standard is also defined as the link access procedure for modems (LAPM) protocol. ITU V.42 is considered very efficient, and is about 20% faster than MNP4. If a V.42 connection can't be established between modems, V.42 automatically provides fallback to MNP4 error correction.

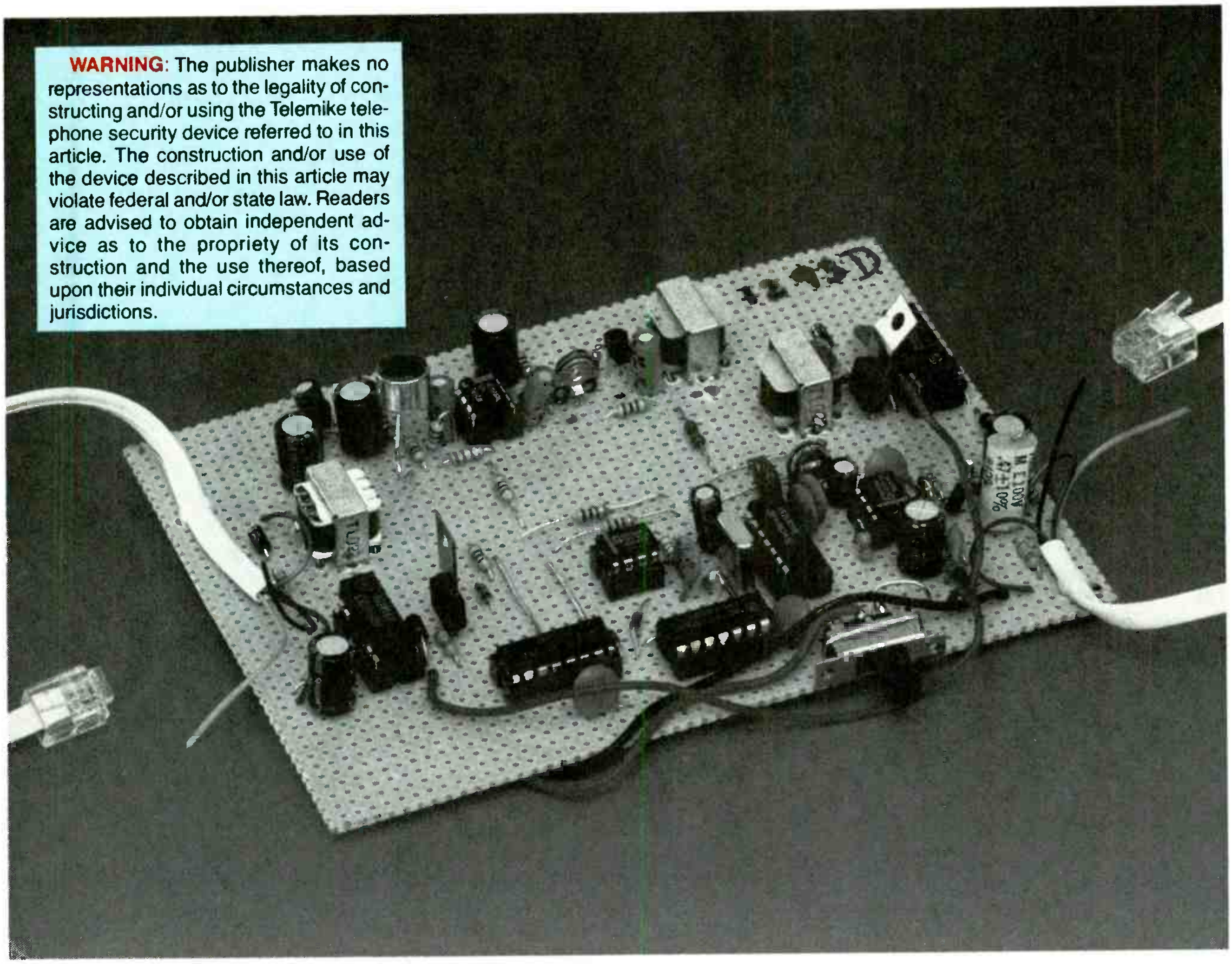
Fax modems

A fax modem is a modem that is capable of sending and receiving faxes as well as data. Virtually all fax modems are compatible with the ITU Group 3 standard. The basic operating principles are similar for modems and fax modems. The data that is transmitted, however, represents picture elements or *pels* instead of pure data.

Communications software that is designed to work with fax modems makes it possible to fax documents created in a word processor without the interim step of printing. Faxes that are received can be converted into a text file (rather than graphic image) with character-recognition software.

Computer communication has come a long way in the last decade. From their humble beginnings of 300 bps, today's modems can effectively and reliably pass the equivalent of 57,600 bps using error correction and data compression. Ω

WARNING: The publisher makes no representations as to the legality of constructing and/or using the Telemike telephone security device referred to in this article. The construction and/or use of the device described in this article may violate federal and/or state law. Readers are advised to obtain independent advice as to the propriety of its construction and the use thereof, based upon their individual circumstances and jurisdictions.



TELEPHONE LINE GRABBER

This listening circuit can be called from a remote phone so you can intercept phone conversations or monitor room activities

ROBERT IANNNINI

TELEMIKE IS A TELEPHONE CIRCUIT that, when located in a room miles away, permits you to listen in on the activities that are taking place in that room. It also permits you to listen to or interrupt a conversation on a separate phone line located wherever Telemike can gain access to it.

Telemike contains a sensitive microphone which is activated by calling the telephone number assigned to the outlet where it is plugged in and entering a code. It also contains circuitry that will permit it to access a telephone on a separate line terminating in the same room or even at the place where the phone line enters the home or building. Sequential pressing of the pound (#) key cycles the circuit to the next mode, that of intercepting a second telephone line and the third mode that resets the circuit after it has been in either of its listening modes.

The "called to" telephone can be miles away, in the same home or building as Telemike, or anywhere Telemike can gain access to the "called from" number. The Telemike circuit can be located anywhere in the room where the "called to" phone jack is located or at the entry point of the phone line—conspicuous or inconspicuous.

Figure 1 gives the number of times the pound (#) key must be pressed in sequence to initiate Telemike's two operating modes. It also shows the third key pressing needed in sequence to terminate the first two modes so the "called to phone" is not left "off hook."

In the *listen* mode 1, you can listen to conversations, music, security alarms, the sound of essential building service machinery, or even the sounds of intruders. To make use of the *intercept phone conversation* mode 2, you must have access to its phone wires or jack for plugging in the second plug from Telemike. The circuit forms a "bridge" between the two lines. Then by keying the pound (#) key twice, you will be on line with both parties of the intercepted phone line.

If you own your own business or vacation cottage that is located some distance from your home, or if you are away from your own home, an installed Telemike will let you find out if a security alarm is sounding, an essential heater or pump is working, or if unwanted persons are present in the room. It could also be useful in unobtrusive monitoring of a bed-ridden patient or child, a teenagers rock and roll party or a romantic adventure in progress.

The *intercept phone conversation* mode will permit you to interrupt a call in progress to announce a call waiting, emergency, or some other event from wherever you are located—in the house or miles away.

Adaptation required

Telemike was designed to be compatible with the AT&T Corporation's ESS electronic switching system. Consequently, there might be differences in its performance if it is installed in a telephone operating system based on a different design.

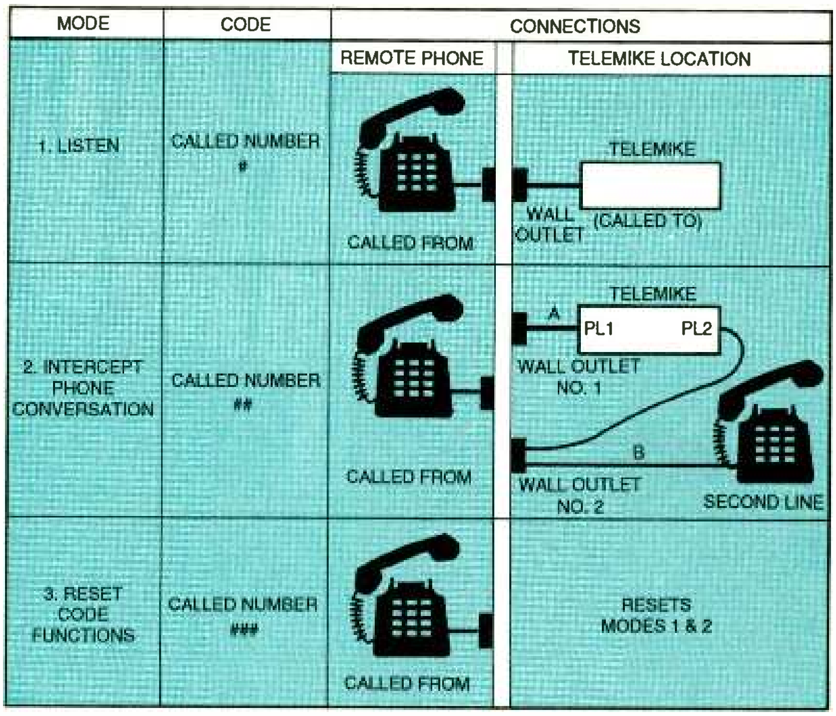


FIG. 1—CODES AND OPERATING MODE for the Telemike telephone line monitor.

This article does not provide details for packaging the Telemike circuitry. However, the circuit can be housed in any suitable metal or plastic project case with provision for mounting the on-off switch on the outside, a battery pack inside, and openings for the phone cords.

Circuit function

Refer to the schematic Fig. 2. Six volts DC is applied to the circuit by switching S1 ON. With this voltage applied, the 555 timer IC3 momentarily holds a high and resets NAND gate IC4-a to zero, "priming" the circuit.

To initiate the *listen* mode 1, call the number of the "called to" telephone line that is connected to plug PL1. A negative ring signal triggers 555 timer IC1, causing transistor Q1 to conduct. That sends current through the coil of reed relay RY1 and closes its contacts, connecting transformer T1 to the telephone line.

A tone signal initiated by pressing the pound (#) key of the "called from" phone immediately after you have keyed in the "called to" telephone initiates a response after Telemike has been primed. The tone is decoded by dual-tone multiple frequency DTMF filter/decoder MC145436 IC2. It is a silicon-gate CMOS LSI IC containing the filter and decoder for the detection of a pair of tones conforming to the DTMF standard.

The output of IC1 indexes the CD4017 decade counter IC5 to the logic 1-state, latching transistor Q1 ON. This response then turns on the 741 operational amplifier IC6.

Any sounds in the room where Telemike is located are picked up by microphone MIC1, amplified, and fed back through transformer T2 to transformer T1 from which they are sent over the phone lines. A person listening on the "called from" phone can then hear any sounds or voice within the range of the microphone. This is the *listen* mode.

The Telemike circuit can be switched to the *intercept phone conversation* mode by pressing the pound (#) key a second time. This sequence connects the "called from" phone through the to the second phone line through plug PL2 of Telemike. This permits any conversation on the second line to be interrupted or monitored from the "called from" phone.

A second pressing of the pound (#) key causes decade counter IC5 to index its count to mode 2. That sets pin 4 high which holds Q2 in a conducting state, energizing relay RY2 and closing its contacts. This connects transformer T1 to plug PL2, the connection to the "called to" phone.

Any audible signals at plug PL2 are now connected by the telephone line at plug PL1, allowing you at the "called from" phone to interrupt a conversation on that line or just listen. Complete DC isolation between the two telephones connected to plugs PL1 and PL2 is achieved by the isolated contacts of relay RY1.

The third *reset code functions* mode is achieved by pressing the pound (#) of the "called from" phone a third time. This indexes decade counter IC4 and turns off Q2 and all other functions, restoring normal telephone operation. Diode D14, connected across RY1's coil, clips the inductive pulse that occurs when relay RY2 is turned off. *Caution*: the "terminate function" must be keyed in before hanging up the "called from" phone or the "called to" telephone might remain off-hook. The telephone company will terminate service if it is not corrected within a reasonable length of time.

If you fail to rest Telemike properly before hanging up the "called from" phone, you must reset the circuit manually by going to it and turning it off and on again. This is an obvious inconvenience if you are miles away from the "called to" telephone or its jack.

To make the most effective use of all of the three modes of Telemike, you should subscribe to a dedicated telephone line. (about $15 per month in most locations).

It is important that *initial access time* be selected properly if you intend to use only a single line. This will be discussed later in this article.

Circuit construction

Refer to the schematic Fig. 2 and the parts placement diagram Fig. 3. The components of the prototype circuit were wired point-to-point on a rectangular piece of perforated board measuring 6¼ × 4½

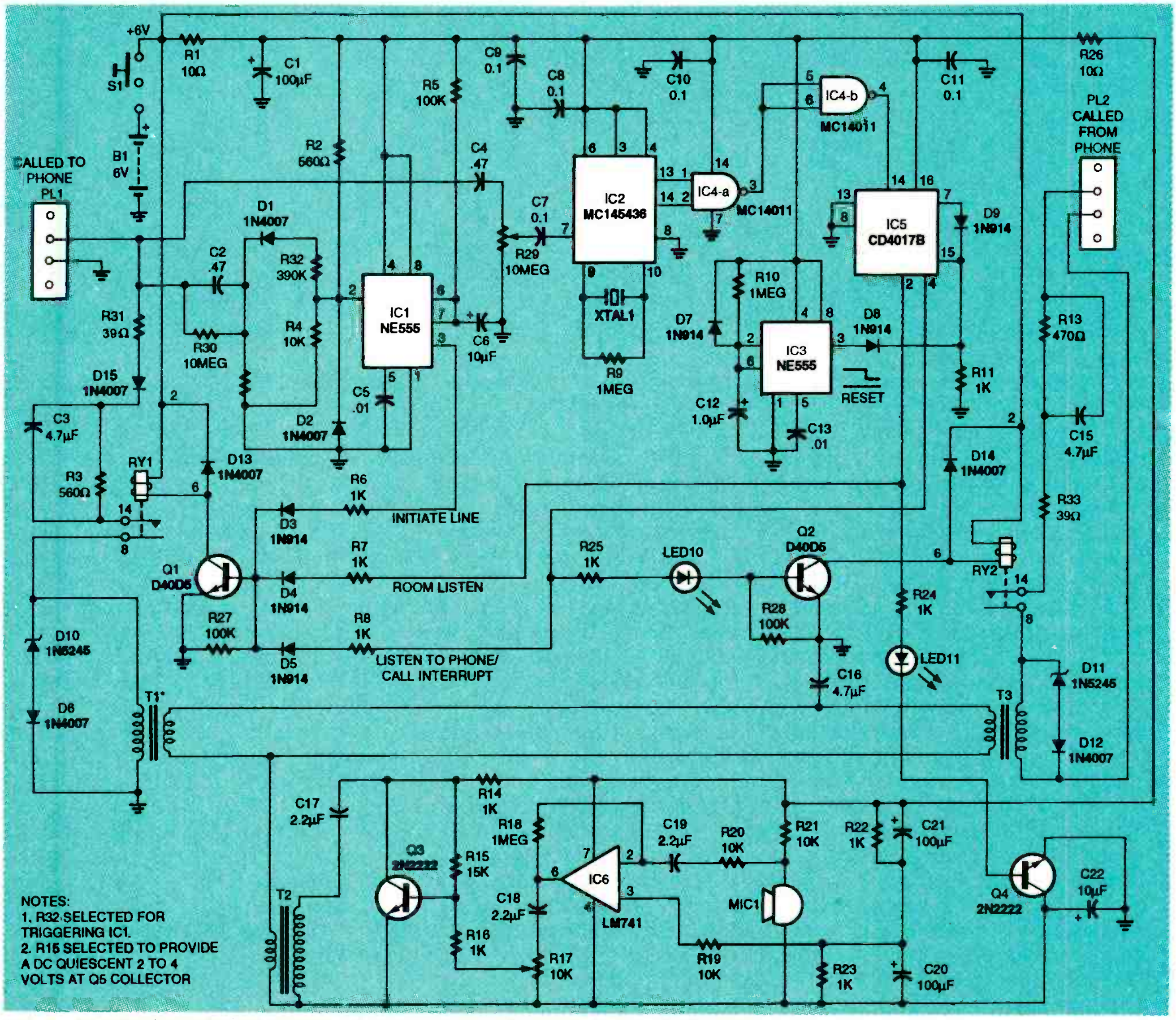


FIG. 2—SCHEMATIC FOR TELEMIKE. All of the integrated circuits and reed relays are inserted in DIP sockets.

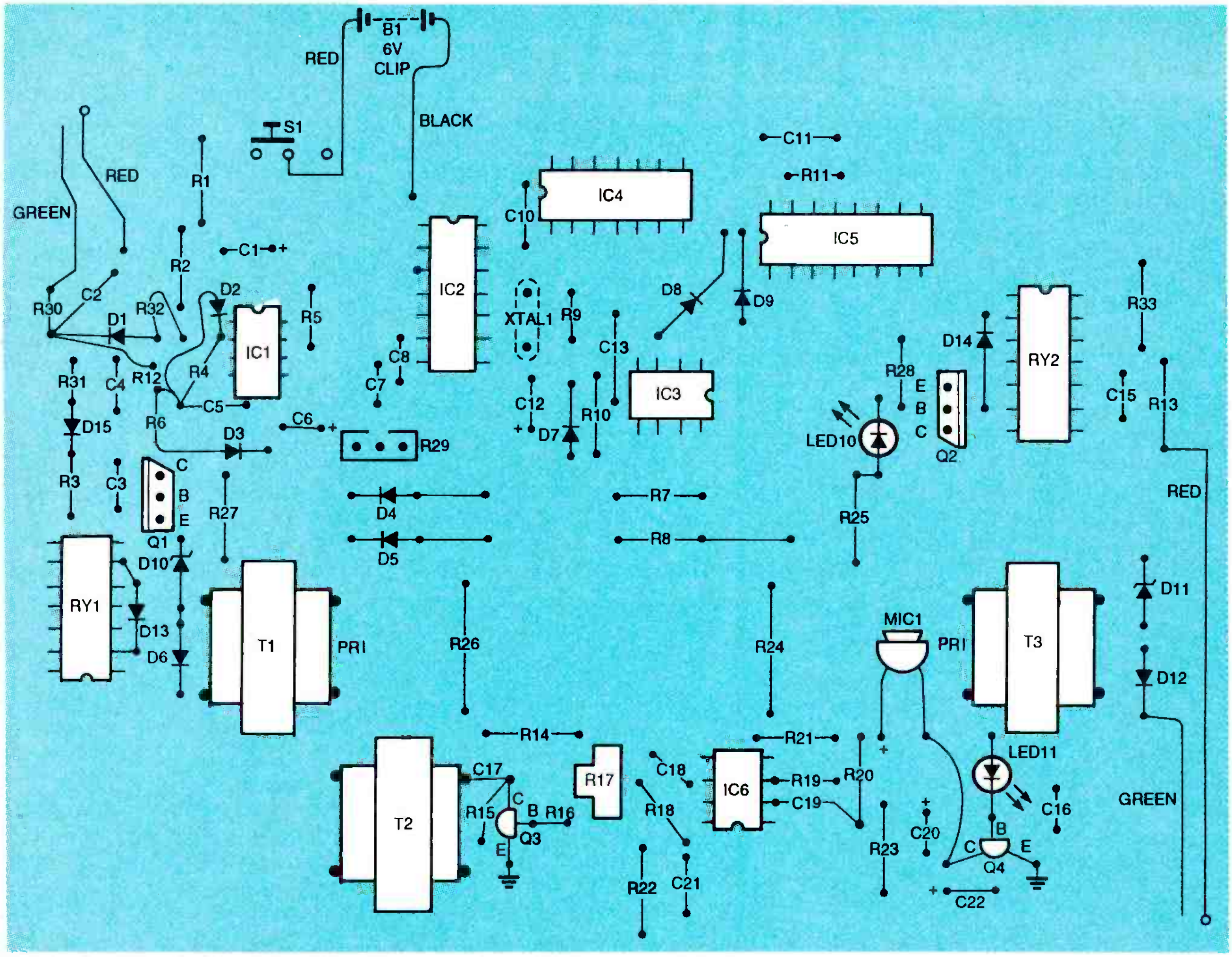


FIG. 3—PARTS PLACEMENT DIAGRAM. The entire circuit fits on a 5⅝ × 4-inch perforated circuit board. The components are interconnected by point-to-point wiring and power and ground bus wires. Switch S1 can be mounted off the board.

inches with 0.42-inch pre-punched holes in a standard 0.1-inch grid.

The component positioning shown in Fig. 3 generally follows that shown in Fig. 2. The component spacing was selected to minimize the length of interconnecting wires without unnecessarily cramping the space between components. This would make the soldering operation more difficult. There are no critical component relationships in this circuit that dictate either close spacing of specific components or isolation between them.

If you want to construct the circuit on a smaller board to fit in a smaller case, you can reduce the spacing between components. However, it is recommended that component orientation remain the same.

Identify all components and set them out on a table as shown in Fig. 3. Start by positioning the seven IC sockets (for ICs and reed relays) on the board with the approximate spacing shown in Fig. 3. Place a drop of fast-drying glue under each socket to hold it in position on the board.

The circuit has three identical isolation/impedance-matching transformers T1, T2, and T3. They are rated for a primary impedance of 600 ohms and a secondary impedance of 1200 ohms at 1000 Hz. Measure the DC resistance of the windings with an ohmmeter to verify the continuity of the windings, and confirm the markings for the primary and secondary sides.

The 600-ohm secondary turns should have an approximate DC resistance of 50 ohms, and the 1200-ohm primary turns should have a DC resistance of about 75 ohms.

Insert the transformers in the board in the correct orientation, being careful not to stress the pins because that might break the winding connections, destroying the transformer.

Start inserting all passive components from left to right across the board in small clusters, noting the polarity and orientation of all diodes and polarized capacitors. (Suggestion: position some of the resistors vertically to conserve circuit board space.)

Temporarily fold the leads of all inserted components back flush with the solder side of the board so they will not fall out when the board is handled. Do not trim the leads at this time. Certain component leads will connect with adjacent component leads as part of the complete circuit.

Solder the leads of the components that have been inserted in small groups before proceeding with the next group. Form the power and ground buses from bare copper wire, and solder them as shown in Fig. 3.

Solder in the clip for the four-cell battery pack, with the red wire to plus (+) and black wire to negative (−).

Strip back the jacketing from both ends of the telephone cords to expose the multicolored wires. Strip back the insulation from the red and green wires and solder them to the proper locations on the circuit board, as shown in Fig. 3. The red wires go to the ground bus and the green wires go to the input points. Trim off the other two black and yellow wires flush with the ends of the cord jacket. Assemble the RJ-11 plugs PL1 and PL2 to the other ends of the telephone cords and crimp them in position.

Verify that all diodes, polarized capacitors and transformers have been inserted correctly with their correct orientation and polarities observed. Examine all soldered joints to be sure they are clean and shiny, and that there are no inadvertent solder bridges. Resolder any "cold" solder joints that appear as dull gray, irregular solder bonds. Trim any leads that overlap or form inadvertent short circuits.

Insert the two reed relays, RY1 and RY2, in their sockets. Insert the ICs only as directed in the circuit test procedures.

PARTS LIST

All resistors are ¼-watt, 10%, unless otherwise specified.
R1, R26—10 ohms
R2, R4, R19, R20, R21—10,000 ohms
R3—100 ohms
R5, R12, R27, R28—100,000 ohms
R6, R7, R8, R11, R14, R16, R22, R23, R24, R25—1000 ohms
R9, R10, R18—1 megohm
R13—470 ohms
R15—15,000 ohms
R17, R29—10 kilohms trimmer potentiometer, PCB mount
R30—10 megohms
R31, R33—39 ohms
R32—390,000 ohms

Capacitors
C1, C20, C21—100 μF, 25 volts, aluminum electrolytic, radial
C2—0.47 μF, 100 volts, polyester
C3, C15, C16—4.7μF, 100 volts, non-polarized aluminum electrolytic
C4—0.47 μF, 50 volts, film
C5, C13—0.01 μF ceramic disk
C6, C22—10 μF, 25 volts, aluminum electrolytic, radial lead
C14—deleted
C7, C8, C9, C10, C11—0.1μF, 25volts, ceramic disk
C12—1 μF, 25 volts, aluminum electrolytic, radial leaded
C17, C18, C19—2.2 μF, 25 volts, non-polarized, aluminum electrolytic, radial leaded

Semiconductors
D1, D2, D6, D12, D13, D14, D15—1N4007 silicon rectifier diode
D3, D4, D5, D7, D8, D9—1N914—silicon signal diode
D10, D11—1N5245, 16 volts, Zener
LED10, LED11—light-emitting diodes, red, T-1¾ (optional, see text)
IC1, IC3—NE555N, Philips or equiv.
IC2—MC145436P, dual-tone multiple frequency receiver, Motorola or equiv.
IC4—MC14011BCP, NAND gate, Harris or equiv.
IC5—CD4017B decode counter, Harris or equiv.
IC6—LM741CN operational amplifier, DIP package, National or equiv.
Q1, Q2—D40D5, NPN power transistor, TO-220 package, Harris or equiv.
Q3, Q4—2N2222 NPN transistor

Other components
MIC1—microphone, omnidirectional, electret, 20 to 15,000 Hz, Radio Shack 270-090 or equiv.
PL1, PL2—RJ-11 modular telephone plugs
RY1, RY2—relay, 1 form A SPST NO DIP reed, Mouser D31A310
S1—slide switch, SPST, Radio Shack 275-401 or equiv.
T1, T2, T3—transformer, audio, isolation, interstage, 1200 ohm primary, 600 ohm, Mouser TLO22 or equiv.
XTAL1—crystal, 3.579 kHz, metal, radial-leaded case, MTRON ot equiv.

Miscellaneous—perforated circuit board; project case (see text); three 8-pin DIP sockets; two 14-pin DIP sockets; one 16-pin DIP socket; holder for four AA power cells; four alkaline AA power cells; solid, tinned copper wire (22 AWG), insulated hookup wire (22 AWG), two lengths of telephone cord; 12-volt battery clip; cable ties; solder.

Note: The following items are available from Information Unlimited, P.O. Box 716, Amherst, NH 03031; phone 603-673-4730, Fax 603-672-5406:
• Complete kit including perforated board, all active and passive components, and telephone cords and plugs.—$99.50
Include $5.00 for shipping and handling. Allow two to four weeks for delivery.

Circuit test

Measure the continuity between the following points and the circuit board ground bus.: IC1—pin 1; IC2—pin 8; IC3—pin 1; IC4—pin 7; IC5—pins 8 and 13; IC6—pin 4; emitters of transistors Q1, Q2, Q3,and Q4; T1 secondary.

Connect the four AA cells which form the 6-volt DC battery pack to the battery clip. Verify that 6 volts appears between the following test points and the ground bus with a voltmeter. (The current drawn should be 0.1 to 0.2 milliamperes):
IC1—pins 4 and 8; IC2—pins 3, 4 and 6; IC3—pins 4 and 8; IC4—pin 14; IC5—pin 16; IC6—pin 7, collectors of transistors Q1 and Q2.

Plug PL1 into a telephone jack connected to a "test" telephone. (It might be necessary to obtain a modular duplex jack such as Radio Shack's 279 386.)

Insert both the 555 timer IC1 and transistor Q1 in their sockets. Connect one lead of a voltmeter set on the 10-volt DC scale to the collector of Q1, and verify a reading of 6 volts.

Short-circuit plug P1 and observe the voltmeter scale to see if the voltage momentarily drops to near zero. Resistor R32 is specified as 390 kilohms, but it might be necessary to substitute a lower value for reliable triggering of IC1 via pin 2. However, make that substitution in gradual increments because if the value is too low, the reed contacts of RY 1 will chatter and the circuit will not work.

Switch off the 6 volts with switch S1, insert the DTMF decoder IC1 in its socket, and set trimmer potentiometer R29 to its midrange. Restore power with S1.

Verify that a logic high appears on pins 13 and 14 each time the pound (#) key is pressed on the connected test telephone to verify the operation of decoder IC2.

Switch off the 6 volts with S1 and insert NAND gate IC4. Restore power and verify a logic low on pin 3 each time the pound (#) key is depressed. Measure the inverted signal at pin 4 to perform this test.

Switch off the 6 volts with S1, and insert the second 555 timer IC3. Verify that there is a momentary 5 volts on pin 3 each time power is restored with S1.

Switch off the 6 volts with S1, and insert the decade counter IC5. Restore power and verify that pins 2 and 4 are at logic low and pins 3 and 15 are at logic high.

Press the pound (#) key and verify that pins 2 and 4 of IC5 show alternating logic levels, each repeating every third keying step. These tests verify the proper operation of the logic, reset digital processing, and function counter.

Switch off the 6 volts with S1, insert op-amp IC6, set trimmer potentiometer R17 to midscale, and turn on the power. Press the pound (#) key on the test telephone and listen for any sounds picked up by the microphone to verify the operation of the *listen* mode.

Connect the leads of a voltmeter to the collector pin of Q2 and ground to verify the presence of 6 volts. Press the pound (#) key of the test telephone, and observe that the voltmeter shows a momentary dip to zero. This energizes relay RY2 for the *intercept phone conversation* mode.

Press the pound (#) key of the test telephone and observe a logic high on pin 3 of IC5. This verifies the operation of the *reset code functions* mode. Pins 2 and 4 of IC5 should be at a logic low.

If all of these tests have been passed successfully, the correct functioning of all Telemike controls has been verified.

The following procedure requires two separate telephone lines in the room where the testing is performed. Line A and line B.

Plug the RJ-11 phone plug PL1 into the outlet jack of Line B. (A telephone need not be connected to this jack.) Set a voltmeter on the 100-volt DC scale and connect it to measure 50 volts across the red ring and green tip telephone wires, and look for the expected 50 volts. Switch on S1 and verify that there is no change in the 50-volt reading on the voltmeter other than a momentary drop. Repeat this step making the measurements at the plug.

Pick up the handset from the Line A test phone and key in the number of the Line B phone. It is important that you press the pound key immediately to access the line during its receptive interval. You should be able to hear low-level sounds in the room where Telemike is located clearly. Turn on a radio in the same room if you want a steady audio signal source.

Press the pound (#) key a second time, putting Telemike in its *intercept phone conversation* mode (non functioning at this time), and then key it a third time to reset the Telemike.

Intercept function

The next test requires a third telephone line (the one to be intercepted).

Plug PL2 into the jack of the third telephone line in the room so you can intercept and monitor any conversations on that line. Switch on S1 and verify that 50 volts DC appears across both ring and tip wires.

Call the Line B phone from the test Line A phone, and access the second phone line by pressing the pound key (#) twice. You should hear a dial tone from the second phone line indicating that you have gained access. This tone indicates that you have intercepted the line and will be able to hear any conversation on it.

Make arrangements for two other persons to converse over the second phone line, and then call the "called to" number and key the pound sign twice to listen in on an actual call in progress. When you are ready to quit this mode, be sure to press the pound key again to reset Telemike.

Note: The audio level on the intercepted conversation might be weak in this mode, forcing you to listen very carefully. If you intend to interrupt a conversation with a message, you might have to speak loudly to be heard.

Telephone compatibility

Not all telephones have the same encoding signal output levels. This could cause circuit unreliability when accessing a second telephone line. If that occurs, you might be able to correct the problem by setting trimmer potentiometer R29 on the Telemike.

Dedicated line

Consider leasing of a dedicated line to Telemike as part of a permanent installation. This will eliminate possible ring signal "sneak through" and the critical timing of the 555 IC1 for allowing access control. Nevertheless, it would still permit all incoming calls to be completed and would have no effect on outgoing calls.

Timer values

The initial access time established by the time constant of resistor R5 and capacitor C6 can be set in most systems to permit a normal incoming telephone call to be made. If this time is too long, and an "off-to-on" hook condition is created that will disable the connection. If it is too short, the encoding tones might not pass. This condition should not interfere with outgoing calls. In most cases, the longer time constant will assure encoding control. Ω

Encourage young children to learn to play the piano or organ with this microcontroller-based training system.

JAMES E. TARCHINSKI

MUSIC BRINGS PLEASURE TO ALL OF us and adds to the quality of our lives. While most of us just listen to music, others play musical instruments for pleasure or profit. Parents, relatives, and friends of young children might want them to learn to play and enjoy music at an early age—even before they are old enough to profit from formal training in an instrument. Micro-Conductor overcomes this problem. This electronic trainer makes it possible for children to play simple tunes on a piano or organ without formal training.

Fifteen LED lamps on an indicator panel light up in the proper sequence under microcomputer control to prompt youngsters to press the associated keys to play nine familiar tunes. The tempo of the music can be regulated from slow to fast as children catch on, and a LED display identifies the tune being played.

The attraction of Micro-Conductor for children aged 4 to 6 is instant satisfaction. With a little practice in following blinking lights with their fingers, children—even those with short attention spans—are rewarded with the sounds of music. Moreover, Micro-Conductor should discourage children from randomly hammering on the keys of the family piano and driving even the most permissive parents to distraction.

The cable-connected indicator panel is placed just above the keyboard, and the circuit board is placed out of the way on top of the organ or piano, as shown in Fig. 1. Power for Micro-Conductor is obtained from an AC-to-DC adaptor that plugs into a wall outlet (saving you the expense of a lot of replacement batteries).

Micro-Conductor can be built from readily available components, and its microcontroller is programmed with nine tunes and musical scales. Moreover, it's a great starter project if you've never built a computer-controlled system. Pre-programmed chips are available from the source given in the Parts List if you prefer not to program the microcontroller.

Circuit operation

Figure 2 is the schematic for Micro-Conductor. The heart of the system is a Motorola MC68705P3 microcontroller which contains random-access memory (RAM) and field-programmable read-only memory (EPROM). Most of the chip's 28 pins perform input/output functions. Reprogrammable EPROM makes it easy to modify the operation of the trainer and add new songs when the first set has been overplayed.

The nine pieces and musical scales, numbered 0 to 9 and listed in Table 1, are programmed into the microcontroller. Number 9, scales, is the default tune when the unit is first powered up. The number of the tune being played is displayed on seven-segment LED display DISP2. It can be increased by pressing switch S3 or decreased by pressing switch S4. Whenever those switches are pressed, the circuit zeros an internal counter so that the new song begins to play on its first note.

To accommodate children of different ages and abilities, ten different tempos have been included: zero is the slowest and nine is the fastest, with the second value assigned to default. DISP1, another seven-segment LED display, shows the tempo selected. Tempo can be increased by pressing switch S1 and decreased by pressing S2. Unlike tune number, however, tempo can be changed at any time without restarting the piece being played.

Micro-Conductor's controls

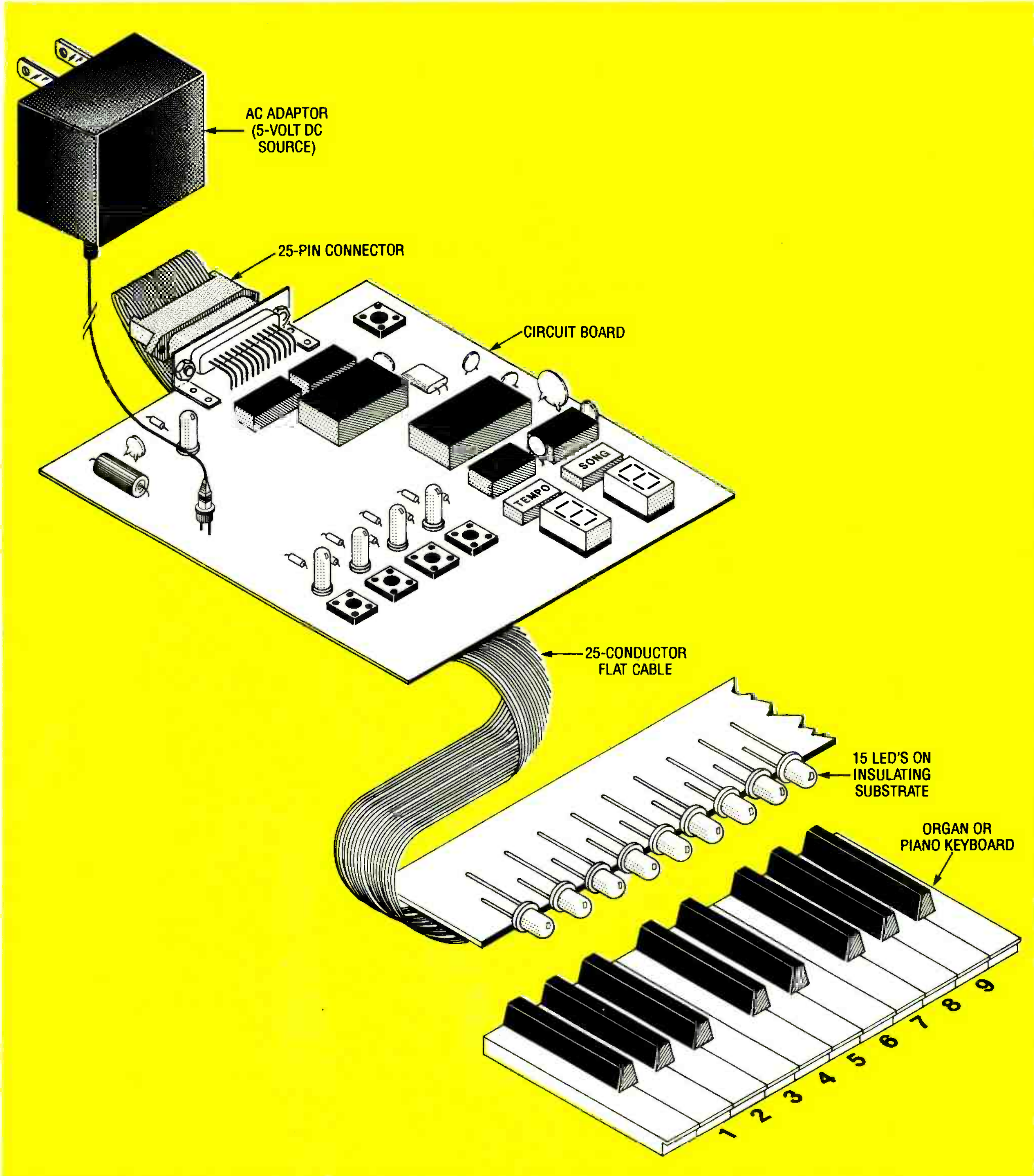


FIG. 1—MICRO-CONDUCTOR SYSTEM INCLUDES (top to bottom) outlet-mounted AC-to-DC adaptor, circuit board with microcontroller, function displays and switches, and a flat-cable connected indicator panel that is placed above the right keys on the piano or organ keyboard.

are simple enough to permit youngsters to operate the system by themselves. The four LED lamps on the PC board (LED1 to LED4) are not a required for the operation of the circuit, but were included to make software debugging easier. Microcontroller IC1's Port B (PB0 to PB7) controls input switches S1 to S4 and those four board-mounted LED's. Software (ORGAN5.S05) illuminates each of those LED's whenever the related pushbutton is pressed.

IC1's Port C (PC0 to PC3) does most of the work of Micro-Conductor although it only has only four of the 20 input/output pins. Port C drives IC2, a 74154 four-to-16-line demultiplexer. In response to the 4-bit input from IC1, IC2 drives the 15 LED's (LED6 to LED20) in the cable-connected indicator panel shown in Fig. 1.

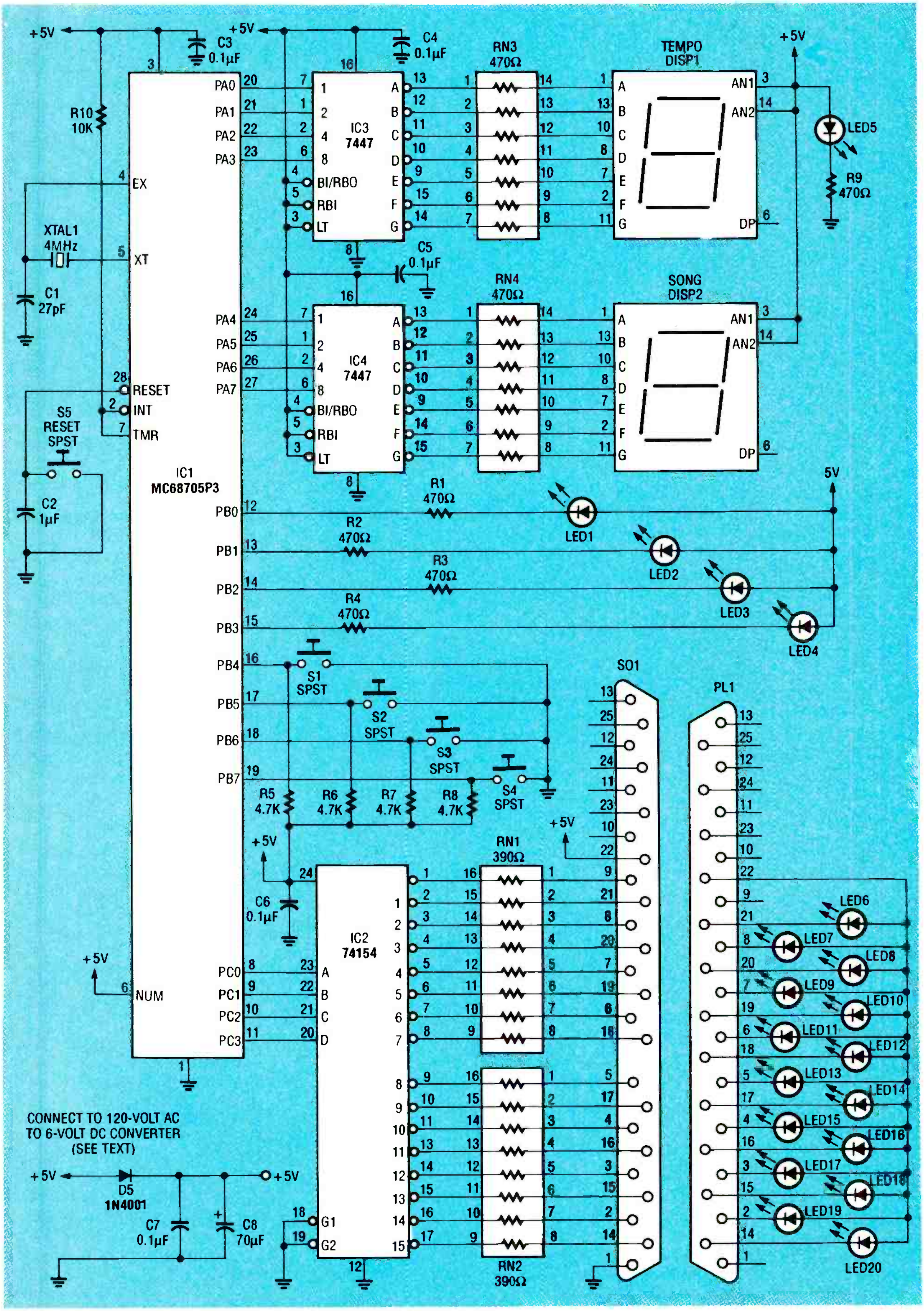


FIG. 2—SCHEMATIC FOR MICROCONTROLLER and indicator panel.

TABLE 1—SONG TITLES

0	Three Blind Mice
1	This Old Man
2	Twinkle-Twinkle Little Star
3	London Bridge
4	Mary Had A Little Lamb
5	Rock-A-Bye Baby
6	Yankee Doodle
7	Pat-A-Cake
8	Hickory-Dickory Dock
9	Scales

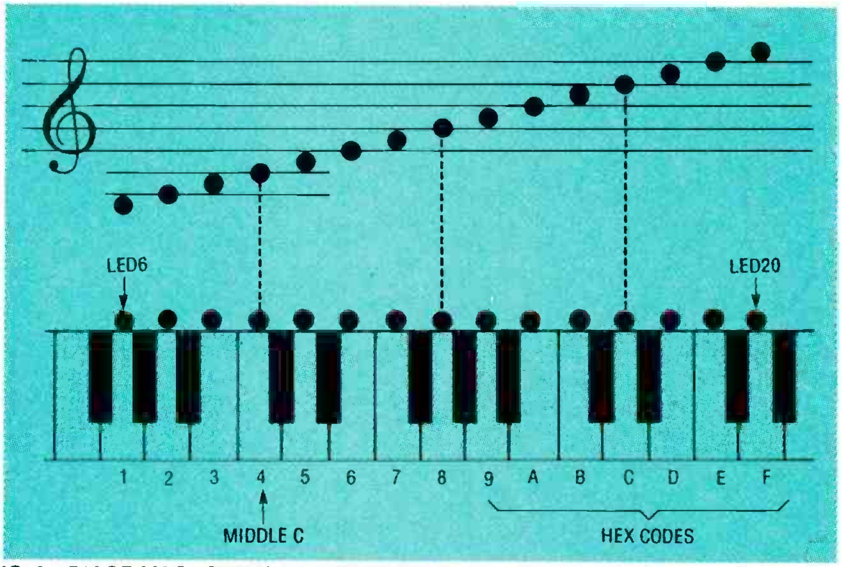


FIG. 3—DIAGRAM SHOWING LOCATION OF LED LAMPS in the indicator unit over the piano or organ keyboard. Hex codes permit coding additional tunes in the microcontroller.

There is no connection on pin 9 of connector PL1 for IC2's output 0 (pin 1). This permits a delay note, a binary code of %0000 on the input lines of IC2 that can turn off all the indicator panel's LED's. That delay note occurs between tunes and is imbedded within them.

Because IC2's outputs run on negative logic, the 15 LED's on the indicator panel are all tied through current-limiting resistors to +5 volts. When the voltage on the outputs of IC2 go to their low value, the connected LED's are illuminated. Figure 3 shows how the LED's are matched with the organ or piano keys. As shown, Middle C on the keyboard is related to LED9. Figure 3 also shows the four-bit single hexidecimal character code programmed into microcontroller IC1 that is associated with each key.

Control circuit construction

The foil pattern for Micro-Conductor's PC board is included in this article. Referring to the schematic Fig. 2 and the parts placement diagram Fig. 4, insert all resistors, resistor networks, capacitors, switches, and LED's 1 to 5 in the PC board and solder them. Trim all excess leads close to the board.

Bend both leads of crystal case XTAL1 at right angles approximately ⅛-inch from the bottom of the case and insert them in the holes as shown on Fig. 4. Then bend about a 4-inch length of tinned copper wire in a "U-"shape with its ends ½-inch apart. Insert those ends over the crystal case into the holes on both sides of the metalized shield patch on the underside of the board. Twist the ends of the wire together to pull the case snugly against the top surface of the board. Solder both the crystal case leads and wire strap ends where they exit the board and trim excess wire lengths.

Insert the 25 pins of the right-angle D-type socket comnnector SO1 into the matching holes of

PARTS LIST

All resistors are ¼-watt, 5 %
R1–R4, R9—470 ohms
R5–R8—4700 ohms
R10—10,000 ohms
RN1, RN2—390 ohms, eight-resistor DIP (CTS 8916 or equivalent)
RN3, RN43—470 ohms, seven-resistor DIP (CTS 8825 or equivalent)

Capacitors
C1—27 pF, 16-volt disc
C2—1 µF, 16-volt disc
C3–C7—0.1 µF, 16-volt disc
C8—470 µF, 10-volt electrolytic

Semiconductors
IC1—MC68705P3, microcontroller (Motorola)
IC2—74154N, 4-to-16 line demultiplexer
IC3–IC4—7447AN, 7-segment LED display drivers
LED1–LED21—red light-emitting diodes, 1¾
DISP1, DISP2—7-segment, common-anode LED displays in standard 14-pin DIP packages

Other components
XTAL1—4MHz quartz crystal, HC-18 case, (ECS, Digi-Key X006 or equivalent)
S1–S5—SPST momentary pushbutton switch, PC-mount, (Panasonic P8034S or equivalent)
SO1—25-pin, type-D connector with right-angle mounting brackets (Amphenol 177 or equivalent)
PL1—25-pin, type-D connector, MTIDC

Miscellaneous: Micro-Conductor PC board, 28-pin DIP socket for IC1, 24-pin DIP socket for IC2, two 16-pin DIP sockets for IC3 and IC4, length of 25-conductor 0.050-inch, 7 × 36 28 AWG flat cable (see text), AC-to-DC adapter, 120-volts AC outlet mounted, 6/7.5 volts DC, 700 mA, (Radio Shack No. 273-1655 or equivalent), DC jack (Radio Shack No. 274-1563 or equivalent), 4 PC board rubber feet with adhesive backing, strip of wood or plastic (see text), tinned copper wire, solder.

Note: The following parts and software are available from James Tarchinski, P.O. Box 080133, Rochester, MI 48308-0133
- Pre-programmed MC68705P3 microcontroller—$17.00
- Programmed 5½-inch disk formatted for MS-DOS compatible computers containing all files—$8.00

Please include $2.00 for shipping and handling. Michigan residents must add 5% sales tax.

the PC board and seat the connector flush with the edge of the board. Fasten the connector to the PC board with one of two methods. Drill two holes through the board using one of the two holes on each bracket as a template. (Be sure that you do not drill into a conductive trace on board underside.) Fasten the brackets with nuts and bolts, solder the conductors and trim excess lengths. Alternatively, place drops of epoxy or a suitable cement in the bracket holes to bond the brackets to the board after the leads are soldered and trimmed.

A socket is reqired for IC1 so that the microcontroller can be removed for reprogramming. While not mandatory, sockets are recommended for IC2 to IC4. Position the sockets, solder them, and trim excess leads.

The prototype has a jack for the coaxial plug from the AC-to-DC adaptor wired to the PC board with short lengths of insulated wire. However, you can cut off the plug, strip the wire ends, insert them in the holes, and solder them directly to the board as shown in Fig. 4. You can also drill a hole in the PC board and mount the jack directly on the board. (Be sure to observe the polarities for both adaptor plug and PC board.) Solder the connecting wires between board and jack, and trim excess lengths. Tape or pot the exposed jack terminals with RTV compound to insulate them.

Place the adhesive-backed rubber feet on the four corners of the underside of the PC board to elevate it board above any conductive surface that could short exposed traces and soldered joints. Insert the integrated circuits IC1 to IC4 in their sockets, taking all precautions to prevent IC damage from electrostatic discharge.

You can improve the appearance of the system and provide better protection for the circuitry by enclosing the circuit board in a suitable plastic or wood case. Its inside dimensions should accommodate the circuit board and allow adequete vertical clearance. However, if you elect this option you will need additional parts *not* listed in the Parts List. Also, the construction procedure given so far must be changed to allow for this alternative.

If you want to put the circuit board in a case, first drill holes at the four corners of the board for standoffs before doing any component assembly. Mount the LED displays on right-angle connectors and cut windows for them in the side walls of the case at the right locations. Also cut openings for the D-type connectors and drill a hole for the DC jack on a side wall. Mount

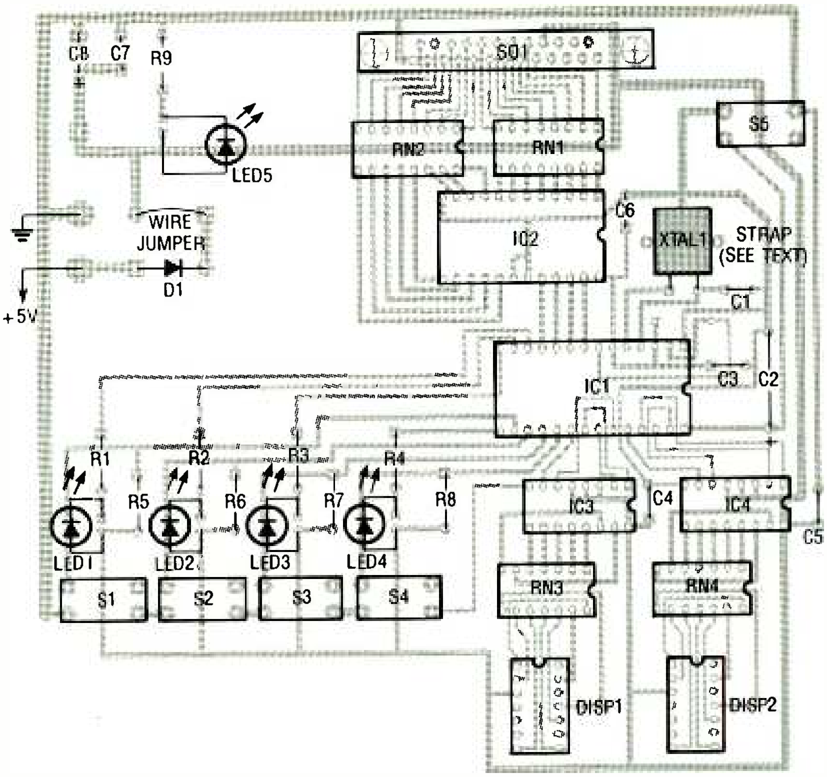


FIG. 4—PARTS PLACEMENT DIAGRAM. Integrated circuits IC1 to IC4 are mounted in sockets. Note wire clamping crystal XTAL1 case to board. A DC jack can be mounted in a drilled hole on the board (not shown).

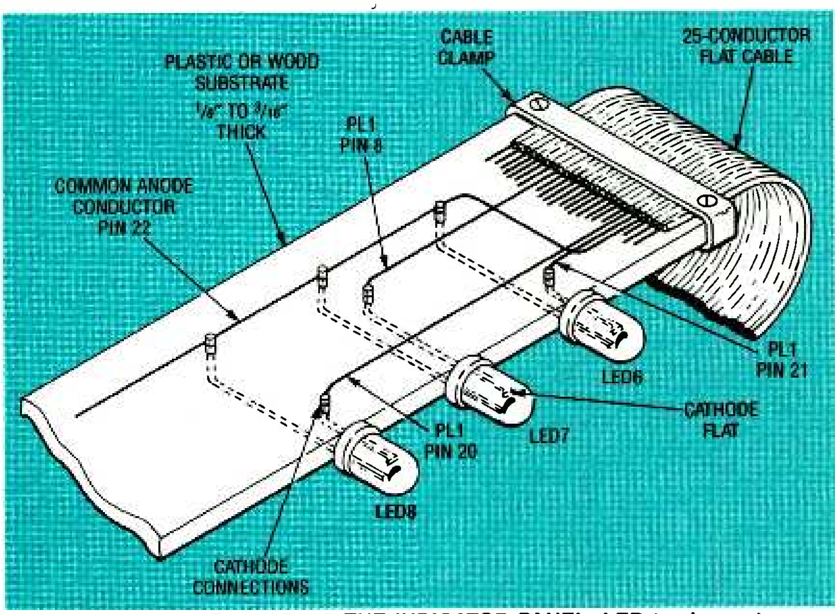


FIG. 5—DETAILS FOR BUILDING THE INDICATOR PANEL. LED leads are bent and inserted in drilled holes in wood or plastic strip and soldered connections are made as shown. Protect exposed conductors with tape or covers (not shown).

switches S1 to S5 on the front panel and wire them to the circuit board with lengths of hookup wire long enough to permit the board to be removed from the case. (You might want to replace them with switches more suitable for case mounting.)

When the board is complete but before inserting the IC's, fasten it to the bottom of the case with screws and standoffs—plastic or metal tubes about ½-inch long.

Indicator panel construction

Determine a satisfactory length for the 25-conductor flat cable (up to three feet) and cut one end square. Insert and seat that end in the slot of connector PL1 (with mass-termination, insulation-displacement contacts). Position the connector and cable in a vise and, holding both cable and connector firmly together, slowly close the vise to drive the row of contacts uniformly into the cable to form secure bonds with each of the conductors.

Referring to Fig. 5, select a suitable strip of wood or plastic from ⅛ to 3/16-inch thick, about 2 inches wide and up to 20 inches long. Determine the actual length by referring to Fig. 3. Add the center line distances between 15 keys on your piano or organ's keyboard, and allow about 2 inches on each end. Measure in about 2 inches from one end to allow for clamping the cable to the strip, and mark the center line locations for each of the 15 LED's (LED6 to LED20) to be mounted.

Carefully bend all LED leads at right angles (as shown in dotted lines on Fig. 5) to account for the thickness of the insulating strip selected. The bent ends of each LED should equal the strip thickness plus about 1/16 inch to act as exposed solder terminals when the LED's are seated. (Note that LED cathode leads are shorter than anode leads and are closest to the packages' flat surfaces.)

With a handheld pin drill and bit slightly smaller than the diameter of the LED leads, drill two rows of 15 holes in the strip for the leads as shown in Fig. 5, observing the proper spacing and alignment. Insert the bent sections of the LED Leads into the holes and press the LED's down gently so their leads are flush with the surface of the strip. The terminals should project above the surface of the reverse side. (The leads should fit snugly in the holes so the LED's will not fall out when the strip is handled.)

Reverse the strip and position it as shown in Fig. 5. Allow enough cable length for conductors to reach the last LED in the series, and clamp the cable to the strip as shown. The clamp can be an aluminum or copper strap wrapped around the strip and squeezed in a vise or fastened with screws near the edges of the strip.

With the cable securely clamped to the indicator strip, separate the conductors carefully with a razor knife back to about ⅛ inch from the clamp. Referring to the schematic Fig. 2, cut off the open-circuited conductors 13, 25, 12, 24, 11, 23, 10, 9, and 1 close to the clamp. Find conductor 22 and cut it off near the anode terminal of LED6, allowing about ½ inch for stripping and wrapping bare wire around the exposed LED posts.

Wrap one end of a 20-inch length of tinned-copper wire around the LED6 anode post, and continue wrapping all exposed anode posts to LED20 to form a common conductor. Solder all anode connections and trim excess wire. Now, starting with the cathode post of LED6, cut and strip conductors 21 to 14 as shown in Fig. 2, making allowance for increasing length. Also allow enough slack on each conductor to minimize overlapping and permit it to be pressed close to the surface of the strip. Wrap one turn of the stripped wire ends around each cathode post, solder the connections and trim excess wire.

Locate the indicator unit on an insulating surface so that no leads are shorted, and check all connections both visually and with a continuity meter to be sure that the LED's are connected in the specified order. Repair any errors and replace any faulty LED's. Protect the exposed conductors of the unit. They can be covered with vinyl electric tape or, for a more professional appearance, covers. Cut matching covers from suitable sheet plastic and drill holes along their lengths to permit them to fastened to both sides of the strip with nuts and bolts, forming a protective sandwich.

Microcontroller software

Due to limited space, only part of the assembly language program has been reprinted here. The complete program is available on the *Electronics Now BBS* (516-293-2283, V.32, V.42bis). Download file ORGAN5.ZIP, an archived file that must be "decompressed" with the PKUNZIP utility, which is also available on the system. (Note that the *Electronics Now BBS* is always free of charge.)

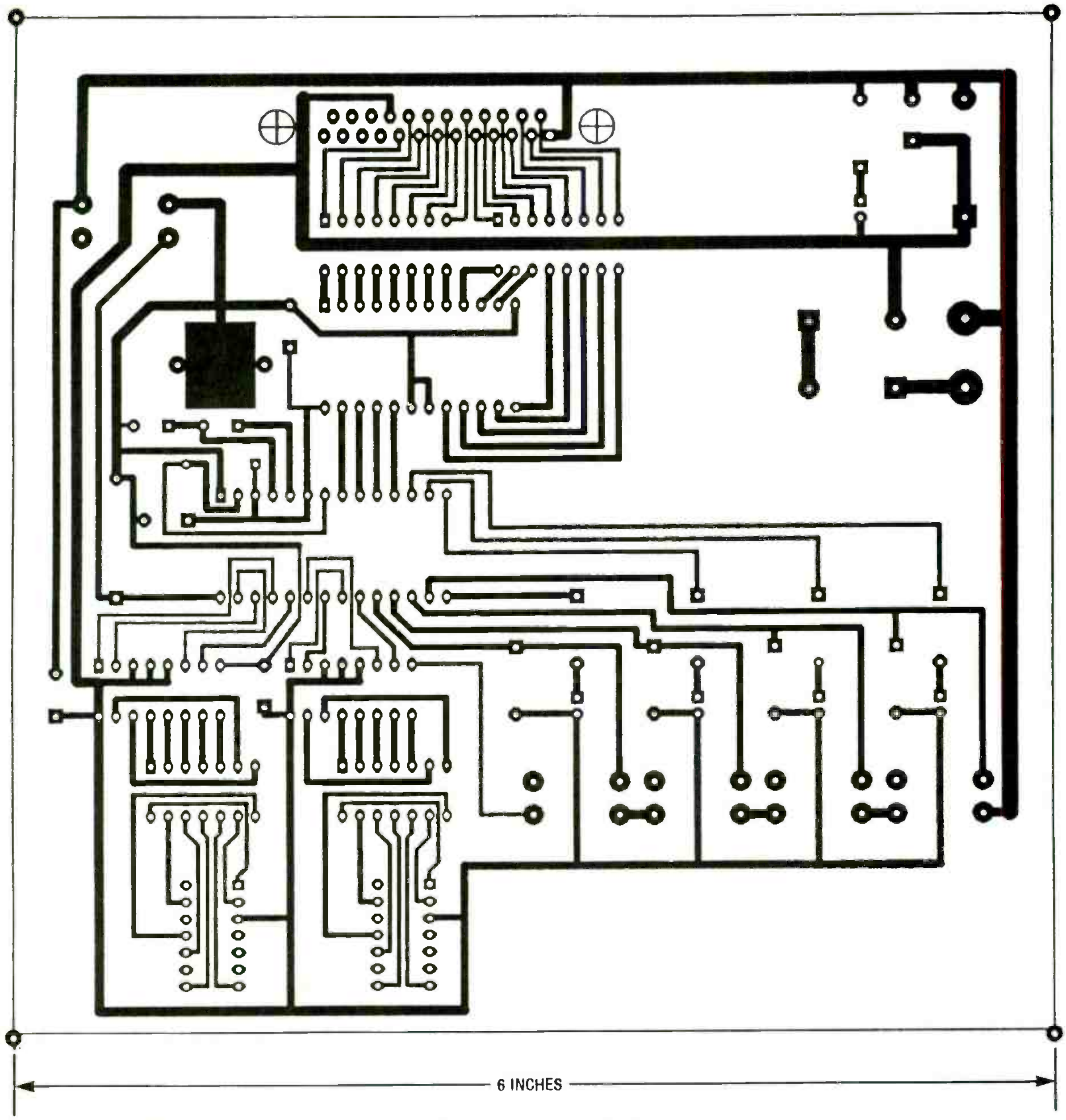
The four files of software are:
ORGAN5.S05—Source code file for the software.
ORGAN5.LST—Output listing file generated by the assembler.
ORGAN5.P05—Motorola S-record listing of the code that can be sent directly to a PROM programmer.
README.TXT—An ASCII file containing any important last-minute advisory notices.

To program microcontroller IC1 from your PC, follow the manufacturer's procedure. An article entitled *68705 Microcontroller* by Thomas Henry, Sept. 1989 R-E includes that procedure.

The assembly language code for Micro-Conductor is in five

LISTING 1—SOURCE CODE DEFINITION OF SCALES

```
* SCALES
TUNE9 FCB    $00,$12,$34,$56,$78,$9A,$BC,$DE,$F0,$FE,$DC,$BA,$98
      FCB    $76,$54,$32,$10,$FF
*
```



BOTTOM FOIL (SOLDER SIDE) for micro-conductor PC board, shown half size.

sections. The first contains all housekeeping functions for the program (e.g. title and version information, RAM variable assignments, general constant equate statements, and definitions of both the processor's mask option register and vector table).

Next, there is code section headed *Initialization*. When the microcontroller detects the end of a reset condition (i.e. when power is first applied), it starts to execute the START label, which is at the beginning of the initialization block. This section of code performs the following duties:

- Initialization of all I/O ports
- Clearing of the entire RAM memory to a value of $00
- Initialization of the registers for creating a regular interrupt frequency
- Setting of initial values for several RAM variables

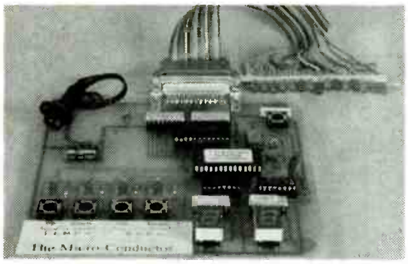
When the microcontroller completes initialization, it switches to the main execution loop labeled MAIN in the source code. That loop handles all Port A and B I/O functions except enabling the 15 indicator unit LED's.

The first function of the MAIN loop is to read the state of the four input switches S1 to S4. After the inputs are debounced via software, the program checks each switch state in sequence. If a specific switch is pressed, either the SONG variable or the TEMPO variable are incremented or decremented by one. After changing either of these variables, the software automatically checks to prevent a user's attempt to call for a variable beyond the microcontroller's permitted range.

The last block of code in the MAIN section updates the LED displays DISP1 and DISP2. The four bits of the SONF variable are rotated over into most significant nibble within the accumulator and ORed with the four significant bits of the SPEED counter. The resulting byte is then available at Port A (PA0 to PA7) of the microcontroller for the LED driver IC's (IC3 and IC4) and display module to indicate tempo and song number.

The fourth section of code in the file source begins with the label TM—INT, which marks the start of the timer interrupt routine. At regular intervals of about 31 milliseconds, the microcontroller stops executing the MAIN program loop and runs the code between the TM—INT and RTM—INT labels. That section of code controls the 15 indicator LED's (LED6 to LED15) connected IC1's Port C.

If enough time (dependent on the TEMPO setting) has elapsed since the keyboard LED's were last updated, the software either turns off any lighted LED or turns on the next one in the song due to the value of the NOTE variable. Because IC1 lacks an addressing mode that can handle 16-bit offsets, each tune must tested in sequence.



AUTHOR'S PROTOTYPE of the Micro-Conductor.

The last section of code in the source file is the song data. After an appropriate "TUNEx" label, form constant byte (FCB) pseudo instructions insert the notes of the songs into the file. This data is encrypted with the coding system shown in Fig. 3. To conserve PROM, two notes (requiring only four bits each) are placed in every byte of the FCB statements.

Note that there are two special codes in each of the ten songs. Every song begins with a $00 code, which allows time for a child to move his fingers back to the keyboard before the song is displayed. Similarly, every song ends with a ?? code, indicating to the software that last song being played is finished. See Listing 1 for a section of the project's source code that defines the Scales tune.

When both components of Micro-Conductor have been built and plugged together, it is ready for a test run. Plug in the wall-adaptor and start the included program.

Micro-Conductor will give children a pleasant introduction to formal music instruction. The child will soon learn the relation between the keys and the musical scale and, it is hoped, take an early interest formal music instruction. **R-E**

NEW *LIFE* FOR OLD SCOPES

Find out how you can give new life to an old oscilloscope.

MICHAEL A. COVINGTON

AN OSCILLOSCOPE IS ONE OF THE most useful test instruments, but also one of the most expensive. A new scope costs $400 or more, but used scopes in less-than-perfect condition sell for under $50. Most industrial users don't want to keep a scope that's showing signs of age. If you learn to troubleshoot oscilloscopes, someone else's loss can be your gain.

Where to find them

Before you can fix up an old scope you've got to find one. The best sources of cast-off scopes are ham radio swap meets, or hamfests. You can find out more about such gatherings by contacting your local amateur radio club for information. The prices at hamfests are really low. This year I bought a Tektronix 541 (originally $1400) for $25 and a Heath IO-14 (originally $400) for $10—both with minor, but fixable defects.

Last year I did even better. I saw a dilapidated Heath IO-12 under a table marked "free," and the owner immediately insisted I take it off his hands. Admittedly, it had no knobs or tubes, but tubes at a hamfest cost only 25 cents each, so it didn't take long to get it working.

You can also find secondhand scopes in classified ads, but the prices are likely to be higher—$100 to $200—although the equipment is usually in better condition. Also, ask at factories and repair shops to see if they are planning to sell off any old or used equipment.

Types of old scopes

There used to be two kinds of scopes; "utility" and "wideband." Nowadays, both have been replaced by calibrated triggered-sweep lab scopes, but the older ones are still worth having.

Utility scopes are designed for audio work and sweep generator alignment; their upper frequency limit is a few hundred kHz. Those scopes were used by the first generation of TV repairmen in the 1950's. Popular models include the Eico 400 and 425; the Heath OM-1, OM-2, OM-3, OL-1, IO-10, and IO-21; the RCA WO-56, WO-57, and WO-88; and the Radio Shack 22-086. (Yes, even Radio Shack used to sell oscilloscopes!)

When color TV arrived, so did wideband scopes—a utility scope can't show the 3.58-MHz color burst on a video signal. Most wideband scopes are good at least to 5 MHz, and some go down to DC. Heath models O-10, O-11, O-12, and IO-12 are progressive refinements of a classic model.

Other wideband scopes include the Eico 435 and 460, and the RCA WO-33, WO-78, WO-79, and WO-91.

In the late 1960's, lab-grade scopes began to replace the cheaper kinds. A lab scope is calibrated on both axes—volts per centimeter vertically and microseconds per centimeter horizontally. In practice, that means that lab scopes have a triggered sweep—they will hold the waveform steady at any sweep speed, whereas with conventional scopes, you have to synchronize the sweep with the signal.

The Heath IO-14 and Knight 83YZ945 were among the first affordable lab scopes. Affluent industrial and government organizations used Tektronix lab scopes, which had been around since the early 1950's. Tektronix spared no expense to provide the best performance. Model 545 had about 75 tubes, including a broadband amplifier with 16 matched 6CB6's, and accepted interchangeable plug-in vertical preamps. Components were silver-soldered to ceramic strips, as shown in Fig. 1. So many of the parts in a Tek scope are custom-made that the best way to get replacements is to find another cast-off Tektronix.

Beware of low-frequency lab scopes designed for precision audio work; they aren't useful above audio frequencies. The Hewlett-Packard 130 shows up fairly often at hamfests. So do the low-frequency preamps for Tektronix and Knight lab scopes.

Initial checkout

The most expensive parts of a scope are the CRT and the power transformer. If they're bad, it usually doesn't pay to fix the scope, unless you can salvage parts from another one just like it. So the first check is simply to plug in the scope and try to get a spot or trace on the screen. If you can, the CRT and transformer are good.

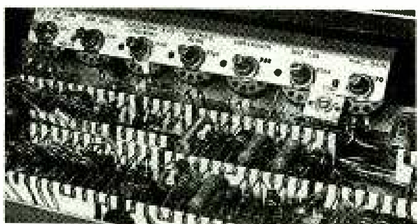


FIG. 1—TEKTRONIX CERAMIC terminal strips use silver solder. Small amounts of tin-lead solder are okay if not overheated. Note the clearly labeled adjustments.

If you can't get a spot or trace, don't give up. A blown fuse may have cut off power, or a bad tube may have deflected the beam all the way off the screen. Also, note that triggered-sweep scopes don't display a trace unless there's a waveform at the input and the trigger level is set properly. Most of them have an "auto" position that makes the trace visible even without an input.

The trace on an old utility or service scope won't be very bright. If you can see it indoors, it's probably as bright as the manufacturer intended; lab scopes are much brighter. You can improve contrast by putting a piece of green plastic over the white screen of the CRT, or sometimes by replacing the original green filter with a lighter one.

FURTHER INFORMATION

Heath oscilloscope manuals are still available from Heath Company, Benton Harbor, MI 49022; Tel: 616-982-3571. Old Tektronix manuals are available on microfiche from Tektronix, Beaverton, OR 97005. You may be able to borrow Tektronix manuals from a nearby government or industrial lab or the electronic repair shop at a university. RCA manuals can be obtained through RCA distributors. The circuit of the RCA WO-33A was published in the 1963 *RCA Receiving Tube Manual*.

A gold mine of information is in the *Encyclopedia on Cathode-Ray Oscilloscopes*, by Rider and Uslan (New York: Rider, 1959). It contains schematics of dozens of scopes, along with advice on troubleshooting. Your local public library may be able to get this for you on an interlibrary loan.

Two books that will help you understand oscilloscope circuitry are *Electronics for Scientists*, by Malmstadt, Enke, and Toren (W. A. Benjamin, N.Y., 1963), and *Typical Oscilloscope Circuitry* (Tektronix, Beaverton, OR, 1961).

Over the years, **Radio-Electronics** has published many articles about oscilloscopes. The ones I particularly recommend are:

- "All About Oscilloscopes," Charles Gilmore, June–September 1975.
- "How to Use Triggered Scopes," Larry Allen, August 1969.
- "Scope × 100," (Wideband Modifications) Tom Jaski, November 1965.
- "How to Wideband Your Scope," Barry Turner, August 1965.
- "Modifying Heath Scope," Edward J. Och, August 1962.

Finally, you can get the basic specifications of an old scope by finding the manufacturer's ad for it. Tektronix advertised regularly in *Proceedings of the IRE*; other manufacturers advertised in **Radio-Electronics** and Electronics World.

Warning

High voltage can kill! Before working on a scope, disconnect power and discharge all electrolytics. When making internal adjustments with power applied, use extreme caution. Stand on a dry, insulated floor and keep one hand in your pocket. Do not wear grounded wrist straps or other devices designed to protect low-voltage IC's.

The most lethal voltage in a scope is probably the 400-volt B+ supply, which can deliver several hundred milliamps. The CRT accelerating voltage is 1500–6000 volts, but is at a much lower current.

Solder, switches, and tubes

Assuming the scope shows signs of life, the next step is to fix bad connections. Many hamfest bargain scopes were built from kits and suffer from cold solder joints. Intermittent, flaky behavior with unknown causes is what often leads the owners to unload a scope. On top of that, the owner usually lets the scope gather dust for a few years in his attic or chicken coop before disposing of it.

The cold solder joints are easy to fix—just melt every joint again, adding solder where necessary. Use a 100-watt soldering iron, not the 15-watt type used for solid state work. We're dealing with 1950's technology, and proper soldering takes power.

The sojourn in the chicken coop really dirties the controls. Solvent squirted from a can will usually fix potentiometers, but rotary switches may need something more potent, like wire brushing. I use miniature brushes that are designed for the Dremel Moto-Tool but will fit an ordinary cordless drill. It takes a lot of brushing to get all the metal clean.

Also, make sure the contacts are properly positioned—they should move visibly as the metal

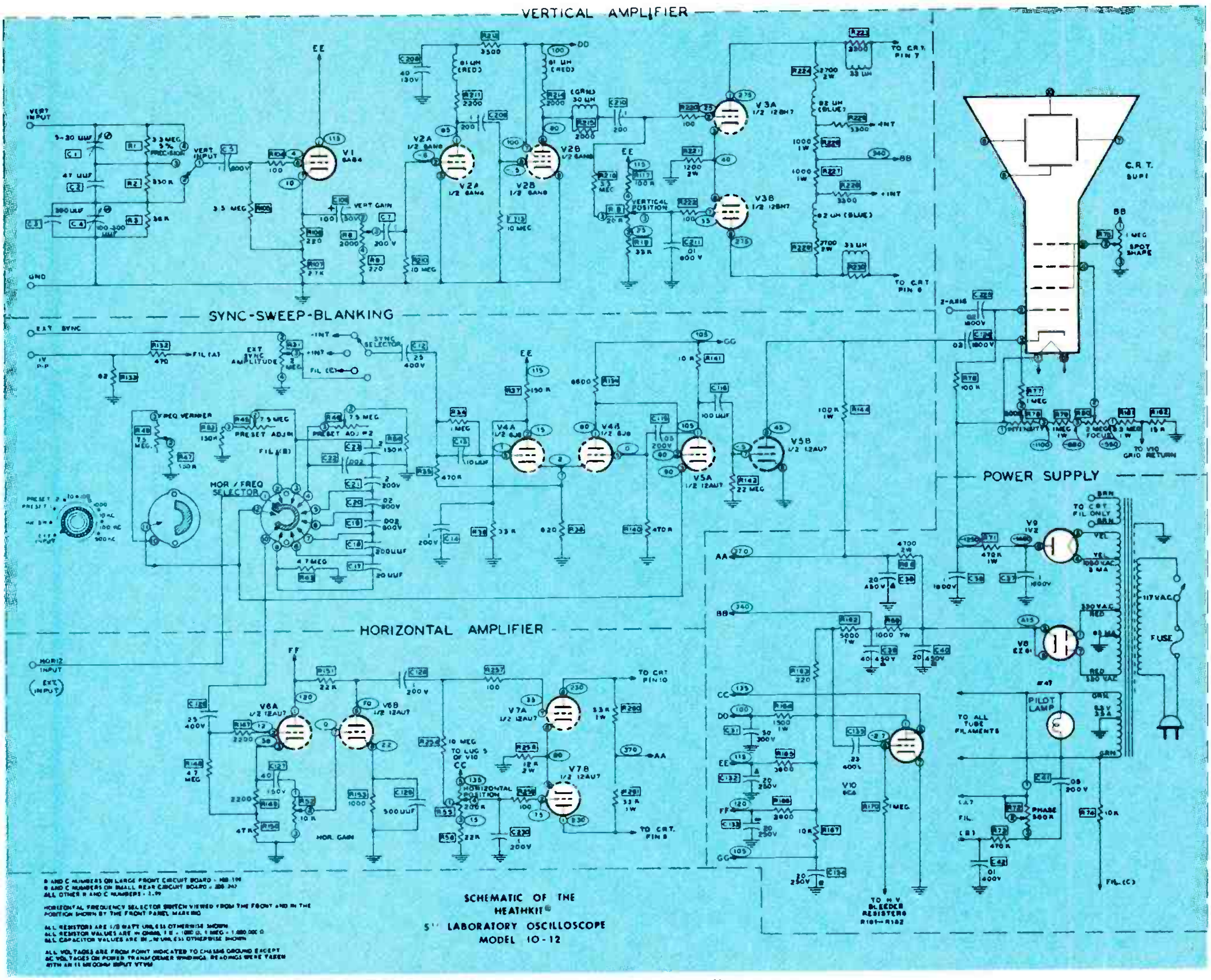


FIG. 2—THIS IS THE SCHEMATIC OF THE Heath IO-12, a popular wideband oscilloscope with recurrent (synchronized, not triggered) sweep.

slides under them. If necessary, you can bend a contact back, clean it with fine sandpaper, and then bend it back into position, but that's tricky. An ohmmeter can tell you whether you've gotten the switch good and clean. Take comfort in the fact that dirty switches and controls usually get cleaner when used regularly.

The next step is to test the tubes. Be warned that tubes in scopes are more critical than in other equipment; matched pairs or selected tubes may be required in some places. If you don't have a tube tester, look for tubes that don't light and try swapping tubes of the same type to see if there is a change in performance. Quite often, a bad tube is all that's wrong.

Oddly enough, if a tube goes bad in a Tektronix vertical amplifier, you may not notice it; the circuit is direct-coupled at low frequencies and the only effect a dead tube has is to decrease bandwidth.

Circuit analysis

Figure 2 shows the circuit of the Heath IO-12, a typical wideband scope. Most troubles are easy to localize because each function of the scope corresponds to a particular circuit—vertical and horizontal amplifiers, sync, sweep, and so forth.

Most failures occur in the power-supply. Look for open or leaky filter capacitors and burned-out resistors. Reduced voltages and excessive ripple may indicate that a selenium rectifier has increased in resistance; you can wire a silicon diode in parallel with it, and all the current will go through the silicon. Remember, too, that you can replace a rectifier tube with silicon diodes.

Lab scopes have regulated supplies in which a 150-volt reference voltage controls all the regulators. If the reference voltage is even slightly off, many other circuits will malfunction. You can correct slight errors with "150-volt adjust" potentiometer.

Lower-cost scopes get their high voltage from the power transformer. Lab scopes, however, use a separate 60- to 100-kHz oscillator, high-frequency transformer, and voltage multiplier. Loss of high voltage is often caused by a shorted high-voltage capacitor. In a Tektronix scope, you can check for that by disconnecting capacitors, one by one, until the filaments of the high voltage rectifiers light up.

If the power supply is okay but you can't center the trace on the screen, look for a bad tube in a push-pull amplifier, and note that more expensive scopes have push-pull stages throughout their vertical and horizontal sections, not just at the output.

Horizontal sweep is seldom perfectly linear. The earliest scopes used an 884 or 2D21 thyratron tube—essentially a neon-lamp blinker with a grid—and generated a poor-quality sawtooth. Later models used dual triods but still weren't perfect, as shown in Fig. 3. Severe nonlinearity, however, may indicate a bad tube or leaky capacitor.

Hum

Many scopes show a noticeable 60- or 120-Hz ripple superimposed on every trace, due to power-supply trouble. To check, try bridging each filter capacitor with a known good one, test all tubes associated with voltage regulation, and check that rectifiers are okay. Hum of that type is normally 120 Hz.

In cheaper scopes, a 60-Hz ripple is caused by the magnetic field of the power transformer, and is considered normal. More expensive scopes have a mu-metal shield around the CRT to block magnetic hum. In tube-type equipment, hum is never totally absent, but its amplitude should be one millimeter of screen deflection or less.

Hum can also come from poor grounding. Mechanical contact between pieces of metal does not always make a good electrical connection, especially if the scope is old. I cured the hum in my Heath IO-14 (Fig. 4) by adding solder lugs to ground PC boards to the chassis, and a grounding strap, made of copper braid, for the vertical attenuator.

Another source of hum is heater-to-cathode leakage in a tube. Regardless of the cause, you can detect where hum is entering the system by removing tubes stage by stage until the hum stops.

Adjustments

Every scope has an astigmatism control to ensure that the beam spot is round, not oval. In some Heath models, that's on the inside (Fig. 5), but it's a good idea to adjust it. Bear in mind that it

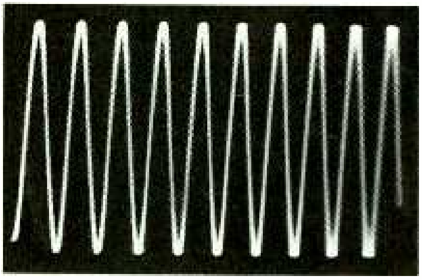


FIG. 3—SWEEP AND FOCUS are somewhat uneven on cheaper scopes; you just have to live with it.

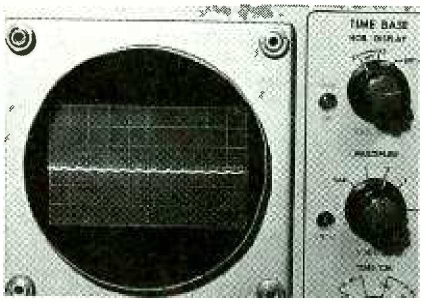


FIG. 4—THIS 60-Hz HUM IS due to poor grounding of the input stage, and can be cured by adding a copper strap.

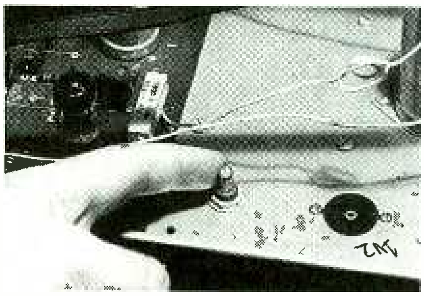


FIG. 5—THE ASTIGMATISM CONTROL of the Heath IO-12 is inside; you may want to make it more accessible.

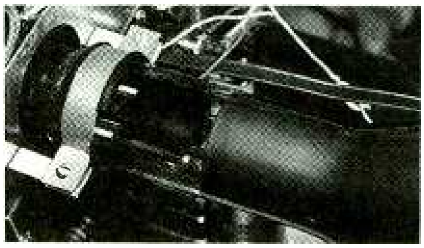


FIG. 6—IF THE TRACE IS TILTED, mark its position on the screen with a grease pencil, then turn the power off, loosen screws, and rotate the CRT.

interacts with focus and intensity controls.

Most lab scopes have one or more vertical balance controls to keep the trace from moving up and down as you switch from range to range, or from "normal" to "invert." Those controls are well worth adjusting. There may also be internal adjustments to center the trace. Try them to see what they do.

Adjustments that affect frequency response, however, should be approached with great caution. Tektronix lab scopes have numerous adjustment points that shouldn't be touched without the manufacturer's manual. It's easier to make things worse than to make them better.

Calibration adjustments aren't as tricky, providing you have test signals of known voltage and frequency. Remember, anything which changes the high voltage will affect the calibration by altering the stiffness of the electron beam.

If the trace is tilted, rotate the CRT (Fig. 6). To do so safely, remove the green filter and mark the trace position on the screen with a grease pencil. Turn the power off, discharge all capacitors, and then align the tube using the grease pencil mark.

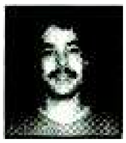
Probes and compensation

One adjustment you must make is the vertical input compensation. Do that with the probe that you're actually going to use in high-frequency circuits. Good probes are designed to reduce capacitive loading on the circuit under test.

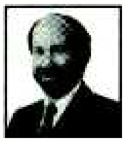
Figure 7 shows the circuit of a typical low-capacitance probe. On the ×1 setting, the 10K resistor keeps the cable capacitance from loading the circuit under test, but high-frequency response is poor. On the ×10 setting, the 9-megohm resistor forms a voltage divider with the 1-megohm impedance of the scope. The 9-megohm resistor is bypassed with a small capacitor so that more signal can get through at high frequencies.

To adjust compensation, first set the probe to "direct" (×1) or temporarily set it aside and connect the scope directly to a good square-wave source, such as the circuit in Fig. 8. Adjust the trimmer capacitors in the vertical input circuit so the top of the square-wave is flat. There may be as many as a dozen trimmers, each for a different range. Set the probe to 10:1 and adjust the capacitor on the probe itself.

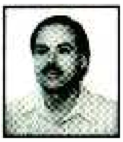
Just like these Fully Trained Electronics Professionals



"Thanks to CIE I have tripled my previous salary, and I am now in a challenging and rewarding new field where only the sky is the limit."
Daniel Wade Reynolds
Industrial Electrician
Ore-Ida Foods



"CIE was recommended to me by my boss. It was appealing since I could study at my own pace at home and during business travel."
Dan Parks
Marketing Manager/Consumer Products
Analog Devices, Inc.



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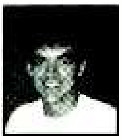

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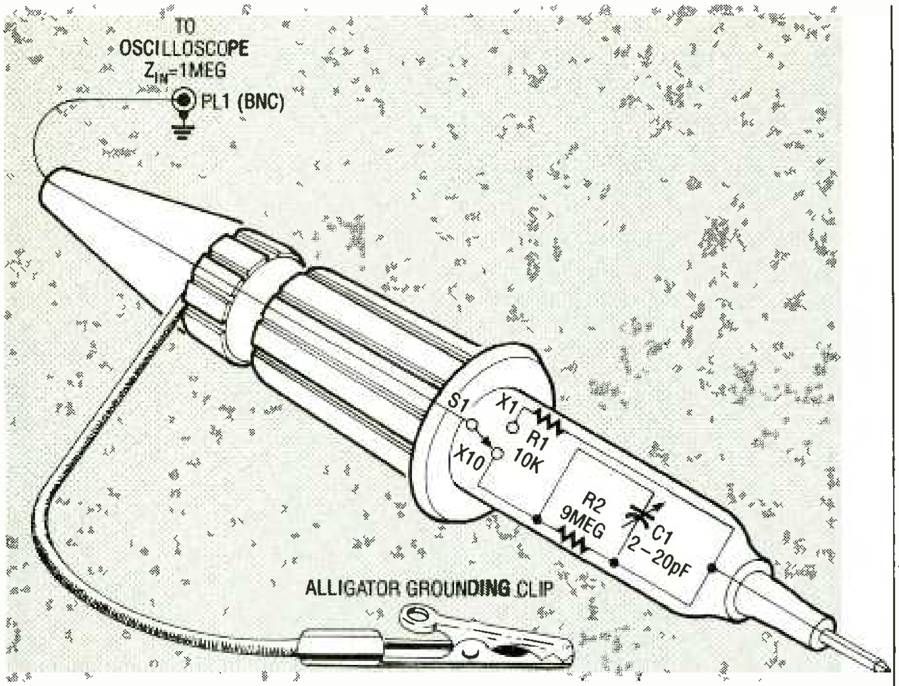


FIG. 7—THIS IS A CIRCUIT OF A TYPICAL low-capacitance probe.

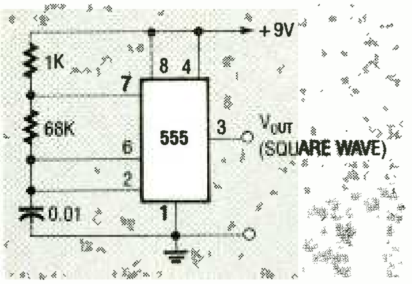


FIG. 8—A SIMPLE 1-kHz SQUARE-WAVE oscillator for testing compensation.

Some scopes have an input impedance of other than 1 megohm—the modern standard—and with them, 10:1 probes don't give 10:1 attenuation. For example, a 10:1 probe is actually 3:1 when connected to the 3.3-megohm input stage of a Heath IO-12. The probe does its job; the attenuation is just different from what you might expect.

Improvements

You can go beyond fixing the scope and actually improve it in several ways. By replacing rectifier tubes with silicon diodes, and getting rid of filaments, the power transformer will have less of a load to drive, reducing the chance of overheating. You may even want to add a cooling fan. To get one, ask a computer dealer to give you a junked power-supply with a 120-volt fan in it. And how about a really long power cord, or BNC connectors on the inputs,

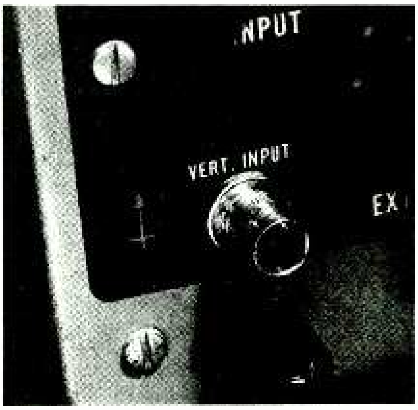


FIG. 9—REPLACING THE binding post with a BNC connector makes it easier to attach modern probes.

as shown in Fig. 9?

If you're more adventurous, you can improve the circuit design. Many ideas for doing that were published in **Radio-Electronics** in the early 1960's (see under FURTHER INFORMATION). You can increase the bandwidth by adding peaking coils, eliminate hum by using DC on filaments, improve the sync by adding an amplifier stage, or design triggered sweep.

Finally, there's still hope for a scope that's beyond economic repair, but still shows a trace. It can be converted into some other kind of instrument, such as a modulation scope (see the *ARRL Handbook*), component tester, or transistor curve-tracer. **R-E**

EQUIPMENT REPORT

continued from page 22

well. At the end of the test, minimum, maximum, and average values for the entire batch of components can be recalled.

A Relative mode makes it easy to separate components whose values measure higher or lower than a reference component. A reference component is inserted in the test sockets, and its value is stored in memory. Then, new component measurements show up as either plus or minus with respect to the reference value.

Electronic components are normally rated with a tolerance figure which indicates how much a given part can vary from its nominal value. Tolerance is given as a percentage of the value marked on the unit. For example, a 100-ohm resistor with a tolerance of 10% should have a true resistance value between 90 and 110 ohms. However, as any experienced technician can tell you, that's not always the case.

The B+K Model 878 includes a Tolerance mode that lets you pick out parts from a batch that don't fall within a given tolerance. To use this feature, you select a tolerance of 1%, 5%, or 10%, and the value of a reference component is stored in memory.

A beeper will sound when a part that doesn't meet the tolerance is tested. These out-of-spec parts can then be discarded, put aside for less-demanding applications, or sent back to the manufacturer for replacement.

To sum up, the B+K Model 878 LCR bridge is really a handy test instrument for anyone seriously involved in electronics. Its features that aid in component sorting make the meter a perfect quality-control tool for checking components before they are installed on a production line.

It's reasonable to expect that the Model 878 will quickly pay for itself by culling out those pesky out-of-tolerance components. The 878 will save the cost of lost production and labor needed to find and replace them. This looks like $275 well spent. Ω

BUILD THIS LIGHT-CONTROLLED SOUND-EFFECT GENERATOR

Generate weird sounds with our sound-effect generator based on a light-controlled, tone-burst oscillator.

JOHN CANIVAN

SOUND EFFECTS MEAN BIG BUSINESS nowadays, from those intended to enhance home videos to silly ones for your phone-answering machine. In the past we've run articles on how to build very sophisticated—and expensive—sound generators, but this time we present a simple novelty sound-effect generator that's sure to give you and your children hours of fun.

The generator contains two photo cells that control a tone-burst oscillator circuit; tone is controlled by one photo cell and the burst interval is controlled by the other. All you have to do is wave your hands above the photo cells to generate all kinds of sounds.

Circuit theory

The tone-burst oscillator circuit uses a 556 timer IC and positive feedback to create the strange sounds. The 556 chip contains two completely independent 555's and, in our application, the output of one 555 controls the interval of oscillation—or the burst time—of the other.

Figure 1 shows the pinouts of both the 555 and the 556, and the equivalent circuit of a 555. Positive feedback, which controls the frequency and duty cycle of the 555 timer, is obtained from the charging and discharging voltage across capacitor C through resistors R_A and R_B. During oscillation, voltage across the capacitor changes from ⅓ V_{CC} to ⅔ V_{CC}, and back again.

The time it takes for the voltage on C to drop from ⅔ V_{CC} to ⅓ V_{CC} is known as the discharge time (t_D). When ⅓ V_{CC} is reached, the 555's flip-flop resets and allows C to charge across R_A and R_B. The time it takes C to charge to ⅔ V_{CC} is known as the charge time (t_C). When that level of charge is reached, the 555's flip-flop sets and causes C to discharge across R_B, and then the cycle begins again.

Figure 2 shows the complete circuit for our light-controlled tone-burst oscillator. You'll notice that two light-dependent resistors, or photocells, are used: R8 and R9. A photocell is basically a resistor whose value depends on the amount of light to which it is exposed. Its resistance is inversely proportional to the intensity of that light. In bright light, the resistance of a typical photo-cell can drop to 100 ohms, while in darkness its resistance can easily exceed 500 kilohms.

If we use a photocell to replace R_B (in Fig. 1), those minimum and maximum resistance values (100 ohms and 500K) can be used to calculate the range of frequencies that can be generated by the 555:

Cycle time $= 0.7(R_A + R_B)C + (0.7 \times R_B \times C)$

If R_B is very small, the cycle time equals $1.4 \times R_B \times C$. If C is 0.1 µF, the maximum cycle time equals 700 milliseconds to give a frequency of 0.7 hertz, and the minimum cycle time equals 0.2 milliseconds for a frequency of 5000 hertz.

The power supply for this project should be capable of supplying between 5 and 15 volts DC, and it should be able to provide at least 1 amp at 5 volts. The output should never

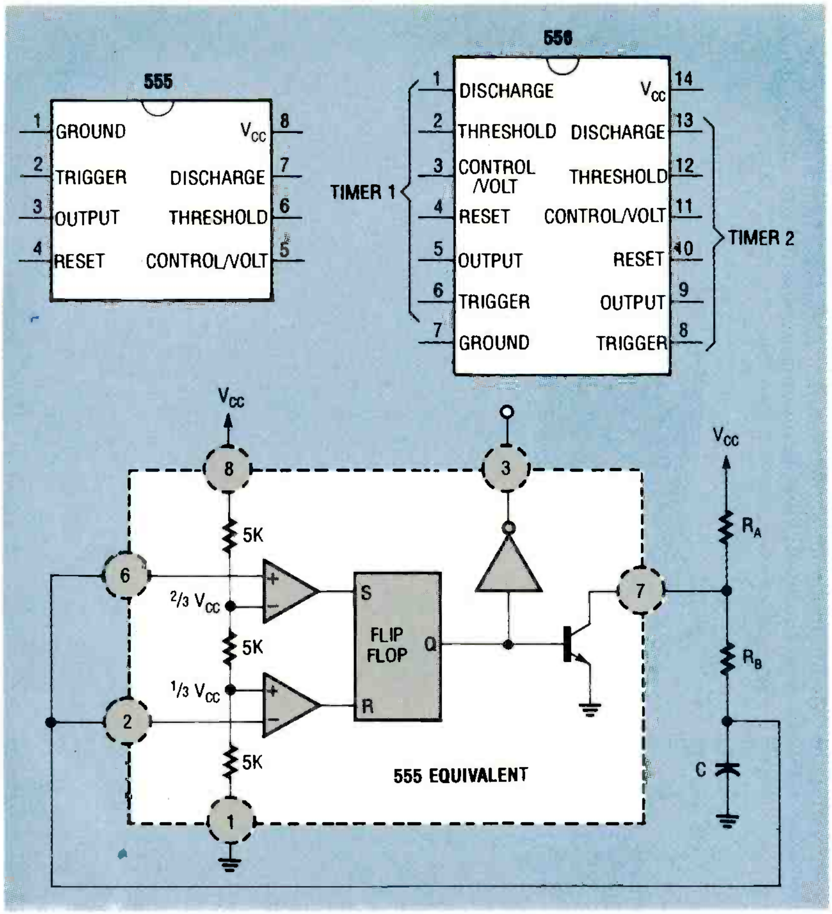


FIG. 1—PINOUTS OF THE 555 AND THE 556, and the equivalent circuit of the 555 timer.

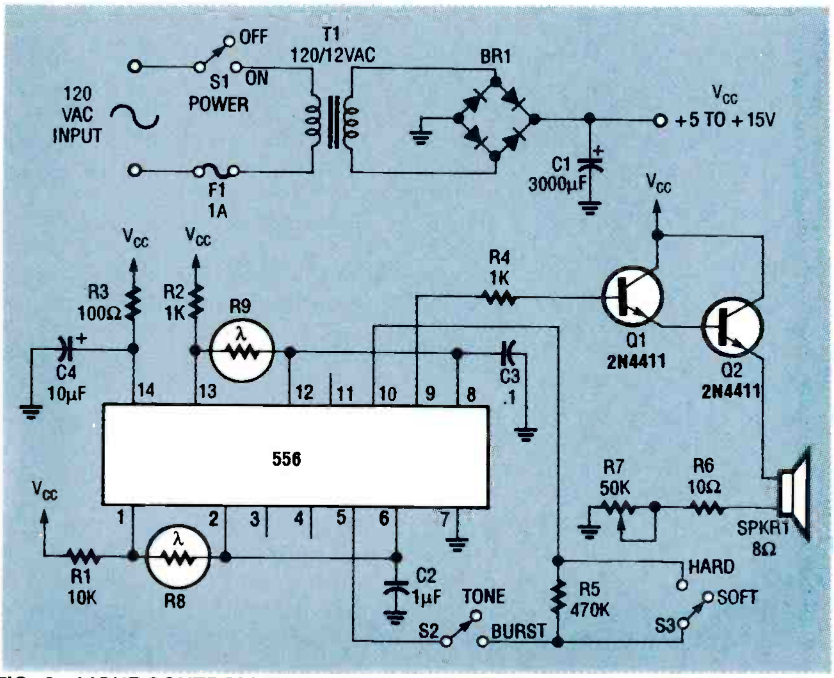


FIG. 2—LIGHT-CONTROLLED TONE-BURST OSCILLATOR. Two light-dependent resistors (R8 and R9) are used to create unusual sound effects.

exceed 15 volts under no-load conditions or else you risk damaging the circuit.

Construction

This project is very easy to build with any acceptable construction technique. The author mounted the components on a piece of perforated construction board and wired them point-to-point. The board, speaker, transformer, switches, and photocells were then installed in a homemade wood cabinet, as shown in Fig. 3. It's best to mount the photocells at least a foot away from each other so that one hand can control frequency while the other hand controls the burst interval. This avoids having motion from one hand interfere with the other hand.

PARTS LIST

All resistors are ¼-watt, 5%, unless otherwise noted.
R1—10,000 ohms
R2, R4—1000 ohms
R3—100 ohms
R5—470,000 ohms
R6—10 ohms, ½-watt
R7—50,000 ohms, 1-watt potentiometer
R9, R9—photo cells (values are not critical)

Capacitors
C1—3000uF, 25 volts, electrolytic
C2—1uF, 50 volts, Mylar
C3—0.1 µF, 50 volts, polyester
C4—10 µF, 50 volts, electrolytic

Semiconductors
IC1—556 dual timer
Q1, Q2—2N4411 NPN power transistor
BR1—50 PIV 1.5-amp bridge rectifier

Other components
F1—1-amp fuse and holder
S1–S3—SPST switch
T1—120/12VAC 1-amp power transformer
SPKR1—8-ohm speaker

Miscellaneous: perforated construction board, enclosure, 14-pin DIP socket, line cord, wire, hardware, etc.

Note: For complete operating instructions, set of sound recipes, schematic, and detailed plans for the cabinet, send $5 to John Canivan, 20 Tyler Ave., W Sayville, NY 11796

Operation

The circuit should be used in room that has plenty of overhead light, because the frequency and burst intervals are

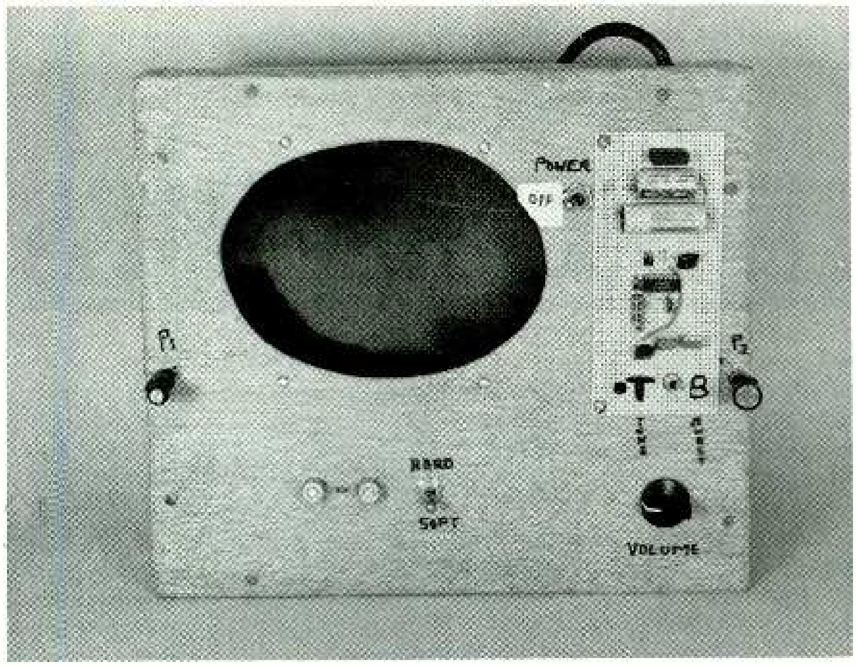


FIG. 3—THE AUTHOR MOUNTED THE COMPONENTS on a piece of perforated construction board and used point-to-point wiring. Everything was then installed in a home-made wood cabinet.

controlled by light intensity. The tone burst feature can be modified by opening and closing S3. That either makes a direct connection between the output of the burst timer and the reset of the tone oscillator, or replaces the direct connection with resistor R5 for a completely different sound effect. By opening S2, the burst feature is eliminated, and the pure tones which result can be controlled by hovering one hand above R9.

Remember that the amount of light striking photocells R8 and R9 is critical for proper circuit operation. Since the sensitivity of photo cells can vary, you should adjust the light to the range of frequencies desired. If the adjustment is not sufficient, you can adjust the range of available frequencies by changing the value of timer capacitors C2 and C3.

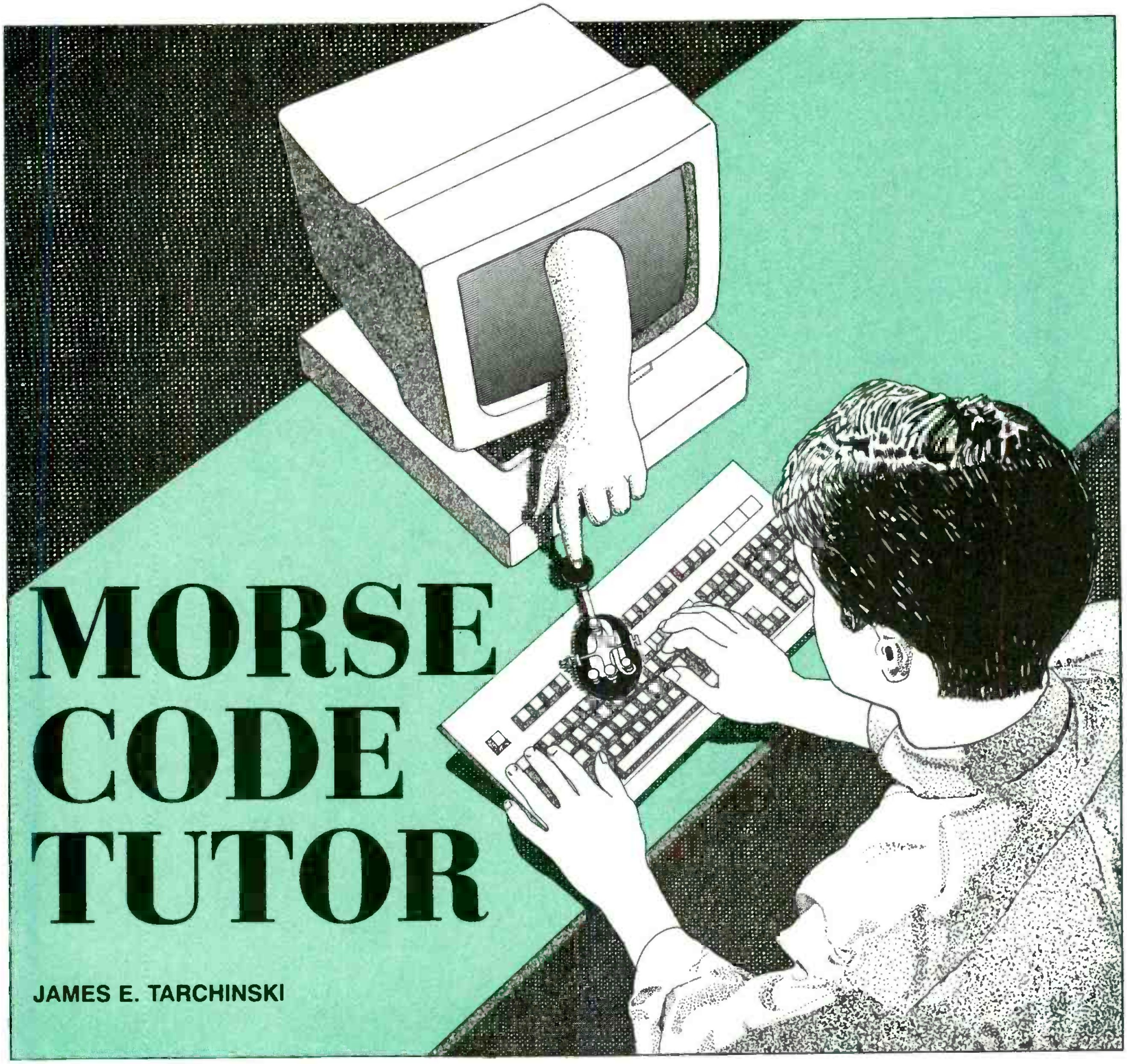
Sound recipes

The following is a list of different sounds you can make and instructions on how to make them:

- Police siren—Set TONE/BURST switch S2 on tone and raise and lower your right hand between 1 and 3 inches above R9, once every second.
- Old car starting—Set TONE/BURST switch S2 on burst and set HARD/SOFT switch S3 to hard. Place your right and left hands over the photocells and raise your left hand (or whichever hand is over R8) slowly.
- Airplane starting—Set TONE/BURST switch S2 on tone and place your right hand on photocell R9 and raise it slowly. Stop at 2 inches.
- UFO landing—Set TONE/BURST switch S2 on burst and set HARD/SOFT switch S3 on hard. Raise your hands above your head and lower them slowly onto the photocells.
- Birds chirping—Set TONE/BURST switch S2 on burst and set the HARD/SOFT switch S3 on hard. Place left hand 2 inches above photocell R8. Spread the fingers of your right hand and wave them across photocell R9 at a distance of about 2 inches.
- Ghosts moaning—Set TONE/BURST switch S2 on tone and set the HARD/SOFT switch on soft. Flutter your right hand above the photocell R9 while raising it up and down between 1 and 3 inches.
- Frankenstein—Set TONE/BURST switch S2 on burst and set HARD/SOFT switch S3 on soft. Raise your hands above your head and lower them slowly until you touch the photocells. Raise your left hand about 3 inches and then lower it to within 1 inch of the switch. At the same time, raise your right hand 3 inches. Repeat the process.
- Radiation warning—Set TONE/BURST switch S2 on burst and set HARD/SOFT switch S3 to hard. Cup your right hand 1 inch above photocell R9 and then cup your left hand about 2 inches above photo-cell R8.
- Foghorn—Set TONE/BURST switch S2 on burst and set HARD/SOFT switch S3 to hard. Place your right hand on photocell R9. Place your left hand on photocell R8.
- Smoke detector—Set TONE/BURST switch S2 on burst and set HARD/SOFT switch S3 to hard. Place your right hand 3 inches above R9, and place your left hand 1 inch from R8.

The light-controlled tone-burst oscillator is basically a musical instrument, and the quality of sound depends on the skill and creativity of the musician. If you've ever been searching for a circuit that can create special sound effects, then this project is right up your alley. **R-E**

MORSE CODE TUTOR



JAMES E. TARCHINSKI

This BASIC program can teach you Morse code— or help sharpen your skills if you already know it.

WHEN TV WAS FIRST INTRODUCED, many thought it was the beginning of the end for radio—why would people want audio when they could have both audio and video? Forty years later, however, radio is still alive and well, thank you.

In this era of global communication, where voice and video signals are carried by wires, radio waves, and fiber optics, you might wonder about the usefulness of Morse code. In fact, it too is alive and well.

Many new shortwave listeners (SWLers) do not know Morse code, hence much activity in the SW bands goes uncomprehended. Even experienced SWLers have a tendency to let their code translation skills lapse over the years, making it difficult to understand MC in real time. Although the Federal Communications Commission (FCC) eliminated the Morse code test from the Technician-class amateur-radio license (**Radio Electronics**, April '91), anyone applying for more advanced license grades must still pass a Morse code test.

We have a solution to both problems: a BASIC-language program that teaches Morse code and runs on any PC or compatible. The program is simple enough to modify for other computers as well.

The Morse code program drills you in a "flash-card" manner by "beeping" and displaying an encoded character on the screen. It then waits for you to press the corresponding key. The program also displays the number of correct and incorrect responses, making it easy to track your learning progress.

The program is presented in its entirety in Listing 1. You can type it in and save it to disk, or download file MCPP.BAS from the RE-BBS (516-293-2283, 1200/2400, 8N1 or 7E1).

Using the program

Run MCODE and the program should ask you to enter a random-number seed. Enter any number in the given range (−32768–32767) and the program will proceed. (The number you enter is used to initialize the computer's random-number generator so that you'll get a different series of characters each time you run the program.) A sign-on screen appears, as shown in Fig. 1; press any key to continue. Then the main menu appears, as shown in Fig. 2.

The menu allows you to choose one of four predefined sets of characters for practice, to define your own set, or exit the program. Set 1 consists of the letters A–Z; set 2, the digits 0–9; set 3, nine common punctuation marks; and set 4, all 45 letters, digits, and punctuation marks.

Table 1 shows the Morse code representation of all characters used in the program. Each section of the table corresponds to a menu item. As you may know, each Morse code character is represented by several short and long sounds (dits and dahs, respectively). In the table and on the screen, dits are represented by asterisks and dahs by dashes.

You can create your own custom character set. If you're just starting to learn Morse code, you can begin by concentrating on just a few characters, the vowels, for example, and gradually add more characters as your skills improve.

If you choose the "User definable" mode, the program allows you to enter 2–46 characters. All characters must be listed in Table 1; if one isn't, the program will crash.

After you select a mode of operation, the screen clears and enters quiz mode. The program displays an encoded character near the center of the screen and

LISTING 1—MORSE CODE PRACTICE CODE

```
1000 CLEAR : DIM A$(46), B$(46): SCREEN 0, 0, 0, 0
1010 COLOR 10, 0, 0: KEY OFF: WIDTH 80: RANDOMIZE: CLS
1020 SPD = 5  'Set default sound speed: 1=slow, 20=fast
1030 '
1040 PRINT "*************************************************************"
1050 PRINT "**                                                        ***"
1060 PRINT "**          MCPP.BAS:  The Morse Code Practice Program    ***"
1070 PRINT "**                                                        ***"
1080 PRINT "***              (c) 1988 by James E. Tarchinski          ***"
1090 PRINT "**                                                        ***"
1100 PRINT "*************************************************************"
1110 COLOR 11
1120 PRINT
1130 PRINT "  This program is designed to help you learn the Morse Code"
1140 PRINT "representation of characters.  You will be given the"
1150 PRINT "opportunity to select which of five modes of operation you"
1160 PRINT "would like to utilize."
1170 PRINT
1180 PRINT "  If you wish to change the mode of operation, or if you wish"
1190 PRINT "to exit the program, just press the 'Esc' while in Quiz Mode"
1200 PRINT "the program will return to the mode selection menu."
1210 PRINT
1220 PRINT "  The following keys are also active in Quiz Mode:"
1230 COLOR 14
1240 PRINT "    F1 = Change sound speed ( 1=slow, 20=fast, default="; SPD; ")"
1250 PRINT "    F2 = Toggle sound on/off"
1260 PRINT "    F3 = Toggle display on/off"
1270 PRINT "    F4 = Display Morse Code reference screen"
1280 '
1290 GOSUB 2580  'Press any key to continue subroutine
1300 '
1310 '
1320 '*************** INITIALIZE PROGRAM ***************************************
1330 '
1340 KEY 1, "[": KEY 2, "]": KEY 3, "(": KEY 4, ")"
1350 FOR I = 5 TO 10: KEY I, "": NEXT
1360 '
1370 FOR I = 1 TO 46: READ A$(I): NEXT
1380 FOR I = 1 TO 26: B$(I) = CHR$(64 + I): NEXT
1390 FOR I = 27 TO 36: B$(I) = CHR$(21 + I): NEXT
1400 FOR I = 37 TO 46: READ J: B$(I) = CHR$(J): NEXT
1410 '
1420 GOSUB 2380  'Set default sound speed
1430 PT.FLG = 1: PL.FLG = 1
1440 '
1450 '
1460 '*************** MAIN MENU ************************************************
1470 '
1480 WIDTH 80: CLS : COLOR 10
1490 PRINT
1500 PRINT "-=-=-=- MODE SELECTION MENU -=-=-=-"
1510 PRINT
1520 PRINT "Which mode would you like to use?"
1530 PRINT "  1. Alpha characters"
1540 PRINT "  2. Numbers"
1550 PRINT "  3. Punctuation"
1560 PRINT "  4. All of the above"
1570 PRINT "  5. User definable"
1580 PRINT "  6. EXIT PROGRAM"
1590 INPUT "Your choice (1-6): ", IN$: M = ABS(VAL(IN$))
1600 PRINT
1610 IF M > 6 OR M < 1 THEN PRINT "PLEASE ENTER A VALID NUMBER!": GOTO 1490
1620 '
1630 CLS : CT = 0: WG = 0: IF M = 6 THEN END
1640 '
1650 '
1660 '*************** GENERATE LIMITS ******************************************
1670 '
1680 IF M = 1 THEN MIN = 1: MAX = 26
1690 IF M = 2 THEN MIN = 27: MAX = 36
1700 IF M = 3 THEN MIN = 37: MAX = 46
1710 IF M = 4 THEN MIN = 1: MAX = 46
1720 IF M <> 5 THEN 1880
1730 '
1740 PRINT "Enter the characters to be used:"
1750 LINE INPUT ">> "; C$
1760 MIN = 1: MAX = LEN(C$)
1770 IF MAX < 2 OR MAX > 46 THEN BEEP: GOTO 1490
1780 '
1790 J2$ = ""
1800 FOR I = 1 TO MAX
1810   J1$ = MID$(C$, I, 1)
1820   IF J1$ >= "a" AND J1$ <= "z" THEN J1$ = CHR$(ASC(J1$) - 32)
1830   J2$ = J2$ + J1$
1840 NEXT
1850 C$ = J2$
1860 '
1870 '
1880 '*************** QUIZ USER ************************************************
1890 '
1900 KY = INT(RND(1) * (MAX - MIN + 1) + MIN): IF KY = KY.OLD THEN 1900
1910 KY.OLD = KY
1920 '
```

```
1930 WIDTH 40: COLOR 15
1940 CLS : PRINT "Correct:                    Incorrect: "
1950 LOCATE 1, 10: PRINT CT: LOCATE 1, 33: PRINT WG
1960 '
1970 PT$ = A$(KY): CT$ = B$(KY)
1980 IF M <> 5 THEN 2030
1990   FOR I = 1 TO 46
2000   IF B$(I) = MID$(C$, KY, 1) THEN PT$ = A$(I): CT$ = B$(I): I = 46
2010   NEXT I
2020 '
2030 PLY$ = ""
2040 FOR I = 1 TO LEN(PT$)
2050   IF MID$(PT$, I, 1) = "-" THEN PLY$ = PLY$ + DASH$ ELSE PLY$ = PLY$ +
DOT$
2060   PLY$ = PLY$ + PS1$
2070 NEXT
2080 '
2090 LOCATE 15, 16: PRINT STRING$(8, 32)
2100 LC = INT(20 - LEN(PT$) / 2)
2110 IF PT.FLG = 1 THEN LOCATE 15, LC: PRINT PT$: LOCATE 20, 1
2120 IF PL.FLG = 1 THEN PLAY PLY$ + PS2$
2130 '
2140 IN$ = INKEY$: IF IN$ = "" THEN 2140
2150 IF IN$ = CHR$(27) THEN 1480
2160 IF IN$ = CHR$(13) THEN 2120
2170 IF IN$ = "[" THEN GOSUB 2280: GOTO 1930
2180 IF IN$ = "]" THEN PL.FLG = 1 - PL.FLG: GOTO 2140
2190 IF IN$ = "(" THEN PT.FLG = 1 - PT.FLG: GOTO 2090
2200 IF IN$ = ")" THEN GOSUB 2450: GOTO 1930
2210 '
2220 IF IN$ >= "a" AND IN$ <= "z" THEN IN$ = CHR$(ASC(IN$) - 32)
2230 '
2240 IF IN$ = CT$ THEN CT = CT + 1: GOTO 1880
2250 WG = WG + 1: LOCATE 1, 33: PRINT WG; : GOTO 2140
2260 '
2270 '
2280 '************** SPEED SUBROUTINE **********************************
2290 '
2300 WIDTH 80: COLOR 10: CLS
2310 PRINT
2320 PRINT "Current Sound Speed is"; SPD; " (1=slow and 20=fast)."
2330 INPUT "New value (RETURN = no change): ", IN$
2340 IF IN$ = "" THEN 2420
2350 J = ABS(VAL(IN$))
2360 IF J < 1 OR J > 20 THEN PRINT "ENTER A NUMBER FROM 1 TO 20!": GOTO 2310
2370 SPD = J
2380 DASH$ = "A" + STR$(SPD)
2390 DOT$ = "A" + STR$(3 * SPD)
2400 PS1$ = "P" + STR$(3 * SPD)
2410 PS2$ = "P" + STR$(SPD)
2420 RETURN
2430 '
2440 '
2450 '************** REFERENCE SUBROUTINE ******************************
2460 '
2470 CLS : COLOR 11
2480 PRINT " == MORSE CODE REFERENCE SCREEN =="
2490 J = 1: K = 1
2500 FOR I = 1 TO 46
2510   LOCATE J + 3, K: PRINT B$(I); " "; A$(I)
2520   J = J + 1: IF J > 16 THEN J = 1: K = K + 13
2530 NEXT I
2540 GOSUB 2580
2550 RETURN
2560 '
2570 '
2580 '************** PRESS ANY KEY SUBROUTINE **************************
2590 '
2600 LOCATE 24, 1: COLOR 15: PRINT "Press any key to continue...";
2610 IN$ = INKEY$: IF IN$ <> "" THEN GOTO 2610
2620 IN$ = INKEY$: IF IN$ = "" THEN GOTO 2620
2630 RETURN
2640 '
2650 '
2660 '************** PROGAM DATA ***********************************
2670 '
2680 DATA "*-","-****","-*-**","-***","**","**-*","--*","*****"   : 'A-H
2690 DATA "***","*---","-*-","*-**","--","-*","---","*--*"      : 'I-P
2700 DATA "--*-","*-*","****","-","**-","***-","*--","-**-"     : 'Q-X
2710 DATA "-*--","--**"                                         : 'Y-Z
2720 '
2730 DATA "-----","*----","**---","***--","****-"               : '0-
2740 DATA "******","-*****","--****","---***","----*"           : '5-
2750 '
2760 '      APOST.  COMMA    HYPHEN   PERIOD   SLASH
2770 DATA "*----*","--**--","-****-","*-*-*-","-**-*"
2780 '
2790 '     COLON    SEMI-C   QUEST-M  UNDER-L  PERENTH.
2800 DATA "---****","-*-*-**","**--**","**--*-","-*--*-"
2810 '
2820 DATA 39,44,45,46,47,58,59,63,95,40
2830 '
2840 'END OF PROGRAM
```

"plays" the Morse code representation on the PC's speaker. Next the program waits for you to press a key corresponding to the encoded character. If you choose incorrectly, you get another chance. If you guess correctly, a new encoded character is displayed. In either case, the program displays the number of right and wrong answers in the status line at the top of the screen.

You have several other options during quiz mode. You may return to the menu at any time by pressing Esc. In addition (referring back to Fig. 1), you can toggle sound on and off by pressing F2, and video on and off by pressing F3. (Of course, if you turn both sound and video off, it's going to be difficult to practice!) You can also press F4 to display a table of Morse codes. In addition, you can press F1 to vary the rate at which characters are played. The lower the number, the slower the playback speed. One other key is active: if you press Enter, the program will replay the current character.

Program description

The program consists of nine distinct sections: five major code sections, three subroutines, and one data section.

The first code section (lines 1000–1310) performs initialization chores and displays the sign-on screen.

The next section (1320–1450) initializes function key labels and reads encoding data into arrays A$ and B$. The A$ array contains the encoded character data, and the B$ array contains the ASCII equivalents.

The third section (1460-1650) displays the Mode Selection Menu and gets user input. If the user chooses item 6, the program simply ends at that point, otherwise processing continues with the next section.

Section four (1660–1870) sets up the range of characters to be practiced, and section five (1880–2270) quizzes the user. Section five actually outputs the Morse code characters to screen and speaker, collects user responses, and tabulates them. It also handles operation of the four function keys.

```
*****************************************************************
**                                                             **
**        MCPP.BAS:  The Morse Code Practice Program           **
**                                                             **
**            (c) 1988 by James E. Tarchinski                  **
**                                                             **
*****************************************************************

 This program is designed to help you learn the Morse Code
representation of characters.  You will be given the
opportunity to select which of five modes of operation you
would like to utilize.

 If you wish to change the mode of operation, or if you wish
to exit the program, just press the 'Esc' while in Quiz Mode
the program will return to the mode selection menu.

 The following keys are also active in Quiz Mode:
   F1 = Change sound speed ( 1=slow, 20=fast, default= 5 )
   F2 = Toggle sound on/off
   F3 = Toggle display on/off
   F4 = Display Morse Code reference screen

Press any key to continue...
```

FIG. 1—THE MORSE CODE PRACTICE PROGRAM signs on like this, showing keys that are active in Quiz Mode. The program is written in GWBASIC and runs on any PC compatible.

TABLE 1—MORSE CODE

Letters						Numbers		Punctuation	
A	*–	K	–*–	U	**–	1	*––––	,	––**––
B	–***	L	*–**	V	***–	2	**–––	.	*–*–*–
C	–*–*	M	––	W	*––	3	***––	?	**––**
D	–**	N	–*	X	–**–	4	****–	;	–*–*–*
E	*	O	–––	Y	–*––	5	*****	:	–––***
F	**–*	P	*––*	Z	––**	6	–****	'	*––––*
G	––*	Q	––*–			7	––***	–	–****–
H	****	R	*–*			8	–––**	/	–**–*
I	**	S	***			9	––––*	(	–*––*–
J	*–––	T	–			0	–––––	—	**––*–

```
-=-=-=- MODE SELECTION MENU -=-=-=-

Which mode would you like to use?
  1. Alpha characters
  2. Numbers
  3. Punctuation
  4. All of the above
  5. User definable
  6. EXIT PROGRAM
Your choice (1-6):
```

FIG. 2—THE MAIN MENU allows you to choose one of several practice sets, define your own, or exit the program.

Customization

You may wish to modify the program operation, including default speed, and whether sound and display are on or off. To modify the default speed, assign the desired value to variable SPD in line 1020, being sure that the new value is between one and twenty. To disable the display, all you have to do is set PT.FLG equal to zero in line 1430. To disable the sound, all you have to do is set PL.FLG equal to zero in line 1430.

One intriguing enhancement would be to add the ability to "play" real text and allow you to try to decipher it in real time. But that's an exercise for the reader.

Oh, by the way: – –* – – – – – – –** *–** **– –*–* –*– *– – ** – **** – **** * *– –* *–* – – – – –* *–* *– – – *–*–*– Ω

The inexpensive Minute Marker can generate variable-duration output pulses with selectable polarity and a wide range of time intervals.

MANY HOBBY PROJECTS REQUIRE the timing of intervals between a fraction of a second and a minute. This article describes the Minute Marker, a simple device that uses low-voltage 60-hertz AC from a power-supply transformer for synchronization. It provides a variable-duration output pulse with selectable polarity and a wide range of time intervals.

Figure 1 shows a block diagram of the Minute Marker. The power supply generates the required 5-volts DC for the circuit, and also provides a 60-hertz signal for the clock generator, which generates a 60-hertz square wave. The square wave is fed to the decoder, which counts cycles and decodes the desired time interval. The output pulse generator, as you probably guessed, generates the output pulse.

Figure 2 shows the schematic of the Minute Marker. The output of transformer T1 is 12.6-volts AC at 60 hertz, which is rectified by D1 and regulated by IC4, an LM7805 regulator, to provide 5-volts DC for the circuit. The unrectified AC is bandpass-filtered by R1, R2, R5, C1, and C2. Resistors R2 and R5 also form a DC-voltage divider which biases the input of Schmitt trigger IC3-a to 2.5 volts. The Schmitt trigger generates a 60-hertz square wave,

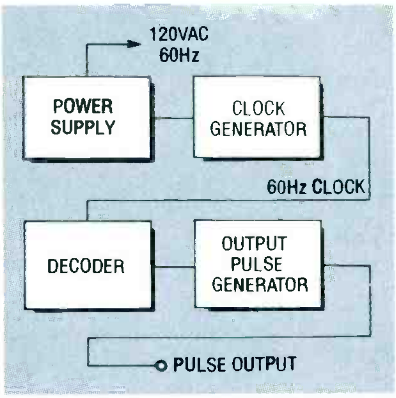


FIG. 1—MINUTE MARKER BLOCK DIAGRAM. A 60-hertz square wave is generated from a 60-hertz signal, which is then used to decode desired time intervals.

which is fed to the input of IC1, a CD4040 12-stage binary counter.

The outputs of the counter are decoded a 4081 quad AND gate (IC2), and the decoded output is fed back to the reset input of the counter, which resets the counter when the desired count is reached. Table 1 shows some useful time intervals that can be decoded with four decoder outputs or less; the desired outputs are simply AND-ed together. (The schematic in Fig. 2 is shown with the decoder outputs wired for a one-minute interval.)

The pulse from IC2-d is inverted by Schmitt trigger IC3-d, and passed along to the output pulse generator. The output pulse is generated by two Schmitt triggers cross-connected as an RS flip-flop (IC3-b and IC3-c). The output of the flip-flop is fed to R3, R4, and C3, whose values set the output pulse duration. The output pulse duration (T) can be approximated by the formula T =

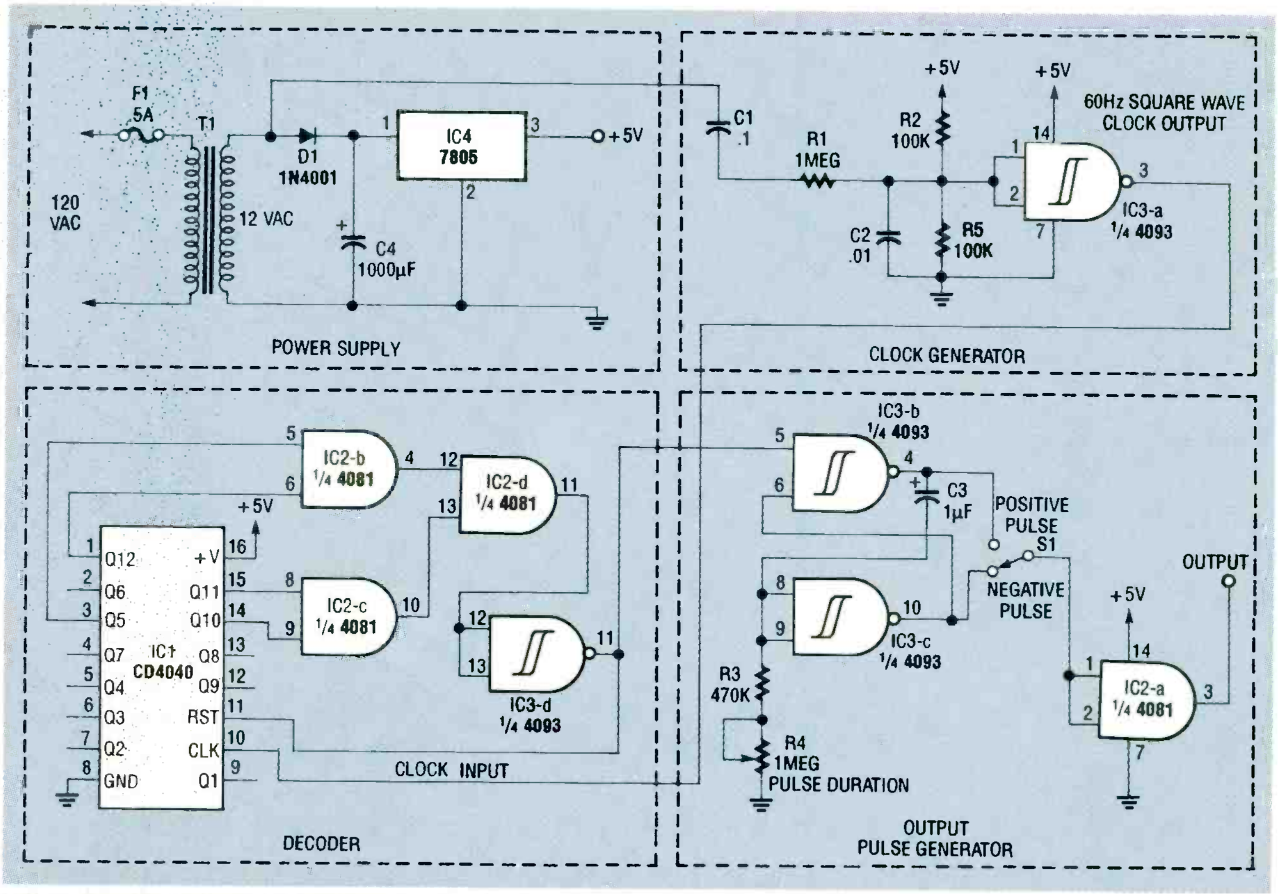


FIG. 2—MINUTE MARKER SCHEMATIC. 12.6-volts AC, at 60 hertz, is rectified and regulated to 5-volts DC for the circuit. Unrectified AC is fed into a Schmitt trigger, which generates a 60-hertz square wave. The square wave is fed to a CD4040 12-stage binary counter, which decodes time intervals.

PARTS LIST

All resistors are ¼-watt, 5%
R1—1 megohm
R2, R5—100,000 ohms
R3—470,000 ohms
R4—1 megohm, potentiometer
Capacitors
C1—0.1 µF, ceramic
C2—0.01 µF, ceramic
C3—1.0 µF, electrolytic
C4—1000 µF, electrolytic
Semiconductors
IC1—CD4040 12-stage binary counter
IC2—CD4081 quad two-input AND gate
IC3—CD4093 quad two-input NAND Schmitt trigger
IC4—LM7805 5-volt regulator
D1—1N4001 diode
Other components
F1—0.5-amp fuse
T1—120/12.6 VAC transformer
S1—SPDT switch
Miscellaneous: Project case, perforated construction board, wire wrap, solder, etc

TABLE 1—TIME INTERVALS

Interval Seconds	Number of 60-Hz Cycles	Decoded Outputs
0.1	6	Q2, Q3
1.0	60	Q3, Q4, Q5, Q6
10.0	600	Q4, Q5, Q7, Q10
60.0	3600	Q5, Q10, Q11, Q12

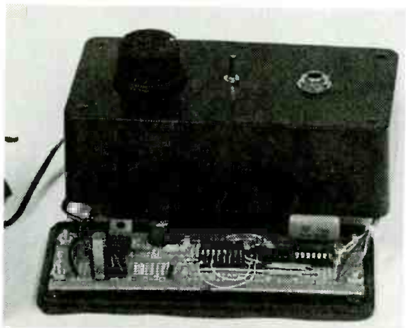


FIG. 3—COMPLETED PROTOTYPE. This circuit can generate timing intervals between a fraction of a second and a minute.

$1.2 \times C3 \times (R3 + R4)$. A positive- or negative-going pulse is selected by S1, and buffered by the remaining AND gate (IC2-a).

Building the marker

Construction is not critical, but be careful when working with AC voltages. The circuit can be built on perforated construction board using point-to-point wiring. The selected time interval can be hard-wired to IC2, or you can use a DIP switch or header to make changing the time interval easy. The output-pulse duration and polarity can be left adjustable, or the polarity can be fixed, and R3 and R4 can be replaced with a single resistor to suit a specific application. Figure 3 shows the author's completed prototype installed in a common plastic hobby case. Ω

HARDWARE HACKER

Cold-fusion update, a $39 laser pointer, video driver circuits, computer I/O boards, and transmission line use.

DON LANCASTER

I always like to look for unusual or controversial topics—mostly because they are there, I guess. In past issues, I have looked into such genuine scientific wonders as sonoluminescence, aerogels, magnetic refrigeration, and solitons, and at such pseudoscience subjects as perpetual motion, UFO resources, and dowsing. Today, there's one topic that seems neither fish nor fowl. So I guess its time to ask...

What ever happened to cold fusion?

The answer to this one depends on whom you ask. So, I will give you several current points of view and let you draw your own conclusions. You will find a summary in Fig. 1.

Many thousands of individuals and hundreds of firms worldwide tried the cold-fusion experiments. But after some early excitement, most of them were unable to reproduce the results claimed.

At the very least, cold fusion is now clearly in chaotic disarray. Several leading scientific journals refused to publish anything on cold fusion. Prevailing opinions are widespread that cold fusion is simply *pathological science* in which most researchers see anything they want to. Just like that *polywater* fiasco a few decades back.

It is another example of what research insiders call the *Utah Effect*. Clearly, a lot of people learned the hard way that calorimetry is a very precise science—one that involves a lot more than glancing sideways at a thermometer.

Your best starting place for obtaining information on cold-fusion is a critical summary review in the January 7, 1994 *Science* on pages 105 and 106. Of the five major books on this topic, the latest and the best appears to be *Bad Science: The Short Life and Weird Times of Cold Fusion* by Gary Taubes.

On the other hand, the cold fusion research continues—mostly by highly vocal mavericks who are well out of the scientific mainstream; they are often discredited out of hand by *Big Science* establishment people. At times unfairly and unreasonably. Further developments in this work is likely to show up in *Cold Fusion Times* or in *Cold Fusion Magazine*.

My own view is this: Yes, there seem to be real circumstances in which excess heat *appears* to result from lab experiments. But, no, I have not seen so much as one credible shred of evidence that a new atomic process is responsible.

I think that the excess heat created in most cold-fusion experiments is caused by bad labwork. Several mundane explanations should eventually crop up for the others. None is likely to lead to a new or useful energy source.

For instance, a little noted paper cropped up in *Science* smack in the middle of the cold-fusion fiasco. A Bell Labs researcher figured out how to make a fuel cell that *premixes* the gasses. This is now thoroughly verifiable, but was previously thought impossible. His work looks amazingly similar to the cold fusion setups that the researchers are now using.

Transmission line review

At DC, audio, and other low frequencies, you can usually assume that a signal identical to the one you send into one end of a wire will arrive at the other end instantaneously. Cables are used primarily for their shielding effects.

Video and RF users do not have this luxury. Instead, they must use *transmission lines*. In a transmission line, a signal is sent from one end of a cable so it can arrive somewhere else sometime later. If you are not *very* careful with your transmission lines, you can end up with reflections, echoes, or standing waves. At best, these effects can badly distort the signal you are trying to transmit, or change the signal size and waste delivered power. At worst, they can literally destroy a high-power transmitter.

When do you need to worry about transmission lines? In addition to radio and video uses, they also become important in networks, in SCSI communication, and even in routing address and data lines on high-speed computers.

The rule is this: *Use transmission lines if the distance from the signal input to the output exceeds one tenth of a wavelength at the highest frequency of interest.* Another rule: *Electrical signals travel about a foot per nanosecond in free space*, or about eight inches per nanosecond in most wires.

Let's say you have a lossless coaxial cable that is so long that you don't have to worry about what is coming out at the far end. A cable is an example of a *distributed* network, where all the inductance and the capacitance will change in small increments. The *lumped* or *discrete* model of Fig. 2 describes it.

But you can't just analyze this model as a plain old network. Instead, you must apply the differential equations of a propagating wave. When you use this advanced math to calculate the input impedance of your cable network, you'll find an amazing result. You end up with an input impedance that looks like a pure *resistor* of constant value, over all frequencies. This is called the *characteristic impedance* of the cable. As far as the source is concerned, it looks and behaves just like a real resistor—*as long as our uniform cable is so long that no* *energy ever returns from the far end.*

The characteristic impedance of free space is 377 ohms. All cables have values lower than this. Twin lead has a value of 300 ohms. Cable TV and most video cables have a Z of 72 ohms. Hams and broadcasters typically use 50-ohm cables. Lower impedances are preferable for higher powers.

Since any infinitely long length of cable looks like a resistor, we can replace any portion of it with a real resistor. This is known as properly *terminating* a cable. One rule is that *all cables must be properly terminated in a resistor whose value equals its characteristic impedance!* Another rule is: *always* use cables in a *series* daisy chain, going from unit to unit, with *only* the farthest unit terminated. *Never* connect cables in parallel or in any star arrangement unless each one has its own distribution amplifier.

What happens if you forget to terminate a cable? Assume you have an ultra-short cable and you purposely short circuit its far end. The input still looks like a short circuit. The signal goes to the end, bounces off the short circuit and returns, almost immediately.

Books:

F. Close, *Too Hot to Handle*, Princeton University Press, 1991.

G. Taubes, *Bad Science*, Random House, 1993.

J. Huizenga, *Cold Fusion: The Scientific Fiasco of the Century*, University of Rochester Press, 1992.

E. Mallove, *Fire From Ice*, Wiley, 1991.

D. Peat, *Cold Fusion: The making of a scientific controversy*, Contemporary Books, 1989.

Critical summary book review:

Richard Crooks, *Cold Fusion Revisited*, Science, v. 263, Jan 1994, p105-6.

Journals & Magazines:

Cold Fusion,
70 Route 202 North, Peterborough, NH 03458, (800) 677-8838.

Cold Fusion Times,
Box 81135, Wellesley Hills, MA. 02181, (617) 239-02181.

Fusion Technology,
555 N. Kensington Avenue, La Grange Park, IL 60525, (708) 352-6611.

Journal of Electroanalytical Chemistry,
Box 882, Madison Square Station, New York, NY (212) 989-5800.

FIG. 1—Some current readings on cold fusion. The entire field has largely been discredited, mostly because of inconclusive labwork.

Things get interesting in a big hurry if the cable is longer. The *time delay* of the cable causes a *phase shift* in the return signal. If you have a cable exactly *one-half* wavelength long, the short circuit returns to the input as a very *high* impedance. Looking at things another way, the incoming signal and the returning signal cancel each other out.

You can also prove that, in a cable exactly *one quarter* wavelength long, the end short circuit will appear at the input as the characteristic impedance. Thus, any dead short circuit one quarter wavelength away will appear as a properly terminated cable—but only for one specific frequency.

The same statement applies for an open termination, except that an open circuit will appear as a short a half wavelength away and appear as the characteristic impedance a quarter wavelength away.

You can't have a true open termination on any cable in the real world. In fact, *any* mismatch in a cable termination will reflect some energy and create *standing waves* along the cable. The strength of these standing waves is described by the *voltage standing wave ratio*, or VSWR. The ideal VSWR value is 1.0, meaning the line has no standing waves.

A higher VSWR limits the power that can be delivered to the load. It also causes excessive voltages and currents along the cable. At worst, it can make the input look like a short circuit and overload the source—or even destroy the transmitter. A mismatched antenna will result in a high VSWR.

So, if your main goal is delivering a signal to a load, you must terminate the cables properly. On the other hand, you can purposely exploit shorted cables as very high Q circuit elements. Cables that are shorter than a quarter wavelength look like inductors. Cables that are longer than a quarter wavelength, but less than half a wavelength, look like capacitors. A half-wavelength cable looks like an open circuit, and the cycle repeats for longer distances.

Purposely mismatched end-shorted cable stubs can be used for tuning, impedance matching, trapping, and filtering. At higher frequencies, you can obtain those

I/O INTERFACE CARD RESOURCES

Aptix
2890 N First Street
San Jose, CA 95134
(408) 428-6200

John Bell
1381 Saratoga Street
Minden, NV 89423
(702) 267-2704

Blue Earth
165 West Lind Court
Mankato, MN 56001
(507) 387-4001

Circuit Cellar
4 Park Street Ste 20
Vernon, CT 06066
(203) 875-2751

ComputerBoards
125 High St
Mansfield, MA 02048
(508) 261-1123

Data Translation
100 Locke Drive
Marlboro, MA 01752
(617) 481-3700

Industrial Computer Source
PO Box 23058
San Diego, CA 92193
(800) 523-2320

Intelligent Instrumentation
1141 W Grant Road, MS131
Tucson, AZ 85705
(602) 623-9801

IOtech
25971 Cannon Road
Cleveland, OH 44146
(216) 439-4091

Keithley
440 Myles Standish Blvd
Taunton, MA 02780
(800) 348-0033

National Instruments
6504 Bridge Point Parkway
Austin, TX 78730
(800) 433-3488

PAIA Electronics
3200 Teakwood Lane
Edmond, OK 73013
(405) 340-6300

Parallax
3805 Atherton Rd
Rocklin, CA 95765
(916) 624-8333

Pro-Log Corp
2555 Garden Road
Monterey, CA 93940
(408) 372-4593

values from a *Smith Chart* available on *GEnie* PSRT as file #367 SMITHCHT.PS.

Video Op-amps

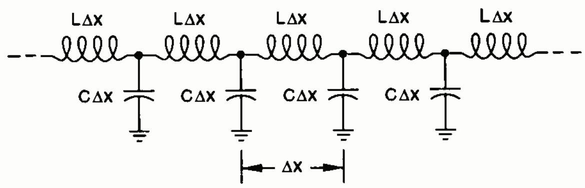
Most video cables require proper termination. The rule is that five or more feet for high-quality videocable and twelve or more feet for TV-quality signals *must* be properly terminated at the far end of the cable—and *only* at the far end. Once again, video cables *must* be daisy-chained unless each has its own distribution amplifier. Midpoints on the cable string must *not* be terminated. Usually a "high-Z" switch on your monitor (or whatever) gives you this choice.

What driver impedance should you use on your cable? If the far end is terminated properly and there are no standing waves, there will be nothing to reflect from the near end. Theoretically you could drive your cable from any impedance source. If you are delivering high power to a radio transmitter, for example, your obvious choice is to make the source driver impedance as *low* as possible to maximize efficiency.

Much of today's video is distributed by a different scheme called *back termination* (see Fig. 3). With back termination, the cable is driven through of a series resistance *equal* to the characteristic impedance. This further helps to cancel any reflections, and also provides the optimum maximum power transfer. As a side benefit, back termination also protects the driver against shorted cables.

But, there is a minor "gotcha" with back termination. Half the power is consumed in the input resistor. And, because of the voltage divider, *you get only one-half the*

Any long and lossless transmission line (or coaxial cable) forms an example of a distributed network, made up of many tiny series inductors of L Henrys per unit length and shunt capacitors of C Farads per unit length...



You cannot simply analyze this as a low pass network; instead you have to take a tiny piece from the middle and ask what happens as a wave passes through it. Doing this leads to a messy differential equation. In the solution, the design factor $\sqrt{L/C}$ pops up in several places.

Specifically, the velocity of the wave turns out to be $1/\sqrt{L/C}$ meters per second and the impedance of the rest of the cable will turn out to be exactly $\sqrt{L/C}$ Ohms. A *constant* resistance that is *independent* of frequency.

This magic resistance value is called the *characteristic impedance* of the cable. To a source driver, a very long or otherwise properly terminated cable will appear the same as a physical resistor of equivalent value.

For cables to work properly:

(1) *All cables MUST be terminated in their characteristic impedance at their far end.*

(2) *Cables must NEVER be used in parallal or in a "star" configuration. Unless they have separate drivers.*

(3) *Cables may be daisy chained from one point to another. But they must NEVER have mid-line terminations.*

FIG. 2—Some transmission line and coaxial cable fundamentals.

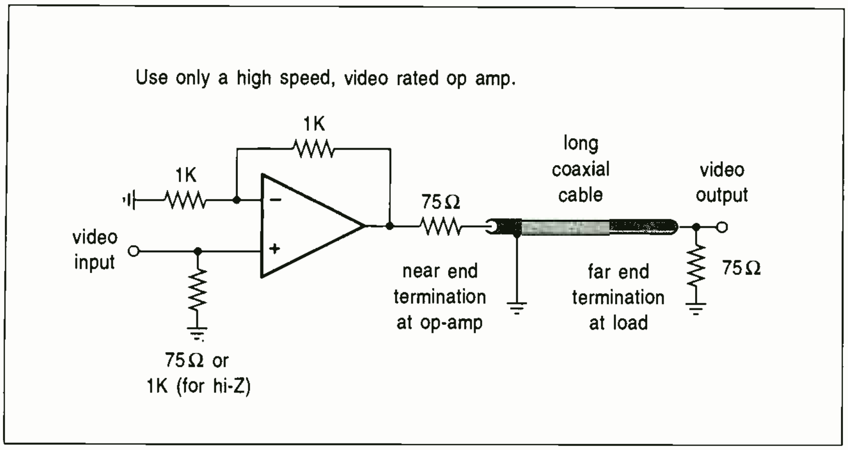


FIG. 3—"Back termination" is a popular method for driving video cables. It is short-circuit proof and minimizes reflections, but an amplifier with a gain of at least +2 is needed. Any unterminated outputs could be badly overloaded..

NAMES AND NUMBERS

Analog Devices
PO Box 9106
Norwood, MA 02062
(617) 329-4700

Burr-Brown
6730 S Tucson Blvd
Tucson, AZ 85706
(602) 746-1111

C Users Group
1601 W 23rd St Ste 200
Lawrence, KS 66046
(913) 841-1631

Fire Engineering
PO Box 1289
Tulsa, OK 74101
(918) 835-3161

Firefighters Bookstore
18281 Gothard No.105
Huntington Beach, CA 92648
(800) 727-3327

GEnie
401 N Washington St
Rockville, MD 20850
(800) 638-9636

Hewlett-Packard
PO Box 10301
Palo Alto, CA 94303
(415) 857-1501

Linear Technology
1630 McCarthy Blvd
Milpitas, CA 95035
(408) 432-1900

Maxim
120 San Gabriel Drive
Sunnyvale, CA 94086
(800) 998-8800

Metrologic
Coles Road $AK Route 42
Blackwood, NJ 08012
(800) ID-METRO

Motorola
5005 E McDowell Road
Phoenix, AZ 85008
(800) 521-6274

National Semiconductor
2900 Semiconductor Road
Santa Clara, CA 95052
(800) 272-9959

RF Micro Devices
7341-D West Friendly Ave
Greensboro, NC 27410
(910) 855-8085

Science
1333 H Street NW
Washington, DC 20005
(202) 326-6400

Siemens Componants
2191 Laurelwood Road
Santa Clara, CA 95054
(408) 980-4500

Small Parts
PO Box 4650
Miami Lakes FL, 33014
(305) 557-8222

ST Publications
407 Gilbert Avenue
Cincinnati, OH 45202
(513) 421-2050

Synergetics
PO Box 809
Thatcher, AZ 85552
(602) 428-4073

signal level at the far end of the cable. To overcome this, you should set up a video distribution amplifier with a gain of +2 or higher. The amplifier *doubles* the signal level. The back termination resistor cuts the signal back down to size. When using back termination, you also must be sure you terminate the far end of the cable. Otherwise, your video levels will be far too high, and might overload your equipment.

Video distribution amplifiers are common these days. *Radio Shack* offers several off-the-shelf models. But it is tricky to make one that works without a negative power supply.

Suitable video driver chips are now available from *Maxim, National, Burr-Brown, Linear Technology*, and *Analog Devices*, among others. My favorite is *Maxim*, which gives away lots of free samples.

National also has some samples available of its new LM6181 high-performance video op-amp. This one uses current, rather than voltage feedback, to give you a 50-megahertz back-terminated bandwidth plus a 2000-volt-per-microsecond slew rate. A demonstration circuit board is also offered (see Fig. 4). This one is also an excellent plug-and-go video driver. It also lets you evaluate competing op-amps. Both the chip and the evaluation board are available free to qualified persons. National's technical support is provided via (800) 272-9959.

"Forgotten Lore" contest

Let's have a different kind of contest this month, one that's especially good for old timers. Just tell us about some long forgotten electronics lore—tips and techniques that fell through the crack somewhere along the way, but still remain useful.

For instance, there's not too much point in reminding people that they can service a classic record changer outside of its case by setting it on three quart-size ginger-ale bottles. But these three tips still *are* very useful: (1) A *tiny* amount of beeswax on a screwdriver tip makes a very useful screwholder; (2) One single thread from a pad of No.000 steel wool might replace the super-expensive and hard-to-find low-amperage fuses for protecting micro-ammeters; and (3) A neon test light still makes a great "hot chassis" tester. Just hold one tester lead and touch the other one to the suspect area. If the lamp lights dimly, you have located a hot chassis and a severe shock hazard.

There will be a dozen of the usual *Incredible Secret Money Machine II* books going to the better entries, with an all-expense-paid (FOB Thatcher, AZ) *tinaja quest* for two going to the very best of all. Be sure to send all of your *written* entries to me at *Synergetics*, rather than to Electronics Now editorial.

A $39 laser pointer

I've been waiting several years for the price of laser pointers and their solid-state laser diodes to drop. It seems that *Metrologic* has turned the corner with a complete and ready-to-use 3-milliwatt laser pointer for $39 (Model ML-211). At long last, no-nonsense lasers for hacking are available at low cost in quantity.

The spot size is about a half inch at thirty feet. Presumably the beam could be further collimated with external lenses. The 675-nanometer red light is visible in bright daylight. Feedback stabilization permits maximum safe output. Battery life is eight hours continuous with a pair of alkaline AAA cells, and much longer with lithium cells. A safety slider on the pocket clip prevents unintended use.

My only complaints are that the delivery was very slow and that the batteries wobble in the case. This is bound to cause damage when the unit bounces around for months in, say, a toolbox or glove compartment. A strip of cloth cures this.

Yes, you can do all the usual "red string" laser stuff. But forget about holography. First, there isn't enough power. And second, the light beam almost certainly operates in the higher-order optic modes, so the light isn't totally coherent. Monochromatic yes, coherent no.

The brightness of the laser pointer should be more than enough for most uses. But as a fireman, I was disappointed by its fireground performance. It turns out that a freshly burned black is black indeed, and it simply does not reflect light. One possible solution would be a pushbutton higher-power mode.

A dozen experiments are described in a pamphlet supplied with the pointer. Obviously, you can strap this onto a level or bounce it off a mirrored loudspeaker. My favorite is annoying cats. It drives them bonkers in a darkened room.

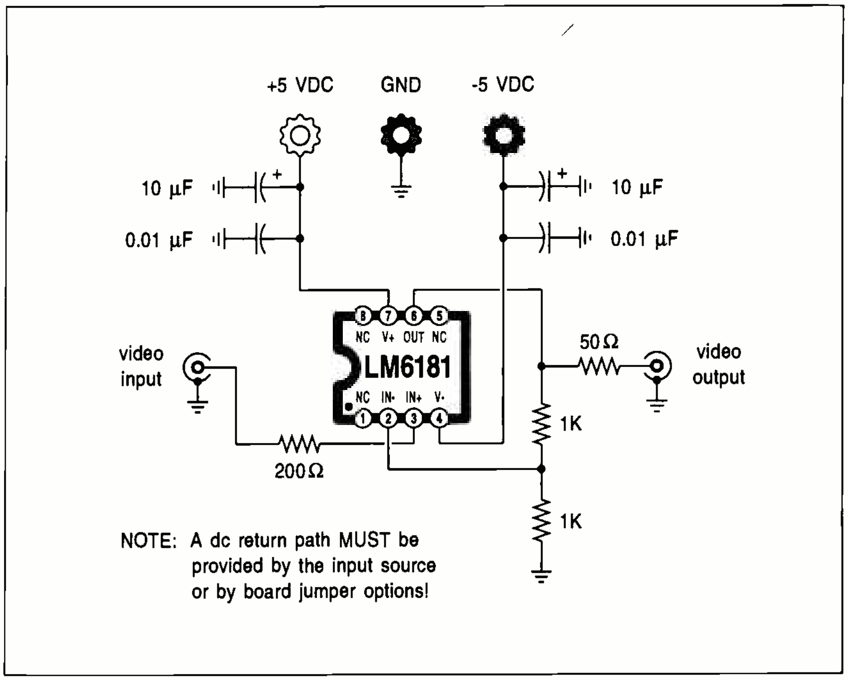


FIG. 4—National Semiconductor's high-speed op-amp evaluation board can be used as-is as a superb video cable driver. It is also very handy for op-amp testing.

Computer I/O interface

A lot of construction projects published in this magazine are those that plug into your PC or other computer and give you real-world I/O. Two other good sources for computer interfaces include *John Bell Electronics* and *Circuit Cellar*.

There are also many commercial I/O card offerings. There are cards that do data acquisition, A/D or D/A conversion, signal conditioning, and power interfacing. While these cards are expensive, they are plug-and-go and usually include warranties, technical help, and software.

For this month's resource sidebar, I've gathered together the names of a few of the major players in the industrial PC I/O arena. Most of them offer fat and free catalogs that include useful application notes and other technical information.

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Synergetics
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New tech lit

From *Siemens*, there's a new *Hall Effect Integrated Circuits Data Package* on automotive applications. And from *RF Micro Devices*, there's a new *RF and Wireless Comm* data book.

Motorola has two free directories: a *Technical Literature Guide* and *Applications Literature Guide*.

There's a new catalog from *Small Parts*. It's an essential source for everything your hardware store never heard of, besides being the greatest hacker robotics store in the world. Small Parts also custom shapes metal and plastic.

There are two other special interest bookstores: *The Working Library* by *ST Publications* on screen printing, sign painting, graphic layout, neon, and pinstriping, and the *Firefighter's Bookstore* on fire science books and videos. Of the dozens of firefighting trade journals, I like *Fire Engineering* the best.

Hundreds of C language public-domain software programs are now offered by the *C User's Group*.

Hewlett-Packard has just started shipping out its new *LaserJet 4M+* printer. At a first glance, this one looks like a routine upgrade with a few minor improvements. It includes genuine Adobe PostScript Level II, a bolt-on-duplexer, enhanced 600 DPI resolution, 12 pages per minute, refillable cartridges, all service manuals available, efficient memory, multiple trays that can hold nearly a thousand pages, and stunning new photo grays. All at an $1800 street price.

All of a sudden, this is *the* machine that will *completely* blow away ink-based black-and-white jiffy printing. At least for 5000 or fewer copies, this new printer gives higher quality at lower cost than ink printing. The photo grays must be seen to be believed. There are 120 gray levels at 106 spots per inch.

A major threshold clearly has been crossed with this machine—one that opens up an incredible number of new hardware hacking opportunities. A new era has clearly been defined in which you could publish your own top-quality books from home, right off your own kitchen table.

The only negative on the 4M+ is its appalling lack of a supporting hard disk. But such a serious omission almost certainly will soon be fixed. You can temporarily work around this omission by the sneaky use of full-page PostScript forms. Additional information and support on this incredible new machine is on *GEnie* PSRT and in my *Book-on-demand Resource Kit.*

For most hardware hackers most of the time, any patent involvement is *absolutely certain* to result in a net loss of time, energy, money, and sanity. Thoroughly tested real-world alternatives appear in my *Case Against Patents* package, which also *includes* my *Incredible Secret Money Machine II* as a bonus book. See my nearby *Synergetics* ad for detail.

A reminder that ten free hours of *GEnie* use are still available, per our "Need Help" box. As usual, most of the resources I've mentioned appear in the *Names & Numbers* and *Computer I/O Resources* sidebars. Be sure to check here before calling our no-charge technical helpline. Ω

WHAT'S NEWS

continued from page 10

movable lens on the drive's laser can be focused to "read" only one disk at a time while ignoring the others in the stack. This ability to focus the beam permits IBM to stack up to 10 layers in a single disk assembly. However, the writing format is the same as that on single disk CDs. The concept is shown in the figure.

IBM researchers say that a 10-layer disk will store about 6.5-million bytes of data, the equivalent of more than a million pages of printed text. The disks are made by stacking disks on top of each other and bonding them together with spacers that provide a gap between each layer. Data can be stored on the surface of any disk within the stack. The surface to be read or written to is selected by moving the optical disk drive's focusing lens up and down.

The maximum number of disks in a stack is limited by the power of the laser, the transparency of the layers, and cost of manufacturing the assembly. Writable disks will have fewer layers because the writing process requires that the disk material absorb some of the laser light. IBM has demonstrated two-, four-, and six-layer read-only disks and two- and four-layer write-once disks.

The IBM scientists do not think that commercial manufacture of drives based on multilayer CDs will be challenging. They say that today's CD drives have movable lenses that can compensate for any warpage in the disks that are spinning under them. However, modifications on existing CD players would be required before the drives can accommodate multilevel disks.

On the other hand, they say that drives built specifically for the stacked CDs will be compatible with and able to play existing single-disk CDs. It could take IBM two years to bring out a commercial version of the multilevel system.

Meanwhile, other companies are working on other methods for increasing the capacity of CD-ROM drives. Philips, for example, is working on a method that will allow disks to hold four to seven times more data than existing disks. Ω

VIDEO NEWS

continued from page 6

trucks? All of the schemes for electronic delivery and inventorying have fallen apart in the past. Now, one is actually in progress.

It took a major power in retailing—Blockbuster Video—to get the tests moving. Sega is participating in those tests, which initially will deliver electronic games to the Blockbuster stores.

Some 10 to 15 Blockbuster stores will participate in the test, which should last two to four months. Although details haven't been announced, a full library of cartridge games might be transmitted and stored on a local server. Each title could be downloaded by the customer in as little as 20 seconds from the in-store server.

Although the system initially would be aimed at supplying rental customers with the latest "hot" video games, it might also be applied to sales of games. Under one scenario, a customer could buy a reprogrammable cartridge for slightly more than a standard one and have it rewritten later with the next hot game for less than it would cost to buy a whole new game cartridge. The same system will be tested for music cassettes, but that test has been delayed because of copyright problems.

• Japan studies digital HDTV. Although the revelation several months ago that Japan might abandon its analog, high-definition TV system caused a hysterical reaction, NHK, the Japan Broadcasting Company, has announced a study group on digital HDTV without causing any riots, or even adverse comments. NHK softened the blow by saying that it would be well into the 21st century before digital HDTV could be implemented. They want to wait for simple and inexpensive consumer converters to become available.

At the same time, NHK's research lab announced it would have a 50-inch, thin, color-plasma display ready for public demonstrations in time for the Nagano Olympics in 1998. Ω

READERS: TELL US WHAT YOU THINK ABOUT THIS ISSUE

Are you interested in helping us make this magazine as good for you as it can be? Then be one of the first to join the 1994 *Electronics Now Reader Council.* Twice a year you'll be asked to complete a detailed questionnaire. It will tell us about the things in this magazine that are important to you and give us the information we need to make this your best possible reading.

If you would like to be considered for this special *Electronics Now* project, take a few minutes to answer the questions on this page and return it to us.

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Please mail the completed questionnaire no later than November 30, 1994, to:

Total Recall Research Group
Box 4079
Farmingdale, NY 11735-9622

Thank you, and I am looking forward to hearing from you!

Larry Steckler,
Editor-in-Chief

1. Where did you get this magazine?
Subscription ☐ Newsstand ☐

2. Are you:
Male ☐ Female ☐

3. How old are you:
I am ______ years old

4a. Highest education achieved?
Attended technical school ☐
Graduated technical school ☐
Attended College ☐
Graduated College ☐
Earned PhD ☐

4b. Do you
Hold FCC license ☐
Hold other license, Certif. ☐

5. What is your total household income?
Total household income, before taxes is $ ______________

6. Name the article in this issue that you liked the best.
____

7. Name the article in this issue that you liked the least.
____

8. Name the department or regular column in this issue that you liked the best.
____

8a. Name the department or regular column in this issue that you liked the least.
____

9. Do you earn your living working in the electronics industry?
Yes ☐ No ☐

10. If you were the editor, would you make the articles:
More complex ☐
Simpler ☐

Longer ☐
Shorter ☐

More build it ☐
Less build it ☐
More how to ☐
Less how to ☐

11. What articles would you publish?
____
____
____
____

12. What new columns would you add?
____
____
____
____

13. What else would you change?
Use a separate sheet for your comments. Please give as much detail as possible.

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AUDIO UPDATE

The joys of audio clipping

LARRY KLEIN

There's a kind of clipping that I, not my amplifier, have been engaged in for several years. I refer to my compulsion to cut out and put aside news items of audio interest for reference or possible use in this column. Unfortunately, in my filing system, any given clipping might end up on top of or behind a bookcase, on a coffee table, on the floor of my office, or—courtesy of the cleaning lady—in a wastepaper basket. The problem is brought on not by my sloth and lack of organization—although these factors could play a role—but by the sheer influx of printed matter coming my way. (Reader mail frequently is not answered for the same reason, or for lack of a stamped, self-addressed envelope, and for that I apologize.)

I am sometimes tempted by a Monty Python suggestion for coping with paper floods: Get a goat. The animal's digestive system would provide an ecologically correct disposal solution to the paper influx and, coincidentally, a ready source of fertilizer for my wife's herb garden. In any case, a 24-hour search of my premises has turned up the following comment-worthy items of interest.

FIG. 1—AN AKIHABARA PARTS counter display.

Akihabara angst

In my half dozen or so trips to Japan starting in 1972, I visited a wonderful melange of shrines, electronics factories, temples, parks, retail establishments, and cultural centers. My two favorite places, to which I returned whenever possible, were the Zen temples in Kyoto and the electronics shops in the Akihabara district in Tokyo. Food for the mind and hobby.

As an adolescent, I haunted the Cortlandt Street electronics area in downtown Manhattan. Dozens of radio-parts stores that sold new, used, and surplus equipment filled the narrow streets where the World Trade Center's dual towers now stand. The Akihabara is everything Cortlandt Street ever was—and far more! During the years when the dollar was worth two or three times in yen what it is today, I could barely restrain myself. Since my position at *Stereo Review* provided all the conventional audio equipment I could use, I loaded up with watches, tools, electrical fixtures, electronic parts, and audio accessories not available in the U.S.

But it wasn't just the bargains, it was the ambiance of the place that turned me on. Dozens of audio, appliance, and hardware discount stores competed with hundreds of little arcade stalls, each displaying tastefully arranged selections of switches, resistors, capacitors, jacks, plugs, semiconductors, and so forth. It was a hobbyist's dream, even if the counter displays frequently resembled gigantic electronic sushi platters.

The international section of *The New York Times* reported that early witnessing is evolution, rather than extinction. But for purely sentimental reasons, I would hate to see the old-fashioned Akihabara area go the way of Cortlandt Street.

Mental Mozart

My musical tastes have always been somewhat eclectic and, in a sense, dated. As far as popular music is concerned, I seem to be stuck in the Sixties along with The Doors, Jefferson Airplane, Cream, and Moody Blues. My classical tastes go even further back, with a heavy concentration on Baroque in general, plus Beethoven and Mozart. Modern music, of any persuasion, seldom tickles my fancy.

For several reasons I was fascinated by a recent item in the science section of *The New York Times* about a series of experiments conducted on 36 students at the University of California at Irvine. It turned out that listening to 10 minutes of Mozart's piano music significantly raised the scores on IQ tests of spatial reasoning. Tests given immediately after the Mozart listening sessions showed an average improvement of 9 points over scores achieved when the same students listened to a 10-minute relaxation tape. (Fundamentalist audiophiles might be concerned about whether the music was in digital or analog format, but I have no relevant information other than that the piece was Mozart's "Sonata for Two Pianos in D Major" performed by Perahia and Lupu.) Interestingly, the Mozartian magic seemed to work whether or not the students even liked the music.

Aside from the doctorates of the researchers, several factors seem to raise this study above the Weird-Science category. For one thing, their working hypothesis seems reasonable. Researcher Dr. Frances H. Rauscher explained that the experiments are testing a neurobiological model of brain function that postulates certain neural firing patterns in the brain. Those patterns might be common in certain activities—chess, mathematics, and listening to certain kinds of music. Mozart was picked because the complex, highly structured, and non-repetitive character of his compositions might stimulate neural pathways important to cognition. Further testing is planned to evaluate the effects of rock and contemporary minimalist music.

I'm surprised that no one seems to have thought of testing the potential positive effects of pulse trains generated by a random-number function-generator. Perhaps it should have been mentioned earlier, but any IQ improvement that occurs is only temporary. You can cancel your trip to the CD dealer if you were looking for a permanent Mozartian mental fix. Sorry about that!

Inner-ear outage

As if we don't have enough ear-damaging sound levels in our environment, a new source of hearing problems has been discovered. The new causal agency is not the old villain, long- or short-term acoustic overload, but rather the result of physical-impact damage to the mechanisms of the inner ear. Couch potatoes have nothing to worry about, but those who are aerobically obsessed and regularly bounce about in local gyms, or who are involved with long-distance running or other jarring activities, could end up with persistent dizziness, unsteadiness, vertigo, motion sickness, ringing, or "fullness" in their ears—and last, but not least, high-frequency hearing loss.

How do all these difficulties come about? According to Dr. Michael I. Weintraub, a clinical professor of neurology at New York Medical College, repeated jarring tends to loosen the tiny granules called otoliths found in two chambers of the inner ear. They are part of a sensing system that provides data to the brain about the body's spatial orientation—which is why inner-ear infections sometimes cause dizziness. When the otoliths are shocked out of place by a blow to the head—or continuous high-impact aerobics—they send confused positional signals to the brain, resulting in one or more of the symptoms described above.

Dr. Weintraub estimates that perhaps 20% to 25% of those who are aerobically involved might end up with otolith-impairment symptoms. He also found that 67% of those with such symptoms also had tinnitus (ringing) or a "full" or muffled sensation in their ears. In addition, over 80% of the instructors and 60% of their students had high-frequency hearing loss. I asked Dr. Weintraub about the nature of the HF loss, and he said that it was actually a notch at about 6 kHz, which is typical of hearing damage brought on by exposure to continuous high sound levels. He suspects that the problem is not the high impacts *per se* but rather the volume of the music typically played during classes. It seems that if your otoliths don't get you, your cochlea's hair cells will.

The good news that not everyone is susceptible to otolith impact is offset by the fact that the problems can take years to develop. The cumulative damage factor is insidious in that significant inner-ear damage can occur before the symptoms become bothersome and perhaps even become irreversible.

What does it mean philosophically when the pursuit of good health might make you deaf and/or dizzy? I don't know, but I think I'm going to lie down now. Ω

A different tachometer design approach.

ROBERT GROSSBLATT

If you've been following this series on building a tachometer and have breadboarded the PLL-based design, you probably have found that it's difficult, if not impossible, to find loop-filter component values that will generate reliable tachometer performance from idle to red line. Most commercial tachometers based on this design have circuitry to automatically switch the loop components as the engine rpm crosses one or more boundary values. If you're determined to use a PLL-based design, you'll probably have to do something similar.

Working out the details of a switching circuit based on engine rpm isn't the kind of thing you can do between breakfast and lunch. Before you do it, follow along here for a while as I go through the alternate design I described before. The hardware might be a bit more complex, but it's much less susceptible to bobble (fluctuation of the digits) than the PLL-based tachometer.

The basic approach to the design is shown in the block diagram of Fig. 1. The fundamental operating principles are simple. The number of high voltage pulses coming from the coil are counted for a precise time period. Then that number (sparks per precise time period) is used to calculate the rate in revolutions per minute. The traditional drawback of a design like this is that by multiplying the spark rate, you also multiply the differences between each successive sample This causes an unacceptable amount of bobble in the final display.

This problem can't be ignored, and there are three basic ways to solve it. The optimum solution depends how the circuit is going to be used. In no particular order, the ways around the problem are:

1. Increase the sampling period.

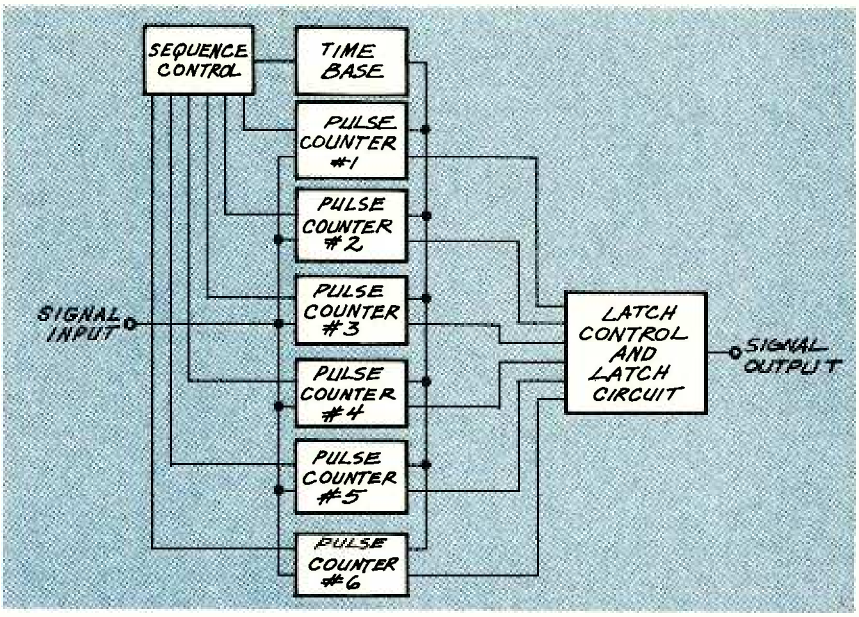

FIG. 1—BASIC TACHOMETER DESIGN. The number of high-voltage pulses coming from the coil for a precise time period is used to calculate the rate in revolutions per minute.

2. Limit the allowable variation between successive samples.
3. Increase the number of samples in the sampling period.

By increasing the sampling period, you're enlarging the statistical universe and, as you would expect, this will smooth the differences between successive samples. If you increased the sampling to a minute, you would be measuring rpm directly. The downside of doing this is, as you probably realize, the display update will be terrible—it would change only once a minute. Since the tachometer should supply meaningful information in real time, any update rate greater than one second is unacceptable.

Limiting the allowable variations between successive samples is a reasonable way to eliminate display bobble while still keeping the update rate at a reasonable interval. This is the kind of thing that is usually done in microprocessor-based designs because it's pretty simple to implement with a couple of lines of code in the software that drives the circuit. While it's possible to do the same thing in a hardware-only circuit, the design considerations are more complex.

If the number of samples per basic counting period is large enough, you can do some gross smoothing by ignoring a couple of the least significant bits. In the case of a tachometer, even an eight-cylinder engine produces only 200 sparks per second at the coil at 3000 rpm, so there's not much room for dropping low-order bits from the count. You really need more than eight bits of data to be able to get away with something like this.

If there's some way to do it, increasing the number of samples per sampling period is the best way to enlarge the statistical universe but, sad to say, short of adding a cylinder or two your engine, there's not much you can do to increase the number of sparks. The pulses from the center-coil pole of the distributor provide as rapid a spark rate as you can get.

So now that each of the three potential solutions has been ruled out for one reason or another, let's come up with another solution.

The statistical sample can be increased without shortening the update rate by using more than one counter to total up the number of samples. That's the basic idea behind the block diagram shown in Fig. 1. Each counter (I've shown six of them, but you can use as few or as many as you like) is fed with the conditioned coil input and it keeps track of the number of pulses. At the end of the update period, the count in one of the counters is sent to the section of the circuit that calculates engine rpm. Immediately after reading the number stored in the counter, the counter is cleared and it starts totaling the coil pulses again.

At the end of the next update period, the same operation is done with the next counter in sequence. This whole operation is controlled by a sequencing circuit that accesses each counter in turn and also opens and closes the latch that holds the spark count for processing before it reaches the circuit for display.

This design approach eliminates the problems stemming from too small a sample. It also permits a short update period so that the information from the tachometer is meaningful. The tachometer will base it's calculation on the last several seconds of engine rpm. If the circuit has an update period of a half a second, and the counters keep a running count of the last three seconds worth of engine pulses, whenever the display is updated, the circuit will drop the oldest half-second pulse count and add the next one. In this way, the display will always show the average rpm from the last three seconds of the engine's activity.

The circuit details for a tachometer like this are not really very difficult. The design is complex, but the basic elements are things that we've done together many times before. Remember that you must break complex circuitry down to bite-sized pieces and then work out the details of each piece. I think Chairman Mao once said something like that.

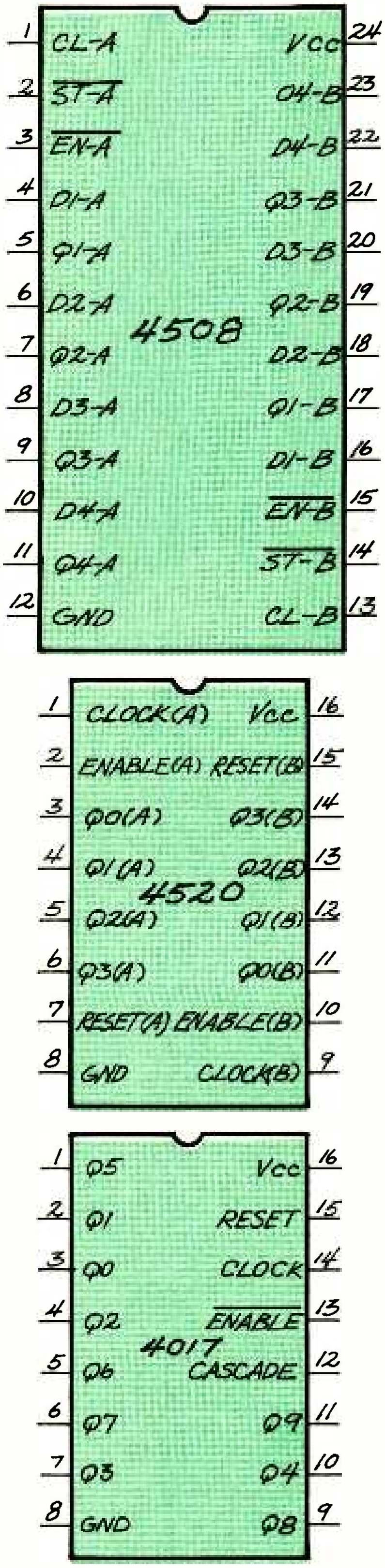

FIG. 2—TO BE READY FOR NEXT MONTH, obtain some 4520 binary counters, 4508 octal latches, 4017 decade counters, and 4049 hex inverters.

Before we continue, you must clearly understand how the tachometer calculates its data. Because the output of the circuit is a combination of time and counts, there are two ways to make the measurement. The first is to measure the time period per pulse, and the second is to do the opposite—measure pulses per time period.

The first case requires an accurate clock that runs at a frequency significantly higher than the frequency of the pulses coming from the engine. The circuitry should count the clock pulses per engine pulse and then use the resulting number to calculate the engine rpm. This is the preferred approach for tachometers that have to work with fairly low-frequency input clocks such as heart-rate monitors.

That method doesn't offer any advantage, and it makes calculating the rpm unnecessarily difficult. The final number produced by a circuit like this would be minutes per revolution, and we would have to design circuitry to take the reciprocal of that number to give us the number of revolutions per minute.

The second measuring scheme (the one I'll show here) not only makes the math simpler, but the circuitry simpler as well. There's always more than one way to design a circuit, but it's always best to keep things as simple as possible.

The circuit we're going to build is based on standard counters, latches, and other bits of logical glue, so you won't have any trouble getting the parts. And although I'll be using specific components, you'll be able to substitute similar ones that you might already have.

Because there will be several engine pulse counters running in parallel, the best way to start it is to get one counter working and then add the other counters afterwards. If you want to be ready for next month, get yourself some 4520 binary counters, 4508 octal latches, 4017 decade counters, and also some 4049 hex inverters. The pinouts for those ICs (excluding the inverters) are shown in Fig. 2. Ω

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The professional is not without his tools. Special equipment has been designed so that the professional can sweep a room so that he can detect voice-activated (VOX) and remote-activated bugs. Some of this equipment can be operated by novices, others require a trained countersurveillance professional.

The professionals viewed on your television screen reveal information on the latest technological advances like laser-beam snoopers that are installed hundreds of feet away from the room they snoop on. The professionals disclose that computers yield information too easily.

This advertisement was not written by a countersurveillance professional, but by a beginner whose only experience came from viewing the video tape in the privacy of his home. After you review the video carefully and understand its contents, you have taken the first important step in either acquiring professional help with your surveillance problems, or you may very well consider a career as a countersurveillance professional.

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COMPUTER CONNECTIONS

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JEFF HOLTZMAN

Cool computer products stand out. They're noticed and remembered. Even after they are no longer available, their legacy lives on, endowing future generations with their most important characteristics. These products are landmarks.

To get on my cool-product list, which stretches back to the late '70's, a product did not necessarily have to be the first available in its category, although some were. In fact, most products on my list are not initial releases, but version 3.0 or later. Every product in the list either defined a new category, or refined and perfected an existing category. Many are not current versions, because the version cited represents what is, in my opinion, the best tradeoff between architecture, ease of use, and feature set. Often, subsequent versions had added features, but did not update the architecture, so overall product integration suffered, often leading to needlessly complex interfaces or generally software.

I've broken my list down into four categories: hardware, DOS software, Windows software, and areas that still lack cool products.

Cool hardware

IBM's PC, PC-XT (with a hard disk and hierarchical directory structure), and PC-AT (with an 80286 CPU and 16-bit expansion bus): IBM defined the first three generations of PCs, and forever changed the way that business is done and, in many ways, the way we live.

Intel's 386 and 486 microprocessors: IBM lost the initiative when Intel released the 386, so the microprocessor itself, rather than any particular computer brand, characterized the next generations of personal computers.

Radio Shack Model 100: Introduced around 1984, this was the first laptop computer. It had a full size keyboard, an eight-line × 40-character LCD, and a 300-bps modem. Built-in software programmed in ROM included a telecommunications program, a word processor, and BASIC. As much as 32 kilobytes of RAM could be installed. A ROM socket and even an expansion-bus connector were provided for future upgrades. I have many fond memories of writing software for the machine, developing hardware for the expansion bus, and simply writing while on the go. Its biggest limitation was its small display. Nonetheless, the Model 100 defined the notebook computer.

Steve Ciarcia's $50 acoustic-coupled 300-bps modem kit: Byte magazine published plans for this kit around 1983. It worked, was reliable, and, most important, it was affordable. It introduced legions of personal computer users to telecommunications.

Hayes 2400 bps SmartModem: At the time, the transition from 300 to 2400 bps (with a short detour through 1200 bps) seemed to take forever. But once it happened, Hayes defined a modem standard that still stands. In the subsequent move to 9600 bps and beyond, Hayes no longer enjoyed the stature it once had. Nonetheless, the phrase "Hayes-compatible" carries a marketing cachet reserved for a rarefied few.

IBM's 256-color video graphics array (VGA) and multicolor graphics aray (MCGA): IBM introduced the 256-color mode with its PS/2 Models 25, 30, 50, and 60 in April 1987. The jump from EGA's 16 colors was simply breathtaking (even with the loss of resolution). Hercules' monochrome video adapters deserves a runners-up award for bringing affordable bit-mapped graphics to the rest of us, at a time when color capability was much more expensive. Super-VGA (SVGA) video has continually evolved since 1987, so that I cannot single out any product that stands head and shoulders above the rest.

Hewlett-Packard's LaserJet Series II: Quality, expandability, de-

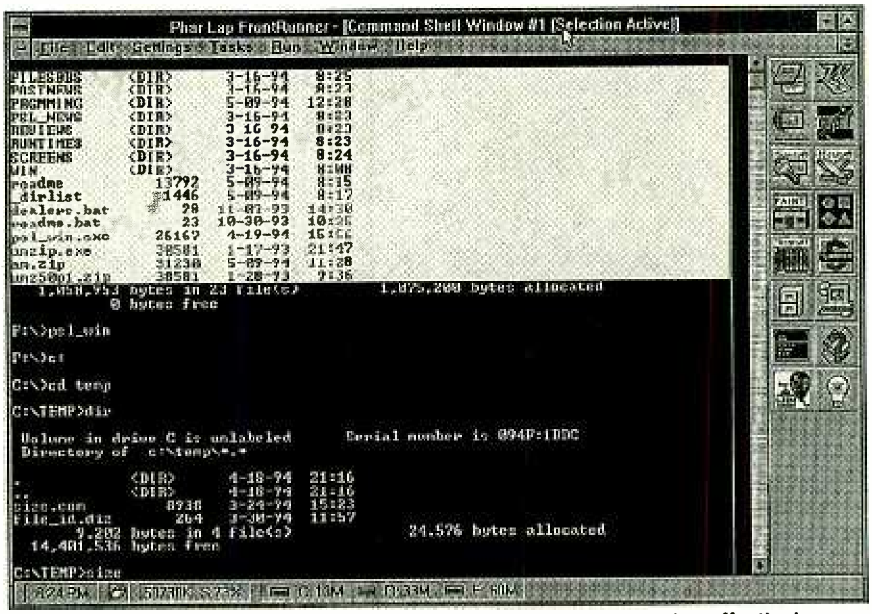

FIG. 1—FRONT RUNNER is a new Program Manager replacement that effectively marries the DOS command-line interpreter with the Windows GUI. You can launch DOS and Windows programs from the command line, peruse a scroll-back buffer, and put your favorite icons on the toolbar.

pendability, and affordability characterize this laser printer. I wish that mine would die so I could buy a newer model—but it won't. 'Nuff said.

NEC Multisync Monitors: In the absence of timing-signal standards from the video-card manufacturers, NEC put the smarts in the monitor, thereby creating a subindustry and a raft of competitors.

Cool software

MicroPro WordStar 3.3: From the late 70's to the early 80's, WordStar was king of the word-processing heap. Extensively customizable, with a powerful, logical, but less-than intuitive interface, its presence is still felt in software development environments from Microsoft and Borland, and text editors from many vendors. The DOS EDIT program (i.e., QBasic) even implements a subset of the old WordStar commands. In WordStar's heyday, WYSIWYG (what you see is what you get) meant accurate on-screen line and page breaks, in monospaced typewriter-style fonts. We've come a long way since then, but true WYSIWYG still eludes even the best high-end systems.

Turbo Pascal 3.0: Turbo Pascal 1.0 for CP/M put a company called Borland on the map in 1983. It simultaneously defined a new software category, what we now call the integrated development environment (IDE). I still use TP3 for quick and dirty programming tasks.

Lotus 1-2-3 2.01: Throughout the mid 1980's, Lotus 1-2-3 was what defined spreadsheet software. It was often used to test machine compatibility and performance. I suspect that few users of today's megaprograms need more than the functionality contained in 2.01.

SideKick 1.5: Another Borland product, SideKick defined the terminate and stay resident (TSR) program, both technically and from the user point of view. Techniques pioneered by SideKick created a huge market for DOS add-ins—at least until Windows 3.0 came along.

386Max: The first 386 memory manager, 386MAX taught the industry about the difference (to the processor) between physical and logical memory. In the process 386MAX extended (prolonged?) the life of DOS by giving PC users software control over the physical memory allocation.

LapLink III: Throughout the 1980's, networking was expensive and difficult. Floppy disks provided a way to transfer data, but that process was slow and error-prone. Traveling Software (which got its start by developing products for the Model 100) recognized a need and moved swiftly to fulfill it. Version 3 of LapLink allowed files to be transfered by serial or parallel ports. It was the first to provide over-the-wire "self-cloning," so the software had to be installed on only one computer. All of that functionality was packed in a 60-kilobyte executable file. I still prefer LapLink III to later versions because of its compactness and efficiency.

Derive: High-end symbolic math programs demand big, fast machines, but Derive from Soft Warehouse always ran comfortably on very low end hardware. Derive has a huge following in the high school and college math markets. Moreover, several textbooks have been written that use Derive for student exercises in algebra, graphics, and beginning calculus.

4DOS: I've always thought that MS-DOS's COMMAND.COM is a brain-damaged command-line interpreter. JPSoft's shareware replacement moves light-years beyond COMMAND.COM. It provides batch-file compiling, file-list processing, and a whole lot more.

The Semware Editor (TSE): This text editor emerged as a follow-on to the highly successful shareware program, Qedit. TSE is a text-editing engine that can be customized extensively; it comes with user interfaces that emulate Brief, WordStar, and WordPerfect, and you can customize it to your heart's content. TSE includes a compiler that lets you build user interfaces and custom features with a Pascal-like language.

Lantastic: In the DOS networking category, Artisoft's Lantastic stood peerless (so to speak) in its balance between power, ease of use, and conformance to industry standards. Alas, the product might be in danger because of the assault from Microsoft Windows for WorkGroups and Chicago, which contain built-in, low-functionality, peer-to-peer networking.

Norton Utilities: To many people, the Norton Utilities means one thing: undeleting files. But Norton Utilities has always included numerous useful file and disk utilities, batch file enhancers, and more.

Cool Windows software

Microsoft Windows 3.1: This is a tentative choice. When Chicago is released and market tested, I think it will probably overtake Windows 3.1. But it could possibly lose it to OS/2 or some other 32-bit operating system. Until then, 3.1 stands as the paradigm of the graphical user interface (GUI). The Macintosh GUI was first, and probably better, but Windows captured the market.

Aldus PageMaker 3.0: This version ran under Windows 286 and Windows 386, and could subsequently be patched to run under successor versions 3.0 and 3.1. PM3 set new standards in smooth-operating controls, intuitive page-design metaphor, and WYSIWYG screen displays. PM3 features that once defined the high end in desktop publishing now come standard in sub-$100 packages.

Visio 2.0: Created by the original developers of PageMaker, Visio single-handedly defined a new product category and brought unprecedented graphics power to non-professional computer users.

Adobe Type Manager 2.5: One of the biggest differences between Windows 3.0 and Windows 3.1 was the addition of the TrueType font system. Prior to TrueType, dealing with fonts under Windows was a nightmare—unless you used Type Manager, which was introduced on the PC for Windows 3.0. Adobe Type Manager is still *the* solution for quality font display and printing. With the current market glut of poor-quality TrueType fonts, good ones are hard to find. It's hard to go wrong with ATM (PostScript) fonts.

Microsoft Word: Throughout the past decade, Microsoft has never sat on its laurels. Instead, the company has steadily improved its namesake word processor with each successive release, starting originally in DOS, and eventually moving to Windows 3.0. From its introduction, Word's document model followed publishing-industry standards now adopted by all major competitors, not proprietary page-description metaphors. Word for Windows 6.0 (really the third Windows version) is the latest and, in my opinion, best—so far. For anyone who views document development as a form of engineering rather than typing, Word is the only choice.

Visual Basic: Another Microsoft product, Visual Basic defined a new technique: Visual Programming. As with Word, it's hard to single out a particular version as superior, because the overall product concept is so radically different. Visual Basic created a new industry: add-on tools, called VBXs (for Visual Basic Extensions). The purpose of this type of environment is to give the programmer a chance to focus on what the user needs rather than the details of how the programmer must implement them. The product's overwhelming success indicates the validity of the concept.

Quicken for Windows: All in all, I consider personal-finance tools to be a pretty boring category. However, one program stands so far above the others that there is no comparison. Quicken for Windows offers 95% of the functionality of the competition, wrapped in a user interface that is far better. Like PageMaker 3.0, Quicken's user interface can teach designers in any software category about the meaning of the terms usability and user-friendly.

Categories lacking cool products

There are several product categories that, I believe, still lack defining products. Among these I include Windows file managers, Windows command-line interpreters, modem communications, and CD-ROM-based database packages.

Each of those categories has its share of pretty good products, some of which show tremendous promise. For example, a relative newcomer in the Windows command-line interpreter category, FrontRunner (by PharLap Software), might make my next list.

On the other hand, the whole telecommunications category is still a complete and total mess. The steps that are required to straighten it out goes far beyond what the computer industry can supply by itself. Standard interfaces and protocols for interacting with the proliferating service providers are desperately needed, but they are nowhere in sight.

CD-ROM suffers from similar problems. Every product out there has a different user interface and database format. Certain products, such as Microsoft's BookShelf (reference works) and Encarta (encyclopedia) deserve special mention as ground-breakers, but not as examples of perfection.

Conclusions

That's my list. Undoubtedly I have forgotten a few things, and neglected others. In the future I'll present reader responses and updates to the list. In the meantime, I welcome any comments you might have (email: jkh+atacm.org). Ω

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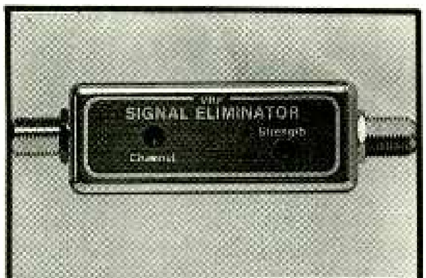

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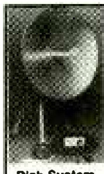

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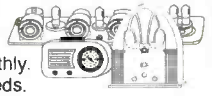

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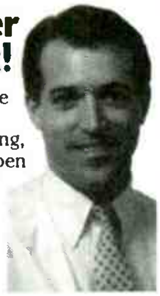

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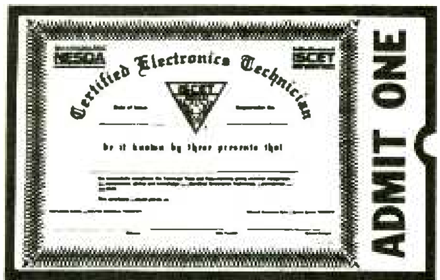

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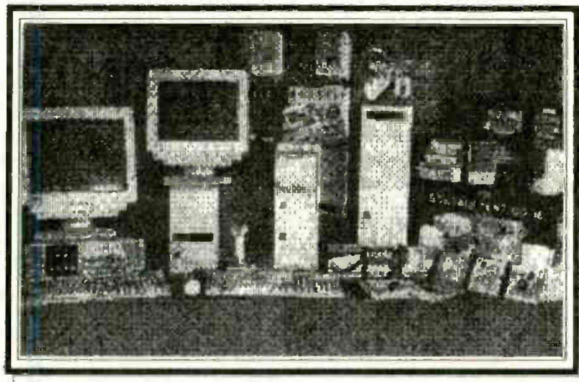

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340MB IDE Fast Hard Drive
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15" Super VGA Mon-Interlaced Monitor
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340MB Fast IDE Hard Drive
32 Bit PCI Hard Disk Controller
1.2MB & 1.44MB Floppy Drive
15" Super VGA Mon-Interlaced Monitor
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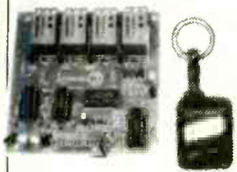
TOTAL COST FOR SHIPPING OF ANY ONE, OR AS MANY OF THE FOLLOWING ITEMS BY AIR MAIL IS $15

ALL PRICES ARE IN U.S. DOLLARS

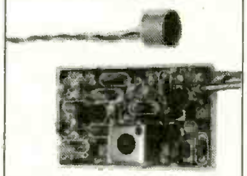
FOUR CHANNEL UHF REMOTE CONTROL KIT



Features a 3 channel transmitter which is small enough to fit onto a key ring. The fourth channel can be accessed by a second transmitter. For example each of the two transmitters could have two common channels and one individual channel. The compact receiver employs a ready made and prealigned (304MHz) UHF receiver "front end" module. Over 100 meters range, has 12A SPDT relay contact outputs, has a user programmable security code with 6561 combinations, easy to construct, is expandable, etc. **Transmitter: $13. Receiver: $46. TWO TRANSMITTERS AND ONE RECEIVER: $68**

The operating frequency of the system is adjustable but you should check local regulations with regards to using this very low power remote control system.

FM TRANSMITTER KIT - MKII



This low cost FM transmitter features pre-emphasis, high audio sensitivity as it can easily pick up normal conversation in a large room, a range of well over 100 meters, etc. It also has excellent frequency stability. Specifications: Tuning range: 88-108MHz, Supply voltage 6-12V, current comsumption @ 9V: 3.5mA, Pre-emphasis: 75µS, Frequency response: 40Hz to greater than 15KHz, S/N ratio: Greater than 60dB, Sensitivity for full deviation: 20mV, Frequency stability with extreme antenna movements: 0.03%, P.C.B. dimensions: 1" x 1.7". Construction is easy and no coil winding is necessary. The coil is preassembled in a shielded metal can. The double sided, solder masked and screened PCB also makes for easy construction. The kit includes a PCB and all the on-board components, an electret microphone, and a 9V battery clip.

$8

IR "TANK SET"

ON SPECIAL is a set of components that can be used to make a very responsive Infra Red night viewer. The matching lens tube and eyepiece sets were removed from working military quality tank viewers. We also supply a very small EHT power supply kit that enables the tube to be operated from a small 9V battery. The tube employed is probably the most sensitive IR responsive tube we ever supplied. The resultant viewer requires low level IR illumination. Basic instructions provided

$85

For the tube, lens, eyepiece and the power supply kit. When ordering specify preference for a wide angle, or a telescopic objective lens.

FIBRE OPTIC TUBES

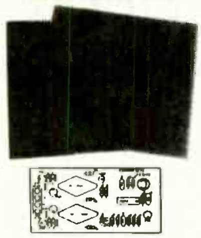
These US made tubes are "pulls" from equipment, in excellent condition. Have 25/40mm diameter, fibre-optically coupled input and output windows. The 25mm tube has an overall diameter of 57mm and is 60mm long. The 40mm tube has an overall diameter of 80mm and is 92mm long. The gain of these is such that they would produce a good image in approximately 1/2 moon illumination when used with suitable "fast" lens, but they can also be IR assisted to see in total darkness. The superior resolution of these tubes would make them suitable for low light video preamplifiers, wild life observation, and astronomical use. **INCREDIBLE PRICES:** Each of the tubes is supplied with a 9V-EHT power supply kit. **INCREDIBLE PRICES:**

$85 For the 25mm intensifier tube and supply.

$130 For the 40mm intensifier tube and supply.

Three of these tubes can be cascaded to make a very high gain image intensifier! We should have a kit and instructions available to make these. Approximately **$195** for 25mm and **$320** for 40mm, three stage kits. Resellers enquiries welcome.

UNIVERSAL SOLAR CHARGER KIT



Two 6" x 6" amorphous glass solar panels, and a PCB and all on-board components kit for a solid state inverter. In normal sunlight, the combination can deliver a charging power of over 1.4 Watts into 5-12V batteries. EG 6V-230mA, 9V-150mA, 12V-120mA. The glass panels need to be terminated and have their rear waterproofed. Simple to do, instructions included.

$20

For the two panels, PCB and components, terminating clips and the instructions.

FM TRANSMITTER MK1 KIT

This unit has most of the features of our FMTXMK2 transmitter, but is much smaller. The complete transmitter PCB (Miniature microphone included) is the size of a "AA" battery, and is powered by a single "AA" battery. We use a two "AA" battery holder (provided) for the case, and a battery clip (shorted) for the switch. Estimated battery life is over 500 hours!! **SAME PRICE AS OUR FMTXMK2:**

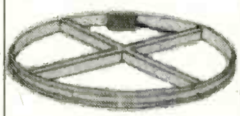
$8

PASSIVE NIGHT VIEWER

This is a completed commercial monocular hand held night viewer, that employs an image intensifier tube. The viewer is of a USSR military standard (model T3C-2), and will produce useful images in very low ambient light. Has adjustable low light objective lens, adjustable eyepiece, and is supplied with a carry case.

$280

MIRACLE TV ANTENNA KIT



This combination of proven circular antenna design, and a wideband low noise amplifier produces remarkable results on VHF, UHF, and FM frequencies. Based on an IC with 20dB of gain, a bandwidth of 2GHz and a noise figure of 3dB. Can be used as a masthead amplifier on existing antennas. The cost of the complete kit of parts for the masthead amplifier PCB and components, the power and signal combiner PCB and components, a balun core and the tinplate for the antenna is priced at only:

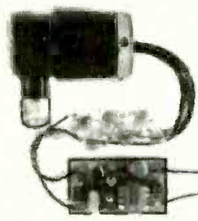
$18

Requires a DC supply (Plugpack etc.) 7V-20V DC at approximately 25mA. Extra reinforcement for the tinplate antenna is also required.

MISCELLANEOUS ITEMS COMPONENTS AND KITS

High Voltage Diodes 8KV-3mA, $0.80; 10KV-20mA, $1.40 **High Voltage Disc Ceramics:** 0.01uF-3KV, $0.80; 0.01uF-5KV $1.30, 1000pF-15KV, $3.50 **Electric Fence Kit:** PCB and components, $28. **Garage-Door-Gate Remote Control Kit:** Tx $13; RX $56. **Laser Beam Communication Kit** TX, RX, plus IR Laser, $39. **Plasma Ball Kit:** PCB and components kit, needs any bulb $18 **IEC Extension Leads:** 2 meters long $3.50. **High Intensity Led's:** 550-1000mCD output at 20mA, 5mm diameter, 10 for $2.80. **Triacs:** 60A-600V Stud mounted THOMPSON type TGAL606 $7.20. **Ultrasonic Transducers:** Murata brand (Japanese), 40KHz TX-Rx Pair, $1.50

IMAGE INTENSIFIER TUBE AND SUPPLY



These are the key components needed for making a PASSIVE NIGHT VIEWER. The small prefocussed Russian image intensifier tube only requires a low current EHT power supply to make it operational, which we provide in kit form. Draws 20mA from a small 9V battery. With a suitable low light objective lens (not provided) the resultant viewer will produce useful pictures in sub-moonlight illumination, and it can also be IR assisted. **INCREDIBLE PRICE:**

$105

for the Russian image intensifier tube and an EHT power supply kit! All that is needed to make a complete passive night viewer is a lens, an eyepiece, a 9V battery, a case and a switch. We can supply a matching lens and eyepiece:

$68 for the pair.

SOLID STATE "PELTIER EFFECT" COOLER - HEATER

These are the major parts needed to make a solid state thermoelectric cooler - heater. We can provide a large 12V-4.5A Peltier effect semiconductor, two thermal cut-out switches, and a 12V DC fan for a total price of:

$32

We include a basic diagram – circuit showing how to make a small refrigerator – heater. The major additional items required will be an insulated container such as an old portable cooler. Two heatsinks, and a small block of aluminium.

INFRA RED FILTER

A very high quality IR filter and a RUBBER lens cover that would fit over most torches including MAGLITES, and convert them to a good source of IR. The filter material withstands high temperatures and produces an output which would not be visible from a few meters away and in total darkness. Suitable for use with passive and active viewers.

$11

For the filter and the rubber lens cover.

All our kits are provided with high quality fibreglass, silk screened and solder masked, printed circuit boards

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CAPACITORS

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RAD. LYTIC 25VDC			
1µF	.05	.040	.035
2.2µF	.05	.040	.035
3.3µF	.05	.040	.035
4.7µF	.05	.040	.035
6.8µF	.05	.040	.035
10µF	.05	.045	.04
22µF	.05	.045	.04
33µF	.06	.055	.05
47µF	.06	.055	.05
100µF	.08	.07	.05
220µF	.08	.07	.055
330µF	.09	.08	.06
470µF	.10	.09	.08
1000µF	.22	.20	.17
2200µF	.42	.40	.38
3300µF	.53	.50	.47
4700µF	.91	.87	.83
RAD. MONO 50V			
.001µF	.05	.045	.035
.0022µF	.05	.045	.035
.0047µF	.05	.045	.035
.01µF	.05	.045	.035
.022µF	.05	.045	.035
.047µF	.05	.045	.035
.1µF	.05	.045	.035
.22µF	.25	.22	.18
.47µF	.42	.35	.28
CERAMIC 50V			
5pF	.05	.038	.025
10pF	.05	.038	.025
18pF	.05	.038	.025
22pF	.05	.035	.025
27pF	.05	.038	.025
33pF	.05	.038	.025
47pF	.05	.038	.025
68pF	.05	.038	.025
82pF	.05	.038	.025
100pF	.05	.038	.025
120pF	.05	.038	.025
150pF	.05	.038	.025
180pF	.05	.038	.025
220pF	.05	.038	.025
270pF	.05	.038	.025
330pF	.05	.038	.025
470pF	.05	.038	.025
1000pF	.05	.038	.025
2200pF	.05	.038	.025
3300pF	.05	.038	.025
4700pF	.05	.038	.025
.01µF	.05	.038	.025
.022µF	.05	.04	.03
.047µF	.07	.055	.035
.1µF	.07	.058	.04
DIP TANT. 25VDC			
1µF	.14	.11	.08
2.2µF	.14	.11	.08
4.7µF	.23	.185	.14
10µF	.28	.26	.22
22µF	.34	.27	.24
47µF	1.22	1.07	.94
AXIAL LYTIC 25VDC			
4.7µF	.09	.075	.054
10µF	.10	.08	.06
22µF	.14	.115	.084
47µF	.16	.13	.096
100µF	.19	.15	.11
220µF	.27	.215	.16
470µF	.35	.28	.31
1000µF	.45	.36	.27
2200µF	.89	.715	.54

DIODES

QTY	1	100	1000
1 AMP RECTIFIER			
1N4001	.03	.02	.015
1N4004	.04	.025	.019
1N4007	.05	.035	.022
3 AMP RECTIFIER			
1N5401	.06	.05	.042
1N5404	.07	.055	.045
1N5408	.08	.06	.049
6 AMP RECTIFIER			
6A10	.21	.185	.156
6A100	.32	.29	.25
1 AMP SCHOTTKY			
1N5817	.20	.145	.09
1N5818	.23	.165	.10
1N5819	.25	.18	.11
3 AMP SCHOTTKY			
1N5820	.34	.255	.17
1N5821	.38	.285	.19
1N5822	.42	.315	.21
GERMANIUM			
1N34A	.10	.08	.06
1N60	.10	.08	.06
1N270	.17	.15	.13
SWITCHING			
1N914	.035	.025	.015
1N4148	.025	.02	.01
1N4448	.035	.025	.015
1 W ZENER			
1N4728	.06	.054	.047
through			
1N4764	.06	.054	.047

INTEGRATED CIRCUITS

QTY	1	100	1000
PART #			
TIL111	.38	.34	.31
MC1458	.43	.36	.29
LM1488	.47	.43	.39
LM1489	.47	.43	.39
CD4001	.29	.25	.21
CD4011	.29	.25	.21
CD4013	.37	.33	.29
CD4017	.37	.33	.29
CD4025	.37	.33	.29
CD4028	.37	.33	.29
CD4040	.47	.43	.39
CD4049	.37	.33	.29
CD4051	.44	.40	.36
CD4066	.38	.34	.31
CD4069	.37	.33	.29
CD4093	.37	.33	.29
MOC3011	.40	.36	.32
LM311	.37	.33	.29
LM324	.47	.36	.25
LM339	.48	.37	.27
LM358	.48	.37	.27
LM386	.67	.49	.33
LM393	.37	.33	.29
4N25	.54	.39	.28
4N28	.58	.41	.34
LM555	.43	.38	.33
LM556	.47	.42	.38
LM741	.43	.38	.33
74LS244	.40	.36	.32
74LS245	.37	.33	.29
74LS374	.37	.33	.29

TRANSISTORS

QTY	1	100	1000
PART #			
2N2222A	.20	.18	.15
2N3055	.55	.50	.45
2N3904	.05	.045	.035
2N3906	.05	.045	.035
2N4124	.09	.07	.045
2N4125	.09	.07	.045
2N4126	.09	.07	.045
2N4401	.05	.045	.035
2N4403	.05	.045	.035
2N5086	.09	.07	.045
2N5087	.08	.06	.04
2N5088	.08	.06	.04
2N5089	.09	.07	.045
2N5209	.09	.07	.045
2N5210	.09	.07	.045
2N5400	.12	.10	.065
2N5550	.12	.10	.065
2N5551	.09	.07	.045
BU806	1.10	.80	.70
MJE3055T	.65	.55	.44
MPSA-05	.10	.08	.05
MPSA-10	.12	.09	.06
MPSA-13	.15	.11	.075
MPSA-14	.15	.11	.075
MPSA-42	.14	.105	.07
MPSA-44	.22	.18	.12
MPSA-56	.10	.08	.05
MPSA-63	.45	.34	.22
MPSA-92	.12	.09	.06
MPSA-93	.15	.11	.075
MPSH-10	.12	.09	.06
MPSH-81	.44	.33	.21
PN2222A	.05	.045	.035
PN2907A	.05	.045	.035
TIP30	.42	.37	.32
TIP31	.42	.37	.32
TIP41	.49	.44	.39
TIP112	.56	.51	.46
TIP122	.57	.52	.47
TIP125	.53	.48	.43
TIP126	.56	.51	.46

VOLTAGE REGULATORS

QTY	1	100	1000
PART #			
7805	.48	.45	.42
7812	.48	.45	.42
7824	.48	.45	.42
7905	.61	.55	.49
7912	.61	.55	.49
7924	.61	.55	.49
78L05	.35	.31	.26
78L12	.35	.31	.26
79L05	.35	.31	.26
79L12	.35	.31	.26
LM317T	.95	.82	.68
LM350T	2.05	1.70	1.35

CRYSTALS

QTY	1	100	1000
HC18 case			
1.8432	.89	.67	.45
2.0000	.74	.55	.39
3.5795	.74	.55	.39
3.6864	.74	.55	.39
4.0000	.74	.55	.39
4.9152	.74	.55	.39
5.0688	.74	.55	.39
7.3728	.74	.55	.39
10.000	.74	.55	.39
11.000	.74	.55	.39
11.059	.74	.55	.39
12.000	.74	.55	.39
14.3181	.74	.55	.39

frequencies are in MHZ

SWITCHES

QTY	1	100	1000
DIP STYLE			
4 POS.	.68	.58	.48
6 POS.	.77	.67	.57
8 POS.	.80	.70	.60
10 POS.	.95	.85	.75
TOGGLE			
SPDT	.62	.52	.40
SPDT-off	.73	.63	.49
DPDT	.69	.59	.46
DPDT-off	.86	.76	.59
PUSH BUTTON			
N. open	.28	.24	.20
N. closed	.29	.25	.21

All toggle and push button switches fit in a ¼" panel hole

LED's

QTY	1	100	1000
3MM			
RED	.06	.05	.04
GREEN	.07	.06	.045
YELLOW	.08	.07	.05
5MM			
RED	.06	.05	.04
GREEN	.07	.06	.045
YELLOW	.08	.07	.05
BI-COLOR	.29	.22	.17
BLUE	1.20	1.10	.95
BLINKER			
RED 5mm	.65	.53	.41
HOLDERS			
3mm	.10	.07	.055
5mm	.10	.07	.055

IC SOCKETS

QTY	1	100	1000
REGULAR			
8 PIN	.04	.035	.025
14 PIN	.08	.063	.045
16 PIN	.10	.08	.055
18 PIN	.11	.085	.06
20 PIN	.12	.095	.07
24 PIN	.15	.115	.08
28 PIN	.17	.13	.09
32 PIN	.20	.155	.11
40 PIN	.24	.185	.13
MACHINE			
8 PIN	.16	.135	.11
14 PIN	.28	.24	.185
16 PIN	.32	.27	.21
18 PIN	.36	.30	.235
20 PIN	.40	.33	.26
24 PIN	.48	.40	.32
28 PIN	.56	.47	.37
32 PIN	.64	.53	.42
40 PIN	.80	.66	.52
WIRE WRAP			
8 PIN	.32	.29	.26
14 PIN	.56	.51	.46
16 PIN	.64	.58	.52
18 PIN	.72	.66	.59
20 PIN	.80	.73	.65
24 PIN	.96	.87	.78
28 PIN	1.12	1.02	.91
32 PIN	1.28	1.16	1.04
40 PIN	1.60	1.45	1.30

BRIDGE RECTIFIER

QTY	1	100
IN LINE		
RS101 1A-50V	.60	.33
RS106 1A-800V	.93	.52
3N256 2A-400V	.95	.53
TL400 4A-50V	.65	.37
TU600 6A-50V	1.02	.65
TU800 8A-50V	1.33	.75
8 PIN DIP		
DF005M 1A-50V	.25	.18
DF10M 1A-1KV	.52	.33
ROUND		
W04M 1A-400V	.35	.17
2W10M 2A-1KV	.50	.27
SQUARE WIRE LEADS		
TB305 3A-50V	.53	.30
TB805 8A-50V	.93	.52
SQUARE TAB LEADS		
TB151 15A-100V	2.30	1.35
TB352 35A-200V	2.68	1.50

special pricing available for quantity over 500pcs.

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NATURAL COLOR

QTY	100	1000	5000
4" LENGHT	2.00	9.00	35.00
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CABLE TIE MOUNT

self stick 100pcs 10.00

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¼ W 5%	.80	7.00	28.00

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QTY	1	100	1000
SOLDER CUP			
DB9 m.	.29	.22	.15
DB9 f.	.29	.22	.15
DB15 m.	.35	.27	.19
DB15 f.	.37	.29	.21
DB25 m.	.53	.37	.21
DB25 f.	.57	.42	.26
RIGHT ANGLE			
DB-9 m.	.49	.39	.30
DB-9 f.	.49	.39	.30
DB15 m.	.54	.44	.33
DB15 f.	.54	.44	.33
DB-25 m.	.69	.54	.49
DB-25 f.	.69	.54	.39
PLASTIC HOOD FOR DB			
DB-09	.26	.195	.13
DB-15	.29	.24	.19
DB-25	.31	.26	.21
DB-37	.53	.43	.34

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486 CPU

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.031" diameter

SN60/40

$6.50 each

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14mm RED

COMMON ANODE

$0.49 each

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QTY	1	100	1000
SINGLE ROW			
40 PIN ST.	.64	.44	.24
40 PIN RA	.80	.59	.38
DOUBLE ROW			
40 PIN ST.	1.28	.88	.48
40 PIN RA	1.60	1.18	.76

ST.= SINGLE ROW
RA.= RIGHT ANGLE

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16 Bit Western Digital Hard Drive/ Floppy Controller

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8035	1.00	(16550)	10.95	8214	2.00	8284	1.49
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8085	1.55	8254	1.80	8228	1.75	8288	3.50
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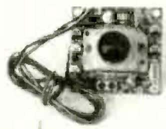

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MICRO-SCOPE Universal Computer Diagnostics was developed to satisfy the expanding need for accurate system diagnosis in the rapidly growing desktop computer market. Patterned after super-mini and mainframe diagnostic routines, MICRO-SCOPE runs independently of any standard operating system, and is therefore at home on any machine in the Intel world. Speed, ease-of-use, and razor sharp accuracy are a few of the advantages that arise from this system independence, together with an impressive list of functions including the ability to perform low level formatting on every drive currently manufactured, including all IDE drives.

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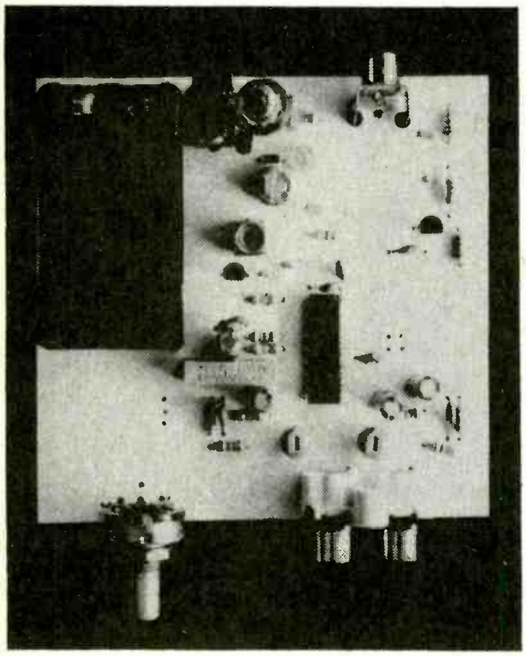

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DC'S all new FM Stereo Transmitter Kit based on the unique BA1404 Stereo Broadcaster Integrated Circuit that includes all the complex circuitry to generate the stereo signal. We've added an RF amplifier circuit to provided excellent transmit range. Additional features like electronic fine tuning, voltage regulation, 38KHz multiplex crystal, input level adjustment makes the Stereocaster the top of the line Stereo FM Transmitter.

ORDER STEREOCASTER $29.95

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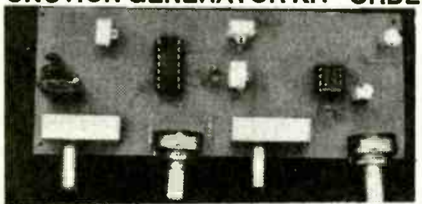

A great project to enhance your bench. This handy little function generator has a built-in buffer amplifier, a 3-decade range selector switch that covers 15 hZ to 25 khZ, output level control and function switch to select sine, square, or triangle.

MAKE CIRCUIT BOARDS THE NEW, EASY WAY

WITH TEC-200 FILM

JUST 3 EASY STEPS:

- Copy circuit pattern on TEC-200 film using any plain paper copier
- Iron film on to copper clad board
- Peel off film and etch

convenient 8½ × 11 size
With Complete Instructions

ORDER TEC200-10 (10-SHEETS) $5.95

POWER SUPPLY KIT
PS-1 $16.99

Output of this power supply is continiously adjustable from 1.2 to 25V DC. The LM317T voltage regulator provides excellent regulation and ripple rejection. Includes a 1 A transformer, PC board, LM317T, 2 binding posts, and all small parts.

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Build this unique seasonal project and have an unusual converstion piece. Powered by two D cells, 17 LEDs flash in a seemingly random fashon. Kit includes everything except batteries. ORDER XMASKIT $16.95

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Etching Tank

This attractive injection moulded designed tank is ideal for etching your PCBs. It includes a thermostatically controlled glass heater, electric agitator and PCB hanging accessories. Measuring graduations are included. Maximum PCB size is 160mm x 250mm or 200mm x 250mm w/o heater. Typical etching time is 4 minutes.

CAT NO	DESCRIPTION	PRICE
ET10EN	Etch Tank System	$48.00

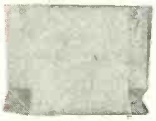
Etching Chemicals

Ferric Chloride

A dry concentrate that mixes with water to make 1 pint of etchant, enough to etch 400 sq. inches of 1oz board.

CAT NO	DESCRIPTION	PRICE EACH 1	5
ER-3EN	Makes 1 pint	$3.50	$2.75

Developer



This product is used as the developer on our positive photo-resist printed circuit boards. Includes instructions. 50 gram package, mixes with water, makes 1 quart.

CAT NO	DESCRIPTION	PRICE EACH 1	10	25
POSDEVEN	Positive Developer	$ .95	$ .80	$ .50

Positive Photo Resist Pre-Sensitized Printed Circuit Boards

These pre-sensitized printed circuit boards are ideal for small production runs. They provide high resolution and excellent line width control. High sensitive positive resist coated on 1oz. copper foil allows you to go direct from your computer plot or art work layout. No need to reverse art.

Single-Sided, 1oz. Copper Foil on Paper Phenolic Substrate

CAT NO	DESCRIPTION	PRICE EACH 1	10	50
PP101EN	100mm x 150mm/3.91" x 5.91"	$2.55	$1.90	$1.70
PP114EN	114mm x 185mm/4.49" x 7.28"	2.98	2.45	1.98
PP152EN	150mm x 250mm/5.91" x 9.84"	5.40	3.98	3.60
PP153EN	150mm x 300mm/5.91" x 11.81"	6.15	4.48	4.10

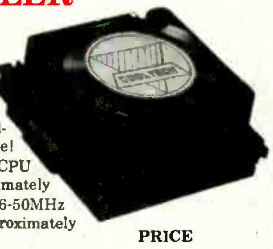
Single-Sided, 1oz. Copper Foil on Fiberglass Substrate

CAT NO	DESCRIPTION	PRICE EACH 1	10	50
GS101EN	100mm x 150mm/3.91" x 5.91"	$ 3.90	$2.98	$2.60
GS114EN	114mm x 185mm/4.49" x 7.28"	4.80	3.49	3.20
GS152EN	150mm x 250mm/5.91" x 9.84"	8.69	5.98	5.78
GS153EN	150mm x 300mm/5.91" x 11.81"	10.20	7.20	6.80

Double-Sided, 1oz. Copper Foil on Fiberglass Substrate

CAT NO	DESCRIPTION	PRICE EACH 1	10	50
GD101EN	100mm x 150mm/3.91" x 5.91"	$ 5.07	$3.68	$3.38
GD114EN	114mm x 185mm/4.49" x 7.28"	5.95	4.29	3.99
GD152EN	150mm x 250mm/5.91" x 9.84"	10.47	7.39	6.98
GD153EN	150mm x 300mm/5.91" x 11.81"	11.95	8.69	8.30

486 CPU Cooler



Increase Performance! Prolong Life!

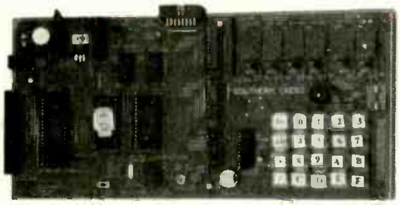
COOL IT! With our easy to install miniature CPU Cooler Fan. This kit includes an omni-directional heat sink, long-life, low noise, DC fan with ready to go power hook-up. The best low-cost, high add-on value investment you can make!

PERFORMANCE Typical 80486-33MHz CPU surface temperature reduces from approximately 79°C to approximately 48°C. Typical 80486-50MHz CPU surface temperature reduces from approximately 95°C to approximately 54°C.

CSI PART#	PRICE 1	5
CC-M3EN	$15.95	$14.95

Want More Info on the Southern Cross?

Use our FaxBack Automated Document Retrieval System. Dial 1-800-662-5426 (602-834-1005 in AZ) and select document #5025 on your push-button phone. You'll receive an article reprint from Australia's "Silicon Chip" magazine, reviewing the Southern Cross SBC. This is a free service available 24-hours a day. Don't forget to have your FAX# handy.



THE SOUTHERN CROSS

A Single Board Z-80-Based Computer

Here is a single board computer designed especially for the 1990's generation of students. With a series of add-on boards, smart sockets, fully commented monitor & an intelligent EPROM emulator, it can teach many aspects of micro-processor & micro-controller techniques of programming.

The Southern Cross SBC is designed to teach beginners modern code development techniques as well as assembly language. Start with machine language using the on-board 21 hex digit keypad, then progress to using a PC Assembler provided with many program examples. Serial download assembled program from PC to Southern Cross. Serial interface provided.

Simple, but powerful monitor program fully annotated. Learn to use parts of it in your own programs by 'system calls' & using a 'header file'.

Learn how to single step through your program to find errors. Both hardware & software single stepping provided & explained.

We do not fill the User Manual with pages of theory. Go straight to program examples. Starts from a very basic level anyone can follow.

The Southern Cross system includes:

- All CMOS IC's
- Hardware speed control
- 8K EPROM
- 64K RAM
- 4.00MHz Z80
- 10 year RAM backup with optional DS1213B
- Calendar/time access & RAM backup with optional DS1216B
- 9-15V AC/DC Single-sided PCB 9.75" x 5.15"

Two add-on boards available. Relay Board to connect to real world of lights & motors and 8 x 8 LED module Board to write moving displays.

SC1EN Southern Cross Kit	**$145.00**
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SC4EN 8 x 8 Board	**$49.00**
SC3EN Relay Board-1 relay	**$27.00**
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DS1213BEN SmartSocket	**$18.00**
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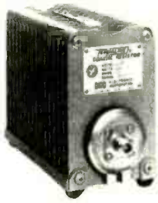

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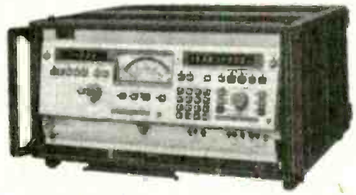

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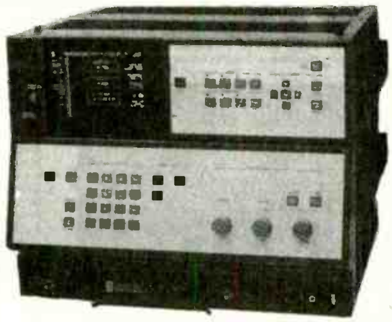

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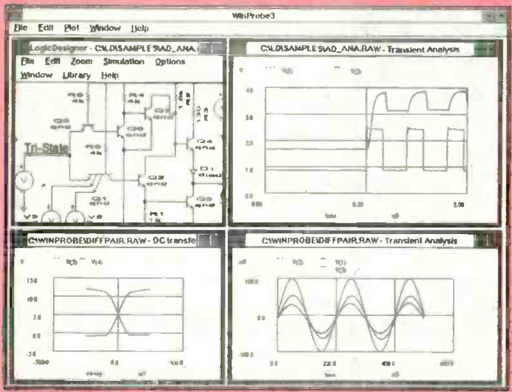

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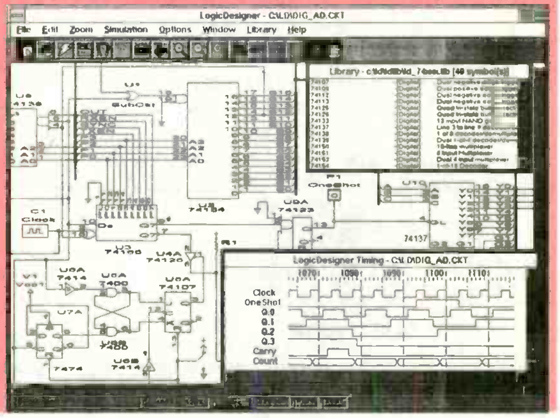

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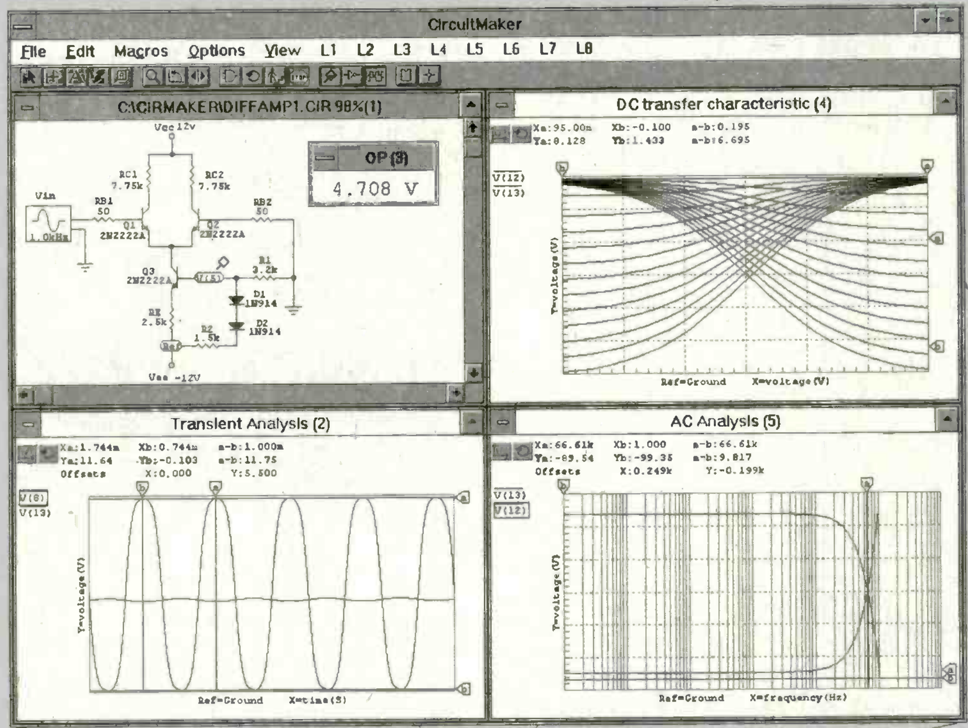
CircuitMaker's analog simulation results are shown in graph windows that provide powerful, interactive analysis options. You can plot multiple waveforms by clicking on the desired nodes and can select linear or logarithmic axes. Horizontal and vertical cursors facilitate quick and accurate measurements. You can also zoom in on any portion of the graph to obtain additional detail.

Electronics Workbench offers a single, small scope or Bode plot instrument window. The windows are not sizeable and only two waveforms can be plotted at a time. EWB has a single measurement cursor and provides no direct way to read results from the instruments.

Superior Digital Simulation

CircuitMaker has an exclusive Trace feature where the state of every node is indicated in color as the simulation runs. You can monitor as many waveforms as your screen will allow, set edge or level breakpoints for analysis, and interactively see the state of any node by touching the logic probe to it. The data sequencer provides 1024 words of pattern data. Additional digital instruments include ASCII and HEX input keys and an ASCII display. CircuitMaker includes tri-state devices and devices have programmable propagation delays.

Electronic Workbench has no interactive logic probe or Trace capability and no Hex or ASCII keys. Their "word generator" is limited to 16 words. EWB does not have tri-state devices and digital devices do not have programmable propagation delays.



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CircuitMaker includes libraries containing programmable, TTL, CMOS, generic analog and digital devices, and many powerful I/O devices. With CircuitMaker's macro function you can quickly and easily create your own functional devices and symbols. Now that's giving you the tools you need to get the job done right!

Electronics Workbench ships with only 17 digital devices. If you want additional devices you pay extra.

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You deserve the best. Upgrade from any competing product for only $99. New users can purchase CircuitMaker for a limited time at a special introductory price of just $269. Suggested Retail Price $299.

High-Performance Schematic Capabilities

CircuitMaker puts you in control of your schematic with SmartWires™, bussing, page connectors, and rubberbanding. You can label devices and pins, add fully stylized multi-line text, and create a parts list or netlist. With the Macro feature you can add user defined symbols to your device library.

Electronics Workbench dictates wire placement to you. EWB limits your overall "workbench" layout to 1 x 2 pages. EWB has no bussing, page connectors, pagebreaks, print scaling, labeling, free text fields, netlisting, zoom, undo, and no Toolbar or Toolbox.

Technical Support

MicroCode Engineering offers free phone support from knowledgeable engineers. And, you won't find yourself listening to music when you call for help.

Interactive Image Technologies offers 3 free calls and then you have to pay for all subsequent calls.

Comparison based on CircuitMaker 2.0 for Windows and Electronics Workbench 3.0 for Windows. All product and company names are trademarks of their respective owners.

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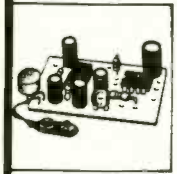
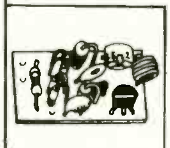
RAINBOW KITS



SUPER SNOOPER BIG EAR

Listen through walls, hear conversations across the room. Add a parabolic reflector & hear blocks away. The BIG EAR can be hidden about anywhere. Makes an ultra- sensitive intercom, Can be used as a 1.5W AMP. We supply a mini- electret mike in the kit. 1"x1.75" 6 to 12vDC

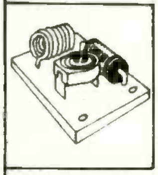
AA-1 **$10.95**



PHONE TRANSMITTER

Small but mighty, it fits anywhere. Phone line powered, never needs batteries. Transmits both sides of a phone conversation loud and clear, wireless, to any FM radio at great distances. Variable tunes from 70MHz TO 130MHz FM. You can also use it as a speaker phone. Size .5"x1"

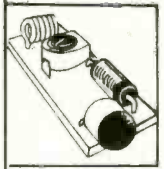
TEL-B1 **$12.95**



MICRO-MINIATURE PHONE TRANSMITTER

We haven't seen a smaller phone transmitter than the MMPT2 Kit. Powered by the phone, it requires no battery. Transmits both sides of a conversation to a FM radio up to a 1\4 mile away, tunable from 88 to 108MHz FM. Attach it to one phone or add it to the line to pick up all incoming calls. The MMPT2 Is undetectable if properly installed. Unit uses surface mounted parts, we have already installed these parts, you install the leaded parts. Size .45"x.6"

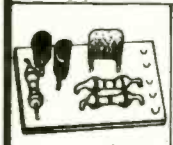
MMPT2 **$29.95**



MICRO-MINIATURE WIRELESS MIKE

So small you could hide this on some real bugs! Its the smallest we've ever seen. With its super sensitive mike it transmits a whisper or a room of conversation to a FM radio, tunable from 88 to 108Hz FM. With a proper antenna & 9v it transmits about 1 mile. The kit is made with surface mounted parts, we have already mounted these parts, you install the leaded parts. Can operate on 6 to 12v DC. Size .35" x.9"

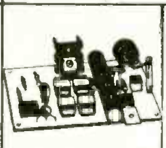
MMWM5 **$34.95**



PHONE RECORDING SWITCH

This phone line powered switch is small enough to be installed any where. Every time the phone is picked up the recorder will record both sides of the conversation automatically. Use It in your office to record all phone calls so you don't loose important information. 1"x.6"

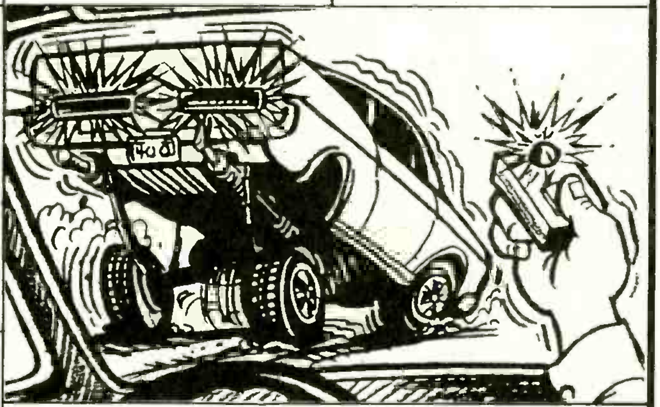
TEL-SW1 **$12.95**



STROBE LIGHT

If you need an attention getter, warning light, or flashing light for model airplanes, then this kit is for you. Use it as an emergency light for your auto, radio tower, even use it on your bicycle. Has a varible flash rate. Size 3.5"x1.8" operates on 6 or 12v DC only.

ST-1 **$9.95**



THE ZAPPER

activates any radar detector within 3/4 of a mile. Check the brake lights of that sports car that just went by 90 miles an hour. Back off those 18 wheelers trying to eat your back bumper. Put the fun back in driving. THE ZAPPER is a 10GHz amateur transmitter the size of a cigarette pack, operates on a 9v battery, when the button is pushed, brake lights and radar detector light the skies. Complete with the rules of the new ROAD WARRIOR GAME... TROLLING FOR TAIL LIGHTS, America's fastest growing highway participatory sport.

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DIGITAL THERMOMETER

The DT-3 kit will turn your digital volt meter into an accurate digital thermometer with .1 degree resolution. Measures temperature from -40F to 250F degrees. It has a remote sensor .25" SQ. and can be mounted many feet away from the meter. Size 1.5x1.2" 9vDC

DT-3 **$8.95**

CAPACITANCE METER

This kit will turn your digital volt meter into a capacitance meter. Turn that junk box of unmarked capacitors into a fortune of usable parts. Measures capacitors from <2.2pF to 2.2uF. 1.75"x2" 9vDC

CA-1 **$12.95**

VOLTAGE MONITOR

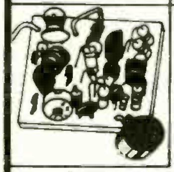
This kit has 7 multi-colored leds to monitor your 12, 8, or 5v DC systems. Build it to work in 1v, 1/2v, or 1/4v steps. Great for nicad packs, autos, boats, mobile homes, or battery chargers. P.C.B. 1.3"X2.7"

VM-1 **$7.95**

BLINKEY LIGHT

This kit is perfect for decorating hats, name badges, & model trains. Add a box, set it on the dash of your car, use it as an auto burglar alarm. Comes with 2 alternate flashing leds. Size .5"x.5" 9 to 12vDC

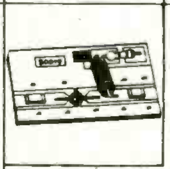
RB-2 **$3.95**



WIRELESS FM MICROPHONE

Small but mighty, this little jewel will out perform most units many times its price. It really stomps out a signal. The WM-1 kit is a buffered wireless mike that operates from 80-MHz to 120MHz FM, the frequency of any broadcast FM radio. Includes a mini-electret mike. .8"x1" 6 to 12vDC

WM-1 **$14.95**



WIDE BAND PREAMP

Ideal for preamp for scanners, hand held radios, frequency counters. Amplifies low level (weak) signals. If the signal is extremely low 2 amps can be used in series. 1MHz TO 2.5MHz @ 2.8dB nf 1dB compression = +0 dBm gain: 1MGHz-20dB to 2.5GHz-6dB Requires 12vDC @ 16Ma

WBA-6 **$19.95**

This Manual contains all schematics, parts & P.C. board layouts for all of the Rainbow Kits. Use your own parts to construct any of our kits.

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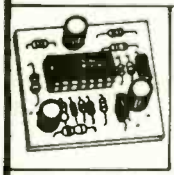

VOICE ACTIVATED SWITCH

This VOX circuit can be used to operate a tape recorder, ham radio, CB radio, or turn on an alarm. The VOX-1 kit has 100MA of output. That operates a relay, light, motor, or ? What could you do with a sound activated switch? Size 1.5"x1.3" 7.5 TO 18vDC

VOX-1 **$6.95**

INDUCTANCE METER

This is the kit every one has been asking for. Turn your digital volt ohm meter into an inductance meter. It will read inductors 3uH to 7MH. Size 1.5"x1.6" 9vDC

IA-1 **$14.95**
CABINET **$ 8.95**

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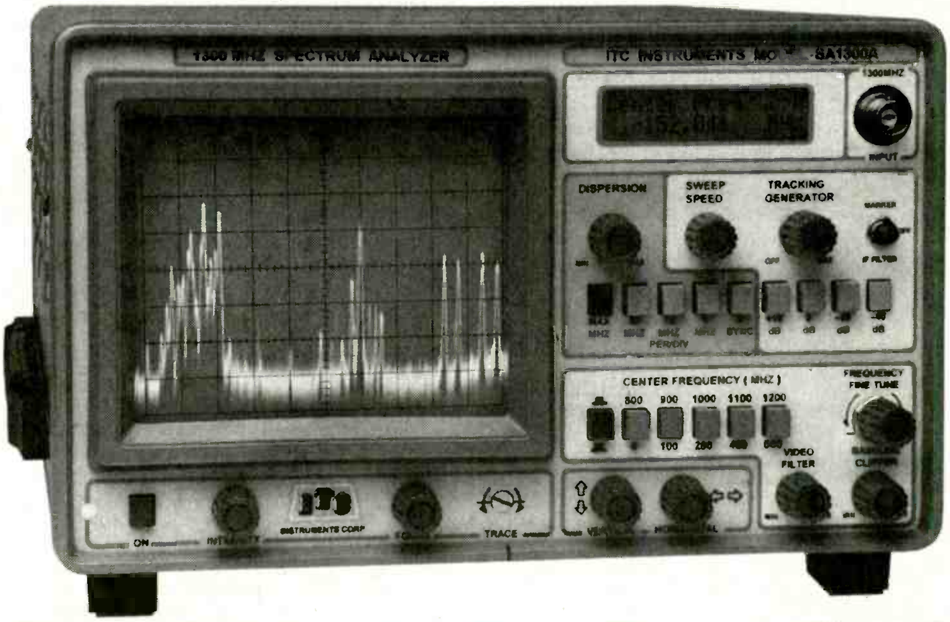

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Let our low-cost Microprocessor trainers lead you to the advanced 80386, 80486, ...etc.. Our training systems will help you learn BASIC, C, and ASSEMBLY languages programming and microprocessor/microcontroller system hardware design and troubleshooting.

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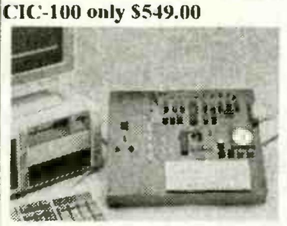


Features: Operate on IBM PCXT/AT or compatible, controlled by ASSEMBLY, C, or BASIC programming languages, 800-pin solderless breadboard for circuit design and test, I/O drivers for controlling relay, step motor, LED, speaker .... experiment manual. Application control modules available, including step motor, matrix key-pad and traffic light, A/D, D/A, F/V, V/F converters.

IFE-01 IC function tester/emulator **$149.00** Test up to 40-pin DIP IC's functions. Clock, pulses, Hi, Lo, and Hi-Z are generated. An inexpensive and required tool for students and technicians.

APEX-IE 8052 $699.00 In-Circuit Emulation Training Systems for 8052.

BGC-8088 only $699.00
Features: Assembly language coding, assembler, disassembler, single step and multi-breakpoint program debugger, display and rewrite registers, download/upload programs from/to external systems(IBM PC or compatible), I/O drivers, 56-key large size keyboard, LCD display, RS-232, UART, printer interface, two expansion slots, +/-5V, +/-12V switching power supply, user's guide and experiment guide, Practical control applications available, such as stepping motor, matrix display,.. etc., and .. more.

BGC-8052 $979.00 Intel 8051/8052 Embedded Microcontroller Trainer. It helps you learn the most powerful and popular Microcontroller in today's appliance control industries. Experiment guide and program examples are included.

U-DBGR $1599.00 Universal Debugger/In-circuit Emulator for commonly used Microprocessors, such as 6502, Z80, 8048, 8051, 8088, .. etc., and programer.

DC POWER SUPPLY

PS-303 $159.00
0-30VDC, 0-3A
0.02%+2mV line regulation
0.02%+3mV load regulation
1mVrms noise & ripple, Short circuit & overload protection.
PS-303D $314.95, dual.
PS-305 $239.95, 0-30VDC, 0-5A.
PS-305D $399.95.

8110 $329.95
0-60VDC, 0-3A.
8112 $449.95
0-60VDC, 0-5A.
8109 $749.95, dual output, 0-60VDC, 0-5A, independent tracking operation. Low ripple.
8202(8203) $499.95($549.95). triple outputs, dual 0-30VDC/0-3A(5A), fixed 5VDC/3A, indepedent tracking operation, constant voltage and current.

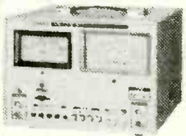
GRID DIP METER

DM-4061A $99.95
1.5-250MHz, 6 bands;
6 plug-in coils, 2 transistor, and 1 diode.
MODULATION: approx. 2KHz Sinewave
CRYSTAL OSCILLATOR: 1-15MHz
POWER SUPPLY: 9VDC.

AM/FM SWEEMAR SCOPE

SM-6225B/C $1999.95
FREQ RANGE:
420-490KHz(AM),
10-11.4MHz(FM).
ACCURACY: +/- 0.1%
MARKER: (AM)455KHz,+/-5KHz, +/-10KHz; (FM)10.7MHz, +/-7.5KHz, +/-150KHz.

WOW-FLUTTER METER



WF-3103 $699.95
FREQ. RANGE:
3KHz+/- 10% JIS/CCIR
3.15KHz+/-10% DIN.
MEASURE RANGE:
0.03/.1/.3/3% full scale.
ACCURACY: +/-5%.
WF-3105A $799.95, Digital;
FUNCTION: LIN/WOW/Flutter/WTD.
FREQ CNTR: 10Hz-9.99MHz
INDICATION: CCIR/DIN/JIS.

AM/FM STD SIGNAL GEN.

SG-4110A $1999.95
FREQ: 100KHz-110MHz
DISPLAY: 6-digit LED
RESOLUTION:
100Hz (100-34.99MHz); 1KHz (35MHz-110MHz)
ACCURACY: <+/-(5X10-E5 +/-1 count)
OUTPUT RANGE: -19dBu, -99dBu, 1dB step
IMPEDENCE: 50Ohm VSWR 1.2.

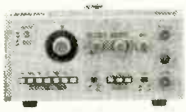
RF SIGNAL GENERATOR

SG-4160B $119.00
100KHz-150MHz up to 450MHz on 3rd harmonics, 6 ranges, AM modulation.
RF OUTPUT: 100mVrms to 35MHz.
MODULATION: INT. 1Khz, EXT. 50Hz-20KHz.
AUDIO OUTPUT: 1KHz, 1Vrms.
SG-4162AD $229.95, with Freq. Counter 10Hz-150MHz for internal & external source.

AUDIO GENERATOR

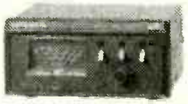
AG-2601A $119.00
10Hz-1MHz, 5 ranges
OUTPUT LEVEL: sinewave 0-8Vrms, square 10Vp-p.
OUTPUT IMPEDENCE: 600 Ohm. *DISTORTION:* <0.05% 500Hz-50KHz, <0.5% 50KHz-500KHz.
AG-2603AD $229.95, with Freq. Counter 10Hz-150MHz for internal & external source.

FUNCTION GENERATOR

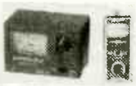


FG-2100A $169.95
0.2Hz-2MHz in 7 ranges; Sine, Square, Trianle, Pulse & Ramp
OUTPUT: 5mVp-p-20Vp-p. 1% distortion.
VCF: 0-10V control freq. to 1000:1.
FG-2102AD $229.95, generates signals same as FG-2100, 4-digit counter display, TTL & CMOS outputs, 30ppm+/-1 count accuracy.
FG-2020B $169.00
0.5Hz-500KHz; Sine, Square, Triagle.
(FG)2103 $329.95, Digital sweep generator. 0.5Hz-5MHz in 7 ranges.
OPERATING MODE: sweep, AM, gated burst, VCG.
FREQ. COUNTER: Internal.5Hz-5MHz
External 5HZ-10MHz

SWR/RF POWER METER



310 $89.95
FREQ RANGE:
1.8-150MHZ
RF POWER:
0-4W/20W/200W
SWR MEASUREMENT: 1.0 - oo, 4W minmum
ACCURACY: 5%-10%
INSERTION LOSS: 0.3dB
INPUT/OUTPUT IMPED.:
50Ohm;SO-239 plugs.



320 $89.95, 130-520MHz.
330 $129.95, 1.8-520MHz.
SWR-3P $26.95
1.7-150MHz, RF Power: 0.5-10W, 0.5W-100W.
SWR-2P $22.95, 1.7-30MHz, RF Power: 0.5-10W.
PM-330 $149.95 1.8-500MHz, 0-5W/20W/120W

STEREO MODULATOR

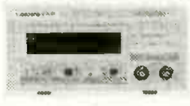
AG-2011A $549.00
RF SECTION: *CARRIER:* 98MHzZ+/-2MHz
OUTPUT: 10mV, 1mV & 0.1mV
COMPOSITE SIGNALS:
PILOT: 19KHz+/-2KHz, 0.8Vrms

INT. MODULATION:
400KHz, 1KHz+/-1%,
1Vrms, distortion: < .5%
L-R SEPARATION: >50dB.
EXT. MODULATION:
FREQ.: 50Hz-15KHz
L-R SEPARATION: >45dB 100Hz - 3KHz
>35dB 50Hz - 15KHz.

AUTO DISTORTION METER

DM-3104A $799.95
MEASUREMENT:
RANGE: 0.01%-30%
0.1/0.3/1/3/10/30% full scale.
FREQ.: 400Hz+/-10%
1000Hz+/-10%(HPF).
INPUT: 3mV-100V, ratio measuring 20dB.
AUTO. SWITCHING RANGES:
Fundamental Freq. = (fo)+/-10%;
Fundamental Rejection: >-80dB at (fo)+/-5%
>-70dB at (fo)+/-10%
HARMONIC ACCURACY: +/-.5dB, 1.8(fo)-20KHz.

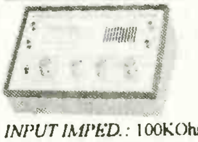
FREQUENCY COUNTER



FC-5250C $119.95
FREQUENCY RANGE:
10Hz-220MHz:
(HF)10Hz-20MHz,
(VHF)10MHz-200MHz
GATE TIME: 0.1 & 1sec.
INPUT SENSITIVITY: 35mV 10Hz-200MHz.
INPUT IMPED.: (HF) 1MOhm, (VHF) 50Ohm.
MAXIMUM INPUT: 10Vp-p.

FC-5260A $139.95
10Hz-600MHz.
FC-5270A $159.95
10Hz-1300MHz.
FC-5600B $329.00
10Hz-600MHz.
(FC)5700B $329.95, 10Hz ~ 1.3GHz

SIGNAL TRACER/INJECTOR

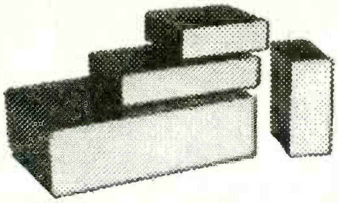


SE-6100 $134.95
TRACER:
Gain Max. 60dB
ATTENUATION:
0/20/40/60dB
INPUT IMPED.: 100KOhm
OUTPUT IMPED.: 600Ohm; SPEAKER: 8 Ohm.
INJECTOR: Freq. 1KHz Squarewave; Output Level: Continuously variable 0-4.5Vp-p.

COLOR PATTERN GEN.

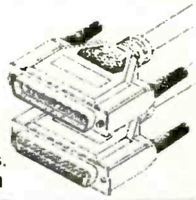
CPG-1366A $159.95. VHF NTSC.

CIRCLE 330 ON FREE INFORMATION CARD

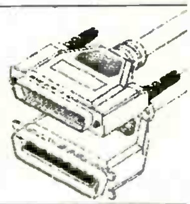


STEEL ENCLOSURES
Features include ventilation holes, self-adhesive rubber feet. Front and real panels are 0.05" aluminum alodine painted white. Top and bottom covers are 0.04" phosphated steel painted black.

E3119A (2.5" x 8" x 7")	$12.95
E3119B (2.5" x 12" x 7")	15.95
E3119F (2.5" x 17" x 11")	19.95
E3119G (3.5" x 8" x 7")	13.95
E3119K (3.5" x 17" x 11")	24.95
E3119P (5.2" x 17" x 11")	29.95

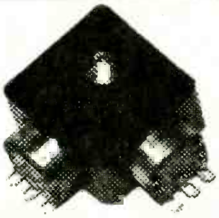


DB25 MALE TO FEMALE CABLE
Hi-quality molded ends. (94W006) **$5.95 each**



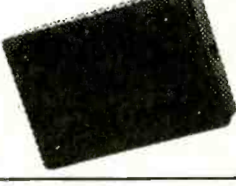
PARALLEL PRINTER CABLE
PC-compatible. High-quality molded ends.
- **3-Ft.** (94W006) **$2.89 each**
- **6-Ft.** (94W007) **$3.29 each**

NEODYMIUM MAGNETS
100+ Gauss each. (92N003)
6 for $9.95



JOYSTICKS
Base 1" x 1" x 1". Well-constructed.
- Two 5K pots. (93P004) **$3.95**
- Two 150K pots. (93P005) **$3.95**

SCANNER RF AMPLIFIER
5 MHz to 900 MHz installs at antenna and serves as a preamplifier to increase signal to noise ratio. Increase the sensitivity of your scanner or short-wave receiver over six times (10 dB gain). Easy hookup. Power supply and coupler included. (92A025) **$19.95 each**



AMAREX UNIBOX
2" x 2.5" x 0.75", with 0.125" hole in one end. (92U065) **Three for $5.00**

STEREO EARPHONES
Unit impedance 32Ω ± 1.5%; 27mm mylar speakers with washable ear sponge; max. power 0.05W; 4-foot cord; compatible with all personal stereo products. (93V002)
$3.95 each

PLUG-IN POWER SUPPLY
12VDC @ 0.8A. CIE #DV-1280. (93E009)
$4.95 each

3-SECTION DIELECTRIC FILTERS
- 1875 MHz. Matsushita #GPS1575. (93P013) **$9.95 each**
- 1226 MHz. Matsushita #GPS1226. (93P014) **$9.95 each**

15KV TRANSMITTING CAPS
10 pF (94P009) • 25 pF (94P010)
50 pF (94P011)
Your Choice - $12.50 Each

20 WATT, 50 OHM STRIPLINE RESISTOR
(92P003) **$9.95 each**

6-POLE LINEAR PHASE FILTER
10.7 MHz. Phase Linear #517N. (94P012) **$11.95**

BRAND "X" LENS
Eyepiece-type magnifier. Focal length = 50mm, f:3.2. Approx. dimensions: dia. = 38mm, length = 43mm. Excellent hand magnifier at approx. two power. (93L009)
$9.95 each

PAY RADIO DECODER (CODART)
Pay radio? That's right. Part of a system that broadcast purchased programs late at night, these Codart units would turn on one of two tape recorders when a coded tone was broadcast. Contains a Z-80 with 4K of EPROM, 2K of battery-backed up RAM, 18-key keyboard, 8-digit display and relays for the recorders. Reprogram it to make your own stereo or lamp timer, or a time lock to keep the kids from watching too much TV. With documents. (92C002)
2 for $19.95

TELETEXT DECODER
Teletext signals may be hidden in the TV signal you receive. The VBI-1 decodes the wealth of data at baseband level and converts it to channel 3 for reinsertion into your TV. Teletext messages may be watched superimposed over your favorite TV show. New. (94V002) **$89.95 each**

TELETEXT DECODER CARD
For the first time, the TeleText Decoder card lets you use your personal computer to receive news, sports, stock, traffic and other important news information through normal commercial, cable or satellite TV signals. Without the need and expense of modems, telephone lines or service fees, TeleText offers PC users the ability to view, capture, store and print TeleText information pages easily and quickly.

By simply connecting the TeleText Decoder card to a conventional TV antenna, cable hookup or satellite receiver and tuning in to a TeleText service TV channel, you can receive any TeleText information in full color and graphics. With additional software, you can even capture and manipulate stocks, mutual funds and money market funds for your own personal use. You can also watch regular TV programs with the built-in TV tuner together with a TV display card or by using an additional TV monitor.

For IBM PC, XT, AT or compatible computers, MS DOS 2.11 or higher. 512K memory required. VGA, CGA or EGA display recommended.
(94C001) **$199.00 each**

28V MINIATURE LAMP
40mA, 6" wire leads. (92L029)
4 for $1.00 or 100 for $19.95

12V ±5% 1W ZENER
RD12F. (93S031) **5 for $1.00**

QUACK MEDICINE?
These units are the heart of devices billed as "muscle stimulators" and marketed in the $200 price range. They run on a 9V battery with a 90V pulse output at the rate of approx. one per second. Assembled on a breadboard, components include a timer chip driver transistor and output transformer. Sneak one into biology labs and make a dead frog's legs kick. (94U002)
$4.95 each - 3 for $10.00

24-Hour BBS
(408) 943-0622
2400 Baud • N-8-1

ALLTRONICS
2300 Zanker Road • San Jose, CA 95131
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Visa, MC, AmEx cards accepted.
Minimum order $15.00.
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Shipping additional on all orders.

030594

CIRCLE 215 ON FREE INFORMATION CARD

KELVIN ELECTRONICS

10 HUB DRIVE, MELVILLE, NY 11747

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(516) 756-1750
(516) 756-1763/FAX

Established 1945

M/C & VISA — $20 Minimum Order

KELVIN CATALOG $3 Stock No. 650412

150 LE - *Student* 200 LE - *Technician* 300 LE - *Auto-Range* 400 LE - *Engineer*

Standard Features ● AC & DC VOLTAGES ● DC CURRENT ● RESISTANCE ● CONTINUITY TESTER - Buzzer ● DIODE TEST ● 10M ohm INPUT IMPEDANCE ● ACCURACY +/- 0.5% RDG

150 LE	200 LE	300 LE	400 LE
TRANSISTOR BATTERY TEST DC CURRENT 10 Amp	FREQ COUNTER up to 20MHz CAPACITANCE from 1pF to 20uF TRANSISTOR AC/DC CURRENT 10 Amp	AUTO RANGE with 3200 counts AC CURRENT DC CURRENT ANALOG BAR 10 Amp	INDUCTANCE Resolution 1uH FREQ COUNTER up to 20MHz CAPACITANCE from 1pF to 200uF AC/DC CURRENT TRANSISTOR DUTY % 20 Amp
Stock # 990122	Stock # 990123	Stock # 990125	Stock # 990124
$29.95	$49.95	$49.95	$79.95

KELVIN 100 Basic

\# 990087 $19.95

- AC & DC VOLTAGES
- DC CURRENT
- RESISTANCE
- 3 1/2 Digit LCD
- CONTINUITY TEST
- -Buzzer
- LOW BATTERY INDICATOR
- DIODE TEST ● BATTERY TEST

CAPACITANCE METER

KELVIN 250 LE $59.95

\# 990126

- 0.5% ACCURACY
- RANGES: 20mF, 2000uF, 200uF, 20uF, 2uF, 200nF, 20nF, 2000pF, 200pF
- Zero Adjust
- Safety Test Leads
- Test Socket for Plug-in Components

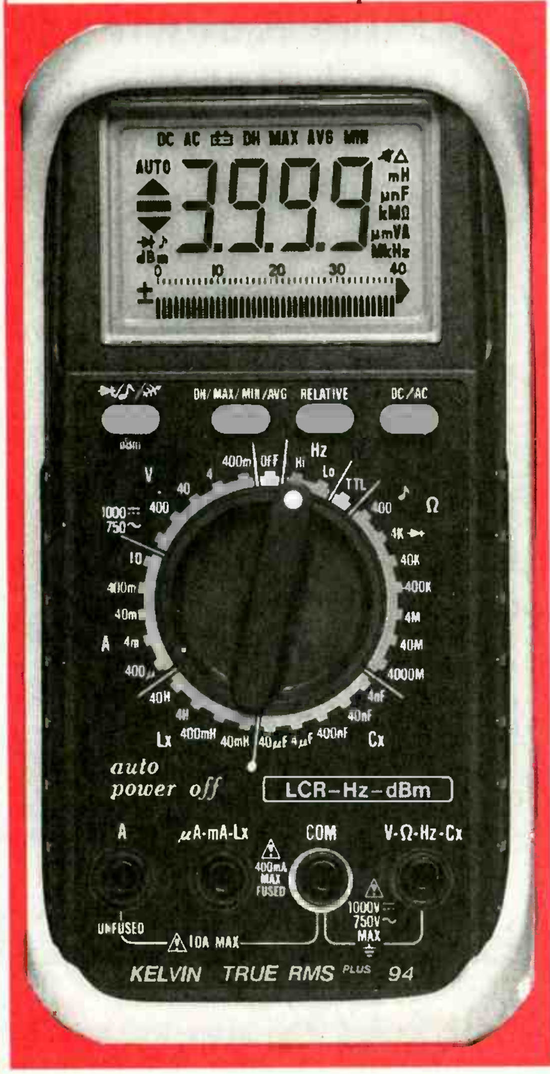
Designed to meet IEC-348 & UL-1244 safety specifications.

Protective Cases

For Models 100 Basic, 150LE, 200LE, 300LE .... $4.95 (#990088)

Case For Model 400LE .... $9.95 (#990116)

2 Year Warranty (Parts & Labor)



The Ultimate Meter

TRUE RMS - LCR - Hz - dBm

Popular Electronics (Reviewed - May 1993)

"Not only does the *Kelvin* 94 boast alot of features ... the features go the extra distance."

"If we had to run into a burning building to do some emergency trouble-shooting and could carry in only one piece of equipment, the *Kelvin* 94 would be it!"

12 INSTRUMENTS IN ONE -

DC VOLTMETER, AC VOLTMETER, OHMMETER, AC CURRENT, DC CURRENT, DIODE TESTER, AUDIBLE CONTINUITY TESTER, dBm, FREQ COUNTER, CAPACITANCE METER, INDUCTANCE METER, LOGIC PROBE

- **0.1% ACCURACY** ON DC VOLTAGES
- **TRUE RMS** ON AC VOLTAGES & CURRENT
- **FREQUENCY COUNTER** *TO 20 MHz*
- **LARGE EASY-TO-READ** 3 3/4 DIGIT LCD DISPLAY
- **AUTO SLEEP & AUTO POWER OFF** BUILT-IN TO SAVE BATTERY LIFE with Bypass
- **SHOCK RESISTANT** HEAVY DUTY CASE WITH YELLOW RUBBER HOLSTER & TILT STAND
- **WATER RESISTANT SEALED CASE**
- **30 DAY MONEY BACK** SATISFACTION GUARANTEE

$199.95 MODEL 94 #990111

COMES COMPLETE WITH YELLOW HOLSTER, PROBES, BATTERY, FUSE, STAND

0.1% ACCURACY on DC Voltages | Water Resistant

Freq Counter to 20 MHz

Protective Cases for Model 94

Regular Padded Zippered .... $9.95 (#990116)

Deluxe Padded Zippered .... $14.95 (#990115)

Meter is designed in accordance with safety requirements specified in IEC-348, UL-1244 VDE-0411.

CIRCLE 249 ON FREE INFORMATION CARD

"I earned $1,000 on just 12 VCR Repairs"

You can too! Learn to earn in one of these exciting areas. Your interest in electronics and these Foley-Belsaw Repair Manuals teach you how to make big profits in the exciting and profitable world of electronics.

- ✔ **VCR Repair Training**
- ✔ **Advanced VCR Repair Training**
- ✔ **Camcorder Repair Training**
- ✔ **Computer Printer Repair Training**
- ✔ **Basic/Digital Electronics Training**
- ✔ **Fax Repair Training**

Repair Manual and Video Tape will Make you a Professional Repair Expert!

All service manuals and training videos are developed and produced in a repair shop. You will discover valuable repair **"secrets"** and tips that are virtually impossible to obtain anywhere else. The service manuals and training videos are thorough, practical, easy to understand, with lots of illustrations.

You'll learn to:

- Pinpoint and analyze problems quickly.
- Successfully complete repairs with hands-on trouble shooting instructions.
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- How to competently use test equipment.
- How to diagnose malfunctions.
- How to keep your equipment in top condition with effective preventive maintenance.

One Source For All Your Repair Needs

Better than a magazine, more current than a book.

- Each service manual developed in a repair shop.
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30 Day Money Back Guarantee

If you are not completely satisfied with your purchase from our company, return it (Freight Prepaid) within 30 days with your original invoice; we will gladly replace the product, give you credit, or refund your money in the original method of payment.

For faster service, call Toll-Free, 1-800-821-3452
Or fax your order - 816/483-5010

Order Form – YES, please send me the items checked below.
I am enclosing a check or money order payable to:
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Kansas City, MO 64120-1395

FOLEY BELSAW

❒	BJKG7025	VCR Training Manual (400 pages) with 30 minute video tape.	$49.95
❒	BJKG7026	Advanced VCR Training Manual (200 pages) with 84 minute video tape.	49.95
❒	BJKG7027	Camcorder Training Manual (500 pages) with 60 minute video tape.	49.95
❒	BJKG7029	Computer Printer Training Manual (300 pages) with 90 minute video tape.	49.95
❒	BJKG7028	Fax Training Manual (400 pages) with 30 minute video tape.	49.95
❒	BJK6100032	Basic Digital Electronics Training Manual (240 pages only).	39.95
❒	BJK6100078	30 minute VCR Tricks & Tips Video Tape	29.95
❒	BJK6100037	30 minute Trouble Shooting VCR's with the Oscilloscope Video Tape	29.95

Add Postage & Handling	$ 3.00
Sales Tax: MO 6.475%, MN Metro Mpls. 7% Non-Metro Mpls 6.5%, MI 4%, NY 8%, WI 5.5%	
Total Enclosed:	

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Please charge to my: ❒ Discover Card ❒ MasterCard ❒ VISA

Signature X ____________________

If MasterCard, please fill in small numbers at left above name.

CIRCLE 321 ON FREE INFORMATION CARD

ALFA ELECTRONICS

HIGH QUALITY TEST EQUIPMENT
BEST PRICE

DMM 89 $199.95
Most Advanced DMM
All Purpose & Communication
-80.7 to 81.4 dBm with 4Ω –1200Ω 20 reference impedances
True RMS
Frequency counter: 0.01Hz-10MHz
Capacitance: 1pF-50,000μF
Measure AC volt to 20kHz
5000 counts, 0.1% accuracy
Auto/manual range, fast bar graph
Min/Max/Ave/DH/Relative/Zoom
Auto power off
Input warning
Splash proof
Volt, amp, ohm, logic, diode, continuity
Ruggerdized case
Rubber holster included

DMM 2360 $119.95
DMM+LCR Meter
Very Versatile DMM
Inductance: 1μH-40H
Capacitance: 1pF-40μF
Frequency: 1Hz - 4MHz
Temperature: -40-302 °F
TTL Logic Test: 20MHz
Diode, Continuity
Volt, Amp, Ohm
3999 count display
Peak Hold
Auto power off
Ruggerdized case.
Rubber Holster $8.00
Temperature probe $7.00

DMM 21 $74.95
Inductance: 1μH-40H
Capacitance: 1pF-200 F
Frequency: 1Hz-1MHz
Volt, amp, ohm, diode, continuity
3999 count display
TTL logic, HFE
Peak hold
Ruggerdized case
Rubber holster $8.00

Full line of DMMs, economy, compact, ruggerdized, solar cell, automotive, heavy duty, industrial, starts from $15.95

Fluke Multimeter

Fluke 12	$84.95
Holster C-10	$10
Fluke 70 II	$67.5
Fluke 73 II	$94
Fluke 75 II	$129
Holster C-70	$16
Fluke 77 II	$149
Fluke 79 II	$169
Fluke 29 II	$169
Fluke 83	$225
Fluke 85	$259
Fluke 87	$287
Fluke 97 Scope Meter	$1785

LCR Meter 131D $229.95
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SMD and chip component test probe $25.00

LCR Meter 814 $189.95
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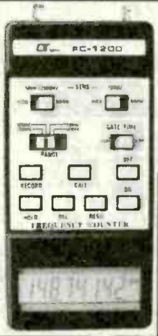
SMD and chip component test probe $25.00, Deluxe carrying case $5.00



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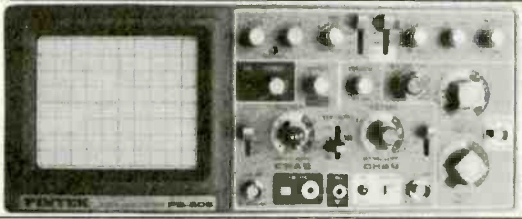

20 MHz Oscilloscope with Delay Sweep PS-205 $429.95
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PS-400 40 MHz DUAL TRACE	$494.95
PS-405 40 MHz DELAY SWEEP	$569.95
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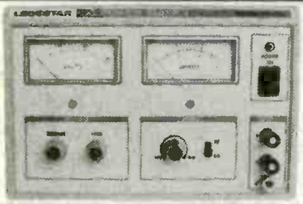

DC Power Supply PS-303 $159.00
0-30 VDC , 0-3A output
Constant voltage & constant current mode
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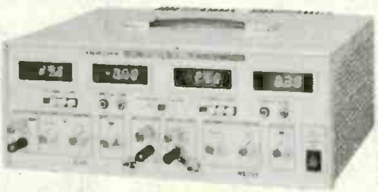

DC Power Supply Triple Output PS-8202 $499.95
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Capable of independent or tracking operation
Constant voltage and constant current mode
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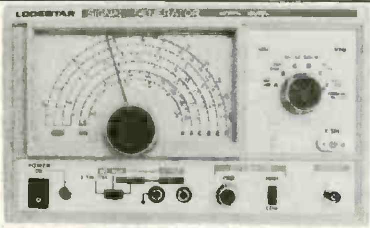
Excellent regulation and low ripple
Short circuit and overload protected
Also available: 30V/5A triple output $549.95
Dual tracking 30V/3A, 30V/5A, 60V/3A, 60V/5A



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100 kHz-150MHz sinewave in 6 ranges
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Audio output 1 kHz, 1 Vrms

AUDIO GENERATOR AG-2601A $119.00
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0-10Vp-p squarewave
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Output distortion:
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0.5 % 50Hz - 500kHz
Output impedance: 600 ohm

FUNCTION GENERATOR FG-2100A $169.95
0.2 Hz -2 MHz in 7 ranges
Sine, square, triangle, pulse and ramp
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1% distortion, DC offset ± 10V
VCF: 0-10V control frequency to 1000:1

FUNCTION GEN/ COUNTER FG-2102AD $229.95
Generates signal same as FG-2100A
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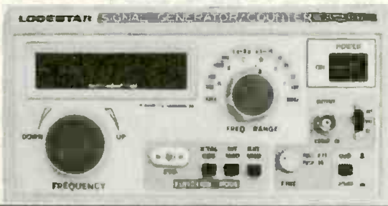
Feature TTL and CMOS output



RF SIGNAL GEN./COUNTER SG-4162 AD $229.95
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10uF/25V............ 5¢
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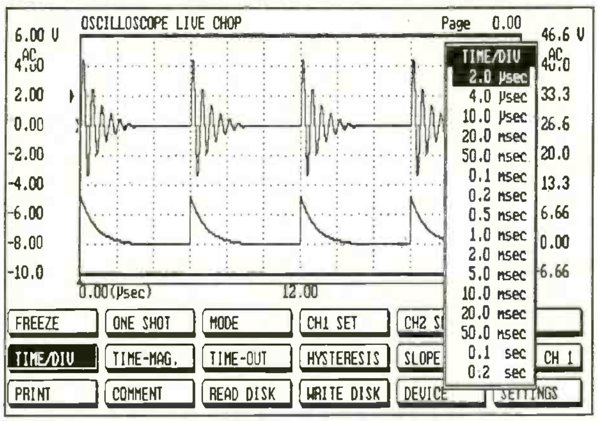

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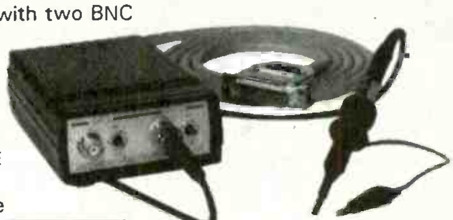

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MULTIFUNCTIONAL: TP5008

The TP5008 is an interface card that provides an analog output in addition to two input channels. This output in combination with the two inputs may be used for the setting up of a complete control loop. The output may also be used as a function generator.
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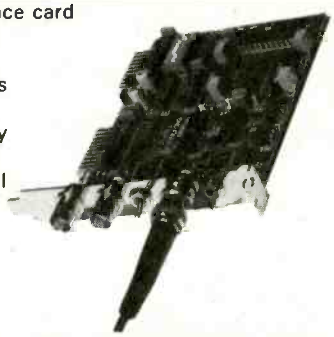
Separately available are 1:1-1:10 probes and 1:100 oscilloscope probes.



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VERY HIGH SPEED: TP208

The TP208 is an interface card with a measuring time of 2x20 Megasamples/sec (8 bits). Phenomena shorter than 1 millionth of a second can still be measured well. The completely digitized triggering ensures very stable triggering with many trigger possibilities.
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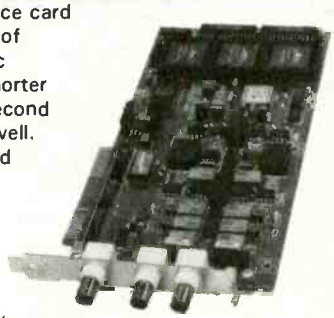

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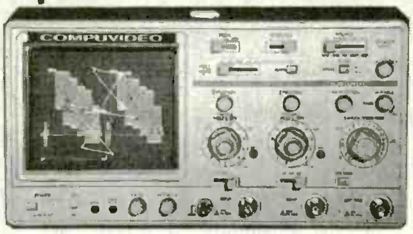

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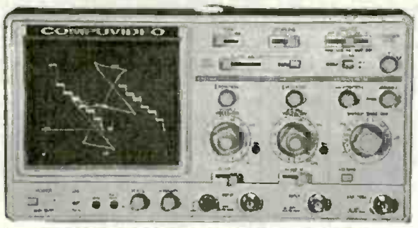

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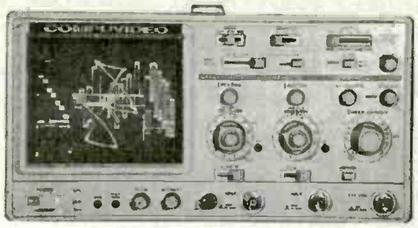

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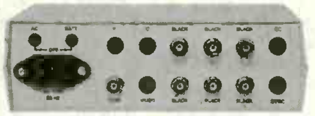

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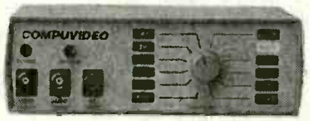

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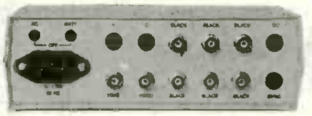

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SMPTE BARS
GENERATOR
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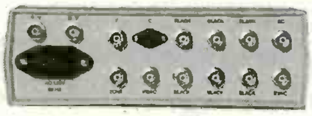

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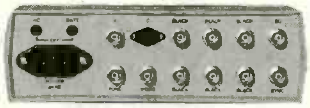

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Great value, 20MHz, dual trace analog-digital o'scope. 1 mV/div. sens. 20 MS/s with 2048x8 bits/Ch. Built-in component tester.

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MODEL 5005.......$995.00
0.5MHz-500MHz, digital freq. display, >110 db range, with scope display. Outstanding!

MODEL 5006....$1,328.00
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Hand-held, 50MS/s digital oscilloscope with 16 ch. logic analyzer and digital multimeter functions.

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Telephone line manager.Used with multi-number service to decode distinctive ring and connect to associated output. Up to 3 numbers/line. Great for FAX, computer, HOT-lines, etc.

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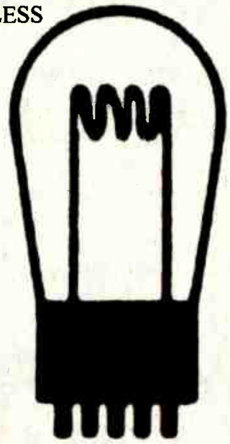

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Built into tube socket. Direct plug-in replacement for all 5Y3, 5U4 and 5AR4 types. $5.90 each, 10 at $5.50 each

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5R4	3.90	6BE6	3.60	6EU7	13.25	6U10	5.80	7308	8.50
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6080 w Philips.	4.90	6BK11ampeg	9.90	6GW8	6.90	6X5	3.90	811A	11.90
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6550GE	23.50	(Triode + ceramic socket)		6K11	6.50	12AV7	2.90	0A2	3.90
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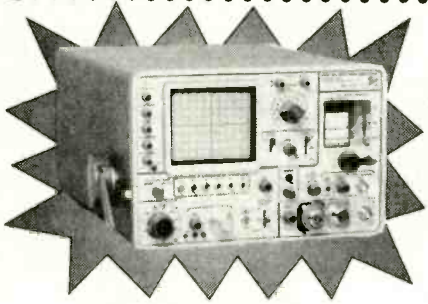
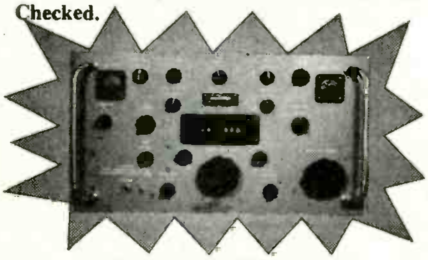


INDUSTRY STANDARD TEKTRONIX 491 SPECTRUM ANALYZER

Covers 10 Mhz - 40 Ghz. Solid state portable unit features internal phase lock, minimum sensitivity is - 100 dBm. A 12.4 Ghz mixer is included with each unit. External mixer kit (40 Ghz) and attenuators are available with purchase of each 491 for $400.00 extra per set. **Price: $1,200.00 ea. Checked.**



R390A RECEIVER

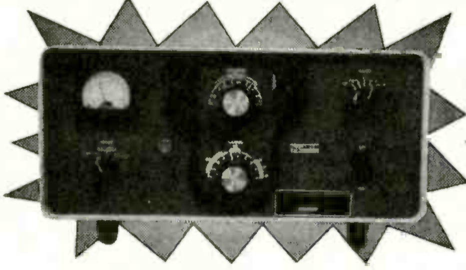
"The **CLASSIC RADIO RECEIVER** that is still a great investment". - These units are complete with ***orig. meters*** and cover the frequency range of 0.5 - 32 Mhz in AM, CW, MCW with direct frequency readout via mechanical digital display -physically complete, less covers.

Price: $195.00 Used Repairable

BECKMAN INDUSTRIAL PROG-POWER SUPPLIES PPS 300 / PPS 600

Either digital high performance power supply operates in any no. of modes e.g.:Man, Delta V, Delta T, Remote, CC, CV, Progammable via IEEE-488 or keyboard entry. Output power for the PPS-300 is 40 VDC @7.5A and PPS-600 is 60 VDC @10.0A. These units are new in original carton and come with instruction book.

Price:PPS-300 $750.00 PPS-600 $1100.00

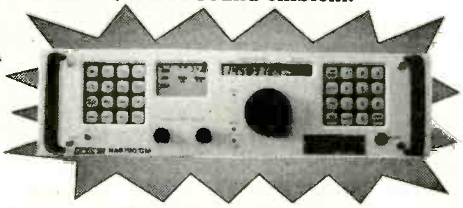


COLLINS 30L-1 POWER AMPLIFIER

One of the finest mid-size linear amplifiers ever produced specifically for the Premier Ham Radio Operator. It covers the 80,40,20,15 and 10 meter bands in either SSB, CW, RTTY or SSTV modes. Input drive power is 70-100 watts for full output. Power input is 1200watts, @ 115/230 vac 60 Hz. **Output power** is 650 watts RF (1000w @ reduced duty cycle).

These units are in exceptional condition complete with cables and connectors. If your looking for the amp opportunity of a life time, you've just checked-in!!!

Price: $695.00 round emblem.



RACAL RECEIVER RA 6790/GM

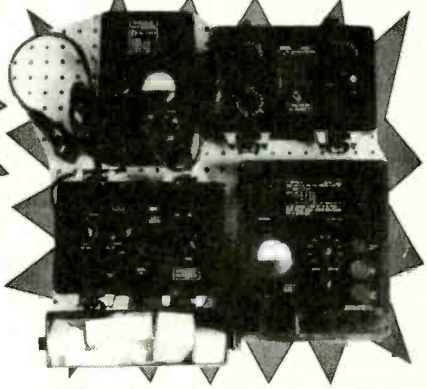
Superior quality and design are standard in this 500Khz-30Mhz general coverage receiver. Modes of operation are AM,FM,CW,U/LSB,ISB -optional, with room for seven bandpass filters. The illuminated LCD display features large readable digits for frequency and mode status as well as AF or RF signal strength.Tuning can be directly entered via keypad or with a tuning knob. Three different gain modes are Manual, Automatic, and Automatic with selectable threshold. Fully Checked & Operational.

Price: $995.00 Radio only-less filters.

Bandpass Filters: 400Hz / 1.2KHz / 2Khz / 6.8KHz 16Khz / USB/ LSB are **$65.00 ea.** max 4 per unit.

All Prices in U.S. Dollars
Please include telephone/fax number with mail-in orders.
Orders must be prepaid by guaranteed instrument.

Manuals available at extra cost



SPECIAL FORCES RADIO SET R-1004/GRC-109 T-784/GRC-109

"Its a dream come true."Complete GRC-109 radio sets including all the goodies as follows:

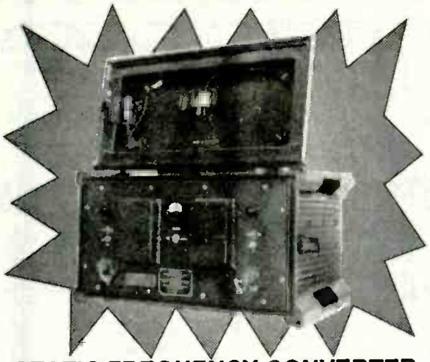
- R-1004/GRC-109 Receiver
- T-784/GRC-109 Transmitter
- PP-2684/GRC-109 Power supply (AC,DC)
- PP-2685/GRC-109 Power supply (AC only)
- CN-590/GRC-109 Voltage regulator (For hand crank generator)
- Plus Headset, Accessory kit with new spare tubes and parts, original manual and cables.

These are new in the box. A ***FABULOUS*** collector item!! **Price : $350.00 Complete sets only.**

MILITARY STANDARD D.C. GENERATOR

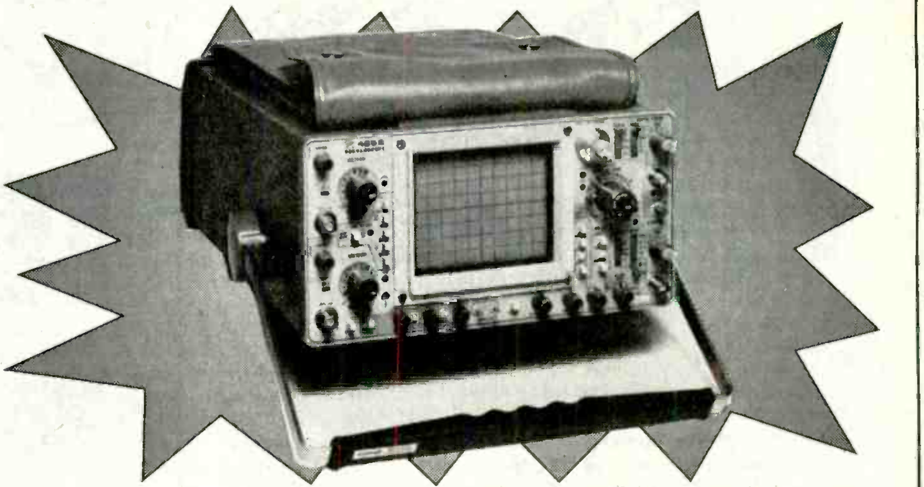
Superior QUALITY plus rugged design are features of this deluxe 2 cylinder gasoline generator. The control panel contains meters for voltage & current indication , main circuit breaker and voltage adjustment.Shielded wires and plugs comprise the RFI suppression ignition system eliminating most radio noise. These units are "new" in the original carton complete with operators manual and only require fuel and oil for operation, output voltage is adjustable approx 10-32v (28v) nominal @ 53.3 amps (1.5Kw) continuous load.

Price: $295.00 New in Original Carton
Weight =121 lbs. Dim=L 27"xH 18"xW 20"



STATIC FREQUENCY CONVERTER

Finally a simple way to power up all that 400 cycle stuff. This is a completely self contained solid state converter that just plugs in to any 115vac 60 Hz power source and provides easy instant 400Hz single phase 115vac output @500 watts. **Price: $595.00 ea. New in Original Carton**
Dim=L21"xW12"xH15" Weight=99lbs

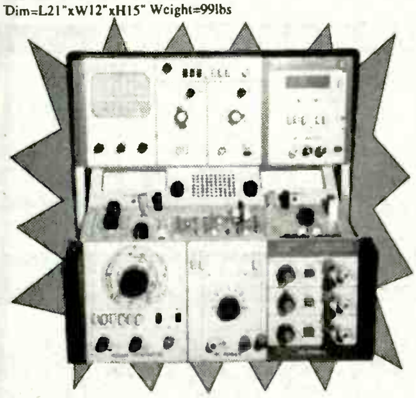


TEKTRONIX 465B

Proof is in the pudding when it comes to this instrument's track record. There's no doubt, that popularity speaks many languages when speaking of the "465B". This excellent instrument continues the tradition of the standard 465 oscilloscope by adding useful features such as CH-1, CH-2 sum or difference, trigger view in any combination, alternate sweep and trace selection versatility. Many technicians dream of owning a quality 100-MHz oscilloscope, but funding rairly permits. Fortunatcly, we were recently able to aquire a limited supply of 465B-s in nearly *new* condition. Our LOW PRICES will likely permit "you" to own one of the best scopes anywhere in the country. If your needs are current and action *swift* you too will be a member of a growing club!!!

SELECTED EXCELLENT COND......$849.00
VERY GOOD CONDITION.................$695.00

These instruments are fully checked out and calibrated. They are supplied with an original front panel cover and complete service manual. Original TEK Probes are $75.00 each with each purchase.



NIDA ELECTRONIC TRAINER

For those of you with limited funds this system provides you with the most essential instruments in one system. It incorporates the following:

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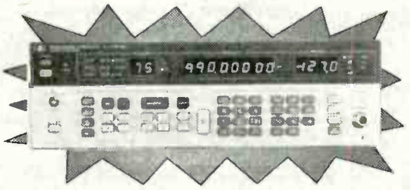
- -Autoranging DVM
- -Function generator
- -"3" variable dc power supplys
- -"1" variable ac power source
- -Precision decade resistance
- -Speaker and 2 analog meters

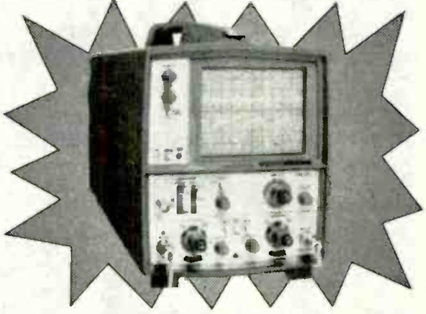
This unit comes complete with a number of electronic experiments assembled on easy to use plug-in cards. **Price: $365.00**

Just Arrived-
New stock of ***high end*** Harris, Rockwell-Collins and Racal communications equipment. Call for more information and availability.



HEWLETT PACKARD 8656B SYNTHESIZED SIGNAL GENERATOR

This Generator operates from .1Mhz-990Mhz. Modulation is AM or FM with int. 400Hz/1KHz modulation. This unit contains a high performance ovenized oscillator OPT 001, HPIB interface and OPT 002 rear panel output. High-performance and economy make this a great investment. The units are "NEW" never used, still factory sealed. manuals available.
Price: $5995.00 New.



TEKTRONIX T-922 15 MHz OSCILLOSCOPE

Recommended as an excellent starter scope or for those on a tight budget but with an appreciation for quality test gear in their lab. This rugged little scope features 2 input channels T.V.. trig, bright large CRT and X,Y capability. Unit is shipped fully checked out and ready to go. **Price: $269.00**

- -HP 8565A SPECTRUM ANALYZER .01-40GHz............$6250.00
- -HP 8558A SPECTRUM ANALYZER .01-1.5GHz............$2750.00
- -HP 8559A SPEC-ANALYZER .01-22GHz............$4995.00
- -HP 8160A OPT-20 PROG PULSE GEN............$4995.00
- -HP 4260A LCR BRIDGE............$ 385.00
- -HP 3551A TRANSMISSION TEST SET............$1275.00
- -EXACT 566 SWEEP/FUNCTION GEN............$ 345.00
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- -COLLINS 516-F2 PWR SUPPLY(USED)............$ 85.00
- -HARRIS RF280 HF/TACTICAL TRANSCEIVER............$1500.00
- -LEXEL MOD 75 HIGH POWER ARGON LASER............$1500.00

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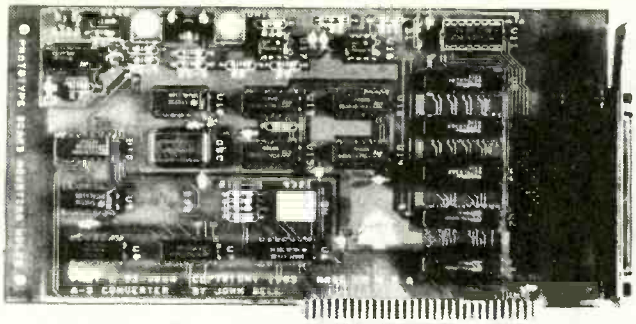

12 Bit 8 Channel A-D Converter

IBM Compatible - Input voltage 0 to 2 volts (0.00048 volts per count). Conversion time <1ms. Accuracy is better than +/- 2 counts. Linearity is better than +/- 1%. Part #93-326A $149.95. Also a 50 MHz sample rate with 8 bit conversion. $179.95 This board has one 8 bit TTL input port and one 8 bit TTL output port and comes with a diskette with BASIC programs for Data logging, Low Frequency Oscilloscope, Temperature measurement using a Radio Shack Thermistor, and Voltage measurement.

I also have a Parallel I/O board using 2 8255s (48 I/O Lines), Relay Output board, Opto Isolated Input board, 8748 Controller and more. Circle my number on the FREE INFORMATION CARD to get more info on my other interface boards.

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CIRCLE 133 ON FREE INFORMATION CARD

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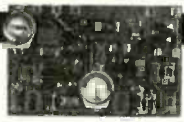

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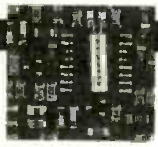

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- SMALL SIZE 1-1/4"x15/16"x1/4"
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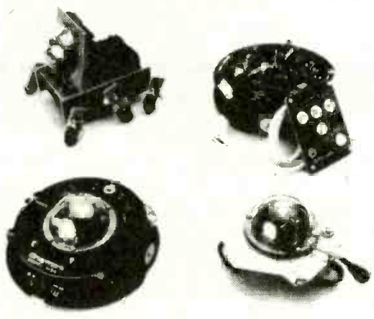

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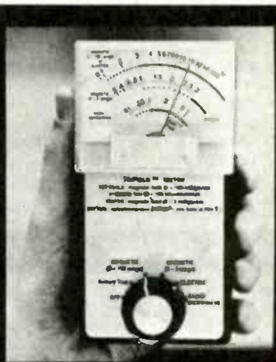

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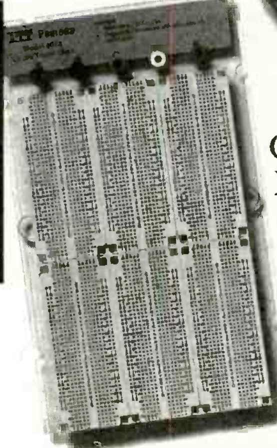

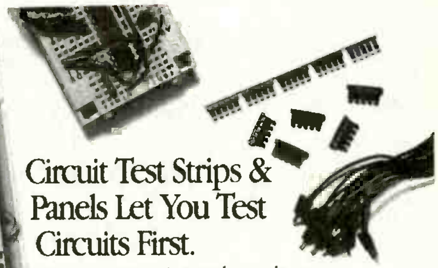

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Since 1971. As seen on TV, etc. John Williams - former Lockheed Senior Engineer, NMSU Computer Science Professor, NIH Health Physicist. WANTED: MAC llci. portable or better.

*All software supports all IBM-PC compatible x86 systems (8086 - Pentium)

Off-The-Shelf HARDWARE

Van Eck Systems, Automated Tempest Module, KX Radar Emitter, Carjacking Foiler, Personal Body Alarm, Voice Disguiser, Hearing Assistor, Shriek Module, EM Countermeasure, Omnimax TENS, 6th Sense Communicator, many nifty Phone Boxes, Bumper Beeper, Subliminal Mixer/Amp, Rife Device, Neurophone, Hieronymus Machine, Magnetometer, Data Card Reader/Writers, Dwelling Security System, Levitator, Vortex Generator, Ultrasonic Jammer & Receiver, Long-Range Eavesdropper, Noise Cancellation System, Unknown Presence Detector, Electronic Dowser, Automatic Pet Feeder, Stealth Paint - many more! See our Catalog.

CELLPHONE MODIFICATIONS

See our Catalog for our infamous cellphone modification guide ($69) - detailed, comprehensive, covers all makes - 10 times more info than competitor's "guides"). (Do Special Projects (below) for up-to-date hardware/software).

SPECIAL PROJECTS

We design, build, repair, modify, maintain and-or consult on any device, system, process or project - electrical, electronic, computer, phone, mechanical, optical, automotive. Invention prototyping. Confidentiality guaranteed. Describe and include $25 pre-engineering fee (does not obligate you). Time and cost estimates in 7-10 days.

VOICE MAIL HACKING

How Voice Mail Box (VMB) systems are used and the specific ways they are hacked. Includes ASPEN, MESSAGE CENTER, BIX, GENESIS, EZ. SYDNEY, PHONE MAIL, AUDIX, CINDY, CENTAGRAM, SPERRY LINK, RSVP, etc. Absolutely required for all users, sysops and security personnel! $29.

PBX HACKING

1,000s of PBXs are hacked to the tune of $ Billions/yr! While "VOICE MAIL HACKING" details how VMSs are hacked for "phun" and profit - including VMS methods for hacking PBXs themselves - "PBX HACKING" addresses ALL issues relating to PBX hacking, including countermeasures! Can your business or agency afford a $90,000 phone fraud loss (the average loss due to hacked PBXs)? As described in Forbes Magazine. $39.

PHREAKING CALLER ID & ANI

Details on how they work and dozens of effective ways of defeating Caller ID, ANI, *69, *57, and Call Blocking and *67. Also describes Caller ID, Orange, Beige, Cheese and CF Boxes, ESS, SS7, E-911, various CLASS services, CNA, NON PUB DA, CAMA, ONR, 800-ECR, Diverters, LD Extenders, Centrex - more. $29.

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As designed by Phone Phreaks! 15 phone color boxes described. Dozens of circuits, simulator programs. Plus call-forwarding, conferencing, phreak history, 50 useful and legal phone circuit plans - more. $29.

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ATM crimes, abuses, vulnerabilities and defeats exposed! 100+ methods detailed, include: Physical, Reg. E, cipher, PIN compromise, card counterfeiting, magnetic stripe, false front, TEMPEST, Van Eck, tapping, spoofing, inside job, super-cool, vibration, pulse, high voltage - others. Case histories, law, countermeasures, detailed security checklist, labeled internal photos, figures. ATMs contain up to $250,000 in cash! Recent $350,000 ATM crime spree still unsolved! $39.

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Unique system that highly discourages costly software piracy while not interfering with legit archival copies. No known way to defeat. No special equipment required. Simple and automatic to install on your distributed software. Compatible with all copy-prevention systems. Manual + Disk* $59.

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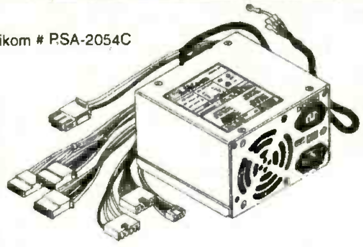

Fan cooled, fully enclosed switching power supply for PS2 computers. Input: 120/240 Vac. Selector switch on case. Outputs: 5 Vdc @ 23 Amps, 12 Vdc @ 9 Amps, -5 Vdc @ 0.3 Amps, -12 Vdc @ 0.5 Amps. 5.92" X 5.53" X 3.4." Male and female IEC connectors for AC input and output. Wire leads with Molex-type connectors for output. UL and CSA listed.

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Teledyne Relays # 615-8500
Control Voltage: 3-32 Vdc
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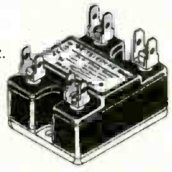
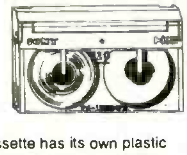


CAT # SSRLY-14

$10.50 each **10 for $95.00**

8 mm Video Camcorder Users! (USED) "HI-8" VIDEO CASSETTE

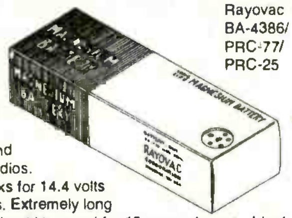


We have a new supply of these popular T-120 (120 minute) Hi-8 video cassettes. These are top quality, metal oxide (particle) cassettes that were used for a short time, then bulk-erased. Each cassette has its own plastic storage box. New, they would sell for considerably more than we're asking. We've sold thousands.

$3.00 each CAT# VCU-8 **10 for $28.00**

LONG LIFE MAGNESIUM BATTERY

Rayovac # BA-4386/ PRC-77/ PRC-25



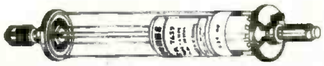
Built for military communications equipment including PRC-77 and PRC-25 radios. Output jacks for 14.4 volts and 3 volts. Extremely long shelf life, should be good for 15 years storage. Ideal for emergency applications. 6 pin output jack can be used with banana plugs. 9.375" X 3.57" X 2.07" cardboard jacketed case. 3 lbs.

$4.00 each

CAT # MB-4386

LASER TUBE

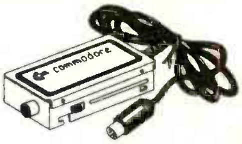
Siemens# LGR 7659.



1 mW helium-neon laser tube. 22.5 mm diameter X 146 mm long. 1.7 mrad beam divergence. 7 kV start voltage. 1kV operating voltage. 3.5 mA current.

$25.00 each CAT # LT-1

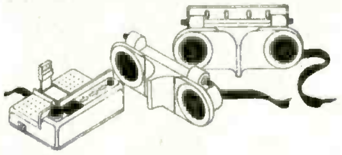
VIDEO/RF MODULATOR



Originally made for use with the Commodore computer, these good quality video modulators were probably originally designed for 9 Vdc use, but they operate well on 6-12 Vdc. They accept color video and audio, and a selector switch is provided for output to channel 3 or 4. Easy to hook-up. Requires a 6-12 Vdc power supply or wall transformer and a connector to interface with your audio/video source. Output is an RCA jack. Hook-up instructions included. 3" X 1.47" X 0.75".

CAT# AVMOD-3 **$5.00 each**

ULTRASONIC PROXIMITY DETECTOR

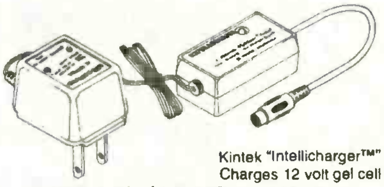


The ED-100 was designed for use as an auto/RV/truck back-up alarm. Two 40 khz ultrasonic emitter/detector modules attach to the back of the vehicle and warn the driver when the rear of the vehicle is within 24 feet of another object. A digital display and audible beeper inside the car continually monitor the distance to impact. The ultrasonic modules measure 5.81" long X 1.9" wide X 2.05". Operates on 12 or 24 Vdc Includes instructions for installation. The units are new, in original cartons and, as far as we know, in working condition. The company that marketed this device is no longer in business, and no manufacturer's guarantee is in effect. **We offer these ultrasonic detectors for experimentation only, and in no way wish to promote their usefulness as a driving aid.**

Originally Sold For OVER $100.00.

$24.95 each CAT # ED-100

GELL CELL BATTERY CHARGER



Kintek "Intellicharger™" Charges 12 volt gel cell lead-acid batteries of 1.6 amp/hours or greater. Charger circuit regulates current, providing more current to low cells and gradually ramping down current as battery approaches full capacity. Bi polar LED glows red when battery is taking a fast charge and green when battery is ready for use. Batteries can be left on charger indefinitely. Originally designed to charge a particular phone battery, the output cord on this device terminates with a 5 pin DIN plug which can easily be replaced with connectors more suitable to your particular application. You will need to open the case, clip-off the DIN cord and reconnect desired output cord.

CAT# CK-128 **$7.50 each**

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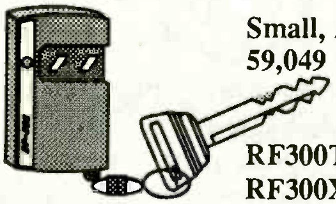

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59,049 Settable Codes, 120'–300' Range, 1–1/4" x 2" x 9/16", Assembled

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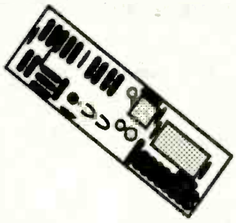
RF300T	150' Range Transmitter	24.95	19.95	15.95
RF300XT	300' Range Transmitter	29.95	24.95	19.95



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1–1/4" x 3–3/4" x 9/16" PCB w/ .1" spaced pads for standard connectors
Input: 8–24 vdc Output: Gated CMOS Momentary and Latching Lines

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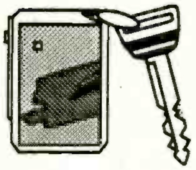
RF300RK	Receiver, Complete Parts Kit	19.95	15.95	12.95
RF300PA	Pre–Amplifier. Doubles Range	14.95	11.95	9.95



Small, Economical, Single Channel Transmitter and Receiver Set
Set Code, 60' Range, 1–7/8"x2–3/8"x7/16" (T), 2"x2–3/4"x9/16" (R)
Receiver Input: 5 vdc Output: Gated TTL Momentary Line

	Qty	1	5	10
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MODEL TD-RFW
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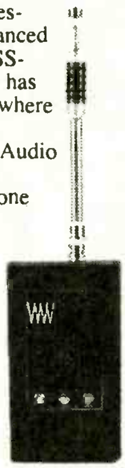
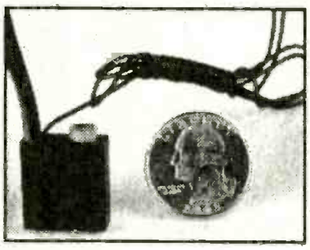


MODEL SS-500 $385

VIDEO TRANSMITTER



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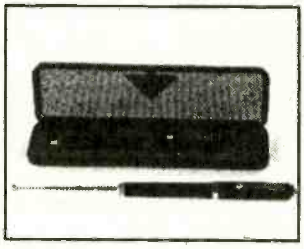

This pen is specially designed for executives and professional technicians, but simple enough for first-time users! Detect transmitters anywhere, anytime including room bugs, body mikes, phone bugs – even your cellular phone!

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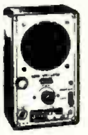

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T-50-3	.55	FT50-77	.75
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T68-0	.75	FT82-67	1.00
T68-2	.75	FT82-68	1.00
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Balanced Mixer/OSC. Popular IC among experimenters for building DC and super-het receivers
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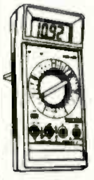

DIGITAL LCR METER measures inductance, capacitance and resistance. At Last! An LCR meter that everyone can afford. Now you can measure coils, transformers, chokes from 1μH to 200H. Capacitors from .1 pfd to 200 mfd and resistors from .1 ohms to 20 meg ohms. All in one handheld instrument.

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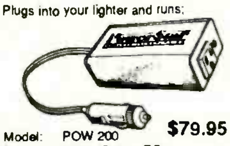

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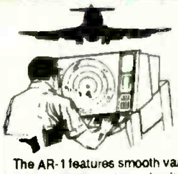
AIRCRAFT RECEIVER KIT ...puts you in the pilots seat!!



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$119.95

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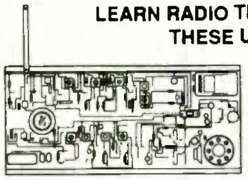
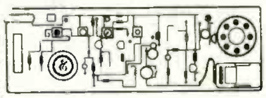


Both kits include an assembly, lesson and theory of operation manual. The actual assembly is broken into simple sections. Each section should be completely tested before moving on. This reduces difficult troubleshooting associated with many similar kits. Both include practical hi-tech PC board, with schematic printed on the surface, battery, all components and solder. The manual is easy to understand, no previous knowledge of electronics necessary. Each radio kit PC board has been so designed that no cabinet is necessary. A special bracket provides the necessary support to use the radio in any location, displaying the work achievement.

AM/FM-108 .... $29.95
AM/FM Superhet RADIO KIT AND TRAINING COURSE 14 Transistors and 5 Diodes



AM-550 Transistor Superhet AM Radio Kit . $19.95

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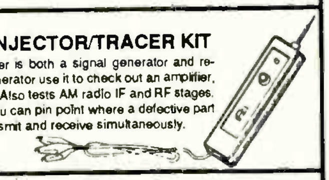
Learn the basics of fiber optics data communications while you build this exciting kit. Comes complete with all the necessary components, including PC board and fiber optics cable, also separate transmitter and receiver.

SIGNAL INJECTOR/TRACER KIT



This handy tester is both a signal generator and receiver. As a generator use it to check out an amplifier, stage by stage. Also tests AM radio IF and RF stages. As a receiver you can pin point where a defective part exists. Will transmit and receive simultaneously.

$18.95

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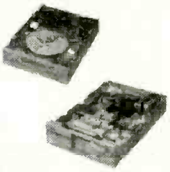
Parts Express International Inc.

Teac Floppy Disk Drives



High quality disk drives made by Teac. Standard putty color. High density 3-1/2", 1.44 MB and 5-1/4", 1.2 MB.

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#EN-130-532 .. $69.90 EACH . $64.95 (2-UP)

The Ultimate Test CD

The Ultimate Test CD was designed for use by both the audio amateur and the professional sound engineer. This CD can be used to test CD players, speakers, amplifiers, and for tuning instruments. The manual is written in easy to understand English and takes you step-by-step through each track of the CD and explains its purpose. The Ultimate Test CD is a necessary tool for anyone who is serious about quality audio sound.
#EN-510-100 .... $7.95 EACH

Ungar UTC SS

The Ungar UTC SS is an economical dual wattage soldering station for use in the home, shop or at work. Dual temperature capability makes it ideal for surface mount components. Station includes an iron holder, and tip protects electronic components from static discharge. UL listed. Net weight: 2 lbs.
#EN-372-060 .... $59.80 EACH

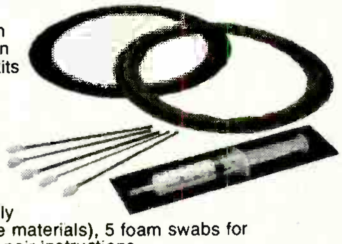
3 In 1 Universal Remote

This remote will operate any remote controlled cable box, TV or VCR at just a fraction of the cost of a factory replacement! This unit is already preprogrammed to include the most common codes. It is attractively styled, durable, and easy to set up and operate. The manufacturer even offers a toll free consumer help line to answer questions and provide customer assistance. Requires 2 AAA batteries (not included).
#EN-180-565 .. $12.50 (1-9) . $9.95 (10-UP)

Designing, Building, And Testing Your Own Speaker System

Completely revised and updated to reflect the latest trends in audio technology, this edition of David B. Weems' best-seller will guide do-it-yourselfers through the building and testing of low-cost speaker systems that rival the most expensive units on the market. 224 pages. Copyright: 1990. Third edition. Net weight: 1 lb.
#EN-500-021 .... $16.95 EACH

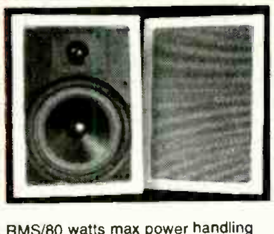
Speaker Surround Repair Kits



Don't throw away expensive loudspeakers just because the foam surround has dry rotted, or has been punctured. With these new repair kits from Parts Express, you can save BIG bucks by repairing the foam surround and avoid costly loudspeaker replacements. The kit includes 2 pair foam surrounds (except for the 15" kit which includes one pair), a plastic syringe filled with 25cc of adhesive (specially formulated for various speaker cone materials), 5 foam swabs for application of glue, and complete repair instructions.

Part #	Size	Price (1-3)	Price (4-UP)
EN-260-920	8" kit	$19.95	$17.95
EN-260-925	10" kit	20.50	18.50
EN-260-930	12" kit	21.90	19.90
EN-260-935	15" kit	22.90	20.90

6-1/2" Two-Way System



The basis of all architectural audio systems. This is our most popular in-wall. The perfect system for main and/or surround speakers. Easily installed in any 2 x 4 or larger wall. Retrofit design allows installation in new or existing walls in minutes. Features high quality crossovers and premium drivers that can outperform the name brands. **Specifications**: 6-1/2" poly woofer with a 10 oz. magnet, 1" field replaceable soft dome tweeter. Integral 2-way crossover with pushbutton wire terminal. 8 ohm impedance. Frequency response: 40-20,000 Hz. 40 watts RMS/80 watts max power handling capability. Sensitivity: 90 dB 1W/1m. Dimensions: 8-1/2" (W) x 12" (L) x 3-1/2" (D). Net weight: 9 lbs. per pair.
#EN-300-036 .... $249.95 (SUG. LIST) ..... $124.90 (1-3 PRS) .... $112.95 (4 PRS-UP)

Kester "44" Solder

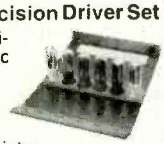
Kester "44" rosin core solder is designed for electronic and electrical work. It uses a fast acting, instant wetting, non-corrosive, and non-conductive flux for faster soldering and a strong, long lasting bond.

Part #	Alloy Lead/Tin	Spool	Dia.	Price (1-3)	Price (4-UP)
EN-370-080	60/40	1 lb.	.031"	$10.95	$9.95
EN-370-090	60/40	1 lb.	.050"	10.95	9.95
EN-370-098	60/40	4 lb.	.031"	43.80	39.50
EN-370-072	63/37	1 lb.	.020"	13.60	12.25
EN-370-074	63/37	1 lb.	.031"	11.50	10.50

Magnetizer/Demagnetizer

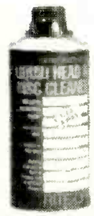
Handy device to magnetize (or demagnetize) screwdrivers, tweezers, and various other tools.
#EN-360-700 .. $9.90 (1-9) $8.90 (10-UP)

36 Piece Precision Driver Set



Contains 6 individual kits. Eac Moody kit contains locking, chuck type, knurled steel handles and 5 interchangeable ends. The set includes: Slotted Screwdriver Kit (.040", .055", .070", .080", and .100" slotted blades), Cross Driver & Awl Kit (1 awl plus, .055"/1.4mm/#000, .080"/2.0mm/#00, .100"/2.5mm/#0, and .125"/3.2mm/#1 cross recess blades), Hex Driver Kit (.035", .050", .062", .078", and .093" hex blades), Torx® Driver Kit (T-6, T-7, T-8, T-9, and T-10 Torx blades), Socket Wrench/Nut Driver Kit (5/64", 3/32", 7/64", 1/8", and 5/32" socket wrenches), and Open End Wrench Kit (7/64", 1/8", 5/32", 3/16", and 1/4" open end wrenches). Includes black leatherette case.
#EN-361-215 $65.90 (1-3) $59.90 (4-UP)

Head/Disc Cleaner

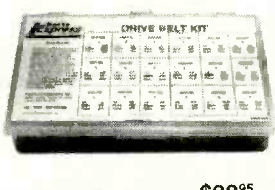


Head and Disc Cleaner is a CFC free cleaner which will remove carbon deposits, metallic oxides, dirt, dust and other contaminants from magnetic heads. Non-flammable Head and Disc Cleaner has superior cleaning properties compared to freon blends and is safe on most plastics. HCFC blend. 6 oz. liquid.
#EN-341-075 .... $3.80 (1-11) .... $3.40 (12-23) $3.25 (24-UP)

12V, 15 Ah Battery

Save big on this rechargeable lead acid battery. Has many uses: computer back-up upgrade, alarm back-up battery, garden tractor starter battery, and more. Sealed in a high impact polystyrene case. Bolt and nut type terminals. Dark blue color. Dimensions: 7"W x 6-1/2"H x 2-15/16"D. Net weight: 14 lbs. Limited availability.
#EN-149-100 .... Compare to $60.00 .... $29.95 (1-4) $24.95 (5-UP)

Drive Belt Kit



We've selected 18 of our most popular VCR, cassette and turntable belts to include in this kit. 87 belts total, five each of 17 square belts from 2.3" to 13.2" for VCRs and cassettes, and 2 each of the 23.6" turntable belt. Have the belt you need in stock when you need it. A $50.00 value. Net weight: 1/4 lb.
#EN-400-910 .... $29.95 KIT

Chamois Swabs

Genuine sheepskin swabs for cleaning delicate video and audio heads. Chamois leaves no residue. 10 pieces per package. Reusable.
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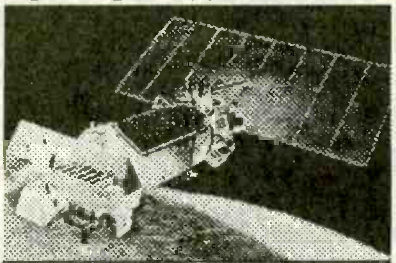

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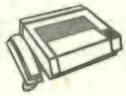

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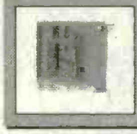

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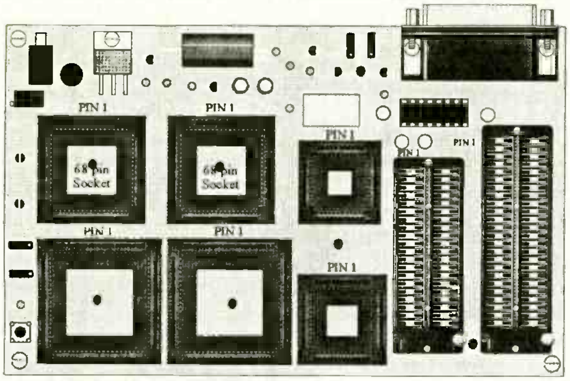
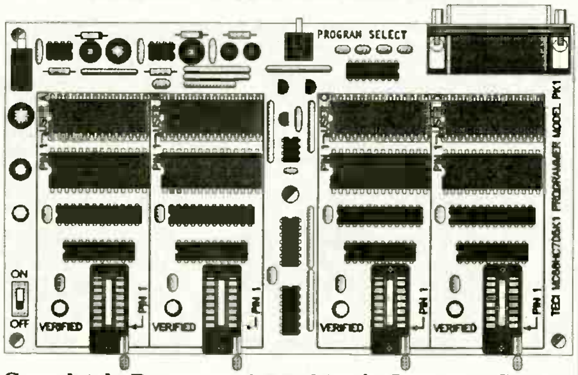
MC68HCx11 PROGRAMMER



Connects to an IBM PC serial port and provides the fastest, easiest way to read, modify, program & verify the eeprom/eprom memory and config. register of 68HCx11xx microcontrollers. Prices from $349.00 for Programmer & host PC S/W.

MC68HC705K1 GANG PROGRAMMER



Completely Programs 4 K1 chips in 5 seconds.Stands alone for production. Connects to a PC serial port for program development.

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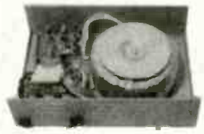
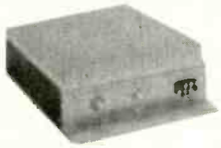
DUAL 24 VCT 8 AMP TORROID



TORROID TRANSFORMER ASSEMBLY from battery charger; has 2.3"H x 4.4" dia torroid transformer with dual 24 VCT 8 amp windings, "as-is" pulse charge PC board and lower half of case. Nice basis for power supply! 6 lbs sh.
#BC-24V-ASSY **$24**

500 WATT DC to DC INVERTER



12.6 VDC to 120 VAC 60 Hz INVERTER, rated 500 watts continuous; 1000 W surge. Output is squarewave with zero-crossing. Has studs for input and terminal strip for output; 3.6x9.1x13.6, 17 lbs sh **##RC-12500, NEW** **$149.50**

#RC-12200 INVERTER, 12 VDC to 115 V 60 Hz 200 W cont., 600 W surge; had 3-conductor outlets. 3x7.5x4.8, 7 lbs. **NEW** .... ~~$130.00~~ **$85.**

SOLDERING KIT

WELLER SOLDER/DESOLDER STATION with TCP-24G 48 W pencil iron, eight solder tips from 3/64" to 1/8" wide, 600° or 700°F; six desolder tips with orifices .038" to .090"; and 2.5"Hx13"Wx4"D steel carrying case. Requires 115 VAC 60 Hz; 7 lbs sh. **WELLER #WTCPK, UNUSED** ...**$69.50**

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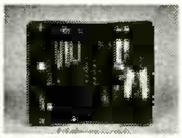

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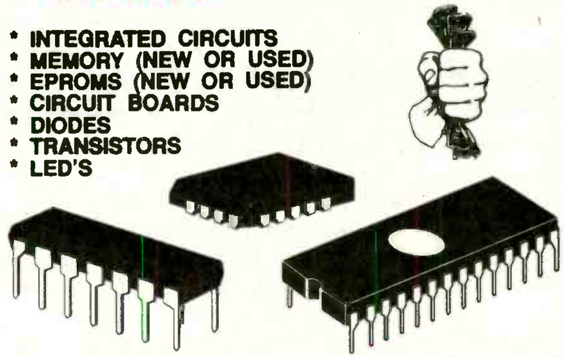

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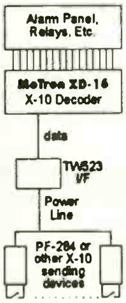
NEW! XD-16 X-10 Decoder



A Typical XD-16 Configuration

The XD-16, when connected to a TW523 Power line data interface module, decodes all 256 X-10 codes sent by PF284, or similar, X-10 senders. The house code is DIP switch selectable. The 16 open- collector outputs are turned on or off as unit and command codes are decoded. Use the XD-16 as an Alarm Panel Interface and save hundreds of dollars in cable installation costs! Or drive relays, LEDs, etc. in custom alarm or house control applications. Requires TW523 data interface. The XD-16 is a 3X3 inch circuit board. Requires 9 to 18 VDC @ 25ma.

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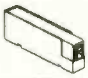

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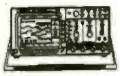

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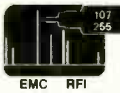

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TYPE or PRINT your classified ad copy CLEARLY (not in all capitals) using the form below. If you wish to place more than one ad, use a separate sheet for the additional ads (a photocopy of this form works well). Choose a category from the list below and write that category number into the space at the top of the order form. If you do not specify a category, we will place your ad under Miscellaneous or whatever section we deem most appropriate.

We cannot bill for classified ads. Payment in full must accompany your order. We do permit repeat ad or multiple ads in the same issue, but in all cases, full payment must accompany your order.

WHAT WE DO

The first two words of each ad are set in bold caps at no extra charge. No special positioning, centering, dots, extra space, etc. can be accommodated.

RATES

Our classified ad rate is $1.25 per word. Minimum charge is $18.75 per ad per insertion (15 words). Any words that you want set in bold or caps are 20¢ each extra. Bold caps are 40¢ each extra. Indicate bold words by underlining. Words normally written in all caps and accepted abbreviations are not charged as all-caps words. State abbreviations must be Post Office 2-letter abbreviations. A phone number is one word.

CONTENT

All classified advertising in the **Electronic Shopper** is limited to electronics items only. All ads are subject to the publisher's approval. We reserve the right to reject or edit all ads.

DEADLINES

Ads received by our closing date will run in the next issue. For example, ads received by April 1 will appear in the July, 1993 issue that is on sale in June 3. Shopper ads will appear Jan., Mar., May etc. No cancellations permitted after the closing date. No copy changes can be made after we have typeset your ad. NO REFUNDS, advertising credit only. No phone orders.

AD RATES: $1.25 per word, Minimum $18.75.

Send your ads with payment to:
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160 — Business Opportunities
190 — Cable TV
210 — CB-Scanners
240 — Components
270 — Computer Equipment Wanted
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330 — Computer Software
360 — Education
390 — FAX
420 — Ham Gear For Sale
450 — Ham Gear Wanted
480 — Miscellaneous Electronics For Sale
510 — Miscellaneous Electronics Wanted
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570 — Plans-Kits-Schematics
600 — Publications
630 — Repairs-Services
660 — Satellite Equipment
690 — Security
710 — Telephone
720 — Test Equipment

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13 - $18.75	14 - $18.75	15 - $18.75	16 - $20.00
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29 - $36.25	30 - $37.50	31 - $38.75	32 - $40.00
33 - $41.25	34 - $42.50	35 - $43.75	36 - $45.00
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Total classified ad Payment $ ________ enclosed.

[ ] Check [ ] MasterCharge [ ] Visa ($18.75 minimum credit card order)

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Expiration Date __ __ / __ __
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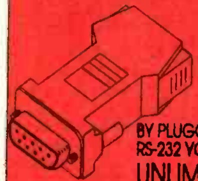

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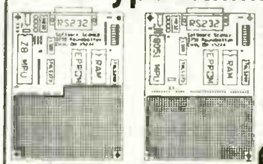

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RC3120C

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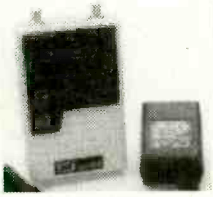

INPUT	FC1000	FC2700
Frequency Range	A Range—10Hz-20MHz B Range—20MHz-1.2GHz	A Range—10Hz-20MHz B Range—20MHz
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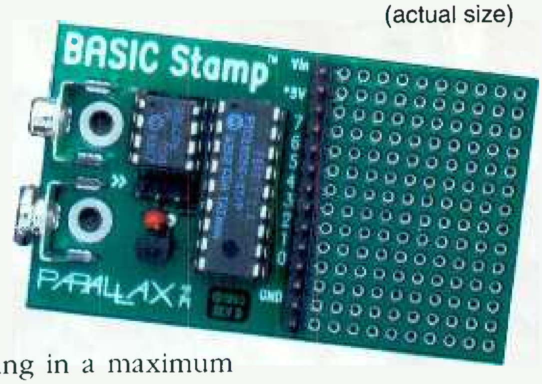
BASIC STAMP™

Stamp-Sized Computer Runs BASIC

(actual size)

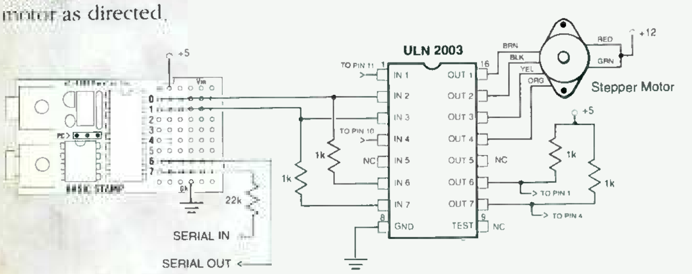


The BASIC Stamp is a small single-board computer that runs BASIC programs. It has 8 I/O lines, which can be used for a variety of digital and analog purposes. The Stamp's BASIC language includes familiar instructions, such as GOTO, FOR...NEXT, and IF...THEN, as well as SBC instructions, such as SERIN, PWM, and BUTTON. Each instruction takes 2-3 bytes of the Stamp's 256-byte EEPROM, resulting in a maximum program size of 80-100 instructions. Programs execute at about 2,000 instructions per second.

The BASIC Stamp Programming Package contains everything you need to program Stamps using your PC. The package includes our editor software, programming cable, manual, application notes, and free technical support. The package is available for $99; Stamps are sold separately for $39.

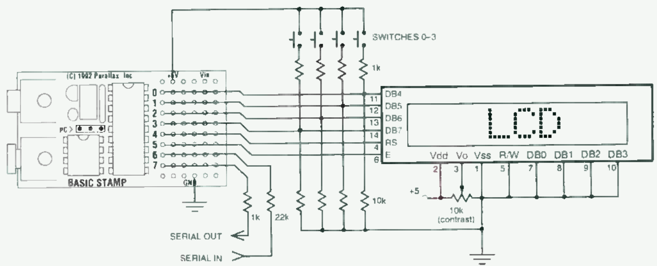
Stepper Motor Controller

This circuit makes the Stamp into a remote stepper motor controller. Using serial communications, the Stamp sends out a request for number of steps and delay between each. When it receives the data, the Stamp steps the motor as directed.



Micro-Terminal

In this application, the Stamp receives serial data and displays it on the LCD. The state of the four buttons is then transmitted serially.



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	MAR-1 0.99	MAR-2 1.35	MAR-3 1.45	MAR-4 1.55	MAR-6 1.29	MAR-7 1.75	MAR-8 1.70	
Freq.MHz,DC to	1000	2000	2000	1000	2000	2000	1000	1000
Gain, dB at 100MHz	18.5	12.5	12.5	8.3	20	13.5	32.5	12.7
Output Pwr. +dBm	1.5	4.5	10.0	12.5	2.0	5.5	12.5	17.5
NF, dB	5.5	6.5	6.0	6.5	3.0	5.0	3.3	3.6

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designer's kit, KH-1 available only \$59.95 includes:
40 AMPLIFIERS* 10 MAR-1, 10 MAR-3, 10 MAR-4, 10 MAR-8
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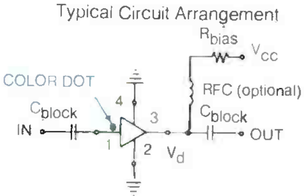
*values or models may be substituted without notice, depending on supplies

Typical Circuit Arrangement



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